



Lidl UK GmbH

Geo-Environmental Investigation Report

Briton Ferry Road, Neath

January 2016





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A Factual Information

1 Introduction

1.1 Instruction

- 1.1.1 Opus International Consultants (Opus) were instructed by Lidl UK GmbH (The Client) to carry out a Geo-Environmental Investigation of a site off Briton Ferry Road (A474), Neath.
- 1.1.2 Lidl UK GmbH propose to re-develop the site with the construction of a new food store with associated delivery area and car parking the adjacent site to the south-west currently occupied by Lidl will be demolished and re-developed for additional car parking. The proposed layout is detailed on the appended **Mistral Architects and Surveyors Proposed Site Plan (Drawing 1219 SK01 dated 27/04/2015)**

1.2 Objectives

- 1.2.1 The objectives of this Geo-Environmental Investigation were to obtain information relating to the ground conditions beneath the site in order to determine suitable methods of design and construction for foundations, floor slabs and external pavements for the proposed development, and to identify any ground contamination in order to enable formulation of an appropriate remediation strategy for the proposed development if necessary.

1.3 Limitations

- 1.3.1 This report has been prepared by Opus with all reasonable skill, care and attention within the terms of the Contract with the Client, Lidl UK GmbH, and taking account of the information made available by the Client, as well as the manpower and resources devoted to it by agreement with the Client. Opus disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above Contract.
- 1.3.2 This report has been produced on behalf of the Client and no responsibility is accepted to any Third Party for all or any part. This report should not be relied upon or transferred to any other parties without the express written authorisation of Opus. If any unauthorised Third Party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care or skill.
- 1.3.3 The desk study information has been obtained from a variety of sources, which Opus believes are reliable. Nevertheless, Opus cannot and does not guarantee the authenticity or reliability of the information it has relied upon from these sources.
- 1.3.4 Whilst this report may express an opinion on the possible configuration of strata, groundwater, ground gas and contaminants between or beyond exploratory hole positions or on the possible presence of features based on either visual, verbal or published evidence, this is for guidance only, and no liability can be accepted for its accuracy.

- 1.3.5 The comments on groundwater and ground gas conditions are based on observations made at the time of the investigation. It should be noted, however, that groundwater levels and ground gas concentrations may vary from those reported due to seasonal or other effects.
- 1.3.6 The exploratory holes were positioned across the site in order to provide adequate coverage and to target any potential sources of contamination identified during the desk study and site observations. The positions were located approximately and no guarantee can be given as to their accuracy on the appended site plans.
- 1.3.7 The site plans appended to this report should not be used for scaling purposes.

2 The Site

2.1 Location and Access

- 2.1.1 The site is located approximately 600m to the south-west of the centre of Neath. The site location, shown on the appended **Site Location Plan (Drawing No. J-B0756.00/G001-A)** is centred on National Grid Reference 274680, 196500.
- 2.1.2 The site is accessed from an unnamed access road off Briton Ferry Road along the north-eastern site boundary.

2.2 Site Description

- 2.2.1 The following section describes the site at the time of Opus' investigation in December 2015. Site photographs are presented in **Appendix 'A'**.
- 2.2.2 The site currently comprises a single commercial unit, with associated car parking and soft landscaping. The commercial unit is located on the north-west site boundary and is orientated south-west to north-east. The building's current use is a 'Poundstretcher' store and child's play centre ('Kidz Korner'). Car parking extends from the store front eastwards towards Briton Ferry Road.
- 2.2.3 The site is bound to the north east by an unnamed access road and further commercial developments. In the south-east the site is bound by Briton Ferry Road, beyond which is Melin Junior School. To the south of the store is an existing Lidl store and associated car parking. Running south-west to north-east along the north-western boundary is the Neath railway line.
- 2.2.4 The site is located within the valley floor of the River Neath, site levels are generally flat at approximately 10m AOD.

3 Desk Study

3.1 Introduction

- 3.1.1 The following sources of information have been consulted as part of the desk study:
- (a) Opus Archives
 - (b) Landmark Information Group Ltd 'Envirocheck' database report
 - (c) Selected County Series and Ordnance Survey plans
 - (d) British Geological Survey 1:50,000 Map, Swansea (Sheet 247) and BGS online Lexicon
 - (e) Environment Agency Website
 - (f) BR 211 Radon; Guidance on Protective Measures for New Dwellings, 2007 Edition
 - (g) Law Society Guidance Notes and Directory for Coal Mining Searches
 - (h) Coal Authority
 - (i) Neath Port Talbot County Borough Council Online Planning Register

3.2 Site History

- 3.2.1 A review of the site history has been undertaken in order to identify any previous potentially significant contaminative activities, located either on-site or off-site. This is summarised in Table 3.1.
- 3.2.2 Potential on-site contamination sources may present a risk to future site users and underlying and/or adjacent 'controlled waters'.
- 3.2.3 Neighbouring potential off-site contamination sources may also present a risk to soils and, if present, groundwater underlying the site through cross boundary migration or deposition of waste materials.
- 3.2.4 The history of the site is recorded over selected periods by inspected maps, copies of which are presented in **Appendix 'B'**. The account presented in this report is restricted by specific time periods represented by these maps only.

Table 3.1 Site History

Map Edition	Key Features	
	On Site	Off Site
1881 (1:2,500)	The site was shown as predominantly marshland (as part of a larger area of marshland) with the exception of the eastern third of the site, where an embankment sloped eastwards. An unidentified watercourse was shown to intersect the site south-east to north-west. The northern area of the site was shown just within the boundary of 'Melin Crythan Works' (a tin works), with an associated rail line (sidings). The only fixed boundary to the site was the railway to the west.	'Melin Crythan Works' (Tin) was shown immediately to the north, extending eastward. Melin Crythan Works (Chemical) was shown to the west of the railway. 'Japan Works' was shown approximately 80m to the south-west. Several clay pits were shown within 250m north of the site, the nearest 190m. A clay mill was also noted approximately 250m north of the site. A brick field was shown approximately 80m to the west. Two old coal pits were shown approximately 160m to the south and south-east. An 'Old Limekiln' was shown approximately 290m to the south-west. Melin Crythan Pond was shown approximately 180m to the east. Neath Canal was shown approximately 110m to the west at its closest point.
1884 (1:10,560)	No significant changes shown.	'Mill-lands' Brick and Tile Works was shown approximately 350m to the north. The River Neath was shown approximately 350m to north at its closest point. A gas works was shown approximately 450m to the north.
1899 (1:2,500) 1900 (1:10,560)	All previous marshland areas were no longer shown. The site was shown to form part of a 'Tin Plate Works', with associated rail sidings. The previously unidentified watercourse was shown to have been redirected moving from the north-east off site, in an arc south of the site and moving north-east on site along the north-west site boundary. An embankment was shown to run north-east to south-west across the western side of the site.	'Eagle Tin Plate Works' was shown immediately to the west of the railway line and further north a 'Steel Sheet and Galvanising Works'. The clay pits to the north were no longer labelled, however the slopes were still shown. Two additional clay pits were shown approximately 200m to the south-west and 220m to the north-west. In addition, several bodies of water were noted to the west of the canal in this area. 'Japan Works' had been further developed. A quarry was shown approximately 380m to the south-east, alongside 'Eaglesbush Colliery'.
1919 (1:2,500)	The embankment was no longer shown. Several railway sidings were shown across the site. A building was shown in the north-east of the site.	The clay pits and brick fields located within 250m of the site were no longer shown. 'Japan Works' had been further developed. The Melin Crythan Chemical works and the Steel Sheet Chemical Works had been further developed.

