

## 12 Water Resources and Ground Conditions

### 12.1 Introduction

This chapter of the ES assesses the likely significant effects of the proposed development with respect to water resources and ground conditions, including hydrology, hydrogeology and the water quality of the proposed development at Foel Trawsnant. The area within the wider 'site boundary' encompasses 117.6ha, whereas the 'planning boundary', within which the wind farm associated infrastructure sits, encompasses 46.5ha. The 'site boundary' corresponds to the area on which previous EIA studies (2014) were based. To ensure a consistent and robust approach, the EIA for the amended scheme is also based on this 'site boundary'. Within the following chapter these terms will be referred to for the purposes of describing the baseline environment and discussing potential effects from the proposed development.

It should be read in conjunction with the development description provided in **Chapter 5** and with respect to relevant parts of **Chapter 9: Non-Avian Ecology**, where common receptors have been considered and where there is an overlap or relationship between the assessments of effects.

This chapter provides an update to the assessment presented in the 2014 ES (Ref. 24311rr073i1) for the 13 turbine wind farm on land at Foel Trawsnant which was subsequently approved. A review of the baseline and design information in the 2014 Environmental Statement (ES) for the approved 13 turbine layout has informed the parameters of this updated assessment for the 11 turbine amendment as set out in Sections 12.9 and 12.10 within this chapter.

### 12.2 Limitations of this assessment

There are no limitations relating to water resources and ground conditions that affect the robustness of the assessment of the potential significant effects of the proposed development.

### 12.3 Policy and legislative context

#### Planning policy

**Table 12.1** lists the issues from the relevant planning policies that are relevant to Water Resources and Ground Conditions.

Table 12.1 Policy issues considered in preparing the water resources and ground conditions assessment

Policy reference	Policy issues	Considered in section
<b>National planning policies</b>		
Technical Advice Note (TAN) 15: Development and Flood Risk (2004).	The key planning objectives of TAN15 are to avoid inappropriate development in areas of high flood risk. Flood risk zones are depicted on the Development Advice Map (DAM) based on definitions of development vulnerability. TAN15 is supplemented by additional climate change guidance published by the Welsh Government (Welsh Assembly Government, 2016). Where development has to be considered in high risk areas, only those developments that satisfy the 'Justification Test' should be located in such areas. TAN15 also discusses management of surface water (including the use of Sustainable Drainage) and climate change effects.	12.5
Planning Policy Wales (PPW) (Edition 9; 2016 and Edition 10 Consultation draft; 2018)	PPW9 sets out the land-use planning policies of the Welsh Government and forms a strategic framework to guide development. Section 4.5 requires 'planning for the consequences of climate change and states that consideration of climate change impacts should use the latest set of UK Climate Projections.  The consultation draft of PPW Edition 10 was issued for review in March 2018. The responses to this consultation are currently being reviewed. The PPW10 draft does not contain any additional relevant policies further to those provided in PPW9.	12.5
<b>Development plan policies</b>		
Neath Port Talbot County Borough Council Local Development Plan (2016) Strategic Policy 1 (SP1) Climate Change	SP1 accounts for increased flood risk to ensure that no highly vulnerable development will be permitted within DAM Zone C2, and development will only be considered in areas where it can be demonstrated that the site can comply with the requirements set out in TAN15.	12.5
Bridgend County Borough Council Local Development Plan 2006 – 2021 (2013), section on Protecting and Enhancing the Natural Environment, ENV6 Nature Conservation	ENV6 states that proposals for development or redevelopment will be required to: In the first instance, retain, conserve, restore and enhance wherever possible existing wetlands, watercourses and ponds; and Where this is demonstrated not to be possible, suitable mitigation or compensatory measures will be required.	12.5 and 12.8
<b>Other Local Plans</b>		
Western Wales River Basin Management Plan (2015)	The plan sets out pressures facing the water environment in this river basin district, and the actions that will address them. It is prepared under the Water Framework Directive and is the second of a series of six-year planning cycles. The current overall status and supporting information with regards to individual watercourses is presented within the plan.	12.5

## Legislative context

### Water Framework Directive

The European Commission's (EC's) Water Framework Directive (WFD) is focussed on delivering an integrated approach to the protection and sustainable use of the water environment on a river basin scale (WFD, 2015). One of the primary objectives of the Directive is for individual water bodies to achieve 'good status' which, for surface water bodies, requires both good ecological status and good chemical status to be achieved. For groundwater bodies, good status is achieved when both quantitative status and chemical status are at least

good. A central principle of the WFD is that River Basin Management Plans (RBMP) are prepared to set out how the water environment within each River Basin District (RBD) will be managed over a succession of planning cycles. The second cycle of the RBMPs cover the period from 2015 – 2021. Foel Trawsnant is located within the Western Wales RBMP area.

### Other relevant legislation

Other legislation relevant to the assessment of effects on water resources and ground conditions includes but is not necessarily limited to:

- Environmental Permitting (England and Wales) (Amendment) (No. 2) Regulations 2016;
- Directive on Environmental Quality Standards (2008/105/EC) also known as the Priority Substances Directive, as enacted into domestic law by the 2015 WFD (2015) Directions;
- Floods and Water Management Act 2010;
- The European Union (EU) Floods Directive (2007/60/EC), as enacted into domestic law by the Flood Risk Regulations 2009;
- Water Act 2003;
- Environment Act 1995;
- Water Resources Act, 1991;
- Environmental Protection Act 1990; and
- Control of Pollution Act 1974.

### Technical guidance

Guidance related to the water environment and best practice measures during design and construction includes:

- Revised Netregs (2017) Guidance for Pollution Prevention (GPPs), including GPP2: Above ground oil storage tanks, GPP5: Works and maintenance in or near water, PPG7: Safe storage – The safe operation of refuelling facilities, and PPG21: Pollution incident response planning;
- CIRIA Report C753 (2015) The SuDS Manual;
- CIRIA Report C532 (2001) Control of water pollution from construction sites; and
- CIRIA Report C692 (2010) Environmental good practice on-site (third edition).

A list of full references can be found in Section 12.15.

## 12.4 Data gathering methodology

The water quality, resources and flood risk baseline has been developed based upon of information collected during a desk-based assessment of existing data and targeted site walkover surveys.

### Desk study

Baseline data have been primarily derived from that held/published by Natural Resources Wales (NRW), Ordnance Survey (OS), the Coal Authority, and local authorities, comprising of Neath Port Talbot and

Bridgend County Borough Councils. Each of these organisations were contacted to receive updates to the existing information presented in the 2014 ES, in order to validate and supplement baseline findings.

Sources of information used for the Water Resources and Ground Conditions assessment are listed in **Table 12.2**.

Table 12.2 Sources of desk study information for water resources and ground conditions

Source	Data
<b>Rainfall</b>	Centre of Ecology and Hydrology (CEH) (2009) Flood Estimation Handbook (CD ROM v3)
<b>Topography</b>	Ordnance Survey mapping
<b>Flood Risk</b>	NRW (2018) Flood Risk mapping – risk of flooding from tidal, fluvial and surface water sources
<b>Surface Water Quality</b>	NRW (2018) 'Water Watch Wales Map Gallery' online interactive maps Western Wales (2015) River Basin Management Plan
<b>Soils and Landuse</b>	Cranfield University Soilscales website (2018)
<b>Geology</b>	British Geological Survey (BGS) website (2018) Coal Authority Report (received 20 March 2018)
<b>Groundwater</b>	NRW '(2018) Water Watch Wales Map Gallery' online interactive maps British Geological Survey (BGS) website (2018)
<b>Water Resources (abstractions and discharges)</b>	Neath Port Talbot County Borough Council data request (received 26 April 2018) Bridgend County Borough Council data request (received 25 April 2018) NRW data request (received 10 April 2018)
<b>Designated Sites</b>	MAGIC natural environment map viewer (2018)

## Survey work

A site walkover was undertaken on 30 October 2013 by hydrology and water quality technical specialists to inform the 2014 ES chapter. This was supplemented by a site walkover undertaken on the 19 April 2018 to validate and verify baseline conditions. The proposed access tracks and the 11 turbines were visited on foot during both visits in order to critically assess the draft design plans with regards to water resources and ground conditions.

## 12.5 Baseline conditions

### Current baseline

#### Topography and hydrology

The site boundary extends across much of Foel Trawsnant, an upland area situated between Duffryn to the north and Nantyllyfflon to the southeast, approximately 10km northeast from the south coast of Wales at Port Talbot and 15.5km southwest of the Brecon Beacons National Park boundary.

**Figure 12.1** presents the elevation across the site. The maximum elevation within the site boundary is 369m AOD (peak of Foel Trawsnant). The minimum elevation within the site boundary is approximately 230m AOD on the northwest site boundary, where Foel Trawsnant slopes off towards the Afon Afan.

The site boundary is predominantly located in the surface water catchment of the Afon Afan. The site is drained by a number of tributaries of the Afon Afan which rise within its boundary. The catchment area of the Afon Afan upstream of its confluence with Nant Cynon is 53km<sup>2</sup>. A portion of the site access road along an existing forestry track is located within the Ffrwd Wylt catchment (Nant Drysiog sub-catchment). A small part of the eastern portion of the site boundary and access road is located within the Afon Llynfi catchment (Nant y Crynwydd sub-catchment). **Figure 12.2** displays the watercourse catchments for those tributaries concurrent with the Site boundary i.e. tributaries of the Afon Afan and the Ffrwd Wylt. **Table 12.3** gives the area of the site which falls into each surface water catchment, as well as other key catchment information discussed in later sections.

Table 12.3 Summary of key catchment characteristics

Catchment (Main River Catchment)	Area of Site within Catchment	Proportion of Site within catchment	Total Catchment Area (km <sup>2</sup> )	Key Catchment Descriptors		
				Upper* Catchment SAAR (mm)	Upper* Catchment SPRHOST (%)	Upper* Catchment BFIHOST
<b>Afon Afan main river catchment</b>						
Nant yr Hwyaid	0.679	0.597	0.82	1883	48.15	0.382
Nant Cynon	0.283	0.249	2.7	1882	47.91	0.384
Nant Tryfal	0.087	0.077	1.23	1960	43.13	0.426
Unnamed Catchment NW*	0.052	0.046	-	1883**	48.15**	0.382**
<b>Afon Llynfi main river catchment</b>						
Nant y Crynwydd	0.008	0.007	0.68	1795	43.5	0.389
<b>Ffrwd Wylt main river catchment</b>						
Nant Drysiog	0.019	0.017	2.18	1848	40.39	0.447
<b>Site Weighted Average</b>			-	<b>1887</b>	<b>47.54</b>	<b>0.387</b>
<p>Table notes; Blaen Nant and Nant y Ffyllon catchments are not included as the area of the proposed development site falling within these catchments is extremely small (equal to or less than 0.006km<sup>2</sup>) and no development is planned in these areas (see <b>Figure 12.2</b>). Observations of the local topography during the walkover survey (as discussed in <b>Table 12.4</b>) confirm that the site area will not drain to the Blaen Nant catchment at all.</p> <p>Data Source: (CEH) (2009) Flood Estimation Handbook (CD ROM v3)</p> <p>* Referring only to that part of the catchment within the site boundary</p> <p>**Not included in FEH CD ROM, area-scaled values from the closest catchment are used as substitute.</p>						

The Afon Afan and Ffrwd Wylt are NRW 'main rivers' (none of the watercourses within the site boundary are NRW 'main rivers'). The Afon Afan is approximately 18km in length from source to its discharge to the Bristol Channel at Port Talbot.

All proposed development activities are located within the Afon Afan catchment. The area of the site within the Afon Afan catchment is split across four main tributary sub-catchments (as illustrated in **Figure 12.2**):

- Nant Cynon;
- Nant yr Hwyaidd;
- Nant Tryfal; and
- an unnamed catchment ('Unnamed catchment NW').

The majority of the proposed development infrastructure (e.g. six out of the eleven turbines) is located in the Nant yr Hwyaidd sub-catchment which flows in a north-easterly direction before it converges with the Afon Afan. Three turbines are located within the Nant Cynon sub-catchment which also initially flows northwest and flows into the Afon Afan downstream of the Nant yr Hwyaidd. A further two turbines are located within the Nant Tryfal sub-catchment which flows north before converging with Afon Afan upstream of the Nant yr Hwyaidd. There are no proposed development activities within the 'Unnamed Catchment NW'.

The Nant yr Hwyaidd watercourse originates at National Grid Reference (NGR) 283590, 194380 with a reach of approximately 750m within the site boundary. Nant Tryfal originates at NGR 283950 193905 with a 200m reach within the site boundary. Two small tributaries of Nant Cynon originate at NGR 283808 193618 and 283925 194093 with reaches of 317m and 472m respectively within the site boundary.

Blaen Nant is a small watercourse with a catchment boundary that runs adjacent to the site boundary in the northeast. The walkover survey on in October 2013 confirmed that the planning application boundary does not extend into the Blaen Nant catchment due to the local topography and an embanked field boundary (see photo 946, **Appendix 12A**) that runs along the subcatchment watershed.

A small tributary ditch of the Nant Drysiog passes beneath the existing forestry track at approx. NGR 283800, 192950. Some upgrading of this forestry track may be required as part of the scheme, in order to accommodate site plant, however the extent of works here will be minimal.

The watercourse channels across the planning boundary were found to be generally small in size i.e. less than 1m in width. At the point at which the Nant yr Hwyaidd crosses the site boundary it was less than 1.5m in width at the time of the site visit in October 2013 (see photo 024, **Appendix 12A**). A number of the smaller tributary channels (of all tributaries) did not contain any visible flow in their headwater sections i.e. in the region of proposed infrastructure, even though the visits in October 2013 and April 2018 were carried out after large rainfall events.

Those hydrological features identified and verified during the initial and subsequent walkover surveys are presented in **Appendix 12A**, which should be read in conjunction with **Figure 12.3** - Walkover survey map (with photograph target numbers) and **Appendix 12A** containing walkover photographs.

