

Appendix H

2011 Nant Helen Extension
Environmental Statement
extracts - Celtic Energy

14 HYDROGEOLOGY

14.1 Background

- 14.1.1 The existing Nant Helen Extension OCCS involves the excavation of coal seams extending between the Soap Rider 2 and Nine Feet seams in a series of north-west/south-east orientated panels. The site is progressing in a south-westerly direction.
- 14.1.2 The proposed extension will involve the excavation of the same sequence of strata as in the current site and continue to intersect previous surface mine workings in the Abercrave/Gwaunton site (within which excavation extended to the Upper Black seam), and abandoned underground workings in the Cornish and Nine Feet seam.
- 14.1.3 The proposed site will be operated in the same manner as the existing site and would form a contiguous extension to it.

14.2 Site Location

- 14.2.1 The proposed site is located immediately to the west of the existing site and extends in a westerly direction by up to 500 metres as shown in Figure 14.01.

14.3 Topography and Surface Features

- 14.3.1 The land within the proposed excavation area is generally inclined towards the north-west and, with the exception of a very minor area at the south-eastern extremity of the site (which is open moorland), is currently covered by a coniferous plantation.
- 14.3.2 To the south-east and south of the site boundary, the land rises and comprises open moorland which similarly falls towards the north-west, see Figure 14.02.
- 14.3.3 The western boundary of the site is defined by a stand-off from a disused railway line which is now used as a public cycleway. To the west of the cycleway the forestry is replaced by open fields which gently sweep down to the River Tawe.

14.4 Hydrology (see also Chapter 13)

- 14.4.1 The principal water feature in the general area is the River Tawe which at its closest lies approximately 370 metres to the north-west of the site boundary and generally flows in a south-westerly direction. The existing site and proposed extension both lie within the catchment of the River Tawe and are located on its south-eastern valley side.
- 14.4.2 Two small north westerly flowing watercourses flow through the proposed extension area. The northernmost watercourse, i.e. Nant Pen-Rhos, has been affected by both the earlier Abercrave/Gwaunton and current sites. The more southerly of the two routes (the former Nant Gyrlais) lies within the proposed extension area and has not so far been affected by the current operations, but does lie on a restored route across the Abercrave/Gwaunton OCCS.
- 14.4.3 Lying immediately outside of the southern boundary of the excavation, is the diverted watercourse now known as the Nant Gyrlais. This is fed by surface run-off and groundwater emergences from higher ground to the east.

- 14.4.4 Details on surface hydrology are contained within the report compiled by Merebrook Consulting (see Chapter 13).

14.5 Water Features

- 14.5.1 As noted, almost the entire proposed extension area is covered by dense coniferous plantation within which there are very limited surface water features present.
- 14.5.2 Details of identified surface water features within 500 metres of the proposed excavation are contained within Appendix II of this report.
- 14.5.3 There will be no impacts of any significance on any of the identified features.

14.6 Excavation Sequence

- 14.6.1 Surface deposits which will be intersected during operations include glacial drift and old surface mine backfill associated with the Abercrave/Gwaunton OCCS, details of which are shown in Figure 14.01. Beneath the surface deposits Coal Measures extending downwards to the Nine Feet seam will be excavated

Glacial Drift Deposits

- 14.6.2 It is expected that glacial drift deposits will be encountered within the proposed excavation area.
- 14.6.3 No detailed information exists which defines the precise sedimentological make-up of the deposit. However, it is likely that the deposits will be broadly similar to those intersected in the present site and exposed in the existing western excavation faces. The deposits can be observed to comprise dark grey brown, stiff, sandy clay with scattered sub-angular boulders and occasional minor discontinuous sandier horizons which contain insignificant amounts of groundwater.

Head

- 14.6.4 No head deposits have been identified and are considered unlikely to be present.

