

## Document History

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# Chapter 10

## Hydrology, Geology and Hydrogeological

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## Glossary

Term	Definition
Abstraction	The process of and location of the removal or diversion of water from the natural water environment, by a variety of means including pumps, pipes, boreholes and wells.
Aquifer	A geological formation, group of formations or part of a formation that can store and transmit water in significant quantities.
Baseflow	The component of the river flow that is derived from groundwater sources rather than surface run-off. The Base Flow Index (BFI) value provided by the Flood Estimation Handbook (FEH) is a measure of the proportion of a catchments long-term runoff that derives from stored sources.
Buffer area	An area which protects the receptor such as watercourses from pollutants and sediment from the adjacent land.
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of carrying out, in a systematic way, an assessment of the likely significant environmental affects arising from a proposed development.
Environmental Impact Assessment Regulations	The Town and Country Planning (EIA (Wales) Regulations 2017 (EIA Regulations).
Environmental Statement	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of rock formations.
Headwaters	A tributary stream of a river close to or forming part of its source. Normally wet flushes, bogs or springs at the head of first-order streams.
Hydrological regime	The statistical pattern of a river's constantly varying flow rate.
Hydromorphology	Term used in river basin management to describe the hydrological and geomorphological processes and attributes of rivers, lakes, estuaries and coastal waters.
Overland flow	Water passing rapidly over or through the surface layer of soil.
Peak flow	The maximum flow recorded during a high flow event.
Peat	A largely organic substrate formed of partially decomposed plant material.
Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
Private water supply	Any water supply which is not provided by a water company and is not connected to mains supply. Most private water supplies are situated in more remote, rural parts of the country and may just serve one property or several properties through a network of pipes.
Return period	Is a measure of the rarity of an event: the longer the return period, the rarer the event.
Riparian zone	Land immediately adjoining the aquatic zone of a watercourse and influenced by it.
Runoff	Surface runoff is the flow of water over the surface that can result due to the surrounding soils lacking the capacity to infiltrate further water or due to the surface water flowing off infrastructure such as access tracks and hardstandings.

Term	Definition
Sedimentation	The tendency for particles in suspension to settle out of the fluid in which they are entrained.
Manmoel site boundary	The area within which the proposed development will be located.
Standard Percentage Runoff	The percentage of rainfall that is likely to contribute to runoff. For example, an SPR value of 50 % would suggest that half of the rainfall during an event will contribute to runoff.
Surface water catchment	The area from which runoff would naturally discharge to a defined point of a river.
The proposed development	Manmoel Wind Farm development.
Topography	The physical features of a geographical area.
Water resources	The supply of groundwater and surface water in a given area.

## List of Abbreviations

Abbreviation	Description
AOD	Above Ordnance Datum
BFI	Base Flow Index
BGCBC	Blaenau Gwent County Borough Council
BGS	British Geological Society
CCBC	Caerphilly County Borough Council
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
CMRA	Coal Mining Risk assessment
COSHH	Control of Substances Hazardous to Health
DOC	Dissolved Organic Carbon
DEFRA	Department for Environment, Food and Rural Affairs
DTM	Digital Terrain Model
ECOW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEH	Flood Estimation Handbook
GIS	Geographical Information System
GPP	Guidance for Pollution Prevention
GWDTE	Groundwater Dependent Terrestrial Ecosystems
Natural Power	Natural Power Consultants
NFM	Natural Flood Management
NRW	Natural Resource Wales
NGR	National Grid Reference
OS	Ordnance Survey
PINS	Planning Inspectorate Wales
PMP	Peat Management Plan
PPG	Pollution Prevention Guidelines
PWS	Private Water Supply
PWSMP	Private Water Supply Monitoring Plan and Method Statement
RBMP	River Basin Management Plans
SAAR	Standard Average Annual Rainfall
SAB	SuDS Approval Body
SEPA	Scottish Environment Protection Agency
SPR	Standard Percentage Runoff
SuDS	Sustainable Drainage Systems
TWI	Topographic Wetness Index

Abbreviation	Description
UKCP	UK Climate Projections
UKSO	UK Soil Observatory
WFD	Water Framework Directive
WQM	Water Quality Monitoring

## 10.1 INTRODUCTION

- 10.1.1 This chapter provides an assessment of potential impacts on the hydrological, geological and hydrogeological environment at Manmoel Wind Farm (the ‘proposed development’) and the likely significant environmental effects resulting from the construction, operation and decommissioning of the proposed turbines and associated infrastructure. The red-line boundary is referred to as ‘Manmoel site boundary’ which includes the main wind farm and proposed access route.
- 10.1.2 The chapter concludes that with good practice design and construction of the proposed development delivered through a skilled team of competent workers, with mitigation and compliance monitored in collaboration with Natural Resources Wales (NRW), Blaenau Gwent County Borough Council (BGCBC) and Caerphilly County Borough Council (CCBC) council and other engaged stakeholders, will result in a risk that is considered to be **not significant** in the professional judgment of Natural Power Consultants (Natural Power).
- 10.1.3 As part of the development process Sustainable Drainage Systems (SuDS) are required which will comply with National Statutory SuDS Standards. An application will be submitted to the SuDS Approval Body (SAB) prior to construction commencing. NPTCBC and BCBC are the SAB for the proposed development.

### Site Area

- 10.1.1 The proposed development is located in both the BGCBC and CCBC areas in South Wales. The proposed development is situated along an elevated ridge and lies within registered Commons Land.
- 10.1.2 The proposed development is located primarily on an area of upland Common Land. Under section 38 of the Commons Act 2006 (‘the 2006 Act’), consent is required to carry out any restricted work on land registered as common land under the Commons Registration Act 1965. Under section 16 (1) of the 2006 Act, secondary consent will be required for the removal of approximately 7.1 hectares of existing common to accommodate the turbines, tracks and associated infrastructure. Suitable replacement land contiguous to the common of approximately 10.0 hectares will be secured.
- 10.1.3 The proposed development consists of upland, plateau landform and steep sides, sheep grazed grassy moorland and blocks of coniferous forestry and woodland covering parts of the steep valley sides.
- 10.1.4 The hydrological study area is larger in extent than the actual Manmoel site boundary (including access route) and includes the upper and lower reaches of watercourse catchments that cover the proposed development area. The extent of the catchments is shown in Figure 10.1: Hydrology Overview which outlines the extent of the study area. Designated sites and relevant developments are considered from the perspective of assessing any potential hydrological linkages or cumulative effects.

## 10.2 LEGISLATION POLICY AND NATIONAL GUIDANCE

### International Legislation and Policy

- 10.1.4 The assessment takes into account the requirements of the Water Framework Directive (2000/60/EC) (WFD). The WFD aims to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, groundwater dependent ecosystems, estuaries and coastal waters. The key objectives of the WFD relevant to this assessment are:
  - To prevent deterioration and enhance aquatic ecosystems; and
  - To establish a framework of protection of surface freshwater and groundwater.

### National Legislation and Regulations

- 10.1.5 This assessment takes into account the following legislation and policy:

- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017;
- Land Drainage Act 1994;
- Flood and Water Management Act 2010;
- Water Act 2014;
- The Pollution Prevention and Control (England and Wales) Regulations 2000;
- The Water Supply (Water Quality) Regulations 2018;
- The Private Water Supplies (Wales) Regulations 2017;
- The Waste (England and Wales) (Amendment) Regulations 2012;
- Part IIa of the Environment Protection Act 1990; and
- The Town and Country Planning Environmental Impact Assessment (EIA) Regulations 2017.

### Policy and Guidance

- 10.1.6 The following Welsh guidance and regional policies are also taken into account during the assessment:
  - Planning Policy Wales (Edition 11) – February 2021;
  - Future Wales: The National Plan 2040 (2021);
  - Technical Advice Note 15: Development and Flood Risk (2004);
  - Statutory standards for sustainable drainage systems (2018);
  - Sustainable Drainage (SuDS) Statutory Guidance (2019);
  - Blaenau Gwent County Borough Council (2012) Local Development Plan up to 2021; and
  - Caerphilly County Borough Council (2010) Local Development Plan up to 2021.
- 10.1.7 Table 10.1 lists other guidance and good practice documentation which has been considered as part of this assessment.

Table 10.1: Guidance and Good Practice

Topic	Source of Information
Natural Resource Wales (NRW)	GPP 1: Understanding your environmental responsibilities - good environmental practices
Guidance for Pollution Prevention (GPP) & Pollution Prevention Guidelines (PPGs)*	GPP 2: Above ground oil storage tanks GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer GPP 5: Works and maintenance in or near water PPG 6: Working at construction and demolition sites GPP 8: Safe storage and disposal of used oil GPP 13: Vehicle washing and cleaning GPP 21: Polluting incident response planning GPP 22: Dealing with spills GPP 26: Safe Storage - drums and intermediate bulk containers
Construction Industry Research and Information	CIRIA C692 Environmental Good Practice on site (third edition) CIRIA C697 The sustainable drainage systems (SuDS) Manual CIRIA C532 Control of Water Pollution from Construction sites

Topic	Source of Information
Association (CIRIA)	CIRIA C624 Development and Flood Risk – guidance for the construction industry CIRIA C648 Control of Water Pollution from Linear Construction Projects CIRIA C689 Culvert Design and Operation Guide CIRIA C758D Abandoned Mine Workings Manual
Other Guidelines	Scottish Renewables Joint Publication, (2019) Good Practice During Wind Farm Construction Version 4. Department for Environment, Food and Rural Affairs (DEFRA) (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Scottish Environment Protection Agency (SEPA) Land Use Planning Guidance Note 31 (2017). Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 3.

\*A review plan for the PPGs is currently underway. The review will result in a replacement guidance series, GPPs. It is intended that the new series will provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales<sup>1</sup>.

## 10.2 METHOD OF ASSESSMENT

### Effects to be Assessed

- 10.2.1 The greatest risk of affecting the hydrological, geological and hydrogeological environment will occur during the construction phase, with the potential for effects reduced during the operational and decommissioning phases. Taking this into account the EIA addresses the following issues for all phases of development:
- Changes to existing drainage patterns;
  - Effects on baseflow;
  - Effects on run-off rates;
  - Effects on erosion and sedimentation;
  - Effects on groundwater levels;
  - Effects on water resources;
  - Effects on impediments to flow;
  - Flood risk;
  - Pollution risk;
  - Effects on groundwater and surface water quality; and
  - Effects on the hydrological and hydrogeological environment arising from previous mineral working.
- 10.2.2 Within section 13: Hydrology, Geology and Hydrogeology of the scoping report<sup>2</sup> (scoping report can be found in Appendix A3 in Volume 3 of this Environmental Statement (ES)) designated sites and peat and soils were scoped out from requiring further consideration in the EIA. It was agreed that designated sites require no further consideration. It was also agreed that further peat surveys were not required but that the ES should demonstrate no impact on peat.

## Methodology

### Overview

- 10.2.3 The assessment has involved the following:
- Detailed desk studies and site visits to establish baseline conditions;
  - Evaluation of the likely significant environmental effects of the proposed development and the impacts that these could have on the current site conditions;
  - Demonstration of how the embedded good practice measures help to avoid and mitigate against any identified adverse effects resulting from the proposed development;
  - Evaluation of the likely significant environmental effects with consideration of the potential embedded mitigation measures, taking account of the sensitivity of the baseline features, the potential magnitude of these impacts and the probability of these effects occurring; and
  - The residual significance of the environmental effects following the consideration of additional mitigation measures, as well as further potential enhancement measures.

### Baseline Assessment

- 10.2.4 A desktop survey to establish the baseline conditions was undertaken in order to:
- Describe surface water hydrology, including watercourses, springs and waterbodies;
  - Identify existing catchment pressures (e.g., point source and diffuse pollution issues);
  - Identify all private drinking water abstractions and public water supplies within 3 km of the proposed development;
  - Identify all flooding risks;
  - Describe the hydromorphological conditions of watercourses;
  - Collect hydrogeological information;
  - Collect information relating to previous mineral working; and
  - Confirm surface water catchment areas and watersheds.
- 10.2.5 Published information sources consulted for the baseline information are outlined in Table 13.2 of the scoping report<sup>2</sup>.

