

## 9 GROUND CONDITIONS

### Introduction

- 9.1 This chapter assesses the potential impact of the Proposed Development on ground conditions, in relation to potential land instability, particularly associated with former coal mining activities at the Site.

### Assessment Methodology

- 9.2 This chapter presents the following:
- Relevant planning legislation, policy and guidance pertaining land instability;
  - Information sources;
  - Details of consultation;
  - Methodology behind the assessment of effects, including the criteria for the determination of sensitivity of receptor and magnitude of change from the existing baseline environment;
  - Explanation as to how the conclusions on potential effects have been reached; and
  - Significance criteria and terminology for the assessment land instability residual effects.

### Planning Policy Context

#### National Planning Policy

##### Planning Policy Wales (Edition 11, 2021)

###### *Physical Ground Conditions and Land Instability*

- 9.3 Paragraphs 6.9.23 (part), 6.9.24, 6.9.25, 6.9.26 and 6.9.27 (part) of PPW states: *'When considering development proposals planning authorities should take into account the nature, scale and extent of ground instability which may pose direct risks to life and health, buildings and structures, or present indirect hazards associated with ground movement, including mine entry collapse, which provide potential pathways for the migration to the surface of landfill or mine gases.'*
- 9.4 *Made Ground, the presence of tips and shallow coal workings are extensive in some parts of Wales and their proximity to the surface could present potential instability risk to future development. Information on shallow working has been published by the Coal Authority, alongside data on mine entries, adits and surface hazards.*
- 9.5 *Planning decisions will need to take into account:*
- *the potential hazard that instability could create to the development itself, to its occupants and to the local environment; and*
  - *the results of a specialist investigation and assessment by the developer to determine the stability of the ground and to identify any remedial measures required to deal with any instability.*
- 9.6 *Any planning application in coal mining consultation areas may need to be accompanied by a coal mining risk assessment report, or equivalent. Any works which may intersect coal mine workings, mine entries or coal seams may have implications for mine gas, spontaneous combustion and surface collapse and liaison with the Coal Authority must take place.*
- 9.7 *Where acceptable measures can overcome instability, planning permission may be granted subject to conditions specifying the necessary measures.'*

## Local Planning Policy

### Rhondda Cynon Taf Local Development Plan up to 2021 (adopted March 2011)

- 9.8 Paragraph 4.84 of the LDP states “*It is important that new development delivered through the LDP recognises the issues raised by former mining uses and how these issues can be positively addressed. Land stability and mining legacy are not necessarily constraints to redevelopment.*”

## Relevant Guidance

- Appendix A (Causes of Instability) and Appendix B (Sources of Information) of Planning Policy Guidance (PPG) 14, ‘Development on Unstable Land’, 1990;
- British Standard (BS) 5930: 2015+A1:2020, Code of Practice for Ground Investigations;
- Coal Authority, Policy For Building Over Or Within The Influencing Distance Of A Mine Entry, January 2012.
- Coal Authority, Guidance on managing the risk of hazardous gases when drilling or piling near coal, June 2019.
- Coal Authority, Risk based approach to development management – Guidance for developers, version 4 – 2017.
- CL:AIRE, Good Practice for Risk Assessment for Coal Mine Gas Emissions, October 2021.
- CIRIA, C758D, Abandoned mine workings manual, 2019.

## Study Area

- 9.9 The study area includes the site and a buffer of up to 50m surrounding the site. This is considered to be sufficient, based on professional judgement, to enable the identification of relevant coal mining related hazards and their zones of influence.

## Baseline Methodology

- 9.10 The description of baseline conditions is informed by desk-based information. A Coal Mining Risk Assessment and Mineral Assessment (CMRA&MA) is provided as **Appendix 9.1** and should be consulted for a detailed description of baseline conditions
- 9.11 The CMRA&MA utilises information from publicly available records and data provided by the Coal Authority. This includes the following:
- British Geological Survey (BGS) – geology maps (Sheet 249 scale 1:50,000, Sheets ST18NW and ST08NE scale 1:10,000) and borehole records.
  - Coal Authority – Non-Residential Mining Report, Non-Residential Coal Mining Consultants Report; and Mine Entry Plan and Data Sheets.
- 9.12 A targeted site walkover inspection was also undertaken on 10<sup>th</sup> November 2021.

