9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO Ireland to carry out an assessment of the potential effects of the Proposed Development on the hydrological and hydrogeological environment.

The Proposed Development is described in full in Chapter 4.

In summary, the Proposed Development includes 9 no. proposed turbines, an on-site 110kV electrical substation, new site access roads, upgrade of existing roads, 1 no. meteorological mast, 3 no. temporary construction compounds, 5 no. onsite borrow pits, amenity proposals and biodiversity enhancement areas, an underground 110kV grid connection and works along the turbine delivery route. The proposed Wind Farm Site is located approximately 11km north of Limerick City and approximately 4km northeast of Sixmilebridge, Co. Clare.

This chapter provides a baseline assessment of the environmental setting of the Proposed Development, as described in Chapter 4, in terms of hydrology and hydrogeology and discusses the potential likely significant effects that the construction, operation and decommissioning of the Proposed Development will have. Where required, appropriate mitigation measures to avoid any identified significant effects to hydrology and hydrogeology are prescribed and the residual effects of the Proposed Development post-mitigation are assessed.

Please note that in this chapter we refer to specific elements of the Proposed Development such as the Wind Farm Site, the Grid Connection route and the Turbine Delivery Route (TDR). The Proposed Development site (as defined by the EIAR red line boundary) includes the Wind Farm Site (including the biodiversity enhancement lands), the Grid Connection route and the proposed work areas along the TDR.

9.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include upland hydrology and windfarm drainage design. We routinely complete impact assessment reports for hydrological and hydrogeological aspects for a variety of project types.

This chapter of the EIAR was prepared by Michael Gill, Conor McGettigan and John Twomey.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design and surface water/groundwater interactions. For example, Michael has worked on the EIS for Oweninny WF, Cloncreen WF, Derrinlough WF, and Yellow River WF, and over 100 other wind farm-related projects.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with 3 years' experience in the environmental sector in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a

B.Sc. in Geology (2016) from University College Dublin. Conor has prepared the hydrology and hydrogeology chapter of environmental impact assessment reports for several wind farm development on peatlands. Conor also routinely prepares hydrological and hydrogeological assessment reports, WFD compliance assessment reports and flood risk assessments for a variety of development types including wind farms.

John Twomey (BSc) is a recent graduate of Earth and Ocean Science from UG and is in the process of training to become an Environmental Scientist. He has recently helped in the completion of hydrogeological and hydrological impact assessments on quarries, windfarms and industrial developments.

9.1.3 Scoping and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the List of Consultees is outlined in Section 2.6 of this EIAR. Matters raised by Consultees in their responses with respect to the water environment are summarised in Table 9-1 below.

Table 9-1: Summary of Water Environment Related Scoping Responses

Consultee	Description	Addressed in Section
Geological Survey of Ireland (Groundwater Section)	A general response was provided with respect potential impacts on groundwater resources/sources.	Section 9.3.15
Inland Fisheries Ireland	The Proposed Development Site is located within 2 no. salmonid bearing catchments, the Blackwater to the south and the Owenogarney to the north, and both require protective measures to be employed. IFI state that these streams provide excellent salmonid spawning habitat with goof to high water quality in the most recent EPA Q-value surveys. Current flow regimes must not be changed.	Sections 9.5.2 and 9.5.3
Department of Housing, Local Government and Heritage	Wetlands are important areas for biodiversity and ground and surface water quality should be protected during construction and operation of the Proposed Development. The EIAR should take account of the guidelines for Planning Authorities entitled "the Planning System and Flood risk Management". All potential cumulative impacts must be assessed, including the Carrownagowan Wind Farm on the western slopes of Slieve Bernagh which was recently granted permission.	Potential surface and groundwater quality effects are assessed in Section 9.5.2 for the construction phase and Section 9.5.3 for the operational phase. A flood risk assessment is presented in Section 9.3.5. Cumulative effects are assessed in Section 9.5.7.

9.1.4 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

The requirements of the following legislation are also complied with:

- S.I. No. 349/1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84/1994, S.I. No. 101/1996, S.I. No. 351/1998, S.I. No. 93/1999, S.I. No. 450/2000 and S.I. No. 538/2001, S.I. No. 134/2013 and the Minerals Development Act 2017), the Planning and Development Act, and S.I. No. 600/2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/337/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Planning and Development Act, 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 94/1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722/2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for the implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("WFD"). The WFD was given legal effect in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003);
- S.I. No: 122/2010: European Communities (Assessment and Management of Flood Risks) Regulations, resulting from EU Directive 2007/60/EC;
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended; and,
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

9.1.5 Relevant Guidance

The Hydrology and Hydrogeology chapter of this EIAR is carried out in accordance with the guidance contained in the following:

- Environmental Protection Agency (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- DoE/NIEA (2015): Wind farms and groundwater impacts - A guide to EIA and Planning considerations";

- OPW (2009) The Planning system and Flood Risk Management;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Wind Farm Development Guidelines for Planning Authorities (2006);
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- Good Practice During Wind farm Construction (Scottish Natural Heritage, 2010);
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001.
- Land Types for Afforestation (Forest Service, 2016b);
- Forest Protection Guidelines (Forest Service, 2002);
- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b); and,
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018).

9.2 Assessment Methodology

9.2.1 Desk Study

A desk study of the Proposed Development site and the Study Area (as defined in Section 9.2.5) was completed in Summer 2022 to collect all relevant hydrological, hydrogeological and meteorological data. The desk study was completed to supplement site walkover surveys, drainage mapping and site investigations. The desk study information has been checked and updated, where necessary, in August, November 2023, January 2024, and June 2024.

The desk study involved consultation with the following sources:

- Environmental Protection Agency Databases (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 17 (Geology of the Shannon Estuary), (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports; and,
- OPW Flood Mapping (www.floodmaps.ie).

9.2.2 Baseline Monitoring and Site Investigations

Site walkover surveys, including drainage mapping, hydrological monitoring, surface water flow monitoring, field hydrochemistry and grab sampling at the Proposed Development site were undertaken by Michael Gill and Conor McGettigan of HES (refer to Section 8.2.1 above for qualifications and experience) on 7th December 2022, 13th July 2023, 15th August, 13th September, 12th October and 26th October 2023. The monitoring and sampling was completed during both dry and wet periods in order to sample and record flow volumes during both high and low flows.

In summary, the site investigations to address the Hydrology and Hydrogeology chapter of this EIAR are as follows:

- HES completed site walkover surveys and drainage mapping at the Proposed Development site on 7th December 2022, 13th July, 15th August, 13th September, 12th October and 26th October 2023 whereby water flow directions and drainage patterns were recorded. These surveys included field hydrochemistry monitoring and stream flow monitoring of watercourses draining the Proposed Development site;
- A total of 32 no. surface water grab samples were undertaken to determine the baseline water quality of the primary surface waters originating from the Proposed Development site. These samples were undertaken across 4 no. monitoring rounds each comprising of 8 no. samples;
- Completion of 569 no. peat probes were completed by FT and MKO to determine to geomorphology of the peat at the Wind Farm Site;
- HES supplemented the above peat probe dataset by completing additional probes and gouge cores at the proposed infrastructure locations. All HES peat probes were characterised to Von Post Humification Scale;
- Irish Drilling Limited (IDL) completed ground investigation at the Proposed Development site, under the supervision of FT in August and September 2023;
- IDL excavated a total of 13 no. trial pits between 28th and 30th August 2023 to investigate underlying mineral soil lithology and the subsoil/bedrock interface;
- IDL drilled a total of 3 no. boreholes within the Wind Farm Site between 11th and 13th September 2023;
- A Peat Stability Risk Assessment (PSRA) was completed for the Proposed Development by FT (FT, 2024); and,
- FT completed a Peat and Spoil Management Plan for the Proposed Development (FT, 2024).

9.2.3 Impact Assessment Methodology

The EPA's Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2022) states that there are 7 no. steps in the preparation of the EIAR. The initial steps relate to screening, scoping, the consideration of alternatives and the description of the project. Step 5 related to the description of the baseline environment which is presented in Section 9.3 for the hydrological and hydrogeological. Step 6 relates to the assessment of impacts and is presented in Section 9.5.

The EPA's guideline criteria (EPA, May 2022) require that the baseline environment is described in terms of the context, character, significance and sensitivity of the existing environment. The description of the baseline environment is Step 5 of the information which must be included in an EIAR as per the guideline criteria (2022).

The assessment of effects follows the description of the baseline environment and is Step 6 of the information which must be included in an EIAR. The guideline criteria for the assessment of effects states that the purpose of an EIAR is to identify, describe and present an assessment of the likely significant effects. The likely effects are described with respect to their quality (positive, neutral or negative), significance (imperceptible to profound), extent (i.e. size of area or number of sites effected), context (is the effect unique of being increasingly experienced), probability (likely or unlikely), duration (momentary to permanent), frequency and reversibility. The descriptors used in this environmental impact assessment are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR.

In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of importance which are defined in Table 9-2 for hydrology and Table 9-3 for hydrogeology are used to assess the potential effects that the Proposed Development may have on them.

Table 9-2: Estimation of Importance of Hydrology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Quality Class A (Biotic Index Q4, Q5). Flood plain protecting more than 50 residential or commercial properties from flooding. Nationally important amenity site for a wide range of leisure activities.
High	Attribute has a high quality or value on a local scale	Salmon fishery Locally important potable water source supplying >1000 homes. Quality Class B (Biotic Index Q3-4). Flood plain protecting between 5 and 50 residential or commercial properties from flooding.
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery. Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3). Flood plain protecting between 1 and 5 residential or commercial properties from flooding.
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities. Local potable water source supplying <50 homes. Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding. Amenity site used by small numbers of local people.

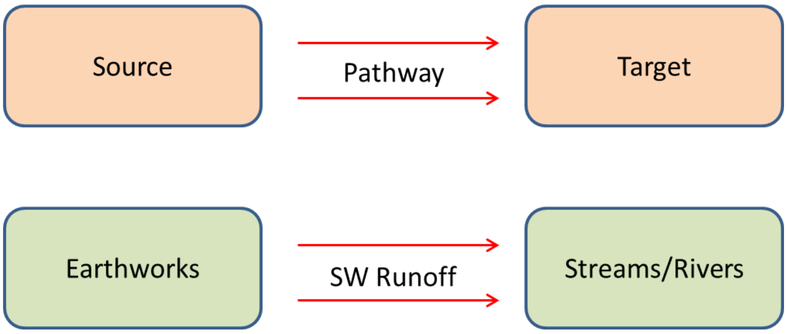
Table 9-3: Estimation of Importance of Hydrogeology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation - NHA status.

Importance	Criteria	Typical Example
		Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes.

9.2.4 Overview of Impact Assessment Process

The conventional source-pathway-target model (see below, top) was applied to assess potential impacts on downstream environmental receptors (see below, bottom as an example) as a result of the Proposed Development.



Where potential effects are identified, the classification of effects in the assessment follows the descriptors provided in the Glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):

- Environmental Protection Agency (May 2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

The description process clearly and consistently identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

The assessment of effects is Step No. 6 of 7 in the EIAR process. In order to provide an understanding of the stepwise impact assessment process applied below (Sections 9.4.2 to 9.4.4), a summary guide is presented below, which defines the steps (Steps 6a to 6g) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all wind farm, grid connection and haul route construction and operation and decommissioning activities which have the potential to generate a source of significant adverse impact on the geological and hydrological/ hydrogeological (including water quality) environments.

Table 9-4: Impact Assessment Process Steps

Step 6a	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 6b	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which potential impacts are generated.
Step 6c	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 6d	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 6e	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by (engineering) design.
Step 6f	Post-Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 6g	Significance of Effects:	Describes the likely significant post-mitigation effects of the identified potential impact source on the receiving environment.

9.2.5 Study Area

The study area for the hydrological (surface water) and hydrogeological (groundwater) impact assessment is defined by the regional surface water catchments and groundwater bodies within which the Proposed Development is located. The hydrological setting of the Proposed Development is detailed in Section 9.3.3 and shown in Figure 9-1. The hydrogeological setting of the Proposed Development is detailed in Section 9.3.7.

9.2.6 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Hydrology and Hydrogeology Chapter of the EIAR.

9.3 Receiving Environment

9.3.1 Site Description and Topography

9.3.1.1 Wind Farm Site

The proposed Wind Farm Site is located approximately 4km northeast of the village of Sixmilebridge, approximately 3km south of the small village of Broadford, and approximately 3.5km southeast of Kilkishen in southeast Co. Clare. The Wind Farm Site is situated approximately 11km north of Limerick City. The Wind Farm Site is elongated along the crest of a hill and is located in the townland of Knockshanvo and adjacent townlands. The Grid Reference coordinates for the approximate centre of the site are E554266 N669733. The Wind Farm Site has a total area of 1,072 hectares (ha).

The Wind Farm Site is comprised of existing commercial forestry plantations, dominated by Sitka Spruce and Lodgepole Pine. The Wind Farm Site also contains areas which are unplanted and comprises wet heath habitats or unplanted areas along riparian buffer zones. Other areas of the Wind Farm Site have been felled and are reverting naturally to wet heath.

The Wind Farm Site is served by an existing network of forestry roads. The Wind Farm Site is accessed via local roads from the R465 Regional Road, which travels in a north-south direction between Broadford and Ardnacrusha, the R471 Regional Road which travels east-west between Sixmilebridge and Clonlara and the Crag Local Road, which travels in a northeast-southwest direction between Sixmilebridge and Broadford.

Topography of the Wind Farm Site is highly variable, ranging from 160 to 310mOD (metres above Ordnance Datum). The Wind Farm Site is located in the Slieve Bernagh Mountain Range in east, Co. Clare and is located on an elevated east-west orientated ridge. The Wind Farm Site contains several local peaks, the highest of which is Knockanuarha (310mOD). The north of the Wind Farm Site slopes to the north and northwest while the south slopes to the south and southeast away from this elevated ridge.

9.3.1.2 Grid Connection Route

The Grid Connection to Ardnacrusha is 9.2km in length. This Grid Connection will originate from the proposed onsite 110kV electrical substation in the townland of Drumsillagh Co. Clare. This underground Grid Connection travels to the south along a local road as far as Ardnacrusha. Elevations along Grid Connection range from approximately 180mOD at the proposed onsite 110kV electrical substation to approximately 20mOD in the vicinity of Ardnacrusha 110kV Electrical Substation. The Grid Connection is located entirely along existing forestry tracks and in the local public road corridor.

9.3.1.3 Turbine Delivery Route

The Turbine Delivery Route (TDR) begins at Foynes Port and travels along the N69 passing through Limerick City. To the north of Limerick City, the TDR follows Corbally Road, the R463 and the R465 before entering the Wind Farm Site in the townland of Kilmore, Co Clare.

Minor works, comprising road widening, are required along the R465 to the south of the Wind Farm Site. Meanwhile, a temporary compound will also be constructed along the N69 in the townland of Court, Co. Limerick.

9.3.2 Water Balance

Long-term rainfall and evaporation data were sourced from Met Éireann (on 28th November 2023). The 30-year Annual Average Rainfall (AAR) (1981-2010) recorded at Ardnacrusha rainfall station, located 7km south of the Wind Farm Site are presented in Table 9-5. The average annual rainfall at Ardnacrusha is 1,128mm/year.

However, the rainfall data from Ardnacrusha is likely to underestimate the actual average annual rainfall at the Wind Farm Site due to the elevation difference between the Wind Farm Site and the weather station. Ardnacrusha rainfall station stands at an elevation of 28mOD (metres above Ordnance Datum) whilst the topography at the Wind Farm Site ranges from 160 to 310mOD.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Wind Farm Site ranges from 1,239 to 1,364mm/year. The average annual rainfall is 1,315mm/yr (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

Table 9-5 Average long-term Rainfall Data (mm)

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Ardnacrusha		158500		161800		28		1952		N/A		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
113	87	92	68	71	82	75	101	90	123	110	117	1,128

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Shannon Airport, approximately 15km west of the Wind Farm Site. The long-term average PE for this station is 543.2mm/year. This value is used as a best estimate of the PE at the Wind Farm Site. Actual Evaporation (AE) is estimated as 516mm/year (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,315mm/year – 516mm/year

ER = 799mm/year

Groundwater recharge coefficient estimates are available from the GSI (www.gsi.ie) (accessed on 28th November 2023). Within the Wind Farm Site recharge coefficients range from 22.5% in areas of peat to 85% in areas where rock is close to or at the ground surface.

An estimate of 200mm/year average annual recharge is given for the Wind Farm Site. This calculation is based on a recharge coefficient of 25%. A recharge coefficient at the lower end of the GSI scale (22.5-85% recharge) was chosen due to the coverage of peat, the sloping nature of the local topography and

[1] Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.

the low to moderate permeability of the underlying bedrock aquifer. This means that the hydrology of the Wind Farm Site is characterised by high surface water runoff rates and relatively low groundwater recharge rates. This is supported by on-site observations made during the site walkover surveys whereby a high density of headwater streams were recorded within the Wind Farm Site.

Therefore, conservative annual recharge and runoff rates for areas of the Wind Farm Site which are covered in peat are estimated to be 200mm/yr and 599mm/yr respectively.

Climate change projections for Ireland are provided by Regional Climate Models (RCM's) downscaled from larger Global Climate Models (GCM's). Projections for the period 2041-2060 (mid-century) are available from Met Eireann. The data indicates a projected decrease in summer rainfall from 0 to 13% under the medium-low emission range scenario and an increase in the frequency of heavy precipitation events of 20%. In total the projected annual reduction in rainfall near the Wind Farm Site 8% under the medium-low emission scenario and 4% under the high emissions scenario. As stated above the local average long-term rainfall data for the Wind Farm Site is estimated to be 1,315mm/yr. Under the medium-low emissions scenario this may reduce to 1,209mm/yr, while under the high emissions scenario this figure may reduce to 1,262mm/yr.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. Table 9-6 presents return period rainfall depths for the area of the Wind Farm Site (using coordinates for the centre of the Wind Farm site). These data are taken from https://www.met.ie/climate/services/rainfall-return-periods (data downloaded on 28th November 2023) and they provide rainfall depths for various storm durations and sample return periods (1-year, 50-year, and 100-year). These extreme rainfall depths will be the basis of the proposed wind farm drainage hydraulic design as described further below.

Table 9-6 Return Period Rainfall Depths (mm) for the Wind Farm Site

	Return Period (Years)			
Storm Duration	1	5	30	100
5 mins	4.0	6.4	10.3	14.0
15 mins	6.5	10.4	17.0	22.9
30 mins	8.5	13.4	21.2	28.3
1 hour	11.1	17.1	26.6	35.0
6 hours	22.0	32.2	47.6	60.6
12 hours	28.7	41.2	59.5	74.9
24 hours	37.5	52.6	74.6	92.6
2 days	46.4	63.6	88.0	107.5

9.3.3 Regional and Local Hydrology

9.3.3.1 Wind Farm Site

The Wind Farm Site is located across 2 no. regional surface water catchments. The east and south of the Wind Farm Site is located in the Lower Shannon surface water catchment and Hydrometric Areas 25D. Meanwhile, the northwest of the Wind Farm Site is located in the Shannon Estuary North surface water catchment and Hydrometric Area 27. Both regional surface water catchments are located in the Shannon River Basin District.

The Lower Shannon Catchment (HA 25D) covers a total area of 1,041km^2 and includes the lower reaches of the River Shannon to Limerick City and the catchment of the Mulkaer River. The catchment is underlain by mostly impure limestones in low-lying areas and the sandstone and metamorphic rocks in the uplands of the Slieve Bernagh and Arra Mountains in the northwest, and the Silvermines and Slieve Feilim Mountains in the east (EPA, 2018).

Within the Lower Shannon surface water catchment, the Wind Farm Site is located in the Shannon[Lower]_SC_100 sub-catchment. More locally this section of the Wind Farm Site lies within the catchment of the Blackwater (Clare) River. Several 1st and 2nd order streams drain the Wind Farm Site and flow to the south before discharging into the Blackwater River. These tributaries of the Blackwater River include the O'Neill's, Mountrice, Drumsillagh rivers, the Sruffaunageeragh stream and several additional unnamed streams. The Blackwater River flows to the east 3.2km to the south of the Wind Farm Site before it veers to the south and discharges into the River Shannon 10.5km to the southeast.

In terms of WFD river sub-basins, this area of Wind Farm Site is located 3 no. river sub-basins: the Blackwater(Clare)_010 sub-basin in the west, the Mountrice_010 sub-basin in the centre and the Glenomra Wood Stream_010 in the east.

The Shannon Estuary North catchment (HA 27) includes the area drained by the River Fergus and all streams entering the tidal waters between Thomond Bridge and George's Head Co. Clare and drains a total area of 1,658km^2 (EPA, 2018).

Within the Shannon Estuary North surface water catchment, the Wind Farm Site is located in the Owenogarney_SC_010 sub-catchment. This area of the Wind Farm Site drains to the north and northwest towards the Owenogarney River via several unnamed streams and the Broadford River. The northeast of the site drains to the Broadford River which flows to the northwest before it discharges into Doon Lough 3.3km to the north of the Wind Farm Site. The Ahaclare River outflows from Doon Lough and is referred to as the Owenogarney River to the west of the Wind Farm Site. Meanwhile, the west of the Wind Farm Site drains via several 1st and 2nd order streams, which flow to the northwest and discharge directly into the Owenogarney River. Downstream of the Wind Farm Site, the Owenogarney River discharges into Ballymulcashel Lough and Castle Lake. Further downstream, the Owenogarney River continues to the south, flowing through the village of Sixmilebridge, and past Bunratty before eventually discharging into the Shannon Estuary 10km to the southwest.

In terms of WFD river sub-basins, this area of the Wind Farm Site is located in 3 no. river sub-basins: the Broadford_030 sub-basin in the east, the Owenogarney_030 sub-basin towards the centre, and the Owenogarney_040 sub-basin in the west.

A regional hydrology map showing the WFD catchments and sub-catchments is shown as Figure 9-1.

A local hydrology map showing WFD river sub-basins is shown as Figure 9-2.

