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Sandfields Young Business Centre, Port Talbot Proposed Commercial Development Exploratory Geotechnical and Geo-environmental Investigation

Report Reference: ESP.9222.4325-03

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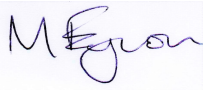
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Sandfields Young Business Centre, Port Talbot Proposed Commercial Development Exploratory Geotechnical and Geo-environmental Investigation

Prepared for:
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Report Reference: **ESP.9222.4325**

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Signature:					
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General Notes

General Construction Advice

Executive Summary

Neath Port Talbot Council is considering a commercial development at Sandfields Young Business Centre. 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. (Section 2.1)	-	The site is currently occupied by a car park associated with the adjacent business park.
	Identified Ground Conditions. (Section 5.1)	-	The investigation has indicated the site is underlain by Made Ground, comprising slag-type material, over Blown Sands to approximately 30m. A peat band was encountered at the base of the Blown Sands.
	Groundwater Conditions. (Section 5.2)	-	The site is underlain by a Secondary A Aquifer. Groundwater is anticipated within the superficial deposits between 4.5 and 6.5m depth.
	Historical Land Use. (Section 2.2)	-	The site was previously occupied within a wider caravan park. The wider area is historically industrial.
Geo-environmental	Potential Contamination Sources (Section 3.1.2)	High/ Moderate	Whilst the site has been largely undeveloped, it is now used as a car park. The wider area is industrial, with former chemical works and tanks adjacent to the site.
	Chronic Risks to Human Health (Section 7.1)	Low/ Moderate	Laboratory testing has indicated generally low levels of contamination, and not positive results for asbestos. Measurable levels of combined hydrocarbon contamination was identified and localised pollutant mitigation measures are likely required in areas of soft landscaping.
	Risks to Controlled Waters (Section 7.2)	Low	Given the site setting, generally low levels of contamination have been identified. Depending on the final adopted foundation solution, further assessment may be warranted.
	Hazardous Ground Gas (Section 7.3)	Low	Potential sources of hazardous ground gas included peat, possible hydrocarbon contamination and Made Ground. Monitoring has recorded low levels of hazardous ground gas, and no evidence of hydrocarbon contamination was identified in the investigation points.
Geotechnical	Abandoned Mine Workings and/or Old Mine Entries (Section 2.10.1)	Low	Site is underlain by Coal Measures bedrock, however the risks associated with historic mining is considered to be low.
	Weak/Compressible Ground, requiring non-traditional foundations (Section 8.3 and Section 8.4)	High/ Moderate	Traditional shallow foundations are not considered suitable for the proposed development due to potentially soft compressible material. Ground improvement measures, or deeper foundations are likely to be required.
	Shrinkage or Swelling (Section 8.2.2)	Low	The soils at probably foundation depth are generally coarse grained.
	Sulphate Attack on Buried Concrete (Section 7.4.2)	High/ Moderate	Laboratory testing has indicated that the Made Ground strata is classed as AC-3 in terms of sulphate attack on buried concrete, likely due to the presence of slag. Further assessment is recommended.
	Soakaway Feasibility (Section 8.8)	-	Soakaway infiltration testing is likely to be suitable for the development.
	Other Hazards (Section 8.2.3)	Low	The potential for volumetric slag expansion is considered to be low however, will require consideration as part of detailed foundation design.
Others	UXO (Section 2.10.9)	-	A specialist preliminary assessment has concluded that 'a detailed desk study, whilst always prudent, is not considered essential in this instance'.
	Flooding (Section 2.6)	Low	Overall low risk of flooding at the site.
	Invasive Plants (Section 8.1.2)	-	None identified.
	Materials Re-use/Disposal (Section 7.5)	-	Further assessment required with regards to materials disposal, see Section 7.5 and supplementary report (ESP.9222.4379).
	Further Investigation Required?	Yes	See Section 9.

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

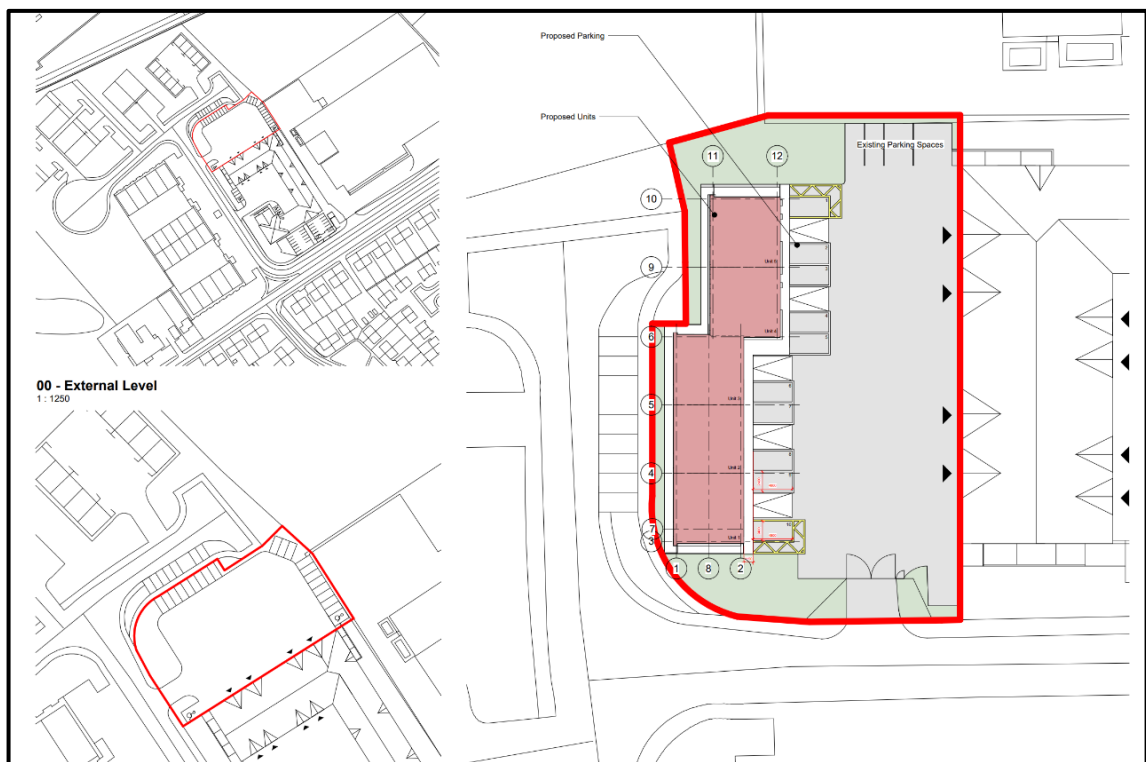
Neath Port Talbot Council (hereafter known as the Client) are proposing to redevelop the subject site for commercial purposes. The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by the Client to undertake an integrated geotechnical and geo-environmental investigation and 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.

The proposed development will comprise a single-storey commercial building housing multiple business units, designed with a layout similar to that of the existing Sandfields Young Business Centre immediately south. Additionally, the project will include external areas for parking, hardstanding, and with limited soft landscaping. Some existing parking spaces within the vicinity of the development will also be repurposed for designated areas.

It is understood that there will be no significant changes to the current ground levels.

The proposed development layout is presented as Insert 1.

It is understood that the proposed structures would be classified as Geotechnical Category 2 (BS5930:2020).



Insert 1: Extract from proposed development plan, provided by the Client

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 reference to the potential impact on the proposed development.

ESP are not aware of any ground hazard related planning conditions relating to the development.

The scope of works for the investigation was 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, the supervision and direction of cable percussion boreholes, windowless sample boreholes, trial pits, soakaway infiltration testing, geotechnical and geo-environmental laboratory testing, gas monitoring, groundwater monitoring and sampling, and a full assessment/report.

The contract was awarded based on a competitive tender quotation. The terms of reference for the assessment are as laid down in the Earth Science Partnership proposal of 14th February 2025 (ref: HD/ESP.9222.It1).

The investigation and assessment was undertaken in March and July 2025.

ESP were subsequently instructed to undertake a WM3 and WAC Assessment (ref.ESP.9222.4379-01), which has been reported separately and summarised within this report. For ease, the assessment is displayed as Appendix Q.

1.3 Report Format

This report includes the desk study and field reconnaissance reports (Section 2), and details of the investigation undertaken of Eurocode EC7 and BS5930:2020 (Section 4), along with the Preliminary Risk Assessment stage (Section 3) and Generic Quantitative Risk Assessment (Section 5) of the land contamination risk management (LCRM) guidelines. A preliminary evaluation of the resulting contamination risks and any remedial measures potentially required is included in Sections 6 and 7. It should be appreciated that this is a preliminary evaluation and will not generally meet the requirements of the LCRM guidelines.

A preliminary geotechnical risk register, based on the desk study review, is presented as Section 2.9, with a full assessment of the geotechnical conditions using the findings of the investigation and assessment in Section 8. This complies the relevant elements of the Geotechnical Design Report of BS EN 1997-2 (Eurocode 7) and BS5930:2020. The report concludes with a summary of any further surveys/ investigations/ assessments recommended (Section 9).

The contamination assessment relative 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. 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 in this section was obtained from desk-based research of sources detailed in the text, including historical maps, a combined environmental and geological data report, information on a previous investigation at the site, and a mining consultant's report obtained from the Mining Remediation Authority. Further records and data are included as subsequent appendices as referenced in the text.

2.1 Site Location and Description

The site consists of a parcel of land designated as a car park, directly associated and within the northern area of Sandfields Young Business Centre. The National Grid Reference of the centre of the site is SS 273269 191171 and the postcode is SA12 7PT. A Site Location Plan is presented as Insert 2 below.



Insert 2: Site Location Plan from Ordnance Survey 1:25,000 scale map
Reproduced with permission (OS License No.: AL100015788).

The site comprises a roughly rectangular shaped parcel of land of around 60m length (east to west) and 40m width (north to south), occupying an area of around 0.23ha. The site is currently utilised as a car park, serving the Sandfields Young Business Centre. A bike shed is present in the northern portion of the site. The boundaries to the north, east and west comprise palisade fencing, with buildings forming the southern boundary.

It is bounded by:

- To the north: Endeavour Close.
- To the east: Macmillan Distribution (industrial building).
- To the south: Sandfields Young Business Centre.
- To the west: Endeavour Close.

Vehicular access to the site is currently gained via a small access road from the southwest/west into the car park.

ESP has not been made aware of any tree survey being conducted. As no established trees were observed on site, which consists solely of tarmac hardstanding and soft grass landscaping, it is unlikely that a tree survey will be required before development proceeds.

The general topography in the wider area is relatively flat, with recent Ordnance Survey maps indicating a spot height of 12m OD in the surrounding area.

A topographic survey provided by the Client (ref. 25-0249), indicates that the site gently slopes from approximately 11.4m AOD in the northwest to approximately 10.7m AOD in southeast. In the north east site corner, a grass bank steeply slopes to the north east, from 11.1m AOD to 10.5mAOD.

As part of this assessment, service plans have been obtained by ESP from the utility companies.

Site observations and the utility plans indicate that the site is crossed by the following services:

- Electricity cables (low voltage) immediately adjacent to the western boundary and to the north on Endeavour Close.
- Gas main (low pressure) immediately adjacent to the western boundary and to the north on Endeavour Close.
- Private drainage crossing central and eastern extent of the site car park (provided by the Client).

Service plans are appended in Appendix C. Private services are present on site due to previous site history (Section 2.0) that do not appear on the above public records, as identified during the site investigation work and associated service clearance. It is recommended that a site wide PAS128 utilities survey is undertaken at the site.

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 are summarised in the table below.

Table 1: Review of Historical Maps

Date	On-Site	In Vicinity of Site
1880 - 1899	The site is undeveloped and shown denoting sand dunes/open sand areas called Baglan Burrows.	The surrounding area is mostly undeveloped and shown denoting sand dunes/open sand areas called Baglan Burrows. Baglan Bay sea is recorded approximately 60m to the west.
1918 - 1948	No significant changes recorded on site.	A marsh is recorded approximately 200m to the southeast. The sand dunes appear to be larger. Otherwise, the surrounding area remains mostly unchanged.
1947-1948	No significant changes recorded on site.	The surrounding area remains mostly unchanged
1965-1966	The site is shown as parcel of land within the grounds of Bayview Caravan Site.	Significant development is recorded in the surrounding area. The site is within Bay View Caravan Site, which expands approximately 100m from east to west. A Chemical Works is recorded approximately 100m to the north/northwest, with associated works buildings and tanks. The closest remaining sand dunes in the surrounding area are approximately 80m to the west.
1985-1987	The site is no longer recorded as grounds with Bay View Caravan Site. The site is now recorded as open land within an industrial estate. Endeavour Close is recorded along the eastern and northern boundary of the site.	Bay View Caravan Site is no longer recorded. The Chemical Works to the north have expanded further, with additional works buildings and tanks recorded. A warehouse is recorded approximately 5-10m to the east/southeast. Industrial units, denoted as 'Factories', are recorded approximately 30m and 40m to the west and north, respectively. An electric substation is recorded approximately 75m to the southeast. Endeavour Close is recorded along the eastern and northern boundary of the site.
1994 - 2001	No significant changes recorded on site.	The industrial units denoted as 'Factories' have expanded, with buildings recorded approximately 50m and 90m to the northwest. Tanks and Works buildings recorded within the Chemical Works are no longer recorded, with only a carpark remaining – the Chemical Works appears to have been demolished and is now disused.
2003	No significant changes recorded on site.	Sandfields Young Business Centre is recorded approximately 60m to the south/southeast. Otherwise, the surrounding area remains mostly unchanged
2010	The site now appears to be within the grounds of Sandfields Young Business Centre, utilised as a carpark and therefore hardstanding.	Sandfields Young Business Centre has expanded and is now recorded immediately adjacent to the south of the site.
2025	No significant changes recorded on site.	The former Chemical Works carpark is no longer recorded. Otherwise, the surrounding area remains mostly unchanged
Notes: 1. Historical maps presented in Appendix B. 2. Features may have been present on site before or between the dates of the mapping that may not have been identified.		

2.2.2 Other Sources

The NRW Data Map for Wales (historic landfill layer) does not indicate the site or immediate area to be designated as a historic landfill.

No further relevant information on the site history has been identified as part of this assessment.

2.3 Previous Investigations and Assessments

ESP are not aware of any previous geotechnical or geo-environmental investigations or assessments at the site.

2.4 Contact with Regulatory Bodies & Local Information Sources

At the time of issue of this report, ESP 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

No surface water features are recorded within, or within 250m, of the site. The nearest major surface water feature to the site is the sea (Baglan Bay/Aberavon Beach), some 300m west.

The site falls under the designation of a Water Framework Directive (WFD) surface water body catchment area, specifically within the management catchment of Tawe to Cadoxton. Its water body ID is 331, and it is classified as a coastal catchment area.

2.5.2 Surface Water Abstractions

The 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 topographical plans and flooding maps presented in the data report and on the Natural Resources Wales (NRW, 2025) the site is located in Flood Zone 1 and not indicated to be at risk flooding from rivers (fluvial) or seas (tidal).

The Data Report (Appendix B) identifies a single historical flood event within 250m of the site. This incident took place on 2nd of May 2008, approximately 233m to the southwest of the site. The flood was classified as a tidal coastal flood, with the source being from the sea. No additional details about the event are provided in the report.

2.6.2 Surface Water

From a review of the data report (Appendix B), the majority site is indicated to be outside areas at risk of surface water flooding and is described at Negligible Risk (defined as very low risk by NRW).

However, according to the data report, a small area in the northwest/north of the site is indicated to be at risk of a 1 in 1000 year, 0.1m - 0.3m, surface water flood which equates to a low risk.

The highest surface water flooding risk within 50m of the site is indicated to be 1 in 30 year, 0.3m - 1.0m, which equates to a high risk.

