Planning and Environmental Consultants

Environmental Impact Assessment Report (EIAR)

Lackareagh Wind Farm, Co. Clare

Chapter 9 – Water

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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 likely and significant effects of the proposed Lackareagh Wind Farm on water aspects (hydrology and hydrogeology) of the receiving environment.

The Proposed Project is described in full in Chapter 4 of this EIAR.

This chapter provides a baseline assessment of the environmental setting of the Proposed Project, 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 Project will have. Where required, appropriate mitigation measures to avoid any identified significant effects to hydrology and hydrogeology are recommended and the residual effects of the Proposed Project post-mitigation are assessed.

As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Project', 'Proposed Wind Farm', 'Proposed Grid Connection Route' and the 'site'.

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 and Conor McGettigan.

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 4 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 developments on peatlands. Conor also routinely prepares hydrological and hydrogeological assessment reports, Water Framework Directive (WFD) compliance assessment reports and flood risk assessments for a variety of development types including wind farms.

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 2.7 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)	"*The Groundwater Data Viewer indicates an aquifer classed as a 'Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones' underlies the proposed development. The Groundwater Vulnerability map indicates the range of groundwater vulnerabilities within the area covered is variable. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in your assessments, as any groundwater-surface water interactions that might occur would be greatest in these areas.*"	Refer to Section 9.3.9
Health Service Executive	"*The proposed development has the potential to have a significant impact on the quality of both surface and ground water. All drinking water sources, both surface and ground water, must be identified. Public and Group Water Scheme sources and supplies should be identified in addition to any private wells supplying potable water to houses in the vicinity of the proposed development. Measures to ensure that all sources and supplies are protected should be described.* *The Environmental Health Service recommends that a walk over survey of the site is undertaken in addition to a desktop analysis of Geological Survey of Ireland data in order to identify the location of private wells used for drinking water purposes. Any potential significant impacts to drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, aquifers and catchment areas should be considered when assessing potential impacts and any proposed mitigation measures.* *Any impacts on surface water as a result of the construction of the underground cables should be identified and addressed in the EIAR*"	All surface and groundwater resources are identified in Section 9.3.16. The potential effects on local groundwater wells are assessed in Section 9.5.2.11. The potential effects on downstream surface water abstractions are assessed in Section 9.5.2.17.
Inland Fisheries Ireland	"*The Owenogarney system is an important Salmonid spawning river with salmon and trout recorded in the upper reached of stream draining both the Lackareagh Mountain and*	Refer to Sections 9.5.2.1 to 9.5.2.4 for impacts and associated mitigation

Consultee	Description	Addressed in Section
	Sliabh Bearnach areas of the development site and as such is especially sensitive to silt losses emanating from site works." IFI present measures in relation of the prevention of discharges of polluting matter such as cement, the prevention of silt deposition in streams, stream crossings, increased runoff from hardcore areas and the storage of fuels and oils at the site.	measures relating to suspended sediment. The potential effects and mitigation measures relating to hydrocarbons are presented in Section 9.5.2.6. The potential effects and mitigation measures relating to cement-based products are presented Section 9.5.2.7. The potential effects and mitigation measures relating to stream crossings are presented in Sections 9.5.2.9 and 9.5.2.10. The potential effects and mitigation measures relating to increased site runoff are presented in Section 9.5.3.1.
Department of Housing, Local Government and Heritage	"Flood plains, if present, should be identified in the EIAR and left undeveloped to allow for the protection of valuable habitats".	Floodplains in terms of the Proposed Project are discussed in Section 9.3.6.

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:

- Planning and Development Acts, 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. 477/2011: European Communities (Birds and Natural Habitats) Regulations, implementing 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;
- 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").
- 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).
- 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 guidance contained in the following:

- 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);
- 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);
- Wind Europe (Nov, 2020): Decommissioning of Onshore Wind Turbines Industry Guidance Document;
- 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 Project site and the water 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 March and April 2024.

The desk study involved consultation with the following sources:

- Environmental Protection Agency Databases (www.epa.ie);
- Environmental Protection Agency's Hydrotool Database (www.catchments,.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); Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- OPW Flood Mapping (www.floodmaps.ie); and,
- Aerial Photography, 1:5000 and 6 inch base mapping.

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, was undertaken by Michael Gill and Conor McGettigan of HES (refer to Section 9.1.2 above for qualifications and experience) on 8th September 2022, 13th July 2023 and 12th October 2023. The hydrological 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 works to address the Water chapter of this EIAR are as follows:

- HES completed site walkover surveys and drainage mapping at the Proposed Project site on 8th September 2022, 13th July 2023 and 12th October 2023 whereby water flow directions and drainage patterns were recorded;
- Hydrological monitoring including field hydrochemistry and stream flow monitoring of watercourses draining the Proposed Project site was completed on 13th July 2023 and 12th October 2023;
- A total of 12 no. surface water grab samples were undertaken to determine the baseline water quality of the primary surface waters originating from the Proposed Project site. These samples were undertaken across 2 no. monitoring rounds each comprising of 6 no. samples;
- Completion of 67 no. peat probes were completed by MKO to determine the geomorphology of the peat at the Proposed Wind Farm site;
- HES supplemented the above peat probe dataset by completing additional probes (where peat was present) and gouge cores at the proposed infrastructure locations. All HES peat probes were characterised to Von Post Humification Scale;
- Causeway Geotechnical completed site investigation comprising of 3 no. boreholes, 14 no. trial pits, 18 no. dynamic probes and 27 no. CBR tests at the Proposed Wind Farm site between 11th December 2023 and 29th January 2024;

- A Peat Stability Risk Assessment (PSRA) was completed for the Proposed Project by AFRY Ireland Ltd (AFRY, 2024);
- AFRY completed a Peat and Spoil Management Plan for the Proposed Project (AFRY, 2024); and,
- HES produced detailed drainage drawings for the Proposed Project (Appendix 4-8).

9.2.3 Impact Assessment Methodology

The 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 Project 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.

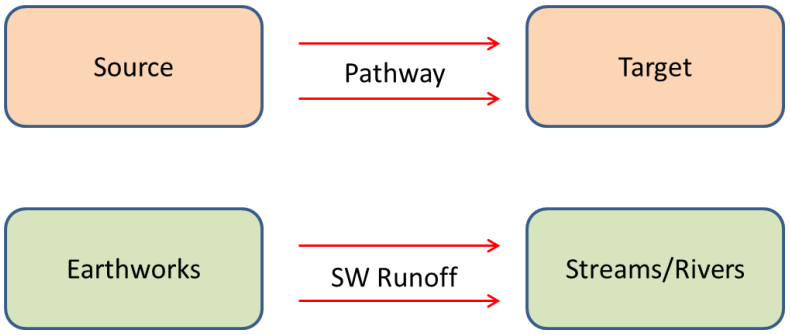
Importance	Criteria	Typical Example
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery. Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3). Flood plain protecting between 1 and 5 residential or commercial properties from flooding.
Low	Attribute 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. 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 Project.



Where potential impacts are identified, the classification of impacts 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 Project is located. The hydrological setting of the Proposed Project is detailed in Section 9.3.3 and shown in Figure 9-1. The hydrogeological setting of the Proposed Project is detailed in Section 9.3.8.

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 Proposed Project Site Description and Topography

9.3.1.1 Proposed Wind Farm

The Proposed Wind Farm is located immediately to the east of the village of Kilbane in east Co. Clare. The Proposed Wind Farm is located ~3.7km northwest of the village of Bridgetown, ~4.6km east of the village of Broadford, Co. Clare and ~14km north of Limerick City. The Proposed Wind Farm is located in the townlands of Killeagy (Ryan), Killeagy (Stritch), Killeagy (Goonan), Kilbane, Shannaknock, Lackareagh Beg, Magherareagh, and Ballymoloney. The EIAR Site Boundary has a total area of 291 hectares (ha).

The Proposed Wind Farm is comprised of agricultural lands in the west and existing commercial forestry plantations, dominated by Sitka Spruce and Lodgepole Pine, in the east. The eastern section of the Proposed Wind Farm also contains areas which have been felled and are reverting naturally.

The Proposed Wind Farm is served by an existing network of local public and private roads. A local road (L7080), known as the Gap Road, dissects the Proposed Wind Farm and joins the village of Kilbane in the west with Garraunboy Cross in the east. This local road is located on a steep gradient in places and passes between Glennagalliagh Mountain to the north and Lackareagh Mountain to the south. Several small farm access tracks and forestry roads branch off from this local road and facilitate access to the Proposed Wind Farm.

Topography of the Proposed Wind Farm is highly variable, ranging from ~90 to 440mOD (metres above Ordnance Datum). The Proposed Wind Farm is located in the Slieve Bernagh Mountain Range. The east of is located on the western slopes of Glennagalliagh and Lackareagh mountains and contains some very steeply sloping ground. Meanwhile, the northwest of the Proposed Wind Farm is located on the southern slopes of Cragnamurragh Mountain.

Turbine Delivery Route

The Turbine Delivery Route (TDR) is detailed in Chapter 4, Section 4.5.

A temporary compound and blade set down area will be constructed along the R466 in the townland of O'Briensbridge, ~1km southeast of the small village of Bridgetown in east Co. Clare.

9.3.1.2 Proposed Grid Connection Route

The Proposed Grid Connection Route to Ardnacrusha is ~14.7km in length. The proposed route is located within the carriageway of regional and local public roads (~14.4km) and ESB access tracks (~300m) on the approach to Ardnacrusha 100kV substation.

The Proposed Grid Connection Route originates from the proposed onsite 38kV electrical substation in the townland of Killeagy (Goonan) within the Proposed Wind Farm site. The underground grid connection electrical cabling travels to the west along the Gap Road as far as Kilbane before it veers to the south and travels along the L3022-8. There are 2 no. bridge crossings along this local road, 1 no. unnamed bridge and a crossing over the Glenomra River at Ahnagor Bridge. The route then travels along the R466 for ~950m, before continuing to the south along the L3046 to Harol's Cross. The route then travels along the L3046, the R463 as far as Barry's Cross with an existing crossing at Blackwater Bridge. The route then travels to the southwest along the L3056 before travelling along internal access tracks within Ardnacrusha generation plant.

Elevations along Proposed Grid Connection Route range from ~270mOD at the proposed onsite 38kV electrical substation to ~20mOD in the vicinity of Ardnacrusha 110kV Electrical Substation. The Proposed Grid Connection Route is located entirely in the existing public road corridor.

9.3.2 Water Balance

Long term Annual Average Rainfall (AAR) and evaporation data was sourced from Met Éireann (sourced on 13th March 2024). The 30-year annual average rainfall recorded at Killaloe rainfall station, located ~6km east of the Proposed Wind Farm site are presented in Table 9-5. The average annual rainfall at Killaloe is 1,357mm/year.

However, the AAR at Killaloe rainfall station is likely to underestimate the actual AAR at the Proposed Wind Farm site due to the elevation difference. The highest elevation at the Proposed Wind Farm site is ~440m OD which is significantly higher than Killaloe rainfall station which stands at 40m OD.

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 Proposed Wind Farm site ranges from 1,385 to 1,499mm/year. The average annual rainfall is 1,442mm/yr (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

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

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Killaloe		170,400		172,700		40		1957		1983		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
152	109	114	82	84	88	83	111	104	144	136	150	1,357

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Shannon Airport, ~25km southwest of the Proposed 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 Proposed 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 Proposed Wind Farm site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,442mm/year – 516mm/year

ER = 926mm/year

Groundwater recharge coefficient estimates are available from the GSI (www.gsi.ie) (accessed on 13th March 2024). Within the Proposed Wind Farm site recharge coefficients range from 60 to 85% in areas with well-draining soils and moderate permeability subsoils and where rock is close to the surface. Meanwhile, lower rates of groundwater recharge (22%) are mapped in areas where peat is present.

An estimate of 210mm/year average annual recharge is given for the Proposed 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 and peaty soils, the steeply sloping nature of the local topography and the low to moderate permeability of the underlying bedrock aquifer

[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.*

which will refuse a high proportion of potential recharge. This means that the hydrology of the Proposed 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 Proposed Wind Farm site.

Therefore, conservative annual recharge and runoff rates for areas of the Proposed Wind Farm site which are covered in peat are estimated to be 210mm/yr and 631mm/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 Proposed 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 Proposed Wind Farm site is estimated to be 1,442mm/yr. Under the medium-low emissions scenario this may reduce to ~1,327mm/yr, while under the high emissions scenario this figure may reduce to 1,384mm/yr.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. Table 9-6 below presents return period rainfall depths for the area of the Proposed Wind Farm site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 50-year, 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 Proposed Wind Farm site

Return Period (Years)				
Storm Duration	1	5	30	100
5 mins	3.6	6.0	10.2	14.0
15 mins	6.0	9.9	16.6	23.0
30 mins	7.7	12.4	20.2	27.4
1 hour	10.1	15.7	24.7	32.7
6 hours	20.0	28.5	41.2	51.8
12 hours	26.0	36.0	50.3	61.8
24 hours	33.9	45.4	61.3	73.9
2 days	42.6	55.8	73.8	87.7

9.3.3 Regional and Local Hydrology

9.3.3.1 Proposed Wind Farm

The Proposed Wind Farm site is located across 2 no. regional surface water catchments. The east of the Proposed Wind Farm site is located in the Lower Shannon surface water catchment and Hydrometric Area 25D. Meanwhile, the west of the Proposed 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 Felim Mountains in the east (EPA, 2018).

Within the Lower Shannon surface water catchment, the Proposed Wind Farm site is located in the Shannon[Lower]_SC_080 sub-catchment. More locally this section of the Proposed Wind Farm site lies within the catchment of the Ardcloony River. This river rises near the summit of Moylussa and flows to the southeast, ~1km east of the Proposed Wind Farm site. The Ardcloony River discharges into Lough Derg ~5km to the southeast. In terms of WFD river sub-basins, this area of the Proposed Wind Farm site is mapped in the Ardcloony_010 river sub-basin.

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 Proposed Wind Farm site is located in the Owenogarney_SC_010 sub-catchment. More locally, this area of the Proposed Wind Farm site is drained by the Glenomra River and is mapped in the Broadford_010 WFD river sub-basin. The Glenomra River flows to the northwest, ~1km southwest of the Proposed Wind Farm site. Several mountain streams rise on the slopes of Lackareagh and Glennagalliagh mountains and flow to the southwest, through the site, before discharging into the Glenomra River. Many of these mountain streams are locally unnamed, with the exception of the Ailleenagommaun Stream which flows ~200m north of T7 and ~250 south of T6. Many of these streams have been assigned names in the EPA blueline database. The Ailleenagommaun Stream is referred to as the Clonconry Beg Stream, while a stream referred to as the Kilbane Stream flows to the south ~220m east of T2. Downstream of the Proposed Wind Farm site, the Glenomra River flows to the west, through the village of Broadford. Downstream of Broadford, this watercourse is referred to as the Broadford River. This river discharges into Doon Lough, ~6.7km west of the Proposed Wind Farm site and outfalls from this lake as part of the Owenogarney River.

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.

Table 9-7 below illustrates the location of the Proposed Project infrastructure with respect to WFD regions and the closest EPA mapped watercourses.

Turbine Delivery Route

The proposed blade transition area along the TDR is located in the Lower Shannon regional surface water catchment. More locally this area is within the Shannon[Lower]_SC_080 sub-catchment and the Bridgetown (Clare)_010 WFD river sub-basin. There are no EPA mapped watercourses in the immediate vicinity of the proposed blade transition area.

9.3.3.2 Proposed Grid Connection Route

The northern section of the Proposed Grid Connection Route, in the vicinity of the Proposed Wind Farm site is mapped in the Shannon Estuary North surface water catchment and Hydrometric Area 27. There are a total of 4 no. watercourse crossings over EPA mapped rivers and streams in this area. These crossings are located as follows:

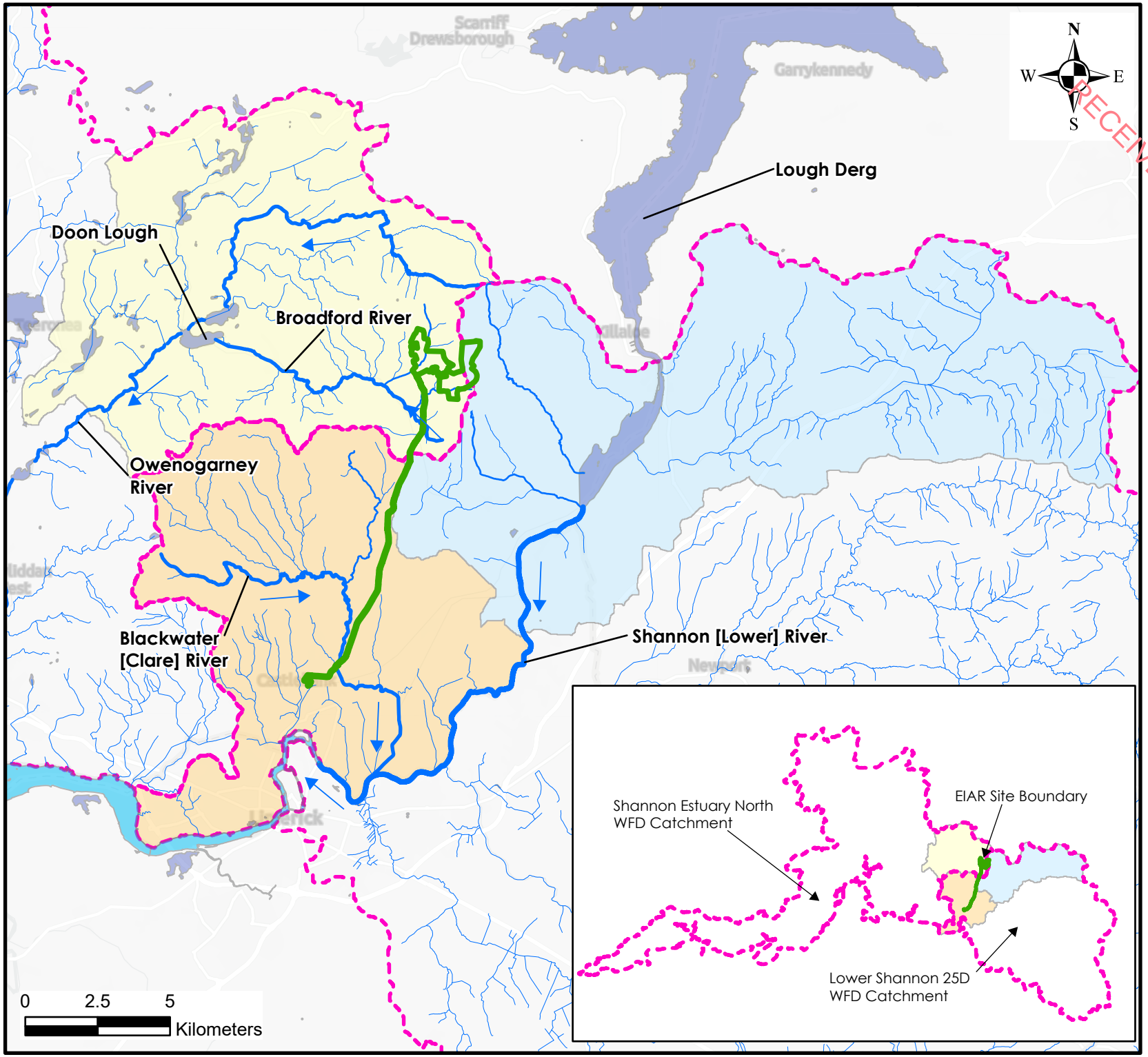
- Along the L7080 (the Gap Road) within the Proposed Wind Farm site over a tributary of the Ailleenagommaun Stream (EPA Name: Cloonconry Beg);

- Along the L3022-8 at an unnamed bridge over the Ailleenagommaun Stream (EPA Name: Cloonconry Beg);
- Along the L3022-8 over the Glenomra River at Ahnagor Bridge; and,
- Along the L3022-8 over a small locally unnamed tributary of the Glenomra Stream referred to by the EPA as the Ballyquin Beg Stream.