Table 12.4 Summary of hydrological walkover notes

Feature	Discussion (photo number - Appendix 12A) <sup>63</sup>
Spring PWS at NGR 283700,195300	Open topped collection tank collecting surface water for farm water supply (agricultural building supply). (937; 938). Stream likely to be partly fed by Blaen Nant watercourse, rather than pure spring fed, given land contours.
T1	The proposed turbine T1 is located on a shallow slope near to the proposed contractors compound (T1 compound) (see 001 for view of T1 location towards the access track and the proposed contractors' compound location and 002 for view of ground conditions). The location is close to the catchment boundary of the Nant y Ffyllon but the walkover confirmed that surface water drainage would be to the west, i.e. to the Nant Cynon subcatchment.
Contractors compound (nr T1)	The contractors' compound near T1 is located near to the boundary of the Nant Cynon and Nant y Ffyllon subcatchments. The hydrological walkover confirmed that its entire area would drain to the Nant Cynon catchment. Photo 006 shows the view along the existing trackway (looking approx. west) that intersects the proposed area of the contractor's compound.
T2	The proposed T2 location is located in close proximity and to the north of an area on the same slope that was found to be 'issuing' or seeping small volumes of groundwater. This small spring feature which is marked on <b>Figure 12.3</b> is propagated as an area of relatively wet ground that has a resultant difference in vegetation ( <i>Juncus</i> sp) relative to the surrounding grass. If the access track to T2 needs to cross this distinct area of wet ground, provision for lateral drainage (horizontal drainage under the track) should be ensured to maintain this water pathway. The 'issuing' water is of a small volume and is directed into the existing plantation; it does not support any valuable habitat and the maintenance of flow pathways is of greatest importance to ensure no build-up of saturation upslope of the proposed access track.
T3	The proposed T3 location is approximately 35m from a small tributary of the Nant Cynon. Photo 010 shows the view down the shallow slope towards the tributary. Photos 011 and 012 show the view u/s and d/s respectively on this small tributary. The T3 location is on a grassed field and beyond the field boundary; rough moorland grasses and rushes form a buffer strip (approx. 5m wide) adjacent to the watercourse.
Existing pipe culvert d/s of T3	On the small watercourse d/s of the T3 location (approximately 75m from the T3 location) an existing pipe culverts the watercourse beneath a track. This 0.8m diameter culvert can be seen in 013 (d/s) and 015 (u/s). The upstream entry to the pipe would benefit from clearance of accumulated sediments to allow full conveyance of high flows.
T4	The proposed T4 location is located approx. 35m from the existing plantation boundary (upslope) in a grassed field. The view down-slope is shown in photo 016 with the ground vegetation shown in 017. Surface runoff would be towards the Nant yr Hwyaidd (located >200m away).
T5	Surface water drainage from the proposed location of T5 would be back towards the plantation in a diffuse SE direction (shallow slope). The view downslope is shown in 019 and the immediate ground conditions are shown in 020. The landcover is different along the plantation at T5 compared to the grassland at T4 and the change is obvious in 018 taken looking along the field boundary at the corner of the plantation.
T6	The proposed T6 location is situated on the broad domed top of Cefn yr Argoed. The slopes are shallow and runoff will occur in a diffuse manner in a northwesterly direction. The view down-slope is shown in 021 and the ground conditions are shown in 022.
T7	The proposed T7 location is on a grassed slope (995 and 996) which will drain to the Nant Tryfal watercourse approximately 80m away. The ground conditions appeared firm and dry.
Potential small 'GW issuing' near T7	On the slope that is crossed by the proposed access track to T7, there was identified to be a distinct patch of <i>Juncus</i> sp vegetation which may be indicative of a small degree of groundwater seepage or 'issuing'. The slopes immediately u/s of this area are firm and dry and inspection of the

<sup>63</sup> Initial observations were made and photographs were taken on visit on 30th October 2013. On the subsequent visit on 19 April 2018 observations were validated.

Feature	Discussion (photo number - Appendix 12A) <sup>63</sup>
	area with <i>Juncus</i> sp cover did not find saturated ground of any degree, so any potential water issuing is of very small scale. This area is marked on <b>Figure 12.3</b> and should be avoided by the route of the access track (no additional buffer required beyond direct avoidance).
T8	Located near to the watershed boundary of the Nant yr Hwyaid and the Nant Tryfal subcatchments, but the walkovers have confirmed that surface waters likely to drain towards the Nant Tryfal. Ground conditions at the time of the walkovers were wet, but firm (see 984 for view upslope towards T8 and 987 for view down slope from adjacent to proposed T8 location). T8 proposed location approximately 25m from the nearest drain (at the point of the small culvert under an existing track – culvert at NGR 284000, 194000).
Contractors compound (nr T8)	The proposed contractors' compound near T8 covers a large, relatively flat area across the top of Foel Trawsant, as shown in photo 974 (down-slope facing direction). The majority of the area was found (at the time of the site visits) to be dry underfoot and it is all covered by long, rough, acidic, upland grass, which would in itself act as an effective sediment runoff barrier.
Saturated ground at NGR 283922, 194093	At the catchment boundary between Nant Cynon and Nant Tryfal at NGR 283922, 194093 two water features 'issue' and flow in opposite directions, at this point it was noted that the ground was saturated and boggy, with pools of standing water (see for example photo 975). This location is situated in close proximity to T8 and the contractors' compound.
Small existing culvert at NGR 284000,194000	A small pipe culvert (979; 981; 983;985) transfers water under a little used farm track at NGR 284000,194000, near to the proposed T8 location. The culvert was blocked with debris and silt, causing an area of pooled water and overflow. Failure to transfer water effectively may be contributing to some of the saturated, boggy area noted at NGR 283922, 194093. It is also resulting in exposure of soil and track deterioration for ~10-15m from culvert in a SE direction (984).
T9	Located in an area with distinctive long moorland grasses (see Ecology discussions for habitat characterisation in Section 9.3 in <b>Chapter 9: Non-Avian Ecology</b> ) (968). View down-slope shown in photograph 968. Dry underfoot. Grasses will offer especially good sediment interception potential i.e. will help to minimise any runoff of suspended sediment.
Stream crossing point	A small tributary of the Nant Cynon is proposed to be crossed at NGR 283700,194100, south of T9. Photographs of the crossing point and the tributary are shown in photos 969 to 973. The tributary was found to be a very small stream approximately 0.25m in width. This main stream channel sits at the bottom of a shallow (approx 1.2 m) v profile, the cross section of which sits below the level of the adjacent land. The cross section of this small stream thus lends itself well to a single span open culvert or piped culvert with little embankment type earth works necessary.
T10	Located in an area with distinctive long moorland grasses (see Ecology discussions for habitat characterisation) (963). Views down-slope shown in photographs 961 and 962. Grasses will offer especially good sediment interception potential i.e. will help to minimise any runoff of suspended sediment.
Source of Nant yr Hwyaid	The proposed T10 location and associated access track is located approx 145m away from the source of the Nant yr Hwyaid according to OS mapping, however field verification found that small springs appear over a large area (as marked on <b>Figure 12.3</b> ) which is not clear from OS mapping– see 965; 964; 966 and 967. A buffer zone to prevent development across this area should be imposed.
Saturated area	A shallow depression in the local contours appears to have slightly different vegetation cover (greater proportion of <i>Juncus</i> sp) which is indicative of greater saturation (as marked on <b>Figure 12.3</b> ). Potential therefore for significant shallow subsurface flow pathway (see 960). Area should be avoided.
T11	Located on the edge of a field of distinctive long moorland grasses (see Ecology discussions for habitat characterisation) (949; 957). Dry underfoot (958). Grasses will offer especially good sediment interception potential i.e. will help to minimise any runoff of suspended sediment. Western boundary of field found to have a shallow drainage ditch (955; 956) which did not contain any water at time of visit – although <i>Juncus</i> sp. were noted which may be indicative of saturation. The northern boundary of the field was also found to have a shallow drainage ditch (not marked on OS)

Feature	Discussion (photo number - Appendix 12A) <sup>63</sup>
	which the proposed infrastructure will overlay (see 950 for crossing location at NGR 283500,194700). The bed of this ditch was dry and the grass vegetation gave the impression of little water inundation (i.e. little flow occurrence). The NW corner of the field where the two boundary ditches converge is considered to be the start of the downstream tributary ditch (although even this will be largely ephemeral); this downstream ditch is shown on the OS and will form a tributary of the Nant yr Hwyaid (952 etc).
Slope 240m downgradient of T11	Located on very shallow slope on upland, grazing pasture, which is well drained, i.e. no saturation. 947 and 948 show views downslope.
Raised field boundary	A raised field boundary, which effectively isolates the Blaen Nant subcatchment from any potential influence by surface water runoff from the site works. Photo 946 shows view towards this feature and 945 shows view from top of the feature looking E down the most upstream extreme of the Blaen Nant.
Slope 360m downgradient of T11	Located on a shallow slope immediately above a steeper slope into a valley (940; 941; 943). Land cover is rough, upland pasture grassland; well drained, i.e. no saturation (942).
Manure storage in development area	Farm bedding manure is being stockpiled (944). Leachate presumably high in ammonia is 'scorching' the grass for approx 3m downslope, but no further visual effects are evident.
Nant yr Hwyaid at site boundary	For context of scale, the Nant yr Hwyaid was visited at the site boundary (approx NGR 282900,194800) (023; 024) and it was found to be less than 1.5m in width at the time of the site visit.

Flow data are available for the Afon Afan from the NRW website. The nearest gauge on the Afon Afan is located at Cwmafan, approximately 4km downstream of the site boundary. The Afon Afan has a catchment area of 81.5km<sup>2</sup> at this location and consequently the flow data from this gauge are not considered to be representative of flow conditions in the small watercourses draining the site.

Greenfield or rural runoff rates at the Site have been estimated using the Institute of Hydrology Report 124 (1994) (IoH124) method (see Equation 1 below) and are displayed in Error! Reference source not found..

$$Q_{BAR\ rural} = 0.00108 \times Area^{0.89} \times SAAR^{1.17} \times SOIL^{2.17} \quad Equ.1$$

Data used for the runoff calculation are as follows:

SAAR 1888 mm/yr (CEH)

Soil type Soil class 5, soil index value (SOIL) = 0.50; from Winter Rainfall Acceptance (WRAP) Map, Flood Studies Report (FSR) Volume 5 (NERC, 1975), which equates to a very high runoff rate.

FSR Growth Region (NERC, 1975) 9

Area Drainage area considered (runoff site area), in km<sup>2</sup>

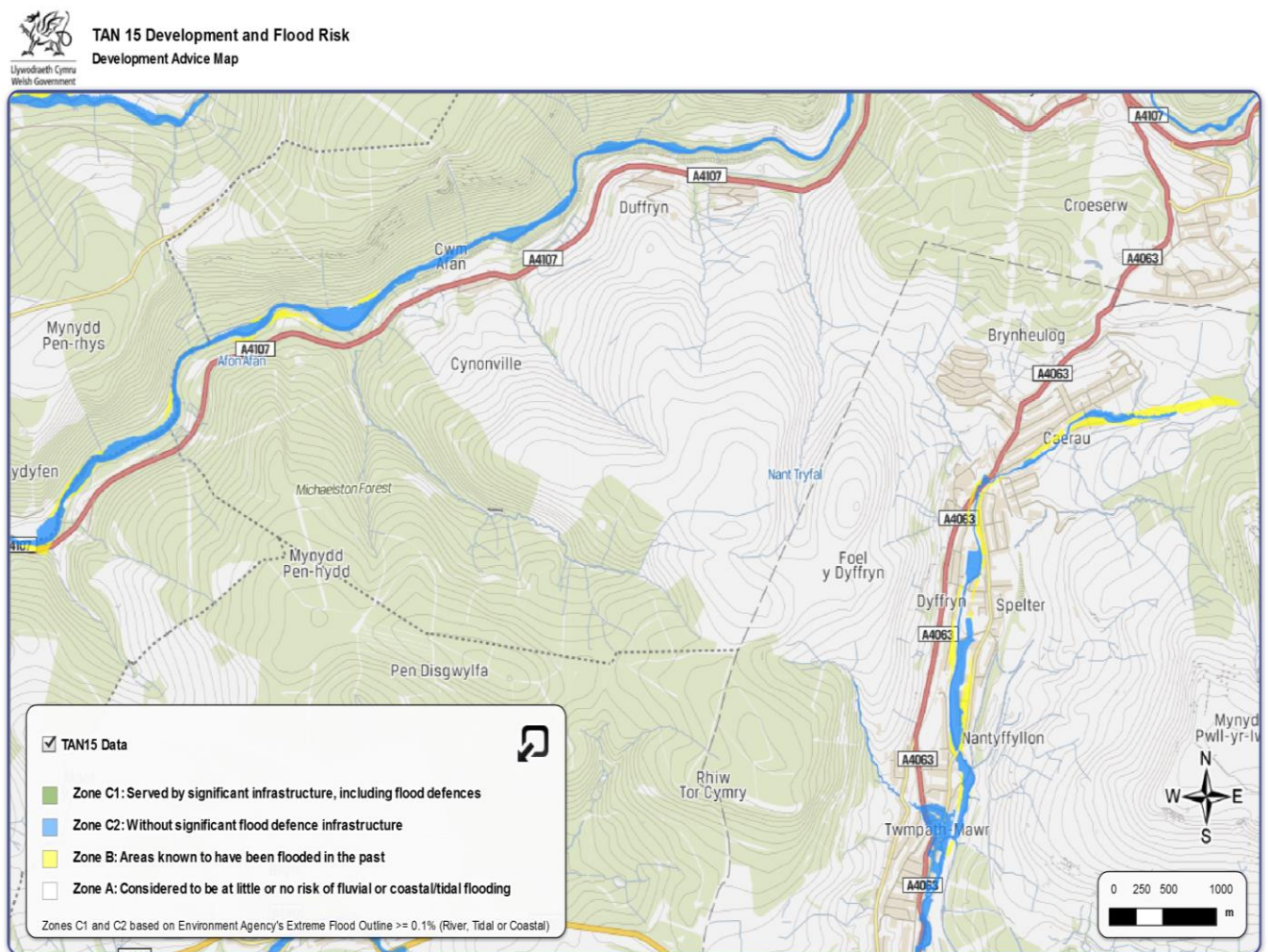
Table 12.5 Greenfield runoff rates (IoH124)

Catchment	Site area (km <sup>2</sup> )	SOIL	SAAR	Q <sub>BAR</sub> (l/s/ha)	Q100 (l/s/ha)	Q <sub>BAR</sub> (l/s)	Q100 (l/s)
Site	1.137	0.50	1888	16	35.1	1831	3992

## Flood risk

The TAN 15 Development Advice Map (DAM) online flood map shows some areas at risk of fluvial flooding along the Afon Afan, but these are limited to the immediate riparian corridor (<50 m from the river – see **Plate 12.1** below). The development site is entirely in Flood Zone A (considered to be at little or no risk of fluvial flooding). The TAN 15 DAM however only includes catchments of greater than 3km<sup>2</sup>; the majority of the site falls within catchments of less than 1km<sup>2</sup>. The steep nature of most of the site means that there is little risk of flooding from watercourses. On the edge of flatter hilltops (e.g. at Foel Trawsnant between T9 and T10) where there is peaty topsoil and surface waters ‘issue’ there is increased risk of flooding from waterlogged soils and standing water, which dictates that such areas should be avoided with regard to development where possible. **Figure 12.4** shows that NRW mapped surface water areas of Low Risk (between 0.1% – 1% AEP) intersect the planning application boundary, along the source headwaters of the Nant yr Hwyaid, Nant Cynon, and Nant Tryfal.