2.6.3 Groundwater

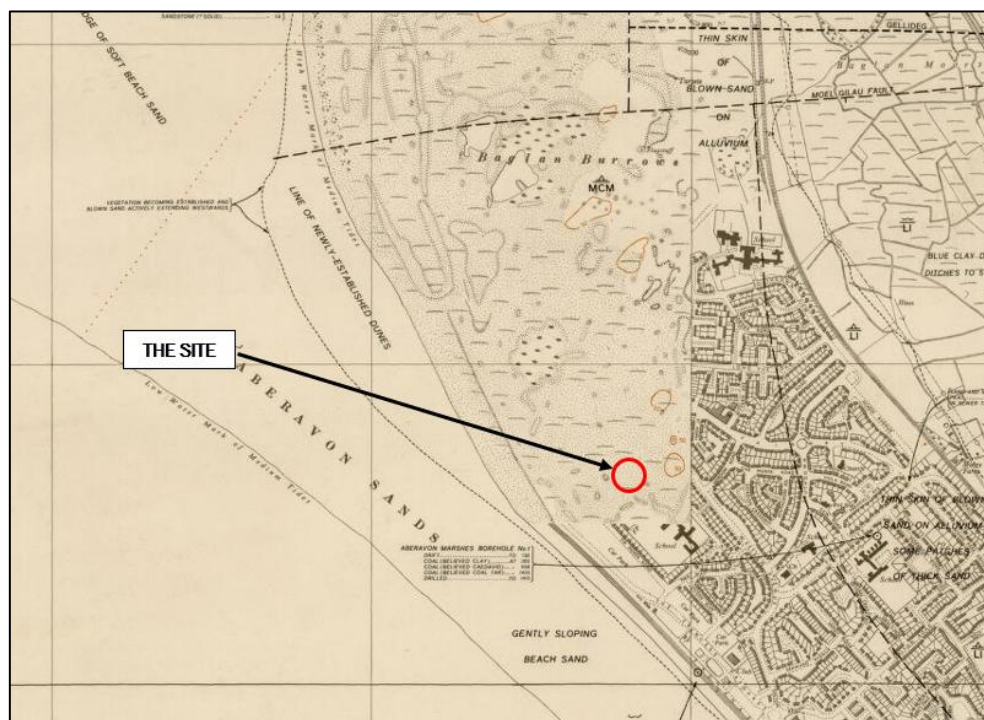
The data report in Appendix B indicates that the site is at a potential low risk at surface from groundwater flooding. This risk assessment is based on a 1 in 100 year return period.

2.7 Geology

2.7.1 Published Geology

The published 1:10,560 scale geological map for the area of the site (Sheet SS79SW, available on the website of the British Geological Survey, 2025 and presented as Insert 3) indicates the site to be underlain by Blown Sand overlying bedrock of the South Wales Middle Coal Measures.

Reference to the up-to-date mapping available on the website of the British Geological Survey (BGS, 2025) indicates a similar succession.



Insert 3 - Extract from BGS Geological Map Sheet SS79NW, original 1:10,560 scale.
Reproduced with permission (BGS licence number: C15/05 CSL)

The Blown Sand superficial strata are expected to be coarse grained in nature, comprising almost entirely of fine to coarse sand, possibly with occasional gravels and shell fragments. The South Wales Middle Coal Measures comprise 'grey (productive) coal-bearing mudstones/siltstones, with seatearths and minor sandstones'.

Based on the historical maps and BGS Borehole information (Section 2.7.2), Made Ground is likely to be present across the site, likely consisting of tarmac, concrete, sub-base material, slag-like material, and construction debris.

Strata dip and strike readings are absent within, and within 1km, of the site. The local area records one major fault within 250m of the site, called the Moel Gilau Fault, which is approximately 240m to the north, trending east to west and down-throwing to the south.

No coal outcrops are recorded on, or within 250m, of the site. The 1:10,560 geological map indicates coal within the succession of the South Wales Coal Measures. However, it is highly likely that these coal seams are located at significant depths, given the anticipated presence of thick superficial deposits—likely exceeding 30.00m, as inferred from geological maps and nearby BGS boreholes (Section 2.7.2)—and the stratigraphical sequence's recorded coal depths.

2.7.2 Available BGS Borehole Records

The British Geological Survey website (BGS, 2025) indicates the available records of two boreholes within 250m of the site. Copies of the available borehole records are presented in Appendix E.

The closest borehole is approximately 180m to the northwest (SS79SW34) with a grid reference of 273100, 191300. Topsoil was encountered from ground level to 0.15m, which is overlying medium dense brown fine to medium sand from 0.15m to 18m. Thin bands of firm grey silty clay are recorded from between 14.00m to 14.20m and 15.70m to 16.00m. Groundwater was not recorded in the borehole, although it is unclear if this is because it was not encountered or if this is a reporting error.

Another BGS Borehole recorded 250m to the northeast (SS79SW15 – 273430, 191420), encountered medium dense to dense brown fine to medium sand with shell fragments from ground level to 15.00m. Underlying this is recorded to be a narrow band of soft grey silty clay and sandy silt from 15.00m to 15.50m, overlying by a layer of dense grey silty fine to medium sand from 15.50m to 21.20m. A “compact” dark grey clayey silt with peat is recorded from 21.20m to 28.00m, underlain by very dense brown peat and sandy silty gravel from 28.00m to 30.20m.

The corrected SPT values ranged from N values of 11 to 55 in the brown sand, 43 to 66 in the grey sand, and 47 to 51 in the peaty soil. Groundwater was encountered at 3.00m.

No boreholes within 250m of the site have recorded the depth to bedrock.

2.8 Hydrogeology

2.8.1 Aquifer Classification

The data report (Appendix B) indicates that the superficial deposits (Blown Sands) and the bedrock (South Wales Middle Coal Measures) beneath the site are classed as Secondary A aquifer.

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, it is considered that the shallowest main groundwater body is likely to be located within the Blown Sand strata. However, localised perched water bodies within the overlying Made Ground soils cannot be discounted.

Due to the relatively close distance to Swansea Bay, it is potentially likely that groundwater depth beneath the site is tidally influenced. There is also likely to be a main groundwater body within the underlying Coal Measures bedrock.

2.8.3 Abstractions and Groundwater Vulnerability

The data report (Appendix B) indicates that there are no groundwater abstractions or Source Protection Zones within 500m of the site.

2.8.4 Groundwater Movement

Groundwater movement in both the Blown Sand and bedrock is likely to flow towards the west (down gradient and towards Swansea Bay), with groundwater flow in the Blown Sands controlled by intergranular flow. In the bedrock, fracture flow is likely to be dominant.

In former mining areas, groundwater conditions may still be changing in response to the cessation or reduction in pumping from underground coal workings. As discussed in Section 2.7.1, major faulting is shown in the area, which can cause preferential flow paths for groundwater. There is also potential for the groundwater depth to be tidally influenced beneath the site.

2.9 Environmental Setting

2.9.1 Summary of Environmental Data

The site exists in a historically industrial area (Chemical Works and Industrial/Factory Units) and historical mapping indicates that the site has been utilised within a caravan site and as a carpark.

A data report has been obtained for the site and is presented in Appendix B, and the relevant data therein is summarised in the table below. The report should be consulted for further detail.

Table 2 - Summary of Environmental Data

Feature	On the Site	In the Immediate Vicinity
Potentially Contaminative Land Use	4no. recorded on site	19no. recorded within 250m.
Historical Tanks, PFS, Garages, Energy Facilities	None identified.	20no recorded within 250m, with the closest being 3no. tanks located within 15m of the site to the east.
Waste and Landfill and Potentially Infilled Land	None identified.	None recorded within 1km of the site.
Current and Recent Industrial/ Commercial Sites	None identified – see below.	18no. recorded within 250m of the site.
Contaminated Land under Part 2A EPA 1990.	None identified.	None recorded within 500m of the site.
Licensed Industrial Activities/Pollutant Release (IPC, Part A (1), Part A (2)/B)	None identified.	None recorded within 500m of the site.
Radioactive and Hazardous Substance Sites	None identified for radioactive substances. 1No. Control of Major Accident Hazards (COMAH) is recorded on site .	No radioactive substances within 500m of the site. 1No. Hazardous substance storage/usage is recorded 89m to the east. 1No. Control of Major Accident Hazards (COMAH) is recorded 97m to the north of the site.
Discharge Consents	None identified.	2no. discharge consents recorded 183m to the northwest.
List 1 and 2 Dangerous Substances Sites	None identified.	None recorded within 250m of the site.
Pollution Incidents	None identified.	3No. within 250m of the site.
Environmentally Sensitive Sites ^{2,3}	None identified.	None recorded within 500m of the site.
Waste Exemptions	None identified.	2No. within 500m of the site.
Notes: 1. Full details of features presented in the data report Appendix B 2. Sensitive land uses include Sites of Special Scientific Interest, Nature Reserves, National Parks, Special Areas of Conservation, Special Protection Areas, Ramsar sites, World Heritage sites and Ancient Woodland. 3. Nitrate vulnerable areas relate to the agricultural use of fertilizers and are not considered further in this assessment.		

2.9.2 Further Discussion on Salient Environmental Features

Potentially Contaminative Land

The site was part of a caravan park and was surrounded by industrial and factory units between 1965 and 1985. Approximately 100m north of the site was a historical chemical works, which operated until its demolition in 1994. The chemical works were associated with significant industrial activities, including works buildings, storage tanks, and a historical Control of Major Accident Hazards (COMAH) concern. While the chemical works site is now vacant land, the factory and industrial units remain in operation today.

Since at least 2003, the site has been utilised as a hardstanding car parking area for the Sandfields Young Business Centre.

An electric substation is also recorded 74m to the southeast of the site, recorded in 1988 according to the historical maps.

Historical Tanks

4no. historical tanks have been recorded 15m south east of the site, specifically within the grounds of the Industrial Unit (Macmillan Distribution) to the east. The available data report and historical map interpretations provide no further details regarding the specific storage contents of these tanks. These tanks were present in the area between 1985 and 1994.

Additionally, records indicate that 14no. historical tanks were situated within the former Chemical Works (BP Oils Ltd), approximately 100m north of the site. These tanks were in place during the operational years of the BP Chemical Works (from at least 1966 to 1994) and were likely used for storing liquids, oils, and/or chemicals. Further assessment of this is provided in Section 2.9.3.

Pollution Incidents

There are 3no. recorded pollution incidents within 250m of the site. The closest occurred in March 2015, approximately 201m to the south, where crude sewage was identified as the pollutant source. The incident resulted in a minor impact on air, while land and water impacts were recorded as 'no impact' and not recorded entirely, respectively. No other information is provided in the data report.

In September 2001, a pollution incident involving 'contaminated water' was recorded approximately 213m to the southwest. It had a minor impact on water, with no impact on land or air, according to the data report. No other information is provided in the data report.

Hazardous Substance Storage/Usage

There is 1no. recorded hazardous substance storage site located approximately 89m to the east. An application under the Hazardous Substances Regulations (1992) was submitted in October 2011 for the storage of highly flammable and extremely flammable substances (hairspray). No other information is provided in the data report.

Due to the significant distance from site, this is not considered a hazard to the proposed development and is not considered further in this report.

Waste Exemptions

2no. waste exemptions are recorded within 250m of the site, located 24m and 40m to the southwest, respectively. Both exemptions, described as "storage of waste in secure containers," are for Omega Environmental Services Limited.

2.9.3 Bulk Liquid Storage

2.9.3.1 On Site Bulk Liquid Storage

The historical maps and field reconnaissance visit have provided no evidence of any past or recent above ground or underground bulk liquid (e.g. fuels/oils) storage on site.

2.9.3.2 Off Site Bulk Liquid Storage

The historical maps and Data Report (Appendix B) indicate that approximately 100m to the north of the site was formerly developed as a Chemical Works for BP Oils Ltd. According to the data report, up to 14no. historical tanks were used. No other information relating to the tanks is provided in the data report.

2.9.4 On-Site Bulk Materials and Waste Storage

The field reconnaissance visit indicated no evidence of recent materials or waste storage on the site.

2.10 Preliminary Geotechnical Risk Register

The potential for various geotechnical and geomorphological hazards at the site is provided in the data report (Appendix B). 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.

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

2.10.1 Past Coal Mining

As discussed in Section 0, the site is underlain by bedrock of the Middle Coal Measures, which contains several seams of coal (and bands of ironstone).

2.10.1.1 Historical and Geological Information

No coal outcrops are recorded on, or within 250m, of the site. The 1:10,560 geological map indicates coal within the succession of the South Wales Coal Measures. However, it is highly likely that these coal seams are located at significant depths, given the anticipated presence of thick superficial deposits—likely exceeding 30.00m, as inferred from geological maps and nearby BGS boreholes (Section 2.7.2)—and the stratigraphical sequence's recorded coal depths.

2.10.1.2 Mining Remediation Authority Website

Reference to the Mining Remediation Authority website (MRA, 2025) provides the following salient information:

- No coal outcrops are recorded on, or within 250m, of the site.
- No past surface hazard or surface mining is identified in the vicinity of the site.
- No recorded or probable past shallow coal mining is indicated in the vicinity of the site.
- No mine entries are shown within the site boundary.
- The site does not lie within a 'Development High Risk Area'.

2.10.1.3 Mining Remediation Authority Report

A consultant's mining report has also been obtained from the Mining Remediation Authority and is presented in Appendix F. This indicates that, based on the available Mining Remediation Authority records:

- There are no recorded mine workings beneath the site.
- There are no mine recorded entries within 20m of the site.

- There are no recorded geological faults or fissures recorded beneath the site.
- There are no recorded damage notices or claims for the subject property, or any property within 50m of the site boundary, since 31st October 1994.
- There is no record of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.
- No mine gas emission has been recorded within 500m of the property.
- There is no proposed future mining or licensing proposed.
- No notices have been given under Section 46 of the Coal Mining Subsidence Act 1991 stating that the land is at risk of subsidence.
- The site located in an area of historical coal mining activity (Baglan), however it is highly unlikely that mining activity has occurred beneath the site.

2.10.1.4 Preliminary Coal Mining Risk Assessment

Given the available information, it is considered that the probability of any coal workings beneath the site is unlikely. Therefore, the risk from subsidence at the site is considered to be **Very Low**.

2.10.2 Shrinkable and Swelling Soils

The coarse grained Blown Sand soils anticipated at shallow depth beneath the site are commonly not susceptible to volume change with changes in moisture content (shrinkage and swelling).

The data report (Appendix B) states that the shrink/swelling potential of soils on site is negligible.

It is considered that the potential for shrinkable/swelling soils at the site is **very low to negligible**.

2.10.3 Disused Coal Tips

Reference to the disused coal tip location mapping data (Category C and D only) on the Welsh Government website (as of November 2023) indicates no coal tips within 1km of the site.

It is considered that the potential for unstable coal tips on/near the site is **negligible**.

2.10.4 Compressible Ground

The Made Ground soils anticipated beneath the site are potentially compressible, particularly where containing organic materials. The Blown Sand is also potentially compressible/prone to settlement if encountered to be very loose/loose in density.

Due to the potential variability of the strength and performance of the Made Ground/natural Blown Sand soils, differential settlement is possible between areas where foundations may span these strata.

BGS Boreholes record peat in the local area underlying Blown Sand deposits; these soils are highly compressive and can lead to significant settlement at the surface dependent upon depth and saturation.

The data report (Appendix B) states that the potential for compressible deposits beneath the site to be negligible.

It is considered that the potential risk for compressible ground at the site is **High**.

2.10.5 Running Sand

The Blown Sand soils anticipated at shallow depth beneath the site commonly contain a high proportion of sand-sized particles and can contain significant water bodies. Running sand could be experienced within any excavations below the anticipated shallow groundwater table.

It is considered that the potential for running sands beneath the site is **Moderate/High**.

2.10.6 Volumetrically Unstable Slag Materials

The potential for volumetrically unstable slag material to be present on the site is not considered in the data report. Some slags can be extremely unstable when hydrated, which can lead to significant heave at the surface and damage to buildings and hard surfaces.

On a former industrial site such as this, which is within close proximity to a historical Chemical Works, there is the potential for slag materials to be present within the Made Ground. If present beneath the site, we can assume that the slag is potentially Blast Furnace or Ferrous Slags from Chemical Works operations. It cannot be discounted that potential slag present beneath the site could be volumetrically unstable and the risk from such instability should be considered **High** at this desk study stage.