Previous Surface Mine Deposits

- 14.6.5 Previous surface mine deposits associated with the Abercrave/Gwaunton site, within which seams extending from the Soap Rider 2 down to the Upper Black seam were excavated, will continue to be intersected, exposed along the northern and western sidewalls. The deposits will comprise a mix of Coal Measures, mudstones, sandstones, siltstones and seatearths and may contain minor discontinuous water-bearing pockets.
- 14.6.6 The area of previous surface coal mining operations associated with the Abercrave/Gwaunton site is shown in Figure 14.01.
- 14.6.7 The thickness of the deposits will vary between 40 to 60 metres at their thickest, tapering westwards towards the incrop position of the Lower Black seam - see cross sections in Figures 14.03 and 14.04.

Solid Measures

- 14.6.8 The solid Coal Measures strata will consist of a number of cyclic sequences (cyclothems) principally comprising mudstones/siltstones with coal seams, seatearths and sub-ordinate sandstone horizons, the thickest of which occurs above the Nine Feet seam. The sequence is classified by the Environment Agency Wales as a secondary aquifer of no significance with respect to groundwater resources but with potential local importance.
- 14.6.9 Potential for the occurrence of minor perched aquifers exists within some of the coal seams and minor sandstone/siltstone horizons though during the operation of the current site no horizons of note have been identified. If any strata water is encountered, it is likely (due to the structurally disturbed nature of the site), to be discontinuous and with low volumes.

14.7 Structural Geology

- 14.7.1 Within the general area the principal structural features are north-north-west/south-south-east orientated normal faults such as the Pwllau Bach which is located approximately 2 kms to the east.
- 14.7.2 The macroscopic structure is relatively simple comprising strata which dip towards the west and south-west at a gentle gradient of 1 in 7 to 1 in 10.
- 14.7.3 At a smaller scale, the existing site is significantly disturbed by low angle thrust faulting and monoclinial, isoclinal and recumbent folding with a north-east/south-west axial trend.

14.8 Sequence of Measures

- 14.8.1 The proposed excavation sequence with separation intervals is shown in Table 14.1 below. The base of the proposed excavation is represented by the Nine Feet seam, seam contour details for which are shown in Figure 14.05.

Table 14.1 Seam sequence and intervals

Seam	Approximate Interval
Soap Rider 2	8-10 metres
Soap Rider 1	15 metres
Soap	20-25 metres
Stwrin	10-12 metres
White Four Feet	10 metres
Upper Black	15-17 metres
Cornish	10-12 metres
Harnlo	10 metres
Nine Feet Rider	20 metres
Nine Feet	

14.9 Previous Mineworkings

- 14.9.1 The proposed excavation area has been affected by previous surface and underground coal mining operations, none of which are now operational, but may have a localised impact upon stability and seam working.
- 14.9.2 Significant mining operations for other minerals, i.e. ironstone, are not recorded in the immediate area, though do occur in the Coal Measures sequence within the wider geographical area.

