Earth Science Partnership

Consulting Engineers | Geologists | Environmental Scientists

Land off A473 & A4222, Talbot Green
Proposed Residential & Retail/Commercial Development
Exploratory Investigation

Report Reference: ESP.9211.4278

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Proposed Residential & Retail/Commercial Development
Exploratory Investigation

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Report Reference: **ESP.9211.4278**

Revision	Status	Date	Written by	Checked by	Approved by
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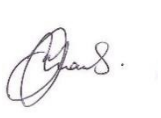
		Signature:			

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Contents

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Executive Summary

Previous assessments have been undertaken at the site and information on the planning portal indicates remedial works may have been completed at the site, the following section should be viewed as preliminary only at this stage. It was recommended that additional Desk Study assessment was undertaken to include a review of all past information to be included within this recent study; however, this has not been instructed at this stage.

Talbot Green Developments Ltd is proposing the sale of the subject site for redevelopment with a mix of land uses for commercial and residential purposes. ESP have undertaken an exploratory 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 comprises an irregular shaped parcel of land of around 275m length (north to south) and 450m width (east to west), occupying an area of around 7.3ha. It is currently unoccupied, with large areas of hardstanding (concrete slabs and localised tarmacadam roads) associated with former land uses.*
	Identified Ground Conditions. (Section 5.1)	-	*The investigation points have identified the site to be generally underlain by variable depths of Made Ground, overlying fine-grained possible Alluvium, followed by coarse-grained River terrace Deposits. Topsoil was also identified in the east extent of the site. The Coal measures bedrock was not encountered within the depths of this investigation.*
	Groundwater Conditions. (Section 5.2)	-	*The investigation did not identify any significant groundwater ingress to a depth of 3.3m. Slow seepages were identified in TP02, TP11 and TP22 at depths of 2.0m, 2.1m and 2.2m respectively.* *All installed monitoring wells have been recorded as dry to a maximum depth of 1.8m from the two completed visits to dates.*
	Historical Land Use. (Section 2.2)	-	*From the review of historical maps and other mapping sources, the site remained largely as open fields (with the exception of the construction of Springfield House in the late 1890's) until around the early 1960's, when the northwest portion of the site was developed with a Water Treating Equipment Work, which continued to expand within the site into the early 2000's. From the late 1970's, a further works/factory was developed in the southwest portion.*
Geo-environmental	*Potential Contamination Sources (Section 3.1.2)*	*Low/ Moderate*	*Several potentially contaminative former land uses have been identified at the site, including former factories, railway land and former above ground tanks. Based on information from the LA, it is likely that some remedial works have occurred at the site, however this will need to be checked by review of past information and confirmatory testing during supplementary works.*
	Chronic Risks to Human Health (Section 7.1)	*Low/ Moderate*	*Assuming an end use of residential and retail/commercial land, the identified levels of soil contamination at the site are below the guidelines for residential development. Based on information from the LA, it is likely that some remedial works have occurred at the site, however this will need to be checked by review of past information and confirmatory testing during supplementary works.*
	Risks to Controlled Waters (Section 7.2)	*Low/ Moderate*	*The Level One assessment of risks to controlled waters has indicated that the levels of contamination within the soils beneath the site could pose an unacceptable risk to controlled waters. Based on information from the LA, it is likely that some remedial works have occurred at the site, however this will need to be checked by review of past information and confirmatory testing of the groundwater during supplementary works.*
	Hazardous Ground Gas (Section 7.3)	*Moderate*	*The current monitoring has indicated levels of methane to be below detection. Levels of carbon dioxide up to 4.8% and gas flow rates up to 6.4L/hr have been generally recorded (locally higher). A full assessment of gas risks will be presented in a gas addendum report/revised version of this report on completion of the monitoring. Given the site setting, a Coal Mine Gas Risk Assessment will be required in the future.* *The risk from radon is low and no radon protection measures will be required.*

Continued Over.

Continued.

	Potential Hazard	Anticipated Risk	Discussion
Geotechnical	*Abandoned Mine Workings and/or Old Mine Entries (Section 8.2.2)*	*Moderate*	*Although the previous report indicated no coal seams/workings to a depth of 30m, given that the superficial soils are potentially up to a depth of around 17m below ground level, dependant on the thickness of any underlying coal seams, there may be insufficient rock cover to mitigate the risk. As detailed in Section 2.10 above, there are several seams underlying the site and further works will be required to investigate their depth and status. At this stage, the risk from subsidence at the site is considered to be moderate. Confirmatory drilling works will be required to confirm the risk.*
	Weak/Compressible Ground, requiring non-traditional foundations (Section 8.3 and Section 8.4)	*Moderate*	*For preliminary design purposes and subject to confirmation of the mining hazard, it is considered that mass concrete spread foundations could be used at the site, constructed in the dense coarse-grained River terrace Deposits encountered from depths of around 1.1 to 1.5m beneath the current ground level. Deepening of spread foundations or alternative solutions, such as a raft or piled foundations, will be required locally in areas where deeper Made Ground is present.*
	Shrinkage or Swelling (Section 8.2.3)	*Moderate*	*Laboratory testing has indicated that the locally present possible Alluvium soils at shallow (within the influence of foundations) depth are of medium volume change potential.*
	Sulphate Attack on Buried Concrete (Section 7.4.2)	*High*	*Based on the characteristic values, it is considered that the site would be classified as Design Sulphate Class DS-4 and Aggressive Chemical Environment for Concrete Class AC-4, allowing for mobile groundwater.*
	Soakaway Feasibility (Section 8.8)	-	*Subject to confirmation of the groundwater condition, it is recommended that 10-5 m/s be used as a typical infiltration rate for preliminary design across the site within the River Terrace Deposits. However, it must be appreciated that where fine-grained soils are present, infiltration rates will be lower. We recommend that location specific soakaways are undertaken once the design proposals have been finalised, and the locations of the proposed soakaways are known.*
	Buried Structures (Section 8.1.3)	*High*	*Evidence of sub-surface structures was identified in localised areas of the site (e.g., TP05, TP17 and TP20). Foundations associated with the former buildings beneath the visible concrete slabs likely remain in the ground. All identified 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.*
	Limestone Solution (Section 8.2.4)	*Moderate*	*Limestone bedrock was identified previously (Opus, 2011) underlying the site in the southeast. This will need to be investigated through drilling works to confirm the presence/absence.*
Others	*UXO (Section 2.10.10)*	-	*Specialist assessment concludes that 'a detailed desk study, whilst always prudent, is not considered essential in this instance'.*
	Flooding (Section 2.6)	*High/ Moderate*	*The site is indicated to be at risk flooding from rivers or seas and is located within a Flood Zone 3/Flood Zone 2.A potential high risk from surface water flooding and medium risk from groundwater flooding has been identified from the Desk Study.*
	Invasive Plants (Section 8.1.2)	-	*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.*
	Services (Section 2.1.4)	*Moderate*	*Live services have been identified on site as described in Section 2.1. Notably, a medium pressure gas main is present along the south boundary, rending roughly west to east. 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 providers.*
	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

The Client is proposing the sale of the subject site for redevelopment with a mix of land uses for commercial and residential purposes. The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by the Client to undertake an integrated, exploratory 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 in Section 2.1.

The proposed development will largely comprise residential development, with some retail/commercial areas in the northwest. No finalised proposed development layout is currently available; however, it is presumed that the residential areas will comprise typical two-storey dwellings with private gardens, landscaping and estate roads. An area of proposed apartments is also identified in the west of the site, with no indication of areas of landscaping. The commercial/retail units are presumed to be proposed large portal-frame units with external areas of car parking, hard-standing and limited landscaping. The current proposed *'Sketch Capacity'* development layout is presented as Figure 1; however, we understand that this does not represent the final development layout.

We are not aware of any proposed significant changes to the current ground levels.

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

1.2 Historical Site Investigation Information

Local Authority liaison and online searches of the Rhondda Cynon Taf County Borough Council (RCTCBC) planning portal have been undertaken as part of the desk study process and several additional historical investigations, not previously known to ESP have been identified for the site. An initial review of the reports identified a past investigation undertaken in 2011 (see Section 2.3). The reports appear to indicate detailed investigation and remedial works completed following identification of risks to human health and controlled waters.

The Local Authority have also provided a list of all past planning applications which include the site boundary. Planning consultations regarding the past reports may also be available, however this has not been reviewed at this stage.

It was recommended that this current assessment should include a review of all available past information; however, this has not been instructed at this stage.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

1.3 Objective and Scope of Works

The objective of the investigation was to obtain preliminary 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 past investigations/reports may have been related to previous conditions; however, this has not been assessed at this stage.

The scope of works for the investigation was designed 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, a field reconnaissance visit, the supervision and direction of trial pits, windowless sample boreholes, soakaway infiltration testing, measurement of in-situ CBR values (using DCP equipment), geotechnical and geo-environmental laboratory testing, gas and groundwater monitoring, assessment and reporting. A review of the past investigation reports or any previous planning consultations was not instructed at this stage.

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 2nd December 2024 (ref: ESP.9211.lt1.Proposal).

The investigation and assessment were undertaken between January and March 2025. It should be noted that gas monitoring is ongoing, and an updated report will be issued on completion.

1.4 Report Format

This report includes the desk study and field reconnaissance reports (Section 2), and details of the investigation undertaken of 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.

1.5 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.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

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.

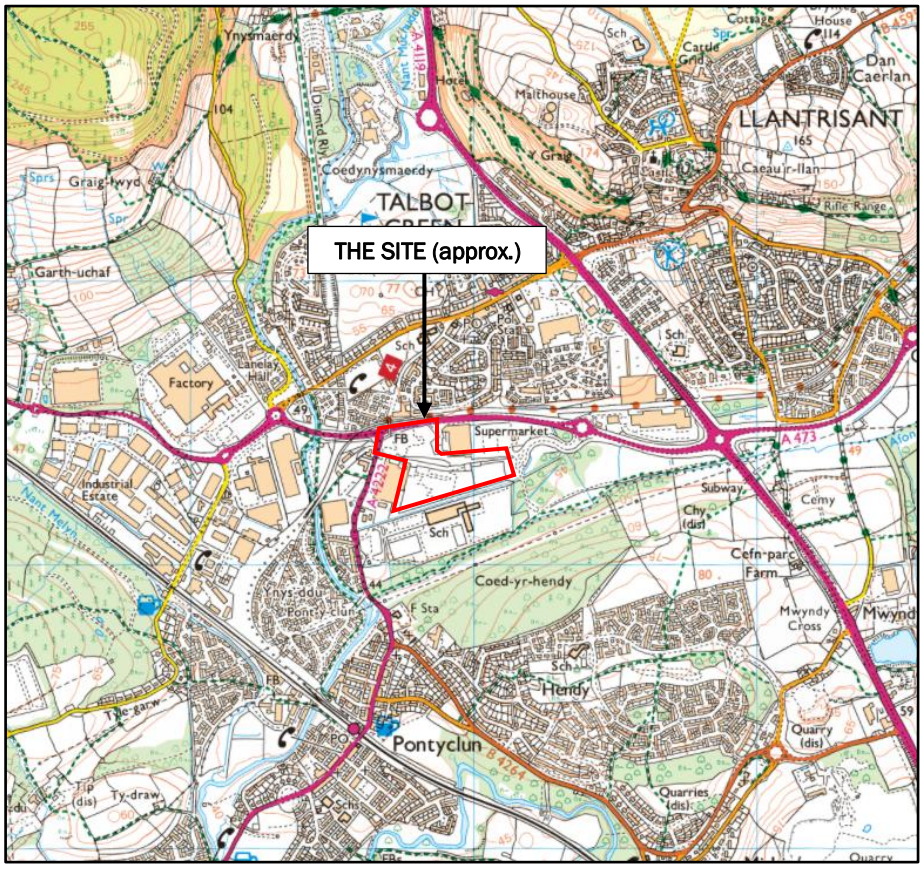
2 Desk Study and Field Reconnaissance Visit

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, and a mining report obtained from the Mining Remediation Authority. Further desk study reports/data/records are included as subsequent appendices as referenced in the text.

The site description is largely based on a field reconnaissance and site inspection visit made at the site on 14th January during dry and cold weather, and general views of the site are included as a series of photographs within the Plates, with inserts also included within the text where required.

2.1 Site Location and Description

The site is located south of the A473 and east of the A4222 in the southwest of Talbot Green in the county of Rhondda Cynon Taf. The National Grid Reference of the approximate centre of the site is (ST) 303891E, 182334N, and the nearest available postcode is CF72 8FN. A Site Location Plan is presented as Insert below.



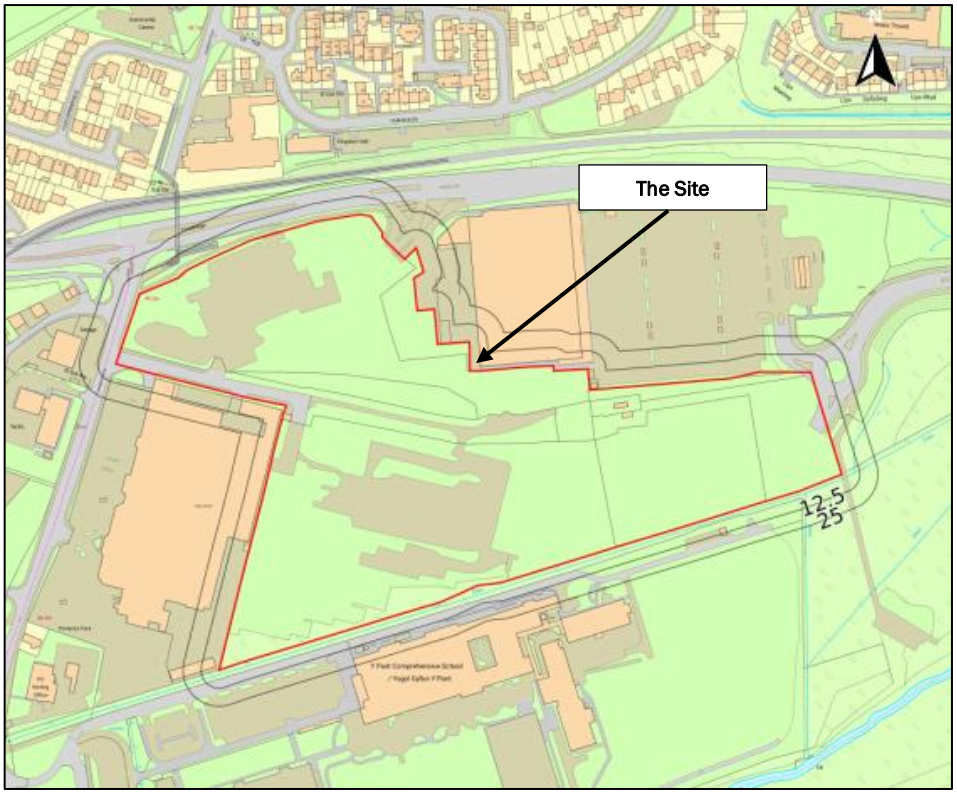
Insert 1 - Site Location Plan from Ordnance Survey 1:25,000 scale map.
Reproduced with permission (OS License No.: AL100015788).

The site comprises an irregular shaped parcel of land of around 275m length (north to south) and 450m width (east to west), occupying an area of around 7.3ha. It is currently unoccupied, with large areas of hardstanding (concrete slabs and localised tarmacadam roads) associated with former land uses (see Section 2).

2.1.1 Current Site Status

To show the current status of the site, an aerial image of the current site status is shown as Insert 2 below, followed by an OS site plan from the data report in Appendix C as Insert 3. for reference.

Insert 2 - Site Plan from Google Maps (Image taken May 2023)



Insert 3 – OS Mapping Site Plan from data report (Appendix C)

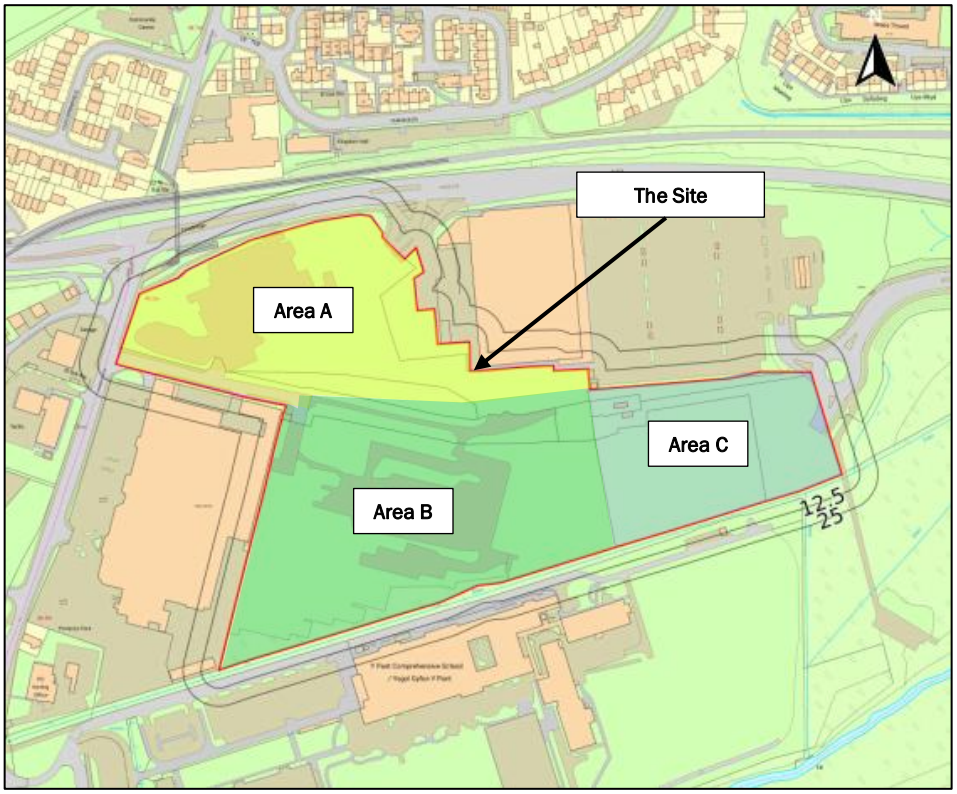
2.1.2 Site Boundaries, Access and Surroundings

The site is bounded by:

- To the north: the A473 in the west portion, with Sainsburys store and car park in the east portion.
- To the east: by Sainsburys store and an area of woodland.
- To the south: immediately by a drainage channel, followed by Y Pant comprehensive school.
- To the west: the A4222 (Cowbridge Road) and Leekes department store.