2.10.7 Historical Underground Structures

Historical information indicates that the site has been occupied by a caravan park and in recent history as a carpark for Sandfields Young Business Centre. No buildings or other structures were recorded on site from at least 1880 to present day.

If any structures are encountered, these will need to be grubbed up as part of the redevelopment and if extensive, this may have cost (larger machinery, backfill materials, disposal costs etc.) and time implications for the re-development.

Care should be executed to avoid damaging the underlying formation, to avoid the requirement for further deepening of the foundations beyond the disturbed ground.

2.10.8 Pyritic Ground

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

Based on a desk-based assessment, the soils underlying the site are not anticipated to contain elevated levels of pyrite, which could oxidise to sulphates. Depending on its origin, the Made Ground anticipated beneath the site may contain elevated levels of pyrite. If Made Ground containing high portions of slag-like material is encountered, the risk may be higher.

It is considered that the potential for sulphate/pyrite attack on buried concrete would be **Moderate**.

2.10.9 Unexploded Ordnance

The data report does not consider the potential risk from unexploded ordnance at the site.

A Preliminary (Pre-Desk Study) UXO Desk Study assessment of risk has been completed by a specialist Ordnance consultant in accordance with CIRIA guidelines (Stone et al, 2009) and is presented in Appendix D (Zetica, 2025).

The assessment concludes that *'a detailed desk study, whilst always prudent, is not considered essential in this instance'*.

2.10.10 Excavation Instability

Due to the coarse grained nature of the superficial materials, it is likely that spalling and collapsing of the pit walls within the Blown Sand will occur. Depending on the composition of the Made Ground, it may also be prone to spalling and collapse, particularly if encountered as a coarse soil, which is anticipated to encompass slag-like material, sub-base material, brick and concrete fragments.

Support of excavations sides is likely to be necessary for shallow excavations as part of future development. It is considered that the potential for excavation stability would be **Moderate to 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 data report (Appendix B) indicates that the site lies in a radon affected area as defined by the Health Protection Agency, with less than 1% of properties above the action level and requires no radon protection measures in new buildings (domestic or non-domestic).

The risk from radon is considered **Low**.

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 (BS EN ISO 21365, 2020). These are discussed in the following sections.

3.1.2 Potential Soil Contamination Sources

The desk study review has identified no evidence of any prior development or former contaminative use on the site. However, although no contaminative former use has been identified for the site, the surrounding area has previously been developed with heavy industry (Chemical Works and Industrial/Factory Units). It is anticipated that there could be a covering of Made Ground beneath the carpark/tarmac, which could contain elevated levels of soil contaminants.

- Made Ground – general diffuse contamination.
- Slag-like Made Ground, comprising slag-like material gravels – diffuse contamination.
- Current land use as car park – potential for hydrocarbon contamination – diffuse contamination.
- Former tanks within 15m of the site (to the east)– off site point source.
- Former chemical works 100m north of site – off site point source.

It is noted that the tanks east of the site are located down gradient of the proposed development, and potential shallow ground contamination relating to the tanks is considered to be a lower risk.

As discussed in Section 2.9.2, an electric sub station is located some 74m to the southeast. Given the distance, topography (downslope) and low likelihood that PCB fuels given the age, there is considered to be no significant risk of potential contamination associated with it.

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. The particular guidance referenced includes the Industry Profile for Oil Refineries and the Industry Profile for Chemical Works - Organic Chemicals (DoE, 1995).

Based on this guidance and our experience, 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); plus other metals as indicated (e.g. barium, boron).
- Cyanide, sulphate, sulphide.
- Polyaromatic hydrocarbon (PAH) compounds.
- Petroleum hydrocarbons, including methyl-tert-butyl-ether (MTBE).
- Phenols.
- Asbestos.

No evidence has been identified from the desk study to suggest that radioactive substances may be present on the site.

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 0.

Based on the available desk study information, the following potential sources of hazardous ground gas have been identified on, or in close vicinity of, the site:

- General Made Ground – on site source.
- Potential petroleum hydrocarbons within shallow soils/groundwater associated with car parking - on-site source
- Potential petroleum hydrocarbons within shallow soils/groundwater from historical tanks within 15m – off-site source.
- Peat – off-site and potential on site 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 very low to low gas generation potential. However, if significant evidence of hydrocarbon contamination is identified, the risk may be higher.

CL:AIRE (2021) published a decision support tool for assessing the risks from mine gas to developments. The following is considered salient (see Section 2.10.1 for more information):

- There are no mine entries within 50m of the site.
- There are no recorded mine workings beneath the site.
- No major faults are recorded within 100m of the site.
- The site lies outside an area of past or probable shallow workings on the Mining Remediation Authority website.

Based on the support tool, the site is in a negligible risk zone from mine gas.

3.1.5 Potential Receptors

The most vulnerable receptors with regards to any contamination or hazardous ground gas present are likely to be as follows.

- Future employees and site visitors at risk from soil contamination, with the critical receptors being construction workers and employees outside during their break periods.
- Future employees and site visitors at risk from ground gas, in excavations and any enclosed buildings/structures that will be present.
- General construction and maintenance workers.
- Buried concrete (foundations, drainage etc.).
- The water quality in the nearest surface water feature (Swansea Bay).
- The groundwater within the superficial or bedrock aquifers beneath the site.

3.1.6 Potential Migration Pathways

The following are considered the most likely migration pathways for 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-and-off-site sources.
- Potential risk from toxic ground gas/vapours from on-and-off-site sources.
- Potential exposure to flammable or toxic ground gas/vapours originating from off-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.
- Potential explosive risk from flammable or toxic ground gas/vapours from off-site sources.

Groundwater:

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

Swansea Bay

- Leaching of mobile contaminants to the groundwater beneath the site, and then into the nearby Swansea Bay.

Buildings:

- Sulphate attack on buried concrete (foundations, drainage etc.).
- Potential explosive risk from flammable ground gas/vapours from on-site sources.
- Potential explosive risk from flammable ground gas/vapours from off-site sources.

From the site history, the site appears to have been hard surfaced for around 15 years (at least from 2010 to present day). Over this time, no infiltration has been able to leach any mobile contaminants present from the shallow soils. Once the site is developed, and the existing hard surfacing (tarmac) removed, infiltration in areas of soft landscaping may re-commence the leaching of any mobile contaminants present.

Although areas of the site are to remain hard surfaced with existing carpark spaces utilised where possible, any soakaways constructed for the development 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 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 in Section 3.2.2 below.

3.2.2 Tabulated Preliminary Risk Evaluation & Plausible Pollutant Linkages

Table 3: 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 Made Ground soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (workers and visitors)	Medium – potential for chronic levels.	Likely ²	Moderate Risk	Sampling of Made Ground soils to confirm levels of total contamination present. Installation of groundwater wells in order to sample and test for contamination.
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Medium – standard PPE may not be sufficient	High likelihood ²	High Risk	
	Leaching of soil contaminants	Impact on Groundwater	Medium – site lies on Secondary A Aquifers	Likely ²	Moderate	
	Leaching of soil contaminants	Impact on surface water features	Medium – site lies relatively close to Swansea Bay	Likely ²	Moderate	
Asbestos in shallow soils	Inhalation of fibres	Site End Users	Medium – potential for chronic levels	Low Likelihood ³	Moderate/Low Risk	Sampling of shallow soils for asbestos.
		Construction/ Maintenance Workers		Low Likelihood ³	Moderate/Low Risk	
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	Likely ⁴	Low/Moderate Risk	Sampling of soils to confirm levels of sulphate, pH, and groundwater.
Notes: 1. Methodology and details of risk consequence, probability and category based on CIRIA C552 (2001) and presented in Section 3.2.1. 2. Although Made Ground is anticipated, the presence of contamination has yet to be confirmed on site. See Section 3.1. 3. The site remained largely undeveloped until after 2000 – see Section 2.2 4. Anticipated Made Ground can potentially contain sulphates/pyrite. – see Section 2.10.8						

Ground gasses assessed on next page...

Table 3 (continued): 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
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users/Visitors.	Severe – acute risk.	Likely ⁵	High Risk	Install and monitor gas wells.
	Damage through explosion.	Building/Property				
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.				
Notes: 5. The organic peat identified in BGS Boreholes, the historical tanks within 15m of the site, and the general anticipated Made Ground soils forms a potential source of hazardous ground gas/vapours at the site. 6. The above risk evaluation is updated following the intrusive investigation and testing in Section 6.2.						

4 Exploratory Investigation

4.1 Investigation Points

4.1.1 Introduction

The intrusive investigation was undertaken between the 23rd of February to the 13th of March 2025 in accordance with BS5930:2020 and BS10175:2017 and was designed to investigate both geo-environmental and geotechnical hazards identified in the desk study (Section 2). It comprised trial pitting, cable percussion boreholes, windowless sample boreholes, soakaway infiltration testing within trial pits, variable head permeability testing within boreholes, gas monitoring, and monitoring and sampling of groundwater.

The investigation points were supervised and logged by an engineering geologist in general accordance with BS5930:2015, BS EN ISO 14688-1 (2002), and BS EN ISO 14688-2 (2004).

The investigation point positions are shown on Figure 1.

The ground levels and coordinates of the investigation points were obtained by a GN53 GPS (Geode) on completion and are shown on the various investigation point records.

4.1.2 Investigation Strategy

The investigation strategy was generally designed in accordance with BS10175:2017 and BS5930, and evolved in response to emerging site conditions.

The desk study identified a number of potential contaminant sources/geotechnical hazards at the site including:

- Potential General Made Ground of unknown origin across the site.
- Potential Made Ground comprising possible expansive slag-like material across the site.
- Historical tanks to the east of the site.
- Potentially compressible Peat underlying anticipated Blown Sand deposits.

The investigation points were selected to maximise the information obtained on these hazards, as well as obtaining a general overview of the general ground conditions present. Cable percussive boreholes and windowless sample boreholes were recommended to be drilled on site to confirm the desk-based assessment of potential ground conditions, the contamination status in both soil and groundwater, and to install deep groundwater and shallow gas monitoring wells to implement a monitoring and sampling regime at the site.

A limited number of trial pits (2no.) were excavated in the western and northeastern portions of the site to perform soakaway infiltration testing. Due to the presence of private services—particularly sewers and high-voltage electrical lines—across the site, and especially along its eastern boundary, only two trial pits with corresponding soakaway infiltration tests could be carried out in accordance with ESP service stand-off requirements.

Investigation points along the eastern boundary of the site were significantly restricted due to private services detected and as such, limited intrusive investigation works have been completed in this area, adjacent to the historic tanks.

4.1.3 Trial Pits

2no. trial pits were excavated in the western and northeastern portion of the site on the 3rd and 12th of March 2025 for TP101 and TP102, respectively, using a tracked hydraulic excavator. The trial pits were excavated to depths of between 2.10 and 2.20m to allow for soakaway infiltration testing. TP101 was excavated within an area of existing grass-covered soft landscaping. The tarmacadam surface was broken out for TP102 prior to the excavation of the pit using a hydraulic breaker. The trial pit records are presented as Appendix I, and their positions are shown on Figure 1.

Disturbed samples were collected from the trial pits for laboratory testing as shown on the trial pit records.

On completion, the trial pits were backfilled with arisings in layers compacted with the excavator bucket. The topsoil was reinstated on the surface for TP101, and the arisings were left slightly proud of the adjacent surface to allow for future settlement. The tarmacadam surface was reinstated for TP102.

4.1.4 Cable Percussion Boreholes

4no. 150mm diameter cable percussion boreholes (CP101/CP101A, CP102, and CP103) were constructed to depths between 0.90m and 30m between the 23rd of February to the 13th of March 2025. The borehole records are presented as Appendix G, and their positions are shown on Figure 1

At the commencement of each borehole, the surface tarmacadam was broken out using a hydraulic breaker, and a service inspection pit excavated by hand to a depth of 1.2m. CP101 was terminated at 0.90m due to an obstruction, and following a CAT & Genny scan of the in-progress hand pit revealing a potential shallow service.

SPTs were undertaken at 1m intervals between 1.2m and 5m and at 1.5m intervals thereafter (see Section 4.1.6.1 for details). In addition, 100mm diameter thick wall (OS-TK/W) thin wall (OS-T/W) open tube samples were attempted to be collected from the finer-grained soils (silty sand) within the boreholes, where suitable, however with limited/no success. Further small and large plastic tub and bag disturbed samples were obtained throughout the boreholes for identification and laboratory testing purposes, as shown on the borehole records.

On completion, monitoring instrumentation was installed in the boreholes CP101A, CP102 and CP103 as detailed in Section 4.2. Below the instrumentation, the borehole was often backfilled with bentonite, for both monitoring purposes and due to the potential risk of gas migration from deep organic peat soils.

On completion, the borehole CP101 was backfilled with arisings and the tarmacadam reinstated at the surface.

4.1.5 Windowless Sampling

3no. windowless sample drillholes (WS101 to WS103) were constructed on the 3rd of March 2025, constructed to depths between 2.00m and 3.00m. The borehole records are presented as Appendix H, and their positions are shown on Figure 1.

A hydraulically powered rig was used to drive plastic lined sampling tubes into the ground, with the soil recovered within the tubes, which are then split to allow sampling and logging. Disturbed samples were obtained throughout the boreholes for identification and laboratory testing purposes,

as shown on the borehole records. SPTs were undertaken at around 1m intervals. The windowless sampling provided generally good recovery to the depth of refusal.

At the commencement of borehole WS101 and WS102, the surface tarmacadam was broken out using a hydraulic breaker and a service inspection pit excavated by hand to a depth of 1.2m.

At the commencement of borehole WS103, a square of the grass landscaping was cut and a service inspection pit excavated by hand to a depth of 1.2m.

On completion, gas monitoring instrumentation was installed in the boreholes as detailed in Section 4.2.

4.1.6 In-situ Strength Testing

4.1.6.1 Standard Penetration Tests (SPT)

Standard Penetration Tests (SPT) were carried out using a split spoon in the windowless sample and cable percussion in accordance with BS EN ISO 22476-3:2005+A1:2011 and BS5930 (2020) to assess the relative density of the coarse-grained soils encountered in the borehole and to provide a correlated assessment of the likely undrained shear strength of soils using relationships published by Stroud (1975). As required in BS5930:2020, the SPT N-values shown on the borehole records are the direct, uncorrected results obtained in the field.

Field SPT N-values may require correction before using in design. In accordance with BS EN ISO 22476-3 (2005), SPT N-values in sandy soils need to be corrected for a number of aspects such as overburden pressure, rod length and rod energy ratio in sands.

Depending on the nature of the test undertaken and the soils subjected to testing, field SPT N-values may require correction before using in design. In accordance with BS EN ISO 22476-3 (2011), SPT N-values in sandy soils need to be corrected for a number of aspects such as overburden pressure, rod length and rod energy ratio in sands.

Caution must be applied when using in-situ data collected using a solid cone (SPT-C). The solid cone has a greater surface area and, therefore, imparts a lower energy per blow than the split-spoon sampler, and can result in an over-estimation of the true SPT N-value. Based on the relationship of energy inputs at the point of penetration (Thorburn 1986), it can be inferred that the equivalent SPT N-value for a test using a cone (SPT-C) is equal to:

$$\text{SPT N-value} = \frac{\text{SPT-C}}{1.869}$$

The corrected SPT N-values (allowing for the use of a solid cone and the presence of sandy soils) are provided in Section 5.1.

4.1.7 Dynamic Cone Penetration (DCP) Testing

CBR testing using the TRL approved dynamic cone penetrometer (DCP) was undertaken at 5no positions (DCP1 to DCP05) on 19th May 2025. The testing was undertaken in areas of soft landscaping at the site. The test positions are shown on Figure 1, and test results are presented in Appendix P.

The DCP testing was undertaken from the existing ground surface with no service pit excavated. Appropriate precautions were taken during the testing to ensure the safety of ESP operatives.

