

PROPOSED DEVELOPMENT AT
CAERWERN HOUSE, CAERWERN, NEATH

POBL GROUP

PRELIMINARY COAL MINING
RISK ASSESSMENT

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1.0 INTRODUCTION AND OBJECTIVES

1.1 Background

The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by Pobl Group (hereafter known as 'the Client'), to undertake a preliminary Coal Mining Risk Assessment at Caerwern House, on Dwr-y-Felin Road in Neath.

This assessment is focussed at assessing the risks posed to the property and end users by features associated with historical mine workings. The site location is shown on Figure 1 and the site layout shown on Figure 2. The scope of this assessment was to:

- Obtain and review relevant desk study data on the site relating to past coal mining; and
- Identify and evaluate the risks (individually and cumulatively) to the proposed development.

It is understood that the site development is to comprise the extension of the existing Caerwern Nursing Home with a two storey extension to the rear of the main building and the construction of a new detached two storey structure in the north portion, adjacent to the existing building. The proposed development plan is presented as Figure 3.

This assessment was completed in general accordance with the published Coal Authority guidance on a risk based approach to development (Coal Authority, 2014).

The precise scope of works was mutually developed with the Client by ESP within an agreed budget, and comprised a desk study review of available historical Ordnance Survey maps, geological maps, memoirs, a Coal Authority mining report, assessment and reporting. No intrusive investigation, sampling or testing of the site soils was required at this stage.

The contract was awarded on the basis of a competitive tender quotation. The terms of reference for the assessment are as laid down in the Earth Science Partnership proposal of 2nd August 2016 (ref. jph/ESP 6346h.It1). The assessment was undertaken in August 2016.

1.2 Limitations of Report

This report represents the findings of an assessment of coal mining subsidence risk relating to a proposed school extension, as detailed in the text. The brief did not require an assessment of the implications for any other end use, nor of other geotechnical or geo-environmental hazards. The report is not a comprehensive site characterisation and should not be construed as such.

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 geotechnical specialists. Earth Science Partnership does not provide legal advice and the advice of lawyers may also be required.

1.3 Digital Copy of Report

A digital copy of this report (in pdf format) is included on a CD in Appendix E.

2.0 DESK STUDY AND SITE RECONNAISSANCE

The information in this section comprises a Preliminary Risk Assessment of coal subsidence hazards and is based on information obtained from desk based research.

2.1 Site Location and Description

The site is located to the east of Dwr-y-Felin Road in Neath. The National Grid Reference of the centre of the site is (SS) 274615 198346, the postcode SA10 7RH, and a Site Location Plan is presented as Figure 1.

The site is roughly trapezoidal in shape and is around 120m in length (south-west to north-east) by between 30 and 70m in width (north-west to south-east) covering an area of approximately 0.6Ha. The site is predominantly occupied by an existing care home (Caerwern), its grounds and an access road leading from Dwr-y-felin. The existing site layout, including boundary is presented as Figure 2.

It is bordered by:

- To the north: residential properties on Heol Illtyd amongst other roads.
- To the east: by gardens and residential properties on Twyn Teg.
- To the south: Caerwern Lodge, and traditional two-storey, semi-detached residential properties on Twyn Teg, followed by Dwr-y-Felin Road.
- To the west: by properties on Heol Illtyd and a previous phase of development on the Caerwern site.

The topography in the area falls to the south. Ordnance Survey maps show a spot height on Dwr-y-Felin Road, near the site entrance of 17.1m OD. The entrance driveway slopes gently up from the main entrance on Dwr-y-Felin Road towards Caerwern House, which stands at the most elevated part of the site, visually estimated to be around 3m to 4m above the site entrance (i.e. around 20 to 21m OD).

Caerwern House comprises a, three-storey, masonry-built building probably dating from the nineteenth century, with more recent single- and two-storey extensions. The land surrounding Caerwern House comprises gardens, sloping to the south-east including an area some 2m below the building level, and an area of woodland (predominantly coniferous).

The tarmacadam entrance driveway off Dwr-y-Felin, leads to a small car parking area in front of, and to the side of, the building. A larger, rough surfaced, car parking area is located in the woodland in the south-eastern portion.

2.2 Site History

The site history has been assessed from a review of available historical Ordnance Survey County Series and National Grid 1:1,250, 1:2,500 and 1:10,560 scale maps. Relevant extracts of the maps are presented in Appendix A. Relevant information from other sources, such as the Landmark report, has also been incorporated where appropriate.