Plate 12.1 TAN 15 Development advice map



## Climate

Standard Annual Average Rainfall (SAAR) for 1961-1990 information obtained from the Centre for Ecology and Hydrology (CEH) Flood Estimation Handbook (FEH) CD ROM (version 3) for each catchment is displayed in **Table 12.5**. **Table 12.3** also gives a weighted average for the site which is 1887mm.

## Geology, hydrogeology and soils

### Geology

The bedrock in the area is the Rhondda Member, consisting of sandstone and thin interbedded coal seams. The area also has some underlying Llynfi Member, which is a conglomerate of sandstone with thin mudstone/siltstone and thin coal interbeds. The BGS Geoscience Data Index shows isolated areas of till (diamiction) that overlie the bedrock in the valleys of Nant yr Hwyaid and the uppermost reaches of Nant Tryfal and Nant y Fflon. It also shows that superficial deposits are absent for most of the site, including along the hilltops and side slope areas. The BGS data does not show peat coverage at the visible 1:50,000 scale. As noted there are, however discrete, isolated pockets of shallow peat which were identified on the flatter hilltops during the October 2013 site visits (see section on soils below). The BGS data also shows some very isolated, small unclassified landslide deposits within the site. There is no artificial ground within the site boundary.

A Coal Authority report confirms that the development area is within the likely zone of influence from workings in 11 seams of coal at shallow to 780m depth. The planning boundary is not in the likely zone of influence of any present underground coal workings. The planning boundary is not in an extent that is likely to be affected at the surface from any planned future workings. The coal authority report (see **Appendix 12B**) provides approximate positions of three mine entries within the planning boundary.

According to the report, the Coal Authority *"is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining"*.

Although it is anticipated that they will not have any cause for concern, given the proposed development overlies areas of coal, the Coal Authority should be consulted with regards final engineering design.

### Hydrogeology

The solid bedrock geology beneath the site is classified as a "Secondary A" aquifer by NRW and BGS. This is defined as *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers"*. Under the Water Framework Directive characterisation the entire development site is underlain by a single groundwater body, the Swansea Carboniferous Coal Measures.

Base Flow Index (BFI) was developed to help assess the low flow characteristics of rivers in the United Kingdom.

*"The BFI may be thought of as a measure of the proportion of the river runoff that derives from stored sources; the more permeable the rock, superficial deposits and soils in a catchment, the higher the baseflow and the more sustained the river's flow during periods of dry weather". NERC (2008).*

The weighted average BFI for the site is 0.39 which indicates that the site is relatively impervious with minimal lake or reservoir storage and the soils are clayey.

The BGS Groundwater Vulnerability Map classifies the majority of the site on higher ground as 'minor aquifer low', although small areas of the lower access routes are within a 'minor aquifer high' area, which indicates that the majority of the sites minor aquifer has low vulnerability of contamination from surface land use activities. The site is not located within a groundwater Source Protection Zone.

### Soils

Consultation of the Cranfield University Soilscales website finds that the vast majority of site is characterised as having ‘very acid loamy upland soils with a wet peaty surface’. All of the site (other than a short section of the access road, which follows the route of an existing forestry track) would be located on soils of this type. The peat survey carried out in 2013 (**Appendix 12C**) shows that across the majority of the site there is a thin peat layer between 0.1 and 0.3m in depth. Note that in some areas the peat is thicker (very localised depths of between 0.7 and 0.8m) and in others there is none at all.

Three known disused mine adits have been identified (see **Appendix 12B**) within the planning boundary. These adits may provide a preferential pathway by which surface waters may interact with groundwater or vice versa.

### Land use

The site consists of upland grassland across its full extent, with the exception of the access track which follows existing forestry (coniferous) tracks. The grassland within the site boundary is used for rough grazing and a range of grass types are evident across the site, some more intensively grazed than others. At the time of the site visit in April 2018, sheep and cows were grazing over the majority of the site.

In the valley bottom to the north there are small former mining villages and to the east of the proposed access track is the town of Maesteg. To the west and south is woodland and to the north is further grassland.

### Surface water quality

The two main rivers that the site discharges to i.e. the Afon Afan and the Ffrwd Wylt, are characterised as WFD waterbodies, for which NRW report surface water quality in the Western Wales RBMP. The Afon Afan and the Ffrwd Wylt waterbodies are assessed as being of Moderate overall status due to biological elements (fish) being of less than Good Status, and they are both classed as a ‘Heavily Modified Water Body’ (HMWB). The Afon Afan also has supporting elements (quantity and dynamics of flow) which are less than Good Status. For a HMWB ecology is measured on a scale of ecological potential, as opposed to ecological status. Ecological potential is defined as the best ecology that the water body can achieve without compromising its human use. A summary of the water quality information contained in the Western Wales 2015 RBMP for WFD Cycle 2 is presented in **Table 12.6**.

Table 12.6 Local WFD waterbody water quality data

Element	GB110058026130	GB110058026100
Waterbody	Afan-conf with Corrwg to confluence with Pelenna	Ffrwd Wylt – headwaters to tidal limit
Current overall ecological status	Moderate (Very Certain), HMWB	Moderate (Very Certain), HMWB
Chemical Status	Good	Good
Status Objective	Good Potential by 2027	Good Potential by 2027
<b>Biological Elements</b>		
Fish	Moderate	Moderate
Macroinvertebrates	High	High
Phytobenthos	High	High

Element	GB110058026130	GB110058026100
<b>Chemical Elements</b>		
Ammonia (Phys Chem)	High	High
Dissolved Oxygen	High	High
pH	High	High
Phosphate	High	High
Temperature	High	High
Copper	Good	Good
Zinc	Good	Good
Ammonia (Annex 8)	High	High
<b>Supporting Conditions</b>		
Quantity and Dynamics of Flow	Does not Support Good	Supports Good
Morphology	Supports Good	Supports Good

Both of the local WFD waterbodies in the vicinity of the site are failing to meet Good Ecological Potential as a result of being at less than Good status for fish. Besides fish, copper and zinc, both of the waterbodies are found to have high current status for all other constituent chemical elements. The Afon Afan and the Ffrwd Wylt are categorised as Moderate status for fish. There are a number of reasons why fish could be failing to reach good status, for example relating to barriers to migration or as a result of recruitment issues. Overall the information in **Table 12.6** indicates that the surface water from the watercourses draining the site is either of good or high quality.

The minor watercourses draining the site boundary, and forming tributaries of these rivers, are not defined as waterbodies under the WFD, and no other data are available to define water quality within them. It is notable that almost the entire downstream area of the Nant Cynon and the Nant Drysiog subcatchments i.e. the areas downstream of the site boundary, are afforested with coniferous plantation, which is likely to have a large influence on the water quality and runoff characteristics of these tributary streams. Coniferous plantations can potentially affect the hydrological environment via (during standing and deforestation phases) acidification processes, sediment delivery, nutrient enrichment, shade and shelter, water yield and peak flow considerations etc. It is likely therefore that the sensitivity of the Nant Cynon and Nant Drysiog watercourses on site is reduced because of the land use downstream of the site.

### Groundwater quality

The site is underlain by a single WFD groundwater body (GB41002G201000), the Swansea Carboniferous Coal Measures. The current overall status of the waterbody is reported by NRW within the 2015 Western Wales RBMP to be Poor, due to the chemical classification component being of Poor Status.

There are a number of disused adits within the development site, however considering the Good Chemical status of the surface water bodies in and around the site, as shown in **Table 12.6**, the current Poor Status of the groundwater body underlying the site is likely to be related to failures or features (e.g. mine workings) elsewhere, rather than in the immediate vicinity of the site.

### Historic mine workings

The latest Coal Authority Report (received in April 2018) confirms that the planning boundary is within the likely zone of influence from workings in 11 seams of coal at shallow to 780m depth, which were last worked in 1980. The planning boundary is not in the likely zone of influence of any present underground coal workings and is not in an area that is likely to be affected at the surface from any planned future workings.

The previous Coal Authority Report (received in September 2013) indicated that there are 10 historic mine entries within the wider site boundary which are shown on a plan. Within 20 metres of the planning boundary, there are three historic mine entries confirmed, and the latest Coal Authority Report (**see Appendix 12B**) which is targeted around the proposed infrastructure works provides approximate positions within the planning boundary. The records disclose the following information for each historic mine working:

- 283193-008 - No treatment details;
- 284193-036 - Adit sealed with compacted brick rubble and backfilled with soil. 4.3 m square fence erected; and
- 283193-007 - No treatment details.

As already reported, the Coal Authority "*is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining*".

It has not received a damage notice or claim for the site boundary or within 50m of its extent since October 1994, and it has no record of a mine gas emission requiring action.

A Coal Stability Risk Assessment, undertaken by James Associates, is presented in **Appendix 12B**. It identified six proposed turbines which lie within zones of potential impact associated with abandoned mining. The assessment recommends a programme of site investigation works be undertaken around the following turbines: T1, T2, T3, T4, T8 and T9, in addition to further mitigation measures which are suggested in Section 12.8 within this chapter.

### Water abstractions

Information on licensed abstractions has been obtained from NRW (5km radius from a central NGR of 283905, 193920), which is presented within **Table 12.7**. The Glyncorwg Ponds abstraction is located 4.1km to the north east of the site boundary, and the Nant Cwm Du is located 4.3km to the south east of the site boundary. No pathways exist via between these abstractions and the proposed development, therefore they have been scoped out from further assessment. The Maesteg Golf Club groundwater abstraction is located approximately 470m to the south of the site boundary entrance off the B4282, and this licensed abstraction has been considered further within Section 12.10.

Information on Private Water Supplies (PWS) was requested from Bridgend County Borough Council and Neath Port Talbot County Borough Council. Bridgend Council provided details of a groundwater spring situated approximately 770m to the west of the site boundary, within the Unnamed SE Catchment of Nant Llynfi. Neath Port Talbot County Borough Council provided details of a single private water supply, within the same catchment as the proposed development (Nant yr Hwyaid), as presented in **Table 12.7**. Both of these private water supplies have been considered further within Section 12.10.

Table 12.7 Abstractions in the vicinity of the site boundary

Abs No.	Information Source	Name	Grid Reference	Any Other Information	Connectivity
1	NRW	Maesteg Golf Club	283800, 191400	Agriculture and Irrigation (Groundwater spring)	<500m from site entrance (within Nant Cwmfarteg subcatchment) so potential connectivity will be assessed – see PWS discussions in Section 12.10.
2	NRW	Glyncorwg Ponds Cooperative Ltd	286600, 197800	Lake & Pond Throughflow	None, within different surface water catchment
3	NRW	Nant Cwm Du at Melin Pont Rhyd Y Cyff	287400, 189400	Production of Electricity Surface Water	None, within different surface water catchment
4	Neath Port Talbot County Borough Council	Nant Y Whiad Farm, Cynoville, Port Talbot	282739, 195085	Private water supply – unknown use. No further info, but likely to be surface water supply given location of stream.	Downstream of site within Nant yr Hwyaid subcatchment. so potential connectivity will be assessed– see PWS discussions in Section 12.10.
5	Bridgend Council	Garnwen Farm, Nantfyllon, Maesteg	284700, 192500	Groundwater Spring	<1km from site access track within Unnamed SE Catchment of Nant Llynfi so potential connectivity will be assessed – see PWS discussions in Section 12.10
6	Walkover	Hendre-owen PWS	283700,195300	Open topped collection tank collecting surface water for farm water supply (agricultural building supply)	None – within Blaen Nant subcatchment.

### Water availability

The relevant NRW Catchment Abstraction Management Strategies (CAMS) have been reviewed (i.e. Neath, Afan and Ogmores CAMS, 2014) to provide an indication of the water availability in the local area. The extreme lower reaches of the Afon Afan are reported to be over-abstracted, which affects the freshwater input to the tidal section of the Afon Afan and limits the potential fish migration in the freshwater reaches. The entire Afon Afan water resource management unit is conservatively managed by NRW as being over-abstracted.

The Ffrwd Wyllt assessment was considered in conjunction with the Afon Afan assessment. It is deemed to be over-abstracted due to the large licensed abstraction from the docks.

The over-abstracted resource availability status of these rivers means that there is no water available for future licensing at low and medium flows.

The Afon Llynfi contributes to Water Resource Management Unit 5 of the Neath, Afan and Ogmore part of the 2014 Swansea Bay CAMS. Although a large industrial abstraction occurs on the Afon Llynfi, it is predominantly non-consumptive and the remaining abstractions are all relatively small. The resource availability status of this unit is deemed to be 'Water Available'.

### Licensed discharges to water

NRW have provided details of consented discharges within a 5km radius of NGR 283905, 193920, which is presented as **Appendix 12D**. All discharges are located outside of the site boundary.

### Designated sites

Defra's interactive MAGIC website has been reviewed and this confirms that there are no water dependent designated sites or species associated with the site boundary, and that there are no aquatic designated sites downstream of the site boundary.

### Water dependent habitats

The most notable water dependent habitat present within the proposed development area is the presence of peat.

In order to assess the distribution and depth of peat across the proposed development site a comprehensive peat survey was undertaken as part of the 2014 ES, and the results are presented as peat spot depth and peat depth interpolated area figures presented within **Appendix 12C**.

Although the spatial extent of peat was found to be large i.e. the vast majority of the planning application boundary surveyed was found to exhibit peat deposits, the depth of the peat was generally shallow. The vast majority of the surveyed area was found to have peat depth of less than 0.3m, with large areas particularly in the north and the north west having less than 0.1m peat depth. Six individual cores recorded peat depths of between 0.7 and 0.8m. In all cases these areas of peat between 0.7 and 0.8m deep were found to be very localised. Good coverage of survey locations provides a high degree of confidence in the extent of these deeper pockets, one of which corresponds to an area (around the source of the Nant yr Hwyaid) already identified via the hydrology walkover survey as a potential 'hydrological constraint' that requires a buffer zone. No peat greater than 0.8m depth was found at any location within the planning application boundary.

### Summary of the existing baseline and potential constraints to development

The site boundary is in an upland location that drains primarily to the Afon Afan to the north. The site currently comprises rough grassland. Evidence of adits reflects previous mining activity beneath the site. The baseline characterisation identified no significant hydrological constraints to development.