The depth of penetration for varying numbers of blows is recorded and is then converted to a CBR value using well established empirical correlations (Highways Agency, 2020). In general, the tests were undertaken between the existing ground surface and 0.9m below ground level, thus providing a profile of correlated CBR values within the near-surface soils. No water was added to the soils prior to testing, so they were in their natural condition. The correlated CBR values are also shown on the test result sheets in Appendix P.

4.1.8 Soakaway Infiltration Testing

The use of Sustainable Drainage (SUDs) systems in Wales, is now regulated and implemented by Statutory Approval Bodies (SABs) within the Local Authority. All testing is required to be undertaken in strict accordance with BRE Digest 365 (2016) to gain SAB approval.

Soakaway infiltration tests were undertaken in 2no. trial pits on the site (TP101 and TP102). The results of the infiltration testing, and the calculated infiltration rates, are presented in Appendix M. The positions of the test pits are shown on Figure 1.

The test pits were excavated to depths of between 2.10m and 2.20m, which was anticipated to be a possible depth for the soakaway given the ground conditions identified and taking into account any proposed change in ground levels. Clean water was added from a large capacity bowser and the water level monitored as it percolated into the soil.

Sufficient time and water were available to repeat the test (a total of three fills) in both trial pits. Due to the high infiltration rate in the Blown Sand, it was not possible to achieve 1m head of water; the bowser was emptied before this could be achieved.

Chapter 8 barrier fencing was erected around the test pits during the testing to protect site visitors and the public. On completion of the testing in each pit, the test pit was backfilled with the excavated arisings. At location TP101, the turf was reinstated and trial pit left slightly raised to accommodate future settlement. At location TP102, the tarmacadam surface was formally reinstated.

4.1.9 In-situ Permeability Tests

Falling head permeability testing was undertaken within 2no. windowless sample boreholes (WS101 and WS102) and 1no. cable percussion borehole (CP102) at depths selected by ESP to determine the hydraulic conductivity of the soils/bedrock at that depth and due to the limited number of soakaway infiltration tests conducted on site due to private services. Borehole drilling was paused to allow for the testing to commence.

The testing was undertaken in accordance with BS5930 (2020) and BS EN ISO 22282-2 (2012). The test positions are shown on Figure 1 and the test results presented in Appendix N.

The test depths and the strata tested are presented in the table below.

Table 4: Permeability Testing Undertaken in Investigation

Borehole	Date of Test	Depth of Test (m)	Test Stratum	Test Type ¹
WS101	04/03/2025	1.80 – 2.00 ³	Blown Sand	F
WS102	04/03/2025	1.55 – 2.00 ³	Blown Sand	F
CP102	11/03/2025	1.85 – 2.00 ³	Blown Sand	F
Notes: 1. F: falling head test. 2. Details of strata tested shown on borehole records. 3. Due to the high infiltration rate in the Blown Sand, it was not possible to achieve 1m head of water. 1No. test was conducted per hole. 4. Test results presented in Appendix N.				

At each test zone, the drilling casing was withdrawn to expose a section of the test stratum within the sides of the borehole. Due to instability within the test stratum (Blown Sands), before the casing was withdrawn, it was ensured that the borehole had not collapsed to an unsuitable depth before proceeding.

In general terms for falling head tests, the prepared test section borehole was filled with clean water from a water bowser and the level to which the resulting water level falls is measured over time. The permeability is calculated using the methodology presented in BS EN ISO 22282-2 (2012).

4.2 Instrumentation

4.2.1 Gas and Groundwater Well Installations

A 50mm diameter monitoring well was installed in boreholes WS101 to WS103 and CP101A to CP103 in accordance with BS8576:2013 in order to allow monitoring of hazardous ground gases and groundwater monitoring.

The wells, comprising slotted plastic pipe with a gravel surround (the response zone), bentonite seals above the response zone, and a lockable vandal proof flush cover, were installed as detailed on the borehole records and summarised in the table below.

Table 5: Gas Well Installations

Well ID	Date of Installation	Response Zone depth	Response Zone Stratum	Rationale
WS101	04/03/2025	1.0 – 3.0m	Slag-like Made Ground and Blown Sand	2, 3, and 4
WS102	04/03/2025	1.0 – 2.8m		2 and 4
WS103	04/03/2025	0.5 – 2.0m		2 and 4
CP102	13/03/2025	1.0 – 3.0m		2 and 4
Notes: 1. Details of each monitoring well are presented on the individual borehole records (Appendix G / H). 2. Well installed to assess if the Made Ground on site is a source of ground gas. 3. Well installed to assess potential migration of gasses from historical tanks off-site. 4. Well installed to assess potential migration of gasses from organic peat deposits underlying the Blown Sands.				

4.2.2 ‘Spot’ Gas Monitoring

Monitoring of the installed gas wells has been undertaken on a ‘spot’ monitoring basis (periodic visits to monitor gas levels at the time of the visit).

As discussed in Section 3.1.4, the most significant source in the vicinity of the site in terms of gas risk is classified as being of very low to low gas generation potential. The proposed commercial development is classified as low sensitivity in terms of gas risk. Based on the guidelines in CIRIA C665, a minimum of 3 monitoring visits are required over a 6 week period.

To date, the installed wells have been monitored for levels of groundwater and ground gas on all 3No. occasions between 18th of March and 14th of April 2025. The results of the 'spot' gas and groundwater monitoring undertaken to date are presented in Appendix L.

During each visit, Gas Data LMSxi G3.18e portable monitoring equipment was used to measure levels of the following ground gases within the airspace in the wells and the flow rates from the wells:

- Methane - total and percentage of Lower Explosive limit (LEL);
- Carbon dioxide;
- Oxygen; and
- Hydrogen sulphide.

The percentage of nitrogen is also calculated by difference. A photo-ionisation detector (PID) was used during the monitoring to measure the levels of volatile organic compounds present in the well.

Following measurement of gas levels and flow rates, the well cap was removed, and groundwater levels were measured using a dipmeter from the site surface.

4.2.3 Groundwater Installations

A 50mm diameter HDPE standpipe/monitoring well was installed in boreholes CP101A and CP103 to allow for sampling of groundwater in accordance with BS ISO 5667-22 (2010) where groundwater sampling was envisaged. The wells, comprising slotted plastic pipe with a gravel/sand surround (the response zone), bentonite seals above and below the response zone, and a lockable vandal proof cover, were installed in boreholes as detailed on the borehole records and summarised in the table below.

The response zone of the wells was designed to account for the potential tidal influence on groundwater depth, accommodating a range from 4.0m to 8.0m.

Table 6: Well Installations

Well ID	Installation Type	Date of Installation	Response Zone depth	Response Zone Stratum	Rationale
CP101A	50mm well	04/03/2025	4.0 – 8.0m	Blown Sand	2, 3, 4, and 5
CP103	50mm well	11/03/2025	4.0 – 8.0m	Blown Sand	2, 4, and 5
Notes: 1. Details of each monitoring well are presented on the individual borehole records (Appendix L). 2. Well installed to assess the contamination status of the groundwater beneath the site. 3. Well installed to assess potential migration of groundwater contamination from historical tanks 15m to the east of the site. 4. Well installed to assess potential migration of groundwater contamination from historical Chemical Works 100m to the north of the site. 5. Well installed to assess if the groundwater is tidally influenced.					

To date the installations have been spot monitored on 4No. occasions between on the 18th of March and the 24th of April 2025. The 50mm wells were monitored on a 'spot' basis at the same time as gas monitoring, i.e. periodic visits to monitor groundwater levels at the time of the visit.

Sampling of the groundwater was undertaken on 2No. occasions, on the 14th and 23rd of April 2025, with results discussed in Section 5.7.

The results of the groundwater monitoring are presented in Appendix L.

4.3 Sampling Strategy

4.3.1 Soil Sampling

Soil samples were collected from the investigation points as discussed in the previous sections. The sampling procedures were selected on the basis of the suitability for the laboratory testing proposed (see Section 4.6).

In general, a non-targeted, random stratified sampling strategy was used to obtain representative information on soil contamination in the various strata encountered across the site as a whole. However, a number of constraints were imposed on the available sampling locations by existing buildings, private services, and the use of the carpark for business as usual. Therefore, a regular grid sampling pattern could not be adopted.

Environmental samples (denoted as ES on the investigation points records) were collected for possible geo-environmental laboratory testing and generally comprised a plastic tub, an amber glass jar and an amber glass vial. The sample containers provided clean by the testing laboratory appropriate for the proposed testing to be scheduled. Immediately after collection the samples were placed in sealed cool boxes with ice packs where they remained during storage and transport to the laboratory.

Samples for logging and geotechnical laboratory testing purposes were collected at regular intervals within the investigation points.

4.3.2 Groundwater Sampling

In order to establish the groundwater quality beneath the site, samples of groundwater were collected from selected installed wells (CP101A and CP103), in general accordance with BS ISO 5667-11 (2009). Prior to sampling, the wells were purged by the removal of three well volumes where practical, to obtain a water sample representative of the groundwater in the vicinity.

The groundwater samples (denoted as W on the investigation points records) were collected for geo-environmental laboratory testing and comprised a glass bottle, a glass vial, and a plastic bottle. The sample container provided by the testing laboratory was clean and appropriate for the proposed testing to be scheduled. Immediately after collection the sample was placed in a sealed cool box with ice packs where it remained during storage and transport to the laboratory.

The results of the groundwater sampling are presented in Appendix O.

4.4 Evidence of Site Contamination Found During Site Works

With regard to potential hazards identified in the desk study and Preliminary Risk Assessment, the following observations were made.

No direct visual/olfactory evidence of contamination was identified in the investigation points. However, Made Ground was present across the site which can contain elevated levels of contaminants such as metals and polyaromatic hydrocarbon (PAH) compounds.

There were no visual signs of asbestos containing materials. No visual or olfactory evidence of hydrocarbon contamination was noted in the soil or groundwater.

Whilst limited intrusive investigation was undertaken in the area adjacent to the tanks, where investigation was undertaken, no visual or olfactory evidence of contamination was noted.

Significant quantities of fine to coarse grained slag-like material were encountered in every inspection point, encountered underlying the tarmac and/or Made Ground topsoil (western boundary only). No coke-like material was encountered in any of the inspection points.

4.5 Geotechnical Laboratory Testing

Geotechnical laboratory testing was undertaken on samples from the suitable quality classes recovered from the investigation points in order to obtain information on the geotechnical properties on the soils beneath the site.

The following tests were undertaken by a UKAS accredited laboratory on samples selected by ESP in accordance with the methodologies presented in BS1377-2:2022. The results are presented in Appendix K.

- Particle Size Analysis.
- Sedimentation by Pipette Method.
- Determination of the Swelling Potential of Fill Material (Slag Expansion Test). (Note that this testing is not UKAS accredited).

Selected samples were also analysed for soil sulphate and pH value in accordance with the analytical methods specified in BRE Special Digest SD1 (BRE, 2005). The results of the sulphate testing are included with the geo-environmental test results in Appendix J.

4.6 Geo-environmental Laboratory Testing

4.6.1 Soil Laboratory Testing

Laboratory testing has been undertaken to identify the levels of selected contaminants within samples of soil recovered during the investigation.

The geo-environmental analyses were carried out by a UKAS accredited testing laboratory with detection limits being generally compatible with the relevant guideline values adopted in the assessment (see Sections O).

To allow an assessment of the potential chronic risks posed to human health, a total of 11no. selected samples of the Made Ground have been analysed for the contaminants identified in Section 3.1.3, plus other determinands typically present on brownfield sites in the UK (see Table table below).

Table 7: Geo-environmental Soil Laboratory Testing

Sample No.	Hole Reference	Depth	Testing Suite (see Notes)
MADE GROUND			
1	CP101	0.30m	1
2	CP102	0.60m	1 and 2
3	CP102	0.60m	1
4	CP103	0.30m	1 and 2
5	CP103	0.60m	1
6	TP101	0.60m	1
7	TP102	0.60m	1 and 2
8	TP102	0.60m	1
9	WS101	0.60m	1

10	WS102	0.30m	1
11	WS103	0.60m	1
Notes - Testing Suites: 1. Arsenic, beryllium, boron, cadmium, total chromium, chromium VI, copper, lead, mercury, nickel, selenium, vanadium, zinc, US EPA 16 polyaromatic hydrocarbon (PAH) compounds, total monohydric phenols, Total cyanide, asbestos qualitative screen, soil organic content, pH value. 2. Waste Acceptance Criteria (WAC) Testing – Single Stage, see Section 4.7.			

The geo-environmental soil test results and WAC test results are presented in Appendix J.

4.6.2 Groundwater Laboratory Testing

Laboratory testing has been scheduled to identify the levels of selected contaminants in groundwater samples collected from CP101A and CP103 at 5.00 and 5.50m depth respectively. The groundwater samples did not show any obvious olfactory contamination, such as that of a visual oily sheen (hydrocarbon free products).

The geo-environmental analyses were performed by a UKAS accredited testing laboratory, with detection limits generally compatible with the relevant guideline values adopted in the assessment (see Section 5.4).

To assess the potential risks posed to controlled waters, the groundwater samples were tested for the following determinands:

- Arsenic, boron, cadmium, total chromium, copper, lead, mercury, nickel, zinc;
- US EPA 16 polyaromatic hydrocarbon (PAH) compounds;
- Total monohydric phenols;
- Cyanide, soluble sulphate, pH value;
- Petroleum Hydrocarbons – Total EPH (C10 – C40).

The results of the groundwater sampling are presented in Appendix O.

4.7 Waste Classification

3no. Made Ground (Slag-Like Material) have been analysed for Waste Assessment Criteria (WAC) to inform waste disposal, with the results presented in Appendix J.

5 Development of the Revised Conceptual Model

5.1 Conceptual Ground Model - Geology

The investigation points have identified the site to be generally underlain by tarmacadam, which covers the majority of the site, or Made Ground Topsoil along the western boundary. Underlying lies sandy gravel comprising slag-like material Made Ground, which is underlain by coarse Blown Sand. One borehole (CP101A) terminated within organic peat at the termination depth, as confirmed by SPT samples, underlying the Blown Sand deposits.

Made Ground (Tarmac): encountered across much of the site from ground level to up to 0.1m depth.

Made Ground (Placed Topsoil): encountered in the western portion of the site in inspection points WS103 and TP101 only, this soil was encountered from ground level to between 0.10 and 0.20m as a (probably soft) dark brown mottled brown variably clayey variably silty sand.

Made Ground (Slag-like Material): encountered across the site, beneath the tarmac or Made Ground (Topsoil) from 0.07 to up to 2.0m depth, generally composed of medium dense to dense dark grey mottled brown variably silty variably sandy variably cobbly fine to coarse gravel of slag-like material, and brick and concrete fragments.

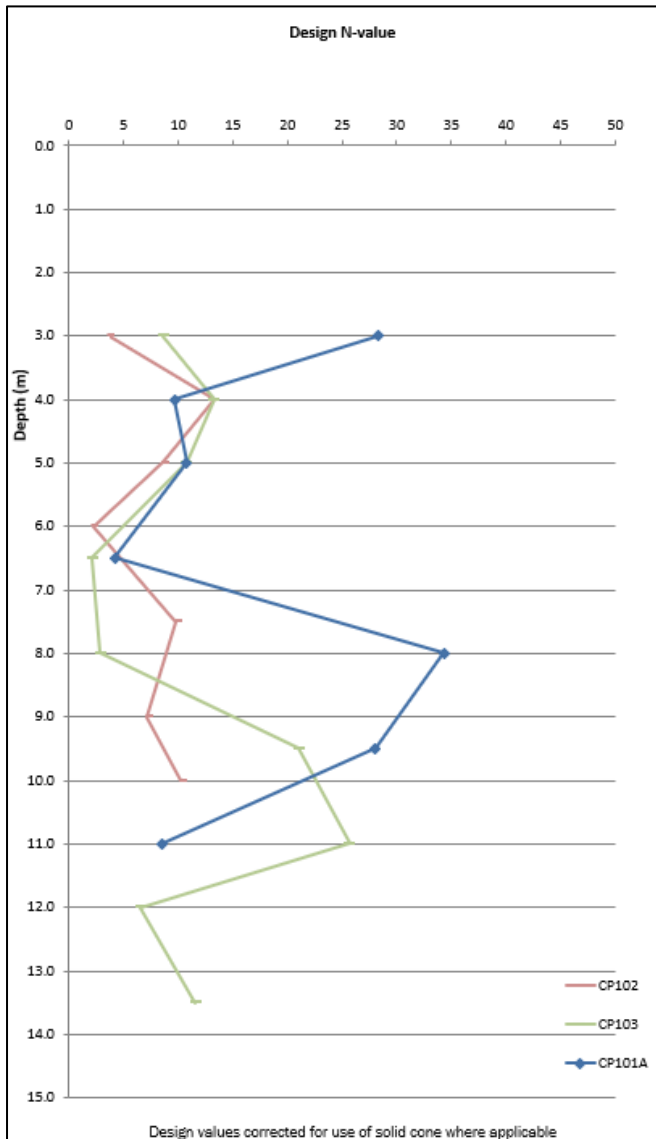
Field SPT N-values within the Made Ground (Slag-like Material gravels) varied between 15 and 42, with most results greater than 20.