Underground Mineworkings

- 14.9.3 Within the proposed excavation area previous underground mineworkings at the Nine Feet seam horizon associated with the Ynyscedwyn Colliery will be intersected in the area indicated in Figure 14.06. Currently these workings are isolated from those being worked through in the existing site by an in-situ underground barrier which comprises an un-worked block of solid strata. In addition, areas of previous underground mineworkings at a higher level in the Cornish seam will be intersected.
- 14.9.4 Previous mineworkings in the Brass seam, which lies approximately 15 to 18 metres below the Nine Feet, occur but will not be intersected by the proposed operations.
- 14.9.5 There are three drainage adits in the general area, which control the outflow of underground mineworkings water, the locations of which are shown in Figure 14.06.
- 14.9.6 To the north is the Yard Adit which is located at a level of approximately 122.5 metres AOD (associated with the International colliery). In the central area (and of relevance to the current operating site) is the Gwaun Clawdd Adit, which is located at a level of 106.1 metres AOD and associated with the Gwaun Clawdd colliery. The southernmost adit is the Cwm Du Adit which is located at a level of approximately 93.6 metres AOD and associated with the Ynyscedwen colliery. All three of the above adits drain into the River Tawe.
- 14.9.7 The current operation requires sump pumping to be undertaken with all water flowing through the site water treatment facility and then to the north-north-west and into the River Tawe. There is potential for natural drainage from the site due to the disposition of the Nine Feet contours which are favourably orientated in the north-eastern part of the site. Any natural flow from the site would be via the Gwaun Clawdd drift, a cross-measures decline drift which accesses the Nine Feet seam workings.
- 14.9.8 The current site is in the process of removing the in-situ barrier at Nine Feet seam level between the Gwaun Clawdd and Ynyscedwen workings. The removal of this barrier is likely to result in an increase in the discharge volume from the Cwm Du adit which is located at a lower elevation than the Gwaun Clawdd adit, i.e. 93.6m AOD versus 106.1m AOD respectively.
- 14.9.9 Whilst underground barriers between the various sets of workings isolated the individual collieries, within the mining blocks there is clear evidence of the inter-connection between mineworkings at various seam horizons, specifically between the Brass and Nine Feet. The implications of this are that below the lowest level at which Nine Feet workings are intersected in the proposed excavation the Brass seam workings will be flooded. In addition, all water entering the Brass workings located to the east and at a higher level than the lowest intercept point in the Nine Feet workings will flow into the base of the excavation void.

Surface Workings

- 14.9.10 The current operating site has been progressively working through old surface mine backfill deposits associated with the Abercrave/Gwaunton site. The proposed extension will similarly involve the re-excavation of old surface mine backfill associated with the same site.
- 14.9.11 The previous level of excavation was down to the pavement of the Upper Black seam which lies approximately 60 metres above the Nine Feet.
- 14.9.12 No significant groundwater is expected to be intersected in the backfill deposits. Groundwater, if any is encountered, is likely to be of limited volume and will almost certainly occur in isolated discontinuous zones, as is commonly the 'norm' for such deposits.

14.10 Site Investigation

- 14.10.1 Exploratory drilling over the south-western and south-eastern parts of the site was undertaken by British Coal leaving a significant central section with no exploration boreholes within it. Nevertheless, the working of the Abercrave/Gwaunton site confirmed the borehole data relevant to that site.
- 14.10.2 The area with no borehole cover is that within which the backfill deposits associated with the Abercrave/Gwaunton site occur. Strike water levels were noted in the boreholes and give an indication of the impact of the underground mineworkings barriers between the various mines on minewater. Boreholes are shown in Figure 14.07.

14.11 Piezometer and adit drainage data

Piezometers

- 14.11.1 Information for two piezometers (installed in the late 1990s with monitoring data extending back to 2003) located in Boreholes 3091 and 3092 indicates average water levels of 108.15 and 98.75 metres AOD respectively with a variation of between 109.04 and 101.96 in BH 3091, and 102.56 and 98.8 in BH 3092.
- 14.11.2 Borehole 3091 is located in the Gwaun Clawdd colliery workings, at Brass seam level, and Borehole 3092 in the Ynyscedwen colliery workings, at the Nine Feet level. The locations of both boreholes are shown in Figure 14.07 and are located along the bed of the dis-used railway line beyond the western site boundary.
- 14.11.3 Underground mineworkings abandonment plan information indicates linkage between the Brass and Nine Feet workings, the implications of which are indicated in section 14.9.
- 14.11.4 Monitoring data extending from March 2003 to November 2010 are shown in Appendix I2, Table No. 2.
- 14.11.5 The data show a reasonable consistency in the level recorded in the piezometer located in Borehole 3092 - varying between approximately 102 and 99 metres AOD, which shows a correlation with water level in the operating void sump.
- 14.11.6 A similar level of consistency can be seen in the piezometer located in Borehole 3091. A future potential drop in level may occur and would be of significance as it is

likely to correspond with the underground barrier between abandoned mineworkings in the Nine Feet seam in Gwaun Clawdd and Ynyscedwen collieries being breached by the current surface mining operations.

