PROPOSED NEW BRANCH SURGERY, COELBREN, NEATH

NJP/ABM ULHB

GEO-ENVIRONMENTAL ASSESSMENT

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Date	Status	Written By	Checked and Approved By
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SUMMARY

ESP were instructed by NJP on behalf of Abertawe Bro Morgannwg University Local Health Board (ABM ULHB) to undertake a Geoenvironmental Assessment for the proposed demolition of an existing surgery building and the construction of a new branch surgery and associated car parking area.

An assessment of the site history confirmed the site to be part of a vacant rural area until the construction of the Health Centre in the 1970's.

7no. windowless sample holes and 3no. rotary openholes identified a thin covering of Made Ground (encountered to a maximum depth 0.7m) followed by firm becoming stiff/medium dense glacial deposits which became more competent with depth. Ground conditions were generally saturated between 2m and 4m in this horizon.

Lower Coal Measures Bedrock was encountered to a maximum depth of 20m as light grey to dark grey Mudstones and Siltstones. Within the Lower Coal Measures bedrock, no solid coal seams, voids or anomalous drilling conditions have been identified beneath the site. Therefore, it is considered that the hazard presented by historical mine workings is low.

No obvious visual or olfactory evidence for significant contamination was encountered in any of the exploratory holes and low contaminant levels have been encountered across the site with the levels of all determinands significantly below the guideline values for 'commercial and industrial' use. Assuming an end use of a branch Surgery, the levels of contamination at the site are not considered to pose a risk to future site users.

Based on the information collected to date and the absence of a significant source at the site we do not consider the site likely to pose a significant risk to Controlled Waters.

Historical evidence indicates that a railway cutting was formerly present approximately 35m to the south west, however this was infilled by the local authority with domestic waste (and other unspecified materials) to form the now closed Coelbren Landfill site (CS11/43). Ground gas monitoring indicates that the filled materials within the cutting have a low gas generation potential and considering the low concentrations recorded (CO_2 and CH_4) at the gas source (i.e. the landfill) the off-ste risk posed from combustible or noxious gasses (considering the distance from the health centre) is considered low. No significant gas sources have been identified on site.

As a precautionary measure we recommend that a minimum 2000g Damp Proof Membrane should be incorporated into the construction as part of the building design.

Whilst mass concrete strip or trench fill foundations could be used at the site we understand a raft foundation solution is to be adopted. The raft is to be constructed on compacted fill, which is to be introduced to the site to reduce the gradient of the development area (due to the sloping nature of the site). We understand the raft is to be deepened and thickened in the north portion to form a structural boundary at this location. For preliminary design a presumed bearing value of up to 75kN/m^2 may be used for rigid reinforced foundations. The floor slabs should be suspended/incorporated into the design of the raft foundation.

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1.0 INTRODUCTION AND OBJECTIVES

The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by NJP on behalf of Abertawe Bro Morgannwg University Local Health Board (ABM ULHB) (hereafter known as 'the Client'), to undertake a Geoenvironmental Assessment for the proposed demolition of an existing surgery building and the construction of a new branch surgery and associated car parking area.

The assessment was conducted 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. Part of this assessment includes the formulation of an opinion as to the potential for hazardous substances (contamination) or conditions to exist on, at or near the site at levels or in a situation likely to warrant mitigation or consideration appropriate to the proposed end use.

The contract was awarded on the basis of a competitive tender quote. The terms of reference for the assessment were mutually developed with the Client within the agreed budget and are as laid down in the Earth Science Partnership proposal of the 17th August 2010 (Ref: 4715e.lt1). The assessment involved a desk study of available historical Ordnance Survey maps, geological maps and memoirs, desk study information, a site reconnaissance walkover, supervision and direction of windowless sample drillholes, rotary drillholes, geotechnical and geo-environmental laboratory testing, assessment and reporting.

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

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

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

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

An electronic version of this report and its appendices is presented in Appendix J.

2.0 DESK STUDY, WALKOVER SURVEY AND PRELIMINARY RISK ASSESSMENT

The information presented in this section comprises a Preliminary Risk Assessment which presents information obtained from desk based research that was used to inform decisions made in scoping the physical works.

2.1 Site Location and Description

The site is located at Coelbren Health Centre, Neath. The National Grid Reference is SN847116 and a Site Location Plan is presented as Figure 1.

The site is roughly rectangular in shape and is located on the slopes of the Nant Llech. The general topography in the vicinity and the site itself slopes gently north towards the Nant at an angle of approximately 10º.

The north eastern portion is occupied by the surgery building and the site is bisected by a path (and associated hand rail) which leads to the surgery from the entrance to the south. To the east of the path is a grassed area which extends round to the rear of the surgery. A small slope (35º - 45º) is present to the east of the surgery building. To the west of the surgery and the path is a taracadam car park.

The southern and western portions (car park area) appear to be elevated in relation to the natural topography. Areas adjacent to the western and southern boundary appear to be wet with marshy/boggy ground conditions apparent (see Plate 3).

The site is at an approximate elevation of 245mAOD covering an area of approximately 0.1Ha.

The site is bordered by:

- To the east: immediately residential housing along Heol Eglwys followed by the village of Coelbren;
- To the south: by Heol Eglwys followed by Coelbren Primary School and its associated buildings and playing fields approximately 10m to the south;
- To the west: by an agricultural field followed by the residential dwelling of Maesycoed;
- To the north: by marshy/boggy agricultural land. A small tributary of the Nant Llech is located approximately 95m beyond.

A general indication of the site and its setting are presented on photographs attached as Plates.

2.2 Site History

The site history has been assessed from a review of available historical Ordnance Survey County Series and National Grid maps. Relevant extracts of the maps are presented in Appendix A. Relevant information from other sources, such as the Local Authority and the Landmark Report, has also been incorporated, where appropriate.

