Chapter 9 – Hydrology & Hydrogeology

Introduction and Methodology

9.1 This chapter assesses the hydrological and hydrogeological environment and discusses the potential impacts associated with the construction, operation and de-commissioning phases of the proposed windfarm development. The present site conditions constitute the baseline environment. The development area ("the site") is a portion of large parcels of land ("the lands") owned by the developer. This chapter has been prepared in respect of the proposed development of agricultural lands, in Rhoscrowther, Pembrokeshire, SA71, centred at National Grid Reference (NGR) 191379 201972 and should be read in conjunction with Chapter 1 of the Environmental Impact Assessment (EIA) which sets out the context and background to the proposed development of the site.

9.2 For the purpose of the EIA the following is defined:

i. The term "Hydrology" refers to surface waters;

ii. The term "Hydrogeology" refers to groundwaters.

9.3 This chapter on Hydrology and Hydrogeology involved the following:

i. Review the site development design;

ii. Consult with relevant statutory authorities and published information to help establish baseline conditions;

iii. Identify and evaluate the nature of the existing controlled waters, including rivers, streams, groundwater resources and other water features;

iv. Identify hydrological constraints on the layout of the proposed windfarm that should be taken into account in the design;

v. Assess the impact of the wind farm on controlled waters and to evaluate the significance of the impact;

vi. Characterise the nature and extent of the soil cover at the site and its risk of impacting controlled waters;

vii. Identify measures for avoiding / mitigating potential impacts; and,

viii. Highlight and assess any residual impacts that would exist following mitigation.

Methodology for Assessment of Effects

9.4 The assessment has been undertaken in line with the Source – Pathway – Receptor Model as defined in guidance document Environment Agency Contaminated Land Report (CLR) 11.

9.5 At the impact assessment stage, any potentially beneficial or adverse impacts associated with the development are identified and assessed with reference to the baseline environment. This requires consideration of:

i. Sensitivity / value of the receptor;

ii. Magnitude of the impact.

iii. Impact duration.

iv. Whether impact occurs in isolation is cumulative or interactive; and

v. Performance against environmental quality standards or other relevant thresholds.

Assessment Criteria and Impact Assessment Methodology

9.6 This assessment considers the potential risk to environmental receptors and the pathways by which the receptors may be affected. Definitions of the key descriptors are detailed below:

i. Source: potential contaminant sources;

ii. Pathway: the mechanism by which the source may affect a receptor; and

iii. Receptor: identified features that may be affected, based on the sensitivity of the site.

9.7 The strength of the pathway between a source and a receptor is a function of the distance between the two and the nature of the migration pathway. For example, on sites underlain by impermeable clays, the migration pathway via groundwater would be weak even over short distances, whereas within sands or gravels, the migration pathway would be strong for receptors in close proximity to a source and weak for receptors at some distance from the source.

9.8 The significance of predicted impacts likely to occur during all phases of the proposed development was determined by considering the value and sensitivity of the key attributes that may be affected and the magnitude of the predicted impact.

Determining the Value and Sensitivity of the Receptor through Baseline Studies

9.9 The value or sensitivity of a receptor is largely determined by its quality, rarity and scale. The determination of value or sensitivity considers the scale at which the attribute is important. For the purpose of assessing the significance of environmental impacts predicted as part of this assessment, the value of receptors is scaled based on the relative importance of the receptor defined as follows:

i. LOCAL LEVEL: On the proposed development Site or immediately adjacent;

ii. DISTRICT LEVEL: Beyond the Site boundary but within the district;

iii. COUNTY LEVEL: County Level e.g. Pembrokeshire;

iv. REGIONAL LEVEL: Wales;

v. NATIONAL LEVEL: United Kingdom;

vi. INTERNATIONAL LEVEL: European Community;

9.10 A receptors value and sensitivity must be defined using available guidance and professional knowledge and considering the site sensitivities. In some cases, the inherent value of the receptor has been recognised and been afforded a statutory designation (e.g. Special Areas of Conservation (SAC's)), which makes the value assignment more simplistic. The judgement of receptor significance is made on a case by case basis for each receptor or resource identified as having the potential to be subject to impacts associated with the proposed development.

9.11 Irrespective of its recognised value, all receptors / features would exhibit a degree of sensitivity to the changes imposed by new development. The 'sensitivity' element of the criterion ensures that this characteristic of each receptor is assessed. The classification for

determining sensitivity of receptors is detailed in Table 9.1: ***Receptor Sensitivity and Typical Descriptors*** This classification is used as a generic methodology and professional judgement has been applied in each case.

Table 9.1: Receptor Sensitivity and Typical Descriptors

Sensitivity	Descriptors
Very Low	Feature / receptor is generally insensitive to impact, no discernible changes e.g. soils are not in use, the land is used for industrial / commercial purposes and /or mainly covered by hard standing.
Low	Feature/receptor has some tolerance to accommodate the proposed change. It responds in a minimal way such that only minor changes are detectable e.g. landscaped areas.
Medium	Feature / receptor has a low capacity to accommodate the proposed form of change. It clearly responds to effects in a quantifiable manner e.g. low grade agricultural land and recreational ground.
High	Feature / receptor has a very low capacity to accommodate the proposed form of change. The response is a major change e.g. agricultural land use for food production, allotments.

Magnitude of Impacts

9.12 Magnitude refers to the 'scale' or 'amount' of an impact. Key impacts have been identified and the likely magnitude of each potential impact has been determined through the predicted change from the baseline conditions throughout the various phases of development. The magnitude of an impact is a measure of aspects such as the impacts:

i. Extent (i.e. the geographical area over which the impact occurs);

ii. Duration (i.e. the time for which the impact is expected to last prior to recovery or replacement of the resource or feature: short, medium or long term);

iii. Likelihood (i.e. the probability that the impact will occur);

iv. Direct or Indirect (i.e. difficult to avoid);

v. Reversibility (i.e. an irreversible (permanent) impact is one from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it: Temporary or Permanent).

9.13 In order to help define the level of impact magnitude the following guidance has been adopted for the purpose of providing a transparent assessment. The professional judgement of the technical author is used in the decision-making process when characterising impacts in accordance with the criteria set out in Table 9.2.

Table 9.2: Assessment Criteria for Magnitude

Magnitude	**Assessment Criteria**
No Change	• No loss or alteration of characteristics, features or elements; • No observable impact on receptors/features.
Negligible	• Noticeable, temporary (for part of the development duration) change; or

	• Barely discernible change for any length of time, over a small area, to any key characteristics or features; • Impact unlikely or rarely to occur; • Results in effects on attribute of insufficient magnitude to affect the use/integrity.
Slight	• Noticeable, temporary (during the project duration) change, over a partial area, to key characteristics or features. Impact will possibly occur; • Impact predicted to extend over a small area; • Impact predicted to affect small numbers of people; • Impact predicted to affect a small number of other receptors (ecological, businesses, facilities); • Impact not predicted to have trans-boundary effects, but possibility remains; • Slight but discernible change in environmental conditions predicted; • Impact not predicted to entail unusual/complex effects for receptors; • Impact not predicted to affect particularly scarce features/resources; • Impact not predicted to result in breaches of legislation or statutory Environmental Quality Standard or Objectives; • Impact not predicted to result in loss of attribute; • Impact will continue for a short period of time only; • Impact will be temporary; • Impact will be intermittent and/or rare;

	• Impact will be reversible; • Impact will be possible to avoid, reduce, repair, or compensate for; or • Slight positive change in environmental conditions resulting in minor improvements in quality or value of a receptor.
Moderate	• Significant, permanent / irreversible changes, over the majority of the development area and potentially beyond, to key characteristics or features. Impact certain or likely to occur. • Impact predicted to extend over a moderate area; • Impact predicted to affect moderate numbers of people; • Impact predicted to affect some other receptors (ecological, businesses, facilities); • Impact unlikely to have trans-boundary effects, but possibility remains; • Moderate change in environmental conditions predicted; • Impact unlikely to entail unusual/complex effects for receptors but possibility remains; • Impact unlikely to affect particularly scarce features/resources but possibility remains; • Impact entails a low probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur; • Impact unlikely to result in loss of attribute but possibility remains; • Impact will continue for a moderate period of time;

	• Impact will be semi-permanent; • Impact will be intermittent; • Impact will be possible to avoid, reduce, repair, or compensate for; or • Notable positive change in environmental conditions resulting in measurable improvements in quality or value of a receptor.
Substantial	• Very significant, permanent / irreversible changes, over the whole development area and beyond (i.e. off-site), to key characteristics or features of character or distinctiveness. Impact certain or likely to occur; • Impact predicted to extend over a large or very large area; • Impact predicted to affect considerable numbers of people; • Impact predicted to affect considerable numbers of other receptors (ecological, businesses, facilities); • Impact predicted to have trans-boundary effects; • Significant change in environmental conditions predicted; • Impact will entail unusual/complex effects for receptors; • Impact will affect particularly scarce features/resources; • Impact entails a high probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur; • Impact will result in total loss of attribute; • Impact will continue for extended periods of time; • Impact will be permanent rather than temporary;

	• Impact will be continuous rather than intermittent, or where intermittent, frequent rather than rare; • Impact will be irreversible; • Impact will be very difficult to avoid, reduce, repair, or compensate for; or • Significant positive change in environmental conditions resulting in major improvements in quality or value of a receptor.

Impact Significance

9.14 The EIA Regulations (2017) are concerned with 'significance' and the identification of 'significant environmental effects'. Therefore, an assessment of significance is necessary in order to identify the main environmental effects of the proposed development and assist in determining what weight these effects should be given. Although there are published transparent methodologies for assessing significance for certain environmental topics (noise, ecology, etc.), there is no definitive guidance available specific to the soil or geological environment. From the guidance provided in the revised Development Control Advice Note (DCAN) 10 'Environmental Impact Assessment' and the Amended Circular on EIA consultation paper, published in June 2006 by the Department for Communities and Local Government (DCLG) 'Environmental Impact Assessment: A Guide to Good Practice and Procedures', it can be concluded that a significant effect may be broadly defined as one that should be brought to the attention of those affected and those involved in the decision-making process.