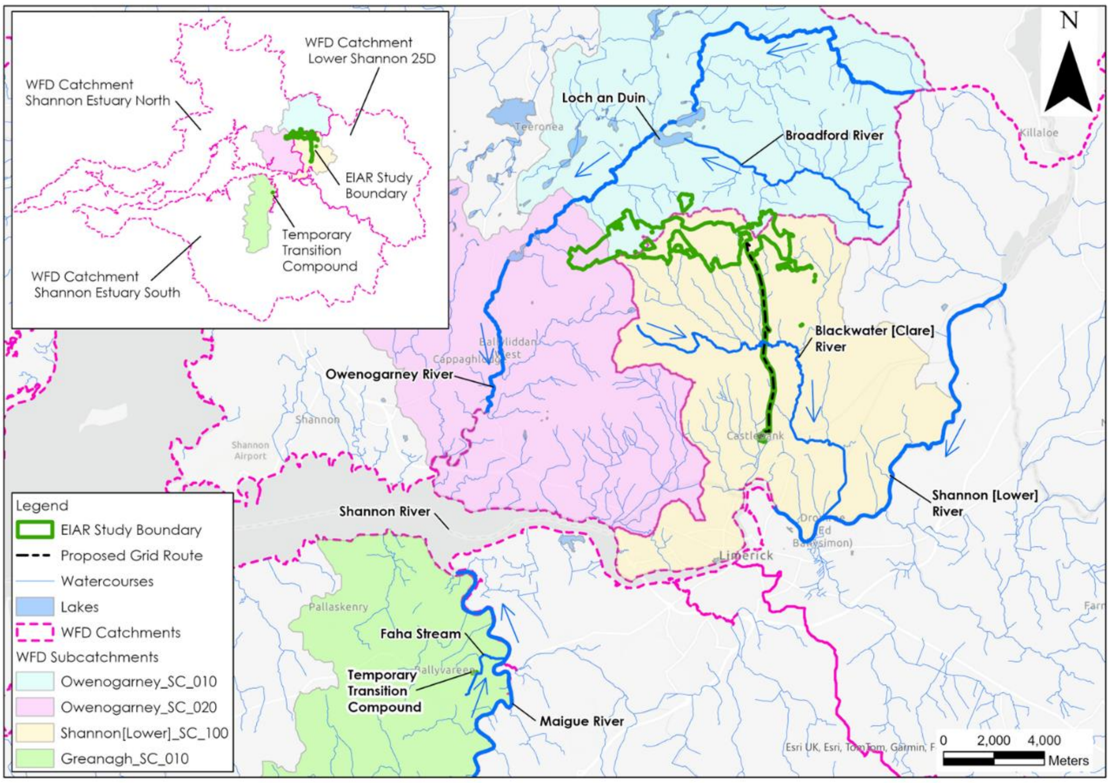


Figure 9-1: Regional Hydrology Map

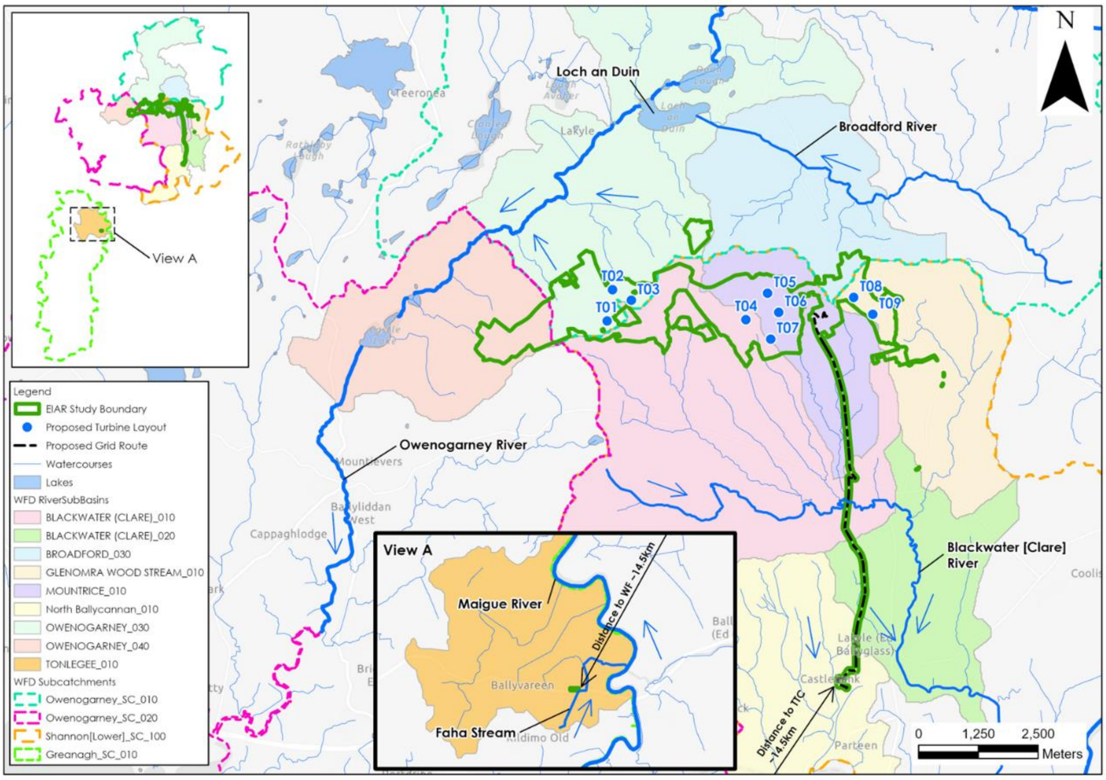


Figure 9-2: Local Hydrology Map

9.3.3.2 Surface Water Flows

There are no Office of Public Works (OPW) gauging stations located in the immediate vicinity of the Wind Farm Site. The closest gauging station is located on the Owenogarney River at the outfall from Castle Lake (Station Code: 27014). Here the 95%ile flow is estimated to be 0.165m^3/s. This means that 95% of the time the flow in the Owenogarney River at this location is at or above 0.165m^3/s. Meanwhile, there are no OPW gauging stations located downstream of the Wind Farm Site along the Blackwater River.

The EPA's Hydrotool, available on www.catchments.ie, was consulted on 29th November 2023, in order to estimate baseline flow volumes in the local area. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several nodes were consulted in the vicinity and downstream of the Wind Farm Site.

Figure 9-3 and Figure 9-4 below present the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Wind Farm Site.

A 95%ile flow relates to the flow which will be exceeded within the river 95% of the time. For example, the 95%ile flow at Node 25_3212 on the Mountrice stream, upstream of its confluence with the Blackwater River, is estimated to be 0.012m^3/s (12l/s). This indicates that 95% of the time, the flow at this location is estimated to be at or above 0.012m^3/s. Due to the increased catchment size, the 95%ile flow at the nodes along the Blackwater River (downstream) are significantly larger. For example at Node 25_3885, near Ardnacrusha, the 95%ile flow is estimated to be 0.093m^3/s (93l/s). The progressively increasing flow volumes downstream of the Wind Farm Site are associated with the increased upstream catchment of the respective waterbodies.

Similarly, within the Shannon Estuary north catchment, flow volumes are small in the small watercourses draining the Wind Farm Site and increase progressively downstream.

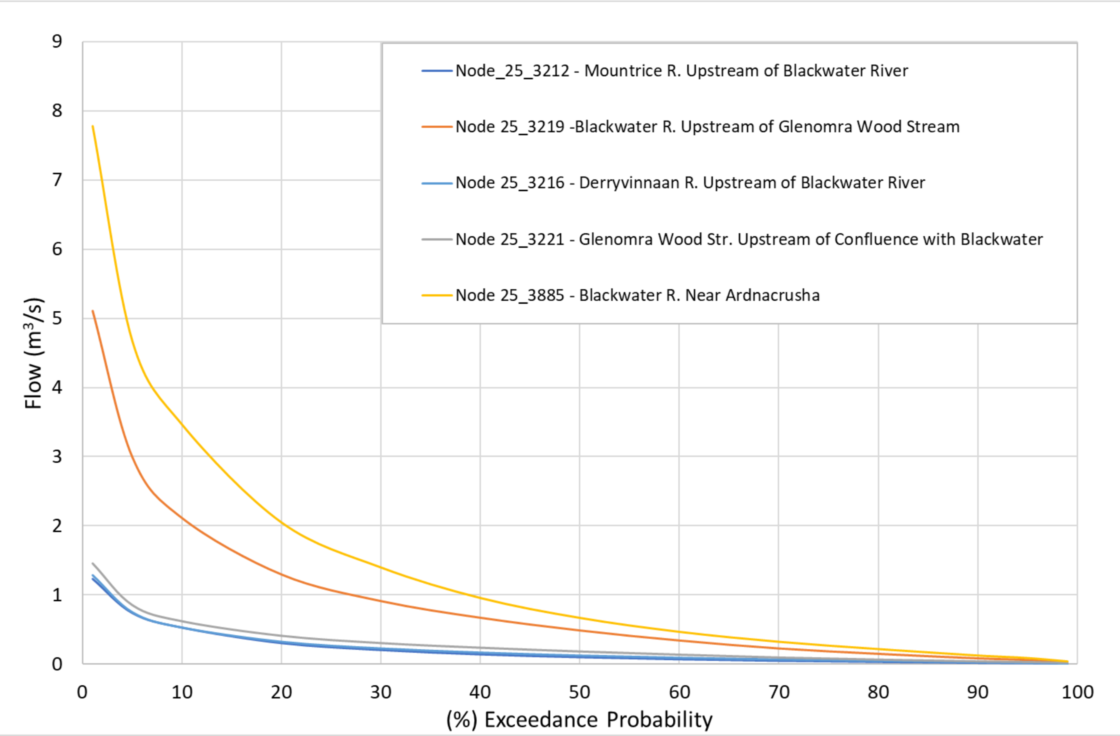


Figure 9-3: EPA Hydrotool Node Flow Duration Curves in the Blackwater Catchment (Lower Shannon)

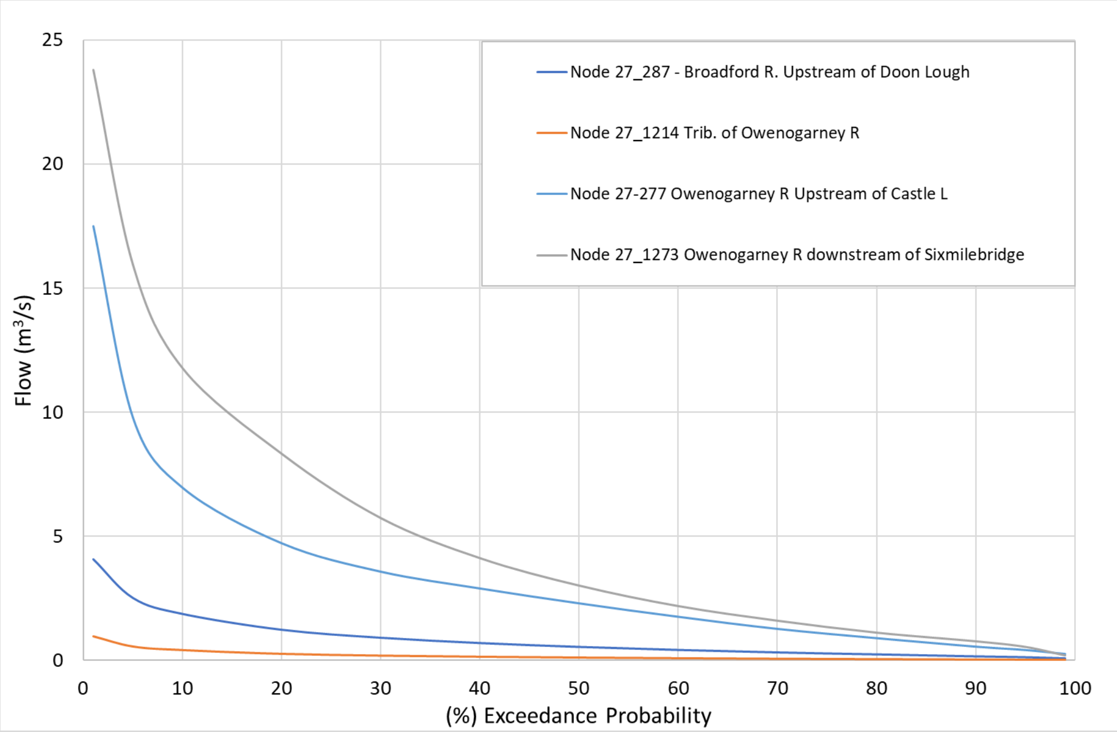


Figure 9-4: EPA Hydrotool Node Flow Duration Curves in the Owenogarney Catchment (Shannon Estuary North)

9.3.3.3 Grid Connection

The Grid Connection is mapped within the Lower Shannon surface water catchment and Hydrometric Area 25D. There are a total of 4 no. crossings over EPA mapped watercourses. These include 2 small tributaries of the Mountrice Stream and the Blackwater River to the south of the R471 Regional Road. Further south the route crosses an unnamed watercourse. This watercourse is a tributary of the Blackwater River and is referred to by the EPA as the Glenlon south watercourse. These watercourse crossings are situated at existing bridge and culvert crossings.

The WFD river sub-basins through which the Grid Connection passes through are detailed in Table 9-8.

9.3.3.4 Turbine Delivery Route

Works are proposed in 3 no. WFD river sub-basins along the TDR. These include minor haul route works at 3 no. locations and a temporary construction compound along the route. The WFD river sub-basins within which these works are proposed are detailed in Table 9-8.

9.3.4 Wind Farm Site Drainage

As stated above, the Wind Farm Site is located in a total of 6 no. river sub-basins, 3 no. sub-basins in the Lower Shannon surface water catchment and 3 no. sub-basins in the Shannon Estuary North catchment.

Table 9-8 below presents the location of the Proposed Development infrastructure within the Wind Farm Site with respect to WFD regions and the closest EPA mapped watercourses.

An existing drainage map for the Wind Farm site is shown within Figure 9-5. The drainage map was created using OSI mapped watercourses, aerial photography, field mapping and Lidar data. Lidar data allows detailed mapping on the topographic contours of the site, thereby identifying all the linear drainage features at the site that are greater than 150m in length. Based on this assessment the main drainage pathways at the site are shown and the connectivity (i.e., pathways and outlet points) of these drains with the downstream EPA mapped streams/rivers can be clearly illustrated.

The Wind Farm Site is drained by several 1st and 2nd order streams. These natural watercourses originate within the Wind Farm Site boundaries and flow downslope before discharging into the Owenogarney River to the northwest and the Blackwater river to the south.

In places the natural drainage is further facilitated by a network of manmade drains. These manmade drains are concentrated within the areas of coniferous forestry and along sections of the existing forestry access roads.

The forest plantations are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation. Mound drains and ploughed ribbon drains are generally spaced approximately every 15m and 2m respectively. Interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of forestry access roads. Culverts are generally located at stream crossings and at low points under access roads which drain runoff onto down-gradient forest plantations. A schematic of a typical standard forestry drainage network and one which is representative of the site drainage network is shown as Figure 9-5. The forestry drains are the primary drainage routes towards the natural streams, but the flows in the higher elevated drains are generally very low or absent most of the time.

5 no. rounds (7th December 2022 to 12th October 2023) of surface water flow monitoring were carried out in the main streams and rivers draining the Wind Farm Site and the results are shown in Table 9-7 below. The measured flows are typical of seasonal flows for 1st and 2nd order streams. Many of the largest recorded flow volumes were encountered during the September and October 2023 monitoring due to high volumes of rainfall in the preceding days. Meanwhile, SW7 and SW8 are located on the Blackwater and Owenogarney river respectively and the recorded flows are more typical of a larger river with significant upstream catchments.

A Wind Farm Site drainage map is shown as Figure 9-6 below.

Table 9-7: Surface Water Flow Monitoring (7th December 2022 to 12th October 2023)

Location	Easting (ITM)	Northing (ITM)	Watercourse – EPA Name	Flow Volume (l/s) Range across 5 no. monitoring rounds
SW1	557153	670030	Mountrice	12 – 20
SW2	556399	669261	Knockshanvo	4 – 8
SW3	554576	669405	Snaty	5 – 12
SW4	552179	669948	Gortadroma	8 – 10
SW5	552868	671871	Clashduff	30 – 50
SW6	559226	669986	Glenomra Wood Stream	4 – 15
SW7	558344	665646	Blackwater River	~250 - ~400
SW8	549979	670269	Owenogarney River	~1,000 - ~2,000

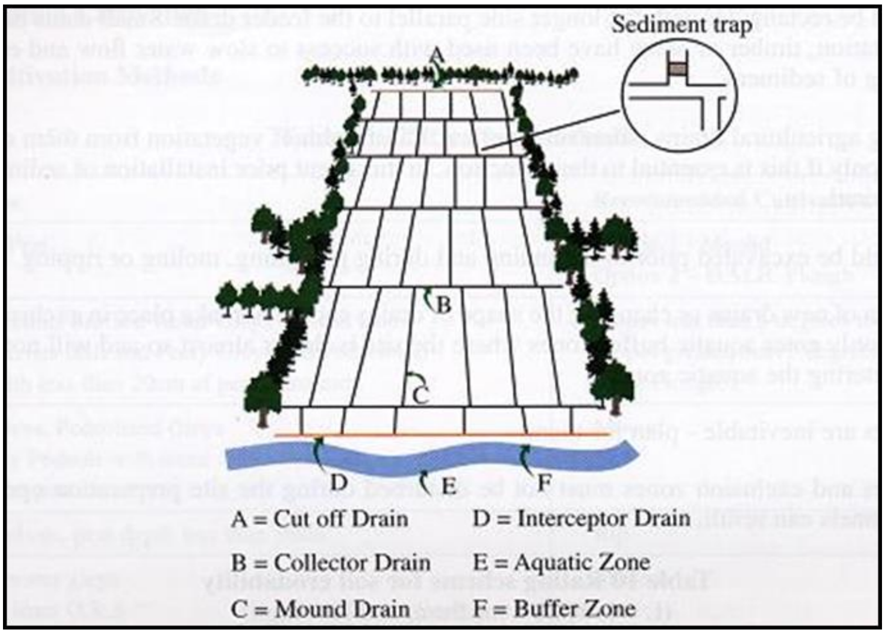


Figure 9-5: Schematic of Existing Forestry Drainage

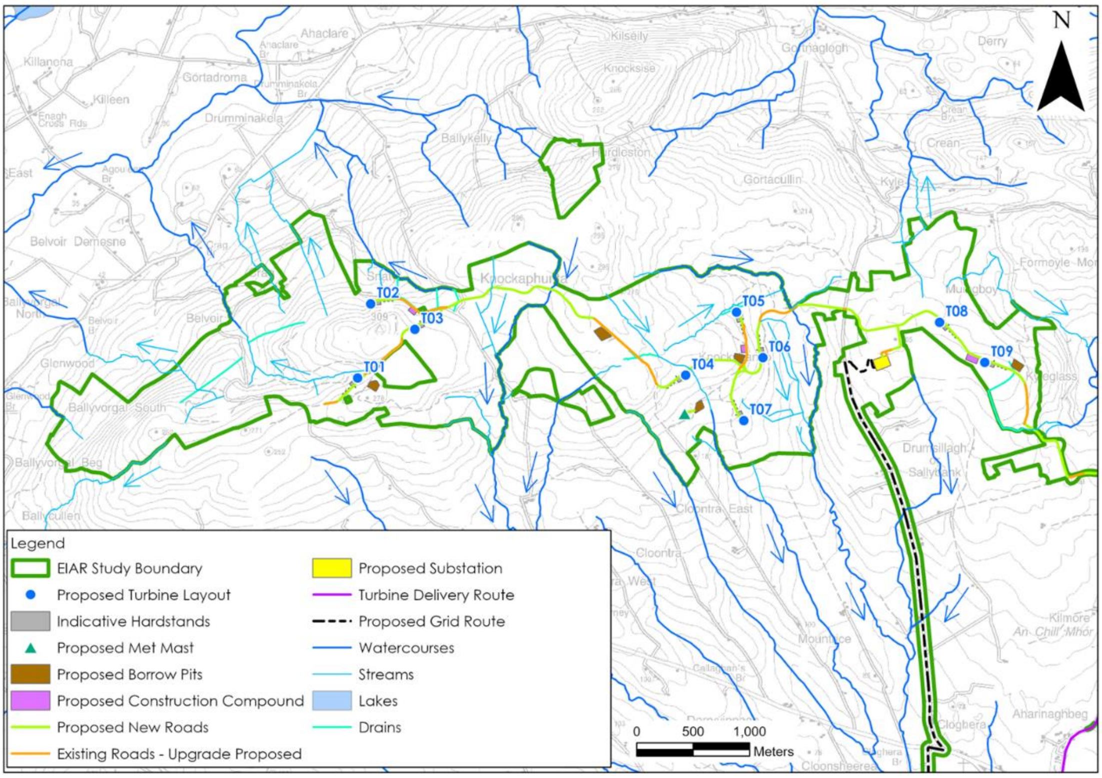


Figure 9-6: Wind Farm Site Drainage Map

Table 9-8: Proposed Development and WFD Regions

Proposed Development Infrastructure	Nearest Mapped Watercourses - Common Name (EPA Name)	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
Wind Farm Site				
2 no. turbines (T08 & T09), 1 no. borrow pit (BP05), 1 no. construction compound (CC3), proposed new site roads, upgrades to existing roads, biodiversity enhancement areas	Unnamed (Glenomra Wood Stream) tributary of the Blackwater River	Glenomra Wood Stream_010	Shannon[Lower]_SC_010	Lower Shannon (HA 25D)
3 no. turbines (T05, T06 and T07), 1 no. borrow pit (BP04), 1 no. construction compound (CC2), onsite substation and associated compound, biodiversity enhancement areas, proposed new site roads, upgrades to existing roads and biodiversity enhancement areas	Drumsillagh River (Mountrice) – tributary of the Blackwater River	Mountrice_010		
1 no. turbine (T40), 2 no. borrow pits (BP02 and BP03), 1 no. met mast, proposed new site roads, upgrades to existing roads and biodiversity enhancement areas	Sruffaunageeragh Stream (Knockshanvo) and O'Neills River (O'Neills) – both tributaries of the Blackwater River	Blackwater(Clare)_010		
Biodiversity enhancement areas	Unnamed (Crean) tributary of Broadford River	Broadford_030	Owenogarney_SC_010	Shannon Estuary North (HA 27)
3 no. turbines (T01, T02 and T03), 1 no. borrow pit (BP01), 1 no. construction compound (CC1), proposed new site	Unnamed (Snaty) tributary of the Owenogarney River	Owenogarney_030		

Proposed Development Infrastructure	Nearest Mapped Watercourses - Common Name (EPA Name)	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
roads, upgrades to existing roads and biodiversity enhancement areas				
None proposed	Unnamed tributaries (Belvoir and Ballyvorgal north) of the Owenogarney River	Owenogarney_040		
Grid Connection				
Grid Connection	2 no. watercourse crossings over tributaries of the Mountrice stream	Mountrice_010	Shannon[Lower]_SC_010	Lower Shannon (HA 25D)
	1 no. crossing over the Blackwater River	Blackwater (Clare)_010		
	1 no. crossing over the Glenlon South stream	Blackwater (Clare)_020		
	No crossings	North Ballycannan_010		
Turbine Delivery Route Works				
Minor Haule Route Works	Area drains to the Glenomra Wood Stream	Glenomra Wood Stream_010	Shannon[Lower]_SC_010	Lower Shannon (HA 25D)
	Area drains to the Glenomra Wood Stream	Blackwater (Clare)_020	Shannon[Lower]_SC_010	Lower Shannon (HA 25D)
Temporary Construction Compound	Area drains to the Maigue Estuary	Tonlegee_010	Greanagh_SC_010	Shannon Estuary South

9.3.5 Summary Flood Risk Assessment

9.3.5.1 Wind Farm Site

A Flood Risk Assessment has been Site has been carried out by HES, the findings of which are presented in full in Appendix 9-1 and are summarised below.