Drainage Adits

- 14.11.7 The discharge of water from three adits, the Yard, Gwaun Clawdd and Cwm Du, has been regularly monitored, data for which are shown in Appendix I2, Table No.2. The locations of the three adits are shown in Figures 14.06 and 14.08-10.
- 14.11.8 Field observations indicate that a noticeable reduction in flow rate from the Yard Adit has occurred from June 2010 and is likely to be related to pumping activity in the active site. For the Gwaun Clawdd Adit, significant reductions in the recorded flow rates from this adit have been recorded since November 2007, and since May 2010 minimal flow volumes have been noted. This reduction in flow corresponds with the current site's pumping operations whereby the water levels in the site have been at 95 to 110 metres AOD. The level at the Gwaun Clawdd outflow is 106.1 metres AOD. There is, therefore, direct linkage between the outflow and excavation activity at the Nine Feet horizon in the active site. For Cwm Du Adit, flow rates have remained reasonably consistent, allowing for normal acyclic trends. It is anticipated that with the breach of the underground barrier between the Gwaun Clawdd and Ynyscedwyn workings that flow will increase from the Cwm Du adit.

14.12 Hydrogeological characteristics of site deposits

- 14.12.1 The site lies in an area of high rainfall which over the past 3 years has seen an increase from 1.78 metres in 2007 to 2.28 metres in 2009, as of the end of November the total was 1.46metres. The rainfall commonly occurs in high intensity episodic events.
- 14.12.2 Due to a history of previous surface and underground mineworkings (and current surface workings) the site hydrogeology has been fundamentally altered and complicated. Within the proposed extension area there are potentially three distinct units, each of which is likely to have its own distinct hydrogeological character. They are:
- Un-disturbed superficial glacial deposits;
 - Old surface mine backfill, and
 - Coal Measures strata

Glacial Deposits

- 14.12.3 Good exposures of glacial deposits are available along the western advance face in the currently operating site and based upon experience within the site no significant variations have been recorded. Generally the deposits comprise a stiff, sandy clay with cobbles, boulders and fine gravel primarily consisting of sandstone clasts.
- 14.12.4 Minor discontinuous water-bearing sandy lenses and bands occur. No significant water-makes are evident though occasional discontinuous 'damp' patches can be observed along with minor scour failure cones around sandy horizons.

Old Surface Mine Backfill

- 14.12.5 The deposits can be clearly observed in the current operating site and are seen as typical surface mine backfill deposits comprising an irregular inhomogeneous mass of angular clasts of variable size of varying materials set in a moderately cohesive matrix.
- 14.12.6 Again, no significant water-makes / inflows from the deposits can be observed, though occasional minor seepages have been noted in the past. It is possible that some surface water infiltration into the deposits occurs, quantities of which may eventually emerge at lower levels as the ground falls away towards the north-west.

Coal Measures Strata

- 14.12.7 The Coal Measures strata are defined as a minor aquifer with the sequence containing a number of horizons which may potentially contain perched water. Generally such aquifers have low storativity and transmissivity. This is in contrast to the significant volumes of water and highly transmissive nature of the network of underground mineworkings at the various seam horizons, i.e. Cornish, Nine Feet and Brass.
- 14.12.8 Whilst in general terms the Coal Measures sequence is classified as an aquifer of no significance, where disturbed by underground mineworkings activity its water bearing potential can be radically changed. The collapse of the strata above mineworkings can give rise to enhanced fragmentation which may result in a significant increase in the strata's water-bearing capacity.
- 14.12.9 As noted in Section 14.1, the various Nant Helen sites which have progressed from north-east to south-west along seam incrops have intersected a series of abandoned underground mineworkings associated with the International, Gwaun Clawdd and Ynyscedwen collieries. The surface coal mine sites have been contiguous and as a result involved the breaching of underground in-situ barriers between the collieries leading to connection.
- 14.12.10 An assessment of borehole standing water levels as recorded (1997) in the above colliery blocks recorded 124.44m in International workings, 108.17m in Gwaun Clawdd workings and 100.52m AOD in Ynyscedwyn workings, i.e. decreasing levels, as followed to the south-west.

