Prepared For:

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1.0 INTRODUCTION

1.1 General

It is proposed to construct a farmhouse on land at Upper Jai Farm, Slamannan. The Client, Naomi Honhold has instructed Geovia Ltd to prepare a Coal Mining Risk Assessment (CMRA). The desk-based study is required to inform on potential coal mining legacy risks relating to ground stability in respect to the construction of the new house.

Plans showing the site locality and the site layout are included as Figures 1 and 2 respectively. A proposed development plan is presented as Figure 3.

1.2 Aims and purpose of the report

The site lies within a coal mining area and the report has been prepared to provide available desk-based information on past/ present mining related activity on or within influencing distance of the site. The purpose of the assessment is to demonstrate to the Local Planning Authority and the relevant statutory consultees that any potential coal mining related risks have been considered, and where relevant, can be appropriately managed.

The findings of the study will be used to provide an assessment of risk in respect to the potential presence of coal mining constraints, and where appropriate, provides recommendations for a mitigation strategy to minimise the risks of mining related ground instability impacting on the proposed development. Where required, recommendations may be made to carry out physical ground investigation works (borehole drilling) to prove the nature of the shallow bedrock and presence or otherwise of shallow mine workings or other mining features. Dependant on the findings, measures such as mine stabilisation/ shaft treatment works could be required.

In preparing the report, the assessment has included review of information obtained from the following sources:-

- Site specific Coal Authority mining report and related information.
- Published geological maps, records, and memoirs.
- Mine Abandonment Plans, where available.
- Online historic maps, where available.
- Published borehole records at the British Geological Survey (BGS), where available.

It should be noted that this report does not incorporate geotechnical or geo-environmental assessment of the site with respect to the proposed development. If these assessments are required, then advice can be sought from Geovia Ltd.

1.3 Notes on Limitations

Notes on Limitations are included as Appendix A.

2.0 SITE DETAILS AND HISTORY

2.1 Site details

Details of the site are summarised in Table 1. It should be noted that a site walkover was not undertaken.

Table 1: Site details

Site address:	Upper Jai Farm, Slamannan, Falkirk, FK1 3AR
National Grid Reference (NGR):	NS 85793 74101 (E: 285793, N: 674101)
Size:	Approximately 1.3 acres
Site description:	The site is understood to comprise arable farmland. A small road lies adjacent to the site's northern boundary, with remaining boundaries backing onto further farmland. Ground level is reported to lie at approximately 160m above Ordnance Datum (AOD).
Description of the surrounding area:	The site lies within an area of arable farmland. Farm buildings associated with Dyke Farm lie approximately 130m to the west. The village of Slamannan is situated approximately 1km to the south.

2.2 Historical Summary

Historical maps available on-line from the National Map Library of Scotland (http://maps.nls.uk), have been reviewed to determine the historical land uses on the site in respect to former mining activity. Other archival information is included where appropriate. Historical mapping extracts are included in Appendix B.

The earliest available map extracts, dated 1843, records the site to form undeveloped ground of suspected agricultural use, with a small road adjacent to its northern boundary. The site has remained unchanged up to present day.

On the 1843 plan, the surrounds include several coal pits and coke kilns north of the site connected by rail lines, the nearest situated approximately 310m to the north-east. By 1888, Jawcraig Colliery (No.16 Pit) is shown approximately 1km to the north-west with several shafts situated within the wider surrounds. By 1937, the collieries and pits are no longer recorded, and no further coal mining activity is shown within the surrounds.

Additional Information

Review of the Royal Commission on Ancient Monuments of Scotland (Canmore mapping) did not highlight any further information or records of historical interest on the site.

3.0 GEOLOGICAL SETTING

3.1 General

The geological setting and ground conditions for the site has been determined by review of published geological mapping and published data.