Map Edition	Key Features	
	On Site	Off Site
1921 (1:10,560)	No significant changes shown.	Several quarries were shown within 500m east of the site. Eaglesbush Foundry (iron) was shown approximately 250m to the east. An old quarry was shown approximately 300m to the south.
1935 (1:2,500)	An additional railway siding was shown parallel to the north-west boundary.	No significant changes shown.
1936 (1:10,560)	No significant changes shown.	'Mill-lands' Brick and Tile Works was no longer shown. An old furnace was shown approximately 300m to the south-west.
1938 (1:10,560)	No significant changes shown.	No significant changes shown.
1945 (1:10,560) <i>Aerial Photography</i>	No significant detail shown.	No significant detail shown.
1951 (1:1,250) 1951 (1:10,560)	Only one siding was shown on site.	The Melin Crythan Chemical works was no longer shown, with the Steel Sheet and Galvanising works in its place. A garage was shown 180m to the east. A Cardboard Box factory was shown approximately 200m to the north-east.
1952 (1:2,500)	No significant changes shown.	No significant changes shown.
1958-1961 (1:1,250)	New sidings were shown to have been constructed across the site.	The refuse area to the west of the canal was shown as fields.
1964 (1:2,500)	No significant changes shown.	The former Melyn Works was shown to have been redeveloped, including new buildings and labelled as a 'works'.
1965 (1:10,560)	No significant changes shown.	The old furnace south-west of the site was no longer shown.
1967 (1:1,250)	Several buildings, a hopper and crane (part of 'Melyn Works') were shown in the east of the site. All sidings were no longer shown.	Six tanks were shown within 100m of the site within the area of 'Melyn Works'. As well as two electrical sub-stations.
1970 (1:10,560)	No significant changes shown.	No significant changes shown.
1974 (1:1,250)	No significant changes shown.	No significant changes shown.
1980 (1:10,560)	No significant changes shown.	No significant changes shown.
1982-1987 (1:1,250)	No significant changes shown.	'Japan Works' were no longer shown to the south and were replaced by 'Melyn Works'. The Steel Sheet and Galvanising works to the north-west were no longer shown.
1989 (1:1,250)	All former features were no longer shown and the site is labelled as a coal yard.	A coal yard was shown approximately 50m to the east.
1990 (1:1,250)	No significant changes shown.	No significant changes shown.

Map Edition	Key Features	
	On Site	Off Site
1992 (1:10,560) 1993 (1:1,250)	No significant changes shown.	The works and all associated buildings to the south were no longer shown.
1995 (1:1,250) 1996 (1:10,560)	No significant changes shown.	A building was shown immediately to the south of the site.
2015 (1:10,560)	A building was shown along the north-west boundary.	No significant changes shown.

3.3 Geology, Hydrogeology and Hydrology

Geology

- 3.3.1 The general geology of the area is shown on the British Geological Survey 1:50,000 Sheet 247 and is summarised in table 3.2.

Table 3.2 Geology

Age	Stratigraphic Name	Description
Holocene Epoch (QH)	Landscaped Ground (Undivided)	The site is shown to have Landscaped Ground at the near surface.
Holocene Epoch (QH)	Tidal Flat Deposits	Tidal Flat Deposits form superficial deposits across the site, and normally comprises “consolidated soft silty clay, with layers of sand, gravel and peat”.
Westphalian D Sub-age (CD)	Hughes Member	The Hughes Member is the recorded bedrock geology across the site, and is listed as “green-grey, lithic arenites (“Pennant sandstones”), with thin mudstone/siltstone and seatearth interbeds, and mainly thin coals”.

- 3.3.2 The Westernmoor Coal Seam is shown by the BGS to outcrop along the south-western boundary of the site dipping beneath the site to the north. Information obtained for additional data sources suggests the presence of Fluvio-glacial gravels to depths of 40m bgl and that the Westernmoor Coal Seam is likely to be eroded from beneath the site and is no longer present.

BGS Recorded Mineral Sites

- 3.3.3 The Envirocheck Report indicates that there are fourteen BGS recorded mineral sites within 1km of the site, with details as follows:

Table 3.3 BGS Recorded Mineral Sites

Operator	Distance & Direction from Site	Commodity and Type	Status
Unknown	215m (West)	Common Clay and Shale (Opencast)	Ceased
Unknown	252m (South-west)	Common Clay and Shale (Opencast)	Ceased
Unknown	279m (South-east)	Coal – Deep (Underground)	Ceased
Unknown	331m (South)	Coal – Deep (Underground)	Ceased
Unknown	430m (West)	Common Clay and Shale (Opencast)	Ceased
Unknown	462m (East)	Sandstone (Opencast)	Ceased
Unknown	467m (South-west)	Sandstone (Opencast)	Ceased
Unknown	475m (South-east)	Sandstone (Opencast)	Ceased

Operator	Distance & Direction from Site	Commodity and Type	Status
Unknown	561m (South)	Sandstone (Opencast)	Ceased
Unknown	681m (East)	Coal – Deep (Underground)	Ceased
Unknown	742m (South-east)	Sandstone (Opencast)	Ceased
Unknown	883m (East)	Coal – Deep (Underground)	Ceased
Unknown	916m (South)	Coal – Deep (Underground)	Ceased
Unknown	934m (South-east)	Sandstone (Opencast)	Ceased

BGS Estimated Soil Chemistry

- 3.3.4 The Envirocheck report provides a summary of the estimated soil chemistry for the site and surrounding area with background concentration ranges for Arsenic, Cadmium, Chromium, Lead and Nickel. The estimated ranges are summarised as follows:
- Arsenic = 25-35mg/kg
 - Cadmium = <1.8mg/kg
 - Chromium = 60-90mg/kg
 - Lead = <150mg/kg
 - Nickel = 15-30mg/kg

Hydrogeology

- 3.3.5 The Environment Agency classifies the superficial deposits underlying the site as Secondary Undifferentiated Aquifers, where it is not possible to designate it as 'A' or 'B'. Secondary 'A' Aquifers are permeable sediments or fissured rocks that are capable of storing and yielding enough water to support local water supplies and base flow to rivers. Secondary 'B' Aquifers are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
- 3.3.6 The Environment Agency classifies the bedrock geology underlying the site as a Secondary 'A' Aquifer.
- 3.3.7 The site is considered to be underlain by soils of High Leaching Potential, with the ability to transmit a wide range of pollutants.
- 3.3.8 The site is not recorded as being within a Groundwater Source Protection Zone.
- 3.3.9 There are no groundwater abstractions recorded within 1km of the site.

Hydrology

- 3.3.10 The nearest surface water feature to the site is Crythan Brook present along the north-west site boundary.
- 3.3.11 There are no surface water abstractions recorded within 1km of the site.
- 3.3.12 The Environment Agency assesses that the site is at a high risk of flooding from rivers or seas, and is not in an area of flood defences.