To identify those areas as being at risk of flooding, the OPW's Past Flood Events Maps, the National Indicative Fluvial Mapping, CFRAM River Flood Extents, historical mapping (i.e. 6" and 25" base maps) and the GSI Groundwater Flood Maps were consulted. These flood maps are available to view at Flood Maps - Floodinfo.ie (last reviewed on 30th January 2024).

The OPW Past Flood Events Maps have no records of recurring or historic flood instances within the Wind Farm Site. Similarly, identifiable text on local available historical 6" or 25" mapping does not identify any lands that are "liable to flood".

Within the Shannon Estuary North surface water catchment, the closest mapped historic flood event is located 1.5km to the southwest of the Wind Farm Site (Flood ID: 4480) where a local road flooded in 2005 due to heavy rainfall. With respect to recurring flood events, a flood event is recorded along the Glenomra stream (Flood ID: 4695), 2.2km northeast of the Wind Farm Site along the R466. A second recurring flood event (Flood ID: 4699) is recorded 2.3km north of the Wind Farm Site at Woodfield Bridge along the Ahaclare River. Further downstream several recurring flood events (Flood ID: 4485, 4479, 4498) are also located downstream of Sixmilebridge where roads are noted to flood in the vicinity of the Owenogarney River due to heavy rainfall and/or tidal backup.

Within the Lower Shannon surface water catchment, a historic flood event (Flood ID: 4697) is mapped immediately to the east of the Wind Farm Site. This event dates from 2005 with the flooding resulting from a rare rainfall event (1 in 20-year event) which caused flooding along the R465 from Broadford to Limerick. With respect to mapped recurring flood events, the nearest flood event downstream of the Wind Farm Site is mapped 10km to the south and in the vicinity of Limerick city. Several historic flood events are also mapped in this area, associated with flooding along the River Shannon.

The GSI's Winter 2015/2016 Surface Water Flood Map shows surface water flood extents for this winter flood event. This flood event is recognised as being the largest flood event on record in many areas. The flood map for this event does not record any flood zones along the streams and watercourses which drain the Wind Farm Site. Further downstream, some flooding was recorded along the Owenogarney River, concentrated in the vicinity of Doon Loughs and Castle Lake.

No CFRAM mapping has been completed for the area of the Wind Farm Site. The closest mapped CFRAM fluvial flood zones within the Lower Shannon surface water catchment are located near Ardnacrusha, 10km south of the Wind Farm Site. Meanwhile, the closest CFRAM fluvial flood zones in the Shannon Estuary North catchment are located on the Owenogarney river downstream of Castle Lake and in the vicinity of Sixmilebridge.

The National Indicative Fluvial Flood Map for the Present Day Scenario does not map any flood zones within the Wind Farm Site. Within the Shannon Estuary North surface water catchment, fluvial flood zones are mapped along the Broadford River from Kilbane to Doon Lough with the nearest flood zones situated 1km north of the Wind Farm Site. Downstream of Doon Lough, fluvial flood zones are mapped along the length of Owenogarney, 1km northwest of the site. Meanwhile, within the Lower Shannon Catchment, fluvial flood zones are mapped along the Blackwater River and several of its tributaries to the south of the Wind Farm Site. The closest mapped flood zone is located 1.6km to the southeast along the Glenomra Wood Stream.

Furthermore, the Wind Farm Site is not mapped within any historic or modelled groundwater flood zones.

The main risk of flooding is via pluvial flooding. This risk is limited to local flat areas due to the mountainous nature of the wider area. Surface water ponding/pluvial flooding may occur in some flat areas of the Wind Farm Site due to the presence of low permeability peat at the surface. Mostly the risk of pluvial flooding is low with the exception of local flat areas.

The risk of flooding at the Wind Farm Site is very low due to the elevated and sloping nature of the site and the high density of mountain streams which flow rapidly downslope.

9.3.5.2 Grid Connection

The proposed substation is located within the Wind Farm Site and as such, is addressed in the preceding section. In addition to the Flood Risk Assessment completed for the Wind Farm Site, the potential for flooding along the Grid Connection has also been assessed.

To identify those areas as being at risk of flooding, the OPW's Past Flood Events Maps, the National Indicative Fluvial Mapping, CFRAM River Flood Extents, historical mapping (i.e. 6" and 25" base maps) and the GSI Groundwater Flood Maps were consulted. These flood maps are available to view at Flood Maps – Floodinfo.ie (last reviewed on 30th January 2024).

The OPW Past Flood Events map does not record any historic or recurring flood events along the Grid Connection. Similarly the GSI's Winter 2015/2016 Surface Water Flood Map does not record any surface water flood zones along the Grid Connection.

CFRAM fluvial flood mapping has been completed on the Shannon in the vicinity of Ardnacrusha and the southern section of the Grid Connection. However, no CFRAM fluvial or coastal flood zones encroach upon the Ardnacrusha substation or the proposed Grid Connection.

The National Indicative Fluvial Flood Mapping for the Present Day Scenario shows fluvial flooding along the Blackwater River. An existing watercourse crossing already exists at this location.

In summary, the Grid Connection is low risk of flooding. However, there are areas which may be prone to flooding, principally along the Blackwater River. Due to the depth of the underground cabling route, this will have no impact during the operational phase of the Proposed Development. During the construction phase, works along the underground electrical cabling route may have to be postponed following heavy rainfall events which could cause flooding in this area.

9.3.5.3 Turbine Delivery Route

The Temporary Transition Compound will not be required for the entire duration of the construction phase which will take 18-24 months. It is estimated that the Temporary Transition Compound will be required for a total of 8 months.

The TDR compound is mapped within the 1 in 100-year NIFM fluvial flood zone and the 1 in 10-year National Coastal Flood Zone. Therefore, in any given year the probability of a fluvial flood event of this magnitude occurring is 1 in 100 (1% probability). Given that the TDR compound is temporary and will be present for only ~8 months, the potential for effects are significantly reduced in comparison to a permanent structure being built in the floodplain. It is unlikely (0.8% probability of a fluvial flood event and 8% probability of a coastal flood event - worst case scenario)) that a fluvial flood event of this magnitude (1 in 100-year flood event) will occur during the time period when the compound is present.

Furthermore, the Temporary Transition Compound has a limited footprint of (~1.2ha) in comparison to the overall area covered by the NIFM flood zone. The 1 in 100-year modelled NIFM fluvial flood zone has a total area of 623ha in the local area. Therefore, the Temporary Transition Compound equates to ~0.2% of the modelled NIFM flood zone.

To facilitate access from the local road, it is proposed to raise the existing ground levels at the Temporary Transition Compound by importing ~19,000m^3 of material. In a worst-case scenario whereby the entire compound is submerged, this will result in the displacement of floodwaters. When spread across the local flooded area, the volume of displaced water equates to a rise in water levels of 3mm. The modelled coastal flood zones have a similar flooded extent to the NIFM flood zone and will therefore have a comparable imperceptible impact in terms of flood displacement and increase in flood levels.

9.3.6 Surface Water Quality

9.3.6.1 EPA Water Quality Monitoring

Biological Q-rating[2] data for EPA monitoring points in the local catchments downstream of the Proposed Development site are shown in Table 9-9 below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from Q1 (Bad) to 4-5 (High).

Downstream of the Proposed Development site within the Owenogarney River sub-catchment, the Broadford River achieved a Q-rating of Q4 ('Good' status) at a bridge in Broadford village in 2022 (Station ID: RS27B020700). Further downstream and upstream of Doon Lough (Station ID: RS27B020800) the Broadford River achieved a Q-rating of Q3-4 ('Moderate' status). Meanwhile, downstream of the Doon Lough the Owenogarney River achieved a Q-rating of Q4 at Agouleen Bridge (Sation ID: RS27O010600). At Pollagh Bridge upstream of Castle Lake the Owenogarney River achieved a Q4 rating (Station ID: RS27O010700). Downstream of Castle Lake, the Owenogarney River achieved a Q3-4 rating at Annagore Bridge (Sation ID: RS27O010900) and at the Old Mill Bridge downstream of Sixmilebridge (Station ID: RS27O011100).

Within the Shannon[Lower} sub-catchment, the Mountrice River achieved a Q4-5 rating ('High' status) upstream of its confluence with the Blackwater River in 2021 (Station ID: RS25M030300). Upstream of its confluence with the Glenomra Wood Stream, the Blackwater River achieved a Q4 rating at Killaly's Bridge (Station ID: RS25B060120). The Glenomra Wood Stream itself has been assigned a Q4-5 rating in the latest EPA monitoring round. Further downstream, the Blackwater River has been assigned a Q3-4 rating at a bridge to the southwest of Mount St. Catherine (Station ID: RS25B060250).

A map of EPA monitoring station is shown as Figure 9-7 below.

Table 9-9: EPA Water Quality Monitoring Q-Rating Values

Watercourse	Station ID	Easting	Northing	Year	EPA Q-Rating Status
Ownogarney_SC_020 sub-catchment					
Broadford River	RS27B020700	157386	172713	2022	Q4 (Good)
Broadford River	RS27B020800	155699	173439	2022	Q3-4 (Moderate)

2 The Q-Rating scheme method is used whereby a Quality-index is assigned to a river or stream based on macroinvertebrate data.

Watercourse	Station ID	Easting	Northing	Year	EPA Q-Rating Status
Owenogarney River	RS27O010600	150815	171233	2022	Q4 (Good)
Owenogarney River	RS27O010700	150022	170229	2022	Q3-4 (Moderate)
Owenogarney River	RS27O010900	147685	167617	2022	Q3-4 (Moderate)
Owenogarney River	RS27O011100	148015	164525	2022	Q3-4 (Moderate)
Shannon[Lower]_SC_100 sub-catchment					
Mountrice	RS25M030300	158200	166123	2021	Q4-5 (High)
Blackwater River	RS25B060120	159373	165547	2021	Q4 (Good)
Glenomra Wood Stream	RS25G120100	160025	165844	2021	Q4-5 (High)
Blackwater River	RS25B060250	161194	161531	2021	Q3-4 (Moderate)

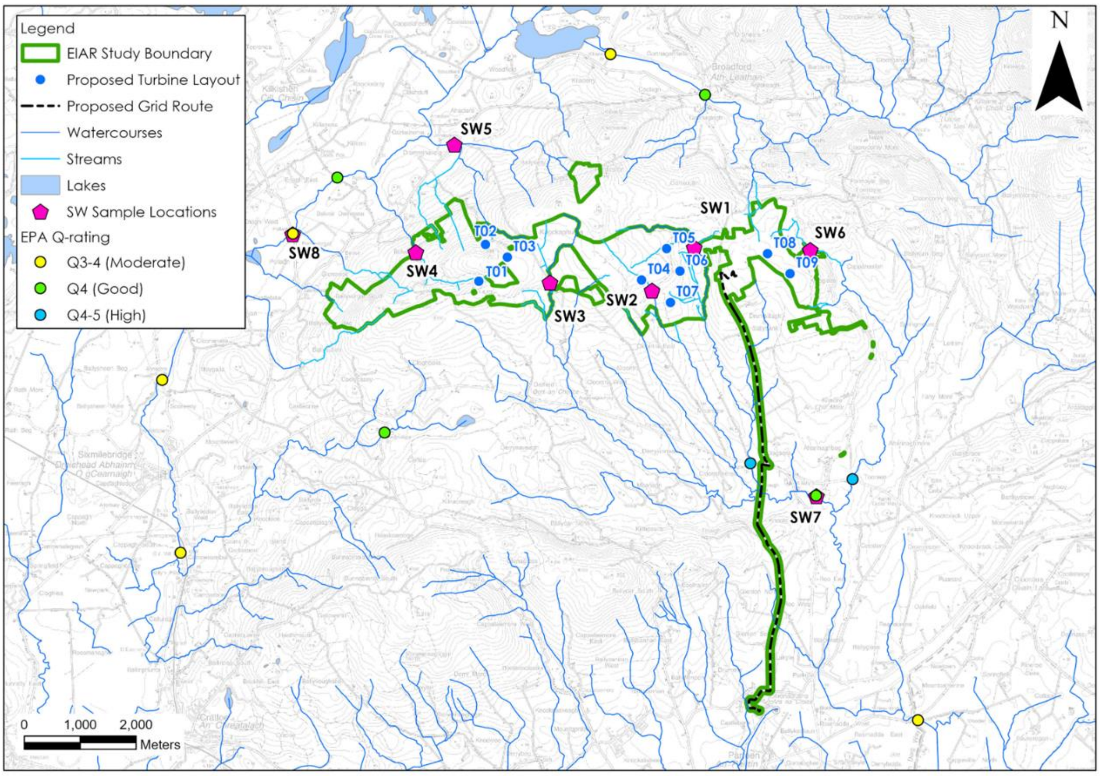


Figure 9-7: EPA and HES Surface Water Monitoring Locations

9.3.6.2 HES Surface Water Monitoring

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) along with turbidity (NTU) were taken at 8 no. surface water sampling locations over 5 no. monitoring rounds completed between 7th December 2022 and 12th October 2023 within surface watercourses draining and directly downstream of the Wind Farm Site and Grid Connection within the Owenogarney and Blackwater river catchments. The results are listed in Table 9-10 below. The monitoring locations are shown in Figure 9-7 above.

Specific electrical conductivity values at the monitoring locations ranged between 65.1 and 347µS/cm, with an average specific conductivity value of 143µS/cm. Turbidity ranged from 0.7 to 23.3NTU. The highest turbidity values of 21.2 and 23.3NTU were recorded on 13th September 2023. Several days of heavy rainfall preceded this sampling event. Oxygen ranged from 82.4 to 95.7 % saturation. The pH values were generally neutral or slightly acidic or slightly basic, ranging between 6.57 and 7.8, with an average pH of 7.43.

Table 9-10: Field Parameters - Surface Water Chemistry Measurements (07/12/2022 to 12/10/2023)

Location ID	Temp °C	DO (% Sat)	SPC (µS/cm)	pH	Turbidity (NTU)
SW1	10.2 – 13.3	90.9 – 93	65.1 – 182.3	7.1 – 7.69	1.48 – 2.14
SW2	10.5 – 13.8	89.4 – 92.1	75.9 – 122.9	6.81 – 7.73	0.7 – 2.78
SW3	10.4 – 13.7	89.6 – 93.5	79.6 – 152.9	6.84 – 7.62	1.15 – 19.5
SW4	10.2 - 13.4	94.5 – 95	78.3 – 135.2	7.46 - 7.69	3.13 – 21.2
SW5	10.2 - 14.3	94.2 – 95.7	126.7 – 204	6.82 – 7.8	1.08 – 2.04
SW6	10.8 – 13.0	82.4 – 91	89.4 – 160.2	6.57 – 7.68	3.41 – 6.78
SW7	11.2 -14.2	93.5 - 94.8	126.6 – 294	7.48 – 7.8	0.84 – 23.3
SW8	11.7 – 17.2	84.1 – 88.4	232.7 - 347	7.35 – 7.68	1.88 – 2.69

Surface water grab samples were also taken at these locations for laboratory analysis on 4 no. occasions (13th July 2023, 15th August 2023, 13th September and 12th October 2023). Results of the laboratory analysis are shown alongside relevant water quality regulations in Table 9-11 below.

Suspended solid concentrations ranged from <5 to 18mg/l. Suspended solid concentrations were below the S.I 293 (of 1988) threshold limit of 25 mg/l in all 32 no. samples.

Ammonia concentrations were predominantly found to be of 'Good' status with regards to the threshold of ≤0.065mg/l as detailed in S.I. 272 of 2009. There was only 1 no. exceedance of this 'Good' status threshold value. Indeed a total of 29 no. samples were of 'High' status (≤0.04) with regards Ammonia concentrations.

BOD concentrations typically exceeded the 'Good' status threshold of ≤1.5mg/l (S.I. 272 of 2009). BOD ranged between <1 and 5mg/l. Meanwhile, 13 no. samples achieved 'High' status with regards to BOD (≤1.3mg/l).

Ortho-phosphate concentrations were at or below the limit of detection (0.02mg/l) in all samples. All samples achieved 'High' status with regard to ortho-phosphate concentrations (≤0.025mg/l).

Nitrate concentrations were found to be below the level of detection of the laboratory in all but 1 no. sample. Meanwhile, chloride concentrations ranged from 9.3 to 19.5mg/l.

Table 9-11: Summary surface water quality data (13/07/2023 to 12/10.2023)

Location ID	Suspended Solids (mg/l)	BOD_5 (mg/l)	Orthophosphate (mg/l)	Nitrate (mg/l NO_3)	Ammonia (mg/l)	Chloride (mg/l)
EQS	**≤25(3)**	**≤ 1.3 to ≤ 1.5(4)**	**-≤ 0.035 to ≤0.025(2)**	-	**-≤0.065 to ≤ 0.04(2)**	-
SW1	<5 - <6	1 - 3	<0.02	<1 - <5	<0.02 - 0.03	9.3 – 11.7
SW2	<5 - 18	2	<0.02	<1 – 6.7	<0.02 - 0.02	12.5 – 16.2
SW3	<5 - <6	<1 - 3	<0.02	<1 - <5	<0.02 - 0.12	10.3 – 19.5
SW4	<5 - 8	<1 - 3	<0.02 - 0.02	<1 - <5	0.02 – 0.03	14.3 - 19
SW5	<5 - <6	<1 - 3	<0.02	<1 - <5	<0.02 – 0.02	13 - 14.2
SW6	<5 - <6	1 - 5	<0.02	<1 - <5	0.02 - 0.04	10.4 – 14.5
SW7	<5 - <6	2 - 5	<0.02 – 0.02	<1 - <5	0.02 - 0.03	10.9 – 13.7
SW8	<5 - 5	1 - 5	<0.02	<1 - <5	0.02 – 0.03	11.9 - 14.8

9.3.7 Hydrogeology

9.3.7.1 Wind Farm Site

The bedrock geology underlying the Wind farm Site is predominantly mapped as Devonian Old Red Sandstones with some Silurian Metasediments and Volcanics and Ordovician Metasediments. The Old Red Sandstones (undifferentiated) are classified as being a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones. Meanwhile, the Silurian Metasediments and Volcanics and the Ordovician Metasediments are classified as being a Poor Aquifer – Bedrock which is Generally Unproductive except in Local Zones. A bedrock geology aquifer map is attached as Figure 9-8.

In terms of WFD Groundwater Bodies (GWBs), the Wind Farm Site lies on the boundary between 2 no. GWBs, the Tulla-Newmarket-on-Fergus GWB in the west and north and the Lough Graney GWB in the south and east.

The GSI's initial characterisation report for the Tulla-Newmarket-on-Fergus GWB (GSI, 2003) states that this GWB is comprised of generally low transmissivity and storativity rocks. The older Silurian and Devonian rocks will have the lowest transmissivities. Groundwater flow will be along fractures, joints and faults. Groundwater recharge will occur diffusely through the subsoils and outcrops but will be a function of slope and aquifer permeabilities. Flows in the aquifer are typically concentrated in a thin zone at the top of the aquifer. Locally groundwater flows to nearby surface watercourses and follows surface topography. Flowpaths ae short (30-300m) and groundwater will discharge to the springs and rivers crossing the aquifer.

---

[3] *S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations*

[4] *S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended by S.I. No. 296/2009; S.I. No. 386/2015; S.I. No. 327/2012; and S.I. No. 77/2019 and giving effect to Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2000/60/EC establishing a framework for Community action in the field of water policy).*

Meanwhile, the GSI's initial characterisation report for the Lough Graney GWB (GSI, 2003) states that this GWB is also comprised of generally low transmissivity and storativity rocks, with the older Silurian and Devonian rocks having the lowest transmissivities. Groundwater flow will occur along fractures, joints and faults however, flows are typically concentrated in a thin zone at the top of the rock. Groundwater recharge occurs where rock outcrops or where subsoils are thein. Meanwhile, in upland areas, the majority of potential groundwater recharge runs off as surface water. Groundwater flows are determined by local topography and flow lengths are short (30-300m). The increased hydraulic gradient, due to the sloping topography in upland areas, will allow groundwater to flow faster. Groundwater discharges to springs and watercourses.

9.3.7.2 Grid Connection

The Grid Connection is predominantly underlain by Poor and Locally Important bedrock aquifers, Meanwhile, approximately 1.4km in the south of the Grid Connection and in the vicinity of Ardnacrusha substation, is underlain by a Regionally Important Aquifer - Karstified (diffuse).

In terms of GWBs, the Grid Connection is predominantly underlain by the Lough Graney GWB. The southern section of the route underlain by the Ardnacrusha GWB. Further details on the Lough Graney GWB are provided in the preceding section.

According to the GSI's GWB Characterisation Report (GSI, 2003), the Ardnacrusha GWB is a small, narrow GWB which is elongated in an east/northeast to west/southwest direction and contains flat to gently undulating land (10-20mOD). This GWB comprises of diffusely karstified limestones in which groundwater is transmitted through a network of small conduits and fissures, and an epikarst zone. The fault/fracture and bedding planes have been enlarged by dissolution resulting in a highly transmissive aquifer with rapid groundwater flow. The aquifer has low storativity. Groundwater recharge occurs diffusely through the subsoils and rock outcrop. The groundwater flux in the aquifer will be concentrated in a 30m zone at the top of the aquifer which comprises of an epikarst layer near the surface and deeper solutionally enlarged joints and faults. Groundwater discharge to the rivers and streams crossing the GWB and to the River Shannon. Local groundwater flow directions are determined by topography and by the local drainage patters. Flow path lengths are generally long (up to several kms).

9.3.7.3 Turbine Delivery Route

The works along the R465 are underlain by a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones and the Lough Graney GWB.

The Temporary Transition Compound is underlain by a Regionally Important Aquifer – karstified (conduit) and Kildimo GWB. No karst features are mapped by the GSI in the local area (www.gsi.ie).

