Planning and Environmental Consultants

Environmental Impact Assessment Report

Briskalagh Renewable Energy Development, Co. Kilkenny

Chapter 9 – Hydrology and Hydrogeology

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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 (MKO) to carry out an assessment of the potential likely and significant effects of the Proposed Project on the hydrological (surface water) and hydrogeological (groundwater) aspects 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 Site, 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' 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, Conor McGettigan and Jennifer Law.

Michael Gill P.Geo (BA, BAI, Dip Geol., MSc, MIEI) is a Civil/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. In addition, he has substantial experience in geological characterisation, peatland morphology, and surface water drainage design and SUDs design and surface water/groundwater interactions. Michael has worked on the EIS/EIAR for Oweninny WF, Cloncreen WF, Derrinlough WF and over 100 other wind farm related projects across the country.

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 routinely prepares the hydrology and hydrogeology chapters of environmental impact assessment reports for wind farm developments. Conor has also prepared several flood risk assessments and Water Framework Directive compliance assessments for various renewable energy developments in Ireland.

Jenny Law (BSc, MSc) is an environmental geoscientist holding a first honour's degree in applied environmental geosciences from the University College Cork in 2022. Jenny has assisted in the

preparation of the land, soils and geology and hydrology chapters for various environmental impact assessment reports, hydrological impact assessments, Water Framework Directive Assessment reports and Flood Risk Assessment reports for a variety of projects including wind farm developments and strategic housing developments.

9.1.3 Scoping and Consultation

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

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

Consultee	Description	Addressed in Section
GSI	The GSI recommend the identification of areas of High to Extreme Vulnerability and 'Rosk at or near surface' as any groundwater-surface water interactions that might occur would be greatest in these areas. The GSI status that there are several groundwater drinking water abstractions with zones of contribution/source protection area close to the site boundary including: › Callan PWS › Tullaroan GWS › BallyCallan Shale Region GWS › BallyCallan Limestone Region GWS Key to groundwater protection in general, and protection of specific drinking water supplies, is preventing ingress of runoff to the aquifer. Design of drainage will need to be cognisant of the public water schemes and the interactions between surface water and groundwater as well as run-off. Appropriate design should be undertaken by qualified and competent persons to include mitigation measures as necessary, such as SUDs or other drainage mitigation measures. Any excavation/cuttings required for realignment should ensure that groundwater flow within the zones of contribution to the groundwater abstraction points is not disrupted, resulting in diminished yields. Note that there could be other groundwater abstractions in the locality for which Geological Survey Ireland has not undertaken studies, and a robust assessment should be undertaken by qualified and competent persons including a	Groundwater vulnerability is addressed in Section 9.3.9. Local GSI mapped groundwater water supplies are detailed in Section 9.3.14.1. The potential effect of the Proposed Project on local Public and Group Water Schemes is assessed in Section 9.5.2.17. The potential effect of the Proposed Project on all local wells, including the potentially unmapped wells, is assessed in Section 9.5.2.11. The occurrence of karst features is discussed in Section 9.3.10 and an assessment of the potential effect of the Proposed Project on karst features is presented in Section 9.5.2.15.

Consultee	Description	Addressed in Section
	survey of all current wells and water abstractions within the vicinity. Given the nearby drinking water sources (Public Water Scheme, Group Water Schemes), the effects of any potential contamination as a result of the Renewable Energy Development would need to be assessed. The Groundwater Karst Viewer indicates that there are karst features in the vicinity of the Renewable Energy Development site boundary.	
Uisce Éireann	Uisce Éireann provided a standard response.	All items are addressed in the assessment of effects on the local water resources (Section 9.5.2.17).

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 Energy Development Guidelines for Planning Authorities, 2006 (the Guidelines);
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010);
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Wind Farms and Groundwater Impacts: A guide to EIA and Planning considerations (DoE/NIEA, April 2015);
- 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 Methodology

9.2.1 Desk Study

A desk study of the Site and Water Study Area (refer to Section 9.2.6) was completed in the Summer of 2023 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 June and July 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, Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- Groundwater Karst Viewer (GSI online mapping portal – www.gsi.ie);
- OPW Flood Mapping (www.floodmaps.ie);
- GSI Groundwater Flood Mapping (www.gsi.ie);
- Department on Environment, Community and Lowe Government on-line mapping viewer (www.myplan.ie);
- Group and Public Water Scheme Zone of Contribution Reports (Callan PWS, Ballycallan Limestone Region GWS, Ballycallan Shale Region GWS, Tullaroan GWS and Ballyconra PWS); and,
- Aerial Photography, 1:5000 and 6 inch base mapping.

9.2.2 Baseline Monitoring and Site Investigations

A comprehensive geological, hydrological and hydrogeological dataset has been collected as part of this EIAR study.

Initial walkover surveys of the Site, including hydrological mapping, was undertaken by Conor McGettigan and Jenny Law of HES on the 28th September 2023 (refer to Section 9.1.2 above for qualifications and experience). Subsequent walkover surveys, hydrological monitoring, surface water flow monitoring, field hydrochemistry, grab sampling, groundwater level monitoring and groundwater sampling were undertaken by Conor McGettigan and Michael Gill of HES on several dates (detailed below). The hydrological monitoring and surface water sampling was completed during both dry and wet periods in order to sample and record flow volumes during both high and low flows.

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

- HES completed initial site walkover surveys and drainage mapping at the Site on 28th September 2023, whereby water flow directions and drainage patterns were recorded. These surveys included field hydrochemistry monitoring and stream flow monitoring of watercourses draining the Site;
- Subsequent walkover surveys and hydrological mapping were completed by HES on 18th and 19th December 2023, 7th February, 13th June and 10th July 2024;
- Intrusive site investigations comprising of 22 no. trial pit excavations (18th and 19th December 2023 and 7th February 2024) and the drilling of 2 no. groundwater monitoring wells (19th December 2023) were completed under the supervision of HES. The site data provides detail and clarity on the nature and extent of the subsoils and bedrock at the Site;
- Groundwater level monitoring was completed in the monitoring wells between December 2023 and July 2024;
- Groundwater sampling was completed at the 2 no. groundwater monitoring wells on 10th July 2024; and,
- A total of 8 no. surface water grab samples were undertaken across 2 no. monitoring rounds (13th June and 10th July 2024) to determine the baseline water quality of the primary surface waters originating from the Site. The June sampling was preceded by very heavy rainfall whilst the July sampling was preceded by a period of relatively dry weather.

9.2.3 Impact Assessment Methodology

Please refer to Chapter 1 of the EIAR for detail on the impact assessment methodology (EPA, 2022). In addition to the above methodology, the importance 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)

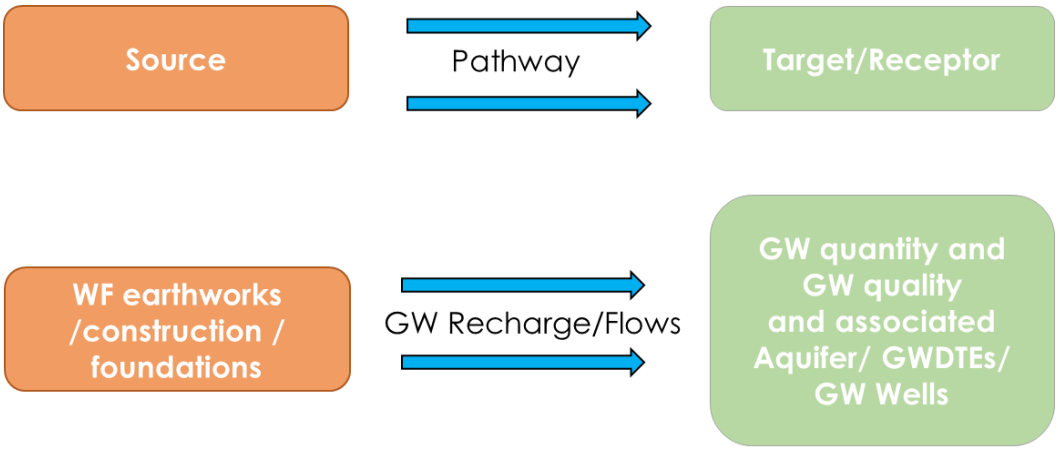
Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the 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.
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 (receptor) model (see below, top) was applied to assess potential effects on downstream environmental receptors (see below, bottom as an example) as a result of the Proposed Project.



Where potential effects are identified, the classification of effects in the assessment follows the descriptors provided in the Glossary of Impacts contained in EPA, 2022.

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 (Section 9.5), 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, 2022 impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all construction, operation and decommissioning activities which have the potential to generate a source of significant adverse impact on the hydrological and 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 a potential impact is 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	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 residual effects of the identified potential impact source on the receiving environment.

9.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of Chapter 9 of this EIAR: Hydrology and Hydrogeology.

9.2.6 Study Area

The Water Study Area for the hydrological and hydrogeological impact assessment is defined by the regional surface water catchments and groundwater bodies within which the Proposed Project is located.