Table 1: Review of Historical Plans

Date	On-Site	In Vicinity of Site
1878	The site is undeveloped and forms part of two agricultural fields. A field boundary or potential surface water feature/drain bisects the north eastern corner.	A road extending east to west is located adjacent to the southern boundary. A railway line extending north west to south east and associated cutting is located approximately 50m to the west, and an additional two lines are present approximately 160m to the south. Earthworks (including cuttings) associated with the railway are located approximately 250m to the north west. A tributary of the Nant Llech is located approximately 80m to the north. A church and graveyard is located approximately 170m to the east. Old ironstone quarries are indicated approximately 200m to the west, 250m to the south west and 270m to the south.
1904	No significant changes are indicated.	A school has been constructed approximately 20m to the south.
1919	No significant changes are indicated.	Some terraced residential development has occurred to the south of the road located, 25m to the south east. Ffosddu Colliery and associated newly constructed railway lines are indicated approximately 250m to the south. Residential development has also occurred approximately 250m to the south west in the area of the former quarry. Additional railway lines are indicated approximately 200m to the south.
1962 - 1964	No significant changes are indicated.	Significant residential development has occurred to the east and south east, and the semi-detached housing is located adjacent to the eastern boundary. An adjacent benchmark indicates an approximate 1m increase in ground elevation, possibly associated with localised filling or change in the benchmark location. Ffosddu Colliery is no longer indicated however a refuse tip is located in its former location. An 'Issues' is now indicated at the head of the tributary previously identified approximately 120m to the north east and another is indicated approximately 260m to the south west with a possibly associated 'sinks' at 120m to the west.
1979	A Health Centre is now present in the north eastern portion along with an associated carpark and access. The field boundary or potential surface water feature/drain is no longer indicated.	The railway line to the west has now been dismantled, however the cutting is still present.
1987	No significant changes are indicated.	A playground (associated with the school to the south) located approximately 45m to the south west and a house (named Maesycoed) approximately 60m to the west have been constructed in the area of the former railway cutting (now infilled). The refuse tip associated with the former Ffosddu Colliery has expanded to the south. A surface water drain is located approximately 50m to the north.
1993	No significant changes are indicated.	No significant changes are indicated.
1996 - 1997	No significant changes are indicated.	The playground formerly indicated to the south west is no longer indicated however a Tennis Court has now been constructed approximately 80m to the south in the area of the former railway cutting.

2.3 Geology, Hydrology and Hydrogeology

The published geological map for the area of the site (1:10,560 scale) indicates the site to be underlain by Glacial Till deposits followed by undivided Carboniferous Lower Coal Measures. A

covering of Made Ground is also anticipated as the car park appears to be elevated in relation to the natural topography (approximately 0.5m), indicating some filling has occurred at the site.

The strike in the region is in a general northwest to southeast direction and the dip is shallow, approximately 12º to the southwest. The Bryn (Gnapiog) seam which is known to have been worked historically in the area is indicated to outcrop approximately 350m to the northwest, with the Upper Coal Seam (situated stratigraphically above the Bryn seam) indicated approximately 330m to the west. Extrapolation of the outcropping position of the Bryn coal seam (at ground level) using the general strike in the area indicates that the Bryn seam may be present beneath the site and at shallow depth (considering the shallow dip in the vicinity).

The nearest major surface water feature to the site is the Nant Llech located approximately 240m to the north. However a smaller tributary of the river is located approximately 95m to the north. Review of historical mapping data, indicated that a potential surface water feature/drain may have been present in the north east portion of the site (see Section 2.2).

The Environment Agency have recently updated their aquifer classification system (Groundwater Protection Policy – April 2010) and have now separated all potential aquifers into three major groups, Principal Aquifers, Secondary Aquifers and Unproductive Strata, with Secondary Aquifers sub divided into an additional three groups. The new groups are described as follows:

Principal Aquifers (generally corresponding with previously classified "Major Aquifers") are described as "rock or drift deposits that have high intergranular and/or fracture permeability. They may support water supply and/or river base flow on a strategic scale.

Secondary Aquifers are split into three classifications:

- Secondary A (generally corresponding with previously classified "Minor Aquifers") – 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 B (generally corresponding with previously classified water bearing parts of "Non Aquifers") – lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
- Secondary Undifferentiated – assigned where it has not been possible to categorise an aquifer in either Secondary Group A or B. In most cases this is attributable to a unit being classified as both minor and non-aquifers in different locations due to the variable characteristics of the rock type.

Unproductive Strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. Review of the Environment Agency Aquifer maps indicates that the Lower Coal Measures bedrock comprises the main aquifer in the vicinity; classified by the Environment Agency as a Secondary A Aquifer. Groundwater movement will be controlled by fracture flow. The superficial Glacial Till deposits are classified as Unproductive Strata. Groundwater conditions may still be changing in response to reduction in pumping from mines (see Section 2.6.3).

2.4 Contact with Regulatory Bodies & Local Information Sources

2.4.1 Planning

Searches made on the Powys Planning Portal (http://www.powys.gov.uk) indicate 1no. planning application for the site itself which is summarised below:

- P/2010/1151 – Coelbren Health Centre – Demolition of existing and construction of new community health centre premises and improvements to access – Full Planning.

2.4.2 Environmental Health

Powys County Council Environmental Health department have provided information stating:

- They do not hold records of any landfill sites, scrap metal dealers or licensed waste sites for the site;
- They do not hold records of any current pollution problems or methane problems for the site;
- They do not hold records of any applications, authorisations, compliance and enforcement action under Part 1 of EPA 1990 including Part B prescribed processes for the site;
- They do not hold any information with regards to petroleum storage tanks above and below ground for the site.

2.4.3 Waste Compliance Department

Powys County Council Waste Compliance Department have provided information stating that their register of closed landfill sites in Powys have identified two sites within 250m of the site (Coelbren Health Centre):

- Coelbren Closed Landfill site (CS11/43) – Situated approximately 35m to the south west;
- Moorside Villas Closed Landfill Site (CS11/38) – Situated approximately 245m to the south west.

A summary of the information provided for each of the landfills have been provided below, and the full responses and monitoring data can be found in Appendix D. The location of each landfill site in relation to the Health Centre is shown on Figure 4.

Coelbren Closed Landfill Site (CS11/43) – Situated approximately 35m to the south west
The Waste Compliance department indicated their records are limited for the closed Coelbren landfill however they have provided the following:

- Unknown when tipping commenced, however it is believed the landfill was closed before 1974;
- Other than domestic waste, it is not known what types of waste were accepted at the landfill site;
- 4no. boreholes (BH1 – BH4) have been constructed in each of the corners of the landfill and monitoring installations have been constructed (see exploratory hole location plan enclosed in Appendix D);
- Ground gas monitoring has been undertaken on 8no. occasions since September 1999;
- The monitoring indicated non detectable levels of methane and carbon dioxide between non detect and 4.4%. Oxygen was depleted where the levels of carbon dioxide were elevated. No gas flows rates have been provided.

Moorside Villas Closed Landfill Site (CS11/38) - Situated approximately 245m to the south west
The Waste Compliance department indicated their records are limited for the closed Moorside Villas landfill however they have provided the following:

- Unknown when tipping commenced, however it is believed the landfill was closed before 1974;

- Domestic and commercial wastes were accepted at the site;
- 5no. boreholes (BH1 – BH5) have been constructed within the landfill and monitoring installations have been constructed (see exploratory hole location plan enclosed in Appendix D);
- Ground gas monitoring has been undertaken on 8no. occasions since September 1999;
- The monitoring indicated non detectable levels of methane and carbon dioxide between non detect and 7.7%. Oxygen was depleted where the levels of carbon dioxide were elevated. No gas flows rates have been provided.

