6. GEOLOGY/ SLOPE STABILITY/ SOILS/ GROUND CONTAMINATION

6.1 Introduction

6.1.1 The planning application site area and the surrounding land holdings of Glamorgan Power have been subject to geological reports undertaken by Blandford Consulting, Consulting Geologists and Geotechnical Engineers. Two reports were produced by Blandford Consulting in 2002 – “A Reserves Assessment on Land at Varteg, Abersychan, near Pontypool” (Report No.BC/MB/05.02.02) and “A Supplementary Reserves Assessment on Land at Varteg, Abersychan, near Pontypool” (Report No.BC/MB/050.02.02) both of which are included as Items 12 and 13 respectively in ES Volume 3 A report was also prepared by Sir William Halcrow and Partners in October 1979 (“Report on the Investigation into the Security of Tips 527 and 528”, Item 11).

6.1.2 Ground investigation works were also carried out in 2005 following discussions with the then Environment Agency and Torfaen County Borough Council to clarify the geological and hydrogeological conditions and to identify the presence of any areas of contaminated land associated with previous operations on the site. The results of the ground investigation are included in the report (“Varteg Hill Reclamation and Coal Recovery Scheme, Blaenavon, South Wales, Hydrogeological and Contaminated Land Assessment, Final Interpretative Report”, November 2006). This document was produced by Faber Maunsell Limited (now AECOM) and was submitted as a technical document supporting the original Environmental Statement. The document has been reviewed and updated by AECOM and is submitted as a supporting document which provides an up to date interpretation of the hydrogeological and geological conditions at the site.

6.1.3 The land is on the uppermost slopes of the Mynydd Varteg Fach and slopes towards the east and south-east; ground slopes are generally 1 in 11 but have been extensively altered by mining activities. The parcel of land is at elevations of between 320m and 544m above Ordnance Datum. The area has experienced mining operations for coal and ironstone extending back in time to the nineteenth century and many relics of those mining operations are still evident on the land including many disused mine entries, spoil heaps and railway beds. In the 1950’s and 1960’s a number of opencast projects were undertaken on and in the area around the land by the National Coal Board Opencast Executive. The restored opencast sites are still plainly evident on the surface by way of manmade slopes on which the vegetation in sparse.

6.2 Summary of the Geology
The geology of the site has been reported on elsewhere, specifically in reports by Blandford Consulting on reserves estimation, detailed geology and mining history.
6.2.1 In brief, the geology of the site comprises strata belonging to the Lower and Middle Coal Measures, dipping gently at an average 1 in 8 to the south west, forming the north eastern margin of the South Wales Coalfield. Local folding results in variations in dip between 1 in 4 and 1 in 15.

6.2.2 The measures of the South Wales Coalfield have been affected by large normal faults frequently referred to as “cross faults”. In the Varteg area the faults have a slightly sinuous trace at the surface that have average trends towards the north-west and north-east. The published 1:10,560 scale geological plan for the area shows that a number of faults on these trends are present within the land holding. Small normal faults typify the same trends as the larger cross faults.

6.2.3 The stratigraphy of the site with relevance to the opencast operations incorporates cyclothems extending upward from the Garw seam to the Two Foot Nine seam. The inferred position of the outcrop of the Garw Scene is shown, on the published geological sheet (SO20NE), to pass through the landholding near its eastern margin. The basal seam for excavation is the Lower Meadow Vein (Lower Seven Feet) seam.

6.2.4 Superficial deposits are limited on the site, likely to be dominated by regolith derived from the weathering of Coal Measures strata but also comprising clay-rich head deposits derived from limited remnant glacial till and isolated occurrences of peat.

6.2.5 The mining history of the general area is such that natural soils largely have been removed and made ground comprised of quarry spoil resulting from past mining for both coal and ironstone is present across many areas of the site. In additional, several areas for the site have been subject to opencast mining and the opencast backfill remains on those areas.

6.2.6 Further details of the local geology specific to the site are available in the Reserves Assessment by Blandford Consulting included as Item 12, in ES Volume 3.