Plans/ information reviewed include:

- BGS Geological Mapping Sheet 31E (Falkirk); 1:50,000 scale Solid Edition, dated 1997.
- BGS Geological Mapping Sheet 31E (Falkirk); 1:50,000 scale, Solid and Drift Map, dated 1997.
- BGS Mapping NS87SE, (Falkirk); 1:10,000 scale
- XXXV.NW; Geology Six-Inch, dated 1937.
- Open Geoscience – Solid and drift geology, obtained from the BGS website.
- BGS historic borehole records where available.

3.2 Made ground

No made ground is recorded on the site. However, there are recorded areas of disturbed ground from north to west, approximately 200m to 400m from the study area. These areas are suspected to be associated with areas of subsidence, made ground and excavation.

3.3 Natural superficial geology

The site is recorded to be underlain by Till deposits that is reported to typically comprise a compact sandy gravelly clay with cobbles and boulders. An area of peat deposits is noted approximately 165m to north of the site. There are no boreholes on the site or in the immediate vicinity to indicate the thickness of the superficial soils. Boreholes in the wider surrounds, 370m south-east, 880m north and 1.4km east, indicate thicknesses of 4.5m (SE borehole), 8.5m (N borehole) and 2.1m (E borehole).

3.4 Solid geology

Published geological maps indicate the underlying bedrock to belong to the Lower Coal Measures of Carboniferous age. This unit comprises cyclic sequences of sandstone, mudstone, siltstone, ironstone, and seat earth with numerous coal seams. Regional dip of the bedrock is shown as approximately 2 degrees to the north.

A fault trending north-east to south-west and down throwing strata to the south-west is shown just south-east of the site.

According to the 1:10,000 mapping, the Coxrod or Lower Drumgray coal is shown to outcrop just beyond the north-eastern corner of the site, broadly orientated north-west to south-east. The Splint or Upper Drumgray coal seam is recorded on mapping to outcrop approximately 600m north of the site (dipping away) and therefore this seam is not expected to pass beneath the study area.

A further coal seam is shown to outcrop approximately 1.8km south-east of the site, the Mill or Auchengane coal, given the local dip direction it is expected to pass beneath the site. Whilst not shown on mapping, the Lower Coxrod or Shotts Gas Coal, is expected to lie in succession between the Coxrod and Mill coal (see table 4 for further seam positions).

The nearest published BGS borehole to the site, is situated approximately 370m to the south-east and sunk to a total depth of 21.2m bgl. Depth to bedrock is recorded at 4.5m and records a succession of sandstone, fireclay, *blaes* (Scottish mining term of shale/ mudstone) and a seam of coal. The coal is recorded at a depth of 20.5m bgl and is recorded as the Mill or Auchengane Coal, with no evidence of workings recorded in the borehole log.

The following table summarises the geological succession in the area.

