9 Hydrology & Hydrogeology

9.1 Introduction

This chapter assesses the impacts of the Development (**Figure 1.2**) on the hydrology and hydrogeology resources. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the following phases of the Development:

- Decommissioning of the Operational Barnesmore Windfarm (initial phase of the Development)
- Construction of the Development (likely to occur in tandem with the above phase)
- Operation of the Development
- Decommissioning of the Development (final phase)

The decommissioning of the Operational Barnesmore Windfarm and the construction of the Development are likely to occur partly in tandem and would have a greater effect than if the two processes were to arise at different times. This represents a worst-case scenario for assessment purposes. Any effects arising as a result of the future decommissioning of the Development, are considered to be no greater than the effects arising when these two phases are combined. As a result, the final decommissioning phase has not been considered further in this assessment.

The Development refers to all elements of the application for the repowering of the Operational Barnesmore Windfarm (**Chapter 2: Development Description**). The repower design layout has provision for the retention and re-use of existing footprint locations, in part, of the Operational Barnesmore Windfarm.

Common acronyms used throughout this EIAR can be found in **Technical Appendix 1.4**.

This chapter of the EIAR is supported by Figures provided in Volume III and the following Technical Appendices provided in Volume IV of this EIAR:

- **Technical Appendix 9.1** Photographic Plates
- **Technical Appendix 9.2** Mapped Surface Water Bodies and Network
- **Technical Appendix 9.3** Mapped Surface Water Features
- **Technical Appendix 9.4** Surface Water Systems and Associated Sensitive Protected Areas
- **Technical Appendix 9.5** Surface Water Survey Maps
- **Technical Appendix 9.6** Surface Water Database
- **Technical Appendix 9.7** Groundwater Database
- **Technical Appendix 9.8** Laboratory Certificates
- **Technical Appendix 9.9** Constraints

An Outline Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Technical Appendix 2.1**. This document will be developed into a Site-Specific Barnesmore CEMP post consent/pre-construction once a contractor has been appointed and will cover both the decommissioning of the Operational Barnesmore Windfarm and the construction of the Development. It will include all of the mitigation recommended within the EIAR. For the purpose of this application, a summary of the mitigation measures is included in **Technical Appendix 15.1**.

9.1.1 Assessment Structure

In line with the revised EIA Directive and current (draft) EPA guidelines the structure of this Hydrology and Hydrogeology chapter is as follows:

- Details of methodologies utilised for both desk and field studies, in the context of legal and planning frameworks
- Description of baseline conditions at the Site
- Identification and assessment of impacts to hydrology and hydrogeology associated with the Development, during the initial decommissioning (Operational Barnesmore Windfarm), construction, operational and decommissioning phases of the Development
- Mitigation measures to avoid or reduce the impacts identified
- Identification and assessment of cumulative impacts if and where applicable

- Identification and assessment of residual impact of the Development considering mitigation measures.
- Summary of Significant Effects and Statement of Significance.

9.2 Assessment Methodology and Significance Criteria

9.2.1 Assessment Methodology

The following calculations and assessments were undertaken in order to evaluate the potential impacts of the Development on the hydrology and hydrogeology aspects of the environment at the Barnesmore Site:

- Characterise the topographical, hydrological and hydrogeological regime of the Site from the data acquired through desk study and onsite surveys.
- Undertake preliminary water balance calculation.
- Undertake preliminary flood risk evaluations.
- Consider hydrological or hydrogeological constraints together with development design.
- Consider drainage issues, or issues with surface water runoff quality as a result of the Development, its design and methodology of construction.
- Assess the combined data acquired and evaluate any likely impacts on the hydrology and hydrogeology aspects of the environment.
- If impacts are identified, consider measures that would mitigate or reduce the identified impact.
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

9.2.2 Relevant Legislation and Guidance

This study complies with the European Directive 2014/52/EU which requires Environmental Impact Assessment for certain types of major development before development consent is granted.

This study was undertaken in accordance with following Irish legislation (transposition of the aforementioned directive):

- SI No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018.

In addition to this planning legislation, other environmental legislation relevant to hydrological and hydrogeological aspects of the environment were referred to:

- Quality of Water Intended for Human Consumption (80/778/EEC) SI No. 81 of 1988 and the Drinking Water Directives (98/83/EC) and resultant SI No. 278 of 2007 Drinking Water Regulations
- Quality Required of Surface Water Intended for Abstraction of Drinking Water (75/440/EEC) and resultant SI No. 294 of 1989: Quality of Surface Water Intended for Abstraction (Drinking Water); European Communities Environmental Objectives (Surface Waters) Regulations 2009 SI No. 272 of 2009.
- Dangerous Substances Directive (76/464/EEC) and resultant SI No. 12 of 2001: Water Quality (Dangerous Substances) Regulations
- Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life (78/659/EEC) and resultant SI No. 293 of 1988: Quality of Salmonid Waters Regulations
- SI No. 258 of 1998: Water Quality (Phosphorous Regulations)
- The Water Framework Directive (2000/60/EC) and resultant regulations;
  - European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003)
  - European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009)
  - European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)
  - European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011)
  - European Union (Water Policy) Regulations 2014 (S.I. No. 350 of 2014)
  - The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003

The Water Framework Directive (WFD), which was passed by the European Union (EU) in 2000, and came into legal effect in December 2015, is a wide-reaching legislation which replaces a number of the other water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the Water Framework Directive. The fundamental objective of the Water Framework Directive aims at maintaining “high status” of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least “good status” in relation to all waters by 2015 (WFD).

The Donegal County Development Plan (2018-2024) was also consulted as part of the EIA process.

This study has been prepared using, inter alia, the following guidance documents, which take account of the aforementioned legislation:

- Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015 (Supersedes 2003 version)
- EPA (2017) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports – DRAFT May 2017 (Supersedes 1997 and 2002 versions)
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance

9.2.3 Desk Study

Minerex Environmental Limited (MEL) undertook a desk study assessment of the water aspects of the Site in July and August 2017 before and after field investigations. This involved the following components:

- Acquire and compile all maps of the Development.
- Study and assess the proposed locations of turbines, Site tracks, anemometer and substation relative to available data on site hydrology and hydrogeology.
- Overlay Ordnance Survey of Ireland (OSI) 1:250,000, 1:50,000 and 1:10,560 (6”) maps with AutoCAD plan drawings.
- Overlay Geological Survey of Ireland (GSI) Geology and Groundwater maps (1:100,000) to determine site bedrock geology and the presence of any major faults or other anomalies, groundwater resource characteristics and sensitivities.
- Overlay Environmental Protection Agency (EPA) / Teagasc (Agricultural Agriculture & Food Authority) Soils and Subsoil maps (1:50,000) to determine categories of soils and subsoil and indirectly geochemical origin for the study area.
- Consultation with the GSI databases, publications and website in relation to well database records and the hydrogeological resources of Co. Donegal.
- Consultation with National Parks and Wildlife Service and EPA maps in relation to designated sites associated with the relevant surface water networks.
- Consultation with Water Framework Ireland (Western River Basin District) in relation to water quality status and risk status of surface water and groundwater in Co. Donegal and associated surface water networks.
- Consultation with Met Éireann for meteorological service records for the 30 Year Averages and Maximums from the closest pertaining synoptic and rain gauge sites
- Consultation with Met Éireann for meteorological thresholds including 1 in 50 years and 1 in 100-year storm events.
- Consultation with publicly available satellite aerial imagery to assess significant drainage features on and in the vicinity of the Site.

9.2.4 Field Work

MEL carried out field investigations at the Site between April and September 2019 (A total of 13 calendar days, with the number of field operatives ranging from one to three per day. This is in conjunction with surveys related to Soils and Geology). These works consisted of the following:

- Drainage distribution and catchment mapping
- Field hydrochemistry of the drainage network (electrical conductivity, pH and temperature)
- Recording of GPS co-ordinates for all investigation and monitoring points in the study
- Digital photography of significant features
- Baseline sampling of surface water for analytical laboratory testing
- Baseline sampling of surface water flow and discharge rates
- Installation and monitoring of phreatic piezometers – groundwater levels
- Onsite design workshop meetings with the Applicant (SPR), the consultant (JOD) and subconsultants to discuss the Development with input from all disciplines associated with the EIA

9.2.5 Evaluation of Potential Effects

9.2.5.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development (EPA, 2017). The EPA provides guidance on the assessment methodology, including defining general descriptive terms in relation to magnitude of impacts however, in terms of qualifying significance of the receiving environment the EPA guidance also states that;

> "*As surface water and groundwater are part of a constantly moving hydrological cycle, any assessment of significance will require evaluation beyond the development site boundary.*" (EPA, 2015)

Potential affects arising by a proposed development in terms of soils and geology will be limited to a localised scale, and therefore in describing the sensitivity of soils and geology it is appropriate to rate such while considering the value of the receiving environment or site attributes. To facilitate the qualification of hydrological and hydrogeological attributes, guidance specific to hydrology and hydrogeology as set out by National Roads Authority (NRA), and guidance specific to landscape as set out by Scottish National Heritage (SNH) has been used in conjunction with EPA guidance.

The following table presents rated categories and criteria for rating site attributes (NRA, 2008):

Table 9.1: Criteria for Rating Site Attributes – Hydrology and Hydrogeology Specific

Importance	Criteria
Extremely High	Attribute has a high quality or value on an international scale.
Very High	Attribute has a high quality, significance or value on a regional or national scale.
High	Attribute has a high quality, significance or value on a local scale.
Medium	Attribute has a medium quality, significance or value on a local scale.
Low	Attribute has a low quality, significance or value on a local scale.

Considering the above categories of rating importance and associated criteria, the following table presents rated sensitivity categories (SNH, 2013):

Table 9.2: Criteria for Rating Site Sensitivity - Landscape Character Specific

Importance	Criteria
High Sensitivity	Key characteristics and features which contribute significantly to the distinctiveness and character of the landscape character type. Designated landscapes e.g. National Parks, Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs) and landscapes identified as having low capacity to accommodate proposed form of change, i,.e. sites with attributes of **Very High Importance**.
Medium Sensitivity	Other characteristics or features of the landscape that contribute to the character of the landscape locally. Locally valued landscapes which are not designated. Landscapes identified as having some tolerance of the proposed change subject to design and mitigation etc. i.e. sites with attributes of **Medium to High Importance**.
Low Sensitivity	Landscape characteristics and features that do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape type. Landscapes identified as being generally tolerant of the proposed change subject to design and mitigation etc. i.e. sites with attributes of **Low Importance**.

9.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in the following table (EPA, 2017). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline tends, for example; a *Moderate* impact is one which *is consistent with the existing or emerging trends*.

Table 9.3: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences.
Slight	An impact that alters the character of the environment without affecting its sensitivities.
Moderate	An impact that alters the character of the environment in a manner that is consistent with the existing or emerging trends.
Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics.

In terms of hydrology and hydrogeology, magnitude is qualified in line with relevant guidance, as presented in the following tables (NRA, 2008) These descriptive phrases are considered development specific terms for describing potential effects of the Development, and do not provide for considering baseline tends and therefore are utilised to qualify impacts in terms of weighting impacts relative to site attribute importance, and scale where applicable.

Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes

Magnitude of Impact	Description	Example/s
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	Loss or extensive change to a waterbody or water dependent habitat, or Calculated risk of serious pollution incident >2% annually, or Extensive loss of fishery
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Partial reduction in amenity value, or Calculated risk of serious pollution incident >1% annually, or Partial loss of fishery
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Slight reduction in amenity value, or Calculated risk of serious pollution incident >0.5% annually, or Minor loss of fishery
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	Calculated risk of serious pollution incident <0.5% annually
Minor Beneficial	Results in minor improvement of attribute quality.	Calculated reduction in pollution risk of 50% or more where existing risk is <1% annually
Moderate Beneficial	Results in moderate improvement of attribute quality.	Calculated reduction in pollution risk of 50% or more where existing risk is >1% annually
Major Beneficial	Results in major improvement of attribute quality.	Reduction in predicted peak flood level >100mm

Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes

Magnitude of Impact	Description	Example
Large Adverse	Results in a loss of attribute.	Removal of large proportion of aquifer, or

Magnitude of Impact	Description	Example
		Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or Ecosystems, or Potential high risk of pollution to groundwater from routine run-off
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Removal of moderate proportion of aquifer, or Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or Ecosystems, or Potential medium risk of pollution to groundwater from routine run-off.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Removal of small proportion of aquifer, or Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems, or Potential low risk of pollution to groundwater from routine run-off.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	Calculated risk of serious pollution incident <0.5% annually

9.2.5.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential impacts, rating of significant environmental impacts is done in accordance with relevant guidance as presented in the Table below (NRA, 2008). This matrix qualifies the magnitude of potential effects based on weighting same depending on the importance and/or sensitivity of the receiving environment. In terms of Hydrology and Hydrogeology, the general terms for describing potential effects (**Table 9.3: Describing the Magnitude of Impacts**) are linked directly with the Development specific terms for qualifying potential impacts (**Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes** and **Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes**) therefore, qualifying terms (**Table 9.6**) are used in describing potential impacts of the development. This is largely driven by the likely transboundary characteristic of potential effects arising as a product of the Development in terms of Hydrology and Hydrogeology.

Table 9.6: Weighted Rating of Significant Environmental Impacts

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
High	Imperceptible	Moderate / Slight	Significant / Moderate	Profound / Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

9.2.5.4 Scoping Responses and Consultation

Information has been provided by a number of consultee organisations during the assessment, and this is summarised in **Table 9.7**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has changed in response to specific issues indicated by respective consultees.

Table 9.7: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response
Department of Agriculture, Environment and Rural Affairs	Letter in response to Scoping Report received 30/09/19	*The foundations of wind turbines have the potential to impact on the groundwater environment. An assessment of the Development's potential risk to impact on the groundwater environment is required. This typically consists of a Water Features Survey as part of the Hydrogeological Assessment. Further information is provided within "Environmental information required" and, Baseline environmental information". This information is required either through an EIA or in support of a full planning application* • Concrete, in particular fresh / wet concrete or lean mix material has the potential to impact on water which comes into contact with it, that is; the pH will be elevated, and there is also the potential for other contaminants such as sulphates etc. This is considered a potential adverse impact on the Environment. The sensitivity of groundwater and the management of cementitious material is addressed as part of this EIA chapter.
Department of Culture, Herritage and the Gaeltacht	Letter / email in response to Scoping Report received 25/06/19	Concerns regarding: *Nature Conservation* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Ecological survey* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Hedgerows and related species* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Watercourses and wetlands* • Generally related to Ecology i.e. Chapter 6: Biodiversity *A 10m riparian buffer on both banks of a waterway is considered to comprise part of the otter habitat. Therefore, any proposed development should be located at least 10m away from a waterway.* • This is specific to the protection of otter habitat, for information relating to ecology refer to Chapter 6: Biodiversity. Surface water bodies are identified as being sensitive in their won right, therefore a series of risks are mitigated for as detailed in **Section 9.5 Mitigation Measures – Chapter 9: Hydrology and Hydrogeology**. *EIAR: Bats* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Alien invasive species* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Bird surveys* • Generally related to Ecology i.e. Chapter 6: Biodiversity *EIAR: Impact assessment* *The positions, locations and sizes of construction infrastructure and mitigation such as settlement ponds, disposal sites and construction compounds may significantly affect European and other designated sites, habitats and species in their own right and could have an effect for example on drainage, water quality, habitat loss, and disturbance. If these are undetermined at time of the assessment all potential effects of the development on the site are not being considered.* • Generally related to Ecology i.e**. Chapter 6: Biodiversity**, however items such as land take and water quality are addressed in **Chapter 8: Soils and Geology** and **Chapter 9: Hydrology and Hydrogeology** respectively**.** Land take (of the Barnesmore NHA) and quality of surface water runoff intercepted by the NHA or associated drainage and surface water networks is assessed and mitigation measures prescribed set out to minimise impact is so far as practical, and to legislative refence limits e.g. water quality of associated surface water network. *EIAR: Construction Management Plans* *Construction work should not be allowed to impact on water quality and measures should be detailed in the EIAR to prevent sediment and/or fuel runoff from getting into watercourses which could adversely impact on aquatic species. See EIAR: Flood Plains for details with regard to flooding risk.* • Generally related to Ecology i.e. **Chapter 6: Biodiversity** i.e. impact to fish species etc, however **Chapter 9: Hydrology and Hydrogeology** identifies risk to water quality and **Section 9.5** prescribes mitigation measures with a view to minimising impacts to the receiving surface water network. Flood risk is also assessed. *EIAR: Cumulative and ex situ impacts* • Cumulative impacts in relation Soils and Geology (**Section 8.5.5 - Chapter 8: Soils and Geology**) and Water (**Section 9.6 - Chapter 9: Hydrology and Hydrogeology**) are considered.