The pertinent aspects of the baseline hydrology and hydrogeology of the site include:

- No main rivers or WFD surface waterbodies within the site. Within 500m of the site are two main rivers. There are several small watercourses within the site boundary. Some of these channels have been found to be ephemeral and were either dry or low during the site walkover in October 2013 and April 2018. The majority of the site is drained by tributaries flowing towards the Afon Afan to the north;
- The current primary land cover is one of long, rough, acidic grasses;
- The site overlies a 'Secondary A' aquifer and a small number of private water supplies (or licensed abstractions) exist in the vicinity of the site boundary;

- Overall Ecological Status of the downstream WFD waterbodies is moderate. There is a failure to meet Good Ecological Potential due to the current assessment of fish populations which is related to physical barriers to migration;
- Water quality of the underlying WFD groundwater body is poor on account of copper concentrations; and
- The extent of peat coverage is large across the site, although depths are generally shallow (<0.3m).

### Predicted future baseline

Hydrological systems do not remain constant with time. Changes to the hydrology of the site could occur in future, mainly as a result of land use change and climate change.

The Coal Authority has stated that they do not know of any plans for coal mining at the site in future, although coal is still present and so could potentially be mined again. There are unlikely to be any other substantial changes in land use during the lifetime of the wind farm, given the location and land type. Afforestation could theoretically be possible given the current adjacent forestry plantations however there are no known plans for this. Deforestation of plantation areas is a predicted future activity for large percentage areas of the Nant Cynon and the Nant Drysiog catchments, outside of and downstream of the site boundary. Even assuming good deforestation practice (adhering to UKFS guidelines on Forests and Water) such activities are likely to have considerable effect on the water quality and runoff characteristics of these streams. These activities are anticipated to occur either with or without the presence of the proposed scheme.

Future changes in global climate are predicted. For Wales, the latest climate change predictions are from UKCP09, which indicate changes from the baseline period (1961-1990):

- By the 2020s, the low, medium and high emissions scenarios all predict an increase in winter and summer temperatures. For the medium emissions scenario, the central estimate of increase in winter mean temperature is 1.3°C, and increase in summer mean temperature is 1.4°C.
- By the 2020s, the low, medium and high emissions scenarios all predict an increase in winter rainfall and decrease in summer rainfall. For the medium emissions scenario, the central estimate of increase in winter mean precipitation is 7% and decrease in summer mean precipitation is -7%. Overall there would be little change in total annual rainfall.
- By the 2050s, the low, medium and high emissions scenarios all predict further increase in winter and summer temperatures. For the medium emissions scenario, the central estimate of increase in winter mean temperature is 2°C, and an increase in summer mean temperature is 2.5°C.
- By the 2050s, the low, medium and high emissions scenarios all predict further increases in winter rainfall and decreases in summer rainfall. For the medium emissions scenario, the central estimate of increase in winter mean precipitation is 14% and decrease in summer mean precipitation is -17%. Overall there would be little change in total annual rainfall.

The higher rainfall in winter could result in higher river flows and potentially greater frequency of flooding. The lower rainfall in summer, coupled with higher temperatures, could lead to higher evapotranspiration and drier conditions during the summer months. These potential future baseline changes have been considered in relation to the vulnerability of the receiving environment to major accidents and natural disasters as part of the assessment of effects.

## 12.6 Consultation

Consultation was carried out with consultees including Neath Port Talbot County Borough Council and Bridgend County Borough Council, NRW and the Coal Authority. Bridgend Council did not make any comments in relation to the scope of the assessment. **Table 12.8** provides a summary of the issues that have been raised by the other consultees and the responses given.

Table 12.8 Summary of issues raised regarding water resources and ground conditions during consultation

Issue raised	Consultee(s)	Response and how considered in this chapter	Section Ref
NRW advised that baseline monitoring e.g. water features survey should be updated to include any new water features that may have appeared since the last survey was completed.	NRW	The findings of the water features survey was checked and updated during a site visit which was carried out on 19 April 2018. There were no new water resources or ground conditions features encountered during this walkover.	Section 12.5 and <b>Appendix 12A</b>
The Coal Authority advised that the proposed development is located within the defined Development High Risk Area, and that the site has been subject to past coal mining activity. In accordance with the risk-based approach, past coal mining activities should be fully considered as part of the ES; this should take the form of a risk assessment, together with any necessary mitigation measures.	Coal Authority	This assessment has taken into account the Coal Authority Consultation Report received on 20 April 2018. This has helped inform the section on existing baseline conditions, and the further assessment which takes into account appropriate mitigation measures in relation to past coal mining land use activities.	Sections 12.5, and 12.10, <b>Appendix 12B</b>
The Coal Authority notes the EIA Scoping Report acknowledges that there will be an update to the assessment carried out in the Water Resources and Ground Conditions chapter of the ES, which will constitute the required Coal Mining Risk Assessment. The Coal Authority welcomes this in meeting the requirements of the National Policy. The proposed site layout should be informed by any coal mining legacy features associated with past mining operations.	Coal Authority	The past mining activities including disused mine entries have been described within the hydrogeology part of the baseline section. It has been concluded that although there are 3 disused mine entries and 11 coal seams in the vicinity the planned works area, the site is not in an area that is likely to be affected at the surface from any planned future workings. The Coal Authority will be consulted during the final engineering detailed design of the site layout.	Sections 12.5, 12.10, <b>Appendix 12B</b>
There are a number of coal mining legacy issues that can potentially pose a risk to new development and therefore should be considered as part of an Environmental Statement for development proposals within coalfield areas: <ul style="list-style-type: none"> <li>- The location and stability of abandoned mine entries;</li> </ul>	Coal Authority	This assessment has taken into account the Coal Authority Consultation Report, which includes information on these legacy issues, which have been taken into account as part of the baseline and impact assessment, supported by an appendix which investigated previous underground mineworking activity and its potential impact upon the proposed development.	Sections 12.5, 12.10, <b>Appendix 12B</b>

Issue raised	Consultee(s)	Response and how considered in this chapter	Section Ref
<ul style="list-style-type: none"> <li>- The extent and stability of shallow mine workings;</li> <li>- Outcropping coal seams and unrecorded mine workings; and</li> <li>- Hydrogeology, minewater and minegas</li> </ul>			
<p>Consideration should be afforded as part of development proposals and the ES to the following:</p> <ul style="list-style-type: none"> <li>- If surface coal resources are present, whether prior extraction of the mineral resource is practicable and viable; and</li> <li>- Whether Coal Authority permission is required to intersect, enter or disturb any coal or coal workings during site investigation or development work.</li> </ul>	Coal Authority	The past mining activities including disused mine entries have been described within the hydrogeology part of the baseline section. It has been concluded that although there are three disused mine entries and 11 coal seams in the vicinity the planned works area, the site is not in an area that is likely to be affected at the surface from any planned future workings. The Coal Authority will be consulted during the final engineering detailed design of the site layout.	Sections 12.5, 12.10, <b>Appendix 12B</b>
<p>Table 2.6 of the report states that the 2013 peat survey found no deep peat deposits (&gt;1m). We advise that NRW considers &gt;0.5m as deep peat. We would therefore require clarified if deep peat deposits are present on site (in accordance with the &gt;0.5m threshold). For any updated surveys carried out, it should be ensured that the standard practice is to carry out 1 peat probe per hectare of development, and then 1 peat core per 10 peat probes, to be consistent with NRW's advice for windfarm applications.</p>	Neath Port Talbot Council	The findings of the 2014 Final Peat Study presented in <b>Appendix 12C</b> remain valid. This study comprised of a comprehensive peat survey, with methodologies including peat probing across proposed infrastructure elements and coring at each proposed turbine base. Whilst a few areas of 'deep peat' (>0.5m) were identified, infrastructure has been microsited to avoid these. For example, Turbines 7 and 8, and a section of access track between Turbine 4 and 10, have been microsited to avoid any deeper peat pockets.	Sections 12.5, 12.10, <b>Appendix 12C</b>

## 12.7 Scope of the assessment

The final scope of assessment is as presented above as informed by scoping opinion responses from statutory consultees.

### Spatial scope

The site boundary and a 1km surrounding radius has been included within the final study area with regards hydrogeological considerations. A 500m radius beyond the site boundary and all associated downstream watercourses have been considered where relevant to the surface water (hydrology and water quality) assessment.

## Temporal scope

The temporal scope of the assessment of water resources and ground conditions effects is consistent with the period over which the proposed development would be carried out and therefore covers the 12-24 month-long construction period and the subsequent 25 year-long operational period.

## Potential receptors

The potential receptors that have been identified through consideration of the baseline assessment and the proposed scheme type and extent are as follows:

- On site watercourses – Tributaries of the Nant Cynon, the Nant Hwyaid, the Nant Tryfal and a tributary ditch associated with the Nant Drysiog may potentially be directly affected by the development (in terms of water quality, water quantity and hydromorphology);
- Downstream watercourses – limited to the Afon Afan, which could be potentially indirectly affected by the scheme in terms of water quality and quantity via the pathway of the tributary watercourses which drain from the site. A lack of interaction with the single tributary ditch associated with the Nant Drysiog dictates that there will not be an impact on the downstream water quality and quantity of the Ffrwd Wylt, which may be scoped out of further consideration in this study;
- Flood risk receptors – people and property downstream of the site boundary along the Afon Afan at risk of fluvial flooding;
- Peat hydrology – Peat is a specifically water dependent soil and habitat type;
- On-site soil hydrology – Further to consideration of peat, shallow hydrological flows within soils is defined as a receptor due to the upland nature of the environment and low weighted BFI;
- Ground stability – Geotechnical and slope considerations for the stability of the proposed development;
- Swansea Carboniferous Coal Measures WFD Groundwater body – with respect to groundwater quality and groundwater quantity; and
- Private Water Supplies (PWS) and a NRW licensed abstraction.

## Potentially significant effects

The main types of hydrological issues that could potentially be of concern with respect to the proposed development include:

- The risk of pollution to onsite and downstream watercourses. Run-off, with elevated levels of suspended sediments or contaminated by polluting substances (e.g. concrete and hydrocarbons), may drain to watercourses flowing through and downstream of the proposed development site. Run-off therefore needs to be managed to prevent degradation of the surrounding water features. This would be most relevant during the construction phase due to the level of activity on site, but could also occur to some extent during the operational phase without ongoing maintenance of site infrastructure (e.g. installed trackside and Substation drainage);
- Potential changes to the flow regime in watercourses on the proposed development site and downstream. This could occur due to increasing areas of hardstanding, disruption of flow paths, or changes to drainage regime. This may occur as a result of activities during the construction phase, but with potentially long-term effects as long as the infrastructure remains;

- Changes to the morphology of watercourses, particularly where watercourse crossings will be provided. Particular consideration needs to be given to the appropriate design of any such watercourse crossings;
- The potential risks to groundwater flow and quality as, even though the proposed development site is underlain by relatively low permeability strata, they are still classified as a Secondary A aquifer. Construction activities will require the use of substances that could be polluting to groundwater, and excavations for turbine bases have the potential to provide rapid pathways to groundwater. Good practice and mitigation therefore needs to be considered to ensure that pollution to groundwater does not occur. This is of most relevance to the construction phase;
- Potential changes to peat hydrology. The 2014 ES contained a standalone Peat Study which remains applicable given that the proposed infrastructure has remained unchanged, apart from the exclusion of two turbines (T12 and T13). Based on the careful design measures which were incorporated during wind farm layout proposals, summarised in Section 12.8 of this report, it is considered that this along with the good construction practice put forward in Section 12.8 will be sufficient to avoid any significant effects as a result of the proposed development;
- Potential implications regarding flood risk. The site boundary is not located within a floodplain (i.e. it is located in Flood Zone A) and as noted in the 2014 ES NRW confirmed it does not require a specific Flood Consequence Assessment. Assessment of fluvial and surface water flood risk is taken into account within consideration of surface water runoff and drainage within this chapter; and
- Potential effects upon private water supplies or other abstractions within the site boundary or downslope of the site boundary (where the site is found to be in the catchment area of the relevant abstraction).

## 12.8 Environmental measures embedded into the proposed development

A range of environmental measures have been embedded into the development proposals as outlined in Section 5.4 of **Chapter 5: Description of the Proposed Development** of this ES. Measures relating to the Water Resources and Ground Conditions are described below and summarised in **Table 12.10**.

### Pollution prevention guidance and pollution prevention plan

Construction Method Statements (CMSs) will be produced for all aspects of site work. A Pollution Prevention Plan (PPP) will be implemented and monitored by the site manager as part of the CMS. The CMS will be consulted upon and approved by the local planning authority and relevant consultees, and it will apply to potentially polluting activities during all phases of the development.

As a minimum the PPP will comply with best practice guidance related to design and construction as advocated by CIRIA and the revised Netregs (2017) Guidance of Pollution Prevention (GPPs) outlined in Section 12.3. The PPP will identify site specific measures, and incorporate a Pollution Incident Plan, which will include emergency contact details, details of spill kits on site, and instructions on actions in case of spillage/emergency.

## Construction phase

### Buffer zones

As a precautionary measure, buffer (exclusion) zones to water features are adopted as constraints to built development and for incorporation as a construction phase buffer in relation to permissible land uses in proximity to watercourses. During construction these buffers will be avoided except at the locations of the two proposed watercourse crossings.

Establishment of intact vegetated buffer zones between infrastructure (including tracks) and water features allows:

- Protection of water quality by filtering runoff within riparian vegetation before it enters the watercourse (as per SuDS best practice);
- Space for natural fluvial processes such as channel shape and platform adjustment therefore maintaining the natural dynamic balance of river systems and associated habitats;
- Establishment/maintenance of vegetation to stabilise banks and reduce soil erosion;
- Access for the maintenance and inspection of watercourses, and for dealing with pollution incidents; and
- Habitats for plants and animals and maintains wildlife corridors, which can be associated with river networks.

The sensitivity of a watercourse and the associated extent of buffer that it should be afforded, is dependent upon a range of factors, including:

- Environmental designations associated with the watercourse or a downstream environment;
- Fisheries or ecological potential of the water feature or in the downstream environment;
- Size of water feature and its capacity to convey water;
- Water feature morphology (e.g. natural or artificial channel, substrate and banking type);
- Nature and topography of the surrounding land, i.e. wet, poorly drained soils and steep slopes (>10°) would require greater protection; and
- Other sensitivity considerations, e.g. silts/nutrient enrichment/chemical pollution.

In the absence of specific relevant guidance for Wales, additional reference has been sought from other UK sources, e.g.:

- Scottish Environmental Protection Agency (SEPA) and Scottish Natural Heritage (SNH) guidance provided in Scottish Planning Advice No.2 (2011) summarised in the following **Table 12.9**;
- PPG5 "Works in or close to water" which recommends that works such as concrete mixing and washing should take place 10m distant from watercourses; and
- Other best practice in relation to management of sediments and nutrients, e.g. standards of good agricultural and environmental condition (GAECs) under cross compliance (10m buffer around watercourses with regards to application of organic manure).