9.15 It is widely recognised that 'significance' reflects the relationship between the magnitude of an impact and the sensitivity (or value) of the affected environmental receptor.

9.16 To assist in the assessment process, the Impact Significance Matrix (ISM) (Table 9.3) provides a transparent methodology to ensure consistency and ease of interpretation of the judgement of impact significance.

9.17 An initial indication of impact significance (adverse or beneficial) is gained by combining magnitude and sensitivity / value in accordance with the ISM provided. It should be noted that although the ISM provides a good framework for the consistent assessment of impacts across all environmental parameters, there is still an important role for professional judgement and further objective assessment to play in moderating an impact's significance. Given that the criteria represent levels on a continuum or continuous gradation, professional judgement and awareness of the relative balance of importance between magnitude and sensitivity / value is required.

9.18 Features to which legally derived designations apply have automatically been determined to be of high value (or of a higher value than non-designated features), and any impact tends to be of a greater significance than an impact of features to which no designation applies. Hence, for designated features, the use of the value criteria leads to an initial presumption that impacts will be of a high significance. Information on sensitivity can then be used to modify or maintain this initial assessment.

Table 9.3: Impact Significance Matrix

Magnitude[1]	**Value/sensitivity of receptor[2]**			
	Very Low	**Low**	**Medium**	**High**
No Change	Negligible	Negligible	Negligible	Minor
Negligible	Negligible	Minor	Minor	Moderate
Slight	Minor	Minor	Moderate	Major
Moderate	Minor	Moderate	Major	Major
Substantial	Moderate	Major	Major	Major

1 Refer to Table 9.2 [2] Refer to Table 9.1

9.19 Given the use of professional judgement in the assessment process, there may be some variation between subject areas (i.e. different environmental parameters) in the significance rating process. This may be as a result of limited information on the sensitivity of features and / or the complexity of interactions that require assessment in determining the magnitude of change. However, the ratings derived through the impact assessment process, as set out in Table 9.3 can also be described in a generic fashion as given in Table 9.4 below. The following definitions are proposed in relation to the significance of environmental impacts predicted through this ES.

Table. 9.4: Impact Significance Definitions

Level of Significance	**Description**
Negligible	No discernible effect. An impact that is likely to have imperceptible or insignificant impact.
Minor	Slight, very short or highly localised impact of no significant consequence. These effects may be raised as local issues but on their own are unlikely to be of importance in the decision-making process. When combined with other effects these could have a more material influence.
Moderate	Intermediate limited (extent / duration / magnitude) impact that may be considered as significant. These effects are likely to be important considerations at a local level. These could have influence on decision making especially when combined with other similar effects.
Major	Very large or considerable impact (extent/duration/magnitude); Effects, both adverse and beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or

	breaches of legislation. In isolation, these could have a material influence on the decision-making process.

Impact Mitigation Measures

9.20 In accordance with EIA regulations this ES includes a description of mitigation measures envisaged to prevent, remove and reduce the significant adverse effects from the development. Following the implementation of mitigation measures the identified impacts may be reduced to environmentally acceptable levels (or not).

9.21 It is best practice to consider mitigation measures for all impacts that are of a minor negative significance (i.e. slight, very short or highly localised impact of no significant consequence) or higher and this has been adopted for the purpose of this assessment.

9.22 The final details on the precise form and extent of each mitigation measure has taken into account the safety, operational and maintenance practicalities on or about the scheme.

9.23 The purpose of mitigation is to reduce the significance of the residual impact (see below) to a minor adverse or negligible level. Individual impacts assessed as being of minor adverse or negligible significance have not automatically been considered to require mitigation. However, where appropriate and possible, and taking into account views and comments received through consultation, consideration has been given to the implementation of mitigation measures designed to reduce minor adverse impacts to a negligible level.

9.24 Mitigation measures can be incorporated at various stages in the proposed development. The preferred hierarchy of mitigation is as follows:

i. Prevention: At the design stage: avoid, relocate, modify the design and / or do not process with the development.

ii. Reduction: introduce design modification or additional structures (e.g. screens), reduce size and scale of development etc.; and

iii. Compensation or remediation: compensation to provide like-for-like replacement for any lost environmental elements. When adverse impacts are unavoidable, it may also be possible to limit the duration of an impact by undertaking remedial works. For example, the impact on the landscape of mineral extraction is largely unavoidable, but the land can be progressively restored following the completion of extraction to complement or enhance the character of the landscape.

Methodology to Inform Baseline

9.25 Key legislation that is relevant to the Chapter on Hydrology & Hydrogeology is listed below. The following legislation is considered relevant:

i. The Control of Pollution Act 1974;

ii. Environmental Protection Act 1990;

iii. The Town and Country Planning (Environmental Impact Assessment) Regulations 2017;

iv. Environment Act 1995.

9.26 The following guidance is considered relevant:

i. Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Impact Assessment (IEMA, 2004 as amended 2006);

ii. Environment Agency, Land Contamination Risk Management (LCRM);

iii. CIRIA 552, Contaminated Land Risk Assessment: A Guide to Good Practice;

iv. CIRIA 692, Environmental Good Practice on Site, 3rd Edition;

v. Environment Agency Pollution Prevention Guidance (PPG) and superseding Guidance for Pollution Prevention (GPP) notes, including:

   a. GPP 1: Understanding your environmental responsibilities – good environmental practices;

   b. GPP 2: Above ground oil storage tanks;

   c. GPP 5: Works and maintenance in or near water;

   d. PPG 6: Working at construction and demolition sites;

   e. GPP 21: Pollution incident response planning;

   f. GPP 22: Dealing with spills;

   g. GPP 26: Safe Storage – drums and intermediate bulk containers;

vi. CIRIA C665, Assessing risks posed by hazardous ground gases to buildings (Construction Industry Research & Information Association (CIRIA), 2007);

vii. BS EN 10175:2011+A1:2013, Investigation of potentially contaminated sites. Code of practice. National Policy;

viii. BS EN 5930:2015, Code of practice for ground investigations;

ix. Contaminated Land Statutory Guidance (2012) WG19243;

x. Development Control Advice Note (DCAN) 10, Environmental Impact Assessment (1999);

xi. Department for the Communities and Local Government, Amended Circular on EIA consultation paper 'Environmental Impact Assessment: A Guide to Good Practice and Procedures' (June 2006);

xii. Department of the Environment, Draft Supplementary Planning Guidance to PPS 18 'Renewable Energy' - Anaerobic Digestion (June 2013); and,

xiii. Department of the Environment, Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy' (August 2009).

9.27 The following sources of information have been used to inform the baseline environment:

i. Published geological map (British Geological Survey GeoIndex Onshore) consulted on 07 July 2020;

ii. United Kingdom Soil Observatory (UKSO) Map Viewer, consulted on 07 July 2020;

iii. Multi-Agency Geographic Information for the Countryside (MAGIC) online viewer consulted on 07 July 2020;

iv. A review of current and historical Ordnance Survey maps;

v. Consultation with local County Council and Natural Resources Wales (NRW) (Water Management Unit) in June 2020 in respect of any abstractions, private water supplies, discharges and pollution incidents close to the site;

vi. Natural Resource Wales Environmental Data Viewer consulted on 07 July 2020;

vii. Natural Resources Wales' Flood Risk Map Viewer consulted on 07 July 2020;

viii. Results of a site walkover on (07 July 2020) by a suitably qualified environmental scientist.

Consultation

9.28 WYG submitted a request for environmental information to the Pembrokeshire County Council and Natural Resources Wales (NRW) on 17 June 2020. Full consultation responses are presented at ES Appendix 9.1. The information provided has been presented in the relevant sections within this chapter.

Explanation of Baseline Conditions

Introduction

The area of ownership which will accommodate the proposed development occupies an area of approximately 80ha and is situated immediately southeast of Rhoscrowther (Figure 9.1 below); a small 14th Century village located 6No. miles west from Pembroke. The proposed development site is a c. 12.83ha portion of the lands and is located within a valley with natural drainage from the valley sides draining to a stream known as 'Angle Stream North' [Water Body ID: GB110061025060] running in a southeast to northwest direction as it dissects the lands.

Figure 9.1: Site Location Plan - Blue line indicates ownership boundary while red boundary is proposed development boundary.

9.30 The valley is gentle to moderately sloping, with no observed rock outcrops during the site walkover. An unnamed road bounds the north of the site and separates the development from Pembroke Refinery. The western site boundary is also bound by agricultural fields with an unnamed road beyond. The centre of the site is located at NGR 191379, 201972.

9.31 The proposed development land to the north of Angle Stream North drains in a north-north east to south-south westerly direction towards the stream. The northern portion of the site at its highest point has an approximate elevation of 63m Above Sea Level (ASL) and at its lowest point occupies an elevation of 10mASL along the north-western most boundary of the site, where the stream exits the ownership boundary, following the valley topography and varying gradients towards and into the Celtic Sea at Milford Haven.

9.32 Although ownership extents to the south of Angle Stream North, no development is currently proposed for this area. The southern portion of the lands (which drains in a south-south

easterly to north-north westerly direction towards the drainage feature) has an approximate elevation of 53m Above Sea Level (ASL) at its highest point. At its lowest point the southern portion occupies an elevation of 10mASL along the north-western most boundary of the lands, where the stream exits the ownership boundary, following the valley topography and varying gradients towards and into the Celtic Sea at Milford Haven.

9.33 Lands at the proposed development site are predominantly green field and are currently used for animal grazing. A farm, known locally as Cheveralton Farm, with NGR 191151, 202030, is located close to the centre of the proposed development area, in the north of the site, and is bound to its south, west and east by the proposed development and access tracks.