Blown Sand: Blown Sand soils were noted across the site, encountered beneath the Made Ground (Slag-like Material). These soils can be separated into two broad categories: coarser brown sand and finer grey silty sand, with the brown sand overlying the silty sand as detailed below.

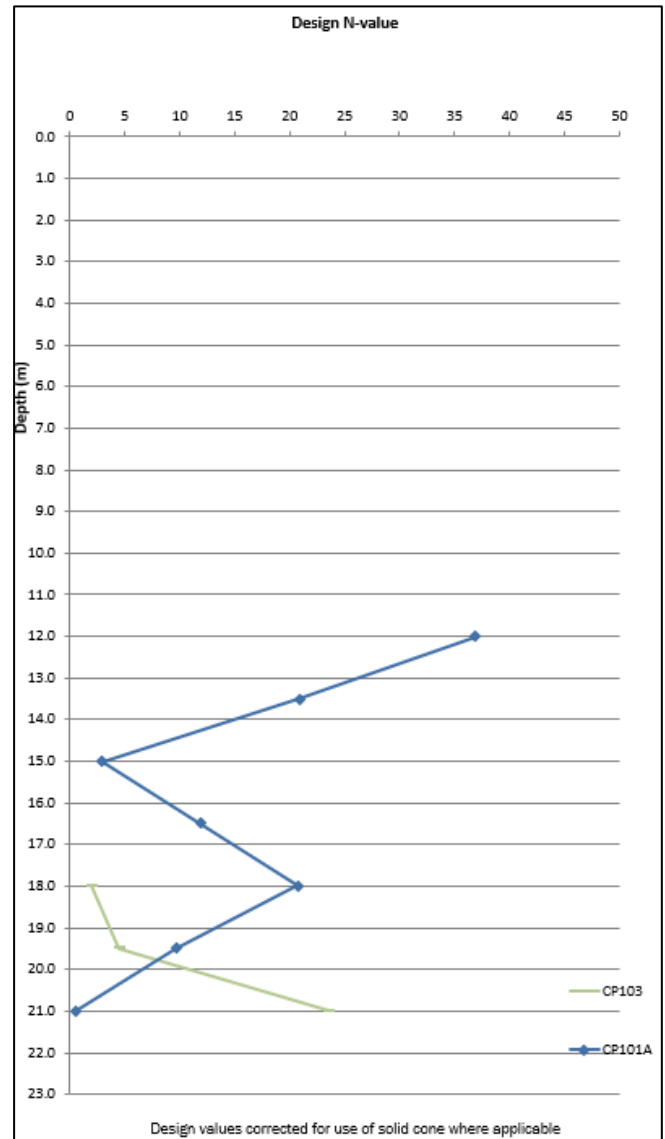
Blown Sand (coarse - grained, brown): encountered beneath the Made Ground (slag-like material) from between 1.40 to 17.0m depth, generally composed of medium dense to dense light brown mottled brown fine sand with occasional shell fragments, and lenses of clay and gravel/low cobble content (at shallow depth only).

Particle size analyses within the laboratory have indicated the coarser grained brown Blown Sand soils to comprise between 0 and 46% gravel, between 28 and 100% sand, between 0 and 20% silt/clay with 0 and 22% cobbles. Based on our observations on site, these proportions are not fully representative. It is considered that that the higher portions of gravel and cobbles, may be due to borehole/trial pit collapse into the upper portions of the Blown Sands strata, and that generally the Blown Sands comprise >85% sand, with a small proportion of clay/silt fines.

Field SPT N-values within the brown Blown Sand varied between 4 and 50 (refusal), with most results greater than 20. The SPT results have been corrected as discussed in Section 4.1.6 and presented as Insert 4 overleaf.



Insert 4: Design N Values against depth (m) for Brown Blown Sand strata



Insert 5: Design N Values against depth (m) for Grey Blown Sand strata

Blown Sand (fine, grey): encountered beneath the coarser-grained brown sand from between 14.0m to 30.0m depth, generally composed of loose to dense dark grey variably silty fine sand.

Particle size analyses within the laboratory have indicated the finer-grained grey Blown Sand soils to comprise 0% gravel, between 85 and 98% sand, between 2 and 9% silt/clay with 0% cobbles. It is noted that on-site observations recorded generally higher levels of silt. However, for the purposes of this assessment, the soils have been considered predominantly sandy and therefore field SPT-N Values corrected, as discussed in Section 4.1.6.

Field SPT N-values within the sandy gravels varied between 5 and 41, with most results greater than 20. The SPT results have been corrected as discussed above and are presented in Insert 5 above.

Probable Peat: encountered in one borehole (CP101A) underlying the finer blown sand, this soil was only identified with 2No. SPTs taken at 30.00m and 30.45m depth. It is described as a dense dark brown mottled greenish-grey, organic-rich silty clayey peat. The borehole and casing were unable to continue drilling through the dense to very dense peat due to presumed high compressibility of the

peat, leading to the termination of sampling with the cable percussive borehole at 30.90m. The description of peat should be considered in the context of the sample (SPT tub description).

2no. Field SPT N-values within the organic peat soils (at 30.0m and 30.45m) varied between 28 and 33.

South Wales Middle Coal Measures Bedrock: not encountered in the investigation or in any BGS boreholes within 250m of the site, with rockhead anticipated at an unknown depth. It is likely to be in excess of 35m.

5.2 Conceptual Ground Model - Hydrogeology

The groundwater conditions identified in the investigation are summarised in the table below.

Table 8 - Summary of Groundwater Ingress in the Investigation

Hole ID	Stratum	Comment on groundwater encountered
Site Investigation		
CP101A	Coarser Brown Blown Sand	Encountered at 5.3m as medium inflow. Groundwater measured at 4.5m following end of drilling.
CP102		Encountered at 6.0m as medium inflow. Groundwater measured at 5.5m following end of drilling.
CP103		Encountered at 6.4m as medium inflow. Groundwater measured at 6.0m following end of drilling.
Long-term Monitoring ²		
CP101A	Coarser Brown Blown Sand	Measured between 4.69m to 5.00m. May indicate absence of tidal influences on groundwater depth.
CP103		Measured between 5.32m to 5.50m. May indicate absence of tidal influences on groundwater depth.
Notes:		
1.	Full details of groundwater ingress presented on investigation point records in Appendix L.	
2.	Results of long term monitoring undertaken between March and April 2025.	

Based on the Conceptual Ground Model, it is considered that the main groundwater body beneath the site is within the coarser, brown Blown Sand soils, at a depth of between 4.5m to 6.50m.

Groundwater spot monitoring was carried out during both high and low tides, encountering consistent groundwater depth. This consistency may suggest that there is no tidal influence on the groundwater at the site..

5.3 Site Instability

5.3.1 Global Site Stability

No evidence was identified of potential landslides or unstable ground in the Preliminary Geotechnical Risk Register and no obvious evidence of any global instability issues were identified on site.

5.3.2 Excavation Instability

During the drilling, the windowless sample boreholes and cable percussive boreholes remained vertical and stable.

All windowless sample boreholes concluded within the coarser brown Blown Sand deposits, likely due to occasional lenses of cobbles encountered within this stratum.

CP101A and CP103 were terminated at depths of 30.90m and 21.00m, respectively. Progress was hindered by very slow drilling and difficulties in advancing the casing, which struggled to be installed at further depth—likely a result of the blowing sand conditions. CP102 was terminated at 10.00m following based on the arising ground conditions and time constraints.

During the excavation of the trial pits TP101 and TP102, some spalling of the pit walls was experienced throughout, particularly within the Made Ground (Slag-like Material) stratum. Both trial pits were terminated at depths between 2.10m and 2.20m to facilitate soakaway infiltration testing

5.3.3 Other Stability Hazards – Expansive Slag Material

Some slags can be extremely unstable when hydrated, which can lead to significant heave at the surface and damage to buildings and hard surfaces. No evidence of instability was observed on site that could be associated with slag heaving (ie; no evidence seen on the existing building - Sandfields Young Business Centre).

2no. samples of the Made Ground (Slag-like Material) were subjected to slag expansion testing (Determination of the Swelling Potential of Fill Material). The swelling percentage after 168 hours of testing for both samples was 17%. Based on expansion rate of 0.17%, for a typical thickness of the slag layer across the pitch of 1200mm to 2000mm, we would expect expansion of 2.0. For the maximum recorded slag layer thickness of 2000mm (CP101A), we would anticipate expansion of around 3.4mm.

This is further assessed in Section 8.2.3. Full slag expansion results are appended in Appendix K.

5.4 Chronic Risks to Human Health – Generic Quantitative Risk Assessment (GQRA)

The assessment criteria used as part of this GQRA are presented on the tables in the following section(s).

The proposed development comprises a commercial business building, with external hardstanding and landscaping. Therefore, the GAC appropriate for the commercial land use have been adopted in this assessment.

The GAC for most organic compounds are dependent on the organic content of the soil. Analysis has shown that the soil organic content in the soils analysed ranged from 0.7 to 3.9%. Therefore, for the purposes of this assessment, GAC for a soil organic content of 1% has been adopted. This is considered a conservative approach for the majority of the soils at the site.

5.4.1 Generic Quantitative Risk Assessment

The samples analysed for soil contaminants comprised 8no. samples of Made Ground (Slag-like Gravels). All samples have been considered across the site as one averaging area. The risks from asbestos are considered further in Section 5.4.5.

The results of the GQRA for the proposed development are presented in the table below. It should be appreciated that if the development were to change, the following assessment should be reviewed and, if necessary, updated.

Table 3: Generic Assessment of Human Health Risks (Commercial/Industrial)

Determinand	Minimum Recorded (mg/kg)	Maximum Recorded (mg/kg)	GAC (mg/kg)	Source of GAC	Exceedances
Metals and Semi-metals					
Arsenic	1.4	11	640	C4SL ²	None
Boron	0.7	6.4	240,000	S4UL ⁴	None
Cadmium	<0.1	0.6	410	C4SL ²	None
Chromium (total) ⁵	5.2	26	8,600	S4UL ⁴	None
Copper	3.7	25	68,000	S4UL ⁴	None
Lead	0.8	77	2,300	C4SL ²	None
Mercury ⁶	<0.05	0.07	1,100	S4UL ⁴	None
Nickel	<1.0	14	980	S4UL ⁴	None
Zinc	11	160	730,000	S4UL ⁴	None
Polyaromatic Hydrocarbons (PAH)					
Acenaphthene	<0.03	<0.03 - <0.60 ¹⁰	84,000*	S4UL ^{4,7}	None
Acenaphthylene	<0.03	<0.03 - <0.60 ¹⁰	83,000*	S4UL ^{4,7}	None
Anthracene	<0.03	<0.03 - <0.60 ¹⁰	520,000	S4UL ^{4,7}	None
Benzo(a)anthracene	<0.03	0.07 - <0.60 ¹⁰	170	S4UL ^{4,7}	None
Benzo(a)pyrene	<0.03	0.08 - <0.60 ¹⁰	77	C4SL ^{2,7}	None
Benzo(b)fluoranthene	0.05	0.12 - <0.60 ¹⁰	44	S4UL ^{4,7}	None
Benzo(ghi)perylene	<0.03	0.07 - <0.60 ¹⁰	3,900	S4UL ^{4,7}	None
Benzo(k)fluoranthene	<0.03	0.03 - <0.60 ¹⁰	1,200	S4UL ^{4,7}	None
Chrysene	<0.03	0.07 - <0.60 ¹⁰	350	S4UL ^{4,7}	None
Dibenzo(a,h)anthracene	<0.03	<0.03 - <0.60 ¹⁰	3.5	S4UL ^{4,7}	None
Fluoranthene	<0.03	0.10 - <0.60 ¹⁰	23,000	S4UL ^{4,7}	None
Fluorene	<0.03	<0.03 - <0.60 ¹⁰	63,000*	S4UL ^{4,7}	None
Indeno(123-cd)pyrene	<0.03	0.04 - <0.60 ¹⁰	500	S4UL ^{4,7}	None
Naphthalene	<0.03 - <0.60 ¹⁰	<0.03 - <0.60 ¹⁰	1,600*	C4SL ^{2,7}	None
Phenanthrene	<0.03	0.06 - <0.60 ¹⁰	22,000	S4UL ^{4,7}	None
Pyrene	<0.03	0.12 - <0.60 ¹⁰	54,000	S4UL ^{4,7}	None
Petroleum Hydrocarbons					
EPH (C10-C40)	<10	4,600	-	-	See below.
Other Organic Compounds					
Phenol	<0.03	0.4	760	S4UL ^{4,7}	None
Notes: - Assessment for commercial/industrial land use. - C4SL: Category 4 Screening Level, published by CL:AIRE. - SGV: Soil Guideline Value published by Environment Agency. - S4ULs Suitable 4 Use Levels. Copyright Land Quality Management Limited, reproduced with permission; Publication No. S4UL3156. All Rights Reserved. - In the absence of Chromium VI, all chromium present likely to be Chromium III. GAC for Chromium III adopted. - GAC for inorganic mercury adopted. - GAC for organic compounds based on 1% soil organic content. - Exceedances highlighted in red and bold. - Laboratory results presented in Appendix J. - Recorded below detection limit for TP102 0.60m * GAC exceeds solubility or vapour saturation limit.					

All the determinands analysed were below their respective GAC. No further statistical analysis is warranted.

The South West Wales Framework Suites includes testing for combined total petroleum hydrocarbons (TPH) bands between C10 to C40. The generic assessment criteria above requires the TPH levels to be speciated out into specific groups of carbon bands for assessment. The results indicate that measurable levels of combined TPH were encountered in 5no. samples, see Section 7.1 for further discussion. No visual or olfactory evidence of petroleum hydrocarbon contamination was identified during the investigation.

5.4.2 Asbestos

No evidence of asbestos was identified in the samples analysed.

5.5 Hazardous Ground Gas

5.5.1 Degradation of Organic Materials

The installed gas wells have been monitored for hazardous gases on three occasions over a six week period to date, i.e. the scheduled preliminary monitoring period has been completed. The monitoring results are presented in Appendix L and are summarised in the table below:

Table 4: Summary of Gas Monitoring Data (Visits 1 to 3)

Well	Response Zone Depth ¹ (m)	No visits	Maximum Methane (%)	Maximum Carbon dioxide (%)	Minimum Oxygen (%)	Maximum Gas Flow (L/hr)	Shallowest Water depth (m)	Atmospheric pressure
WS101	1.0 – 3.0m	3	nd	nd	23.6	5.7	Dry	1,000 – 1,022
WS102	1.0 – 2.8m	3	nd	nd	23.6	5.8	Dry	1,000 – 1,022
WS103	0.5 – 2.0m	3	nd	nd	23.4	5.5	Dry	1,000 – 1,022
CP102	1.0 – 3.0m	3	nd	nd	24.0	5.6	Dry	1,000 – 1,022
Notes: 1. Wells were installed with response zones in Made Ground/Blown Sands. 2. nd – none detected with instrument (<0.1% for methane, <0.1% for carbon dioxide).								