Table 1: Review of Historical Plans

Date	On-Site	In Vicinity of Site
1877 – 1951	The house <i>Caewern</i> is shown in the east of the site and is likely to be the large masonry building remaining on site. A driveway is shown accessing the house from Heol Dwr-y-felin to the west, but also running on past the house to access a possible farm to the north.	The site is located in a rural setting around 170m north of the main railway. Heol Dwr-y-felin is shown to the west, although then line of the road is slightly further west than the present day, with the trees on the field boundary probably on the line of the present-day road. The farms Ffrwd Vale and Waun-cierch are shown 100m to the south and 280m to the west. Two old mine shafts are indicated 160m north-west and 500m west of the site. An old quarry is shown around 500m to the east.
1965 – 1968	No significant changes within the site in 1965, but by 1967, the extension to the north-west of Caewern had been built, including cutting into the north-western boundary.	The 1965 edition shows the housing development to the north of the site, including Heol Illtyd. To the west, Dwr-y-Felin Road had been re-aligned to its present position and housing developments constructed further west.
1977 – Present day	Ty Bryncoch is shown in the west of the site on the edition from 1977. At this time, the site was broadly in its present layout.	Further residential developments are encroaching towards the site from the east and south, with the current developments around the site shown by 1986.

2.3 Geological Setting

The published geological map for the area (1:10,560 scale, SS79NW) indicates the site to be underlain by bedrock of the Grovesend Beds of the Upper Coal Measures with no significant superficial deposits. Fluvio-Glacial Gravels are shown just to the east, and may extend to beneath the site itself.

Based on the information presented on the geological map, including regional bedrock dips to the north and around 10 degrees, the following coal seams are potentially present beneath the site:

- Thin unnamed coal seam (0.2m in thickness) present at around 12m depth;
- Swansea Four Feet coal seam (1.2m in thickness), present at around 30m depth.

The upward succession shows the next major seam to comprise the Little Bryncoch (2 feet 6" to 3 feet) identified some 135m higher in the vertical succession. Based on the local topography and elevation of each seam, the Little Bryncoch is unlikely to be present beneath the site.

An extract from the geological sheet SS79NW and the associated vertical section is presented on Figure 4.

2.4 Available BGS Borehole Records

The British Geological Survey website indicates five boreholes having previously been drilled close to the site boundary. Copies of these boreholes have been obtained and are presented in Appendix B. Two boreholes (SS79NW16 & 17) were constructed for the Neath to Abergavenny Trunk Road in around 1967 just to the south of the site (close to Caewern Lodge), and identified:

- In SS79NW/16, a brown mottled clay to 1 ft (0.3m) over 'pebbles' and an obstruction), and
- In SS79NW/17, 4ft (1.2m) of 'Black clayey Topsoil and Fill', over dark grey/'fawn', clayey sand and sandy gravelly clay to 10ft (3.0m), and 'fawn sand and gravel' to 12.5ft (3.8m). Weathered sandstone was then encountered to 25ft (7.6m), which was weak enough to be drilled using 'shell and auger' (cable percussion) techniques. Water was encountered at around 1.5ft depth (0.45m), i.e. very shallow.

A further borehole from this investigation (SS79NW/24) was constructed some 80m to the east of the site and identified Topsoil over a 'firm fawn mottled (grey and orange sandy clay' to 5ft (1.5m) overlying 'fawn/grey medium coarse sand and gravel with boulders' to 15ft (4.6m). Groundwater was encountered at 8ft (2.4m).

Two further boreholes were drilled to the east of the site in 1977, and identified 300mm of Topsoil over brown-yellow mottled, and orange 'stony clay' with shale fragments, initially of a stiff consistency but soft below 3.0m in one borehole, to a depth of 4.0m, underlain by 'highly to moderately weathered dark grey shaly mudstone' to a depth of 4.5m. Both boreholes remained dry.

These boreholes confirmed that bedrock is present at shallow depth beneath the area of the site (around 4m depth), and is overlain by a variable deposit, which appears to be both fine- and coarse-grained.

2.5 Previous Investigation Works

ESP have previously undertaken a number of phases of work on an adjoining parcel of land (bounded in blue on Figure 2). These works comprised:

- Geoenvironmental Desk Study (Ref: 5186e.1909 – March 2013);
- Exploratory Ground Investigation (Ref: 5186e.02.1952 – July 2013);
- Supplementary Rotary Investigation (Ref: 5186e.03 – August 2013);
- Drilling and Ground Investigation (Ref: 5186e.04 – October 2014);
- Supplementary Ground Investigation (Ref: 5186e.05 – December 2014).