9.34 The village of Rhoscrowther is situated west of the north-western boundary of the site, and has a small number of residential buildings, a church, a farm and a village hall. The line of Angle Stream North, which flows through the centre of the lands, to the south of the development site, is accompanied by woodland. Further detail in terms of the site's ecology are outlined in Chapter 7 and discussed below.

9.35 The proposed application site includes the construction of the following components:

- Extensive access tracks
- Turbines
- Sub-station
- Construction compound
- Associated earthworks

Site Walkover Observations

9.37 The results of a site walkover completed on 07 July 2020 by a suitably qualified WYG environmental scientist are presented in Table 9.5. Photographs of site conditions are included at ES Appendix 9.2.

Table 9.5: Site Walkover

Land Use	Arable (wheat) and agricultural (cattle grazing) land use
Ground Cover	To the northeast, the ground is covered with wheat. The remainder of land is soft ground, vegetated with grasses with dedicated cattle grazing to the North
Drainage	There is low to moderate potential for natural infiltration due onsite due to a lack of infrastructure; however, clay rich shallow ground will naturally inhibit infiltration in areas of soft ground. Therefore, precipitation is primarily expected to drain from the site by overland flow in line with the topography of the site. As there will be no domestic, commercial or industrial foul flows from the development, a drainage network within the application site is not required.
Topography	The topography slopes downwards from the north to the south of the site, towards the centre of the larger parcels of lands (to Angle Stream North). Similarly, lands to the south, slope from the south to the north, towards Angle Stream North.
Nearest Surface Water Body	A small stream, Angle Stream North is noted to flow broadly southeast to northwest through the larger parcels of lands, located to the south of the development site. The stream continues northwest to the Celtic Sea at Milford Haven.
Signs of Previous Investigation	No signs of previous investigations observed

Site Boundary	The main site entrance has security gates. All other boundaries are predominantly hedge rows or farm gates
Signs of Vegetative Stress	None observed
Evidence of Contamination	None observed
Evidence of Geological Features	None observed
Evidence of Tanks	None observed
Evidence of any buildings	At the east and south of the site there are a grouping of agricultural buildings housing farm equipment.
Surrounding present day contaminative land uses	Surrounding land is generally agricultural
Evidence of groundwater	No evidence of groundwater issuing at the surface was observed.

Site Investigations

9.38 There have been no known site investigations completed within the confines of the proposed site boundary.

Made Ground / Reclaimed Land

9.39 Based on the site visit on 07 July 2020, no areas suggestive of reclaimed or made ground were evident.

Climate

9.40 The Average Annual Rainfall at the site is expected to be between 65-130mm/month, and 1,075mm/year for the total annual average. This information has been taken from the Milford Haven C.B. (Nearest climate station to Rhoscrowther, located approximately 2 miles away) using Meteorological Office dataset from 1981-2010.

Surface Hydrology

9.41 As described above, a stream known as Angle Stream North runs through the site, flowing in a south-east to north-westerly direction. Angle Stream North forms part of the South West Wales River Basin and has a total length of circa 2.6km from where it emerges to the east of the site at Green Hill Reservoir. The stream flows south of the site and generally acts as a localised drainage basin, with the stream having an elevation of circa 25mASL to the east as it enters the ownership boundary and an elevation of 10mASL along the western ownership boundary. The gradient of the stream shallows towards the centre of the small valley. Table 9.6 below summarises all mapped and or identified water features at the proposed development site and within the larger parcel of lands, owned by the developer.

Table 9.6: Surface Water Features at Rhoscrowther Site

Surface Water Feature	Site Region	Easting (NGR)	Northing (NGR)	Comments
Spring No.1	NE	191315	201938	Not observed to be flowing. Significantly overgrown and suspected Japanese Knotweed in vicinity
Spring No.2	Outside site	190568	201613	No flow observed

Spring No.3	Outside site	190694	202140	Could not access field to observed potential flow
Well	Outside site	191236	201387	Well not in use, lost/ not located.
Angle Stream North (Up-stream)	Outside site	191494	201456	No flow observed in stream
Angle Stream North (Down-stream)	Outside site	190472	202070	Field Hydrochemistry taken
Ford	Outside site	190878	201807	
Settlement Lagoons	Outside site	191018	201724	

9.42 There are 5No. minor tributaries / drainage features that drain the lands within the ownership boundary and discharge into the Angle Stream North. No drainage features / minor tributaries are located within the site boundary; however, a spring is located close to the southern boundary of the site. All of these drainage features are expected to have been formed naturally along spring lines and the flow of water from said springs running overland has carved these features into the landscape.

9.43 A spring is located close to the southern boundary of the site which has created a minor tributary which flows south to join Angle Stream North in the valley to the south. The spring was not observed to be flowing during WYG's site walkover in July 2020.

9.44 A second drainage feature is located in the south-eastern portion of the site originated along the line of a now out-of-use well which was not located during WYG's site walkover in July 2020.

9.45 Angle Stream North follows the land topography and eventually collect at a series of lagoons located in the centre of the lands around co-ordinates 191929, 201722. Some of these lagoons consist of reeds and tall grass and become stagnant during periods of low flow, allowing fines and sediment to precipitate out of the water. The stream continues to flow north-westwards, crossing a ford before it meets two smaller tributaries in the site's western portion formed by local drainages and springs (SW 2 and SW 3) coming from the north and south. The stream continues to follow the valley bottom, flowing north-westwards leaving the ownership boundary near the town of Rhoscrowther in the northwest at grid reference 190472, 202070. The stream elevation at this location is circa 10mASL. Field hydrochemistry was taken points where Angle Stream North enters and leaves the ownership boundary and the baseline results are presented in Table 9.7.

9.46 The surface water field hydrochemical results indicate that the water which is fed from the site is slightly alkaline and undergoes minimal change between entering and exiting the lands. After leaving the ownership boundary, the tributary continues to flow 0.65km westwards from Rhoscrowther town and discharging into Angle Bay which ultimately feeds into the Milford Haven and eventually the Celtic Sea.

Table 9.7: Field Hydrochemistry at Stream Tributary Leaving Point taken on 07/07/20

Parameter	Units	Reading	
		Up-stream (Entry)	Down-stream (Exit)
pH	pH units	8.63	8.52
Electrical Conductivity (EC)	uS/cm	399.29	281.90
Temperature	ºC	15.7	15.31
Rugged Dissolved Oxygen	mg/l	9.72	9.27
Signs of Oil & Grease	Visual Inspection	None	None

9.47 Lands to the north of the proposed development site are occupied by Rhoscrowther Oil Refinery. The proposed development site and Oil Refinery are separated by an unnamed road. The southeast – northwest trending road roughly marks the line of a local flow divide. Drainage to the south of this flow divide drains the northern portion of the proposed development and discharges to Angle Stream North. Drainage to the north of the flow divide (lands occupied by the oil refinery) is in a northerly direction towards Nangle Bay, which also discharges into Milford Haven.

9.48 There is expected to be no risk of surface water draining from lands to the north onto the proposed development site.

9.49 An annual rainfall of circa 1,000mm together with expected shallow top and subsoil cover at the site, form the principal controls on the hydrological regime at the proposed development site. These factors likely combine to produce a well-draining environment, with rainfall percolating through the soils and then encountering the poorly transmissive bedrock at shallow depth. The combination of freely draining soils and poorly productive / poorly transmissive bedrock are expected to explain why there are multiple annotated springs

emerging at that the site. Springs represent the point at which groundwater, and in this case presumed to be shallow groundwater in the soil environment, encounters lower permeability strata (assumed to the be the on-site bedrock) and is forced up, emerging at the ground surface as a spring. Springs were not observed to be flowing at the time of WYG's survey in July 2020.

9.50 Given the nature of the shallow to moderate sloping hills at the site, and the relatively high rainfall input, it is considered that there is a moderate to high potential for runoff at the site; however, the freely draining nature of the sub-soil ensures that much of the rainfall is absorbed by the soil environment and only emerges as springs where conditions permit.

9.51 Some limited recharge of the local shallow bedrock system is also likely, helping to support springs and small Private Water abstractions in the area; however it is expected given the geology that the majority of wells are shallow installations designed to harness shallow groundwater in the soil / drift.