14.13 Comments on the validity of the previous Hydrogeological Model

- 14.13.1 A detailed hydrogeological assessment was undertaken as supportive documentation to the planning application associated with the current site. The key controlling element in the model was identified as the abandoned underground mineworkings which, prior to surface mining operations removing in-situ barriers, were hydraulically isolated from one another (other than the possibility of minor leakage occurring). The current site is working through the barrier between the Gwaun Clawdd and Ynyscedwyn workings.
- 14.13.2 It is expected that once the underground barrier is breached that there could be a drop in the recorded water level in piezometer 3091 which is located in Nine Feet workings associated with Gwaun Clawdd workings. Figures 14.08 to 14.10 which are associated with the application documentation for the current site, show existing conditions, conditions during the operational phase and conditions post-restoration respectively. The plans are based upon an assessment of underground mineworkings

barriers, seam contours, horizon interconnection and the influence of existing drainage adits.

- 14.13.3 From the plans it can be seen that the breaching of the underground barriers will result in a change in the flow pattern involving a larger element of water flowing towards the Cwm Du adit. It is considered likely that the model will hold true for the proposed site. The principal change, i.e. breach of mineworkings barrier, will occur in association with the currently consented site.
- 14.13.4 The monitoring of flow rates at the three drainage adits will continue during the life of the proposed extension site and it is expected that a trend towards an increased flow through the Cwm Du adit and potential reduction in the Gwaun Clawdd adit will occur. A test of the validity of the model has yet to occur but with the breach of the barrier between the Gwaun Clawdd and Ynyscedwen workings, resulting from the mining advance programmed for early 2011, the original hydrogeological assessment for the site can be validated.
- 14.13.5 It should be noted that there has been a recent flow of water into the void from the Nine Feet horizon along the western and north western sides of the site which may be confirmation of the validity of the anticipated hydrogeological model as shown in Figure 14.09 i.e. Hydrogeological Model – Operational Phase. Conditions will be continually monitored as the site develops.

14.14 Protected rights search

- 14.14.1 The Environment Agency Wales has been consulted for information with respect to licensed abstractions within a 1.5 kilometres search radius of the site centre. Details are contained in Appendix I3.
- 14.14.2 In summary, the only licensed feature within close proximity to the site is the reservoir at Gwaunclawdd Farm, Caerlan (water feature number 23). The feature is likely to have been formed on glacial boulder clay and therefore will not be affected by the proposed operation. Other licensed features occur at some distance to the north west of the site and are not likely to be affected by the proposed operation. There is one de-regulated which is an abstraction from a spring, the water from which flows into the river Tawe, and the others comprise a farm abstraction, a pond, a reservoir and abstractions from a tributary to the River Tawe. The features lie closer to the currently operating site and there are no reports of them having been affected by it.
- 14.14.3 In addition, under the Private Water Supplies Regulations 1992, the local authority has been consulted for details of exempt private water supplies in the area. There are no records of any interests in close proximity of the site.

14.15 Likely impacts of proposed operations on groundwater

- 14.15.1 As noted in Section 14.6, a number of material types with potentially very different hydrogeological characteristics and groundwater regimes contained within occur.
- 14.15.2 Within the superficial and old surface mine backfill deposits it is highly unlikely that there will be any groundwater systems of significance. Groundwater, if intersected, is likely to be low volume and without any appreciable flow rate, other than potentially an initial flow which reduces rapidly as pockets are de-watered, a phenomenon which has often been observed in working areas within the operating sites.

