GEO-TECHNICAL AND GEO-ENVIRONMENTAL REPORT

PROPOSED RESIDENTIAL DEVELOPMENT
HEOL Y GLYN
GLYN-NEATH

Prepared for:
Moore Knight Limited

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Report No. 10287

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Executive Summary

Moore Knight Limited are proposing the development of their site off Heol-y-Glyn, Glyn-Neath, for residential and/or commercial use.

Historically, the site remained unoccupied up until between 1938 and 1962, whereby the northern half of the site was woodland and the southern half comprised open fields. By 1962 within the north of the site much of the woodland had been cleared and a large spoil heap was present, with a level plateau alongside Heol-y-Glyn and a steep downwards sloping batter forming its southern and eastern edge. Two buildings had been constructed upon the plateau, but were no longer present by 1977. Since 1977 there have been no apparent changes to the site.

The geological map of the area shows the site to be directly underlain by rocks of the Lower Coal Measures. Across the southern part of the site, running southwest to east-northeast is a major fault. A stream on site follows the same line of this fault. North of the fault the bedrock is shown to comprise mudstone, siltstone of sandstone. South of this fault the bedrock is sandstone. Superficial boulder clay is present north of the fault, whilst alluvial fan sand and gravel deposits are shown to be present south of the fault. Coal seams are shown to be present to the northwest, dipping away from the site. It is considered that there are no risks to the site from past shallow mining.

Investigation of the site, comprising eleven trial pits, five shell and auger boreholes and five rotary probeholes was undertaken. The ground conditions on site were found to comprise made ground of soft to firm becoming stiff gravely sandy clay or medium dense becoming dense gravels and cobbles with brick, timber, glass, coal fragments and asphalt to between 2.6m and 8.5m depth. The made ground was seen to be underlain by stiff but soft in places sandy clay with gravels, cobbles and boulders. Completely weathered to moderately weathered highly fractured mudstone was encountered at between 7.2m and 16.0m depth. Peaty clay was identified in PH2 and peat was present in TP8 (adjacent to the stream) from ground level to the full investigation depth of 3.04m.

Following the re-profiling of the site to obtain the desired levels for the development it is proposed that a raft foundation solution be used for the development. The maximum load beneath the foundation should not exceed 100kN/m^2 on the newly compacted ground. For the foundations, to prevent additional loads being transferred to the any batters or retaining walls, a 45 degree line from the base of the foundations should not impinge across the face of the batters. Allowances should be made for the removal of any 'soft spots' and their replacement with well-compacted granular materials.

On re-profiling of the site levels, in order for there to be tolerable settlements from the placed fill material, it needs to be compacted at or close to its Optimum Moisture Content (+ or – 1.5%). This will ensure that a minimum 95% compaction will be achieved. The natural moisture content of the materials is at present between 2% and 3% higher than the Optimum Moisture Content. In order to meet the above criterion it is clear that the materials will need to be dried. This can be achieved by excavating and allowing the materials to dry naturally.

Four samples were underwent grading analysis. Based upon the results, the samples can be classified as type 7D, 6F1 or 6F2. The compaction requirements for such materials are given in Table 6/4, Method 2 of the Specification for Highway Works. Fpur consolidated drained shear box tests were undertaken in order to assess the appropriate profile angle that can be applied to the sides of any new slopes created during the development. Based on these results it is considered that any batters be constructed at a maximum angle of 29 degrees.

Laboratory chemical testing of soils identified exceedences of arsenic, zinc and benzo(a)pyrene above their respective Tier 1 threshold values. It is therefore recommended that in order to eliminate all human health risks on residential development that all landscaped areas be capped with 600m of inert soils. If or where the site is to be in use commercially, then no mitigation measures will be required to make the site suitable for its proposed end users. Leachate testing identified no exceedences of any substance and as such it is confirmed that there are no risks to the aquatic environment.

In-situ gas monitoring to date has confirmed that no gas protection measures will be required for the development. Basic radon protection measures are required for the site.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Tables

Annexes

Drawings

SECTION 1 Introduction and Proposed Development

Moore Knight Limited are proposing the development of a site off Heol-y-Glyn, Glyn-Neath, for residential and/or commercial use.

Jenkins and Potter Limited are the Consulting Civil and Structural Engineers for the development.

Terra Firma (Wales) Limited have been commissioned to carry out a geo-technical site investigation of the above site and a geo-environmental assessment.

The main objectives of the geo-technical site investigation were to:

- Determine the type, strength and bearing characteristics of the shallow superficial and underlying solid geology.
- Provide recommendations for a suitable and economic foundation/floor slab solution for the development.
- Provide recommendations with regard to any other geo-technical aspects pertaining to the development.

The main objectives of the geo-environmental assessment programme were to:

- Identify the potential environmental liabilities at the site associated with any soil and groundwater contamination from past site uses.
- Provide a summary of the environmental conditions at the site, together with any necessary remediation works to render the site fit for its intended use.
- Provide recommendations with regard to any other geo-environmental aspects pertaining to the development such as radon gas and ground gas.

In order to achieve the above objectives, Terra Firma (Wales) Limited carried out an assessment programme including a review of existing data, followed by a field investigation to determine the prevailing ground conditions and also to collect and analyse soil samples from selected locations around the site.

It is understood that maximum foundation loads should not exceed 100kN/m run of the walls and that the maximum imposed loads on the floor slabs should not exceed 2.5kN/m^2.

1.1 Limitations and Exceptions of Investigation

Moore Knight Limited have requested that a Geo-environmental Site Assessment (GSA) and Geo-technical Investigation (GI) be performed in order to determine if contamination is present beneath the site, the affect if any of radon gas, and to determine an appropriate foundation solution for the proposed development.

The GSA and GI were conducted and this report has been prepared for the sole internal reliance of Moore Knight Limited and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (Wales) Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (Wales) Limited does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

The site investigation was limited within the lower south-western part of the site due to the topography and soft ground conditions.

SECTION 2 Review of Existing Data

2.1 Physical Setting

The site is located south of Heol-y-Glyn, Glyn-Neath, at National Grid Reference 288580 206940, see Drawing 01. The site is irregular in shape and covers an area of 2.71 hectares. The boundary of the site along Heol-y-Glyn is defined by trees and temporary herrace fencing. The remainder of the site boundaries are fenced. There is a lower entrance onto the site, leading off Woodland Park Road.

A site layout plan is given in Drawing 02.

2.2 Site History

The recent history of the site has been traced with the aid of Envirocheck Historical Plans (see Annex A). The most relevant editions are summarised below:

1877
In 1877 the northern half of the site was wooded; this woodland extends to the northwest of the site. The lower half of the site situates across field land. A stream, flowing in a south-westerly direction, passes from the east to the southwest of the site towards the River Neath, which is present 150m south of the site. The village of Glyn-Neath centres along two main roads, 100m south and within 50m of the south-eastern corner of the site. Tramways run along the two main streets. At a distance of 180m and further to the northwest of the site numerous old coal levels are shown.

1899
This edition shows no significant changes to the site or immediate surrounding area from the previous map.

1918
This map shows no significant changes to the site or immediate surrounding area from the previous edition. The southern part of the site is denoted as rough grassland.

1938
There has been no change to the site from the previous edition. Glyn-Neath has undergone residential development southwest and northeast of the site.

1962
By 1962 the site has been altered. A road, Heol-y-Glyn, has been constructed along the north-western edge of the site. Within the north of the site much of the woodland has been cleared and a large spoil heap is now present, with a level plateau alongside Heol-y-Glyn and a steep downwards sloping batter forming its southern and eastern edge. Two buildings have been constructed upon the plateau.

1977
There has been little change to the site or surrounding area. The two buildings previously shown on site are no longer present. The south-western and south-eastern boundaries of the site are now defined by adjacent residential housing. Where the stream hits the south-western boundary it may have been culverted, but appears to run along the inside of the site boundary, now heading to the northwest.

1981 and 1993
The site and surrounding area remains unchanged.

2.3 Current Use and Site Conditions

The site is currently disused. Overall the site is spread across two levels. Off Heol-y-Glyn the site enters onto an upper man-made plateau, which is divided into two parts and slopes gently to the south. Around the north-western part of the site a trackway leads down to the lower plateau. This sits approximately between 6.0m to 10m below the upper plateau. The lower plateau, comprised of raised ground in the south-western corner of the site and sits at an approximate maximum of 5.0m above the south-eastern corner of the site. This shallows off towards the south-western site corner where no made ground is present.

A stream is seen to run from adjacent to the site entrance off Heol-y-Glyn and flows around the eastern and then continuing close to the southern boundary of the site. The stream leaves the site where it is culverted away from the south-western corner. A patch of wetland and soft wet ground were evident at the surface on parts of the lower south-western area of the site.

2.4 Environmental Setting

2.4.1 Geology

The 1:50,000 scale geological map of the area (Sheet No 231) and the Envirocheck Geology Report (see Annex B) shows the site to be directly underlain by rocks of the Lower Coal Measures strata, which are Carboniferous in age.

Across the southern part of the site, running southwest to east-northeast is a major fault, although the faulting direction is unclear. The stream located on site follows the same line as this fault. North of the fault the bedrock is shown to comprise mudstone, siltstone and sandstone, dipping at 10 degrees to the northwest. South of this fault the bedrock is sandstone, which dips 40 degrees to the southeast.

Similarly, the superficial deposits vary either side of the fault. Superficial boulder clay is present north of the fault, whilst alluvial fan sand and gravel deposits are shown to be present south of the fault.

Made ground is known to overlie the superficial deposits across the majority of the site.