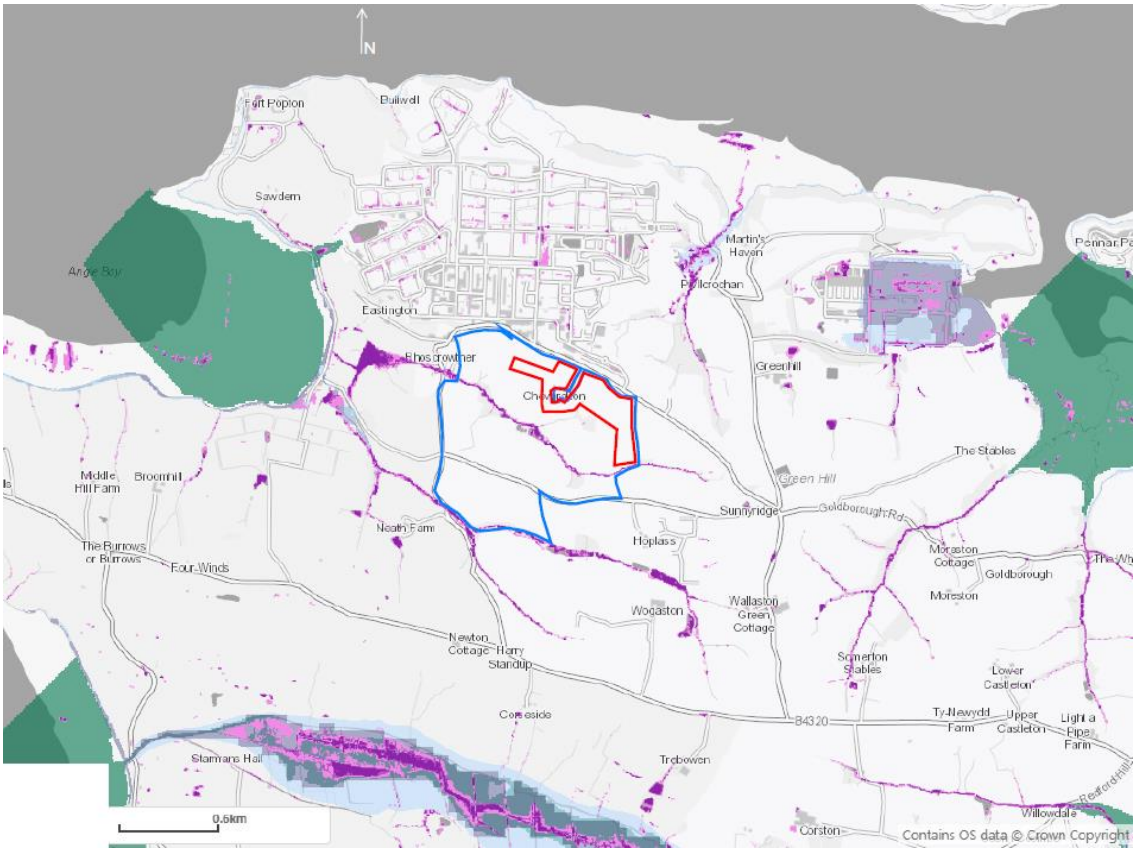
Flooding

9.52 The development boundary lies within an area identified as at low risk from land flooding, this is shown on the Risk of Flooding from Surface Water Map presented below in Figure 9.2. The map shows that, with the exception of some small areas of low risk extending a few meters from the stream, the remainder of the high and medium risk areas are confined to the stream channel itself.

9.53 The site area has not been identified to be at risk of flooding from the sea. The nearest main river lies over 1km to the south of the site area, this has been identified by NRW as having no impact to the site due to its extended proximity. Two small areas of flood zone three has been identified approximately 0.5km away, further down gradient from the site towards

Angle Bay, these zones have been classified by NRW as outlying areas which are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year. The site has been shown to display a low risk of flooding from rivers and the sea. There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year.

Figure 9.2: Flood Risk from Surface Water - Adapted 1:10 000 risk of Flooding from surface water map from Natural Resources Wales (NRW). Blue line indicates ownership boundary while red boundary is proposed development boundary. Image from NRW Flood Risk Viewer consulted on 07 July 2020.



Surface Water Quality

9.54 During the site visit a visual inspection of the on-site streams were undertaken. The water quality appeared to be visually good, with no on-site sources of pollution apparent. The series of settlement lagoons located in the central area of the site, have presumably formed naturally, however, this has been difficult to establish using historical maps, given in part the presence of dense tree vegetation along the central portion of the site. The 1977 – 1994 Ordnance Survey Map and all older Historical OS Maps reviewed for the site show no signs of the settlement lagoons, suggesting that they may be man-made features.

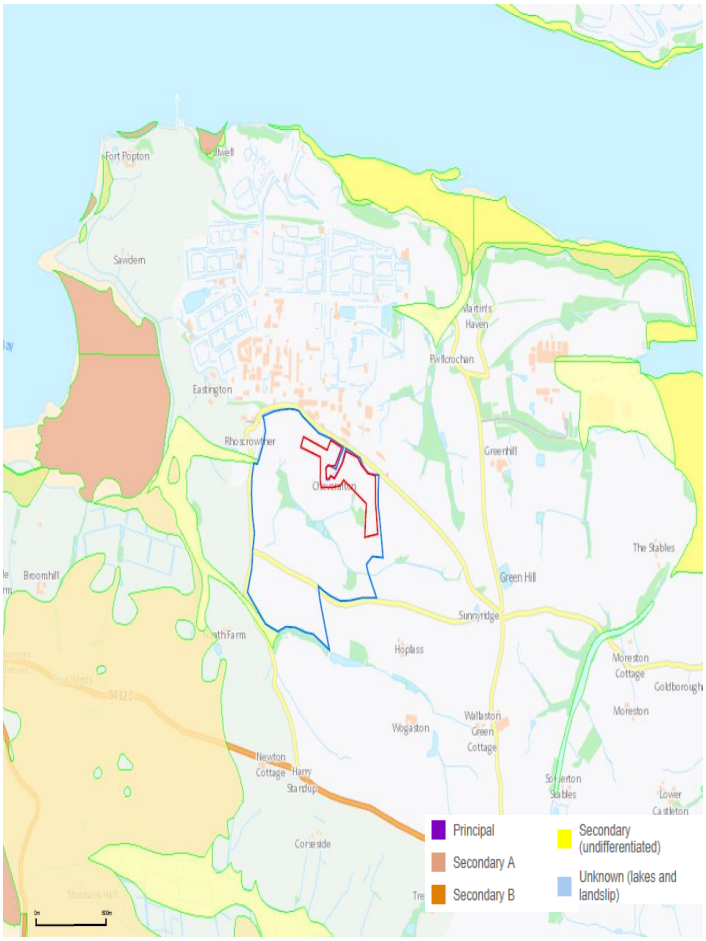
9.55 No published information is available in respect of the chemical water quality of stream. No water quality samples were taken for analysis during the site visit.

Superficial Aquifer

9.56 Only a small portion of the Site contains superficial deposits (Figure 9.3 below). A small wedge present in the north western corner of the Site as Angle Stream North flows off site towards Rhoscrowther town and Angle Bay. This small wedge of alluvium has been identified by Natural Resources Wales having a 'Secondary A' aquifer designation - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers. Whilst alluvium can sometimes support abstractions, it is considered that given the size and extent of the superficial cover, it is unlikely to be widely exploited.

9.57 The remainder of the site has been established to not be covered with any superficial geological deposits and therefore there are no further superficial aquifers.

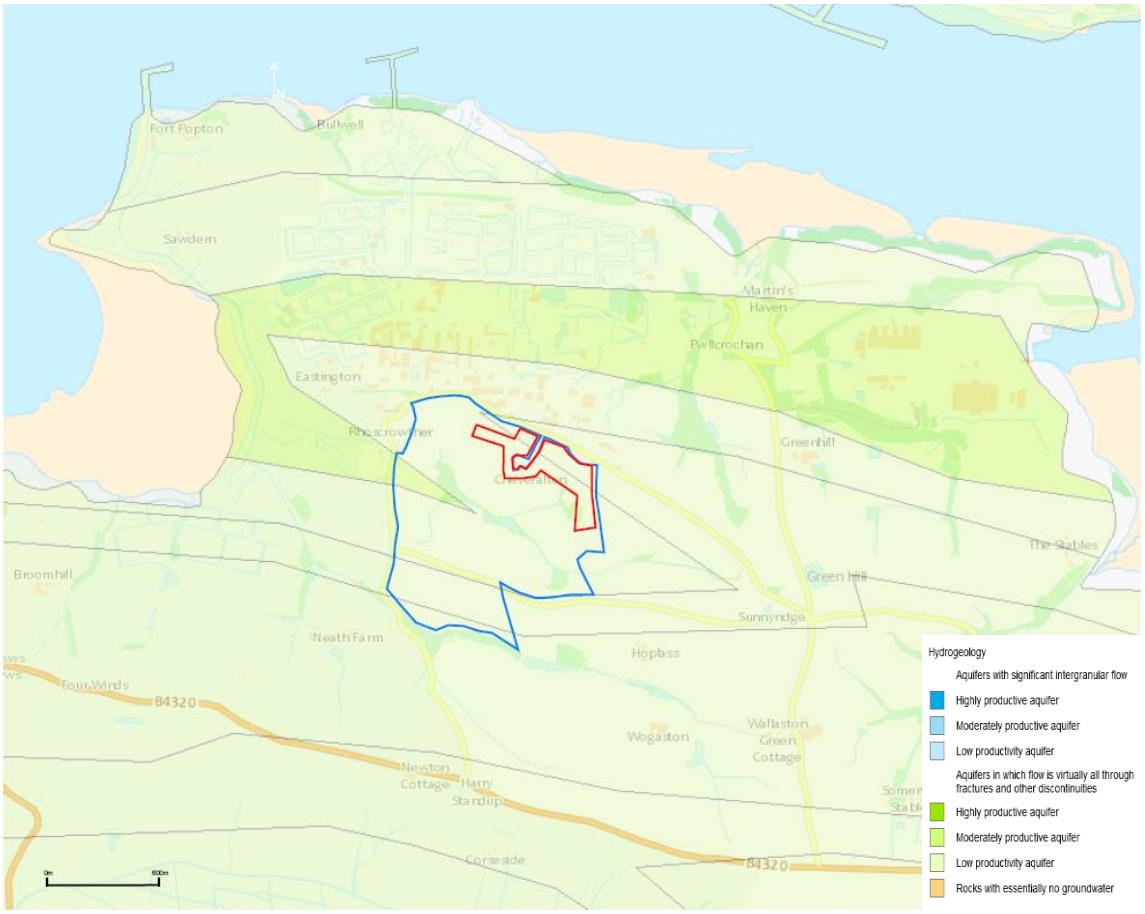
Figure 9.3: Superficial Hydrogeological Deposits – Adapted 1:75:000 map of superficial deposit. Blue line indicates ownership boundary while red boundary is proposed development boundary. Image from BGS GeoIndex consulted on 07 July 2020.



Bedrock Hydrogeology

9.58 The BGS has identified the Skrinkle Sandstone formation and the Ridgeway Conglomerate Formation to be a low productivity aquifer (Figure 9.4 below). The interbedded limestone and mudstone of the Avon group lying to the west of the site, within the ownership boundary is identified to be a moderately productive aquifer.