A regional hydrology map showing WFD surface water catchments and sub-catchments is included as Figure 9-1. The relevant surface water catchments within which the Proposed Project is located are detailed in Section 9.3.2.2. In addition, the bedrock aquifers and groundwater bodies which underlie the Site are detailed in Section 9.3.8.

9.3 Receiving Environment

9.3.1 Proposed Project Site Description and Topography

9.3.1.1 Proposed Wind Farm

The Proposed Wind Farm site is located within a rural, agricultural setting in northwest County Kilkenny, approximately 8.5km west of Kilkenny City. The settlement of Kilmanagh is located approximately 1.2km south of the nearest proposed turbine, and the settlement of Tullaroan is located approximately 2.7km north of the nearest proposed turbine. The Proposed Wind Farm site is located in the townlands listed in Table 1-1 of Chapter 1 of this EIAR. The Site has a total area of ~1,000 hectares.

The R695 regional road runs immediately south of the Proposed Wind Farm site in an east-west orientation entering the settlement of Kilmanagh and then heading south from Kilmanagh towards Callan, passing within 920m of the nearest proposed turbine. Existing access is via farm entrances off the L5023 local road to the northwest, L5024 to the north, and L1009 to the south. The Proposed Wind Farm site is traversed by a number of existing agricultural roads and tracks.

Landuse within the Site currently comprises a mix of pastoral agriculture and small-scale, private forestry. The surrounding landuse predominantly comprises pastoral agriculture and residential within Kilmanagh and Tullaroan.

The Proposed Wind Farm is located to the east of the Slieve Ardagh Hills. The local topography is hilly, with land generally sloping towards the Tullaroan Stream which dissects the Proposed Wind Farm site. Ground elevations are greatest in the east at approximately 190mOD (metres above Ordnance Datum) and fall towards the Tullaroan Stream which stands at approximately 110mOD in the south.

9.3.1.2 Proposed Grid Connection

The Proposed Grid Connection includes the proposed onsite 38kV substation and associated control buildings in the townland of Oldtown within the Proposed Wind Farm site. The proposed onsite 38kV substation is located in agricultural lands and will be accessed via Proposed Wind Farm access roads.

The Proposed Grid Connection underground cabling route originates at the proposed onsite 38kV substation and connects to the existing 110kV Ballyragget substation. The Proposed Grid Connection underground cabling route is located primarily within the public road corridor, with ~260m located within a Site road to the west of the proposed substation, and a short off-road section through agricultural lands near Ballyragget substation.

The Proposed Grid Connection underground cabling route will originate at the proposed onsite 38kV substation and run west for approximately 260m through the Proposed Wind Farm access Site road towards the L5023 local road. The Proposed Grid Connection underground cabling route continues underneath the local road network for approximately 12.3km before following the R694 north for 8.6km. The underground cabling route then follows the N77 national road north for ~1km before crossing the River Nore via directional drilling. On the eastern side of the River Nore, the proposed cable route then passes through several agricultural fields and tracks, for approximately 660m, before then joins the R432 for the remainder of the route, a stretch of approximately 140m. From the R432 the cable route turns right into the existing 110kV Ballyragget Substation compound in the townland of Moatpark.

Much of the southern section of the Proposed Grid Connection is located at elevations in excess of 100mOD associated with the Slieve Ardagh Hills. Topography rises rapidly to the north of the Brittas cross roads and the greatest elevations are recorded in the townland of Picketstown where ground

elevations stand at ~240mOD. Further to the north in the vicinity of Freshford and Ballyragget, ground elevations are relatively flat and range from 70 to 80mOD.

9.3.2 Water Balance

9.3.2.1 Proposed Wind Farm

Long term Annual Average Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (1981-2010) recorded at Kilkenny rainfall station, located ~8.6km east of the Proposed Wind Farm site are presented in

Table 9-5. The long-term average annual rainfall at Kilkenny rainfall station is ~871mm/year.

However, the average annual rainfall (AAR) at Kilkenny rainfall station may underestimate the actual AAR at the Proposed Wind Farm site due to the elevation difference (the highest elevations at the Proposed Wind Farm site (~190mOD) are ~125m higher than the elevation of Kilkenny rainfall station (~66mOD).

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 1,027 to 1,046mm/year. The average annual rainfall at the Proposed Wind Farm site is 1,036.5mm/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 (Kilkenny) (mm)

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Kilkenny		249,400		157,400		66		1957		N/A		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
82.5	62	67.4	58.1	61.2	66.4	62	77.4	70.4	95.8	84.8	83.4	871.4

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Kilkenny, approximately 8.6km east of the Proposed Wind Farm site. The long-term average PE for this station is 458.8mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 435.9mm/year (which is 0.95 × PE).

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

$$\text{Effective rainfall (ER)} = \text{AAR} - \text{AE}$$

$$= 1{,}036.5\text{mm/year} - 435.9\ \text{mm/year}$$

$$\text{ER} = 600.6\text{mm/year}$$

Groundwater recharge and runoff coefficient estimates are available from the GSI (www.gsi.ie). Within the Proposed Wind Farm site groundwater recharge coefficients range from 7.5% to 85%. The Proposed Wind Farm site is generally mapped as having low recharge rates with recharge coefficients of 7.5% due to the presence of low permeability glacial tills. Areas of higher groundwater recharge (85%) are mapped in the elevated ground in the northeast of the Proposed Wind Farm site where rock is close to

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

the surface. Meanwhile, high recharge rates are also mapped in the valley of the Tullaroan Stream due to the presence of permeable glaciofluvial sands and gravels.

Based on site specific data, groundwater recharge rates are considered to be low (10%) across the majority of the Proposed Wind Farm site due to the coverage of low permeability glacial tills, the poor bedrock aquifer, the sloping nature of the Proposed Wind Farm site and the presence of several surface water drainage features. In these areas of the Proposed Wind Farm site conservative annual recharge and runoff rates are estimated to be ~60mm/yr and 540mm/yr respectively. This means that the hydrology of much of the Proposed Wind Farm site is characterised by high surface water runoff rates and relatively low groundwater recharge rates.

However, in the valley of the Tullaroan Stream, high rates of groundwater recharge are likely due to the presence of permeable sands and gravels. In this area of the Site the conservative annual recharge and runoff rates are estimated to be ~510mm/yr and 90mm/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 is ~8% under the medium-low emission scenario and ~6% 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 ~1,036mm/yr. Under the medium-low emissions scenario this may reduce to ~953mm/yr, while under the high emissions scenario this figure may reduce to ~973mm/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, 5-year, 30-year and 100-year). These extreme rainfall depths will be the basis of the Proposed Wind Farm drainage hydraulic design as described further below.

Table 9-6: Return Period Rainfall Depths (mm) for the Proposed Wind Farm site (mm)

Return Period (Years)				
Storm Duration	1	5	30	100
5 mins	3.6	5.6	8.8	11.7
15 mins	5.8	9.1	14.4	19.1
30 mins	7.6	11.7	18.0	23.6
1 hour	9.9	14.9	22.6	29.2
6 hours	19.8	28.1	40.4	50.6
12 hours	25.8	36.0	50.6	62.6
24 hours	33.6	46.0	63.4	77.3
2 days	40.8	54.2	72.6	87.0

9.3.2.2 Proposed Grid Connection

The Proposed Grid Connection, in the vicinity of the proposed onsite 38kV substation overlaps with the Proposed Wind Farm site. The average annual rainfall along the Proposed Grid Connection underground cabling route ranges from 1,045 in the vicinity of the Proposed Wind Farm site to

911mm/yr near Ballyragget substation. Groundwater recharge estimates from the GSI along the Proposed Grid Connection underground cabling route range from 7% in the south to ~85% in the north.

Across the southern section of the route, the average annual rainfall ranges from 1,028 to 1,045mm/yr with an average of 1,036mm.yr. In this area, where recharge is estimated to be ~7%, the split between groundwater recharge and runoff will be 73mm/yr and 963mm/yr respectively. Meanwhile, across the northern section of the route, the average annual rainfall ranges from 911 to 1,020mm/yr with an average of 949mm/yr. In this area, where recharge is estimated to be ~85%, the split between groundwater recharge and runoff will be 807mm/yr and 141mm/yr respectively.

9.3.3 Regional and Local Hydrology

9.3.3.1 Proposed Wind Farm

Regionally, the Proposed Wind Farm site is located in the River Nore surface water catchment within Hydrometric Area 15 of the South Eastern River Basin District. More locally, the Proposed Wind Farm is located within 2 no. WFD river sub-catchments. The vast majority of the Proposed Wind Farm is located in the Munster River sub-catchment (Munster_SC_010) whilst a small area in the northeast is mapped in the Nore_SC_090 sub-catchment.

Within the Munster River sub-catchment the Proposed Wind Farm is mapped in 2 no. WFD river sub-basins. The north is located in the Tullaroan Stream_020 river sub-basin whilst the majority of the Proposed Wind Farm site is mapped in the Tullaroan Stream_030 river sub-basin. The Tullaroan Stream flows to the south, dissecting the Proposed Wind Farm site, and continues southwards before discharging into the Munster River ~5.7km to the south. Further downstream the Munster River discharges into the King's River to the northwest of Callan (~7.7km from the Proposed Wind Farm site). The King's River discharges into the River Nore ~17km to the southeast.