The vast majority of the Proposed Grid Connection Route is mapped in the Lower Shannon surface water catchment and Hydrometric Area 25D. Within this catchment, there is 1 no. crossing over the EPA mapped Blackwater River near Barry's Cross at Blackwater Bridge.

The watercourse crossings over EPA mapped watercourses are at existing bridge and culvert crossings.

The WFD river sub-basins through which the Proposed Grid Connection Route passes are detailed in Table 9-7.



Legend

- EIAR Site Boundary
- Watercourses
- Lakes

WFD Subcatchments

- Owenogarney_SC_010
- Shannon[Lower]_SC_080
- Shannon[Lower]_SC_100
- WFD Catchments
- WFD Transitional Waterbodies

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Client: EDF Renewables Ireland	
Job: Lackareagh Wind Farm, Co. Clare	
Title: Regional Hydrology Map	
Figure No: 9-1	
Drawing No: P1598-0-0724-A4-901-00A	
Sheet Size: A4	Project No: P1598-0
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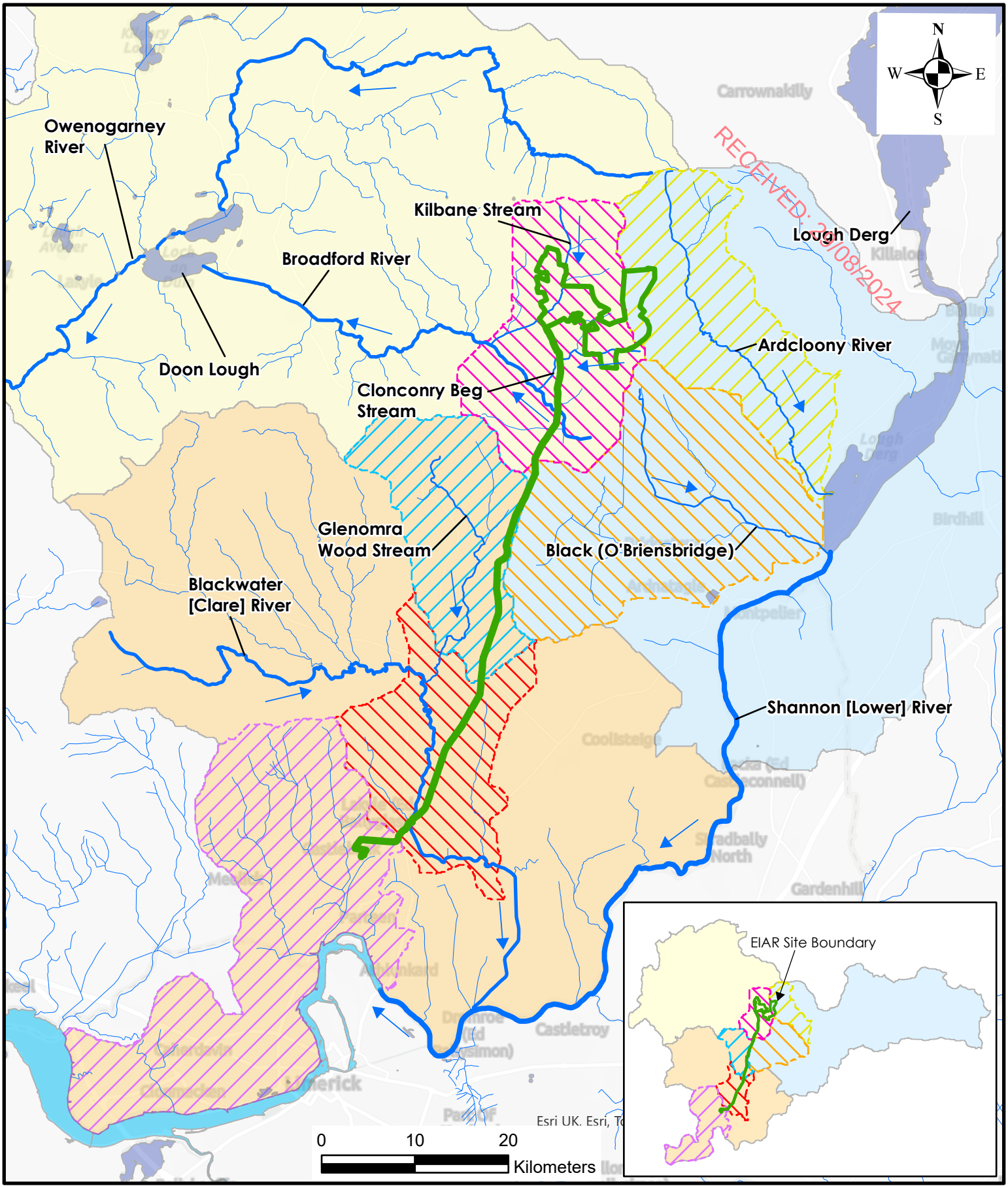
Date: 08/07/2024	Checked By: MG



Legend

- EIAR Site Boundary
- Watercourses
- Lakes
- WFD Transitional Waterbodies

WFD Subcatchments

- Owenogarney_SC_010
- Shannon[Lower]_SC_080
- Shannon[Lower]_SC_100

WFD River Sub-Basins

- ARDCLOONY_010
- BLACKWATER (CLARE)_020
- BRIDGETOWN (CLARE)_010
- BROADFORD_010
- GLENOMRA WOOD STREAM_010
- North Ballycannan_010

Client: EDF Renewables Ireland

Job: Lackareagh Wind Farm, Co. Clare

Title: Local Hydrology Map

Figure No: 9-2

Drawing No: P1598-0-0724-A4-902-00A | Scale: 1:100,000 | Drawn By: GA

Sheet Size: A4 | Project No: P1598-0 | Date: 08/07/2024 | Checked By: MG

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Table 9-7: Proposed Project and WFD Regions

Proposed Project Infrastructure	Nearest Hydrological Features	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
Proposed Wind Farm				
T3, T4, T5 and new proposed site access roads	Several unmapped mountain stream which rises in the east of the Proposed Wind Farm site	Ardcloony_010	Shannon[Lower]_SC_080	Lower Shannon
T1, T2, T6, T7, construction compound, borrow pit, storage area, substation, met mast, upgrades to existing roads and new proposed roads	Several mapped and unmapped mountain stream which rise in this area of the Proposed Wind Farm site	Broadford_010	Owenogarney_SC_010	Shannon Estuary North
Temporary blade transition area along the TDR	McNamara's Lake (~120m to southeast)	Bridgetown (Clare)_010	Shannon[Lower]_SC_080	Lower Shannon
Proposed Grid Connection Route				
Underground cable connection (~5.1km) and 4 no. crossings over EPA mapped watercourses	Glenomra River and its tributaries	Broadford_010	Owenogarney_SC_010	Shannon Estuary North

Proposed Project Infrastructure	Nearest Hydrological Features	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
Underground cable connection (~0.7km)	Tributaries of the Bridgetown River	Bridgetown (Clare)_010	Shannon[Lower]_SC_080	Lower Shannon
Underground cable connection (~4km)	Glenomra Wood Stream	Glenomra Wood Stream_010	Shannon[Lower]_SC_100	
Underground cable connection (~3.4km) and 1 no. EPA mapped watercourse crossing	Blackwater River	Blackwater (Clare)_020		
Underground cable connection (~1.5km)	River Shannon	North Ballycannan_010		

9.3.4 Surface Water Flows

There are no Office of Public Works (OPW) gauging stations located in the immediate vicinity of the Proposed Wind Farm site. The closest downstream gauging station in the Lower Shannon surface water catchment is located on the Shannon River at Parteen Weir (Station Number: 25075). Here the 95%ile flow is estimated to be $10m^3/s$. This means that 95% of the time the flow in the River Shannon at this location is at or above $10m^3/s$. Meanwhile, the closest OPW gauging station in the Shannon Estuary North catchment is located on the Owenogarney River, downstream of Castle Lake. Here the 95%ile flow volume is estimated to be $0.165m^3/s$.

The EPA's hydrotool, available on www.catchments.ie, was consulted on 27th June 2024, in order to estimate baseline flow volumes in the local area. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several Hydrotool nodes were consulted in the vicinity and downstream of the Proposed Wind Farm site.

Within the Lower Shannon surface water catchment there is only 1 no. Hydrotool Node located downstream of the Proposed Wind Farm site. This Node (Node 25_2595) is located on the Ardcloony River, immediately upstream of its confluence with the River Shannon. The 95%ile flow at this Node is estimated to be $0.05m^3/s$.

Meanwhile, several Hydrotool Nodes are located downstream of the Proposed Wind Farm site in the Shannon Estuary North Catchment. Figure 9-3 below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Proposed Wind Farm site. The flow volumes increase progressively downstream of the Proposed Wind Farm site. For example, the 95%ile flow in the Glenomra River upstream of the Kilbane Stream (Node: 27_323) is estimated to be $0.033m^3/s$. Meanwhile, the 95%ile flow in the Broadford River upstream of Doon Lough (Node: 27_287) is estimated to be $0.141m^3/s$. Further downstream flow volumes increase significantly in the Owenogarney River, where the 95%ile flow is estimated to be $0.426m^3/s$ upstream of Castle Lake (Node: 27_377).

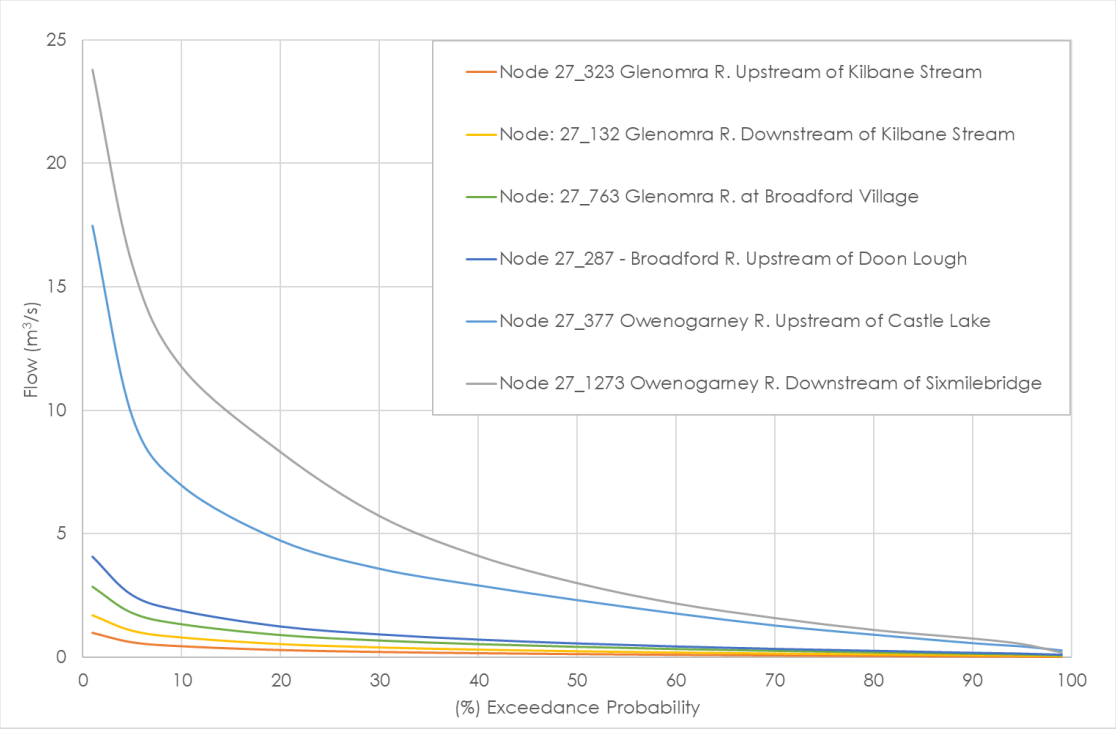


Figure 9-3: Flow Duration Curve (Shannon Estuary North Catchment)

9.3.5 Proposed Wind Farm Site Drainage

An existing 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 Proposed Wind Farm 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 Proposed Wind Farm site is drained by several 1st and 2nd order streams. These natural watercourses originate within the EIAR Site Boundary and flow downslope before discharging into the Ardcloony River to the east and the Broadford River to the southwest.

In places, the natural drainage is further facilitated by a network of manmade drains. The nature of these drains depends on the local land use. In agricultural areas of the Proposed Wind Farm site, manmade field drains are located along many of the local field boundaries and hedgerows and connect to downstream natural watercourses. Manmade drains are also located along sections of the existing roads.

The forestry plantations in the east of the Proposed Wind Farm site 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 9-4. 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.

2 no. rounds (13th July 2023 and 12th October 2023) of surface water flow monitoring were carried out at 6 no. locations on the main streams and rivers draining the Proposed Wind Farm site and the results are shown in Table 9-8 below. The measured flows at SW2, SW3, and SW4 are typical of seasonal flows for 1st and 2nd order mountain streams. The largest recorded allowed volumes were encountered at SW6 on the Blackwater River (along the Proposed Grid Connection Route) with the recorded flows are more typical of a larger river with significant upstream catchment.

An existing drainage map for the Proposed Wind Farm site is shown as Figure 9-5 below.

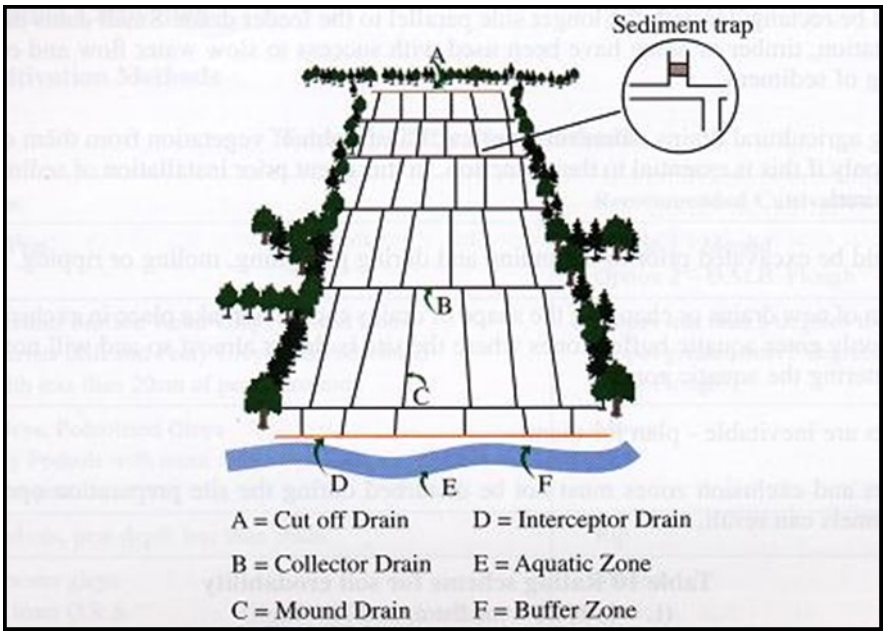
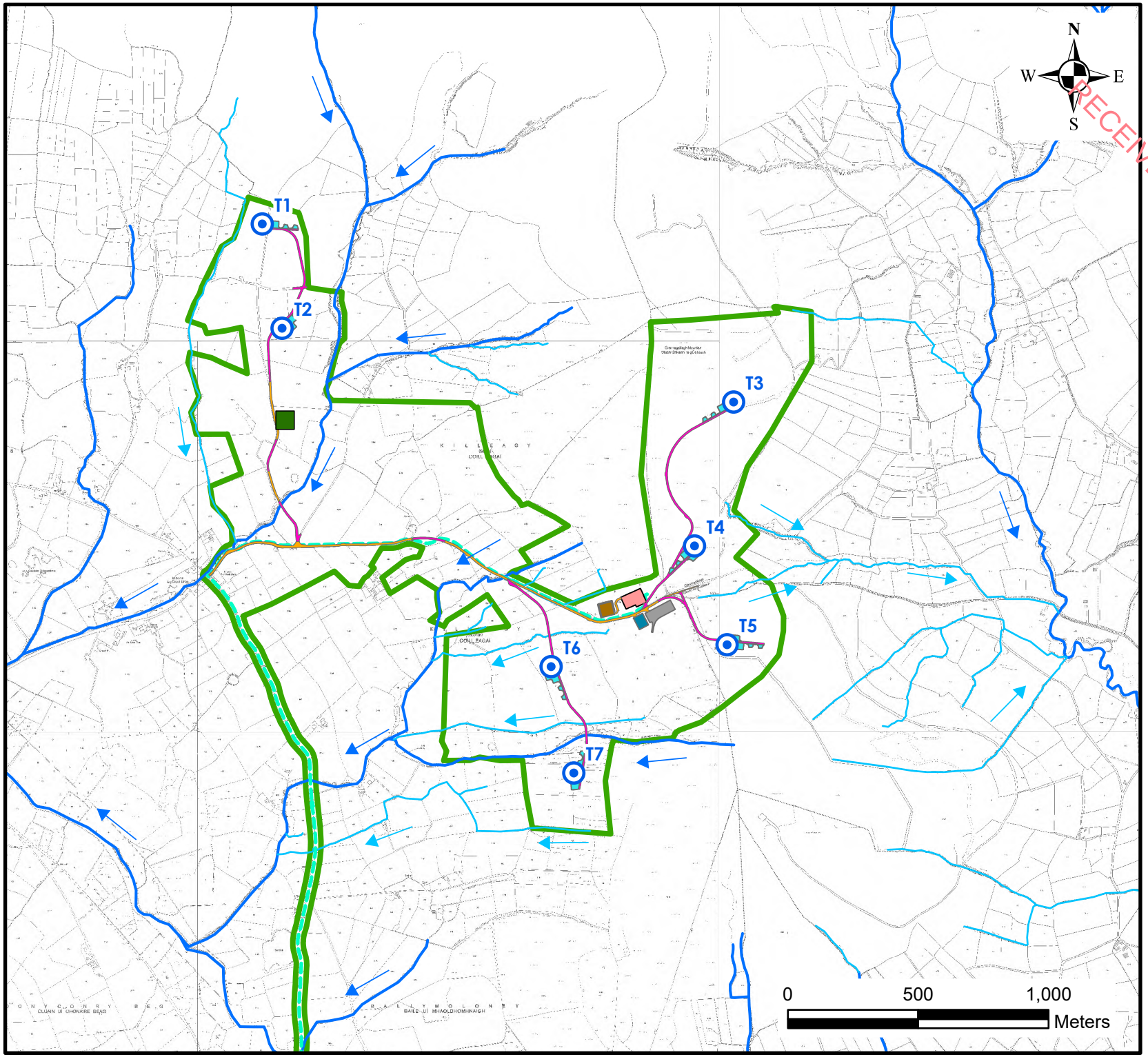


Figure 9-4: Schematic of Existing Forestry Drainage

Table 9-8: Surface Water Flow Monitoring

Location	Easting (ITM)	Northing (ITM)	Watercourse – EPA Name	Flow Volume (m^3/s) Range across 2 no. monitoring rounds
SW1	560998	672116	Glenomra River	0.05 – 0.06
SW2	562191	672827	Kilbane Stream	0.02 – 0.025
SW3	564890	672673	Unnamed stream	0.008 – 0.01
SW4	562372	671855	Cloonconry Beg	0.008 – 0.012
SW5	565267	672503	Ardcloony	0.03 – 0.04
SW6	559376	662466	Blackwater River	~5



Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Proposed Hardstand Area
- Proposed Met Mast
- Proposed Upgrades to Existing Roads
- Proposed New Roads
- Proposed Borrow Pit
- Proposed Storage Area
- Temporary Construction Compound
- Proposed Onsite 38kV Substation
- Proposed Grid Connection Route
- Watercourses
- Streams/Drains

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Client: EDF Renewables Ireland

Job: Lackareagh Wind Farm, Co. Clare

Title: Proposed Wind Farm site Drainage Map

Figure No: 9-5

Drawing No: P1598-0-0724-A4-905-00A

Sheet Size: A4	Project No: P1598-0
Scale: 1:20,000	Drawn By: GA
Date: 08/07/2025	Checked By: MG

9.3.6 Summary Flood Risk Assessment

9.3.6.1 Proposed Wind Farm

A Flood Risk Assessment of the Proposed Wind Farm 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 13th March 2024).