To date, no information has been received from the Building Control Officer and this will be forwarded under separate cover, once available if any pertinent information is contained within.

2.5 Environmental Setting

The site exists in a historically semi-rural and industrial setting and now rural setting.

Table 2: Summary of Envirocheck Data

Item	On the Site	In the Immediate Vicinity
Discharge Consents	None Identified.	1no. within 250m of the site. • 140m to the west, operated by Dwr Cymru Cyfyngedig at Coelbren for emergency sewerage discharge – New Consent.
Potentially Contaminative Uses	None Identified.	3no. within 250m of the site. . • 50m to the west and 130m to the south east, railways; • 70m to the west, extensive ironstone quarrying; • 250m to the south, a heap (probable refuse tip identified on 1962-1964 historic map) consisting of unknown materials.
Potentially Infilled Land	None Identified.	Approximately 70m to the west and 250m to the south a former quarry pit has been infilled with unknown materials.
BGS Recorded Mineral Sites	None Identified.	None Identified within 250m of the site. However historical data indicates extensive ironstone quarrying has occurred in areas to the west.
Contemporary Trade Directory Entries	None Identified.	None Identified within 250m of the site.
Water Abstractions/Protection Zones	None Identified.	None Identified within 250m of the site.
Sensitive Land Uses	None Identified.	2no. identified within 250m of the site. • SSSI – Nant Llech (401,364m^2) located approximately 80m to the north west; • The boundary of the Brecon Beacons National Park is located approximately 80m to the north west.
Landfill Sites & Waste Management Facilities	None Identified.	2no. Local Authority recorded landfill sites within 250m of the site. • Coelbren (Ref: CS11/43) – located 35m to the southwest; • Moorside Villas (Ref: CS11/38) – located 245m to the south.
Fuel Station Entries	None Identified.	None Identified within 250m of the site.
Radon Measures	No radon protection measures are necessary in the construction of new dwellings or extensions.	

2.6 Anticipated Site Hazards

2.6.1 Flooding

From a review of topographical plans and data presented on the EA Website, the site is not indicated to be at risk from flooding.

2.6.2 Site Stability

The site is not in an area where it will be affected by Limestone Solution Features.

2.6.3 Mining

The Coal Measures bedrock in the area contains several seams of coal (and bands of ironstone).

A Coal Authority mining report has been obtained for the site and is presented in Appendix B. The mining report indicates that based on the available Coal Authority records, the site is not within the zone of past or present underground coal workings which are likely to have a physical influence on the surface.

The report also states that there are no known coal mine entries within 20m of the site boundary, and that there are no records of mine gas emissions for the site requiring action by the Coal Authority.

Extrapolation of the outcropping position of the Bryn coal seam (at ground level) using the general strike in the area indicates that the Bryn seam may be present beneath the site and at shallow depth (considering the shallow dip in the vicinity). The Bryn seam has been worked in the general area, and Collieries are indicated in the vicinity (Ffosddu) which suggests the potential presence of shallow unrecorded workings beneath the site. However, topographical modification as a result of glacial erosion in the general area may have removed the coal seam. Confirmation of these aspects is required.

2.6.4 Landslips

Reference to available geological maps and published records has not identified any post glacial landslips within 1km of the site.

A small slope (35º - 45º) is present to the east of the surgery building; however we understand that this is to be re-graded as part of the site redevelopment.

2.6.5 Geomorphology

The existing topography and geomorphology at the site has evolved over a period of many, perhaps sixty to seventy millions of years under a number of different erosional regimes. However, the original geomorphology of the area has been altered by man's activities, in particular by the development of the Health Centre on the site and the residential development of the surrounding area, the construction and deconstruction of the railway line (including the subsequent filling of the railway cutting) and industrial activity in the vicinity (ironstone quarrying and coal mining). The southern and western portions (car park area) appear to be elevated in relation to the natural topography, which indicates potential uplift of the site.

2.7 Previous Investigations and Assessments

We are not aware of any previous investigations or reports prepared for the site itself. However, the local authority have provided ground gas monitoring data for two closed landfill sites (Coelbren and Moorside Villas) located in the vicinity of the site and this is summarised in Section 2.4.

2.8 Anticipated Site Contamination & Migration Pathways

No contaminative former use has been identified for the site however the site has been previously developed with a Health Centre and an associated carpark. The carpark appears to be raised above the surrounding topography (approximately 0.5m) indicating some filling has occurred. Filling with unknown materials has also occurred approximately 35m to the south west in the former railway cutting. Ground gas monitoring information has been provided by the Local Authority (see Section 2.4) and the gas risks posed to on-site users have been considered further in Section 4.5.

It is therefore anticipated that a covering of Made Ground will be present for which a range of potential contaminants could be present.

2.9 Development Considerations

A proposed development plan showing the envisaged constructed layout and current site boundary is presented as Figure 3. We understand the new branch surgery building is to be located in the northern portion of the site, while the new carparking area is to be located in the southern portion. The existing demountable surgery building is yet to be demolished.

We understand due to the sloping nature of the site, uplift is to occur to reduce the gradient of the development area. A raft foundation is the preferred foundation solution for the proposed development constructed on the compacted fill. We further understand a retaining structure is to be incorporated into the raft foundation at the rear of the building to mitigate any adverse stability associated with the emplacement of the granular layer on the sloping topography.

2.10 Preliminary Risk Evaluation & Plausible Pollutant Linkages

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

2.10.1 Introduction to Risk Evaluation Methodology

The methodology set out in CIRIA C552 (2001), Contaminated Land Risk Assessment – A guide to Good Practice, has been used to assess whether or not risks are acceptable, and to determine the need for collating further information or remedial action.

Whilst at a later stage, this methodology may be informed by quantitative data (such as laboratory test results) the assessment is a qualitative method of interpreting findings to date and evaluating risk. The methodology requires the classification of:

- The magnitude of the potential consequence (severity) of risk occurring (defined below);
- The magnitude of the probability (likelihood) of risk occurring (defined below).

Classification of Consequence

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

Classification of Probability

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

The classifications defined above are then compared to indicate the risk presented by each pollutant linkage, allowing evaluation of a risk category.

Risk Categories – Comparison of consequence against probability

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

Description of Risk Categories

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

The methodology described above has been used to establish Plausible Pollutant Linkages and to evaluate the risks posed by those linkages, using information known about the site, at this stage.

2.10.2 Tabulated Preliminary Risk Evaluation & Plausible Pollutant Linkages

Table 3: Preliminary Risk Evaluation & Plausible Pollutant Linkages (PPL).