Consultee	Type and Date	Summary of Consultee Response
		Appropriate Assessment • Considered separately to both **Chapter 8: Soils and Geology** and **Chapter 9: Hydrology and Hydrogeology.** *Post construction monitoring* • *Monitoring principals are described in **Section 8.5*** **Chapter 8: Soils and Geology** and **Section 9.5 - Chapter 9: Hydrology and Hydrogeology** *Licences* • Generally related to Ecology i.e. **Chapter 6: Biodiversity** *Baseline data* • Generally related to Ecology i.e. **Chapter 6: Biodiversity**
Inland Fisheries Ireland (IFI)	Email in response to Scoping Report received 08/07/19	Concerns regarding: *Storage of fuel, bunded and 100m from any watercourse.* • The requirement for a bunded fuelling station is identified and included in mitigation measures, the CEMP, and will be specified in the Site Specific CEMP. The location of same will be positioned in the contractors' yard (**Figure 1.2**). Unfortunately, given the restrictive nature of the Site in terms of layout and the drainage network being close proximity to same, a 100m buffer zone from significant drainage or surface water features is not a viable approach, however mitigation measures to address the potential for hydrocarbon contamination incidents, including emergency responses are described in the Mitigation Measures sections of **Chapter 8: Soils and Geology** and **Chapter 9: Hydrology and Hydrogeology.** *Watercourse crossings.* • Addressed, 3 no. new watercourse crossings associated with the Development will be planned and designed adequately, and consent will be sought from the Office of Public Works (OPW). **Section 9.5 Mitigation Measures and Residual Effects** *Erosion and entrainment of suspended solids and management of same.* • Entrainment of SS is considered an unavoidable impacts of the Development due to excavation activities required. However if precautionary and mitigation measures described in **Section 9.5 Mitigation Measures and Residual Effects**, the potential impact can be significantly reduced. *Existing drainage channels should remain untouched* • Given the constrained nature of the Site in terms of layout design limitations i.e. restricted to the foot print of the Operational Barnesmore Windfarm and it's relationship with topography and existing natural and artificial drainage etc. some drainage features will be impacted including being rerouted or upgraded as a product of the Development, however this conforms to baseline and ongoing practices on the Operational Barnesmore Windfarm. Furthermore, some of the mitigation measures outlined in **Chapter 9: Hydrology and Hydrogeology** require the modification or construction of in line drainage infrastructure e.g. stilling ponds, check dams, etc. Furthermore, in some places infrastructure associated with both the Operational Barnesmore Windfarm and the proposed Development will be within surface water body buffer zones, in such unavoidable instances additional attention will be given including additional mitigation measures with a view to minimising any impact to those water bodies. The application of such measures will be detailed in the Site Specific CEMP and SWMP. *Cement and wet concrete must be kept out of all watercourses and drains.* • Mitigation measures to address this potential issue are described in **Section 9.5** *Track ruttings by machinery movement must be kept to a minimum and no discharge or run off containing high sediment loads must occur from the Site.* • It is recommended in the mitigation measures of this report that no vehicular movements over peat should occur. If vehicular movement over peat needs to occur it will be limited to the footprint of the Development. *Any stockpiling of peat or other site materials will require careful management to ensure that slippage or collapse to any adjacent watercourses will not occur.* • Management of stockpiles is addressed. *The monitoring of all surface flows during construction is essential and remote sensing equipment should be considered as a normal precaution and extended into the post construction phase* • Monitoring of surface water quality is addressed. Remote sensing telemetry equipment is recommended. *Consideration should be afforded to the likely increase in surface water flow from the Site which has the potential to alter the downstream prevailing hydrological regime and impact on the fisheries resource.* • Increased hydro loading is addressed. Net increase in surface water runoff is considered negligible / imperceptible. **Section 9.3.7.**

Consultee	Type and Date	Summary of Consultee Response
		Recommended that a suitably qualified person be on site for the duration of works to ensure: *(a) All mitigation measures identified are implemented prior to and during the construction phase, as appropriate.* *(b) Continual assessment to ensure the mitigation measures are effective including assessment of adjacent peats for cracking/instability.* *(c) Cessation of works should slippage indicators develop and/or settlement arrangements are inadequate for suspended solid removal in surface waters.* *(d) Peat reinstatement is completed according to a detailed restoration plan.* *(e) Arrangements are established in relation to a contact protocol for the relevant statutory bodies on progress of works.* • It is recommended that suitably qualified person/s be in attendance, particularly during significant works e.g. excavation activities. Other particulars are addressed and will be included in the Site Specific CEMP.
An Taisce	Email in response to Scoping Report received 14/06/19	Concerns in relation to Peat Displacement. • The Development will require peat, subsoil and bedrock removal by excavation, this is addressed **Chapter 8: Soils & Geology**
Geological Survey Ireland	Letter in response to Scoping Report dated 08/07/19	*The Donegal County Audit is due to be published later this year, but I can confirm now that there are no County Geological Sites within the area of the proposed work. There are two sites close to the area to the north and we would appreciate if these were included in the report, but with the current plans, there is no envisaged impact on the integrity of County Geological Sites by the development.* • Geological sites, including mineral localities, and the Barnesmore Gap, are considered in the Baseline Section/s of this EIAR (**Chapter 8: Soils & Geology**). The Development will not impact on same. *Groundwater - The area is a poor aquifer as it is mainly rock at the surface but it is considered extremely vulnerable to groundwater contamination. The River Finn to the north is part of a €14m INTERREG CatchmentCARE cross-border project and should be included in your report as such but it is not envisaged that the proposed works will be of concern.* • Groundwater is not considered to be at significant risk due to (a) the aquifer is poor with low productivity except for local zones (b) the recharge coefficient for the area is low which implies much of the water / rainfall landing on the Site will be intercepted by drainage and surface water network (c) risk to groundwater is limited to mobile contamination e.g. hydrocarbons, the risk for which is considered low provided precautionary and mitigation measures are adhered to, and (d) the risk conforms to baseline conditions and practices associated with the Operational Barnesmore Windfarm. Sensitive, designated sites downstream of the Development are considered. All waters (groundwater and surface water) associated with the Site are considered as being highly sensitive and in turn of high importance – mitigation measures are described accordingly.
HSE	Letter in response to Scoping Report dated 08/07/19	*Water Quality – The proposed development has the potential to have a significant impact on both surface water and groundwater quality. All drinking water sources, both surface and groundwater must be identified. Any potential impacts to these drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, catchment areas etc. should be considered when assessing the potential impacts and any proposed mitigation measures. It is strongly recommended that a site survey is undertaken to gather all necessary information as desk top studies cannot be relied upon to reflect current accurate use of water resources.* • Water quality, import mace as a resource, and its vulnerability to being impacted by the Development is assessed as normal procedure carrying out this EIA assessment. Works included both desk and site based assessments. The potential for the development to impact on sources of drinking water is considered negligible. *Geological Impacts – A detailed assessment of the current ground stability of the Site for the proposed windfarm development together with the necessary mitigation measures should be included in the EIS. The assessment should include the impact construction work will have on the future stability of ground conditions taking into account extreme weather event, site drainage and the possibility for soil erosion.* • A detailed slope stability assessment has been carried out as part the EIA process (**Technical Appendix A8.3**). The risk for slope stability issues to arise as a product of the Development is considered negligible to low, furthermore all potential receptors are surface water features i.e. no immediate risk to populations / communities.
Irish Water	Letter in response to	*Irish water suggests a site investigation be carried out prior to the beginning of construction and proposals outlined for dealing with situations where works would interfere with existing water services infrastructure*

Consultee	Type and Date	Summary of Consultee Response
	Scoping Report dated 06/08/19	• Site surveys have been carried out, including peat depth probing and peat gouge coring as normal procedure carrying out this EIA assessment, no impacts to water services on the Site are identified or envisaged. Furthermore, no trade effluent will be discharged to sewer, or any surface water body.
Office of Public Works	Letter in response to Scoping Report dated 27/08/19	*The footprint of the Barnesmore Windfarm does not coincide with any existing or proposed OPW Drainage of Flood Relief Scheme.* • Regards, the net increase in surface water runoff as a product of the Development is considered imperceptible. *Construction or alteration of any watercourse crossing will require Section 47/50 consent as per the Arterial Drainage Act of 1945* • Consent will be sought for 3 no. new watercourse crossings. This will be specified in the Site Specific CEMP, that is; consent will be sought post planning application review. *The Development shall follow The Planning System and Flood Risk Management: Guidelines for Planning Authorities.* • Flood Risk has been considered as part of the Baseline Assessment and in terms of net increase of surface water runoff (imperceptible) associated with the Development (**Section 9.3.8).**

9.3 Baseline Description

9.3.1 Introduction

The Development is defined as the repowering of the Operational Barnesmore Windfarm and titled the Barnesmore Windfarm Repower. The Operational Barnesmore Windfarm was installed c. 1997 and consists of twenty five c. 61 m wind turbines with associated Site tracks, hardstands and other infrastructure. The repowering of the Operational Barnesmore Windfarm entails the removal of the original wind turbines and replacing them with a lower number of more modern and efficient, larger, higher capacity turbines.

The Site is situated in an area known as Barnesmore Bog, located on the southern limits of the Bluestack Mountains, Co. Donegal, and in turn the southwest limits of the North Western Caledonian Province – an area underlain by ancient Precambrian rocks which have been folded into mountains. The underlying rock types are considered 'hard', e.g. granites and quarzitic peaks which were rounded but not destroyed by glacial movements during the ice age. The soils however, were generally stripped from the region and thus, the region is agriculturally poor. (Johnston, ND)

The existing turbines are sited on elevated moorland adjacent to Barnesmore Gap between the N15 and the Irish national border. The Site boundary is wholly within the Republic of Ireland. A Site Location Map showing the Site boundary outline is appended as **Figure 1.1** and a copy of the operational windfarm layout is outlined as **Figure 3.2**.

The decommissioning of Operational Barnesmore Windfarm and the construction of the Development is likely to occur partly in tandem and would have a greater effect than if the two processes were to arise at different times. This represents a worst-case scenario for assessment purposes. Any effects arising as a result of the future decommissioning of the Development, are considered to be no greater than the effects arising when these two phases are combined. As a result, the final decommissioning phase of the Development has not been considered further in this assessment.

9.3.2 Site Description

The land around Barnesmore Windfarm, which is wholly owned by SPR, was designated as an NHA in 2005 owing to the peatland habitat (Barnesmore Bog NHA 002375). This designation was subsequent to the construction of the operational windfarm and the designated boundary sought to exclude the operational windfarm infrastructure from the NHA. However, the map contained within the NHA Site synopsis indicates that this exercise has not been completed accurately; although the NHA Site Synopsis confirms that this was the intention when the boundaries were drawn "A wind power installation and associated Site tracks, which occupies part of Croaghakeadew Mountain (398 m) on the west and extends eastwards to Loughnaweelagh, northwards to Lough Namaddy, and southwards to just north of Lough Allegheny, has been excluded from the Site."

Barnesmore Bog NHA covers an area of 2,183 ha. The footprint of the Operational Barnesmore Windfarm covers an area of c. 7.26 ha (this allows for a 3 m buffer along the NHA exclusion zone (as per the NHA definition), and factors in backfill associated with the Operational Barnesmore Windfarm which has been vegetated over the operational phase of same).

NHAs are sites that support elements of our natural heritage which are unique or are of outstanding importance at a national level, therefore for the purpose of assessing the Development and its potential impact on the receiving environment, the Site is regarded as being of **Very High Importance**, and is **Highly Sensitive**. Note: This does not apply to any developed area, that is; existing infrastructure is not considered to of Very High Importance / Highly Sensitive.

The Site covers an area of c. 423.35 ha within the Barnesmore NHA. The area is mountainous with variable elevations ranging from c. 290 mOD to c. 390 mOD within the Site boundary (Digital Land Surveys, 2018). Within the Site boundary there are several lakes, the most significant of which is Lough Golagh which is central relevant to the existing and proposed Development, however there are several other smaller lakes within the Site boundary, for example Lough Nabrackboy, and also some minor unnamed lakes. There are also lakes on or close to the Site boundary including; Lough Slug, Lough Namaddy and Loughnoweelagh.

With reference to **Chapter 6: Biodiversity** of this report, the land cover of the Site is a mosaic of different habitats including, inter alia; active blanket bog, mountain heath, acid grass land, and turbary areas (areas where the practice of peat cutting is evident or ongoing), however for the purpose of this chapter and in regard to hydrology and hydrogeology, the area is defined as comprising of blanket bog with rocky outcrops, with extensive natural drainage features associated (EPA, ND). Some natural drainage features have been modified or enhanced as a function of the Operational Barnesmore Windfarm and associated infrastructure, in addition, artificially installed drainage is also present as a product of the existing infrastructure, and also, but to a lesser extent, as a product of ongoing turbary activities. The majority of surface water runoff associated with the Site first flows into the numerous lakes in the vicinity, and in turn said lakes discharge into two catchment areas associated with both the Republic of Ireland and Norther Ireland, namely; Donegal Bay North and Foyle catchments. There are several sensitive and protected areas associated with each catchment. A detailed flow chart describing the surface water features and protected areas associated with the Site are presented in **Technical Appendix 9.4 – Surface Water Systems & Associated Sensitive Protected Areas**. (EPA, ND; EPA, ND; WFDI, ND; NIEA, ND)

9.3.3 Topography

The topography at and in the immediate area surrounding the Site is highly variable with multiple peaks, ridges with variable elevations and inclines. At lower elevations the topography is relatively flat or comprising of low magnitude inclines, however at mid and high elevation relative to the Site, steep high magnitude inclines are common place, and in one particular location, south of the proposed location of T6, there is a near vertical rock face, however the infrastructure associated with the Operational Barnesmore Windfarm is positioned predominantly along ridges and on peaks, or within troughs, and where inclines are gentle, that is; steep inclines have been avoided. Similarly, the Development utilises the same infrastructure but proposed turbine and hardstand locations will be positioned further away again from steep inclines where possible, that is; with reference to **Chapter 8: Soil and Geology**, the existing infrastructure is within areas mapped as being Low Risk (LR), Moderately Low Risk (MLR), and Moderately High Risk (MHR) in terms of land slide susceptibility, however the proposed infrastructure will be positioned in areas mapped as being LR and MLR predominantly or in so far as possible, with minor portions overlapping into MHR areas.

Elevation contours are included within maps such as Surface Water Survey Map presented in **Technical Appendix 9.5.**

9.3.4 Rainfall and Evapotranspiration

Rainfall data for the region associated with Barnesmore Bog (northwest of Ireland) has been assessed in terms of thirty-year average monthly rainfall and effective rainfall, and thirty-year maximum rainfall and effective rainfall.

Data from the following meteorological stations were used in the assessment (MET, ND).

Table 9.8: Meteorological Stations

Category	Meteorological Station/s	Approx. Distance from the Site (km)
Rainfall (30 Year Monthly)	Ardnawarak Barnesmore	2
Rainfall (2019 Monthly)	Finner	30

Category	Meteorological Station/s	Approx. Distance from the Site (km)
Rainfall (2019 Daily & Monthly)	Barnesmore Bog Rain Gauge (Data courtesy of Woodrow Environmental)	0
Evapotranspiration	Belmullet	130
	Malin Head	85
	Finner	30
	Ballyhaise	75

The following graphs present rain fall trends for both monthly data at a regional and local scale, and daily data at a local scale.