The OPW Past Flood Events Maps have no records of recurring or historic flood instances within the Proposed 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 west of the Proposed Wind Farm site along the Glenomra River (Flood ID: 4695). In relation to this recurring flood event, the local area engineers report states that "*land on north side of R466 floods over an extensive area on average twice per year. The cause is rainfall/runoff causes stream running by road to overflow*" (www.floodinfo.ie). A recurring flood event is also mapped downstream of Doon Lough along the Owenogarney River (Flood ID: 4699). 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, there are no historic or recurring flood events mapped along the Ardcloony River. Several historic flood events, dating from 2009 and 2015, are mapped further downstream on the River Shannon near O'Brien's Bridge. With respect to mapped recurring flood events, the nearest recurring flood event (Flood ID: 13690) downstream of the Proposed Wind Farm site is mapped at Parteen Weir, ~6km to the southeast.

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 Proposed Wind Farm site. Further downstream, some flooding was recorded at Doon Lough and at Lough Derg.

No CFRAM mapping has been completed for the area of the Proposed Wind Farm site. The closest mapped CFRAM fluvial flood zones within the Lower Shannon surface water catchment are located near Ardnacrusha. 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 Proposed Wind Farm site. Within the Shannon Estuary North surface water catchment, fluvial flood zones are mapped along the Glenomra / Broadford River from Kilbane to Doon Lough with the nearest flood zones situated 900m southwest of the Proposed Wind Farm site. Meanwhile, within the Lower Shannon Catchment, fluvial flood zones are mapped along the Ardcloony River ~1km east of the Proposed Wind Farm site.

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

The risk of pluvial flooding at the Proposed Wind Farm site is low. Some ponding may occur in some flat areas of the Proposed Wind Farm site due to the presence of low permeability peat at the surface.

Elsewhere the sloping topography and the high drainage density transfer surface water away from the Proposed Wind Farm site and into downstream natural watercourses. Mostly the risk of pluvial flooding is low with the exception of local flat areas.

The risk of flooding at the Proposed 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.

Turbine Delivery Route

The proposed blade transition area will not be required for the entire duration of the construction phase which will take ~18-24 months. It is estimated that the compound will be required for a total of 8 months.

The OPW Past Flood Events Map does not record any historic or recurring flood events at the blade transition area. The GSI's Winter 2015/206 Surface Water Flood Map shows surface water flooding ~120m to the southeast, corresponding to the location of McNamara's Lake. The blade transition area is not mapped within any CFRAM or NIFM fluvial or coastal flood zone.

Therefore, the blade transition area is located in Flood Zone C and is at low risk of flooding.

9.3.6.2 Proposed Grid Connection Route

In addition to the Flood Risk Assessment completed for the Proposed Wind Farm site, the potential for flooding along the Proposed Grid Connection Route has also been assessed.

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

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

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 at Blackwater Bridge and the underground grid connection electrical cabling and bridge strapping option for crossing this watercourse will not result in any displacement of floodwaters or increase in downstream flood risk

In summary, the Proposed Grid Connection Route is at 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 Project. 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.

9.3.7 Surface Water Quality

9.3.7.1 EPA Water Quality Monitoring

Biological Q-rating[2] data for EPA monitoring points in the local catchments downstream of the Proposed Project site are shown in Table 9-9 below. The Q-Rating is a water quality rating system

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

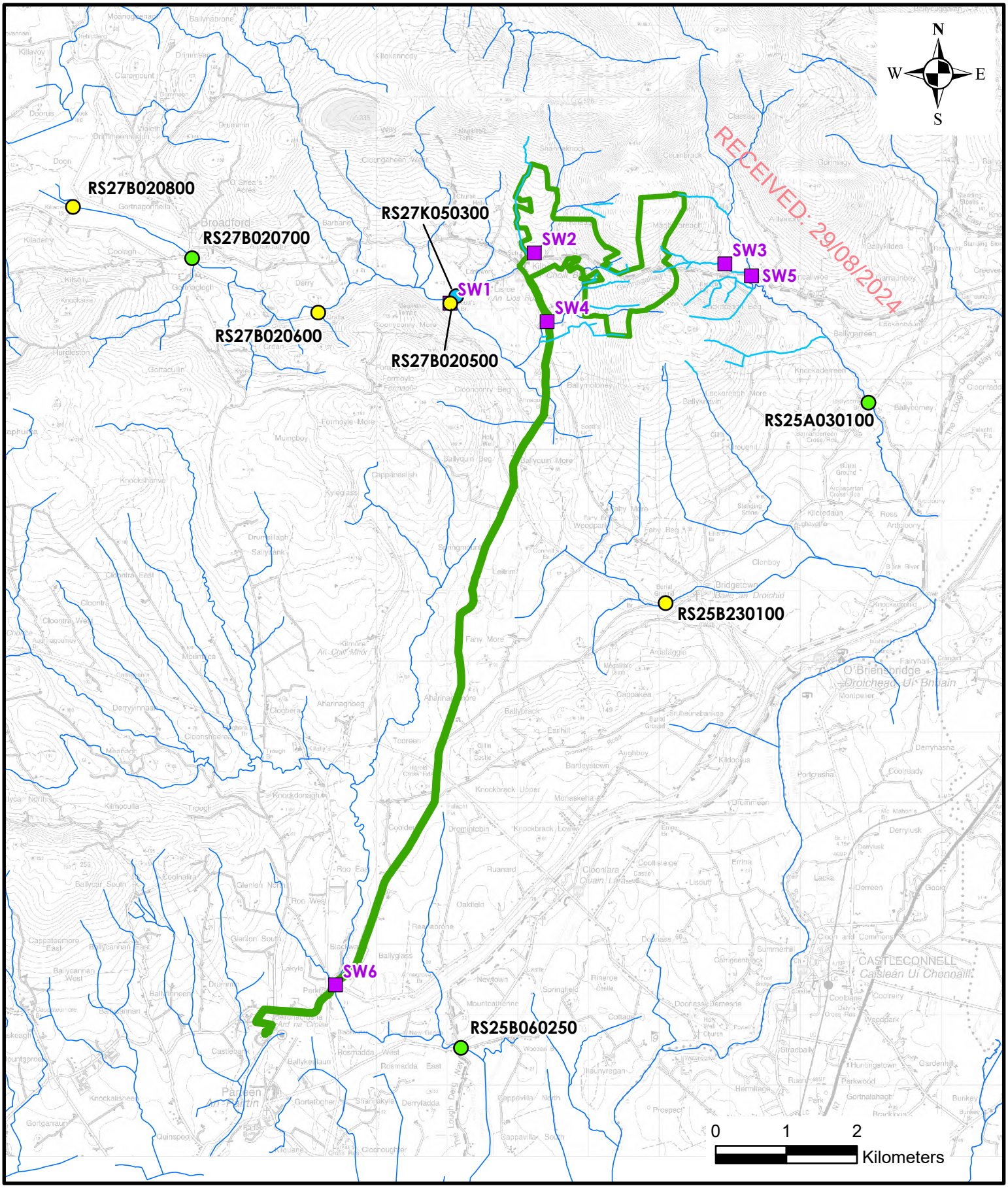
based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from Q1 (Bad) to 4-5 (High).

Within the Lower Shannon surface water catchment, the closest EPA monitoring station downstream of the Proposed Wind Farm site is located on the Ardcloony River at Ballycorney Bridge (Station ID: RS25A030100). At this station, the Ardcloony River achieved a Q4 rating in 2024 (i.e. 'Good' status). Meanwhile, downstream of the Proposed Grid Connection Route the Bridgetown River achieved a Q3-4 rating (i.e. 'Moderate' status) at Fahy Bridge (Station ID: RS25B230100). The Blackwater River achieved Q4 rating downstream of the Proposed Grid Connection Route at a bridge southwest of Mount St. Catherine (Station ID: RS25B060250).

Within the Shannon Estuary North surface water catchment, the Kilbane Stream achieved a Q4-5 rating upstream of its confluence with the Glenomra River in 2022 (Station ID: RS27K050300). The Glenomra River itself was assigned a Q3-4 rating in 2022 at Scott's Bridge near the village of Kilbane (Station ID: RS27B020500) and further downstream near Graffa Bridge (Station ID: RS27B020600). Further downstream, the Broadford River achieved a Q4 rating in Broadford village (Station ID: RS27B020700). Meanwhile, upstream of Doon Lough the Broadford River was assigned a Q3-4 rating (Station ID: RS27B020800). The EPA monitoring stations are shown on Figure 9-6.

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

Watercourse	Station ID	Easting	Northing	Year	EPA Q-Rating Status
Lower Shannon Surface Water Catchment					
Ardcloony River	RS25A030100	166966	170668	2023	Q4 (Good)
Bridgetown River	RS25B230100	164093	167829	2023	Q3-4 (Moderate)
Blackwater River	RS25B060250	161194	161531	2023	Q4 (Good)
Shannon Estuary North Catchment					
Kilbane Stream	RS27K050300	161128	172176	2022	Q4-5 (High)
Glenomra River	RS27B020500	161042	172072	2022	Q3-4 (Moderate)
Glenomra River	RS27B020600	159172	171943	2022	Q3-4 (Moderate)
Broadford River	RS27B020700	157386	172713	2022	Q4 (Good)
Broadford River	RS27B020800	155699	173439	2022	Q3-4 (Moderate)



Legend

- EIAR Site Boundary
- Watercourses
- SW Sampling Locations

EPA Monitoring locs

- Q4-5 (High)
- Q4 (Good)
- Q3-4 (Moderate)
- Streams/Drains

Client: EDF Renewables Ireland

Job: Lackareagh Wind Farm, Co. Clare

Title: EPA Surface Water Monitoring and HES Sampling Locations Map

Figure No: 9-6

Drawing No: P1598-0-0724-A4-906-00A

Scale: 1:70,000

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9.3.7.2 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 6 no. surface water sampling locations over 2 no. monitoring rounds completed on 13th July 2023 and 12th October 2023 within surface watercourses draining and directly downstream of the Proposed Wind Farm site and the Proposed Grid Connection Route. The results are listed in Table 9-10 below. The monitoring locations are shown in Figure 9-6 above.

Specific electrical conductivity (SPC) values at the monitoring locations ranged between 96 and 177µS/cm, with an average specific conductivity value of 133µS/cm. Turbidity ranged from 0.42 to 4.85NTU. Dissolved oxygen ranged from 65.1 to 110 % saturation. The pH values were generally neutral or slightly acidic or slightly basic, ranging between 6.55 and 7.8, with an average pH of 7.7.

Table 9-10: Field Parameters - Surface Water Chemistry Measurements (13/07/2023 to 12/10/2023)

Location ID	Temp °C	DO (% Sat)	SPC (µS/cm)	pH	Turbidity (NTU)
SW1	10.8 – 13.2	65.1 – 110	130 – 176.9	6.55 – 7.65	1.2 – 2.5
SW2	11.1 – 12.3	93.5 – 94.6	122.4 – 144.2	7.03 – 7.67	0.42 – 2.15
SW3	11.3 – 12.2	91.9 – 93.5	96 – 114.3	7.54 – 7.64	1.28 – 1.38
SW4	11.8 – 12.9	94 – 94.2	121 – 137.6	7.43 - 7.58	1.53 – 4.85
SW5	11.3 – 12.9	93.4 – 94.1	116.5 – 135.8	7.45 – 7.7	0.69 - 1.08
SW6	11.1 – 13.2	72.2 – 94	141.2 – 162.7	7.19 – 7.5	1.54 – 2.98

Surface water grab samples were also taken at these locations for laboratory analysis on 2 no. occasions (13th July 2023 and 12th October 2023). Results of the laboratory analysis are shown alongside relevant water quality regulations in Table 9-11 below and are included in full in Appendix 9-2.

Suspended solid concentrations ranged from <5 to 9mg/l. Suspended solid concentrations were below the S.I 293 (of 1988) threshold limit of 25 mg/l in all 12 no. samples.

Ammonia concentrations were found to be of 'High' status with regards to the threshold of ≤0.04mg/l as detailed in S.I. 272 of 2009. Ammonia concentrations were at or below the level of detection in 10 of the 12 no. samples.

BOD concentrations were found to be of 'High' status with regards to the threshold of ≤1.3mg/l (S.I. 272 of 2009). BOD ranged between <1 and 2mg/l. 11 of the 12 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 3 no. samples. Meanwhile, chloride concentrations ranged from 8.5 to 16.5mg/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([4])**	**-**	**-≤0.065 to ≤ 0.04([4])**	**-**
SW1	<5 – 7	<1 - 1	<0.02	5.6 - 8.1	0.02	11.1 – 11.7
SW2	<5	<1 - 1	<0.02 – 0.02	<5	<0.02	9.6 - 10.6
SW3	<5 - <10	<1	<0.02	<5	<0.02	10.3 - 11.2
SW4	7 – 9	<1 - 1	<0.02 - 0.02	<5	<0.02 - 0.03	10.9 - 14
SW5	<5 - <6	<1 - 1	<0.02	<5 - 5.9	<0.02	8.5 - 9.1
SW6	<5 - <10	1 - 2	<0.02	<5	0.02 – 0.03	14.3 - 16.5

9.3.8 Hydrogeology

9.3.8.1 Proposed Wind Farm

The bedrock geology underlying the Proposed Wind Farm site is mapped as Silurian Metasediments and Volcanics (www.gsi.ie). These rocks are classified by the GSI as being a Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones. A bedrock aquifer map is included as Figure 9-7.

In terms of Groundwater Bodies (GWBs), the east of the Proposed Wind Farm site is underlain by the Lough Graney GWB, and the west is underlain by the Tulla-Newmarket on Fergus GWB. Additionally, a small area in the west of the Proposed Wind Farm site, in the vicinity of Kilbane village, is underlain by the Broadford Gravels GWB. This gravel aquifer is located in the Glenomra River valley.

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 are short (30-300m), and groundwater will discharge to the streams and rivers crossing the aquifer; all potential water resources are considered in Section 9.3.16 above.

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 thin. Meanwhile, in upland areas, the majority of potential groundwater recharge runs off as surface water. Groundwater flows are

[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).*

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.

Based on observations at the Proposed Wind Farm site, groundwater baseflow contribution to local streams is expected to be very low all year round. Overall, the hydrology of the Proposed Wind Farm site is dominated by surface water runoff.

Turbine Delivery Route

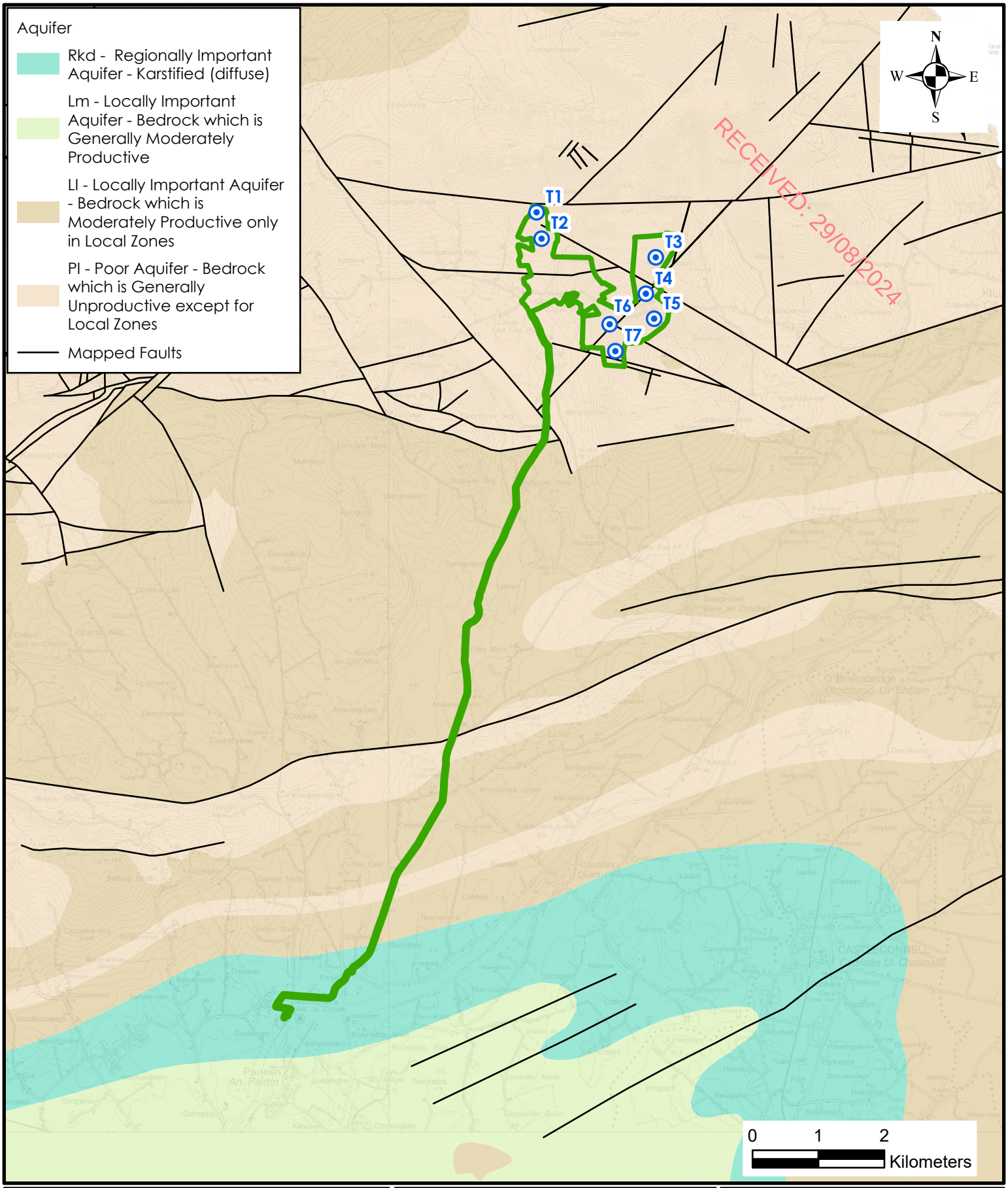
The blade transition area is underlain by a Locally Important gravel aquifer and a Locally Important Bedrock Aquifer (www.gsi.ie). This area is underlain by the Lough Graney GWB (described above).