For the purposes of this Coal Mining Risk Assessment, only the pertinent geotechnical information has been summarised below, relating to hazards from historical coal workings and the reports listed above should be referred to for full context and discussion of any other geoenvironmental aspects.

ESP 5186e Phases 1 to 3 – March to August 2013

The works undertaken across all phases of work predominantly identified a ground model comprising up to 0.9m of Made Ground (generally reworked natural soils with fragments of ash and brick) or Topsoil over predominantly fine-grained fluvio-glacial deposits. Coal Measures bedrock is present from depths of around 6.0m beneath the development area.

Ten drillholes were constructed across the site with evidence of abandoned mine workings within the Swansea Four Foot coal seam identified in nine of the drillholes. Only one drillhole identified an open void (of 1.6m height), with remaining identifying backfill within the workings.

Of the boreholes outlined above, three were constructed within the current site boundary (DH1, DH6 and DH7). The following pertinent information has been identified within the following exploratory hole records, which are presented in Appendix D:

- DH1 - Voided/backfilled workings identified between 22m and 23.5m below ground level.
- DH6 - Coal recorded at 5.6m to 5.8m and 24.5m to 27m below ground level.
- DH 7 - Coal was recorded 13.0m to 13.7m below ground level, with a void recorded 31m to 31.5m below ground level. Following the void soft drilling was noted from 31.5m to 32.5m. DH7 was undertaken adjacent to the existing Caerwern House and the most pertinent borehole record.

The deeper coal seams/workings encountered in DH1, DH6 and DH7 is anticipated to comprise the Swansea Four Foot, whilst the shallower seam encountered in DH6 and DH7 is likely to comprise the thin 'unnamed' seam identified on the geological mapping.

ESP 5186e Phase 4 – October 2014

The adjoining parcel of land was subject to a drilling and grouting exercise between the 17th July 2014 and 2nd September 2014. In total 110no. drillholes were constructed and a total of 775 tonnes of grout injected.

Evidence of abandoned coal workings was identified in 75no. of the 110no. drillholes constructed, with around 23% identifying open voids. The workings beneath the northern part of the development (and closest to the current study site) were considered to be at sufficient depth with sufficient bedrock cover to mitigate the subsidence risk and, hence, treatment of this area was not deemed necessary.

2.6 Coal Authority Records

A mining report (provided by the client) has been obtained from the Coal Authority and is presented in Appendix B. It should be noted that the boundary indicated on the Coal Authority search exceeds the development boundary and includes adjacent properties. The pertinent development boundary has been superimposed upon the Coal Authority information for clarity.

The Coal Authority information indicates:

- The property is in the likely zone of influence from workings in 4no. seams of coal at shallow to 280m depth, and last worked in 1928.

- The property is not in the likely zone of influence of any present underground coal workings.
- Within, or within 20 metres of, the boundary of the property, there are two mine entries. (utilising the correct and superimposed pertinent site boundary indicates both of these mine entries are outside the development boundary).

The mine entry located closest to Caerwern House is referred to by the Coal Authority 274198-022 and is approximately 15 to 20m outside the southern site boundary.

Enquiries made to the Coal Authority during a previous phase of works (ESP, 2013) have failed to identify any further information on this shaft (such as shaft depth or strata section). The Swansea Four Feet seam is a heavily worked coal in the Neath area. Given the presence of this shaft close to the outcrop of the seam and the findings of the exploratory works on the adjacent site, we consider that it is highly likely that the seam has been worked beneath the site.

2.7 Additional Geological Information

The geological sheet also provides some detail of the succession at the Waun-cierch Pit, the shaft shown on historical maps some 160m north-west of the site. This indicates that the Swansea Four Feet seam is present at 120 feet (37m) depth at the pit, whose pithead is at 95 feet OD (29m OD). Therefore, the elevation of the seam at this position would be around 8mAOD.

A Conceptual Geological Section has been prepared using this data and as presented in Figure 5. From this, we estimate that the seam (and associated workings) could be present at depths of around 30m below the existing property and 30m to 35m below the proposed extensions.

3.0 IDENTIFICATION AND ASSESSMENT OF SITE SPECIFIC COAL MINING RISKS

3.1 Ground Model

The ground model for the site is likely to comprise a cover of Made Ground (generally reworked natural soils) or Topsoil over predominantly fine-grained fluvio-glacial deposits. Coal Measures bedrock is likely to be present at shallow depths beneath the development area.