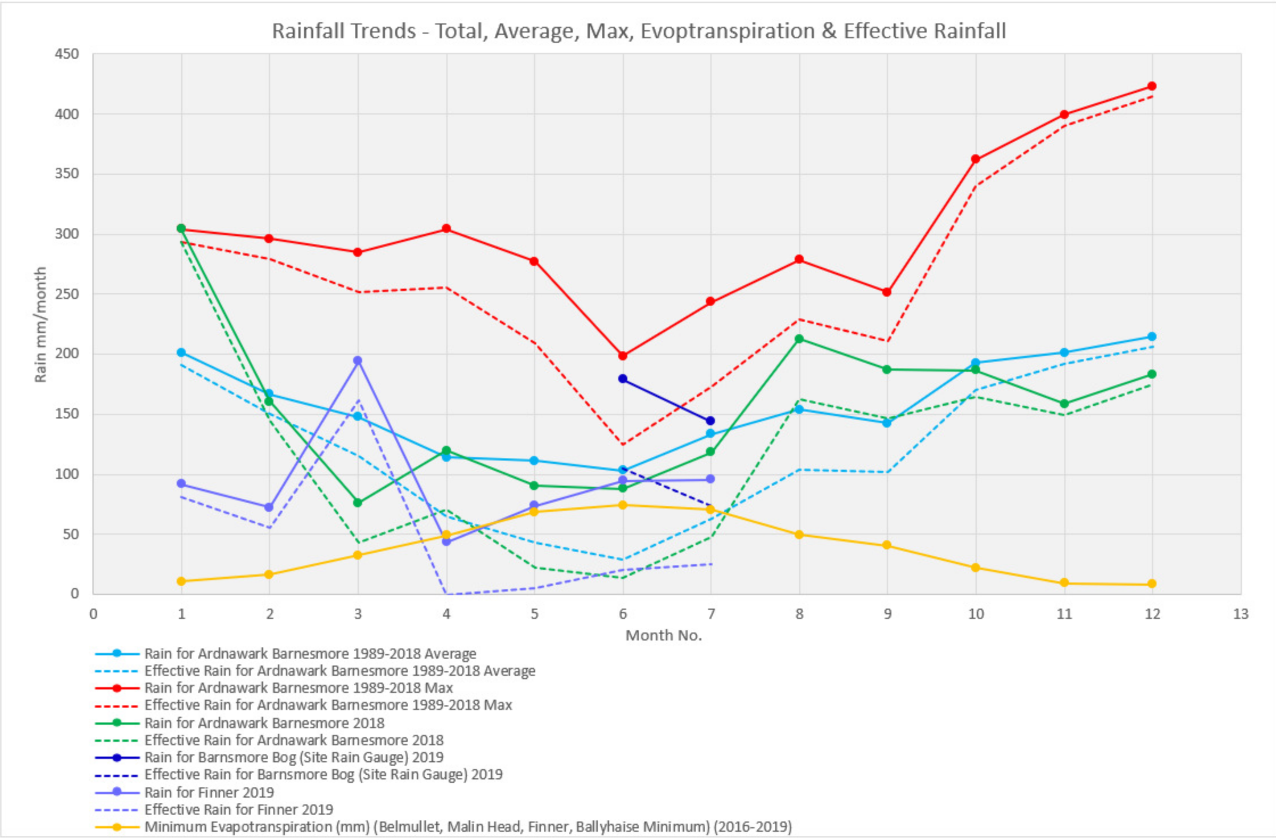


Chart 9.1: Rainfall Trends - Regional - Monthly

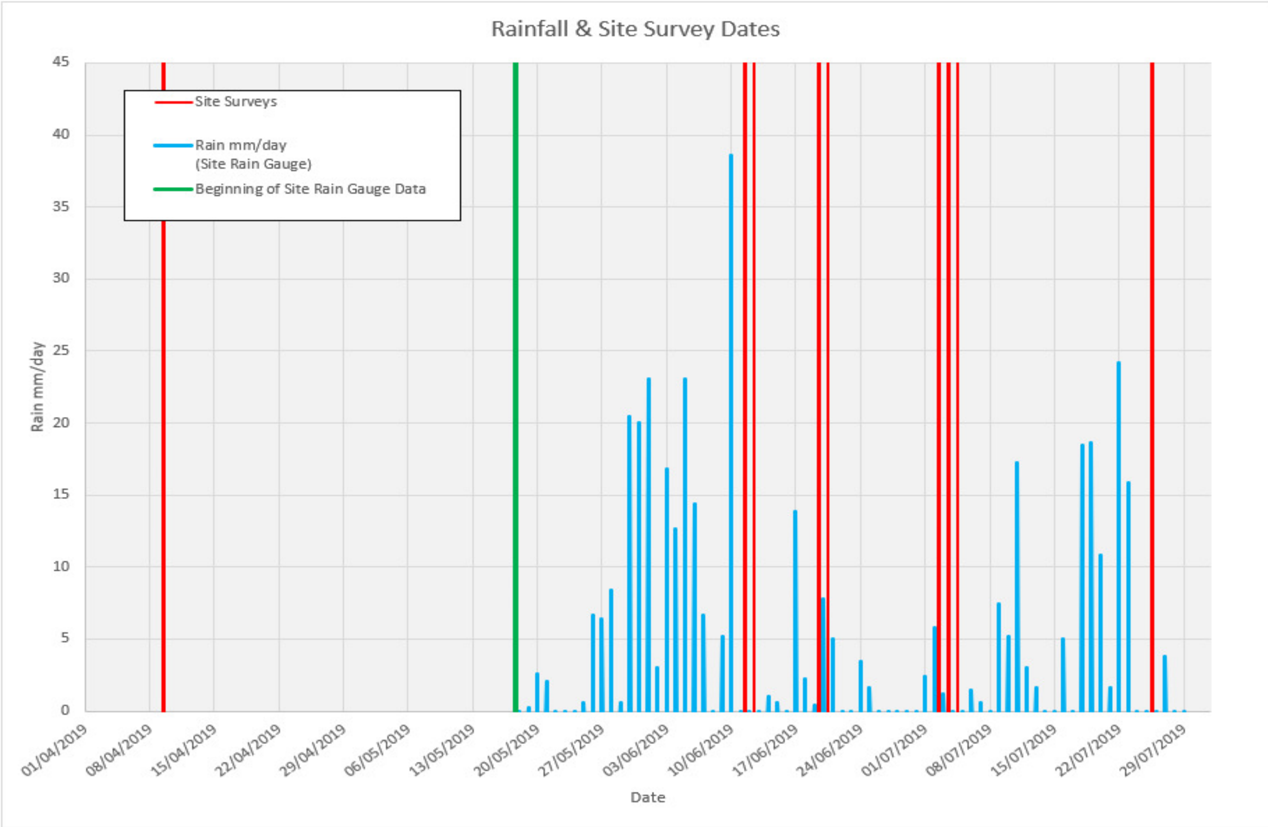


Chart 9.2: Rainfall Data - Barnesmore Bog - Daily

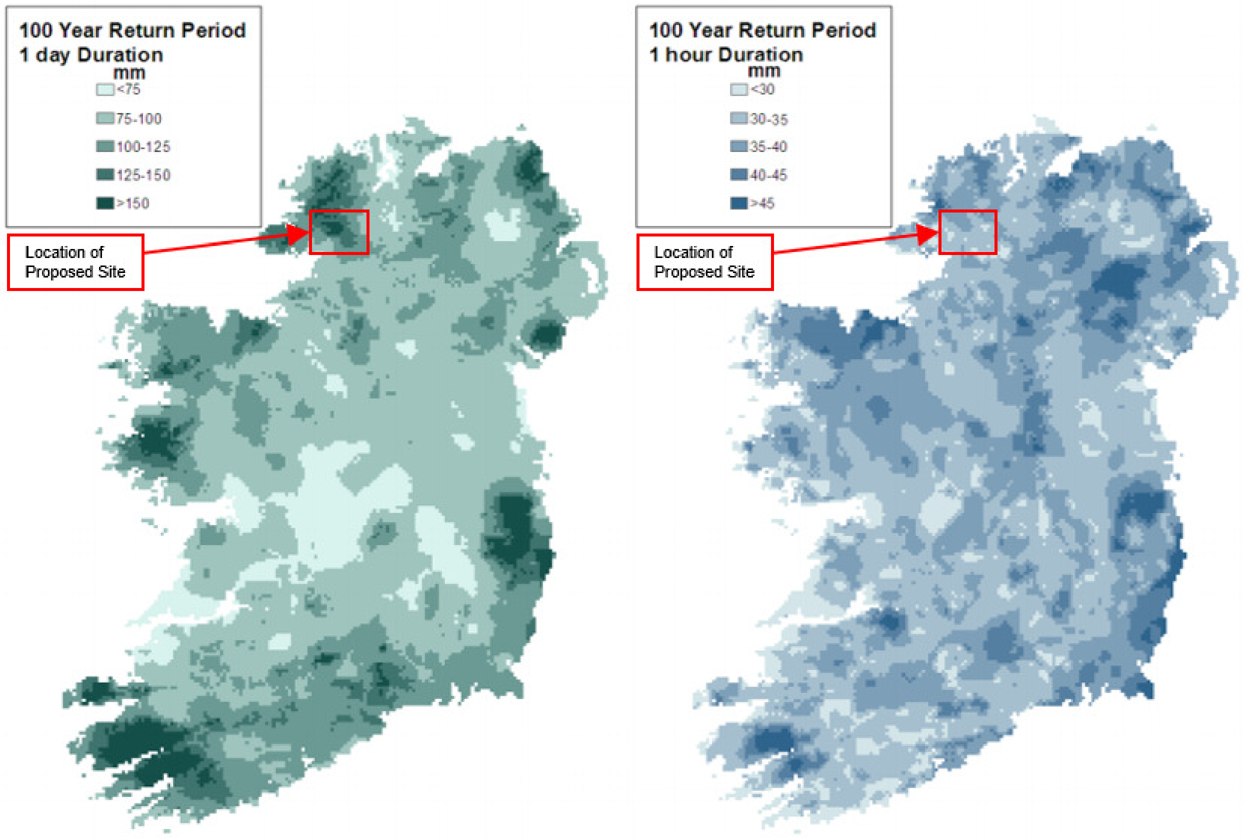
The closest meteorological station to the Site is Ardnawarak Barnesmore situated approximately two kilometres west / northwest. The thirty year (1989-2018) monthly data for rainfall has been assessed to determine average monthly rainfall and maximum monthly rainfall over the thirty-year period. Minimum average (2016-2019) evapotranspiration has been assessed using the closest active synoptic meteorological stations with evapotranspiration data available; Belmullet, Malin Head, Finner, and Ballyhaise. The minimum evapotranspiration rates recorded at these stations have been used to determine worst case effective rainfall (rainfall – evapotranspiration = effective rainfall). Effective rainfall is the quantity of rain fall which is available for groundwater recharge and surface water runoff. The following Table presents recorded rainfall and indicative effective rainfall for the Site:

Table 9.9: Rainfall Data, Evapotranspiration and Effective Rainfall

30 Year AVERAGE Rainfall (Ardnawarak)(AR), Minimum Evapotranspiration (EV), and Effective Rainfall (ER_{AVG})													
Category	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
AR (mm)	201.5	166.85	147.89	114.24	111.39	103.05	133.5	153.92	142.52	192.7	201.49	214.65	1883.7
EV (mm)	10.53	16.45	32.70	49.18	78.48	81.58	81.78	49.75	40.60	22.3	9.19	8.5	480.99
ER_{AVG} (mm)	**190.9**	**150.4**	**115.2**	**65.07**	**42.79**	**29.05**	**63.20**	**104.17**	**101.92**	**170.40**	**192.32**	**206.15**	**1431.64**
30 Year MAXIMUM Rainfall (Ardnawarak)(AR), Minimum Evapotranspiration (EV), and Effective Rainfall (ER_{MAX})													
Category	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
AR (mm)	304.20	295.90	284.80	304.30	277.30	198.50	243.70	278.60	251.70	361.80	399.70	**423.10**	3623.60
EV (mm)	10.53	16.45	32.70	49.18	78.48	81.58	81.78	49.75	40.60	22.3	9.19	**8.5**	480.99
ER_{MAX} (mm)	**293.68**	**279.45**	**252.10**	**255.13**	**208.70**	**124.50**	**173.40**	**228.85**	**211.10**	**339.50**	**390.53**	**414.60**	**3171.53**

Maximum effective rainfall data (Ardnawarak Barnesmore) indicates that the Site could potentially receive approximately 206 mm/month of effective rain fall during the wettest months, or approximately an average of 13 mm of effective rainfall per day during the wettest months. However, 100-year return periods, or 1 in100 year storm event data indicates that the

Site could potentially receive up to or more than 150 mm of rainfall in a day, and potentially 40 mm of rainfall in hour during extreme weather events (**Graphic 9.1**) (Fitzgerald, D.L., 2007).



Graphic 9.1: One in a 100 Year Rainfall Events – Extreme Storm Events (Fitzgerald, D.L., 2007)

Consultation with Met Eireann Rainfall Return Periods in regard to the Barnesmore Bog indicates that the 1 hour rainfall for a 100 year return period could equate to 30.5 mm, and the 24 hour rainfall depth for a 100 year return period could equate to 137.5 mm (**Graphic 9.2**) (MET, ND). Comparing worst case 30 year max data (Table 9.9; December ER Max = c. 415 mm/month or c. 14 mm/day) with 100 year return depth for a 24 hour period (Graphic 9.2: 137.5 mm/day) indicates a difference equating to an order of magnitude. However, the 100 year return for 25 days (451.3 mm per 25 days) is in line with worst case 30 year max data (423.1 mm per month (c. 30 days)).

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 203932, Northing: 382669,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	3.1,	3.9,	4.3,	4.9,	5.2,	5.5,	6.3,	7.2,	7.8,	8.5,	9.2,	9.7,	10.4,	10.9,	11.4,	N/A ,
10 mins	4.3,	5.4,	6.0,	6.8,	7.3,	7.7,	8.8,	10.1,	10.9,	11.9,	12.8,	13.5,	14.5,	15.2,	15.9,	N/A ,
15 mins	5.1,	6.4,	7.1,	8.0,	8.6,	9.0,	10.4,	11.9,	12.8,	14.0,	15.1,	15.9,	17.0,	17.9,	18.7,	N/A ,
30 mins	7.1,	8.9,	9.8,	11.1,	11.9,	12.5,	14.4,	16.5,	17.7,	19.4,	20.9,	22.0,	23.7,	24.9,	25.9,	N/A ,
1 hours	9.8,	12.3,	13.6,	15.4,	16.5,	17.4,	20.0,	22.8,	24.6,	27.0,	29.0,	30.5,	32.8,	34.5,	35.9,	N/A ,
2 hours	13.7,	17.1,	18.9,	21.3,	22.9,	24.1,	27.8,	31.7,	34.1,	37.5,	40.3,	42.4,	45.6,	48.0,	49.9,	N/A ,
3 hours	16.5,	20.8,	22.9,	25.8,	27.7,	29.2,	33.7,	38.4,	41.4,	45.4,	48.8,	51.4,	55.2,	58.1,	60.4,	N/A ,
4 hours	19.0,	23.8,	26.2,	29.6,	31.8,	33.4,	38.6,	44.0,	47.4,	52.0,	55.9,	58.9,	63.3,	66.6,	69.2,	N/A ,
6 hours	23.0,	28.8,	31.7,	35.8,	38.5,	40.5,	46.7,	53.3,	57.4,	63.0,	67.7,	71.3,	76.6,	80.6,	83.9,	N/A ,
9 hours	27.8,	34.9,	38.4,	43.4,	46.7,	49.1,	56.6,	64.6,	69.6,	76.3,	82.1,	86.4,	92.9,	97.7,	101.7,	N/A ,
12 hours	31.9,	40.0,	44.1,	49.8,	53.5,	56.2,	64.9,	74.0,	79.7,	87.5,	94.1,	99.0,	106.4,	112.0,	116.5,	N/A ,
18 hours	38.6,	48.5,	53.4,	60.3,	64.8,	68.2,	78.6,	89.7,	96.6,	106.0,	114.0,	120.0,	128.9,	135.7,	141.2,	N/A ,
24 hours	44.3,	55.6,	61.2,	69.1,	74.2,	78.1,	90.1,	102.8,	110.7,	121.5,	130.6,	137.5,	147.8,	155.5,	161.8,	182.9,
2 days	60.3,	73.3,	79.6,	88.4,	94.0,	98.2,	111.0,	124.2,	132.4,	143.4,	152.6,	159.4,	169.6,	177.2,	183.3,	203.6,
3 days	74.3,	88.6,	95.4,	104.9,	110.9,	115.3,	128.8,	142.6,	151.1,	162.3,	171.7,	178.7,	188.9,	196.6,	202.7,	222.8,
4 days	87.2,	102.6,	109.9,	119.9,	126.2,	130.9,	145.0,	159.3,	168.0,	179.5,	189.1,	196.2,	206.5,	214.2,	220.3,	240.5,
6 days	111.2,	128.4,	136.4,	147.4,	154.2,	159.2,	174.2,	189.4,	198.5,	210.4,	220.3,	227.6,	238.2,	246.0,	252.2,	272.5,
8 days	133.8,	152.4,	161.0,	172.7,	179.9,	185.2,	201.0,	216.7,	226.2,	238.5,	248.6,	256.1,	266.8,	274.8,	281.1,	301.5,
10 days	155.5,	175.2,	184.3,	196.6,	204.2,	209.7,	226.1,	242.4,	252.1,	264.7,	275.0,	282.5,	293.5,	301.5,	307.8,	328.4,
12 days	176.6,	197.4,	206.9,	219.6,	227.4,	233.2,	250.1,	266.7,	276.7,	289.5,	300.0,	307.6,	318.6,	326.7,	333.1,	353.7,
16 days	217.7,	240.1,	250.2,	263.7,	272.0,	278.0,	295.6,	312.9,	323.1,	336.2,	346.9,	354.7,	365.8,	374.0,	380.4,	401.0,
20 days	257.9,	281.4,	292.0,	306.1,	314.6,	320.8,	339.0,	356.6,	367.0,	380.3,	391.1,	398.9,	410.1,	418.2,	424.6,	445.1,
25 days	307.4,	332.0,	343.0,	357.5,	366.2,	372.6,	391.1,	408.9,	419.4,	432.8,	443.6,	451.3,	462.5,	470.6,	476.9,	497.1,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Graphic 9.2: Return period Rainfall Depths for Sliding Durations – Barnesmore Bog (Irish Grid: 203932, 382669) (MET, ND [Accessed: 16/12/19)

Monthly rainfall for 2018 is included in rainfall trends in **Chart 9.1**. In 2018, Ireland experienced a significant drought, with absolute drought conditions recorded at twenty-one stations at various times between the 22 May and 14 July (MET, 2018). As per **Chart 9.1** the Site generally experienced drier than average conditions between March and July 2018, with wetter than average conditions in the following months, August and September 2018. This can be viewed as a natural "stress test" for slope stability given that such conditions are indicative triggering mechanisms for peat failure and landslides (Lindsay, R, et al, 2005) (Creighton, R, 2006) (**Chapter 8: Soils and Geology**).

Rainfall data recorded on the Site (Barnesmore Bog Rain Gauge) indicates rainfall volumes above average (Ardnawarak) during July and August 2019, however rainfall data (Finner) indicates below average (Ardnawarak) total monthly rainfall for the region in the months preceding Site surveys carried out in April, June and July 2018, with exceptionally dry conditions experienced by the region in April 2018.

9.3.5 Regional and Local Hydrology

The Site is associated with two catchments; Donegal Bay North catchment (EPA ID = 37, Area = 805.36 km^2) and Foyle catchment (EPA ID = 01, Area = 1105.66 km^2). A detailed flow chart describing sub-catchments, river sub-basins, and the surface water features contained in each catchment is presented in **Technical Appendix 9.4** (EPA, ND; EPA, ND; WFDI, ND; NIEA, ND). The chart also indicates which turbines are associated with each surface water system, note: a small number of proposed turbine locations are on or close to surface water catchment boundaries, and are therefore accounted for more than once.

The surface water features associated with the Site are mapped and presented in **Technical Appendix 9.3.**

The majority of surface water runoff associated with the Site drains into Lough Golagh and directly connected streams which are central to the Site. Lough Golagh discharges into the Leaghany River, part of the Derg River sub basin, within Leghany River sub catchment, and Foyle River catchment. Surface water runoff associated with a small number of proposed turbine locations drain into Loughnaweelagh and Lough Innaghachola, which in turn discharge into Glendergen River, part of the Glendergan River sub basin, within Leghany River sub catchment, and Foyle River catchment. The surface water runoff associated with the remaining proposed turbine locations drains into Lough Namaddy and Lough Slug, which both discharge into the Lowerymore River sub basin/s, part of the Eske sub catchment, within Donegal Bay North catchment.

The surface water systems associated with Lowerymore sub basin/s and Eske sub catchment flow into Lough Eske, before discharging into the Eske River.

Groundwater recharge is the term used to describe the amount of rainfall that percolates diffusely through particular soils and subsoils. In areas underlain by poorly productive aquifers, where the potential for acceptance of all available effective recharge is limited, a maximum recharge capacity is assumed of 200 mm/year for locally important aquifers that are productive only in local zones (Ll) and 100 mm/year for Poor fissured bedrock aquifers (Pl and Pu). (GSI, ND)

The average recharge rate (recharge coefficient) for the local area, as mapped by GSI, ranges from 61 to 100 mm year, (GSI, ND), or approximately 4% to 7% of effective average rainfall (ER_{AVG}) and 2% to 3% of effective maximum rainfall (ER_{MAX}) based on the figures in **Table 9.9: Rainfall Data, Evapotranspiration and Effective Rainfall** however, consultation with the GSI map viewer also indicates that the recharge rate is capped at 100mm (2% of worst case ER_{MAX}). Low recharge rates and base flow, and high surface water runoff is indicative of areas comprising of peat soils, such as the blanket peat which covers the majority of the Site and surrounding area (**Chapter 8: Soils and Geology**). The dominant flow processes in rain-fed peatlands, such as blanket peat, are over or close to the surface. As such, the condition of the peat at the surface influences the rate of run off, whereby bare or eroded peat areas will have the most rapid runoff, and peat which is in good condition and with grasses and/or sphagnum moss etc. the acrotelm, will have lower rates of runoff, the lowest rates associated with sphagnum moss. Peat is described as “sponge” like and retains high volumes of water, and therefore the groundwater table in peat is generally high.

The hydraulic conductivity of peat is what determines the rate or velocity of water flow through peat, and this is influenced by physical properties of the peat including; vegetation composition, compaction, decomposition, and the presence of macropores. The layer of peat at the surface, the acrotelm, is the least decomposed, and therefore will have the highest hydraulic conductivity rates. The deeper peat, the catotelm, is generally more highly decomposed with less coarse fibres, is more compact, and therefore has lower hydraulic conductivity rates. The groundwater table in peat is shallow generally, that is the catotelm is generally saturated, this also influences and impedes groundwater recharge rates, and increases rates of surface water runoff. (Labadz, J., et al, 2010).

Therefore, considering the quality and condition of the peat on and around the Site (**Chapter 8: Soil and Geology** – peat profile includes high Von Post values (highlight decomposed), shallow acrotelm), and the mapped recharge rates, and the mapped aquifer classification (discussed in the following sections) the Site is characterised as an area of very low recharge rates and very high surface water runoff rates.

Data on surface water flow at representative baseline sampling locations is presented in **Technical Appendix 9.6**. Observations of surface water runoff contained within natural and artificial drainage channels during Site surveys included; such drainage channels were generally dry during Site surveys particularly during initial Site surveys carried out in April 2019, which may be expected during drier summer months. Said channels were observed to have flow only during and for a short time after significant rainfall events, i.e., the Site can be described as “flashy” where by the Site reacts acutely to rainfall events, surface water runoff infiltrates surface water systems rapidly, and such run off events are short lived, relative to the magnitude of the rainfall event. Similarly, receiving surface water systems were observed to be flashy, for example; during Site surveys on 20th and 19th June 2019 intermittent heavy rainfall events were experienced, and intermittent visual inspections of Lough Golagh discharge (baseline sampling location: SW1) indicated an increase in water level of approximately five cm which then decreased to original levels by the end of the same day (within approximately six hours between visual inspections).

No Site surveys have been carried out during wetter winter months to date however, site hydrology in terms of surface water runoff discharge rates will correlate directly with rainfall rates, and in this respect surface water runoff is assessed in terms of worst case max rainfall data (**Section 9.3.4**). In terms of water quality, surveys were conducted during worst case conditions (lower water volumes leading to higher concentrations in potential contaminates of constituents of surface waters. For information on surface water quality refer to **Section 9.3.9**

9.3.6 Windfarm Site Drainage

Aside from the considerable natural surface water network associated with, and within the boundaries of the Site as described in the previous section, the Site contains numerous drainage features, both natural and artificial. Such drainage features are mapped and presented in **Technical Appendix 9.5.**

At several locations on the Site there are natural drainage channels present. These channels facilitate the natural flow of surface water runoff into the streams, rivers and lakes in the vicinity. In some instances, these natural channels are in areas where erosion is evident and peat is degraded (**Chapter 8: Soils and Geology**), that is, erosion and degradation of peat is a function of surface water drainage. Furthermore, some natural drainage features have been artificially enhanced or modified as a function of surface water management associated with the Operational Barnesmore Windfarm.