Coal seams are shown to be present to the northwest, dipping away from the site.

2.4.2 Mining

The Mining Report from the Coal Authority states that records show the site it is not within the zone of likely influence on the surface from past underground workings. However, the report does say that the site is in an area where the Coal Authority believes there is coal at or close to the surface which may have been worked at some time in the past.

The geology map shows no coal seams to be present beneath the site. In addition, given the topography of the site and the fault across the site, it is concluded that there are no risks to the site from past shallow mining.

There are no known mine entries upon or within 20m of the site.

There is no record of mine gas emission requiring action by the Coal Authority within the boundary of the property.

A copy of the mining report is given in Annex C.

2.4.3 Landslips

The Envirocheck Geology Report confirms that there are no landslips in close proximity to the site.

2.4.4 Radon

A BRE 211 Radon Report obtained for the site, entitled 'Advisory report on the requirement for radon protective measures in new buildings and extensions', confirms that basic radon protective measures are required for the site.

The report is given in Annex D.

2.4.5 Hydrology

A stream flows around the site from north to south-west, following the eastern site boundary.

The next nearest surface water body is the River Neath, which situates 150m south of the site.

Any perched groundwater flows from the site within the made ground and superficial deposits will be in a southerly direction following the southward sloping natural topography of the site. The majority of waters will be collected by the stream that runs around the site.

Deeper groundwater flow, within the coal measures bedrock, will be controlled by the dip and any fractures or bedding planes within the rock unit.

2.4.6 Hydrogeology

The Groundwater Vulnerability map for the area classifies the underlying coal measures bedrock as being a Minor Aquifer with variable permeability.

Minor aquifers of this kind are defined as 'being fractured or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Although these aquifers will seldom produce large quantities of water for abstraction, they are important both for local supplies and in supplying base flow to rivers'.

The superficial deposits are shown to have low leaching potential.

2.4.7 Pollution, Waste and Groundwater

The Environment Agency website was consulted. The relevant information from this database is summarised below:

Environment Agency and Hydrological
The site does not situate within an area that is at risk of flooding.

There are no groundwater source protection zones within 1km of the site.

Pollution
There are no industrial sites within 1km of the site where pollution is being released or where processes are being undertaken that may pose an environmental risk.

Similarly there are no recorded pollution incidents that have occurred within 1km of the site.

Waste
The Envirocheck confirms that no historical or current landfill sites situates within 1km of the site.

Water Framework Directive
The Water Framework Directive (WFD) is a set of guidelines for managing large bodies of water. Its main aims are to improve water quality and reduce pollution while reducing any danger a water body poses, such as flooding. It's also designed to stop the deterioration of wetlands and improve aquatic habitats for wildlife.

The WFD assesses the risks to rivers, lakes, transitional waters (estuaries and lagoons), coastal waters and groundwater against its objectives. The risk assessments take into account the following:

- Point Sources of Pollution
- Diffuse Sources of Pollution
- Water Abstraction and Flow Regulation
- Physical or Morphological Alteration to Water Bodies
- Alien Species

The groundwater in this area is classed as 'being at risk' of failing the WFD objectives.

The River Neath is classed as 'being at risk' of failing the WFD objectives.

2.5 Risks to Ancient Monuments and Listed Buildings

A search of the Royal Commission on the Ancient and Historic Monuments of Wales (RCAHMW) public record database has shown that there are no historic structures within 100m of the site.

SECTION 3 Preliminary Risk Assessment

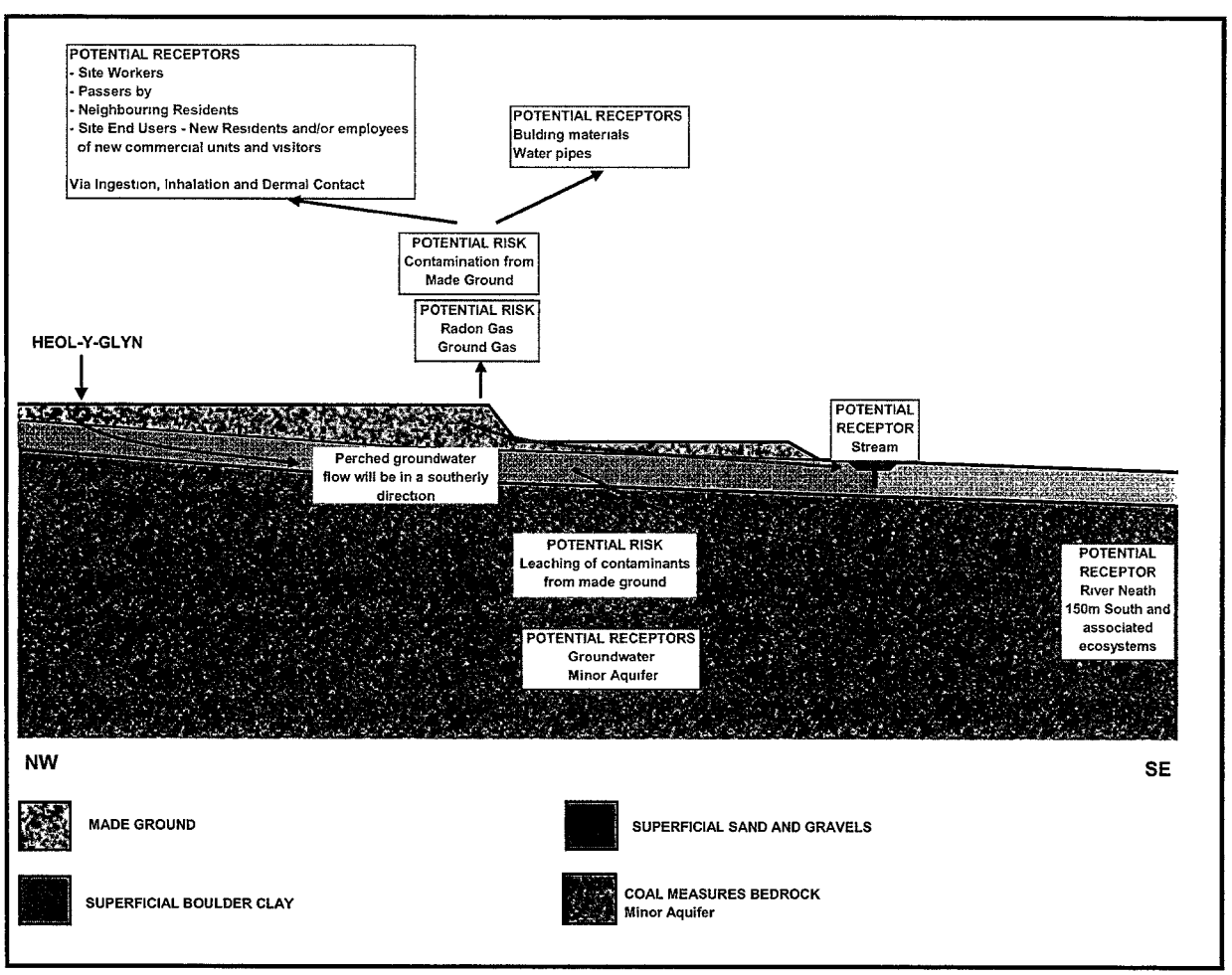
Environmental risk assessment evaluates the risk to receptors via an analysis of the 'source-pathway-target' linkage. In order for a risk to be present, there must be a contaminant source capable of causing a health risk, a vulnerable receptor, and a pathway linking the two.

The following sub-sections detail a preliminary risk assessment, based upon the desk study information.

3.1 Preliminary Site Conceptual Model

The preceding sections enable a preliminary conceptual model of the site to be drawn up, to illustrate the likely ground conditions beneath the site together with a preliminary assessment of the nature of any underlying aquifers and groundwater movement. The preliminary site conceptual model is used as a model for the design and implementation of the site investigation, whereby areas of potential contamination can be targeted as well as investigating the site as a whole.

The following illustration represents a theorised cross section through the site. The drawing is generalised and not to scale.



3.2 Potential Sources of Contamination

The potential contamination beneath the site, whether in the matrix of soil or groundwater will be related to the sites past use.

The site has never been occupied apart from two buildings that are shown to have been constructed on site between 1938 and 1962. The use of these buildings is unknown and they were no longer present by 1977.

The only potential source of contamination is the spoil heap of made ground, which occupies the majority of the site. It is unknown what soils the spoil is comprised of.

As well as potential contamination from the made ground, given its thickness it is likely that ground gas may also be generated from the spoil.

3.3 Potential Pollution Linkages

The potential pollution linkages relating to human health and the protection of the aquatic environment are as follows:

- Ingestion of soil and soil dust and soil on vegetables
- Inhalation of soil particles, dust and vapours, both indoors and outdoors
- Dermal contact with soil and soil dust
- Surface runoff
- Leaching into the groundwater
- Groundwater transport

3.4 Potential Receptors

The potential receptors of any contamination are:

- Construction workers
- Neighbouring site users/passers by
- Site end users
- Surface water - River Neath, stream and associated ecosystems
- Groundwater
- Building Materials - High levels of sulphates in the ground can damage building materials.
- Building Materials - Permeation of pipes

3.5 Qualitative Preliminary Risk Assessment

A Qualitative Preliminary Risk Assessment (QPRA) aims to make initial assumptions about potential risks posed towards the human health and to the aquatic environment during all stages of the development. Where it is assumed that a potential pollution pathway exists, there is a potential source, a potential receptor and a likely pathway, which links the two. The QPRA can be refined into a qualitative and quantitative risk assessment once the site investigation and laboratory soil chemical testing/environmental assessment has been undertaken.