- 14.15.3 Within a 500 metres zone (an assumed zone beyond which it is highly un-likely that there could be any potential impacts associated with the proposed operation) extending beyond the proposed limit of excavation at surface minor diffuse seepages are evident from the rising moorland areas to the east and south-east of the site, and are thought likely to represent the outcrop position of minor sand horizons contained within the Glacial Drift. These features will not be affected by the proposed extension as their re-charge areas lie to the east and south of the emergence points.
- 14.15.4 There is no known hydrogeological connection between the operations at the site and any area of statutory protection.
- 14.15.5 Within the solid measures, and based upon experience in the currently operating site, it is unlikely that any significant strata inflows will occur. The major source of water inflow will be via the system of previous underground mineworkings roadways, extraction cavities and broken strata which overlie the worked areas.
- 14.15.6 The principal consequence associated with mining through the various areas of previous underground mineworkings in the extension area will be no different from within the currently consented operation.
- 14.15.7 It is possible that with the breach of the underground in-situ barrier at the Nine Feet seam horizon there will be an increase, during the operational phase, in the outflow from the Cwm Du adit with a decrease in the Gwaun Clawdd. The possible increase in outflow rate cannot be easily predicted though will be monitored during the operational phase of the site.

Post-Restoration rebound

- 14.15.8 Following the completion of coaling operation the final void will be infilled with overburden and the site restored to the consented restoration landform.
- 14.15.9 Infiltration into the backfill deposits to a greater or lesser extent may occur and therefore the deposits may or may not contain groundwater which may be affected by drainage via the Cwm Du adit. The lowest projected level of excavation at Nine Feet level in the proposed extension will be approximately 76 metres AOD which is approximately 17 metres below the level of the Cwm Du adit (93.6m AOD). If there is significant infiltration into the backfill, there will potentially be saturation below 93.6 metres AOD. It is likely therefore that upon restoration and groundwater rebound in the backfill, some increased outflow from the Cwm Du adit will occur.
- 14.15.10 Due to the character of surface mine backfill with respect to its ability to contain and allow the passage of water, it is not possible to predict accurately whether there will be a significant build up of water level above that of the Cwm Du adit (93.6m AOD). It is possible that water levels could build up against the excavation sidewall along the western site boundary leading to infiltration into the strata which form the wall.
- 14.15.11 However, any seepage through the sidewall is likely to be via coal seam horizons in the excavation sequence and possibly sandy horizons contained within the overlying glacial drift deposits.
- 14.15.12 A programme of groundwater monitoring will be proposed 12 months before the completion of operations at the site. It is possible that this may involve the installation of a number of standpipe piezometers within areas of backfill.

14.15.13 The potential consequences of a re-bounce in groundwater levels may be a re-activation of original spring-lines or the formation of new points of groundwater emergence.

14.15.14 As a part of the scheme it will be necessary to undertake a programme of post-restoration monitoring to identify any incidences of groundwater rebound and emergence at surface, and implement control measures as required.

Acid Rock Drainage Potential (ARD)

14.15.15 Within Coal measures strata varying quantities of pyrites (iron sulphide) can occur, typically associated with carbonaceous shales and coal seam horizons. Upon exposure to air the sulphide oxidises and converts into a water soluble oxide which in contact with water goes into solution with the effect of acidifying the water. The effects of the acidifying property of pyrites can be counter-balanced by the presence of carbonate rich minerals.

14.15.16 The excavation sequence in the proposed extension site is the same as that which is extracted in both the current and previous sites, associated with which there have been no recorded problems relating to acid rock drainage, primarily due to the presence of acid neutralising carbonate rich minerals contained within the sedimentary sequence. It is therefore anticipated that there will be no ARD problems arising as a consequence of the proposed operation.

14.16 Monitoring.

14.16.1 A scheme of monitoring will be agreed with the Environment Agency Wales no later than 12 months before the completion of coaling on the site. In the interim routine monitoring of piezometers and the three drainage adits will be undertaken and results submitted to the EAW on an annual basis or whatever frequency is reasonably requested.

14.17 Conclusions

14.17.1 On the basis of the above assessment of hydrogeology, it is concluded that the proposed Nant Helen Remainder site will not cause any additional impact than that predicted for the current site. Old underground mine workings will control the drainage from the site and upon restoration.