### Effects Evaluation

- 10.2.6 The likely significant environmental effects are defined by taking account of two main factors: the sensitivity of the receptor and the potential magnitude should that effect occur. The sensitivity of the receptor i.e., its baseline quality as well as its ability to absorb the effect without perceptible change is defined in Table 10.2.

Table 10.2: Definition of sensitivity of the receptor

Sensitivity	Definition
High	<b>National importance.</b> Receptor with a high quality and rarity, local scale and limited potential for substitution/replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement.

<sup>1</sup> Net Regs (2020). *Guidance for Pollution Prevention (GPPs) - Full List*. [Online]. Available from: <https://www.netregs.org.uk/environmental-topics/guidance-for-pollution-prevention-gpp-documents/> [Accessed: 13/02/2023]

<sup>2</sup> Manmoel Wind Farm (2021) *Scoping Report* (Document Reference: 1249669)

Sensitivity	Definition
Medium	<b>Regional importance.</b> Receptor with a medium quality and rarity, local scale and limited potential for substitution/replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement.
Low	<b>Local importance.</b> Receptor with a low quality and rarity, local scale. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.

10.2.7 The magnitude of impact includes the timing, scale, size and duration of the likely significant environmental effects. For the EIA the magnitude of impact criteria is defined in Table 10.3.

Table 10.3: Magnitude of Impact

Magnitude	Criteria	Definition
High	<b>Total loss</b> of or major/substantial alteration to key elements/features of the baseline (pre-development) conditions such that the post development character/composition/attributes will be fundamentally changed.	Fundamental (long term or permanent) changes to geology, hydrology, water quality and hydrogeology.
Medium	<b>Loss or alteration</b> to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of the baseline will be materially changed.	Material but non-fundamental and short to medium term changes to the geology, hydrology, water quality and hydrogeology.
Low	<b>A minor shift</b> away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but not material. The underlying character/composition/attributes of the baseline condition will be similar to the pre-development circumstances/situation.	Detectable but non-material and transitory changes to the geology, hydrology, water quality and hydrogeology.
Negligible	<b>Very little change</b> from baseline conditions. Change barely distinguishable, approximating to a 'no change' situation.	No perceptible changes to the geology, hydrology, water quality and hydrogeology.

10.2.8 The sensitivity of the receiving environment together with the magnitude of the impact (assuming the successful implementation of industry good practice and design mitigation measures) is then combined to define the significance of the effect, as per Table 10.4. Those residual adverse effects indicated as **Major and Major/Moderate** will be regarded as being **significant** effects. However, other factors may have to be considered including the duration and the reversibility of the effect. It should also be noted that in most cases the assessment considers only the adverse effects. Where positive effects are identified these will be also be discussed.

Table 10.4: Significance of Effect

		Magnitude of Change			
		High	Medium	Low	Negligible
Sensitivity	High	Major	Major/Moderate	Moderate	Moderate/Minor
	Medium	Major/Moderate	Moderate	Moderate/Minor	Minor
	Low	Moderate	Moderate/Minor	Minor	Minor/Negligible

### 10.3 CONSULTATION

10.3.1 The scoping and consultation responses relating to the hydrological, geological and hydrogeological environment are summarised in Table 10.5.

Table 10.5: List of consultee responses

Consultee	Topic	Consultation Response	Applicant Action
The Planning Inspectorate Wales (now Planning and Environment Decisions Wales (PEDW))	Peat	Agree that further peat surveys are not necessary. However, the ES should demonstrate that the proposed development, including internal roads and construction areas including borrow pits are not located within areas where peat is inferred to be at a depth higher than 0.5 m. If not possible, mitigation measures and a peat management plan (PMP) should be included in the ES.	No new infrastructure located on peat inferred to be a depth higher than 0.5 m.
	Coal Mining Risk assessment (CMRA) and subsidence	Note that a CMRA has been conducted and includes risk of subsidence. A detailed description of construction methods and worst case scenarios where appropriate.	Refer to Appendix A10.2
	Groundwater Dependent Terrestrial	Welcome integrated approach in terms of GWDTE.	Refer to Chapter 6: Ecology

Consultee	Topic	Consultation Response	Applicant Action
	Ecosystems (GWDTE)		
	Designated Sites	Agree that these can be scoped out.	Not considered within this ES.
	Peat and Soils	Agree that a peat slide risk assessment can be scoped out; this will need reflected in the information regarding the risk of major accidents and disasters in the ES.	Refer to Chapter 13: Public Health and Safety.
Blaenau Gwent County Borough Council (BGCBC)	Ground Stability, Hydrology and Hydrogeology	Welcome review of surrounding area in terms of landslide and coal mining risk.	Refer to Appendix A10.2: Coal Mining Risk Assessment (CMRA). A Ground Stability Risk Assessment would be submitted via a planning condition should Welsh Ministers positively determine the application.
Natural Resource Wales (NRW)	Outline Construction Environmental Management Plan (CEMP)	Welcome inclusion of information to include outline CEMP to ensure construction effects on land and water are fully controlled. Information should comply with GPP.	Refer to Section 10.5: Mitigation Measures.
	Water Quality Monitoring (WQM)	To ensure effectiveness of the CEMP a WQM Plan should be incorporated into the CEMP to manage any effects on water quality during the construction phase.	Section 10.9 Monitoring confirms that WQM will be carried. The detailed plan would be created post consent and be submitted via planning condition should Welsh Ministers positively determine the application.
		A survey documenting the location and quality of hydrology – surface waters should be undertaken. This should be used to inform the CEMP. This should be documented in a map/figure.	Refer to Figure 10.1: Hydrology Overview. Further survey would be undertaken post consent as part of a detailed CEMP and WQM Plan.

Consultee	Topic	Consultation Response	Applicant Action
The Coal Authority	Coal Mining	Welcome a formal coal mining risk assessment with a more detailed review of the abandonment plan and the potential risks.	Refer to Appendix A10.2
	Coal Mining	Expect the exact location of mine entries to be established and this information used to inform the layout, in order to ensure adequate separation between these features and any structures.	
Dŵr Cymru Welsh Water	Water Quality	The proposed development may be subject to Schedule 3 of the Flood and Water Management Act 2010 and may require approval of SuDS features. Recommend that the Applicant engage in pre-application consultation with the Local Authority.	This will be confirmed with the Local Authority.
	Water Quality	No surface water from any increase in the roof area of the building / or impermeable surfaces within its curtilage shall be allowed to drain directly or indirectly to the public sewerage system.	Details of embedded mitigation and outline CEMP content are provided in Section 10.5: Mitigation Measure.

### 10.3 BASELINE

#### Field Survey Technique

10.3.2 A hydrology walkover survey and peat survey were undertaken by Natural Power at the proposed development to inform the baseline. The hydrology surveys comprised of a walkover survey, undertaken on foot by a hydrologist, where watercourses and other hydrological features were inspected to establish their morphology and morphometry. Peat survey included the collection of thickness values by advancing ‘peat probes’ through to the underlying substrate. More information of peat surveys is presented in Section 10.5: Peat Survey Results.

10.3.3 The phase 1 peat depth survey and hydrological walkover were undertaken during May 2021. Weather conditions were generally dry and cloudy with periods of light rain.

**Context**

10.3.4 This subsection presents the information gathered on the existing (baseline) topographical, hydrological, geological and hydrogeological (including peat) conditions within Manmoel site boundary.

**Climate**

10.3.5 The standard average annual rainfall (SAAR) for the proposed development has been derived from the Flood Estimation Handbook (FEH) Web Service for the main river catchments as ranging from 1503 mm - 1589 mm based on the Manmoel site boundary catchments. To put this into context, rainfall in Wales varies from <1000 mm in places along the coast, to over 3000 mm in Gwynedd.

10.3.6 The Met Office 1991-2020 average annual rainfall total from Tredegar climate station is 1715.85 mm with 166.54 days of rainfall greater than 1 mm recorded between 1981 and 2010. This climate station is located at Tredegar just north west of the proposed development at an elevation of 324 m Above Ordnance Datum (AOD). According to the 1991-2020 average for Tredegar climate station, the highest rainfall totals are recorded during the winter months from October through to January as shown in Chart 10.1. Given the station's proximity to the proposed development average rainfall volume and rainfall patterns will be extremely similar.

Source: Met Office

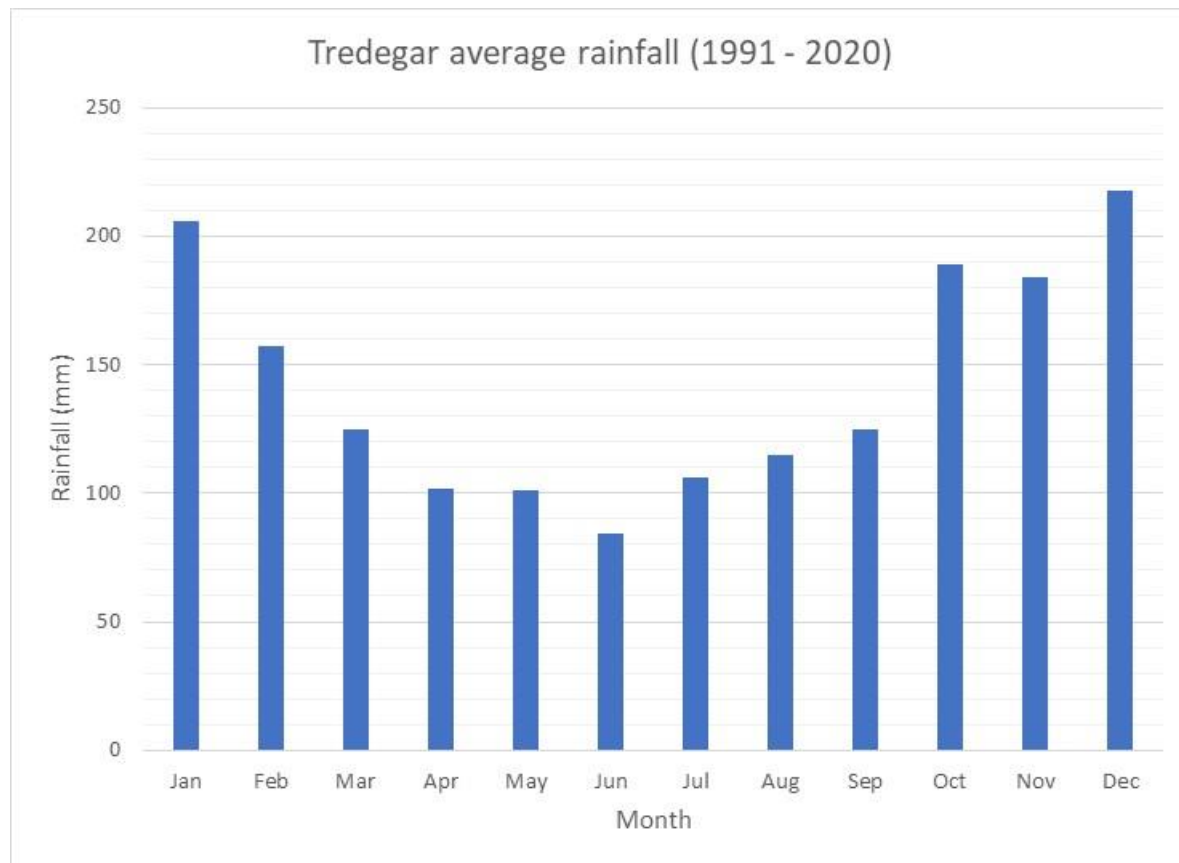


Chart 10.1: Average monthly rainfall data for climate period 1981-2010 for Tredegar Climate Station

**Surface Water Hydrology**

10.3.1 Surface water hydrology is discussed below and is supported by the following figures:

- Figure 10.1: Hydrological Overview;
- Figure 10.2: Topographic Wetness Index; and
- Figure 10.3: Flow Accumulation.