Plate 9.1: Example of Natural Drainage Channels

Artificial drainage features present on the Site include: newly cut channels in peat (associated with both generally undisturbed areas and turbary areas), enhanced (deepened / widened) artificial drainage channels, modified natural drainage features (whereby natural drainage channels have been re-routed), Site track culverts, and drainage channels along the edges of Site tracks associated with the Operational Barnesmore Windfarm. There is also a drainage discharge point associated with each existing turbine foundation on the Operational Barnesmore Windfarm, which invariably feeds into natural drainage channels. There was no direct connection to surface water features (stream, river or lake) by artificial drainage channels observed on the Site, during Site surveys. There are two surface water crossings present as part of the Operational Barnesmore Windfarm infrastructure (baseline sampling locations SW1 and SW5, **Technical Appendix 9.5**).

Plate 9.2:Example of Track Culvert Discharging to Enhanced / Cut Drainage Channel

Plate 9.3: Example of Track Culverts and Drainage Channel Adjacent to Existing Track

Plate 9.4: Example Drainage Discharge Point and Channel Associated with Existing Turbine Foundation

9.3.7 Assessment of Changes in Site Run-off Volumes

The Development has the potential to temporarily result in increased volumes of runoff during the construction and operational phases of the Development relative to baseline conditions (the Operational Barnesmore Windfarm). This is a function of the progressive excavation and removal of vegetation cover and replacement with hardstanding surfaces (effectively or assumed impermeable) along the Development footprint and thus removing the hydraulic absorption / buffer control from this part of the Site.

Table 9.10 summarises a preliminary water balance analysis for the Site. The Meteorological Service records for the period 1989 to 2018 show that the maximum effective monthly rainfall recorded at Ardnawarak is in the month of December (ER_{MAX} = 414.6 mm). As this data represents the worst-case scenario, it has been used to estimate runoff volumes from the Site for both (a) baseline (in-situ vegetation) conditions and (b) construction and operational phase (changed ground conditions on footprint).

Worst case scenario baseline calculations indicate that the Site will receive approximately 1.75M m^3/month of effective rainfall (**Table 9.10**). Factoring in the area of existing infrastructure which is assumed to be impermeable, and the majority of undeveloped natural area which is assumed to have a yearly recharge rate of 7% (capped at 100mm per year, which equates to 2% of ER_{MAX}), the worst case scenario baseline Total Site Runoff is estimated to be 1.72M m^3/month.

Considering the existing infrastructure associated with the Operational Barnesmore Windfarm will be utilised (c. 7.26 ha within the Site), preliminary water balance calculations allows for the addition of the area of hardstand required (land take) for the construction of the Development, which equates to approximately 7.1 ha or 71,000 m^2 (Total area of proposed infrastructure = 14.36 ha). The resulting worst case scenario net increase of surface water runoff associated with the Development is calculated to be 591.67 m^3/month, or a net increase of 0.034% relative to the entire area of the Site. This is considered **Imperceptible**.

With reference to **Section 9.3.4**, accounting for a 100 year return rainfall depth over a 24 hour period, net increase in runoff will likely equate to an order of magnitude increase (0.34%), that is; comparing c. 14 mm/day (Based on ER_{MAX}) and 137.5 mm/day (Based on 24 hour 100 year return). However, accounting for a 100 year return rainfall depth over a 25 day period the net increase, net increase in runoff will be similar to results presented in Table 9.10. that is; comparing c. 415 mm/month (Based on ER_{MAX}) and 451.3 mm/25 days (Based on 25 day 100 year return). In all instances, net increase in surface water runoff as a product of the Development is considered to be **Imperceptible**.

Table 9.10: Preliminary Water Balance Analysis

Preliminary Water Balance Analysis				
Baseline / Development	**Description**	**Data Used**	**Site Assessment** Values Based on worst case 30 yearr MAX (Worst Case, and realtive to the scale of the Site)	**Unit**
Baseline	Maximum Month Rainfall (R-MAX)	Maximum (1989-2018) - December	423.1	mm/month
Baseline	Minimum Month Evapotranspiration (PE)	Minimum (2016-2019) - December	8.5	mm/month
Baseline	Effective Maximum Month Rainfall (ER-MAX)	December Max (R) - December Min (PE) = ER-MAX	414.6	mm/month
Baseline	Total Area of propsoed Site (AT)	Red line boundary	4,233,504.3	m2
Baseline	Area of existing infrastructure (AE)	Operational Barnesmore Windfarm	72,600.0	m2
Baseline	Undeveloped Area (AU)	AU = AT - AE	4,160,904.3	m2
Baseline	Total Effective Maximum Rainfall (Total ER-MAX) received over site area	(ER-MAX / 1000) * AT (= AE + AU)	1,755,210.9	m3/month
Baseline	Total Effective Maximum Rainfall (Total ER-MAX) received over OBWF area	(ER-MAX / 1000) * AE	30,100.0	m3/month
Baseline	Total Effective Maximum Rainfall (Total ER-MAX) received over site area	(ER-MAX / 1000) * AU	1,725,110.9	m3/month
Baseline	Maximum (Capped) Recharge Coefficient (%/year of effectve rainfall) (μ)	Groundwater Map Viewer i.e. ((100mm/12months)/ER-MAX*100)	2%	%/year
Baseline	Undeveloped Area Site Runoff (Worst Case i.e. Max Effective Rainfall)	Total ER-MAX - (Total ER-MAX * EMRc%)	1,690,436.70	m3/month
Baseline	Existing Infrastructure Site Runoff (Worst Case i.e. Max Effective Rainfall)	Assume impermeable i.e. 0% recharge	30,099.96	m3/month
Baseline	Total Site Runoff (Worst Case i.e. Max Effective Rainfall) (BSR)		1,720,536.66	m3/month
Development	Proposed Developmentg Infrastructure Area (TDA)		143,600.0	m2
Development	Proposed Area Increase of Impermeable Surfaces – estimated. (DA)	(TDA - AE)	71,000.0	m2
Development	Proposed Area of Impermeable Surfaces – % of Total Area of Subject Site (DA%)	DA / A	1.677%	%
Development	Undeveloped Area (AU)	AU = AT - TDA	4,089,904.3	m2
Development	Total Effective Maximum Rainfall (Total ER-MAX) received over site area	(ER-MAX / 1000) * AT (= AE + AU)	1,755,210.9	m3/month
Development	Total Effective Maximum Rainfall (Total ER-MAX) received over Development area	(ER-MAX / 1000) * AE	59,536.6	m3/month
Development	Total Effective Maximum Rainfall (Total ER-MAX) received over site area	(ER-MAX / 1000) * AU	1,695,674.3	m3/month
Development	Maximum (Capped) Recharge Coefficient (%/year of effectve rainfall) (μ)	Apply 100mm/year cap Ref. GSI Groundwater Map Viewer i.e. ((100mm/12months)/ER-MAX*100)	2%	%/year
Development	Undeveloped Area Site Runoff (Worst Case i.e. Max Effective Rainfall)	Total ER-MAX - (Total ER-MAX * EMRc%)	1,661,591.77	m3/month
Development	Infrastructure Site Runoff (Worst Case i.e. Max Effective Rainfall)	Assume impermeable i.e. 0% recharge	59,536.56	m3/month
Development	Total Site Runoff (Worst Case i.e. Max Effective Rainfall) (BSR)		1,721,128.33	m3/month
Comparison	Baseline Runoff from Proposed Area of Impermeable Surfaces under highest rainfall & lowest PE conditions (DA-BSR)	BSR * DA%	28,855.08	m3/month
Comparison	Worst Case Net Increase in Runoff in one month from Site as a function of Development (NSRInc)	(DA-SR) - (DA-BSR)	591.67	m3/month
Comparison	Worst Case Net Increase in Runoff in one month from Site as a function of Development, relaive to the scale of the Site	NSRInc / BSR	0.034%	%

9.3.8 Flood Risk Identification

There are no areas mapped as being low, medium or high probability flood areas within or directly down-gradient of the Site (OPW, ND).

The closest areas down-gradient of the Site which are mapped as having low, medium or high probability flood areas are within Donegal Town, approximately 10 km south west of the Site. The next closest mapped area with a mapped probability flood area is Strabane, approximately 32 km north east of the Site (OPW, ND).

Other than the mapped probable flood areas described above, there is one location mapped as experiencing flood events in the past. This area is located approximately 2.5 km west of the Development. Flood event information as provided by the OPW include: Flood Event: Lowerymore Barnesmore Gap Recurring, Flood Source: River, "Flood plain along Lowerymore River near "Biddy's" – frequent, but less so since new bridge built" (OPW, ND; DCC, 2006).

The portion of the Development associated with the area which has experienced past flooding events is limited to a low number of proposed turbines, and limited to a small portion of the surface water systems associated with the Development, that is; Lowerymore 020 river sub basin (**Technical Appendix 9.4**).

The net increase in surface water runoff relative to the scale of the Site (conservative) as a product of the Development is 0.05%, this is considered as imperceptible, and therefore any potential risk of increased flood risk arising as a product of the Development is considered imperceptible.

The above is considered Stage 1 of Flood Risk Assessment, and considering the imperceptible increase of surface water runoff, and minimal recorded or mapped flood risk areas associated with or directly down-gradient of the Site, this assessment will conclude at Stage 1, this is accordance with relevant guidance relating to Flood Risk Management (OPW, 2009).

9.3.9 Surface Water Hydrochemistry

Surface water features associated with the Site were surveyed and baseline samples were obtained from several representative locations. The baseline sampling locations are mapped and presented in **Technical Appendix 9.5**. Field hydrochemistry data and flow rates were also assessed and recorded during Site surveys. Field and lab hydrochemistry results and flow rates are presented in **Technical Appendix 9.6**. Baseline sampling laboratory certificates are presented in **Technical Appendix 9.8**.

Surface water directly associated with the Operational Barnesmore Windfarm is of good quality (assessed against limits set out in legislation relating to bathing and drinking water). This is likely a function of the location and nature of the Site, that is, an upland blanket bog area, and the area containing the source/s or head waters of the surface water systems associated with the Site, with little potential for surface waters to be adversely impacted by agricultural activities etc i.e. the water quality is expected to be good.

It should also be noted that the surveys conducted to date have been completed during summer months, a time when water levels and discharge rates are low and baseline hydrochemistry results are indicative of worst-case baseline conditions, that is; low water volumes leading to increased concentrations in potential contaminants and water constituents.

9.3.10 Hydrogeology

The bedrock aquifer underlying the Site and the general area of the Site is mapped as being Poor Aquifer (PI) – Bedrock which is generally unproductive except for local zones (GSI, ND).

There are no bedrock faults or similar geological features underlying the Site (GSI, ND).

There are no mapped karst features within six km of the Site (GSI, ND).

Groundwater flow directions are presumed to follow the topography of the area, however groundwater flow is not considered a significant concern in relation to potential adverse impacts associated with the Development in comparison to surface water runoff and interception to surface water systems, as discussed in previous sections.

9.3.11 Wells

There are no mapped wells, springs or boreholes within six km of the Site (GSI, ND). The likelihood of significant numbers of unmapped wells being present in closer proximity to the Site is low given the unproductive nature of the bedrock aquifer in the vicinity of the Site. Risk to any such well or borehole is low given the same reason and considering the high rate of surface water runoff to surface water systems associated with the Site, as opposed to recharge to groundwater systems.

9.3.12 Groundwater Vulnerability

Vulnerability depends on the quantity of contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels. These factors are controlled by the types of subsoil that overlie the groundwater, the way in which the contaminants recharge the geological deposits (point or diffuse source) and the unsaturated thickness of geological deposits from the point of contaminant discharge.

Where low permeability subsoil overlies the bedrock, it is the thickness of subsoil between the release point of contaminants and bedrock that is considered when assessing vulnerability of bedrock aquifers, regardless of whether the low permeability materials are saturated or not. The GSI vulnerability mapping guidelines allow for the assignment of vulnerability ratings from “extreme” to “low”, depending upon the subsoil type and thickness. With regard to sites where low permeability subsoil is present, the following thicknesses of unsaturated zone are specified (GSI, ND).

Table 9.11: Vulnerability rating in relation to thickness of unsaturated zone

Vulnerability Rating	Thickness of unsaturated zone (m)
Rock at or Near Surface (X)	0
Extreme (E)	0 to 3
High (H)	3 to 5
Moderate (M)	5 to 10
Low (L)	>10

The majority of the Site is mapped as having Moderate (M) aquifer vulnerability. Some areas, particularly to the west, are mapped as having High (H) and Extreme (E) aquifer vulnerability, and some areas, particularly areas at higher / highest elevations are mapped as having Rock at or Near Surface (X) (GSI, ND). However, it is important to consider the aquifer classification in the assessment of aquifer vulnerability, that is; the aquifer vulnerability underlying the Site ranges from Pl/M to Pl/X.

Considering observations onsite in relation to subsoil type (peat) and thickness etc (**Chapter 8: Soils and Geology**) the actual vulnerability of the areas surveyed as part of the Development, the aquifer vulnerability is likely to be Pl/H to Pl/X, in areas potentially directly impacted by the Development, and areas where aquifer vulnerability is likely to be Pl/M (peat >5 m deep) will likely be unimpacted generally, however the principal mode of water infiltration, surface water runoff, must also be considered.

In conclusion, the Site is underlain by areas mapped as Pl/M to Pl/X, whereby the receiving aquifer is poor and only productive in local zones, and the majority of water introduced (rainfall) and the mode of transport for any potential contaminates which may arise will largely infiltrate surface water systems, rather than bedrock aquifer or groundwater.

9.3.13 Groundwater Levels

Peat saturation and groundwater levels were assessed and monitored at each proposed turbine location. Phreatic piezometers were installed at most proposed turbine locations (for example, excluding proposed met mast location, however this location is on a peak with generally shallow peat and rocky outcrops). Piezometer installations are mapped and presented in **Technical Appendix 9.5**. Piezometer water level dipping data including groundwater level metre depth below ground level (mbGL) is presented in **Technical Appendix 9.7**. Piezometer installation details are included in gouge core graphical logs and presented in **Chapter 8: Soil and Geology – Technical Appendix 8.4**. The following table show results of the most recent dipping round carried out on 25 July 2019, that is; the first dipping round whereby all piezometers were given sufficient time to stabilise.

Table 9.12: Results of Piezometer Dipping Round (Carried Out 25/07/19)

Piezo. No.	Groundwater Level (25/07/19) (mbGL)	Association & Comment
SP101	0.11	T1 – WL indicative of active blanket bog.
SP102	0.12	T2 – WL indicative of active blanket bog.
SP103	0.15	T4 – c. 20 m from existing track. WL indicative of active blanket bog.
SP104	0.14	T4 – c. 30 m from existing track. WL indicative of active blanket bog.
SP105	0.15	T4 – c. 55 m from existing track. WL indicative of active blanket bog.
SP106	0.12	T11 – WL indicative of active blanket bog.
SP107	0.14	T5 – WL indicative of active blanket bog.
SP108	0.10	T5B – WL indicative of active blanket bog.
SP109	0.11	T6 - High elevation near peak/ridge
SP110	0.15	T7 – WL indicative of active blanket bog.
SP111	0.08	T8 – WL indicative of active blanket bog.
SP112	0.35	T3 - High elevation near peak/ridge
SP113	0.77	T9 - High elevation near peak/ridge
SP114	0.24	T9 - High elevation near peak/ridge
SP115	0.15	T9A - High elevation near peak/ridge
SP116	0.57	T10A - High elevation near peak/ridge, areas is also eroded / degraded.
SP117	0.15	T12 – WL indicative of active blanket bog.
SP118	0.32	T10B - Area influenced by peat cutting
SP119	0.19	T13 - Area influenced by peat cutting
SP120	0.20	T13B - Area influenced by peat cutting

Groundwater levels at proposed turbine locations across the Site are generally less than 0.2 mbGL, which is in line with expectations and indicative of blanket peat, particularly active blanket bog. Locations with lower groundwater levels are typically at higher elevations near or on peaks and ridges. There also appears to be a correlation between slightly lower than expected groundwater levels, and areas impacted by ongoing peat cutting activities with associated artificial drainage and exposed excavations or cuttings.

At the location of proposed turbine T4, three piezometers were installed; approximately 20 m (SP103), 30 m (SP104), and 50 m (SP105) perpendicular distance from the existing track way associated with the Operational Barnesmore Windfarm. There is effectively no difference in water levels at these three piezometers (25/07/19) and therefore it is inferred that the existing track way has no significant impact on groundwater levels on the Site. Variations of groundwater levels are more likely impacted, and at far greater magnitudes, by elevation, peat condition and ongoing peat cutting activities, rather than potential highly localised impacts arising from the existing infrastructure associated with the Operational Barnesmore Windfarm.

9.3.14 Groundwater Hydrochemistry

Due to the absence of any recorded groundwater quality data within or proximal to the study area, no published data on groundwater quality is available (GSI, ND) however, drilling of boreholes is envisaged as part of Development Specific Site Investigation, and for the establishment of a groundwater source within in the Substation Compound. Groundwater samples obtained from the proposed potable water supply well will be sent for analysis at an accredited laboratory (**Section 9.4.4.8**). Groundwater hydrochemistry is not considered significant at a regional scale dur to the classification of the underlying aquifer (PI).

9.3.15 Water Framework Directive Water Body Status & Objectives

The Water Framework Directive (WFD) surface water body status (2010-2015) and objective assigned for each surface water body associated with the Development is presented in **Technical Appendix 9.4**.

The WFD status of surface water bodies associated with the Donegal Bay North catchment ranges from High to Moderate. Surface water bodies assigned Moderate status are limited to portions of the Lowerymore River, Lough Eske, and portions of the Eske River. Surface water bodies with good or high status have an overall objective to protect i.e. no deterioration. Only surface water bodies assigned Moderate Status are “at risk” of not meeting objectives i.e. restore by 2021 or else at risk of deteriorating or not achieving at least good status by 2021 (WFD, ND).

The status of surface water bodies associated with the Foyle catchment ranges from Good to Moderate, and in contrast to the Donegal bay North catchment most surface water bodies in the Foyle catchment are of Moderate status, with bodies assigned Good status limited to portions of Derg River and Lough Foyle. Similarly, surface water bodies with good have an overall objective to protect i.e. no deterioration, and surface water bodies assigned Moderate Status are “at risk” of not meeting objectives i.e. restore by 2021 or else at risk of deteriorating or not achieving at least good status by 2021 (NIEA, ND).