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Covering of Made Ground associated with historical redevelopment.	Direct contact/ Inhalation/ Ingestion of contaminated soil or dusts.	Site users/visitors.	Severe – potential for chronic levels.	Likely – Due to long term exposure.	High Risk	Further investigation to establish contamination status, be undertaken, as described within remainder of the report.
	Direct contact/ Inhalation/ Ingestion of contaminated soil or dusts.	Construction and Maintenance workers.	Severe – potential for chronic levels.	Likely – May be reduced on establishing actual contaminant levels.	High Risk	
	Leaching of soil contaminants.	Impact on Groundwater - Secondary A Aquifer.	Severe – As groundwater is sensitive.	Likely – May be reduced on establishing actual contaminant levels.	High Risk	
	Leaching of soil contaminants.	Impact on surface waters - Nant Llech and small tributaries.	Severe – As surface water is sensitive.	Likely – May be reduced on establishing actual contaminant levels.	High Risk	
	Damage to building materials by aggressive ground.	Building/property	Mild – Owing to potential aggressive ground.	Likely.	Moderate / Low Risk	
Ground gas generated by Made Ground, Natural Strata.	Asphyxiation/poisoning. Injury due to explosion.	Site users/visitors.	Severe – due to the possible generation and accumulation of combustible gasses.	Likely.	High Risk	May be reduced on establishing the actual extent of the Made Ground and nature of the natural strata.
	Damage through explosion.	Building/property		Likely.	High Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance workers.		Likely.	High Risk	

Table 3 (continued): Preliminary Risk Evaluation & Plausible Pollutant Linkages (PPL).

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Ground gas from the now closed Coelbren Landfill Site (located 35m to the south west).	Asphyxiation/poisoning. Injury due to explosion.	Site users/visitors.	Severe – due to the possible generation and accumulation of combustible gasses.	Low Likelihood – Non detectable levels of CH_4 and slightly levels of CO_2 (maximum of 4.4%) were recorded during monitoring of boreholes within the landfill (i.e. the identified potential source). Therefore considering the low on site concentrations the off-site risk posed by the landfill is considered low.	Moderate Risk	May be reduced on establishing the actual extent of the Made Ground and nature of the natural strata on-site. This is discussed further in Section 4.5.
	Damage through explosion.	Building/property			Moderate Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance workers.			Moderate Risk	

3.0 EXPLORATORY INVESTIGATION

3.1 Field Investigations

3.1.1 Windowless Sampling

7no. windowless sample drillholes (WS1 to WS7) were constructed on the 15th September 2010 to a maximum depth of 4m. The windowless sampling technique was selected for the investigation due to access restrictions at the site associated with the hand rail along the path bisecting the site. Access to the surgery building was restricted and areas in the vicinity of the underground foul sewer and surface drainage identified were also unexplored (see Figure 2).

A hydraulically powered rig is used to drive plastic lined sampling tubes into the ground, with the soil recovered within the tubes. Standard Penetration Tests (SPT) were carried out in the boreholes to assess the relative density of the granular materials encountered and assess the consistency of cohesive materials by using published relationships by Stroud (1975). The SPT results have not been corrected for overburden pressure, rod length or rod energy ratio.

The windowless sampling provided generally good recovery to the depth of refusal. However, within the upper saturated horizon of the Glacial Deposits (between 2m and 4m depth) recovery was minimal within 3no. of the 7no. windowless sample boreholes.

3.1.2 Rotary Drillholes

The Coal Authority was contacted prior to undertaking the rotary drilling works to discuss whether an indemnity licence was required for the intended works at the site. As there was no mine entries on the site, and no known mine workings within the intended drilling depths a license was not required. However, due to the potential for shallow coal workings associated with the Bryn coal seam (see Section 2.6.3) and to avoid potential human health risks associated with the displacement of mine gasses (due to the residential dwellings located in the vicinity) water flush methods were utilised when drilling within the Lower Coal Measures bedrock at the site. It was recommended if significant coal seams or old workings are encountered the Coal Authority should be contacted.

3no. 115mm diameter rotary percussive openhole drillholes (RO1 to RO3), were constructed between the 5th and 7th of October 2010 to a maximum depth of 20m. Access was not achievable in the landscaped areas in the eastern portion due to the hand rail along the path and the sloped bank to the side of the surgery.

Both compressed air (within the superficial deposits) and water (within the Lower Coal Measures bedrock) were used as flushing mediums and due to the significant thickness of superficial deposits present over the site, the Symmetrix system of simultaneous drilling and casing was used. The rotary drillholes were progressed through windowless sample drillholes previously undertaken at the site, to ensure that the identified underground services at the site were not damaged (see Appendix I).

The drillholes were constructed to locate the rockhead profile and possible presence of coal workings. During the drilling process the rock chippings returned to the surface were described by the driller and rate of progress monitored. Should large voids be encountered the drilling rotation was stopped and the drill rods lowered down the hole and the estimated depth of void recorded. It should be noted that, although adequate for identification purposes, the nature of the drilling method does not permit an accurate description of the strata.

The exploratory hole positioning rationale is summarised on the table below.

Table 4: Placement rationale for exploratory holes

Hole ID	Placement Rationale
WS1 – WS7	Constructed across the site to assess the near surface contamination, to obtain information on the ground conditions and to obtain samples for geoenvironmental and geotechnical testing.
RO1 – RO3	Constructed generally across the site to obtain data on the deeper ground conditions and mining aspects.

The exploratory holes were supervised and logged by an engineering geologist in accordance with BS5930:1999. Descriptions and depths of the strata encountered are presented on the rotary drillhole records in Appendix F and the windowless sample drillholes records in Appendix E. The locations of the exploratory holes are presented on Figure 2.

3.2 Evidence of Site Hazards Found During Site Works

3.2.1 Site Stability

During site works, no evidence of instability was noted within the exploratory holes. Ground conditions were generally saturated below 2m depth and there was a reduced/minimal sample recovery within this horizon (between 2m and 4m depth) within 3no. of the 7no. windowless sample boreholes.

No coal seams, voids or anomalous features were identified during the rotary drilling works.

Review of historical mapping data, indicated that a potential surface water feature/drain may have been present in the northeastern portion of the site (see Section 2.2). Soft ground conditions associated with this feature may be present in this area.

A foul sewer network is located in the southern portion, however assuming the provided site layout plan is adopted the footprint of the proposed building is in the northern portion and is unlikely to be affected (see Figure 3).

We understand due to the sloping nature of the site, filling is to occur to reduce the gradient of the development area. A retaining structure is to be incorporated into the raft foundation (at the rear of the building) to improve stability associated with the emplacement of the granular layer on the sloping topography.

3.2.2 Site Evidence of Contamination

In the areas of hardstanding, a thin covering of Made Ground was encountered up to a maximum of 0.7m depth in WS2.

No Made Ground was encountered in the landscaped areas in the eastern portion (WS3 – WS6). Some concrete fragments were encountered in the superficial topsoil layer in WS7 which was constructed on the edge of the car parking area.