10.3.2 A site visit was undertaken in early May 2021 on the 5<sup>th</sup> and 6<sup>th</sup>, despite some showers the ground was generally dry with no or very limited flow in many of the mapped drains.

10.3.3 The proposed development would be situated on an elevated flat ridgeline, with steep slopes to the east and west down to the valleys on either side. The lowest elevation is in the south west corner. There are areas of made ground and exposed rock. Being situated on a ridgeline there are no mapped or named watercourses within Manmoel site boundary.



Photograph 10.1: View from ridge to valley and Sirhowy River



Photograph 10.2: Flat elevated ridge

10.3.4 Hydrologically the site lies within the catchments of Ebbw Fawr River and the Sirhowy River. Both Rivers flow south through urban areas and forestry before merging at Aberbeeg eventually flowing into the River Usk and River Severn/Bristol Channel. Although there are no named watercourses within the site boundary but are a number of mapped drains. The drains varied in dimensions but were general 1 m - 1.5 m wide and 0.5 m - 1 m depth and were generally dry. At the time of the site visit despite there being light rainfall there was no flowing water within the drains as shown on Photograph 10.1 and Photograph 10.2.

Source: Natural Power



Photograph 10.3: Example of a dry drainage ditch orientation NE-SW

Source: Natural Power



Photograph 10.4: Wide ditch running south at Photograph taken at National Grid Reference (NGR) (SO 16725 06799)

Source: Natural Power



Photograph 10.7: Steep crag

- 10.3.5 There are three mapped springs/watercourses adjacent to the eastern site boundary. These mapped watercourses are predominantly in the north at Briery Hill, that flow into the Sirhowy River. A reservoir is located on the western slope of the Sirhowy valley outside the Manmoel site boundary.
- 10.3.6 One mapped pond was identified within the Manmoel site boundary and there are several other ponds and reservoirs of varying size in the surrounding area. The proposed development has hydrological connectivity with nearby mapped pond/reservoir to the west of the proposed development at approximate NGR (315825 207131) and east at approximate NGR (317315 206366).

Source: Natural Power



Photograph 10.5: Mapped pond within the site boundary at NGR (SO 16372 07249)

Source: Natural Power



Photograph 10.6: Example of hummocky made ground NGR (SO 15877 08919)

### Hydrological Regime

- 10.3.7 Base Flow Index (BFI) and Standard Percentage Runoff (SPR) data for the catchments covering the proposed development have been calculated. The BFI is a measure of the proportion of a catchment's long-term runoff that derives from stored sources, with the BFI ranging from 0.1 in relatively impermeable catchments to 0.99 in highly permeable catchments. The SPR values represent the percentage of rainfall that is likely to contribute to runoff.
- 10.3.8 The BFI value for the catchments within the site ranges from approximately 0.39 to 0.42<sup>3</sup>. This indicates just over a third of streamflow within the proposed development is derived from stored sources such as groundwater. For the site catchments groundwater contribution to flow is moderate. The SPR values for these catchments range from 37% to 40%, indicating that approximately just over a third to half of the rainfall during a rainfall event contributes to runoff.<sup>4</sup>
- 10.3.9 Figure 10.2 provides information on the flow direction of the surface runoff within the site boundary. Flow accumulation is based on the 5 m resolution Digital Terrain Mapping (DTM) of the area occupied by the proposed development. The flow accumulation represents the volume of water that would flow into each 5 m cell of the DTM, assuming that all water becomes runoff and there was no interception, evapotranspiration or infiltration. The volume of accumulation is represented in greyscale with higher flow accumulations being darker in shade to areas with lower flow accumulation. This figure illustrates the influence of topography on the accumulation and direction of surface water runoff across the proposed development.
- 10.3.10 Figure 10.3 provides information on how the topography influences the surface saturation of the peat and soils across the proposed development. The analysis of the DTM derived a topographic wetness index (TWI). The TWI is a dimensionless index, defined by the equation:  $\ln(a/\tan b)$  where  $a$  = area draining through a point from an upslope contributing area and  $\tan b$  is the local slope angle. The index provides results on the hydrological similarity of peat. All points with the same value of the index are assumed to respond in a similar hydrological manner. High index values will tend to saturate first and will therefore indicate potential subsurface or high surface runoff areas.
- 10.3.11 As shown in Figure 10.3, the TWI for the proposed development has identified those areas where water will accumulate on site and result in saturation of the surrounding soils and peat. The highest values (13.5 plus) in the TWI form linear channels or where areas have a tendency to become saturated, are shown in blue and drier areas where there may be less tendency for the ground to saturate, are shown in yellow and orange. The dark blue linear channels are considered to show achievable flow rates that are likely to occur throughout the year or during extreme rainfall events. The lighter blue is likely to represent areas of the proposed development where the

<sup>3</sup> Natural River Flow Archive (2022) [Online]. Available from <https://nrfa.ceh.ac.uk/> [Accessed 13/02/2023].

<sup>4</sup> HR Wallingford Tools for Sustainable Drainage Systems. [Online] Available from <https://www.uksuds.com/> [Accessed 13/02/2023].

topography allows the accumulation and potential saturation of soils from shallow subsurface or surface during prolonged and/or intense rainfall events. Whilst it is recognised that other areas of the proposed development are likely to become saturated, it is expected that any saturation will be dependent upon climatic conditions such as the intensity and duration of rainfall. Figure 10.3 suggests that away from the watercourses, riparian corridors, man-made furrows and drainage channels and flatter ground, that the areas of the proposed development where are generally dry with TWI at the lower end of the range.

### Flood Consequence Assessment

10.3.12 A qualitative flood risk assessment has been undertaken where the risks of flooding have been considered from all potential sources which are listed below and with reference to NRW's Flood Map<sup>5</sup>. The assessment has considered the risk to the proposed development as well as the potential to increase flooding downstream that could be caused by the proposed development.

#### Fluvial and Pluvial Flooding

10.3.13 A review of NRW's Flood Map indicates that there is no risk of flooding from fluvial and pluvial sources within the site boundary. Flooding from surface water and small watercourses on site is localised and poses no flood risk to the proposed development or areas downstream. The Sirhowy River and the Ebbw Fawr River are at low to high risk of flooding, but this is confined to the banks of the rivers and would not impact on the proposed development. Details on site design and mitigation would be included within the EIA to prevent the proposed development exacerbating flood risk downstream of the site.

#### Flooding from Reservoir Extents

10.3.14 The reservoir located to the west of Briery Hill on the eastern valley slope of Sirhowy River shows a high risk of flooding. However, this flooding is localised and will not pose as a flood risk to the proposed development as it is located outside the site boundary. Mitigation during construction of the proposed development means that it would not exacerbate flood risk for the reservoir.

#### Tidal Flood Sources

10.3.15 Manmoel site boundary is approximately 28 km away from the nearest coast. The proposed development will not be affected by tidal flooding.

#### Groundwater Flood Sources

10.3.16 Flooding can also result from high groundwater levels if the water table rises above the surface level. Groundwater flooding happens in response to a combination of already high groundwater levels (usually during mid- or late-winter) and intense or unusually lengthy storm events. Groundwater flooding is difficult to predict as it rarely follows a consistent pattern. The response time between rainfall and groundwater flooding is also relatively long.

10.3.17 Groundwater flooding is often associated with the shallow unconsolidated sedimentary aquifers that over lie non-aquifers. Such aquifers are susceptible to flooding as the storage capacity within these deposits is often limited and direct rainfall recharge can be relatively high, subsequently increasing the water levels within the groundwater. Further information on the superficial geology is provided in Section 13.4.6. This will be discussed and assessed as part of the ES.

### Flooding from Artificial Drainage

There is evidence of artificial drainage associated with the forestry works located immediately outside Manmoel site boundary. There is the potential that this could cause some localised flooding by increasing runoff rates to the watercourses that they drain from the site boundary to the surrounding area.

Due to proximity of proposed infrastructure to mapped watercourses which have been determined as being at risk from fluvial flooding, albeit localised, further assessment on the potential impacts will be required. As part of the site design, infrastructure will be located as far as possible but a minimum of 50 m from mapped watercourses and waterbodies whilst taking into account other constraints.

### Flooding Down Catchment

The proposed development is situated on the topographical highs of the Sirhowy Valley, with the steep sided slopes towards the Sirhowy River and the Ebbw River. Although there are no named watercourses within the proposed development, the site drainage flows into the two primary watercourses of the Sirhowy River and the Ebbw River. The Sirhowy River features a catchment size of around 81 km<sup>2</sup> in its entirety with the Ebbw River featuring 225 km<sup>2</sup> prior to its confluence with the Afon Wysg at the mouth of the Severn<sup>6</sup>. The proposed development is located within the upper catchment of these watercourses.

With reference to the Wales Flood Risk Assessment Map viewer<sup>7</sup>, the proposed development features medium to high risk of surface water flooding (0.5 % to 10% chance of flooding each year). The Sirhowy River features a high likelihood of flooding downstream from the proposed development (10% chance of flooding each year), however this is confined to the channel extent. For the Ebbw River, the likelihood of flooding downstream of the proposed development is currently low to medium (0.1% to 0.5% chance of flooding each year), however there is a currently a section demarcated as being under review for risk level.

## Water Quality

### WFD Classification

10.3.1 There are three River Basin Management Plans (RBMP) which cover Wales and the proposed development is within the 'Severn River Basin District'. The RBMP are one of the requirements of the Water Framework Directive (WFD) (2000/60/EC) and are the plans designed for protecting and improving the water environment. A number of waterbodies within the vicinity of the proposed development have been classified under NRW's RBMP (NRW 2018). Table 10.6 details the classified watercourses associated with the proposed development<sup>8</sup>.

Table 10.6: RBMP classification of surface waterbodies within the vicinity of the proposed development

Waterbody ID	Waterbody	Current Overall Status (2021)	Ecological	Chemistry	Fish
GB109056032891	Sirhowy River	Moderate	Moderate	High	Good
GB109056032900	Ebbw River	Moderate	Moderate	High	Moderate

Source: RBMP

<sup>7</sup> Flood Risk Assessment Wales Map (2020). Natural Resource Wales. [Online]. Available from [https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood\\_Risk/viewers/Flood\\_Risk/virtualdirectory/Resources/Config/Default&ayerTheme=0](https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Default&ayerTheme=0) [Accessed 13/02/2023]

<sup>8</sup> Water Watch Wales (2021) Natural Resource Wales. [Online] Available from <https://waterwatchwales.naturalresourceswales.gov.uk/en/> [Accessed 13/02/2023]

<sup>5</sup> NRW. (2018) *Long term flood risk*. [Online]. Available from <https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en> [Accessed 13/02/2023].

<sup>6</sup> Flood Estimation Handbook Web Service (2022) UK Centre of Ecology & Hydrology. [Online]. Available from <https://fehweb.ceh.ac.uk/Map> [Accessed 13/02/2023]

None of the watercourses are situated within the proposed development area, with the adjacent watercourses classed as Moderate overall status.

### Effects of Coal Mining on Water Quality

- 10.3.2 The proposed development lies within the Western Wales River Basin District which has a long legacy of both mining and quarrying. Mining legacy has resulted in pressure on water quality from two sources, the underground workings and waste materials spread on the surface. Groundwater leaching from abandoned mines can be contaminated with iron, zinc, lead, cadmium, manganese, copper, nickel, arsenic and can also be quite acidic. This pollution can have significant ecological impacts some from the direct toxic impact on biology and the smothering impact of sludge and solids on riverbed gravels which affects invertebrates and fish spawning<sup>9</sup>.
- 10.3.3 The legacy of coal mining within the area of the proposed development has the potential to influence the baseline water quality of surface and groundwaters. Even after mining has ceased there is still potential for river pollution, causing harm to aquatic fauna and ecosystems. For the watercourses draining the proposed development there is potential for there to be low pH and elevated concentrations of iron, aluminium and sulphates in the watercourses<sup>10</sup>. This could be the reason for the 'Fails' for Chemistry shown in Table 10.6. The extent of historic coal mining is discussed further in Appendix A10.2: Coal Mining Risk Assessment (CMRA).