Vehicular access to the site is currently gained via a gate north of the existing Leekes department store. Access can also be gained through large concrete bollards via the former entrance in the west of the site (see insert 2). The site boundaries generally comprise post and wire fences to the west, south and north. The east of the site is open to the new road layout constructed as part of the adjacent Sainsburys development.

To aid in the description of the site in this section, the site has been separated into three areas (Area A, B and C) as shown on Insert 4 below.



Insert 4 – OS Mapping Site Plan from data report (Appendix C) – See Below Site Descriptions

Area A

This comprises a large area of former hardstanding, located in the central and west, with the remainder being open grass/scrub where some scrub and limited small trees have been recently cleared by the Client (see Plates 1 & 2). In the northwest, a former possible pumping station associated with former water mains remains.

In the east, an inaccessible fenced area is present, with evidence of previous ground investigation (probable borehole covers), with a cleared path leading to a narrow strip of land adjacent to the existing Sainsburys store to the north and further evidence of previous investigation and standpipes in the ground. (see Plates 3 to 6).

Area B

This comprises the former entrance to the site (previous use – See section 2) and a localised area of tarmacadam. The central area is occupied by a large concrete slab, with further areas of concrete and tarmacadam in the south and southwest. Steel runs were identified within the concrete in the central area, possibly associated with former crane/lifting runs or reinforcement to the slabs. Several drain covers were also identified but could not be lifted (see Plates 7 to 12).

In the west portion, possible fill was identified by a raised area which doesn't seem consistent with the adjacent levels to the north, east and south.

The east extent is marked by a fence line which trends roughly north to south, separating Area B and area C, with only a small access point between the two (pedestrian) at the north extent of the fence. The southeast portion of Area B is largely dense vegetation and wooded areas which have been recently partially cleared by the Client to allow access (see Plates 13 to 15).

Two derelict structures are present in the east portion, resembling possible old train carriages or narrow temporary cabin-type buildings.

Area C

This comprises an open field with the Area B/Area C fence line in the west, partial fencing in the north, a fence line along the south boundary and open access in the east/northeast. Areas of trees are present in the south and west, with recently cleared ground across the central area.

The ground level is approximately 1 to 2m below the land to the north and east in some areas, indicating that the recent Sainsburys development may have raised ground levels in some areas to create a level platform for development (see Plates 16 to 18).

2.1.3 Existing Surveys

ESP are not aware of a tree survey having been undertaken. A tree survey should be completed by a specialist arboriculturist prior to development, to understand the extent and species of the trees that are to be removed or preserved as part of the development works.

A topographic survey has been provided by the Client and indicates Area A to be in the region of around 48.5m AOD, with a slightly elevated central area of around 49m AOD. Area B is shown to be at approximately 47.5m in the north and 46.8m in the south, also sloping to around 45.5 in the east. An elevated area is also present in the east of Area B, rising to around 48.3m AOD. Area C is shown to be at a level of around 46.5m in the west and 45.7 in the east.

Variations in ground levels across all of the three areas (see insert 4) are present, however the above provides an overall indication of the site levels, which generally fall to the south/southwest to the river.

The topographic survey has been reproduced as Figure 2, however due to the size of the site and the resolution of the data, the site levels are not clearly identifiable; the digital version has been provided by the Client and is presented in Appendix P at the rear of this report. This should be referred to for detailed elevations of any specific areas.

2.1.4 Services

As part of this assessment, service plans have been obtained by ESP from the utility companies – copies of this service information are presented in Appendix O at the rear of this report.

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

- 11kV Electricity cables in the northwest, trending along the north boundary also extending south and then east along the former access road. These cables then extend east through the approximate centre and trend south to the boundary (along the fence line between Areas B and C).
- Low pressure gas mains in the northwest.
- An intermediate pressure gas main trends roughly southwest to northeast in the south.
- A 160mm HDPE water main extends along the north boundary, with a 7-inch cast iron main shown to extend into the access road off the A4222 in the west, which terminates approximately 10m into the road.
- A private sewer is shown on the east margins, extending north to south along the boundary.
- BT cables are shown along the north boundary and along the access road in the west.

For ease of reference, the above services have been included on Figure 3.

2.1.5 Evidence of Placed Materials

No significant areas of obvious contamination have been identified, however there are areas where evidence of possible fly tipping have been identified in the west within the area of the former site entrance/security house (see Plate 8).

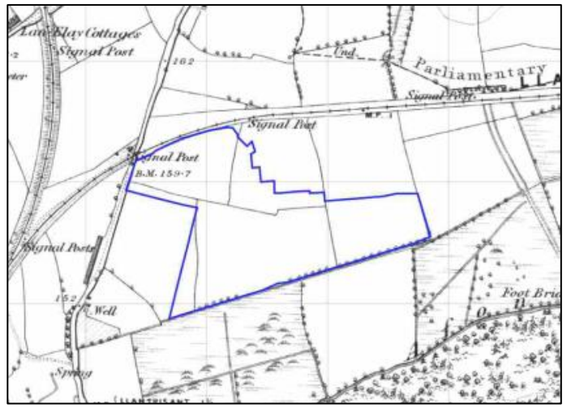
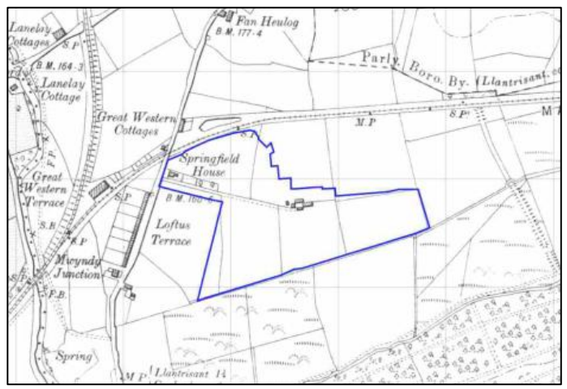
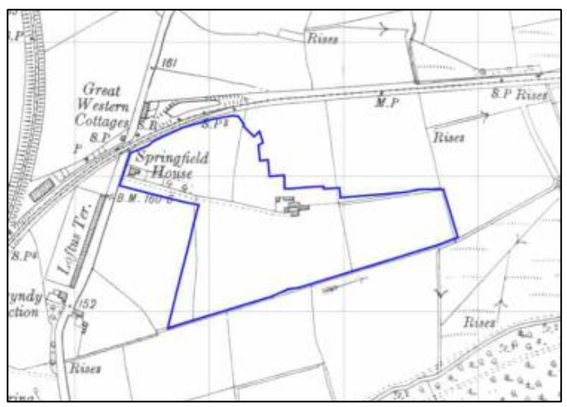
In the east extent of the site, materials (tarmacadam, brick and concrete) have been noted immediately adjacent to the recently constructed access road for the Sainsburys store. These were likely excess materials left during construction.

2.2 Site History

2.2.1 Published Historical Maps

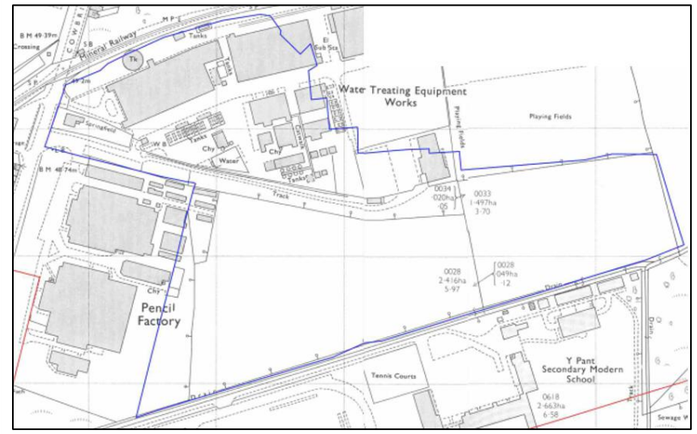
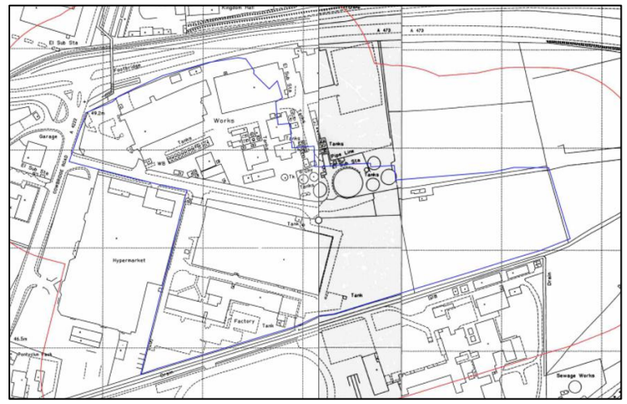
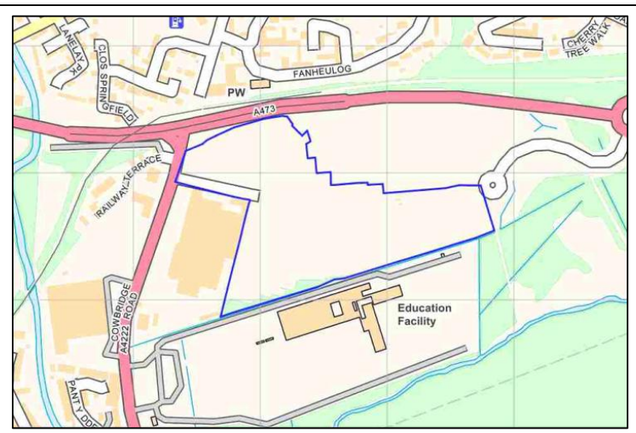
The site history has been assessed from a review of available historical Ordnance Survey County Series and National Grid maps. The historical maps are presented in Appendix B, and the salient features are summarised in the table below.

Table 1: Review of Historical Maps

Date	On-Site	In Vicinity of Site	
1875-1878	No significant features are noted, and the site is within an area of wider fields. A railway line extends along the northwest boundary and may encroach onto the site. A line of trees is shown along the south boundary.	The Llantrisant and Taff Vale Junction Railway Line extends along the north of the site, trending east with a further connected railway line extending roughly north to south some 125m west. A cutting is also identified north of the track. An old tramway is identified approximately 150m east. A road trends roughly north to south and is located almost immediately adjacent to the northwest portion of the site. A well is identified some 135m west from the southwest of the site. The Afon Clun River is shown approximately 180m south of the site at its closest point. Coed Yr Hendy woods is located around 190m south, immediately south of the river. The Afon Elai (River Ely) is around 225m west at its closest point. A gasworks and gasometer are shown around 320m northwest. Talbot Row village is shown around 460m north. Lan-Elay Colliery and an associated shaft and engine shed are identified approximately 600m southwest, with a further shaft noted 735m west. An airshaft is identified approximately 730m southeast and 8no. ironstone shafts are identified between around 700m and 1,200m to the southeast. An Old Coal Level is shown to the southeast, connected to the tramway.	
1897-1899	Springfield House is now shown in the west, with likely private gardens extending east/southeast. A cluster of 5no. small unnamed buildings are also noted in the north portion of the approximate centre of the site.	A row of residential properties is (Loftus Terrace) shown 25m west at their closest point, extending southwest. Great Western Cottages are also identified some 25m north., with Great Western Terrace also shown around 95m west. Lan-Elay Colliery is now named Cardiff Navigation Colliery and appears to have expanded. An Old coal level is also noted around southeast adjacent to the previously identified air shaft, which now named as Old Air Shaft. The gas woks previously identified are now not shown. A small pond is noted within the cutting adjacent to the track identified previously. Large areas of marshy ground are noted adjacent to the site to the east/southeast.	
1914-1948	Springfield house and associated gardens appear to have expanded, and further structures are noted in the centre to the east of Springfield House.	Talbot Row has expanded, and further small residential areas have developed within around 500m of the site. The railway lines to the north and west appear to have expanded. North of the site and just north of the railway earthwork, a large residential development has been constructed, with a council yard also present approximately 50m north of the site.	

Continued Over.

Table 1 (Continued): Review of Historical Maps

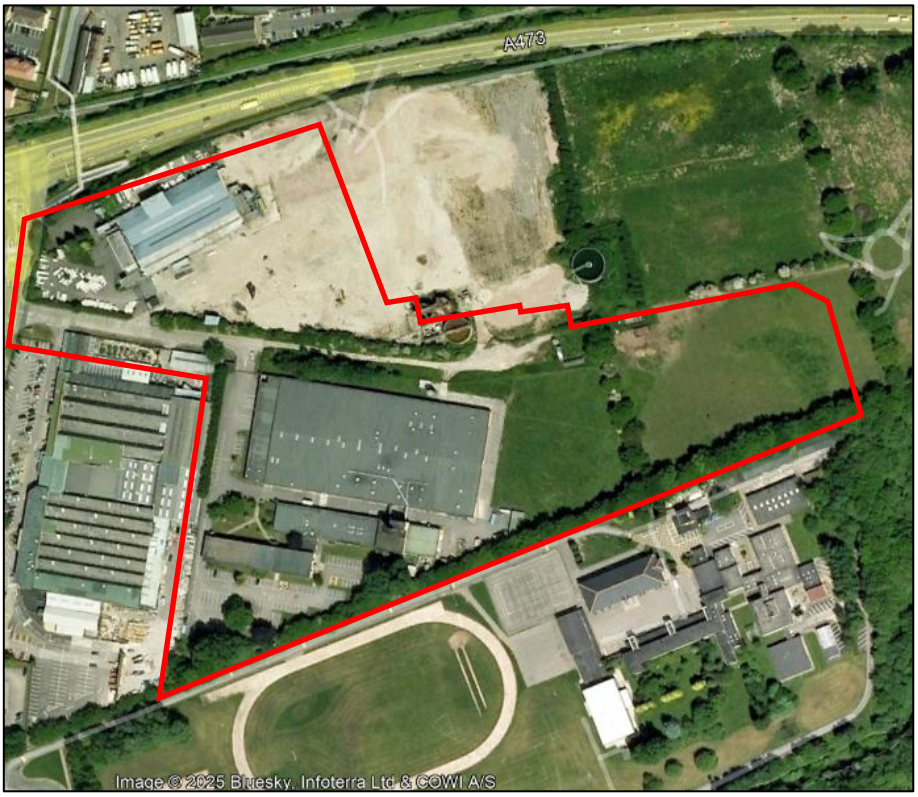
1962-1974	Springfield House remains and a significant 'Works' development has been constructed across the site, with the majority of the buildings located in the northwest and central portions. From around 1970, the works are named as Water Treating Equipment Works. Two large structures are noted in the northwest, with further structures to the south, with a notable number of 'Tanks' two chimneys and several other structures, including an electrical substation. Railway lines are also now present along the north of the site, trending southwest to northeast and joining the railway line to the north of the site. A structure is also noted to be named 'Water' and is likely a large water tank or bunded water storage area. A road/track now enters the site from the west from the road adjacent to the site (now named Cowbridge Road) and trends east/southeast into the site, terminating at the approximate centre. Three buildings possibly associated with the adjacent pencil factory are located in the west, below the onsite Works.	A drain now extends along the south boundary, trending southwest to northeast. South of the drain in, Y Pant Secondary Modern School and associated grounds has been developed. Immediately west of the site is now a Factory, with two large structures and several associated smaller structures. This is named as a pencil factory from 1970. A chimney is noted almost immediately adjacent to the site in the southwest portion. An electrical substation is note immediately adjacent to the site in the northeast. The railway lines have expanded further, and the line north of the site is named Mineral Railway. Cardiff navigation Colliery is no longer shown and the area I now replaced with a large 'Works'. Talbot Row has expanded significantly and is now named as the town Talbot Green. The marshy ground to the east/southeast appears to have had several drains (likely surface channels) installed.	
1979-2001	The works in the north of the site has expanded further, with a significant number of tanks now shown in the northern central portion. A further large structure and factory are now shown in the southwest of the site, with associated tanks and infrastructure.	The adjacent former Pencil Factory is no longer present, and a Hypermarket is now shown in its place. The railway north of the site remains until around 1991, with a road shown from around 1992 (now the A4222). A garage is noted some 15m west of the site, with a Telephone Exchange building south of this. The council yard to the resembles earlier layouts and is now also shown to have a tank within its boundary and a depot is now shown just to the west of the council yard, also with associated tanks. The surrounding area has expanded significantly and resembles the current day layout. No large scale 1:2,500 mapping is available from 1993/1995.	
2010 to present	From 2010, the large works occupying the north and north centre of the site is no longer shown. No mapping is published between the 1:10,000 scale 2001 and 2010 maps to narrow the demolition/decommissioning dates. We understand these works were a Purolite Factory The 2024 1:10,000 published map indicates the factory in the south to have been demolished by 2024. Again, no mapping is published between these dates to determine a more accurate date of demolition.	The surrounding area has expanded significantly and resembles the current day layout.	