Based on the information presented on the geological map and refinement utilising previous site investigation information, the following coal seams are potentially present beneath the site:

- Thin unnamed coal seam (0.2m – 0.7m in thickness) present at around 7m to 13m depth;
- Swansea Four Feet (1.2 – 2.5m in thickness), present at around 22m to 31m depth, with the greater depths recorded adjacent to Caerwern House.

3.2 Identified Coal Mining Risks

The potential coal mining risks identified at the site are summarised in Table 2 below:

Table 2: Identified Coal Mining Risks

Coal Mining Issue	Hazard	Risk Assessment
Underground Coal Mining (recorded at shallow depth ¹)	Yes	See Section 3.2.
Underground Coal Mining (unrecorded shallow ¹)	Yes	See Section 3.2.
Mine entries (shafts and adits)	No (Outside site boundary)	See Section 3.3.
Recorded Coal Mining Geology (fissures)	No	None identified.
Recorded Past Mine Gas Emissions or Potential	No	None identified.
Recorded Surface Coal Mining Hazard	No	None identified.
Recorded Surface Mining (opencast workings)	No	None identified.
Notes:		
1. The Coal Authority defines shallow depth as within 30m of the ground surface.		

3.3 Abandoned Shallow Workings

As discussed in Section 2.6, the Coal Authority (CA) confirms that there are recorded mine workings within four seams of coal beneath the site, from shallow (defined by the CA as less than 30m) to 280m depth. Dependant on the type and quality of overlying bedrock, any abandoned mine workings within 30m of the site surface could pose a subsidence risk to the development due to the potential for void migration.

Based on the information available from the Coal Authority, the Conceptual Ground Model and previous investigation works, it is likely that backfilled workings and/or void spaces associated with the Swansea Four Feet are likely to be present of depths of around 30m in the location of the existing Caerwern House and its ground in the north portion of the site. There is a potential for the workings to be shallower below the south (currently undeveloped portion) and below the site access road.

The shallower 'unnamed' coal seam has been encountered in a borehole adjacent to the existing property at a depth of 13m (0.7m thickness).

In South Wales, a common rule of thumb successfully used to assess subsidence risks above abandoned coal workings considers that the risk is low where the thickness of bedrock cover above workings is ten times (or more) the height of the workings.

Previous exploratory works adjacent to the Caerwern House (DH7) indicate that this rock cover is likely to be present in the proposed development areas.

Whilst the risk is considered to be low to moderate for the existing building, this will need to be confirmed through a series of intrusive works to prove the depth to the Swansea Four Foot.

3.4 Mine Entries

Utilising the corrected site boundary (See Figure 2) it is shown that no mine entries are present within or within 20m of the site boundary.

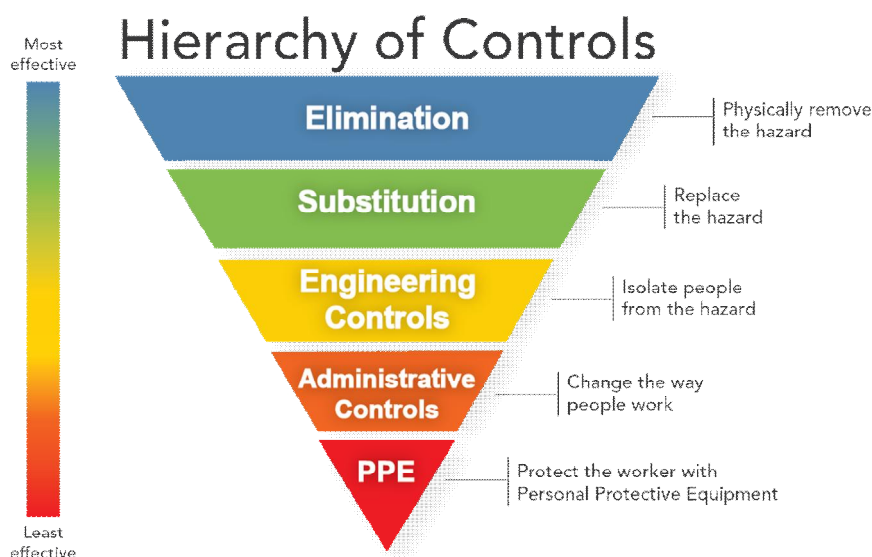
Notwithstanding the above, it should be appreciated that in any area of past mining activity the possibility of the existence of unrecorded mine entries cannot be discounted. During site clearance operations and all excavation, a careful watch should be maintained for any isolated pockets of loose fill, brickwork or other anomalous features which may be indicative of past mining operations. Any such features should be subject to further investigation.