More locally the Proposed Wind Farm site is drained by several tributaries of the Tullaroan Stream. Many of these streams originate within the Proposed Wind Farm site and flow downslope into the Tullaroan Stream. These watercourses are locally unnamed but have been assigned names in the EPA blueline database (www.epa.ie).

- Within the Tullaroan_020 WFD river sub-basin the Proposed Wind Farm site is drained by the EPA named Tullaroan watercourse (EPA Code: 15T22) which flows to the southwest and discharges into the Tullaroan Stream. Note that the only infrastructure associated with the Proposed Wind Farm in this sub-basin comprises of 460m of new proposed roadway to the northwest of the proposed borrow pit and the upgrade of ~230m of an existing track to the northwest of the proposed onsite 38kV substation.
- The vast majority of the proposed infrastructure is located in the Tullaroan_030 WFD river sub-basin. The EPA mapped tributaries of the Tullaroan Stream in this area include the Briskalagh (EPA Code: 15B98) and Knockeenglass (EPA Code: 15K44) streams in the east and the Foylatalure (EPA Code: 15F10) and Kilmanagh (EPA Code: 15K74) streams in the west.

Within the Nore_SC_090 sub-catchment the Proposed Wind Farm site is mapped in the Breagh(Kilkenny)_010 WFD river sub-basin. This area is drained by the Bregagh River, however no infrastructure associated with the Proposed Wind Farm is located in this WFD river sub-basin.

Refer to Table 9-7 below for a summary of hydrological setting of the Proposed Project infrastructure.

A regional hydrology map showing the WFD catchments and sub-catchments is included as Figure 9-1. Meanwhile, a local hydrology map for the Proposed Wind Farm site, shown as Figure 9-2 below, presents the WFD river sub-basins.

9.3.3.2 Proposed Grid Connection

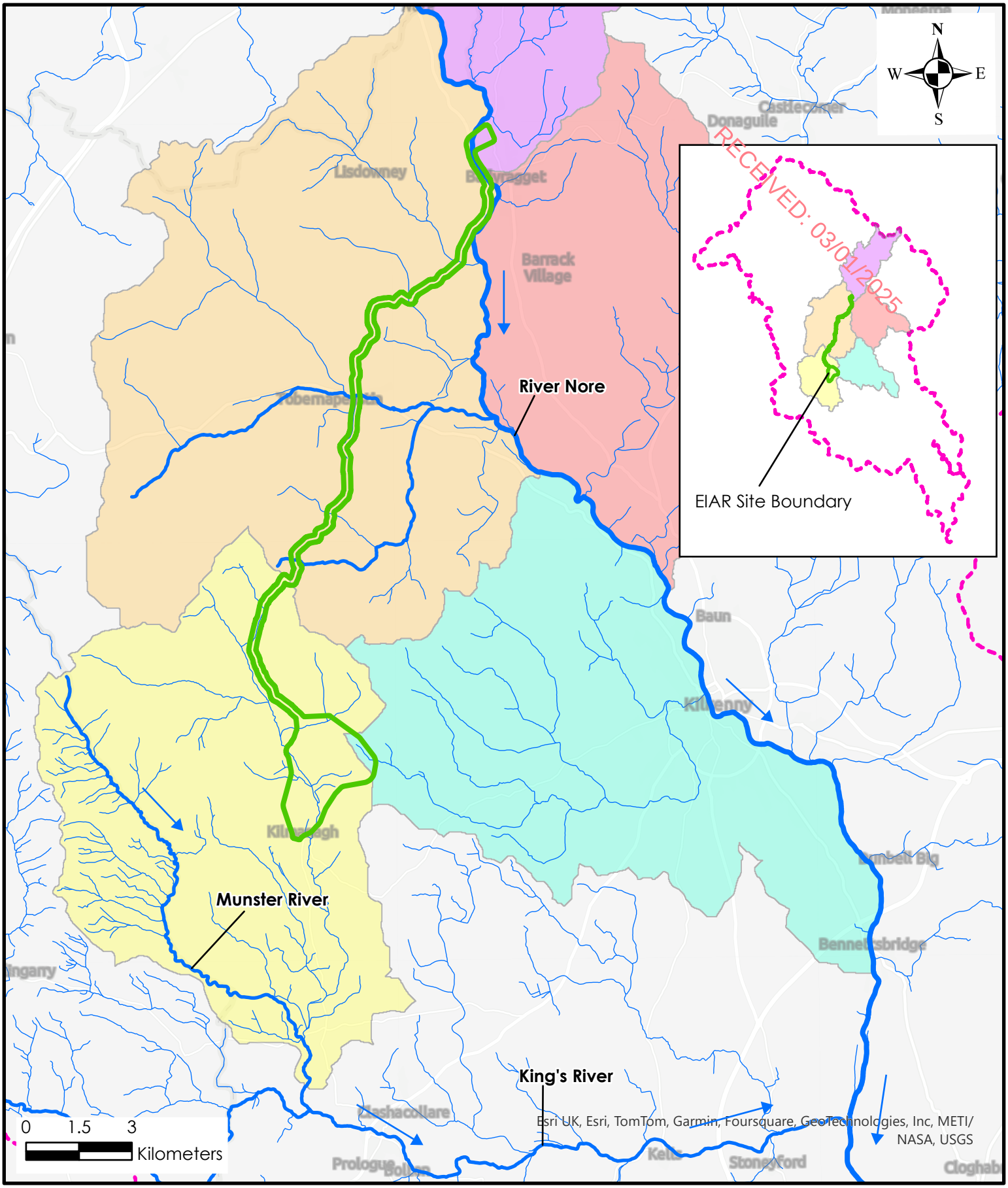
The proposed onsite 38kV substation is mapped within the Tullaroan_030 WFD river sub-basin. There are no EPA mapped watercourses in the immediate vicinity of the proposed substation location. The Tullaroan Stream is mapped ~120m to the southwest. However, during site walkover surveys a small watercourse was recorded along the western boundary of the field within which the substation is proposed. This watercourse recharges into the sand and gravel subsoils in the valley of the Tullaroan Stream and does not directly discharge into the Tullaroan Stream.

The Proposed Grid Connection underground cabling route is located entirely within the River Nore surface water catchment and passes through a total of 4 no. WFD river sub-catchments and 8 no. WFD river sub-basins. These are detailed in Table 9-7 below. A local hydrology map of the Proposed Grid Connection underground cabling route is shown in Figure 9-3.

There are a total of 10 no crossings over EPA mapped watercourses along the Proposed Grid Connection underground cabling route, comprising of 7 no. existing bridge crossings, 2. no existing culvert crossings and 1 no. new proposed crossing. These crossings are detailed below:

- An existing bridge crossing along a local road in the townland of Oldtown over the EPA mapped Tullaroan watercourse (EPA Code: 15T22);
- 2 no. existing bridge crossings along a local road in the townland of Brittas (to the north and south of Brittas crossroads) over the EPA mapped Blackbottom stream (EPA Code: 15B83);
- An existing crossing (concrete pipe) along a local road in the townland of Picketstown over the EPA mapped Arigna River (EPA Code: 15A01);
- An existing bridge crossing over a local road between the townlands of Ballyroa (Grace) and Ballyroe over the EPA mapped Ballylarkin Stream (EPA Code: 15B85);
- An existing bridge crossing over the Monabrika Stream (EPA Code: 15M30) to the south of Freshford;
- An existing bridge crossing along New Bridge Street (R694) in Freshford over the Nuenna River;
- An existing culvert crossing along the R694 over the Lismaine Stream (EPA Code: 15L16) between the townlands of Sweethill and Clone;
- An existing crossing along the R694 over the Lisdowney Stream (EPA Code: 15L02) at Grange Bridge; and,
- A new proposed crossing under the Nore River to the south of Ballyragget 110kV substation.

In addition, walkover surveys have revealed an additional 3 no. crossings along the Proposed Grid Connection underground cabling route which are over watercourses which are not included in the EPA blueline database. These are at existing bridge and culvert crossings.