Table 3.1 Preliminary Risk Assessment

Potential Source	Potential Pathway	Potential Target	Preliminary Risk Assessment
Made Ground and contaminated soils	Ingestion Ingestion Dermal contact	Construction workers Site end Users Building Materials	Potential for contamination from any contaminated soils/made ground **Moderate Risk**
Made Ground and contaminated soils	Surface runoff Leaching into the groundwater Groundwater transport	Groundwater River Neath Stream Building Materials	Potential for contamination from any contaminated soils/made ground **Moderate Risk**
Radon gas	Inhalation	Site end users	The site lies within an area where basic radon protection measures are required. This will only impact on site end users. **Moderate Risk**
Methane and carbon dioxide ground gas	Inhalation	Site end users Construction workers Neighbouring site users/passersby	The Made Ground is a potential source of methane and carbon dioxide gas. **Moderate Risk**

SECTION 4 Field Investigation

4.1 Site Works

A geo-technical and geo-environmental site investigation comprising eleven trial pits, five shell and auger boreholes and five rotary probeholes was undertaken during March 2008.

The trial pits were excavated using a JCB 3CX.

The shell and auger boreholes, 200mm in diameter, was sunk using a Cable Percussive drilling rig to a maximum depth of 11.60m. Within the borehole, Standard Penetration (SPT) tests were undertaken at close and regular intervals. The boreholes were terminated at assumed rock head.

The rotary probeholes, 105mm in diameter, were sunk using a Beretta rotary drilling rig. Compressed air was used as the flushing medium.

The fieldworks were supervised by Terra Firma (Wales) Limited, who also logged the trial pits, boreholes to the requirements of BS5930:1999. Summaries of the probeholes were prepared by an examination of the air flush returns and by reference to the driller's logs.

The trial pit logs are given in Annex E, the shell and auger borehole logs are presented in Annex F and the rotary probehole logs are presented in Annex G.

4.2 Exploratory Strategy

No specific areas of concern were identified in the desk study. It is considered that the number and spacing of the boreholes within the accessible areas was adequate to:

- Determine the presence, nature and distribution of contamination on site in an efficient but cost effective manner.
- Optimise the chances of finding contamination hot spots of various sizes and orientations.
- Represent the chemical composition of both made ground and natural soils.
- Represent the ground conditions beneath the entire site.
- Provide sufficient data to determine suitable remedial measures if necessary.

4.3 Sampling Regime

During the intrusive investigation, small disturbed soil samples were collected.

The sampling regime was conducted in accordance with BS5930: 1999 in order to satisfy the following criteria:

- Identify and confirm suspected sources of contamination
- Determine type and concentration of contamination
- Determine lateral and vertical spread of contaminants
- Ensure representativeness of the entire site
- Provide sufficient data to determine suitable remedial measures if necessary

4.3 Sampling Regime (Continued)

The sample locations and depths are illustrated in the following table.

Table 4.1 Sample Locations and Depths

Sample	Depth (m)	MCERTS Sample Description
TP3	0.4	**Made Ground:** Soft to firm brown gravely sandy **SILT**, glass, tarmac, wire, metal, timber
TP5	0.6	**Made Ground:** Soft black brown very sandy gravely **CLAY**, brick, timber, metal, asphalt
TP6	0.5	**Made Ground:** Soft black brown very sandy gravely **CLAY** with cobbles and boulders, concrete, wire, asphalt
TP8	0.7	Soft dark brown **PEAT**
TP9	1.4	**Made Ground:** Soft brown gravely sandy **CLAY**, brick, plastic
TP10	0.7	**Made Ground:** Firm dark brown mottled black gravely sandy **CLAY**, brick, plastic

4.4 Quality Assurance

Care was taken to ensure that sampling quality assurance occurred during site works. This included the following measures:

- The use of nitrile gloves at each sampling point.
- Stainless steel shovels were used to collect soil samples. The tool was cleaned with distilled water between each sample point.
- Soil samples were stored at a temperature below 4 degrees.
- No head space was left in sample containers.
- Samples were submitted for testing on the day of collection.

4.5 Ground Conditions

The ground conditions encountered by boreholes across the entire can in have been summarised as shown in Table 4.2.

Table 4.2 Summary of Ground Conditions

Depth (m)			Thickness (m)	Stratum
GL	-	2.6/8.5	2.6/8.5	**MADE GROUND:** Soft to firm becoming stiff at depth in places dark brown/grey gravely sandy **SILT/CLAY** with gravels and cobbles **or** Medium dense becoming dense brown/greysandy **GRAVELS** and **COBBLES** With brick, glass, timber, concrete, glass, wire, metal bars, ash, fabric, coal fragments, asphalt and occasional roots and rootlets in places
2.6/8.5	-	7.2/16.0	3.7/12.4	Stiff but soft in places (PH3) brown/grey/orange/blue sandy in places **CLAY** with gravels and cobbles and boulders in places. Peaty clay in PH2 from 5.5m to 11.0m depth underlain by blue clay to 16.0m depth
7.2/16.0	-	16.0/27.0	-	Completely weathered to moderately weathered in places highly fractured grey **MUDSTONE**

Within PH1 a horizon of mudstone gravels was identified between 7.0m to 8.5m depth, with the stiff clay both above and below.

No made ground was identified in TP8 (close to the stream), where peat was present from ground level to the full investigation depth of 3.04m.

The weakness of the underlying mudstone may be related to the proximity of the fault that runs through the site.

4.6 Water Strikes

Groundwater was encountered in BH1 at 7.m, in BH3 at 8.0m and in BH5 at 6.0m

4.7 Laboratory Chemical Testing

The soil samples taken were despatched to the laboratories of STL Midlands for laboratory chemical testing. Due to the past usage of the site a broad based chemical analysis was conducted. The following chemical tests were undertaken:

4.7.1 Soils

Metals and Metalloids

Lead
Cadmium
Mercury
Nickel
Zinc
Arsenic
Chromium
Copper
Selenium

In-Organics

Cyanide
Sulphate

Organic Chemicals

Phenols
Aromatic Petroleum Hydrocarbons (PAH)

Others

pH (acidity)

The results of the above chemical tests are presented in Annex H.

4.7.2 Leachates

Metals and Metalloids

Arsenic
Zinc

Organic Chemicals

Aromatic Petroleum Hydrocarbons (PAH)

The leachate results are presented in Annex I.

4.8 In-situ Gas Monitoring

Gas monitoring wells were installed in BH1, BH2 and BH4. The monitoring pipes were 50mm diameter pipe comprising 1m plane pipe and the remainder slotted to the full depth of 4m.

A programme of in-situ gas monitoring for the presence of methane, carbon dioxide and oxygen was implemented following completion of the installations. The barometric pressure of the atmosphere was also measured at the time of monitoring.

The results of the gas monitoring are presented in Annex J.

4.9 Soil Property Testing

During the investigation bulk soil samples were taken and submitted to the laboratories for grading analysis, dry density/moisture content testing and shear box testing.

The results of the tests are presented in Annexes K to M and are discussed in section 8.0.

SECTION 5 Evaluation of Analytical Results

5.1 Methodology

Environmental risk assessment evaluates the risk to receptors via an analysis of the 'source-pathway-target' linkage. In order for a risk to be present, there must be a contaminant source capable of causing a health risk, a vulnerable receptor, and a pathway linking the two.

This sort of risk assessment is usually conducted using a tiered approach. Tier 1 consists of a comparison of the analytical results obtained from the site investigation with Soil Guideline Values (SGV's) specific to the type of development obtained from The Environment Agency Contaminated Land Exposure Assessment (CLEA) Guidelines.

Where SGV values are not available reference has been made to Soil Screening Values (SSV's) developed by Atkins using RISC. All receptor profiles, source inputs and toxicological parameters comply with both peer reviewed literature and CLR 7 to CLR 10.

Where necessary SRCeco values given by BP RIVM (Research for Man and Environment, April 2001) published by the National Institute of Public Health and the Environment have also been used.

Should Tier 1 levels be exceeded, a choice is made either to remediate the site to conservative Tier 1 levels, or proceed to Tier 2. Tier 2 makes use of site-specific data to evaluate acceptable concentrations of chemicals for the particular conditions present at the site. At each tier, the amount and detail of investigation work increases as more site-specific data are needed to refine the characterisation of the site. Conversely, as site conditions are better understood, a more site-specific remediation strategy can be determined.

It should be noted that for contamination concentrations, which are measured to be lower than the detection limits, then the detection limit has been included in the statistical assessment.

In the case of leachate the regulatory guidelines/target concentrations used to undertake a generic risk assessment for the aquatic (freshwater) environment are the Environment Quality Standards for freshwater, or in their absence UK Drinking Water Standards.

The EQS for naphthalene has been used to assess the risk from all sixteen priority polyaromatic hydrocarbons (PAH), in the absence of other guidelines.

The water hardness has been obtained from the 'River Quality Targets' section of the Environment Agency website. The closest monitoring station to the site records an average water hardness of 301mg/l $CaCO_3$ from the River Neath.

5.2 Soils

For Tier 1, the site itself is considered to be the receptor. Therefore, attenuation of contaminants between the source and receptor is not considered.

A summary of the chemical test results which include the regulatory Soil Guideline Values or Soil Screening Values used in the Tier 1 assessment are given in the tables on the following pages.