3.4 Environmental Considerations

- 3.4.1 The 'Envirocheck' database report comprises a summary of statutory data held on public registers which can be used to identify potential sources of contamination on the site and within a search radius of 1km. In addition, the report also contains data which can be used to identify potential receptors of contamination on the site and within 1km.
- 3.4.2 Specific details relating to the environmental setting of the site are presented within the Environmental Database Report presented as **Appendix 'C'**. The salient issues which relate to the site are summarised in the following sections.

Discharge Consents

- 3.4.3 There are fourteen recorded Discharge Consents within 500m of the site, with details as follows:

Table 3.4 Discharge Consents

Operator	Distance & Direction from Site	Discharge Type	Receiving Water	Status
Welsh Development Agency	153m (North)	Unspecified	Cryddan Brook	Expired
Carnaud Metal Box Plc <i>3 entries</i>	156m (South-west)	Trade Discharges – Cooling Water	Japan Brook	Revoked
	229m (West)	Unspecified		Expired
	348m (West)	Sewage Discharges – Final / Treated Effluent – Not Water Company		Revoked
Dwr Cymru Cyfyngedig <i>6 entries</i>	343m (North-west) <i>3 entries</i>	Unspecified	Estuarial Waters of River Neat	Expired
	354m (North-west) <i>2 entries</i>		River Neath	Revoked <i>2 entries</i>
	357m (North-west)	Public Sewage: Storm Sewage Overflow	Estuarial Waters River Neath	New Consent
Midland Metal Spinning Co Ltd	377m (North-west)	Unspecified	Crythan Brook	Expired
Mr P E Woodhouse	445m (South-east)	Unspecified	To Land	New Consent
Mr M Davies <i>2 entries</i>	492m (South-east)	Unspecified	Unnamed Stream at Eaglebush	New Consent
				Revoked

Integrated Pollution Controls

- 3.4.4 There are four recorded Integrated Pollution Controls approved processes within 500m of the site, with details as follows:

Table 3.5 Integrated Pollution Controls

Name	Distance & Direction from Site	Description	Status
Quasar Chemicals Ltd <i>4 entries</i>	97m (North)	4.2 A (D) Manufacture and use of Organic Chemicals within the Chemical Industry	Superseded <i>3 entries</i>
	99m (North-west)		
	103m (North-west)		
	104m (North-west)		Revoked

Local Authority Pollution Prevention and Controls

- 3.4.5 There are seven recorded Local Authority Pollution Prevention and Controls approved processes within 500m of the site, with details as follows:

Table 3.6 Local Authority Pollution Prevention and Controls

Name	Distance & Direction from Site	Description	Status
Metal Processors Ltd	74m (North)	PG2/6 Aluminium and aluminium alloy processes	Revoked
Mr H. J. G. Smith Mile End Service Station	111m (South-west)	PG1/14 Petrol filling station	Permitted
Ds Smith Packaging Ltd	145m (North-east)	PG6/16 Printworks	Authorised
Deoxidant Ltd	146m (North-east)	PG2/1 Furnaces for the extraction of non-ferrous metal from scrap	Revoked
Crown Packaging UK Plc	332m (South-west)	PG4/1 Processes for the surface treatment of metals	Transferred to LAIPPC
Tarmac Topmix Ltd	356m (North)	PG3/1 Blending, packing, loading and use of bulk cement	Revoked
Sandvik Osprey Ltd	478m (North)	PG6/35 Metal and other thermal spraying processes	Authorised

Pollution Incidents to Controlled Waters

- 3.4.6 There are five Pollution Incidents to Controlled Waters within 500m of the site, three of which are recorded as 'Category 3 – Minor Incidents'. The details of the two recorded 'Category 2 – Significant Incidents' are listed as follows:

Table 3.7 Pollution Incidents to Controlled Waters

Distance & Direction from Site	Receiving Water	Pollutant	Category	Date
42m (North)	Not given	Light Oils	Category 2 – Significant Incident	07/10/1991
286m (West)	Not given	Coal	Category 2 – Significant Incident	30/04/1992

Historical Landfill Sites

- 3.4.7 There is one Historical Landfill Site recorded within 1km of the site, with details as follows:

Table 3.8 Historical Landfill Sites

Licence Holder	Distance & Direction from Site	Key Dates	Specified Waste
Neath Borough Council	782m (North-west)	First & Last Input Date: 31/12/1980	Inert, Industrial, Commercial, Household and Special Waste

Licensed Waste Management Facilities

- 3.4.8 There is one recorded Licensed Waste Management Facility within 500m of the site, with details as follows:

Table 3.9 Licensed Waste Management Facilities

Operator Name	Distance & Direction from Site	Key Dates	Licence Status	Site Category
Fordpad Ltd	102m (North-east)	Issued: 02/02/1992 Modified: 22/02/2002	Modified	Metal Recycling Sites (Mixed)

Local Authority Recorded Landfill Sites

- 3.4.9 There is one Local Authority Recorded Landfill Site within 1km of the site, with details as follows:

Table 3.10 Local Authority Recorded Landfill Sites

Authority	Distance & Direction from Site	Last Reported Status	Types of Waste
Neath Port Talbot County Borough Council, Environmental Health Department	859m (North-west)	Not Supplied	Not Supplied

Registered Waste Treatment or Disposal Sites

- 3.4.10 There is one Registered Waste Treatment or Disposal Site within 500m of the site. The relevant details are as follows:

Table 3.11 Registered Waste Transfer Sites

Licence Holder	Distance & Direction from Site	Status / Date	Authorised Waste
Fordpad Ltd	111m (North-east)	Cancelled – 01/08/88	- Batteries - Electrical Scrap - Ferrous Metal Scrap - Non-Ferrous Metal Scrap

Control of Major Accident Hazards Sites (COMAH)

- 3.4.11 There is one record of Control of Major Accident Hazards Sites (COMAH) within 1km of the site, with details as follows:

Table 3.12 Control of Major Accident Hazards Sites (COMAH)

Name	Distance & Direction from Site	Type	Status
Transco Plc	506m (North)	Lower Tier	Record Ceased To Be Supplied Under COMAH Regulations

Notification of Installations Handling Hazardous Substances (NIHHS)

- 3.4.12 There is one record of Notification of Installations Handling Hazardous Substances (NIHHS) within 1km of the site, with details as follows:

Table 3.13 Notification of Installations Handling Hazardous Substances

Name	Distance & Direction from Site	Status
Transco	456m (North)	Not Active

Contemporary Trade Directory Entries

- 3.4.13 The Envirocheck Report indicates that there are forty-eight Contemporary Trade Directory Entries within 500m of the site. Activities include the following:

Table 3.14 BGS Contemporary Trade Directory Entries

Classification	Number Active	Number Inactive
Agricultural Machinery – Sales and Service		1
Aluminium Fabricators	1	
Blinds, Awnings and Canopies	1	
Bookbinding Equipment		1
Boxes and Cartons	1	
Builders Merchants	1	1