Legend

- EIAR Site Boundary
- Watercourses
- WFD Catchments
- Nore
- WFD Subcatchments
- Munster_SC_010
- Nore_SC_060
- Nore_SC_070
- Nore_SC_080
- Nore_SC_090

Client: Briskalagh Ltd.		
Job: Briskalagh Renewable Energy Development, Co. Kilkenny		
Title: Regional Hydrology Map		
Figure No: 9-1		
Drawing No: P1657-0-0824-A4-901-00A	Scale: 1:130,000	Drawn By: GA
Sheet Size: A4	Project No: P1657-0	Date: 27/08/2024	Checked By: MG

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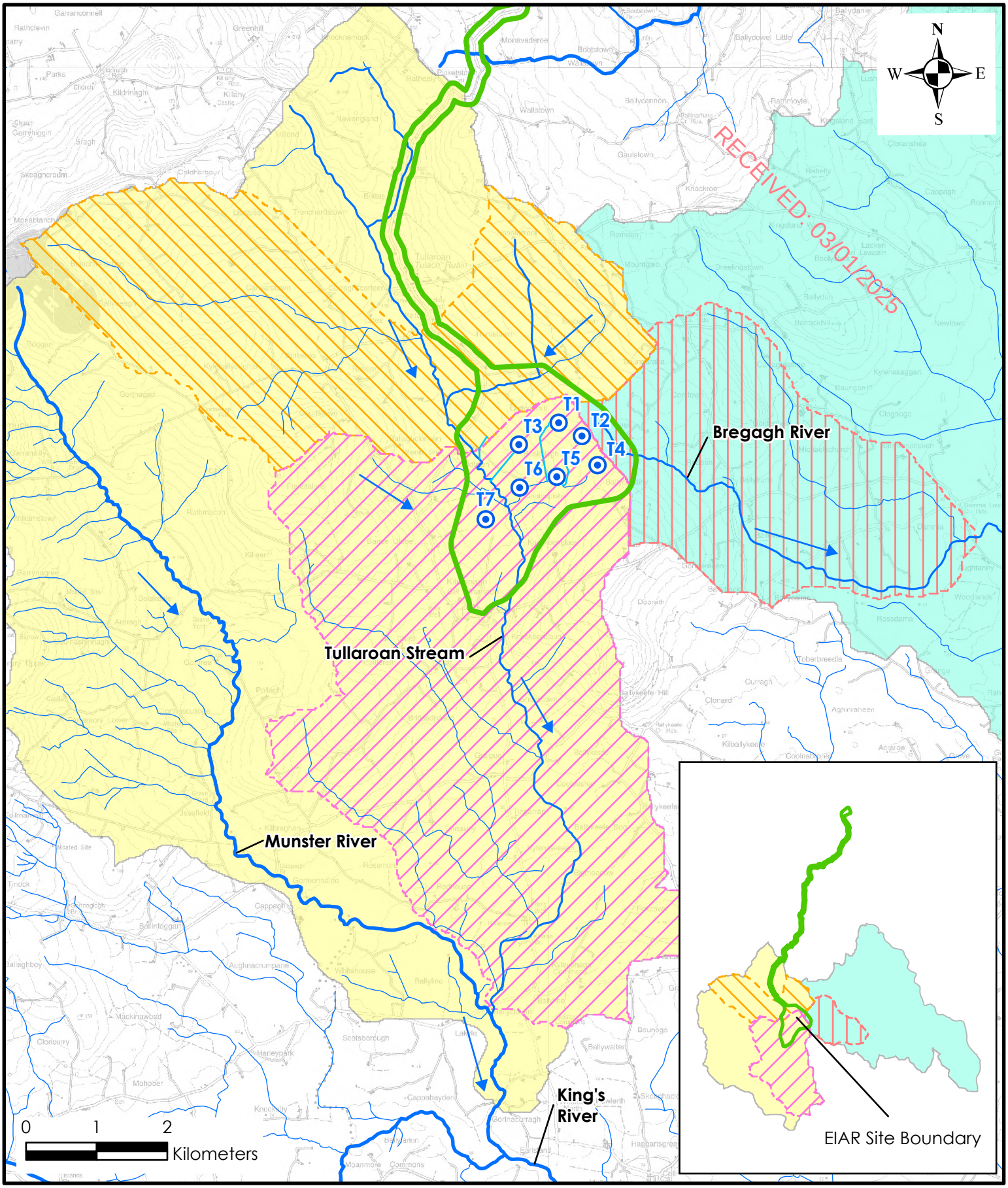

Legend

- EIAR Site Boundary
- Proposed Turbine Locations

WFD Subcatchments

- Munster_SC_010
- Nore_SC_090

WFD River Sub-Basins

- BREGAGH (KILKENNY)_010
- TULLAROAN STREAM_020
- TULLAROAN STREAM_030
- Watercourses
- Additional streams

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Local Hydrology Map (Proposed Wind Farm Site)

Figure No: 9-2

Drawing No: P1657-0-1024-A4-902-00A | Scale: 1:70,000 | Drawn By: GA

Sheet Size: A4 | Project No: P1657-0 | Date: 01/10/2024 | Checked By: MG

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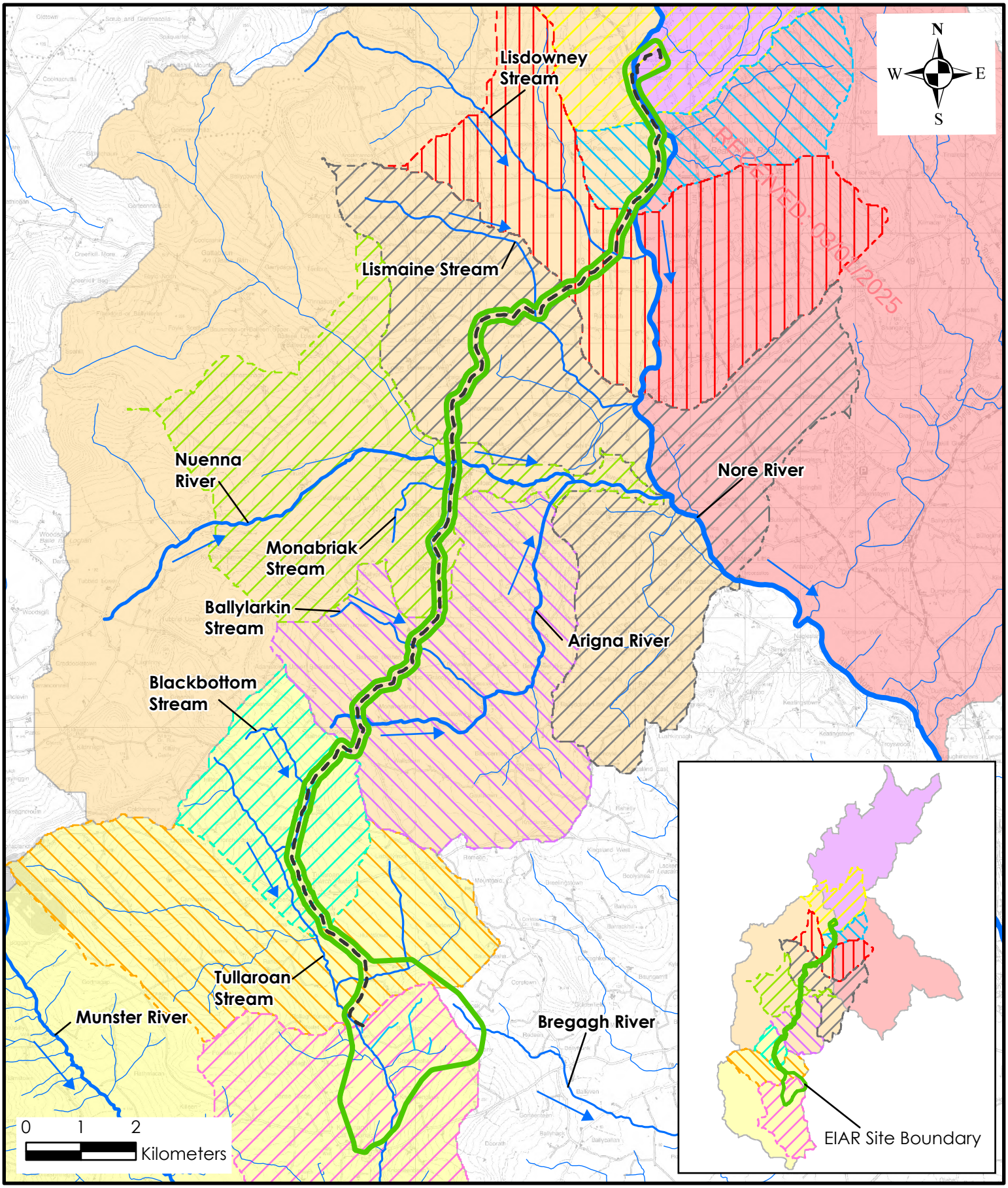

Legend

- EIAR Site Boundary
- Proposed Underground Cabling Route

WFD River Sub-Basins

- TULLAROAN STREAM_020
- TULLAROAN STREAM_030
- TULLAROAN STREAM_010
- ARIGNA (KILKENNY)_010
- NORE_120
- NORE_130
- NORE_140
- NORE_150
- NUENNA_020

WFD Subcatchments

- Munster_SC_010
- Nore_SC_060
- Nore_SC_070
- Nore_SC_080
- Watercourses
- Additional streams

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Local Hydrology Map (Proposed Grid Connection underground cabling route)

Figure No: 9-3

Drawing No: P1657-0-0824-A4-903-00A | Scale: 1:70,000 | Drawn By: GA

Sheet Size: A4 | Project No: P1657-0 | Date: 27/08/2024 | Checked By: MG

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Table 9-7: Proposed Project and WFD Regions