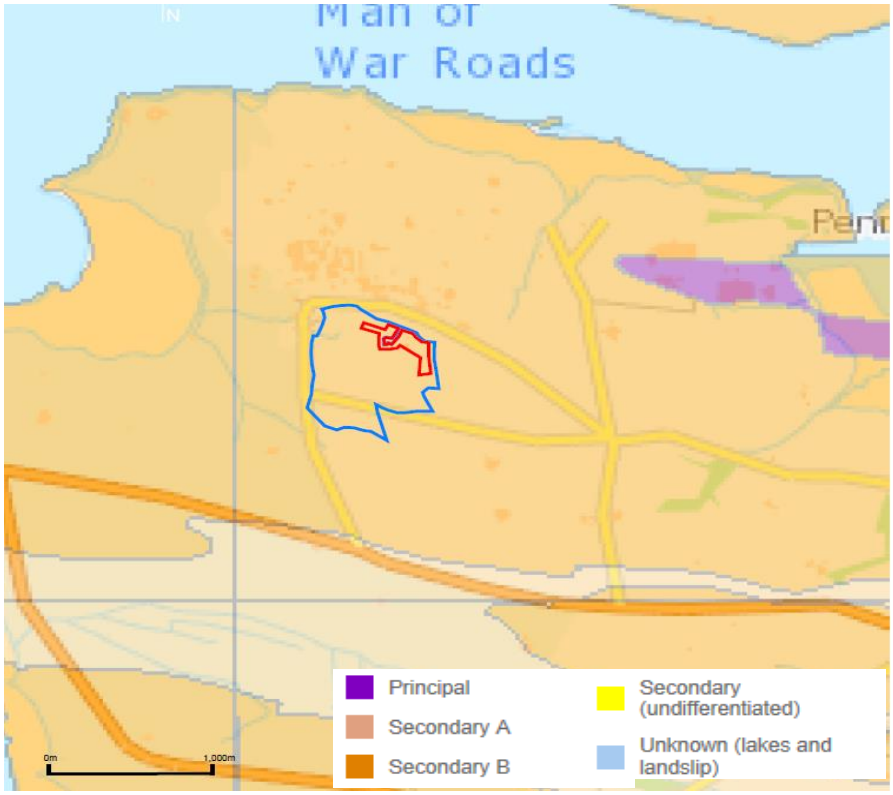
Figure 9.4: Bedrock Hydrogeology – Adapted 1:75:000 map of bedrock hydrogeology. Blue line indicates ownership boundary while red boundary is proposed development boundary. Image from BGS GeoIndex consulted on 07 July 2020.



9.59 Groundwater classification by Natural Resources Wales, classifies all bedrock within the site as Secondary A aquifer designation (Figure 9.5 below): permeable layers capable of supporting water supplies a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

9.60 Both interbedded limestone and mudstone aquifers and sandstone conglomerate aquifers rely heavily on secondary porosity (fracture flow), for the transmission of water.

Figure 9.5: Bedrock Hydrogeological Designation – Adapted map of bedrock hydrogeological designation. Blue line indicates ownership boundary while red boundary is proposed development boundary. Image from BGS GeoIndex consulted on 07 July 2020.



Abstractions and Impoundments

9.61 Consultations were carried out with Natural Resources Wales (NRW) in respect of abstraction points within 2km of the proposed wind farm at Rhoscrowther. These abstractions points are presented in Table 9.8 below. The abstraction points have mostly been identified for general agricultural uses; some abstraction points have been in use since the mid-1980s.

9.62 NRW identified a discharge consent within 2km of the site area for a water company discharging sewage disposal works (NGR SM 900 022).

Table 9.8: Abstraction data within 2Km radius of Rhoscrowther site area adapted from Natural Resources Wales

Abstraction Licence No	Original Effective Date	Version Application No	Address Line 2	Purpose Description	Abstraction Start	Abstraction End	Source Description	NGR1
22/61/6/0069	21-Aug-90		Hundleton	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 919 007
22/61/6/0117	29-May-96	WR733	Hundleton	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 911 010
22/61/6/0021	26-Mar-91	WR1/3/40	Hundleton	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 906 010
22/61/6/0040	05-Aug-97		Angle	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 910 016
22/61/6/0064	19-Jul-84	NPS/WR/008389	Whitehill Way	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 928 018
22/61/6/0120	16-Apr-97		Angle	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 899 012
22/61/6/0081	28-Jun-88	NPS/WR/008389	Whitehill Way	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 920 022
22/61/6/0114	13-Feb-96		Angle	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 893 014

22/61/6/0105	19-Jul-95	WR705	Hundleton	Agriculture	01-May	31-Aug	EAW Surface Water	SM 900 014
22/61/6/0068	24-May-85		Rhoscrowther	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 918 008
22/61/6/0069	21-Aug-90		Hundleton	Agriculture	01-Nov	31-Mar	EAW Surface Water	SM 902 014

Land Contamination

9.63 In order to evaluate the potential for land contamination associated with historical land use, historical maps were reviewed in order to identify potentially contaminative historical activities. Information on the site's history was obtained through an inspection of available historical maps (https://maps.nls.uk/os/6inch-england-and-wales/). The historical description below encompasses the period from 1862 to the present day.

9.64 A review of the historical maps show that the site has remained undeveloped from 1862 to present day. The proposed development site is generally consistent with the OSNI first edition (1862 -1864) map. The large refinery located to the north of the site was placed on lands which were marked as agricultural (1862 – 1952).

9.65 Pembrokeshire County Council was consulted on 17 June 2020 to which they provided a database of Environmental Pollution Incidents[1]. The dataset contains pollution incidents reported to NRW and only substantiated and closed environmental protection incidents are included. A total of 27No. events are recorded as occurring within the Pembrokeshire Unitary

[1] Natural Resources Wales, Environmental Pollution Incidents, Lle: A Geo-portal for Wales [consulted 24th June 2020]

Authority. Of these, only 1No. event (ID: 1704667) occurred within 2km of the site: 1.07km northwest of the site boundary. The significant event is noted to have impacted the air with inorganic chemicals / products with no secondary impact.

Protected Areas

9.66 The Multi-Agency Geographic Information for the Countryside (MAGIC) online viewer was consulted on 29th June 2020 to further understand the Ecological designations in the vicinity of the proposed Rhoscrowther wind farm. The site area itself is not under any designations of ecological value; however, approximately 1.1km northwest and 1.5km southwest of the site, further down gradient of the small catchment area lie a number of designations as identified by MAGIC shown in Table 9.7 below.

Table 9.9: Ecological Designations in the vicinity of Rhoscrowther wind farm by MAGIC

Ecological Designation	**Type of Designation**	**Distance away from site/ description**
Woodland Habitat	Broadleaved Forest	0.1km southwest of site area
Milford Haven Waterway	Sites of Special Scientific Interest (SSSI) – Code: 32WO3	1.1km west of site area Eastings: 189682 Northings: 202202
Pembrokeshire Marine	Special Areas of Conservation – Reference: UK0013116	1.1km west of site area
Pembrokeshire Marine	Inshore Special Area of Conservation with Marine Components – Reference: UK0013116	1.1km west of site area
Seagrass Bed	Seagrass, CCW Phase 1 Intertidal Survey (1996-2003) – Reference: 7	1.1km west of site area

Sand - Seagrass Bed	Intertidal Substrate, CCW Phase 1 Intertidal Survey (1996-2003) – Reference: 4689	1.1km west of site area
Broomhill Burrows	Sites of Special Scientifics Interest	1.5km southwest of site area
Limestone Coast of South West Wales	Special Protection Area	1.5km southwest of site area
Limestone Coast of South West Wales	Special Area of Conservation	1.5km southwest of site area
Kilpaison Burrows	Special Protection Area	1.7km southwest of site area

9.67 NRW has designated the northwest running stream through the middle of the site as Angle Stream North – headwaters to tidal limit; its current ecological quality is of moderate status. Angle Stream North has a hydrology status of not high and good morphology status providing the over hydro morphological quality to be not high.

Landfill / Waste Sites

9.68 Natural Resources Wales have highlighted that there is a historical inert landfill site ("Cheveralton Landfill") within the proposed development site. The landfill is classified as having received inert material between December 1992 and October 1995 under licence number 34195 and licensee, W. J. A. Williams & Son. The total site area expected to contain waste is circa 1.1ha. The landfill occupies an area of land to the south east of Cheveralton Farm.

9.69 The landfill is recorded as inert but there is evidence that industrial, commercial and household waste may have also been accepted.

9.70 It is possible that if the landfill contains industrial, commercial and household waste that there may be the potential for gas generation / migration. The current site development plan indicates that a track will trend north of the landfill and a hardstanding associated with a wind turbine is to be sited at the northwest corner of the landfill but outside of the landfill boundary. Earthworks relating to the hardstanding are proposed to extend marginally into the boundary of the historical landfill.

9.71 It is proposed that a preliminary risk assessment (PRA) will be completed for the site and supplemented with site investigation works following the completion of an investigation design as part of the PRA. The site investigation works would then be undertaken as part of a Generic Quantitative Risk Assessment (GQRA), in line with Guiding Principles for Land Contamination, and it is hoped that the GQRA works would be conditioned to the Planning Application.

Natural Hazards and Mining

9.72 The BGS Geoindex database of historic mine working, shaft and adits was consulted. There are no known historical mining features located within 1km of the site. Regarding natural hazards, a historical earthquake is noted from 1892 c. 1.39km northwest of the north site boundary.