Classification	Number Active	Number Inactive
Bus and Coach operators	1	
Can Manufacturers	1	
Car Body Repairs		2
Car Dealers Used		1
Carpet, Curtain and Upholstery Cleaners		1
Cleaning Services- Domestic	1	
Clothes and Fabrics- Manufacturing		1
Coal & Smokeless Fuel Merchants and Distributors		1
Coating Specialists	1	
Commercial Cleaning Service	1	4
Chemical Engineers		1
Chemical Manufacturers		2
Exhaust and Shock Absorber Centres		1
Floorcovering- Manufacturing and Wholesalers	1	
Gunsmiths	1	
Joinery Manufacturers		1
Manufacturers	1	
Packaging and Wrapping Equipment and Supplies	1	1
Petrol Filling Station	1	1
Pumps – Sales, Servicing and Repairs		1
Precision Engineers		1
Printers	1	1
PVC-U Products		1
Scaffolding and Work Platforms	1	
Scrap Metal Merchants	1	
Refrigeration Equipment- Commercial	1	1
Road Haulage Services		4
Window Frame Manufacturers		1

Fuel Station Entries

3.4.14 There is one recorded Fuel Station Entry within 500m of the site, with details as follows:

Table 3.15 Fuel Station Entries

Name	Distance & Direction from Site	Premises Type	Status
Mile End Filling Station	97m (South-west)	Petrol Station	Open

Local Natural Reserves

3.4.15 There is one recorded Local Natural Reserve within 500m of the site, this was noted to be Eaglebush Valley approximately 269m to the east of the site.

Other Items

3.4.16 There are other headings that the Envirocheck Report indicates not being present within 500m of the site. These include:

- Local Authority Pollution Prevention and Control Enforcements
- Prosecutions Relating to Authorised Processes / Controlled Waters
- Registered Radioactive Substances
- BGS Recorded Landfill Sites
- Integrated Pollution Control Registered Waste Sites
- Registered Landfill Sites
- Registered Waste Transfer Sites

3.5 Radon

- 3.5.1 Reference to the 'Envirocheck' database report and BR211: 2007 indicates that the site is in an area where less than 1% of homes are above the radon action level and where no radon protective measures are necessary in the construction of new buildings or extensions.

3.6 Mining

- 3.6.1 Neath is listed in the Law Society's Guidance Notes and Directory of Coal Mining Searches as a location that requires a Coal Mining Report.
- 3.6.2 The full Coal Authority Mining Report is presented as **Appendix 'D'**. The salient issues which relate to the site are summarised below:
- The site is not in the likely zone of influence from past or present, underground or opencast workings, however the property is in an area where the Coal Authority believe there is coal at or close to the surface, which could be worked at some time in the future.
 - The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres, since 31st October 1994.
 - There are no known coal mine entries within the site boundary or within 20m of the site boundary.
 - There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property.

3.7 Previous Investigations

- 3.7.1 Reference to the Neath Port Talbot County Borough Council Online Planning Register has indicated that several ground investigations have been undertaken on the site previously. The salient points from these reports are summarised in the following section.

Geo-Environmental Report – Earth Science Partnership (May 2002)

- 3.7.2 The investigation was carried out to obtain geotechnical and geo-environmental information with regard to the nature and thickness of the underlying strata in order to provide engineering data to assist in the design of the proposed development, which believed to be the building currently present on site.
- 3.7.3 The ground investigation comprised seven trial pits and two light cable percussion boreholes, and found that the ground conditions comprised Made Ground to depths of 3.25m to 3.60m bgl, underlain by Alluvial superficial deposits to depths of 5.95m to 7.30m bgl, and further underlain by Fluvio-glacial gravels. Concrete obstructions were identified in five of the exploratory holes. The maximum depth of the trial pits was to 3.50m bgl and the boreholes was to 15.45m bgl.
- 3.7.4 The desk study element of the report identified the conjectured outcrop of the Westernmoor Coal Seam on site and which was recorded as being 0.5m thick and dipping to the north. However the report goes on to confirm that the site is not within the zone of likely physical influence on the surface from past underground workings and that there are no records of any mine entries in the immediate vicinity of the site.
- 3.7.5 Earth Science Partnership (ESP) also refer to having sight of Rotary Open Hole Borehole Logs produced by Atkins for the local area which indicate the presence of Fluvio-glacial gravels to

depths of 40m bgl. ESP conclude that despite the geological map interpretation, the Westernmoor Coal Seam is likely to be eroded from beneath the site and is no longer present.

- 3.7.6 Based on a commercial end use, the levels of contamination at the site were not considered to pose a risk to future site users, and not remedial measures were considered necessary. However, it was noted that there was a risk to construction and maintenance workers, and suitable measures would need to be taken to protect their safety.
- 3.7.7 The report recommended transferring foundation load through to the underlying Fluvio-glacial gravels, utilising a bored piles or continuous flight auger piles. The report also addressed the need to deal with existing buried foundations encountered during the ground investigation.
- 3.7.8 The report indicated a CBR value of at least 15% to be appropriate for preliminary design purposes.
- 3.7.9 It was anticipated that large capacity excavators and hydraulic breakers would be required to remove old foundations and underground structures.

Controlled Water Risk Assessment – Earth Science Partnership (June 2006)

- 3.7.10 The investigation was carried out to assess the risk the site posed to controlled waters, by assessing groundwater contaminant concentrations and deriving remedial targets for the site.
- 3.7.11 The ground investigation comprised seven rotary boreholes, and found that the ground conditions comprised Made Ground to depths of 2.00m to 3.40m bgl, underlain by Alluvial superficial deposits to depths of 6.20m to 6.40m bgl, and further underlain by Fluvio-glacial gravels. The maximum depth of the boreholes was to 12.00m bgl.
- 3.7.12 The report noted that the building on site is constructed on shallow foundations including rafts placed on imported fill materials.
- 3.7.13 The report concluded that contaminant levels identified posed a low risk to controlled waters and that no remedial action would be required.

4 Preliminary Conceptual Site Model

4.1 Background

- 4.1.1 The Contaminated Land (Wales) Regulations provide a risk based approach to contaminated land in Wales. The government has adopted a 'suitable for use' criteria under the Regulations. This means that remediation is only required to the standard which is acceptable for the use of a site.
- 4.1.2 Land is only defined as 'contaminated' under the Regulations where it appears to the regulatory authority that:
- Significant environmental harm is being caused, or is likely to be caused; or
 - Significant pollution of controlled waters is being caused, or is likely to be caused.
- 4.1.3 Risk is defined as the combination of:
- The probability, or frequency, of occurrence of a defined hazard; and
 - The magnitude (including the seriousness) of the consequences.
- 4.1.4 For a risk of environmental harm or pollution to occur as a result of contaminated land, all of the following elements must be present:
- A **Source**, i.e. a contaminant which could cause harm to health and/or the environment. Sources include current and historical uses, activities and events either on the site or in the surrounding area;
 - A **Receptor**, i.e. a target which could be harmed by the contaminant. Receptors include both human and non-human organisms, 'controlled waters' (groundwater and surface water) and building materials (concrete and plastic); and
 - A **Pathway**, i.e. a route by which contaminants could move from a source to a receptor.
- 4.1.5 A **Pollutant Linkage** occurs when a contaminant is able to move from a source, via a pathway to a receptor. Each element may exist in isolation and pose no environmental risk. It is only when all three elements are linked to each other that a pollution linkage exists, and poses an environmental risk. If all three elements are present, then the magnitude of the risk is a function of the mobility of the source, the sensitivity of the receptor and the nature of the pathway.
- 4.1.6 Environmental risks associated with pollutant linkages at a site are assessed on the basis of information obtained from the desk study, site observations and laboratory testing results and are ranked into the following categories:
- **High:** A pollutant linkage is present and this poses a significant risk to the identified receptors(s). Action must be taken to remove the pollutant linkage and/or reduce the risk.
 - **Medium:** A pollutant linkage is present and there is sufficient evidence to suggest that this is likely to pose a significant risk to the identified receptors(s). Further investigation and assessment should be undertaken to confirm this.
 - **Low:** A pollutant linkage is present and there is sufficient evidence to suggest that this is unlikely to pose a significant risk to the identified receptors(s). Further investigation and assessment may be undertaken to confirm this.
 - **Negligible:** A pollutant linkage may be present but this poses no significant risk to the identified receptors(s).