### Geology

- 10.3.4 Bedrock Geology has been scoped out of requiring further assessment within this chapter. However, bedrock geology is discussed with Appendix A10.2: Coal Mining Risk Assessment.

### Coal Mining Assessment

- 10.3.5 The risk to the proposed development from historic coal mining has been assessed, in Appendix A10.1. The assessment concludes that there is potential for infrastructure associated with the proposed development to be underlain by historical workings. It is concluded in the report that the proposed development will require detailed site investigation at each turbine location and planned access tracks due to the elevated risk of coal mining related hazards. These activities are generally conducted during the post consent and pre-construction phase of works. Turbines 1 and 2 are at highest risk based on the increased potential for shallow underground coal workings at these locations. Numerous mine entries on site have been identified across the proposed development and a strategy to remove or lower the risk should be planned where the proposed development intersects these features. Following this risk assessment; it is concluded that a site investigation should proceed, and the CMRA report should be updated following the conclusion of intrusive investigations.

### Hydrogeology

- 10.3.6 Following review of the 1:625,000 scale BGS Hydrogeological Map<sup>11</sup> the majority of the Manmoel site boundary is underlain by a moderately productive aquifer associated with the South Wales Upper Coal Measures Formation. The aquifer is a regional, cyclic multi-layered aquifer with moderate yield from sandstones and many springs, however mine water quality is poor. The access track for the proposed site is underlain by the Pennine Middle Coal Measures Formation and South Wales Middle Coal Measures Formation (Undifferentiated) which exhibits the same characteristics as the South Wales Upper Coal Measure Formation, including the aquifer productivity.
- 10.3.7 With the exception of the south west corner of the proposed development area which is underlain by till there are no mapped superficial deposits.

<sup>9</sup> Environment Agency (2009) Water for life and livelihoods - River Basin Management Plan Western Wales River Basin District Annex C: Actions to deliver objectives. Available from <https://naturalresources.wales/media/675074/annex-c.pdf> [Accessed 13/02/2023]

### Groundwater Dependent Terrestrial Ecosystems

- 10.3.8 National Vegetation Classification (NVC) surveys have been undertaken and are discussed in Chapter 6: Ecology including Table 6.11. NVC habitats were identified as having potential to be groundwater dependent terrestrial ecosystems. An assessment of the likelihood of these habitats actually being dependent on groundwater has been undertaken.
- 10.3.9 The soils underlying the proposed development have been surveyed and the findings outlined within the scoping report. The surveys identified that the site is underlain by a thin soil which is assumed to extend to the bedrock. The thin subsoil and elevated flat ground (plateau) would impede the emergence of any diffuse groundwater flow in this area meaning that the habitats are nourished by direct rainfall and overland flow. As a result there are no potential GWDTE habitats identified within the turbines area. Potential GWDTE has been identified along the existing access (to be upgraded). In this area the accumulation of surface water and ombrotrophic habitat occur both as a result of the convergence of surface flows and limited opportunities for infiltration through bedrock. This is demonstrated in the predominance of potential GWDTE communities to accumulate within artificial drainage features, or areas of constrained topography such as re-entrants. As such, it is considered that these habitats are not reliant on groundwater and are not actual GWDTEs and therefore the SEPA Land Use Planning System (LUPS) 31 buffers (as no equivalent in Wales) need not apply.
- 10.3.10 Notwithstanding this, the potential GWDTE's habitats exist on both sides of the existing access and flow pathways to these habitats would be maintained and where possible enhanced. It is also highlighted that there are no designated sites of ecohydrology/GWDTE interest within the site boundary.

### Water Resources

#### Public Resources

- 10.3.11 There are no mapped Drinking Water Protected Areas (Lake or River) within or within the vicinity of the Manmoel site boundary.

#### Private Water Supplies

- 10.3.12 BGCBC and CCBC provided information on private water supply (PWS) within 3 km of the Manmoel site boundary.
- 10.3.13 CCBC replied by email on the 28<sup>th</sup> of November 2022 that only a very small area of the PWS information request fell within Caerphilly and that they had no record of any PWS in that area.
- 10.3.14 BGCBC replied by email on the 27<sup>th</sup> of October and provided a list of 17 PWS within 3 km of the site boundary.
- 10.3.15 In order to determine the potential risks to the identified PWS, a source-pathway-receptor approach has been adopted to initially screen whether a pollutant linkage could exist between the proposed development and the water supply. Where PWS abstractions could be conceivably 'hydrologically connected' (either by means of overland or groundwater flow) then further, more detailed assessment was undertaken to qualify the level of risk. Based on the hydrological and hydrogeological setting of the proposed development, it is considered that only PWS abstractions within the proposed development or up to 3 km of the Manmoel site boundary could be hydrologically or hydrogeologically connected.
- 10.3.16 An initial desktop screening assessment adopting the source-pathway-receptor approach was undertaken to screen out any PWS abstractions that are not hydrologically (surface and groundwater) connected to the proposed development. Criteria for screening out was based on the abstraction and supporting infrastructure either being in a separate catchment or sub catchment to the proposed development, the abstraction and supporting

<sup>10</sup> Environment Agency (2019) 2021 River Basin Management Plan – Mine Waters Challenge. Available from [https://consult.environment-agency.gov.uk/environment-and-business/challenges-and-choices/user\\_uploads/pollution-from-abandoned-mines-challenge-rbmp-2021-1.pdf](https://consult.environment-agency.gov.uk/environment-and-business/challenges-and-choices/user_uploads/pollution-from-abandoned-mines-challenge-rbmp-2021-1.pdf) [Accessed 13/02/2023].

<sup>11</sup> BGS (2018). *BGS hydrogeology 625K*. [Online]. Available from <http://www.bgs.ac.uk/products/hydrogeology/maps.html> (Accessed 13/02/2023)

infrastructure was sufficiently up catchment or separated by intervening built infrastructure such as towns and major roads from the proposed development. Of the 17 properties identified, 14 were screened out on this basis.

10.3.17 A list of all properties identified by BGCBC can be provided on request. For the three properties that weren't initially screened out, consultation with owners was undertaken through the submission of a questionnaire, requesting details concerning the abstraction location, the location of delivery infrastructure and general anecdotal information on temporal changes in water quality and quantity. Further information obtained from each supply are presented in Table 10.7.

Table 10.7: Private Water Supplies

PWS Supply Name	Easting	Northing	PWS Type	Distance from nearest infrastructure (approx) (km)	Response	Notes	Further consultation required?
Ton Y Fedw Farm	316270	207021	Spring	0.23	No	Possible hydrological connection to the proposed development, PWS abstraction could be within the site boundary	Yes: Whilst the abstraction location could not be confirmed. there are several mapped springs in the vicinity of the property. Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure.
Troed Rhiw Clawdd Farm &	317304	206200	Spring	0.35	No	Possible hydrological connection to the proposed development, Although unlikely PWS abstraction could be	Yes: Whilst the abstraction location could not be confirmed. there are several mapped springs in the

PWS Supply Name	Easting	Northing	PWS Type	Distance from nearest infrastructure (approx) (km)	Response	Notes	Further consultation required?
						within the site boundary	vicinity of the property. Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure.
Troed Rhiw Clawdd Bungalow	317304	206189	Spring	0.35	No	Possible hydrological connection to the proposed development, Although unlikely PWS abstraction could be within the site boundary	Yes: Whilst the abstraction location could not be confirmed. there are several mapped springs in the vicinity of the property. Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure.

**Soils**

10.3.18 A phase 1 peat survey was undertaken prior to submission of the scoping report. Based on the results of the phase 1 survey it was recommended that further peat probing, a peat slide risk assessment and peat management plan could be scoped out of the EIA, and this was agreed by consultees.

- 10.3.19 A carbon balance assessment has been undertaken as a precautionary measure however, to provide an indication of the net CO<sub>2</sub> losses potentially resulting from the proposed development as the assessment also considers carbon emissions resulting from turbine life and the back-up electricity required for wind power as well as from impacts on peat. The results of the assessment are presented in Appendix A10.1: Carbon Balance Assessment (CBA).
- 10.3.20 The distribution of soils across the site boundary is dependent upon land use, geology, topography and hydrological regime of the area. Information on the site soils has been provided by the UKSO<sup>12</sup> and is presented below in Table 10.8. The mapper indicates that the dominant soil types are very acid/loamy soils with a slowly permeable wet surface. The quality of the soils is affected by past and existing land use, having been mined in the past. There is also evidence of artificial drainage ditches to dry the soils.

Table 10.8: Summary of Soil Types

Generalised Soil Type	Parent Material
Very acid loamy upland soils with a wet peaty surface (pale pink).	Mudstone and Sandstone
permeable, seasonally wet acid loamy and clayey soils (salmon pink).	Mudstone and Sandstone
Slowly permeable wet, very acid upland soils with a peaty surface (light green).	Mudstone and Sandstone

### Modifying Influences

- 10.3.21 Information regarding climate change was obtained from the UK Climate Projections (UKCP18) website<sup>13</sup>. The UKCP18 is a climate analysis tool which features comprehensive projections for different regions of the UK. General climate change trends projected over UK land for the 21<sup>st</sup> century show an increased chance of warmer, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of weather extremes. This is seen in the Probabilistic (25 km), Global (60 km), Regional (12 km) and Local (2.2 km) projections.
- 10.3.22 Warmer and wetter winters suggest less snow and more rain. This will create increased risk for flood events, and issues with water quality as less precipitation will be held in its frozen state during the winter season. If climate predictions are correct, summer months will become drier. This will create pressure on the needs of water abstractions and on sensitive ecosystems that rely on aquatic habitats. Evidence also suggests that although the summer months will have an average decrease in rainfall, summer storms will be more frequent and intense. This may lead to more extreme flow values during and immediately following such events, with consequential flooding and water quality issues. This is of key importance for the hydrological environment during summer construction periods.
- 10.3.23 Increased temperatures in the summer could also increase evapotranspiration and potentially cause desiccation of peat and peat dominant soils. The desiccation could result in the peat being more susceptible to erosion due to increased intensity in summer storms and increased rainfall during the winter months. As peat and peat dominant soils are composed of vegetation remains, they contain a high proportion of carbon compared to other soils.

## 10.4 RECEPTOR SENSITIVITY

On the basis of the baseline surveys and available information, Table 10.9 presents the sensitivity of the identified receptors based on the criteria outlined earlier in Table 10.2.

Table 10.9: Justification for receptor sensitivity classification

Receptor	Sensitivity	Justification
<b>Surface Water</b>		
Sirhowy River	Medium	Classified under RBMP as having 'moderate' overall status from source to Rock Villas, and 'Good' overall status downstream of Rock Villas to confluence with Afon Ebbw. Driving elements for classification include fish, hydrology and morphology. Watercourses of high status are of national importance in achieving good water quality status targets. There is proposed infrastructure situated in within this catchment.
Ebbw River	Medium	Classified under RBMP as having 'moderate' overall status from source to confluence with Ebbw Fach. Watercourse is classified as heavily modified but is of national importance in achieving good water quality status targets. Includes tributary Nant Cynon which has a large catchment with proposed infrastructure situated in headwaters.
<b>Flood Risk</b>		
The proposed development	Low	The proposed development is not identified as being in an area of flood risk area.
Watercourses downstream of the proposed development	Medium	Downstream watercourses are at potential risk of flooding and any changes to the hydrological environment that results in additional flow could exacerbate the likelihood of flooding. The addition of the proposed development infrastructure will not significantly alter the existing baseline hydrological regime and is likely to have a minimal effect on the existing rainfall-runoff scenario.
<b>Water Resources</b>		
Private Water Supplies	High	Private Water Supplies are of low regional importance, but high in a local context from the perspective of the water supply user.
<b>Soils</b>		
Site soils	Low	Site soils are generally <0.3 m deep and therefore are classified as peat soils. In addition, soils are modified by adjacent forestry activities and are of local significance.
<b>Hydrogeology</b>		
Underlying Groundwater	Medium	The majority of the proposed development is underlain by a moderately productive aquifer with moderate yields from

<sup>12</sup> UKSO (2018). *UK Soil Observatory map viewer*. [Online]. Available from <https://mapapps2.bgs.ac.uk/ukso/home.html> [Accessed 13/02/2023]

<sup>13</sup>Met Office (2020) UK Climate Projections (UKCP). [Online]. Available from <https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index> [Accessed 13/02/2023]

Receptor	Sensitivity	Justification
		sandstones and springs. Groundwater has an overall classification of 'poor' under RBMP.