No obvious visual or olfactory evidence for significant contamination was encountered in any of the exploratory holes.

3.3 Geotechnical Laboratory Testing

Geotechnical laboratory testing was undertaken on samples recovered from the windowless sample drillholes. The following tests were undertaken in accordance with BS1377:1990 and the results are presented in Appendix G

- Natural moisture content;
- Atterberg limits;
- Soil and groundwater sulphate content;
- pH value.

3.4 Geoenvironmental Laboratory Testing

3.4.1 Soil Samples

In order to provide further information on the potential for contamination within the near surface soils, a suite of geo-environmental laboratory testing was undertaken on samples recovered from the exploratory holes.

Owing to site restrictions described above, a strictly statistically valid regime was not implemented, however samples were tested from across the site to provide a general coverage of the site.

All testing was undertaken at an established testing laboratory with details of appropriate test accreditation including UKAS and MCERTS provided on the individual test certificates.

The suite of geo-environmental laboratory testing undertaken on 4no. samples is based on the guidelines provided in the Environment Agency CLR publications as part of the CLEA Model, and other contaminants typical on brownfield sites.

- Arsenic, cadmium, total chromium, lead, mercury, nickel, selenium, total cyanide, pH value, total polyaromatic hydrocarbons (PAH), B(a)P, phenols, asbestos screen and organic content.

The geo-environmental soil laboratory test results are presented in Appendix H.

4.0 DEVELOPMENT OF THE CONCEPTUAL MODEL

4.1 Geology

The main features of the geological environment are a thin covering of Made Ground/Topsoil followed by Glacial Till underlain by Lower Coal Measures Bedrock. The following ground conditions were encountered in the exploratory holes:

Made Ground: encountered in WS1 and WS2 to a maximum depth of 0.7m as a thin tarmacadam surface and sub base layer followed by a soft dark brown to black gravelly clay layer. Carbonaceous fragments and a rare piece of coal were encountered.

Some concrete fragments were also encountered in a superficial gravelly clay layer which was encountered to 0.5m in WS7 which was constructed on the edge of the car parking area.

Topsoil: the original topsoil was encountered in the landscaped areas (WS3 to WS6) to a maximum depth of 0.3m. The topsoil generally comprises a soft dark brown gravelly clay with rootlets.

Glacial Till: encountered beneath the Made Ground and Topsoil to a maximum depth of 7.3m in RO1 as firm becoming stiff brown gravelly clays and medium dense brown clayey to clayey sandy gravels. Cobbles were rare in the upper portion, however they increased in abundance with depth with rare boulders also being described by the driller. Ground conditions were generally saturated between 2m and 4m in this horizon.

Lower Coal Measures Bedrock: encountered in R01 to RO3 to a maximum depth of 20m as light grey to dark grey Mudstones and Siltstones. Within the Lower Coal Measures bedrock, no solid coal seams, voids or anomalous drilling conditions have been identified beneath the site.

4.2 Hydrogeology

The main features of the hydrogeological environment are shallow unproductive strata followed by a shallow Secondary A Aquifer.

Table 5: Summary of hydrogeological information

Hole ID	Stratum	Comment on groundwater encountered
WS1	Glacial Till	Saturated ground conditions were encountered between 2m and 3.5m.
WS2	Glacial Till	Saturated ground conditions were encountered between 2m and 3.6m.
WS3	Glacial Till	Saturated ground conditions were encountered between 2m and 3.5m.
WS4	Glacial Till	Slightly wet ground conditions between 1.8m and 1.9m and saturated ground conditions were encountered between 2m and 3.35m.
WS5	Glacial Till	No groundwater encountered due to shallow refusal at 1m.
WS6	Glacial Till	Saturated ground conditions were encountered between 2m and 2.7m.
WS7	Glacial Till	Saturated ground conditions were encountered between 2m and 3.5m.
RO1	Lower Coal Measures	Water strike at 2.20m, constant inflow of groundwater from 9.80m.
RO2	Lower Coal Measures	Seepage at 6.70m, constant inflow of groundwater from 9m.
RO3	Lower Coal Measures	Seepage at 6.5m, constant inflow of groundwater from 10.1m.

Due to the granular nature of the Glacial Till deposits below 2m, and the saturated ground conditions encountered at these depths it is likely that the deposits could also be classified a Secondary A Aquifer.

4.3 Geotechnical Stability

During site works, no evidence of instability was noted within the exploratory holes. Ground conditions were generally saturated below 2m depth and there was a reduced/minimal sample (between 2m and 4m depth) within this horizon within 3no. of the 7no. windowless sample boreholes.

No coal seams, voids or anomalous features were identified during the rotary drilling works.

Laboratory testing has indicated the cohesive soils present at shallow depth to be of low plasticity and therefore of low shrinkage potential.

Review of historical mapping data, indicated that a potential surface water feature/drain may have been present in the north east portion of the site (see Section 2.2). Soft ground conditions associated with this feature may be present in this area, however none have been confirmed during the exploratory works.

A foul sewer network is located in the southern portion, however assuming the provided site layout plan is adopted the footprint of the proposed building is in the northern portion and is unlikely to be affected (see Figure 3).

We understand due to the sloping nature of the site, filling is to occur to reduce the gradient of the development area. A retaining structure is to be incorporated into the raft foundation (at the rear of the building) to improve stability associated with the emplacement of the granular layer on the sloping topography.

4.4 Soil Contamination

The long term risks to health have been assessed using methodologies and frameworks determined by the Environment Agency within documents SR2, SR3, SR4 and the CLEA Technical Review published to support the Contaminated Land Exposure Assessment Model (CLEA). Where applicable, reference has been made to the supporting Toxicological reports (TOX Series) and the Soil Guideline Value reports (SGV Series). It is assumed that the reader is familiar with the above documents and it is not intended to repeat these described methodologies in detail, for further information, please refer directly to the specific documents.

Publication of additional SGV and TOX reports by the Environment Agency depends on factors including the availability of good scientific data, timely agreement on data interpretation, reaching cross government consensus and interaction with other on-going work with other national and international authorities. Further future reports are expected as part of the ongoing research and development by the Environment Agency.

The Chartered Institute of Environmental Health (CIEH) Generic Assessment Criteria for Human Health Risk Assessment have been used to supplement the CLEA SGVs where applicable in order to provide additional confidence in assessing the risk to human health at the site. The CIEH GAC's have been developed using the CLEA UK software for the standard land use scenarios outlined in the CLR documents with the exception of Allotments.

In order to provide an initial 'screen' to identify elevated levels of contaminants, a Generic Quantitative Risk Assessment (GQRA) has been undertaken using the most appropriate guidance levels, determined by assessment of exposure frequency/duration and the Critical Receptor.