## Consultation

- 9.13 A summary of all consultation with stakeholders or consultees is provided in the table below.

**Table 9.1: Consultation Responses Relevant to this Chapter**

Date	Consultee and Issues Raised	How/ Where Addressed
06/05/2022	PEDW. Appendix 5 of the Scoping Report includes a detailed Coal Mining Risk Assessment and indicates that two adits and shafts are close to or	This chapter.

Date	Consultee and Issues Raised	How/ Where Addressed
	within the proposed cable route, and one within close proximity to the northern and south-western boundary. The information provided within the Scoping Report indicates that there are potential hazards and sections of the site that must be avoided. Coal Mining Risk to be scoped into the ES.	

## Assessment Criteria and Assignment of Significance

9.14 The following section describes the approach taken to identifying the magnitude of an impact and the sensitivity/value of the receptor. The definitions used for sensitivity and magnitude are presented in **Table 9.2** and **Table 9.3** below and are based on professional judgement.

### Receptor Sensitivity/Value

**Table 9.2: Definitions of Sensitivity or Value**

Sensitivity	Built Environment	Human Health
Very High	Residential, commercial, education and employment development, motorways and A roads, mainline railway line, power transmission lines (grid), gas/oil pipelines	High density development, places where children may be present. Construction workers
High	Dual carriageway, B roads, branch line railway, power distribution lines (local)	Moderate density development.
Medium	Local services and C roads only.	Low density development. Public Open Space.
Low	Non-permanent structures.	Limited access.
Negligible	None.	Unoccupied land.

### Magnitude of Impact

**Table 9.3: Definitions of Magnitude**

Impact	Typical Descriptors
High	Large scale land instability across a wide area (Adverse).
	Extensive remediation (Beneficial).
Medium	Moderate scale land instability within a wide or localised area (Adverse).
	Benefit to key features e.g. location and treatment of mine shafts, adits or mine workings (Beneficial).
Low	Small scale localised land instability (Adverse).
	Minor benefit to, one (maybe more) key features or a reduced risk of negative impact occurring (Beneficial).
Negligible	Very limited land instability (Adverse).
	Very minor benefit to of one or more features (Beneficial).
No change	No mining instability.

## Significance of Effects

9.15 The assessment of significance is based on the following matrix.

**Table 9.4: Assessment Matrix**

Sensitivity	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
Very high	No change	Minor	Moderate or Major	Major or Substantial	Substantial

9.16 The broad definitions of the terms used should align with the following:

- **Substantial:** Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
- **Major:** These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
- **Moderate:** These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
- **Minor:** These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
- **Negligible:** No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

## Limitations of the Assessment

9.17 The baseline data set out in this assessment are based on information collated and assessed as part of the CMRA&MA (see **Appendix 9.1**). Assumptions and limitations relevant to this assessment are as follows.

- This chapter is based on available factual and interpretative data for the site obtained from the sources described in the text and related to the site.
- The accuracy of maps cannot be guaranteed and it should be recognised that different conditions on the site may have existed between, and subsequent to, the various map surveys.
- Any borehole data from British Geological Survey sources is included on the basis that: "*The British Geological Survey accept no responsibility for omissions or misinterpretation of the data from their Data Bank as this may be old or obtained from non-BGS sources and may not represent current interpretation*".

- Where any data supplied by other sources, it has been assumed that the information is correct. No responsibility can be accepted by RPS for inaccuracies in the data supplied by any other party.

9.18 Notwithstanding the above, a moderate to high level of certainty has been applied to the baseline and assessment presented in this chapter. The information which was available is considered sufficient to establish a baseline for the purposes of the EIA. Therefore, there are no data limitations that affect the robustness of the conclusions of this assessment.

## Baseline Environment

9.19 Baseline conditions of the site are detailed within the CMRA&MA presented in **Appendix 9.1** and a summary provided in the following sections.

### Published Geology

9.20 The geological sequence at the site comprises extensive superficial cover of glacial Boulder Clay, with sporadic areas of Glaciofluvial Deposits and Alluvium, and the Upper Coal Measures comprising the Grovesend Formation across the majority of the site with the Hughes Member to the north. Dip arrows indicate beds dip 26° to the southeast and 30° to the south in the southern central area of the site. Nearby available borehole logs for the area indicate the superficial deposits in the local area are likely to be < 5m thick. The bedrock Coal Measures are expected to be over 450m thick.