Table 12.9 SEPA and SNH guidance of watercourse buffer distances

Width of watercourse	Width of buffer strip
Ditches	3m
Less than 1m	6m
1-5m	6-12m
5-15m	12-20m
15m+	20m+

All on-site watercourses (within 100m of any planned development or access routes) are less than or at maximum 1m in width. Based upon the guidance presented in **Table 12.9** buffer strips of 6m width would be appropriate for application across the proposed development, however the scheme has been designed where possible to maximise the distance from watercourses and a presumption of a 20m+ buffer zone was employed across the development during design. Under the final proposed layout there were three locations where the final development layout necessitated a distance of less than 20m from a watercourse thus, although still in excess of the guidance presented in **Table 12.9**; further consideration and specific mitigation measures have been employed at these locations (see **Figure 12.5** and the additional design mitigation below).

**Additional design mitigation where buffer zones of <20m are possible**

The final wind farm layout was influenced by the requirement to maintain buffer zones around watercourses. The final layout, on account of compromises with regards to elevations and road contours for example, necessitated three locations where development is proposed within a distance of 20m from a watercourse. Further consideration of these locations was made and specific environmental measures designed to mitigate against any potential effects.

Turbine 3 (T3) is situated approximately 25m from a small tributary of Nant Cynon. The associated crane hardstanding final layout boundary was found to be located in close proximity to this small tributary (as marked on the OS 10k plan). The hydrological walkover examined the topography at the proposed T3 location and confirmed that any surface runoff would be diffuse and spread over approximately 180 degrees i.e. only a portion of runoff would be directed toward the nearby stream. Furthermore, the location of the small tributary was found to be slightly further north than represented on the OS plan i.e. the distance is in actual fact greater than shown on **Figure 12.5**. The existing field boundary fence which broadly demarcates the edge of the site boundary is installed approximately 8m parallel to the stream and maintains a riparian strip of longer grasses and rushes (e.g. *Juncus effusus*) which will serve to act as an effective buffer strip for sediments etc. Given that the distance to this watercourse is less than the 20m adopted elsewhere for this project further mitigation is proposed (to ensure a precautionary approach with regards potential water quality effects). A minimum of 60m of sediment fencing will be installed parallel and adjacent to (set back distance of approx 3m) the small tributary i.e. 20m u/s and 40m d/s of the nearest development activity. The small nature of this tributary, the parallel installation (on left bank) and the steep longitudinal slope all confirm that the sediment fencing will not present a flood risk. The sediment fencing will be maintained until such time as the T3 surrounds (bankings etc.) are fully vegetated.

The final layout of the hardstanding area associated with Turbine 11 (T11) brings it within 20m of a watercourse shown on the OS 10k map i.e. brings it within the scheme’s preferred buffer zone extent. The hardstanding area is 10m from the watercourse channel therefore it is still compliant with the recommended buffer of 6m in **Table 12.9**. The watercourse which forms through a convergence of the two field boundary ditches was found during the site walkovers to be a dry ditch with little evidence of water inundation (likely



to be dry for the majority of time). It is proposed that a 20m length of sediment matting is installed in the bed of this ditch, in order to capture any suspended sediments that may be generated from the construction area upstream around T11.

The hardstanding areas associated with Turbine 8 (T8) are located 6m from a watercourse shown on the OS 10k map. The site walkover observations (see **Table 12.4**) confirmed that this feature is a very small and indistinct ditch (not a well-defined channel and generally <0.2m width) that flows eastwards to the Nant Tryfal subcatchment (in contrast to the impression given by the OS map, which indicates that it flows westwards towards the Nant Cynon). An area of saturated ground at NGR 283922, 194093 (photo 975, **Appendix 12A**) was also identified. Based upon the guidance presented in **Table 12.9** above, a buffer zone of 3m width would be appropriate for application for the watercourse in close proximity to T8 which will be maintained at all times. The small piped track crossing identified during the walkover (which is currently silted up, and blocked by debris, contributing to local surface saturation) will be upgraded at the start of the construction phase (prior to construction works at T8). Given the proximity of this small ditch and also the local ground conditions additional (precautionary) mitigation against sediment laden runoff will be implemented. The entire north and eastern boundary of the T8 works (including associated hardstanding) and associated construction compound will be surrounded by sediment fencing, which will effectively isolate the construction area from the small ditch to the north.

### Access roads

There are no existing tracks across much of the site (beyond the existing forestry access track), and as a result new tracks will be required. However the track length has been kept to a minimum, and, where possible, turbines are located in series along the same track. Of the 11 turbines only T3 and T7 are located in positions that require short individual access tracks (on account of topography and to minimise the number of watercourse crossings).

In order to minimise the potential for any effects on the water environment from the introduction of access tracks, the following measures will be taken during construction:

- Finished track level will be above the surrounding ground level and the track surface will have suitable lateral fall to allow surface water to drain laterally with avoidance of drains where possible in order to retain baseline saturation levels (typical track cross sections are shown in **Figure 5.4**);
- Where drains are deemed necessary alongside tracks e.g. where overland and shallow surface water flows may collect against the upper slope face of track embankment, the drains will comprise vegetated swales to help encourage infiltration whilst diverting run-off to lateral cross drains. The correct invert depth and profile will allow excess water to drain ultimately to a watercourse, while vegetation will retain run-off from smaller events and encourage local infiltration and retain sediment. Multiple points of discharge to watercourses will ensure dispersal of discharges and minimise any impacts on existing hydrology. The location and spread of discharge points will be shown in drainage management figures that will form part of the CMS;
- Cross track drainage will be installed where ground saturation conditions indicate an area of groundwater connectivity;
- Silt traps (in the form of in-channel berms, silt fencing and silt mats) will be included in drains to capture suspended solids in runoff;
- Water bars will be placed at regular intervals in the track to slow surface water flows, facilitate settlement of entrained solids and to ensure run-off is not increased above existing greenfield run-off rates. The frequency of water bars will be influenced by the nature of the prevailing

topography, with more bars being used where the terrain is steeper, although a maximum gradient of 8 degrees should be noted;

- Where necessary the use of swales and ponds will assist in the attenuation of runoff from the site to pre-development (Greenfield) rates;
- Appropriate materials will be used for access roads construction, which do not have the potential to release harmful substances or be easily eroded (i.e. no acidic, alkaline, metal or sulphur-rich spoil from mine workings), thereby minimising the risk of pollution to watercourses. Granular material (from local quarries) will be used for the road beds as far as possible, so as not to create completely impermeable and smooth surfaces, allowing some infiltration of rainfall. There will also be a greater degree of trackside infiltration following runoff from the track surface towards adjacent swales. Limestone aggregate will not be used due to its potential to influence the acidity of surrounding water and dependent habitats (e.g. areas of acid grassland present); and
- Given the shallow nature of the peat across the entire site, there is no requirement for consideration of any 'floating road' sections, even on sloping sections (see further discussion below).

### Watercourse crossings

Watercourse crossings have the potential to affect surface water quantity, quality and disrupt aquatic ecosystems. The layout of the site and the access tracks has therefore been optimised to minimise the number of watercourse crossings as far as possible. The access track has for example been routed along the saddle of the Foel Trawsnant to avoid crossing the Nant Tryfal and a tributary of the Nant Cynon.

One new crossing of a minor watercourse is required at approx. NGR 283700,194100 (shown for example on **Figure 12.2**). The watercourse at the crossing location is a small stream approximately 0.25m in width. This stream channel sits at the bottom of a shallow (approx 1.2m deep) v profile, the cross section of which sits below the level of the adjacent land. It is assumed for the purposes of this assessment that the crossing will be achieved by culverting the watercourse as per the previous planning submission i.e. assuming a worst-case scenario in terms of hydrological considerations, however the cross section of the channel lends itself well to potential installation of a single span crossing.

The only other watercourse crossing is associated with a possible upgrade to an existing crossing point (existing culvert) on the access track i.e. crossing of a small headwater tributary of the Nant Drysiog, at NGR 283800, 192950. The existing culvert is likely to need upgrading, especially if the existing forestry track requires widening.

The design of the culvert/crossings will be agreed with the Lead Local Flood Authority (LLFA) (a typical culvert detail is illustrated in **Figure 5.5**). Consultation with the LLFA regarding culvert design will take place as part of the CMS consultation and specifically with the LLFA during the determination process for a Flood Defence Consent (which is anticipated to be required under the Land Drainage Act). The culvert(s) will be designed in accordance with the CIRIA Culvert Design and Operation Guide (1997). The length of the culverts will be restricted to a minimum at both crossings. Neither of the culverts will have a significant effect on drainage or flowpaths.

Downstream of all crossing points, sediment fencing or sediment matting will be installed (and maintained) within the channel to mitigate against any increased suspended sediment runoff that may occur during the construction of the crossings or that may be associated with track runoff during subsequent phases.

## Electric cables

It is assumed that electric cables will be laid in trenches alongside the access roads, thus minimising new land take and potential erosion and minimising trench slopes. As far as is practicably possible, trenches will be dug in sections (over short distances of nominally 50-100m) during drier periods, in order to reduce the possibility of them acting as alternative drainage channels, with surface material replaced carefully and quickly. **Figure 5.8** shows a typical cable trench detail. Temporary silt traps will be installed for longer trench runs and plugs of soil left in place at regular intervals in the longer trench runs to prevent their acting as preferential subsurface flow pathways. Permanent impermeable clay bunds shall be placed in trenches that run perpendicular to steep slopes over extended distances or where local conditions encountered during installation dictate, in order to prevent the formation of preferential subsurface flow routes.

## Peat

Construction (e.g. tracks) upon areas of peat has the potential, without sufficient mitigation measures, to cause drainage, desiccation, and even liquefaction of the deposits. These impacts have consequences for water quality, erosion and subsequent watercourse sediment loads and water storage potential. Slumping and liquefaction of highly saturated thick peat deposits also pose issues of health and safety. These impacts are however constrained by peat thickness, saturation and hydrology.

A peat depth survey was commissioned as part of the 2014 ES to gain a greater understanding of the spatial distribution and depth of peat across the site to inform site design (see **Appendix 12C**). It is generally recognised that to minimise hydrological disruption and associated mitigation practices, peat depths exceeding around 50cm should be avoided where possible, whilst depths of less than 50cm, are unlikely to significantly constrain development layout.

The peat survey undertaken as part of the baseline characterisation established that peat depths across the site are shallow. There are no areas of peat in excess of 1m deep which may necessitate the use of 'floating track' construction methodologies as recommended within good practice guidance on floating roads on peat (SNH, 2010). The vast majority of the site is underlain by peat of less than 30cm depth and therefore there are no mitigation measures necessary beyond those that form part of good access track design.

Where, during the construction phase, ground saturation conditions are encountered that indicate areas of shallow groundwater connectivity, sufficient cross-track drainage will be installed beneath the access track to ensure maintenance of these hydrological pathways and prevent any drying out (which is deemed not to be likely on account of shallow peat cover).

## Excavation and management of spoil

Soil and subsoil excavation and movement (e.g. at turbine bases) will be undertaken in accordance with best practice guidelines such as Good Practice Guide for Handling Soils (MAFF, 2000). Where practicable the upper vegetated layer will be stored separately in order to maintain vitality and used to re-cover excavations on completion of the construction phase.

Areas of stockpiled spoil, including stored peat, would not be permitted within watercourse buffer zones (20m distance from all watercourses and defined exclusion zones), where it would obstruct the flow of overland surface water, or on steep slopes defined as greater than 2:1.

Formal drainage will be designed on a bespoke basis for spoil storage areas to allow controlled dewatering and prevent washout of suspended solids to the receiving water environment. As part of the CMS a spoil management strategy will be developed by the appointed contractor for the site. The lack of substantial peat deposits present on this site reduces risks associated with spoil storage.

## Wind turbine foundations & crane pads

The design of the turbine foundations is described in **Chapter 5: Description of the proposed development**, which will in part be dictated by the local ground conditions. Based on local groundwater level investigations a water exclusion strategy or pumping control measures will be adopted, based on CIRIA guidance and Netregs PPG6; typical measures are described in this section. The turbine foundation type and general ground conditions (e.g. depth to rockhead) minimise the depth of excavations required (typically to around 3m depth).

To avoid surface water run-off flowing into the excavations, cut off drains will be used on the top side of excavations. They will be designed to prevent high flow rates and will include appropriate sediment transport mitigation measures (typically sediment fencing). In the event that water should accumulate in the excavation despite the precautions taken, the excavation will be designed to allow gravity drainage as far as possible, with drainage through a limited number of controlled outlets, where sediment can be controlled through a series of settlement ponds or filtering systems and discharged onto open land (to reduce suspended sediment concentrations further). NRW will be consulted prior to construction (to be confirmed via consultation and confirmation of the CMS) to determine if Environmental Permits are required, as this is dependent on the duration of the discharge activity.

Should it become necessary to pump water from the excavation, permission will be sought for appropriate discharge locations, and NRW will be consulted to determine if Environmental Permits are required. Re-infiltration will be used where possible and the coarse, long acidic grasses characteristic of the site lend themselves to this purpose, but should local topography or ground conditions prove unsuitable for infiltration, water will be released at a controlled rate into the watercourses on site. The design for the dewatering will ensure collection and settling of suspended sediment (i.e. use of silt traps, silt fences, straw bales or lagoons) prior to discharge. Dewatering of water contaminated by cement or concrete would be retained on site for removal off-site by a licensed waste carrier in accordance with PPG requirements.

Specific drainage consideration needs to be given to Turbine 8, the proposed location of which is at the northeast corner of the proposed contractors' compound. It is situated in close proximity to an identified area of surface water ponding (see **Table 12.4**). The primary reason for this surface water ponding is the heavily silted blocked pipe culvert beneath the track at NGR 284000, 194000. This blocked pipe will be replaced with a new cross track drain at this location to assist in the effective drainage of excess surface water at this location, prior to other construction activities at T8. The construction area will be separated from the boggy area by silt fencing (see buffer zone discussions above).

For the reinforced areas of the crane pads the same mitigation measures as for access tracks will be observed in order to control sediment laden run-off. Crane pads will be reinforced using semi permeable granular material from local quarries (acidity neutral material i.e. not limestone), thus reducing surface run-off. The total area of hard standing at each turbine location including the turbine foundations and the crane pad will be approximately 990m<sup>2</sup> (22m x 45m). Approximately a third of this area will be dressed back with topsoil and landscaped into the surrounding area upon completion of turbine erection.

The dimensions of the reinforced concrete base slab at each turbine location will be approximately 15m x 15m x 2m, which will form part of the 22 m x 45m crane pad area, and in the context of a catchment or sub-catchment scale does not represent a significant impedance or obstruction to shallow groundwater flows. All proposed turbine locations are on relatively shallow gradients and downslope shallow groundwater flows are not expected to be affected.