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 following images have been reviewed using the historical imagery tool on Google Earth ©.

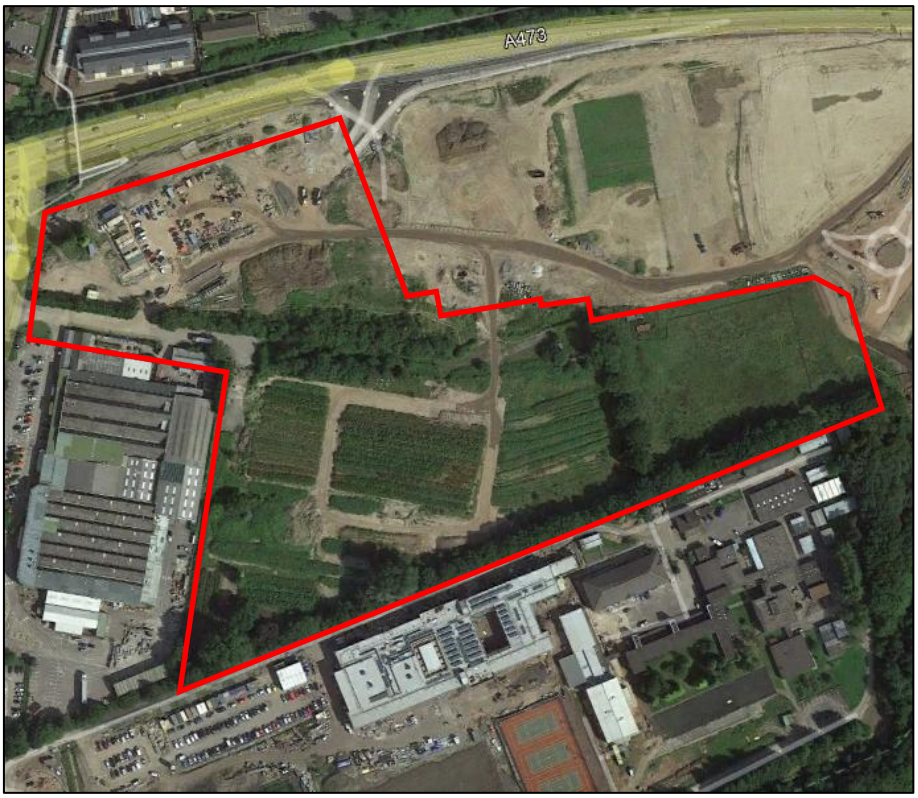
Insert 5 – Image of the site from 2001 (site boundary approximate only).



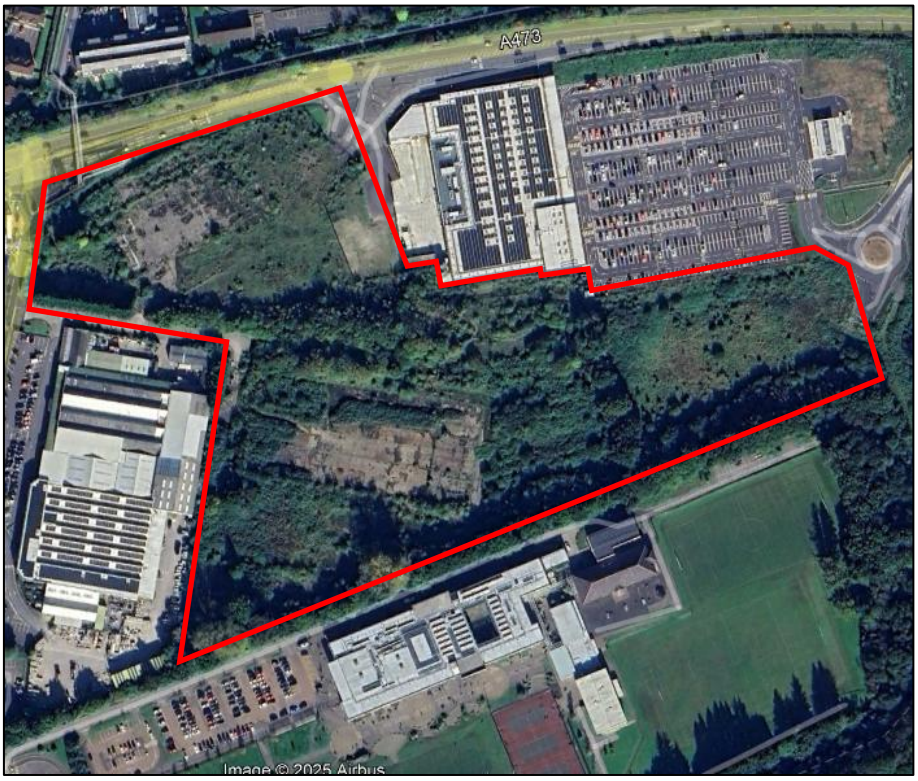
Insert 6 – Image of the site from 2006 (site boundary approximate only).

Insert 7 – Image of the site from 2009 (site boundary approximate only).

Insert 8 – Image of the site from 2013 (site boundary approximate only).



Insert 9 – Image of the site from 2016 (site boundary approximate only).



Insert 10 – Image of the site from 2024 (site boundary approximate only).

2.2.3 Summary of Site History

From the review of historical maps and other mapping sources, the site remained largely as open fields (with the exception of the construction of Springfield House in the late 1890's) until around the early 1960's, when the northwest portion of the site was developed with a Water Treating Equipment Work, which continued to expand within the site into the early 2000's. From the late 1970's, a further works/factory was developed in the southwest portion.

Reference to the Coflein website[1] (the online database for the National Monuments Record of Wales (NMRW)), the works on site were '*The chemical production division of the water purifying company, Permutit, was established near Talbot Green after WW2 (the company had been involved in the production of Sea Water Desalting Apparatus for war use). The company later changed its name to 'Purolite'. The building was closed and then demolished in the 1990s.'*

As shown by the aerial imagery from Google earth ©, the works in the northwest portion of the site were partially demolished between 2001 and 2006 and are seen to have been completely removed by 2009. The works in the southwest portion remained until 2009 and were demolished sometime between then and 2013. As seen on the imagery, large areas of concrete slabs remained.

In the 2013 image, the northwest portion of the site is likely being used as a compound for ground preparation/investigation works for the recently constructed Sainsburys food store, which is shown completed in the 2024 image.

With the exception of some recent vegetation clearance undertaken by the Client, the site remains as per the image shown from 2024.

2.3 Previous Investigations and Assessments

As detailed in Section 2.4, liaison with Rhondda Cynon Taf County Borough Council (RCTCBC) and reference to the publicly available online planning portal has identified several planning applications relating to the site which will likely include a number of investigation and assessment reports, including remedial works. The list of planning references is included within Appendix E and each application will likely contain previous investigation/assessment reports for the site.

ESP recommended that this current assessment should include a review of all available past information; however, this has not been instructed at this stage.

Prior to the above instruction from MG, ESP had identified a past report which was undertaken by Opus in 2011, comprising a *'Geo-Environmental Interpretive Report'* (ref: C7915.00-RepG01. Rev R1). The report includes findings of multi-method intrusive works across the site and wider areas, details of the ground model identified, risks from historical mine workings, identification of potential risks to human health and controlled waters (including remedial works recommendations) and geotechnical/geo-environmental advice and recommendations. No detailed review has been completed, however as the report has been briefly viewed by ESP, some information has been included where relevant.

[1] https://coflein.gov.uk/en/site/418827/

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

2.4 Contact with Regulatory Bodies & Local Information Sources

Liaison with RCTCBC planning department has identified several historic planning register items which may be pertinent to the site. These are summarised in the table below.

Table 2: Summary of Historic Planning Applications provided by RCTCBC

Ref	Status	Type	Location	Further Details
11/1330/OUT	*Granted*	*Outline Application*	*Land Adjacent to Cowbridge Road and A473 (Inc Leekes Dept Store Former Purolite Works and Staedtler Factory Site) Talbot Green CF72 8XU*	*Development of new town centre comprising: a 10,801sq m gross food store (Class A1); 8 pump petrol filling station; 35,522 sq. m gross retail floor space (Class A1); 600sq m gross cafe space (Class A1); 1,000sq m financial/professional service space*
19/1267/DIS	*Granted*	*Discharge of Condition/s*	*Land South of A473 Talbot Green*	*Discharge of conditions - 16 (Validation report), 52 (Verification report) and 53 (Long term monitoring and maintenance plan) of previous application 12/1102/10.*
18/0798/DIS	*Application Withdrawn*	*Discharge of Condition/s*	*Land South of A473 Talbot Green (North - East of Leekes Dept Store)*	*Discharge of conditions 16 (validation report for contamination), 52 & 53 (reports on sampling, monitoring, maintenance and contingency action carried out in accordance with a long-term monitoring and maintenance plan of controlled waters) of previously*
23/0848/ADV	*Granted*	*Advertisement Consent*	*Land South of A473 Talbot Green Cowbridge Road Talbot Green Pontyclun CF72 8XU*	*Erection of a retail concession pod and associated signage (advertisement consent)*
23/0849/FUL	*Granted*	*Full Application*	*Land South of A473 Talbot Green Cowbridge Road Talbot Green Pontyclun CF72 8XU*	*Erection of a retail concession pod and associated signage*
20/0988/FUL	*Refuse*	*Full Application*	*Former Purolite Site Cowbridge Road Pontyclun*	*Change of use to B8 for use as a storage facility (storage containers and caravans). (Preliminary Ecological Appraisal rec. 13/05/2021)*
17/0559/RVOC	*Granted*	*Renewal/Variation of Condition*	*Land Adjacent to Cowbridge Road and A473 Talbot Green CF72 8XU*	*Section 73 application seeking the variation of Condition 2 as imposed on outline planning permission 11/1330/13 (Development of new town centre comprising: a 10,801sq m gross food store (Class A1); 8 pump petrol filling station; 35,522 sq. m gross retail*
05/1514/RVOC	*Granted*	*Renewal/Variation of Condition*	*Purolite International Ltd Cowbridge Road Talbot Green Pontyclun CF72 8YL*	*Variation of Condition No 7 as imposed on Planning Permission Ref. 04/1820 (Remediation Works) to allow a raised clean up target for Ethyl Benzene to 300 mg/kg(amended description 05/05/06).*

Continued Over.

Table 2 (Continued): Summary of Historic Planning Applications provided by RCTCBC

Ref	Status	Type	Location	Further Details
12/1102/FUL	*Granted*	*Full Application*	*Land South of A473 Talbot Green (North - East of Leekes Dept Store)*	*Erection of a supermarket (class A1), service yard, car park, petrol filling station, new customer access road and new access from A473 and associated development (Amended vehicular and pedestrian accessibility, landscaping and elevation plans received*
16/0624/DIS	*Application Withdrawn*	*Discharge of Condition/s*	*Land South of A473 Talbot Green (North - East of Leekes Dept Store)*	*Discharge Condition 14 of planning permission 12/1102/10.*
16/0260/DIS	*Raise No Objection*	*Discharge of Condition/s*	*Land South of A473 Talbot Green (North - East of Leekes Dept Store)*	*Discharge of Condition 14 (Chemical Testing Soil Material/Aggregate) and Condition 34 (Oil and Petrol Interceptor) of previously approved planning application Talbot Green 12/1102/10.*
16/1098/DIS	*Granted*	*Discharge of Condition/s*	*Land South of A473 Talbot Green Rhondda Cynon Taff*	*Discharge of condition 14 (Soil Importation) of approved application 12/1102/10*

Several further references are also included which relate to the newly constructed Sainsburys food store immediately east of the site, which may include information for this study site.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

2.5 Hydrology

2.5.1 Surface Water Features

Based on the information in the data report (Appendix C, the nearest major surface water feature to the site is the Afon Clun which flows from east/northeast to west/southwest approximately 157m to the southeast. A number of smaller water courses and drains are also present in the area, the closest of which lies some 2m to the south. (see Appendix C).

The historical map review identified areas of marsh ground to the east/southeast, which later had drains installed, sometime in the early 1960's.

2.5.2 Surface Water Abstractions

The data report (Appendix C) indicates that there are no surface water abstractions within 1,000m of the site.

2.6 Flooding

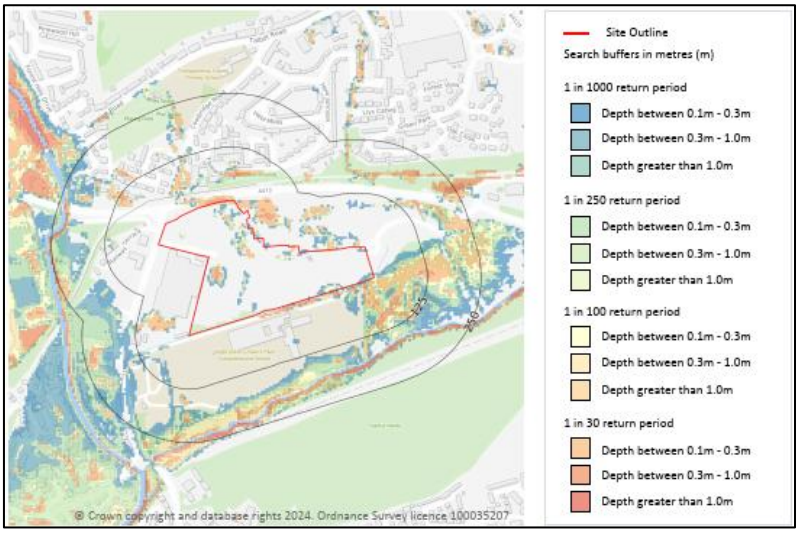
2.6.1 Rivers and Seas

From a review of topographical plans and flooding maps presented in the data report and on the Natural Resources Wales (NRW) website the site is indicated to be at risk flooding from rivers or seas and is located within a Flood Zone 3/Flood Zone 2.

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

2.6.2 Surface Water

From a review of the date report the highest surface water flooding risk on the site is indicated to be 1 in 30 years, 0.3m - 0.1m, which equates to a high risk Locally). A high risk means that each year, this area has a chance of flooding of greater than 3.3% (1 in 30). The risks from surface water flooding are show in Insert 11 below.



Insert 11 – Extract from Section 8 of Appendix C – Areas at Risk from Surface Water Flooding

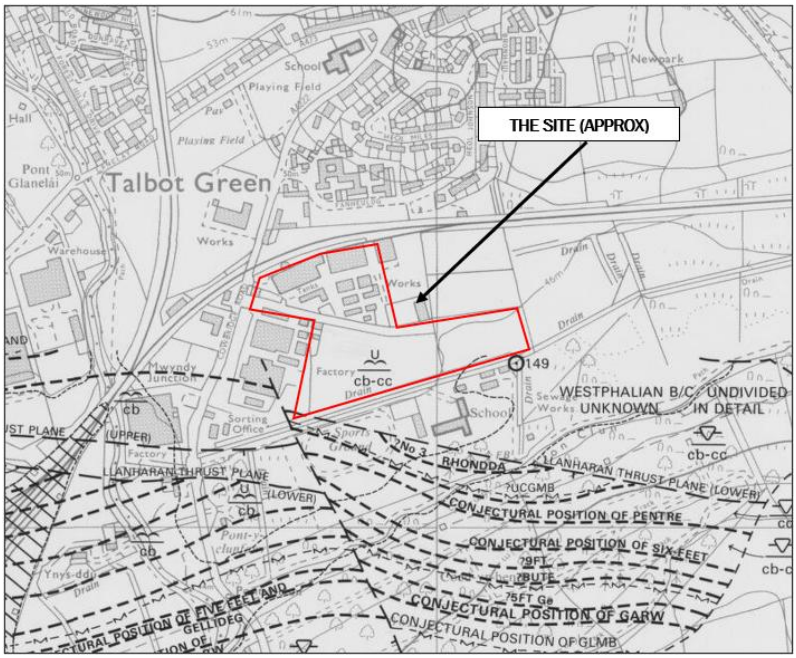
2.6.3 Groundwater

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

2.7 Geology

2.7.1 Published Geology

The published 1:10,560 scale geological map for the area of the site (Sheet ST08SW), available on the website of the British Geological Survey, 2025 and presented as Insert 12) indicates the site to be underlain by River Terrace Deposits (undifferentiated) overlying bedrock of the South Wales Middle Coal Measures Formation. Detailed mapping data is not available for the majority of the site, as shown on the insert below.