Temporal Change

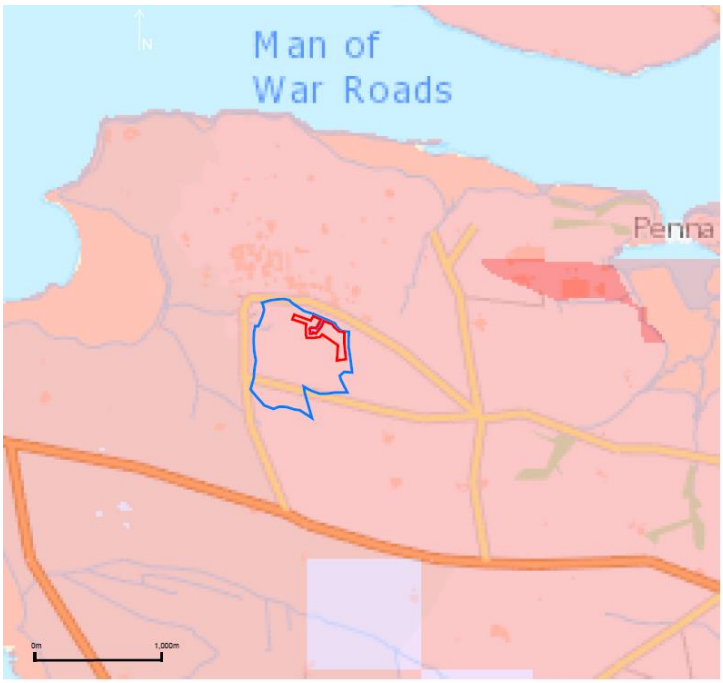
9.73 The future baseline in relation to surface waters and groundwaters is unlikely to change significantly in the short, medium or long term unless there is a significant change in land use within the vicinity of the site. Use of the site as a windfarm will result in little change to the

baseline soil environment and geological environments. This is discussed further within the assessment section below.

Aquifer Vulnerability

9.74 The entire site has been classified as under groundwater vulnerability zones by NRW (Figure 9.6 below). The site and surrounding owned lands have been designated as 'Secondary Aquifer: High vulnerability'. The vulnerability appears to be associated with the Ridgeway Conglomerate Formation.

Figure 9.6: Groundwater Vulnerability Designation – Adapted map of groundwater vulnerability. Blue line indicates ownership boundary while red boundary is proposed development boundary. Image from BGS GeoIndex consulted on 07 July 2020.



Groundwater Protection Zones

9.75 Natural Resources Wales identified no Groundwater Protection Zones in the vicinity of the site area.

Hydrogeological Conceptual Model

9.76 The site area as mentioned above acts as a localised drainage system, with only a small wedge of alluvium to the northwest of the site, the remainder of the site area is overlain by thin soil cover which was historically used as agricultural land. Despite the site area not having any superficial deposit cover which would reduce the site's aquifer vulnerability, the soil cover over the entire site contains a degree of clay content, this acts partially as a semi-permeable barrier to potential contamination sources. The majority of precipitation falling onto the site will become runoff into Angle Stream North following the gradient of the local site catchment. Some of the precipitation will infiltrate slowly through the soil but because of the semi permeable nature of the bedrock, recharge will likely run along the surface of the bedrock together with the relatively steep gradient of the land and enter into Angle Stream North with minor lag time.

Hydrological Designations

9.77 As outlined above, Natural Resources Wales has identified the stream running northwest through the site to be Angle Stream North – headwaters to tidal limit. Angle Stream North is classified by NRW as "Low, Extra Small, Calcareous"; it sits as part of South West Wales management catchment and lies as part of the Western Wales river basin district. The stream has a waterbody ID of GB110061025060 (Grid Reference X: 191,262.54; Y: 201,495.38), is a part of a protected area and its overall risk is probable. No historic measurements of the quality of Angle Stream North are available.

Predicted Trends

9.78 Hydrological systems are nominally in a state of constant flux. However, the potential influences on the future hydrology of the site have been identified as changes in land use and climate change. NRW has predicted the stream's ecological quality to remain the same as moderate.

9.79 The nature of the site means that the land use is unlikely to change substantially during the lifetime of the proposed wind farm. However, climate is likely to prove more variable, with observed historical and predicted future changes in global climate due to a combination of both natural and human causes. The main human influence on global climate is increasing emissions of greenhouse gases such as carbon dioxide and methane. For Wales, the latest climate change predictions indicate a change in summer rainfall of between -43% and +5% by 2080. This is predicted to be accompanied by increases in winter rainfall of between 4% and 42% respectively[2].

Sensitive Hydrological and Hydrogeological Features

9.80 The hydrological and hydrogeological features with greatest sensitivity to the development are areas immediately adjacent to the surface watercourses, any changes to the surface water will have a direct impact to the downstream environment of Angle Stream North where the Milford Haven Waterway presents some ecological value and is a designated SSSI. Other features of interest include the catchments relating to groundwater abstractions. The constraints caused by these features have been used to inform the design mitigation of the wind farm.

Design Optimisation

[2] Online Climate Change Report 4.3.8 Precipitation Maps (ukclimateprojections.defra.gov.uk)

9.81 This section outlines the mitigation and offsetting measures that have been incorporated during the design and planning of the Rhoscrowther Wind Farm layout. Where possible, wind farm structures are sited such that they avoid the requirement for unnecessary earthworks. Where co-location is unavoidable, mitigation measures are to be introduced during their construction and operation. Such measures will be implemented as a matter of course at all construction locations, regardless of their location within the wind farm site. The measures described are essential to pollution prevention and control and reflect current industry best practice.

i. Location of Turbine(s) and crane pads a minimum of 50m from water course on site;

ii. Location and maintenance of minimum 25m distances from wells and springs on site.

Hydrological Constraints

9.82 The main hydrological constraints (Table 9.10) for the development are the surface watercourses. A 50m buffer zone has been incorporated to prevent development near watercourses. This is a standard buffer based on professional judgement for watercourses on wind farms and similar developments and is considered protective of ecology.

Table 9.10: Hydrological Constraints to Development at Rhoscrowther

Hydrological Constraint	**Rationale**
Areas to be avoided – 50m buffer zone surrounding all watercourses and springs	Risk of soil erosion, accidental spillages or concrete pollution entering controlled waters, accidental spillage of spoil or plant fuels entering controlled waters

Areas acceptable with mitigation – Areas of wet ground where not in the immediate vicinity of watercourses. Crossings of Angle Stream North and tributaries	Sensitive hydrological regime. Damage to soils may occur from structural damage and/or changes to the soil water table. Construction acceptable if mitigation in place and suitable engineering design implemented
Private water supply sources and their immediate indicative catchments: No PWS were found within 2Km of site area (Pembrokeshire Council)	Risk of contamination by groundwater drainage.
Areas suitable without mitigation – Drier, elevated ground well away from watercourses and catchments of nearby water supplies.	Unlikely to result in accelerated runoff rates, except for wind farm tracks. Not likely to lead to significant changes in hydrological regime. Impacts expected to be minimal in light of best working practices

Proposed Development

9.83 Consideration will be given to the potential impact of track construction on hydrogeology: wind farm track layout has been designed so that minimal watercourse crossings are required and where possible the siting of tracks will avoid steep slopes. Based upon the site access track revision plan (ES Appendix 9.3), the tracks (totalling a length of 1.3km) will have a maximum width of approximately 4.5m, and rectangular hardstanding adjacent to turbine localities for turning, works access etc, thereby minimising the land take and thus ground disturbance, where possible.

9.84 Cable trench is considered likely to be laid on the site, with some sections housing up to four cables running in parallel. Cable laying has the potential to damage soils and introduce new

drainage pathways in the trenches that could generate silty runoff. To minimise disturbance impacts, it is intended that cables will be laid in small trenches along the side of wind farm tracks as far as possible. This layout will ensure they will not be located close to any key hydrological features.

9.85 Based upon understanding of the site plan, each crane pad for turbine access and construction is expected to cover an area of 50m by 30m. Subject to micro-siting, these will be located at co-ordinates 191098, 202098; 191423, 201926 and 191577, 201601. During the initial design phase, the impact of turbine and crane pad construction was considered, resulting in a decision not to locate any such facilities in the boggy grasses found close to the headwaters of on-site streams.

9.86 Road stone required for the upgrading / construction of wind farm tracks will be sourced from an off-site quarry.

Predicted Environmental Effects and Their Significance - Construction Period

9.87 This section of the assessment outlines the potential, i.e., without additional mitigation, impacts of the wind farm construction on surface waters and groundwaters.

Wind Farm Tracks

9.88 In order to access the wind farm site for construction, it is understood that new tracks will be used to form two routes from the un-named road north of the development: one directly from the road via an existing track, the other from a lay-by. The wind farm tracks between turbines associated with the development will be newly constructed.

9.89 Potential impacts from the construction of these tracks include erosion of exposed ground and track surface that could result in silt laden runoff eventually entering nearby

watercourses or springs. The increased area of bare ground could also disrupt natural flow pathways and reduce infiltration rates.

Culverts

9.90 The construction of the culvert at the ford crossing on site is expected to result in disruption to the stream for a short duration (circa 2 weeks), in this time frame, priority will be given to minimum ground disturbance, loss of soil and bank side structure and sediment generation. If deemed necessary, potential mitigation will include partial containment of the river channel and temporary diversion during the temporary construction period of the culvert.

9.91 The watercourse crossing is to consist of a 1050mm diameter, high strength concrete piped culvert, approximately 7.0m in length. The culvert will have a concrete base and surrounded with a suitable engineered, site won, appropriate fill. The base of the watercourse channel at entrance and exit to the culvert is to be surfaced with stone pitching to prevent scouring at the base of the structure. The structure surrounding the culvert is proposed to be faced with concrete block or similar material. Either side of the concrete block reinforced earth will be used to minimise the batter slopes, provide additional strength, minimise the possibility of erosion and tie into existing ground levels.

9.92 As the ford itself and the area surrounding the crossing are relatively shallow, this temporary construction phase is expected to cause some minor disruption to the natural drainage, quality and quantity of Angle Stream North and embankment area. A detailed design in terms of the culvert crossing is available and presented on WYG Drawing reference A078181-51-003, entitled Watercourse Crossing Details, dated 08/01/2014. Authorisation from NRW shall be required for the proposed crossing prior to works commencing on site.

Electric Cable Laying

9.93 The electric cable laying has the potential to damage soils and introduce new drainage pathways that could generate silty runoff while the trenches are open, and also to disrupt sub-surface flows even after the trenches have been closed.

Wind Turbine and Crane Pad Construction

9.94 The removal of soils for the turbine foundations could lead to the short-term drainage of surrounding soils, particularly if soils are saturated. Where drainage into these excavations does occur, slumping of soils could result in the damage of soil structure and changes to local soil water hydrology.