9.3.16 Groundwater Body Status

The WFD status of groundwater bodies associated with the Development and in the region in general are classified as Good. The WFD groundwater bodies underlying the Site are named Castlederg (eastern region relative to the Site) and Donegal South (western region relative to the Site), and each are not at risk and have an overall objective to protect i.e. prevent deterioration.

9.3.17 Designated Sites & Habitats

Designated Sites, that is, sensitive protected areas associated with the surface waters systems (hydrologically connected) associated with the Development are listed and presented in **Technical Appendix 9.3** (EPA, ND; NIEA, ND).

Designated sites which are not hydrologically connected to the Site are not considered in this assessment.

The Site itself is situated within Barnesmore Bog National Heritage Area (NHA, site code 002375).

Special Areas of Conservation (SAC), Special Protection Areas (SPA) and other designations associated with the Donegal Bay South catchment include; Lough Eske and Ardnamona Wood SAC (Natural Heritage Area (000163)), Donegal Bay (Murvagh) SAC, Donegal Bay SPA (Natural Heritage Area (000133)).

SACs, SPAs and other designations associated with the Foyle catchment include; River Finn SAC, River Foyle & Tributaries SAC (Proposed NHA (002067) Mongavlin to Carrigans), and Lough Foyle SPA.

In relation to the nearest designated area in the western catchment, Donegal Bay North Catchment, the Site surface water will flow into the Lowerymore and the associated Lough Eske and Ardnamona Wood SAC approximately 1.5 km west of the Site boundary.

In relation to the nearest designated area in the eastern catchment, Foyle Catchment, the Site surface water will flow into the Leaghany River and associated River Finn SAC approximately 8 km south east of the Site boundary.

In both SACs listed above, the Site synopsis lists the habitat ‘Oligotrophic Waters containing very few minerals’, that is; waters with very low levels of nutrients or contaminants / pollutants and which are considered very pure or very clean. Results of baseline surface water sampling coincide with this, that is; baseline sampling results indicate very low levels of metals, organics, or physiochemical properties such as BOD (Biological Oxygen Demand). Oligotrophic Waters are sustained in these areas due to the high quality of surface water upstream and feeding into these areas, for example; the surface water draining the Site which is indicative of Oligotrophic Waters (Section 9.3.9: Surface Water Hydrochemistry).

The Donegal Bay North catchment surface water systems associated with the Development contain Fresh Water Pearl Mussel, a species listed under Annex II and Annex V of the Habitats Directive, and protected as part of the protection of SACs. Donegal Bay is designated as a Shellfish Area and protected under the European Communities (Quality of Shellfish Waters) Regulations 2009 (EPA, ND). Refer to the **Chapter 6: Biodiversity** for further information on ecological sensitivities.

9.3.18 Water Resources

Groundwater throughout the island of Ireland is designated and protected for drinking water purposes as per the European Drinking Water Regulations 2007 (SI no. 278/2007). However, it should be noted that considering the poor productivity of the underlying aquifer in the region of the Site, the potential for abstraction of groundwater for the purposes of drinking water is considered low.

Surface water features protected under the Drinking Water Regulations associated with the Development include Lough Eske (Donegal Bay North catchment) and Lough Braden and the Derg / Strule (Foyle catchment) (**Technical Appendix 9.2**).

9.3.19 Receptor Sensitivity

All receptors associated with the Development, i.e. streams, rivers, lakes and groundwater, are considered highly sensitive receptors considering; high or good WFD status and objective to protect same, moderate WFD status and objective to restore same to at least good status by 2021, the numerous down-gradient designations (sensitive protected areas) associated with each of the two associated catchments and the sensitive habitats and species associated with same, and the designation of some down-gradient surface water bodies and all groundwater bodies as sources of drinking water. Ultimately, all surface water and groundwater associated with the Site is considered sensitive and must be protected as per numerous legislative instruments relating to same. However, risk to receptors must consider both the hazard, and likelihood of adversely impacting on any given sensitive receptor, and therefore parameters such as; distance from potential source of hazard to receptor, pathway directness and/or connectivity, and assimilative capacity of the receiving water body should also be considered.

In terms of groundwater sensitivity and susceptibility, as discussed in previous sections, although all groundwater associated with the Site is protected as a source of drinking water, the bedrock aquifer underlying the Site and surrounding area is a *poor aquifer except for local zones* (PI), which can be expressed as an aquifer with poor production and low connectivity and therefore the risk of potential adverse impacts will be limited to localised zones. Furthermore, the vast majority of any potential contaminants or adverse impacts will likely infiltrate to surface water systems rather than recharge and percolation into groundwater. However, the potential impact of groundwater in terms of peat saturation and drainage must also be considered, i.e. peat lands, in this instance blanket bogs are fundamentally Groundwater Dependent Terrestrial Ecosystems (GWDTEs) (only if active, refer to **Chapter 6: Biodiversity** for the extent of active blanket bog associated with the Development) (Kimberley, S., et al, 2013) and therefore any changes to groundwater in terms of water table and drainage etc can potentially adversely impact on GWDTEs whereby the acrotelm will have lower capacity for growth or cease to grow (the terrestrial ecosystem). The onset of peat erosion and degradation will also be potentially accelerated, and release of carbon to the atmosphere will also potentially increase if groundwater levels and or drainage is impacted in any area underlain by peat (IPCC, ND; NPWS, 2015).

In terms of surface water sensitivity, as stated above, the vast majority of potential contaminants or adverse impacts will infiltrate to surface water bodies, however sensitive receptors are of variable distance to proposed turbine locations, and the pathways are of variable condition for each proposed turbine location and/or any part of the Development. Referring to **Chapter 8: Soils and Geology, Technical Appendix 8.3** Risk Matrices and Ratings, the distance of proposed turbine locations to sensitive receptors are presented again in the following table:

Table 9.13: Distances between proposed turbine locations and associated receptor

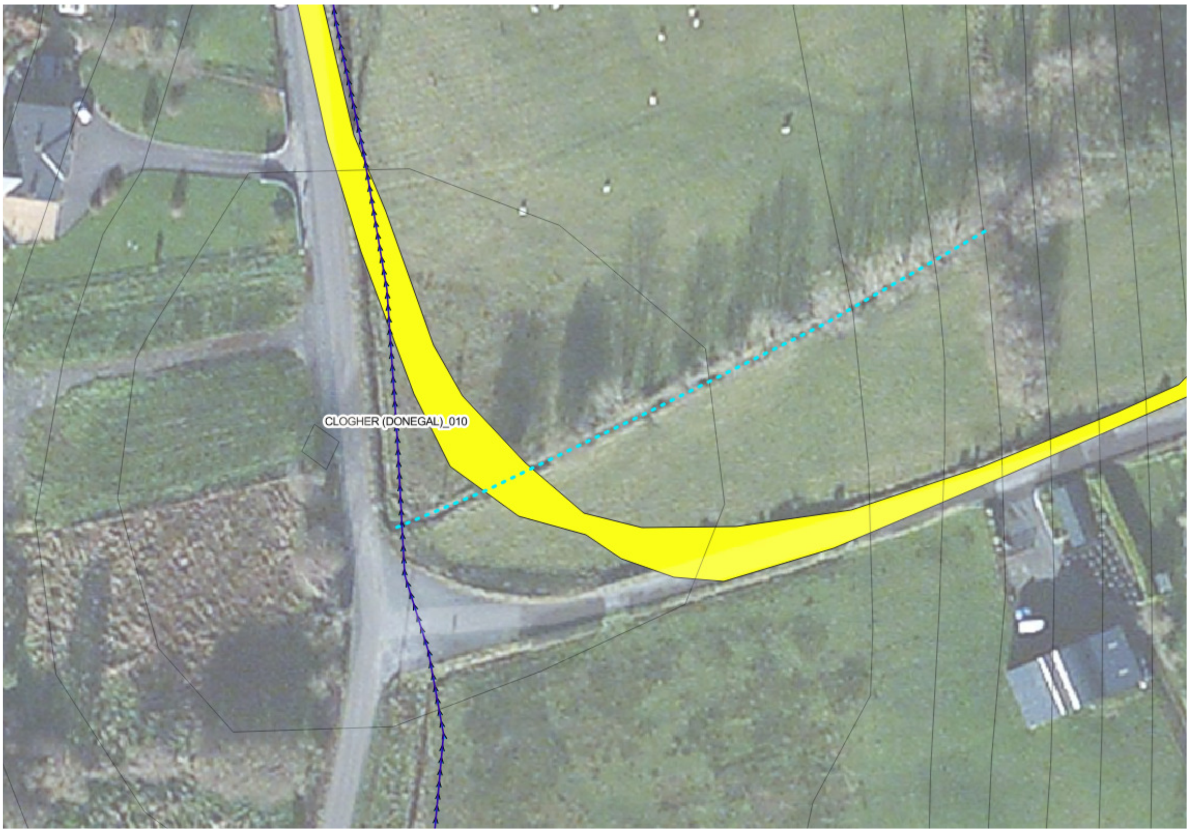
Turbine No.	Associated Sensitive Recptor	Approximate Distance (m)	µ	Comment
T1	Glendergan River	450	1	Low risk with respect to distance
T2	Unnamed lake (Glendergan River)	75	2	Moderate risk with respect to distance
T3	Unnamed lake (Derg River)	30	4	High risk with respect to distance
T4	Derg River	80	2	Moderate risk with respect to distance
T5	Lowerymore River	300	1	Low risk with respect to distance
T6	Lowerymore River	300	1	Low risk with respect to distance
T7	Lough Gologh	250	1	Low risk with respect to distance
T8	Lough Gologh	225	1	Low risk with respect to distance
T9	Lough Gologh	200	1	Low risk with respect to distance
T10	Unnamed lake (Derg River)	340	1	Low risk with respect to distance

Turbine No.	Associated Sensitive Recptor	Approximate Distance (m)	µ	Comment
T11	Derg River	200	1	Low risk with respect to distance
T12	Derg River	130	2	Moderate risk with respect to distance
T13	Trib. Of Derg River	30	4	High risk with respect to distance

9.3.20 Haul Route

The Haul Route and existing Site Access Track associated with the Operational Barnesmore Windfarm will be utilised as part of the Development. The route is in good condition and in use currently, therefore no intrusive geological surveys were carried out in this respect however, the Haul Route and Site Access Track will require some localised upgrading in terms of widening for the increased turbine dimensions primarily. The most significant works in this regard are in regard to one particular junction (Irish Grid: 199226.5, 380418.6) whereby the haul route will require the construction of a minor portion of new roadway, which will include the culverting of a tributary of the Clogher River (Ref. Name: CLOGHER (DONEGAL)_010) and a drainage ditch in the vicinity, as presented in **Map 9.1** below. (approximate). The new section of roadway will be privately owned by ScottishPower Renewables and will not be used by the public.

The Clogher River and its tributaries are located in the Donegal Bay North Catchment and drains most of the area associated with the haul route between the aforementioned junction and the Site (up to the catchment boundary, **Technical Appendix 9.2**), flows in westerly / north westerly direction, merges with the Lowerymore, and flows into Lough Eske. Immediately downgradient (c. 0.5 km north) of the junction the Clogher River tributary flows into a mapped waterbody (Segment Code: 37_64). Consultation with the EPA map viewer indicates that said water body is not considered a lake waterbody. The Clogher River and its tributaries are classified as having a Poor WFD status, however the Lough Eske and Ardnamona Wood SAC includes a portion of the river (not including the area requiring culverting).



Map 9.1: Haul Route and Required Culverting

9.3.21 Other Infrastructure - Borehole/s

With reference to **Chapter 8: Soils and Geology** no boreholes or geotechnical testing has been carried out as part of this assessment however, Development specific Site Investigation will be carried out pre Construction phase which will include drilling of boreholes and geotechnical testing of the underlying bedrock.

One borehole will be drilled within the Substation Compound for the purposes of extracting groundwater for use by site operatives (a well for potable water).

9.4 Potential Effects and Mitigation Measures

9.4.1 Assessing the Magnitude of Potential Effects – Surface Water

The receiving environment in terms of **SURFACE WATER** associated with the Development is considered as being of **Very High Importance** and **Highly Sensitive**, and therefore classification of any potential impacts associated with the Development will be limited to Magnitudes associated with Very High Importance, as presented in the following table.

Table 9.14: Weighted Rating of Significant Environmental Impacts – Surface Water Systems – Limited to Very High

Sensitivity (Importance of Attribute/s)		Magnitude of Impact			
		Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Very High		Imperceptible	Significant / Moderate	Profound / Significant	Profound

In terms of determining and assessing the magnitude of impacts on surface water features, categories of magnitude relate to the potential effect on the status of the attribute, that is; the attribute driving the classification of sensitivity is the current WFD status (if applicable) and condition of the surface water feature/s, the risk of not reaching WFD objectives (if applicable) and the potential for the surface water system to support, or function as part of designated and protected areas (SAC, SPA, NHA etc).

9.4.2 Assessing the Magnitude of Potential Effects – Groundwater

The receiving environment in terms of **GROUNDWATER** associated with the Development is considered as being of **Low to Medium Importance** and **Low to Medium Sensitivity**, and therefore classification of any potential impacts associated with the Development will be limited to Magnitudes associated with Medium Importance (conservative), as presented in the following table.

Table 9.15: Weighted Rating of Significant Environmental Impacts – Groundwater Systems – Limited to Medium

Sensitivity (Importance of Attribute/s)		Magnitude of Impact			
		Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Medium		Imperceptible	Slight	Moderate	Significant

In terms of determining and assessing the magnitude of impacts on groundwater features, categories of magnitude relate to the potential effect on the status of the attribute, i.e. the attribute driving the classification of sensitivity is the current WFD status (if applicable) and condition of the groundwater feature/s, the risk of not reaching WFD objectives (if applicable) and the potential for the groundwater system to support, or function as part of designated and protected areas (SAC, SPA, NHA etc).

9.4.3 Do Nothing Impact

Site investigations of the baseline hydrology and hydrogeological conditions of the Operational Barnesmore Windfarm indicate the following:

- The Site in general has already experienced impacts to baseline conditions due to the installation of the Operational Barnesmore Windfarm, that is; installation of Site tracks and hardstands, excavation of peat/soils and rock, installation of turbine foundations, installation or enhancement of drainage features. The presence of the existing infrastructure has potentially enhanced erosion in some areas and changed groundwater / hydrogeological regimes to a minor extent. There are no indications that the presence of the Operational Windfarm has had adverse impacts with regard to surface or groundwater quality, however there was likely some adverse impacts during the construction phase. This represents a moderate / significant, negative, temporary impact during the construction phase, and an imperceptible to slight, neutral, permanent impact during the operational phase of the Operational Barnesmore Windfarm.
- The southern region of the Site has already experienced impacts to baseline conditions due to turbary activities, that is; peat cutting and harvesting. There are no indications that the peat cutting activities onsite have had any adverse impacts with regard to surface water or groundwater quality at a significant scale, but is likely to impact on surface water quality at a localised scale. This represents a moderate / significant, negative, long term / permanent impact to the area.

Should the Development not proceed, the existing land-use practices of wind power production and peat cutting will continue, therefore the current status of the Site is considered baseline for the purposes of assessments carried out as part of this study.

9.4.4 Construction Phase Potential Effects

9.4.4.1 Assessment of Effects - Increased Hydraulic Loading

The Development has the potential to result in increased rates of runoff during the construction phase of the project relative to baseline conditions. Increased surface water runoff from the construction footprint has the potential to result in increased hydraulic loading to the receiving drainage network, and in turn the surface water network associated with the Development.

Preliminary water balance calculations indicate that the Development will lead to a net increase of surface water runoff of approximately 814 m^3/month (or 0.05% relative to the area of the Site) during the wettest months of the year. This is considered to be a likely, negative, imperceptible or not significant, imperceptible weighted significance, transboundary, permanent impact of the Development.

The increase in hardstand area associated with the Development will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered a likely, negative, imperceptible or not significant, Imperceptible weighted significance, transboundary, permanent impact of the Development, which conforms to baseline conditions.

9.4.4.2 Assessment of Effects - Earthworks

The construction phase of the Development will invariably involve earthworks including; removal of vegetation cover, excavations to facilitate the installation of turbine foundations etc., and temporary stockpiling of subsoils and bedrock.

During the excavation, storage and reuse of materials, it is likely that a high content of suspended solids will be entrained by surface water runoff and intercepted by surface water networks associated with the Development, particularly during sustained rainfall events.

The most vulnerable areas to surface water quality deterioration are:

- Site track crossings of existing streams/drains
- Turbine hardstand and infrastructure development, particularly at moderate to high gradient slopes to existing waterways.

This is considered a direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance, likely transboundary impact of the Development. This impact is considered to be in contrast to baseline conditions (except for peat cutting areas where it conforms to bassline) but is also temporary. Although this impact is likely to be temporary, considering the mobility and transboundary characteristics associated it is not considered reversible. However, with appropriate environmental engineering controls and mitigation measures, this impact will be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this chapter.

Vehicular movements and excavation works associated with the construction phase of the Development have the potential impact on soil and slope stability, as discussed in **Chapter 8: Soils and Geology** of this EIAR. The risk associated with stability issues varies depending on the degree of the issue at hand.

Localised stability issues, and erosion or degradation of peat by e.g. vehicular movements have the potential to increase the potential for entrainment of suspended solids in surface water runoff, impact or obstruct established drainage networks, and increase the amount of excavation works required generally which in turn increases the potential for standard effects associated with earthworks. This is considered an unlikely (assuming mitigation measures described in **Chapter 8: Soils and Geology** are implemented and adhered to), direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance impact on receiving surface waters. This is likely to be a transboundary impact of the Development. This impact is considered to be in contrast baseline conditions (except for peat cutting areas where it conforms to bassline) but also temporary or reversible.

The worst-case scenario associated with earthworks activities is the potential for significant stability issues leading to mass movement or landslides. As discussed in **Chapter 8: Soils and Geology** of this EIAR, the risk of significant stability issues leading to mass movement or landslides is negligible to low. However, in the unlikely event of such occurrences, significant stability issues have the potential to dramatically increase the potential for entrainment of suspended solids in surface water runoff, impact or obstruct established drainage or surface water networks potentially obliterating sensitive aspects of the environment, and increase the amount of excavation works required including for emergency remediation, which in turn increases the potential for standard effects associated with earthworks. This is considered an unlikely, indirect, negative, potentially profound, potentially Profound weighted significance impact. This impact would likely be a transboundary impact of the Development. This impact is considered to be in contrast baseline conditions and also potentially permanent.

Table 9.16 summarises the potential impacts discussed in this section.

Table 9.16: Impact Summary – Earthworks

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency	Reversible
Entrainment of suspended solids during earthworks	Direct	Negative	Moderate to Significant	Significant / Profound	Potentially Transboundary	Contrast to baseline	Likely	Temporary	No but can be minimised
Increased entrainment of contaminants and other impacts arising due to localised stability issues	Direct	Negative	Moderate to Significant	Significant / Profound	Potentially Transboundary	Contrast to baseline	Unlikely*	Temporary	No but can be minimised
Catastrophic impacts arising from significant stability issues (Landslide – worst case)	Indirect	Negative	Potentially Profound	Potentially Profound	Potentially Transboundary	Contrast to baseline	Unlikely**	Permanent	No
Note: * Assuming mitigation measures described in Chapter 8 – Soils and Geology are implemented and adhered to, localised stability issues are unlikely to give risk to impacts on surface water networks associated with the proposed development. ** With reference to Appendix A8.3 Slope Stability Risk Assessment of Chapter 8 – Soils and Geology, the risk of mass movement or landslide is negligible to low.									