5.2 Soils (Continued)

Table 5.1 Summary of Soil Chemical Test Results Pathfinder Suite

Substance	SGV/SSV (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		95% UCL	Number of Exceedences
			Minimum	Maximum		
Arsenic	20	CLEA	8.6	57	**	1
Cadmium	8	CLEA	<0.50	2.1		0
Chromium	130	CLEA	6.9	27		0
Copper	653	ATRISK	18	89		0
Lead	450	CLEA	35	160		0
Mercury	8	CLEA	<0.25	0.26		0
Nickel	50	CLEA	15	24		0
Selenium	35	CLEA	<0.30	0.77		0
Zinc	139	ATRISK	73	310		3
Cyanide	8	ATRISK	<2.5	<2.5		0
Phenols	78	ATRISK	<0.75	<0.75		0
Sulphate	2000	BRE	<240	980		0
pH	-	-	7.8	9.0		-
PAH	*	ATRISK	<2.0	11		4 ADL

Notes:

- CLEA-Soil guideline values for residential development
- ATRISK - Atkins Soil Screening Values for residential development
- BRE - British Research Establishment
- A total of 6 samples were tested
- Cadmium based on an average pH of 8.4
- Phenol based on worst case 1% SOM
- PAH - Polyaromatic Hydrocarbons
- - No available guideline value
- ADL - Above detection limit
- * See speciated PAH results
- ** Insufficient Number of samples to undertake a statistical analysis

5.2 Soils (Continued)

Table 5.2 Summary of Soil Chemical Test Results Speciated PAH

Substance	SSV (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		95% UCL	Number of exceedences
			Minimum	Maximum		
Naphthalene	4.4	ATRISK	<0.50	0.89	**	0
Acenaphthylene	-	-	<0.50	<0.50		0
Acenapthene	536	ATRISK	<0.50	<0.50		0
Fluorene	454	ATRISK	<0.50	<0.50		0
Phenanthrene	31	SRCeco	0.8	1.1		0
Anthracene	4300	ATRISK	<0.50	<0.50		0
Fluoranthene	796	ATRISK	0.95	1.4		0
Pyrene	590	ATRISK	0.82	1.6		0
Benzo(a)anthracene	4.79	ATRISK	<0.50	0.87		0
Chrysene	479	ATRISK	<0.50	1.1		0
Benzo(b)fluoranthene	5.54	ATRISK	<0.50	1.1		0
Benzo(k)fluoranthene	55.4	ATRISK	<0.50	0.81		0
Benzo(a)pyrene	0.54	ATRISK	<0.50	1.1		1
Dibenzo(ah)anthracene	0.61	ATRISK	<0.50	<0.50		0
Benzo(ghi)perylene	62.6	ATRISK	<0.50	1.1		0
Indeno(123cd)pyrene	6.04	ATRISK	<0.50	0.98		0

Notes:

- ATRISK - Atkins Soil Screening Values for residential development
- SRCeco - RIVM Ecotoxicological Serious Risk Concentrations for Soils
- A total of 4 samples were tested for speciated PAH
- ** Insufficient number of samples to undertake a statistical analysis

5.3 Leachate

For Tier 1, the site itself is considered to be the receptor. Therefore, attenuation of contaminants between the source and receptor is not considered.

The results of the leachate tests are presented in Table 5.3.

Table 5.3 Summary of Leachate Test Results

Substance	Threshold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		95% UCL	Number of exceedences
			Minimum	Maximum		
Arsenic	0.05	EQS	0.0022	-	**	0
Zinc	0.125*	EQS	<0.005	0.0069		0
PAH						
Napthalene	0.01	EQS	0.00005	0.00031		0
Acenaphthene	0.01	EQS	0.000015	0.000022		0
Acenaphthylene	0.01	EQS	<0.00001	0.000022		0
Fluorene	0.01	EQS	0.000037	0.00017		0
Phenanthrene	0.01	EQS	0.000021	0.000051		0
Anthracene	0.01	EQS	0.000012	0.000066		0
Fluoranthene	0.01	EQS	<0.00001	0.00011		0
Pyrene	0.01	EQS	<0.00001	0.000097		0
Benzo(a)anthracene	0.01	EQS	<0.00001	0.000018		0
Chrysene	0.01	EQS	<0.00001	0.000017		0
Benzo(b)fluoranthene	0.01	EQS	<0.00001	0.000014		0
Benzo(k)fluoranthene	0.01	EQS	<0.00001	<0.00001		0
Benzo(a)pyrene	0.01	EQS	<0.00001	0.000012		0
Dibenzo(ah)anthracene	0.01	EQS	<0.00001	<0.00001		0
Benzo(ghi)perylene	0.01	EQS	<0.00001	<0.00001		0
Indeno(123cd)pyrene	0.01	EQS	<0.00001	0.000016		0

Notes:

- EQS - Environmental Quality Standards (modelled as naphthalene as agreed with EA)
- PAH - Polyaromatic Hydrocarbons
- One sample was tested for arsenic
- Three samples were tested for zinc
- Four samples were tested for speciated PAH
- * Based on water hardness of 301mg/l $CaCO_3$ as given on the EA website for the River Neath.
- ** Insufficient number of samples to undertake a statistical analysis

5.4 Contaminants of Concern in Soils

Contaminants of concern in soils are deemed to be those in which either the maximum value or the 95% Upper Confidence Limit (UCL) value exceeds the threshold value shown. (The 95% UCL is the concentration that 95% of the values for a particular substance is expected to be less than or equal to). There were an insufficient number of samples to undertake a statistical analysis for this assessment.

The substances tested for above their respective Tier 1 threshold values are summaried in Table 5.4.

Table 5.4 Summary of Elevated Contaminants in Soil

Contaminant	Sample	Depth (m)	Measured Concentration (mg/kg)	Tier 1 SGV / SSV	Stratum
Arsenic	TP9	1.4	57	20	Made Ground
Zinc	TP5 TP9 TP10	0.6 1.4 0.7	310 260 140	139	Made Ground
Benzo(a)pyrene	TP3	0.4	1.1	0.54	Made Ground

Measures to deal with these exceeded levels are discussed in Section 7.

5.5 Contaminants of Concern in Leachates

The leachability of contaminants within soils at the site is a measure of their availability, and hence potential risk, to the water environment.

Leachate testing found all substances to be below their respective threshold values.

SECTION 6 Evaluation of In-situ Gas Monitoring Results

As previously discussed in Section 4.8, three gas-monitoring wells were installed to enable monitoring for the presence of methane, carbon dioxide and oxygen following completion of the fieldworks.

To date two rounds of gas monitoring has been undertaken.

This indicates methane levels as being between N/D (non-detectable) and 0.1% by volume (V/V). Carbon dioxide was found to vary between 0.9%V/V and 1.7% V/V.

The oxygen concentration was found at concentrations between 5.3%V/V and 18.2% V/V.

The gas flow rate from the boreholes was also measured at the time of monitoring. The maximum flow rate was confirmed to be 0.1 l/hr.

When these results are compared with table 8.5 of CIRIA report C665, the site can be classified as 'Gas Characteristic situation 1'.

For gas characteristic 1 sites no special precautions are required:

Once the full 6 monitoring visits have been made, this classification will be reviewed and if necessary amended.

The gas monitoring results to date, are presented in Annex J.

SECTION 7 Qualitative Risk Assessment/Mitigation Measures

7.1 Site Summary

Historically, the site remained unoccupied up until between 1938 and 1962, whereby the northern half of the site was woodland and the southern half comprised open fields. By 1962 Heol-y-Glyn had been constructed along the north-western edge of the site. Within the north of the site much of the woodland had been cleared and a large spoil heap was present, with a level plateau alongside Heol-y-Glyn and a steep downwards sloping batter forming its southern and eastern edge. Two buildings had been constructed upon the plateau, but were no longer present by 1977. Since 1977 there have been no apparent changes to the site.

The ground conditions on site were found to comprise made ground of soft to firm becoming stiff gravely sandy clay or medium dense becoming dense gravels and cobbles with brick, timber, glass, coal fragments and asphalt to between 2.6m and 8.5m depth. The made ground was seen to be underlain by stiff but soft in places sandy clay with gravels, cobbles and boulders. Completely weathered to moderately weathered highly fractured mudstone was encountered at between 7.2m and 16.0m depth. Peaty clay was identified in PH2 and peat was present in TP8 (adjacent to the stream) from ground level to the full investigation depth of 3.04m.

The nearest surface water body is the River Neath, which situates 150m south of the site.

Any perched groundwater flows from the site within the made ground and superficial deposits will be in a southerly direction following the southward sloping natural topography of the site. The majority of waters will be collected by the stream that runs around the site.

Given the development of the area over the years the majority of these shallow waters are now probably drained by storm systems.

The underlying coal measures are classified as a minor-aquifer.

7.2 Potential Contaminants

The potential contaminants of concern have been identified as arsenic, zinc and benzo(a)pyrene.

7.3 Potential Receptors

The potential receptors for the site construction workers, neighbouring site users, passers-by, and future site users.

The potential aquatic receptors are taken to be surface waters and perched groundwater, the stream on site and the River Neath.

The underlying bedrock is considered to be a receptor as it is a minor-aquifer.

Local wildlife/plantlife ecosystems are considered to be potential receptors.

Building materials are at potential risk from sulphate levels and permeation of contaminants into water pipes may also be problematic.

7.4 Potential Pathways

How the proposed development finish affects the various possible contamination pathways for the entire site is considered below, and summarised in Tables 7.1 and 7.2 on the following pages.

Ingestion of soil/soil dust and soil on home-grown vegetables/ dermal contact

Potential risks are present during the development to site workers from soil/soil dust ingestion. By adhering to appropriate protection measures any risks to workers can be considered low.

It is considered that the site will be sufficiently fenced off during development, meaning there will be a no risk to passers by or neighbouring site occupants.