9.21 Geological mapping indicates the shallow coal seams Llantwit No 1 (Big Rider), Llantwit No 2 (Small Rider) trend approximately north-east to south-west through the site, and there are several other conjectural seam outcrops. Similarly, the Llantwit No 3 (Mynyddislwyn Lower Leaf) is indicated to outcrop in the north-western part of the site. To the east of the site the seam is recorded to be dipping 15.6 ° to the south-east.

### Coal Mining Records

9.22 Numerous coal seams present below the site within the Coal Measures are indicated to have been worked from underground mines in the past. The greatest mining activity is indicated beneath the northern half of the site where the Llantwit No 3 seam is indicated to have been mined between 5m and 90m depth. There is no record of the shallower coal seams identified to sub-crop within the site having been worked.

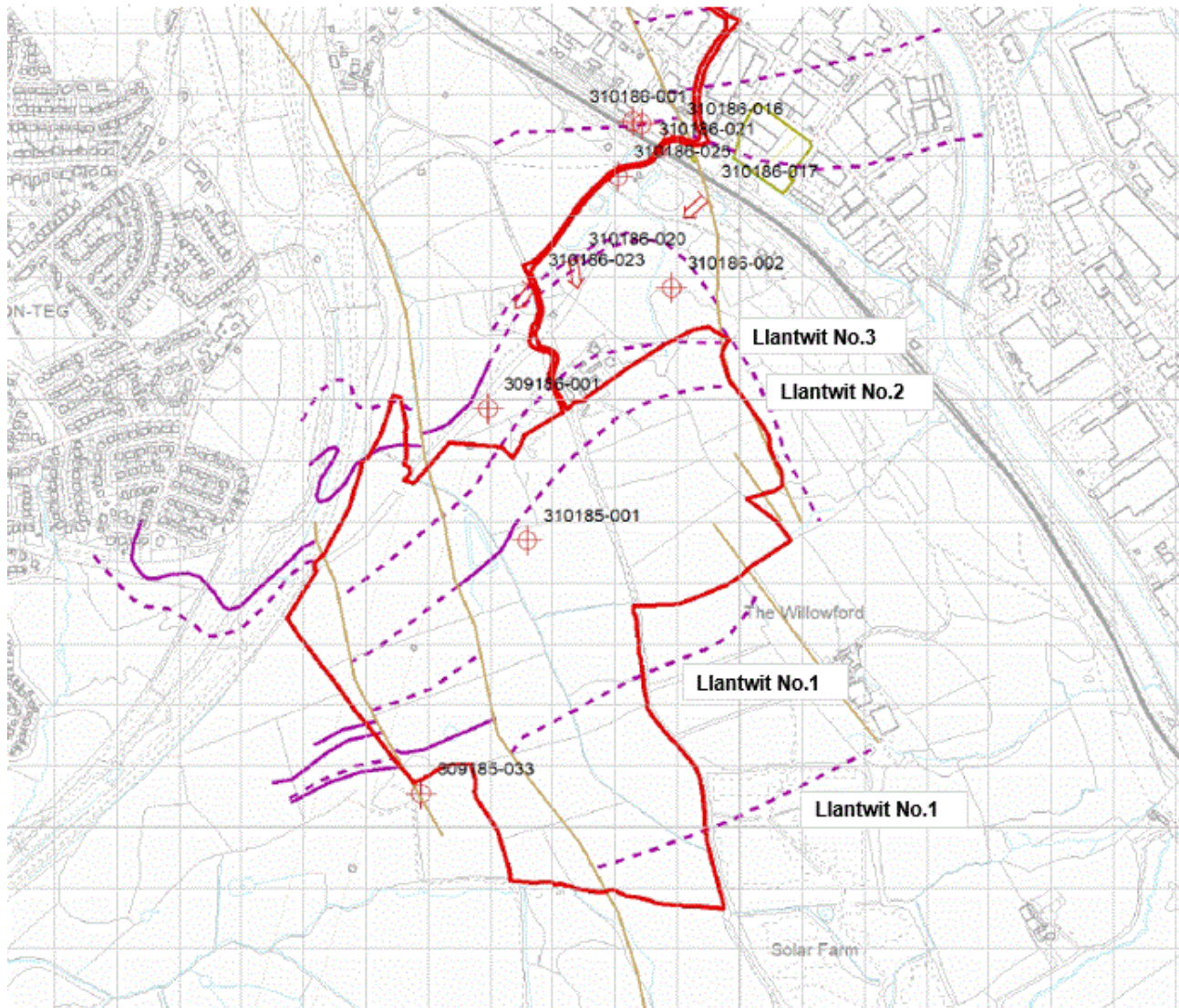
9.23 Adits are indicated to extend toward the south and south-west to the north of the main site and at the base of the valley. There are no records to indicate whether they have been subject to either treatment or capping.