9.3.8.2 Proposed Grid Connection Route

The Proposed Grid Connection Route is predominantly underlain by Poor and Locally Important bedrock aquifers. Approximately 1.4km in the southern section of the Proposed Grid Connection Route and in the vicinity of Ardnacrusha substation, is underlain by a Regionally Important Aquifer - Karstified (diffuse).

In terms of GWBs, the northern section of the Proposed Grid Connection Route is underlain by the Broadford Gravels GWB in the valley of the Glenomra River. In this area the Broadford Gravels GWB overlies the Tulla-Newmarket-on-Fergus GWB. The vast majority of the Proposed Grid Connection Route is underlain by the Lough Graney GWB whilst the south is underlain by the Ardnacrusha GWB. Additional details on the Tulla-Newmarket-on-Fergus and Lough Graney GWBs 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 is 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).



Legend

- EIAR Site Boundary
- Proposed Turbine Layout

Client: EDF Renewables Ireland		
Job: Lackareagh Wind Farm, Co. Clare		
Title: Local Bedrock Aquifer Map		
Figure No: 9-7		
Drawing No: P1598-0-0724-A4-907-00A	Scale: 1:75,000	Drawn By: GA
Sheet Size: A4 / Project No: P1598-0	Date: 05/07/2024	Checked By: MG

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9.3.9 Groundwater Vulnerability

9.3.9.1 Proposed Wind Farm

The GSI describes 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 Proposed 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/soils and subsoils in this area i.e. rock is close to the ground surface. A total of 6 no. turbines, the onsite substation, construction compound and storage area are mapped in areas of 'Extreme' groundwater vulnerability. A map of groundwater vulnerability is shown as Figure 9-8.

Site investigations at the Proposed Wind Farm 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 2.2 to 2.5m. Given the shallow depth to rock and the nature of the subsoils (silts, clays, sands and gravels), the vulnerability at the Proposed Wind Farm ranges from High to Extreme in accordance with Table 9-12.

However, due to the low permeability nature of the underlying bedrock aquifer, 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 Proposed Wind Farm.

Turbine Delivery Route

The GSI mapped groundwater vulnerability rating at the blade transition area ranges from Moderate to High (www.gsi.ie). Due to the shallow nature of the works no impacts on groundwater quality would be anticipated.

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.

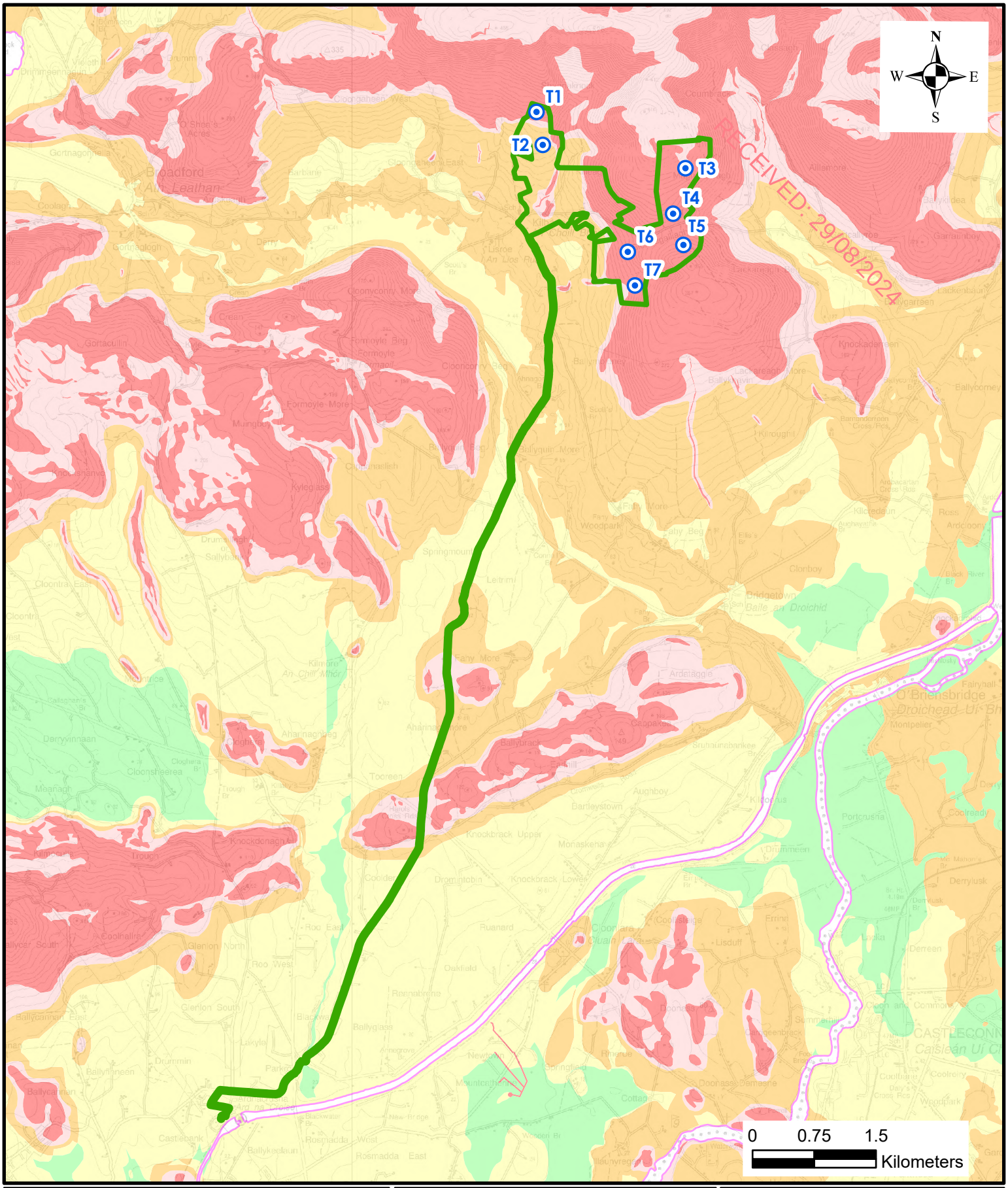
9.3.9.2 Proposed Grid Connection Route

The GSI mapped groundwater vulnerability rating along Proposed Grid Connection Route ranges from 'Moderate' to 'Extreme' (www.gsi.ie). Much of the Proposed Grid Connection Route is mapped as

having 'Moderate' to 'High' vulnerability with the 'Extreme' vulnerabilities mapped in the south near Coolderry. The total length of the Proposed Grid Connection Route, outside of the Proposed Wind Farm site, mapped in areas of 'Extreme' is ~1.06km.

However, due to the low permeability nature of the underlying bedrock aquifers along much of the Proposed Grid Connection Route, groundwater flowpaths are likely to be short (30 – 300m), with recharge emerging close by and discharging into local surface water streams.

Along the Proposed Grid Connection Route, groundwater is most vulnerable to potential effects in areas which are underlain by the Regionally Important Karst Aquifer. The length of the Proposed Grid Connection Route which is underlain by the karst aquifer is ~2.4km. Groundwater vulnerability in this area is mapped by the GSI as 'Low' to 'Moderate'.



Legend

- EIAR Site Boundary
- Proposed Turbine Layout

GW Vulnerability

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water

Client: EDF Renewables Ireland

Job: Lackareagh Wind Farm, Co. Clare

Title: GW Vulnerability Map

Figure No: 9-8

Drawing No: P1598-0-0724-A4-908-00A

Scale: 1:60,000

Drawn By: GA

Sheet Size: A4

Project No: P1598-0

Date: 05/07/2024

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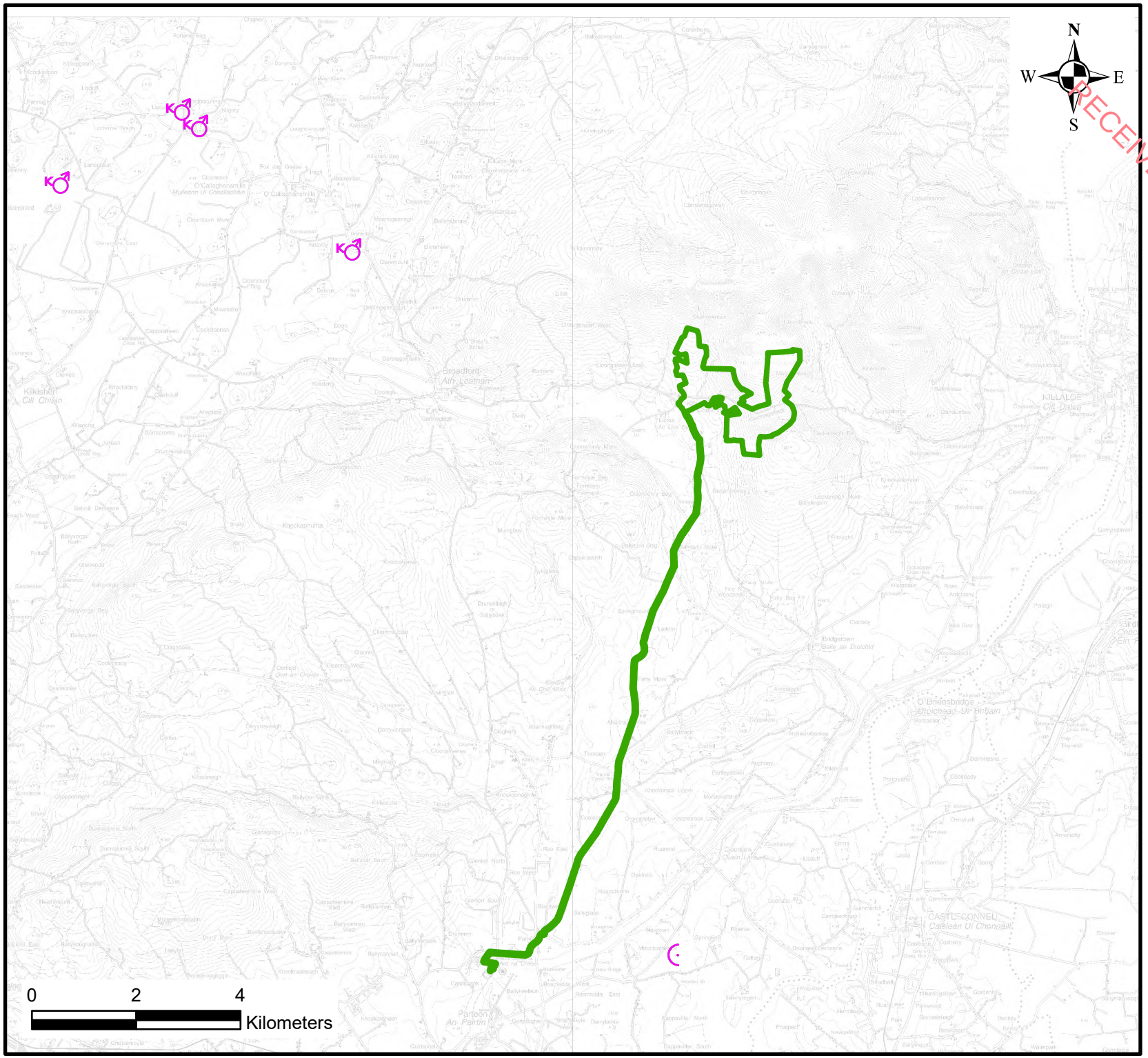
9.3.10 Karst Features

Karst features are mapped by the GSI and available through the GSI online viewer (www.gsi.ie).

Due to the siliceous nature of the bedrock, there are no karst features in the area of the Proposed Wind Farm site or in the vicinity of the temporary blade transition area.

As stated above, ~2.4km of the Proposed Grid Connection Route is underlain by a Regionally Important Karst Aquifer. However, no karst features are mapped along the Proposed Grid Connection Route or in the surrounding lands. The closest mapped karst feature is a swallow hole mapped ~2.2km to the east of the Proposed Grid Connection Route.

A map of karst features is shown below as Figure 9-9.



Legend

EIAR Site Boundary

Karst Features

Spring

Swallow Hole

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Client: EDF Renewables Ireland	
Job: Lackareagh Wind Farm, Co. Clare	
Title: GSI Mapped Karst Features Map	
Figure No: 9-9	
Drawing No: P1598-0-0724-A4-909-00A	
Sheet Size: A4	Project No: P1598-0
Scale: 1:100,000	Drawn By: GA
Date: 08/07/2024	Checked By: MG

9.3.11 Groundwater Hydrochemistry

9.3.11.1 Proposed Wind Farm

There are no groundwater quality data for the Proposed 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 hydrogeological regime at the Proposed Wind Farm site is characterised by high rates of surface water runoff and low rates of groundwater recharge as a result of the steeply sloping nature of the local topography, the low permeability soils and subsoils and the low permeability of the underlying bedrock aquifer. Therefore, downstream surface waters are more sensitive to potential water quality effects.

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.

Turbine Delivery Route

The available hydrochemical data for the Lough Graney GWB is provided above. Groundwater quality effects are not anticipated due to the nature of these works.

9.3.11.2 Proposed Grid Connection Route

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 Proposed Grid Connection Route.

9.3.12 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 Project, 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.

9.3.13 Groundwater Body Status

Local Groundwater Body (GWB) status information is available from (www.catchments.ie) (last accessed and reviewed on 27th June 2024).

The Lough Graney GWB (IE_SH_G_157) underlies the east of the Proposed Wind Farm site and much of the Proposed Grid Connection Route. Meanwhile, the west of the Proposed Wind Farm site and the northern section of the Proposed Grid Connection Route are underlain by the Tulla-Newmarket-on-Fergus GWB (IE_SH_G_229). The Broadford Gravels GWB (IE_SH_G_095) also overlies the Tulla-Newmarket-on-Fergus GWB in the Glenomra River valley. The Ardnacrusha GWB (IE_SH_G_09) underlies the south of the Proposed Grid Connection Route. 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
Broadford Gravels	Good	Good	Good	Not at risk	None

9.3.14 Surface Water Body Status

A summary of the WFD status and risk result for Surface Waterbodies (SWBs) in the vicinity and downstream of the Proposed Project site are shown in Table 9-14 below.

Within the Shannon Estuary North surface water catchment, the Broadford_010 SWB in the vicinity of the Proposed Wind Farm site achieved "Moderate" status in the latest WFD cycle (2016-2021). Further downstream the Broadford_020 SWB achieved "Good" status. This waterbody is a high ecological status objective waterbody and is currently not meeting this objective. Further downstream, the Broadford_030 SWB achieved 'Moderate' status. 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. 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 5 no. SWBs downstream of the Proposed 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_010, _020 and _030 river waterbodies, 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_010 SWB is under significant pressure due to hydromorphological changes. 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 Ardcloony_010 SWB in the vicinity of the Proposed Wind Farm site achieved 'Good' status in the latest WFD cycle (2016-2021). This SWB is listed as a high ecological status objective waterbody, and it is currently not meeting this objective. This SWB however did achieve "High" status in the 1st and 2nd WFD cycles. The Arcloony_010 SWB discharges into the Lough Derg heavily modified waterbody (HMWB). This SWB has been modified due to power generation at Ardnacrusha. The Lough Derg HMWB achieved "Good" status in the latest WFD cycle. Meanwhile, the Glenomra Wood Stream_010 along the Proposed Grid Connection Route achieved "High" status. Further to the south along the Proposed Grid Connection Route, the Blackwater (Clare)_020 and the North Ballycannan_010 SWBs achieved 'Good' status. Downstream of Lough Derg, the Shannon (Lower)_050 and _060 SWBs "Poor" and "Moderate" status respectively.

A total of 3 no. river waterbodies downstream of the Proposed Project site in the Lower Shannon surface water catchment have been deemed to be 'at risk' of failing to meet their WFD objectives. These include the Ardcloony_010, Blackwater (Clare)_020 and Shannon (Lower)_050 SWBs. Further downstream the Limerick Dock waterbody is also "at risk".

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. No significant pressures have been identified on the Ardcloony_010 SWB. Agriculture is listed as a pressure on the Blackwater (Clare)_020 SWB. 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 Shannon (Lower)_050 SWB and the Limerick Dock transitional waterbody are under significant pressure due to hydromorphological changes.

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_010	Poor	Poor	Moderate	At risk	Hydromorphology
Broadford_020	High	Good	Good	At risk	Agriculture & Hydromorphology
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					
Ardcloony_010	High	High	Good	At risk	None
Bridgetown (Clare)_010	Good	Good	Good	Not at risk	None
Glenomra Wood Stream_010	Good	High	High	Not at risk	None
Blackwater(Clare)_020	Good	Good	Good	At risk	Agriculture
Derg HMWB	Good	Good	Good	Under review	None
Shannon (Lower)_050	Moderate	Moderate	Poor	At risk	Hydromorphology
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	Hydromorphology

9.3.15 Designated Sites and Habitats

9.3.15.1 Proposed Wind Farm

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 map of local designated sites is shown as Figure 9-10.

The Proposed Wind Farm site is not located within any designated conservation site, however there are several designated sites in close proximity and downstream of the Proposed Wind Farm site. The connectivity of these designated sites to the Proposed Wind Farm is discussed below.