The monitoring to date has indicated levels of methane and carbon dioxide below the limit of detection (0.1%). Maximum gas flow rates of 5.8L/hr were recorded. Levels of volatile organic compounds were recorded as between below the limit of detection and 1.0ppm.

5.5.2 Preliminary Gas Screening Values

The results of monitoring undertaken have been used to calculate preliminary Gas Screening Values (GSV) appropriate for the site using the methodology published in CIRIA C665 (Wilson et al, 2007) and BS8485 (2019). The calculated worst case GSV for the site are presented in the table below.

Table 5: Gas Screening Values (based on three visits)

	Maximum Recorded Level (%)	Maximum Gas Flow Rate (L/hr)	Worst Case GSV (L/hr)
Methane	<0.1	5.8	0.0058 ²
Carbon dioxide	<0.1	5.8	0.0058 ²
Notes: 1. GSV calculated using method derived in CIRIA 665 (2007). 2. Assumed that at least 0.1% of carbon dioxide and methane is present – Worst Case Scenario.			

Based on the calculated worst case GSV, it is considered that the site would be classified as Characteristic Situation CS-1 for a commercial development (CIRIA C665:2007).

5.6 Sulphate Attack

The assessment of the concrete protection against sulphate attack has been undertaken in accordance with BRE SD1 (2005).

5.6.1 Classification of Site

Due to the presence of Made Ground, the site should be considered as 'brownfield' in terms of concrete classification.

5.6.2 Groundwater Setting

Groundwater was encountered in the investigation points and installed wells in the Blown Sand soils. Depending on the chosen foundation solution, this may be close to the depth to which buried concrete will be placed (ie; friction piles, see Section 8.3). Therefore, groundwater has been considered as mobile in this assessment.

5.6.3 Soil Sulphate Levels and Characteristic Values

The results from the sulphate testing from the various strata are summarised in the table below.

Table 6: Summary of Sulphate Testing & Results

Determinand	Amount of Tests	Minimum Value ³	Maximum Value ^{2,4}	Characteristic Value ¹
MADE GROUND (SLAG-LIKE MATERIAL)				
Water soluble sulphate (mg/l)	3	13	400	400
pH values	3	6.8	7.8	6.8
Acid soluble sulphate (%)	3	0.02	0.48	<i>Not Required⁶</i>
Total Sulphur (%)	3	0.01	0.30	<i>Not Required⁶</i>
Total Potential Sulphate (%)	3	0.03	0.90	0.90
Oxidisable Sulphate (%)	3	0.01	0.42 ⁵	<i>Not Required^{5 and 6}</i>
COARSER BROWN BLOWN SANDS				
Water soluble sulphate (mg/l)	5	10	25	25
pH values	5	7.3	9.6	7.3
Acid soluble sulphate (%)	5	0.02	0.03	<i>Not Required⁶</i>
Total Sulphur (%)	5	0.01	0.01	<i>Not Required⁶</i>
Total Potential Sulphate (%)	5	0.03	0.03	0.03
Oxidisable Sulphate (%)	5	0.00	0.01	<i>Not Required⁶</i>
FINER GREY BLOWN SANDS				
Water soluble sulphate (mg/l)	2	10	180	180
pH values	2	8.2	8.9	8.2
Acid soluble sulphate (%)	2	0.03	0.06	<i>Not Required⁶</i>
Total Sulphur (%)	2	0.02	0.10	<i>Not Required⁶</i>
Total Potential Sulphate (%)	2	0.06	0.30	0.30
Oxidisable Sulphate (%)	2	0.03	0.24	<i>Not Required⁶</i>
Notes: - Selection of characteristic value based on guidance in BRE SD1 (2005). - As levels of water soluble sulphate are less than 3,000mg/l, there is no need to consider the levels of magnesium present in the soils. - As the pH levels all exceed 5.5, there is no need to further assess the soils for the types of acids present (e.g. hydrochloric and nitric acids). - As the levels of oxidisable sulphide are well below 0.3%, pyrite is unlikely to be present. - As the levels of oxidisable sulphide exceed 0.3%, pyrite is likely to be present. - Not required for BRE SD1 concrete design class assessment (see Section 7.4.2). - Laboratory results presented in Appendix J.				

5.7 Risk to Controlled Waters – Level Two Assessment

5.7.1 Methodology

The potential impact of contamination originating at the site on controlled waters (i.e. groundwater in the underlying Secondary A Aquifers and surface water in Baglan Bay to the west) has been initially evaluated in line with the Environment Agency guidance (Carey et al, 2006). Levels of contaminants within the groundwater (Level Two) has been analysed and risk assessed (Carey et al, 2006). No leachate samples (Level One) have been taken at the time of writing.

5.7.2 Assessment Criteria

For the purposes of the Level Two assessment, the following points are deemed pertinent:

- Groundwater within the Superficial Deposits (Blown Sands) and the South Wales Middle Coal Measures Bedrock are classified as a Secondary A Aquifer,
- There are no surface water abstractions within 250m of the site.
- There are no groundwater abstractions or Source Protection Zones within 500m of the site.
- The nearest major surface water feature to the site is the sea (Baglan Bay/Swansea Bay), some 300m west.
- Groundwater spot monitoring (Section 5.2) was carried out during both high and low tides in installed boreholes, encountering consistent groundwater depth. This consistency may indicate that the groundwater at the site is not tidally influenced.
- Closest significant source of contamination are historical tanks (adjacent to the east of the site) and the historical works at BP Oils approximately 100m to the north.

Given the available information, we consider that the most vulnerable receptor with regards to leachable and mobile contamination would be the groundwater beneath the site and our assessment has concentrated on this/these receptors. However, for completeness, we have also extended the assessment to include the surface water of Baglan Bay.

General Groundwater:

In order to assess the potential risk to general groundwater beneath the site, the published Prescribed Concentration Values (PCV) of the Water Supply (Water Quality) Regulations (WSR, 2016), which relate to the use of groundwater as a potable resource, have been adopted as the assessment criteria.

Where no PCV is published, the '*concentrations of hazardous substances within groundwater below which the danger of deterioration of the groundwater quality is avoided*' published by UKTAG (2016) have been adopted as assessment criteria. These UKTAG concentrations have been calculated from thresholds designed to be protective of drinking water.

Surface Water Receptors:

In order to assess the potential impact on the waters of the Swansea Bay, the levels of contaminants have been compared to the Environmental Quality Standards (EQS) published within the Water Framework Directive Directions (WFD, 2015). For the purposes of this assessment, the Annual Average (AA) or long term (mean) EQS have been adopted which represent the acceptable levels of a contaminant over an annual period. Given the most vulnerable receptor is considered to be the waters in Swansea Bay, the EQS published for saline water have been adopted.

For zinc the EQS is calculated from the ambient background concentration in the local river catchment (WFD, 2015). For this assessment, the catchment has been taken of the Swansea Bay.

5.7.3 Groundwater Test Results

A total of 4No. groundwater samples (2No. from each location) were collected from the Blown Sand deposits at boreholes CP101A and CP1031 on 14th and 23rd April 2025. During spot visits, all other borehole installations were observed to be dry.

Table 7: Level Two Controlled Waters Risk Assessment

Compound	Range Recorded	UKTAG ⁵	EQS - AA ⁸	Exceedances
Metals				
Arsenic ¹	5.6 – 12 µg/l	5.0µg/l	25µg/l	4 of 4 UKTAG
Chromium VI ^{1,3}	<0.25 – 1.4µg/l	5.0µg/l	0.6µg/l	2 of 4 EQS
Copper	1.1 – 1.5µg/l	-	3.76µg/l	None of 2
Lead ¹	<0.09µg/l	5.0µg/l	1.3µg/l	None of 2
Mercury ¹	<0.01µg/l	0.5µg/l	-	None of 2
Nickel ²	1.3 – 2.4µg/l	-	8.6 µg/l	None of 2
Zinc ^{2,9}	14.1 – 221.1µg/l	-	7.9 µg/l	4 of 2 EQS
Polyaromatic Hydrocarbons				
Anthracene ¹	<0.01µg/l	0.05µg/l	0.1µg/l	None of 4
Benzo[a]pyrene ¹	<0.01µg/l	0.005µg/l	0.00017µg/l	None of 4 – see below.
BbF ¹	<0.01 – 0.02µg/l	0.05µg/l	-	None of 4
BghiP ¹	<0.01µg/l	0.05µg/l	-	None of 4 – see below.
BkF ¹	<0.01µg/l	0.05µg/l	-	None of 4 – see below.
IDP ¹	<0.01µg/l	0.05µg/l	-	None of 4 – see below.
Naphthalene ²	<0.05 µg/l	-	2.0 µg/l	None of 4 – see below.
Fluoranthene ¹	<0.01 – 0.17µg/l	-	0.0063µg/l	2 of 4 EQS
Petroleum Hydrocarbons				
Total EPH (C10 – C40)	36 – 43 µg/l	-	10ug/l TPH (Total) ¹⁰	4 of 4 EQS
Notes: - Hazardous substance (JAGDAG, 2019). - Non-hazardous substance (JAGDAG, 2019). - All chromium present assumed to be chromium VI (conservative approach). - Assessment based on non-potable groundwater beneath the site. - UKTAG – UK TAG concentration below which the danger of deterioration in the groundwater quality is avoided. For hazardous substances only. 2015 AA EQS (Saltwater) annual average, measure of long-term impact. Arithmetic mean of concentrations measured within water body across year. Generally total of all isomers. 2015 MAC EQS (Saltwater) - maximum allowable concentration, measure of short term impact. - EQS-AA – Environmental Quality Standard (estuarine/saline waters) - Annual Average or Mean. - Zinc EQS includes ambient background concentration of 1.1µg/l. - EA – Environmental Agency defined value - Exceedances in bold and red represent the amount over the EQS Guidelines. Exceedances in bold and blue represent the amount over the 2016 UK TAG Guidelines. - Test results presented in Appendix O.				
Key to PAH compounds: BbF: benzo[b]fluoranthene BghiP: benzo[ghi]perylene BkF: benzo[k]fluoranthene IDP: indeno[123-cd]pyrene				

As previously stated, the groundwater samples showed no visual evidence of contamination, such as an oily hydrocarbon sheen, which might have been anticipated considering the surrounding areas historical land use (ie; adjacent tanks and BP Oils Ltd to the east and north, respectively).

Most contaminants analyses were below the acceptable criteria for both surface and groundwater quality standards with the exception of some metals and Fluoranthene (PAH), as detailed below.

- Minor exceedance of Arsenic above UKTAG values for groundwater in sample from both boreholes.
- Minor exceedance of Chromium in CP103 above EQS value for saline surface water.

- Exceedances of Zinc in both boreholes above the EQS value for saline surface water. The recorded values of 13 and 210 µg/l are above the guidance value of 7.9µg/l.
- Exceedance of total petroleum hydrocarbons, in both boreholes.

The levels of Arsenic and Chromium recorded are considered to be marginal exceedances and are not considered to be contaminants of concern. No further assessment is warranted at this stage.

The levels of PAH's are considered to generally be low, and only marginally exceed the extremely stringent guidance values for PAH's. Fluoranthene is listed as a JAGDAG hazardous substance. The maximum recorded value of 0.17 µg/l, exceeds the EQS value of 0.0063µg/l. Given the industrial site setting, the exceedance is not considered to be significantly elevated, however further assessment may be warranted.

The recorded levels of petroleum hydrocarbons (C10 – C40), with a maximum value of 43µg/l, exceeds the guidance value of 10 µg/l for total petroleum hydrocarbons. It is important to acknowledge that the petroleum hydrocarbon threshold represents a preliminary, broad-brush appraisal of contamination levels. An exceedance does not necessarily equate to an unacceptable environmental risk. Given the industrial site setting, the exceedance is not considered to be significantly elevated, however depending on detailed development design further assessment may be warranted, see Section 7.2.

6 Phase Two Geo-Environmental Risk Assessment

6.1 Discussion on Occurrence of Contamination and Distribution

The desk study review has identified no evidence of any prior development or former contaminative use on the site. However, although no contaminative former use has been identified for the site, the surrounding area has previously been developed with heavy industry (Chemical Works and Industrial/Factory Units). Potential on/off-site sources of contamination include, general Made Ground, current land use as a car park, and adjacent industrial land-use including historical tanks and chemical works.

Laboratory testing of the shallow soils has generally identified low levels of contamination, and no asbestos has been recorded in the samples analysed. Measurable levels of combined TPH were identified in samples of the shallow Made Ground at the site.

A consistent groundwater body was identified within the Blown Sands formation at depths ranging from approximately 4.5 to 6.5m. The monitoring to date indicates limited tidal influence in groundwater levels. Groundwater laboratory analysis has indicated generally low levels of contamination, particularly given the wider industrial legacy of the area. Low levels of PAH and petroleum hydrocarbon contamination may warrant further assessment, depending on the detailed design and the adopted foundation solution.

Potential sources of hazardous ground gas include, general Made Ground, potential hydrocarbon contamination, and deep peat within the coarse grained superficial deposits. The potential gas sources would generally be classified as of very low to low gas generation potential. Gas monitoring to date has identified generally low levels of methane and carbon dioxide.

6.2 Revised Risk Evaluation & Relevant Pollutant Linkages

As discussed in Section 3.2.1, the methodology set out in CIRIA C552 (2001) has been used to assess whether or not risks are acceptable, and to determine the need for collating further information or remedial action.

The risks evaluated at the desk study stage of this report have been updated and revised in the below table following information learned from the exploratory works and results of monitoring and laboratory testing.

Table 8 - Revised Risk Evaluation & Relevant Pollutant Linkages (RPL)

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow Made Ground soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (workers and visitors)	Medium – potential for chronic levels.	Low Likelihood ²	Moderate/ Low Risk	See Section 7.1
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Medium – standard PPE may not be sufficient	Likely ²	Moderate Risk	See Section 7.1
	Leaching of soil contaminants	Impact on Groundwater	Medium – site lies on Secondary A Aquifers	Low Likelihood ²	Moderate/ Low Risk	See Section 7.2
	Leaching of soil contaminants	Impact on surface water features	Medium – site lies relatively close to Swansea Bay	Low Likelihood ²	Moderate/ Low Risk	See Section 7.2
Asbestos in shallow soils	Inhalation of fibres	Site End Users	Medium – potential for chronic levels	Unlikely ³	Low Risk	See Section 7.1
		Construction/ Maintenance Workers		Unlikely ³	Low Risk	
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High likelihood ⁴	Moderate Risk	See Section 7.4.2
Notes: - This table updates Table 3 in Section 3.2.2 using results of the investigation. Methodology and details of risk consequence, probability and category presented in Appendix A - Generally no elevated contamination has been identified with the exception of measurable levels of combined petroleum hydrocarbons. No obvious visual or olfactory evidence of contamination was identified. - No obvious ACM noted in the Made Ground and no asbestos identified in the ten samples tested. - Elevated levels of potential sulphate recorded in Made Ground and the finer grey silty sand (Blown Sand). General levels are low. Further investigation and testing may be required.						

Ground gasses assessed on next page...

Table 6 (continued): 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
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users/Visitors.	Severe – acute risk.	Low Likelihood ⁵	Moderate Risk	See Section 7.3
	Damage through explosion.	Building/Property				
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.				
Notes: 5. Numerous on-site and off-site potential sources of ground gas and vapours identified. Methane and Carbon Dioxide not recorded above detectable levels following 6 week monitoring period.						

7 Remedial Strategy for Contamination Risks

The following recommendations are based on interpretations made from the relatively limited site investigation data obtained to-date, and do not form the full Options Appraisal stage of the Land contamination risk management (LCRM) guidelines. If at any stage of the construction works, contamination or a potential for such contamination is identified that is different to that presented within this report, all of the following should be reviewed and the advice of ESP should be sought.

7.1 Risks to Health

7.1.1 Asbestos

No asbestos was detected in the ten samples of Made Ground tested as part of the exploratory investigation. However, it cannot be discounted that during the construction of the nearby industrial buildings, that excess building materials could have been placed on the site.

If any ACM are encountered during development, the advice of a suitably qualified specialist should be sought, and any identified ACM removed from site by a licensed specialist contractor.