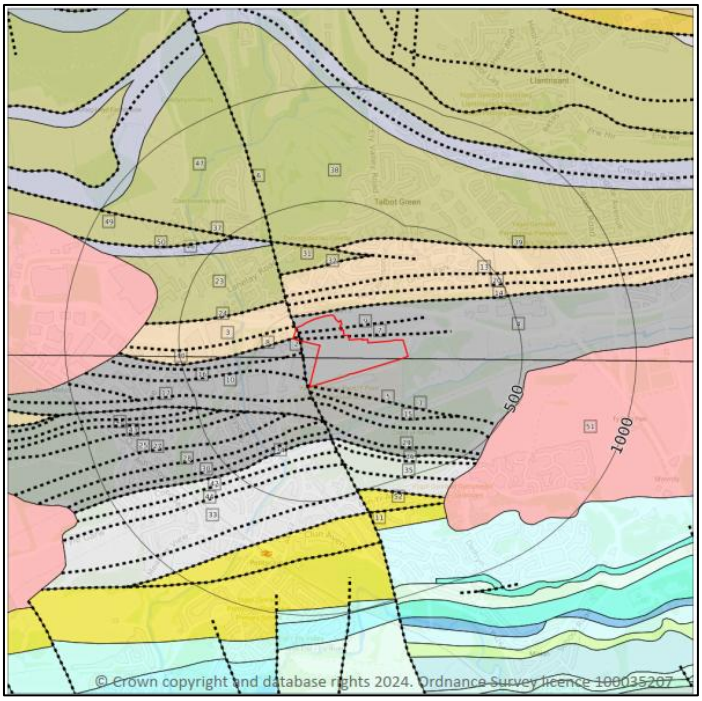


Insert 12 - Extract from BGS Geological Map Sheet SS68NW, original 1:10,560 scale. Reproduced with permission (BGS licence number: C15/05 CSL)

Reference to the up-to-date mapping available on the website of the British Geological Survey (BGS, 2025) indicates a similar succession, but the River Terrace Deposits are named River Terrace Deposits, 1 (sand and gravel). An area of Alluvium is also shown in the southeast portion.

The River Terrace Deposits (RTD) superficial strata would be expected to comprise sand and gravel, locally with lenses of silt, clay or peat. The Coal Measures bedrock comprises an interbedded succession of sandstone, siltstone and mudstone, with coal seams and associated seat earths.

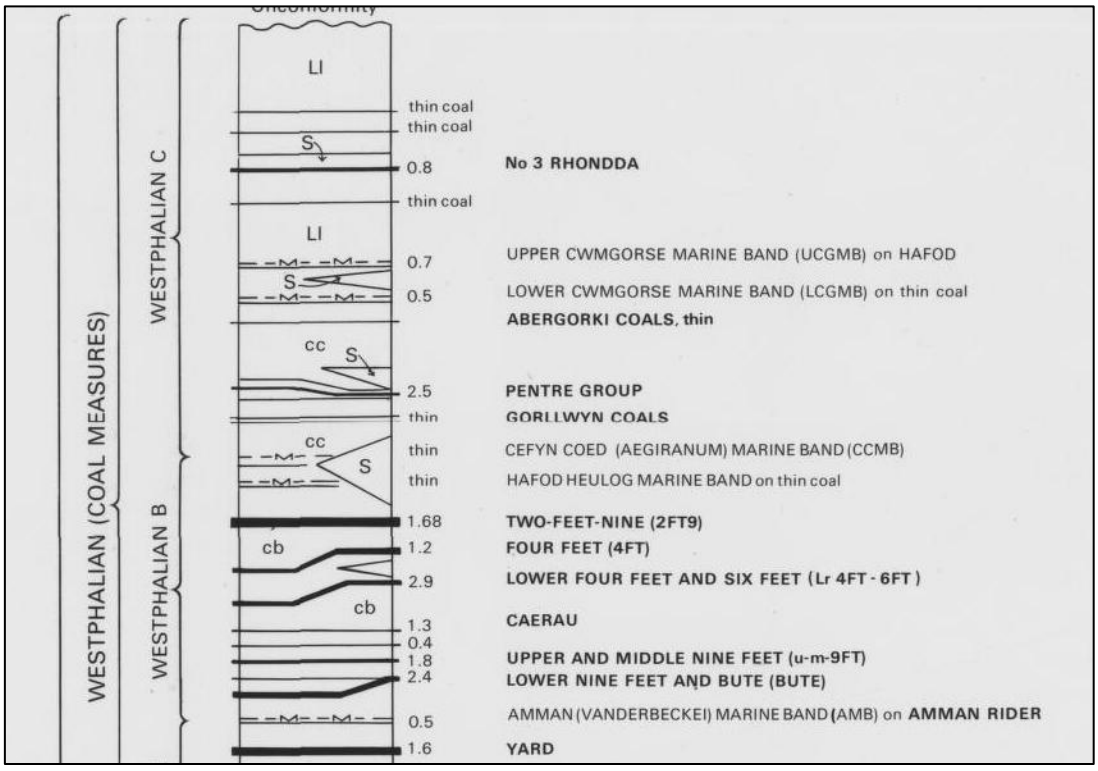
The 1:10,560 map (see insert 13) indicates no conjectured outcrops on site as the data does not cover the site. However, reference to the 1:50,000 scale map (Sheet 248) and the data report (Appendix C), identifies possible coal outcrops on site, as shown on Insert 13 below.



Insert 13 - Extract from Section 15.8, Appendix C – Bedrock Geology

A fault is present on the west boundary, thrusting to the south.

The No.3 Rhondda seam is shown to the south of the site, with several successions of seams extending further south. Based on the mapping and the locations of the outcrops, the general dip in the area is to the north (i.e., beneath the site), however no indication of the angle is provided. For reference, the stratigraphical section from the geological map (sheet ST08SW) is shown below in Insert 14.



Insert 14 - Extract from BGS Geological Map Sheet SS68NW, original 1:10,560 scale. Reproduced with permission (BGS licence number: C15/05 CSL)

This is addressed further in the mining discussion, presented in Section 2.10.1.

2.7.2 Available BGS Borehole Records

The British Geological Survey website (BGS, 2025) indicates the available records of 5no. useful boreholes on/adjacent to the central east portion of the site. Copies of the available borehole records along with a plan showing their positions relative to the site are presented in Appendix D.

Boreholes ST08SW298, ST08SW299 ST08SW301 and ST08SW302 indicate the general ground conditions to comprise approximately 2m of overburden/soils (presumed Topsoil and subsoil), overlying coarse gravels to between approximately 9m and 12m below the surface. In BHST08SW298, the gravels are shown to extend down to around 20.5m depth.

Bedrock is identified beneath the gravels and proved to a maximum depth of 92m (ST08SW298) and 98.2m (ST08SW299), described as *'Middle-Upper Coal measures, Undifferentiated).'*

Borehole ST08SW300 is progressed to 140m below the surface and identified *'soils'* to 3m, followed by sands and gravels to 11m depth. This is underlain by Sandstone, proved to 98m, followed by shale to 100m, coal to 103m and shale to 140m.

2.7.3 Available Previous Investigation Records

Extensive historical works have been completed at the site, however as MG instructed ESP not to review any past information at this stage, no previous investigation point records have been reviewed as part of this assessment.

An initial brief review of the report text indicates the site to be underlain by Made Ground, River Terrace Deposits and Coal Measures bedrock. Limestone bedrock is also noted in the far southeast of the site. Limited information obtained from the brief review completed has been incorporated where appropriate within this report.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

2.8 Hydrogeology

2.8.1 Aquifer Classification

The data report (Appendix C) indicates that the superficial deposits and bedrock beneath the site are classed as Secondary A Aquifers.

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

2.8.2 Anticipated Groundwater Bodies

The previous investigation at the site (Section 2.3) identified groundwater generally at a level of around 3.5m within the River Terrace Deposits across the wider investigation area, much of which included this study site. Sshallower groundwater was encountered locally (up to around 0.5m depth).Perched water bodies within the shallow superficial soils and Made ground may be present.

The groundwater gradient is likely similar to the topography at the site to the south/southwest towards the Afon Clun.

2.8.3 Abstractions and Groundwater Vulnerability

The data report (Appendix C) indicates that there are no groundwater abstractions or Source Protection Zones within 1,500m of the site. The groundwater vulnerability is shown in the data report (Appendix C) to be medium to low.

2.8.4 Groundwater Movement

The previous investigation identified that monitoring has shown '*a general south to south-westerly flow within the River Terrace deposits'*. This is in line with the topography sloping towards the Afon Clun.

In former mining areas, groundwater conditions may still be changing in response to the cessation or reduction in pumping from underground coal workings (see Section 2.10.1).

2.9 Environmental Setting

2.9.1 Summary of Environmental Data

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

Table 3 - Summary of Environmental Data

Feature	On the Site	In the Immediate Vicinity
Potentially Contaminative Historical Land Use	See Section 2.9.2.1.	See Section 2.9.2.1.
Historical Tanks, PFS, Garages, Energy Facilities	See Section 2.9.2.2.	See Section 2.9.2.2.
Waste and Landfill	See Section 2.9.2.3.	See Section 2.9.2.3.
Current Industrial/ Commercial Sites	See Section 2.9.2.4.	See Section 2.9.2.4.
Contaminated Land under Part 2A EPA 1990.	See Section 2.9.2.5.	See Section 2.9.2.5.
Licensed Industrial Activities/Pollutant Release (IPC, Part A (1), Part A (2)/B)	See Section 2.9.2.6.	See Section 2.9.2.6.
Radioactive Substance Sites	None identified.	None recorded within 500m of the site.
Discharge Consents	None identified.	See Section 2.9.2.7.
List 1 and 2 Dangerous Substances Sites	See Section 2.9.2.8.	See Section 2.9.2.8.
Pollution Incidents	See Section 2.9.2.9.	See Section 2.9.2.9.
Environmentally Sensitive Sites[2,3]	None identified.	See Section 2.9.2.10.

Notes:

1. Full details of features presented in the data report (Appendix X).
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

Extensive on and off-site industrial developments have occurred in the past and the following is only a brief summary. Full details of the historical information are presented in Appendices B and C.

2.9.2.1 *Potentially Contaminative Historical Land Use*

On Site

Unspecified factory, unspecified tanks, unspecified works, railway sidings.

Off Site (within 50m)

Tanks and garage 10m northwest. Railway sidings, unspecified pit, telephone exchange, unspecified works, council yard, corporation yard.

2.9.2.2 *Historical Tanks, PFS, Garages, Energy Facilities*

On Site

As shown in Table 1 and the historical maps in Appendix B, a large number of tanks have been identified at the site from past land use. No details on what the tanks were storing is available. Electrical substations associated with the former works have also been identified to encroach onto the site, as shown in the historical mapping.

Off Site (within 50m)

Several tanks and sub-stations are noted within 50m of the site.

2.9.2.3 *Waste and Landfill*

No former landfills have been identified on site. The closest landfill is noted to be 441m northwest, for inert waste, with the licence held by the former Mid Glamorgan Council in 1990. An historical waste site is also noted 414m west, associated with Blakemore Retail, comprising waste packaging compaction. The cutting identified to the north in the historical map review was also infilled.

2.9.2.4 *Current Industrial/ Commercial Sites*

On Site

The site is currently vacant (areas of hardstanding remain). Two tanks are noted in the data report (Appendix C) as recent industrial uses; however, these were not identified during the works.

Off Site (within 50m)

Several current industrial/commercial sites are present within 50m of the site including an MOT centre/garage 40m west, telephone exchange 51m west and several electricity substations. Sainsburys food store and associated petrol station are also adjacent to the site to the north.

2.9.2.5 *Contaminated Land under Part 2A EPA 1990.*

None identified on or off-site (within 500m)

2.9.2.6 *Licensed Industrial Activities/Pollutant Release (IPC, Part A (1), Part A (2)/B)*

On Site

Integrated Pollution Control (IPC) records of substance releases to air, land and water are detailed in the data report, associated with Purolite International Ltd, with 15no. permits dating between 1994 and 2001. All permits are associated with the manufacture and use of organic chemicals.

One licensed pollutant release is also identified, associated with Steadler UK Ltd (the former adjacent pencil factory). A Type B permit was historically provided for the coating processes of the works. No enforcements are notified.

2.9.2.7 Discharge Consents

None identified on site. Within 50m, 2no. discharge consents are noted, both associated with Purolite International Ltd and relate to unspecified trade discharges to land, with one revoked in 1994 and the other in 2008.

2.9.2.8 List 1 and 2 Dangerous Substances Sites

These relate to discharges of substances identified on List I and List II of the European Directive E2006/11/EC and are regulated under the Environmental Damage (Prevention and Remediation) Regulations 2015.

One List I substance is identified, associated with the former Purolite International Ltd works, with the receiving water named as the River Ely and the authorised substance is 1,2-dichloroethane.

2.9.2.9 Pollution Incidents

On Site

- 2001 – Atmospheric pollutant (sulphide odour) – minor impact to air.
- 2003 – pollutant not identified – minor impact to air.
- 2003 – pollutant not identified – minor impact to air.
- 2003 – Atmospheric pollutant (chemical odour) – minor impact to air.

Off Site (within 50m)

- 2002 – Atmospheric pollutant (ammonia/amine odour) – minor impact to air (18m north).
- 2001 – Atmospheric pollutant (dust) – minor impact to air (47m north).
- 2003 – Atmospheric pollutant (dust) – minor impact to air and land (50m north).

2.9.2.10 Environmentally Sensitive Sites

An ancient semi natural woodland is listed 76m east.

2.9.3 On-Site Bulk Liquid Storage

As shown in Table 1 and the historical maps in Appendix B, a large number of tanks have been identified at the site from past land use. No details on what the tanks were storing is available. No tanks were identified on site during the walkover. Several tanks are noted within 50m of the site.

2.9.4 On-Site Bulk Materials and Waste Storage

Areas where evidence of possible fly tipping have been identified in the west within the area of the former site entrance/security house (see Plate 8).

In the east extent of the site, materials (tarmacadam, brick and concrete) have been noted immediately adjacent to the recently constructed access road for the Sainsburys store. These were likely excess materials left during construction.

2.10 Preliminary Geotechnical Risk Register

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

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 Upper Coal Measures, which contains several seams of coal (and bands of ironstone).

2.10.1.1 Historical and Geological Information

A summary of the mining features is discussed in historical map review in Section 2.2. Reference to the 1:50,000 scale map (Sheet 248) and the data report (Appendix C), identifies possible coal outcrops on site, tentatively identified to possibly be the No. 2 Rhondda; however, due to the scaling of the mapping, this is not certain. This is discussed further in the following sections.

2.10.1.2 Mining Remediation Authority Website

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

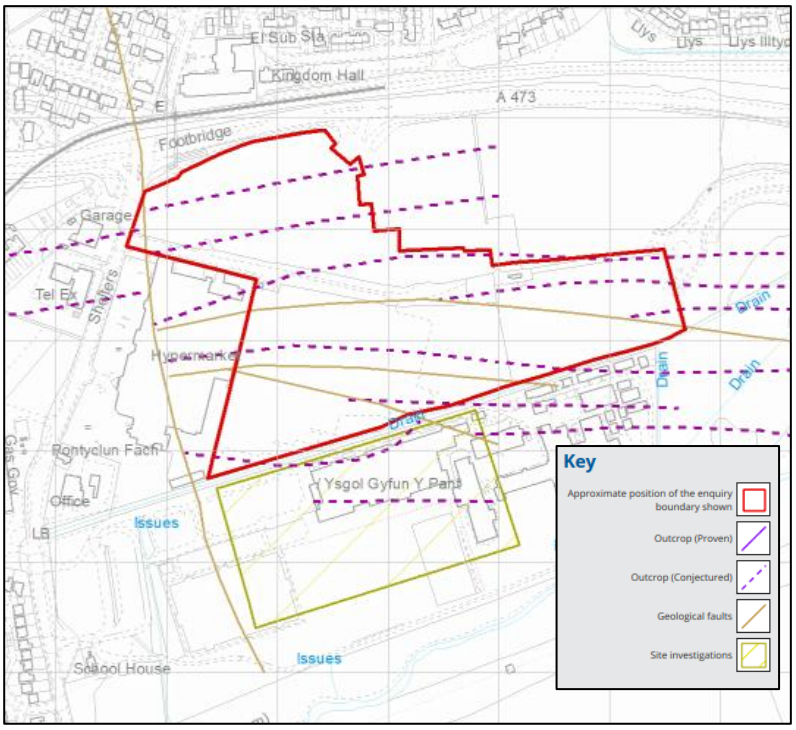
- The outcrop of several unnamed coal seams are shown to cross the site in a west-east trend.
- No past surface hazard or surface mining is identified in the vicinity of the site.
- No recorded or probable past shallow coal mining is indicated in the vicinity of the site.
- No mine entries are shown within the site boundary.
- The site lies 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 G. An image of the mapping associated with the report s also shown as Insert 14 for reference. This indicates that, based on the available Mining Remediation Authority records:

- No past underground mining is recorded.
- The outcrops of 7no coals seams are recorded within the site boundary, including the outcrop of the Four Foot, Hafod, Lower Pentre, No.3 Rhondda, Tormynydd Rider No.2, Two Foot Nine and Upper Six Feet coal seams.
- 4no. coals seams are also indicated to outcrop within 50m of the site.
- No probable unrecorded shallow mine workings are identified.
- No spine roadway recorded at shallow depth.
- There are no mine entries recorded within 100m of the site.
- A fault runs in a general northwest to southeast orientation, which down throw's strata towards the northeast. This intersects the site in the northwest margin. Further faulting is shown in a general west to east orientation across the southern portion of the site (see insert 14).

- There are no opencast mines recorded within 500m of 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. However, the report does state that this does not mean that mine gas is not present within the vicinity. The Mining Remediation Authority recommends that a more detailed Gas Risk Assessment is undertaken by a competent assessor.
- 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.



*Insert 15 - **Extract from Mining Remediation Authority (MRA) Report (Appendix G).***

2.10.1.4 Previous Investigation Information

Based on a brief review of a previous report text (Opus, 2011), *'none of the five boreholes identified any evidence of coal seams or mine workings to a depth of 30m.'*

No detailed review of the individual borehole findings or their location has been undertaken.