6.2.7 Published information indicates that the site is not affected by landslip.

6.2.8 The sequence of coal seams included within the proposed extraction scheme by opencast techniques is (top-down):
- Two Feet Nine (Elled) seam
- Four Feet (Big) seam
- Six Feet (Three-quarter) seam
- Upper Nine Feet (Horn) seam
- Lower Nine Feet (Bottom Rock) seam
- Bute or Bydylog (Dirty) seam
- Yard [including Standard Yard & Amman Rider seams] (Upper Meadow vein) seam
- Upper Seven Feet (Middle Meadow vein) seam
Lower Seven Feet (Lower Meadow vein) seam

6.2.9 The Coal Measures strata in this area are dominated by mudstone facies with subordinate sandstones, siltstones, seathearts and thin coal seams. Sandstones within the Coal Measures comprise both rare thick lenticular channel sandstones and thin, discontinuous interbedded sandstone dominated units.

6.2.10 Two significant sandstone members have been identified in this locality including the Gellideg Rock and the Elled Rock.

6.2.11 The Gellideg Rock, a lenticular, quartzitic channel sandstone between 1.9m and 8.2m in thickness is known from borehole and mining evidence to occur locally between the Gellideg seam and the overlying Lower Meadow Vein seam.

6.2.12 To the north of the site, the Elled Rock comprising hard quartzitic sandstone forms the roof of the Two Feet Nine seam in the Waun Hoskyn OCCSs. However, a cautious interpretation of the stratigraphical sequence from borehole data in the vicinity of the site indicates that the Two Feet Nine seam locally has a mudstone roof and that the Elled Rock is not present at the Varteg site. The nature of the Elled Rock may be an important factor in determining whether old workings remain intact or the degree of bulking up which may occur following collapse and consequently the local permeability of the strata.

6.2.13 The 1:50,000 geological sheet 232 indicates the presence of further sandstone units forming the floor of the Garw seam and within the interseam measures between the Garw seam and the Gellideg seam.

6.2.14 To the east of the site, in the Llwyd valley, the Coal Measures overlie a thin outcrop of Namurian Millstone Grit strata which rest unconformably on the Visean Clydach Valley Group strata, here dominated by the Castell Coch Limestone. This formation comprises an oolitic sandy limestone and crops out in the base of the Afon Llwyd valley.

6.2.15 The regional geology is shown in Table 6.1 below.
### Table 6.1: Regional Geology

<table>
<thead>
<tr>
<th>Formation</th>
<th>Strata</th>
<th>Thickness (m)</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial deposits</td>
<td>Boulder clay, head, peat and solifluction deposits</td>
<td>2-3</td>
<td>Variable – largely absent from former coal extraction areas</td>
</tr>
<tr>
<td>Coal Measures</td>
<td>Upper Coal Measures: Pennant Measures</td>
<td>Up to 265</td>
<td>Principally sandstone with some thin mudstones and a few coal seams</td>
</tr>
<tr>
<td></td>
<td>• Hughes Beds</td>
<td></td>
<td>Mudstone, siltstone, quartzite and conglomerate. Occasional coal seams.</td>
</tr>
<tr>
<td></td>
<td>• Brithdir Beds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rhondda Beds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Llynfi Beds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle Coal Measures</td>
<td>300</td>
<td>Mainly mudstone and siltstone with quartzitic sandstone, ironstone and coal seams a</td>
</tr>
<tr>
<td>Lower Coal Measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millstone Grit</td>
<td></td>
<td>25</td>
<td>Quartzitic sandstone and marine mudstone</td>
</tr>
<tr>
<td>Carboniferous Limestone</td>
<td>Dowlais Limestone</td>
<td>185</td>
<td>Bioclastic limestone with thin shales</td>
</tr>
<tr>
<td></td>
<td>Clydach Valley Group</td>
<td></td>
<td>Dolomitic Limestone</td>
</tr>
<tr>
<td></td>
<td>Cwmyniscoy Mudstone</td>
<td></td>
<td>Grey mudstone with thin limestone</td>
</tr>
<tr>
<td></td>
<td>Castell Goch Limestone</td>
<td></td>
<td>Oolitic sandy limestone</td>
</tr>
<tr>
<td>Old Red Sandstone</td>
<td>Brownstones</td>
<td>140</td>
<td>Reddish-brown sandstone and thin red mudstone units</td>
</tr>
<tr>
<td></td>
<td>Senni Beds</td>
<td>240</td>
<td>Green and buff sandstone with some thick mudstone beds and conglomerates. Purple sandstone at base.</td>
</tr>
</tbody>
</table>