The proposed development comprises the demolition of an existing demountable surgery building and the construction of a new branch surgery and an associated carparking area.

No CLR SGV exists directly relevant to the proposed development however, for preliminary screening (Tier 1) the SGV's for 'commercial/industrial development' have been selected for the assessment, based on the fact that the patients exposure is likely to be limited and the most sensitive users will be the full time doctors and caretakers. As summarised on the table below, all of the determinands are well below the respective guideline values.

Table 5: Summary of Geoenvironmental Soil Results

Compound	Maximum Recorded	Guideline Value	Source of Guideline Value
Arsenic	47mg/kg	640mg/kg	CLR SGV
Cadmium	1.6mg/kg	230mg/kg	CLR SGV
Chromium III	21mg/kg	30,400mg/kg	LQM/CIEH
Chromium VI	<1mg/kg	35mg/kg	LQM/CIEH
Lead	67mg/kg	750mg/kg	CLR SGV
Copper	30mg/kg	71,700mg/kg	LQM/CIEH
Mercury	0.09mg/kg	3,600mg/kg	CLR SGV
Nickel	17mg/kg	1,800mg/kg	CLR SGV
Selenium	1mg/kg	13,000mg/kg	CLR SGV
Zinc	130mg/kg	665,000mg/kg	LQM/CIEH
Phenol	<0.3mg/kg	3,200mg/kg	CLR SGV
Asbestos	None identified.		
Polyaromatic Hydrocarbons (PAH)			
Acenaphthene	0.2mg/kg	85,000mg/kg	CIEH GAC (Dependant on SOM %) Lowest Value Used
Acenaphthylene	0.3mg/kg	84,000mg/kg	
Anthracene	0.9mg/kg	530,000mg/kg	
Benzo(a)anthracene	6.4mg/kg	90mg/kg	
Benzo(a)Pyrene	5mg/kg	14mg/kg	
Benzo(b)Fluoranthene	5.3mg/kg	100mg/kg	
Benzo(k)Fluoranthene	2.4mg/kg	140mg/kg	
Benzo(g,h,i)perylene	4.3mg/kg	650mg/kg	
Chrysene	9.3mg/kg	140mg/kg	
Dibenzo(a,h)anthracene	0.8mg/kg	13mg/kg	
Fluoranthene	11mg/kg	23,000mg/kg	
Fluorene	0.5mg/kg	64,000mg/kg	
Indeno(1,2,3-c,d)pyrene	3.5mg/kg	60mg/kg	
Naphthalene	0.1mg/kg	200mg/kg	
Phenanthrene	3.8mg/kg	22,000mg/kg	
Pyrene	7.7mg/kg	54,000mg/kg	

4.5 Ground Gas

4.5.1 Degradation of Organic Materials

A thin covering of Made Ground (up to a maximum of 0.7m) was encountered in the western portion and no putrescible/potentially gassing materials were encountered during the investigation.

The former Coelbren landfill (CS11/43) is present approximately 35m to the south west in the former railway cutting and this is registered as a closed landfill by the Local Authority. The landfill poses a potential gas risk however other than domestic waste, it is not known what types of waste were accepted at the landfill site. No gas risk is considered to be posed by the Moorside Villas Closed Landfill Site (CS11/38) located approximately 245m to the south west.

The Local Authority have provided ground gas monitoring information for four boreholes constructed within the closed landfill. 8no monitoring visits have been undertaken over a period of 7 years between September 2009 and June 2006. The monitoring has indicated non detectable levels of methane and slightly elevated levels of carbon dioxide between non detect and 4.4%. No gas flows rates have been provided.

The monitoring indicates that the filled materials within the cutting have a low gas generation potential and considering the low concentrations recorded at the gas source (i.e. the landfill) the off-site risk posed (considering the distance from the health centre) is considered low. The low permeability cohesive Glacial Till horizon present is likely to further mitigate on-site ground gas migration by forming a low permeability barrier beneath site, and investigations in other areas (with similar ground conditions) where landfills are in close vicinity to a development have generally proven low levels of on-site ground gas and low risks to on-site receptors.

It is considered that the risk from combustible or noxious gas at the site is low, however as a precautionary measure basic mitigation measures should be incorporated into the construction as part of the building design (as described in Section 6.3.1). If during development, any organic or putrescible material is encountered, it should be removed from site.

4.5.2 Radon

The BRE Report BR211 (2007) classifies the risk from radon, based on the underlying geology. Radon is a colourless, odourless, radioactive gas, which can pose a risk to human health. It originates where uranium and radium are naturally present in the bedrock and can move through fractures in the bedrock and overlying superficial deposits to collect in spaces in structures.

The site lies in an area identified by the BRE where there is no risk from radon.

5.0 CONTAMINATION RISK EVALUATION & RELEVANT POLLUTANT LINKAGES

5.1 Discussion on Occurrence of Contamination and Distribution

During the site works, a thin covering of Made Ground was encountered in the area of hardstanding (western portion) up to a maximum of 0.7m depth in WS2. Some concrete fragments were also encountered in the superficial topsoil layer in WS7 which was constructed on the edge of the car parking area.

No Made Ground was encountered in the explored landscaped areas in the eastern portion (WS3 – WS6).

No obvious visual or olfactory evidence for significant contamination was encountered in any of the exploratory holes.

The levels of all determinants were below the relevant commercial guideline values.

Filling with unknown materials has occurred approximately 35m to the south west in the former railway cutting and this is registered as a landfill by the Local Authority. Ground gas monitoring indicates that the filled materials within the cutting have a low gas generation potential and considering the low concentrations recorded at the gas source (i.e. the landfill) the off-site risk posed from combustible or noxious gasses (considering the distance from the health centre) is considered low. However, as a precautionary measure basic mitigation measures should be incorporated into the construction as part of the building design (as described in Section 6.3.1).

5.2 Revised Risk Evaluation & Relevant Pollutant Linkages

As discussed in detail within Section 2.0, the methodology set out in CIRIA C552 (2001), Contaminated Land Risk Assessment – A guide to Good Practice, has been used to assess whether or not risks are acceptable, and to determine the need for collating further information or remedial action.

The risks evaluated at the desk study stage of this report (Section 2.0) have been updated and revised following information learned from the exploratory works and results of monitoring and laboratory testing.