Proposed Project Infrastructure	Nearest Mapped Watercourses - Common Name (EPA Name)	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
Proposed Wind Farm				
~460m of new proposed roads and upgrades to ~230m of an existing road	Tullaroan Stream and associated tributaries	Tullaroan Stream_020	Munster_SC_010	River Nore Surface Water Catchment
7 no. turbines and associated hardstands, 2 no. construction compounds, 1 no. met mast, spoil repository areas, 1 no. borrow pit, upgrades to existing roads and new proposed roads.	Tullaroan Stream and associated tributaries	Tullaroan Stream_030	Munster_SC_010	
None	Bregagh River	Bregagh (Kilkenny)_010	Nore_SC_090	
Proposed Grid Connection				
Proposed Grid Connection underground cabling route and proposed onsite 38kV substation, 1 no. construction compound	Tullaroan Stream	Tullaroan_030	Munster_SC_010	River Nore Surface Water Catchment
Proposed Grid Connection underground cabling route	1 no. crossing over the EPA mapped Tullaroan watercourse	Tullaroan Stream_020		
	2 no. crossings over the EPA mapped Brittas Stream	Tullaroan Stream_010		
	2 no. watercourse crossings over the EPA mapped Arigna River and Ballylarkin stream	Arigna (Kilkenny)_010	Nore_SC_070	

Proposed Project Infrastructure	Nearest Mapped Watercourses - Common Name (EPA Name)	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
	2 no. crossings over the Nuenna River and the Monabriak Stream An additional 2 no. crossings over unmapped watercourses	Nuenna_020		
	1 no. crossing over the Lismaine Stream 1 no. crossings over an unmapped watercourse	Nore_150		
	1 no. crossing over the Lisdowney Stream	Nore_140		
	No crossings	Nore_130	Nore_SC_070 / Nore_SC_080	
	1 no. new crossing over the Rover Nore	Nore_120	Nore_SC_060	

9.3.4 Surface Water Flows

There are no OPW gauging stations located in the immediate vicinity of the Proposed Wind Farm site. The closest gauging station is located on the King's River at Callan (Station Code: 15009).

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

Figure 9-4 below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Proposed Wind Farm site in the Nore surface water catchment.

A 95%ile flow relates to the flow which will be exceeded within the river 95% of the time. For example, the 95%ile flow at Node 15_1649 on the Tullaroan Stream within the Proposed Wind Farm site is estimated to be 0.053m^3/s (53l/s). This indicates that 95% of the time, the flow at this location is estimated to be at or above 53l/s. Due to the increased catchment size, the 95%ile flow at the nodes along the Munster, King's and Nore rivers downstream of the Proposed Wind Farm site increase progressively. For example, at Node 15_1734 (Munster River upstream of its' confluence with the King's River), Node 15_1733 (King's River at Callan) and Node 15_705 (River Nore downstream of King's River) the 95%ile flows are estimated to be 0.12m^3/s, 0.243m^3/s and 4.038m^3/s respectively.

Due to the increasing flow volumes downstream of the Proposed Wind Farm the potential for effects associated with the Proposed Project decreases progressively downstream.

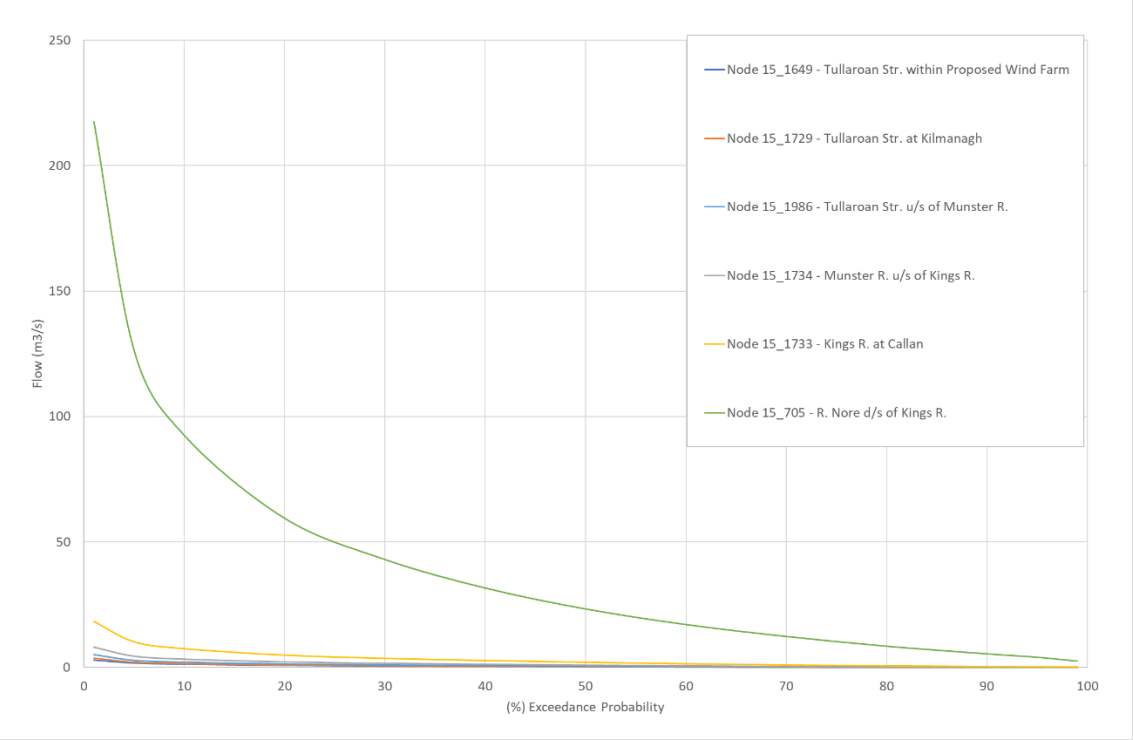


Figure 9-4: EPA Hydrotool Node Flow Duration Curves

3 no. rounds (29th September 2023, 13th June and 10th July 2024)) of surface water flow monitoring were carried out in the main watercourses draining the Proposed Wind Farm site and the Proposed Grid Connection and the results are shown in Table 9-8 below. The measured flows vary depending on the nature of the waterbody being monitored. The smallest recorded flow volumes were noted within the Briskalagh Stream (tributary of the Tullaroan Stream) while larger flows being recorded in the

Tullaroan Stream itself. Meanwhile, the flow volumes measured along the Grange River, referred to by the EPA as the Lisdowney Stream, ranged from ~10 - ~15l/s.

Table 9-8: Surface Water Flow Monitoring (29/09/2023 to 13/07/2024)

Location	Easting (ITM)	Northing (ITM)	Watercourse – EPA Name	Flow Volume (l/s) Range
SW1	238806	154700	Tullaroan Stream	~20 – 25
SW2	239528	153851	Briskalagh Stream	~1 – 2
SW3	239426	152305	Tullaroan Stream	~25 – 30
SW4	243624	168637	Grange River (Lisdowney Stream)	~10 – 15

9.3.5 Proposed Wind Farm Site Drainage

As stated above, the Proposed Wind Farm site is drained by the Tullaroan Stream and its tributaries.

An existing drainage map for the Proposed Wind Farm site is shown within Figure 9-6. The drainage map was created using OSI mapped watercourses, aerial photography, field mapping and Lidar data. Lidar data allows detailed mapping on the topographic contours of the site, thereby allowing identification of potential drainage pathways at the Proposed Wind Farm site that are greater than 150m in length. Based on this assessment the main drainage pathways at the Proposed Wind Farm 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 Proposed Wind Farm site boundaries and flow downslope before discharging into the Tullaroan Stream. Runoff rates are high on the valley sides due to the presence of glacial till. On the lower ground there is some recharge to ground as the watercourses pass over permeable glaciofluvial sands and gravels which are present in a thin strip along the banks of the Tullaroan Stream.

In places the natural drainage is further facilitated by a network of manmade drains. The nature of these manmade drains depends on the local land use. To the east of the Tullaroan Stream, agricultural drains are located along hedgerows and field boundaries and connect to natural watercourses. Meanwhile, in a forested area to the west of the Tullaroan Stream, drainage is enhanced by forestry drains.