9.24 One shaft (Coal Authority Ref 310185-001) is located in a central location on site (excavations by Wimpeys in 1985 to locate this were not successful). Another two shafts are indicated to be within 50-75m of the northern boundary of the site or immediately adjacent to the south-west boundary. There are no records as to whether these shafts have been capped or treated.

9.25 **Figure 9.1** shows the summarised Coal Authority records for the site.



**Figure 9.1: Annotated Coal Mining Record Schematic**



**BGS Ground Stability Hazard Ratings**

9.26 British Geological Survey Ground Stability Hazard ratings for the site are summarised as follows:

**Table 9.5: BGS Ground Stability Hazard Ratings**

Ground Stability Hazard	BGS Risk rating (highest pertaining to Site)
<b>Collapsible ground</b>	Very Low
<b>Compressible ground</b>	Moderate
<b>Ground dissolution</b>	No Hazard
<b>Landslide</b>	Low
<b>Running sand</b>	Low
<b>Shrinking or swelling clay</b>	Very Low

## Preliminary Geotechnical Risk Register

9.27 **Table 9.6** summarises the potential geotechnical hazards associated with the proposed development based on freely available published information. Preliminary information relating to the hazard and associated engineering considerations are provided.

9.28 The potential risks are given one of the following classifications:

- **Low risk** - it is considered unlikely that issues within the category will give rise to significant damage in relation to the proposed development.
- **Moderate risk** - it is possible, but not certain that issues within the category will give rise to significant damage in relation to the proposed development.
- **High risk** - there is a high potential that issues within the category will give rise to significant damage in relation to the proposed development.
- **N/A** - The anticipated ground conditions are not consistent with this hazard.

**Table 9.6: Potential Geotechnical Hazards**

<b>Sudden lateral / vertical changes in ground conditions</b>	M	It is anticipated that there will be a variable thickness of Glacial Till across the site ranging from approximately 1.7m to 5m thick which may be suitable for placement of anchoring systems for the photovoltaic panels, however, the extent and variability of composition of these deposits is unconfirmed from the Desk Study findings therefore intrusive investigation will be required to confirm a suitable depth for any foundations/anchoring systems for the panels and any ancillary structures. This will provide further information on the proportion of cobbles and boulders present within the Glacial Till that may deflect and deform driven piles and this is likely to vary laterally.  There is also potential for shallow bedrock, which may impede the ability to install driven/augered foundations or anchors in some areas of the site. It is likely that the Glacial Till will also provide a suitable bearing stratum for shallow spread foundations supporting lightly loaded structures.
<b>Highly compressible / low bearing capacity soils, (including peat and soft clay)</b>	H	A limited thickness of Made Ground is anticipated although up to 5m thick Glacial Till including cohesive materials are anticipated. The Envirocheck report indicates a moderate hazard of compressible ground across the Site. Sporadic areas of shallow peaty soils have been identified at the Site at a maximum depth in excess of 70cm.
<b>Ground dissolution features / natural cavities</b>	L	Ground conditions beneath the site are not consistent with these conditions.
<b>Shrinking and swelling clays</b>	L	The BGS database indicates that there is very low hazard from shrinking and swelling clays.
<b>Slope stability issues</b>	L	Whilst no significant slopes are present on site, any temporary created as part of the development should be subject to appropriate geotechnical design based on site-specific site investigation information.
<b>High groundwater table (including waterlogged ground)</b>	M	The site is within an area indicated to have limited potential for groundwater flooding of property situated below ground level. BGS borehole records indicate relatively shallow groundwater strikes within the superficial deposits.