7.1.2 Site End Users

Assuming an end use of a proposed new business centre, the identified levels of soil contamination at the site are generally not considered to pose a risk to future site users. Measurable levels of combined petroleum hydrocarbons were identified in the shallow Made Ground soils. No visual or olfactory evidence of hydrocarbon contamination was noted during the investigation.

The presence of the hydrocarbon contamination may be due to the origin of the Made Ground materials (likely imported), or due to the current land use as a car park.

The proposed development generally comprise a commercial building, with car parking and limited areas of soft landscaping. Whilst the measurable laboratory test results were generally identified in the areas of hard standing, one measurable level was recorded in TP102, in the northern grassed area.

The following further analysis and/or mitigation measures should be considered. Further sampling and laboratory analysis of the shallow soils in areas of soft landscaping could be undertaken to allow for an assessment of the risks posed to human health, comprising laboratory analysis to include a speciated TPH and BTEX suite.

If preferred, appropriate measures would need to be taken prior to development to break the pollutant linkage and mitigate these risks in areas of soft surfacing (e.g. public landscaping etc.). In areas of hard surfacing (e.g. beneath structures, driveways, roads and other hardstandings), the hard surface would break the pollutant linkage and no further risk mitigation would be required in terms of risks to human health.

Provided that finished site levels allow, one option of mitigating risk could be to isolate the contaminated soils beneath a surface cover layer of clean, inert soil. The thickness and make up of this layer would need to be agreed with the regulators. For preliminary design and costing purposes, it is considered that the clean cover layer would need to be at least 600mm in thickness (to include placed Topsoil), and would need to be proven to be 'suitable for use' by an appropriate scale of validation testing. The preferred risk mitigation strategy should be detailed within a remediation

strategy and implementation plan and supervised and validated by ESP. On completion, a validation report should be prepared to demonstrate to regulators and insurance providers that the risk has been successfully mitigated.

Given the site levels, it may be necessary to remove some of the contaminated soils in order to provide sufficient space to allow a minimum 600mm thickness of clean cover to be constructed.

A suitable geotextile should be placed at the base of the cover layer and immediately overlain by a capillary break layer to prevent contaminants being drawn up into the cover system.

Notwithstanding the above, as discussed in Section 7.1.1, it cannot be discounted that former hollows in the site surface may have been infilled in the past with contaminated materials. The eastern extent of the site, adjacent to the historic tanks has had limited intrusive investigation, however given the site topography, distance from the development, and no recorded evidence of contamination, it is considered unlikely that a significant risk is posed in this regard.

If any evidence of Made Ground that is different from that encountered during the site investigation (i.e.; differs from predominantly slag-like material) or other contaminated soils is identified during development, further specialist advice should be sought from ESP.

7.1.3 New Service Connections

The current water industry guidance for the suitability of pipe materials on potentially contaminated sites (Blackmore et al, 2010) has onerous requirements and it is likely/possible, based on this guidance, that the levels of contaminants on site may prevent the use of plastic pipework. It is recommended that enquiries are made to the local water authority to confirm their requirements for underground service materials for this development.

7.1.4 Risk to Construction and Maintenance Workers

Short term (acute) risks to construction and maintenance workers are generally poorly understood within the industry, certainly when compared to the volume of research undertaken on long term risks. However, it is anticipated that the levels of contamination at the site are not likely to pose a severe acute risk to construction workers or future maintenance workers. Ground workers would need to undertake their own assessment of the risks to their workers.

It is recommended that construction workers adopt careful handling of the potential contaminants and good standards of personal hygiene should be adopted to reduce the risk of possible ingestion and skin contact should any hotspots be encountered. The contractor should comply with the appropriate current Health and Safety at work legislation.

7.1.5 General Public/Neighbouring Properties

The site is an active carpark, which lies adjacent to Sandfields Business Centre. Workers and visitors/shoppers to the business centre and surrounding industrial units may be particularly sensitive to any dust created during developments.

It is recommended strict dust control measures during development, and particular care would be required when excavating and removing Made Ground soils.

7.2 Risk Assessment for Controlled Waters

A total of 4No. groundwater samples (2No. from each location) were collected from the Blown Sand deposits at boreholes CP101A and CP1031 on 14th and 23rd April 2025.

The following points are also considered salient.

- The site is situated in an area with a potentially contaminative historical background. The most significant source of potential contamination is the former Chemical Works, located approximately 100m to the north and upgradient of the site.
- The levels of soil contaminants are generally low, well below the GAC adopted.
- Measurable levels of combined petroleum hydrocarbons were recorded in the shallow soils. Groundwater monitoring to date, identified the shallow monitoring wells to be dry.
- The groundwater samples showed no visual evidence of contamination.
- Most contaminant levels fell within acceptable criteria for both surface and groundwater quality standards.
- Minor exceedances of Arsenic, Chromium and Fluoranthene were recorded. Exceedances of Zinc and total petroleum hydrocarbons were also recorded at notable levels. Given the industrial site setting, the exceedances are not considered to be significantly elevated.
- The proposed development comprises a conventional commercial business centre building which will include areas of new and old car parking which are anticipated to be hard surfaced – surface drainage from these areas could contain leached oils and fuels from vehicle spills and leaks.
- Soakaways are being considered for the development.
- The site is underlain by mainly coarse grained Blown Sand soils
- A consistent groundwater body was identified within the Blown Sands formation at depths ranging from approximately 4.5 to 6.5m. The monitoring to date indicates limited tidal influence in groundwater levels.
- Although bedrock was not encountered, a deeper groundwater body is anticipated within the bedrock.

Given the site setting, the overall risk to controlled waters associated with site development is likely to be **Low**, and no further assessment is warranted if a shallow spread foundation option is implemented. However, if a deeper foundation solution is adopted, a detailed assessment will be necessary in the form of a Piling Risk Assessment, as this may create new pathways for contamination. A standalone risk assessment will likely be required to demonstrate that the foundation construction will not create additional contamination pathways that could detriment underlying aquifers.

Consideration of the presence of measurable levels of petroleum hydrocarbons within the shallow soils will be required if soakaway infiltration is proposed. Some risk mitigation is likely to be required where soakaways are used to dispose of surface water run-off – see Section 8.8 for further discussion.

7.3 Risks from Ground Gas and Radon

7.3.1 Ground Gas Risk to the Development

Based on the calculated worst case GSV, it is considered that the site would be classified as Characteristic Situation 1 for a commercial development (CIRIA C665:2007). No gas protection measures are required for the site development.

The requirements for gas protection have been assessed in accordance with BS8485:2019, which considers gas protection in terms of a ranking 'score' for various types of property.

The proposed development comprises an office/commercial development with small room sizes, and anticipated to have a central building management control of the use and maintenance of the building. Given the residential element to the building use, it is considered this to be classified as a Type C building of BS8485:2019.

Prior to/during construction, all existing monitoring wells should be decommissioned and sealed in accordance with available good practice guidance (Environment Agency and Mine Remediation Authority) to remove potential gas migration pathways and associated risks that may affect the development.

7.3.2 Radon Risk to the Development

No radon protection is required.

7.3.3 Risk to Construction and Maintenance Workers

It is not considered there is a particular risk to construction and maintenance workers, and there is no requirement to define shallow excavations as confined spaces. However, good site practice is recommended, and all excavations should be considered potentially confined spaces.

Carbon dioxide is a particular risk in Made Ground materials as it is commonly present and as it is heavier than air, it can displace it at the base of excavations, which can then lead to workers being at risk from asphyxiation. If during construction any organic materials are encountered they should be excavated and replaced.

7.4 Risks to Property

7.4.1 Spontaneous Combustion

No evidence of combustible materials has been identified in the shallow soils. Therefore, the risk from spontaneous combustion is considered to be low.

7.4.2 Sulphate Attack on Buried Concrete

The following characteristic values are applicable for the shallow Made Ground soils at the site (all as SO₄):

Water soluble sulphate:	400mg/l;
Total potential sulphate:	0.9%
pH value:	6.8

Based on the above characteristic values results, it is considered that the Made Ground would be classified, as Design Sulphate Class DS-3 and Aggressive Chemical Environment for Concrete Class AC-3, allowing for mobile groundwater. As the levels of oxidisable sulphide exceeds 0.3% in one sample of Made Ground, it is likely that pyrite is present in this sample. The high sulphate levels are likely associated with the slag type material encountered within the Made Ground.

However, the values are based on limited testing of the shallow soils and a reduction in concrete design class may be achievable through further sampling and analysis.

The following characteristic values are applicable for the shallower Blown Sands at the site (all as SO₄):

Water soluble sulphate:	25mg/l;
Total potential sulphate:	0.06%
pH value:	7.3

Based on the testing undertaken to date and the characteristic values, the underlying natural brown fine sand (Blown Sand) would be classed as DS-1 and AC-1.

The following characteristic values are applicable for the deeper Blown Sands at the site (all as SO₄):

Water soluble sulphate:	180mg/l;
Total potential sulphate:	0.30%
pH value:	8.2

Based on the testing undertaken to date and the characteristic values, the grey silty sand (Blown Sand) underlying this would be classed as DS-2 and AC-2.

Based on the varying results to date, it is recommended that further testing is undertaken, particularly in the shallow Made Ground soils to confirm the concrete design class. Depending on the adopted foundation approach, differing design classes may be adopted, relative to varying depths of foundations.

7.5 Re-Use of Materials/Disposal of Excess Arisings

7.5.1 General Comments on Re-use/Disposal

All soils or other materials excavated from site are generally classified as waste under the Waste Framework Directive (European Union, 2008) and their re-use is controlled by this legislation.

If the soils are to be re-used on site (e.g. within the red-line planning boundary), provided that they are 'uncontaminated' or other naturally occurring deposits and they are certain to be used for the purposes of construction in their natural state on the site from which they are excavated, they may be excluded from waste regulation (Duckworth, 2011). A Materials Management Plan (MMP) may be required, which may also enable the re-use of materials classed as waste on excavation (e.g. Made Ground or re-worked soils) if in accordance with the CL:AIRE Definition of Waste, Development Industry Code of Practice (DoWCoP). If excavated soils or materials are contaminated, their re-use potential on-site may be limited.

If the soils are to be removed from site, they are automatically classified as waste, and they may only be:

- Disposed at a licensed landfill;

- Disposed at a licensed, permitted soil treatment centre; or
- Removed to a Receiver Site for beneficial re-use.

Prior to removal from site, any excavated arisings would need to be classified as either 'hazardous' or 'non-hazardous' waste based on a WM3 assessment.

Re-use of soils on a receiver site could be undertaken via an Environmental Permit or Exemption, however, these can take time and are costly to arrange. In certain circumstances, it is permissible to use the protocols laid down in the CL:AIRE DoWCoP (Duckworth, 2011) which is generally more efficient (in terms of time and cost) to implement.

Further guidance on the legislative requirements of the re-use/disposal of materials generated by the development can be provided by ESP once the development proposals have been finalised.

7.5.2 WAC Testing & WM3 Assessment

As discussed in Section 4.7, Single Stage Waste Acceptability Criteria (WAC) testing has been undertaken on 3no. samples. Full results of the WAC testing can be found in Appendix J.

A WM3 and WAC assessment of the shallow Made Ground soils has been undertaken by ESP and is reported separately (ESP.9222.4379-01). The report is displayed as Appendix Q for ease, and should be referred to in full alongside this report. A brief summary of the findings is provided below.

- We consider the relatively limited sampling undertaken to date has been sufficient to initially characterise the slag-like Made Ground to be disposed of.
- As 50% of the samples have been classified as hazardous in terms of WM3 assessment and 33% of the samples indicate that they would require disposal at a stable non-reactive waste disposal facility.
- We would recommend that additional sampling of the soils, once excavated and stockpiled appropriately, is undertaken to further assess the waste characteristics.
- An alternative option would be to sample, test and classify the material in-situ, in the known areas of the trenches. We would also recommend prior engagement with disposal sites with regards to the assessment already undertaken to confirm.
- Mixing of waste streams is not permitted, therefore any excavation arisings should be managed and disposed of separate from any other materials processing. Records should be kept demonstrating this was undertaken appropriately.
- Final classification of the waste and where it can be disposed of/treated will need to be determined by the chosen disposal contactor/disposal destination and the testing results and our letter report should be provided to inform this. Further testing may be warranted/required.

7.5.3 Imported Materials

Any soils or materials to be imported to site (including Topsoil) should be certified clean and inert, and suitable for use. An appropriate number of samples (depending on the volume of soils imported) should be analysed for an appropriate suite of contaminants, and verification certificates should be provided. Further guidance can be provided by this office if required.

8 Geotechnical Comments

8.1 Site Preparation and Earthworks

8.1.1 Unexploded Ordnance

As discussed in Section 2.10.9, a specialist preliminary assessment has concluded that ‘a *detailed desk study, whilst always prudent, is not considered essential in this instance*’.

Notwithstanding this, given the site is located in Port Talbot, which was heavily targeted during the Second World War, the risk from buried ordnance cannot be totally discounted as records are not complete. Therefore, although no special precautions are considered necessary, a careful watch should be maintained during all excavation and any suspected ordnance identified should be investigated further by specialists. Ordnance awareness is recommended during site inductions.

8.1.2 Invasive Plants

No evidence of invasive plants such as Japanese Knotweed/Himalayan Balsam etc. was identified on the site during the site works. However, their growth is seasonal and therefore their presence cannot be discounted.

8.1.3 Existing Foundations and Services

No evidence of old foundations and underground structures have been identified in the investigation and are not anticipated beneath the site. However, if any are discovered then they should be grubbed up as part of the site preparation works.

These sub-structures and any others identified during development should be grubbed up within the zone of influence of the development as part of the site preparation works. If visual or olfactory evidence of contamination is observed during these works, further advice should be sought by ESP.

Live services have been identified on site as described in Section 2.1, with private services of electric and sewers in particular present in the eastern boundary of the site. Considering the presence of these services, an allowance for diversion/a suitable exclusion zone should be made when planning the development and site works. Further details and permissions should be obtained from the provider.

8.1.4 New Services

For new services, flexible pipework and connections should be provided as a safeguard against potential settlements. Consideration could be given to increasing the gradients on sewage connections to mitigate against possible settlements.

Any permanent cuttings or embankment surcharges associated with earthworks or landscaping within the site should be kept to a minimum to avoid any possible adverse effects on the existing stability of the site. Any proposed changes to the topography should be reviewed by ESP.

8.1.5 Earthworks

ESP have not been advised that the development requires any significant earthworks. The site is relatively gently sloping and some amount of levelling may be required. ESP can provide further support in this regard where required.

8.2 Geotechnical Risk Register

8.2.1 Updated Geotechnical Risk Register

Following the site investigation the potential geotechnical hazards have been re-assessed as described in the following section. This includes construction risks identified by the intrusive investigation.

8.2.2 Shrinkage and Swelling

The shallow soils are coarse-grained in composition and, therefore, should not be affected by seasonal changes in moisture content.

8.2.3 Volumetrically Unstable Slag Material

As discussed in Section 2.10.6, some slags can be extremely unstable when hydrated, which can lead to significant heave at the surface and damage to buildings and hard surfaces. No evidence of instability was observed on site.

Slag expansion testing was undertaken on 2no. samples of the Made Ground (Slag-like Material). The swelling percentage after 168 hours of testing for both samples was 17%. Based on expansion rate of 0.17%, for a typical thickness of the slag layer across the pitch of 1200mm to 2000mm, we would expect expansion in the order of 2mm. For the maximum recorded slag layer thickness of 2000mm (CP101A to CP103), we would anticipate expansion of around 3.4mm.

Therefore, we consider that the slag identified beneath the site proposed new business centre is likely to be of low expansion potential were it to be left in-situ. However, we cannot discount that so far unidentified pockets of slag of differing chemistry and potentially higher expansion risk, may be present.

Due to the limited samples tested, we also recommend that additional samples are taken across the site to confirm, or otherwise, the current findings. This could potentially be undertaken during the initial excavation phase at the start of construction on the proposed building for both financial reasonings and whilst ensuring minimal disruption to the regular operations of the existing car park.