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

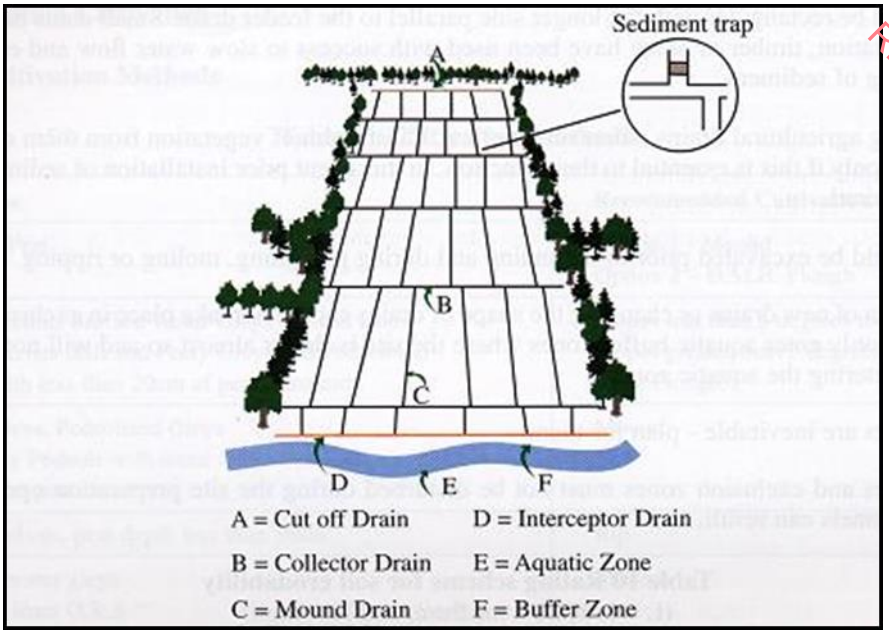
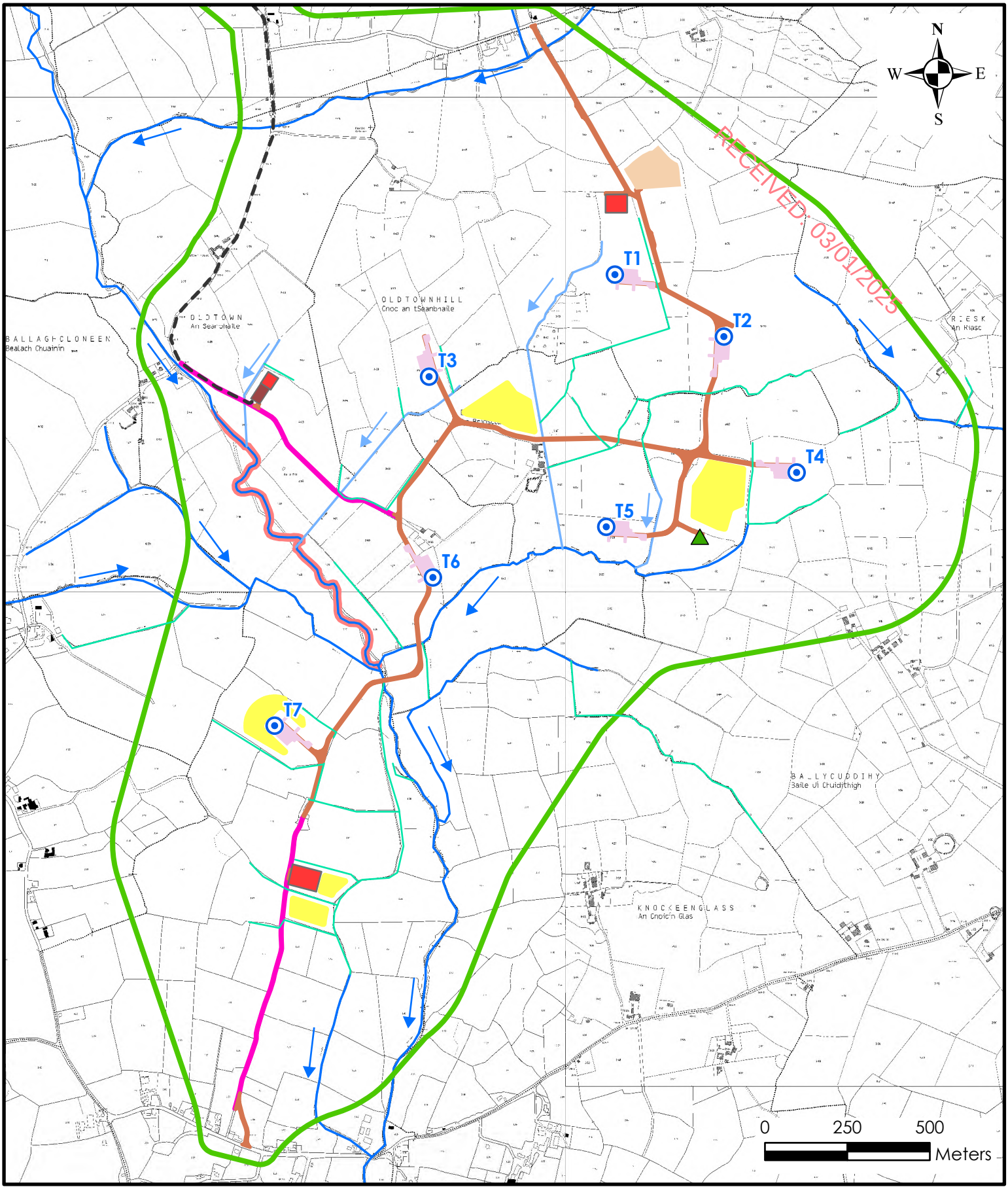


Figure 9-5: Schematic of Existing Forestry Drainage



Legend

- EIAR Site Boundary
- Proposed Turbine Locations
- Proposed Hardstands
- Proposed Met Mast
- Existing Roads for Upgrade
- Proposed New Roads
- Proposed Temporary Construction Compound
- Spoil Management Areas
- Proposed Borrow Pit
- Proposed Onsite Substation
- Proposed Underground Cabling Route
- Riparian Planting Buffer
- Watercourses
- Additional streams
- Additional drains

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Proposed Wind Farm site existing drainage network

Figure No: 9-6

Drawing No: P1657-0-1024-A4-906-00A

Scale: 1:15,000

Drawn By: GA

Sheet Size: A4

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Date: 01/10/2024

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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, National Catchment-based Flood Risk Assessment and Management (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.

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".

The closest OPW mapped recurring flood event is located immediately to the south of the Proposed Wind Farm site at Kilmanagh. Recurring flooding is reported along the R695, associated with flooding along the Tullaroan Stream. Several recurring flood events are also mapped further downstream along the Tullaroan Stream, the Munster River and the King's River.

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 within the Proposed Wind Farm site. No areas of surface water flooding were recorded downstream of the Proposed Wind Farm site along the Tullaroan Stream.

No CFRAM mapping has been completed for the area of the Proposed Wind Farm site. The closest mapped CFRAM fluvial flood zones for the Present Day Scenario are mapped along the King's River near Callan (~7.8km south of the Proposed Wind Farm site). No CFRAM mapping has been completed on the Tullaroan Stream or its tributaries.

National Indicative Flood Mapping (NIFM) has been completed along the length of the Tullaroan Stream in the vicinity of the Proposed Wind Farm site. However, the modelled medium and low probability fluvial flood zones do not extend any significant distance from the river channel. The only proposed infrastructure located within the mapped flood zones comprises ~240m of existing access road (proposed for upgrade) to the west of the proposed substation location, a new proposed crossing over the Tullaroan Stream and associated new proposed site access roads. Note that the mapped flood zones do not encroach upon the proposed substation location. The closest turbine (T6) is ~154m from the mapped NIFM fluvial flood zones.

The proposed infrastructure within the mapped flood zones has a limited footprint of ~0.226ha (0.112ha of existing roads to be upgraded and 0.114ha of new proposed roads). This area is negligible in comparison to the total areas of the low probability NIFM flood zone within the EIAR site boundary which is ~48ha. Therefore, the proposed footprint within the flood zone represents <0.5% of the flood zone within the EIAR study boundary. Nevertheless, to mitigate the risk of floodwater displacement, the sections of access road within he modelled flood zones will have the track surface raised at least 500mm above the 1,000-year fluvial flood level. Culverts will be places at 25m intervals in these sections of the roads to maintain the hydrological regime and to prevent a damming effect occurring during flood events. Therefore, the impact from displaced floodwaters will be negligible.

The modelled NIFM flood zones associated with the Mid-Range and High-End future climate change scenarios do not differ significantly from those for the Present Day Scenario. Therefore, there will be no increase in flood risk associated with climate change at 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 is low due to the sloping nature of much of the Proposed Wind Farm site. This risk is limited to local flat areas where some ponding/pluvial flooding may occur where low permeability soils are present.

9.3.6.2 Proposed Grid Connection

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

The OPW Past Flood Events map record recurring flood events along the Proposed Grid Connection underground cabling route at Freshford and Ballyragget. At Freshford the recurring flooding is associated with flooding of the Nuenna River whilst the Nore is noted to flood at Ballyragget.

The GSI's Winter 2015/2016 Surface Water Flood Map records fluvial flooding along the River Nore to the west of Ballyragget.

CFRAM flood zones are mapped along the Proposed Grid Connection underground cabling route at Freshford and Ballyragget.

Meanwhile, the National Indicative Fluvial Flood Mapping for the Present Day Scenario shows fluvial flooding along the Proposed Grid Connection underground cabling route in the vicinity of the Proposed Wind Farm site along the Tullaroan Stream. Note that the mapped flood zones do not encroach upon the proposed substation location. NIFM flood zones are also mapped along the Nuenna River and the Lisdowney Stream along the Proposed Grid Connection underground cabling route.

There are no historic or modelled groundwater flood zones along the Proposed Grid Connection.