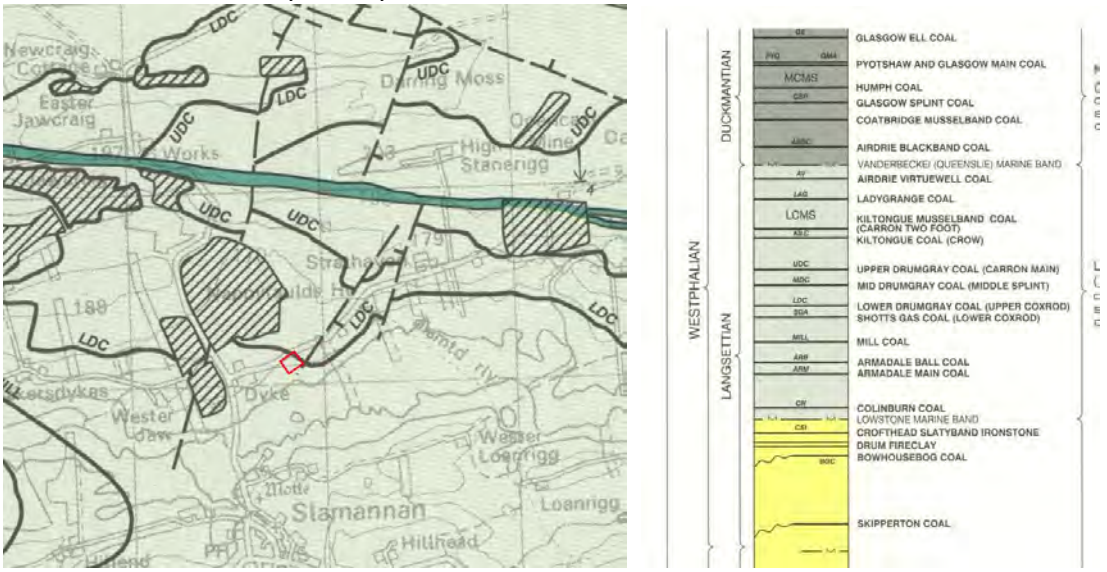
Table 4: Geological succession

Seam	Recorded Thickness (m)	Approximate Vertical Separation (m)
Splint or Upper Drumgray	0.46-0.61	
Strata		23.8
Coxrod or Lower Drumgray	0.38-0.81	
Strata		9.1
Lower Coxrod or Shotts Gas	0.0-0.94	
Strata		20.1
Mill or Auchengane	0.30	

Note: Seam thicknesses approximate and taken from the 1:10,000 mapping and BGS memoir.

An extract from the British Geological Survey 1:50,000 mapping is shown below.

Extract of BGS Sheet 31E, Falkirk, 1997.



Red line: Approximate site boundary

4.0 MINING INFORMATION

4.1 Coal Authority report and other information for Coal Mining

The Coal Authority interactive map viewer records the study area to lie within the defined Development High Risk Zone. The following presents an extract from the viewer.

Coal Authority Interactive Viewer Extract

Red line boundary – Approximate site location.
Hatch – Probable Working
Brown Line – Coal Outcrop
Cross – Mine Entry

A site specific mining report was procured for the site. The main points are summarised below and a copy of the report is included in Appendix D.

- No underground mining is recorded beneath the site.
- However, the Coal Authority believes there is coal at or close to the surface that may have been worked at some time in the past.
- The property is not within a surface area that could be affected by present underground mining.
- The property is not in an area where the Coal Authority has received an application for, and is currently considering whether to grant a license to remove or work coal by underground methods.
- No notice of the risk of the land being affected by subsidence has been given under section 46 of the Coal Mining Subsidence Act 1991.
- The Coal Authority does not record the presence of any mine entries within 20m of the site boundary.

- The Coal Authority does not record any faults, break lines or fissures within the site.
- The property is not within the boundary of an opencast site. Nor does it lie within 200m of the boundary of an opencast site.
- The Coal Authority has not received a damage or claim for the subject property, or any property within 50 metres, since 31st October 1994.
- The Coal Authority has no record of mine gas investigations.

4.2 BGS Memoirs

BGS memoir *The economic geology of the Central Coalfield of Scotland; description of area 2 including the districts of Denny and Plean, Banknock, Carron and Grangemouth, Cumbernauld, Castle Cary and Bonnybridge, Falkirk and Slamannan (with contributions by CT Clough). 1917* has been reviewed. Notes of interest are as follows:

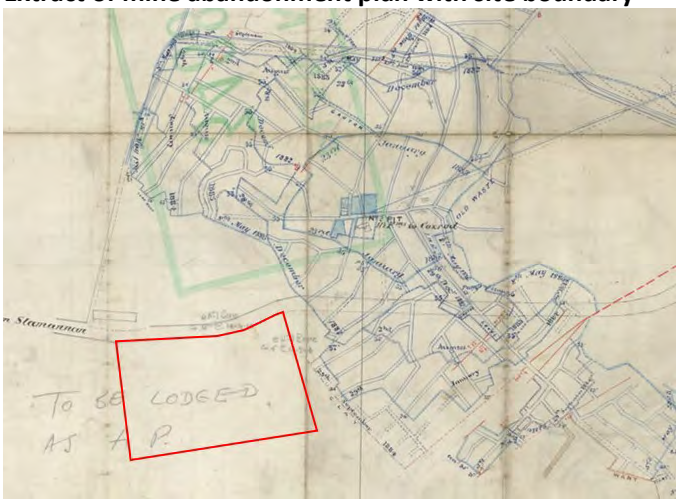
- The Coxrod or Lower Drumgray Coal was a smithy or household coal but has been largely wrought out within the district.
- The Splint or Upper Drumgray Coal has been almost entirely exhausted.
- Balmoral Coal of Slamannan or Lower Coxrod is not supposed to be of very good quality and only wrought to a small extent.

4.3 Mine Abandonment Plan

A mine abandonment plan has been procured for the site by the client and is included in Appendix E. The mine plan is referenced S4764 999999 1OF2 and shows the extent of former workings in the Coxrod (Lower Drumgray Coal).

The extract below shows that the recorded workings within the Coxrod Coal are not expected to extend beneath the site as a result of a clay roof just off site to the north-east. The note of the clay roof indicates that the sub-crop position of the coal was reached at this point.

Extract of mine abandonment plan with site boundary



Red Line: Approximate site boundary

5.0 RISK ASSESSMENT

Based on the findings and observations gathered in the foregoing desk study sections, the following table provides an assessment of potential risks associated with coal mining legacy in respect to the proposed development on the site.

Table 6: Coal Mining Risk Assessment

Coal Mining Issue	Risk to Development	Risk Assessment
Recorded mining	**LOW**	The Coal Authority report that the property is not within a surface area that is affected by past recorded underground mining. Given this and information gathered from the geological plans and coal mining data, a low risk is considered with respect to potential impacts to the development from recorded mining. Mine abandonment plans record workings within the Coxrod Coal just north-east of the site, and the workings appear to cease at crop and therefore do not extend beneath the study area.
Potential for shallow (unrecorded) mining – See note 1	**LOW to MEDIUM**	The Coal Authority identifies the potential for unrecorded shallow workings to be present below the site. Youngest in succession is the Splint or Upper Drumgray Coal which is recorded to outcrop north of the site and also dipping away, so is not expected to pass beneath the study area. However, the Lower Coxrod (Shotts Gas Coal) lies in succession below the Coxrod and therefore can be expected to pass beneath the study area, potentially cropping at the western boundary or a short distance beyond meaning it would be present at a relatively shallow depth below the site. The geological memoirs suggest this seam has not been extensively mined in the district so the presence of unrecorded mining may be unlikely but cannot be fully discounted. The Mill Coal is next in succession and expected to sub-crop approximately 29m depth bgl, with a reported thickness of 0.30m. Based on this, it would be expected that there would be enough rock cover above this horizon to mitigate against any surface stability, in the event that it has been formerly worked below the site. Furthermore, a published borehole south-east of the site records no workings within the seam.
Coal mining geology	**LOW**	The Coal Authority report states that they are not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining.
Potential for mine gas emissions	**LOW to MEDIUM**	The Coal Authority report indicates that there has been no record of mine gas emissions on the site as such a low risk is considered in this regard. However, the presence of shallow mining adjacent to the site does highlight a potential source of mine gas. A low to medium risk is considered.
Presence of mine	**LOW**	The Coal Authority and review of historical mapping has

entries		not identified the presence of mine entries beneath the site. The Coal Authority does not record the presence of any mine entries within 20m of the site boundary.
OVERALL RISK		**LOW**

Note 1: Underground coal mining has taken place in the UK since as early as the 12th century. However, it was only made statutory in the UK to produce and submit mine plans to the Secretary of State when the Coal Mines Regulation Act of 1872 was enacted. Prior to that, plans of underground workings were either not made or were of poor-quality meaning that much shallow mining has gone unrecorded. Small mining operations were also unlikely to be documented in other sources of information such as historical mapping or geological memoirs.