In terms of the eventual site end users, if or where the site is to be residential, capping of all garden/landscaped areas with 600mm of inert soils will be required to eliminate all human health risks.

If or where the site is to be in use commercially, then no mitigation measures will be required to make the site suitable for its proposed end users.

Inhalation of soil dust and vapours

It is considered that none of the contaminants identified are of concern as vapours.

Protection of site workers from soil dust inhalation can be minimised by simple health and safety measures and dust suppression.

Passers-by and neighbouring site occupants are not considered to be at risk from inhalation.

Basic radon protection measures are required.

No gas protection measures are required.

Surface water run-off/leaching into the groundwater/groundwater transport

Leachate testing has found no elevated levels of any substance.

It is therefore concluded that there are no risks to the aquatic environment from the site materials.

During development, measures to avoid accidental spillage of materials during earthmoving activities, and to control surface run off should be taken.

7.5 Human Health Risks

A Qualitative Risk Assessment on the potential human health effects is detailed in Table 7.1.

Table 7.1 Human Health Risk Assessment

Source	Pathway	Target	Risk Assessment	Mitigation Measures
In-situ Made Ground	Dermal contact with soil/dust Inhalation of soil/dust Ingestion of soil/dust	Construction workers	Moderate risk to site construction workers involved in excavation phase of development	COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures if required
In-situ Made Ground	Inhalation of fugitive soil dust Ingestion of soil dust Dermal contact with soil dust	Passers by, neighbouring site occupants	Insignificant risk during excavation phase of development and on completion of the development	Site screening and dust suppression measures if required
In-situ Made Ground	Dermal contact with soil dust Inhalation of soil/dust Ingestion of soil/dust	Site end users – Residential: Residents and visitors Commercial: Employees and visitors	Potential risks to the site end users	Residential Use: Human health risks to be eliminated by capping of garden/landscaped areas with 600mm of inert soils Commercial Use: No mitigation measures required
Methane and carbon dioxide gas	Inhalation	Site end users – Residents and visitors	No Risk	No gas protection Measures Required
Coal Measures Bedrock	Radon Gas	Site end users – Residents and visitors	No radon protection required	Not applicable

During construction phases, human health risks should be mitigated by:

- COSHH Assessment and good standards of site hygiene, PPE etc;
- Appropriate H&S instructions being in place to cover the above;
- Dust suppression measures when necessary
- Measures to limit contact with any contaminated groundwater

It should be noted that the appointed contractor should provide Method Statements and Risk Assessments in place to deal with these matters.

During the ground works, the contractor should comply with all current Health and Safety regulations.

7.5 Human Health Risks (Continued)

If during the development materials or abnormal ground conditions are encountered that are significantly different to those encountered in the investigation, the occurrence should be reported to the Engineer and appropriate action taken prior to continuing with the works.

If plastic pipes are to be laid beneath the site an assessment should be made, by the water provider, of soils along the route of the pipe with reference to the material selection criteria quoted in the Water Regulations Advisory Scheme Guidance Note No.9-04-03 (October 2002).

When laying underground services the made ground in the service trench should be removed and replaced with clean fill to prevent human contact during future maintenance works.

Any soils to be removed from site should be subject to Waste Acceptance Criteria (WAC) testing.

7.6 Risks to the Aquatic Environment

A Qualitative Risk Assessment on the potential effects to the aquatic environment is detailed in Table 7.2.

Table 7.2 Risks to the Aquatic Environment

Source	Pathway	Target	Risk Assessment	Mitigation Measures
In-situ Made Ground	Surface water/runoff	Adjacent sites and bodies of water	Insignificant risk during construction and excavation phase of development Post development, there is insignificant risk of contaminant migration into bodies of water	Measures to avoid accidental spillage of materials during earthmoving activities, and to control surface run off Not Applicable
In-situ Made Ground	Leaching into Groundwater	Groundwater	Leachate testing confirms there are no risks to the aquatic environment.	Not applicable Suitable pipes for water supply

In respect of physical effects of the works, there is a risk of accidental spillage of earthmoving materials/groundwater during the earthworks.

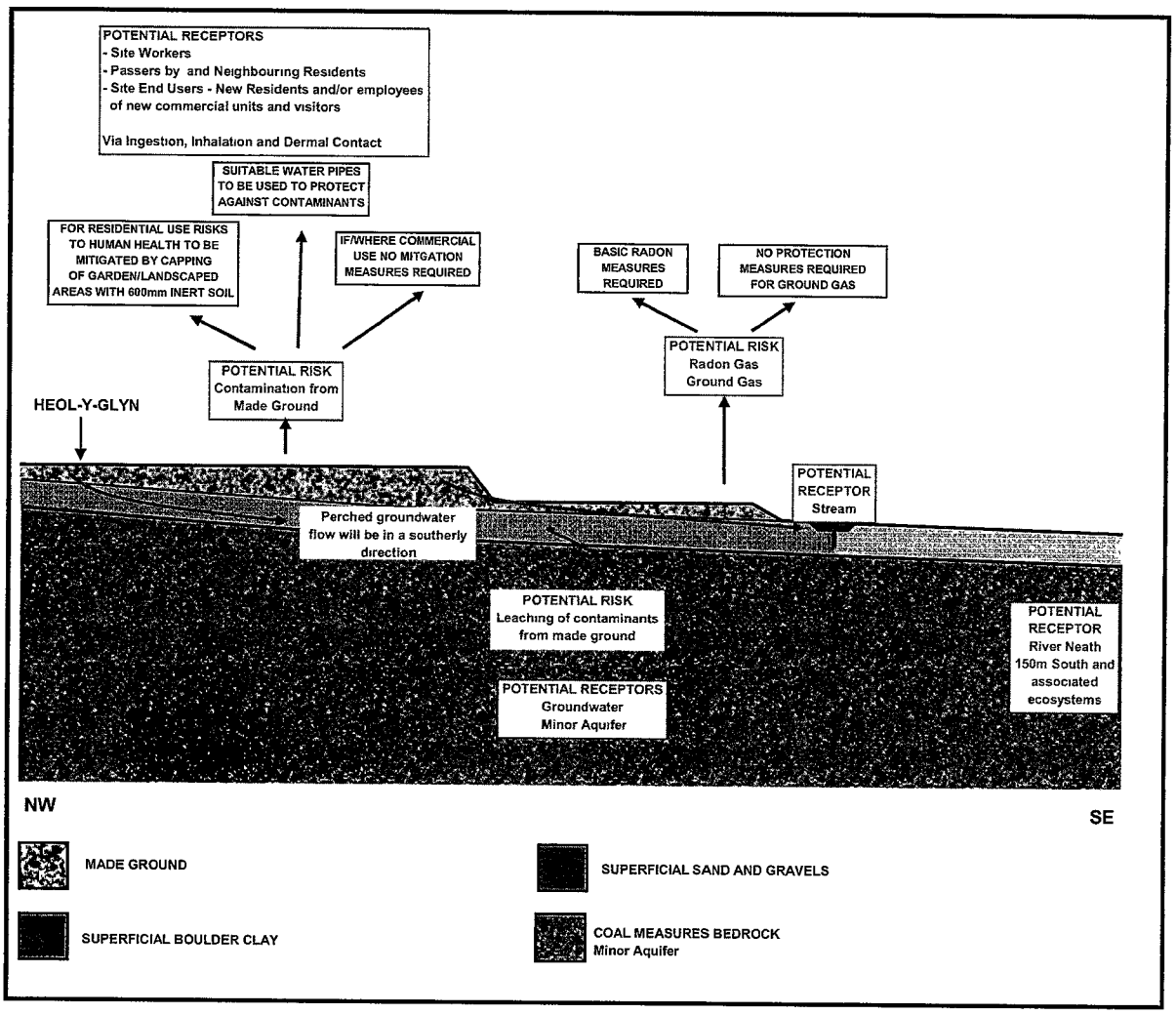
During the construction phase, the following mitigation measures should be applied:

- Measures to avoid accidental spillage of materials during earthmoving activities;
- Measures to control surface run off

It should be noted that the appointed contractor should provide Method Statements and Risk Assessments in place to deal with these matters.

7.7 Site Conceptual Model

The site conceptual model is presented below:



SECTION 8 Soil Property Testing

8.1 Optimum Moisture Content/Maximum Dry Density Test Results

The results of the optimum moisture content and maximum dry density tests are detailed in the table below.

The results of these tests are given in Annex K.

These tests were conducted in accordance with BS 1377: Part 4: 1990.

Table 8.1 Optimum Moisture Content/Maximum Dry Density Test Results

Sample	Initial Moisture Content (%)	Optimum Moisture Content (%)	Maximum Dry Density(mg/m^3)
TP1	17	15	1.84
TP2	17	14	1.82
TP5	16	13	1.84
TP6	17	15	1.83

In order for there to be tolerable settlements from the placed fill materials, it needs to be compacted at or close to its Optimum Moisture Content (+ or – 1.5%). This will ensure that a minimum 95% compaction will be achieved.

It can be seen from table 8.1 that the natural moisture content of the materials is at present between 2% and 3% higher than the Optimum Moisture Content.

In order to meet the above criterion it is clear that the materials will need to be dried. This can be achieved by excavating and allowing the materials to dry naturally.

Once the given moisture content has been achieved then the materials may be used as structural fill beneath the buildings, car park and road areas. The materials have been graded according to the Specification Works for Highways 600 and should be laid and compacted in layers.

A programme of in-situ testing should also be carried out in order to confirm the effectiveness of the compaction procedure.