In summary, the vast majority of the Proposed Grid Connection is at low risk of flooding. However, there are areas which may be prone to flooding, principally at existing watercourse crossings. Due to the depth of the Proposed Grid Connection underground cabling, this will have no impact during the operational phase of the Proposed Project. During the construction phase, works along the Proposed Grid Connection underground cabling route may have to be postponed following heavy rainfall events which could cause flooding in these areas. The proposed onsite 38kV substation is mapped in Flood Zone C and is at low risk of flooding.

9.3.7 Surface Water Quality

9.3.7.1 EPA Water Quality Monitoring

9.3.7.1.1 *Proposed Wind Farm*

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

The latest Q-ratings for the watercourses in the vicinity and downstream of the Proposed Wind Farm site are from the 2022 monitoring round. The Tullaroan Stream in the vicinity of the Proposed Wind

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

Farm site at a bridge in Oldtown (Station Code: RS15T020250) achieved a rating of Q4 ('Good' status). Further downstream the Tullaroan Stream is also of 'Good' status upstream of its confluence with the Munster River (Station Code: RS15T020450). The Munster River, upstream of its confluence with the King's River (Station Code: RS15M030700), and the King's River at a bridge in Callan (Station Code: RS15K020500) were also assigned a Q4 rating in 2022. The Q-rating stations are shown on Figure 9-7.

Table 9-9: EPA Water Quality Monitoring Q-Rating Values (Proposed Wind Farm)

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Tullaroan Stream	RS15T020250	2388183	154691	2022	Q4 (Good)
Tullaroan Stream	RS15T020450	239211	146723	2022	Q4 (Good)
Munster River	RS15M030700	239319	145352	2022	Q4 (Good)
King's River	RS15K020500	241439	143933	2022	Q4 (Good)

9.3.7.1.2 Proposed Grid Connection

The southern section of the Proposed Grid Connection underground cabling route and the proposed onsite 38kV substation is drained by the Tullaroan Stream. Recent EPA monitoring along the Tullaroan Stream is described above.

The Arigna River downstream of the Proposed Grid Connection underground cabling route achieved a Q-rating of Q3-4 ('Moderate' status) in 2022 at Arigna Bridge (Station Code: RS15A010400). Meanwhile, the Nuenna River was assigned a Q3 rating ('Poor' status) in Freshford (Station Code: RS15N020200). The River Nore achieved a Q4 rating at a bridge in Ballyragget (Station Code: RS15N011450). The Q-rating data downstream of the Proposed Grid Connection underground cabling route is summarised in Table 9-10.

Table 9-10: EPA Water Quality Monitoring Q-Rating Values (Proposed Grid Connection)

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Arigna River	RS15A010400	242466	164078	2022	Q3-4 (Moderate)
Nuenna River	RS15N020200	240690	164836	2022	Q3 (Poor)
River Nore	RS15N011450	244524	170820	2022	Q4 (Good)

9.3.7.2 HES Water Quality Monitoring

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) along with turbidity (NTU) were taken at 4 no. surface water sampling locations over 2 no. monitoring rounds completed on 13th June and 10th July 2024. The June sampling was preceded by a day of very heavy rainfall whilst the July sampling was preceded by a period of relatively dry weather. The results are listed in

Table 9-11 below. The monitoring locations are shown in Figure 9-7.

The surface water samples indicate a basic type surface water, with pH ranging from 8.16 to 8.63. Dissolved oxygen ranges from 9.4 to 10.57mg/l, with electrical conductivity relatively high ranging from 312 to 718µS/cm. Turbidity ranged from 1.16 to 67.9NTU, with the greatest values recorded on the 13th June (note that this sampling was preceded by heavy rainfall which likely contributed to higher turbidity during this sampling round).

Table 9-11: Field Parameters - Surface Water Chemistry Measurements (13/06/2024 to 10/07/2024)

Location ID	Temp °C	DO (mg/l)	EC (µS/cm)	pH	Turbidity (NTU)
SW1	11.6 – 12.2	10.02 – 10.57	640 – 654	8.22 - 8.63	1.87 – 2.9
SW2	11.6 – 12.0	9.61 – 10.01	312 – 718	8.42 - 8.58	10.6 – 67.9
SW3	11.8 – 12.5	9.4 – 9.52	617 – 631	8.16 – 8.26	4.43 - 7.46
SW4	12.3 – 13.0	9.6 – 9.89	706 - 708	8.24 - 8.4	1.16 – 1.68

Surface water grab samples were also taken at these locations for laboratory analysis on 2 no. occasions (13th June and 10th July). Results of the laboratory analysis are shown alongside relevant water quality regulations in Table 9-12 below. The laboratory reports are attached as Appendix 9-2.

Suspended solid concentrations ranged from <6 to 21mg/l. Suspended solid concentrations were below the S.I 293/1988 threshold limit of 25 mg/l in all samples.

Ammonia concentrations were predominantly found to be of 'High' status with regards to the threshold of ≤0.04mg/l as detailed in S.I. 272/2009. 6 no. samples were of 'High status with 1 no. sample of 'Good' status (≤0.065mg/l). Meanwhile, the sample collected at SW3 on 13th June exceeded the 'Good' status threshold of ≤0.065mg/l.

Biological Oxygen Demand (BOD) concentrations exceeded the 'Good' status threshold of ≤1.5mg/l (S.I. 272/2009) in 7 of the 8 no. samples taken with BOD in these samples ranging from 2 to 9mg/l. 1 no. sample at SW1 was found to be of 'High' status with respect to BOD concentrations (≤1.3mg/l).

Ortho-phosphate concentrations were generally at or below the limit of detection of the laboratory (0.02mg/l). 6 no. samples achieved 'High' status with regard to ortho-phosphate concentrations (≤0.025mg/l). Meanwhile, both samples from SW2 recorded exceedances of the 'Good' status threshold value of ≤0.035mg/l.

Nitrate concentrations ranged from 7.8- 16.8 . Meanwhile, chloride concentrations ranged from 11.8 to 26.6mg/l.

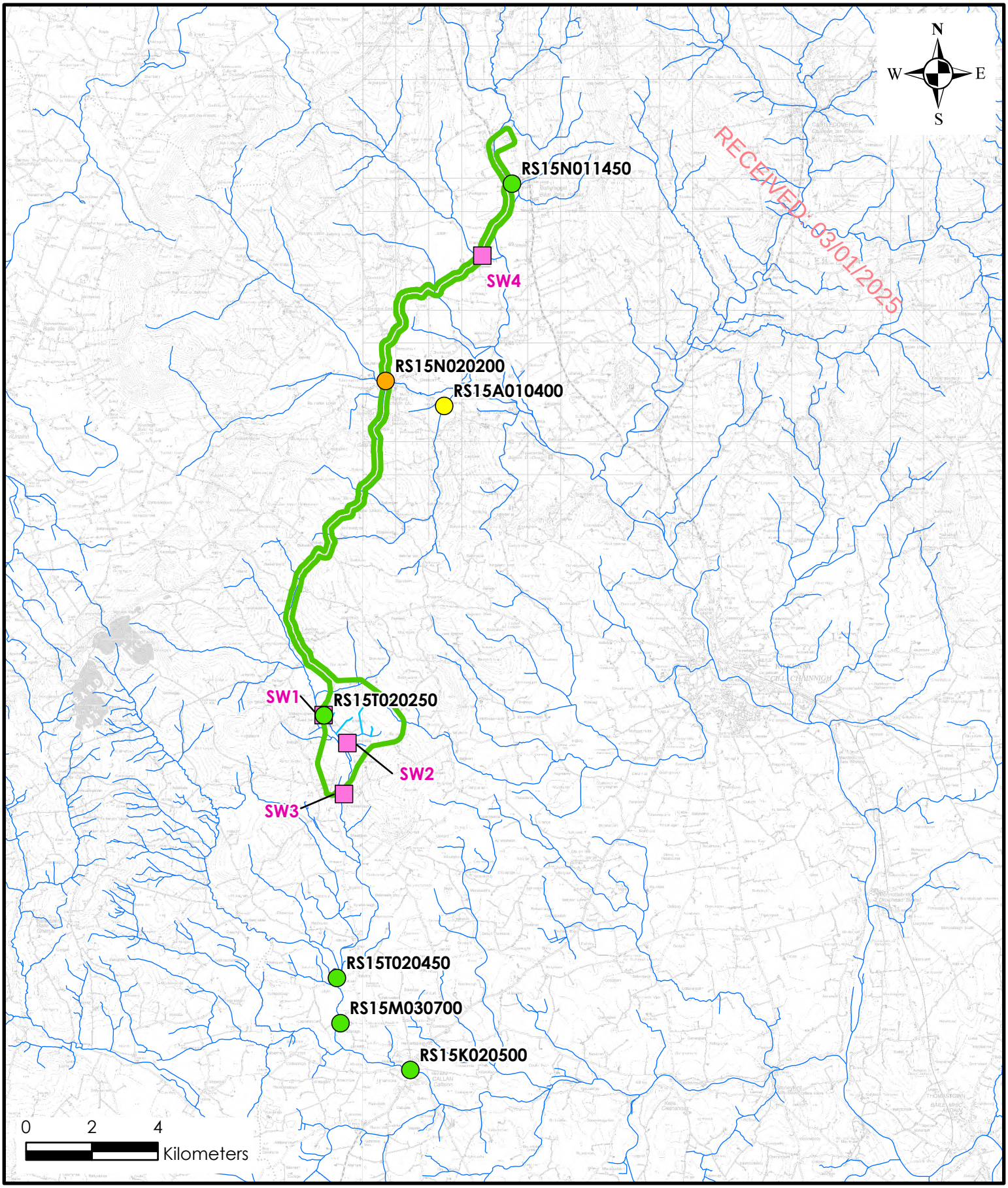
The elevated concentrations of several parameters on 13th June 2024 were influenced by the preceding heavy rainfall which resulted in high runoff rates.