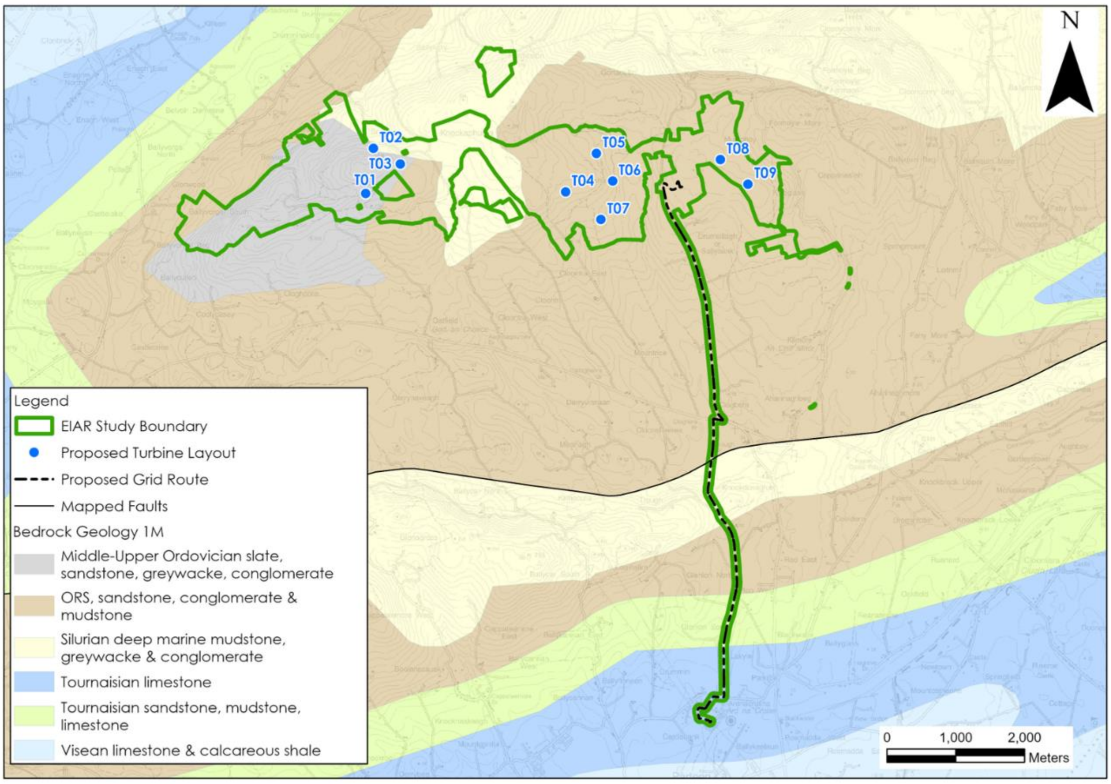


Figure 9-8: Bedrock Aquifer Map

9.3.8 Groundwater Vulnerability

9.3.8.1 Wind Farm Site

The GSI describe groundwater vulnerability as a term used to represent the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities. Groundwater vulnerability embodies the characteristics of the intrinsic geological and hydrogeological features at a site that determine the ease of groundwater contamination. Groundwater vulnerability is related to recharge acceptance, whereby in areas where recharge occurs more readily, a higher quantity of contaminants will have access to groundwater.

The vulnerability rating of the bedrock aquifer underlying Wind Farm Site is mapped by the GSI (www.gsi.ie) to range from High to Extreme. The extreme vulnerability rating is due to the thin coverage of peat and subsoils in this area i.e. rock is close to the ground surface. A map of groundwater vulnerability is shown as Figure 9-9.

Site investigations at the Wind Farm Site comprising of peat probes, trial pits and boreholes have revealed that the depth to rock is typically shallow. Intrusive site investigation found that depth to rock ranges between 0.7 – 4.6m. Only 1 of the 13 no. trial pits and 2 of the 3 no. boreholes encountering bedrock deeper than 3m. Given the shallow depth to rock and the nature of the subsoils (silts, clays, sands and gravels), the vulnerability at the Wind Farm Site ranges from High to Extreme in accordance with Table 9-12.

However, due to the low permeability nature of the underlying bedrock aquifers, groundwater flowpaths are likely to be short (30 – 300m), with recharge emerging close by and discharging into local surface water streams. This means there is a low potential for groundwater dispersion and movement within the aquifer, therefore surface water bodies such as drains and streams/rivers are more vulnerable (to contamination from human activities) than groundwater at the Wind Farm Site.

Table 9-12: Groundwater Vulnerability and Subsoil Permeability and Thickness

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

9.3.8.2 Grid Connection

The GSI mapped groundwater vulnerability rating along Grid Connection ranges from Extreme-X to Moderate (www.gsi.ie). Much of the Grid Connection is mapped as having moderate vulnerability with the extreme vulnerabilities mapped in the vicinity of the Wind Farm Site and further south near Knockdonagh.

9.3.8.3 Turbine Delivery Route

The GSI mapped groundwater vulnerability rating at the TDR work areas ranges from Moderate to Extreme (www.gsi.ie). Due to the shallow nature of the works no impacts on groundwater quality would be anticipated.

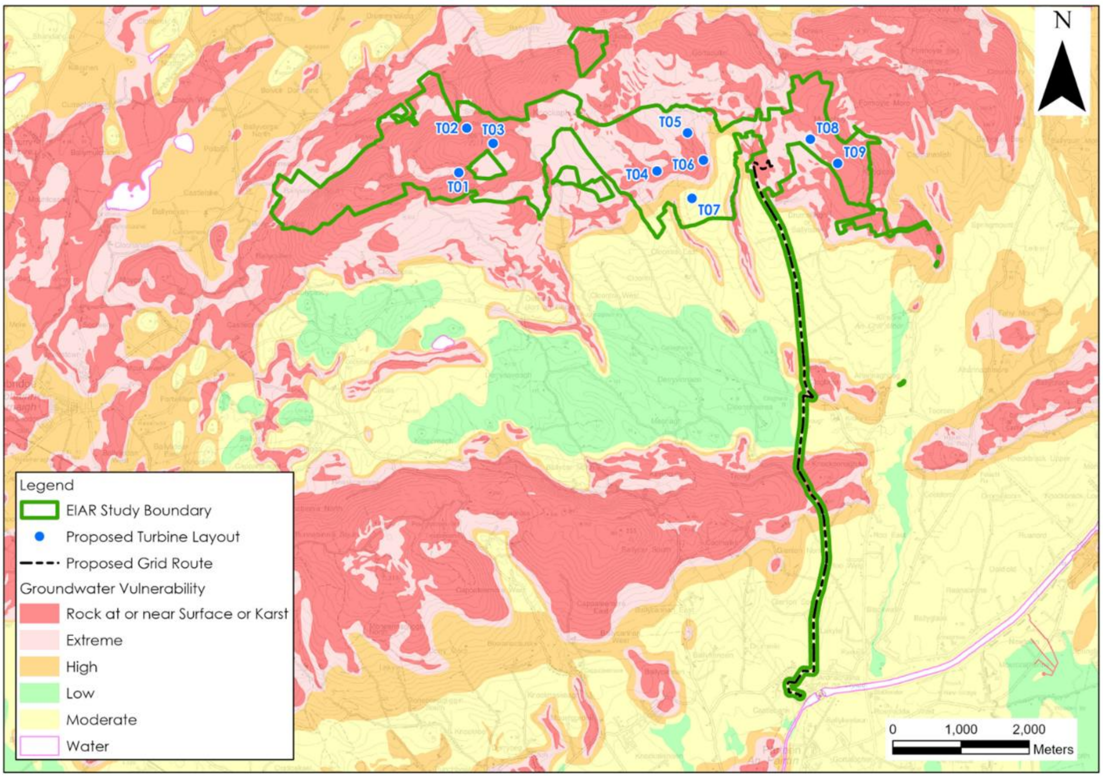


Figure 9-9: Groundwater Vulnerability Map (www.gsi.ie)

9.3.9 Groundwater Hydrochemistry

9.3.9.1 Wind Farm Site

There are no groundwater quality data for the Wind Farm Site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting, as groundwater quality impacts would not be anticipated.

The GSI's initial characterisation of the Tulla-Newmarket-on-Fergus and Lough Graney GWBs (2003) states that there are limited hydrochemical data available for this GWB. However, the GSI state that all aquifers are likely to have a calcium-bicarbonate signature. However, hardness, alkalinity and electrical conductivities will vary between the aquifers. Groundwaters from the Silurian strata are likely to range from Slightly Hard to Hard (90–360 mg/l $CaCO_3$), with alkalinities ranging from 60 to 270 mg/l (as $CaCO_3$) and electrical conductivities from 260–600 µS/cm. pHs will be neutral. In the Old Red Sandstone aquifers, groundwaters are Moderately Hard (145-235 mg/l as $CaCO_3$) with moderate alkalinities (140-225 mg/l as $CaCO_3$) and electrical conductivities (310-440 µS/cm), and neutral to slightly acidic pHs. The groundwater is characterised by relatively low calcium and magnesium concentrations, but elevated iron and magnesium.

9.3.9.2 Grid Connection

Details on the hydrochemistry of the Lough Graney GWB are provided in the preceding section.

With respect to the Ardnacrusha GWB, the GSI state that no hydrochemical data is available for this GWB. The hydrochemistry of groundwaters from the nearby Fedamore GWB indicates Very Hard (370–430 mg/l as $CaCO_3$), calcium-bicarbonate type waters with high alkalinities (330–380 mg/l as $CaCO_3$) and electrical conductivities (720–900+ µS/cm).

Groundwater sampling would not generally be undertaken in terms of EIAR reporting, as groundwater quality impacts would not be anticipated along the Grid Connection.

9.3.9.3 Turbine Delivery Route

No hydrochemical data is available for the Kildimo GWB. Groundwater quality effects are not anticipated along the TDR.

9.3.10 Water Framework Directive Water Body Status & Objectives

The River Basin Management Plan (2022-2027) has amalgamated all previous river basin districts into one national river basin management district. The River Basin Management Plan (2022 - 2027) objectives, which have been integrated into the design of the Proposed Development, include the following:

- Ensure full compliance with relevant EU legislation;
- Build on the achievements of the 2nd Cycle;
- Prevent deterioration and maintain a 'high' status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least good status by 2027;
- Ensure waters in protected areas meet requirements; and,
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at restoring impacted waters and protecting waters from deterioration.

Our understanding of these objectives is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all. Furthermore any proposed development must not in any way prevent a waterbody from achieving at least good status by 2027.

9.3.11 Groundwater Body Status

Local GWB status information is available from (www.catchments.ie) (last accessed and reviewed on 30th January 2024).

The Lough Graney GWB (IE_SH_G_157) underlies the east and south of the Wind Farm Site and most of the Grid Connection. Meanwhile, the north and west of the Wind Farm Site is underlain by the Tulla-Newmarket-on-Fergus GWB (IE_SH_G_229). The Ardnacrusha GWB (IE_SH_G_09) underlies the south of the Grid Connection. The Kildimo GWB (IE_SH_G_119) underlies the Temporary Transition Compound along the TDR. Summary WFD information for these GWBs is presented in Table 9-13 below.

These 4 no. GWBs achieved 'Good' status in all 3 no. WFD cycles (2010-2015, 2013-2018 and 2016-2021) which is defined based on the quantitative status and chemical status of the GWB. These GWBs have been deemed to be 'not at risk' of failing to meet their respective WFD objectives. Furthermore, no significant pressures have been identified on these GWBs.

Table 9-13: WFD Groundwater Body Status

GWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Lough Graney	Good	Good	Good	Not at risk	None
Tulla-Newmarket on Fergus	Good	Good	Good	Not at risk	None
Ardnacrusha	Good	Good	Good	Not at risk	None
Kildimo	Good	Good	Good	Not at risk	None

9.3.12 Surface Water Body Status

A summary of the WFD status and risk result for SWBs in the vicinity and downstream of the Proposed Development site (Wind Farm Site, Grid Connection and TDR work areas) are shown in Table 9-14 below.

Within the Shannon Estuary North surface water catchment, the Broadford_030 SWB achieved 'Moderate' status in the latest WFD cycle (2016-2021). The Broadford River flows into the Owenogarnery_030 SWB before it discharges into the Duin CE Lake waterbody. The Owengarney_030 SWB achieved 'Good' status while Duin CE lake waterbody achieved 'Moderate' status in the latest WFD cycle (2016-2021). Further downstream, the Owenogarney_040 and _050 SWBs also achieved 'Good' status. However, the Castle CE lake waterbody was found to be of 'Poor' status. The Owenogarney_060 SWB achieved 'Good' status while the Upper Shannon Estuary is of 'Poor' status.

A total of 3 no. SWBs downstream of the Wind Farm Site in the Shannon Estuary North surface water catchment have been deemed to be 'at risk' of failing to meet their respective WFD objectives. These 'at risk' SWBs include the Broadford_030 river waterbody, Castle Lake waterbody and the Upper Shannon Estuary transitional waterbody. The risk status of the Duin lake waterbody and the Owenogarney_060 SWB are currently under review. The remaining SWBs have been deemed to be 'not at risk' of failing to meet their WFD objectives.

The 3rd Cycle Draft Shannon Estuary North Catchment Report (EPA, 2021) states that excess nutrients and morphological issues remain the most prevalent issues in this catchment. The Broadford_030 and Upper Shannon Estuary SWBs are listed as being under significant pressure from agricultural activities. Meanwhile, the Castle Lake SWB is under significant pressure from agriculture, invasive species (in the form of zebra mussels) and surface water abstraction (Shannon/Sixmilebridge public water supply abstraction).

Within the Lower Shannon surface water catchment, the Blackwater (Clare)_010 and the Mountrice_010 SWBs in the vicinity of the Wind Farm Site achieved 'Good' status in the latest WFD cycle (2016-2021). Meanwhile, the Glenomra Wood Stream_010 SWB achieved 'High' status. Further downstream and along the Grid Connection the Blackwater (Clare)_020 SWB and the Lower Shannon_060 SWBs achieved 'Good' and 'Moderate' status respectively. The North Ballycannan_010 SWB also achieved 'Good' status along the Grid Connection. In terms of downstream transitional waterbodies, the Limerick Dock waterbody achieved 'Poor' status.

A total of 3 no. river waterbodies in the Lower Shannon surface water catchment in the vicinity and downstream of the Proposed Development site have been deemed to be ‘at risk’ of failing to meet their WFD objectives. These include the Blackwater (Clare)_010 and _020 SWBs and the Mountrice_010 SWB. In addition, the Limerick Dock transitional waterbody is ‘at risk’. The risk status for the Shannon (Lower)_060 SWB is currently under review. The remaining SWBs downstream of the Proposed Development site are not at risk failing to meet their WFD objectives

The 3rd Cycle Lower Shannon and Mulkear Catchment Report (HA 25D) states that excess nutrients and morphological impacts remain the most prevalent issues in this catchment. Agriculture and forestry have been identified as significant pressures on the Blackwater (Clare)_010 SWB. Agriculture is also listed as a pressure on the Blackwater (Clare)_020 SWB further downstream. In relation to agriculture the catchment report states that the issues relating to farming in this catchment are diffuse phosphorus loss to surface waters and sediment from land drainage works, bank erosion or stream crossings. Meanwhile the significant issues for forestry are a combination of general forestry practices such as road construction, planting and clear felling which have resulted in heavy siltation. The Mountrice_010 SWB is under significant pressure from hydromorphology, with the catchment report stating that overgrazing is likely to have altered habitat through changes in river morphology. The Limerick Dock transitional waterbody is under significant pressure from hydromorphology.

Downstream of the Temporary Transition Compound along the TDR, the Tonlegee_010 SWB and the Maigue Estuary SWB are of ‘Poor’ and ‘Moderate’ status respectively.

Further details are provided in the WFD Compliance Assessment attached as Appendix 9-3.

Table 9-14: WFD Surface Waterbody Status

SWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Shannon Estuary North Catchment					
Broadford_030	Good	Good	Moderate	At risk	Agriculture
Owenogarney_030	Good	Good	Good	Not at risk	None
Duin CE	Unassigned	Good	Moderate	Under review	None
Owenogarney_040	Good	Good	Good	Not at risk	None
Castle CE	Moderate	Poor	Moderate	At risk	Abstraction, agriculture & invasive species
Owenogarney_050	Good	Good	Good	Not at risk	None
Owenogarney_060	Unassigned	Moderate	Good	Under Review	None
Upper Shannon Estuary	Poor	Poor	Poor	At risk	Agriculture
Lower Shannon Catchment					
Blackwater(Clare)_010	Good	Good	Good	At risk	Agriculture & forestry
Mountrice_010	High	Good	Good	At risk	Hydromorphology
Glenomra Wood Stream_010	Good	High	High	Not at risk	None
Blackwater(Clare)_020	Good	Good	Good	At risk	Agriculture
Shannon (Lower)_060	Unassigned	Moderate	Moderate	Under review	None
North Ballycannan_010	Unassigned	Moderate	Good	Not at risk	None
Limerick Dock	Moderate	Good	Poor	At risk	None
Shannon Estuary South Catchment					
Tonlegee_010	Unassigned	Good	Poor	Under review	None
Maigue Estuary	Moderate	Moderate	Moderate	At risk	Agriculture

9.3.13 Designated Sites and Habitats

9.3.13.1 Wind Farm Site

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). A designated site map for the area is shown as Figure 9-10.

The Wind Farm Site is not located within any designated conservation site, however there are several designated sites in close proximity and downstream of the Wind Farm Site. The connectivity of these designated sites to the Wind Farm is detailed in Table 9-15.

Within the Shannon Estuary North surface water catchment:

- Gortacullin Bog NHA (Site Code: 002401) borders the norther boundary of the Wind Farm Site. This designated site contains a mosaic of upland blanket bog and wet heath habitats. The site also supports a good diversity of blanket bog microhabitats, including hummock/hollow complexes, flushes and regenerating cutover with willow and birch scrub. However, no works are proposed upgradient of this designated site. There is no hydrological connection between the Proposed Development and this NHA.
- Doon Lough NHA (Site Code: 000337) is located 2.4km to the north of the Wind Farm Site. The site comprises a raised bog, that includes both areas of high bog and cutover bog, woodlands, lakes, marsh, fen and wet meadows. This NHA is hydrologically connected to the Wind Farm Site via the Broadford River and its tributaries. The works proposed in the catchment to the Broadford River comprise solely of ~150m of new proposed access road.
- Danes Hole, Poulnalecka SAC/pNHA (Site Code: 00030) 600m north of the Wind Farm Site. This site consists of a small fossil cave in the banks of the Ahaclare River situated within a wood. It is a winter hibernation site and also a mating site of the Lesser Horseshoe Bat. This SAC/pNHA is hydrologically connected with the Wind Farm Site via the Clashduff stream, however this SAC has not been assessed in terms of hydrological impacts as the bat roosts are not hydrologically dependent.
- Castle Lake pNHA (Site Code: 000239) is located 520m west of the Wind Farm Site and is hydrologically connected with the Wind Farm Site via the Owenogarney River and its tributaries.
- The Ratty River Cave SAC (Site Code: 002316) is located 2.5km to the west of the Wind Farm Site. This site consists of a cave, and also an important winter roost and is a breeding site of the Lesser Horseshoe Bat. This designated site is hydrologically linked with the Wind Farm Site via the Owenogarney River.
- The Lower River Shannon SAC (Site Code: 002165) is located 8.2km to the southwest. This very large site stretches along the Shannon valley from Killaloe in Co. Clare to Loop Head/ Kerry Head, a distance of some 120 km. The site is an SAC for the presence of several special and habitats listed on Annex I/II of the Habitats Directive.
- The Fergus Estuary and Inner Shannon, North Shore pNHA (Site Code: 002048) is located 9.6km from the Wind Farm Site.
- The River Shannon and Fergus Estuary SPA (Site Code: 004077) is located 9.6km from the Wind Farm Site.

Within the Lower Shannon surface water catchment:

- Gortacullin Bog NHA (Site Code: 002401) is located immediately to the north of the Wind Farm Site Boundary. However, no works are proposed upgradient of this designated site. There is no hydrological connection between the Proposed Development and this NHA.

- The Glenomra Wood SAC/pNHA is located 1.8km to the southeast of the Wind Farm Site. This site is a deciduous woodlands and is designated for the presence of Old Oak Woodlands. This site is not assessed in terms of hydrological impact as this site is designated due to the presence of a terrestrial woodland which is not hydrologically dependent.
- The Lower River Shannon SAC (Site Code: 002165) is located 8.7km to the south of the Wind Farm Site.

Table 9-15: Summary of Distances and Connectivity to Designated Sites

Designated Site	Minimum Distance to Site from EIAR Boundary	Hydrological connectivity to Designated/European Sites	Groundwater connectivity to Designated / European Sites
Shannon Estuary North Surface Water Catchment			
Gortacullin Bog NHA	Immediately north of Wind Farm Site	None – NHA is upgradient of all proposed works	None - NHA is upgradient of all proposed works
Doon Lough NHA	2.4km north of Wind Farm Site	Linked via the Broadford River and its tributaries	Limited – groundwater will discharge to the nearby surface watercourses
Danes Hole, Poulnalecks SAC / pNHA	600m north of Wind Farm Site	Linked via Clashduff Stream	Limited – groundwater will discharge to the nearby surface watercourses
Castle Lake pNHA	520m west of Wind Farm Site	Linked via the Owenogarney River	Limited – groundwater will discharge to the nearby surface watercourses
Ratty River Cave SAC	2.5km west of Wind Farm Site	Linked via the Owenogarney River Qualifying interests are not hydrologically dependent.	Limited – groundwater will discharge to the nearby surface watercourses
Lower River Shannon SAC	8.2km southwest of Wind Farm Site	Linked via the Owenogarney River	None – groundwater will discharge to the nearby surface watercourses
Fergus Estuary and Inner Shannon, North Shore pNHA	9.6km southwest of Wind Farm Site	Linked via the Owenogarney River	None – groundwater will discharge to the nearby surface watercourses
River Shannon and Fergus Estuary SPA	9.6km southwest of Wind Farm Site	Linked via the Owenogarney River	None – groundwater will discharge to the nearby surface watercourses
Lower Shannon Surface Water Catchment			

Designated Site	Minimum Distance to Site from EIAR Boundary	Hydrological connectivity to Designated/European Sites	Groundwater connectivity to Designated / European Sites
Gortacullin Bog NHA	Immediately north of Wind Farm Site	None – NHA is upgradient of all proposed works	None - NHA is upgradient of all proposed works
Glenomra Wood SAC/pNHA	1.8km southeast of Wind Farm Site	Linked via the Glenomra Wood Stream Qualifying interests are not hydrologically dependent.	Limited – groundwater will discharge to the nearby surface watercourses
Lower River Shannon SAC	8.7km south of Wind Farm Site	Linked via the Blackwater River	None – groundwater will discharge to the nearby surface watercourses

9.3.13.2 Grid Connection

No designated sites are mapped along the Grid Connection. The Grid Connection is located upstream and is hydrologically connected to the Lower River Shannon SAC.