4.0 PROPOSED MITIGATION STRATEGY

4.1 Requirement for Risk Mitigation

It is understood that the site development is to comprise the extension of the existing Caerwern Nursing Home with a two storey extension to the rear of the main building and the construction of a new detached two storey structure in the north portion, adjacent to the existing building.

Given the available information, we consider that there is a low risk posed by shallow coal workings in the north portion (<30m depth) and this is likely to be proved by a limited proof drilling exercise. The risk of subsidence above abandoned mine workings within the south (currently undeveloped) portion of the site and below the access road is likely to be high. No new structures are proposed in this area. Various options have been considered in relation to a Hierarchy of Controls for risk management, as outlined below (from HSE, 1999):



Risks should be reduced to the lowest reasonably practicable level by taking preventative measures, ***in order of priority***. Simply bypassing more effective methods to implement the easiest control measure is not preferable.

We consider that the risks presented by the historical mining issues at the site can be managed, provided a clear and methodical strategy is generated and followed. In broad terms, the risk management strategy is defined in the following sections. All of the below risk mitigation options would require an open site, with any constraints (e.g. trees, dense vegetation) removed prior to implementation.

From experience, this project requires consideration of legacy coal mining issues commonly encountered on sites across the coalfields of the UK. Provided that suitable investigation, assessment and mitigation measures are put in place, we conclude that there are suitable remedial methods and design opportunities for safe development of this project, as discussed in the following sections.

4.2 Risk Management: Shallow Mine Workings

As discussed in previous sections, a historic mine shaft is recorded to the south east of the site boundary. In addition, we consider that the south portion of the site could be underlain by abandoned mine workings at a depth which could have an impact, however, we understand that all development will be undertaken to the north of the existing Caerwern House care home. In the south portion, we consider the risk posed by shallow workings to be **moderate**. In the north portion, where development is proposed, we consider that the subsidence risk from shallow workings to be **low to Moderate**, with the depths to the unnamed coal and Swansea Four Foot, generally recorded to increase northward away from the seam outcrop (~110m south of the existing Caerwern House).

Next Step:

In order to confirm the anticipated low posed to development in the north portion, it is likely that a limited drilling investigation undertaken at the proposed extension and new build locations will be sufficient to discount the presence of shallow workings. Following the drilling investigation, the following outcomes are likely to be identified.

Outcome 1:

Once the intrusive investigation has provided better definition of the subsidence risk zones, it may be possible to confirm the low risk anticipated and progress the development with no further consideration of extraordinary ground conditions in the north portion.

- Hierarchy of Control Classification: **Elimination** (hazard is removed or eliminated).

Outcome 2:

If workings or anomalous are proven at depths greater than where void migration is unlikely, targeted/zoned ground treatment could be undertaken such as drilling and grouting, and over strengthening of foundations to prevent subsidence:

- Hierarchy of Control Classification: **Substitution/Engineering Controls** (implementation of engineered ground treatment).

Outcome 3:

In the south portion, no development is proposed, however the depth to the Swansea Four Feet is likely to be less. A monitoring and management approach may be suitable to ensure the safety of workers and the public in the grounds to the south and along the access road (note: the site is to be well secured to prevent public access).

- Hierarchy of Control Classification: **Administrative Controls** (identifying and implementing procedures).

The above approach provides an outline mitigation strategy for the site and provided suitable consideration and implementation occurs, the residual risks presented by the mining legacy should be decreased sufficiently to enable the project to continue with the required level of financial and human safety. This will need to be adapted based on the emerging conditions encountered during the exploratory works.

5.0 CONCLUSIONS

Utilising the hierarchy of control outlined in Section 4.0 and based on the assessment undertaken to date, we consider the risk posed to the proposed development in the north is low to moderate.

At this stage, we recommend that further investigation is undertaken to confirm the low risk anticipated, with drilling works to confirm the status (solid coal/voided/backfilled workings etc.) of the unnamed coal seam (5m to 13m) and the Swansea Four Feet (~30m). This should be undertaken in the north portion and in the area of proposed extension and new build.

Coal seams in the UK are owned by The Coal Authority and their permission is required before the exploratory work can be undertaken. A formal investigation strategy, remediation approach and design should be prepared in accordance with CIRIA SP32 (Healy and Head, 1984).

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 all 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 investigation.

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