9.4.4.2.1 Monitoring

Monitoring of material management during the construction phase of the Development will be key in ensuring that the potential for contaminant entrainment is minimised, and that any potential significant occurrences of entrainment by surface water runoff can be addressed as they arise. With adequate planning and preparation, and implementing relevant mitigation measures the potential for acute escalations in terms of abating entrainment by surface water runoff are likely to be minimal.

Monitoring of surface water quality is discussed in greater detail in the following sections of this chapter.

9.4.4.3 Assessment of Effects – Excavation Dewatering

Dewatering of excavations during the construction phase of the Development is likely to have significant adverse effect on surface water runoff quality, that is; if dewatering of an open excavation is necessary, the receiving engineered drainage and attenuation features will likely be loaded with a surge of water elevated in suspended solids. Overflow of such water into the receiving surface water systems is considered to be a likely, direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance, likely transboundary impact of the Development. This impact is considered to be in contrast to baseline conditions but also temporary. Although this impact is likely to be temporary, considering the mobility and transboundary characteristics associated it is not considered reversible. However, with appropriate environmental engineering controls and mitigation measures, this impact can be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this report.

Dewatering by means of drainage ahead of excavation activities, or dewatering by pumping during excavation activities will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered a likely, negative, slight, Slight weighted significance, localised impact of the Development. During the construction phase the effects on groundwater will be more significant (slight) in contrast to the operational phase of the Development. This is in contrast to baseline conditions, except for peat cutting areas where it conforms to bassline, whereby drainage channels have been introduced to drain peat ahead of peat cutting activities.

9.4.4.4 Diversion and Enhancement of Drainage

The Development will likely result in diversion and enhancement of the existing drainage networks during the construction of the project relative to baseline conditions. The drainage network at and around the Site is mapped and presented in **Technical Appendix 9.5**.

Considering established drainage networks associated with the Operational Barnesmore Windfarm are in place, the diversion, enhancement or indeed introduction of additional drainage features is considered a likely, negative, moderate, localised impact of the Development which conforms to baseline, however there are risks associated with the earthworks required to carry out such work, potential impacts of which are addressed in previous section of this chapter, and in **Chapter 8: Soils and Geology**.

9.4.4.5 Watercourse Crossings

In relation to the Site, one (1 no.) new watercourse crossing / culvert will be constructed as part of facilitating access to the proposed turbine, T13.

In relation to the Haul Route, two (2 no.) new watercourse crossings / culverts will be constructed as part of works associated with upgrading of the 'public highway' to accommodate the delivery of turbine materials.

A total of 3 no. new watercourse crossings (culverts) will be constructed however, some existing watercourse crossings associated with the Operational Barnesmore Windfarm will also require to upgrading works including widening.

Construction of any new watercourse crossing will have inherent risk given the level of disruption (e.g. excavations) and risk (e.g. heavy plant machinery) involved with construction activities, and the proximity, or lack thereof, to the primary sensitive receptor, that is; the watercourse itself. It should be noted that there are 2 no. existing watercourse crossings / culverts, and numerous drainage culverts under existing Site tracks associated with the Operational Barnesmore Windfarm, therefore the introduction of the proposed new watercourse crossing itself is considered to conform with baseline conditions.

Release of suspended solids in surface water due to excavations or other earthworks etc, or the accidental release of any form of anthropogenic contaminant (e.g. fuel) during construction of new watercourse crossings are both potential significant adverse effects. This is considered a likely, negative, significant, potentially transboundary but temporary impact of the Development, which contrasts baseline condition. The impacts relating to the release of contaminants during earthworks is addressed in previous sections of this report. The impacts relating to contaminants are addressed in following sections of the report.

The worst case scenario/s associated with installation of new watercourse crossings is: 1) the potential for poor planning and construction methodology, and 2) the potential for poor design of new watercourse crossings, both of which can potentially result in significant changes in flow, erosion and deposition patterns and rates associated with the surface water feature, which can potentially lead to flow being restricted leading to increased risk of flooding locally. These impacts are considered a likely (if poor planning/design), negative, significant, Profound weighted significance, localised impact of the Development, which contrasts to baseline conditions.

9.4.4.6 Potential Effects on Surface Water and Groundwater Quality

9.4.4.6.1 Assessment of Effects - Release of Suspended Solids

The Development has the potential to result in the release of suspended solids during the construction phase of the project relative to baseline conditions.

Runoff of suspended solids will add turbidity to the surface water which can block fish gills, smother spawning grounds, reduce light penetration for flora growth, and promote bacteria and algae to the water. Nutrients that are associated with the solids (inorganic nutrients such as phosphorus and organic such as hydrocarbons, sewage if present) can lead to eutrophication of the water environment and eventually to fish-kills due to lowering of oxygen supply. Freshwater Pearl Mussels are particularly sensitive to perturbations in water quality, and in particular suspended solids. **Chapter 6: Biodiversity** of this EIAR outlines further information on the Freshwater Pearl Mussels and other ecological sensitivities.

In addition to direct adverse impacts on ecological sensitivities down-gradient of the Site, runoff of suspended solids will potentially impact on the WFD status and objectives associated with the surface water networks associated with the Development. Ultimately, considering the good quality of the surface water draining from the Site (baseline), and the sensitivity and 'Very High' importance of the associated surface water networks, any introduction of contaminants is considered an adverse impact of high significance.

As stated in relation to earthworks, the release of suspended solids is considered a direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance, potentially transboundary impact of the Development. This impact is considered to be in contrast to baseline conditions but also temporary. Although this impact is likely to be temporary, considering the mobility and transboundary characteristics associated it is not considered reversible. However, with appropriate environmental engineering controls and mitigation measures, this impact can be reduced to within water quality regulatory limits.

As discussed in previous sections of this report, release of suspended solids can be brought about via a number of different mechanisms, but are generally related to excavation works during the construction phase.

The release of suspended soils does not have significant potential to adversely impact on groundwater due to the natural process of filtration associated with percolation of water through soils.

9.4.4.6.2 Assessment of Effects – Release of Hydrocarbons and Storage

During the construction phase of the Development, plant equipment and vehicles associated with excavation, material transport, and construction activities introduce the risk of hydrocarbon (fuel and oil) spillages and leaks, particularly in relation to regular refuelling which in turn implies the requirement of a fuelling station which will likely include fuel storage onsite OR will be supplied by fuel tanker scheduled to refuel the plant machinery directly.

Similar to suspended solids arising from excavation activities, hydrocarbons accidentally introduced to the environment will likely be intercepted by drainage and surface water networks associated with the Site. As discussed in **Chapter 8: Soils and Geology** of this EIAR, the cumulative retardation, by both structural and chemical processes, determines the spatial distribution and temporal variation of hydrocarbon mass and concentration within a contaminated site, which results in limited movement through peatland, therefore the risk to subsoils / peat is limited, and in turn risk to groundwater at a significant scale is limited.

Hydrocarbons are a pollutant risk due to their toxicity to all flora and fauna organisms. Hydrocarbons chemically repel water and sparingly dissolve in water. The majority of hydrocarbons are light non-aqueous phase liquids (L-NAPL's) which means that they are less dense than water and therefore float on the water's surface (whether surface water or groundwater). Hydrocarbons adsorb ('stick') onto the majority of natural solid objects they encounter, such as vegetation, animals, and earth materials such as peat. They burn most living organic tissue, such as vegetation, due to their volatile chemistry. They are also a nutrient supply for adapted micro-organisms, which can deplete dissolved oxygen at a rapid rate and thus kill off water based vertebrate and invertebrate life.

In terms of surface water associated with the Site, an accidental hydrocarbon spillage is considered a likely, negative, significant to potentially profound, Profound weighted significance, transboundary, medium to long term impact of the Development, which is contrast to baseline conditions.

In terms of groundwater associated with the Site, an accidental hydrocarbon spillage is considered a likely, negative, significant, Significant weighted significance, localised medium to long term impact of the Development, which is contrast to baseline conditions.

With appropriate environmental engineering controls and measures (i.e. Mitigation measures), these potential risks can be significantly reduced.

9.4.4.6.3 Assessment of Effects – Release of Wastewater Sanitation Contaminants

The Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto soils / peat, and into the drainage network during the construction phase of the project.

There are existing permanent and temporary sanitation facilities in place associated with the Operational Barnesmore Windfarm, which are located in the existing site compound. It is envisaged that the same compound and facilities will be used during the construction of the Development. All existing sanitation facilities are self-contained, for example; toilets (other than portaloos) are supplied water by tank truck, have water storage tanks associated, and waste is stored in another tank the contents of which is removed off site by tank truck.

Wastewater (e.g. increases BOD) and wastewater sanitation chemicals are pollutant risks due to their potential impact on the productivity or status of surface water systems, and toxicity to water-based flora and fauna.

The level of risk posed by such facilities is dependent on the condition and upkeep of facilities that are put in place, and the chemical agents used if applicable, and therefore can range from a potentially significant to insignificant impact in direct correlation to the type of sanitation used (e.g. septic tank versus port-a-loo).

The worst case scenario/s associated with waste water sanitation is the potential for sanitation chemical, particularly related to portaloos, accidentally spilling or leaking and being intercepted by surface water drainage features and in turn surface water networks associated with the Development. This is considered an unlikely, negative, significant, Profound weighted significance, transboundary, medium to long term impact of the Development, which contrasts to baseline.

In relation to the Development, the existing sanitation facilities will be used. Considering that these facilities are in good working order with no indication of any leaks observed, the risk of contamination is low, in addition the volume of chemicals used is minor relative to the scale of the Site, and will only be present in the contractor's compound. None the less, correct precautions and mitigation measures should be implemented.

9.4.4.6.4 Assessment of Effects – Construction or Cementitious Materials

The Development has the potential to result in the accidental spillage or deposition of construction waste into peat soils and in turn impact on surface water runoff, or accidental spillages directly intercepted by drainage or surface water networks associated with the Development.

Depending on the material in question, the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitivities e.g. ecology. For example, the introduction of cementitious material (concrete / cement / lean mix etc.) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete. Fresh or wet concrete is a much more significant hazard when compared to older or set concrete which is considered inert in comparison, however it should also be noted that any construction materials or waste deposited, even if inert, is considered contamination. Surface water runoff coming into contact with concrete will be impacted to a degree, however water percolating through lean mix will be impacted significantly.

Accidental spillage or deposition of construction materials such as wet concrete which is intercepted by drainage or surface water networks associated with the Development is considered a direct, negative, moderate to significant, Significant / Profound weighted significance, transboundary, temporary to medium term impact of the Development.

Although the Operational Barnesmore Windfarm includes concrete features, no raw construction materials or waste are impacting baseline conditions, therefore this impact is considered contrast to baseline.

With appropriate environmental engineering controls and measures, these potential risks can be significantly reduced and considered unlikely.

9.4.4.7 Potential Effects on Hydrologically Connected Designated Sites

Contaminants arising as a product of the Development will likely be intercepted by the drainage and surface water network associated with the Site. The Site is situated within the Barnesmore Bog NHA, and therefore any contaminants arising will automatically impact on a designated site, but contaminants which are intercepted by the surface water network will also be carried by same towards other designated sites downstream of the Site.

As discussed in the **Section 9.3: Baseline Description** of this chapter, and presented in **Technical Appendix A9.2**, both of the two surface water catchments possess designated sites downstream of the Site.

The potential of the Development to introduce contaminants to these surface water catchments and in turn impact on the designated areas downstream is considered a negative, significant to profound, Significant / Profound weighted significance, transboundary, potentially temporary to long-term impact of the Development, which is in contrast to baseline. However, with appropriate environmental engineering controls and measures, these potential risks can be significantly reduced and considered unlikely.

It should be noted that, considering the geographical scale of both catchments, or portions of the catchments or sub-catchments associated with the Site, the assimilative capacity of the surface water systems will buffer against any potential contaminants introduced, that is; contaminants will be 'diluted' in receiving waterbodies. This **does not lessen** potential adverse impacts in the immediate vicinity and **does not reduce** the need for mitigation measures to be implemented, but is considered a 'last line of defence' for the protection of designated areas downstream of the Site.

9.4.4.8 Drilling of Boreholes and Extraction of Groundwater

With reference to **Section 8.3.3** (**Chapter 8: Soil and Geology**), the bedrock underlying the Site is the Lough Mourne Formation, indicative of granite, with no significant faults or similar features underlying the Site. With reference to **Section 9.3: Baseline Description** of this report; the groundwater aquifer underlying the Site is classified as poor except for local zones, this implies that aquifer is poor in terms of yield. Poor aquifers will have moderate to low well yields of less than 100 m^3 per day (GSI, ND).

Drilling of boreholes in general is not considered to have potentially significant impacts on groundwater however, extraction of groundwater is considered to have potentially significant impacts on groundwater and sensitivities associated with same.

The effects associated with pumping water from a well in a poor aquifer situated in blanket bog, a water dependant system, is that the peat pore water pressure in the local area will lower, and water extracted will be replaced by water in the local area above the well screen / pump intake (cone of depression), thus potentially lowering the productivity of the bog impacting on the ecological health. The worst case scenario in terms of excessive pumping is to lower the ground water table in the local area during sustained metrological conditions, killing off vegetation in the acrotelm peat layer leading to the area being susceptible to erosion. A low water table will also lead to the bog emitting carbon as opposed to sequestering carbon under ideal conditions (Swenson M. M. et al, 2019).

A well drilled within the Substation Compound (**Figure 1.2**) is likely to have a poor yield (<100 m^3/day) due to the underlying geology and associated aquifer however, the well is for the purpose of supplying potable water to site operatives during the construction and operational phases of the Development. As discussed in **Section 9.4.4.6.3**, water required for sanitation facilities will be imported by tank truck, similarly waste water will be exported by tank truck. Therefore, the volumes required for the purposes of potable water will be minor – for the purposes of this assessment 75 litres (or 0.075 m^3) per person per day has been allowed for, this is considered a conservative value.

For context; allowing for 20 no. site operatives during the construction phase, and 0.075 m^3 of water used per person per day, water demand will equate to 1.5 m^3 of water per day. Allowing for 4 no. site operatives during the operational phase at 0.075 m^3 of water per person per day, water demand will equate to 0.3 m^3 of water per day.

At the maximum probable yield (100 m^3 / day) the estimated water demand is considered Slight in relation to the Construction phase (1.5% of potential yield) and Imperceptible in relation to the Operational Phase (0.3% of potential yield).

Allowing for a reduced yield of 20 m^3 per day, the estimated water demand is considered Slight/Moderate in relation to the Construction phase (7.5% of potential yield) and Slight in relation to the Operational Phase (1.5% of potential yield). At a yield of 20 m^3 /day the water demand has the potential to have a Moderate impact during sustained dry metrological conditions.

As per the above preliminary calculations, the impact associated with a pumping well varies from Imperceptible to potentially Moderate depending on the demand and groundwater productivity. This is considered a neutral to negative respectively, localised, impact of the Development. With appropriate precautionary steps and mitigation measures, the extraction of groundwater can be managed to limit the associated impact range, that is; Imperceptible to Slight.

In terms of groundwater quality, the risk associated with groundwater used as drinking water is unknown currently.

9.4.4.9 Potential Effects on Local Groundwater Supplies (Wells)

With reference to **Section 9.3: Baseline Description** of this report; the groundwater aquifer underlying the Site is classified as poor except for local zones, in addition there are no mapped wells, springs or boreholes within 6 km of the Site, therefore is no significant potential for the Development to impact on groundwater supplies.

9.4.4.10 Potential Groundwater and Surface Water Effects due to the Grid Connection Cable Works at the Site

Considering the Operational Barnesmore Windfarm is already connected to the grid, there is no additional significant impact arising in terms of Grid Connection cabling, with the exception of the replacement of a portion of overhead power cable with underground cable, which will be run within Development footprint. The portion of overhead cable to be replaced is situated between the western Site boundary and the existing Site compound and is required to facilitate the erection of proposed turbines T10 and T12. Effects are characterised similarly to those related to other excavations; however, it should be noted that the area in question contains areas of deep peat which will need to be considered in the design phase of the decommissioning of overhead cable and the installation of buried cable route, in relation to access in particular. The area and indicative cable route is mapped and presented in **Technical Appendix 9.9.**

9.4.4.11 Potential Groundwater and Surface Water Effects due to the Internal Cable Works at the Site

The excavation of subsoils to facilitate underground power cables will be minimal considering that there is an existing established network of buried power cable connecting the infrastructure associated with the Operational Barnesmore Windfarm. None the less, considering the proposed layout of the Development micro-sited proposed locations of turbines, which are not necessarily in line with existing infrastructure, some excavation of cable trenches is considered likely to facilitate the connection of the Development to the existing power cable network.

The effects associated with the installation of underground cables are similar to that of other excavations, however less significant than that of excavations for foundations and hardstands. None the less, the effects are characterised similarly and will require similar mitigation measures.

It should be noted that the Operational Windfarm contains two existing significant lengths of buried cable which traverse the Site (**Technical Appendix 9.9**). It is envisaged that these cable lengths will be left as is, that is; in situ, and will not require any alterations outside of the main footprint of the Development.

9.4.5 Reinstatement of Redundant Access Track and Hardstand Areas

Portions of access tracks and hardstand areas associated with the Operational Barnesmore Windfarm which will become redundant following the construction of the proposed Development will be reinstated (**Figure 1.2**). This implies;

- Removal of some / top layer of existing hardstand / access track. The underlying Soil / Peat will not be exposed.
- Depositing of acrotelm / vegetated peat over the areas in question. Catotelm peat will not be used as such would be prone to being eroded rapidly.

Reinstatement will not include the total excavation of all hardstand and access track materials, or turbine foundations, that is; the areas of the Operational Barnesmore Windfarm which are made redundant following the construction of proposed Development will not be fully restored to original (pre existing) baseline conditions. Further details in **Section 9.5.4.**

No new impacts are anticipated to arise during the reinstatement phase of the project on the geological, geomorphological and geotechnical environment, however the potential for solids being entrained by surface water runoff is relatively elevated.

Any impacts to the hydrological and hydrogeological environment during reinstatement are likely to be minimal and infrequent, however the mitigation measures and precautions described in this report will be implemented as applicable.

Reinstatement of redundant infrastructure areas following the Development construction phase is considered a positive, or beneficial impact of the development (**Section 9.2.5.2 - Table 9.4**). Although reinstatement will not revert areas in question to pre existing baseline conditions, it will serve as the foundation and promote the establishment of new blanket bog (landscape character) and associated ecology and biodiversity. For further information refer to **Chapter 6: Biodiversity** of this EIAR.