4.2 Potential Sources of Contamination

- 4.2.1 The site has historically been occupied by a number of buildings, and a number of railway sidings. Currently the site is occupied by a commercial building, along with associated road networks and associated car parking. In addition, it is likely that historically the course of Crythan Brook ran across the site and was relocated. Alongside this it was evident that some excavation works took place on site.
- 4.2.2 There is the potential for Made Ground to be present on the site due to the demolition of the historical buildings, removal of railway sidings and the formation of existing ground levels.
- 4.2.3 Hence, the following potential **on-site** sources of contamination have been identified:
- Potentially contaminated Made Ground beneath the site from the former phases of development. Typical contaminants of concern may include metals, sulphates, PAH's, Hydrocarbons, and asbestos fibres;
 - Potential ground gas generation from organic materials within Made Ground on site and natural strata as well as areas where the historical course of Crythan Brook have been backfilled. Ground gases may include methane and carbon dioxide.
- 4.2.4 The following potential **off-site** sources of contamination have been identified:
- Potential ground gas migration from backfilled quarries and clay pits in adjacent sites.

4.3 Potential Migration Pathways

- 4.3.1 The following potential migration pathways have been identified:
- **Inhalation:** Breathing dust and vapours from contaminated soil in outdoor air. Vapours can also migrate into buildings resulting in inhalation by the occupants.
 - **Ingestion:** Eating and swallowing of contaminated soil either by deliberate consumption, indirectly by eating or smoking with dirty hands or by ingestion of fugitive dust.
 - **Dermal Contact:** Direct contact with contaminated soil and groundwater, causing skin conditions such as dermatitis etc. Certain contaminants can be absorbed into the body through the skin or enter directly through open cuts or abrasions.
 - **Leaching:** Infiltration of water through soil can leach out soluble contaminants resulting in groundwater pollution.
 - **Migration of Hydrocarbons:** Mobile contaminants such as hydrocarbons can migrate through near surface materials and impact adjoining land.
 - **Migration of Contaminated Water:** Contaminated water can migrate laterally or vertically dependent on permeability, preferential pathways, man-made voids etc.
 - **Migration of Ground Gas/Vapours:** Ground gases/vapours can migrate laterally or vertically through permeable or voided ground and accumulate within unprotected buildings.
 - **Direct Contact:** Building materials can be damaged by direct contact with aggressive ground conditions, for example sulphate attack on concrete.

4.4 Potential Receptors of Contamination

- 4.4.1 The following potential human health and environmental receptors have been identified:
- Future Customers and Staff of the Lidl store
 - Construction and Maintenance Workers

- Groundwater in the Hughes Member (Secondary 'A' Aquifer)
- Crythan Brook surface watercourse
- Neath Canal
- Buried concrete and Water Supply Pipes

4.5 Pollutant Linkages and Environmental Risks

4.5.1 The preliminary **Source-Pathway-Receptor** relationships identified for the site bearing in mind the proposed redevelopment of the site are summarised as follows:

Table 4.1 Preliminary Source Pathway-Receptor Relationships

Source Material/Activity	Potential Contaminant	Pathways	Receptor	Risk
Made Ground	Metals, PAHs, TPH, VOCs, Phenols	Inhalation, Ingestion, Dermal contact	Future Customers, Lidl Staff, Construction Workers, Maintenance Workers	Medium
	Water-soluble Sulphate	Direct Contact	Buried Concrete	Medium
	Hydrocarbons	Direct Contact	Water Supply Pipes	Low
Bulk materials / free fibres in Made Ground	Asbestos Containing Materials	Inhalation	Construction Workers, Maintenance Workers	Medium
Made Ground (on and off site), Natural Strata	Methane, Carbon Dioxide, Carbon Monoxide, Hydrogen Sulphide	Gas migration through permeable strata and accumulation inside buildings	Future Customers, Lidl Staff, Construction Workers, Maintenance Workers	Low
Made Ground and Tanks (off site)	Metals, PAHs, TPH, VOCs, Phenols	Leaching and migration through permeable strata	Underlying Secondary Aquifers, Crythan Brook	Low

5 Investigation Methodology

5.1 Objectives

- 5.1.1 The objectives of this Geo-Environmental Investigation were to obtain information relating to the ground conditions beneath the site in order to determine suitable methods of design and construction for foundations, floor slabs and external areas for the proposed development, and to identify any ground contamination in order to enable formulation of an appropriate remediation strategy for the proposed development if necessary.

5.2 Clearance of Underground Services

- 5.2.1 Service location plans for the site were provided by the Client prior to the intrusive investigation which indicated that a number of services were located beneath the site, however the positions of gas and water mains were unknown. Therefore, due to the high risk, all exploratory hole locations were scanned by Opus using a cable avoidance tool (CAT) and a hand dug inspection pit (to 1.20m bgl) was carried out as a precautionary measure prior to the advancement of each exploratory hole.

5.3 Exploratory Holes

- 5.3.1 Eight window sample boreholes (WS1-WS7) were advanced across the site using a small, tracked, light percussion window sampling rig on 3rd and 4th December 2015. These were located to provide adequate coverage to characterise the ground conditions beneath the available areas of the site. The window sample boreholes were advanced to depths of between 0.40m and 5.00m below ground level (bgl).
- 5.3.2 Combined ground gas and groundwater monitoring wells were installed in WS3 and WS4A. The wells were constructed using 50mm HDPE plain pipe in a bentonite seal from existing ground level to 0.50m bgl and 50mm HDPE slotted pipe in a gravel surround to 2.00m (WS4A) and 2.50m bgl (WS3). The wells were fitted with a gas tap assembly at ground level suitable for connection to proprietary gas monitoring equipment and a lockable cover at ground level to provide protection. The remaining window sample holes were backfilled with arisings and reinstated at surface with concrete.
- 5.3.3 The approximate locations of the exploratory holes are shown on the appended **Exploratory Hole Location Plan (Drawing No. J-B0756.00/G002-A)**.

5.4 Logging and Sampling

- 5.4.1 Engineers' logs of the strata encountered in the window sample holes were developed in accordance with BS EN ISO 14688 and copies are presented as **Appendix 'E'**.
- 5.4.2 Standard Penetration Tests (SPT's) were taken at regular 1.00m intervals within the window sample boreholes (where it was possible to fully hand dig the inspection pits) to provide 'N' values for empirical assessment of strength and density parameters of the strata.

- 5.4.3 Disturbed soil samples were taken at selected depths in all exploratory holes, placed in appropriate containers and submitted for chemical and geotechnical laboratory testing.