		Shallow excavations may be unstable and excavation support as well as groundwater control measures may be required.
<b>Filled and Made Ground (including embankments)</b>	M	BGS borehole records indicate a limited thickness of Made Ground up to 0.2m at the site (where present). There is however evidence of 'soft' mine workings and former mine entries on and close to the Site suggesting the historical mine workings may be present including colliery spoil.
<b>Obstructions (including foundations, services, basements, tunnels and adjacent sub-structures)</b>	L	Relic structures could be encountered within the footprint of former structures, which may require removal to enable the construction of the Proposed Development. It is likely these obstructions, if encountered may be removed using standard construction plant. The presence of unidentified mine entries and shallow mine workings could also provide a constraint to development and identification and treatment required as necessary.
<b>Underground mining</b>	H	A number of mine entries have been identified across the site. Evidence from BGS borehole records indicate areas of 'soft drilling/mine workings' at depth although the Mining Report obtained identifies possible past mining at shallow depth beneath the site. The Coal Authority identify a 20m buffer zone around recorded mine entries for assessing risks of ground stability for collapse or subsidence.
<b>Concrete classification</b>	M	Both the Made Ground and the Glacial Till have the potential for low pH and/or the presence of sulphates that could impact on selection of concrete for any foundations. Site-specific testing will be required to confirm this.

## Future Baseline Conditions

- 9.29 The assessment considers how the future baseline may evolve in the absence of the Proposed Development. The primary sources of future change with respect to the baseline conditions, in the absence of any redevelopment, are changes arising due to climate change.
- 9.30 Generally, there is a potential for climate change to lead to more frequent periods and intensity of rainfall leading to the potential flooding of mine workings or destabilisation of poorly capped/infilled mine entries where timber has been used.
- 9.31 Increased ambient temperatures may result in the warming of soils and groundwater beneath the site, which could have the following impact:
- accelerated breakdown of natural organic matter beneath the site leading to increased rates of carbon dioxide and methane generation.

## Mitigation Measures Adopted as Part of the Project

### Construction

- 9.32 Whilst it is appreciated that for solar arrays the Coal Authority do not require a Coal Mining Risk Assessment to be undertaken on the basis that no significant permanent ground works will be required, exceptions relate to the locations of mine entries and the more heavily loaded or enclosed structures (expected within the Distribution Network Operator (DNO) compound). The site will be subject to a ground investigation, the scope of which will be dependent on the tolerance for maintenance repair of the solar arrays which are generally considered to have very high settlement tolerances. Where the expectation for maintenance/remedial works is high the investigation will be targeted and may include a geophysical survey. The investigation will be undertaken prior to the construction phase to:
- Confirm the location of the mine entries;



- Determine the presence of worked seams to potentially impact upon the DNO compound; and
  - Determine the mine gas risk.
- 9.33 The ground investigation will be undertaken using best practice guidance, minimising ground related risks to human health and/or the built environment.
- 9.34 The findings of the ground investigation and subsequent risk assessment will inform the final design layout of the Proposed Development (construction within high-risk areas e.g. mine shaft location and deep peaty soils will be avoided) and the requirement for, and nature of, any remedial measures. Remedial measures may include capping of shafts, sealing of adits or grouting of shallow mine workings or use of geogrids on access roads. This approach will be agreed with the Coal Authority and Local Authority as appropriate. Any remedial measures will be incorporated within a detailed Construction Environmental Management Plan (CEMP).
- 9.35 During construction of the Proposed Development ground disturbance may lead to land instability and ground collapse. Construction workers may also be exposed to mine gases that may accumulate in confined spaces, and in exceptional circumstances lead to a risk of explosion (e.g. methane or carbon monoxide) or asphyxiation (e.g. carbon dioxide).
- 9.36 Standard construction protocols in accordance with CDM Regulations (2015) will be adopted during construction as outlined below:
- appropriate risk assessments and recognition of confined spaces;
  - use of safe entry procedures;
  - appropriate use of standard personal protective equipment; and
  - appropriate training and briefing of site staff.

## Operation

- 9.37 During operation preferential drainage pathways created by run off from the solar arrays has potential to destabilise poorly capped/infilled mine entries. However, following implementation of any required remedial measures, identified as part of the ground investigation during the construction phase no further mitigation measures are considered necessary during operation.