Within the Shannon Estuary North surface water catchment:

- The Slieve Bernagh Bog SAC (Site Code: 002312) is located directly to the north of the Proposed Wind Farm site. However, this SAC is located upgradient of the Proposed Project. Therefore, there is no potential for the Proposed Project to impact on the status of this SAC.
- Gortacullin Bog NHA (Site Code: 002401) is located ~5.6km (straight line distance) southwest of the Proposed Wind Farm site. There is no hydrological connectivity between the Proposed Wind Farm and this NHA as the Broadford River acts as a hydrological barrier.
- Doon Lough NHA (Site Code: 000337) is located ~5km (straight line distance) to the west of the Proposed Wind Farm site. The NHA 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 Proposed Wind Farm via the Glenomra and Broadford rivers. The length of the hydrological flowpath between the Proposed Wind Farm site and this NHA is ~6.4km.
- Danes Hole, Poulnalecka SAC/pNHA (Site Code: 00030) is located downstream of Doon Lough and ~8km southwest of the Proposed Wind Farm site (straight line distance). This SAC/pNHA 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 Proposed Wind Farm via the Broadford and the Owenogarney rivers. The length of the hydrological flowpath between the Proposed Wind Farm site and this SAC/pNHA is ~11.7km.
- Castle Lake pNHA (Site Code: 000239) is located ~12.3km (straight line distance) southwest of the Proposed Wind Farm site. This pNHA is hydrologically connected to the Proposed Wind Farm via Broadford and the Owenogarney rivers. The length of the hydrological flowpath between the Proposed Wind Farm site and this pNHA is ~16.38km.
- The Ratty River Cave SAC (Site Code: 002316) is located ~14.5km (straight line distance) to the southwest of the Proposed 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 Proposed Wind Farm via the Owenogarney and Broadford rivers. The length of the hydrological flowpath between the Proposed Wind Farm site and this SAC is ~19.32km.
- The Lower River Shannon SAC (Site Code: 002165) is located ~19km (straight line distance) 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. This designated site is hydrologically linked with the Proposed

Wind Farm via the Owenogarney and Broadford rivers. The length of the hydrological flowpath between the Proposed Wind Farm site and the SAC is ~29.24km.

- The Fergus Estuary and Inner Shannon, North Shore pNHA (Site Code: 002048) is located ~20.6km (straight line distance) southwest of the Proposed Wind Farm. This designated site is hydrologically linked with the Proposed Wind Farm via the Owenogarney and Broadford rivers.
- The River Shannon and Fergus Estuary SPA (Site Code: 004077) is located 20.7km (straight line distance) from the Proposed Wind Farm site. This designated site is hydrologically linked with the Proposed Wind Farm via the Owenogarney and Broadford rivers. The length of the hydrological flowpath between the Proposed Wind Farm site and the SPA is ~31.93km.
-

Within the Lower Shannon surface water catchment:

- The Slieve Bernagh Bog SAC (Site Code: 002312) is located immediately to the north of the Proposed Wind Farm site. However, no works are proposed upgradient of this designated site. There is no hydrological connection between the Proposed Wind Farm and this NHA.
- The Lower River Shannon SAC (Site Code: 002165) is located ~4km (straight line distance) to the southeast of the Proposed Wind Farm site. The Proposed Wind Farm is connected to this designated site via the Ardcloony River. The length of the hydrological flowpath between the Proposed Wind Farm site and the SAC is ~6.3km.

Turbine Delivery Route

The blade transition area is located ~670m northwest of the Lower River Shannon SAC. However, Ardnacrusha Canal is not designated and is located to the southeast, separating the Temporary Transition Compound from the SAC.

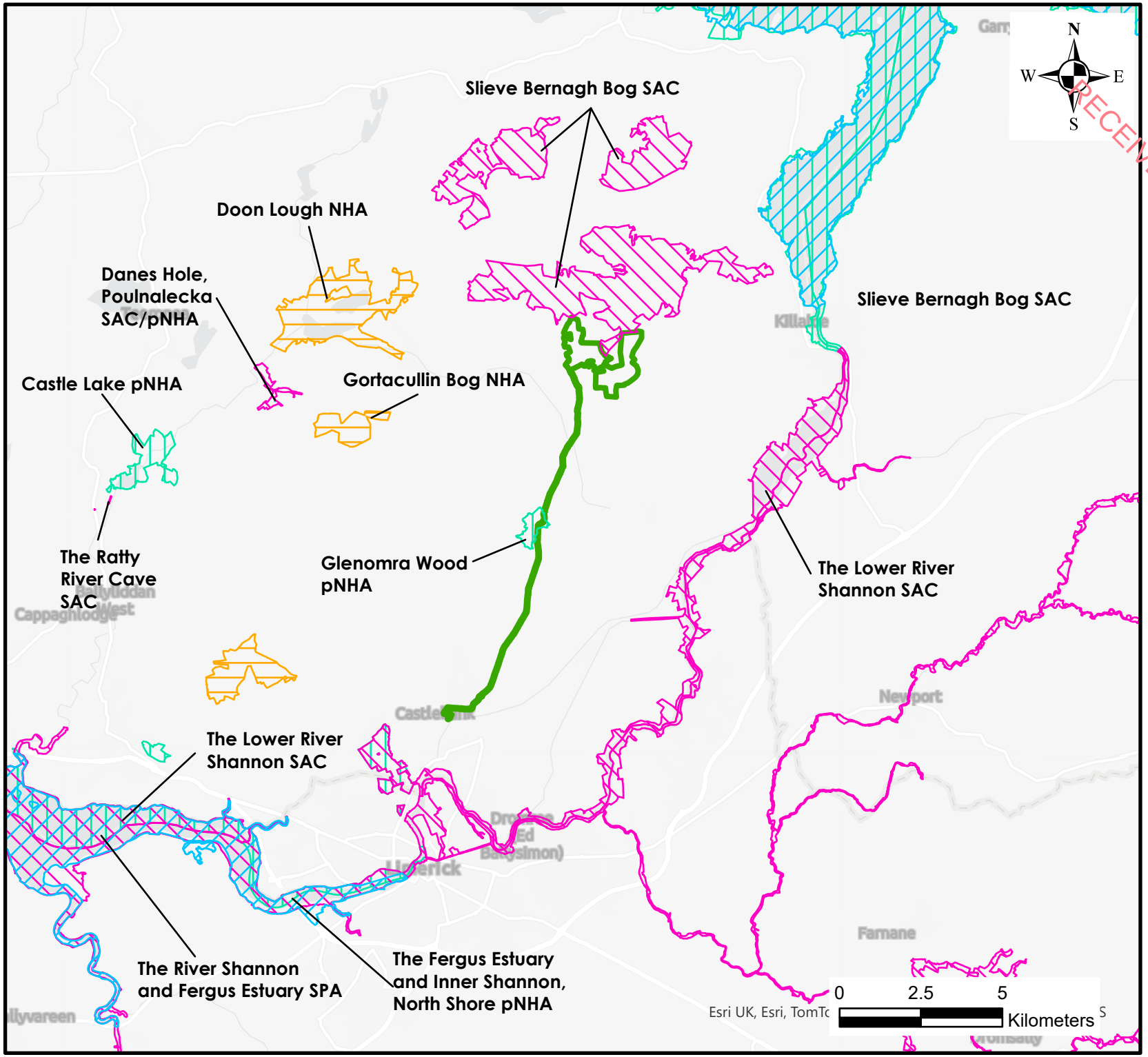
9.3.15.2 Proposed Grid Connection Route

The Proposed Grid Connection Route is mapped to cross the Glenomra Wood SAC and pNHA (Site Code: 001013) in the townland of Leitrim. Glenomra Wood is a deciduous woodland located in south-east Co. Clare, about 10km north of Limerick city. The site is a Special Area of Conservation (SAC) due to the presence of Old Oak Woodlands.

Elsewhere, the north of the Proposed Grid Connection Route is drained by the Glenomra River and is hydrologically connected with several downstream designated sites including Doon Lough NHA, Danes Hole, Poulnalecka SAC/pNHA and the Castle Lake pNHA.

Most of the Proposed Grid Connection Route drains towards the Shannon River. The local watercourses in the vicinity of the Proposed Grid Connection Route provide a hydrological connection with downstream designated sites including the Lower River Shannon SAC.

The hydrological flowpaths and connectivity between the Proposed Project and downstream designated sites are detailed in Figure 9-11.



Legend

- EIAR Site Boundary
- NHA
- pNHA
- SAC
- SPA

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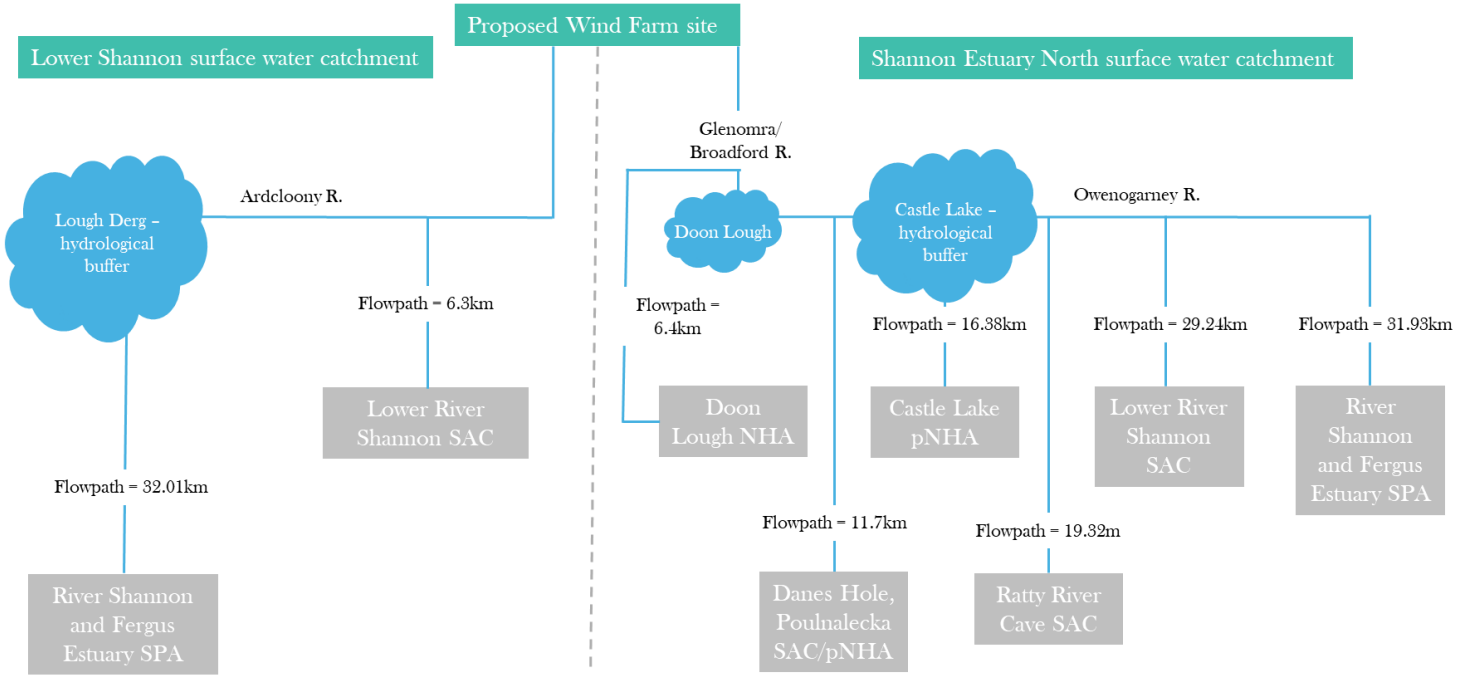
Client: EDF Renewables Ireland	
Job: Lackareagh Wind Farm, Co. Clare	
Title: Designated Sites Map	
Figure No: 9-10	
Drawing No: P1598-0-0724-A4-910-00A	
Sheet Size: A4	Project No: P1598-0
Scale: 1:160,000	Drawn By: GA
Date: 08/07/2024	Checked By: MG



Note: This is a simplified schematic representation of a complex hydrological system. It is not to scale. The flowpath distances are shown on their natural course/alignment on the relevant drainage maps for the proposed development site. Please refer to Figures 9-1: Regional Hydrology Map and Figure 9-10: Designated Sites Map.

Figure 9-11: Hydrological Flowpaths between the Proposed Wind Farm site and Downstream Designated Sites

9.3.16 Water Resources

9.3.16.1 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 Proposed Wind Farm site, in the surrounding lands or along the Proposed Grid Connection Route.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie) (accessed on 13th March 2024). The majority of wells in the lands surrounding the Proposed Wind Farm site have a large locational accuracy. However, the GSI do map several boreholes with a locational accuracy of less than 200m to the west of the Proposed Wind Farm site, in the vicinity of Kilbane village. These wells are listed as having 'Poor' to 'Good' yields and are used for agricultural and domestic purposes.

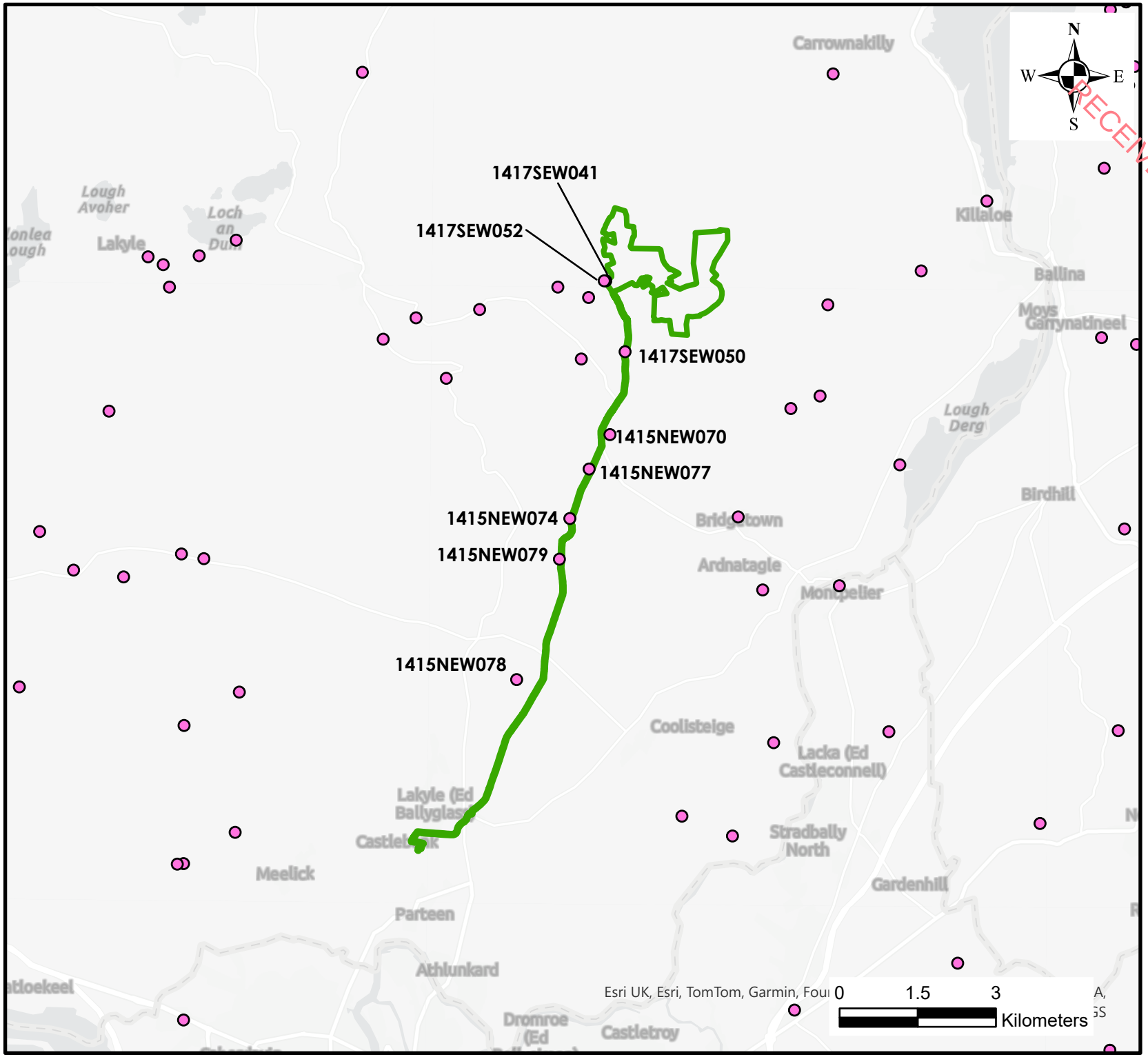
We accept that the GSI database does not include all potential water wells. As such, and in order to be conservative, for the purposes of assessment (as completed in Section 9.5.2.11) we assume that there is a groundwater well source at each local house location.

A map of nearby mapped groundwater wells is included as Figure 9-12.

9.3.16.2 Surface Water Resources

The 3rd Cycle Shannon Estuary North Catchment Report (EPA, 2021) states that there is 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 Proposed Wind Farm site. This designated DWPA is located at Castle Lake and is downstream of the Proposed Wind Farm site via the Owenogarney and Broadford rivers.

The 3rd Cycle Lower Shannon Catchment Report (EPA, 2021) states that there is 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 Proposed Wind Farm site and the Proposed Grid Connection Route.



Legend

- EIAR Site Boundary
- GSI Mapped Wells (accuracy 1-50m)

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Client: EDF Renewables Ireland	
Job: Lackareagh Wind Farm, Co. Clare	
Title: Groundwater Resources Map	
Figure No: 9-12	
Drawing No: P1598-0-0724-A4-912-00A	
Sheet Size: A4	Project No: P1598-0
Scale: 1:100,000	Drawn By: GA
Date: 08/07/2024	Checked By: MG

9.3.17 Receptor Sensitivity and Importance

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

Due to the nature of the construction works associated with 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 Project 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 Project and mitigation measures are proposed below to deal with these potential effects.

The following groundwater receptors are identified for impact assessment:

- The Poor Bedrock Aquifer underlying the Proposed Wind Farm site. This aquifer can be considered as being of Low Importance (refer to Table 9-3);
- The Poor, Locally Important and Regionally Important Aquifers underlying the Proposed Grid Connection Route. 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 Proposed Grid Connection Route can be considered as being of 'Very High' Importance (Table 9-3);
- The WFD status of the GWBs underlying the Proposed Project site (i.e. the Tulla-Newmarket-on-Fergus, Lough Graney, Ardnacrusha and Broadford Gravels GWBs); and,
- Local private groundwater abstractions in the lands surrounding the Proposed Wind Farm site.

Surface waters are the main sensitive receptors associated with the Proposed Project, 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 9.3.4 indicates that the watercourses in the immediate vicinity of the Proposed 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 Proposed Wind Farm site will occur downstream of the Doon Lough due to the increasing in flow volumes in the Owenogarney River. Doon Lough will also act as a hydraulic buffer between the Proposed Wind Farm site and watercourses downstream of this lake waterbody. Meanwhile, within the Lower Shannon Catchment, no effects associated with the Proposed Wind Farm site will occur downstream of Lough Derg due to the large volumes and the buffering capacity of this lake waterbody.

The following surface water receptors are identified for impact assessment:

- The Glenomra, Broadford and Ardcloony rivers and their associated tributaries downstream of the Proposed 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 EPA Q-ratings;

- The Glenomra River, Glenomra Wood Stream, Bridgetown and Blackwater rivers and the River Shannon along the Proposed Grid Connection Route;
- Local watercourse downstream of the TDR work areas; and,
- The WFD status of all SWBs downstream of the Proposed Project site.

In terms of designated sites, only those designated sites which are hydrologically/hydrogeologically linked with the Proposed Project site will be included in the impact assessment. Table 9-15 discusses the connectivity of the Proposed Project with nearby and downstream designated sites.