5.5 Chemical Testing

- 5.5.1 Selected soil samples were subjected to appropriate chemical testing at the MCERTS and UKAS accredited laboratory of QTS Environmental for a suite of potential contaminants taking account of the Preliminary Conceptual Site Model and site observations.

- 5.5.2 The following chemical testing was carried out on selected soil samples:

• Metals	10 samples
• Speciated Polycyclic Aromatic Hydrocarbons (PAH)	10 samples
• Soil Organic Matter	5 samples
• Asbestos Screen	9 samples
• Asbestos Identification	1 sample
• TPH/CWG including BTEX	4 samples
• Volatile Organic Compounds (VOCs)	4 samples

- 5.5.3 The results of the chemical testing are presented as **Appendix 'F'**.

5.6 Geotechnical Testing

- 5.6.1 Selected soil samples were subjected to appropriate geotechnical testing at the UKAS accredited laboratory of QTS Environmental.

- 5.6.2 The following geotechnical testing was carried out on selected soil samples:

• pH	10 samples
• Water-Soluble Sulphate	10 samples

- 5.6.3 The results of the pH and water-soluble sulphate testing are included with the chemical testing results presented as **Appendix 'F'**.

5.7 Gas/Groundwater Monitoring

- 5.7.1 Ground gas monitoring has been undertaken in the two monitoring wells during a single visit. Methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide concentrations have been measured using a calibrated Gas Data GFM436 Gas Analyser. Atmospheric pressure and gas flow rates have also been recorded at the same time.

- 5.7.2 The results of the ground gas / groundwater monitoring are presented as **Appendix 'G'**.

6 Results of Investigation

6.1 Introduction

- 6.1.1 The ground conditions encountered in the exploratory holes across the site generally comprised a significant layer of Made Ground that was difficult to penetrate below 1.00m bgl. Where the Made Ground was penetrated, this was underlain by natural, grey, very soft consistency CLAY.

6.2 Strata Observations

Made Ground

- 6.2.1 In the area of the car park, the Made Ground generally comprised a thin layer of asphalt, underlain by grey gravel sub-base, and further underlain by ashy, sandy gravel and cobbles. Constituents included brick, metal, sandstone and slag. The Made Ground in this area was penetrated to a maximum depth of 1.20m bgl, and a concrete slab was identified at 0.40m bgl in WS7.
- 6.2.2 To the rear of the commercial units, the Made Ground generally comprised ashy, gravel and sand, with occasional cobbles of brick and concrete. The base of the Made Ground was proven to the rear of the existing building at a depth of 4.7m bgl in WS3. WS4 was terminated at 0.4m upon encountered 'No Dig' tape. WS4A could not be advanced beyond 2.4 m due to refusal of the window sampling barrel.

Natural Strata

- 6.2.3 Natural strata was encountered beneath the Made Ground in WS3, and comprised grey, very soft consistency, very low strength CLAY.

6.3 Standard Penetration Tests (SPT's)

- 6.3.1 The SPT's taken at 1.00m intervals in the Made Ground and natural strata gave the following ranges of corrected 'N' values:

Table 6.1: Corrected SPT 'N' Values

Depth (m)	Exploratory Hole		
	WS1	WS3	WS4A
1.20	18	21	15
2.00	-	19	59
3.00	-	7	-
4.00	-	11	-
5.00	-	3	-

6.4 Groundwater Observations

- 6.4.1 Groundwater was encountered in WS3 at a depth of 1.90m bgl within the Made Ground during the intrusive investigation.

- 6.4.2 Standing groundwater levels were recorded in the monitoring wells in WS3 and WS4A at depths of 2.52m and 2.00m bgl respectively.

6.5 Chemical Testing

- 6.5.1 The results of the chemical testing of soil samples have been reviewed in accordance with the current legislative framework and criteria to assess the risk to human health.
- 6.5.2 The soil sample chemical testing results have been compared to the Environment Agency Soil Guideline Values (SGV's), DEFRA Category 4 Screening Levels, Opus In-House Tier 1 Screening Values (IHSV's) and Land Quality Management (LQM) & Chartered Institute for Environmental Health (CIEH) 'Suitable 4 Use Levels' (S4UL's) derived using CLEA 1.06 to be protective of human health.
- 6.5.3 The 'Commercial' site end use scenario has been adopted for the assessment of the site bearing in mind the site redevelopment proposals.
- 6.5.4 The metal and PAH results for the five tested near-surface soil samples have been subjected to a statistical Tier 1 Human Health Risk Assessment in accordance with the CL:AIRE and CIEH document titled 'Guidance on Comparing Soil Contamination with a Critical Concentration' published in May 2008 using the ESI Contaminated Land Statistical Calculator software.
- 6.5.5 Under the land use planning system, the objective is to determine the 'suitability for use' of the land under consideration and hence demonstrate that there is a 95% probability that the true population mean is below the set critical concentration, such as published SGV's, and Category 4 Screening Levels and, in their absence, Opus Tier 1 IHSV's and LQM/CIEH S4UL's for a 'Commercial' site end use.
- 6.5.6 Where the objective is to demonstrate 'suitability for use', the Null and Alternative Hypotheses are as follows:
- Null Hypothesis: "Is the true mean concentration more than or equal to that of the critical concentration?"
 - Alternative Hypothesis: "Is the true mean concentration less than the critical concentration?"
- 6.5.7 The Tier 1 Human Health Risk Assessment Spreadsheets are presented as **Appendix 'H'**.
- 6.5.8 Soil Organic Matter (SOM) analysis has also been undertaken to enable the determination of appropriate screening values for organic contaminants. The average SOM% value for the site is 3.0% therefore screening values applicable for 3% SOM have been used within the generic screening assessment.
- 6.5.9 The results of the TPHCWG, BTEX, MTBE and VOC analysis cannot be assessed by statistical means due to a number of the samples analysed being targeted for analysis and not being part of a general screen. Any elevated concentrations detected as a result of the targeted sampling and analysis would skew the statistical analysis and general distribution of the data set giving a false representation of the distribution of TPHCWG, BTEX, MTBE and VOC contamination on site.

Metals

- 6.5.10 Nine samples of Made Ground and one of natural clay were analysed for a standard metals suite.
- 6.5.11 No metal concentrations exceeded their applicable screening values in the tested samples. The statistical analysis of the metals data set has confirmed that the Null Hypothesis has been rejected for metals (i.e. the true mean concentration is less than the critical concentration). Hence, no remedial action is considered necessary for metals with respect to human health.

Speciated PAH's

- 6.5.12 Nine samples of Made Ground and one of natural clay were analysed for speciated PAH's.
- 6.5.13 No individual PAH concentrations exceeded their applicable screening values in the tested samples. The statistical analysis of the PAH data set has confirmed that the Null Hypothesis has been rejected for PAH's (i.e. the true mean concentration is less than the critical concentration). Hence, no remedial action is considered necessary for PAH's with respect to human health.

Total Cyanide and Total Phenol

- 6.5.14 Nine samples of Made Ground and one of natural clay were analysed for total cyanide and total phenol.
- 6.5.15 No total cyanide and total phenol concentrations were detected above their laboratory detection limit of 2mg/kg in the tested samples. Hence, no remedial action is considered necessary for Cyanide or Total Phenol with respect to human health.