## 10.5 MITIGATION METHODS

10.5.1 Existing tracks have been utilised where practicable and possible. Typically, the construction phase will involve a period of earthworks inclusive of track construction and excavations for forming turbine bases. Following this, the turbine bases and infrastructure will be installed and finally the turbines will be transported to site and erected.

### Mitigation by Design

10.5.2 The distribution of the proposed infrastructure has evolved as additional site specific information on soil and water resources became available through consultation and on-site survey works. Hydrological receptors and soils were identified as key constraints from the outset, and the design has evolved to minimise impacts on these receptors as far as possible. The proposed development will introduce physical changes which have the potential to alter hydrological characteristics of the site catchments. During the construction phase and to a lesser extent during the operational phase, potential sources of pollution will be present. Hydrological surveys have been undertaken to establish the existing on-site baseline conditions and associated areas downstream, to assess the potential effect of the proposed development on the identified receptors, the significance of these effects and the potential for mitigation to reduce the significance of the identified effects.

10.5.3 A summary of the hydrological influences on the layout is given with full details of the project design evolution provided in Chapter 4: Site Selection and Design Evolution of the ES. Due to the nature of the environment occupied by the proposed development, it is important that the design and infrastructure helps maintain or even enhance the local hydrology. Poor design of development infrastructure can result in significant implications to the hydrological environment with secondary effects on soils and ecology.

10.5.4 The findings of the peat depth survey carried out as part of the scoping report show that the site is predominantly underlain by soil and infrastructure has been sited outside areas of peaty soils ( $\geq 0.3$  m). The exception is the existing site access to be upgraded where there is a small pocket of deeper soils.

10.5.5 To facilitate the reduction of potential impacts on the hydrological environment. A series of set-back distances have been adopted and have been designed proportionately to allow greater protection in more sensitive areas:

- All watercourses and waterbodies shown on a 1:25,000 and 1:50,000 scale Ordnance Survey (OS) map were allocated a 50 m buffer from turbines and other new infrastructure.

10.5.6 Other embedded mitigation integrated as part of the design of the proposed development is as follows:

- The layout of new tracks has been designed to minimise impacts on the hydrological environment and as far as possible avoid sensitive receptors such as watercourses and deeper soils. Where required, track widening works will also aim to avoid identified receptors and where unavoidable, widening works will be favoured to progress on the far side of the track i.e., the side with the shallowest soil depth and the opposite side from PWS abstractions;
- The construction compound and substation have been located to avoid deeper soils and to minimise impacts on the hydrological environment as far as possible;
- One new watercourse crossing will be required for the proposed development where there is no existing track. Where possible, existing crossings have been utilised in order to minimise the impact of disturbance on the hydrological environment. The number of new and existing watercourse crossings required is three in total;

- There are no natural watercourses but there are a low number of straightened channels and artificial drainage ditches. Crossings are culverts and these will be upgraded if required and suitably sized to maintain flow; and
- The proposed development sits within the catchment of the Sirhowy River and the Ebbw River, which are susceptible to flooding downstream. Through careful design of the supporting drainage, any required watercourse crossing upgrades and the implementation of good management practices, it is envisaged that the potential risk of increased flooding to downstream areas can be effectively mitigated.

### Standard Good Practice Mitigation

10.5.7 A number of planning, design and construction proposals have been identified during the assessment. Full details of the good practice construction management and mitigation measures to be implemented will be outlined in a site specific CEMP which would be prepared post consent as part of the conditions discharge process. A summary of the measures which are likely to be included in the CEMP are presented in this chapter and have been assumed to be part of the proposals when the residual effects and their significance are reported.

10.5.8 Some of the mitigation measures described in the following paragraphs can also be adopted during the operational phase of the proposed development.

### Outline Construction and Environment Management Plan (CEMP)

10.5.9 A detailed CEMP will facilitate the implementation of industry good practice measures in such a manner as to prevent or minimise effects on the surface and groundwater environment. The CEMP will include information on:

- Drainage – all runoff derived from construction activities and site infrastructure will not be allowed to directly enter the natural drainage network. All runoff will be adequately treated via a suitably designed drainage scheme with appropriate sediment and pollution management measures. The proposed development is situated in an upland, previously mined hydrological area, and it is imperative that the drainage infrastructure is designed to accommodate storm flows based on a 1 in 200-year event plus climate change to help maintain the existing hydrological regime. Drainage management will be agreed with BGCBC and CCBC as part of their role as SAB;
- Storage – all equipment, materials and chemicals will be stored well away from any watercourses. Chemical, fuel and oil stores will be sited on impervious bases with a secured bund at a designated location (likely to be construction compound);
- Vehicles and Refuelling – standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable, refuelling of vehicles and machinery will be carried out in designated areas, on an impermeable surface, and well away from any watercourse;
- Maintenance – maintenance to construction plant will be carried out in designated zones, on an impermeable surface well away from any watercourse or drainage, unless vehicles have broken down necessitating maintenance at the point of breakdown, where special precautions will be taken;
- Welfare Facilities – on-site welfare facilities will be adequately designed and maintained to allow the appropriate disposal of sewage. This may take the form of an on-site septic tank with soakaway, or tankering and off-site disposal depending on the suitability of the proposed development for a soakaway;
- Cement and Concrete – fresh concrete and cement are very alkaline and corrosive and can be lethal to any downstream aquatic life. The use of wet concrete in and around watercourses or drainage will be avoided and carefully controlled through implementation of the buffer zones where applicable and good practice construction methods;
- Demarcation – where potentially sensitive receptors have been identified in areas proximal to proposed infrastructure, such as PWS, demarcation on the ground as well as within constraints plans will be undertaken to facilitate their protection;

- Monitoring Plan – all activities undertaken as part of the proposed development will be monitored throughout the construction phase to monitor environmental compliance. Water quality monitoring, including PWS if required will also occur throughout each phase of the proposed development and will help to maximise the effectiveness of embedded mitigation measures whilst monitoring effects on the hydrological environment;
- Contingency Plans – a pollution prevention plan will be prepared and will be implemented to allow plans to be put in place to manage spills or other pollution incidents. The plans will ensure that emergency equipment is available on site i.e. spill kits and absorbent materials, advice on action to be taken and who should be informed in the event of a pollution incident; and
- Training – All relevant staff personnel will be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on site.

10.5.10 Further details regarding the pollution prevention and mitigation measures that will be adopted during the construction and operation of the proposed development are detailed in the following paragraphs.

### Runoff and Sediment Management

- 10.5.11 The following measures will be adopted to appropriately attenuate and treat runoff during the construction and operation of the proposed development.
- 10.5.12 The material used during construction of the proposed development, particularly for access track upgrades and dressing will be carefully considered. This is important to prevent degradation of the track, particularly during construction when there is a high volume of vehicle movements which can result in increased sediment generation if the construction materials are not fit for purpose. Further detail would be provided during detailed design.
- 10.5.13 The proposed development drainage system will convey water away from construction activities and built infrastructure, however, due to the nature of the works at the proposed development, the steepness of the slopes and the low infiltration and storage capacity of the underlying soils and bedrock, there is significant potential for sediment and other pollutants to become entrained in the surface runoff. To reduce this potential, prior to the commencement of and during construction, plans showing site drainage and hydrologically sensitive areas (watercourse buffers, PWS abstraction source and properties) will be designed, constructed and regularly checked to review potential for runoff and ponding of water within the proposed development so that that runoff patterns are well known.
- 10.5.14 The drainage systems installed within the proposed development will incorporate the principles of SuDS and have sediment management measures incorporated into their design to help reduce or wholly mitigate effects on the hydrological environment. The type of sediment management will depend on the volume of construction activities occurring in particular areas within the proposed development. For all of the suggested control measures, regular inspection and maintenance is necessary, particularly after prolonged heavy rainfall.
- 10.5.15 Silt traps will be installed within the proposed development drainage system. Silt traps could take the form of terram fences or clean stone, however, the ability of the silt traps to successfully treat runoff will be dependent upon the permeability of the terram geotextile material and the size and source of the clean stone. If required, flocculants could also be used to treat runoff. Flocculants are very effective at removing suspended sediment from water, but they can also have effects on water chemistry. As such, any requirement for flocculent application would be agreed with NRW prior to use.

### Pumping and Dewatering of Excavations

- 10.5.16 All pumping operations e.g., removal of water from turbine base excavations, will be carried out in line with good practice and, if required, in line with the necessary permits required by NRW. Suitable measures to minimise the impact of the pumped water on the hydrological environment shall be taken.

10.5.17 Groundwater ingress is a possibility at the interface between soil and the substrate layer as well as through potential sub-surface features. The time that excavations are open will be kept to a minimum to prevent water ingress, as well as secondary impacts on up-slope soils due to dewatering. The ingress of surface water into the excavations will be minimised through the use of up gradient drainage measures e.g. cut-off ditches that will also prevent shallow throughflow entering excavations. It is recognised that water can still enter the excavation and would need to be removed. This can be achieved by allowing the water to gravity drain to a designated area before being pumped from the excavation to a predesigned settlement tank, settlement lagoon or other suitable silt treatment area. The settlement lagoons would be, subject to ground conditions, located as close to the excavation as possible and would attenuate and treat runoff before discharging back into the natural drainage network, mimicking natural flow patterns as far as possible.

10.5.18 The treated water from the settlement lagoons or other silt treatment measures will not be discharged directly into watercourses but directed onto vegetated surfaces where appropriate. Sediment will be removed from site and the treated water will be deposited amongst the rough surface vegetation, away from sensitive habitats or watercourses.

10.5.19 To reduce the likelihood of erosion channels being formed by the discharge from the sediment treatment outfalls it is recommended that the water is discharged at a slow rate or spread evenly across a surface. For discharge onto rough vegetation to be effective the discharge must be spread efficiently, and the vegetation, soils and topography be carefully considered to determine an appropriate discharge location. For example, filtering the water through a length of pipe with multiple discharge points will allow attenuation as well as diffuse dispersion, thus reducing the erosive potential of the runoff.

10.5.20 The discharge can also utilise silt traps, silt fencing or other attenuation measures. The utilisation of such measures could help to prevent the formation of erosion channels.

10.5.21 To maximise the efficiency of the settlement measures e.g., Siltbusters or other holding lagoons or tanks, the sediment sludge that collects at the base will be removed as required.

### Storage of Fuels/Chemicals and Bund Arrangements

10.5.22 Throughout construction, and to a lesser extent during the operational phase of the proposed development, a number of oils and chemicals will be used. Such materials will be used and stored in compliance with Control of Substances Hazardous to Health (COSHH) requirements at the construction compounds.

10.5.23 The following measures will be adopted to protect the surface and groundwater environment from the inappropriate storage and use of substances hazardous to the environment:

- All equipment, materials and chemicals to be stored away from any watercourses or drains. Chemicals, fuel and oil will be stored in tanks of sufficient strength and structural integrity to reduce the chances of bursting or leaking in ordinary use. They will also be sited on impervious bases within a secured bund of 110% of the storage capacity;
- Where oil is stored in a bunded area, oil residue can build up. This residue build-up will reduce the storage capacity of the bund and will be removed regularly. The residue will be disposed of by a specialist contractor;
- Locks shall be fitted to all fuel storage tanks or containers and there shall be a nominated trained person to oversee the refuelling and delivery to minimise the risk of spillage; and
- Standing machinery to have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable refuelling of vehicles and machinery will be carried out at central designated areas, on an impermeable surface, which will be located at least 50 m away from any watercourses.