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

Designated Site	Hydrological Connectivity	Hydrogeological Connectivity	Inclusion in Impact Assessment
Slieve Bernagh Bog SAC	All works are located downgradient of this SAC – no hydrological connectivity	All works are located downgradient of this SAC – no hydrogeological connectivity	No
Doon Lough NHA	Hydrologically connected with the Proposed Project site via the Glenomra/Broadford River	No hydrogeological connectivity due to the separation distance – groundwater will discharge into nearby surface waters	Yes
Danes Hole, Pulnalecka SAC/pNHA	SAC/pNHA is located downstream of Doon Lough which acts as a hydrological buffer between the Proposed Project site and this SAC/pNHA	No hydrogeological connectivity due to the separation distance – groundwater will discharge into nearby surface waters	No
Castle Lake pNHA	pNHA is located downstream of Doon Lough which acts as a hydrological buffer between the Proposed Project site and this pNHA	No hydrogeological connectivity due to the separation distance – groundwater will discharge into nearby surface waters	No
Ratty River Cave SAC	SAC is located downstream of Doon Lough and a significant distance from the Proposed Project site	No hydrogeological connectivity due to the separation distance – groundwater will discharge into nearby surface waters	No
Glenomra Wood SAC/pNHA	~170m of the Proposed Grid Connection Route traverses this SAC/pNHA	~170m of the Proposed Grid Connection Route traverses this SAC/pNHA	Yes
Lower River Shannon SAC	Located downstream of the Proposed Wind Farm at Lough Derg and ~6km downstream of the Proposed Grid Connection Route	Limited as groundwater at the Proposed Wind Farm will discharge into the Ardcloony River and the works along the Proposed Grid Connection Route are shallow	Yes
Fergus Estuary and Inner Shannon, North Shore pNHA	Distant from the Proposed Project site and limited potential for effects given the large volume of water in this coastal waterbody	None	No
River Shannon and River Fergus Estuary SPA	Distant from the Proposed Project site and limited potential for effects given the large volume of water in this coastal waterbody	None	No

9.4 Characteristics of the Proposed Project

The Proposed Project is defined in full in Chapter 4 Section 4.3.

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

- Establishment of the temporary construction compound within the Proposed Wind Farm site, which will involve the excavation of peat/topsoil (966m^3) and the emplacement of the construction compound. Runoff from this construction area has the potential to effect surface water quality. In addition, welfare facilities will be provided at the temporary construction compound. 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 Proposed Wind Farm site. It is estimated that ~13,179m^3 of peat/topsoil and 14,375m^3 of 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 importation of material from local appropriately authorised quarries. Construction of these areas has the potential to impact on surface water quality.
- Construction of the onsite substation and battery storage compound will be completed with a ground bearing foundation. This will require the excavation of ~2,225m^3 of peat/topsoil and 13,340m^3 of spoil. 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 Project. Construction of the sub-station and associated parking area has the potential to effect surface water quality.
- Construction of the foundations for the 7 no. proposed wind turbines. Volumes of peat/subsoil to be removed at the turbine locations is estimated to be 20,597m^3 peat/topsoil and 114,195m^3 of spoil. 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 which will be sourced from local concrete batching plants / quarries. Concrete could affect surface water and groundwater quality.
- Construction of the met mast which will require the removal of 242m^3 of peat/topsoil and ~173m^3 of spoil. Construction 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.
- Construction of the Proposed Grid Connection Route underground electrical cabling between the proposed onsite 38kV substation and the existing Ardnacrusha 110kV substation will involve the excavation of a trench 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.
- Construction of the blade transition area along the TDR.

- Storage of excavated peat and subsoils within the borrow pit within the Proposed Wind Farm has the potential to impact surface water quality.
- Tree felling and replanting of forestry at alternative replacement lands. It is estimated that 13.8ha of forestry will be felled for the Proposed Project. While this work will be done with Forestry Service licences and approvals, the works could result in soil/subsoils erosion.

9.4.1 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the Proposed Project. 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 area. 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. A schematic of the proposed site drainage management is shown as Figure 9-13 below. A detailed drainage plan showing the layout of the proposed drainage design elements is shown in Appendix 4-8.

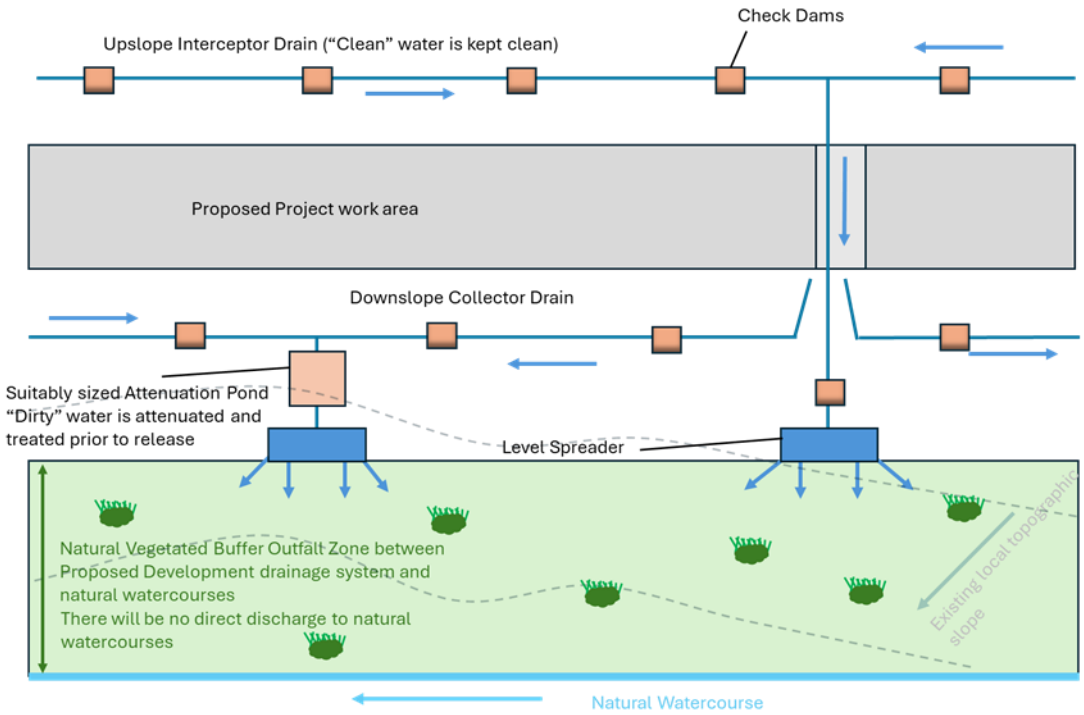


Figure 9-13: Schematic of Proposed Site Drainage Management

9.4.2 Development Interaction with the Existing Site 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. The layout of the Proposed Wind Farm has been subject to several design iterations which aimed to reduce the requirement for works within the hydrological buffer zones. The

works proposed within the delineated buffer zones and the associated mitigation measures are detailed in Section 9.5.2.3 and typically relate to watercourse crossings or road upgrades. The manmade forestry and agricultural drains at the site are not considered to be a significant hydrological constraint and therefore no buffering of these manmade drains has been undertaken. These drains can be rerouted around the proposed infrastructure as required.

The general design approach to wind farm layouts is to utilise and integrate with the existing infrastructure where possible whether it be existing access roads or the existing forestry/agricultural drainage network. Utilising the existing infrastructure means that there will be less of a 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). Site surveys have confirmed that the existing manmade forestry and agricultural 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 4-8) the following design approach has been implemented:

- Contour data and existing online mapping (www.Geohive.ie) was used to map in detail the existing farm and forestry drainage at the site and how the proposed infrastructure interacts with these existing manmade and natural drainage patterns;
- Contour data and available aerial photography was used to digitise existing farm and forestry drainage, and field drains within the development area;
- The Proposed Wind Farm footprint was divided up into drainage catchments (based on topography, outfall locations, catchment size) and we have calculated stormwater runoff rates for each catchment based on the 10-year return period rainfall event. These flows are used to design settlement ponds for each drainage catchment;
- Settlement pond(s) required for Proposed Wind Farm 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)[5]; and,
- The proposed locations of temporary drainage measures that will be installed prior to the construction of the Proposed Project are identified on the drainage plans (Appendix 4-8).

[5] *Environmental Protection Agency (2006): Environmental Management in the Extractive Industry;*

9.5 Likely Significant Effects and Associated Mitigation Measures

9.5.1 Do -Nothing Scenario

If the Proposed Project was not developed, the Proposed Wind Farm site will continue to function as it does at present, with no changes made to the current land-use of agricultural pastures and commercial forestry. The underground grid connection electrical cabling between the Proposed Wind Farm and Ardnacrusha 110kV substation would not be inserted into the local road network and there would be no change along the Proposed Grid Connection Route. The impact of this is considered neutral in the context of the EIAR. If the Proposed Project 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 Project were not to proceed some areas of the Proposed Wind Farm site would continue to function as a coniferous forestry plantation. The forestry operations would comprise felling and replanting. All forestry operations would continue to conform with the current best practice Forest Service regulations, policies and guidance documents as well as Coillte and DAFM guidance documents. Some areas of the Proposed Wind Farm site are utilised as agricultural lands and these land use practices, and associated drainage would continue in the Do Nothing Scenario.

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

In the Do-Nothing Scenario, there may be a slight decrease in average annual rainfall at the Proposed Project site as a result of climate change. This is discussed in Section 9.3.2 above and any change in annual rainfall will result in changes in local recharge and runoff volumes.

9.5.2 Construction Phase - Likely Significant Effects and Mitigation Measures

9.5.2.1 Potential Effects from Tree Felling

A total of 13.8ha of forestry will have to be permanently felled within and around the footprint of the Proposed Project. The total area to be felled (13.8ha) accounts for 4.7% of the EIAR Site Boundary (291ha). All felling is proposed within the Proposed Wind Farm site, with no felling associated with the Proposed Grid Connection Route.

The tree felling activities required as part of the Proposed Project 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 effects during tree felling occurs mainly 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 waters (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

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 Proposed 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 Project infrastructure is located outside of the 50m self-imposed hydrological buffer zone, thereby limiting the felling which will occur in close proximity to natural watercourses. Only 0.6ha of the total proposed tree felling area (19ha) will be required inside

the 50m hydrological buffer zone. Additional mitigation (detailed below) will be carried where tree felling is required inside the 50m hydrological buffer zone.

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:

Mitigation by Design:

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 soil 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 vehicle 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, 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;
- 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 and spoil repository 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;
- 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 with appropriate machinery. Care will be taken to avoid removing natural debris deflectors and to avoid interference with watercourses

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, 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, as detailed below, 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 Proposed Project 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 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 within 10m of drains will 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, if impeded by silt or debris, 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 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.in the unlikely event that an impact has been shown).

Details of the proposed surface water quality monitoring programme are outlined in the Surface Water Management Plan (refer to Appendix 4-4).

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 (for visual inspections and field chemistry measurements) 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 Effect: 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 Potential Effects from 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, underground cabling works will require varying degrees of earthworks resulting in excavation of peat and mineral subsoil. Due to the topography of the Proposed Wind Farm site significant cut and fill is required to facilitate the construction of suitable foundations. 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 site could be significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependent ecosystems.

All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection Route (Glenomra River, Glenomra Wood Stream, Bridgetown, Blackwater and Shannon River).

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

Proposed Mitigation Measures:

Mitigation by Avoidance

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).

All of the key Proposed Project areas are located significantly away from the delineated 50m watercourse buffer zones with the exception of the upgrading of the existing watercourse crossing, new watercourse crossing, upgrades to existing site access tracks and cut and fill along section of new and existing roads to be upgraded. Additional control measures, which are outlined further on in Section 9.5.2.3, will be undertaken at these locations.

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 systems will be implemented:

Proposed Wind Farm site:

- 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.
- 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 that for the Proposed Wind Farm site, an extensive network of forestry, agriculture and roadside drains already exists, and these will be integrated and enhanced as required and used within the Proposed Wind Farm 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 existing 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 site 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 be not 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 Proposed Wind Farm 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 2.5km of the Proposed Wind Farm site roads already exist and are proposed for upgrade. The upgrading of these roads, albeit presents a potential short-term potential non-significant effect on surface water quality during construction, will be a positive, slight, long-term effect with regard to improved drainage controls.

Proposed Grid Connection Route

The majority of the Proposed Grid Connection Route is >50m from any nearby watercourse, sections within 50m of the Proposed Grid Connection Route are confined to existing watercourse crossings. It is proposed to limit any works in any areas located within 50m of any watercourse/waterbody including the stockpiling of excavated soils and subsoils.

There are a total of 5 no. crossings over EPA mapped watercourses along the Proposed Grid Connection Route (one of which is located within the Proposed Wind Farm site). In addition, there are a total of 8 no. crossings over smaller watercourses and drains which are not recorded on the EPA database. All the crossings are existing bridges, pipes and culverts along the public road, further details on these crossing locations are located in Chapter 4 of this EIAR.

No in-stream works are required at any of these crossings, however due to the proximity of the watercourses to the construction work at the crossing locations, there is a potential for surface water quality impacts during trench excavation work. Additional mitigation measures at watercourse crossings are prescribed in Section 9.5.2.10 below.

A constraint/buffer zone will be maintained for all crossing locations where possible, whereby all watercourses will be fenced off. In addition, measures which are outlined below will be implemented to ensure that silt laden or contaminated surface water runoff from the excavation work does not discharge directly to the watercourse.

Pre-commencement Temporary Drainage Works

Prior to the commencement of road 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 interceptor 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 of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be placed within drains down-gradient of all construction areas inside the hydrological buffer zones.

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 Project footprint has been divided into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates based on the 10-year return period rainfall event were calculated for each catchment. These flows were then used to design settlement ponds for each drainage catchment. The settlement ponds are designed for 11hr or 24hr retention times used to settle out medium silt (0.006mm) and fine silt (0.004mm) respectively (EPA, 2006)6. Settlement ponds at the borrow pit are designed to allow 24hr retention and settlement ponds along access roads and at turbine hardstands will have 11hr retention as there is additional in-line drainage controls proposed along access tracks and at hardstands.

The supporting design calculations for all settlement ponds are included on Drawing D501 included in Appendix 4-8.

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 stand 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.

[6] *Environmental Protection Agency (2006): Environmental Management in the Extractive Industry (Non-Scheduled Minerals).*

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 Proposed Wind Farm site 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 stand 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 Proposed Project 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 basis at the Proposed Project 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;
- 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 as below 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.

Management of Runoff from the Borrow Pit:

It is proposed that excavated peat/subsoil (spoil) will be stored in an excavated borrow pit within the Proposed Wind Farm site or used for landscaping throughout the site. The borrow pit is located outside the 50m stream buffer zone.

Proposed surface water quality protection measures regarding the peat and spoil repository areas are as follows:

- During the initial emplacement of peat and subsoil at the borrow pit, silt fences, straw bales and biodegradable matting will be used to control surface water runoff from the enclosure.
- The borrow pit is an enclosed area. Its drainage can be easily managed.
- Drainage from the borrow pit will be pumped to settlement ponds as required or will overflow through controlled overflow pipes.
- Discharge or pumping will be intermittent and will depend on preceding rainfall amounts.
- Once the borrow pit has been seeded and vegetation is established the risk to downstream surface water is significantly reduced.

Therefore, the above mitigation measures will be deployed to ensure protection of downstream water quality.

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.

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, 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 Environmental Quality Standards (EQSs) will be undertaken for each primary watercourse, and specifically following heavy rainfall events (as per the CEMP 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 Project, as the turbines have a life span of 35 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 we have designed settlement ponds 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.

However, the settlement ponds are designed for 1 in 10 years flows with built in redundancy (+20%) to account for climate change effects on rainfall.

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, likely effect on water quality, and water-dependant ecosystems downstream of the Proposed Wind Farm site and Proposed Grid Connection Route.

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 the Hydrological Buffer Zones within the Proposed Wind Farm Site

Whilst the majority of the proposed work areas within the Proposed Wind Farm site are located outside of the delineated 50m natural watercourse buffer, the following work areas encroach upon the delineated buffer zones:

- A new proposed watercourse crossing over the EPA named Cloonconry Beg Stream between T06 and T07;
- Upgrade of an existing crossing along the Gap Road over an unnamed 1st order stream (tributary of the EPA named Cloonconry Beg Stream) ~380m to the west of the proposed borrow pit location;
- A new crossing over the EPA named Kilbane Stream ~300m south of the proposed met mast location;
- Cut and fill at each of the above watercourse crossings over EPA mapped watercourses;
- Cut and fill associated with the upgrades to the Gap Road immediately east of Kilbane village;
- New roads and associated watercourse crossings over 2 no. new tributaries of the Cloonconry Beg Stream (not mapped on the EPA database), ~220m to the southeast and ~120m north of T6 respectively;
- Cut and fell at each of these crossings which are not mapped on the EPA database;
- Upgrade works along the Gap Road to the west of the proposed borrow pit are mapped within the 50m buffer associated with a stream which is not mapped in the EPA database; and,

- Cut and fill associated with these new proposed roads and existing roads in the vicinity of streams which are not mapped by the EPA.

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.

Additionally, there are several crossings over forestry and agricultural drains.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra, Broadford rivers and their associated tributaries) and associated water-dependent ecosystems.

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

Proposed Mitigation Measures:

Mitigation by Avoidance:

The Proposed Wind Farm site layout has been designed to limit the amount of works within the delineated hydrological buffer zones associated with natural watercourses. Several multi-disciplinary consultations between HES, MKO and the project design team completed in the spring and summer of 2023 resulted in multiple design iterations (as described in Chapter 3 of this EIAR) which had the overall aim of reducing potential impacts on the receiving environment including reducing the volume of works within the delineated hydrological buffer zones.

In relation to Proposed Wind Farm access tracks, where possible, the Proposed Project design utilises the existing local road network within the Proposed Project site (~2.5km of the existing roads are proposed for upgrade). The upgrade of 2 no. existing watercourse crossings reduces the potential for effects in comparison with the construction of new crossings over local watercourses.

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 or triple silt fences will be placed downgradient of all work locations within the hydrological buffer zones.
- All works will be completed during the dry summer months and works will be postponed in the event of 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 Potential Effects from Excavation Dewatering

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, substation compound excavations, sections of the internal cabling trenches, 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 sediments. No contaminated land was noted at the Proposed Wind Farm site and therefore pollution issues arising from such sources will not occur.

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

Pathway: Overland flow and site drainage network.

Receptor:

Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependent ecosystems.

All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection Route (Glenomra River, Glenomra Wood Stream, Bridgetown, Blackwater and Shannon River).

Pre-Mitigation Potential Effect: Indirect, negative, significant, temporary, unlikely effect on surface water quality and 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, 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;
- 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 the Environmental Clerk of Works 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 water quality 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 Proposed Wind Farm site. Any effects will be temporary and will be contained within the Proposed Wind Farm site.

No groundwater level impacts are predicted from the construction of the Proposed Grid Connection Route, access roads, substation compound or met mast due to the shallow nature of the excavation (i.e. maximum depth is approximately 1m).

Pathway: Groundwater flowpaths.