9.3.13.3 Turbine Delivery Route

The Lower River Shannon SAC (Site Code: 002165), the River Shannon and River Fergus Estuaries SPA (Site Code: 004077), the Inner Shannon Estuary – South Shore pNHA (Site Code: 000435) and the Fergus Estuary and Inner Shannon, North Shore pNHA (Site Code: 002048) are located downstream of the Temporary Transition Compound on the Maigue Estuary.

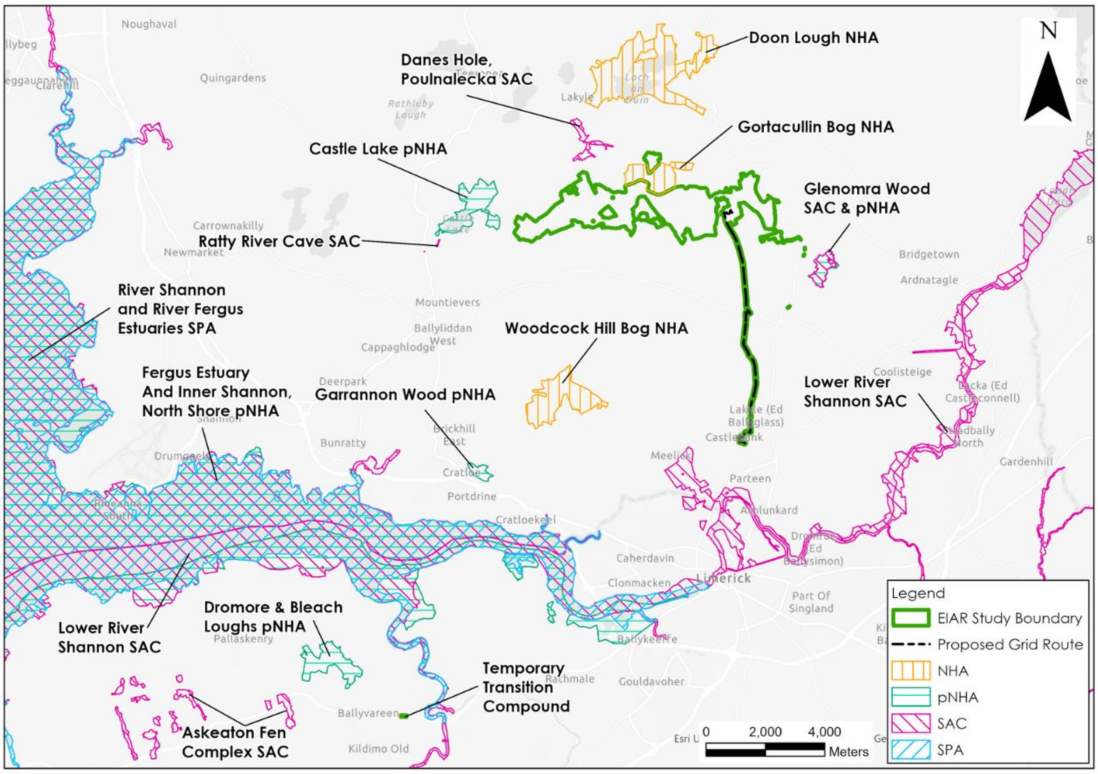


Figure 9-10: Designated Sites Map

9.3.14 Water Resources

9.3.14.1 Groundwater Resources

The GSI do not map the presence of any National Federation registered Group Water Schemes (GWS) or Public Water Schemes (PWS) or an associated source protection area within the Wind Farm Site, in the surrounding lands or along the Grid Connection.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie) (accessed on 29th November 2023). The majority of wells in the lands surrounding the Wind Farm Site have a locational accuracy of 1km or greater. However, the GSI do map 1 no. borehole in the townland of Crag, within the Wind Farm Site. This borehole is reported as having agricultural and domestic uses and has a poor yield class. Another borehole, with a location accuracy of 50m is mapped by the GSI to the northeast of the Wind Farm Site in the townland of Muinbog. This borehole is reported as having a good yield class (21.8m^3/day) and is used for domestic use only.

Other wells in the surrounding lands have a locational accuracy on 1km or greater. These are predominantly reported as having a poor yield class.

A map of nearby mapped groundwater wells is included as Figure 9-11.

9.3.14.2 Surface Water Resources

The 3rd Cycle Shannon Estuary North Catchment Report (EPA, 2021) states that there are a total of 6 no. SWBs in the catchment which are identified as Drinking Water Protected Areas (DWPAs). However, only 1 of these is located downstream of the Wind Farm Site. This designated DWPA is located at Castle Lake and is downstream of the Wind Farm Site via the Owenogarney River.

The 3rd Cycle Lower Shannon Catchment Report (EPA, 2021) states that there are a total of 3 no. SWBs in the catchment which are identified as DWPAs. The Shannon (Lower)_060 SWB has been identified as a DWPA and is located downstream of the Wind Farm Site, the Grid Connection and the TDR.

There are no DWPAs located downstream of the Temporary Transition Compound along the TDR.

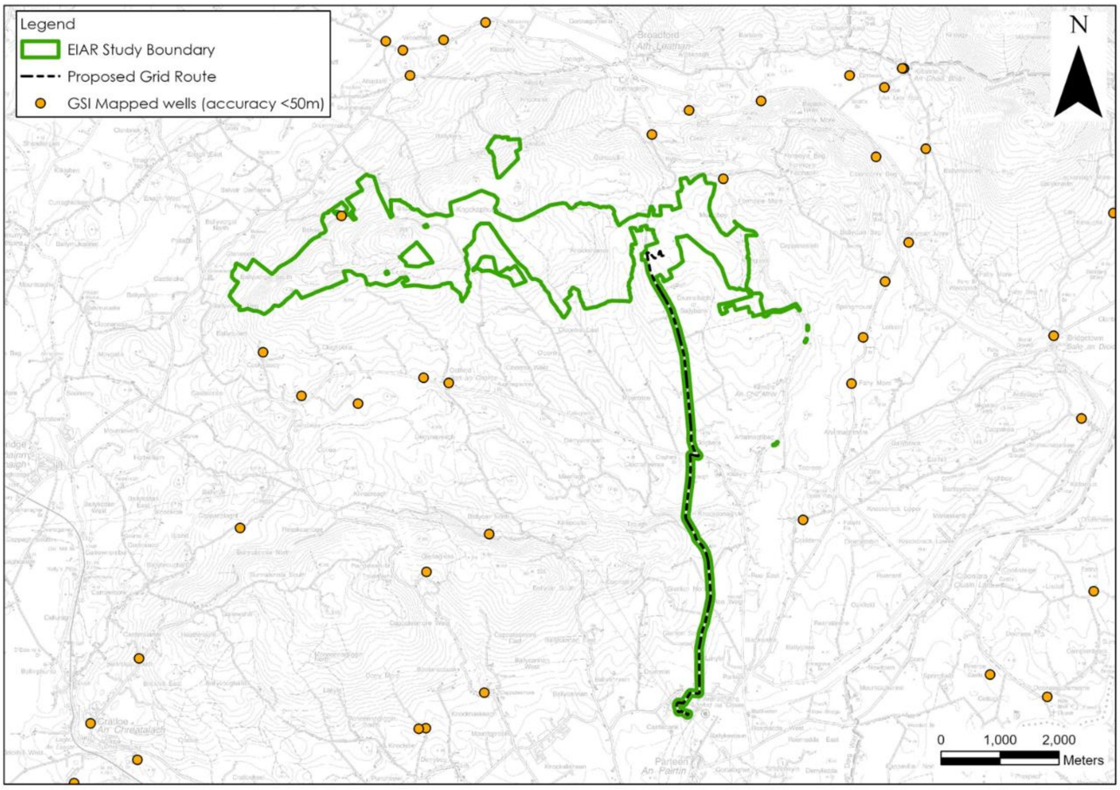


Figure 9-11: Local Groundwater Wells (www.gsi.ie)

9.3.15 Receptor Sensitivity and Importance

This section discusses the sensitivity of the receiving hydrological and hydrogeological environment in terms of the Proposed Development and identifies those receptors which will be carried forward into the impact assessment.

Due to the nature of wind farm developments (and associated grid connections and TDR works), being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risks to groundwater at the Proposed Development site would be from cementitious materials, hydrocarbon spillage and leakages, potential piling works. Some of these (cementitious materials, hydrocarbon spillage and leakages, suspended sediment entrainment) are common potential impacts on all construction sites (such as road works and industrial sites). All potential contamination sources are to be carefully managed at the site during the construction and operational phases of the Proposed Development and mitigation measures are proposed below to deal with these potential effects.

The following groundwater receptors are identified for impact assessment:

- The Poor and Locally Important Aquifers underlying the Wind Farm Site. These aquifers can be considered as being of Low to Medium Importance respectively (refer to Table 9-3);

- The Poor, Locally Important and Regionally Important Aquifers underlying the Grid Connection. The Locally Important Aquifer and the Poor Aquifer are of Medium and Low Importance (Table 9-3). Meanwhile, the Regionally Important Karstified Aquifer underlying the southern section of the Grid Connection can be considered as being of Very High Importance (Table 9-3);
- The Locally Important and Regionally Important Aquifers underlying the TDR work areas;
- The WFD status of the GWBs underlying the Proposed Development site (i.e. the Tulla-Newmarket-on -Fergus GWB, the Lough Graney GWB, the Ardnacrusha GWB and the Kildimo GWB); and,
- Local private groundwater abstractions in the lands surrounding the Wind Farm Site.

Surface waters are the main sensitive receptors associated with the Proposed Development, due to the local hydrological regime which is characterised by high runoff rates and low rates of groundwater recharge. The primary potential contamination downstream surface waters are via elevated concentrations of suspended solids and nutrient enrichment.

The quantification of flow volumes presented in Section 9.3.3.2 indicates that the watercourses in the immediate vicinity of the Wind Farm Site will be most susceptible to potential effects. Further downstream, the watercourses will be less susceptible to potential effects due to increasing flow volumes which provide a greater dilution effect. Within the Shannon Estuary North Catchment, no effects associated with the Wind Farm Site will occur downstream of the Castle Lake due to the increasing in flow volumes. Castle Lake will also act as a hydraulic buffer between the Wind Farm Site and downstream watercourses. Meanwhile, within the Lower Shannon Catchment, no effects associated with the Wind Farm Site will occur on the Shannon River Estuary due to the large volumes of water within this SWB and the saline nature of these waters.

The following surface water receptors are identified for impact assessment:

- The Broadford and the Owenogarney rivers and their associated tributaries downstream of the Wind Farm Site. These watercourses can be considered as being of High to Very High Importance (refer to Table 9-2) based on their assigned Q-ratings.
- The Blackwater River, Mountrice Stream, Glenomra Wood Stream and all associated tributaries downstream of the Wind Farm Site. Based on their assigned Q-ratings these watercourses are of Very High Importance (Table 9-2).
- The Blackwater River and all watercourses along the Grid Connection.
- Local watercourse downstream of the TDR work areas;
- The WFD status of all SWBs downstream of the Wind Farm Site, the Grid Connection and TDR work areas; and
- The DWPA's (Castle Lake and Shannon (Lower)_060) downstream of the Wind Farm Site/Grid Connection.

In terms of designated sites, only those designated sites which are hydrologically/hydrogeologically linked with the Proposed Development site will be included in the impact assessment (refer to Table 9-15).

- Gortacullin Bog NHA will not be included in the impact assessment as no works are proposed upstream or upgradient of this designated site. The Proposed Development has no potential to effect this NHA.
- Doon Lough NHA will be included in the impact assessment as this designated its hydrologically connected to the Wind Farm Site via the Broadford River and its tributaries. It is worth noting that the potential for this designated site to be impacted is limited due to the small scale of the works proposed in the catchment of the Broadford River - comprising solely of approximately 150m of new proposed access road.

- Danes Hole, Poulnalecka SAC/pNHA will be included as this site is connected with the Wind Farm Site via the Clashduff stream. Works are proposed in the catchment of the Clashduff stream.
- Castle Lake pNHA (Site Code: 000239) will be included in the impact assessment as it is hydrologically connected with the Wind Farm Site via the Owenogarney River and its tributaries.
- The Ratty River Cave SAC (Site Code: 002316) is located downstream of Castle Lake and will not be included in the impact assessment as the lake acts as a hydrological buffer between the SAC and the Proposed Development. Furthermore, the qualifying interests of this SAC are not water dependent. There is no potential for the Proposed Development to effect this SAC.
- The Glenomra Wood SAC/pNHA is connected with the Wind Farm Site via the Glenomra Wood Stream. However, the qualifying interests of the SAC are not water dependent and it will therefore not be included in the impact assessment.
- The Lower River Shannon SAC (Site Code: 002165) is located in close proximity to the Proposed Development (Temporary Transition Compound). The SAC is located at a distant location downstream of the Wind Farm Site. Due to the large flow volumes and saline nature of the waters in the Shannon Estuary the Proposed Development has limited potential to impact this designated site. However, it will be included in the assessment due to its proximal location to the Temporary Transition Compound.
- The Fergus Estuary and Inner Shannon, North Shore pNHA is located a significant distance from the Proposed Development. Due to the large flow volumes and saline nature of the waters in the Shannon Estuary the Proposed Development has no potential to impact this designated site.
- The River Shannon and Fergus Estuary SPA (Site Code: 004077) is located a significant distance from the Wind Farm Site and Grid Connection. Due to the large flow volumes and saline nature of the waters in the Shannon Estuary the Proposed Development has no potential to impact this designated site. However, the SPA is located proximal to the Temporary Transition Compound and will therefore be included in the assessment.
- The Inner Shannon Estuary South Shore pNHA is located downstream of the Temporary Transition Compound and will be included in the impact assessment.

9.4 Characteristics of the Proposed Development

The Proposed Development is defined in full in Chapter 4.

The main characteristics of the Proposed Development that could affect the hydrological and hydrogeological environment comprise the following:

- Opening of the 5 no. proposed on-site borrow pits, which will involve the stripping of peat and spoil (42,000m^3). The estimated volume of rock to be extracted from the borrow pits is 151,000m^3. Runoff and discharge from the borrow pits have the potential to effect surface water quality. Extraction of the borrow pits will be above the groundwater table and no pumping or dewatering will be required.
- Establishment of the 3 no. temporary construction compounds within the Wind Farm Site, which will involve the excavation of peat and soils (13,300m^3) and the emplacement of the construction compounds. Runoff from these construction areas have the potential to effect surface water quality. In addition, welfare facilities will be provided at the temporary construction compounds. Wastewater effluent will be collected in a wastewater holding tank and periodically emptied by a licenced contractor.
- Construction of the new proposed internal site access roads and upgrades of existing roads. The proposed new site access roads will be constructed using an excavate and replace technique. In addition, the existing forestry road network will be upgraded within

the Wind Farm Site. This will involve the use of material sourced from the onsite borrow pits. It is estimated that 72,000m^3 of peat and spoil will be removed. These activities have the potential to impact on surface water quality.

- Construction of the crane hardstand areas and turbine assemblage areas will utilise ground bearing foundations. This will involve the use of material sourced from the onsite borrow pits. Construction of these areas has the potential to impact on surface water quality.
- Construction of the onsite substation will be completed with a ground bearing foundation. Wastewater effluent will be collected in an underground concrete holding tank and periodically emptied by a licenced contractor for the operational phase of the Proposed Development. Construction of the sub-station and associated parking area has the potential to effect surface water quality.
- Construction of the foundations for the 9 no. proposed wind turbines. Volumes of peat/subsoil to be removed at the turbine locations is estimated to be 16,000m^3 peat and 50,000m^3 of non-peat subsoils. The movement of large volumes of peat and spoil have the potential to effect surface water quality. Construction of the turbine foundations will require large volumes of concrete could affect surface water and groundwater quality.
- Construction of the met mast which will require the removal of 300m^3 of peat and 300m^3 of spoil. Construction of has the potential to impact on surface water quality.
- Cabling between turbine locations and the onsite substation will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling with aggregate, lean-mix concrete, and excavated material, as appropriate (depending on the location of the cable trench). These works have the potential to impact on surface water quality.
- Underground electrical cabling between the proposed onsite substation and the Ardnacrusha substation. This will involve the excavation of a trench predominantly within the public road, placement of ducting and backfilling with lean-mix concrete and compacted engineered fill. These works have the potential to impact on surface water quality.
- Settlement ponds where constructed will be volume neutral, i.e. all material excavated will be used to form side bunds and landscaping around the ponds. There will be no excess material from settlement pond construction. The material will also be reinstated during decommissioning.
- Grey water will be supplied by rainwater harvesting and water tankered to site where required. Bottled water will be used for potable supply.
- Temporary and permanent road improvement works along the TDR and construction of the temporary TDR construction compound.
- Tree felling and replanting of forestry at alternative replacement lands. It is estimated that 107.65ha of forestry will be felled for the Proposed Development. This includes 48.89ha of permanent felling for the Proposed Development footprint, 5.69ha of temporary felling, and 52.98ha in the biodiversity enhancement areas. While this work will be done with Forestry Service licences and approvals, the works could result in soil/subsoils erosion.
- Construction of the amenity trails and the associated 2 no. viewing points. These works have the potential to impact on surface water quality.

9.4.1 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface watercourses. Two distinct methods will be employed to manage drainage water within the Proposed Development. The first method involves ‘keeping clean water clean’ by avoiding disturbance to existing drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas. The second method involves collecting any drainage waters from works areas within the site that might carry silt or sediment, and nutrients, to route them towards new proposed silt traps and settlement ponds (or stilling ponds) prior to controlled diffuse release into the existing drainage network. There will be no direct discharges to the existing forestry drains.

During the construction phase, all runoff from works areas (i.e. dirty water) will be slowed down and treated to a high quality prior to being released (refer to Chapter 4 Section 4.6 for details). A schematic of the proposed site drainage management is shown as Figure 9-12 below. A detailed drainage plan showing the layout of the proposed drainage design elements is shown in Appendix 4-4 of the EIAR.

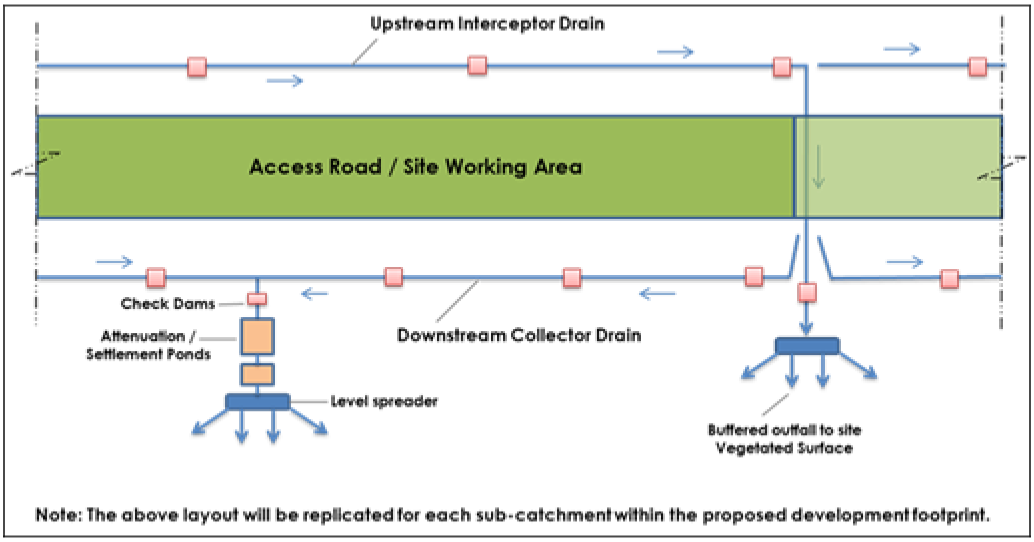


Figure 9-12 Schematic of Proposed Site Drainage Management

9.4.2 Development Interaction with the Existing Forestry Drainage Network

In relation to hydrological constraints, a self-imposed buffer zone of 50m has been put in place for on-site streams and rivers. Manmade forestry drains at the Wind farm Site are not considered a hydrological constraint and therefore no buffering of forestry drains has been undertaken.

The best practice design approach to wind farm layouts in existing forestry is to utilise and integrate with the existing forestry infrastructure where possible, whether it be existing access roads or the existing forestry drainage network. Utilising the existing infrastructure means that there will be less requirement for new construction/excavations, which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing forestry drains have no major ecological or hydrological value and can be readily integrated into the proposed wind farm drainage scheme using the methods outlined below (Section 9.5.2.1).

In order to integrate the proposed wind farm drainage with the existing forestry drainage (as per the drainage plans included in Appendix 4-4) the following design approach has been implemented:

- Lidar data was used to map in detail the existing forestry drainage at the site and how the proposed infrastructure interacts with this existing drainage. Using these Lidar data potential runoff pathways that are >150m in length have been mapped;
- Lidar data and available aerial photography was used to digitise existing forestry drainage and field drains within the development area;
- The Proposed Development footprint was divided up into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates were calculated for each catchment based on the 10-year return period rainfall event (refer to Table 9-6). These flows are used to design settlement ponds for each drainage catchment;

- Settlement pond(s) required for each development footprint catchment have been designed, and a location has been identified for each proposed pond;
- Cut-off (interceptors drains) are included to locally re-route to existing forestry drains;
- The proposed construction phase settlement ponds are designed for 11hr and 24hr retention times used to settle out medium silt (0.006mm) and fine silt (0.004mm) respectively (EPA, 2006); and,
- The proposed locations of temporary drainage measures that will be installed prior to wind farm construction commencing are identified on the drainage plans.

9.5 Likely and Significant Effects and Associated Mitigation Measures

9.5.1 Do -Nothing Scenario

If the Proposed Development was not developed, the Wind Farm Site will continue to function as it does at present, with no changes made to the current land-use of commercial forestry. The impact of this is considered neutral in the context of the EIAR. If the Proposed Development were not to proceed, the opportunity to capture an even greater part of County Clare's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

If the Proposed Development were not to proceed the site would continue to function as a coniferous forestry plantation. Currently felling operations are ongoing in some areas of the project site and, in the Do Nothing Scenario, such forestry operations would continue. The forestry operations would comprise felling and replanting.

In terms of hydrology, the existing surface water drainage regime would continue to function and may be extended in places.

9.5.2 Construction Phase - Likely Significant Effects and Mitigation Measures

9.5.2.1 Clear Felling of Coniferous Plantation

A total of 107.65ha of forestry will have to be permanently felled for the construction of the Proposed Development (48.89) and in the biodiversity enhancement areas (52.98ha). In addition, ~5.69ha of temporary felling will be completed to facilitate the construction phase. The total area to be felled accounts for 10% of the Wind Farm Site are which is 1,072ha.

The tree felling activities required as part of the Proposed Development will be the subject of a Felling Licence application to the Forest Service, in accordance with the Forestry Act 2014 and the Forestry Regulations 2017 (SI 191/2017) and as per the Forest Service's policy on granting felling licenses for wind farm developments.