6.2.16 The results of a ground investigation carried out in 2005 proved made ground in most of the trial pits and in all of the boreholes inside the proposed extraction area. The made ground materials comprise principally colliery spoil, an angular to sub-angular clayey sandy gravel of mudstone and coal with brick and occasional metal. The made ground varied in depth.
6.2.17 The findings of the five deep boreholes drilled in the proposed coal extraction area show that the lithology of the sequence to be worked comprised almost entirely of alternating coals and mudstones. A number of sandstone units were proved below the proposed base of the workings. Figures 5.1 and 5.2 of the supporting document, Varteg Hill Reclamation and Coal Recovery Scheme Hydrogeological and Contaminated Land Assessment, October 2014 show geological cross-sections through the proposed coal extraction area based on the findings of the boreholes and an interpretation of the down-hole geophysical survey.

6.3 Summary of the Mining History of the Site.

6.3.1 Recorded old workings are reported from historical mining records in most of the seams of interest to the opencast project including the following:

- Four Feet seam
- Six Feet seam
- Lower Nine Feet seam
- Yard / Standard Yard seam
- Seven (Upper/Lower) Feet seam
- Five Feet / Gellideg seam (not included in extraction scheme)

The workings vary considerably in age with some dating back to the beginning of the 19th Century and forward to the 1930s. AECOM has not inspected the historical mining records and it is not therefore known whether the relevant plans are “lodged returns” or full abandonment plans. As a consequence the full extent of old workings as determined from records cannot be confirmed at this stage.

6.3.2 Evidence exists of unrecorded old workings in the majority of seams incorporated within the site. The evidence is in the form of notes on historical mine plans, where recorded mine workings have intersected older workings. Unrecorded old workings are understood to be present in the following seams in the vicinity of the project:

- Two Feet Nine
- Four Feet
- Six Feet
- Standard Yard
- Seven Feet / Five Feet Gellideg
- Garw seam and ironstone beds (not included in extraction scheme)

6.3.3 Some of the earliest workings open pit, or patchworkings, were along the outcrops of the Bottom Vein and Jack and Ball Ironstone Veins and the outcrop of the combined Two Foot Nine (Elled)/Four Feet (Big)/ Six Feet
(Threequarter) Seam. Early underground workings were developed from adits, or levels, driven at a gently rising gradient in order to achieve gravity drainage of mine water. Records of mine workings dating back to the early 1820’s show the position of some mine entries with no associated underground workings, suggesting that the latter had already been abandoned. The adits were later supplemented or superseded by a number of shafts and air pits. Many of the workings of different horizons were interconnected by cross measure drivages and stable pits as well as by the colliery shafts. Some of the workings from individual mines were also connected to each other.

6.3.4 There are no working collieries that would affect any development on the site or be affected by the proposed scheme.

6.3.5 There have been a series of opencast coal workings within the area, all of them developed by the former National Coal Board Opencast Executive. The sites were all working between 1948 and 1962. The Executive also carried out exploration drilling within the site area as part of a programme of developing other progressive opencast sites. The prospective sites, however, were not taken though the production stage. There is no current opencast coal site operating within influencing distance of the proposed development.

6.3.6 The Reserves Assessment prepared by Blandford Consulting (Item 12) is essentially based on a review of mining records for the district and on published geological information. Glamorgan Power’s Company Ltd subsequently purchased exploration data for the area from Celtic Energy and Blandford Consulting re-assessed the resources and their findings were published in the Supplementary Reserves Assessment (Item 13). The two assessments have been used to assess the amount of coal resources that are available to finance the land reclamation scheme of the site and was reassessed in December 2011 (Item 10) prior to the Planning Inquiry.

6.3.8 Three colliery spoil tips are present on the site including Tip 527, Tip 528a and Tip 528b. Tip 528b in the south of the proposed opencast area is reported to be partially burnt. Burning of colliery spoil commonly results in the creation of indurated red shale, but also friable red ash, dependent on the initial composition of the tip/contributory measures in terms of carbon, clay and sulphur contents.