Table 6: 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
Covering of Made Ground associated with historic development.	Direct contact/ Inhalation/ Ingestion of contaminated soil or dusts.	Site users/visitors.	Medium – potential for chronic levels	Low Likelihood – no historic contaminative use identified and laboratory testing has confirmed no significant contamination.	Moderate / Low Risk	Further consideration required (see Section 6.0).
	Direct contact/ Inhalation/ Ingestion of contaminated soil or dusts.	Construction and Maintenance workers.	Medium – potential for chronic levels	Low Likelihood – Due to short term exposure and no historic contaminative use identified. Laboratory testing has confirmed no significant contamination.	Moderate / Low Risk	
	Leaching of soil contaminants.	Impact on Controlled Waters	Medium – Secondary A Aquifer, and small tributary of the Nant Llech located approximately 95m to the north.	Low Likelihood – no historic contaminative use and no significant contamination encountered.	Moderate / Low Risk	No further consideration required.
	Damage to building materials by aggressive ground.	Building/property	Mild.	Low likelihood - Results confirm low levels of aggressive compounds.	Moderate / Low Risk	
Ground gas generated by Made Ground and natural deposits.	Asphyxiation/poisoning. Injury due to explosion.	Site users/visitors.	Severe – due to the possible generation and accumulation of combustible gasses associated with the nearby landfill (approximately 35m to the south west of the site).	Unlikely – no potential gassing sources were identified on the site, generally low concentrations of CO_2 and CH_4 have been recorded during monitoring of the closed Coelbren landfill, and low permeability Glacial Till deposits are likely to mitigate any risks.	Moderate / Low Risk	Further consideration required (see Section 6.3.1).
	Damage through explosion.	Building/property			Moderate / Low Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance workers.			Moderate / Low Risk	

6.0 REMEDIAL STRATEGY FOR CONTAMINATION RISKS

The following recommendations are based on interpretations made from the relatively limited site investigation data obtained to-date. 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 a Geoenvironmental Specialist sought immediately.

6.1 Risks to Health

6.1.1 Site End Users

Low contaminant levels have been encountered across the site with the levels of all determinants below the commercial end use guideline values.

Assuming an end use of a branch Surgery, the levels of contamination at the site are not considered to pose a risk to future site users. The proposed earthworks at the site will further mitigate any potential pathways and potential future risk. Therefore, no specific remedial measures are considered necessary. We do not consider a Tier Two site specific risk assessment is necessary.

6.1.2 New Service Connections

With reference to WRAS No 9-04-03-October 2002 it is likely that plastic water supply pipework will not be acceptable. Alternative more durable materials will be required. The final design and selection of the pipe and associated backfill should be agreed with the appropriate regulator, prior to installation.

6.1.3 Risk to Construction and Maintenance Workers

Notwithstanding the above, we recommend 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.

6.1.4 General Public

Careful dust control measures should be adopted during construction to minimise the risk to the general public.

6.2 Risks to Controlled Waters

Whilst no formal assessment of groundwater conditions has been carried out, a preliminary discussion of the risk to controlled waters has been made as part of this investigation. In summary:

- No potentially contaminative use has been identified on the site from historical evidence;
- A thin covering of Made Ground was encountered in the area of hardstanding (western portion) up to a maximum of 0.7m depth in WS2. No Made Ground was encountered in the explored landscaped areas in the eastern portion (WS3 – WS6);
- No obvious visual or olfactory evidence for significant contamination was encountered in any of the exploratory holes;
- Generally low levels of organic and inorganic contaminants have been identified by laboratory testing, and no elevated levels were recorded in terms of human health (a commercial end use). Whilst not above guideline values, elevated levels of PAHs were encountered in the Made Ground of WS1;
- The site is located on a shallow Secondary A Aquifer;
- The nearest major surface water feature to the site is the Nant Llech located approximately 240m to the north. However a smaller tributary of the river is located approximately 95m to the north;
- Review of historical mapping data, indicated that a potential surface water feature/drain may have been present in the north east portion of the site (see Section 2.2);
- Saturated ground conditions were encountered in the Glacial Till deposits generally between 2m and 4m depth and constant groundwater inflow was encountered in the Lower Coal Measures strata below approximately 9m depth;
- No potential point sources (e.g. fuel tanks) have been identified on or adjacent to the site, and no significant evidence of contamination has been encountered during the investigation;
- Groundwater quality is likely to be reduced in the vicinity as a result of the historical industrial activity in the region (quarrying and mining) and the landfills identified in close proximity.

It is likely that due to the limited Made Ground, generally low concentrations encountered, and the probable reduced groundwater quality in the vicinity a low potential risk is presented to the local environment i.e. the aquifer body and potential off site targets. Based on the information collected to date and the absence of a significant source at the site we do not consider the site likely to pose a significant risk to Controlled Waters.

Should any obvious point source of contamination, not identified by this investigation (i.e. buried tank, chemical drum, municipal waste etc.) be identified at any stage of the construction works, the advice of a geoenvironmental specialist should be sought immediately, and off-site disposal should be considered.

6.3 Risks from Ground Gas

6.3.1 Risk to the Development – Degradation of Organic Material

A thin covering of Made Ground (up to a maximum of 0.7m) was encountered in the western portion and no putrescible/potentially gassing materials were encountered during the investigation.

Filling with domestic waste (and other unspecified materials) has occurred approximately 35m to the south west in the former railway cutting and this is registered as Coelbren landfill by the Local Authority (CS11/43).

Ground gas monitoring for the now closed landfill (see Section 2.4) indicates that the filled materials within the cutting have a low gas generation potential and considering the low concentrations recorded (CO_2 and CH_4) at the gas source (i.e. the landfill) the off-site risk posed from combustible or noxious gasses (considering the distance from the health centre) is considered low.

The low permeability cohesive Glacial Till horizon present is likely to further mitigate on-site ground gas migration by forming an impermeable barrier beneath site, and investigations in other areas (with similar ground conditions) where landfills are in close vicinity to a development have generally proven low levels of on-site ground gas and low risks to on-site receptors

Whilst no specific gas protection measures are anticipated to be necessary in the construction of new development, we recommend that a minimum 2000g Damp Proof Membrane should be incorporated into the construction as part of the building design. The recommended suspended floor slab (Section 7.2) will provide additional gas protection for the anticipated conditions. However we understand that a raft foundation option is preferred and therefore the slab will be incorporated into the construction.

If during development, any organic or putrescible material is encountered, it should be removed from site.

6.3.2 Risk to the Development – Radon

The site lies in an area identified by the BRE as of no risk from radon. No further precautions are required to mitigate the risk.

6.3.3 Risk to Construction and Maintenance Workers

The potential presence of elevated levels of methane, carbon dioxide and depleted oxygen associated with the nearby landfill 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.

6.4 Risks to Property

6.4.1 Knotweed

No evidence of Japanese Knotweed was identified on the site during the site works.

6.4.2 Sulphate Attack on Buried Concrete

Laboratory test results indicate the levels of soil sulphate (as SO_4) to be between 0.33g/l and <0.1g/l. pH values between 5.46 and 8.5 were recorded indicating slightly alkaline to slightly acidic conditions to exist.