## Refuelling

- 10.5.24 External fuel delivery lorries will only be allowed as far as the relevant site compound where there will be a bunded refuelling/fuel storage area constructed on an impervious base. Delivery lorries will transfer fuel to the on-site fuel tank or truck located within the bunded refuelling area to minimise the amount of fuel being driven around the proposed development and minimise external drivers accessing the proposed development.
- 10.5.25 A designated fuel truck/bowser will be used for refuelling in designated refuelling areas. The bowser driver will receive extra training on spill prevention and response.
- 10.5.26 The refuelling area shall be equipped with a mobile spillage control kit containing oil absorbent booms and mats. Nominated personnel will be trained and responsible for refuelling. Other personnel will also be trained on spill response as part of the proposed development induction training or toolbox talks. Special attention will be paid to spillage control at/near watercourses.

## Vehicle Maintenance and Management

- 10.5.27 All plant used during the construction of the proposed development will be in suitable condition and fit for purpose to carry out the works and will be maintained as per manufacturers guidelines.
- 10.5.28 Maintenance of construction plant to be carried out only in designated areas, on an impermeable surface away from any watercourse or drainage. Only if vehicles have broken down will maintenance be permitted outside of a designated area, and this would only be carried out after implementing special precautions. Such precautions include, but are not limited to:
- Ensure that drip trays are placed underneath vehicles during maintenance;
  - As a precautionary measure, and if deemed appropriate, straw bales, booms or entrapment matting would be placed downstream of the maintenance area;
  - All heavy construction plant will be inspected daily by the operating personnel and any defects or issues resolved immediately prior to starting works. All heavy construction plant shall be issued with spill kits. Should a spillage occur, larger spill kits shall also be positioned at various areas within the proposed development which will be highlighted to all operatives during the site induction; and
  - Standing machinery and plant will have industry standard drip trays (or similar, e.g., plant nappies – open metal drip trays are not permitted) placed underneath to prevent oil and fuel leaks causing pollution.

## Concrete Works

- 10.5.29 Concrete would be required for the construction of the wind turbine foundations and foundations for the substation building. The following section provides best practice measures that are required to be implemented to prevent detrimental effects to the hydrological environment.
- 10.5.30 Care will be taken during the transportation of concrete to the turbine and building foundations and will be carried out following good practice measures. Freshly mixed concrete and/or dry cement powder will not be allowed to enter any watercourse. This will be avoided by:
- Locating turbines, concrete batching or wash out areas as far as practical from watercourses;
  - Concrete wagons will only be permitted to wash-out into specifically designed wash-out areas at predetermined and agreed locations site wide;
  - The drivers will be informed at their site induction of the location of the designated wash-out areas and issued with a location map;

- Loads will be managed and assessed with regards to the size of vehicle and ground conditions whilst keeping at appropriate speed limits to avoid spillage;
- Tools and equipment will not be cleaned in watercourses. Should it be necessary to clean tools and equipment on site, this will be done in the predetermined wash-out areas;
- A designated concrete wash-out area will be constructed within the proposed development at a location agreed with the relevant consultees to protect watercourses. The design and construction of these wash out areas will be agreed with consultees post consent; and
- Wash out areas will be continually monitored, and findings recorded to reduce the chances of effluent spilling over into the environment.

## Site Drainage

- 10.5.31 Full details on the site drainage would be provided post consent and subject to detailed engineering design and finalised layout. To facilitate this design, the following section discusses the standard site drainage measures that would, in some form, be installed during the construction and operation of the proposed development.
- 10.5.32 Surface drainage ditches will be installed alongside tracks only where necessary. The length, depth and gradient of individual drains will be minimised to avoid intercepting large volumes of diffuse overland flow and generating high velocity flows during storm events. Sediment traps, settlement ponds and buffer strips will be incorporated into the drainage system as necessary and will serve the dual purpose of attenuating peak flows, by slowing the flow of runoff through the drainage system and allowing sediment to settle before water is discharged from the drainage system.
- 10.5.33 As well as utilising sediment traps, structures such as check dams will be installed within the drainage channels. Such structures will throttle the flow within the channel, thus reducing erosive potential of any runoff and allowing sediment and/or pollutants to settle.
- 10.5.34 To reduce the impact of the proposed development on the natural hydrological regime, the site drainage will mimic greenfield runoff response through the use of sustainable drainage practices.
- 10.5.35 SuDS will be taken into consideration as part of the water management plan and details of the proposed SuDS regime would be included in the detailed CEMP and to meet the requirements of the SAB. The statutory guidance<sup>14</sup> will be followed, specifically the requirements of the six standards:
- S1 – Runoff Destination;
  - S2 - Hydraulic Control;
  - S3 - Water Quality;
  - S4 – Amenity;
  - S5 – Biodiversity; and
  - S6 – Construction, Operation and Maintenance.
- 10.5.36 SuDS are used to attenuate rates of runoff from development sites and can also have water purification benefits. The implementation of SuDS as opposed to conventional drainage systems provides several benefits by:
- Reducing peak flows to watercourses and potentially reducing risk of flooding downstream;
  - Reducing the volumes and frequency of water flowing directly to watercourses;
  - Improving water quality by removing pollutants;
  - Reducing potable water demand through rainwater harvesting; and

<sup>14</sup> Welsh Government (2019) Sustainable Drainage (SuDS) Statutory Guidance. [Online]. Available from <https://www.gov.wales/sites/default/files/publications/2019-06/statutory-guidance.pdf> [Accessed 13/02/2023]

- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.
- 10.5.37 Whilst it is understood that the scope for traditional SuDS measures is limited by the hydrological environment and topographic setting of the proposed development, the adoption of the principles mentioned in designing the drainage across the site will maintain greenfield runoff rates.
- 10.5.38 Access tracks crossing slopes will disrupt surface flow that consequently will collect in drains constructed upslope of the tracks. Cross-drains and/or water bars will be constructed at regular intervals to conduct this surface flow below or across the track where it will be discharged back into the drainage system. All efforts will be made to segregate this runoff from more-silty runoff originating from track surfaces and other exposed construction areas, thus reducing the silt load and volume discharging to all silt treatment areas. Regular discharge points will limit the concentration of surface runoff and the diversion of flows between catchments. Such cross drains need to be strong enough to withstand the expected traffic loadings.
- 10.5.39 During storm events there is the possibility for ponding on the uphill side of tracks, as percolation alone is unlikely to be able to accommodate surface flows. To minimise this ponding, small diameter cross drains or perforated pipes (similar to plastic pipe field drains) would be incorporated into the track base at regular intervals to allow more flow to pass through the track and maintain the current flow regime. It is recommended that such pipes are surrounded by free draining material that is wrapped in a separator geotextile. The number of pipes and associated dimensions will be dependent upon the width of and wetter areas and the hydrological regime.
- 10.5.40 Prior to track construction, site operatives will identify flush areas, depressions or zones which may concentrate water flow. These sections will be spanned with plastic pipes to help maintain hydraulic conductivity under the road and reduce water flow over the road surface during heavy precipitation.
- 10.5.41 The constructed drainage system will not discharge directly to any natural watercourse, but will discharge to buffer strips, trenches or SuDS measures, preferably on flatter, lower lying ground. These buffers will act as filters and will minimise sediment transport, attenuate flows prior to discharge and maximise infiltration of water back into the soils and peat.
- 10.5.42 Drainage from the construction compound, welfare facilities, and concrete wash out areas will be collected and treated separately from the main site drainage, as the runoff from these areas is more likely to be contaminated and therefore will require treatment. Appropriate treatment, such as oil interceptors and treatment for high alkalinity, will be installed.
- 10.5.43 Mitigation will follow industry good practice. All mitigation and drainage will be subject to detailed design and approved by NRW prior to construction with the Environmental Clerk of Works (ECoW) ensuring compliance.
- 10.5.44 One new watercourse crossing will be required, along with possible upgrading of some of the existing watercourse crossings, as part of the access tracks associated with the proposed development. The crossings will be appropriately designed so that they do not alter the natural drainage and can accommodate flow at a minimum of 1:200yr + allowance for climate change event. All watercourse crossings will be designed with edge upstands or bunds e.g., booms, sandbags or silt fences to prevent sediment laden runoff from construction plant movement from directly entering watercourses. Relevant authorisation will be sought from the NPTCBC as the Lead Flood Authority for construction of the watercourse crossings.

### Welfare Facilities/Foul Water

- 10.5.45 The following measures will be adopted for the design of the foul water drainage system:
- Any sewage associated with the temporary construction compounds, substation and welfare facilities will be collected in appropriately sized interceptor tanks and shall be located at the construction compounds. All wash basins, toilets and shower areas shall also be connected to an interceptor tank;

- The interceptor tanks and the tanks within any site portable toilets, which shall be situated not less than 50 m from any watercourse, will be emptied regularly by a suitably licensed contractor. The final location will be in agreement with NRW; and
- Sewerage from these facilities will be disposed offsite in accordance with waste management legislation.

### Emergency Water Management Measures

- 10.5.46 A significant volume of oils and chemicals will be stored on site during the construction phase and to a lesser extent the operational phase. Site traffic will also be present in significant numbers during the construction phase of the proposed development, with traffic volumes significantly reduced during the operational phase.
- 10.5.47 The appropriate storage of oils, chemicals and maintenance of site plant has been discussed in the preceding paragraphs. However, despite these measures, accidents can happen, and these can have significant impacts upon the quality of the surface and groundwater environment. The following emergency procedures can be implemented to provide additional protection to the surface and groundwater environment during wind farm construction and operation:
- All relevant on-site staff to be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on site. The staff training and implementation of site procedures will be overseen by the infrastructure contractor so that these measures are carried out effectively to minimise the risk of a pollution incident;
  - Contingency plans will be designed that clearly highlights the location of emergency equipment available on site (i.e., spill kits and absorbent materials), training on correct use and that advice is provided on actions to be taken and who would be informed, in the event of a pollution incident;
  - Contingency planning procedures must be regularly reviewed to include changes to site operations that were not foreseen during design;
  - The procedures set out in site contingency plans need to be prepared in conjunction with the assessment of the risk of a pollution incident occurring and the measures to be taken to minimise pollution. The location of the procedures will be publicised, and it is essential that they are set out clearly so that they can easily be understood and acted upon; and
  - The emergency procedures can include the following:
    - Containment measures;
    - Emergency discharge routes;
    - List of appropriate equipment and clean-up materials;
    - Maintenance schedule for equipment;
    - Details of trained staff, location, and provision for 24-hour cover;
    - Details of staff responsibilities;
    - Notification procedures to inform the relevant environment protection authority;
    - Audit and review schedule;
    - Telephone numbers of statutory and local water company; and
    - List of specialist pollution clean-up companies and their telephone numbers.

### Soil Handling and Storage

- 10.5.48 The construction of roads, turbine foundations, crane hardstanding areas, construction compounds and substation, require the stripping of surface soils / peat soils and its temporary storage. The following paragraphs present the mitigation measures required to minimise impact on underlying soils.