Potential water quality effects during tree felling arise from:

- Exposure of soil and subsoils due to vehicle tracking, and skidding or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;

- Damage to roads resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

These effects have the potential to affect the water quality and fish stocks of downstream water bodies. Potential effects on all watercourses downstream could be significant if not mitigated.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface watercourses in the vicinity and downstream of the Wind Farm Site including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, significant, temporary, likely effect on surface watercourse and associated water-dependent ecosystems.

Proposed Mitigation Measures:

Forestry operations will conform to current best practice Forest Service regulations, policies and strategic guidance documents as well as Coillte and DAFM guidance documents, including the specific guidelines listed below, to ensure that felling, planting and other forestry operations result in minimal potential negative effects to the receiving environment.

- Forestry Standards Manual (Forest Service, 2015)
- Environmental Requirements for Afforestation (Forest Service, 2016a)
- Land Types for Afforestation (Forest Service, 2016b)
- Forest Protection Guidelines (Forest Service, 2002)
- Forest Operations and Water Protection Guidelines (Coillte, 2013)
- Forestry and Water Quality Guidelines (Forest Service, 2000b)
- Forestry and the Landscape Guidelines (Forest Service, 2000c)
- Forestry and Archaeology Guidelines (Forest Service, 2000d)
- Forest Biodiversity Guidelines (Forest Service, 2000e)
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018)
- Coillte Planting Guideline SOP
- A Guide to Forest Tree Species Selection and Silviculture in Ireland (Horgan et al., 2003)
- Management Guidelines for Ireland's Native Woodlands. Jointly published by the National Parks & Wildlife Service (Cross and Collins, 2017)
- Native Woodland Scheme Framework (Forest Service, 2018)
- Code of Best Forest Practice (Forest Service, 2000)

Mitigation by Avoidance:

There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document "Forestry and Water Quality Guidelines" are shown in Table 9-16.

With moderate slopes existing across much of the Wind Farm Site, a 10m setback for felling will be established along all aquatic zones. Buffer zone widths will be increased at vulnerable hydrological features where deemed necessary. This will ensure water quality is protected during the felling operations. However, most of the Proposed Development infrastructure is located outside of the 50m hydrological buffer zone, thereby limiting the felling which will occur in close proximity to natural watercourses.

The setback distance from sensitive hydrological features means that adequate room is maintained for the proposed mitigation measures (discussed below) to be properly installed and operate effectively. The buffer/setback zone will:

- Avoid physical damage (river/stream banks and river/stream beds) to watercourses and the associated release of sediment;
- Avoid peat/soil disturbance and compaction within close proximity to surface watercourses;
- Avoid the entry of suspended sediment from works into watercourses; and,
- Avoid the entry of suspended sediment from the drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

Table 9-16 : Minimum Buffer Zone Widths (Forest Service, 2000)

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m
Steep	(15 – 30%)	15 m	20 m
Very steep	(>30%)	20 m	25 m

In addition to the application of buffer/setback zones, the following supplementary mitigation measures will be employed during felling works:

<u>Mitigation by Design</u>:

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods which are set out as follows:

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- All machinery will be operated by suitably qualified personnel;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicles through watercourses will occur, as vehicles will use road infrastructure and existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;
- Machines will traverse the site along specified off-road routes (referred to as racks);
- The location of racks will be chosen to avoid wet and potentially sensitive areas;
- Brash mats will be placed on the racks to support the vehicles on soft ground, reducing peat and mineral soil disturbance and erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall. An ECoW will monitor forecasts and determine when works should be suspended;
- Silt fences will be installed at the outfalls of existing drains downstream of felling areas. No direct discharge of such drains to watercourses will occur. Sediment traps and silt fences will be installed in advance of any felling works and will provide surface water settlement for runoff from work areas and will prevent sediment from entering downstream watercourses. Accumulated sediment will be carefully disposed

of at pre-selected peat disposal areas. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;

- In areas particularly sensitive to erosion it will be necessary to install double or triple sediment traps and increase buffer zone width. These measures will be reviewed on site during construction;
- Double silt fencing will also be put down slope of felling areas which are located in close proximity to streams and/or relevant watercourses;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded;
- Timber will be stacked in dry areas, and outside watercourse buffer zones. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water runoff (refer to Pre-Emptive Site Drainage Management below);
- Refuelling or maintenance of machinery will not occur within 50m of an aquatic zone or within 20m of any other hydrological feature. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required; and,
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors.

Silt Traps:

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time, and allow settling of silt in a controlled manner.

Pre-emptive Site Drainage Management :

The works programme for the felling operations will also take account of weather forecasts and predicted rainfall in particular. Operations will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily/weekly basis and reviewed by an EcoW, as required, to allow site staff to direct proposed and planned construction activities:

- General Forecasts: Available on a national, regional and county level from the Met Éireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3-hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Éireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3-hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Éireann provide a 24-hour telephone consultancy service. The forecaster will provide an interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow planned works to be safely executed (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests any of the following is likely to occur:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Timing of Site Felling Works:

Felling will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses.

Drain Inspection and Maintenance:

The following items will be carried out during pre-felling inspections and after:

- Communication with tree felling operatives will be undertaken in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections the main drainage ditches will be identified. Ideally the pre-felling inspection will be carried out during rainfall;
- Following tree felling all main drains will be inspected to ensure that they are functioning;
- Extraction tracks nears drains need to be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site will be unblocked; and,
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring:

Sampling will be completed by the ECoW before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling will be conducted within 4 weeks of the felling activity commencing, preferably in medium to high water flow conditions. The "during" sampling will be undertaken once a week or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Criteria for the selection of water sampling points include the following:

- Avoid man-made ditches and drains, or watercourses that do not have year round flows, i.e. avoid ephemeral ditches, drains or watercourses;
- Select sampling points upstream and downstream of the forestry activities;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the impact of land-uses other than forestry;
- Downstream locations will be selected: one immediately below the forestry activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no impact through dilution effect or contamination by other

land-uses where impact increases at third downstream location relative to second downstream location); and,
- The above sampling strategy will be undertaken for all on-site sub-catchments streams where tree felling is proposed.

Also, daily surface water monitoring forms will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

Post-Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors during tree felling is a risk to water quality and the aquatic quality of the receptor. Proven forestry best practice measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be negative, imperceptible, indirect, temporary, likely effect on downstream watercourses and associated water-dependent ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

9.5.2.2 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities including access road construction, turbine base/hardstanding construction, construction compound construction, met mast construction, substation construction, grid cable route works and TDR works will require varying degrees of earthworks resulting in excavation of peat and mineral subsoil where present. Potential sources of sediment-laden water include:

- Drainage and seepage water resulting from excavations;
- Stockpiled excavated material providing a point source of exposed sediment; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface water and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects on all watercourses downstream of the Wind Farm Site could be significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface watercourses in the vicinity and downstream of the Wind Farm Site including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, likely effect downstream watercourses and water-dependent ecosystems.

Proposed Mitigation Measures:

<u>Mitigation by Avoidance</u>

The key mitigation measure during the construction phase is the avoidance of sensitive hydrological features where possible, by application of suitable buffer zones (i.e. 50m to main watercourses).

The majority of the key Proposed Development works areas are located outside of the delineated 50m natural watercourse (river and stream) buffer zones. However there some locations were Proposed Development works areas encroach upon these buffer zones and additional specific mitigation measures are detailed below for these locations in Section 9.5.2.3.

The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively. The proposed buffer zone will:

- Avoid physical damage (river/stream banks and river/stream beds) to watercourses and associated release of sediment;
- Avoid excavations within close proximity to surface watercourses;
- Avoid the entry of suspended sediment from earthworks into watercourses; and,
- Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

Mitigation by Design:

The following types of controls and treatment system will be implemented:

- Source controls:
  - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with gravel, filter fabrics, and other similar/equivalent or appropriate systems.
  - Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
- In-Line controls:
  - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.
- Treatment systems:
  - Temporary sumps and ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.

It should be noted for this Wind Farm Site that an extensive network of forestry and roadside drains already exists, and these will be integrated and enhanced as required and used within the wind farm development drainage system. The integration of the existing forestry drainage network and the proposed wind farm network is relatively simple. The key elements being the upgrading and improvements to water treatment elements, such as in line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls.

The main elements of interaction with existing drains will be as follows:

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works / tree felling is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- Runoff from individual turbine hardstanding areas will not be discharged into the existing drain network but discharged locally at each turbine location through settlement ponds and buffered outfalls onto vegetated surfaces;

- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site; and,
- Drains running parallel to the existing roads requiring widening will be upgraded, widening will be targeted to the opposite side of the road. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

It should be noted that 3.3km of the Proposed Wind Farm access roads already exist (as forestry tracks) and are proposed for upgrade. The upgrading of these forestry tracks , albeit presents a potential short-term potential non-significant effect on surface water quality during construction, will be a positive effect in the long-term with regard to improved drainage controls.

Pre-commencement Temporary Drainage Works

Prior to the commencement of forestry track upgrades (or new road/hardstand or turbine base installs) the following key temporary drainage measures will be installed:

- All existing dry forestry drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using forestry check dams/silt traps;
- Clean water diversion drains will be installed upgradient of the works areas;
- Check dams/silt fence arrangements (silt traps) will be placed in all existing forestry drains that have surface water flows and also along existing forestry roadside drains; and,
- A double silt fence perimeter will be placed down-slope of works areas that are located inside the watercourse 50m buffer zone.

Silt Fences:

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids such as those present in the subsoils/sandstone tills that overlie the site. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning as stated purpose. They will remain in place throughout the entire construction phase.

Silt Bags:

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, the majority of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats. Sediment entrapment mats, consisting of coir or jute matting, will be placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Settlement Ponds:

The Proposed Development footprint will be divided into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates based on the 10-year return period rainfall event will be calculated for each catchment. These flows will then be used to design settlement ponds for each drainage catchment. The settlement ponds will either be designed for 6hr or 24hr retention times used to settle out medium silt (0.01mm) and fine silt (0.004mm) respectively (EPA, 2006)[5]. Settlement pond at borrow pits will be designed to allow 24hr retention and settlement ponds along access roads and at turbine hardstands will have 6hr retention as there is additional in-line drainage controls proposed along access tracks and at hardstands. Example pond sizes are illustrated beside Detail A1 on drainage drawing D501 included in Appendix 4-4.

Level Spreaders and Vegetation Filters:

The purpose of level spreaders is to release treated drainage flow in a diffuse manner, and to prevent the concentration of flows at any one location thereby avoiding erosion. Level spreaders are not intended to be a primary treatment component for development surface water runoff. They are not sand alone but occur as part of a treatment train of systems that will reduce the velocity of runoff prior to be released at the level spreader. In the absence of level spreaders, the potential for ground erosion is significantly greater than not using them.

Vegetation filters are essentially end-of-line polishing filters that are located at the end of the treatment train. In fact, vegetation filters are ultimately a positive consequence of not discharging directly into watercourses which is one of the mitigation components of the drainage philosophy. This makes use of the natural vegetation of the site to provide a polishing filter for the wind farm drainage prior to reaching the downstream watercourses.

Again, vegetation filters are not intended to be a single or primary treatment component for treatment of works area runoff. They are not sand alone but are intended as part of a treatment train of water quality improvement/control systems (i.e. source controls→check dams→silt traps→settlement ponds→level spreaders →silt fences→vegetation filters).

Water Treatment Train:

A final line of defence will be provided by a water treatment train such as a "Siltbuster". If the discharge water from construction areas fails to be of a high quality during regular inspections, then a filtration treatment system, such as a 'Siltbuster' or similar equivalent treatment train (sequence of water treatment processes), will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase.

Pre-emptive Site Drainage Management

The works programme for the entire construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily and weekly basis at the site to direct proposed construction activities:

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3-hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;

[5] Environmental Management Guidelines - Environmental Management in the Extractive Industry (Non-Scheduled Minerals) (EPA, 2006).

- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3-hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24-hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:

- All active excavations will be secured and sealed off;
- Temporary or emergency drainage will be installed to prevent back-up of surface runoff; and,
- No works will be completed during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Timing of Site Construction Works:

Construction of the site drainage system will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.

Monitoring:

An inspection and maintenance plan for the on-site construction drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken by the ECoW, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended. Inspections will also be undertaken after tree felling.

Any excess build-up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed. Checks will be carried out on a daily basis.

During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs will be undertaken for each primary watercourse, and specifically following heavy rainfall events (as per the CEMP is included in Appendix 4-3 of this EIAR).

Allowance for Climate Change

Climate Change rainfall projections are typically for a mid-century (2050) timeline. The projected effects of climate change on rainfall are therefore modelled towards the end of the life cycle of the Proposed Development, as the turbines have a life span of ~30 years. It is likely that the long-term effects of climate change on rainfall patterns will not be observed during the lifetime of the proposed wind farm. As outlined in the above sections settlement ponds have been designed for a 1 in 10 year return flow. This approach is conservative given that the project will likely be built over a much shorter period (12-18 months), and therefore this in-built redundancy in the drainage design more than accounts for any potential short term climate change rainfall effects.

Post-Mitigation Residual Effect: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be negative, imperceptible, indirect, short term, likely impact on down gradient watercourse and water-dependant ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

9.5.2.3 Potential Effects Associated with Works Within Hydrological Buffer Zones

Whilst the majority of the proposed work areas within the Wind Farm Site are located outside of the delineated 50m natural watercourse, the following work areas encroach upon the delineated buffer zones as detailed in the drainage drawings included as Appendix 4-4:

- The cut and fill associated with T05;
- The cut and fill associated with T01;
- Several sections of existing roads, totalling 320m, which will be upgraded;
- Section of the new proposed site roads, totalling 650m; and,
- At new and existing crossings over natural watercourses.

Due to the close proximity of these works to rivers and streams, these works could result in the release of suspended solids to surface waters and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects could be significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface watercourses in the vicinity and downstream of the Wind Farm Site including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, likely effect downstream watercourses and water-dependent ecosystems.

Proposed Mitigation Measures:

Mitigation by Avoidance:

The Wind Farm Site layout has been designed to limit the amount of works within the delineated hydrological buffer zones. Several consultations between HES, MKO, FT and the project design team completed in the spring of 2023 resulted in several design iterations which had the overall aim of reducing the volume of works within the buffer zones. These consultations particularly concentrated on T01 and T05, with all hardstand areas located outside of the buffer zones for the final layout. However, the cut and fill associated with these turbines will encroach upon the buffer zone and will require specific mitigation measures.

In relation to proposed Wind Farm access tracks, where possible, the Proposed Development utilises the existing forestry road network at Knockshanvo.

Mitigation by Design:

All mitigation measures detailed in Section 9.5.2.2 above will be implemented at these work locations.

The following additional mitigation measures will also be implemented:

- Double silt fences will be placed downgradient of all work locations within the hydrological buffer zones.
- All works will be completed during the summer months and works will be postponed in the event of heavy rainfall.

Post-Mitigation Residual Effect: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be negative, imperceptible, indirect, short term, likely impact on down gradient watercourse and water-dependant ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

9.5.2.4 Excavation Dewatering and Potential Effects on Surface Water Quality

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, the borrow pits, substation and construction compound excavations and in the internal cabling trenches. This will create additional volumes of water to be treated by the runoff management system. Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore pollution issues are not anticipated.

With respect to the Grid Connection route, some minor groundwater/surface water seepages will likely occur in trench excavations and this will create additional volumes of water to be treated by the runoff management system. Inflows will require management and treatment to reduce suspended solids. No contaminated land was noted along the Grid Connection route and therefore pollution issues are not anticipated.

Pathway: Overland flow and site drainage network.

Receptors:

Wind Farm Site: All watercourses in the vicinity and downgradient of the Wind Farm Site (including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Grid Connection: All watercourses in the vicinity of the Grid Connection including the Mountrice and Blackwater rivers and associated water-dependent ecosystems.

Pre-Mitigation Potential Effects: Indirect, negative, significant, temporary, unlikely effect on surface watercourses and associated water-dependent ecosystems.

Proposed Mitigation Measures:

Management of groundwater seepages and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, following periods of heavy rainfall, pumping of excavation inflows will prevent build-up of water in the excavation;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- The borrow pit settlement ponds have been designed to allow a 24hr retention time as per EPA guidance (2006) which is highest level of protection recommended by the EPA with regard to retention time;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of excavations by a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

Post-Mitigation Residual Effect: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be – Negative, imperceptible, indirect, short term, unlikely impact on local surface watercourses and associated water-dependent ecosystems.

Significance of the Effects: For the reasons outlined above, no significant effects on the surface watercourses will occur.

9.5.2.5 Potential Effects on Groundwater Levels during Excavation Works

Small scale temporary dewatering may occur at some excavations (i.e., turbine bases, cable trenches), and these have the potential to temporarily affect local groundwater levels. However, temporary reductions in groundwater levels by short duration and transient dewatering works will be very localised and of small magnitude due to the nature and permeability of the local subsoil and bedrock geology. Groundwater level effects will not be significant due the local hydrogeological regime and the elevation of the Wind Farm Site. Any effects will be temporary and will be contained within the Wind Farm Site.

No groundwater level impacts are predicted from the construction of the Grid Connection, access roads, substation, compound, TDR works or met mast due to the shallow nature of the excavation (i.e. 0 -~1.2m).

Pathway: Groundwater flowpaths

Receptor: Groundwater levels within the underlying GWBs (Tulla-Newmarket-on-Fergus and Lough Graney GWBs).

Pre-Mitigation Potential Effect: Negative, indirect, temporary, imperceptible unlikely effects on local groundwater levels within the Wind Farm Site.

Mitigation Measures / Impact Assessment:

The Wind Farm Site is underlain by Poor and Locally Important aquifers and contains bedrock which is generally unproductive. The Wind Farm Site is elevated and groundwater will flow downslope, discharging into nearby surface water streams and tributaries of the Owenogarney and Blackwater rivers.

The topographical (i.e., the elevation of the turbines and other proposed infrastructures) and hydrogeological setting of the Wind Farm Site means that no significant groundwater dewatering is expected to be required. Moreover, direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. For the avoidance of doubt, dewatering is defined as a requirement to permanently drawdown the local groundwater table by means of over pumping, e.g. as would be required for the operation of a bedrock quarry in a valley floor.

Relevant environmental management guidelines from the EPA quarry 2006 guidance document – "Environmental Management in the Extractive Industry" in relation to groundwater issues will be implemented during the construction phase.

Post-Mitigation Residual Effects: Due to the topographic elevation and hydrogeological setting of the Wind Farm Site the potential for water level drawdown impacts at receptor locations is considered negligible. The residual effect will be – Negative, imperceptible, direct, short term, unlikely impact on groundwater levels.

Significance of Effects: For the reasons outlined above, no significant effects on groundwater levels will occur.

9.5.2.6 Potential Release of Hydrocarbons during Construction and Storage

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Hydrocarbon storage will not occur during the Grid Connection construction as the works are transient. Vehicles will be refuelled before reaching the Grid Connection route.

Some small volumes of hydrocarbons may be stored at the Temporary Transition Compound along the TDR.

Pathway: Groundwater flowpaths and site drainage network.

Receptors:

Wind Farm Site: All watercourses in the vicinity and downgradient of the Wind Farm Site (including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Grid Connection: All watercourses in the vicinity of the Grid Connection including the Mountrice and Blackwater rivers and associated water-dependent ecosystems.

TDR: All watercourses in the vicinity of the Temporary Transition Compound including the Migue Estuary.

Pre-Mitigation Potential Effects:

Negative, indirect, slight, short-term, unlikely effect on local groundwater quality below the Wind Farm Site and the Grid Connection.

Indirect, negative, significant, short term, unlikely effect on surface water quality downstream of the Wind Farm Site and Grid Connection.

Proposed Mitigation Measures:

Mitigation measures to be implemented to avoid release of hydrocarbons at the Proposed Development site are as follows:

- All plant will be inspected and certified to ensure that they are leak free and in good working order prior to use at the Proposed Development site.
- On site re-fuelling of machinery will be carried, as required, out using a mobile double skinned fuel bowser:
    - The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off site, and will be towed around the site by a 4x4 jeep to where machinery is located.
    - The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages.
    - The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site.
    - Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- Onsite refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Fuels stored on site will be minimised. Fuel storage areas if required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be included within the CEMP (Appendix 4-3). Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

Post-Mitigation Residual Effect: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact to local groundwater quality. Negative, imperceptible, indirect, short term, unlikely impact to surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

9.5.2.7 Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ≥ 6 ≤ 9 is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment.

Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to the introduction of high pH alkaline waters into the system. Batching of wet concrete on site and washing out of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution. Placed concrete in turbine bases and foundations can also have minor local effects on groundwater quality over time. However, due to the limited surface area of exposed concrete, the anoxic conditions below ground, and the high rate of dilution from the wider groundwater system relative to the small volumes of groundwater that would come in contact with the concrete, the potential for impacts are low.

Pathway: Site drainage network.

Receptors:

Wind Farm Site: All watercourses in the vicinity and downgradient of the Wind Farm Site (including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Grid Connection: All watercourses in the vicinity of the Grid Connection including the Mountrice and Blackwater rivers and associated water-dependent ecosystems.

TDR: All watercourses downstream of the TDR work areas.

Pre-Mitigation Potential Effects: Indirect, negative, moderate, short term, likely effect to surface watercourses and water-dependent ecosystems.

Proposed Mitigation Measures:

- No batching of wet-cement products will occur on the Wind Farm Site. Ready-mixed supply of wet concrete products and/or emplacement of pre-cast elements will take place;
- Pre-cast elements for culverts and concrete works will be used;
- No washing out of any plant used in concrete transport or concreting operations will be allowed on-site;
- Where concrete is delivered on the Wind Farm Site, only the chute will be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be isolated in temporary lined wash-out pits located near proposed wind farm site compound. These temporary lined wash-out pits will be removed from the wind farm site at the end of the construction phase;
- The contractor will use weather forecasting to plan dry days for pouring concrete; and,
- The contractor will ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.

Post-Mitigation Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact to surface and groundwater quality.

Significance of the Effect: For the reasons outlined above, no significant effects on surface or groundwater quality will occur.

9.5.2.8 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from on-site (Wind Farm Site and along the Grid Connection) temporary wastewater treatment systems has the potential to impact on groundwater and surface water quality if conditions are not suitable for an on-site percolation unit. Impacts on surface water quality could affect fish stocks and aquatic habitats.

Pathway: Groundwater flowpaths and site drainage network.

Receptors:

Wind Farm Site: All watercourses in the vicinity and downgradient of the Wind Farm Site (including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Grid Connection: All watercourses in the vicinity of the Grid Connection including the Mountrice and Blackwater rivers and associated water-dependent ecosystems.

Pre-mitigation Potential Effect: Negative, significant, indirect, temporary, unlikely effect to surface water quality. Negative, slight, indirect, temporary, unlikely effect on local groundwater quality.