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

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

Mitigation Measures / Impact Assessment:

The Proposed Wind Farm site is underlain by Poor bedrock aquifers and contains bedrock which is generally unproductive. The Proposed Wind Farm site is elevated, and groundwater will flow downslope, discharging into nearby surface water streams including the Cloonconry Beg Stream, Kilbane Stream, Broadford River and Ardcloony River.

The topographical (i.e., the elevation of the proposed turbines and other proposed infrastructures) and hydrogeological setting of the Proposed 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. we would generally define dewatering 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 Effect: Due to large topographic elevation and hydrogeology of the Proposed 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 effect on groundwater levels.

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

9.5.2.6 Potential Effects from use of Hydrocarbons

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 construction of the Proposed Grid Connection Route as the works are transient. Vehicles will be refuelled before reaching these work areas.

Pathway: Groundwater flowpaths and site drainage network.

Receptors:

Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependent ecosystems.

All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection Route (Glenomra River, Glenomra Wood Stream, Bridgetown, Blackwater and Shannon River).

All watercourses in the vicinity and downstream of the blade transition area.

Pre-Mitigation Potential Effect:

Negative, indirect, slight, short-term, unlikely effect on local groundwater quality below the Proposed Project site.

Indirect, negative, significant, short term, unlikely effect on surface water quality downstream of the Proposed Project site.

Proposed Mitigation Measures:

Mitigation measures proposed to avoid release of hydrocarbons at the 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 uses at the Proposed Project site.
- On site re-fuelling of machinery will be carried 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;

- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- All fuel storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The electrical control building (at the substation) will be bunded appropriately to 110% of the volume of oils that will be stored, and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be 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 is included within the Construction and Environmental Management Plan (Appendix 4-3). Spill kits will be available to deal with any 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 Potential Effects from use 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 $\geq 6 \leq 9$ is set in S.I. No. 293/1988 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:

Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependent ecosystems.

All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection Route (Glenomra River, Glenomra Wood Stream, Bridgetown, Blackwater and Shannon River).

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

Proposed Mitigation Measures:

- No batching of wet-concrete products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place;
- Where possible pre-cast elements for culverts and concrete works will be used;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. 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 will be undertaken at lined concrete washout ponds;
- Weather forecasting will be used to plan dry days for pouring concrete; and,
- The pour site will be kept 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 water quality will occur.

9.5.2.8 Potential Effects from Wastewater

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

There will be no requirement for the storage of wastewater along the Proposed Grid Connection Route.

Pathway: Groundwater flowpaths and site drainage network.

Receptors: Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra and Broadford rivers and their associated tributaries) and associated water-dependent ecosystems.

Pre-mitigation 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 construction 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 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 Potential Effects from Morphological Changes to Surface Water Courses within the Proposed Wind Farm

Within the Proposed Wind Farm site, there are a total of 3 no. watercourse crossings over EPA mapped watercourses (2 no. upgrades to existing crossings and 1 no. new proposed crossing). These crossing locations are outlined below:

- A new proposed watercourse crossing over the EPA named Cloonconry Beg Stream between T06 and T07;
- Upgrade of an existing crossing along the Gap Road over an unnamed 1st order stream (tributary of the EPA named Cloonconry Beg Stream) ~380m to the west of the proposed borrow pit location; and,
- A new crossing over the Kilbane Stream ~330m south of the proposed met mast location and along an existing access track north from the Gap Road to T2.

In addition to the EPA mapped watercourses, there is a high density of unmapped natural 1st order streams draining the area of the Proposed Wind Farm site. There are an additional 2 no. crossings over these streams:

- A new crossing over a 1st order stream ~220m southeast of T6; and,
- A new crossing over a 1st order stream ~120m north of T6.

A network of manmade forestry and agricultural drains also exists within the Proposed Wind Farm site. However, these are not considered to be a significant constraint and can be rerouted around the Proposed Wind Farm infrastructure and/or integrated into the proposed drainage design. Several of these drains are deeply incised and will be culverted where road crossings are proposed.

Pathway: Site drainage network.

Receptors: Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Cloonconry Beg Stream, Kilbane Stream, Broadford River and Ardcloony River) and associated water-dependent ecosystems.

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 Project design has been optimised to utilise the existing infrastructure (i.e. existing site roads) where practicable. Only 4 no. new crossings are proposed. The use of existing crossings where possible prevents the unnecessary disturbance of the existing site drainage network prevents the requirement for widespread instream works across the Proposed Wind Farm site.

Mitigation measures for the proposed new crossings within the Proposed Wind Farm site are detailed below:

- The proposed new stream crossings and upgrade of an existing crossing will be clear span or box culverts crossings, and the existing banks will remain undisturbed. No in-stream excavation works are proposed at this location and therefore there will be no direct impact on the stream at the proposed crossing location;
- All guidance / mitigation measures required by the OPW and/or the Inland Fisheries Ireland (IFI)[7] is incorporated into the design of the proposed crossings;
- All drainage measures will be installed in advance of the works;
- Plant and equipment will not be permitted to track across the watercourse;
- Access to the opposite site of the watercourse for excavation and foundation installation will require the installation of a temporary pre-cast concrete or metal bridge;
- Once the foundations have been completed at both sides of the watercourse, the pre-cast concrete box culvert will be installed using a crane and there will be no contact with the watercourse;
- Where the box culvert is installed in sections, the joint will be sealed to prevent granular material entering the watercourse;
- As a further precaution, near stream construction work, will only be carried out during the period permitted by IFI for in-stream works according to the IFI (2016) guidance document "Guidelines on protection of fisheries during construction works in and adjacent to waters", i.e., July 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 (any deviation from this will be done in discussion with the IFI);
- Where works are necessary inside the 50m buffer 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 concrete allowed in the vicinity of the crossing construction areas; and,
- All new 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.

The watercourse crossings will be constructed to the specifications of the OPW bridge design guidelines 'Construction, Replacement or Alteration of Bridges and Culverts - A Guide to Applying for Consent under Section 50 of the Arterial Drainage Act, 1945', and in consultation with Inland Fisheries Ireland. Abutments will be constructed from precast units combined with in-situ foundations, placed within an acceptable backfill material.

Confirmatory inspections of the proposed new watercourse crossing location will be carried out by the Project Civil/Structural Engineer and the Project Hydrologist prior to the construction of the crossing.

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.

[7] *Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters*

9.5.2.10 Potential Effects from Morphological Changes to Surface Watercourses along the Proposed Grid Connection Route

The Proposed Grid Connection Route includes a total of 5 no. crossings over EPA mapped watercourses (including 1 no. crossing within the Proposed Wind Farm site). These crossings are detailed above in Section 9.3.3.2. In addition, there are a total of 8 no. culvert crossings over watercourses which are not mapped on the EPA database.

The potential proposed crossing methods are as follows:

- Horizontal Directional Drilling (HDD) will be completed at an unnamed bridge which crosses the Cloonconry Beg Stream along the L30028. HDD is required due to there being insufficient cover and depth in the bridge to cross within the bridge deck. This method is only employed where standard installation methods are not possible.
- The proposed crossing over the Glenomra River at Ahnagor Bridge will be completed within the bridge deck as this bridge has sufficient room to install the cable to ESBN specifications.
- The proposed crossing at Blackwater Bridge may be achieved by Bridge Strapping as there is insufficient room to install the cable within the deck and HDD was deemed to be unfeasible at this location.
- The 8 no. culvert crossings will be crossed via flat formation crossing.
    - Option A: 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.
    - Option B: 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: All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection Route (Glenomra River, Cloonconry Beg Stream, Glenomra Wood Stream, Bridgetown, Blackwater and Shannon River).

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

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 Proposed Grid Connection Route crossing works:
- No stockpiling of construction materials will take place along the Proposed Grid Connection Route;
- No refuelling of machinery or overnight parking of machinery is permitted in this area;
- No concrete truck chute cleaning is permitted in this area;

- 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.

Please note that mitigation measures for Horizontal Directional Drilling (HDD) are detailed in Section 9.5.2.13 below.

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 Local 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 Wind Farm.

No effects on groundwater levels / quantity will occur due to the elevated nature of the Proposed Wind Farm site. No significant dewatering works, other than local temporary works at turbine bases, are required for any excavations.

There are no downgradient public or group scheme groundwater supply source that can be impacted by the Proposed Project within the Proposed Wind Farm site. However, there are dwellings located in the lands surrounding the Proposed Wind Farm site. The closest inhabitable dwelling is located ~720m away from the nearest proposed turbine location (T03). Meanwhile, the village of Kilbane is located ~800m to the south of T02.

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

Pathway: Groundwater flowpaths.

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

Pre-Mitigation 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 immediate vicinity of Proposed Project infrastructure within the Proposed Wind Farm site.

All local dwellings are located significant distances from Proposed Project infrastructure. The closest inhabitable dwelling is 720m from the nearest proposed turbine location (T03). This dwelling is located on the opposite side of a deeply incised valley and the associated stream acts as a hydrological barrier.

Groundwater flows at the Proposed Wind Farm site following local topography and flowing towards and discharging into the local streams. The closest dwelling located downgradient of the Proposed Project locations are located 750m west of the nearest proposed turbine (T07). However several streams act as a hydrological barrier between this proposed turbine location and the dwelling.

However, due to the Poor Aquifer which underlies the Proposed Wind Farm Site, the short groundwater flowpaths (30-300m), and the high density of watercourses which act as hydrological barriers, there is no potential for effects on any local well supplies at these dwellings.

Regardless, if private wells are located downslope of the Proposed 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 Proposed Wind Farm site is underlain by aquifers of low permeability;
- Groundwater flowpaths are therefore typically very short (~300m maximum);
- Consequently, the majority of groundwater flows within the Proposed Wind Farm 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 Project infrastructure and potential source typically do not exist due to the large setback distance;
- Nevertheless, mitigation is provided in the EIAR to deal with typical construction phase groundwater hazard such as oils and fuels; and,
- Therefore, based on the hydrogeological assessment of the site with regard to groundwater user risk and the proposed mitigation measures, it can be robustly determined 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), we consider the residual effect to 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 Potential Effects from the use of Siltbuster

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 provide 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 9-14. 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 1,194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

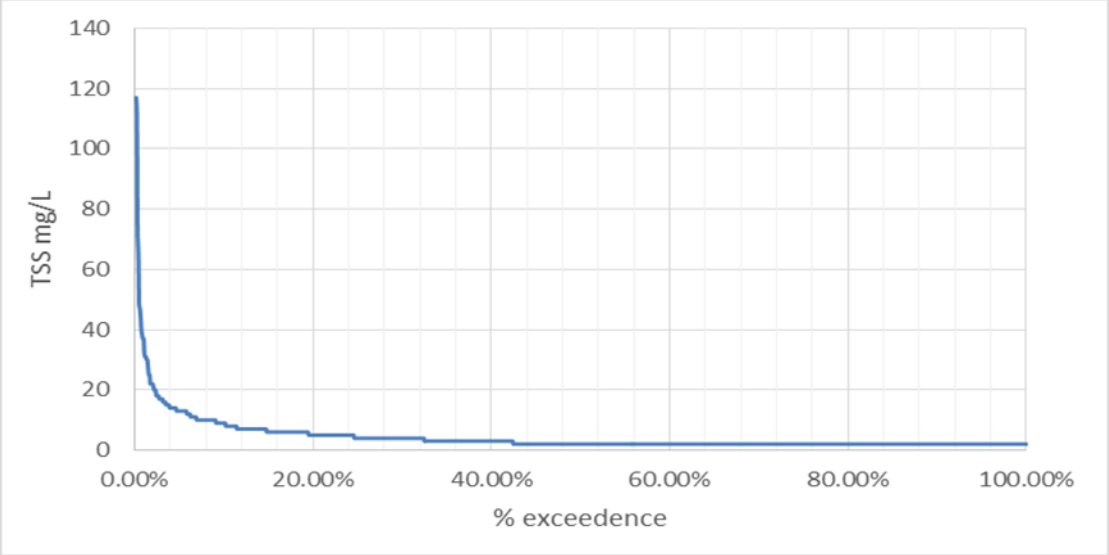


Figure 9-14: Example of treatment capability of Siltbuster treatment

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity and downstream of the Proposed Wind Farm site (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) 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 not occur. In fact, it is considered that the use of siltbuster systems has a significant positive effect in respect of protected surface water quality.

9.5.2.13 Potential Effects from Horizontal Direction Drilling along the Proposed Grid Connection Route

Surface water quality effects on local watercourses may occur during drilling and groundworks associated with potential directional drilling at an unnamed bridge over the EPA named Cloonconry Beg Stream along the L3022-8.

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: All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection Route (Cloonconry Beg Stream and the Glenomra 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 in order to facilitate the HDD, 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 clean 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 100m 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:

- 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.

9.5.2.14 Potential Effects from Proposed Bridge Strapping along the Proposed Grid Connection Route

Surface water quality effects on local watercourses may occur during the construction of the cable crossing over the Blackwater Bridge in the event that there is insufficient room to install the cable in the bridge deck and HDD has been deemed to be unfeasible.

One potential option is that the bridge may be crossed by utilizing a stainless steel pipe fixture strapped to the exterior of the bridge to encompass the grid cables. In an unmitigated scenario, the proposed works could result in negative effects on local and downstream surface water quality.

Pathway: Surface water and groundwater flows.

Receptor: Blackwater River.

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

Proposed Mitigation Measures:

- No instream works will be required;
- All works will only be done during a dry period between July and September (while no instream works will be required as part of the Proposed Project, alignment with the IFI requirements for instream works will be deployed for works at the Blackwater Bridge as is best practice) to avoid the salmon spawning season and to have more favourable conditions;
- An underbridge access unit will be used to install a stainless steel beam supported by brackets at desired intervals on the bridge exterior;
- Weather conditions will be considered when planning construction activities and works will be completed during low flows in the river;
- The works will use prefabricated elements which minimises the period of time required to complete the works.
- Wall drainage and below ground waterproofing will be in place on the bridge for the duration of the works;
- The contractor will ensure that all personnel are trained in pollution incident control;
- A daily review of weather forecasts is required;
- The contractor will carry out visual examination of local watercourses during construction to ensure that sediment is not above baselines conditions;
- Excavations will be temporarily reinstated for minimal periods to avoid acting as conduits for flows; and,
- Only emergency breakdown maintenance will be carried out on site (all mitigation measures in relation to hydrocarbons spills and leaks detailed in Section 9.5.2.6 will be implemented).

Post-Mitigation Residual Effect: Due to the avoidance of instream works, the short timeframe of construction, 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 of the Turbine Delivery Route Works

Minor earthworks are required for the construction of the blade transition area along the TDR.

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 Section 9.5.2.2 will be employed at the TDR work area.

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.

9.5.2.16 Potential Effects on Karst Bedrock and Karst Features

There are no karst features in the area of the Proposed Wind Farm site due to the siliceous nature of the underlying bedrock.

However, a section of the Proposed Grid Connection Route (~2.4km in length) is underlain by a Regionally Important Karst Aquifer. The closest mapped karst feature is a swallow hole mapped ~2.2km to the east of the Proposed Grid Connection Route underground electrical cabling.

Any potential alteration in local groundwater quality or surface water quality has the potential to impact the Karstic Bedrock Aquifer.

Pathway: Groundwater recharge and surface water drainage.

Receptor: Local karst features and the Regionally Important Karst Aquifer.

Pre-Mitigation Potential Effect: Indirect, negative, slight, unlikely effect on karst features and karst aquifer.

Mitigation Measures / Impact Assessment:

The potential for effects on the underling karst aquifer are limited for the following reasons:

- Only a small section of the Proposed Grid Connection Route overlies the karst aquifer;
- There are no mapped karst features in the immediate vicinity of the Proposed Grid Connection Route ;
- Walkover surveys of the route did not encounter any karst features; and,
- The proposed works are minor and transient in nature.

Nevertheless, the following mitigation measures will be implemented:

- Site drainage will be put in place in order to prevent any poor quality drainage water reaching any potential unmapped karst features.
- Mitigation measures relating to hydrocarbons, cementitious materials and wastewater disposal as prescribed in Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products) and Section 9.5.2.8 (wastewater) will provide adequate protection to groundwater and surface water quality and will ensure that groundwater quality will not be impacted.

Post Mitigation Residual Effect: Due to the minor and transient nature of the works along the Proposed Grid Connection Route there is limited potential for effects on nearby karst features. Furthermore, the mitigation measures associated with drainage management and the protection of water quality will ensure that the residual effect is an indirect, negative, imperceptible, short-term, unlikely effect.

Significance of Effects: No significant effects on karst features will occur.

9.5.2.17 Potential Effects on Downstream Surface Water Abstractions

As stated above in Section 9.3.16.2, there are 2 no. surface water abstractions mapped downstream of the Proposed Project. The identified Drinking Water Protected Areas (DWPAs) are the Castle Lake and the Shannon (Lower)_060 SWBs.

The Castle Lake DWPA is not included in the impact assessment as this DWPA is distant from the Proposed Project and is located downstream of Doon Lough. The length of the hydrological flow path between the Proposed Wind Farm site and this DWPA is ~17.8km. The Doon Lough lake waterbody acts as a hydrological buffer between the Proposed Project infrastructure and the Castle Lake DWPA and provides a significant dilution effect. Therefore, there is no potential for effects to occur on the Castle Lake DWPA.

Meanwhile, the Shannon (Lower)_060 SWB is located in close proximity and downstream of the Proposed Grid Connection Route. Any potential surface water quality effects which may arise as a result of the Proposed Project have the potential to impact on this DWPA. Meanwhile, there is no potential for works at the Proposed Wind Farm site to affect this DWPA as the Ardcloony River discharges into Lough Derg which acts a hydrological buffer between the Proposed Wind Farm and the DWPA.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect on the Shannon (Lower)_060 DWPA.

Mitigation Measures / Impact Assessment:

The potential for effects is limited given the small scale and temporary nature of the works along the Proposed Grid Connection Route.

Nevertheless mitigation measures relating to the protection of surface water drainage regimes and surface water quality along the Proposed Grid Connection Route have been detailed in Section 9.5.2.2 (suspended solids), Section 9.5.2.6 (hydrocarbons) and Section 9.5.2.10 (watercourse crossings) and Section 9.5.2.13 (directional drilling).

Post-Mitigation Residual Effect: Construction activities pose a threat to downstream surface water abstractions hydrologically linked with the Proposed Project 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 Project site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or surface water abstractions. Furthermore, the potential for effects is limited given the small scale and transient nature of the works along the Proposed Grid Connection Route. 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.

9.5.2.18 Potential Effects on Hydrologically Connected Designated Sites

The following designated sites are included in the impact assessment:

- Doon Lough NHA located ~6.35km (length of the hydrological pathway) downstream of the Proposed Wind Farm site and the Proposed Grid Connection Route;
- Glenomra Wood SAC/pNHA is encroached upon by 170m of the Proposed Grid Connection Route; and,
- The Lower Shannon SAC is located ~6.8km downstream of the Proposed Wind Farm site via the Ardcloony River and ~6km downstream of the Proposed Grid Connection Route via the Blackwater River.