- 10.5.49 Topsoil will be stripped keeping some intact. Turves will be stripped and handled with care and kept vegetation side up such that damage to the living vegetation mat is prevented or minimised as far as possible.
- 10.5.50 This material will be stored upright adjacent to the working area but sited away from watercourses and drains, as far as is practicable. Surface water would ideally be directed away from construction activity to avoid silty run off entering watercourses or ecologically sensitive areas. The stored mounds will be limited in height to 1.5 m to minimise the risk of instability and compaction of lower layers. If encountered, any subsoil that is stripped and stored will be kept separate from the topsoil.
- 10.5.51 The excavation of soils is to be undertaken in such a manner as to avoid cross contamination between distinct horizons. The different soil horizons will be kept and stored separately for use at a later date.
- 10.5.52 During and after excavation, the storage, haulage and reuse of excavated material will be planned in advance to minimise material movement around the site. Immediate reuse is preferred to temporary storage (where possible). Further details are provided in the following paragraphs.
- 10.5.53 Turves will be stripped and handled with care and kept vegetation side up such that damage to the living vegetation mat is prevented or minimised as far as possible.
- 10.5.54 The following will also be considered in the handling and storage of excavated soils:
- Sediment Discharges – implementation of a buffer zone to minimise impacts to watercourses and water supplies, undertaking of water quality monitoring particularly after heavy rainfall, and assurance that culverts are of sufficient size and spacing with appropriate erosion mitigation measures; and
  - Contaminant discharges – follow GPPs and PPGs, refuel and store oils and fuels in designated areas.
- 10.5.55 Further details on the measures to appropriately manage the excavation, storage and reinstatement of excavated material is provided in the following paragraphs.

### Excavation

- 10.5.56 Prior to any excavation, detailed method statements will be produced identifying where and how excavated soil will be used in reinstatement or landscaping works. Specific requirements for the excavation, handling, storage and reinstatement of soil will be outlined in the above method statement. The method statements will consider the potential impacts on downstream hydrological receptors and the potential for instability issues with the excavated material.
- 10.5.57 The principal requirements are outlined:
- All excavations where required should be monitored and measures taken to prevent collapse and the destabilising of soil deposits adjacent to excavations;
  - A system of daily reporting of excavations will be established during construction and utilised to monitor the geotechnical performance of slopes including sub-soil and bedrock. This would be implemented and undertaken by a suitable, experienced and trained member of the site team;
  - Excavated soils should be as intact as possible. Turves will be stored vegetation side up to promote the retention of structure prior to use in reinstatement; and
  - Care will be taken when stripping and removing topsoil and appropriate storage methods will be used on site, i.e. excavated material will be stored in separate horizons with turves being placed on top of excavated material to minimise desiccation and oxidisation. They would be placed in a manner to maximise coverage in a 'checkerboard' pattern.

### Temporary Storage of Excavated Material

- 10.5.58 Excavated material that is stockpiled on site for further use should be managed to prevent silty run-off or losses due to drying out and wind. The temporary storage of excavated material shall seek to minimise the disturbance of soil deposits through minimising haul distance between temporary storage sites.
- 10.5.59 The suitability of temporary storage areas will be confirmed prior to works taking place and the following key control measures will be considered:
- Topsoil and soil will be stripped and stored separately within the pre-identified areas to maximise the success of safe storage and swift and successful reinstatement;
  - If space does not allow storage and the surplus is to be stored elsewhere on the site, the ECoW will be consulted in advance to agree appropriate areas;
  - Separate areas will be created for the different layers and topsoil will not be mixed with subsoil layers;
  - Stacked topsoil will not exceed a height that enables the topsoil to breakdown. The maximum height for stacked material will be agreed in advance with a maximum height likely to be 1.5 m;
  - Storage areas will be located away from watercourses (minimum of 50 m, where practical) protected from run-off from adjacent areas;
  - Storage areas should be reinstated to their original condition on completion of their use for storage;
  - If soil storage is being carried out on sensitive habitats, consideration will be given to storage on top of a geotextile mat and storage duration shall be minimised;
  - Other site works will not impact on stored soil (e.g. construction traffic will not track over stored soils);
  - If significant soil erosion is occurring from storage piles during periods of heavy rain action will be taken to cover the stockpiles, where practical. The silt fencing or other mitigation around the base of the stockpile will be monitored and replaced as necessary;
  - In periods of dry weather check the need for watering to reduce dust and potential nuisance;
  - A silt fence will be constructed at the base of the stockpile using a suitable geotextile if required; and
  - Construct drainage channels to direct surface water away from stockpiles and prevent erosion at the base.

### Site Reinstatement

- 10.5.60 So far as is reasonably practicable, all disturbed areas which require reinstatement will be reinstated with the same vegetation types as exist at present, thereby ensuring minimum disruption to the surrounding landscape.
- 10.5.61 The reinstatement and storage of any excavated materials will involve replacement of previously stripped soils, vegetated layers or turves. Timing of reinstatement works will also consider adjacent construction activities which may disturb any reinstatement works already carried out.
- 10.5.62 Stripped soils are likely to degrade and become unsuitable for use in reinstatement if stored for prolonged periods of time. Therefore, the amount of time between the construction activities and subsequent reinstatement will be minimised as much as practically possible.
- 10.5.63 The fundamental aspects of reinstatement are summarised as follows:
- Stripped soil will be reinstated, including landscaping of infrastructure verges, as close to where it was removed as possible. This will help to maintain a local seed base and the local geological/hydrological characteristics;
  - Subsoil, topsoil and turfs replaced in same order as removed;
  - During periods of dry weather, exposed soils shall be kept moist;
  - Unless otherwise agreed, soils will be reinstated following the works and orientated vegetation side up;

- Reinstatement will be carried out as soon as is possible following stripping to ensure integrity of material is maintained;
- Where turfs are not available, areas will be left to re-vegetate naturally. If there is not sufficient turf to completely cover an area, then turf will be spread in smaller sections to offer some protection and spread the seed bank rather than leave larger exposed areas;
- Any soil found to be contaminated will not be used for reinstatement but disposed of off-site to a licensed or exempted facility, if necessary; and
- The reinstatement of the construction areas will be undertaken to a high standard, using the existing soil and vegetation material wherever possible, in accordance with industry good practice.

### Additional Mitigation

- 10.5.64 Where specific risks exist for individual receptors as a result of the construction and operation of the proposed development, additional mitigation will also be used alongside embedded mitigation to further reduce measurable impacts. The recommendations outlined will be incorporated into the CEMP post-consent.
- 10.5.65 Site-specific mitigation will be undertaken at the relevant private water supplies situated adjacent to the Manmoel site boundary. This will include the implementation of a series of additional measures which are summarised in Table 10.10 and include, as a minimum:
- Completion of investigations to verify the supply details, including abstraction location and supply delivery infrastructure;
  - Completion of further investigations to further characterise the groundwater system;
  - Detailed design of drainage system to encourage infiltration of treated and discharged runoff;
  - Demarcation of supply and infrastructure and appropriate design of standard good practice mitigation to avoid potential for impact;
  - Where necessary provision of alternative temporary or permanent alternative water supply; and
  - Establishment of a program of baseline and construction inspection and monitoring.
- 10.5.66 The above measures will be provided in a detailed Private Water Supply Monitoring Plan and Method Statement (PWSMP) that will be prepared following the completion of the detailed investigations undertaken pre-construction. The implementation of this additional mitigation will be the responsibility of the Developer and nominated Principal Contractor.

## 10.6 PREDICTED CONSTRUCTION EFFECTS

- 10.6.1 The potential for effects on the hydrological environment is greatest during the construction phase due to the high levels of activity on-site and when there is greatest change to the existing environment. The potential effects associated with the construction of the proposed development is discussed and assessed in the following sections.
- 10.6.2 The evaluation of construction effects is provided in Table 10.10. The assessment results are based on the successful implementation of the embedded good practice mitigation measures as well as the additional mitigation measures provided in Section 10.5: Mitigation Methods.

### Predicted Construction Effects

#### *Pollution Incidents*

- 10.6.3 During the construction phase, a number of potential pollutants will be present onsite, including oil, fuels, chemicals, unset cement and concrete, waste and wastewater from construction activities and staff welfare facilities. The majority of these potential pollutants will be located or stored within the construction compound in

addition, there is the potential for contamination of the hydrological and terrestrial environment caused by spillages along the access tracks, and construction areas.

#### *Erosion and Sedimentation*

- 10.6.4 Soil and sediment generation may occur in areas where the ground has been disturbed, particularly where surface runoff has been concentrated. Drainage ditches are particularly prone to this problem, due to the high velocities of surface water runoff passing through the drainage network. Some sediment generation is expected where the ground has been excavated for the proposed development infrastructure.
- 10.6.5 Sediment transport in watercourses can result in high turbidity levels which can impact on the water quality, particularly affecting the ecological potential of the watercourses. High turbidity in watercourses can reduce the light and oxygen levels in the watercourses, while sediment deposition can smother plant life and spawning grounds. Sediment deposition can also reduce the flood storage capacity of the watercourses and block culverts, resulting in an increased flood risk.
- 10.6.6 As a result of the construction operations, all catchments with new and upgraded infrastructure present are vulnerable to erosion and sedimentation.

#### *Changes in Water Quality*

- 10.6.7 Excavation and disturbance of soils could result in changes in the chemistry of surface water runoff including colour, dissolved organic carbon (DOC), turbidity and dissolved metals. As with erosion and sedimentation, this can have implications on both the quality of the aquatic habitat and also the resource potential of the water itself.
- 10.6.8 Potential pollutants coming into contact with bedrock, or the superficial sediments also have the potential to alter the quality of the groundwater resource. Such alterations including changes in pH or addition of chemicals could be difficult to rectify, and due to the limited extent of any superficial aquifer, would attenuate very slowly.

#### *Increases in Runoff*

- 10.6.9 Turbine bases, hardstand areas and access tracks etc. will act as impermeable areas, restricting the natural movement of water within the hydrological environment, potentially resulting in increased rates of runoff into the onsite and downstream catchments. The pre-construction, construction and permanent site drainage will be designed to mimic greenfield runoff response through the use of sustainable drainage practices.
- 10.6.10 Localised increases in runoff could cause issues for downstream flood storage capacity and/or pollution incidents. Increases in the volume of runoff entering watercourses could also cause erosion and sedimentation, therefore having detrimental effects on surface water hydrology.

#### *Modification of Surface Drainage Patterns*

- 10.6.11 The interception of diffuse overland flow by the proposed development infrastructure and associated drainage may disrupt the natural drainage regime of the area, concentrating flows and potentially diverting flows from one catchment to another. This may have implications for water quality or quantity (including PWS and GWDTE) and on flood issues downstream of the proposed development.
- 10.6.12 As well as potentially negative effects, construction may also positively effect surface drainage patterns through the blocking of artificial ditches during habitat restoration and natural flood management (NFM) enhancement measures and therefore encouraging the development of a natural rainfall-runoff response.

#### *Impediments to Surface Water Flow*

- 10.6.13 The design and construction of watercourse crossings will be appropriately sized to accommodate the 1 in 200 years + Climate Change flow. However, there remains the risk that drainage channels and culverts can become blocked with debris particularly during periods of heavy and/or prolonged precipitation.

**Modification of Groundwater Flows and Levels**

- 10.6.14 Deep excavations, such as those required for the turbine foundations are likely to disrupt the shallow groundwater systems and bedrock geology. Surface water ingress will be minimised by utilising upgradient cut-off drains or other drainage measures. The installation of cut-off drains has the potential to lower local groundwater levels within surrounding peat dominated soils.
- 10.6.15 The majority of temporary and permanent infrastructure (apart from foundations) would be permeable to some extent.

10.6.16 Access tracks and other linear infrastructure elements such as cable trenches have the potential to disrupt flow pathways as granular backfill may create preferential infiltration and throughflow pathways. These may interrupt shallow groundwater flow or alter the hydrological regime impacting baseflow to watercourses, habitats and PWS.

**Assessment of Construction Effects**

Table 10.10 identifies the likely construction effects on the identified receptors and their significance assuming the successful implementation of good practice and embedded mitigation measures. A further column has also been provided considering the effect significance upon receptors following the implementation of additional mitigation outlined in paragraphs 10.5.64 – 10.5.64.