Turbine foundation construction will need to adopt mitigation measures to prevent contaminants entering the shallow groundwater system, associated with the local Secondary A aquifer. The main potential groundwater effect arising from the construction of the wind turbine foundations and adjacent crane pads is the risk of leaking concrete residues into the water environment. To minimise the risk, excavations and concrete pouring for the turbines should be carried out in dry weather. Prior to concrete pouring, the

excavation should be lined with geotextile material in order to prevent concrete leaking into groundwater and sulphate resistant concrete formulas will be utilised to prevent acidic erosion over time.

### Sub-station and construction compound

The development proposals include a sub-station and two temporary construction compounds. The sub-station will remain in place for the lifetime of the development, while the temporary compounds will be removed once construction has been completed, with the ground surface being re-vegetated.

Sustainable drainage measures will be incorporated into the design of buildings and areas of hardstanding, for example, silt traps and vegetated swales. Any hydrocarbon or other chemical storage areas will be required to be on areas of fully impermeable hardstanding, to be bunded so that 110% of the stored capacity is provided, and to be located at least 20m from any surface watercourses or drains. Both compound locations are located at distance from watercourses. Areas for construction plant parking and refuelling will be also be on impermeable hardstanding, which will drain via a hydrocarbon interceptor, as discussed further below under 'site activities'.

### Flood risk and surface water management

Given the location of the turbine bases and crane pads at the higher elevations (with broadly flat or gently sloping slopes), disruption of natural near surface flow paths will be minimal.

To minimise increased flood risk from the development, the overall strategy inherent in the scheme design is to ensure that run-off rates do not exceed the greenfield run-off rate in any of the watercourses (strictly speaking at the boundary of the site, however greenfield run-off rate will be assumed for all points at which discharges to watercourses occurs). This is in accordance with TAN 15 and will be achieved through the use of sustainable drainage systems and attenuation techniques. Given the lack of interruption and interaction with regard the natural hydrological processes, the use of SuDS measures that include features such as trackside swales, filter drains at crane pads, and infiltration/attenuation basins at construction compounds, which in conjunction with buffer zones around watercourses will ensure greenfield run-off rates. As part of the CMS, which will be prepared in consultation with NRW, where there is identified a requirement for a large settlement lagoon (nominally greater than 10m x 10m in size) then the specific characteristics of the lagoon (i.e. storage capacity and discharge infrastructure/mechanism) will be designed to ensure greenfield runoff rates are adhered to.

It is anticipated that the planning conditions for the amended scheme would include the same requirement to prepare a drainage assessment (potentially as part of the CMS) as per the current conditions (planning condition no. 8) that will include sizing of the necessary attenuation systems to restrict run off to greenfield rates, including an allowance for climate change. It is reiterated again that the topography and hydrological characteristics of the site are likely to exclude the necessity for large attenuation lagoons (i.e. beyond attenuation measures incorporated into drainage channels and existing watercourses).

### Site activities

Site induction for contractors should include a specific session on good practice to control water pollution from construction activities. Contractors are to be made aware of their statutory responsibility not to "cause or knowingly permit" water pollution. As previously noted, a Construction Method Statement (CMS) will be produced detailing the mitigation measures discussed above, and a Pollution Incident Response Plan will be prepared for the site in line with Netregs PPGs and CIRIA good practice guidance. All contractors will be briefed on these plans, with copies made available on site. Equipment to contain and absorb spills will also be readily available.

Plant and machinery used during the construction phase need to be well maintained to minimise the risks of oil leaks or similar. Where it is possible, contractors will be encouraged to use (e.g. by applying a preference

at competitive appointment stage) biodegradable oils and lubricants for machinery used on-site. Maintenance and refuelling of machinery will occur only within designated areas of temporary hardstanding. Any major maintenance works will be conducted offsite. In the designated hardstanding areas, contingency plans should be implemented to ensure that the risks of spillages are minimised. Placing a drip tray beneath plant and machinery during refuelling and maintenance will contain small spillages (in addition to the hydrocarbon interceptor which will form part of the compound drainage infrastructure) and proprietary spill kits will be available.

The requirements for mitigating effects of dust and vehicle movements include the dampening down of areas potentially producing dust and the provision of wheel washing facilities. Areas where these activities occur should also provide measures for sediment capture within run-off, such as silt traps, settlement ponds or specialist silt removal plant, e.g. Siltbuster® type devices.

Throughout all phases of development best working practices will be adopted and measures to protect the water environment will be taken by adopting recommendations set out in the PPG and CIRIA guidance (as listed in Section 12.3). This will be secured through the PPP which will be implemented and monitored as part of the CMS.

Any silts that are removed from settlement features will be moved to adjacent bankings/adjacent land, where it will be allowed to drain and consolidate naturally. Sensitive habitat/sensitive vegetation will be avoided through consultation of habitat mapping undertaken in support of this environmental statement, prior to any removal and depositing of silts. Deposited silts will be reseeded at the earliest opportunity in order to allow prompt stabilisation.

### Monitoring

To ensure that the measures proposed above succeed in protecting the water environment within and downstream of the site, a programme of monitoring and inspection will be carried out during all phases of development, with increased frequency at times and in locations associated with construction activities. An increased frequency of monitoring checks should also take place after periods of heavy rainfall and before periods of forecast heavy rainfall. Auditable inspections (i.e. with associated recording of inspection activities) will include visual checks of culverts, watercourse sedimentation, installed sediment fencing, pollution prevention measures, hydrocarbon interceptors, stored chemicals on site etc. Maintenance (to clear blockages or remove silt) will be carried out in periods of dry weather where practicable.

It is not deemed necessary to provide a programme of water quality sample collection and analysis on all watercourses given the assessed low risk potential for water quality pollution and the mitigation measures proposed. It is proposed that water quality sampling and testing would be undertaken on the Nant yr Hwyaid, which is the watercourse most likely to be affected by the proposed development, on account of the proportion of infrastructure within its catchment. It is proposed that during the construction phase fortnightly water quality samples would be collected from the Nant yr Hwyaid at the point at which it crosses the site boundary and these samples would be submitted to a UKAS and MCERTS accredited environmental testing laboratory for the following range of parameters:

- pH;
- alkalinity;
- total hardness;
- total ammonia;
- ammonium;
- nitrite;
- nitrate;

- soluble reactive phosphorus;
- sodium;
- chloride;
- Biochemical Oxygen Demand (BOD);
- suspended solids;
- turbidity;
- total petroleum hydrocarbons;
- sulphate;
- soluble reactive phosphorus;
- total iron;
- dissolved iron;
- dissolved organic carbon; and
- total organic carbon.

This approach would be clarified with NRW and assuming such a programme were deemed necessary by the regulator (as suggested by the NRW scoping opinion), then this would be started a number of months prior to construction in order to establish a baseline.

## Geological and groundwater

Consultations with the Coal Authority have shown the location of disused adits in close proximity to T1, T2 and the access track that goes between these two turbines.

Following planning consent (should it be granted), and prior to the development of this area of the site, a targeted investigation including structural stability will be undertaken, specifically in relation to the location and risk associated with historical adits and focussed on this area of the site. This information would primarily be undertaken to inform engineering considerations i.e. to establish any risk to foundation integrity etc. It is assumed that micrositing of these turbines and the access track would allow identified adits to be avoided and any potential effects on ground stability due to shallow level abandoned mine workings may be readily engineered out by adopting ground stabilisation works. Any grouting works would be highly localised and would follow best practice; consequently negligible interaction with groundwaters is anticipated. Furthermore, given the intention to avoid adits and adopt suitable ground stabilisation works (where necessary) there will be no destabilisation of historic mine workings, or seams, as a result of the proposed infrastructure which can impact on hydrogeology and minewater in the vicinity of the site.

All excavations will be shallow and there are no proposals to excavate into bedrock, other than minor earthworks associated with establishing suitable foundations at turbine base locations. There are no proposals to establish borrow pits within the site boundary and aggregates will be sourced from offsite (established local quarries).

Tracks and crane pads have been routed and located to avoid slopes as far as practicable. Stockpiles, although anticipated to be minor given ground conditions, will not be located on steep slopes.

The peat survey confirmed no deep areas of peat which may give rise to peat slumping.

## Project design measures – operational phase

Environmental measures that form part of project design during the operational phase of the development include:

- Monitoring to ensure that best practice is adhered to on site and to help avoid pollution release to watercourses by incorporating PPG guidance into ongoing operational phase management policy (including storage of any oils/lubricants on site). Monitoring proposals will be identified as part of the CMS and will include (but not be limited to) weekly visual inspections of watercourses and chemical storage facilities;
- Permanent welfare facilities will be installed as part of operational control building facilities. Foul effluent will be controlled through use of chemical facilities with periodic removal for offsite disposal;
- Regular maintenance of permanent SuDS drainage features installed during the construction phase, including unblocking of drains, maintenance of site tracks and other hard standing surfaces, and removal of silt build-up from settlement features; and
- Any servicing works on infrastructure during the operational phase would be preceded by a risk assessment, which will consider environmental, including hydrological risk. Relevant control measures will be assessed and put in place prior to relevant works. As a pre-requisite the storage, use and disposal of oils etc will be done in accordance with best practice guidance (as identified in Section 12.3).

## Project design measures – decommissioning phase

Given that many of the activities that will be undertaken in the decommissioning phase are construction related and are common with the construction phase, the same measures set out above in relation to construction phase activities will be implemented during the decommissioning phase.

Where infrastructure will be removed during the decommissioning phase, this will be phased in such a way as to allow effective protection of the water environment at all times. For example, drainage infrastructure and in particular sediment control measures will be left in place until such time as all 'upstream' infrastructure is removed. Thus the order of infrastructure removal will be the reverse of the installation during the construction phase.

It is intended that turbine bases would be left in place in order to minimise the disturbance to the site, including the site hydrology.

**Table 12.10** outlines how these embedded measures will influence the water resources and ground conditions assessment. These were included in the 2014 ES and are equally applicable to this chapter.

Table 12.10 Summary of the embedded environmental measures and how these influence the water resources and ground conditions assessment

Receptor	Potential changes and effects	Embedded measures and influence on assessment
<b>Construction phase</b>		
<b>On site watercourses (Nant yr Hwyaid, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) and downstream watercourses (Afon Afan)</b>	Erosion of exposed ground, exposed foundations and track surfaces producing silt-laden runoff	<ul style="list-style-type: none"> <li>- Track length kept to a minimum, layout follows topography where possible;</li> <li>- Mapping and avoidance of key water features in design;</li> <li>- Cable trenches routed adjacent to tracks;</li> <li>- Use of SuDS techniques to control run-off, including silt traps, berms, sediment fencing, filter strips and buffer strips;</li> <li>- Water bars across access tracks where appropriate;</li> <li>- Trackside ditches and swales;</li> <li>- Soils stored on low gradients;</li> <li>- Permits to discharge applied for from NRW (if required following consultation of CMS) for any site discharges;</li> <li>- Micrositing to avoid key hydrological features;</li> <li>- Foundation design minimises excavation requirement;</li> <li>- Land disturbance minimised and quickly re-stabilised;</li> <li>- Take actions to prevent runoff from up-slope entering excavations (using cutoff drains or barriers, as appropriate); and</li> <li>- Works according to PPGs.</li> </ul>
<b>On site watercourses (Nant yr Hwyaid, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) and downstream watercourses (Afon Afan)</b>	Generation of sediment-laden runoff from stockpiled soils	<ul style="list-style-type: none"> <li>- Surface vegetation removed separately in order to recover;</li> <li>- Appropriate selection of stockpile locations;</li> <li>- Works according to PPGs;</li> <li>- Localised collection of stockpile drainage as appropriate;</li> <li>- Where long term stockpiling is unavoidable, undertake prompt reseedling; and</li> <li>- Stockpile peat separately to other soils.</li> </ul>
<b>On site watercourses (Nant yr Hwyaid, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Disturbance of watercourses at crossing points	<ul style="list-style-type: none"> <li>- Track layout designed to minimise watercourse crossings (one small stream crossing &lt;1m width and one small ditch crossing &lt;1m width);</li> <li>- Full culverting (disturbance of bed) avoided where possible, if not practical then box culverts to be used;</li> <li>- Series of d/s sediment fencing in channel compulsory.</li> <li>- Works according to PPGs and culvert design best practice; and</li> <li>- Works undertaken under Flood Defence Consent</li> </ul>
<b>On site watercourses (Nant yr Hwyaid, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Effect on ground instability; potential for interaction with groundwater and/or generation of silt-laden runoff	<ul style="list-style-type: none"> <li>- Steep slopes that may have landslip potential avoided in design;</li> <li>- Peat survey conducted and confirmation of no deep peat;</li> <li>- Geotechnical survey to be undertaken and micrositing of turbines conducted if necessary; to include investigation and avoidance via micrositing of known historical mine adits; and</li> <li>- Avoidance of steep gradient slopes for development</li> </ul>
<b>On site watercourses (Nant yr Hwyaid, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Disruption of natural flow pathways	<ul style="list-style-type: none"> <li>- Minimum 20m buffer zones around all surface water courses. Exclusion of all activities from buffer zones and further hydrologically sensitive sites.</li> </ul>
<b>Ground stability</b>	Potential to affect near surface ground stability	<ul style="list-style-type: none"> <li>- Steep slopes that may have landslip potential avoided in design;</li> <li>- Peat survey conducted and confirmation of no deep peat;</li> <li>- Geotechnical survey to be undertaken and micrositing of turbines conducted if necessary; to include investigation and avoidance via micrositing of known historical mine adits and</li> </ul>