Based on the above results, and assuming a mobile groundwater table, based on Table C2 we consider that the site is classified as Design Class DS-1 and ACEC Class AC-3z (BRE, 2005).

7.0 GEOTECHNICAL COMMENTS

7.1 Foundation Design and Construction

It is understood that the site is being considered for potential development for commercial purposes and the comments and recommendations in this report assume that the development will involve the construction of a typical one/two storey structure of conventional load bearing construction.

A small slope (35º - 45º) is present to the east of the surgery building; however we understand that this is to be re-graded as part of the site redevelopment.

Exploratory works to date have identified no solid coal seams, void spaces or soft backfilled zones within the critical zone. Therefore, it is considered that the hazard presented by historical mine workings is low. However, it should be appreciated that in any area of past mining activity the possibility of the existence of unrecorded mine entries cannot be discounted. During site clearance operations and foundation excavation, a careful watch should be maintained for any isolated pockets of loose fill, brickwork or other anomalous features which may be indicative of past mining operations. Any such features should be subject to further consideration.

For all spread foundations, formations should be cleaned, and subsequently inspected by a suitably qualified engineer prior to placing concrete. A potential stream is indicated on the historical maps in the north east portion of the site; whilst no evidence of this was encountered during the investigation, 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.

7.1.1 Spread Foundations

On the basis of the available investigation information it is considered that mass concrete strip or trench fill foundations could be used at the site. The foundations should be placed at a minimum depth of 1m, within the natural firm Glacial Till strata. For foundation sizing purposes an allowable bearing pressure of 75kN/m^2 is considered appropriate.

Laboratory testing has indicated the cohesive soils present at shallow depth to be of low to intermediate plasticity and therefore of low to moderate shrinkage potential. The modified plasticity index values obtained for the Glacial Till deposits encountered are as follows (based on NHBC Guidance):

- Plasticity Index: 14%, 15%, 17% and 16%. Average = 15.5%.
- 88.25% of the particles are smaller than 425um.
- Therefore, modified Plasticity Index: I'p = $\frac{15.5 \times 88.25}{100}$ = 12.79%

The calculated modified plasticity index values suggest a low volume change potential. Based on this shrinkage potential, the minimum foundation depth would need to be 0.75m however this should be 1m based on the strength of the underlying strata. Within the zone of influence of existing, removed or proposed planting, the appropriate precautions provided in BRE Digest 298 and the NHBC guidelines should be adopted.

A blinding layer of concrete should be placed after excavation and inspection in order to protect the formation against softening and disturbance.

7.1.2 Excavation and Replacement

Whilst mass concrete strip or trench fill foundations could be used at the site we understand a raft foundation solution is to be adopted. The raft is to be constructed on compacted fill, which is to be introduced to the site to reduce the gradient of the development area (due to the sloping nature of the site).

A thickness of approximately 1.5m of imported material is anticipated beneath the northern edge of the proposed building, reducing to approximately 0.75m beneath the southern edge. We understand the raft is to be deepened and thickened in the north portion to form a structural boundary at this location.

It should be ensured that a minimum of depth of the order of 1m of suitable granular material (e.g. Department of Transport Type 1 Sub Base or similar approved) is present beneath the proposed formation level of the main structural foundations. The granular fill should be compacted in layers in a controlled manner to a suitable specification. Where the minimum depth is not achieved (southern edge of the building) the existing ground should be excavated and replaced with suitable granular material or further assessment carried out.

Thickening of the foundations is likely to be required beneath the columns and any load bearing walls.

Based on our investigation it is considered that the soils to be excavated in this treatment would not be suitable for re-use as compacted materials. It would be suitable for use as landscaping on the site.

The presumed bearing value would be dependent on foundation size, compacted material type and quality, compaction characteristics and foundation loading details. However, for preliminary design a presumed bearing value of up to 75kN/m^2 may be used for rigid reinforced foundations.

7.2 Floor Slab Foundations

Due to the presence of over 600mm of Made Ground at the site, it is considered that ground bearing floor slabs would not be suitable and floor slabs should be suspended/incorporated into the design of the raft foundation.

7.3 Site Preparation and Earthworks

7.3.1 Existing Foundations and Services

Subsequent to the demolition of the surgery building some old foundations and underground structures will be present at the site. These foundations should be grubbed up as part of the site preparation works.

We understand that the live services associated with the existing surgery building located on the site will be disconnected prior to demolition. A foul sewer network is located in the southern portion, however assuming the provided site layout plan is adopted the footprint of the proposed building is in the northern portion and is unlikely to be affected. However, the statutory undertakers may need to be contacted to confirm that no easements are required around the sewer.

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

7.3.2 New Services

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

The statutory undertakers may need to be contacted with regards to possible easements required around drainage services existing on the site.

7.3.3 Earthworks

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 a geotechnical engineer.

Excavations below groundwater level are not anticipated to be necessary.

7.4 Pavement Design

We understand that vehicle access roads/hardstanding are proposed at the site.

California Bearing Ratio (CBR) tests have not been carried out at the site, but based on experience and published guidelines, a CBR value of <2% for the Made Ground and 2-5% for the Glacial Till is considered appropriate for preliminary design purposes, for the near surface granular/cohesive soils. Actual design values should be determined for designated areas as required.

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 geogrid may be considered.

The near surface cohesive/granular soils are considered to be frost susceptible. A total construction thickness of 450mm non-frost susceptible pavement construction will be required to avoid frost heave.

7.5 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.

For shallow excavations where there is no danger to life, support of excavation sides is unlikely to be necessary. Should indication of excavation instability be noted at any depth, support should be provided as appropriate.

Based on our understanding of the proposed development, no significant groundwater ingress is anticipated within the upper 1.5m. However, below 2m saturated ground conditions have been encountered within the granular Glacial Till deposits. Where water ingress occurs it is likely that pumping from screened sumps within shallow excavations will be adequate. Care should be taken when excavation is occurring below groundwater level.

Excavations below groundwater level are not anticipated to be necessary as a raft foundation solution is to be adopted for the development.

7.6 Comments with Respect to Soakaway Drainage

No permeability testing was undertaken as part of this investigation. Whilst the granular Glacial Till Deposits may prove a suitable horizon for soakaway drainage, shallow Groundwater within this horizon is likely to restrict the use of soakaway drainage.

Full size soakaway trials could be undertaken in accordance with BRE guidance within this horizon at proposed locations once determined, however their use may be restricted as described above.

8.0 RECOMMENDED FURTHER WORK

Based on our understanding of the proposed development and the current scheme, we do not consider any further investigatory works to be required to progress the design, at this stage.

For all spread foundations, formations should be cleaned, and subsequently inspected by a suitably qualified engineer prior to placing concrete. A potential stream is indicated on the historical maps in the north east portion of the site; whilst no evidence of this was encountered during the investigation, 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.

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