As shown in Insert 15 above, an investigation to the south (likely for the school) has also been undertaken. Further review should be undertaken to identify if the investigation is on the local planning portal.

2.10.1.5 Preliminary Coal Mining Risk Assessment

Although the previous report indicated no coal seams/workings to a depth of 30m, given that the superficial soils are potentially up to a depth of around 17m below ground level, dependant on the thickness of any underlying coal seams, there may be insufficient rock cover to mitigate the risk. As detailed in Section 2.10 above, there are several seams underlying the site and further works will be required to investigate their depth and status. At this stage, the risk from subsidence at the site is considered to be moderate.

Confirmatory drilling works will be required to confirm the risk.

2.10.2 Non-Coal Mining

The data report (Appendix C) identifies that *'Underground mine workings may have occurred in the past or current mines may be working at significant depth to modern engineering standards.'* This is in relation to Iron Ore mining. Ironstone mining was also noted on the historical mapping in the area.

The report also states that the *'Potential for difficult ground conditions are unlikely and are at a level where they need not be considered.'*

It is therefore considered that risk from iron ore mining at the site is low. This should be confirmed following the detailed review of all past information and during the supplementary drilling works to confirm the risk from coal mining.

2.10.3 Shrinkable and Swelling Soils

Trees are present across the site and a survey should be undertaken to determine the species and to indicate where trees are to be removed or are to remain as part of the development works.

The previous investigation at the site (see Section 2.3) identified localised fine-grained soils to be present at the site and based on the testing undertaken, these were identified to be generally of low plasticity and low volume change potential.

Confirmatory testing will be required and at this stage it considered that the risk from shrink/swell should be considered as low to moderate.

2.10.4 Karst Solution Features (Ground Dissolution)

Limestone bedrock was identified previously (Opus, 2011) underlying the site in the southeast. The limestone could be susceptible to chemical weathering, producing natural solution cavities in both the horizontal and vertical direction. Such features can cause uncontrolled subsidence at the surface in the right conditions.

The data report (Appendix C) includes information regarding ground cavities and sinkholes and identifies an area of sinkholes 369m south in an area of glacial superficial deposits (Diamicton) overlying Marginal Facies - Dolomitic Conglomerate.

At this stage, we consider the potential for ground dissolution impacting on the development is likely to be low, however this will require further investigation to confirm the absence of Marginal Facies bedrock.

2.10.5 Compressible Ground

The localised Alluvium deposits anticipated beneath the southeast extent site can comprise soils of low strength and are potentially compressible. The Made Ground soils anticipated beneath the site are also potentially compressible, particularly where organic materials are present, which could lead to significant settlement at the surface.

We consider the potential for compressible ground at the site is moderate and this should be confirmed during the investigation works.

The River Terrace Deposits would be low risk with regards to compressible ground.

2.10.6 Running Sand

The River Terrace Deposits anticipated beneath the site could contain bands of sand. The previous investigation (see Section 2.3) identified generally sand and gravel superficial deposits, within fractions of clay and silt. In general, groundwater was identified at around 3.5m, but shallower groundwater was encountered locally (up to around 0.5m depth).

Where bands of sand are located and if the groundwater is shallow, there is a potential for running sands. It is considered that the potential for running sands beneath the site is moderate and this should be investigated during the works.

2.10.7 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.

The previous report (Opus, 2011) did not identify any slag materials; however, on a former industrial site such as this, there is the potential for slag materials to be present within the Made Ground.

It cannot be discounted that any slag present on site could be volumetrically unstable and the risk from such instability should be considered moderate at this desk study stage.

2.10.8 Historical Underground Structures

Historical information indicates that buildings were formerly located in the west and central portions of the site, and these were demolished between 2001 and 2013 and are no longer present. Large areas of hardstanding remain from the probable floor slabs of the former buildings. Several other large structures and tanks were also present.

It is likely that foundations/underground structures associated with the former buildings/structures remain in the ground.

Any remaining structures 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.

2.10.9 Pyritic Ground

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

The previous report (Opus, 2011) identified elevated levels of sulphates within the shallow soils and groundwater.

It is considered that the potential for sulphate/pyrite attack on buried concrete would be moderate to high pending further assessment.

2.10.10 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 G (Zetica, 2025).

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

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 C) indicates that the site does not lie in a radon affected area as defined by the Health Protection Agency. The risk from radon is considered Low.

3 Preliminary Geo-Environmental Risk Assessment

Given that previous assessments have been undertaken at the site and information on the planning portal indicates remedial works may have been completed at the site, the following section should be viewed as preliminary only at this stage.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

Although no final development plans have been completed, it is understood that the development will comprise largely residential areas, with a portion of the site in the northwest shown to be retail/commercial (se Figure 1).

For the purposes of this exploratory investigation assessment, the site has been assessed generally in terms of the most stringent criteria for residential developments. Once the design proposals are finalised, further investigation and specific assessment in line with the proposed development (i.e., residential or retail/commercial) will likely be required.

The following section does not include any historical investigation information.

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

From the review of historical maps and other mapping sources, the site remained largely as open fields (with the exception of the construction of Springfield House in the late 1890's) until around the early 1960's, when the northwest portion of the site was developed with a Water Treating Equipment Work, which continued to expand within the site into the early 2000's. From the late 1970's, a further works/factory was developed in the southwest portion.

Reference to the Coflein website[2] (the online database for the National Monuments Record of Wales (NMRW)), the works on site were '*The chemical production division of the water purifying company, Permutit, was established near Talbot Green after WW2 (the company had been involved in the production of Sea Water Desalting Apparatus for war use). The company later changed its name to 'Purolite'. The building was closed and then demolished in the 1990s.'*

[2] https://coflein.gov.uk/en/site/418827/

It is considered that the following features on site could prove sources of diffuse and point source contamination that could impact on the development, environment or site users:

- Appendix C lists - List I substance identified, with the receiving water named as the River Ely and the authorised substance is 1,2-dichloroethane.
- Former Purolite Factory.
- Made Ground – general diffuse contamination.
- Railway Land – general diffuse contamination.
- Former above/below ground tanks– point source.
- Possible former Electricity sub-station – point source.
- Made Ground, superficial deposits and bedrock – potentially contain pyrite – general diffuse contamination.
- Potentially deep demolition arisings from previous buildings – general diffuse contamination.
- Asbestos within the shallow soils/any remaining demolition rubble.

Reduced contamination sources are noted in the east extent of the site where no previous development has occurred.

3.1.3 Potential Contaminants Present

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

Based on this guidance and our experience, 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).
- cyanide, sulphate, sulphide.
- polyaromatic hydrocarbon (PAH) compounds.
- petroleum hydrocarbons (inc. BTEX).
- Phenols.
- VOC's & SVOC's.
- 1,2-dichloroethane
- asbestos.

It cannot be confirmed if specific contaminants of concern were previously identified at the site and this will need confirming during the past information review.

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

3.1.4 Potential Sources of Hazardous Ground Gas

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.
- Petroleum hydrocarbons within shallow soils/groundwater – on site source.
- Chlorinated solvents within the shallow soils/groundwater – on site source.
- Infilled land north of former railway – off site source.
- Abandoned underground mine workings– on and off-site source.

Based on the guidelines presented by O'Riordan and Milloy (1995) and revised by Wilson et al (2009) and-BS8576 (2013), the above potential gas sources would generally be classified as of very low to low gas generation potential. If present, underground mine workings could pose a moderate gas generation potential.

CL:AIRE (2021) published a decision support tool for assessing the risks from mine gas to developments. Based on the support tool, the site could be within a moderate to high-risk zone from mine gas; however, further detailed assessment would be required to refine the potential risk category and confirm/disprove the presence of mine workings. Detailed mine gas assessment may be required in the future.

3.1.5 Potential Receptors

The site is being considered for redevelopment with a mix of land uses for commercial and residential purposes. The most vulnerable receptors with regards to any contamination or hazardous ground gas present are likely to be as follows.

- Future residents, the critical receptors being young children playing in private garden areas.
- Future employees and site visitors (e.g. shoppers), the critical receptors being employees outside during their break periods.
- Construction and maintenance workers.
- Buried concrete (foundations, drainage etc.).
- The water quality in the Afon Clun located 157m to the southeast
- The groundwater beneath the site.

3.1.6 Potential Migration Pathways

Based on the Conceptual Site Model 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 garden areas.
- Ingestion of soils and inhalation of dust in landscaping areas.
- Ingestion of edible plants and dust associated with such plants.
- Dermal contact with contaminated soils.
- Exposure to asbestos containing materials within the shallow soils.
- Potential explosive risk from flammable ground gas/vapours from on-site sources.
- Potential risk from toxic ground gas/vapours from on-site sources.
- Potential exposure to flammable or toxic ground gas/vapours originating from off-site sources – the near surface RTD are likely to allow free migration of any gas/vapours present.
- Chronic (long term) exposure to unacceptable levels of radon.

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 bedrock.

Afon Clun:

- Leaching of mobile contaminants to the groundwater beneath the site, and then on to the nearby surface water course.
- Surface run-off of contaminated leachate to adjacent stream/river.

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.

Although no final development plan has been completed, a large portion of the site is likely to be hard surfaced (see Figure 1); however, any soakaways constructed for the development will have the potential to leach contaminants from the infiltration strata, which could then impact on the groundwater beneath the site. In addition, areas currently covered by hardstanding may be following the development works (dependant on the locations of hardstanding's/roads etc) and leaching from these areas could occur. Further consideration will be required once the development proposals are finalised.

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 in Section 3.2.2 below.

3.2.2 Tabulated Preliminary Risk Evaluation & Plausible Pollutant Linkages

Table4: Preliminary Risk Evaluation & Plausible Pollutant Linkages (PPL)

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (residents)	Medium – potential for chronic levels.	High likelihood[2]	High Risk	Sampling of near-surface soils to confirm levels of total contamination present.
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Minor – standard PPE likely to be sufficient	High likelihood[2]	Moderate/ Low Risk	
	Leaching of soil contaminants	Impact on Groundwater /Potable Water	Medium – site lies on Secondary A aquifers	High likelihood[2]	High Risk	Sampling of near-surface soils to confirm levels of leachable contamination present.
	Leaching of soil contaminants	Impact on Afon Clun	Medium – site lies 157m from river	High likelihood[2]	High Risk	
Asbestos in shallow soils	Inhalation of fibres	Site End Users	Medium – potential for chronic levels	High Likelihood[3]	High Risk	Sampling of shallow soils for asbestos.
		Construction/ Maintenance Workers		High Likelihood[3]	High Risk	
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High likelihood[4]	Moderate Risk	Sampling of soils to confirm levels of sulphate, pH, and groundwater.
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	Severe – acute risk.		High Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		High Risk	
Radon gas	Migration into Buildings	Site Users (residents)	Medium – potential for chronic levels	Unlikely[6]	Low Risk	See Section 0

Notes:

1. Methodology and details of risk consequence, probability and category based on CIRIA C552 (2001) and presented in Section 3.2.1.
2. Made Ground is anticipated across the site, potentially with localised deepening in the areas of the former factories in the west. Known List 1 dangerous substance has been used previously at the site (1,2-dichloroethane) and pollution incidents have occurred (mainly impacting air). The location and extent of contamination has yet to be confirmed on site.
3. Given the age of the historic developments on site, it is likely tat asbestos/asbestos containing materials were used.
4. The previous report (Opus, 2011) identified elevated levels of sulphates within the shallow soils and groundwater.
5. The previous report (Opus, 2011) identified a Characteristic Situation of CS2, based on limited testing. The assessment pre-dated the requirement for a detailed mine gas risk assessment and therefore this was not considered.
6. Radon risk identified in data report (Appendix C) indicates that the site does not lie in a radon affected area as defined by the Health Protection Agency. The risk from radon is considered Low.
7. The above risk evaluation is updated following the intrusive investigation and testing in Section 6.2.

4 Exploratory Investigation

It should be noted that gas monitoring is currently ongoing. Preliminary comments are provided in the following sections with regards to the results to date; however, this should be viewed as preliminary only and a full assessment will be undertaken on completion of the monitoring.

4.1 Investigation Points

4.1.1 Introduction

The intrusive investigation was undertaken between the 14th and 17th January 2025 in general 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, windowless sample boreholes, measurement of the correlated in-situ CBR value using DCP equipment, soakaway infiltration testing and gas and groundwater monitoring.

The investigation points were supervised and logged by an engineering geologist in general accordance with BS5930:2020, BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2018, and BS EN ISO 14689:2018, along with published weathering schemes.

The investigation point positions are shown on Figure 4. The coordinates of the investigation points were surveyed by ESP on completion and are shown on the various hole records.

4.1.2 Investigation Strategy

The investigation strategy was generally designed in accordance with BS10175:2017, taking into account the additional potential for geotechnical hazards to be present.

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

- Potential Made Ground across the site, with possible localised areas of contamination.
- Former Purolite factory in the northwest, including numerous above ground tanks.
- Former works in the southwest with associated tanks.
- Potentially shrinkable/swelling soils across the site.
- Potentially elevated levels of sulphate across the site.
- Possible coal seams at shallow depth.

The investigation points were positioned to obtain preliminary information in the areas of some historical features, as well as obtaining a general overview of the general ground conditions present, with an approximate 50m grid spacing across the site for these exploratory works (allowing for site constraints and services etc). A figure identifying the historical features on site and the positions of the investigation points is shown as Figure 5 for reference.

No testing of the surface waste materials (e.g., in the far east extent of the site) has been undertaken at this stage.

4.1.3 Trial Pits

24no. trial pits (TP01 to TP24) were excavated across the site between the 14th and 17th January 2025, using a tracked hydraulic excavator. The trial pits were excavated to depths of between 0.5m and 3.3m. Where present, the tarmacadam/concrete surface was broken out prior to the excavation of the pits using a hydraulic breaker. The trial pit records are presented as Appendix H, and their positions are shown on Figure 4.

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 concrete/tarmacadam surface was not reinstated. The arisings were left slightly proud of the adjacent surface to allow for future settlement.

4.1.4 Windowless Sampling

8no. windowless sample drillholes (WS01 to WS08) were constructed on the 16th and 17th January 2025 to depths between 0.5m and 1.5m. The borehole records are presented as Appendix I, and their positions are shown on Figure 4.

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 where feasible (see Section 4.1.5.1 for details).

Due to the very dense ground conditions identified within the Made Ground and natural River Terrace Deposits (RTD), the windowless sampling method provided limited penetration beyond the hand excavated service inspection pits.

At the commencement of each borehole, a service inspection pit excavated by hand to a depth of 1.2m where possible. Where required, the surface tarmacadam/concrete was broken out using a hydraulic breaker and a service inspection pit excavated by hand to a depth of 1.2m.

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

4.1.5 In-situ Strength Testing

4.1.5.1 Standard Penetration Tests (SPT)

Standard Penetration Tests (SPT) were carried out where feasible using a solid cone in the windowless sample boreholes 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 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.

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:

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

4.1.5.2 Hand Vane

In situ measurements of the undrained shear strength of fine-grained soils at shallow depth within the trial pits were taken using a calibrated hand vane where feasible. Where the gravel/cobble content of any fine-grained soils was too high, hand vane tests could not be completed. The results of hand vane measurements are presented on the trial pit records.

4.1.6 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 was undertaken in six selected trial pits across the site (TP01, TP03, TP04, TP06, TP07, TP14). The results of the infiltration testing, and the calculated infiltration rates, are presented in Appendix J. The positions of the test pits are shown on Figure 4.

At each position, the test pit was excavated to a depth which was anticipated to be a possible depth for the soakaway given the ground conditions identified. Clean water was added from a large capacity tanker 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 all test pits.

Herras fencing was erected around the test pits during the testing to protect site workers/ the general public. On completion of the testing in each pit, any remaining water was removed from the test pit, and it was backfilled with the excavated arisings.

4.1.7 Dynamic Cone Penetration (DCP) Testing

CBR testing using the TRL approved dynamic cone penetrometer (DCP) was undertaken at sixteen positions (DCP1 to DCP16) on 7th February 2025. The test positions are shown on Figure 4, and test results are presented in Appendix K.

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 K.

4.2 Instrumentation

4.2.1 Gas Well Installations

A 50mm diameter monitoring well was installed in selected boreholes in general accordance with BS8576:2013 in order to allow monitoring of hazardous ground gases. The wells, comprising slotted plastic pipe with a gravel surround (the response zone), bentonite seals above the response zone, and a lockable vandal proof 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
WS01	16/01/2025	0.5 – 1.0m	Made Ground/River Terrace Deposits
WS02	16/01/2025	0.5 – 1.5m	Made Ground
WS03	16/01/2025	0.3 – 1.2m	Made Ground
WS04	16/01/2025	0.3 – 1.1m	River Terrace Deposits
WS05	16/01/2025	0.4 – 1.4m	River Terrace Deposits
WS06	17/01/2025	0.3 – 1.2m	Made Ground/River Terrace Deposits
WS07	17/01/2025	0.3 – 1.0m	Made Ground/River Terrace Deposits
WS08	17/01/2025	0.5 – 1.5m	Made Ground/River Terrace Deposits

Notes:
1. Details of each monitoring well are presented on the individual borehole records (Appendix I).

4.2.2 'Spot' Gas Monitoring

Monitoring of the installed gas wells is being undertaken on a 'spot' monitoring basis (periodic visits to monitor gas levels at the time of the visit).