8.2 Grading Analysis

Four samples were tested in the laboratory by dry and wet sieving analysis to determine their grading characteristics. These tests were conducted in accordance with BS1377: Part 2, Clause 9.2: 1990.

Based upon the soil property test results, and referring to Table 6/1:Acceptable Earthworks Materials: Classification and Compaction Requirements, Series 600 Specification for Highway Works, the samples can be classified as shown in the table below.

The soil type has been determined by comparison of results with Table 6/2: Grading Requirements for Acceptable Earthworks Materials. The type is then classified and the typical use obtained by referring to Table 6/1 of this publication.

8.2 Grading Analysis (Continued)

Table 8.2 Grading Analysis Results

Sample	Type	Soil Description	Classification	Typical Use
TP1	7D	Made Ground: Soft to firm gravely sandy silt with cobbles	Selected Stoney Cohesive Material	Fill to reinforced earth
TP3	7D	Made Ground: Firm slightly sandy and gravely clay with cobbles	Selected Stoney Cohesive Material	Fill to reinforced earth
TP7	6F1	Made Ground: Soft to firm gravely very sandy clay	Selected Granular Material (fine grading)	Capping
TP9	6F2	Made Ground: Soft brown gravely sandy clay	Selected Granular Material (coarse grading)	Capping

The compaction requirements for such materials are given in Table 6/4, Method 2 of the Specification for Highway Works.

The results of these tests are presented in Annex L.

8.3 Shearbox Test Results

A consolidated drained shear box test was undertaken on four representative samples of the made ground in order to assess the appropriate profile angle that can be applied to the sides of any new slopes created during the development..

These tests were conducted in accordance with BS 1377: Part 7: 1990.

These results of these tests are presented in Annex M, and summarised in the table below:

Table 8.3 Shearbox Test Results

Sample	TP1	TP2	TP8	TP10
Effective Angle of Shearing Resistance (θ)	29	30	14	32
Effective Cohesion (kPa)	2	7	0	15

Based on these results it is considered that any batters be constructed at a maximum angle of 29 degrees.

The sample from TP8 was taken from the peat. This material will not be suitable for any slopes created unless they incline at a 14 degree angle or less.

SECTION 9 Engineering Recommendations

9.1 Preparation of Site

All grass and vegetation beneath the proposed building including all roots should be removed from site.

Any reduced levels should be brought up to the required levels with well, compacted imported granular materials. Department of Transport (DoT) Type 2 sub-base or similar may be used and should be compacted in layers, in accordance with the Specification for Highway Works. Alternatively, appropriate selected inert imported fill could be used. Alternatively suitable site won mainly granular materials should be used.

Allowances should be made for removing any 'soft spots/area' and their replacement with well compacted granular materials.

Where cut and fill works are to be carried out, it should be noted that any slope angles should not exceed 29 degrees. The ground surface should be adequately cut and benched, all batters grass seeded and drains installed at top and bottom of batters.

It may be necessary to retain materials on site. Similarly, it is important to ensure that sufficient drainage measures are put in place, behind the wall, prior to development.

It is advised that no additional loads are applied to retaining walls or batters from the new development. Therefore, a 45° line cut from the base of the outermost house foundations should not impinge upon any retaining walls/slopes.

Contingencies should be made for the protection/diversion of any underground services present beneath the site brought about as a result of the proposed works.

Contingencies should also be made for redirection or culverting the stream around the site where necessary.

It is assumed that no development of the area in the southwest of the site, adjacent to the stream, will take place. If this area is to be built upon then the peat will need to be excavated and removed from site.

All materials to be removed from site should be taken to an appropriately licensed tip.

9.2 Foundation and Floor Slab Solution

Following the successful re-profiling of the site to obtain the desired levels for the development it is recommended that a reinforced concrete raft type foundation/floor slab solution be used for the development.

For a raft foundation the maximum load beneath the foundation should not exceed 100kN/m^2 on the newly compacted ground.

In order to prevent the effects of frost heave and or thermal shrinkage, the edge beams should be taken down to 900mm below finished ground level. Alternatively the non frost susceptible materials can be taken down to the above quoted depths.

For the foundations, to prevent additional loads being transferred to the any batters or retaining walls, a 45 degree line from the base of the foundations should not impinge across the face of the batters.

9.2 Foundation and Floor Slab Solution (Continued)

Allowances should be made for the removal of any 'soft spots' and their replacement with well-compacted granular materials. Department of Transport (DoT) Type 2 materials or similar could be used and should be compacted in layers to the specification for Highway Works.

All foundation formations should be inspected by a suitably qualified Engineer before being concreted.

9.3 Excavations and Formations

Most of the shallow excavations should be possible with normal soil excavating machinery.

The shallow excavations are unlikely to encounter significant perched water/groundwater inflows. Any inflows together with rainwater infiltration should be dealt with by conventional pumping techniques.

The sides of any excavations deeper than 1.0m should be supported by planking and strutting or other proprietary means.

The sub-formations/formations will be susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations.

As a minimum the formation/excavation surfaces must be protected by blinding concrete or a minimum thickness of 200mm of hard cover immediately after exposure.

The capping filling should be compacted in layers not exceeding 150mm thick with suitable mechanical compacting plant of specified weight, in accordance with the Specification for Highways Works. Compaction should be continued until there are no visible signs of fill being pushed up in front of the compacting plant, and all surface voids/unevenness must be filled to create a relatively smooth and even terrain.

Allowances should be made for trimming, re-trimming and re-compaction if necessary

Allowances should be made for the removal of soft spots/areas and their replacement with well compacted granular materials.

Contingencies should also be made for special precautions to prevent formation deterioration in addition to the above.

It is recommended that approval be gained from a qualified engineer of the formation condition before covering them with any subsequent construction.

9.4 Access and Car Parking Areas

The access road and car parking areas will be within the existing fill materials.

Following the proposed earthworks and re-compaction of the made ground it is likely that a California Bearing Ratio (CBR) Value of 5% may be suitable for design purposes.

The local authority may require field testing to confirm the California Bearing Ratio.

Allowances should be made for the removal of any 'soft spots/areas' and their replacement with well compacted granular materials as previously described.

9.5 Retaining walls

Given the topography of the site it is likely that new retaining walls will be required.

The effective angles of shearing resistance of the encountered materials have been determined from the publication BS 6031: 1981 Code of Practise for Earthworks.

Effective Cohesion	Effective Angle of Shearing Resistance
$c'=0kN/m^2$,	$\phi'=25°$ for made ground
$c'=0kN/m^2$,	$\phi'=30°$ for well compacted imported granular materials

Allowances should be made for incorporating drainage behind the walls in order to prevent the build up of hydrostatic pressure.

9.6 Protection of Buried Concrete

The laboratory chemical tests revealed a total sulphate content of between <240mg/kg and 980mg/kg and pH values of between 7.8 and 9.0

Based on these results all buried concrete should as a minimum conform to Class AC-1 of BRE Special Digest 1 (2001).

SECTION 10 Remediation Strategy and Validation Report

10.1 Remediation Strategy

A Remediation Strategy should be submitted to the Local Authority for approval, prior to the remediation of the site. The Remediation Strategy should contain, but not be limited to the following:

- A summary of the significant pollution linkages
- Details of the proposed remedial methods
- Key participants/contractor(s)
- Technical procedures
- Phasing of works and approximate timescales
- Site plans to scale
- Details of consents or license needed (discharge consents, asbestos waste removal license etc)
- Health and Safety, COSHH Assessment, Method Statements and Risk Assessments
- Emergency contingencies

Any changes made to the remedial strategy must be agreed with Neath and Port Talbot Council. The remedial works must be adequately supervised by an independent Specialist/Contractor, with final submission of a Validation Report.

10.2 Validation Report

Once the Remediation Works have been undertaken, and before site occupation, a Validation Report or equivalent documentation should be compiled by the appropriate Specialist/Contractor/Consultant for each of the proposed remedial measures.

The imported inert soils to be used as capping in landscaped areas should also be chemically tested, prior to bringing them to site, to ensure they are suitable for use.

The number of soil samples required to be chemically tested should be discussed and confirmed with Neath and Port Talbot Council.

The soils should be chemically tested for the following determinants: arsenic, cadmium, total chromium, lead, mercury, selenium, boron, copper, nickel, zinc, phenol and polyaromatic hydrocarbons. The chemical test results should be compared to Soil Guideline Values (SGV's) in accordance with the CLEA guidelines. In the absence of SGV's, the chemical test results should be compared to other guidelines which comply with UK guidance and legislation.