Table 10.10: Assessment of construction effects

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation				Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation Requirements	Sensitivity	Magnitude of Impact	Significance of Effect
<b>Surface Water Quality</b>								
Pollution incidents	River Avan/Afon Afan (including tributaries)	Medium	Low	Moderate/Minor	None	-	-	-
Erosion and sedimentation		High	Low	Moderate	None	-	-	-
Changes in Water Quality	Ffrwd Wylt (including named tributaries)							
Increase in Run-off								
Modifications to Surface Drainage Pattern								
Impediments to Surface Water Flow								
<b>Flooding</b>								
Increase in run-off	The proposed development	Low	Low	Minor	None	-	-	-
Modifications to Surface Drainage Patterns	Watercourses downstream of the proposed development	High	Low	Moderate	None	-	-	-
Impediments to Surface Water Flow								
Compaction of Soil								
<b>Water Resources</b>								
Pollution incidents	Private Water Supplies (not hydrologically connected)	High	Negligible	Moderate/Minor	None	-	-	-
Erosion and sedimentation		High	Medium	Major/Moderate	None	High	Negligible	Moderate/Minor
Changes in Water Quality	Private Water Supplies with potential hydrological connection (Table 10.10) IDs: 4,9,56,57							
Increase in Runoff								
Modifications to Surface Drainage Pattern					Additional mitigation outlined in Table 10.10 including further detailed investigations post consent and paragraph 10.7.68 – 10.7.69.			
Impediments to Surface Water Flow								
Modification of Groundwater Flows and Levels								
Compaction of Soils								
<b>Soils</b>								

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation				Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation Requirements	Sensitivity	Magnitude of Impact	Significance of Effect
Pollution incidents	Site soils and peat <0.3 m depth	Low	Low	Minor	None	-	-	-
Modifications to Surface Drainage Patterns	Site soils and peat ≥0.3 m depth	Medium	Low	Moderate/Minor	None	-	-	-
Modification of Groundwater Flows and Levels								
Compaction of Soils								
<b>Hydrogeology</b>								
Pollution incidents	Groundwater within Sub Soils	Medium	Low	Moderate/Minor	None	-	-	-
Modification of groundwater flows and levels	Underlying Groundwater	Low	Low	Minor	None	-	-	-
Compaction of Soils								

## 10.7 PREDICTED OPERATION EFFECTS

10.7.1 The effects of the proposed development will be substantially lower during the operational phase. The following paragraphs discuss and assess the potential effects that are predicted to occur during the operational phase of the proposed development. The assessment of effects assume the implementation of the good practice mitigation that is outlined above and would be incorporated into a full site-specific CEMP post consent.

### Predicted Operation Effects

#### *Pollution Incidents*

10.7.2 The potential risk of pollution is substantially lower during operation than during construction because of the reduced levels of activity in the operational phase. Most potential pollutants will have been removed when construction was completed; however, lubricants for turbine gearboxes, and transformer oils may be stored on site (as well as being contained within the equipment themselves) and there is the risk of possible fuel leaks from maintenance vehicles whilst onsite.

#### *Erosion and Sedimentation*

10.7.3 Levels of erosion and sedimentation during operation will be much lower than construction as there will be no excavations or bare exposed ground. Some erosion and sedimentation are still possible on the access tracks and drainage ditches as a result of scouring during extreme rainfall events. Similarly, there could be some short term increases to erosion and sedimentation around new or upgraded stream crossings as watercourses reach new equilibrium primarily within the construction and early in the operational phases of the proposed development.

#### *Changes in Water Quality*

10.7.4 During the operation phase there will be no continued construction works associated with excavation and exposure of soils, peat and sediments. Opportunities for erosion and transportation of materials will be considerably reduced during the operational phase as previously exposed surfaces become vegetated.

#### *Changes in Runoff Regime*

10.7.5 Temporary drainage management features such as silt ponds and silt fencing will be dismantled and the ground reinstated, with retained features designed to blend into the landscape. The retention of permanent drainage management features such as trackside ditches is likely to reduce the rate of runoff compared to the construction phase with permanent drainage designed to mimic greenfield hydrological regimes.

#### *Modification of Surface Drainage Patterns*

10.7.6 Modification of surface runoff will occur as a result of the construction of the new infrastructure associated with the proposed development. The operational effects could result in changes to volume and/or changes to runoff rate, however the permanent drainage will be designed to avoid this.

#### *Impediments to Surface Water Flow*

10.7.7 During the operational phase impediments to flows can generally occur as a result from blockages to watercourse crossings, ditches and watercourses themselves, resulting from vegetation and erosion debris. The cost of maintaining the mitigation measure shall be met by the operator through the lifetime of the planning permission.

#### *Modification of Groundwater Flows and Levels*

10.7.8 Cut tracks and their drainage as well as turbine foundations and hardstands will potentially alter the water table within the upslope and downslope peat and bedrock groundwater, which can also have implications for the long-term functionality of peatland environments.

#### **Assessment of Predicted Operation Effects**

10.7.9 Table 10.11 identifies the likely operational effects on the identified receptors and their significance based on the successful implementation of good practice and embedded mitigation measures. The only additional mitigation during the operational phase will be the permanent mitigation for PWSs and the adoption of NFM enhancement measures as part of long-term flood risk management.

Table 10.11: Assessment of predicted operational effects

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation				Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation Requirements	Sensitivity	Magnitude of Impact	Significance of Effect
<b>Surface Water Quality</b>								
Pollution incidents	Sirhowy River	Medium	Negligible	Minor	None	-	-	-
Erosion and sedimentation	Ebbw River	Medium	Negligible	Minor	None	-	-	-
Changes in Water Quality						-	-	-
Increase in Run-off						-	-	-
Modifications to Surface Drainage Pattern						-	-	-
Impediments to Surface Water Flow						-	-	-
<b>Flooding</b>								
Increase in run-off	The proposed development	Low	Negligible	Minor/Negligible	None	-	-	-
Modifications to Surface Drainage Patterns	Watercourses downstream of the proposed development	High	Negligible	Moderate/Minor		-	-	-
Impediments to Surface Water Flow								
Compaction of Soil								
<b>Water Resources</b>								
Pollution incidents	Private Water Supplies (not hydrologically connected)	High	Negligible	Moderate/Minor	None	-	-	-
Erosion and sedimentation								
Changes in Water Quality	Private Water Supplies with potential hydrological connection (Table 10.10) IDs: 4,9,56,57	High	Low	<i>Moderate</i>	Monitoring might be required at the start of the operational phase this would be confirmed in the PWSMP.	High	Negligible	Moderate/Minor
Increase in Runoff								
Modifications to Surface Drainage Pattern								
Impediments to Surface Water Flow								
Modification of Groundwater Flows and Levels								
Compaction of Soils								
<b>Soils</b>								
Pollution incidents	Site soils	Low	Negligible	Minor/Negligible	None	-	-	-
Modifications to Surface Drainage Patterns						-	-	-
Modification of Groundwater Flows and Levels								
Compaction of Soils								
<b>Hydrogeology</b>								
Pollution incidents	Groundwater within Sub Soils	Medium	Low	Moderate/Minor	None.	-	-	-
Modification of groundwater flows and levels						-	-	-

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation Requirements	Sensitivity	Magnitude of Impact
Compaction of Soils							

## 10.8 CUMULATIVE EFFECTS

### Predicted Cumulative Effects

- 10.8.1 Off-site cumulative hydrological effects are primarily related to changes in water quality and increases in flood risk. Mitigation has been presented in Section 10.7 to adequately protect on-site hydrological receptors and therefore will be suitable to ensure the protection of those development situated downstream and should not contribute to or exacerbate any effects arising from other developments, land uses or activities. With regards to flood risk specifically, the design of the drainage will mimic the existing hydrological and greenfield regime of the proposed development area, as outlined in Section 10.7.
- 10.8.2 It is concluded that following the successful implementation of the mitigation outlined in Section 10.7, cumulative impacts of the proposed development during construction and during operation will be negligible.

## 10.9 MONITORING

- 10.9.1 Monitoring for the proposed development will be required and will be confirmed post-consent. A breakdown of the proposed monitoring methodologies has been provided to consider sensitivities of the on-site and downstream environments.
- 10.9.2 The details of any required water quality monitoring should be discussed and agreed with NRW, BGCBC and CCBC prior to commencement. The extent and the frequency of the monitoring will be proportionate to the level of activity on site during the construction, operation and decommissioning of the proposed development. Appropriate monitoring is important to:
- Provide reassurance that established in-place mitigation measures are effective and that the proposed development is not having any significant adverse effect upon the environment;
  - Indicate whether further investigation is required and, where pollution is identified, the need for additional mitigation measures;
  - Confirm that construction has not increased flood risk;
  - Reduce or remove any impacts on the water environment;
  - Confirm that there has been no impact on PWS; and
  - Understand the long-term effects of the proposed development on the natural environment.
- 10.9.3 A baseline surface water monitoring programme will be undertaken prior to the commencement of construction works. The establishment of a baseline is very important as it provides a suite of parameters against which to compare samples taken during the proposed development’s lifetime, and with which to assess any impacts and the requirement for any appropriate remedial measures. However, due to the variance in climatic conditions, recording like for like water quality prior to and during construction is likely to be unusual. Therefore, it is also recommended that control sites, situated outside the area affected by the proposed development infrastructure are also established at the same time.

- 10.9.4 It is recommended that flow monitoring is undertaken during all phases of the proposed development to demonstrate that there has been no exacerbation of downstream flood risk.
- 10.9.5 Following further investigation of the identified private water supplies it might be that monitoring is required during construction of the proposed development.
- 10.9.6 A suitably qualified ECoW will be employed throughout the construction of the proposed development. The appointed ECoW can provide advice to the contractors about how environmental effects can be minimised, and what methods can be employed to reduce effects on water quality, soils and associated habitats.
- 10.9.7 Monitoring will be undertaken throughout construction of the proposed development. The monitoring will help to identify areas where infrastructure is having a negative effect on water quality and quantity, soils and utilise the appropriate methods to prevent further deterioration and/or promote further enhancement.
- 10.9.8 All construction management and water management techniques will be agreed prior to construction. The techniques would be agreed following consultation with, NRW, BGCBC and CCBC. In conjunction with this, there should be a programme of visual monitoring to ensure that the designed drainage system is functioning well. In addition to this, PWS monitoring will be undertaken to ensure that supply quality and quantity is not altered as a result of the construction and operation of the proposed development.

## 10.10 DECOMMISSIONING

- 10.10.1 During decommissioning of the proposed development, potential impacts on the hydrological, geological and hydrogeological environment are expected to be less than those encountered during the construction phase and therefore ‘not significant’. No specific mitigation measures in addition to those noted for the construction phase are therefore identified.
- 10.10.2 The decommissioning of the proposed development would adhere to the latest legislative and guidance requirements at the time.

## 10.11 SUMMARY

- 10.11.1 An assessment has been carried out of the likely impacts of the proposed development on the hydrological, geological and hydrogeological environment. The assessment has considered site preparation, construction and operation of the proposed development.
- 10.11.2 The potential effects on the hydrological, geological and hydrogeological environment have considered, pollution incidents, erosion and sedimentation, changes in water quality, and private water supplies, modification of surface water and groundwater flows, modification of natural drainage patterns, impediments to flow and flood risk and compaction of soils.
- 10.11.3 Following the identification and assessment of the key receptors, taking into account the potential effects listed above, mitigation and good practice measures has been incorporated into the design, including buffer areas. In addition, a site-specific CEMP as well as detailed design of infrastructure and associated mitigation will be

implemented to protect the groundwater and surface water resources from pollution and minimise changes to the hydrological environment.

- 10.11.4 Production of a CEMP is in line with the Well-being of Future Generations (Wales) Act 2015<sup>15</sup> goal 'A Resilient Wales' for 'a nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change'.
- 10.11.5 The impact assessment has taken into account the hydrological regime, highlighting that the principal effects will occur during the construction phase. Following the successful design and implementation of mitigation measures the significance of construction effects on all identified receptors are not defined as significant. The assessment of predicted operational effects has determined that the significance of effects on all receptors to be of no significance. A 50 m micro-siting allowance for infrastructure, where it doesn't infringe on recognised sensitive receptors, has been applied to the assessment, and is considered in the significance of effects.

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<sup>15</sup> Well-being of Future Generations (Wales) Act 2015. [Online]. Available from <https://www.legislation.gov.uk/anaw/2015/2/contents/enacted> [Accessed 13/02/2023]