To date, the installed wells have been monitored for levels of groundwater and ground gas on three occasions between 7th February and the 4th march 2025. The initial 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 measures 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.

Gas monitoring is ongoing, with a total of six fortnightly visits planned. This section will be updated in the final report on completion of the monitoring.

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).

Sampling for soil contaminants was undertaken on a generally targeted and non-targeted strategy to obtain preliminary information in areas where historic development has identified potentially contaminative land uses and to provide a general indication of the variability in concentrations of possible diffuse source contamination across the site as a whole (allowing for site constraints and services etc).

Targeted investigation points include:

- TP01, TP02, TP05, TP06, TP19, TP20, TP21 – former factory concrete slab.
- TP04, TP17, TP18, TP24, WS02/WS02a, WS03 – areas of former tanks.

A plan showing the locations of the investigation points against the historical features is presented as Figure 5 for reference.

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.

4.4 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.

Made Ground was encountered across the site (albeit limited within the east extent), with direct visual or olfactory evidence of contamination identified in the investigation points as summarised in the table below.

Table 6: Site Evidence for Contamination

Hole ID	Stratum	Comment on contamination encountered
TP02	Made Ground/River terrace Deposits	Made Ground identified to a depth of 3.2m – base not proved due to spalling at base and dense ground. Soils recovered appeared to be RTD gravels, coloured black with a hydrocarbon odour from approximately 0.8m depth.
TP01, TP03-TP10, TP15, TP17-TP23	Made Ground	General Made Ground identified to maximum depth of 2.0m.
TP16	Made Ground	General Made Ground encountered to 2.6m depth, but base not proven.
TP24	Made Ground	Light yellow possible sand identified with possible polystyrene balls and coated concrete identified to around 1.1m depth. Between approximately 1.1m and 1.4m, black clay with hydrocarbon smell noted.

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 M.

- Natural moisture content.
- Atterberg limits.
- Particle size analysis.

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 N.

4.6 Geo-environmental 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 0).

To allow an assessment of the potential chronic risks posed to human health, a total of eighteen selected samples of the Made Ground and twelve samples of the near-surface natural soils (one Topsoil, eight possible Alluvium and three River Terrace Deposits samples) 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 7). The geo-environmental soil test results are presented in Appendix N.

Table 7: Geo-environmental Soil Laboratory Testing

Sample No.	Hole Reference	Depth	Testing Suite (see Notes)
TOPSOIL			
1	TP11	0.2m	1
SUPERFICIAL DEPOSITS (POSSIBLE ALLUVIOUM & RIVER TERRACE DEPOSITS)			
1	TP07	0.6m	1
2	TP08	0.55m	1
3	TP10	0.8m	1
4	TP11	0.5m	1
5	TP12	0.6m	1
6	TP13	0.4m	1
7	TP21	0.6m	1
8	TP23	0.5m	1
9	WS06	0.5-0.6m	1, 2, 3
10	WS07	0.5-0.6m	1, 2, 3
MADE GROUND			
1	TP03	0.8m	1
2	TP06	0.3m	1
3	TP07	0.3m	1
4	TP16	0.5m	1, 4
5	TP17	0.2m	1, 4
6	TP02	0.6m	1, 2, 3
7	TP02	1.5m	1, 2, 3
8	TP02	2.5m	1, 2, 3, 4
9	TP03	0.6m	1, 2, 3
10	TP04	0.3m	1, 2, 3
11	TP09	0.65m	1, 2, 3
12	TP10	0.4m	1, 2, 3
13	WS01	0.4m	1, 2, 3
14	WS03	0.4-0.5m	1, 2, 3
15	WS08	0.4-0.5m	1, 2, 3
16	TP19	0.5m	1, 2, 3
17	TP24	0.6m	1, 2, 3
18	TP24	1.3m	1, 2, 3

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. TPH CWG inc. BTEX.
3. VOCs and SVOCs.
4. Asbestos Quantification.

5 Development of the Revised Conceptual Model

The following section should be considered a preliminary ground model at this stage, based on the relatively limited information of the exploratory investigation, with an approximate 50m grid spacing.

Although previous investigations have been undertaken at the site, a review of previous information has not been instructed at this stage.

5.1 Conceptual Ground Model - Geology

The investigation points have identified the site to be generally underlain by variable depths of Made Ground, overlying fine-grained possible Alluvium, followed by coarse-grained River Terrace Deposits. Topsoil was also identified in the east extent of the site.

The Coal measures bedrock was not encountered within the depths of this investigation; further works will be required to investigate the depth to bedrock and the presence of any underlying coal seams/workings.

Made Ground: encountered across the site with the exception of the east extent, generally between around 0.5m and 1.5m (locally deeper). In the east portion, limited/no Made Ground was encountered (TP15 only).

In the areas of hardstanding in the northwest and southeast/south central portions (see Inserts 2 and 3), the Made Ground generally comprised concrete hardstanding, followed by sub-base gravels overlying re-worked fine and coarse-grained soils with anthropogenic materials and occasional possible slag gravels, to a maximum depth of 1.6m (TP09). A tarmacadam surface was identified in TP07 and TP08, followed by sub-base materials.

TP02 identified dark grey to black, angular gravel with a hydrocarbon odour to around 1.9m, followed by black, rounded to subrounded gravels of apparent contaminated River Terrace Deposits, with a hydrocarbon odour to a depth of 3.2m. The base of the contaminated gravels could not be proved due to spalling of the trial pit.

In TP24, anomalous Made ground comprising a possible sand with very small possible polystyrene balls was identified overlying a concrete slab with a green/blue coating to a depth of1.1m. This was underlain by a thin layer of possible hydrocarbon impacted clay followed by probable re-worked natural gravels, however the base of this could not be determined due to spalling of the trial pit.

In WS08, constructed on top of the small, raised area in the southwest, made ground was identified to a depth of 1.55m, comprising fine-grained soils with brick, concrete, glass and metal. Between 1.45m and 1.55m, a band of slightly decomposed green and dark brown grass was identified, which may indicate the original ground level/grass surface and relict Topsoil.

Locally, deeper Made Ground was identified, and possible sub-surface structures have also been identified (see Section 8.1.3).

Topsoil: identified in the east extent of the site (TP11 to TP14, WS04 and WS05) to a maximum depth of 0.35m as a soft, dark brown clay with fractions of sand and frequent rootlets. TP23 also identified Topsoil to a depth of 0.3m.

Possible Alluvium: encountered locally across the site beneath the Made Ground/Topsoil, from between 0.3m to 0.7m and proved to a maximum depth of 1.1m, generally as a light, orangish brown clay, with fractions of sand and gravel. Deeper Alluvium was identified in TP22 where possible fill has raised the existing ground level. The alluvial soils here were identified between around 1.2m to 2.1m, underlying Made Ground and possible relict Topsoil.

The modified plasticity indices (after the coarse-grained particles have been removed) suggest that the soils are generally of medium volume change potential.

Hand vane data indicated strengths of between 46kPa and 130kPa, with an average of 75kPa, indicating generally firm clays, locally firm to stiff.

River Terrace Deposits: encountered across the site to a maximum depth of 3.3m, generally as a light, orangish brown/brownish orange (locally darker) gravel of rounded to subrounded sandstone, with fractions of silt/clay, sand and cobbles. In TP14, localised weathering was identified, with the recovered gravels and cobbles comprising a dark greyish brown with dark grey and blackish grey staining.

Particle size analyses within the laboratory have indicated the coarse-grained glacial soils to comprise between 47% and 76% gravel, between 12% and 24% sand, between 2% and 5% silt/clay and with between 9% and 34% cobbles. Based on our observations on site, these proportions would appear representative of the in-situ soils.

Limited field SPT N-values within the River Terrace Deposits were all in excess of 50, likely due to cobbles.

Coal Measures Bedrock: not encountered within the depths of this exploratory investigation.

A brief review of the previous report (Opus, 2011) indicates that rock head is likely at depths of around 15-17m.

5.2 Conceptual Ground Model - Hydrogeology

The previous investigation at the site (Opus, 2011) identified groundwater generally at a level of around 3.5m within the River Terrace Deposits across the wider investigation area, much of which included this study site.

The recent investigation did not identify any significant groundwater ingress to a depth of 3.3m.

Slow seepages were identified in TP02 (Made Ground), TP11 (River Terrace Deposits) and TP22 (River Terrace Deposits)at depths of 2.0m, 2.1m and 2.2m respectively.

All installed monitoring wells have been recorded as dry to a maximum depth of 1.8m from the two completed visits to dates.

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 Stability

During the excavation of the trial pits, some spalling of the pit walls was experienced, particularly within the River Terrace Deposits below around 1.7m to 2.0m, or where a higher percentage of cobbles were identified. Localised heavy spalling was noted in TP02, TP16 and TP24 within the Made Ground soils.

5.3.3 Mining Hazard

Based on a brief review of a previous report text (Opus, 2011), *'none of the five boreholes identified any evidence of coal seams or mine workings to a depth of 30m.'* No detailed review of the individual borehole findings or their location has been undertaken.

Although the previous report indicated no coal seams/workings to a depth of 30m, given that the superficial soils are potentially up to a depth of around 17m below ground level, dependant on the thickness of any underlying coal seams, there may be insufficient rock cover to mitigate the risk. As detailed in Section 2.10 above, there are several seams underlying the site and further works will be required to investigate their depth and status. At this stage, the risk from subsidence at the site is considered to be moderate.

Confirmatory drilling works will be required to confirm the risk.

5.3.4 Limestone Solution

No obvious evidence of limestone solution was identified in the investigation. Limestone bedrock has been previously identified at the site and confirmatory works will be required to prove the presence/absence on site.

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).

It should be noted that these exploratory works were widespread to get a general overview of the site (around 50m grid spacing), and we cannot guarantee that unidentified areas of contamination were not investigated/found during these works.

Given that the site has been subject to various historical investigations, assessments, remedial works and planning applications, it is likely that areas of contamination exist, and the previous reports must be reviewed in full to further assess the potential contamination risks.

The proposed development largely comprises conventional residential properties with private gardens and areas of retail/commercial development. Given that the final development layout proposals have not been completed, we consider that the site should be assessed as a whole, using the most stringent criteria. Therefore, the GAC appropriate for the residential land use with plant uptake 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 0.2 to 5.9%. Therefore, for the purposes of this assessment, GAC for a soil organic content of 1% has been adopted. This again 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 a total of eighteen samples of the Made Ground and twelve samples of the near-surface natural soils (one Topsoil, eight possible Alluvium and three River Terrace Deposits samples). All samples have been considered across the site as one averaging area. The risks from asbestos are considered further in Section 5.4.4.

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 8 - Generic Assessment of Human Health Risks (Residential with Plant Uptake)

Determinand	Minimum Recorded (mg/kg)	Maximum Recorded (mg/kg)	GAC (mg/kg)	Source of GAC	Exceedances
Metals and Semi-metals					
Arsenic	0.3	29	37	C4SL[2]	None of 30
Beryllium	<0.2	0.7	1.7	S4UL[4]	None of 30
Boron	<0.2	1.6	290	S4UL[4]	None of 30
Cadmium	<0.1	1.9	22	C4SL[2]	None of 30
Chromium (total)[5]	<0.15	26	910	S4UL[4]	None of 30
Chromium (hexavalent)	<1.0	-	21	C4SL[2]	None of 30
Copper	<0.2	250	2,400	S4UL[4]	None of 30
Lead	<0.3	190	200	C4SL[2]	None of 30
Mercury[6]	<0.05	0.75	40	S4UL[4]	None of 30
Nickel	<1.0	25	130	S4UL[4]	None of 30
Selenium	<0.5	28	250	S4UL[4]	None of 30
Vanadium	<0.8	31	410	S4UL[4]	None of 30
Zinc	25	510	3,700	S4UL[4]	None of 30
Polyaromatic Hydrocarbons (PAH)					
Acenaphthene	<0.03	0.04	210	S4UL[4,7]	None of 30
Acenaphthylene	<0.03	0.05	170	S4UL[4,7]	None of 30
Anthracene	<0.03	0.13	2,400	S4UL[4,7]	None of 30
Benzo(a)anthracene	<0.03	0.59	7.2	S4UL[4,7]	None of 30
Benzo(a)pyrene	<0.03	0.21	5.0	C4SL[2,7]	None of 30
Benzo(b)fluoranthene	<0.03	0.45	2.6	S4UL[4,7]	None of 30
Benzo(ghi)perylene	<0.03	0.12	320	S4UL[4,7]	None of 30
Benzo(k)fluoranthene	<0.03	0.13	77	S4UL[4,7]	None of 30
Chrysene	<0.03	0.53	15	S4UL[4,7]	None of 30
Dibenzo(a,h)anthracene	<0.03	0.04	0.24	S4UL[4,7]	None of 30
Fluoranthene	<0.03	2	280	S4UL[4,7]	None of 30
Fluorene	<0.03	0.07	170	S4UL[4,7]	None of 30
Indeno(123-cd)pyrene	<0.03	0.12	27	S4UL[4,7]	None of 30
Naphthalene	<0.03	1.9	15	C4SL[2,7]	None of 30
Phenanthrene	<0.03	0.86	95	S4UL[4,7]	None of 30
Pyrene	<0.03	1.3	620	S4UL[4,7]	None of 30
BTEX Compounds					
Benzene	<0.01	-	0.87	C4SL[2,7]	None of 15
Toluene	<0.01	-	130	S4UL[4,7]	None of 15
Ethyl benzene	<0.01	-	47	S4UL[4,7]	None of 15
Xylene[7]	<0.01	-	56	S4UL[4,7]	None of 15

Continued Over.

Table 8 (continued) - Generic Assessment of Human Health Risks (Residential with Plant Uptake)

Determinand	Minimum Recorded (mg/kg)	Maximum Recorded (mg/kg)	GAC (mg/kg)	Source of GAC	Exceedances
Aliphatic Petroleum Hydrocarbons (Equivalent Carbon Number)					
Ali EC 5-6	<0.01	-	42	S4UL[4,7]	None of 15
Ali EC 6-8	<0.01	0.11	100		None of 15
Ali EC 8-10	<0.01	-	27		None of 15
Ali EC 10-12	<1.50	3.75	130*		None of 15
Ali EC 12-16	<1.20	2.93	1,100*		None of 15
Ali EC 16-35	<3.4	-	65,000*		None of 15
Aromatic Petroleum Hydrocarbons (Equivalent Carbon Number)					
Aro EC 5-7	<0.01	-	70	S4UL[4,7]	None of 15
Aro EC 7-8	<0.01	-	130		None of 15
Aro EC 8-10	<0.01	-	34		None of 15
Aro EC 10-12	<0.90	9.43	74		None of 15
Aro EC 12-16	<0.50	21.93	140		None of 15
Aro EC 16-21	<0.60	8.71	260		None of 15
Aro EC 21-35	<1.40	75.47	1,100		None of 15
Other Organic Compounds					
Phenol	<0.3	0.6	280	S4UL[4,7]	None of 15
1,2-dichloroethane	<0.01	0.02	0.11	S4UL[4,7]	None of 15

Notes:

1. Assessment for residential land use with home-grown produce uptake.
2. C4SL: Category 4 Screening Level, published by CL:AIRE.
3. SGV: Soil Guideline Value published by Environment Agency.
4. S4ULs Suitable 4 Use Levels. Copyright Land Quality Management Limited, reproduced with permission; Publication No. S4UL3156. All Rights Reserved.
5. In the absence of Chromium VI, all chromium present likely to be Chromium III. GAC for Chromium III adopted.
6. GAC for inorganic mercury adopted.
7. GAC for organic compounds based on 1% soil organic content.
8. GAC for xylene based on p-xylene (lowest S4UL).
9. Exceedances highlighted in red and bold.
10. Laboratory results presented in Appendix N.

* GAC exceeds solubility or vapour saturation limit.

All the determinands analysed were below the GAC for residential development with plant uptake. No further statistical analysis is warranted.

Low levels of other VOC and SVOC compounds have been detected in samples of the Made Ground, however the levels are not considered to pose a risk.

One sample of Made Ground identified a level of 15mg/kg of Bis(2-ethylhexyl)phthalate (TP19, 0.5m) which would need further investigation during the supplementary works.

It should be noted that these exploratory works were widespread to get a general overview of the site (around 50m grid spacing) and we cannot guarantee that unidentified areas of contamination were not investigated/found during these works.

Given that the site has been subject to various historical investigations, assessments, remedial works and planning applications, it is likely that areas of contamination exist, and the previous reports must be reviewed in full to further assess the potential contamination risks.

The above results should be viewed with caution and may not represent the worst-case scenario at the site.

5.4.2 Asbestos

Qualitative and quantitative analyses of the asbestos identified in the samples tested is summarised below.

Table 11: Summary of Asbestos Screening and Quantitative Laboratory Testing

Exploratory Hole Ref.	Depth	Strata	Qualitative Assessment	Qualitative Assessment Level
TP02	2.5m	Made Ground – probable re-worked RTD.	Amosite present as fibre bundles.	0.001%
TP16	0.5m	Made Ground – probable demolition rubble.	Chrysotile present as fibre bundles.	<0.001%
TP17	0.2m	Made Ground – probable demolition rubble.	Chrysotile present as fibre bundles.	<0.001%

5.5 Risk to Controlled Waters - Level One Assessment

5.5.1 Methodology

The potential impact of contamination originating at the site on controlled waters in the area of the site (i.e. groundwater and surface water) has been initially evaluated in line with the Environment Agency guidance (Carey et al, 2006).