We recommend that, if the slag is to be left in-situ, the building design includes measures to minimise the infiltration of rain and surface water into this layer, e.g. using an impermeable membrane

8.3 Preliminary Foundation Design and Construction

8.3.1 General Considerations

The site is being considered for commercial development and it is understood that the main structure currently proposed will be a business unit similar to that that already exists directly adjacent to the site (Sandfields Young Business Centre). At this stage, preliminary details of the proposed loadings have been provided by the Client, which are in the order of 7.5kN/m² floor slab load, and approximately 70kPa point column loads. It is understood that the proposed building will comprise a portal framed steel structure.

The ground investigation to date has identified a covering of Made Ground (slag) to approximately 2.0m depth, over Blown Sands to a depth of 30m. Peat was encountered at 30.0m in one borehole, however due to difficulties in drilling, the borehole could not be progressed further to confirm the thickness.

Blown sands typically require deep foundations (piles driven to competent bearing strata) or ground improvement techniques due to their variable strength and potential for settlement.

The following assessment should be updated following confirmation of final loadings. Once a preferred foundation solution has been confirmed, ESP can provide further support if required.

8.3.1.1 Option 1: Shallow Trench Fill Foundations

Based on the information provided by the Client, it is understood that a shallow foundation option is preferred, in the form of reinforced concrete trench fill strip foundations constructed in the natural sand at approximately 2.0m depth. We understand that the shallow Made Ground (slag) is to be excavated in these areas.

Based on a founding depth of approximately 2.0m within the natural Blow Sands, with a foundation width of 0.5m, for foundations placed in this stratum, we consider that an allowable bearing values of around 75kPa could be adopted, with settlement likely to be within a tolerable range (<25mm).

Reinforced concrete pad foundations connected by ring beams could provide a flexible alternative solution if preferred.

For all spread foundation options, the formations should be cleaned, and subsequently inspected by a suitably qualified engineer prior to placing concrete. Should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by lean mix concrete or suitable compacted granular material. It is recommended that a blinding layer of concrete be placed on the formation after excavation and inspection in order to protect the formation against softening and disturbance. The proposed founding stratum is coarse-grained in composition and, therefore, should not be affected by seasonal changes in moisture content.

Detailed foundation design should be completed by a structural engineer to ensure that the allowable bearing capacity is sufficient and that anticipated settlement is within the allowable tolerance for the proposed structure. Should higher loads be anticipated, or alternative solution feature be preferred due to the potential for differential settlement, the following foundations options may be considered.

8.3.1.2 Option 2: Reinforced Ground Beam/Raft Foundation

A suitable foundation option may be either a reinforced ground beam or raft foundation constructed on compacted fill. The existing ground should be excavated to the full extent of the Made Ground deposits, which will be at a minimum of depth in the order of 1.2m below the proposed bearing level of the main structural foundations. The excavation should be replaced with suitable granular material (e.g. Department of Transport Type 1 sub-base or similar approved) compacted in layers in a controlled manner to a suitable earthworks specification. This ground improvement should be carried out over an area extending to a minimum of 1.0m outside the footprint of each foundation. Thickening of the foundations is likely to be required beneath the columns and any load bearing walls.

Based on the proposed development plan (Insert 1), the proposed building is noted to be staggered, and consideration of the suitability of one individual raft spanning the full development, or two separate rafts will be required. Consideration of differential settlement, and potential heave/expansion will be required.

The Made Ground was found to extend to a depth of up to 2.00m in certain areas. If such a depth of excavation is deemed unsuitable, it may be advisable to consider alternative solutions as discussed below.

Prior to backfilling, the base of the excavation should be proof rolled and inspected by a suitably qualified engineer, and should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by lean mix concrete or suitable compacted granular material.

It is considered that the coarse-grained Made Ground soils that would be excavated as part of this treatment would be substantially suitable for re-use as compacted materials beneath the structures. Any unsuitable materials, such as putrescible and contaminated materials, soft, wet soils, large fragments of concrete and masonry would need to be removed prior to placement. Concrete and masonry fragments greater than a nominal 100mm would need to be crushed to make them suitable for use as general structural fill.

The presumed bearing value of the re-compacted fill materials would be dependent on the foundation size, the compacted material type and quality, the compaction characteristics and foundation loading details. Based on the information provided to date, anticipated settlement is likely to be within likely tolerable ranges. Should higher loads be imposed by the development, anticipated settlement may be higher than tolerable. As discussed above, depending on adopted raft design, measures to mitigate against differential settlement may be required.

8.3.1.3 Option 2: Vibro Improved Ground

The Made Ground was found to extend to a depth of up to 2.00m in certain areas. If such a depth of excavation is deemed unsuitable, an alternative foundation solution may comprise reinforced strip foundations constructed on vibro-improved ground. Of the two vibro-treatment options, it is considered that vibro-vibrated concrete columns may be the optimum technique to improve the shallow soils identified at this site.

Vibrated concrete columns are a similar technique to vibro-replacement except that concrete is used instead of stone to create the columns, thus constructing in effect mini-piles.

The Made Ground at the site should respond well to this technique but the suitability and design of any specific solution based on vibro ground treatment will depend on the layout and loading details of the structure together with the type of foundation and the ground conditions. There are also unlikely to be significant structures on site due to the limited historical buildings being recorded.

Any vibro-replacement works should be undertaken by an experienced specialist contractor, whose propriety system should be compatible with the end use of the proposed structures and based on the proposed structural design details. Allowable loadings should normally be determined by the contractor. All designs and site works should, however, be assessed and fully supervised by a suitably qualified geotechnical engineer and comply with the ICE Specification for Ground Treatment (1987).

The vibro contractor should satisfy himself that their propriety system would enable penetration of the relatively dense and stiff materials at the site including the various obstructions. In this regard provision for pre-boring and the use of a mechanical excavator may be required for a vibro solution, should these materials be too dense for vibro penetration.

Preliminary enquiries should be made to the Client's civil engineer, who should confirm, or otherwise, that the vibro-technique is likely to be successful in the Made Ground soils encountered in the investigation.

The construction of vibrated stone columns will create a potential pollution pathway between the Made Ground and the underlying Blown Sands, which are classed as a Secondary A aquifer. Depending on the findings of ongoing laboratory testing, further assessment may be required.

8.3.1.4 Option 3: Friction Piles

Should a shallow foundation option be unfeasible due the presence of insufficient bearing capacities and settlement above tolerable rates, a deeper piled foundation solution may be considered more suitable.

Given that the proposed development is single storey, and proposed loadings are anticipated to be relatively low, a friction pile foundation could present a more appropriate solution, taken down to the Blown Sand stratum at depths below approximately 10m (below more variable Blown Sands).

The following initial criteria should be considered for pile design:-

- The magnitude and resulting effect of different structural loadings, including any machine vibration effects;
- Possible impacts on neighbouring structures and underground services;
- Pile/soil/structure interaction effects;
- The design philosophy for pile bearing capacity - the estimation of pile bearing capacity in the Blown Sand requires careful consideration of the skin friction developed over the penetration depth and the end bearing resistance beneath the pile toe.
- Negative skin friction forces from the Made Ground.
- Risks to controlled waters, including creating a pathway between Made Ground and superficial aquifer.

The final safe working load on the pile will be dependent on the pile type, diameter and length of the piles, the penetration into the bearing stratum, and the settlement tolerances required.

Based on the available information, and given the site constraints, it is likely that the most appropriate system is likely to be a non-displacement vibration-less technique (friction piles) however

this technique will generate arisings at the surface which will need to be re-used or disposed of under a materials management plan.

Discussions should be held with specialist piling contractors to obtain specific piling proposals based on their particular proprietary system and to evaluate costs. The piling contractor should be asked to provide a performance specification and in particular the magnitude of total and differential settlements which could be guaranteed. Test loading will be required on a proportion of the piles to confirm that they are adequate to carry the design working loads, and the contractor should monitor closely the pile installations to satisfy himself that the ground conditions encountered are as good as, or better than, those assumed in his design. Care should be taken to ensure that piles are not stopped short on obstructions and that all are taken down into the coarse-grained glacial soils.

If adopted as a foundation solution, a Piling Risk Assessment is required prior to the commencement of any piling works at the site. This assessment is essential to identify, evaluate, and mitigate potential risks associated with the proposed piling operations, particularly in relation to underlying ground conditions, nearby structures, and potential contamination pathways, as discussed in Section 7.2.

If required, further guidance on design criteria can be given by this office when structural loadings, design and cost implications have been finalised.

8.4 Floor Slab Foundations

Due to the presence of over 600mm of Made Ground at the site, it is considered that ground bearing floor slabs would not be suitable for the development. It is understood that the floor slab will be designed accordingly, with intermediate ground beams adopted to reduce overall spans.

8.5 Retaining Wall Design

ESP are not aware of any retaining structures being required in the development.

8.6 Pavement Design

It is understood that vehicle access roads/hardstanding are proposed at the site. However, the majority of the existing car park and access road is aimed to be utilised for these purposes.

8.6.1 Design CBR Value

An assessment of the likely CBR values in areas of grade (no change in ground level) has been undertaken using a dynamic cone penetrometer (DCP). Testing was undertaken at 4no. locations. The results of the DCP testing are converted to CBR values using correlations published by the Highways Agency (2020).

The DCP results and the correlated CBR values are presented in Appendix P.

It is considered that a Design CBR value of 5% would be suitable for preliminary design purposes. Design values in areas of proposed roads should be confirmed.

The near-surface soils comprise coarse-grained materials and it is not expected that the Design CBR value to vary to any significant degree seasonally or in the long term.

The final sub-grade should be inspected by a qualified engineer, and any soft or loose material removed and replaced as necessary, to ensure that the Design CBR value is achieved. It is further recommended that the sub-grade be proof-rolled with a suitable roller prior to the placement of the sub-base materials. In order to improve the sub-base performance the use of a suitable geo-grid may be considered.

It would be prudent to re-measure the CBR values of the sub-grade on exposure to confirm that they are equal to or better than the values measured in this investigation (as recommended by the Highways Agency [HA, 2020]). If the CBR values in the sub-grade are found to be lower than the Design CBR, the subgrade must be improved to achieve the Design CBR or the road pavement foundation redesigned.

8.6.2 Susceptibility to Frost Action

The near surface Made Ground and Blown Sand soils are considered to be non-frost susceptible.

8.7 Excavation and Dewatering

It is anticipated that excavation throughout most of the site will be within the capabilities of conventional mechanical excavators. Old foundations will require higher capacity machines for their removal. The tracked excavator used in the investigation failed to excavate below 2.20m due to the instability of the trial pit.

For shallow excavations, support of excavation sides is likely to be necessary. Based on our understanding of the proposed development, no significant groundwater ingress is anticipated above 2m depth. Where water ingress occurs it is likely that pumping from screened sumps within shallow excavations will be adequate.

8.8 Soakaway Drainage

8.8.1 Soakaway Design

Soakaway infiltration tests were undertaken in 2No. test pits excavated across the site (TP101 and TP102). The results of the testing are presented in Appendix M.

3No. Falling Head Permeability Tests were also conducted within three boreholes (WS101, WS103, and WS102). The results of the testing are presented in Appendix N.

The calculated infiltration rates are presented in the table below.

Table 14 - Summary of soakaway infiltration test results

Test Pit	Test depth	Measured Infiltration Rate ¹	Infiltration Soils
Soakaway Infiltration Tests¹			
TP101 – Test 1 of 3	2.10 - 2.20m	4.44x10 ⁻⁴	Blown Sand
TP101 – Test 2 of 3	2.10 - 2.20m	3.56x10 ⁻⁴	Blown Sand
TP101 – Test 3 of 3	2.10 - 2.20m	2.96x10 ⁻⁴	Blown Sand
TP102 – Test 1 of 3	1.70 - 2.10m	5.00x10 ⁻⁴	Blown Sand
TP102 – Test 2 of 3	2.10 - 2.20m	4.35x10 ⁻⁴	Blown Sand
TP102 – Test 3 of 3	2.10 - 2.20m	3.62x10 ⁻⁴	Blown Sand
Falling Head Permeability Tests²			
WS101 – Test 1 of 1	1.80 - 2.00	1.80x10 ⁻⁵	Blown Sand
WS103 – Test 1 of 1	1.55 - 2.00	1.80x10 ⁻⁵	Blown Sand
CP102 – Test 1 of 1	1.85 - 2.00	1.80x10 ⁻⁵	Blown Sand
Notes: 1. Testing undertaken in accordance with BRE 365. 2. Testing undertaken in accordance with BS EN ISO 22282-1/2. 3. Due to the high infiltration rate in the Blown Sand, it was not possible to achieve 1m head of water. Bowser was emptied before this could be achieved.			

The high infiltration rate of the Blown Sand made it impossible to achieve a 1m head of water within the soakaways and falling head permeability tests.

In general, an infiltration rate of 10⁻⁴ m/s is recommended for design purposes across the site. However, it is important to note that the presence of fine material within the soil, which was occasionally found in the shallow Blown Sand as clay lenses; this will likely result in lower infiltration rates.

As discussed in Section 7.2, consideration of the presence of measurable levels of petroleum hydrocarbons within the shallow soils will be required if soakaway infiltration is proposed. Some risk mitigation is likely to be required where soakaways are used to dispose of surface water run-off.

8.8.2 Location Considerations

Care should be taken in the siting of the soakaways, with in particular, soakaways should be constructed a minimum of 10m away from the crest of slopes.

Soakaways should not normally be constructed closer than 5 m to building foundations or sensitive structures.

It is recommended that the soakaway discharge point is kept as high as possible within the ground to maximise the thickness of soils between the discharge point and the groundwater below, i.e. the attenuation potential of the soils is maximised. The base of the soakaway should be constructed a minimum of 1m above the shallowest groundwater level to ensure long term functionality.

8.8.3 Regulatory Considerations

8.8.3.1 Natural Resources Wales

The infiltration stratum at the site would be the Blown Sand deposits which is classed as a Secondary A aquifer and the groundwater within is vulnerable to pollution. Natural Resources Wales has a general policy that no direct discharge of surface run-off would be accepted in vulnerable groundwater aquifers. Given the unknown, but likely in excess of 35m depth, of the bedrock

beneath the site at the site, any soakaways are unlikely to result in the direct discharge of surface water run-off into the aquifer.

It is still recommended that enquiries are made to Natural Resources Wales to identify whether they would allow such discharge at the site. As a minimum, risk mitigation measures such as oil interceptors are likely to be required.

8.8.3.2 Statutory Approval Bodies (SABs)

The use of Sustainable Drainage (SUDs) systems is now regulated and implemented by Statutory Approval Bodies (SABs) within the Local Authority. Applications for SuDS will be reviewed by the relevant SAB which will establish if the application is feasible, suitable for its intended use and is acceptable for adoption and maintenance by the SAB.

Whilst adoption and maintenance approval will be the final stage in the process, SAB's will require validation of the constructed SuDS and will utilise commuted sums to ensure the proposed vs as built construction. SAB's will also be tasked with enforcement action in the event SuDS applications are not submitted appropriately or are not constructed as per authorised details.

It should be noted that the SABs process can take up to seven to eight weeks for a complete and properly filed application to be processed and approved, and, if not already made, the application timeline should be considered as part of any development.

9 Recommendations

It is considered that the following further investigation and assessment would be required or prudent prior to development:

Required Further Actions:

- PAS128 GPR survey to confirm existing underground services at the site.
- Additional sampling and analysis to support concrete classification. Depending on the adopted foundation solution, deeper groundwater samples should be obtained.
- Measure CBR values at sub-grade prior to pavement construction.
- Further sampling and laboratory analysis may indicate a low risk to end users with regards to petroleum hydrocarbons and should be considered as part of future works.
- Confirmation of mitigation measures with regards to shallow petroleum hydrocarbon contamination in areas of soft landscaping. The preferred risk mitigation strategy should be detailed within a remediation strategy and implementation plan and supervised and validated by ESP.
- Confirmation of acceptance of soakaway infiltration testing from NRW.
- Confirmation of proposals with regards to excess site materials, including disposal.
- Verification testing of any soils imported to site, if required.
- Materials management plan for re-use of soils on site if required.

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