Proposed Mitigation Measures:

- During the construction phase, a self-contained port-a-loo with an integrated waste holding tank will be used at each of the site compounds, maintained by the providing contractor, and removed from site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use from the Wind Farm Site to be discharged at a suitable off-site treatment location; and,
- No water or wastewater will be sourced on the site, nor discharged to the site.

Post-Mitigation Residual Effects: The potential for contamination resulting from wastewater disposal is a risk to surface and groundwater quality. This is a risk common to all construction sites containing welfare facilities. Proven and effective measures to mitigate the release of wastewater on site have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be - Negative, imperceptible, indirect, temporary, unlikely effect on surface water or groundwater quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

9.5.2.9 Morphological Changes to Surface Water Courses within the Wind Farm Site

Diversion, culverting and bridge crossing of surface watercourses can result in morphological changes, changes to drainage patterns and alteration of aquatic habitats. Construction of structures over water courses has the potential to significantly interfere with water quality and flows during the construction phase.

Within the Wind Farm Site, there are a total of 6 no. crossing locations over natural watercourses (rivers and streams). Several sections of these watercourses have not been mapped by the EPA but have been digitised based on site walkover surveys and inspection of historical maps of the local area. The crossing locations are outlined below:

- A new crossing over the Gortadroma stream (EPA Name – Not locally named) to the northeast of T01;
- A new crossing over a tributary of the Snaty stream (EPA Name – Not locally named) 750m to the northeast of T03;
- A new crossing over the Snaty Stream 1.2km to the northeast of T03;
- A new crossing over the Knockshanvo Stream (EPA Name = Sruffaunageeragh Stream) to the east of T04;
- Existing crossing over the Mountrice River 500m to the east of T05; and,
- New crossing over the Glenomra Wood stream in the east of the Wind Farm Site and near the new proposed site entrance.

In addition to the natural watercourses, there is a high density of manmade forestry drains within the Wind Farm Site. However, these are not considered to be a significant constraint and can be rerouted around the proposed infrastructure and/or integrated into the proposed drainage design.

Pathway: Site drainage network.

Receptor: Surface water flows, stream morphology and water quality in the Gortadroma, Snaty, Knockshanvo streams and the Mountrice River.

Pre-Mitigation Potential Effect: Negative, moderate, direct, long-term, likely effect on surface water flows, local stream morphology and surface water quality.

Proposed Mitigation Measures:

The Proposed Development design has been optimised to utilise the existing infrastructure (i.e. existing site roads) where practicable. 1 no. crossings is proposed along existing site tracks with a total of 5 no. new crossings proposed. This design prevents the unnecessary disturbance of the existing site drainage network prevents the requirement for widespread instream works across the Wind Farm Site.

Mitigation measures to be implemented for the upgrade of the existing crossings and the new proposed crossing are detailed below:

- All proposed new stream crossings will be bottomless or clear span culverts and the existing banks will remain undisturbed. No in-stream excavation works are proposed and therefore there will be no direct impact on the stream at the proposed crossing location;
- Where the proposed underground cabling route follows an existing road or road proposed for upgrade, the cable will pass over or below the culvert within the access road;
- As a further precaution near stream construction work will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the

Eastern Regional Fisheries Board (2004) guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites", that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses;
- During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase. There will be no batching or storage of cement allowed on-site; and,
- All new road river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

Post-Mitigation Residual Effect: The potential for the construction of watercourse crossings and associated in-stream works is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to protect water quality have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be - Negative, imperceptible, direct, long-term, unlikely effect on downstream water quality and aquatic habitats.

Significance of Effects: For the reasons outlined above, no significant effects on stream morphology or stream water quality will occur at crossing locations.

9.5.2.10 Morphological Changes to Surface Watercourses along the Grid Connection

The Grid Connection includes a total of 4 no. watercourse crossings over EPA mapped watercourses. In addition there are several smaller crossings over unmapped drains.

The proposed crossing methodologies are as follows:

- Horizontal Direction Drilling is proposed over the existing crossings at Trough Bridge over the Blackwater River and along a tributary of the Mountrice Stream in the townland of Drumsillagh. Directional Drilling is a method of drilling under obstacles such as bridges, culverts, railways, water courses, etc. in order to install cable ducts under the obstacle. This method is employed where installing the ducts using standard installation methods is not possible.
- Elsewhere, existing culverts will be crossed using open trenching with either an undercrossing or an overcrossing depending on the depth of the culvert:
    - <u>Option A</u>: Where adequate cover exists above a culvert, the standard trench arrangement will be used where the cable ducts pass over a culvert without any contact with the existing culvert or water course. The cable trench will pass over the culvert in a standard trench.
    - <u>Option B</u>: Where the culvert consists of a socketed concrete or sealed plastic pipe and sufficient depth is not available over the crossing, a trench will be excavated beneath the culvert, and cable ducts will be installed in the standard formation 300mm below the existing pipe.

Pathways: Runoff and surface water flowpaths.

Receptors: Surface water flows, stream morphology and water quality along Grid Connection (Mountrice River and its tributaries, Blackwater River and the Glenlon South stream).

Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on downstream surface water flows and surface water quality (for all proposed crossing methods described above).

Prior to the commencement of cable trenching or crossing works the following key temporary drainage measures will be installed:

- All existing roadside drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using check dams/silt traps;
- Culverts, manholes and other drainage inlets will also be temporarily blocked;

A double silt fence perimeter will be placed along the road verge on the down-slope side of works areas that are located inside the watercourse 50m buffer zone. The following mitigation measures are proposed for the Grid Connection crossing works:

- No stockpiling of construction materials will take place along the grid route;
- No refuelling of machinery or overnight parking of machinery is permitted in this area (within 50m of the watercourse crossings);
- No concrete truck chute cleaning is permitted in this area (within 50m of the watercourse crossing);
- Works will not take place at periods of high rainfall, and will be scaled back or suspended if heavy rain is forecast;
- Local road drainage, culverts and manholes will be temporarily blocked during the works;
- Machinery deliveries will be arranged using existing structures along the public road;
- All machinery operations will take place away from the stream and ditch banks, apart from where crossings occur. Although no instream works are proposed or will occur;
- Any excess construction material will be immediately removed from the area and sent to a licenced waste facility;
- No stockpiling of materials will be permitted in the constraint zones;
- Spill kits will be available in each item of plant required to complete the stream crossing; and,
- Silt fencing will be erected on ground sloping towards watercourses at the stream crossings if required.

Post-Mitigation Residual Effect: The potential for the release of suspended solids and other contaminants to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, direct, long term, likely effect on surface water flows and surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water flows and surface water quality will occur.

9.5.2.11 Potential Effects on Groundwater wells

The biggest risk to groundwater wells will be from groundwater contamination due to the accidental release of hydrocarbons and cement-based products as a result of construction activities within the Proposed Development site.

No effects are groundwater levels / quantity will occur due to the elevated nature of the Wind Farm Site. No significant dewatering works are proposed for any excavations (refer to Section 9.5.2.5).

There are no downgradient public or group scheme groundwater supplies that can be impacted by the Proposed Development. Due to the remote location of the Wind Farm Site, there are a limited number of dwellings which are located in the immediate vicinity of the site. The closest dwelling to a turbine is located in the east of the site, 751m southwest of T06. A dwelling is also located 277m to the west of the proposed substation location.

Due to the shallow nature of the proposed work along the Grid Connection and along the TDR, no effects on private groundwater well supplies will occur.

Pathway: Groundwater flowpaths.

Receptor: Down-gradient groundwater supplies (groundwater wells).

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, long-term, unlikely effect on down gradient water supplies.

Mitigation Measures / Impact Assessment:

There are no local groundwater well supplies in the vicinity of the Wind Farm Site. All local dwellings are located significant distances from Proposed Development infrastructure within the Wind Farm Site.

Regardless if private wells are located downslope of the Wind Farm Site or not (or if wells are installed in the future), the potential for impact is negligible for the following conclusive reasons:

- The Wind Farm Site is underlain by an aquifer of low permeability;
- Groundwater flowpaths are therefore typically very short (~300m maximum);
- Consequently, the majority of groundwater flows within the site emerge as springs/baseline along streams/rivers and leave the site as surface water flows and not groundwater flows;
- Therefore, the potential to impact on local wells (whether they are downslope or not) is very low as groundwater flowpaths between the Proposed Development infrastructure and potential source typically do not exist due to the large setback distance;
- Nevertheless, mitigation is provided in the EIAR to deal with construction phase groundwater hazard such as oils and fuels; and,
- Therefore, based on our hydrogeological assessment of the site with regard to groundwater user risk and the proposed mitigation measures, it is concluded that the potential to impact on local wells/water supply sources is negligible.

Post-Mitigation Residual Effects: For the reasons outlined in the impact assessment above (separation distances, and prevailing geology, topography and groundwater flow directions), the residual effect will be - negative, imperceptible, indirect, long-term, unlikely effect in terms of quality or quantity on local groundwater abstractions.

Significance of Effects: For the reasons outlined above, no significant effects on existing groundwater supplies will occur.

9.5.2.12 Use of Siltbuster and Effect on Downstream Surface Water Quality

Siltbusters are regularly used to remove suspended sediments on construction sites by means of chemical dosing and sedimentation (i.e. use of coagulants and flocculants to accelerate the settlement process). The benefits of using enhanced settlement systems on downstream surface water quality are widely known, and are a positive effect. However, potential overdosing with chemical agents means there is a perceived risk of chemical carryover in post treatment water which could result in negative effects on downstream water quality.

Wind farm construction water (i.e. surface water runoff or pumped groundwater) has sometimes very fine particles, particularly clays and peat, with slow settling velocities which do not settle out efficiently, even in a lamella clarifier at normal flow rates. In these cases chemical dosing can be used to aggregate the particles (i.e. force them to combine and become heavier), increasing the particle settling rate and cleaning the water via gravity separation techniques. Agents commonly used include poly aluminium chloride (PAC), aluminium sulphate, ferric iron and ferrous iron. These agents are commonly used in drinking water treatment plants. So their use is widespread, and there is significant scientific knowledge around their use and control.

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of siltbuster systems from northwest Mayo is provided in Figure 9-13. This is a duration curve of downstream water quality data post siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

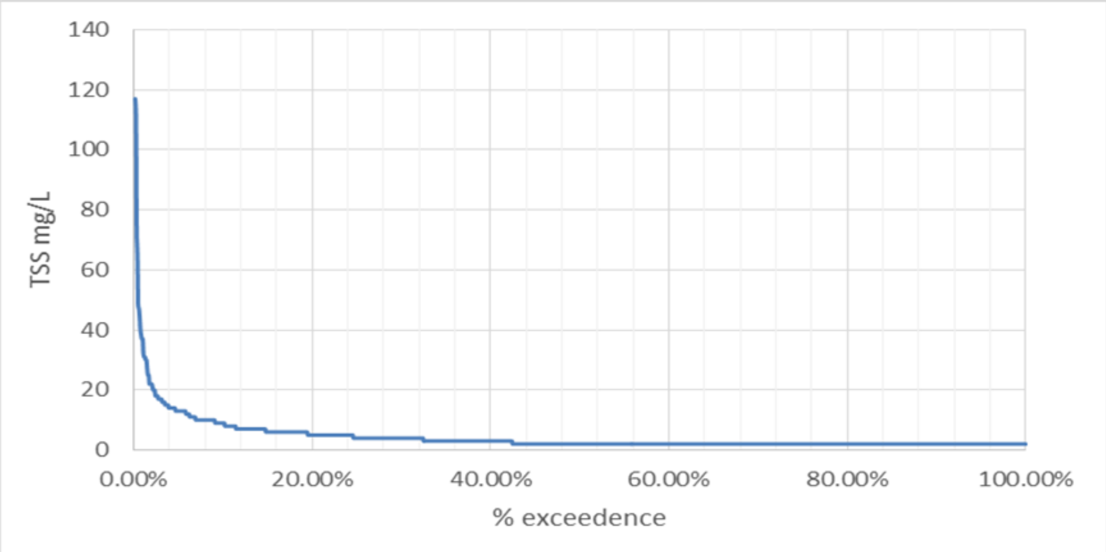


Figure 9-13: Example of treatment capability of Siltbuster treatment

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Keerglen and Ballinglen Rivers) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, unlikely effect on downgradient water quality.

Proposed Mitigation Measures:

Measures employed to prevent overdosing and potential chemical carryover:

- The siltbuster system comprises an electronic in-line dosing system which provides an accurate means of adding agents so overdosing does not occur;
- Continued monitoring and water analysis of pre and post treated water by means of an inhouse lab and dedicated staff, means the correct amount of chemical is added by the dosing system;
- Dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L and the vast majority of the chemical is removed in the deposited sediment;
- Final effluent not meeting the discharge criteria is recycled and retreated, which has a secondary positive effect of reducing carryover; and,
- Use of biodegradable chemical agents can be used at very sensitive sites.

Post-Mitigation Residual Effects: With the implementation of the dosing technology and the continual monitoring of pre and post treatment water, the appropriate volume of chemical agent can be added to ensure that chemical carryover concentrations are present only in tiny trace amounts which will not cause any effects to receiving waters or associated aquatic ecology. The residual effect is - Negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur. It is concluded that the use of siltbuster systems has a significant positive effect in respect of protected surface water quality.

9.5.2.13 Turbine Delivery Route Works

Minor earthworks are required for turbine delivery works and for the construction of the Temporary Transition Compound along the haul route. These TDR works are described in Section 4.2 of the EIAR.

Pathway: Surface water flowpaths.

Receptor: Down-gradient surface water quality.

Pre-Mitigation Potential Effect: Indirect, negative, slight, short term, likely effect.

Proposed Mitigation Measures:

No significant effects will occur for the following reasons:

- All works are relatively minor and localised and cover very small areas;
- Excavation/earthworks will all be small scale; and,
- All works are temporary in nature.

Nevertheless, the "Pre-commencement Temporary Drainage Works" described in 9.5.2.2 will be employed at all the TDR works areas.

Post-Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely effect on down gradient rivers, water quality, and dependant ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects will occur on surface waters.

9.5.2.14 Surface Water Quality Effects During Direction Drilling along the Grid Connection

Surface water quality effects on local watercourses and the downstream Blackwater River may occur during drilling and groundworks associated with potential directional drilling at the bridge crossing locations along the Grid Connection route to Ardnacrusha.

It is proposed that directional drilling under the bridge will be undertaken to prevent direct impacts on the watercourse. However, there is a risk of indirect impacts from sediment laden runoff during the launch pit and reception pit excavation works. There is also the unlikely risk of fracture blow out and contamination of the watercourse with drilling fluid.

Pathway: Surface water and groundwater flows.

Receptor: Local watercourses and the downstream Blackwater River.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on surface water quality.

Proposed Mitigation Measures:

- Although no in-stream works are proposed, the drilling works will only be done over a dry period between July and September (as required by IFI for in-stream works) to avoid the salmon spawning season and to have more favourable (dryer) ground conditions;
- The crossing works area will be clearly marked out with fencing or flagging tape to avoid unnecessary disturbance;
- There will be no storage of material / equipment or overnight parking of machinery inside the 15m buffer zone;
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channel along the 15m buffer zone boundary;
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse;
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages;
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area;
- Spills of drilling fluid will be cleaned up immediately and stored in an adequately sized skip before been taken off-site;
- If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works);
- This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed percolation area at least 50m from the watercourse;
- The discharge of water onto vegetated ground at the percolation area will be via a silt bag which will filter any remaining sediment from the pumped water. The entire percolation area will be enclosed by a perimeter of double silt fencing;
- Any sediment laden water from the works area will not be discharged directly to a watercourse or drain;
- Works shall not take place during periods of heavy rainfall and will be scaled back or suspended if heavy rain is forecasted;
- Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse;
- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied;
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion;
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated;
- There will be no batching or storage of cement allowed at the watercourse crossing;

- There will be no refuelling allowed within 50m of the watercourse crossing; and,
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.

Fracture Blow-out (Frac-out) Prevention and Contingency Plan is included in the CEMP:

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e., Clear Bore Drilling Fluid or similar will be used);
- The area around the drilling fluid batching, pumping and recycling plants will be bunded using terram and/or sandbags to contain any potential spillage;
- One or more lines of silt fencing will be placed between the works area and the adjacent river;
- Spills of drilling fluid will be cleaned up immediately and transported off-site for disposal at a licensed facility;
- Adequately sized skips will be used where temporary storage of arisings are required;
- The drilling process / pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology or local watercourse;
- This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur then drilling will be immediately stopped;
- Any frac-out material will be contained and removed off-site;
- The drilling location will be reviewed, before re-commencing with a higher viscosity drilling fluid mix; and,
- If the risk of further frac-out is high, a new drilling alignment will be sought at the crossing location.

Post-Mitigation Residual Effect: Due to the avoidance of instream works, the works being mainly carried out in the corridor of a public road along with the proposed mitigation measures the residual effect is considered to be negative, imperceptible, indirect, temporary, likely effect on surface water in the downstream watercourses.

Significance of Effects: For the reasons outlined above, no significant effects on surface water quality will occur.

9.5.2.15 Potential Effects on Downstream Surface Water Abstractions

As stated above in Section 9.3.14.2, there are 2 no. surface water abstractions mapped downstream of the Proposed Development. Within the Shannon Estuary North Catchment Report, there is a surface water abstraction located downstream of the Proposed Development at Castle Lake. Meanwhile, within the Lower Shannon Catchment the Shannon (Lower)_060 SWB is located downstream of the Proposed Development.

Any potential surface water quality effects which may arise as a result of the Proposed Development have the potential to impact on the surface water abstractions.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality and designated sites.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect on downstream surface water abstractions.

Mitigation Measures / Impact Assessment:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 9.5.2.1, 9.5.2.2, 9.5.2.3 and 9.5.2.4 (suspended solids), Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products), Section 9.5.2.8 (wastewater) and Section 9.5.2.10 (grid route).

Post-Mitigation Residual Effect: Construction activities pose a threat to downstream surface water abstractions hydrologically linked with the Proposed Development site. Proven and effective measures to mitigate the risk of surface water contamination have been proposed which will break the pathway between the potential source and the downstream receptor. These mitigation measures will ensure that surface water runoff from the Proposed Development site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or surface water abstractions. The residual effect is considered to be Negative, imperceptible, indirect, short term, unlikely effect on downstream surface water abstractions.

Significance of Effects: No significant effects on downstream surface water abstractions will occur.

9.5.2.16 Potential Effects on Hydrologically Connected Designated Sites

There are several designated sites which are hydrologically connected with the Proposed Development site (Wind Farm Site, Grid Connection and TDR).

The surface water connections from the Proposed Development site could transfer poor quality surface water that may affect the conservation objectives of these designated sites.

The designated sites included in this assessment and deemed to be hydrologically connected to the Proposed Development site include:

- Doon Lough NHA
- Castle Lake pNHA
- Lower River Shannon SAC
- River Shannon and River Fergus Estuaries SPA
- Fergus Estuary and Inner Shannon, North Shore pNHA
- Inner Shannon Estuary – South Shore pNHA

All other downstream designated sites have been screened out of the assessment due to their distance location from the Proposed Development and the increasing volumes of water within these downstream waterbodies which will dilute any potential effects associated with the Proposed Development.

Note that the Danes Hole. Poulnalecka SAC/pNHA and the Glenomra Wood SAC/pNHA are not included in the assessment as the designated features within these sites are not hydrologically dependent.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality and designated sites.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect on designated sites.

Mitigation Measures / Impact Assessment:

Doon Lough NHA:

Doon Lough NHA is hydrologically connected to the Wind Farm Site via the Broadford River and its tributaries. The potential for the Wind Farm Site to affect this NHA is limited due to the minor nature of the works proposed in the catchment of the Broadford River. The only potential pathway for connectivity is via surface waters and mitigation measures set out above will be implemented in full and will ensure the protection of surface water quality in the Broadford River.

Castle Lake pNHA:

This pNHA is hydrologically connected with the Wind Farm Site via the Owenmore River and its tributaries. Mitigation measures set out above will be implemented in full and will ensure the protection of surface water quality in the Owenmore River.

Lower River Shannon SAC:

This designated site is hydrologically connected with the Wind Farm Site, the Grid Connection and the TDR. Due to the large flow volumes within the Lower River Shannon and the saline nature of these waters downstream of the Proposed Development site, there is limited potential for effects to occur. Where the Proposed Development is located in close proximity to the SAC (i.e. the Temporary Transition Compound), the minor and temporary nature of the works and the volume of water in the Maigue Estuary limit the potential for effects. Nevertheless, the mitigation measures set out above will be implemented in full and will ensure the protection of surface water quality and quantity.

River Shannon and River Fergus Estuaries SPA:

This designated site is hydrologically connected with the Wind Farm Site, the Grid Connection and the TDR. Due to the large flow volumes within the Shannon Estuary and the saline nature of these waters downstream of the Proposed Development site, there is limited potential for effects to occur. Where the Proposed Development is located in close proximity to the SPA (i.e. the Temporary Transition Compound), the minor and temporary nature of the works and the volume of water in the Maigue Estuary limit the potential for effects. Nevertheless, the mitigation measures set out above will be implemented in full and will ensure the protection of surface water quality and quantity.

Inner Shannon Estuary – South Shore pNHA:

This pNHA is located downstream of the Temporary Transition Compound along the Maigue Estuary. The mitigation measures set out above will be implemented in full and will ensure the protection of surface water quality and quantity.

Fergus Estuary and Inner Shannon, North Shore

This pNHA is located downstream of the Proposed Development in the Upper Shannon Estuary. Given the pNHAs distant location from the Proposed Development and the large volumes of water within the estuary there is limited potential for effects. Nevertheless. the mitigation measures set out above will be implemented in full and will ensure the protection of surface water quality and quantity.

Post-Mitigation Residual Effect: Construction activities pose a threat to designated sites hydrologically linked with the Proposed Development site. Proven and effective measures to mitigate the risk of surface and groundwater contamination will be implemented and will break the pathway between the potential source and the downstream receptor. These mitigation measures will ensure that surface water runoff from the Proposed Development site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or the status or ecology of the protected species and habitats within the designated sites. The residual effect is considered to be Negative, imperceptible, indirect, short term, unlikely effect on downstream designated sites.

Significance of Effects: No significant effects on designated sites will occur.

9.5.2.17 Potential Effects on Surface Water and Groundwater WFD Status

The EU Water Framework Directive (2000/60/EC) requires that all member states protect and improve water quality in all waters, with the aim of achieving good status by 2027 at the latest. Any new development must ensure that this fundamental requirement of the Directive is not compromised.

The WFD status for GWBs and SWBs underlying and downstream of the Proposed Development are defined in Section 9.3.11 and Section 9.3.12 respectively.