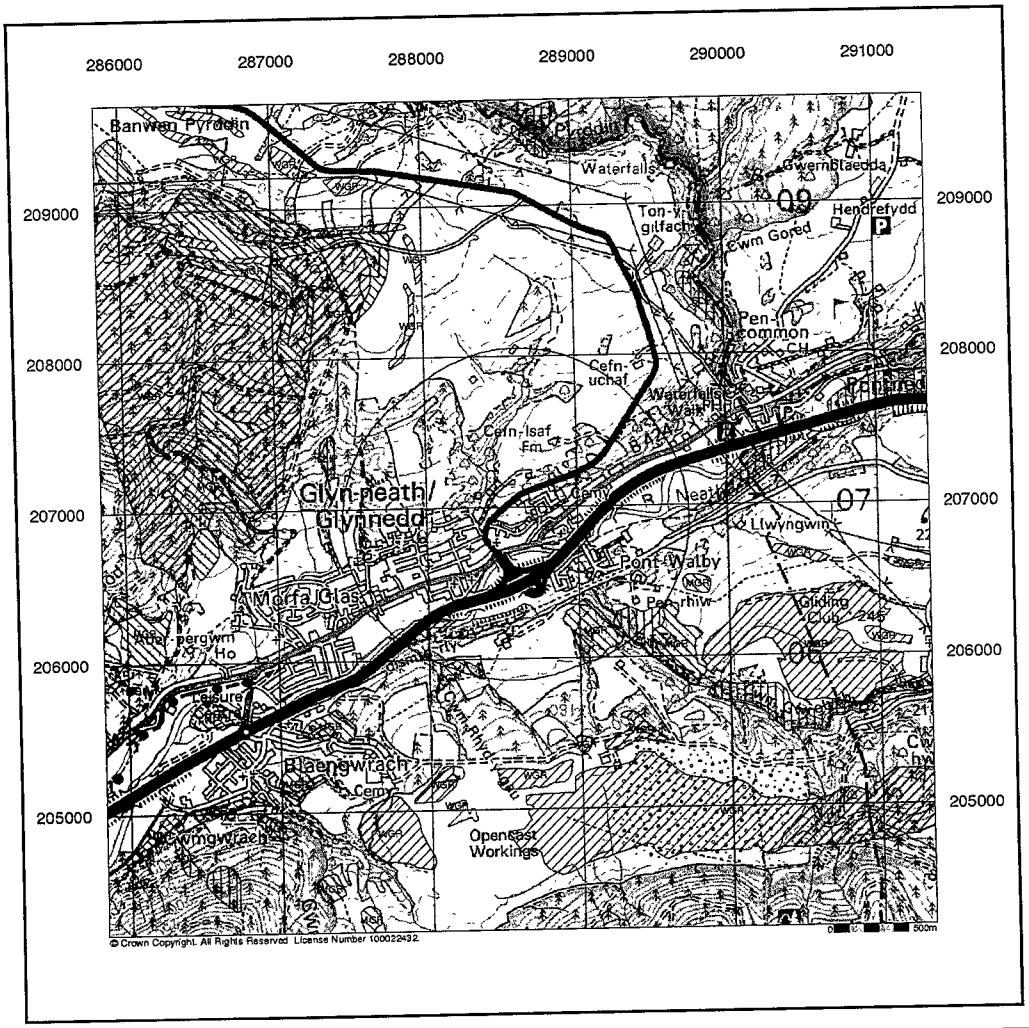
Validation Reports should contain, but not be limited to the following:

- Information as detailed within the Remedial Strategy/Method Statement about works undertaken, including scaled site plans.
- Details and justification of any changes from the original Remedial Strategy/Method Statement.
- Details of who carried out the work.
- Substantiating data, for example, laboratory and in-situ test results, monitoring of performance of remedial measures introduced, scaled plans of the site/area subject to remediation.
- Documentation for asbestos/waste disposal.
- Confirmation that remediation objectives have been met.

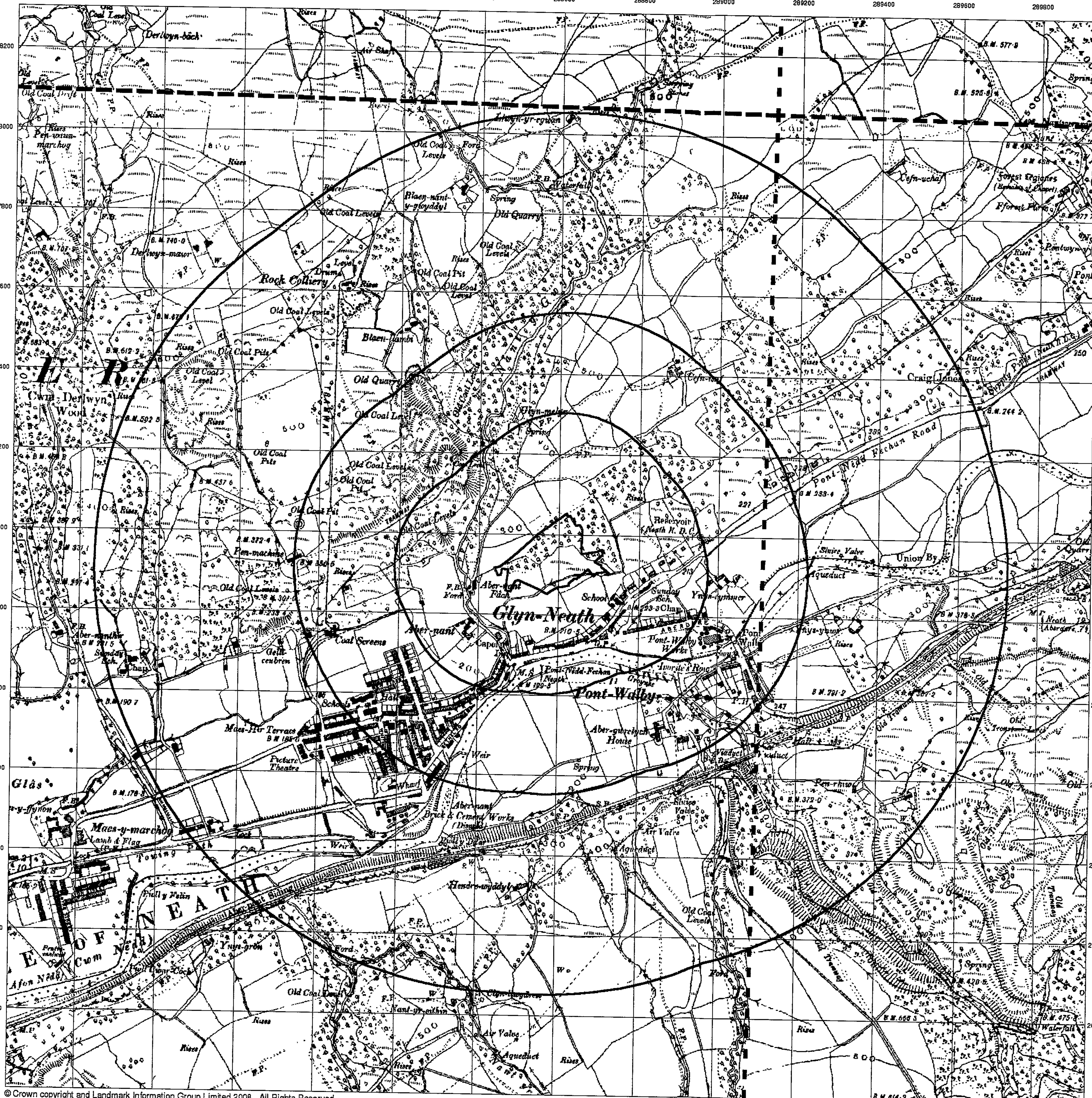
Annex A
Envirocheck Historical Plans

Annex B
Historical Geology Report

Artificial Ground and Landslip Map



Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WGR	Worked Ground (Undivided)	Void	Present Day - Present Day
	MGR	Made Ground (Undivided)	Made Ground (Composition Unspecified)	Present Day - Present Day
	SLIP	Landslip	Unknown Lithology	Quaternary - Quaternary



Envirocheck®

A Landmark service

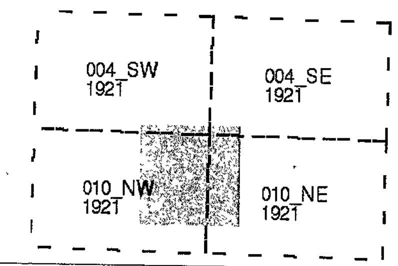
Glamorganshire

Published 1921

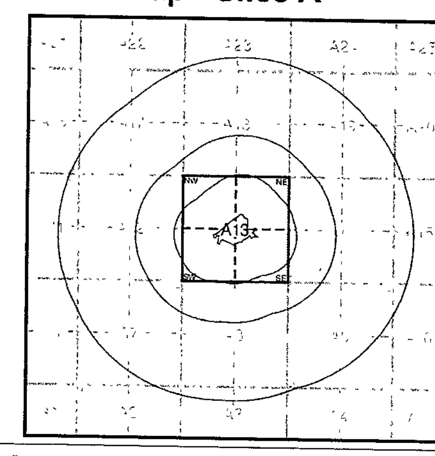
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number:	24537603_1_1
Customer Ref:	10287
National Grid Reference:	288580, 206940
Slice:	A
Site Area (Ha):	2.71
Search Buffer (m):	1000