Levels of leachable contamination within the soil samples recovered at the site have been analysed, which represents a 'Level One' risk assessment (Carey et al, 2006).

5.5.2 Assessment Criteria

As for the assessment of human health risks above, the results of the contamination testing have been compared to assessment criteria appropriate to the controlled water receptors in the area.

The Preliminary Risk Assessment has identified that the following controlled water receptors are potentially at risk from contamination originating at the site:

- The groundwater within the Alluvium/River Terrace Deposits/Coal Measures bedrock, which is classified as a Secondary A aquifer, where the groundwater could be abstracted for potable use in the future.
- The water within the Afon Clun located some 157m to the southeast. The groundwater within the shallow soils beneath the site may be in hydraulic connection with the river water.

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 receptor. However, for completeness, we have also extended the assessment to include the surface water courses.

Surface Water Receptors:
In order to assess the potential impact on the waters of the Afon Clun, 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 Afon Clun, the EQS published for fresh water have been adopted.

For cadmium, the EQS are dependent on the hardness of the receptor water body. Reference to information provided on the Dwr Cymru/Welsh Water (DCWW) website indicates the hardness of the local waters in the area to be around 77mg/l $CaCO_3$. Therefore, EQS values appropriate for this hardness have been adopted where applicable, which equates to the '*Class 3*' guideline values.

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 *'All other freshwaters not listed above'* in the list provided.

Groundwater as a General Resource:
In order to assess the potential risk to groundwater as a general resource beneath the site, we have adopted 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, so may be conservative in this instance. Therefore, an exceedance may not necessarily indicate an unacceptable risk.

Hazardous Substances:
Some contaminants which can impact on controlled waters have been classed as hazardous substances (JAGDAG, 2019) and include arsenic, lead, mercury, and some of the polyaromatic and petroleum hydrocarbon compounds. Natural Resources Wales (NRW) require that the entry of hazardous substances into controlled waters is phased out, or at least any further entry should be minimised. The remaining contaminants are classed as non-hazardous. The classification of each determinand analysed is presented in the below tables.

Petroleum Hydrocarbons:

There are currently no EU or UK guidelines for ethylbenzene and the World Health Organisation criteria (WHO, 2011) have been adopted for this compound. Similarly, with the exception of the BTEX compounds, there are no published assessment criteria for petroleum hydrocarbons within controlled waters.

The Environment Agency/NRW have previously stipulated an assessment criterion of 10µg/l for all bands of petroleum hydrocarbons, and this has been used tentatively as the assessment criteria. However, it should be appreciated that this only represents a preliminary, broad-brush appraisal of the levels of contamination present and an exceedance does not necessarily define an unacceptable risk.

The actual assessment criteria adopted are shown in the following table(s), and further details on them can be found in the respective published documents.

5.5.3 Assessment of Leachate Test Results

The samples selected for leachate testing comprised thirteen samples of Made Ground, and two natural River Terrace Deposits samples. These have been assessed together initially.

The results of the leachate testing and their comparison to the relevant assessment criteria are presented in the tables below, based on the groundwater (as a general resource) and Afon Clun as the most vulnerable receptors.

Table 9: Level One Controlled Waters Risk Assessment – Leachate Results (General Groundwater)

Compound	Range Recorded	UKTAG[5]	Exceedances
Metals			
Arsenic[1]	<0.16 – 2.2µg/l	5.0µg/l	None of 15
Chromium VI[1,3]	<0.25 – 0.34µg/l	5.0µg/l	None of 15
Lead[1]	0.1 – 1.3µg/l	5.0µg/l	None of 15
Mercury[1]	<0.01 – 0.1µg/l	0.5µg/l	None of 15
Polyaromatic Hydrocarbons			
Anthracene[1]	<0.01 – 0.05µg/l	0.05µg/l	None of 15
Benzo[a]pyrene[1]	<0.01 – **0.05**µg/l	0.005µg/l	**6** of 15
BbF[1]	<0.01 – **0.06**µg/l	0.05µg/l	**2** of 15
BghiP[1]	<0.01 – **0.07**µg/l	0.05µg/l	**1** of 15
BkF[1]	<0.01 – 0.02µg/l	0.05µg/l	None of 15
IDP[1]	<0.01 – **0.06**µg/l	0.05µg/l	**1** of 15
Petroleum Hydrocarbons			
Benzene[1]	<1.0µg/l	0.5µg/l	None of 15
Toluene[1]	<1.0µg/l	350µg/l	None of 15
Other Contaminants			
1,2-dichloroethane	<1.0 µg/l	-	None of 15

Notes:

1. Hazardous substance (JAGDAG, 2019).
2. Non-hazardous substance (JAGDAG, 2019).
3. All chromium present assumed to be chromium VI (conservative approach).
4. Assessment based on non-potable groundwater beneath the site.
5. UKTAG – UK TAG concentration below which the danger of deterioration in the groundwater quality is avoided. For hazardous substances only.
6. Exceedances indicated in bold, and colour coded as shown.
7. Test results presented in Appendix N.

Key to PAH compounds:

BbF: benzo[b]fluoranthene
BkF: benzo[k]fluoranthene
BghiP: benzo[ghi]perylene
IDP: indeno[123-cd]pyrene

As shown in the table above, the levels of leachable metals are below the assessment criteria for groundwater as a general resource.

PAH contaminants have been identified against the assessment criteria.

All of the exceedances were from samples of Made ground, with the exception of one marginal elevation of Benzo(a)Pyrene (0.01µg/l) identified in WS07 (0.5-0.6m).

Detectable levels of TPH have been identified (some above 10 µg/l). VOC's and SVOC's were below detection limits, with the exception of Di-n-butylphthalate (1.1µg/l) and Bis(2-ethylhexyl)phthalate (1.1µg/l).

Table 10: Level One Controlled Waters Risk Assessment – Leachate Results (Afon Clun)

Compound	Range Recorded	EQS - AA	Exceedances
Metals and Semi-metals:			
Arsenic[1]	<0.16 – 2.2µg/l	50µg/l	None of 15
Cadmium[2,4]	<0.3 – **0.18µg**/l	0.09µg/l	**1** of 15
Chromium[2,5]	<0.25 – 0.34µg/l	3.4µg/l	None of 15
Copper[2]	<0.4 – **3.7**µg/l	1.0µg/l	**7** of 15
Iron[3]	12 - 220µg/l	1,000µg/l	None of 15
Lead[1]	0.1 – **1.3**µg/l	1.2µg/l	**1** of 15
Nickel[2]	<0.5 – 0.7µg/l	4.0µg/l	None of 15
Zinc[2,6]	<1.3 - **64**µg/l	1.4µg/l	**7** of 15
Polyaromatic Hydrocarbons			
Anthracene[1]	<0.01 – 0.05µg/l	0.1µg/l	None of 15
Benzo[a]pyrene[1]	<0.1 – **0.05**µg/l	0.00017µg/l	**6** of 15
Naphthalene[2]	<0.05 – 0.21µg/l	2.0µg/l	None of 15
Fluoranthene[3]	<0.01 – **0.14**µg/l	0.0063µg/l	**13** of 15
Petroleum Hydrocarbons			
Benzene[3]	<1.0µg/l	10µg/l	None of 15
Toluene[4]	<1.0µg/l	74µg/l	None of 15
Other Contaminants			
Cyanide[4]	<0.1µg/l	1.0µg/l	None of 15
Phenol[4]	<1.0µg/l	7.7µg/l	None of 15
1,2-dichloroethane	<1.0 µg/l	-	None of 15

Notes:

1. Hazardous substance (JAGDAG, 2019).
2. Non-hazardous substance (JAGDAG, 2019).
3. Iron not classified by JAGDAG 2019.
4. Cadmium EQS based on hardness of 77 µg/l $CaCO_3$.
5. All chromium present assumed to be chromium VI (conservative approach).
6. Zinc EQS based on ambient background concentration in catchment.
7. Based on Afon Clun as main receptor.
8. EQS-AA – Environmental Quality Standard (estuarine/saline waters) - Annual Average or Mean.
9. Exceedances indicated in bold and red.
10. Test results presented in Appendix N.

PAH contaminants have been identified against the assessment criteria.

High levels of leachable zinc were recorded from TP02 at 1.5m (64 µg/l), 2.5m (53 µg/l) and TP03 at 0.6m (18 µg/l).

All of the exceedances were from samples of Made Ground, with the exception of one marginal elevation of Benzo(a)Pyrene (0.01µg/l) identified in WS07 (0.5-0.6m) and Fluoranthene (0.02 µg/l) identified in WS06 (0.5-0.6m) and WS07 (0.5-0.6m), within the River Terrace Deposits.

Detectable levels of TPH have been identified. VOC's and SVOC's were below detection limits, with the exception of Di-n-butylphthalate (1.1µg/l) and Bis(2-ethylhexyl)phthalate (1.1µg/l).

5.6 Hazardous Ground Gas

5.6.1 Degradation of Organic Materials

Gas wells have been installed in eight boreholes at the site and monitored for hazardous gases on three occasions over a six-week period to date. Hence, four visits are still to be completed. The current monitoring has indicated levels of methane to be below detection. Levels of carbon dioxide up to 4.8% and gas flow rates up to 6.4L/hr have been generally recorded. In WS08, carbon dioxide levels of between 9.2% and 10.5% have been recorded, with flow rates up to 6.8L/hr . A full assessment of gas risks will be presented in a gas addendum report/revised version of this report on completion of the monitoring.

5.7 Sulphate Attack

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

5.7.1 Classification of Site & Groundwater Setting

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

Limited groundwater was encountered in the investigation points in the shallow soils. This is likely to be close to the depth to which buried concrete will be placed. Therefore, groundwater has been considered as mobile in this assessment.

5.7.2 Soil Sulphate Levels and Characteristic Values

The results from the sulphate testing for the shallow soil/various strata are summarised in the Table below.

Table 12 – Summary of Soil Sulphate Testing

Determinand	Number of Tests	Minimum Value[3]	Maximum Value[2,4]	Characteristic Value[1]
MADE GROUND				
Water soluble sulphate (mg/l)	4	19	170	**170**
pH values	19	7	11.6	**7.45**
Acid soluble sulphate (%)	4	0.01	0.27	*Not Required[5]*
Total Sulphur (%)	4	0.02	0.62	*Not Required[5]*
Total Potential Sulphate (%)	4	0.06	1.86	**1.86**
Oxidisable Sulphate (%)	4	0.05	1.59	*Not Required[5]*
SUPERFICIAL SOILS (ALLUVIUM & RIVER TERRACE DEPOSITS)				
Water soluble sulphate (mg/l)	16	<10	88	**80**
pH values	25	6.5	9.4	**7.1**
Acid soluble sulphate (%)	16	<0.01	0.02	*Not Required[5]*
Total Sulphur (%)	16	0.01	0.04	*Not Required[5]*
Total Potential Sulphate (%)	16	0.03	0.12	**0.11**
Oxidisable Sulphate (%)	16	0.02	0.1	*Not Required[5]*

Notes:

1. Selection of characteristic value based on guidance in BRE SD1 (2005).
2. 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.
3. 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).
4. Where the levels of oxidisable sulphide exceed 0.3%, pyrite is likely to be present.
5. Not required for BRE SD1 concrete design class assessment (see Section 7.4.2).
6. Laboratory results presented in Appendix N.

6 Phase Two Geo-Environmental Risk Assessment

The following section should be considered preliminary only at this stage, based on the relatively limited information of the recent exploratory investigation, with an approximate 50m grid spacing.

Although previous investigations have been undertaken at the site, a review of previous information has not been instructed at this stage.

Given that previous assessments have been undertaken at the site and information on the planning portal indicates remedial works may have been completed at the site, the following section should be viewed as preliminary only at this stage.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site. This will be essential to inform/support contemporary findings of the current investigation.

6.1 Discussion on Occurrence of Contamination and Distribution

From the review of historical maps and other mapping sources, the site remained largely as open fields (with the exception of the construction of Springfield House in the late 1890's) until around the early 1960's, when the northwest portion of the site was developed with a Water Treating Equipment Work, which continued to expand within the site into the early 2000's. From the late 1970's, a further works/factory was developed in the southwest portion.

In 2013 image, the northwest portion of the site is likely being used as a compound for ground preparation/investigation works for the recently constructed Sainsburys food store, which is shown completed by 2024.

The investigation points have identified the site to be generally underlain by variable depths of Made Ground, overlying fine-grained possible Alluvium, followed by coarse-grained River Terrace Deposits. Topsoil was also identified in the east extent of the site. The Coal measures bedrock was not encountered within the depths of this investigation. Localised deepening of the Made Ground as well as areas of potential contamination have been identified, as detailed in Section 5.1.

Limited Made Ground is identified in the east of the site where no historical development has been identified.

Visual and olfactory evidence of contamination has been identified locally, with hydrocarbon odours noted in TP02 and TP24, with other areas of deeper made ground also identified (e.g., TP16). The contamination/deeper made ground correlates with areas within the former factory, however these are not noted to be in the area of a specific source/tank etc. Laboratory testing has indicted that all the levels of the determinands tested are below the guideline values for residential development.

Marginal exceedances of metals and PAH contaminants have been identified for the controlled waters risk assessment for surface waters and exceedances of PAH's have been identified for the assessment for groundwater as a general resource. The planning references provided by the LA indicates that remedial works have been undertaken at the site and evidence of possible groundwater remediation (numerous historical standpipes) has also been noted (see plates).

Qualitative and quantitative analyses of the asbestos identified in the samples tested has identified the levels to be between <0.001% and 0.001%.These were identified in three samples from TP02 at 2.5m (within re-worked River Terrace Deposits), TP16 at 0.5m and TP17 at 0.2m (both within probable demolition arisings).

The current monitoring has indicated levels of methane to be below detection. Levels of carbon dioxide up to 4.8% and gas flow rates up to 6.4L/hr have been generally recorded. In WS08, carbon dioxide levels of between 9.2% and 10.5% have been recorded, with flow rates up to 6.8L/hr . A full assessment of gas risks will be presented in a gas addendum report/revised version of this report on completion of the monitoring.

Elevated levels of sulphates have been identified in the Made Ground soils, while the natural soils have identified generally low levels of sulphates.

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 (Table, Section 3.2.2) have been updated and revised in the table below following information learned from the exploratory works and results of monitoring and laboratory testing.

Table 13 - 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 soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (residents)	Medium – potential for chronic levels.	Likely[2]	**Moderate Risk**	See Section 7.1.2.
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Minor – standard PPE likely to be sufficient	Likely[2]	Low Risk	See Section 7.1.4.
	Leaching of soil contaminants	Impact on Groundwater /Potable Water	Medium – site lies on Secondary A aquifers	Likely[3]	**Moderate Risk**	See Section 7.2.
	Leaching of soil contaminants	Impact on Afon Clun	Medium – site lies 157m from river	Likely[3]	**Moderate Risk**	
Asbestos in shallow soils	Inhalation of fibres	Site End Users	Medium – potential for chronic levels	Likely[4]	**Moderate Risk**	See Section 7.1.1.
		Construction/ Maintenance Workers		Likely[4]	**Moderate Risk**	
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High likelihood[5]	**Moderate Risk**	See Section 7.4.2.
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users/Visitors.	Severe – acute risk.	Likely[6]	**High Risk**	See Section 7.3.1.
	Damage through explosion.	Building/Property	Severe – acute risk.		**High Risk**	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		**High Risk**	
Radon gas	Migration into Buildings	Site Users (residents)	Medium – potential for chronic levels	Unlikely[6]	Low Risk	See Section 7.3.2.

Notes:

1. This table updates Table 4 in Section 3.2.2 using results of the investigation. Methodology and details of risk consequence, probability and category presented in Appendix A.
2. Low levels of contaminants have been identified within the shallow soils, however given that the exploratory works were intended to obtain a broad overview of the site status (~50m grid spacing), we cannot discount that areas of contamination currently unidentified may be present and therefore a risk remains. Further works will be required, particularly in areas of proposed residential development, to more robustly assess the potential risks.
3. PAH contaminants have been identified against the assessment criteria and localised elevations of zinc. Further assessment will be required to more robustly assess the overall risk to controlled waters, including sampling and analysis of the groundwater beneath the site (Level 2 Controlled Waters Risk Assessment).
4. Given the relatively low number of samples tested given the size of the site, the historic land uses and the presence of Made Ground (including demolition rubble) across the majority of the west and central portions of the site, we cannot discount that asbestos may be present in other unexplored areas of the site and therefore a risk remains.
5. Variable and highly elevated levels of total potential sulphate have been identified from the limited testing of the Made Ground soils. Low levels of sulphates were identified within the samples of natural soils tested. Given the extent of Made ground across the site, the levels of sulphates are likely to require an advance concrete classification to protect against long term degradation. Further sampling and assessment should be undertaken in areas of proposed foundations, once the design proposals are finalised. Levels of groundwater sulphates should also be tested during the additional works.
6. Levels of methane have been identified below detection and levels of carbon dioxide between approximately 5% and 10% have been identified from the limited data to date (two visits). Further assessment will be completed once the gas monitoring regime has been completed, and a revised version of this report will be issued.
7. Radon risk identified in data report (Appendix C) indicates that the site does not lie in a radon affected area as defined by the Health Protection Agency. The risk from radon is considered Low.

7 Remedial Strategy for Contamination Risks

The following section should be considered preliminary only at this stage, based on the relatively limited information of the recent exploratory investigation, with an approximate 50m grid spacing.

Although previous investigations have been undertaken at the site, a review of previous information has not been instructed at this stage.