Receptor	Potential changes and effects	Embedded measures and influence on assessment
		<p>standard ground stabilisation techniques e.g. grouting, as necessary; and</p> <ul style="list-style-type: none"> <li>- Avoidance of steep gradient slopes for development</li> </ul>
<b>Peat hydrology</b>	Drying out of deep peat; interruption of hydraulic pathways	<ul style="list-style-type: none"> <li>- Peat survey conducted – confirmed peat depths are shallow in all areas where infrastructure proposed. No requirement for floating tracks;</li> <li>- Track design e.g. cross track drainage to allow continuity of shallow groundwater flow;</li> <li>- Vigilance ensured by contractors to stay on tracks; and</li> <li>- Infiltration within proximal swales will be encouraged or SuDS systems to promote re-saturation where applicable.</li> </ul>
<b>Peat hydrology</b>	Disruption of natural flow pathways	<ul style="list-style-type: none"> <li>- Hydrological post consent walkover survey to consider final scheme layout;</li> <li>- Identification and exclusion of hydrologically sensitive sites;</li> <li>- Micro-siting to avoid observed flow pathways; and</li> <li>- Cross track drainage to ensure continuity of drainage.</li> </ul>
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Increased volumes of runoff and reduced infiltration	<ul style="list-style-type: none"> <li>- Track length kept to a minimum;</li> <li>- Use of road camber to shed water;</li> <li>- Use of swales and ditches to provide temporary storage and reduce run-off rates;</li> <li>- Buffer zones around all watercourses;</li> <li>- Diffuse discharges to watercourses (if necessary at all);</li> <li>- Control of discharge rates to Greenfield through appropriate infiltration and attenuation storage; and</li> <li>- Works according to PPGs and best practice SuDS design.</li> </ul>
<b>On-site soil hydrology</b>	Creation of new drainage pathways	<ul style="list-style-type: none"> <li>- Avoidance of key hydrological features;</li> <li>- Trenches dug in stages and during dry periods, where possible, and quickly backfilled;</li> <li>- Silt traps in longer trench runs;</li> <li>- Impermeable 'plugs' installed in trenches on slopes and adjacent to saturated areas to reduce potential for longitudinal water flow;</li> <li>- Working areas around foundations and crane pads will be revegetated as soon as possible; and</li> <li>- SuDS techniques used to control site run-off.</li> </ul>
<b>Peat hydrology</b>	Creation of new drainage pathways	<ul style="list-style-type: none"> <li>- Avoidance of key hydrological features;</li> <li>- Trenches dug in stages and during dry periods, where possible, and quickly backfilled;</li> <li>- Silt traps in longer trench runs;</li> <li>- Impermeable 'plugs' installed in trenches on slopes and adjacent to saturated areas to reduce potential for longitudinal water flow;</li> <li>- Working areas around foundations and crane pads will be revegetated as soon as possible; and</li> <li>- SuDS techniques used to control site run-off.</li> </ul>
<b>On-site soil hydrology</b>	Damage to soil profile	<ul style="list-style-type: none"> <li>- Best practice track construction methodologies;</li> <li>- Stockpiling of peat and distinct soil types separately;</li> <li>- Soils replaced carefully and quickly from the same area they were excavated; and</li> <li>- Cables laid in small trenches next to access tracks, where possible.</li> </ul>
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon,</b>	Concrete spillages (low pH potential) reaching surface waters	<ul style="list-style-type: none"> <li>- Turbines located at least 20m from watercourses; (with the exception of the hardstanding areas previously discussed at T8 and T11)</li> </ul>

Receptor	Potential changes and effects	Embedded measures and influence on assessment
<b>Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>		<ul style="list-style-type: none"> <li>- Sulphate resistant concrete formulas utilised;</li> <li>- Water tight shuttering as standard;</li> <li>- Emergency planning in place; and</li> <li>- Works according to PPGs.</li> </ul>
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Hydrocarbon/ chemical spillage associated with storage, refuelling and plant maintenance	<ul style="list-style-type: none"> <li>- Water pollution prevention measures included in contracts to enforce good practice;</li> <li>- Hydrological issues included in site induction;</li> <li>- Refuelling undertaken on hardstanding, using drip trays and oil interceptors;</li> <li>- All hazardous substances (oils, chemicals or fuels) must be stored on chemical bunds which are a minimum of 110% of the largest container stored in the area;</li> <li>- Security on the compound maintained vigilance and lockable pumps;</li> <li>- Refuelling only at designated stations;</li> <li>- No planned maintenance activities on site; and</li> <li>- Works according to PPGs.</li> </ul>
<b>On site watercourses (Nant Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Increase in flood risk	<ul style="list-style-type: none"> <li>- Overall strategy to ensure run-off rates do not exceed greenfield rate;</li> <li>- Use of SuDS measures;</li> <li>- If a large settlement lagoon is required (unlikely), then discharge mechanisms will be included to limit rates to greenfield; and</li> <li>- CMS to be prepared and agreed in consultation with NRW, which will contain a drainage assessment.</li> </ul>
<b>On site watercourses (Nant Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Changes to morphology	<ul style="list-style-type: none"> <li>- Buffer zones established around all watercourses;</li> <li>- Watercourse crossings constructed according to PPGs;</li> <li>- Diffuse discharges (if necessary) to watercourses; and</li> <li>- All discharges limited to greenfield runoff rates.</li> </ul>
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Discharge of welfare facility foul effluent affecting water quality	<ul style="list-style-type: none"> <li>- Foul effluent to be collected and controlled through use of chemical facilities with periodic removal (by a licensed contractor) for offsite disposal.</li> </ul>
<b>Groundwater quality (Swansea Carboniferous Coal Measures WFD GW body)</b>	Introduction of pollutants into groundwater through excavations/ ground stabilisation techniques	<ul style="list-style-type: none"> <li>- Excavations during dry weather where possible;</li> <li>- Use of geotextile lining in base of excavations, to prevent concrete entering groundwater; and</li> <li>- Any grouting of historic, shallow mine workings to follow best practice.</li> </ul>
<b>Groundwater quantity (Swansea Carboniferous Coal Measures WFD GW body)</b>	Reduction in recharge to the GW body	<ul style="list-style-type: none"> <li>- Use of semi-permeable materials with regards the access tracks and temporary hardstanding areas; and</li> <li>- Small spatial extent and depth of impermeable turbine bases is insignificant in the context of catchment scale and will therefore not impede recharge.</li> </ul>
<b>Private water supplies (PWS)</b>	Adverse chemical or quantitative effect on local PWSs	<ul style="list-style-type: none"> <li>- Further discussion on PWS has been provided in Section 12.10 and found that there is no hydrological continuity with the potential catchments of the local PWS, and therefore no specific measures are required.</li> </ul>
<b>Operational phase</b>		
<b>On site watercourses (Nant Hwyaidd, Nant Cynon, Nant</b>	Erosion of track surfaces producing silt-laden runoff	<ul style="list-style-type: none"> <li>- Construction phase mitigation continues to be effective; and</li> <li>- Periodic visual monitoring and maintenance of track surfaces and associated drainage infrastructure.</li> </ul>

Receptor	Potential changes and effects	Embedded measures and influence on assessment
<b>Tryfal and Nant Drysiog (tributaries) &amp; Afon Afan</b>		
<b>On site watercourses (Nant Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Disruption of natural flow pathways	- Construction phase mitigation continues to be effective; and - Periodic visual monitoring and maintenance of drainage infrastructure.
<b>On site watercourses (Nant Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Increased volumes of runoff & reduced infiltration	- Construction phase mitigation continues to be effective; and - Restoration of ground around turbine bases and reduced crane pad areas.
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Creation of new/preferential flow pathways e.g. infilled cable trenches acting as drainage conduits	- Construction phase mitigation continues to be effective.
<b>Groundwater quality – (Swansea Carboniferous Coal Measures WFD Groundwater body)</b>	Groundwater contamination from concrete	- Mitigation measures including sulphate resistant concrete continues to be effective.
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Chemical spillage associated with refuelling and plant maintenance	- Construction phase mitigation continues to be effective, subject to periodic inspection and maintenance of plant, and equipment e.g. oil interceptors.
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Generation of silt-laden runoff from dust control and wheel washing activities	- Construction phase mitigation continues to be effective.
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Discharge of operational phase foul effluent affecting water quality	- Foul effluent to be collected and controlled through use of chemical facilities with periodic removal (by a licensed contractor) for offsite disposal.
<b>Decommissioning phase measures above as identified for construction phase</b>		
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries) &amp; Afon Afan</b>	Generation of silt-laden runoff associated with decommissioning phase	In addition to mitigation measures listed under construction phase, leave turbine bases to avoid unnecessary environmental disturbance.

## 12.9 Assessment methodology

### Methodology for prediction of effects

The generic project-wide approach to the assessment methodology is set out in **Chapter 2**. However, whilst this approach has informed the approach that has been used in this water resources and ground conditions assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this assessment.

The assessment methodology employed to evaluate the significance of potential effects of the proposed development on water resources and ground conditions is based on a combined evaluation of the sensitivity of the receptor and the magnitude of the environmental change, and is informed by professional judgement.

The sensitivity of the receptor is based on the value of the water feature or resource, including its use, as shown in **Table 12.11**. The approach also takes account of the baseline quality of the receptor. For instance, a wetland may have a statutory designation, but if it is significantly degraded it may be only of 'Medium' value.

Table 12.11 Definitions of sensitivity for water resources and ground conditions

Sensitivity	Criteria	Examples
<b>High</b>	Regional or national scale, high quality and rarity, limited potential for substitution	Principal, high quality aquifer Water-dependent habitats or species, or geologically important sites with statutory conservation designations; Direct connectivity with WFD water body status defined as high or good; Large abstractions/PWS for industry, agriculture or drinking water for potable use; Watercourse supporting self-sustaining species of international/national conservation interest (e.g. salmonids, brook lamprey, freshwater pearl mussels etc); Active Flood Plain (Flood zone C1 or C2).
<b>Medium</b>	District scale, medium quality, potential for substitution	Secondary aquifer Indirect connectivity with WFD water body status defined as High or Good; Direct connectivity with WFD water body with Moderate status; Medium-sized abstractions/PWS for industry, agriculture for potable use; Supports pockets of self-sustaining species of conservation interest; locally important for fisheries; Flood Zone B
<b>Low</b>	Local scale and use, variable quality, potential for substitution	Minor, or WFD water body status defined as Poor or Bad, or water bodies without WFD classification; Small abstractions for Industry or agriculture for non-potable use; Fish sporadically present or restricted, no designated features; Limited floodplain/ Flood Zone A; Receptor heavily engineered or artificially modified.

The magnitude of change is estimated based on the degree of the impact and is independent of the sensitivity of the feature, as described in **Table 12.12**.

Table 12.12 Magnitude of change

Magnitude	Criteria	Examples
<b>Negligible</b>	No measurable change to feature	No discernible change in water quality (surface or groundwater); No increase in flood risk; No measurable decline in groundwater levels or river flow.
<b>Low</b>	Results in minor effect on feature, with insufficient magnitude to affect its use/integrity in most circumstances	Measurable changes in attribute (e.g. a river water quality indicator) but of limited duration and magnitude. Change is not sufficient to alter WFD status class. Change equivalent to naturally occurring fluctuations. May be short-term, small scale disturbance to water dependent ecology (in relation to hydrology-related factors); Unquantifiable change to river morphology or geomorphology; Measurable decline in groundwater levels or river flow, with no consequences for use or ecology; No detectable increase in flood risk and erosion potential; No change in pressure, flow or quality to local water supply.
<b>Medium</b>	Results in noticeable effect on feature, of sufficient magnitude to affect its use/integrity in some circumstances	Compromise integrity of a designated site/species/habitat; Loss in productivity of a fishery (in relation to hydrology-related factors); Measurable change to river morphology over medium scale i.e. moderate changes in erosion and deposition regimes; Measurable effect on water quality, with potential to alter status of individual WFD waterbody supporting elements, but only medium risk of altering overall RBMP status. Moderate decline in groundwater levels or river flow, with consequences for use or ecology; Detectable increase in flood risk and erosion potential. Temporary loss of water supply or minor change in quality of supply with respect to Drinking Water Standards (DWS);
<b>High</b>	Results in major/fundamental change to feature, of sufficient magnitude to affect its use/integrity	Loss of (all or part of) a water-dependent designated site/species/habitat; Change in overall WFD status of river reach; Loss of flood storage/significant increase in flood risk; Significant and permanent change to river morphology over large scale i.e. large changes in erosion and deposition regimes Pollution or loss of water supply. Major decline in groundwater levels or river flow, with consequences for use or ecology.

### Significance evaluation methodology

The significance of an effect is derived by considering both the sensitivity of the feature and the magnitude of the change. The EIA Regulations require that a final judgement is made about whether or not each effect is likely to be significant. In this assessment, effects are considered to be significant or not significant according to the matrix in **Table 12.13**.

Table 12.13 Matrix of EIA Significance

		Magnitude of change			
		High	Medium	Low	Negligible
Sensitivity	High	Major (Significant)	Major/Moderate (Significant)	Moderate (Not Significant)	Slight (Not Significant)
	Medium	Major/Moderate (Significant)	Moderate (Not Significant)	Moderate/Slight (Not Significant)	Slight/Negligible (Not Significant)
	Low	Moderate (Not Significant)	Moderate/Slight (Not Significant)	Slight (Not Significant)	Negligible (Not Significant)

Significant effects are those highlighted in grey.

## 12.10 Assessment of water resources and ground conditions effects

### Predicted effects and their significance

Effects are more likely to occur during the construction phase of the proposed development on account of the volume and type of works undertaken during this period. There are a number of similarities between the activities that are planned for the decommissioning and the construction phases and many of the considerations and mitigation approaches that apply to the construction phase also apply to the decommissioning phase.

The significance of all potential effects is presented in **Table 12.14**. This table should be read in connection with the discussions regarding environmental measures that are incorporated into project design (see Section 12.8), which are integral to an understanding of the associated magnitude ratings in particular. Given that many of the predicted effects have been found to be 'not significant', the discussions presented below are suitably concise.

As discussed in section 4.4 and section 5.2 of this ES, due to its location it is considered that the vulnerability of the proposed development to natural disasters is low, and measures to minimise major accident or disasters from occurring during construction will be set out in a Construction Environmental Management Plan (CEMP). In the unlikely event of a major accident or disaster at the proposed development site, such as flooding, or the release of pollutants due to infrastructure failure, the measures set out in section 12.8 would mitigate any potential effects upon the identified water resource receptors (e.g. people and property, and private water supplies) to ensure that there are no significant effects arising from the proposed development.

### Construction effects

#### *Effect on dilution of downstream discharges*

There will be no anticipated change to the hydrological flow characteristics of the surface watercourses that discharge from the site boundary and therefore there will be no anticipated effects on parameter concentrations associated with consented discharges downstream.

#### *Surface watercourses: Water quality*

The on-site watercourses are small and do not have WFD status or associated designation themselves and are defined as Low Sensitivity. The downstream Afon Afan is assigned a sensitivity of Medium on the basis of it being indirectly directly connected to the site and having an overall Moderate Ecological WFD status.

Effects on water quality in surface watercourses leaving the site are theoretically possible from sediment entrainment in runoff, or pollution from site activities. However implementation of the environmental measures summarised in **Table 12.10** will ensure that any effects are Low or Negligible in magnitude, as they will be limited in scale and magnitude and not sufficient to change WFD status. This will include the provision of additional design mitigation where buffer zones of <20m are possible (for T11, T3, and T8) outlined in Section 12.8 above. As a result, the effects on surface water quality from construction, operation and decommissioning activities associated with the proposed development are concluded to be not significant.