Full restoration, which implies the complete removal of hardstand, access track and turbine foundations, will not be carried out as part of the Construction phase of the Development due to the potential for significant adverse impacts arising from same. Further details in **Section 9.5.5**.

9.4.6 Operational Phase Effects

No new impacts are anticipated to arise during the operational phase of the Development on the hydrological and hydrogeological environment.

Any impacts to the hydrological and hydrogeological environment during the operation phase are likely to be minimal and infrequent, however the mitigation measures and precautions described in this report will be implemented as applicable.

9.4.7 Decommissioning Phase

No new impacts are anticipated to arise during the decommissioning phase of the project on the hydrological and hydrogeological environment.

Any impacts to the hydrological and hydrogeological environment during the decommissioning phase are likely to be minimal and infrequent, however the mitigation measures and precautions described in this report will be implemented as applicable.

9.5 Mitigation Measures and Residual Effects

The Development has associated potential impacts as described in the previous sections of this report. The following sections describe mitigation measures to be implemented during the design, construction, operational and decommissioning phases of the Development. Potential residual effects after mitigation measures are implemented are also described.

9.5.1 Design Phase

9.5.1.1 Mitigation by Avoidance

A process of “mitigation by avoidance” was undertaken by the EIA team during the design of the turbine and associated infrastructure layout. Arising from the results of this study, a constraints map was produced that identifies areas where geotechnical constraints could make parts of the Site less suitable for development. The constraints map is presented in **Technical Appendix 9.9**.

MEL, in consultation with the design team has reviewed the layout plan and has identified it as the best layout design available for protecting the existing hydrological regime of the Site, while at the same time incorporating and overlaying engineering and other environmental constraints as detailed in this EIAR.

In addition, an important part of the “mitigation by avoidance” procedure was to limit the footprint of the Development to the existing infrastructure associated with the Operational Barnesmore Windfarm in so far as practical, that is; utilise existing infrastructure as far as practical.

9.5.1.2 Constraints

As part of mitigation by avoidance during the desk study of this assessment and design phase of the Development, a 50 m buffer zone around significant drainage and surface water features was established during the desk study undertaken as part of this report. The buffer zone is intended to drive the design process by minimising or avoiding the risk to surface water features by restricting construction disturbance to outside these zones, in turn protecting riparian vegetation and providing potential for filtering of runoff from the Site. The prescription of surface water buffer zones is not a strict requirement, particularly for unmapped surface water features (6” historic maps) but is a recommended method for identifying areas of the Development which pose an elevated risk in terms of sensitive surface water receptors (DMNR, 2000). It should also be noted that some of the existing infrastructure associated with the Operational Barnesmore Windfarm is situated in close proximity surface water features, less than 10 m in some instances.

Some of the Development infrastructure footprint will fall within the 50 m buffer zone due to the unique and limiting circumstances associated with the Site and the Development, that is:

- The Development is restricted to existing infrastructure which is already in close proximity to surface water features.
- The layout of the Development is restricted due to constraints related to other environmental disciplines including; ecology, ornithology, etc.
- The layout of the Development is restricted due to the proposed infrastructure itself, that is; the proposed turbines require a minimum distance from each other to ensure the potential for wind turbulence impacting on downwind locations is minimised.

The proposed turbines which fall within the desk based surface water buffer zone include:

- T3 (within 50 m buffer zone associated with unnamed lake (Unnamed (A) (01_8)) – Note: The proposed location for T3 is of greater distance to surface water features than that of existing infrastructure associated with the Operational Barnesmore Windfarm in the vicinity.
- T13 (within 50 m buffer zone associated with unmapped drain / stream associated with Derg River) - Note: The proposed location for T13 is of greater distance to surface water features than that of existing infrastructure associated with the Operational Barnesmore Windfarm on the Site. However, 1 no. watercourse crossing is associated with the proposed T13.

Mitigation by avoidance during the design phase of the Development in regard to the aforementioned proposed turbine locations has been considered and incorporated in so far as practical, none the less, extra attention and planning will need to be applied to those proposed locations. However, although the available 'space' associated with the aforementioned propose turbine locations is limited given the close proximity to surface water features, the restrictive nature of the Site in general requires mitigation measures and infrastructure to be located in close proximity to existing or Development infrastructure in so far as practical, that is; reducing the net land take (of NHA land) as a product of the Development.

Following site surveys significant natural and artificial drainage features observed which are relatively well connected to the mapped surface water network have been included in considering constraints. Given the extensive drainage network existing at the Site and the limited nature of the Development in terms of utilising the existing infrastructure associated with the Operational Barnesmore Windfarm, the construction activities associated with the development will invariably be in close proximity to surface water features, including within the 50 m buffer zone.

Refer to **Technical Appendix 9.9**.

As discussed above, special attention and planning is required for construction activities within the surface water 50 m buffer zone. An example of such special mitigation is presented in the Outline Surface Water Management Plan (SWMP) whereby silt fencing will be installed along all roadways within the 50 m buffer zone. General measures such as this are effective and easily achieved, however each proposed construction location will possess unique characteristics and will be dealt with on a case by case basis to ensure adequate measures are implemented.

9.5.2 Construction Phase

9.5.2.1 Earthworks Proposed Mitigation Measures

Mitigation measures to reduce the potential for adverse impacts arising from earth works and management of spoil include the following:

- Management of excavated material will adhere to the measures related to the management of temporary stockpiles outlined in **Chapter 8: Soils and Geology** of this EIAR, that is: a materials management plan will be established and form part of the Construction Management Plan with a view to establishing material balance during the construction phase, thus minimising the potential for, or the length of time excavated materials are exposed and vulnerable to entrainment by surface water runoff. No permanent, or semi-permanent stockpile will remain on the Site during the construction or operational phase of the Development.
- Suitable locations for temporary stockpiles will be identified on a case-by-case basis. The suitability of any particular location will consider characteristics of the Site including; slope incline and topography, drainage

networks in the vicinity and proximity to same, other relevant characteristics which are likely to facilitate, increase, or compound the potential for entrainment by surface water runoff.

- With reference to Section 9.3.4, the hypothesis of the spring to autumn period being optimum in terms of dry meteorological conditions is based on 30 year average data, and in reality 30 year max rainfall events are observed to be significant throughout the year over the 30 year period. Therefore, considering the variability of meteorological conditions and the potential for significant events to occur at any stage of the year, the construction phase will not be limited to any particular annual period, but will be driven by current meteorological conditions. Construction activities will not occur during periods of sustained significant rainfall events, or directly after such events (allowing time for work areas to drain excessive surface water loading and discharge rates reduce). Similar to measures outlined in relation ground stability during excavation works (Chapter 8: Soils and Geology), an emergency response system will be developed for the construction phase of the project, particularly during the early excavation phase. This, at a minimum, will involve 24-hour advance meteorological forecasting (Met Eireann download) linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g. 1 in 100-year storm event or very heavy rainfall at >25 mm/hr), planned responses will be undertaken. These responses will include, inter alia; cessation of construction until the storm event including storm runoff has passed over. Following heavy rainfall events, and before construction works recommence, the Site will be inspected and corrective measures implemented to ensure safe working conditions, for example, dewatering of standing water in open excavations, etc.
- Any additional drainage infrastructure required for the management of surface water runoff or draining peat ahead of excavation works will be established before excavation works commence. Similarly, mitigation measures related to surface water quality will be implemented before excavation works commence.

9.5.2.2 Excavation Dewatering Proposed Mitigation Measures

Mitigation measures to reduce the potential for adverse impacts arising from earth works and management of spoil include the following:

- Management of excavations will adhere to the measures related to the preparations outlined in **Chapter 8: Soils and Geology** of this EIAR, that is: areas of peat / subsoils to be excavated will be drained ahead of excavation works, thus reducing the volumes of water encountered during excavation works. However, considering the water content of peat and blanket bog, and the frequency of rainfall events in the region, there will likely be residual water within excavations which needs to be dewatered and managed despite preparation works.
- Engineered drainage and attenuation features (discussed in following sections) will be established ahead of excavation works. These features are discussed in the following sections of this report.
- Dewatering flow rate or pumping rate will be controlled by an inline gate valve or similar infrastructure. This will facilitate reduction of loading on the receiving drainage and attenuation network, thus enhancing the attenuation and settlement of suspended solids.
- In some areas of the Development constraints related to incline and/or stability, or construction activities within the 50 m buffer zone, will likely limit the potential for installation of engineered attenuation features. In such instances it is recommended that water arising from dewatering activities is pumped to a settlement tank before being discharge to the receiving drainage network, OR pumped to an area of the Site where the installation of attenuation features is suitable. Areas with such constraints are highlighted in **Technical Appendix 9.9**.
- No extracted or pumped water will be discharge directly to the surface water network associated with the Site (This is in accordance with The Irish Water Pollution Acts (1977 & 1990)).

9.5.2.3 Release and Transport of Suspended Solids Proposed Mitigation Measures

In order to mitigate the impact posed by release of suspended solids to the surface water environment, the following mitigation measures will be implemented.

The drainage, attenuation and other surface water runoff management systems will be installed prior to the main construction activities to control increased runoff and associated suspended solids loads in discharging waters from the Development areas. Where possible drainage control will be installed during seasonally dry ground conditions.

Diffuse surface water runoff will be managed as follows:

- Collector drains and/or soil berms will be established to direct/divert surface water runoff from Development areas, including temporary stockpiles, and direct same into established stilling ponds, buffered discharge points or other surface water runoff control infrastructure as appropriate. This is particularly important in relation to plan effectively for surface water management associated with proposed infrastructure within 50 m surface water buffer zones.

- Silt fences will be established in the drainage network, and in existing natural drains and degraded peat areas which are likely to receive surface water runoff. This will reduce the potential for surface water runoff loaded with suspended solids to rapidly infiltrate towards and be intercepted by drainage or significant surface water features. It is recommended that multiple silt fences are used in drains discharging to the surface water network.

Waters arising as a product of excavation activities will be managed as follows:

- Waters arising from dewatering practices during excavation works are highly likely to be significantly loaded with suspended solids. As such, constructed stilling ponds or buffered outfalls may be insufficient in controlling the release of suspended solids to the surface water network, or have the potential to clog due to significant volumes of settled or attenuated solids. Therefore, any water pumped from excavations, or any waters clearly heavily laden with suspended solids will be pumped through 'silt dewatering bags', or through a settlement tank before the treated water is discharged to the established drainage network.

Waters (likely loaded with suspended solids) intercepted by the established drainage network will be managed as follows:

- In line Stilling Ponds will buffer the run-off discharging from the drainage system during, by retaining water, thus reducing the hydraulic loading to watercourses. Stilling ponds are designed to reduce flow velocity to 0.3 m/s at which velocity silt settlement generally occurs. Note: this method of mitigation may not be feasible at some locations on the Site.
- In line Check Dams will be constructed across drains. Check dams will reduce the velocity of run-off in turn promoting settlement of solids upstream of the dam. Check dams will also reduce the potential for erosion of drains. Rock filter bunds may be used for check dams however, wood or straw/hay bales can also be used if properly anchored. It is recommended that multiple check dams are installed, particularly in areas immediately down-gradient of construction areas.
- Surface water runoff will be discharged to land via buffered drainage outfalls. Buffered drainage outfalls will contain hard core material of similar or identical geology to the bedrock at the Site to entrap suspended sediment. In addition, these outfalls promote sediment percolation through vegetation in the buffer zone, reducing sediment loading to any adjacent watercourses and avoiding direct discharge to the watercourse. It is recommended that a relatively high number of discharge points are established, thus decreasing the loading on any particular outfall. Discharging at regular intervals mimics the natural hydrology by encouraging percolation and by decreasing individual hydraulic loadings from discharge points.
- Buffered drainage outfalls will be located outside of 50 m surface water buffer zones. Similarly, outfalls will not be positioned in areas with extensive erosion and degradation.
- Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite the aforementioned measures. To address this, it is recommended that coagulant or flocculant is used to promote the settlement of finer solids prior to discharging to surface water networks. Flocculant 'gel blocks' are available and can be placed in drainage channels. Gel blocks are passive systems, self-dosing, self-limiting, and are environmentally friendly.

Monitoring and maintenance will include the following:

- Site water runoff quality will be monitored on a continuous basis at a reasonable frequency during both the construction and operational phases of the Development. A relatively high frequency of monitoring (e.g. daily) is required during the construction phase, similarly the early stages of the operational phase will require a relatively high frequency of monitoring, however the frequency of monitoring can gradually reduce thereafter – presuming there are no issues with the quality of discharging water at that point in time.
- It is recommended that continuous monitoring systems are put in place, particularly in principal surface water features draining the Site. For example; remote sensing, or telemetric monitoring sensors (turbidity) can be employed in this regard. It is recommended that a handheld turbidity meter is at available to accurately measure the quality of water discharging from the Site. The meter should be maintained and calibrated frequently and will also be used to check and calibrate remote sensors if they are employed. It is recommended that quality

thresholds are established for the purposes of escalating water quality issues as/if they arise. For example; TSS limit of 25mg/l (S.I. no. 293 of 1988 – Salmonid Regulations).

- Surface water runoff control infrastructure will be checked and maintained on a regular basis and stilling ponds and check dams will be maintained (desludged/settle solids removed) on a regular basis, particularly during the construction phase of the Development. It is important to minimise the agitation of solids during these works, otherwise it will likely lead to an acute significant loading of suspended solids in the drainage network.
- As part of the Site Specific CEMP regular checking and maintenance of pollution control measures are required, with an immediate plan for repair or backup if any breaches of design occur. In the event that established infrastructure and measures are failing to reduce suspended solids to an acceptable level, construction works will cease until remediation or upgrading works are completed.

These measures reduce the suspended sediment and associated nutrient loading to surface water courses and mitigates potential impacts on plant and animal ecologies.

Ensuring the precautionary and mitigation measures listed here are implemented, the risk of significant loading of suspended solids in the receiving surface water bodies is low. Therefore, the risk to sensitive receptors is low. However, in the unlikely event of a significant discharge of suspended solids to surface waters it should also be noted that the numerous lakes associated with the Development and their assimilative capacity will also act as a natural hydrological buffer in terms of suspended solids loading, where by the reduction in flow and retention time through the water body will increase attenuation and enable solids to settle out, therefore reducing the potential impact on sensitive receptors further down-gradient. This however, is not considered a prescribed mitigation measure, but is a 'last line of defence'. Any loading of suspended solids in lakes is considered an adverse effect of the Development, regardless of the positive mitigation potential for other more sensitive receptors downstream.

A detailed design of required drainage, collector drainage, stilling ponds and other listed mitigation infrastructure has not been developed as part of this EIAR, however suitable and particularly sensitive areas are identified and presented in **Technical Appendix 9.9**. A detailed design of surface water mitigation infrastructure will accompany the Site Specific CEMP.

9.5.2.4 Release of Hydrocarbons Proposed Mitigation Measures

To control and contain any potential hydrocarbon and other harmful substances spillage by vehicles during construction, it is recommended where possible to refuel plant equipment off the Site, thus mitigating this potential impact by avoidance. However, given the remote nature of the Site, this is not likely to be a practical measure.

If fuelling must occur onsite, then a discrete "fuel station" will be designated for the purpose of safe fuel storage and fuel transfer to vehicles. This fuel station should be bunded to 110% volume capacity of fuels stored at the Site. The bunded area will be drained by an oil interceptor and drainage of same will be controlled by a pent stock valve that will be opened to discharge storm water from the bund. A suitably qualified management company will take responsibility for management and maintenance of the oil interceptor and associated drainage on a regular basis, including decommissioning.

Despite the management of refuelling and fuel storage, there remains the risk of leakage from vehicles and plant equipment during construction activity. The plant equipment used onsite will require regular mechanical checks and audits to prevent spillage of hydrocarbons on the exposed ground (during construction).

Oil (hydrocarbon) absorbent booms will be installed in all surface water features associated with the Development, downstream of each of the proposed construction areas, and at principal surface water drainage features drainage. Two no. oil booms will be installed at each required location, this will facilitate changing out of booms if needed, without facilitating direct flow of floating product during such activities if present. Oil booms deployed will have sufficient absorbency relative to the hazard, for example, the volume of fuel in a particular construction vehicle.

In the event of an accidental spill during the construction or operational phase of the Development, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. In this regard, spill kits will be kept in each vehicle associated with the Development i.e. spill kits will be readily available to all operators. Spill kits will contain a minimum of; oil absorbent granules, oil absorbent pads, oil absorbent booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter). No materials, contaminated or otherwise will be left on the Site. Spill kits will also be established at construction areas, for example, a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.

If the above measures are implemented the risk of hydrocarbon contamination intercepting the surface water network will be significantly reduced, however there remains a level of risk, and therefore both precautionary measures and emergency response protocols will be established and specified on the CEMP.

9.5.2.5 Construction and Cementitious Materials Proposed Mitigation Measures

In order to mitigate the potential impact posed by the use of concrete and the associated effects on surface water in the receiving environment, the following precautions and mitigation measures are recommended:

- Precast concrete will be used wherever possible i.e. formed offsite, however this is not likely to be possible in terms of significant concrete structures, for example, turbine foundations.
- Lean mix concrete will not be used.
- The acquisition, transport and use of any cement or concrete onsite will be planned fully in advance and supervised at all times.
- Vehicles transporting such material will be relatively clean upon arrival onsite, i.e. vehicles will be washed/rinsed removing cementitious material leaving the source location of the material. There will be no excess cementitious material on the vehicle which could be deposited on trackways or anywhere else onsite. To this end, vehicles will undergo a visual inspection prior to being permitted to drive onto the Site or progress beyond the contractor’s yard. Vehicles will also be in good working order.
- Any shuttering installed to contain the concrete during pouring will be installed to a high standard with minimal potential for leaks. Additional measures could be taken to ensure this, for example the use of plastic sheeting or other sealing products at joints.
- Concrete will be poured during periods of minimal precipitation. This will reduce the potential for surface water run off being significantly affected by freshly poured concrete.
- Ground crew will have a spill kit readily available, and any spillages or deposits will be cleaned/removed as soon as possible and disposed of appropriately.
- Pouring of concrete into standing water within excavations will be avoided. Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place.
- No surplus concrete will be stored or deposited anywhere onsite. Such material will be returned to the source location or disposed of offsite appropriately.

9.5.2.6 Watercourse Crossings Proposed Mitigation Measures

The construction of three (3 no. – 1 no. in relation to the Site, and 2 no. in relation to the Haul Route) new watercourse crossings / culverts requires detailed planning and consideration to ensure potential impacts are assessed adequately and in turn mitigated against.

A detailed assessment in terms of bridge design and the proposed location including characteristics of water flow at that location, has not been carried out as part of this study, however at both locations (associated with T13, and Haul Route Junction) the proposed watercourse crossings are relatively near the head waters of the surface water network each are associated with, therefore bridge or culvert specification and construction are envisaged to be of relatively low significance in terms of expected flow, culvert diameter, etc.