## Assessment of Construction Effects

### Land Instability

- 9.38 Numerous coal seams are known to be present below the site within the Coal Measures, with many of them having been worked from underground mines in the past at shallow depth. The shallowest of the known worked seams sub-crops in the northern half of the site. A number of mine entries (shafts and adits) have also been identified within or in close proximity to the site.
- 9.39 During the construction process, certain activities would involve breaking ground with potentially new pathways being created e.g. piling into mine workings, which is considered to be applicable to the DNO compound only. Construction personnel may be at increased risk from ground collapse or mine gas emissions.
- 9.40 Given the requirement to undertake specific Health and Safety risk assessments prior to construction works, in accordance with the CDM Regulations 2015, construction workers would be provided with appropriate protective equipment, and any specific control measures would be implemented. With this mitigation in place, the magnitude of the impact is considered to be negligible.

- 9.41 Construction workers are considered to have a very high sensitivity to potential impacts. Considering the magnitude of impact with measures in place (negligible), the significance of effect is considered to be **Minor Adverse**.

### Mine Gases

- 9.42 During the construction phase the migration of mine gas through coal workings or other pathways e.g. faults, permeable strata and service ducts, may impact adjacent site users and buildings/structures either through explosion or in case of the former, inhalation of elevated concentrations of ground gas causing asphyxiation. A detailed assessment of the mine gas risk will be undertaken prior to the construction phase and appropriate mitigation measures implemented. On this basis the impact is considered negligible. Adjacent receptors may be considered very high sensitivity and therefore the significance of effects is considered **Minor Adverse**.

### Further Mitigation

- 9.43 No further mitigation is considered necessary.

### Future Monitoring

- 9.44 Ground gas monitoring will be undertaken during construction activities involving ground disturbance as required, in accordance with CDM Regulations 2015.

### Accidents and/or Disasters

- 9.45 There is a low risk of catastrophic ground collapse during construction, however the mitigation measures identified above will take into consideration this possibility.

## Assessment of Operational Effects

- 9.46 Impacts which may have occurred during the construction phase would have been mitigated through a staged process of ground investigation and assessment with any remedial measures having been implemented prior to operation. In this regard it is considered that the magnitude of impact is considered to be low to medium (beneficial).
- 9.47 It is considered future site users and the Proposed Development would be of low sensitivity and the significance of effect is considered to be **Minor Beneficial**.

### Further Mitigation

- 9.48 No further mitigation is considered necessary.

### Future Monitoring

- 9.49 No future monitoring is likely to be required once the Proposed Development is operational.

### Accidents/Disasters

- 9.50 It is not considered that the Proposed Development will increase risks associated with underground voids and consequently the level of risk associated with catastrophic collapse, where the proposed mitigation measures are implemented.

## Potential Changes to the Assessment as a Result of Climate Change

- 9.51 It is not considered that any future changes in baseline conditions would change any of the assessments for the operational phase.

## Assessment of Cumulative Effects

- 9.52 No cumulative schemes have been identified that are relevant to the assessment in this chapter. As such, an assessment of potential cumulative effects has not been undertaken.

## Inter-relationships

- 9.53 No inter-related effects are considered relevant to this chapter.

## Summary of Effects

- 9.54 It is considered that land instability associated with coal mining activities will be mitigated through appropriate design and remedial works.
- 9.55 A summary of the effects for the construction and operational phases is provided in **Table 6.7**.

**Table 6.7: Summary of Likely Environmental Effects on Ground Conditions**

Receptor	Sensitivity of receptor	Description of impact	Short / medium / long term	Magnitude of impact	Significance of effect	Significant / Not significant	Notes
<b>Construction phase</b>							
Construction workers	Very high	Ground collapse. Mine gas emissions causing explosion/asphyxiation.	Long term	Negligible	Minor adverse	Not significant	
Adjacent site users/built environment	Very high	Mine gas emissions causing explosion/asphyxiation.	Long term	Negligible	Minor adverse	Not significant	
<b>Operational phase</b>							
Future site users	Low	Ground collapse. Mine gas emissions causing explosion/asphyxiation.	Long term	Low or Medium	Minor Beneficial	Not significant	
Built environment	Low	Ground collapse. Mine gas emissions causing explosion.	Long term	Low or Medium	Minor Beneficial	Not significant	