#### *Groundwater body: Water quality*

Effects on groundwater quality are theoretically possible, most notably where excavations are required for the turbine bases. This could be associated with runoff into the excavations, with concrete pouring, or from spills of pollutants. There is also the potential (if ground survey identifies the requirement) for standard ground stabilisation techniques to be employed, which may include localised grouting. However implementation of the environmental measures summarised in **Table 12.10** will ensure that any effects are Low or Negligible in magnitude. The aquifer beneath the site is currently defined as having Poor chemical status by NRW; it is also defined as a Secondary A aquifer. As a result of these designations, the groundwater body is defined as being of Low sensitivity. When the magnitude and sensitivity are considered together, it can be concluded that effects on groundwater quality from construction and operation of the proposed wind farm site are concluded to be not significant.

#### *Surface watercourses: Drainage and flood risk (flow regime)*

Effects on flood risk downstream from the site are theoretically possible as a result of increased surface water runoff. Increased runoff could occur during construction as a result of increased areas of disturbed ground and hardstanding (areas stripped of vegetation and soil for construction, spoil mounds, access tracks, turbine bases, laydown areas and works compounds), and drainage and/or dewatering from excavations. However implementation of the environmental measures summarised in **Table 12.10** will ensure that any effects are Negligible in magnitude. A drainage assessment will be carried out to ensure that the drainage design will allow greenfield runoff rates to be achieved, and it is anticipated that discussions will be carried out with Neath Port Talbot Council (as the LLFA) regarding the two proposed watercourse crossings. The site is located in Flood Zone A and this flood zone extends all the way to the Afon Afan watercourse (within channel), but since there are (limited) urban areas comprising people and property within flood zones C1 and C2 downstream from the site, the sensitivity of the downstream receptor has been defined as High in relation to flood risk. When the magnitude and sensitivity are considered together, it can be concluded that effects on flood risk from construction and operation of the proposed development are concluded to be not significant.

#### *Peat hydrology*

Effects on peat hydrology are found to have Low potential magnitude, particularly on account of the shallow depth of peat that is characteristic across the site, avoidance of areas of deeper peat through careful siting of infrastructure, track design which allows provision for cross track drainage and thus maintenance of localised drainage pathways/saturation and other measures incorporated into drainage design. The peat habitat is afforded a Medium sensitivity score on account of its water dependence. Consideration of the magnitude and sensitivity scores concludes that effects on peat hydrology are not significant.

#### *Private water supplies*

Initial consideration of the location and therefore connectivity of Abstractions 2, 3 and 6 (**Table 12.7**) dictates that these abstractions would not be affected by the proposed development.

Abstraction number 4 (**Table 12.7**) relates to a private water supply to Nant yr Hwyaid Farm, Cynonville. It is located downstream of the site boundary in the Nant yr Hwyaid sub-catchment. There is limited information available on the type and use of this abstraction. Given the proximity of a small stream (tributary of the Nant yr Hwyaid) which flows adjacent to the Nant yr Hwyaid Farm and the poor aquifer potential, it is likely that the abstraction is from surface water, however given that this is not confirmed further consideration of both a surface water and a possible groundwater abstraction at this location has been carried out.

The Nant yr Hwyaid Farm private water supply is located approximately 480m downslope of the nearest planned development i.e. Turbine 6. This is a considerable distance over which any runoff related effects would be reduced to a scale which would not be measurable, particularly given that the area between the source and the receptor and separated comprises of long grasses which would help filter out potential contaminants. Notwithstanding this, in order to provide a precautionary assessment, additional private water supply risk assessment techniques have been applied before scoping this abstraction out of further consideration. If the abstraction is a surface water or spring fed abstraction, its catchment is defined on the basis of topography on the understanding that the catchments are likely to reflect the up-gradient topography; therefore catchment analysis has been carried out on a sub-tributary scale around the Nant yr Hwyaid Farm private water supply.

The catchment analysis finds that the access track which is contiguous with the northern site boundary will effectively capture any surface drainage from the slopes of Cefn yr Argoed and direct this toward the Nant yr Hwyaid watercourse at 282900, 194800. Thus, the surface water catchment of the small tributary adjacent to the Nant yr Hwyaid is found to lie outside of the development boundary and to be non-contiguous with the catchment area in which Turbine 6 for example is located (as illustrated on **Figure 12.2**). Due to the topographical catchment divide, and the lack of hydrogeological connectivity there will not be any impacts on the water serving the Nant yr Hwyaid Farm private water supply.

The groundwater spring abstraction at Maesteg golf course (which is used for both irrigation and cooking/sanitary purposes) is located approximately 470m to the south of the proposed site entrance (where there may be superficial upgrades to the existing forestry track entrance) within a corner of the Nant Cwmfarteg catchment. Given the distance between the site entrance and the spring, and because the track upgrades will not require deep excavation, there will not be any impacts on the groundwater serving the Maesteg golf course spring.

The groundwater spring abstraction at Garnwen Farm in Nantyyffyllon is located approximately 780m to the east of the existing forestry access track which may be partly upgraded. It is located in the unnamed SE catchment which is topographically disconnected from the nearest site infrastructure which straddles the top of the Nant y Crynwdd catchment (see **Figure 12.2**). Therefore there would not be any effects on the groundwater serving the Garnwen Farm spring.

This assessment finds that the proposed development would not result in any significant effects on private water supplies and the licensed abstraction.

### *Ground stability*

Potential effects on near surface ground stability have been mitigated through the avoidance of steep slopes and the confirmation that no areas of deep peat are present. A geotechnical survey (to include mapping and exploratory drilling) will be undertaken, that will focus on the area of development around T1, T2, T3, T4, T8 and T9 as recommended by the ground stability risk assessment (**Appendix 12B**). The assessment concluded that the potential effects can be readily engineered out and that the presence of shallow level abandoned mineworking does not preclude the safe foundation of infrastructure provide the appropriate level of ground stabilisation works are undertaken prior to erection. Depending upon the findings of the site investigations it may be necessary to stabilise the disturbed over-lying strata by either partial grouting to improve the bearing capacity of specific zones or to undertake full grouting of the workings and overlying strata. The survey, investigation and avoidance via micro-siting and standard ground stabilisation works where necessary will

further reduce the potential magnitude of effect on ground stability to Low/Negligible. When the magnitude and sensitivity are considered together, it can be concluded that effects on ground stability from the proposed development are concluded to be not significant.

### Operational effects

Anticipated effects on hydrological receptors that are associated with the operational phase are the same as those already identified during the construction phase, however the magnitude of potential effects are found to be (usually) much reduced (compared to the construction phase) because of the lack of activities and exposed soils etc. during the operational phase.

The main drainage control features associated with permanent infrastructure during the construction phase (e.g. crane pads, substation, and tracks) will remain in place during the operational phase. As a result, it is considered that there would be no significant effects during the operational phase.

### Decommissioning effects

The activities associated with the decommissioning phase will be similar to those undertaken during the construction phase. Anticipated effects on hydrological receptors that are associated with the decommissioning phase are largely the same as those already identified during the construction phase, however the magnitude of potential effects are found to be in most cases reduced (compared to the construction phase) because the SuDS features and site tracks may be utilised in the phased removal of infrastructure.

Turbine bases will be left in place following the lifetime of the development to avoid unnecessary environmental disturbance.

The decommissioning phase will allow much of the drainage infrastructure and control mechanisms to be applied throughout much of the decommissioning phase. As a result, it is considered that there would be no significant effects during the decommissioning phase.

### Summary of predicted effects

A summary of the results of the assessment of the Water Resources and Ground Conditions assessment is provided in **Table 12.14**.

Table 12.14 Summary of significance of adverse effects

Receptor	Sensitivity/ importance/ value of receptor <sup>1</sup>	Magnitude of change <sup>2</sup>	Significance <sup>3</sup>	Summary rationale
<b>On site watercourses (Nant yr Hwyaidd, Nant Cynon, Nant Tryfal and Nant Drysiog tributaries)</b>	Low	Negligible to Low	Negligible to Slight (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development
<b>Afon Afan</b>	Medium	Negligible to Low	Negligible to Moderate (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development
<b>Flood risk</b>	High	Negligible	Slight (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development

Receptor	Sensitivity/ importance/ value of receptor <sup>1</sup>	Magnitude of change <sup>2</sup>	Significance <sup>3</sup>	Summary rationale
<b>Peat hydrology</b>	Medium	Low	Slight/Moderate (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development
<b>Ground stability</b>	Low	Negligible to Low	Negligible to Slight (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development. Targeted site investigation works to be carried out prior to construction.
<b>On-site soil hydrology</b>	Low	Low	Slight (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development
<b>Groundwater quality (Swansea Carboniferous Coal Measures WFD GW body)</b>	Low	Negligible	Negligible (Not significant)	Implementation of environmental measures (see <b>Table 12.10</b> ) will ensure no significant effects would result from the proposed development. Any subsurface grouting to be highly localised and following best practice.
<b>Groundwater quantity (Swansea Carboniferous Coal Measures WFD GW body)</b>	Low	None	No Effect (Not significant)	Small spatial extent and depth of impermeable turbine bases is insignificant in context of catchment scale and will therefore not impede recharge.
<b>Private water supplies (PWS)</b>	High	None	No Effect (Not significant)	PWS assessment has confirmed no hydrological continuity with the potential catchments of local PWSs.

The sensitivity/importance/value of a receptor is defined using the criteria set out in section 12.9 above and is defined as low, medium and high.

The magnitude of change on a receptor resulting from activities relating to the development is defined using the criteria set out in section 12.9 above and is defined as negligible, low, medium and high.

The significance of the environmental effects is based on the combination of the sensitivity/importance/value of a receptor and the magnitude of change and is expressed as major (significant), or moderate/minor/negligible (not significant), subject to the evaluation methodology outlined in section 12.9.

## 12.11 Assessment of cumulative effects

As described above, any effects on water resources and ground conditions will be not significant due to the good practice measures to be implemented in design and construction, and specific measures that will be put in place with regards to the watercourse crossings. Nevertheless, it is important to consider potential cumulative effects with other developments that may have an effect on the same hydrological receptors.

There are no developments (current or planned) within the surface water study area i.e. relevant surface water catchments.

There may be other potential developments within the same groundwater unit (i.e. that also overlay the Swansea Carboniferous Coal Measures WFD Groundwater body), however the degree of potential interaction from the proposed development with the groundwater receptor is highly localised (and is not significant) and any cumulative effects on the groundwater receptor may be scoped out.

As a result, cumulative effects on water resources and ground conditions are concluded to be not significant.

## 12.12 Consideration of additional mitigation or compensation

No additional mitigation measures are proposed to further reduce the water resources and ground conditions effects that are identified in this ES. This is because all relevant and implementable measures have been embedded into the development proposals and are assessed above in this chapter. These measures are considered likely to be effective and deliverable and address the likely significant effects of the proposed development.

## 12.13 Conclusions of significance evaluation

**Table 12.14** showed that the construction, operation and decommissioning of the proposed development is not expected to lead to any significant effects on the water environment, provided that all recommended environmental measures outlined in section 12.8 are put in place. The conclusions reflect those of the 2014 ES.

## 12.14 Implementation of environmental measures

This section describes the environmental measures embedded within the proposed development and the means by which they will be implemented, i.e. they will be secured through the incorporation of the design requirements into Contractor's method statements (i.e. the Construction Method Statement) and operational measures in the site's Environmental Management Plan.

Geophysical survey work (to confirm any requirement for standard ground stabilisation works around shallow abandoned mine workings) will need to be undertaken early in the scheme of works for the proposed development. This will ensure that discussion, decision-making and any further investigation can be undertaken before main contract operations begin. Furthermore, micro-siting of the affected turbines and the section of access track around T1 and T3 will be necessary prior to construction of the main contractors' compound.

**Table 12.15** summarises the compliance mechanisms by which the implementation of the recommended environmental measures will be ensured.

Table 12.15 Summary of environmental measures relevant to water resources and ground conditions to be implemented

Environmental measure	Responsibility for implementation	Compliance mechanism	ES Section Reference
<b>On-site measures to control sediment entrainment to surface water during construction</b>	Contractor	<p>Scope/design of works e.g. SuDS design and track design will be dictated by CMS</p> <p>Auditable monitoring checks</p> <p>Water quality monitoring at exit of Nant yr Hwyaid surface watercourse from western site boundary.</p> <p>A planning condition will state that no works are to commence without LPA approval of the CMS, in consultation with NRW</p>	Section 12.8
<b>On-site SuDS drainage features including impermeable 'plugs' in trenching runs</b>	Contractor	<p>Scope/design of works e.g. SuDS design and track design will be dictated by CMS</p> <p>Auditable monitoring checks</p> <p>A planning condition will state that no works are to commence without LPA approval of the CMS in consultation with the LLFA (Neath Port Talbot County Borough Council)</p>	Section 12.8
<b>Protection of surface water quality from spillages of fuels, oils and other chemicals during operation</b>	Contractor	<p>Scope/design of works will be dictated by CMS which will include a PPP; Implementation of CEMP</p> <p>Auditable monitoring checks; Water quality monitoring at exit of surface watercourse from western site boundary</p> <p>A planning condition will state that no works are to commence without LPA approval of the CMS, PPP and the CEMP, in consultation with NRW</p>	Section 12.8
<b>Flood risk considerations (surface water management) and prevention of sediment entrainment in runoff</b>	Developer/Contractor	<p>Appropriate storage integrated into site design</p> <p>Specific consideration of drainage designs including watercourse crossing design and installation under OWCs from the LLFA, which is Neath Port Talbot County Borough Council. All drainage design to be agreed with Neath Port Talbot County Borough Council acting as the LLFA.</p> <p>A planning condition will state that no works are to commence without LPA approval of the CMS in consultation with NRW and the LLFA.</p>	Section 12.8

Environmental measure	Responsibility for implementation	Compliance mechanism	ES Section Reference
<p><b>Geotechnical survey (site investigation works) focussing on areas around T1, T2, T3, T4, T8 and T9. Micro-siting and standard ground stabilisation techniques as appropriate.</b></p>	Developer/Contractor	<p>Production of CMS</p> <p>Water quality monitoring at exit of surface watercourse from western site boundary</p> <p>Environmental permits would be obtained in consultation with NRW as required, and is dependent on the duration of the discharge activity</p> <p>A planning condition will state that no works are to commence without LPA approval of the CMS and in consultation with NRW</p>	Section 12.8
<p><b>Geotechnical survey (site investigation works) focussing of areas around T1, T2, T3, T4, T8 and T9. Micro-siting and standard ground stabilisation techniques as appropriate.</b></p>	Developer/Contractor	<p>Scope/design of works will be dictated by CMS;</p> <p>Pre-requisite of subsequent site access, therefore in interests (both structurally and logistically to complete early in construction program)</p> <p>A planning condition will state that no works are to commence without LPA approval of the CMS in consultation with Neath Port Talbot County Borough Council and NRW</p>	Section 12.8

## 12.15 References

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