Site Details

Intervalley Road, Glynneath, Neath, SA11 5TU

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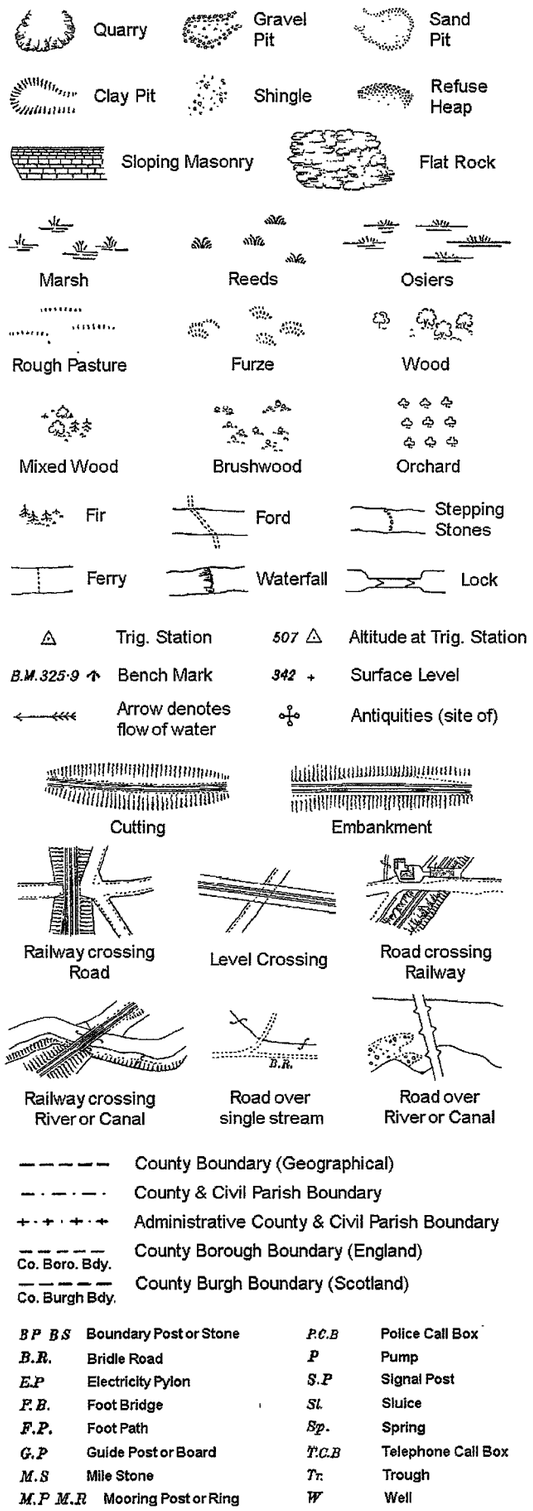
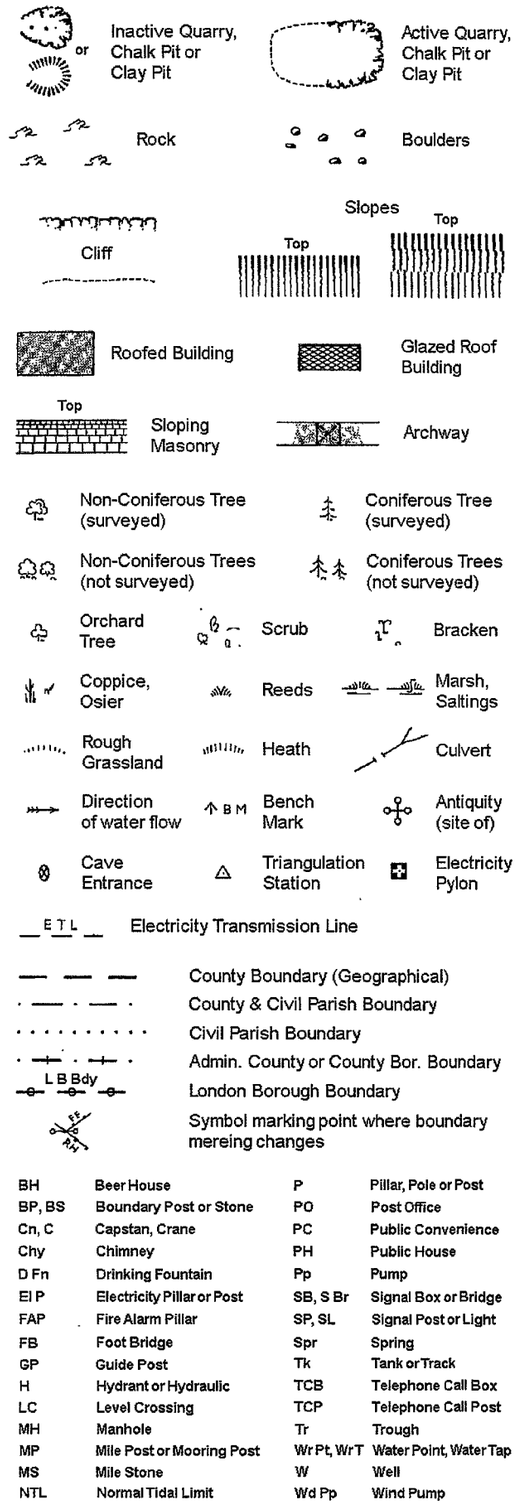
Historical Mapping Legends

Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



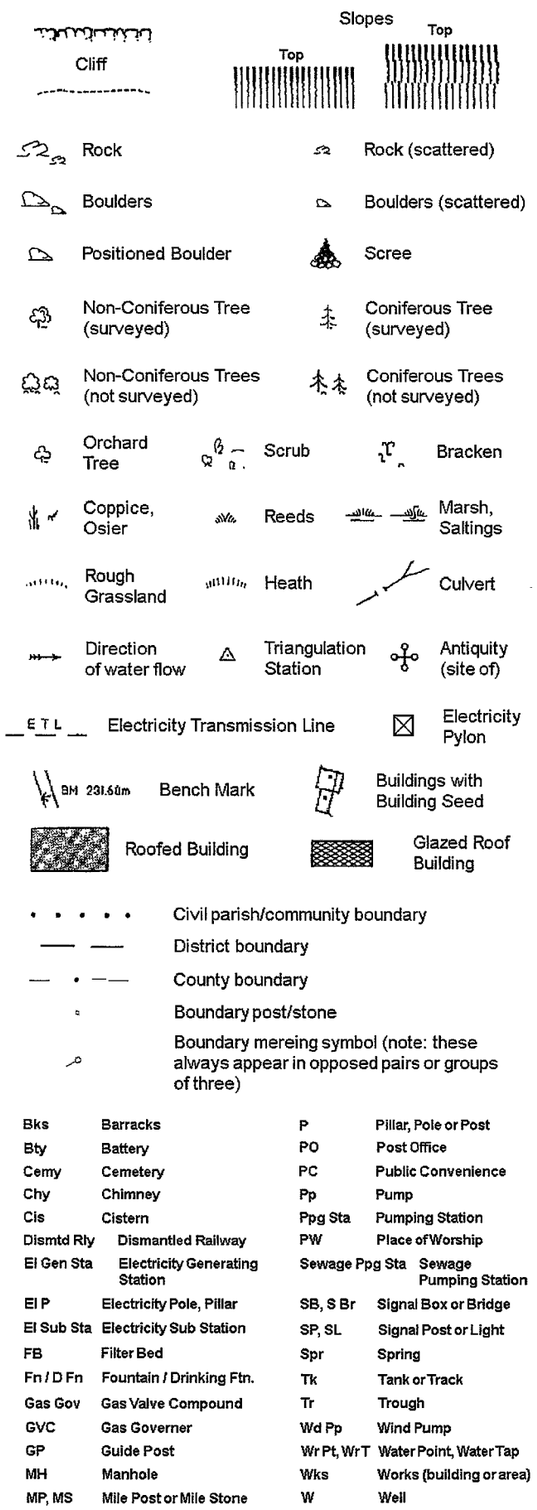
B P	Boundary Post or Stone	P.C.B	Police Call Box
B.R.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F. B.	Foot Bridge	Sl.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.R	Mooring Post or Ring	W	Well

Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250



BH	Beer House	P	Pillar, Pole or Post
BP, BS	Boundary Post or Stone	PO	Post Office
Cn, C	Capstan, Crane	PC	Public Convenience
Chy	Chimney	PH	Public House
D Fn	Drinking Fountain	Pp	Pump
El P	Electricity Pillar or Post	SB, S Br	Signal Box or Bridge
FAP	Fire Alarm Pillar	SP, SL	Signal Post or Light
FB	Foot Bridge	Spr	Spring
GP	Guide Post	Tk	Tank or Track
H	Hydrant or Hydraulic	TCB	Telephone Call Box
LC	Level Crossing	TCP	Telephone Call Post
MH	Manhole	Tr	Trough
MP	Mile Post or Mooring Post	Wr Pt, Wr T	Water Point, Water Tap
MS	Mile Stone	W	Well
NTL	Normal Tidal Limit	Wd Pp	Wind Pump

Large-Scale National Grid Data 1:2,500 and 1:1,250



Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Dismtd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity Pole, Pillar	SB, S Br	Signal Box or Bridge
El Sub Sta	Electricity Sub Station	SP, SL	Signal Post or Light
FB	Filter Bed	Spr	Spring
Fn / D Fn	Fountain / Drinking Ftn.	Tk	Tank or Track
Gas Gov	Gas Valve Compound	Tr	Trough
GVC	Gas Governer	Wd Pp	Wind Pump
GP	Guide Post	Wr Pt, Wr T	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

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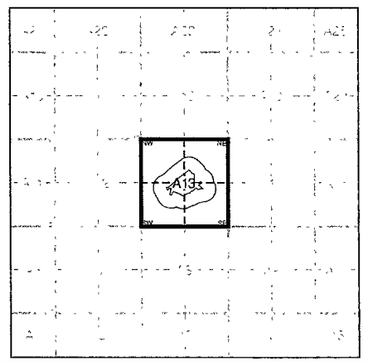
Ordnance Survey mapping included:

Mapping Type	Scale	Date	Pg
Glamorganshire	1:2,500	1877	2
Glamorganshire	1:2,500	1899	3
Glamorganshire	1:2,500	1918	4
Ordnance Survey Plan	1:2,500	1962 - 1964	5
Additional SIMs	1:2,500	1977	6
Ordnance Survey Plan	1:2,500	1981	7
Ordnance Survey Plan	1:2,500	1984	8
Large-Scale National Grid Data	1:2,500	1993	9

Historical Map - Segment A13



N

Order Details

Order Number: 24537603_1_1
Customer Ref: 10287
National Grid Reference: 288580, 206940
Slice: A
Site Area (Ha): 2.71
Search Buffer (m): 100

Site Details

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