Speciated TPH, BTEX & MTBE

- 6.5.16 Four Made Ground samples were analysed for speciated TPH and BTEX.
- 6.5.17 No individual TPH, BTEX or MTBE fractions exceeded their applicable screening values in the tested soil samples. Hence, no remedial action is considered necessary for TPH, BTEX or MTBE with respect to human health.

VOCs

- 6.5.18 Four samples of Made Ground were analysed for VOCs.
- 6.5.19 Trace concentrations of VOC's were identified in samples WS3/3.0m and WS4A/1.4m however the individual compound concentrations did not exceed their applicable screening values. All other concentrations did not exceed their lower laboratory detection limits. Hence, no remedial action is considered necessary for VOC with respect to human health.

Asbestos

- 6.5.20 Nine samples of Made Ground were screened for asbestos fibres, and one bulk sample was tested to confirm the presence of asbestos.
- 6.5.21 Asbestos fibres (chrysotile) were detected in four samples of Made Ground taken from WS1 (0.60m), WS3 (1.40m and 2.00m) and WS6 (0.40m).
- 6.5.22 The bulk material identified in WS1 was confirmed to be cement type chrysotile.

6.6 Geotechnical Testing

- 6.6.1 Nine samples of Made Ground and one of natural clay have been tested for pH and water-soluble sulphate. The results of the geotechnical testing are summarised as follows:

Made Ground

- pH values between 7.2 and 9.3
- Water-soluble sulphate values between 16mg/l and 592mg/l

Natural Strata

- pH value of 7.5
- Water-soluble sulphate value of 44mg/l

6.7 Ground Gas Monitoring Results

- 6.7.1 Gas monitoring results have been compared to guidance presented in CIRIA Report C665, Assessing Risks Posed by Hazardous Ground Gases to Buildings, 2007.
- 6.7.2 CIRIA C665 indicates that ground gas protection measures may be necessary in new buildings on sites where methane concentrations exceed a threshold value of 1% v/v and/or where carbon dioxide concentrations exceed a threshold value of 5% v/v. The gas flow rate is also considered in the required level of protection.
- 6.7.3 Maximum methane (CH₄) and carbon dioxide (CO₂) concentrations, as percentage volume in air (%v/v), minimum oxygen (O₂) concentrations (%v/v), maximum carbon monoxide (CO) and hydrogen sulphide (H₂S) concentrations, in parts per million (ppm), and gas flow rates in litres per hour (l/hr) have been monitored in the two monitoring wells during the monitoring visit.
- 6.7.4 The results of the gas monitoring visit are summarised as follows:
- Methane has not been recorded above the instrument detection limit (<0.1% v/v).
 - Carbon dioxide has been recorded at concentrations between 1.0% v/v (WS3) and 1.1% v/v (WS4A).
 - Carbon monoxide has been recorded at a concentration of 1ppm in WS3.
 - Hydrogen sulphide has not been recorded above the instrument detection limit (<1ppm).
 - Gas flow was detected at a peak of 2.0 l/hr in WS3.
- 6.7.5 The atmospheric pressure recorded at the time of the monitoring visit was 1021mb with a falling pressure trend.

B Assessment & Recommendations

7 Environmental Assessment

7.1 Soil

- 7.1.1 No metal, PAH, Cyanide, Phenol, TPH, BTEX, MTBE or VOC concentrations were found to exceed their adopted screening values in any of the tested soil samples. However, Asbestos fibres were identified with the Made Ground in WS1, WS3 and WS6, in addition to a bulk sample in WS1. Hence, it is considered that there is requirement for remedial action with respect to asbestos to be undertaken as part of the proposed development of the site with respect to human health.
- 7.1.2 It is likely that the asbestos is present as a result of the importation of fill materials to create a development platform for the existing development on site. Given the depth of the identified fibres, it is likely that the material will be disturbed as part of the re-development works.
- 7.1.3 Initially the remedial action should be in the form of a watching brief and inspection of the exposed Made Ground in and around exploratory holes by a suitably qualified Geo-Environmental Engineer in these areas during demolition to determine the extent of the asbestos impacted area. Appropriate remedial and mitigation measures can then be determined.
- 7.1.4 The water-soluble sulphate concentrations in the soils and groundwater beneath the site indicate that the risk posed to future buried concrete structures is low. This issue is characterised further in Section 8.7 of this report.

7.2 Ground Gas

- 7.2.1 The nearest Historical Landfill Sites were recorded between 750m and 900m of the site. However, there is a significant amount of Made Ground on site. As a result, the ground gas potential for the site and surrounding area is considered to be low risk.
- 7.2.2 A maximum carbon dioxide concentration of 1.1% v/v and peak flow of 2.0 l/hr has been recorded in the single monitoring visit undertaken to date. No detectable concentration of methane has been recorded across all monitoring wells.
- 7.2.3 The maximum carbon dioxide concentration of 1.1% v/v and a maximum gas flow rate of 2.0 l/hr have been selected to calculate an initial Gas Screening Values (GSV) for the site in accordance with CIRIA Report C665 to determine the required level of carbon dioxide protection measures for the proposed future site development.
- 7.2.4 The GSV is calculated as follows:

$$\text{GSV} = \text{Gas Concentration}/100 \times \text{Flow Rate}$$

- 7.2.5 In line with the recommendations provided in CIRIA 665, a preliminary GSV of 0.022 l/hr has been calculated for carbon dioxide. The GSV's for carbon dioxide put the site within 'Characteristic Situation 1' (Very Low Risk) in accordance with CIRIA 665.
- 7.2.6 On the basis of the very low risk assessed for the site as part of this investigation, no gas protection measures are considered necessary for the proposed development.
- 7.2.7 It is recommended that the above assessment be submitted to the Local Authority EHO for approval or comment on whether further monitoring is required.

7.3 Revised Conceptual Site Model

- 7.3.1 The revised Conceptual Site Model based on information obtained from the intrusive investigation, the Tier 1 Human Health Risk Assessment and the provisional Ground Gas Risk Assessment has identified that the majority of the potential pollutant linkages identified at the desk study stage have been broken due to no source being identified. The remaining identified pollutant linkages that require mitigation or remedial works as part of the proposed development are tabulated below.

Table 7.1 Updated Source Pathway-Receptor Relationships

Source Material/Activity	Potential Contaminant	Pathways	Receptor	Risk
Made Ground	Water-soluble Sulphate	Direct Contact	Buried Concrete	Low
Bulk materials / free fibres in Made Ground	Asbestos Containing Materials	Inhalation	Construction Workers, Maintenance Workers	Medium

7.4 Health & Safety

- 7.4.1 The Principal Contractor should provide an assessment of the appropriate procedures required to protect site workers from the materials likely to be encountered at the site.
- 7.4.2 The following basic health and safety measures should be adopted as a minimum during the site development works:
- Basic Personal Protective Equipment (PPE) including hard hats, gloves, coveralls and steel toe-capped boots to be worn at all times;
 - Eating, drinking and smoking to be forbidden at all times except in designated mess areas; and
 - Breathing equipment to be available for those working in confined or unventilated spaces.
- 7.4.3 In addition, the presence of asbestos fibres and cement bound asbestos within the Made Ground pose a risk to construction workers. Therefore, appropriate measures should be put in place to reduce the risk to human health.
- 7.4.4 If ground conditions should differ significantly from those encountered during the intrusive investigation, including the discovery of any visible or odourous contamination, site redevelopment works should be suspended until the suspect material has been inspected and assessed by a competent Geo-Environmental Engineer.