A detailed WFD Compliance Assessment Report has been completed in combination with this EIAR Chapter and is included in Appendix 9-3.

Pathway: Surface water flowpaths.

Receptor: WFD status of downstream surface water bodies and underlying GWBs.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect on surface water and groundwater bodies.

Proposed Mitigation Measures:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 9.5.2.1, 9.5.2.2, 9.5.2.3 and 9.5.2.4 (suspended solids), Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products), Section 9.5.2.8 (wastewater) and Section 9.5.2.10 (grid route).

Similarly, mitigation measures for the protection of groundwater quantity and quality have been detailed in Section 9.5.2.5 (groundwater levels), Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products), Section 9.5.2.8 (wastewater).

The implementation of these mitigation measures will ensure the protection of downstream SWBs and underlying GWBs.

Post-Mitigation Residual Effects: Mitigation for the protection of surface and groundwater during the construction phase of the Proposed Development will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Proposed Development.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Development. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration.

No residual effect on Groundwater Body WFD status will occur.

No residual effect on Surface Water Body WD status will occur.

Significance of Effects: For the reasons outlined above, no significant effects on WFD Groundwater Bodies and Surface Water Bodies status, risk or future objectives will occur as a result of the Proposed Development.

9.5.3 Operational Phase – Likely Significant Effects and Mitigation Measures

9.5.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the peat or vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. This could potentially increase runoff from the site and increase flood risk downstream of the development. In reality, the access roads will have a higher permeability than the underlying peat. However, it is conservatively assumed in this assessment that the proposed access roads and hardstands are impermeable. The assessed footprint comprises turbine bases and hardstandings, access roads, amenity links, site entrances, substation and temporary construction compounds. During storm rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

Pathway: Site drainage network.

Receptor: All watercourses in the vicinity and downgradient of the Wind Farm Site (including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, permanent, moderate probability effect on all downstream surface water bodies.

Effects Assessment:

The emplacement of the Proposed Development footprint (18.5ha), as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials as a worst-case scenario) could result in an average total site increase in surface water runoff of approximately 5,365m^3/month. This represents a potential increase of approximately 0.6% in the average daily/monthly volume of runoff from the Wind Farm Site area in comparison to the baseline pre-development site runoff conditions (Table 9-17). This is a very small increase in average runoff and results from the naturally high surface water runoff rates and the relatively small area of the Wind Farm Site being developed, the proposed total permanent development footprint being, representing 1.7% of the Wind Farm Site area of 1,072ha.

Table 9-17: Baseline Site Runoff V Development Runoff

Site Baseline Runoff/wettest month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff (m^3)/wettest month	Hardstanding Area 75% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions across Wind Farm Site (m^3)
943,360	30,431	185,000	21,645	16,280	5,365	173	0.6%

The additional volume is low due to the fact that the runoff potential from the Wind Farm Site is naturally high (a very conservative estimation of 75% has been used in this assessment, with a groundwater recharge coefficient of 25% chosen from the estimated GSI recharge rates for the Wind

Farm Site – refer to Section 9.3.2 above). Also, the calculation assumes that all hardstanding areas will be impermeable which will not be the case as access tracks will be constructed of permeable stone aggregate. Furthermore, the above assessment does not consider the presence of existing site roads within the Wind Farm Site. Overall, this is a very conservative assessment. The increase in runoff from the Proposed Development will, therefore, be negligible. This is prior to mitigation measures being put in place.

Proposed Mitigation by Design:

The operational phase drainage system of the Proposed Development will be installed and constructed in conjunction with the road and hardstanding construction work as described below and as shown on the Drainage drawings submitted with this planning application (Appendix 4-4):

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground by means of a level spreader;
- Swales/road side drains will be used to collect runoff from access roads and turbine hardstanding areas of the site, likely to have entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- On steep sections of access road transverse drains ('grips') will be constructed in the surface layer of the road to divert any runoff off the road into swales/road side drains;
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;
- Settlement ponds, emplaced downstream of road swale sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses; and,
- Settlement ponds will be designed in consideration of the greenfield runoff rate.

As described above the proposed integration of the wind farm drainage with the existing forestry drainage is a key component of the proposed drainage management within the development. By integration we mean maintaining surface water flowpaths where they already exist, avoid creation of new or altered surface water flowpaths, and maintaining the drainage regime (i.e. normal flow) within each forestry compartment. There will be no alternation of the catchment size contributing to each of the main downstream watercourses. All wind farm drainage water captured within individual site sub-catchments will be attenuated and released within the same sub-catchments that it was captured.

Post-Mitigation Residual Effect: Direct, negative, neutral, long term, likely effect. Proven and effective measures to attenuate runoff and mitigate the risk of flooding will be employed. The residual effect will be - Neutral, indirect, long term, likely effect on down gradient streams/rivers.

Significance of Effects: No significant effects on downstream flood risk will occur during the operational phase of the Proposed Development.

9.5.3.2 Runoff Resulting in Contamination of Surface Waters

During the operational phase, the potential for silt-laden runoff is much reduced compared to the construction phase. In addition, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of site entrances, internal roads and hardstand areas. These works would be of a very minor scale and would be very infrequent. Potential sources of sediment laden water would only arise from surface water runoff from small areas where new material is added during maintenance works.

These minor activities could, however, result in the release of suspended solids to surface water and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects could be significant if not mitigated against.

During such maintenance works there is a small risk associated with release of hydrocarbons from site vehicles, although it is not envisaged that any significant refuelling works will be undertaken on site during the operational phase.

Maintenance works will likely be contained within the Wind Farm Site and no maintenance works will be required along the Grid Connection.

Pathways: Drainage and surface water discharge routes.

Receptors: All watercourses in the vicinity and downgradient of the Wind Farm Site (including the Blackwater River and its tributaries (including the Mountrice, O'Neills and Derryvinnaan rivers and the Sruffaunageeragh stream) and the Owenogarney River and its tributaries (all of which are locally unnamed) and the associated water-dependant ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect.

Proposed Mitigation Measures:

Mitigation measures for sediment control are the same as those outlined above for the construction phase.

Mitigation measures for control of hydrocarbons during maintenance works are similar to those outlined in Section 9.5.2.6.

During the operational phase, it is proposed to manage wastewater from the staff welfare facilities in the control buildings by means of a sealed storage tank, with wastewater being tankered off site by a permitted waste collector to wastewater treatment plants. wastewater storage tank will be fitted with an automated alarm system that will provide sufficient notice that the tank requires emptying. The wastewater storage tank alarm will be part of a continuous stream of data from the site's turbines, wind measurement devices and electricity substation that will be monitored remotely 24 hours a day, 7 days per week. Only waste collectors holding valid waste collection permits under the Waste Management (Collection Permit) Regulations, 2007(as amended), will be employed to transport wastewater away from the site.

Post-Mitigation Residual Effects: With the implementation of the proposed wind farm drainage measures as outlined above, and based on the post-mitigation assessment of runoff, we consider that residual effect are - Negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

9.5.3.3 Assessment of WFD Effects

There is no direct discharge from the Proposed Development to downstream receiving waters. Mitigation for the protection of surface water during the operational phase of the Proposed Development will ensure the qualitative status of the receiving SWBs will not be altered by the Proposed Development.

Similarly there is no direct discharge to groundwaters associated with the Proposed Development. Mitigation for the protection of groundwater during the operational phase of the Proposed Development will ensure that the qualitative status of the receiving GWBs will not be altered by the Proposed Development.

A full assessment of the potential effects of the operational phase of the Proposed Development on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as Appendix 9-3.

As such, the Proposed Development:

- Will not cause a deterioration in the status of all surface and groundwater bodies assessed;
- Will not jeopardise the objectives to achieve 'Good' surface water/groundwater status;
- Does not jeopardise the attainment of 'Good' surface water/groundwater chemical status;
- Does not jeopardise the attainment of 'Good' surface water/groundwater quantity status;
- Does not permanently exclude or compromise the achievement of the objectives of the WFD in other waterbodies within the same river basin district;
- Is compliant with the requirements of the Water Framework Directive (2000/60/EC); and,
- Is consistent with other Community Environmental Legislation including the EIA Directive (2014/52/EU), the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC) (Note that a full list of legislation complied with in relation to hydrology and hydrogeology is included in Section 9.1.4 of EIAR Chapter 9).

9.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The Proposed Development is expected to have a lifespan of ~30 years. Upon decommissioning, the wind turbines and meteorological masts will be dismantled and all above ground components would be removed off-site for recycling.

The potential effects associated with decommissioning of the Proposed Development will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works. A description of the decommissioning works is contained in Chapter 4 of this EIAR.

During decommissioning, it will be possible to reverse or at least reduce some of the potential effects caused during construction, and to a lesser extent operation, by rehabilitating constructed areas such as turbine bases and hard standing areas. This will be done by covering with vegetation to encourage vegetation growth and reduce run-off and sedimentation.

The Wind Farm Site roadways will be kept and maintained following decommissioning of the wind farm infrastructure, as these will be utilised by ongoing forestry works and by local farmers.

The electrical cabling connecting the site infrastructure to the on-site substation will be removed, while the ducting itself will remain in-situ rather than excavating and removing it, as this is considered to have less of a potential environmental impact, in terms of soil exposure, and thus on the possibility of the generation of suspended sediment which could enter nearby watercourses.

The turbines will be removed by disassembling them in a reverse order to their erection. This will be completed using the same model cranes as used in their construction. They will then be transported off-site along their original delivery route. The disassembly and removal of the turbines will not have an impact on the hydrological/hydrogeological environment at the wind farm site.

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude than the construction phase because of the smaller scale of the works and reduced volumes on-site.

Some of the impacts will be avoided by leaving elements of the Proposed Development in place where appropriate. The onsite 110kV electrical substation and 110kV electrical cabling will be retained as a permanent part of the national grid. The turbine bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures.

No significant effects on the hydrological and hydrogeological environment will occur during the decommissioning stage of the Proposed Development.

9.5.5 Risk of Major Accidents and Disasters

The main risk of Major Accidents and Disasters at peatland sites is related to peat stability. A PSRA (Appendix 8-1) has been completed for the Proposed Development and it concludes that with the implementation of the proposed mitigation measures that the risk of a peat failure at the Proposed Development site is low.

Flooding can also result in downstream Major Accidents and Disasters. However, due to the small scale of the Proposed Development footprint and with the implementation of the proposed mitigation measures, the increased flood risk associated with the Proposed Development is low (refer to Section 9.5.3.1).

9.5.6 Assessment of Potential Health Effects

Potential health effects arise mainly through the potential for surface and groundwater contamination which may have negative effects on public and private water supplies. There are no mapped public or group water scheme groundwater protection zones in the Proposed Development site. Furthermore, no private wells are located in close proximity to the Proposed Development. Notwithstanding this, the Proposed Development design and mitigation measures ensures that the potential for effects on the hydrogeological will not be significant.

There are 2 no. surface water abstractions downstream of the Proposed Development, at Castle Lake in the Shannon Estuary North surface water catchment and along the Shannon (Lower)_060 SWB in the Lower Shannon Catchment. Due to the downstream distance from the Proposed Development, along with the proposed wind farm drainage plan and the proposed mitigation measures, no health effects with regard to these water supplies will occur.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues. A detailed Flood Risk Assessment has also shown that the risk of the proposed wind farm contributing to downstream flooding is very low, as the long-term plan for the site is to retain and slow down drainage water within the existing site. On-site drainage control measures will ensure no downstream increase in flood risk.

9.5.7 Cumulative Effects

This section presents an assessment of the potential cumulative effects associated with the Proposed Development and other developments (existing and/or proposed) on the hydrological and hydrogeological environment.

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the hydrogeological setting of the Proposed Development site (i.e. low permeability peat overlying a locally important bedrock aquifer) and the near surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Development are assessed as not likely.

The primary potential for cumulative effects will occur during the construction phase of the Proposed Development as this is when earthworks and excavations will be undertaken at the Proposed Development site. The potential for cumulative effects during the operational phase of the Proposed Development will be significantly reduced as there will be no exposed excavations, there will be no sources of sediment to reach watercourses, there will be no use of cementitious materials and fuels/oil will be kept to a minimum at the site. During the decommissioning phase, the potential cumulative effects are similar to the construction phase, but to a lesser degree with less ground disturbance.

A cumulative hydrological and hydrogeological study area has been delineated as shown below in Figure 9-14.

A quantitative analysis has been completed in order to delineate our hydrological cumulative assessment area. Our assessment is based on flow volumes obtained from EPA HydroTool Nodes in the vicinity and downstream of the Wind Farm Site. With the Wind Farm Site being located in 2 no. surface water catchments (Lower Shannon Catchment and North Shannon Estuary Catchment), it is required to delineate a separate cumulative assessment area within each catchment:

- Within the Lower Shannon Catchment our assessment concludes that due to dilution no hydrological cumulative effects will occur beyond EPA Hydrotool Node 25_3883 on the Blackwater River.
- Within the North Shannon Estuary Catchment, no cumulative hydrological effects will occur downstream of Castle Lake due to the large volumes of water and dilution/attenuation provided by this lake waterbody. The assessment has been extra conservative, with the delineated cumulative assessment area which extends further downstream to Node 27_1273.

There will be no potential for cumulative effects beyond this cumulative study area due to increases in flow volumes (as the catchment area increases) and increasing distance from the Proposed Development.

The cumulative hydrological and hydrogeological study area has a total area of 14,033ha (8,081ha in the North Shannon Estuary Catchment and 5,952ha in the Lower Shannon Catchment).

A further assessment has been completed within a 200m zone of the proposed Grid Connection. Due to the shallow nature of the underground cabling connection trench, a 200m study area is an appropriate scale when considering potential cumulative effects on the water environment. In addition, a cumulative assessment was completed in the Tonlegee_010 WFD river sub-basin due to the proposed Temporary Transition Compound.

9.5.7.1 Cumulative Effects with Agriculture

The delineated cumulative study area is a largely agricultural area.

Agriculture is the largest pressure on water quality in Ireland. Agricultural practices such as the movement of soil and the addition of fertilizers and pesticides can lead to nutrient losses and the entrainment of suspended solids in local surface watercourses. This can have a negative effect on local and downstream surface water quality.

In an unmitigated scenario the Proposed Development would have the potential to interact with these agricultural activities and contribute to a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

However, the mitigation measures detailed above in Section 9.5.2, 9.5.3 and 9.5.4 for the construction, operation and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons it is concluded that there will not be a significant cumulative effect associated with agricultural activities.

9.5.7.2 Cumulative Effects with Forestry

The Wind Farm Site is situated in an area of coniferous forestry on the Slieve Bernagh Mountain Range in east Co. Clare.

The most common water quality problems arising from forestry relate to the release of sediment and nutrients to the aquatic environment, and impacts from acidification. Forestry may also give rise to modified stream flow regimes caused by associated land drainage.

Due to the close proximity of these forested areas to the Proposed Development site and given that they drain to the same watercourses as the Wind Farm Site,, the potential cumulative effects on downstream water quality and quantity need to be assessed.

However the mitigation measures detailed in Section 9.5.2, 9.5.3 and 9.5.4 for the construction, operation and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons it is concluded that there will not be a significant cumulative effect associated with commercial forestry activities.

9.5.7.3 Cumulative Effects with Other Wind Farm Developments

Only 1 no. existing / permitted and or proposed wind farm has been identified within the cumulative study area. This is the proposed Oatfield Wind Farm and includes 11 no. proposed turbines. The application for Oatfield Wind Farm was submitted on 22nd December 2023 and is currently under consideration by An Bord Pleanála. It is possible that the construction phase of the Proposed Development and the construction of the proposed Oatfield Wind Farm could overlap. This would result in potential cumulative hydrological effects on downstream watercourses in the absence of mitigation measures.

Please note that nearby wind farms including the permitted Carrownagowan Wind Farm and the proposed Lackeragh, Ballycar and Fahybeg Wind Farms are located outside of the cumulative study area and therefore there is no potential for cumulative effects to occur (due to lack of hydrological connectivity).

The EIAR for the above Oatfield wind farm development details potential hydrological and hydrogeological issues relating to the operation and decommissioning phases of these developments and propose a suite of best practice mitigation measures designed to ensure that the developments do not in any way have a negative effect on downstream surface water quality and quantity. Similarly, the mitigation and best practice measures proposed in this EIAR chapter will ensure that the Proposed Development does not have the potential to result in significant effects on the hydrological/hydrogeological environment.

Therefore, with the implementation of the proposed mitigation measures (both for the Proposed Development and for the other wind farms there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Development and other wind farms within the cumulative study area.

9.5.7.4 Cumulative Effects with Other Wind Farm Grid Connection Routes

A study was completed to identify any grid connection routes associated with other wind farm developments which overlap with the proposed Grid Connection. From this study, the following overlaps were recorded:

- ~800m overlap with the grid connection underground cabling route associated with the proposed Lackareagh Wind Farm in the townland of Castlebank. The overlap occurs along the L3056 and along existing ESB access tracks in the vicinity of Ardnacrusha 110kV substation;
- ~5km overlap with the grid connection underground cabling route associated with the proposed Carrownagowan Wind Farm. The overlap extends from the R471 at Cloghera as far as Ardnacrusha 110kV substation.
- ~150m overlap with the grid connection underground cabling route associated with the permitted Fahybeg Wind Farm. The overlap occurs in the vicinity of Ardnacrusha 110kV substation.

There is no overlap associated the proposed grid connection for Oatfield Wind Farm as this is a loop in connection to an existing overhead line.

The greatest potential for cumulative effects to occur would be if the construction phase of the underground grid connection routes overlapped with each other. In an unmitigated scenario, there may be some cumulative effects on the downstream receiving watercourses. However, practicalities will make it highly unlikely that the construction phase of the overlapping sections of the grid connections would occur at the same time as this would result in road closures (two trenches being excavated). Therefore, the overlapping sections of the grid connections cannot be built at the same time.

Furthermore, the EIARs for the above wind farm developments detail potential hydrological and hydrogeological issues relating to the construction of the grid connection underground cabling routes. The EIARs propose a suite of best practice mitigation measures designed to ensure that the construction of the grid connection underground cabling routes do not in any way have a negative effect on downstream surface water quality and quantity. Similarly, the mitigation and best practice measures proposed in this EIAR chapter will ensure that the construction of the proposed Grid Connection does not have the potential to result in significant effects on the hydrological/hydrogeological environment.

Therefore, with the implementation of the proposed mitigation measures (both for the Proposed Project and for the other grid connections) there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Project and other grid connections within the cumulative study area.

9.5.7.5 Cumulative Effects with Other Developments

A detailed cumulative assessment has been carried out for all planning applications (granted and awaiting decisions) within the cumulative assessment area for the Wind Farm Site and the Grid Connection described above.

The planning applications identified within the study area for new dwellings or renovations of existing dwellings, as well as for the erection of farm buildings. Based on the scale of the works, their proximity to the Proposed Development site and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Development (construction, operation and decommissioning phases).

9.5.8 Post Consent Monitoring

No monitoring is required.

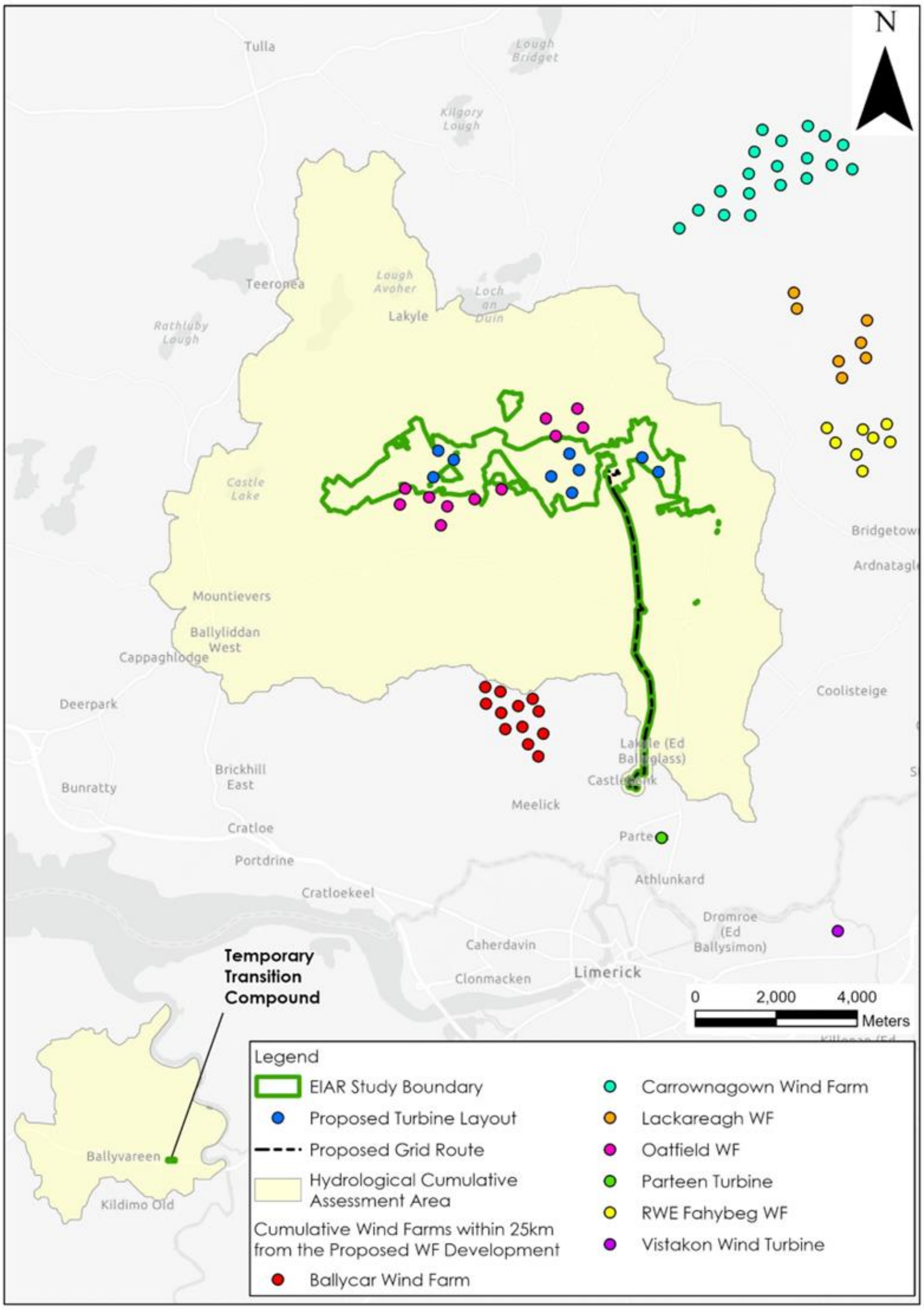


Figure 9-14: Hydrological Cumulative Study Area and Other Wind Farm Developments