Given that previous assessments have been undertaken at the site and information on the planning portal indicates remedial works may have been completed at the site, the following section should be viewed as preliminary only at this stage.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment so that the improvements afforded by the remedial works can be understood. This will be essential to inform/support contemporary findings of the current investigation.

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

Amosite and chrysotile asbestos fibres were initially identified within the Made Ground soils in the northwest portion of the site. Further testing has quantified the levels of asbestos within these soils to be between less than 0.001% and 0.001%. The Opus investigation identified one sample to contain asbestos out of 48no. tested.

There is no clear UK guidance on what would constitute an acceptable concentration of asbestos in soil. Working with asbestos (even within soils) is governed by the Control of Asbestos Regulations (2012). This requires that the excavation and removal of the asbestos contaminated soils musty be undertaken by a licensed contractor.

CIRIA have published a document *Asbestos in soil and made ground: a guide to understanding and managing risks C733 (2014)*. Using this guidance, and for appropriate sites, ESP can assist in coordinating a multistakeholder team to further assess the potential for fibre release and risk evaluation of the residual health hazard. Capping may be required for the development. Please contact ESP for further details.

The following sections presume that any risks from asbestos materials at the site are mitigated.

7.1.2 Site End Users

Based on the relatively limited testing undertaken during the recent works, the levels of contamination have been identified to be low and are below the guideline values for residential development.

A full review of all previous information is required to confirm the risk to future site users and determine any remedial requirements; a capping layer may be required due to the presence of localised asbestos.

Remedial requirements will be reduced in east where limited/no Made Ground has been identified.

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. However, given that previous assessments have been undertaken at the site and information on the planning portal indicates remedial works may have been completed at the site, it cannot be discounted that residual contamination remains in the shallow soils in areas currently unexplored during the exploratory works. Ground workers would need to undertake their own assessment of the risks to their workers following further assessment.

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.

We cannot discount that additional measures in accordance with best practise may be required if currently unidentified contamination is realised during assessment of the historical investigations/remedial works at the site, or during the supplementary works required.

7.1.5 General Public/Neighbouring Properties

Significant risks to the general public from the development of the site are not anticipated. However, careful dust control measures should be adopted during construction to minimise the risk (and nuisance) to the general public and neighbouring residents.

The south portion of the site lies adjacent to a school whose occupants (children) would be particularly sensitive to any dust created during development. It is recommended strict dust control measures during development, and particular care would be required when excavating and removing from site any asbestos containing soils within the Made Ground.

7.2 Risks to Controlled Waters

The Level One assessment of risks to controlled waters has indicated that the levels of contamination within the soils beneath the site could pose an unacceptable risk to controlled waters, and further assessment or the provision of risk mitigation measures is warranted. Groundwater remediation may have been undertaken in the past and a review of this will be required. Sampling and testing of the groundwater should be included as part of future assessments to confirm the current land condition.

7.3 Risks from Ground Gas and Radon

7.3.1 Ground Gas Risk to the Development

The current monitoring has indicated levels of methane to be below detection. Levels of carbon dioxide up to 4.8% and gas flow rates up to 6.4L/hr have been generally recorded. In WS08, carbon dioxide levels of between 9.2% and 10.5% have been recorded, with flow rates up to 6.8L/hr . A full assessment of gas risks will be presented in a gas addendum report/revised version of this report on completion of the monitoring.

Given the site setting, a Coal Mine Gas Risk Assessment will be required in the future.

7.3.2 Radon Risk to the Development

The data report (Appendix C) indicates that the site does not lie in a radon affected area as defined by the Health Protection Agency. The risk from radon is considered low and no radon protection is required.

7.3.3 Risk to Construction and Maintenance Workers

Currently, the presence of elevated levels of carbon dioxide and depleted oxygen in the Made Ground could pose a risk to construction workers, and lead to asphyxiation in confined spaces. All excavations should be treated as confined spaces and suitable precautions taken prior to man entry.

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 soils at the site (all as SO_4):

Table 14 – Soil Sulphate Characteristic Values

Stratum	Characteristic Values			Groundwater	Design Class	ACEC
	Water Soluble Sulphates (mg/l)	pH values	Total Potential Sulphates			
Made Ground	170	7.45	1.86	Mobile	DS-4	AC-4
Superficial Soils	16	7.10	0.12	Mobile	DS-1	AC-1

Based on these characteristic values, we consider that the site would be classified as Design Sulphate Class DS-4 and Aggressive Chemical Environment for Concrete Class AC-4, allowing for mobile groundwater.

Further testing and assessment, including sampling and testing for the levels of groundwater sulphates should be undertaken to more robustly assess the risk from sulphates at the site, once the foundation designs are known.

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.
- Removed to a Receiver Site for beneficial re-use.

Prior to removal from site, the excavated arisings would need to be classified as either 'hazardous' or 'non-hazardous' waste based on a WM3 assessment. Waste Acceptability Criteria (WAC) testing would be required to determine the type of landfill in which the arisings could be disposed.

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 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

The following section should be considered preliminary only at this stage, based on the relatively limited information of the recent exploratory investigation, with an approximate 50m grid spacing.

Although previous investigations have been undertaken at the site, a review of previous information has not been instructed at this stage.

Given that previous assessments have been undertaken at the site, the following section should be viewed as preliminary only at this stage.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site and the benefit afforded from any historic remediation. This will be essential to inform/support contemporary findings of the current investigation.

8.1 Site Preparation and Earthworks

8.1.1 Unexploded Ordnance

As discussed in Section 2.10.10, a specialist preliminary assessment has concluded that '*a detailed desk study, whilst always prudent, is not considered essential in this instance'.* 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

The site remained largely as open fields (with the exception of the construction of Springfield House in the late 1890's) until around the early 1960's, when the northwest portion of the site was developed with a Water Treating Equipment Work, which continued to expand within the site into the early 2000's. From the late 1970's, a further works/factory was developed in the southwest portion.

As detailed in Section 5.1, evidence of sub-surface structures was identified in localised areas of the site (e.g., TP05, TP17 and TP20). Foundations associated with the former buildings beneath the visible concrete slabs likely remain in the ground.

All identified 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.

Live services have been identified on site as described in Section 2.1. Notably, a medium pressure gas main is present along the south boundary, trending roughly west to east. 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 providers.

A network of land drains may also be present and may provide a seepage path into excavations. The land drains should be diverted where they enter foundation excavations.

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.

8.1.5 Earthworks

ESP have not been advised that the development requires any significant earthworks. The site is relatively flat and, therefore, no significant earthworks are anticipated.

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 reviewed by ESP.

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.

For risk associated with poor temporary stability of excavations and groundwater ingress see Section 8.7. For risks associated with sulphate attack see Section 7.4.2.

8.2.2 Coal Mining Hazard

Based on a brief review of a previous report text (Opus, 2011), *'none of the five boreholes identified any evidence of coal seams or mine workings to a depth of 30m.'* No detailed review of the individual borehole findings or their location has been undertaken.

Although the previous report indicated no coal seams/workings to a depth of 30m, given that the superficial soils are potentially up to a depth of around 17m below ground level, dependant on the thickness of any underlying coal seams, there may be insufficient rock cover to mitigate the risk. As detailed in Section 2.10 above, there are several seams underlying the site and further works will be required to investigate their depth and status. At this stage, the risk from subsidence at the site is considered to be moderate.

Confirmatory drilling works will be required to confirm the risk.

The risk from mine gasses is discussed in Section 7.3.

8.2.3 Shrinkage and Swelling

The site inspection has identified the presence of trees and areas of dense vegetation across the site. on the northern boundary. If not available, a tree survey (including current tree heights and species) should be undertaken prior to any removal of trees in order to allow an assessment of the most economical foundation design.

Laboratory testing has indicated that the locally present possible Alluvium soils at shallow (within the influence of foundations) depth are of medium volume change potential.

As discussed in Section 8.3, initial recommendations for foundations would be to extend the foundations beyond any fine-grained soils, into the underlying coarse-grained River Terrace Deposits.

Consideration of any lateral pressures acting on the foundations will need to be considered in the designs.

One the design proposals have been finalised; further advice can be provided by this office as to the required safe depth of foundations across the development. BRE report 298 provides guidance on methods to reduce swelling pressures (e.g. compressible layers).

8.2.4 Karst Solution Features (Ground Dissolution)

No evidence of limestone solution was identified in the investigation.

Limestone bedrock was identified previously (Opus, 2011) underlying the site in the southeast. The limestone could be susceptible to chemical weathering, producing natural solution cavities in both the horizontal and vertical direction. Such features can cause uncontrolled subsidence at the surface in the right conditions. This will need to be investigated through drilling works to confirm the presence/absence.

Therefore, following excavation in this area, the formation should be very carefully inspected and any anomalous features investigated further. As the bedrock is likely to be deep across the site (in excess of 10-15m), it may not be feasible to identify any anomalous conditions within shallow excavations.

Should any anomalous features be identified, further advice should be sought.

8.2.5 Compressible Ground

Soft alluvial soils and areas of deep Made Ground are present which could be potentially compressible and require foundations to be extend beyond. We recommend that during the supplementary works, boreholes are extended in line with published guidance (depending on the foundation type and depth etc) to ensure that no low-strength soils are present beneath the proposed foundations. Advice from the structural engineer with regards to the preferred foundation solution should be confirmed prior to the additional works.

8.2.6 Running Sand

No significant bands of sand were identified within the exploratory works and no significant groundwater ingress was identified above 2.0m depth.

It cannot be discounted that bands/lenses of sand may be present within the River Terrace Deposits and, if below the water table, could lead to running sands within excavations.

A careful watch should be maintained throughout the development works for any sand stratum and further inspection/advice can be provided by ESP if required.

8.2.7 Volumetrically Unstable Slag Materials

No significant areas of slag materials were identified during the exploratory works; however, possible slag materials have been identified locally within the Made Ground and, given the historical legacy at the site, it cannot be discounted that areas of abundant slag materials could be present.

A careful watch should be maintained throughout the development works for any significant areas of slag materials and further inspection/advice can be provided by ESP if required.

8.3 Foundation Design and Construction

The following comments are preliminary only and will require further review once the design proposals have been finalised, the past information has been reviewed and the risks from subsidence from historical mining have been investigated. The foundations solutions for all areas of the site, depending on the proposed land-use, will require review.

The site is being considered for potential development for residential and retail/commercial purposes and the comments and recommendations in this report assume that the development will involve the construction of typical two-storey residential structures of conventional load-bearing brickwork construction. It is understood that flats may also be planned in the northwest of the site, however no details of the proposed building(s) are available at this stage. For the retail/commercial developments, it is presumed that the development will involve a conventional portal frame construction point loads, and line loads from conventional load-bearing brickwork construction.

For preliminary design purposes, it is considered that mass concrete spread foundations could be used at the site, constructed in the dense coarse-grained River terrace Deposits encountered from depths of around 1.1 to 1.5m beneath the current ground level. Deepening of spread foundations or alternative solutions, such as a raft or piled foundations, will be required locally in areas where deeper Made Ground is present.

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.

To minimise the potential for excavation instability, it is recommended that as short a time as possible is left between excavating the foundation trenches and pouring the concrete.

Further consideration will be required as to the preferred foundation solutions across the site once the proposed developments have been finalised.

8.4 Floor Slab Foundations

The floor slab solutions should be reviewed following completion of the gas monitoring.

Due to the presence of over 600mm of Made Ground across the majority of the site and medium volume change potential of the shallow alluvial soils, it is considered that ground bearing floor slabs would not be suitable for the development, and floor slabs should be suspended. Where commercial /retail developments are placed, ground bearing slabs may be feasible where excavation/replacement is undertaken (e.g., for the foundation solution).

Further consideration will be required as to the preferred floor slab designs across the site once the proposed developments have been finalised.

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.

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 16no. locations concentrated along the proposed access roads. 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 K.

The results indicate variability across the site, with some correlated CBR values of more than 10% and others less than 2% (a CBR of 0.9% was identified in location DCP14).

Given that the near-surface soils locally have a CBR value of less than 2.5%, it is not considered that conventional road pavements would be suitable in these areas without some pre-treatment of the subgrade soils. Possible treatment options include the removal of the soft soils and their replacement with compacted suitable granular fill materials, treatment with lime or cement to reduce the moisture content, or the use of geo-synthetics. Following treatment, the Design CBR should be limited to 2.5% (Highways Agency, 2020).

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 fine coarse-grained 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 8T tracked excavator used in the investigation generally reached depths of between 2-3m, however some areas where compacted demolition/substructures were identified will require higher capacity machines or hydraulic breakers to progress.

Support should be provided as appropriate within the excavations. Some spalling of the pit walls was experienced, particularly within the River Terrace Deposits below around 1.7m to 2.0m, or where a higher percentage of cobbles were identified. Localised heavy spalling was noted in TP02, TP16 and TP24 within the Made Ground soils.

Based on our understanding of the proposed development, no significant groundwater ingress is anticipated above 2-3m depth, although some seepages were noted between around 2.0m and 2.5m 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 six test pits excavated across the site (TP01, TP03, TP04, TP06, TP07, TP14). The results of the testing are presented in Appendix J.

The calculated infiltration rates are presented in the table below.

Table 15 - Summary of soakaway infiltration test results

SA Test	Test Pit	Fill Number	Test depth	Measured Infiltration Rate[1]	Infiltration Soils
SA1	TP01	1	1.90m	2.21 x 10^{-5}m/sec	RIVER TERRACE DEPOSITS
		2		1.46 x 10^{-5}m/sec	
		3		3.80 x 10^{-4}m/sec	
SA2	TP03	1	2.10	2.21 x 10^{-5}m/sec	
		2		3.39 x 10^{-5}m/sec	
		3		2.63 x 10^{-5}m/sec	
SA3	TP04	1	2.10m	4.38 x 10^{-6}m/sec	
		2		1.71 x 10^{-5}m/sec	
		3		1.35 x 10^{-5}m/sec	
SA4	TP06	1	1.60m	1.61 x 10^{-5}m/sec	
		2		1.57 x 10^{-5}m/sec	
		3		5.42 x 10^{-6}m/sec	
SA5	TP07	1	1.90m	2.17 x 10^{-5}m/sec	
		2		1.52 x 10^{-5}m/sec	
		3		5.47 x 10^{-6}m/sec	
SA6	TP14	1	1.90m	2.75 x 10^{-5}m/sec	
		2		3.11 x 10^{-5}m/sec	
		3		3.19 x 10^{-5}m/sec	

Notes:
1. Testing undertaken in accordance with BRE 365. Water level fell to 25% of fill depth.

The soakaway infiltration rate is dependent on the fine fraction within the soils. As the fine-grained portion of the River Terrace Deposits is generally low (between 2% and 5% silt/clay based on the PSD results – see Appendix M), the infiltration was observed to generally be in the region of 10^{-5} m/sec. Some results identified slower infiltration rates of 10^{-6} m/sec (e.g., SA3 Fill 1, SA4 Fill3 and SA5 Fill 3).

In general, it is recommended that 10^{-5} m/s be used as a typical infiltration rate for preliminary design across the site within the River Terrace Deposits. However, it must be appreciated that where fine-grained soils are present, infiltration rates will be lower.

We recommend that location specific soakaways are undertaken once the design proposals have been finalised, and the locations of the proposed soakaways are known.

The contamination status of the groundwater will also require checking prior to the finalisation of any soakaway development plans.

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 and not within the Made Ground soils or any areas of contamination (including within the contaminated River Terrace Deposits).

Soakaways should not normally be constructed closer than 5m 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 River Terrace 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. It is 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 an any development.

9 Recommendations

Although previous investigations have been undertaken at the site, a review of previous information has not been instructed at this stage. Given that previous assessments have been undertaken at the site and information on the planning portal indicates remedial works may have been completed at the site, the following section should be viewed as preliminary only at this stage.

It is recommended that all previous investigation information is reviewed in detail and pertinent information is included in this and any future assessment in order to fully understand any possible residual hazards at the site and the benefits afforded by any historic remediation. This will be essential to inform/support contemporary findings of the current investigation.

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

Required Further Actions:

- Complete current gas monitoring and update gas assessment.
- Collate, review and assess all previous investigations/works at the site and incorporate into an updated report.
- Undertake additional site investigations at specific locations, designed to assess the proposed land-use, once the designs have been finalised (i.e., residential land use, retail/commercial land use etc). This should include targeting any areas that may be identified as a potential geo-hazard following the review of all previous information.
- Undertake borehole investigation across the site to prove/disprove the anticipated low risk from historical mining.
- The supplementary works should include, as a minimum:
    - Additional trial pitting on a closer grid spacing, tailored to the proposed land-use.
    - Deep boreholes to investigate the risks from mining. This should include the installation of gas and groundwater monitoring wells.
    - Deep boreholes to investigate the presence/absence of limestone bedrock.
    - Mine gas Risk Assessment in line with CL:AIRE guidance.
    - Groundwater sampling and Level 2 Controlled Waters Risk Assessment.
    - Further assessment of the risks from contamination.
    - Further assessment of the risks to buried concrete – sulphate levels.
    - Location specific soakaway testing.

Recommended Further Actions:

- Tree survey across the site.
- Re-measure CBR values at sub-grade prior to pavement construction.
- Enquiries to NRW to confirm acceptance of soakaways and any risk mitigation measures required.
- Verification testing of any soils imported to site.
- WM3 assessment of soils to be disposed of off-site, followed by WAC testing if disposal to landfill.
- If proposed, materials management plan for re-use of soils on site.
- 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.

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