7.5 Waste Disposal

- 7.5.1 The reuse of Made Ground as engineered fill should be undertaken in accordance with an appropriate Environment Agency licence as defined in the statutory guidance on the 'Definition of Waste' or CL:AIRE Code of Practice.
- 7.5.2 Any materials designated for off-site disposal are likely to require classification by the Waste Acceptance Criteria (WAC) in accordance with the Landfill Regulations. No WAC testing has been undertaken as part of this investigation.

7.6 Liaison with Regulators

- 7.6.1 It is recommended that this report be submitted to the Local Authority Environmental Health Officer for review and comment prior to any irrevocable action taking place.

7.7 Water Supply Pipes

- 7.7.1 It is recommended that this report be submitted to the relevant Water Supply Authority to confirm the necessary level of protection, if any, for future plastic water supply pipes.

7.8 Environmental Protection

- 7.8.1 The following environmental protection measures should be adopted as a minimum during the site redevelopment works:
- Covering or dampening of spoil to prevent the spread of dust;
 - Containment of surface water runoff to prevent the pollution of surface water drains, sewers etc.; and
 - Cleaning and washing of boots, vehicle wheels and other equipment at site entry and exit points to prevent the spread of mud.

8 Geotechnical Assessment

8.1 Discussion

- 8.1.1 In the area of the car park, the Made Ground generally comprised a thin layer of asphalt, underlain by grey gravel sub-base, and further underlain by ashy, sandy gravel and cobbles. Constituents included brick, metal, sandstone and slag. The Made Ground in this area was penetrated to a maximum depth of 1.20m bgl, and a concrete slab was identified at 0.40m bgl in WS7.
- 8.1.2 To the rear of the commercial units, the Made Ground generally comprised ashy, gravel and sand, with occasional cobbles of brick and concrete. . The base of the Made Ground was proven to the rear of the existing building at a depth of 4.7m bgl in WS3. WS4 was terminated at 0.4m upon encountered 'No Dig' tape. WS4A could not be advanced beyond 2.4 m due to refusal of the window sampling barrel.
- 8.1.3 Natural strata beneath the Made Ground was only encountered in WS3, and comprised grey, very soft consistency, very low strength CLAY.
- 8.1.4 The SPT's taken at 1.00m intervals in the Made Ground and natural strata gave the ranges of corrected 'N' values, as shown in table 6.1.
- 8.1.5 A previous investigation undertaken by ESP found that the ground conditions comprised Made Ground to depths of 3.25m to 3.60m bgl, underlain by Alluvial superficial deposits to depths of 5.95m to 7.30m bgl, and further underlain by Fluvio-glacial gravels. Concrete obstructions were identified in five of the exploratory holes. The maximum depth of the trial pits was to 3.50m bgl and the boreholes was to 15.45m bgl.
- 8.1.6 Groundwater was encountered in WS3 at a depth of 1.90m bgl within the Made Ground during the intrusive investigation. Standing groundwater levels were recorded in the monitoring wells in WS3 and WS4A at depths of 2.52m and 2.00m bgl respectively.

8.2 Foundation Design

- 8.2.1 At present the finished ground levels and anticipated loadings for the proposed Lidl retail store are not known. The following account should therefore be reviewed on completion of the detailed design and planning process.
- 8.2.2 Given the presence of significant levels of Made Ground, it is considered that a piled foundation solution is the most appropriate option, taken down to the underlying gravels anticipated at depths of around 6.0m to 7.5m bgl however this would need to be confirmed by advancing deeper boreholes to ascertain the characteristics of the underlying natural strata.
- 8.2.3 A suitably experienced piling contractor should be consulted in order to derive the most appropriate and cost effective piled foundation solution.

8.3 Floor Slab Design

- 8.3.1 Assuming that piled foundations are adopted for the foundation design, and in view of the variable Made Ground and low strength natural deposits, a reinforced, cast in-situ floor slab is considered to be the most appropriate.

8.4 Pavement Design

- 8.4.1 A significant layer of predominantly granular Made Ground was encountered across the site, although the demolition of the existing store will disturb the near surface soils. Hence it is recommended that preliminary design be undertaken based upon a Design CBR value of <2% however it is anticipated that the granular Made Ground materials could be improved to in the region of 10% following heavy proof rolling. This would however need to be confirmed by in-situ testing.

8.5 Buried Concrete Obstructions and Services

- 8.5.1 A buried concrete obstruction was encountered within WS7 at a depth of 0.40m bgl. The concrete obstruction is believed to be remnants of former buildings. This was also found to be the case in some exploratory holes from the investigation carried out in 2002.
- 8.5.2 Prior to the site investigation, the provided utilities survey and utility providers' records were unable to indicate the position of gas and water supply pipes to the building. If possible, the positions of these services should be confirmed to enable more intrusive investigation to be carried out.
- 8.5.3 All former foundations and services must be located and removed to enable construction of the proposed store.

8.6 Construction

- 8.6.1 Anticipated excavation depths should be readily achieved using conventional plant (JCB 3CX or similar), although larger machinery may be required to remove old foundations or slabs.
- 8.6.2 Support must be provided for all excavations requiring entry by site workers in accordance with guidance presented in CIRIA Report 97 'Trenching Practice'.
- 8.6.3 Groundwater is likely to be encountered in excavations at depths in excess of 1.90m bgl. In view of the relatively low permeability of the natural strata, it is considered that sump pumping may be appropriate to deal with groundwater entries.

8.7 Concrete Specification

- 8.7.1 The ground conditions, pH values and water-soluble sulphate concentrations have been assessed for potential aggressive attack on concrete in accordance with BRE Special Digest 1 'Concrete in Aggressive Ground (2005)'.

- 8.7.2 A review of the pH values and water-soluble sulphate concentrations for the whole site has indicated that the Made Ground, natural soils beneath the site fall within Design Sulphate Class DS-2 and ACEC (Aggressive Chemical Environment for Concrete) Class AC-2.
- 8.7.3 The specific concrete mixes for the DS Class to be used at the site will be determined, mindful of the ACEC Class, by the site-specific concrete requirements in terms of the required durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any Additional Protection Measures (APM).

8.8 Soakaways

- 8.8.1 Soakaway tests in accordance with BRE 365 have not been undertaken as part of this investigation. Given the significant thicknesses of Made Ground, and the presence of natural cohesive strata beneath, it is considered that soakaways are unlikely to provide a suitable drainage solution for the proposed development.

9 Recommendations

9.1 The following further works are recommended prior to the redevelopment of the site:

- Undertake further investigation consisting of deep boreholes to confirm the depth and characteristics of the underlying natural strata to enable pile design.
- Undertake a watching brief and inspection of the exposed Made Ground by a suitably qualified Geo-Environmental Engineer in the areas within close proximity of WS1, WS3 and WS6 during demolition to determine the extent of the asbestos impacted areas. Appropriate remedial and mitigation measures can then be determined.
- Design appropriate remedial and mitigation measures for asbestos impacted Made Ground.
- Submission of this report to the Local Authority Environmental Health Officer for review and comment prior to any irrevocable action taking place. Further gas monitoring if required.



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