6.3.9 Colliery spoil is also understood to be present as a thin layer across much of the valley beneath Mynydd Farteg Fach and in the hummocky terrain to the east of Tip 527 and Tip 528. The spoil within Mynydd Farteg Fach is understood to be derived from the former Waun Hoskyn opencast sites (OCCSSs). The spoil to the east of the site is believed to be derived from old workings, possibly accessed from the numerous adits recorded within the project area.
6.4 Slope Stability

6.4.1 In 2011 Blandford Consulting produced a report entitled “Ground Investigation and Slope Stability Analysis, Varteg Hill, Abercychan, near Pontypool” (Report No.BC/MB/02.11.02/5). This report was commissioned by Glamorgan Power Company Ltd. in response to concerns raised by Torfaen Council about the slope stability of the western high wall and opencast overburden mound prior to the Planning Inquiry. A copy of this document is included as Item 9 in ES Volume 3. As part of this analysis a ground investigation programme was instigated to inform a slope stability analysis of the western high wall of the open excavation that forms a central part of the proposed land reclamation scheme. The ground investigation also included the overburden backfilled mound to the west of the proposed coal extraction area.

6.4.2 The conclusions of the stability analysis are as follows:

(i) The opencast backfill is considered metastable, there is evidence that failure has already occurred at some time in the past and that this occurrence is likely to reduce the likelihood of additional failure where such failures have already occurred. There will be no influence on the existing opencast backfill as the proposed excavation does not encroach on the slope within the backfill, colliery spoil or drift. The headwall design is considered acceptable in terms of both circular and bedrock failure scenarios and will not affect Varteg Hill.

(ii) The headwall design is considered to be acceptable in terms of standard circular failure and specific bedrock failures (block, planar, wedge).

6.5 Soils

6.5.1 The land within the site is designated as Grade 5 Agricultural Land and Soil Survey information identifies the land as “Disturbed : Opencast coal workings”. The lack of mature soil is also indicated by the geology map, which designates the site area as worked out open cast mining and made ground.

6.5.2 The areas of the tips carry little or no recognisable soil with bare and eroding surfaces widely visible. In part the tips carry heath and grassland communities and under the latter surface roots have started to facilitate rudimentary soil formation with a mat of humus-enhanced surface material.

6.5.3 The other areas of made ground support grasslands ranging from very open swards and scattered small stones etc. to closed swards of established grassland communities. Under the former the soil is essentially skeletal with minimal development of recognisable horizons and with a tendency for surface run-off of incident rainfall. Under the latter there is recognisable
6.5.4 The main northern heathland area of the site shows signs of soil development. On the better drained parts there is some indication of surface leaching under a thin organic horizon but in other parts the strong surface flows of water have resulted in seasonal waterlogging, with signs in the grey colours associated with this gleying process.

6.5.5 Locally there are sites of water emergence creating ephemeral springs and mire conditions. Here there are local developments of sphagnum moss and incipient peat formation. More widely present are mire plant communities growing on gleyed soils some showing limited enrichment in their plant communities.

6.5.6 Soil development is generally very limited and the site is likely to provide little soil of quality for pasture improvement at reinstatement. However, for reinstatement of the existing semi-natural communities of the site it should provide a valuable seed source, especially from any areas of established grassland or shrub communities. This soil will be stored for spreading back over appropriate areas during habitat restoration in the restoration/landscaping phase of the project.

6.6 Ground Contamination

6.6.1 Following discussions between AECOM, the Environment Agency (EA) and Torfaen Council in 2005, it was agreed that further information was required to clarify the geological and hydrogeological conditions at the site and to identify the presence of any areas of contaminated land associated with previous operations at the site. A ground investigation specification was agreed with the two regulatory bodies which consisted of six boreholes and the excavation of 30 trial pits. Soil samples were analysed mainly from the made ground in the area of the former Varteg Hill Colliery in the northern part of the proposed coal extraction area or from the colliery spoil tips on the site.

6.6.2 The results of the laboratory analyses are included in Chapter 7 of the document “Varteg Hill Reclamation & Coal Recovery Scheme, Blaenavon, South Wales, Hydrogeological and Contaminated Land Assessment Final Interpretative Report.” which is submitted as a supporting document to the ES.

6.6.3 Based on the results of the soils sample analyses, the report concluded that there is no evidence of significant or widespread ground contamination at the proposed land reclamation/opencast site, which would place any constraint on the proposed workings or represent a significant risk to human health. Locally elevated metal concentrations (lead, copper, and zinc) are associated with the made ground in the vicinity of the former Varteg Hill Colliery and at Cwm Glo Mine in the northern part of the coal extraction area. Leachate tests show that most contaminants are not readily soluble,
and therefore do not present a significant risk to controlled waters.

6.6.4 There is potential for the generation of acidic run off from the colliery spoil tip in the southern part of the site. However the leachate tests on other samples from the site did not show any significant contamination associated with acidic drainage.