Substation and Temporary Construction Compound

9.95 The location of the substation (E: 191202, N: 202182) and temporary construction compound (E: 191631, N: 201947) is shown in ES Appendix 9.3. During the construction and use of the compound and substation areas, there is a low potential for the generation of silt laden runoff, given the proximity of the substation and compound to the main entrance, however consideration has been afforded to the risk of silt laden runoff that could potentially enter surface watercourses.

Site Working Practices

9.96 As with all similar construction operations, there will be heavy plant and machinery on site, and this will result in the need to store oils and diesel. There is a potential for accidental spillages and leaks during storage, refilling, and maintenance operations.

9.97 The main potential environmental effects reasonably expected during the construction phase have been tabulated in Table 9.11.

Table 9.11: Construction Phase Potential Environmental Effects

Receptor	Potential Environmental Effects	Magnitude of impacts	Impact Significance and Discussion
Surface Water Drainage Features (Low)	There is the potential for erosion of exposed ground, stockpiles and track surfaces producing silt-laden runoff during the construction stage of site buildings and access roads.	Slight	**Minor** No mitigation measures required
	Potential contamination of drainage features as a result of onsite re-fuelling facilities and vehicle servicing during the construction stage.	Moderate	**Moderate** (without mitigation) Mitigation is proposed in Table 9.13
Groundwater and Abstractions (High)	Alteration of superficial and bedrock groundwater quality through movement of earth and reduced travel time of recharge (pH and organic content).	Moderate	**Moderate** (without mitigation) Mitigation is proposed in Table 9.13

Predicted Environmental Effects and Their Significance – Operational Period

9.98 This section of the assessment outlines the potential, i.e. without additional mitigation, impacts of the wind farm during operation on hydrology and hydrogeology.

Wind Farm Tracks

9.99 Erosion of track surfaces and disruption of natural flow pathways could continue throughout the operation phase.

Electric Cable Laying

9.100 Restored soils will have different structure to those already existing on site. This has the potential to create preferential flow pathways.

Wind Turbine and Crane Pad Pads

9.101 The introduction of wind turbines on the site will lead to an increase in hard-standing that could alter the run-off characteristics of the site. The concrete used for the turbine bases could erode and potentially cause pollution to surface water and groundwater.

Substation and Temporary Construction Compound

9.102 In the same way as the turbine foundations, the substation will provide permanent hard-standing, which will change run-off characteristics. The restoration of the compound area could damage the soil profile and lead to localised surface water ponding.

Site Working Practices

9.103 During the operation and maintenance of the site there will be the need to store and use oils, greases and other substances. This will create the potential for accidental spillages, and pollution of the ground.

9.104 The main potential environmental effects during the operational phase have been tabulated in Table 9.12.

Table 9.12: Operational Phase Potential Environmental Effects

Receptor	Potential Environmental Effects	Magnitude of impacts	Impact Significance and Discussion

Surface Water Drainage Features (Low)	Potential contamination of drainage features and surface waters as a result of leaks/spills of waste and land spreading during the operational phase	Moderate	**Moderate** (without mitigation) Mitigation is proposed in Table 9.14
Groundwater and Abstractions (High)	Potential contamination of superficial and bedrock aquifers as a result of leaks / spills of waste and land spreading during the operational phase	Negligible	**Negligible** No mitigation measures required

Predicted Environmental Effects and Their Significance – Decommissioning Period

9.105 The future of the wind farm beyond the design life is uncertain. Decommissioning of the site is one option involving removal of the turbines and possible dismantling / breaking up of other structures. The potential impacts on surface waters and groundwaters during decommissioning are similar to those during the construction phase, although risks will be lowered as many elements of the site will remain undisturbed, such as turbine bases, wind farm tracks and underground cabling. Any new legislation or guidelines published prior to decommissioning will be adhered to and incorporated into mitigation design prior to decommissioning taking place.

Proposed Mitigation Measures

Construction Phase

9.106 This section outlines the specific mitigation measures that will be incorporated during the construction of the wind farm in order to prevent significant impacts on the hydrological and hydrogeological environment. Mitigation will be implemented as a matter of course at all

construction locations, regardless of their location within the wind farm site. The measures described are essential to pollution prevention and control and reflect current industry best practice.

9.107 Construction Method Statements (CMSs) will be produced for all aspects of site work listed below. These will contain mitigation measures to prevent, as far as possible, any detrimental effects on the geological environment from the construction of the wind farm and will require approval from NRW prior to commencement of site works.

Wind Farm Tracks

9.108 New wind farm tracks will be constructed specifically for the wind farm development. The tracks will typically be 5m wide with an extra allowance (estimated to be 10%) on bends to allow for long vehicles.

9.109 The following measures will be implemented to minimise impacts on hydrology and hydrogeology during construction:

i. During construction of new tracks on sloping ground, drainage will be controlled by placing excavated soils on the downhill slopes and lateral drainage ditches on the uphill slopes, and working on small stretches of track at any one time;

ii. Temporary drainage routes will be provided while upgrading existing tracks, where necessary to minimise erosion;

iii. Sustainable urban drainage measures will be incorporated into the design of track drainage, such as track-side vegetated swales and ditches, providing temporary storage for run-off and reducing run-off rates;

iv. A geotextile base will be used to minimise compaction and drying out of the surface material;

v. Construction of suitable passage on a temporary and permanent basis will be undertaken to facilitate naturally occurring drainage beneath the tracks;

vi. Construction will be carried out according to SEPA/EA GPP and PPG and CIRIA guidance for site works (C692); and,

vii. Construction activities will primarily take place during summer months when the weather is at its driest, to prevent working erosion of soils via overland flow and to prevent instability due to saturated conditions;

Electric Cable Laying

9.110 It is important to minimise ground disturbance, loss of soil structure and the risk of generating silt laden runoff during construction. Therefore, it is intended that cables will be laid in small trenches along the side of wind farm tracks as far as possible. The trenches will be dug during drier periods, in sections and kept open for short periods to reduce the possibility of them acting as alternative drainage channels. On some lengths of the cable trenches permanent water stops may be required but this can only be ascertained during the construction phase.

Wind Turbine and Crane Pad Foundations

9.111 Each turbine and neighbouring crane pad will disturb an area of approximately 60m by 20m.

9.112 Shallow concrete pad foundations will be used where possible to minimise excavation works. This design will be supplemented by mitigation measures as described in the SEPA/EA's pollution prevention guidance and special requirements, including the following:

i. Scheduling construction activities to minimise the area and period of time that soil will be exposed, particularly during winter periods;

ii. Installation of cut-off drains around the working areas to intercept uncontaminated surface runoff and divert it around the works;

iii. Minimising the stockpiling of materials and locating essential stockpiles as far away as possible from watercourses; and,

iv. Re-vegetation of foundation and crane pad working areas where appropriate as soon as possible after construction.

9.113 Other generic mitigation measures will include a 30m micrositing tolerance to avoid sensitive local features, whereby the proposed turbine locations may be moved slightly during initial field visits. The use of sulphate-resistant concrete will minimise leaching, and spill response measures will be prepared for any accidental spillages. Wooden supports or impermeable barriers on excavation sides can be used where necessary to prevent slumping or drainage of surrounding soils

Substation and Temporary Construction Compound

9.114 The substation will likely comprise of a building of approximately 48m by 25m[KM1], although the construction area will be larger than this. It is proposed that suitable sustainable drainage measures are incorporated into the design of the substation (and any required temporary substation), such as silt traps, sulphate-resistant concrete, careful stockpiling and the adoption of spill response measures.

9.115 The temporary site compound will comprise an area of approximately 20m by 20m; again, the construction area will be slightly larger than this. Mitigation measures will be similar to those proposed for the substation.

Site Working Practices

9.116 During the tendering process the expected level of environmental control will be included in the tender documents, so that all contractors allow for mitigation measures in their costs and method statements.

9.117 The site induction for contractors will include a specific session on good practice to control ground pollution from construction activities. Contractors will be made aware of their statutory responsibility not to "cause or knowingly permit" ground pollution.

9.118 The requirements for mitigating effects of dust and vehicle movements include the use of dust covers over vehicles and stockpiles, dampening down of areas which could potentially produce dust and the provision of wheel washing facilities. Areas where these activities occur will also provide sustainable drainage measures for sediment entrained run-off, such as silt traps.

9.119 As with all similar construction operations, there will be heavy plant and machinery on site, and this will result in the need to store oils and diesel. With such storage, and during refilling

and maintenance operations, there is the potential for accidental spillages. To mitigate these effects, all chemical storage areas will be within areas of hardstanding and will be bunded to a capacity of 110%. The chemical storage area will be located at least 20m away from any surface watercourses or drains.

9.120 Plant and machinery used during the construction phase will be well maintained to minimise the risks of oil leaks or similar. Maintenance and refuelling of machinery will be undertaken off-site or within designated areas of temporary hardstanding. In these designated areas contingency plans will be implemented to ensure that the risks of spillages are minimised. Placing a drip tray beneath plant and machinery during refuelling and maintenance to contain small spillages will be a requirement.

9.121 Throughout the construction phase best working practices will be adopted including emergency spill response plans, and measures to protect the water environment will be taken by adopting recommendations set out in the SEPA / EA's PPG and GPP Notes.

Summary

9.122 Table 9.13 summarises the measures so far detailed above. It identifies the impacts for each element of the construction and indicates the extent to which this impact will be mitigated according to predetermined criteria. The practical mechanism by which the mitigation measures will be implemented on site is identified, as are any monitoring requirements thought necessary to ensure the ongoing effectiveness of the measures.