Section 50 of the European Communities (Assessment and Management of Flood risks) Regulation SI 122 of 2010 requires that: No Person, including a body corporate, shall construct any new bridge or alter, Reconstruct, or restore any existing bridge over any watercourse without the Consent of the Commissioners or otherwise than in accordance with plans previously approved of by the Commissioners. The word “bridge” includes a culvert or other like structure.

The OPW is responsible for the implementation of the regulations and consent to construct any bridge will be sought from the OPW via their application process. Details on the application process and guidance / requirements of the bridge design and considerations in terms of flow can be found in the OPW guide Construction, Replacement, or Alteration of Bridges and Culverts (A Guide to Applying for Consent under Section 50 of the EU(Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). This application and consent process will mitigate against the potential for the design of the new bridge leading to significant adverse impacts.

There remains the potential for the actual construction of such bridges to have significant adverse impacts on the receiving watercourse/s. Relevant guidance documents will be consulted and applicable mitigation measures i.e. applicable to the consented detailed design of proposed bridges and construction methodology of same, will be adhered to with a view to mitigating and reducing any potential impact on the receiving watercourse. The following is a non-exhaustive list of relevant guidance documents:

- NRA (2008) Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes
- Inland Fisheries Ireland (IFI) (2016) Guidelines on the Protection of Fisheries During Construction Works in and Adjacent to Waters
- Office of Public Works (OPW) (2013) Construction, Replacement or Alteration of Bridges and Culverts
- Scottish Environment Protection Agency (SEPA) (2010) Engineering in the water environment: good practice guide – River Crossings

Given the absence of a detailed design and assessment of the proposed bridges at present, the following general mitigation measures are suggested as a non-exhaustive list, or minimum requirements to ensure any potential impacts of the proposed watercourse crossing are minimised:

- Proposed bridges will be designed in such a way as to minimise, in so far as practical but to the extent deemed acceptable by the competent authority, the disturbance or alteration of water flow, erosion and sedimentation patterns and rates. This will be done following and adhering to relevant available guidance and will be reviewed and consented (or otherwise) by the OPW, thus mitigating against any significant impact in terms of surface water flow and in turn the risk of flooding locally or indeed elsewhere.
- A detailed construction management plan, and detailed method statement and risk assessment (RAMS), will be drafted and will include details of the bridge design and construction methodology, including the environmental risk/s involved (as identified in this report) and how each can be minimised using best practice techniques.
- Construction methodology will be designed and planned with a view to minimising the potential for contaminating the receiving watercourse, in particular the potential for the release of suspended solids into the receiving watercourse.
- Plant machinery used in the construction of proposed bridges, or any part of the Development, will only be refuelled at an established refuelling station.
- During use of heavy plant machinery there is an inherent risk of accidental leaks or spillages of fuel/hydrocarbons. This will be incorporated in the RAMS, including an emergency response plan for such incidents. An emergency spill kit will be kept onsite at all times and within 50m of ongoing construction works. The spill kit will contain oil absorbent pads and booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter) at a minimum. An oil absorbent boom will be installed downstream (within 25m) of construction works, before works commence.
- Construction management plans and methodology, including RAMS, will be included with the application submitted to the OPW requesting consent to construct said watercourse crossing / bridge.
- All construction works related to watercourse crossing, i.e. any construction works within 50m surface water buffer zones (e.g. trackways leading to crossings), will be incorporated in watercourse crossing construction plans and considerations, and the above mitigation measures will be applied in these instances also.

9.5.2.7 Groundwater Contamination Proposed Mitigation Measures

As identified and discussed in the previous sections of this report, the risk posed to groundwater quality by the Development is low, however mitigation measures to further reduce the risk will be implemented regardless.

The main threat to groundwater quality is the introduction of hydrocarbons to the Site. In order to mitigate groundwater contamination by hydrocarbons in particular, the following are strongly recommended:

- No fuel storage should occur on site and that re-fuelling of plant equipment should occur offsite at a controlled fuelling station.
- If fuelling must occur onsite due to logistical reasons, then a discrete "fuel station" should be designated for the purpose of safe fuel storage and fuel transfer to vehicles. This fuel station should be bunded to 110% volume capacity of fuels stored at the Site. The bunded area should be drained by an oil interceptor and this drainage will be controlled by a pent stock valve that will be opened to discharge storm water from the bund. A suitably

qualified management company will manage and maintain the oil interceptor and associated drainage on a regular basis.

- A construction phase EMP should be in operation to check equipment, materials storage and transfer areas (where applicable), drainage structures and their attenuation ability on a regular basis.

The following mitigation measures are recommended in relation to non-hydrocarbon potential contamination:

- Wastewater from sanitation facilities will be mitigated by use of temporary and portable sanitary facilities that are self-contained. These facilities will not interact with the existing hydrological environment in any way and they will be maintained, serviced and removed from the Site at the end of the construction phase.
- Inorganic nutrients such as nitrogen and phosphorus compounds (if present in excavated sediment) will be controlled by attenuation of the suspended solids to which they adsorb to and by retention of discharge waters within stilling ponds to allow peak runoff to recede prior to discharge. It is noted that the baseline surface water chemistry (under relatively high flow regime) indicates low Ammoniacal Nitrogen and low concentrations of Phosphate.
- Bacteriological contamination arising from availability of nutrients (e.g. sanitation, livestock etc.) will be mitigated by appropriate self-contained sanitation facilities (above) and livestock grazing control on the Site overall, but particularly on areas zoned for excavation and development.
- There is low risk of mobilising trace metals that may naturally be present. The potential impact may arise from introduced water percolation with excavated bedrock substrate. Concentrations of trace metals are usually low in the natural environment. However, water quality should be checked for metals concentration before, during and after the construction phase.

9.5.2.8 Groundwater Extraction Proposed Mitigation Measures

The following measures will be implemented to ensure that the potential impact of extracting groundwater for the purposes of a potable water supply;

- The borehole / well will be drilled to a relatively significant depth and will target bedrock aquifer groundwater for the purposes of extraction. Preferential flow from the bedrock aquifer will be facilitated by the elevated transmissivity of weathered bedrock fissures compared to that of overburden peat or till. This in turn will reduce the potential impact to overburden pore water pressure.
- Upon completion of the well, a pumping test will be conducted to properly evaluate the yield of same. The data obtained will be used to set pumping or extraction limits with a view to limiting the impact of groundwater extraction relative to the yield, that is; groundwater extraction will be limited to 2% per day. For example; as per preliminary calculations (**Section 9.4.4.8**), if the yield is found to be low (c. 20 m^3 per day) the impact during the operational phase is likely to be Slight (1.5%), however an alternative source may be required to supplement the well during the Construction phase (higher demand). If the yield is found to be relatively high (c. 100 m^3 per day) the impact during Construction and Operational phases is likely to be Slight (1.5%) to Imperceptible (0.3%) respectively, that is; no control required at the assumed demand. Limiting the extraction of groundwater will minimise the cone depression / zone of influence, thus reducing the potential impact to overburden pore water pressure. Under these conditions the area impacted is likely to be less than 50m radius from the well location.
- Water extraction and consumption rates will be monitored by an inline flow meter. Corrective measures and/or pumping limits will be prescribed if excessive use is observed (>2% of yield).
- An alternative source (for example; importation of tanked water) will be used during periods of sustained dry metrological conditions, for example; extraction of groundwater will cease during drought conditions (15 consecutive days with less than 0.2 mm rain fall per day).
- Groundwater obtained from the well will be sampled and samples sent for analysis at an accredited laboratory. Analysis scheduled will be inline with drinking water legislative reference limits, and results will be screened against those limits for the purposes of establishing whether the groundwater is safe for human consumption without treatment.

The above measures, including borehole specific data and resulting limitations, will be specified in the Site Specific CEMP.

9.5.2.9 Monitoring

The following recommendations are made for Site monitoring in relation to the hydrological and hydrogeological impacts:

- The baseline monitoring undertaken at the Site as part of this study should be repeated periodically before, during and after the construction phase of the Development to monitor any deviations from baseline hydrochemistry that occur at the Site. This monitoring along with the detailed monitoring outlined below will help to ensure that the mitigation measures that are in place to protect water quality are working. Specifically, a construction period and post construction monitoring programme for the Site should include the following.
- During the construction phase; daily inspection of silt traps, buffered outfalls and drainage channels and daily measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations on the Site. Monitoring of same during times when excavations are being dewatered (likely high in solids) should be done in real time.
- Post construction; inspection of silt traps, buffered outfalls and drainage channels, measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations at the Site will be carried out at a reasonable frequency, and will also be scheduled following extreme metrological events. During the operational phase of the project the stilling ponds and buffered outfalls will be periodically inspected during maintenance visits to the Site.
- During the construction phase of the project, the Development areas should be monitored daily for evidence of groundwater seepage, water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system so that it does not become blocked, eroded or damaged during the construction process.
- During both the construction and operational phases of the project, watercourse crossings should be monitored frequently (daily during construction and intermittently during operational phase). The water course crossings should be monitored in terms of structural integrity and in terms of their impact on respective watercourses.
- A detailed inspection and monitoring regime, including frequency will be specified in the Construction Management Plan.

9.5.2.10 Emergency Response

Mitigations measures as outlined in the previous sections will reduce the potential for soil contamination during the construction phase of the Development. However, there remains the risk of accidental spillages and or leaks of contaminants, and excessive loading of surface water mitigation infrastructure.

Emergency responses to potential contamination incidents will be established and form part of the Construction Management Plan before construction works initiate. The following is a non-exhaustive list of potential emergencies and respective emergency responses:

- Hydrocarbon spill or leak – Hydrocarbon contamination incidents will be dealt with immediately as they arise. Hydrocarbon spill kits will be prepared and kept in vehicles associated with the construction phase of the Development. Spill kits will also be established at construction areas, for example; a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.
- Significant hydrocarbon spill or leak – In the event of a significant or catastrophic hydrocarbon spillage, emergency responses will be escalated accordingly. Escalation can include measures such as; installation of temporary sumps, drains or dykes to control the flow or migration of hydrocarbons; excavation and disposal of contaminated material. Any such measures will be reviewed by appropriate consultants, considering that collector drainage will be established prior to construction activities, the need for drainage as an emergency response will be limited, however 'dig and dump' remediation processes will likely be required.
- If a significant hydrocarbon spillage does occur, the contractor on behalf of the developer must have an approved and certified clean-up consultancy available on 24-hour notice to contain and clean-up the spill. The faster the containment or clean-up starts, the greater the success rate, the lower the damage caused and the lower the cost for the clean-up.
- Cementitious material – Cement / concrete contamination incidents will be dealt with immediately as they arise. Spill kits will also be established at construction areas, e.g. a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for cementitious materials will also be at hand.
- Other construction and general waste – Wastes which are dispersed by construction activities or by natural causes such as wind will be collected and dealt with immediately.

In the event of a significant contamination or polluting incident the relevant authorities will be informed.

Emergency responses, including methodologies, will be specified in the Site Specific CEMP.

9.5.2.11 Construction Phase Residual Impacts

The residual impact on the hydrological environment arising during the construction phase of the Development is anticipated to be a limited temporary decrease in water quality within the Site likely to arise from the release of suspended solids and sediments during the excavation and construction process, particularly following rainfall events after a sustained dry period. This local deterioration in water quality is likely to be reduced naturally by dilution and managed by mitigation prior to exiting from the Site. The aims of the mitigation measures are to reduce contaminant concentrations, namely suspended solids, to below relevant legislative reference limits upon being intercepted by the associated surface water network (streams and rivers) downgradient of the Site. The effects will be further reduced in proportion to the distance travelled downstream within each catchment via the assimilative capacity of the surface water networks. Thus, the impact overall is anticipated to be direct, negative, imperceptible, Imperceptible weighted significance, transboundary and temporary.

9.5.3 Operational Phase

9.5.3.1 Increase in Hydraulic Loading Proposed Mitigation Measures

The Development will lead to an increase in hardstand area or impermeable surface area within the Site, which in turn will lead to an increase in hydraulic loading by surface water runoff. However, preliminary water balance calculations indicate that the worst-case net increase in surface water runoff volumes will be approximately 490 m^3/month, or +0.03% relative to the area of the Site, therefore this is considered an imperceptible, or not significant impact.

Given the low significance of this impact, mitigation measures to facilitate the increase in surface water runoff are limited to ensuring that existing and newly established drainage infrastructure (discussed in previous sections) is sufficient for the discharge rates associated with any particular area of the Site and are maintained to ensure blockages or other anomalies are addressed and rectified as the need arises.

No other new impacts are envisaged during the operational phase of the Development.

9.5.3.2 Operational Phase Residual Impacts

The residual impact on the water environment during the operational phase of the Development is anticipated to be increased runoff of rainwater and increased drainage discharge as a result of changes in ground surfacing including areas of new hardstands. Different parts of the Site may experience a net change in ‘wetting’ and ‘drying’ as a function of the constructed drainage design. This is considered a direct, neutral, localised impact of the Development, which conforms to baseline conditions.

9.5.4 Development Decommissioning and Restoration Phase/s

9.5.4.1 Decommissioning of Infrastructure

As discussed in **Section 9.1**, no new impacts are anticipated during the decommissioning phase of the project (removal of turbines and similar infrastructure, similar to the initial decommissioning of the Operational Barnesmore Windfarm) on the hydrological and hydrogeological environment therefore no additional mitigation measures are required, however the decommissioning of major infrastructure including proposed turbines poses similar hazards and risks to the environment compared to that of the construction phase.

Excavation of material is not anticipated, similarly vehicular movement on peat is not anticipated considering adequate hardstand will have been established, therefore the risk of solids being entrained by surface water runoff is low however, the risk of fuel or other contaminant spillages, or management of waste are valid hazards during the decommissioning phase of the Development. The principal/s of mitigation measures described in this EIAR chapter will be adopted and implemented by means of a Decommissioning Phase Management Plan (DPMP).

9.5.4.2 Reinstatement of Redundant Access Track and Hardstand Areas

No new impacts are anticipated during the decommissioning phase of the project on the hydrological and hydrogeological environment therefore no additional mitigation measures are required.

Activities during the reinstatement phase of the Development pose similar hazards and risks associated with the construction phase but to a far lesser extent, for example; the potential for fuel spills from vehicles, therefore the principal/s of mitigation measures described in this EIAR chapter will be adopted, specified in the Site Specific CEMP and implemented. However, reinstatement of redundant access track and hardstand areas pose unique circumstances in terms of susceptibility soil creep, erosion and entrainment of solids in surface water runoff in comparison to other earthworks associated with the Development, particularly where slope inclines are present, therefore particular attention and planning is required in terms of;

- he preparation of the hardstand surface prior to material being deposited, discussed in Chapter 8: **Soils and Geology**.
- The potential for entrainment of solids in surface water runoff will be elevated. Mitigation measures described in this chapter will be adopted and implemented, however its is also recommended that silt fences are employed along the perimeter of the entirety of reinstatement areas. Particular attention is required where surface water runoff is likely to be intercepted by both natural and existing artificial drainage features. Furthermore, drainage features which will likely draw water from reinstatement areas, or promote preferential surface water runoff flow pathways through reinstatement areas will be reduced, blocked or filled in / decommissioned where applicable.

The methodologies adopted will be specified in the Site Specific CEMP.

For further information on the envisaged methodology with respect to reinstatement of areas if the Site, in particular regard to the associated sensitivities and habitat management objectives, refer to **Chapter 6: Biodiversity** and **Barnesmore Windfarm Repowering HMP**.

Monitoring and maintenance of the reinstated areas will be carried out at a regular frequency during the initial stages of establishment. This will ensure that the occurrence of excessive surface water runoff eroding deposited material along preferential pathways is minimised.

9.5.4.3 Reinstatement Residual Impacts

Effective reinstatement of redundant areas will lead to beneficial impacts, and passive continuous improvements in the areas in question where by the areas will recover and with time become similar in composition to the surroundings of respective areas.

The reinstatement of any area will enhance water storage in that area, while also facilitating the filtration of potentially contaminated surface water runoff originating upgradient of reinstatement areas, thus the residual impact of reinstatement is positive, localised but potentially transboundary (hydrological connections) and permanent. For further information refer to **Chapter 6: Biodiversity.**

9.5.5 Decommissioning and Restoration Phase – Physical Infrastructure

Restoration of the Site following decommissioning of the proposed infrastructure is in its own right a phase of the Development. Restoration activities have the potential to be disruptive and hazardous to the environment, to the point that a ‘benefit analysis’ will likely be required to evaluate any such activity before it is permitted (Schumann, M., and Joosten, H., 2008).

Restoration activities will need to be assessed under the scope of multiple environmental disciplines, similar to this EIAR, and the potential synergistic effects. Given that the condition of the environment will likely change over the course of the operational phase of the Development, particularly in terms of the health and degree of establishment of blanket bog and associated ecology, and ornithology, it is recommended that the potential for restoration following the decommissioning phase of the Development is evaluated closer to the time.

9.5.6 Cumulative Effects

Considering hydrology, and the fact that potential effects of the Development on same are transboundary, the effects of the Development are considered to contribute and add to the cumulative nature of adverse impact imposed on the surface water network in the catchments associated with the Development. However, considering the presence of the Operational Barnesmore Windfarm (>20 years), the generally good WFD status particularly in relation to headwaters within the Development (and NHA), and high quality of baseline samples of the associated surface water network draining the Site, the potential for the Development to have adverse cumulative impacts on hydrology is limited to the construction phase predominantly, and furthermore, considering the catchments areas, volumes of water associated (assimilative capacity), and the baseline impact on surface waters in the region/s, the Development is not considered to significantly contribute to cumulative effects in terms of water quality, or indeed hydraulic loading (flood risk).

Considering hydrogeology, and the fact that potential effects of the Development on same are likely to be localized when considering the classification of the overlying subsoil (peat / blanket bog) and underlying groundwater aquifer (poor except for local zones), the Development is not considered to significantly contribute to cumulative effects.

9.6 Summary of Significant Effects

The unavoidable impacts on the hydrological environment as a function of the Development is that:

- There will be a loading of suspended solids in surface water runoff at the Site particularly in relation to excavation works during the construction phase of the Development. While the loading of suspended solids in runoff is unavoidable, if precautionary and mitigation measures described in this report are implemented, concentrations of suspended solids can be reduced to acceptable levels prior to runoff being intercepted by the surface water network associated with the Site. Achieving this implies minimal effects on surface water features, this is considered a likely, neutral to negative, imperceptible to slight significance, Imperceptible weighted significance, transboundary impact of the Development which conforms to baseline (when considering areas of peat cutting).
- There will be some local changes to how water flows at the Site, this is considered a likely, neutral to negative, slight to moderate significance, localised impact of the Development which conforms to baseline.

Other potential impacts are considered to range in significance from slight to significant, and can potentially be long term to permanent, however if mitigation measures are applied and proper precautions and planning are executed effectively, the risk of such potential impacts can be significantly reduced, or are considered avoidable.

No new impacts are anticipated during the operational phase of the Development. Similar hazards are identified when comparing the construction and operational phases of the Development, however considering that works will be far less intensive during the operational phase the likelihood of impacts is low, thus the risk is low.

9.7 References

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