Note 2: The collapse of pillar and stall (stoop and Room) working can occur through pillar crushing and roof collapse. The mechanism for this can be unpredictable and can occur suddenly. Roof collapse can be the most common form of collapse and is the primary closure mechanism applicable to shallow mine workings. The competency of the overlying roof strata and its discontinuities affect both roof behaviour and the form of collapse. However, strata overlying stoop and room workings may continue to collapse for many years after mining ceases and the roof can continue to fail until bulking of the collapsed material fills the voids or a horizon is reached that has enough tensile strength to bridge the void.

Where longwall methods are employed large areas of the mine remain unsupported after extraction has taken place, meaning that collapse can take place a short while after mining operations cease. This means that voids close up thus reducing the risks/ effects of belated subsidence. However, in this form of mining there are also areas of loosely packed wastes and also supported access roadways that can remain open.

When assessing the potential for shallow workings to present a surface stability risk, a common procedure is to consider the amount of rock cover above a worked seam relative to the extraction thickness or height of that seam. In this regard, a design criteria of 10T is commonly applied as a suitable cover ratio for normal development, where T is the extraction thickness of the seam in the locality.

Using the adopted design criteria, this means that for every one metre of seam extraction, there should be 10m of rock cover above to provide an acceptable factor of safety against potential surface instability which may result from the sudden collapse of a mine workings and upward migration of a mining void creating subsidence or the formation of crown holes at the surface.

Where seam extraction thickness information is not available from mine abandonment plans, the ground investigation and geological information is used.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the information gathered during the desk study, the following conclusions are drawn from the Coal Mining Risk Assessment:

- The site is located within the defined Development High Risk Area according to the Coal Authority.
- The underlying bedrock is reported to belong to the Lower Coal Measures of Carboniferous age, comprising cyclic sequences of sandstone, mudstone, siltstone, ironstone, and seat earth with numerous coal seams.
- Two coal seams are anticipated to be present below the site, this includes the Lower Coxrod and Mill seams. The Coxrod and Smithy Coal are expected to sub-crop north of the site and therefore not expected to pass beneath the study area.
- The Coal Authority state there are no records of workings beneath the study area, however, possible shallow unrecorded workings may be present.
- The mine abandonment plan appears to prove the workings within the Coxrod coal did not extend beneath the site as a result of a clay roof north-east of the site.
- Although the presence of unrecorded mine workings within the Lower Coxrod Coal is considered unlikely, without any specific ground information, it cannot be fully discounted at this stage.
- The Mill coal would be expected to be at a depth below the site such that the effects of a belated collapse of any unrecorded workings in this seam would not affect surface stability associated with the proposed development.
- The Coal Authority and review of historical mapping has not identified the presence of mine entries beneath the site. The Coal Authority does not record the presence of any mine entries within 20m of the site boundary.

6.2 Recommendations

Based on the findings of the coal mining risk assessment it would be considered prudent to undertake some limited borehole drilling below the proposed building footprint to check the depth to bedrock and the depth and condition of the Shotts Gas Coal seam.

Information gathered from the borehole drilling will be used to fully establish shallow mining risks and whether or not mitigation measures are required. This work can be combined with any geo-environmental investigation requirements for the new farmhouse. Given the presence of the adjacent mine workings it is recommended that gas monitoring and gas risk assessment be carried out as part of these works.

The presence of mine entries below/ within influence of the proposed development is not recorded by The Coal Authority. However, the risk of unrecorded entries being present within the site or within influence cannot be fully discounted in former mining areas such as this. It is recommended that vigilance is maintained during all phases of the construction and if any suspicious ground is exposed that that may indicate a mine entry, then it should be thoroughly investigated.

FIGURES

FIGURE 1

SITE LOCALITY PLAN