Table 9.13: Construction Phase Potential Environmental Effects

Potential Environment Effect	**Impact of Significance**	**Receptor**	**Mitigation**	**Impact of Significance Following Mitigation**
Potential contamination of hydrology and hydrogeology as a result of onsite re-fueling, vehicle servicing and concrete spillages	**Moderate**	Drainage features Superficial and bedrock aquifers	• Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • The clay rich soil is expected to restrict the vertical movement of contamination; • Adherence to GPP1, GPP2, GPP5, PPG6, GPP21, GPP22 and GPP26 will help to prevent any works from giving rise to contamination; • Deliveries are to be offloaded within the contractor's compound; • Control measures specified in COSHH assessments to be implemented and monitored; • All COSHH Data Sheets to be retained in the relevant appendix of	**Negligible**

Alteration of superficial and bedrock groundwater quality through movement of earth and reduced travel time of recharge (pH and organic content).	**Moderate**	Bedrock aquifer and abstractions	• The removal of soils is minimised to only what is required. • It is recommended that active excavation works are completed during periods to dry weather to restrict pooling / surface runoff from dirty or contaminated water across the site. • Excavation works across the site should be phased to limit the area of open excavation. Following the completion of excavation works, the ground should be restored as soon as practically possible to restrict exposed soils across the site. • Low permeability sheeting should be used to cover any open excavations during non-active construction periods and during periods of rainfall. This will restrict surface runoff across the open excavations. This will limit potential infiltration of dirty / contaminated surface water to the water table / bedrock aquifer. • Adherence to PPG guidance throughout the construction phase is recommended to reduce contamination risks.	**Negligible**

Operational Period

9.120 This section outlines the specific mitigation measures that will be incorporated during the operation of the wind farm in order to prevent significant impacts on the soil and geological environment. Mitigation will be implemented as a matter of course at all operational locations, regardless of their location within the wind farm site. The measures described are essential to pollution prevention and control and reflect current industry best practice.

9.121 Standard Operating Procedures (SOP) will be produced for all aspects of site work listed below. These will contain mitigation measures to prevent, as far as possible, any detrimental effects on the geological environment from the operation of the wind farm.

Wind Farm Tracks

9.122 The proposed mitigation for the construction of the wind farm tracks will continue to function throughout the operational phase of the site. Methods incorporated into the scheme are designed to be sustainable and to cope with storm events.

9.123 Only routine maintenance is envisaged to be necessary for the track network within the site during the operational phase. Such maintenance will generally be carried out in the summer months when the tracks are more likely to be dry, reducing further the potential impact on soil erosion.

Electric Cables

9.124 Once the electric cables have been installed, and the soil profile restored, the cable runs will return to close to their natural, pre-construction condition. Consequently, no mitigation measures regarding electric cable laying will be required during the operational phase of the development.

Wind Turbine and Crane Pad Foundations

9.125 No continuing impact from the turbine and crane pad foundations is envisaged once the construction work is complete. Soils and vegetation will be restored on part of the site, and the remaining hard surfaced areas are sufficiently small that any surface runoff is not considered to have any significant adverse effect on soil erosion.

Substation

9.126 Once construction and commission has taken place, no further works will be required, other than routine maintenance. Consequently, no further mitigation measures regarding the substation will be required during the operational phase.

Site Working Practices

9.127 There will be very little in the way of on-site activities during the operation of the wind farm. However, there will still be the need to carry out regular maintenance or emergency repair of the wind turbines, and this will require access by maintenance crews. Nevertheless, throughout the site operation best working practices will continue to be adopted. Measures to protect the soil and geological environment will be taken by properly briefing all site workers on the recommendations set out in the SEPA / EA PPG and GPP Notes.

Summary

9.128 Table 9.14 summarises the measures so far detailed above. It identifies the impacts for each element of the construction and indicates the extent to which this impact will be mitigated according to predetermined criteria. The practical mechanism by which the mitigation measures will be implemented on site is identified, as are any monitoring requirements thought necessary to ensure the ongoing effectiveness of the measures.

Table 9.14: Operational Phase Potential Environmental Effects

Potential Environmental Effect	**Impact of Significance**	**Receptor**	**Mitigation**	**Impact of Significance with Mitigation**
Potential contamination of hydrology and hydrogeology as a result of onsite re-fuelling, vehicle servicing and maintenance works.	Moderate	Drainage features Superficial and bedrock aquifers	• Use spill kits, fill point drip trays, bunded pallets and secondary containment units • The clay rich soil is expected to restrict the vertical movement of contamination • Adherence to GPP1, GPP2, GPP5, PPG6, GPP21, GPP22 and GPP26 will help to prevent any works from giving rise to contamination • Deliveries are to be off loaded within the contractor's compound • Control measures specified in COSHH assessments to be implemented and monitored • All COSHH Data Sheets to be retained in the relevant appendix of the construction stage health and safety plan and provided by the principal contractor as the contract progresses • All materials stored and used in accordance with manufacturer's instructions and corresponding COSHH assessments • A Waste Management Plan to be produced before the commencement of work • Sulphate resistant concrete of suitable consistency used • Emergency planning in place	Negligible

Decommissioning Phase

9.129 The future of the wind farm beyond the design life is uncertain. Decommissioning of the site is one option involving removal of the turbines and possible dismantling / breaking up of other structures. The potential impacts on controlled waters during decommissioning are similar to those during the construction phase, although risks will be lowered as many elements of the site will remain undisturbed, such as turbine bases, wind farm tracks and underground cabling. Any new legislation or guidelines published prior to decommissioning will be adhered to and incorporated into mitigation design prior to decommissioning taking place.

9.130 Table 10.15summarises the measures so far detailed above. It identifies the impacts for each element of the construction and indicates the extent to which this impact will be mitigated according to predetermined criteria. The practical mechanism by which the mitigation measures will be implemented on site is identified, as are any monitoring requirements thought necessary to ensure the ongoing effectiveness of the measures.

Description of Residual Effects and their Significance

Construction Phase

9.130 This section assesses the residual impacts of the proposed development, i.e. the impacts following implementation of the design mitigation and specific mitigation measures, during the wind farm construction on controlled waters.

Wind Farm Tracks

9.131 Even with mitigation measures in place, extreme rainfall events may result in some sediment eroded from wind farm tracks entering local watercourses. However, the mitigation will remove the majority of suspended sediments, whilst the dilution potential of the watercourses will also be at its greatest during these high flow periods.

Culverts

9.132 The proposed mitigation of containment and temporary diversion along with the short duration of the construction phase to install the culvert prevents long term damage or changes in drainage for Angle Stream North.

Electric Cable Laying

9.133 The proposed mitigation including the opening of trenches over a short period and clay bunding will prevent long term damage to the soils and potential for flow diversions.

Wind Turbine and Crane Pad Foundations

9.134 The risk of pollution from suspended sediments will be reduced as far as practicable by the provision of drainage measures and silt traps. Mitigation is also included for further risks of pollution from accidental spillages of lubricants so that any unforeseen incident that does occur is both small in magnitude and quickly ameliorated. Sulphate resistant concrete will be used to prevent the infiltration of concrete residues into shallow groundwater.

Substation and Temporary Construction Compound

9.135 The areas involved are small, and the mitigation measures will ensure that any impacts are minor and quickly controlled. The substation will be replacing natural grassland with an area of hardstanding, but the limited land take is not expected to alter the hydrological response of the land significantly. The site of the temporary compound will be restored to near pre-construction conditions when the construction phase is completed.

Landfill

9.136 Further investigations are to be carried out into the size and extent of the identified landfill East of Cheveralton Farm. As mentioned above, a PRA has been planned to be carried out in February 2014.

Site Working Practices

9.137 Following mitigation, the impacts of site working practices on the hydrology and hydrogeology are anticipated to be small and negligible. Spill response measures will intercept and control accidental spillages as best as practicably possible.

Operational Phase

9.138 This section assesses the residual impacts of the proposed development, i.e. the impacts following implementation of the design mitigation and specific mitigation measures, during the wind farm operation on the soil and geological environment.

9.139 Following construction there will be no further impacts from the cables, wind turbine and crane pad foundations and the temporary compound. However, remaining impacts are discussed below.

Wind Farm Tracks

9.140 During heavy rainfall events there is therefore the potential for the erosion of track surfaces and excavated soil material, which could lead to sediment entrainment within runoff. However, any sediment will be filtered by the track materials and naturally by the adjoining vegetation, and it is also unlikely that significant track runoff will enter watercourses, as the tracks are some distance away.

Substation

9.141 Changes in the hydrological response of the area occupied by the substation will continue throughout the operational phase. This effect will be very small and will not fundamentally affect the hydrological regime of the area.

Site Working Practices

9.142 Due to the small scale of site works during this period, spillages related to site working practices are likely to be very small and readily contained, so the risk to water bodies is very low. Appropriate method statement procedures will be followed at all times.

Decommissioning Phase

9.143 Potential residual impacts during decommissioning are likely to be similar to those during the construction phase but would depend on the exact nature of the decommissioning activities that take place. However, it is likely that the ground disturbance would be less. The most likely impacts are from spillages and leaks associated with plant and machinery. Mitigation similar to that implemented during the construction phase, though updated to reflect changes in legislation/guidance, and would ensure that the significance of such impacts is very low.

Vulnerability of Development to Major Accidents or Disasters

9.144 Given the geographic location of the proposed windfarm, the vulnerability of the proposed development to natural disasters such as earthquakes, fire, tidal or weather events is considered low. In terms of accidents, the wind turbines and associate infrastructure are all to be constructed in accordance with best practice.

9.145 Operation of the wind farm in accordance with planning, regulatory and legislative requirements, as well as good industry practice, will ensure the vulnerability of the development to major accidents or disasters and is considered low and not significant in terms of Hydrology and Hydrogeology.

Conclusions

9.146 This Chapter presents an assessment of the potential impacts regarding the hydrological and hydrogeological environment from the proposed wind farm at Rhoscrowther, Pembrokeshire. The receptors for this assessment are considered to be the local drainage features, aquifers and abstraction wells.

9.147 Based on the findings of the impact assessment mitigation measures are advised to reduce the potential of significant impacts. All impacts following mitigations are considered to have a negligible level of impact significance. No significant adverse impact upon the local surface waters and groundwaters is therefore considered to arise from the operation of the wind farm on the site