All other downstream designated sites have been screened out of the assessment due to their distant location from the Proposed Project and the large volumes of water within the associated waterbodies. All other hydrologically connected designated sites are located downstream of large lake waterbodies (Lough Derg and Doon Loughs) which act as hydrological barriers between the Proposed Project and these designated sites:

- Danes Hole, Poulnalecka SAC/pNHA;
- Castle Lake pNHA;
- The Ratty River Cave SAC;
- The Fergus Estuary and Inner Shannon, North Shore pNHA; and,
- The River Shannon and Fergus Estuary SPA.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality in the Doon Lough NHA, Glenomra Wood SAC/pNHA and Lower Shannon SAC.

Pre-Mitigation Potential Effect: Indirect, negative, slight, short term, likely effect on Doon Lough NHA, Glenomra Wood SAC/pNHA and Lower Shannon SAC.

Mitigation Measures / Impact Assessment:

Doon Lough NHA

This NHA is located downgradient of both the Proposed Wind Farm site and the Proposed Grid Connection Route. The potential for effects are reduced due to the progressively increasing volumes of water within the Glenomra/Broadford rivers downstream of the Proposed Project site and the distance between the NHA and the site (6.35km).

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality within the Proposed Project site have been detailed in Section 9.5.2.1 (clear felling), Section 9.5.2.2 (suspended solids), Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products), Section 9.5.2.8 (wastewater) and Section 9.5.2.9 and 9.5.2.10 (morphological changes).

The implementation of these mitigation measures will ensure the protection of the Doon Lough pNHA.

Glenomra Wood SAC/pNHA

Due to the nature and scale of the works along the Proposed Grid Connection Route the potential for effects is limited. The works will be transient and short-term in nature and all works adjacent the SAC/pNHA will be located within the carriageway of the existing public road network.

Mitigation measures relating to the protection of surface water and groundwater quality along the Proposed Grid Connection Route have been detailed in Section 9.5.2.2 (suspended solids), Section 9.5.2.6 (hydrocarbons) and Section 9.5.2.10 (morphological changes).

The implementation of these mitigation measures will ensure the protection of the Glenomra Wood SAC/pNHA.

Lower River Shannon SAC

The potential for the Proposed Project to effect the SAC is limited due to the large volumes of water within the River Shannon and Lough Derg.

Nevertheless, mitigation measures relating to the protection of surface water drainage regimes and surface water quality within the Proposed Project site have been detailed in Section 9.5.2.1 (clear felling), Section 9.5.2.2 (suspended solids), Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products), Section 9.5.2.8 (wastewater) and Section 9.5.2.9 and 9.5.2.10 (morphological changes).

The implementation of these mitigation measures will ensure the protection of the Lower River Shannon SAC.

Post-Mitigation Residual Effect: Construction activities pose a threat to designated sites hydrologically linked with the Proposed Project site. Proven and effective measures to mitigate the risk of surface and groundwater 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 Project 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.

9.5.2.19 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 Project are defined in Section 9.3.13 and Section 9.3.14 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 SWBs and underlying GWBs.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect on downstream SWBs and underlying GWBs.

Proposed Mitigation Measures:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality within the Proposed Project site have been detailed in Section 9.5.2.1 (clear felling), Section 9.5.2.2 (suspended solids), Section 9.5.2.6 (hydrocarbons), Section 9.5.2.7 (cement-based products), Section 9.5.2.8 (wastewater) and Section 9.5.2.9 and 9.5.2.10 (morphological changes).

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 Project will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Proposed Project.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Project. 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 Project.

9.5.3 Operational Phase – Likely Significant Effects and Mitigation Measures

9.5.3.1 Potential Effects from the 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 Proposed Project. 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 Wind Farm access roads and hardstands are impermeable. The assessed Proposed Project footprint comprises turbine bases and hardstandings, access roads, junction accommodation areas amenity links, site entrances, onsite 38 kV 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.

There will be no potential increase in runoff along the Proposed Grid Connection Route. The works are located in the carriageway of the existing road corridor and no change in surface water runoff rates will result as the trench and road surface will be reinstated.

Pathway: Site drainage network.

Receptor: Surface waters (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

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

Effects Assessment:
The emplacement of the Proposed Project permanent development footprint (8.4ha), as described in Chapter 4 of the EIAR, (assuming a precautionary scenario of emplacement of impermeable materials) could result in an average total site increase in surface water runoff of approximately 3,192m^3/month (Table 9-17). This represents a potential increase of approximately 1% in the average daily/monthly volume of runoff from the entire EIAR site in comparison to the baseline pre-development site runoff conditions. This is a very small increase in average runoff and results from the naturally high surface water runoff rates (estimated to be 75% runoff – refer to Section 9.3.1.1) and the relatively small area of the site being developed, the Proposed Project total permanent development footprint being approximately 8.4ha, representing 2.9% of the EIAR site area (291ha).

Table 9-17: Baseline Site Runoff V Development Runoff

Site Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff (m^3)	Hardstanding Area 75% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions (m^3)
331,740	10,701	84,000	12,768	9,576	3,192	103	1%

The additional volume is low due to the fact that the runoff potential from the site is naturally high (~75%). 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 EIAR Site Boundary. Therefore, the assessment is very conservative. Nevertheless, the increase in runoff from the Proposed Project site will, therefore, be negligible. This is even before mitigation measures will be put in place.

Proposed Mitigation by Design:

The operational phase drainage system of the Proposed Project 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 4-8):

- Interceptor drains will be installed up-gradient of all Proposed Project 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 have been designed in consideration of the greenfield runoff rate.

As described above the proposed integration of the Proposed Wind Farm site drainage with the existing forestry drainage is a key component of the proposed drainage management within the Proposed Project. In this context, integration means 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. Critically, there will be no alteration of the catchment size contributing to each of the main downstream watercourses. All Proposed Project 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 Project.

9.5.3.2 Potential Effects from 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 Proposed Wind Farm site and no maintenance works will be required along the Proposed Grid Connection Route.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Glenomra, Broadford and Ardcloony rivers and their associated tributaries) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

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

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**

Post-Mitigation Residual Effects: With the implementation of the Proposed Project drainage measures as outlined above, and based on the post-mitigation assessment of runoff, residual effects 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 Potential Effects on Surface Water and Groundwater WFD Status

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

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

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

9.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The Proposed Project is expected to have a lifespan of ~35 years. Upon decommissioning, the wind turbines and meteorological mast will be dismantled, and all above ground components would be removed off-site for recycling.

The potential effects associated with decommissioning of the Proposed Project 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 and Appendix 4-7 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 soil to encourage vegetation growth and reduce run-off and sedimentation.

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

The electrical cabling connecting Proposed Project site infrastructure to the proposed onsite 38kV 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 Proposed 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.

The underground electrical cabling route and the proposed onsite 38kV substation will remain in place as it will be under the ownership and control of the ESB and EirGrid.

A Decommissioning Plan has been prepared (Appendix 4-7) the detail of which will be agreed with the local authority prior to any decommissioning. The Decommissioning Plan will be updated prior to the end of the operational period in line with decommissioning methodologies that may exist at the time and will agree with the competent authority at that time. The potential for effects during the decommissioning phase of the Proposed Project has been fully assessed in the EIAR.

As noted in the Scottish Natural Heritage report (SNH) '*Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms'* (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the Proposed Wind Farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is, therefore:

> *"best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm".*

Some of the impacts will be avoided by leaving elements of the Proposed Project in place where appropriate. The proposed onsite 38kV substation and 38kV electrical cabling will be retained as a permanent part of the national grid. The turbine bases will be allowed to covered with earth and reseeded as appropriate, which will reduce runoff and sedimentation effects, please see Section 4.10 of Chapter 4 of this EIAR for further details. 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 Project.

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 Geotechnical and Peat Stability Assessment Report (Appendix 8-1) has been completed for the Proposed Project and it concludes that with the implementation of the proposed mitigation measures that the risk of a peat failure at the Proposed Project site is low.

Flooding can also result in major accidents or disasters downstream of the event. However, due to the small scale of the Proposed Project footprint and with the implementation of the proposed mitigation measures, the increased flood risk associated with the Proposed Project 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 within the EIAR Site Boundary. Furthermore, no private wells are located in close proximity to the Proposed Project infrastructure. Notwithstanding this, the Proposed Project design and mitigation measures ensures that the potential for effects on the hydrogeological will not be significant.

The Proposed Grid Connection Route is located upstream of the Shannon (Lower)_060 SWB which is listed as a DWPA. The potential effects are assessed above in Section 9.5.2.17 and have demonstrated that there is no potential for effects.

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 (included as Appendix 9-1 to this EIAR) has also shown that the risk of the Proposed Project contributing to downstream flooding is also 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 Project 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 Wind Farm site (i.e. low permeability peat and subsoils overlying a locally important and poor bedrock aquifers) and the near surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Project are assessed as not likely.

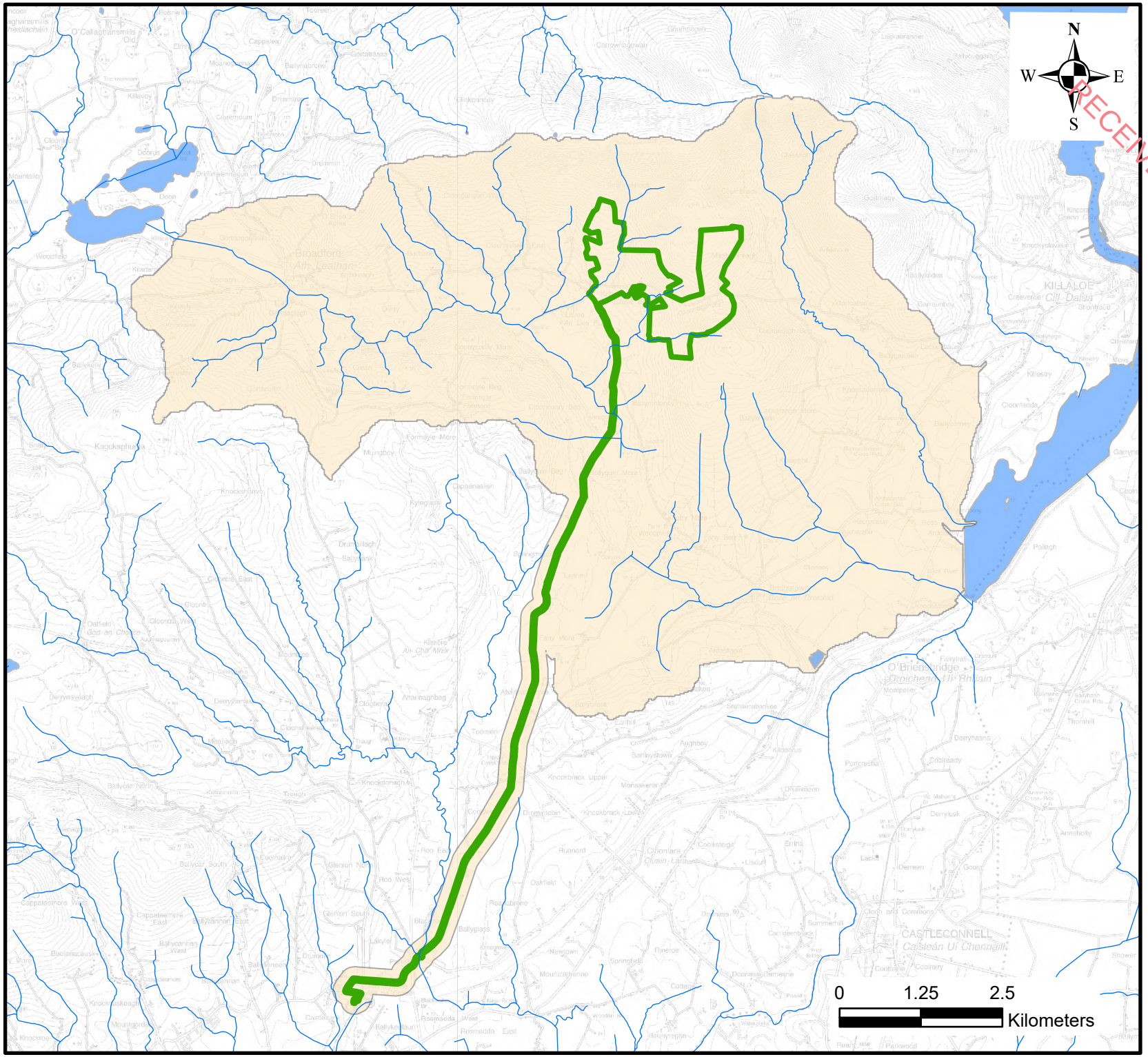
The primary potential for cumulative effects will occur during the construction phase of the Proposed Project as this is when earthworks and excavations will be undertaken at the Proposed Project site. The potential for cumulative effects during the operational phase of the Proposed Project will be significantly 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 for the Proposed Project is shown below in Figure 9-15. This cumulative study area has been delineated as follows:

- Within the Shannon Estuary North surface water catchment no effects will occur downstream of Doon Lough. This lake waterbody contains a significant volume of water and therefore has a considerable dilution capacity. There is no potential for effects to occur downstream of Doon Lough.
- Within the Lower Shannon surface water catchment no effects in relation to the Proposed Wind Farm will occur downstream Lough Derg. This lake waterbody contains a significant volume of water and therefore has a considerable dilution

capacity. There is no potential for effects associated with the Proposed Wind Farm to occur downstream of Doon Lough.

- A further assessment has been completed within a 200m zone of the Proposed Grid Connection Route. Due to the shallow nature of the underground cabling connection trench, a 200m buffer zone is an appropriate scale when considering potential cumulative effects on the water environment.
- A cumulative assessment was also completed in the Bridgetown (Clare)_010 WFD river sub-basin due to the proposed Temporary Transition Compound.



Legend

- EIAR Site Boundary
- Hydrological Cumulative Study Area
- Lakes
- Watercourses

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Job: Lackareagh Wind Farm, Co. Clare	
Title: Hydrological Cumulative Study Area	
Figure No: 9-15	
Drawing No: P1598-0-0724-A4-915-00A	
Sheet Size: A4	Project No: P1598-0
Scale: 1:80,000	Drawn By: GA
Date: 08/07/2024	Checked By: MG

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 Project 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 Project will ensure the protection of downstream surface water quality.

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

9.5.7.2 Cumulative Effects with Forestry

The Proposed 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 felling may also give rise to modified stream flow regimes caused by associated land drainage.

Given the occurrence of several forestry blocks within the Proposed Wind Farm site and in the surrounding lands, and given that they drain to the Ardcloony and Glenomra rivers, 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 Project will ensure the protection of downstream surface water quality.

For these reasons it is considered 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

A study was completed to identify all existing, permitted and/or proposed wind farm developments within the cumulative hydrological study area. From this study a total of 2 no. permitted / proposed wind farms have been identified to partly overlap within the delineated cumulative hydrological study area. These wind farms are as follows:

- 2 no. turbines (T01 and T02) associated with the permitted Fahybeg Wind Farm are located in the cumulative study area. These turbines are located in the Broadford_010 WFD river sub-basin. This area is drained by the Glenomra / Broadford River.
- 1 no. turbine (T10) associated with the proposed Oatfield Wind Farm is mapped in the cumulative study area. This turbine is located in the Broadford_030 WFD river sub-basin. This area is drained by the Broadford River.

The greatest potential for cumulative effects to occur would be if the construction phase of the permitted wind farms and the Proposed Project overlapped. In an unmitigated scenario, there may be some cumulative effects on the downstream Glenomra / Broadford River.

However, the EIARs for the above wind farm developments detail 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 Project 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 wind farms) there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Project 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 underground grid connection routes associated with other wind farm developments which overlap with the Proposed Grid Connection Route. From this study, the following overlaps were recorded:

- ~800m overlap with the grid connection underground cabling route associated with the proposed Knockshanvo 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;
- ~8.4km overlap with the grid connection underground cabling route associated with the proposed Carrownagowan Wind Farm. The first overlap occurs along the L3022-8, the R466 and the L3046 from the village of Kilbane as far south as Harols Cross Roads (~7.6km).Further to the south, the grid connection underground cabling routes overlap for ~800m along the L3056 and along existing ESB access tracks in the vicinity of Ardnacrusha 110kV substation.
- ~2.1km overlap with the grid connection underground cabling route associated with the permitted Fahybeg Wind Farm. The routes overlap for ~400m along the L3046 to the north of Harols Cross. An additional overlap occurs along the L3056 and along existing ESB access tracks in the vicinity of Ardnacrusha 110kV substation.

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, 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 Route 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 underground grid connection routes) 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 Wastewater Discharges

The EPA online viewer (https://gis.epa.ie/EPAMaps/default) was consulted in order to identify any licenced Section 4 trade effluent discharges to water within the cumulative hydrological study area. A total of 4 no. Section 4 discharge locations were identified as follows:

- Keelgrove Construction Ltd (WP: 142); located within the Broadford_030 WFD river sub-basin downstream of the Proposed Wind Farm.
- Keelgrove Construction Ltd (WP: 098); located within the Blackwater (Clare)_020 WFD river sub-basin along the Proposed Grid Connection Route. Discharges to the Blackwater River.
- Barry's shop (WP: 119); located within the Blackwater (Clare)_020 WFD river sub-basin along the Proposed Grid Connection Route.
- ESB Ardnacrusha (WP: 144); located in the North Ballycannan_010 WFD river sub-basin in the vicinity of the Proposed Grid Connection Route.

These discharges of trade effluent are licenced and the licencee are required to comply with the emission limit values set in the respective discharge licences. Furthermore, the mitigation and best practice measures prescribed in this EIAR chapter will ensure that the construction of the Proposed Project does not have the potential to result in significant effects on the hydrological/hydrogeological environment.

Therefore, there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Project and licenced Section 4 discharges within the cumulative study area.

9.5.7.6 Cumulative Effects with Other Development

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

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

Other large-scale developments within the cumulative study area associated with the Proposed Wind Farm include the proposed extraction of sand and gravel from a greenfield site to the north of the R466 in the townland of Fahymore (Clare Co. Co. Planning Ref: 2460230). The planning application was accompanied by a hydrogeological assessment which details mitigation measures for the protection of water quality/quantity. Furthermore, with the implementation of the mitigation measures prescribed in this EIAR, there will be no potential for cumulative effects to occur.

A desk study of planning applications within 200m of the Proposed Grid Connection Route was undertaken. The majority of these applications relate to the construction or renovation/extension of domestic dwellings, which will not generate potential cumulative effects due to their scale. Other developments located within the 200m study area include: a proposed sand and gravel pit ((Clare Co. Co. Planning Ref: 2460230), the permission to construct a medical centre (ABP Case Number: 317705), proposed residential development (ABP Case Number: 248074), proposed solar farm (ABP Case

Number: 316043) and upgrade of electrical network in the vicinity of Ardnacrusha (Clare Co. Co. Planning Ref Number: 211232). Due to the small scale and transient nature of the works along the Proposed Grid Connection Route, there will be limited potential for effects. Nevertheless, mitigation measures as prescribed in this EIAR will be implemented for the protection of water quality. There will be no potential for cumulative effects.

9.5.8 Post Consent Monitoring

No monitoring is required.