Table 9-12: Summary surface water quality data (13/06/2024 to 10/07/2024)

Location ID	Suspended Solids (mg/l)	BOD_5 (mg/l)	Orthophosphate (mg/l)	Nitrate (mg/l NO_3)	Ammonia (mg/l)	Chloride (mg/l)
EQS	**≤25([3])**	**≤ 1.3 to ≤ 1.5([4])**	**-≤ 0.035 to ≤0.025([2])**	**-**	**-≤0.065 to ≤ 0.04([2])**	**-**
SW1	<8 - 11	1 - 2	<0.02	9.3 - 10.5	0.02 – 0.03	11.8 – 14.5
SW2	10 - 21	3 - 9	0.1 – 0.19	10.5 – 11.4	0.03 – 0.04	12.8 – 26.6
SW3	<6 - 15	2 - 8	<0.02 – 0.02	7.8 - 9.6	0.05 - 0.41	15.1 – 16.5
SW4	<7 - <8	3	<0.02	16.1 - 16.8	<0.02 – 0.03	16.7 – 17.6

(+) S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations, 1988.
(*) S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009.

[3] *S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations*
[4] *S.I. No. 272/2009: 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).*



Legend

- EIAR Site Boundary
- Watercourses
- Additional streams
- Surface Water Flow Monitoring

EPA Water Quality Monitoring Q-Rating Values

- Q4 (Good)
- Q3-4 (Moderate)
- Q3 (Poor)

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: EPA and HES Water Quality Monitoring Locations Map

Figure No: 9-7

Drawing No: P1657-0-0824-A4-907-00A | Scale: 1:150,000 | Drawn By: GA

Sheet Size: A4 | Project No: P1657-0 | Date: 27/08/2024 | Checked By: MG

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9.3.8 Hydrogeology

9.3.8.1 Proposed Wind Farm

The Proposed Wind Farm site is mapped to be underlain by the Namurian Shales of the Killeshin Siltstone Formation (www.gsi.ie). The bedrock underlying the Proposed Wind Farm site is classified by the GSI as being a Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones.

In terms of Groundwater Bodies (GWBs), the Proposed Wind Farm site is underlain by the Ballingarry GWB which is characterised by poorly productive bedrock. According to the GSI's Characterisation Report for this GWB (GSI, 2003), transmissivities in this GWB can be considered to be in the range of 1-6m^2/day. Most groundwater recharge occurs along the peaks of the Slieveardagh Hills and in the Castlecomer Plateau. The GSI note that potential recharge may be significantly higher than actual recharge as the bedrock is not considered to be permeable. Groundwater flowpaths will be short and most groundwater flow will be in the upper few metres of bedrock. Discharge from this GWB will occur locally to nearby surface water features as there is no regional flow system.

The GSI also map the presence of a Regionally Important Gravel Aquifer in the valley of the Tullaroan Stream. In terms of Proposed Wind Farm infrastructure a total of 1 no. turbine (T07), 2 no. construction compounds, new proposed roads and spoil management areas are underlain by this overburden aquifer. This aquifer forms part of the Kilmanagh Gravels GWB. The GSI's Characterisation Report (GSI, 2003) states that this GWB lies in the valley of the Tullaroan River, extending from Tullaroan to Callan. The aquifer is comprised of glacial outwash sand and gravel deposits with clays and silts more common towards Kilmanagh. The body comprises a north-south oriented sand & gravel aquifer which is unconfined in the north and confined in the south. The GSI state that transmissivity is between 200 to 250m^2/day. The main recharge mechanism to this GWB is rainfall which falls on the unconfined portions of the aquifer, with the Tullaroan stream providing recharge in times of low water tables. The river course is noted to dry up in certain years. Flows through the Body move southwards from the unconfined portion, with some discharging back into the Tullaroan Stream and some passing into the confined portion. Discharge mainly occurs to the series of small springs that lie close to the junction of the Munster and King's River.

A map of the underlying bedrock and overburden aquifers is included as Figure 9-10.

9.3.8.1.1 *Summary Proposed Wind Farm Geology*

A detailed description of the geology of the Proposed Wind Farm site is presented in Chapter 8. A summary is presented here to inform the discussion on the hydrogeology that follows.

Baseline geological data is available from the GSI through their online Mapviewer (www.gsi.ie). The bedrock across the Proposed Wind Farm site is mapped as the Killeshin Siltstone Formation with the subsoils predominantly mapped as till derived from Namurian shales and sandstones. Meanwhile, the GSI also map a significant area of sand and gravels derived from Carboniferous limestones in the vicinity of the Tullaroan Stream towards the centre and south of the Proposed Wind Farm site.

The site-specific data on the geology of the Proposed Wind Farm site is included in Section 8.3.3.1 of Chapter 8 of this EIAR. The site-specific data is summarised as follows:

- There are no significant peat deposits present at the Proposed Wind Farm site;
- Only a thin layer of organic peaty topsoil (0.1-0.3m) was encountered at T7;
- The subsoils are dominated by glacial till, described as sandy, gravelly, silty clay;
- These glacial till deposits cover the sides of the valley;
- Thick deposits of glaciofluvial sands and gravels were encountered in the valley of the Tullaroan Stream and towards the south of the Proposed Wind Farm site;

- These granular deposits are limited to a thin strip along the banks of the Tullaroan Stream;
- Depth to bedrock is shallow on the sides of the valley with weathered siltstone bedrock encountered at depths of 0.4 to 3.3mbgl;
- The depth to bedrock is deeper (13.4 to 18.7m) in the vicinity of the Tullaroan Stream due to the thick deposits of sand and gravel; and,
- The bedrock encountered during the site investigations correlates with the GSI mapped Killeshin Siltstone Formation.

9.3.8.1.2 *Proposed Wind Farm Field Hydrogeological Data*

A total of 22 no. trial pits were excavated at the Proposed Wind Farm site under the supervision of HES in December 2023 and February 2024.

Based on these intrusive site investigations it has been determined that the local geology of the Proposed Wind Farm site is characterised by low permeability glacial tills away from the valley of the Tullaroan Stream. Sand and gravel deposits were only encountered in 6 of the 22 no. trial pits. In 5 of these trial pits the sands are relatively thin (0.3 to 0.6m) and overlie the lower permeability tills. Only 1 no. trial pit encountered thick granular deposits (TP14 is located immediately adjacent to the Tullaroan Stream).

Groundwater inflows were recorded in 8 of the 22 no. trial pit excavations (36%). Groundwater was encountered at depths ranging from 1.3 to 3mbgl (metres below ground level). 7 of these water strikes were encountered in the glacial tills and were typically described as 'slow' and 'slight' inflows of groundwater. Meanwhile, significant ingress of groundwater was only recorded in glaciofluvial sands and gravel subsoil in 1 no. trial pit excavation (TP14).

In addition, 2 no. monitoring wells (MW01 and MW02) were drilled in December 2023 by Peterson Drilling under the supervision of HES. These 2 no. monitoring wells detailed the full overburden profile in the vicinity of the Tullaroan Stream and encountered thick deposits of sands and gravels. These 2 no. monitoring wells facilitated the monitoring of groundwater levels in the overburden aquifer. Continuous groundwater monitoring was completed over a period of ~7 months to determine the local hydrogeological regime (19th December 203 to 10th July 2024). The water level data are presented in Figure 9-8 below alongside local daily rainfall totals from Callan rainfall station which were obtained from Met Eireann (this data is currently only available to the end of March 2024). A small range in water levels was recorded (MW01 = 0.9m and MW02 = 1.2m), with water levels falling to the south. The maximum recorded groundwater levels were 108.67mOD and 100.66mOD in MW01 and MW02 respectively. A clear correlation can also be identified between groundwater level and precipitation events as the overburden aquifer is rapidly recharged.

Note that the monitoring period was completed during a very wet period of time. Figure 9-9 presents the monthly rainfall totals for the monitoring period compared to the Long-Term Average (LTA) for Oak Park rainfall station, Co. Carlow (~40km northeast of the Proposed Wind Farm site). As seen from the graph, the LTA rainfall was exceeded in several months during this monitoring period including a very wet March and April. Therefore, the recorded groundwater levels are likely to represent maximum winter groundwater levels.

Based on site investigations and walkover surveys, there is a high degree of connectivity between surface and groundwaters in the area of the Proposed Wind Farm site. High rates of surface water runoff occur on the sides of the valley due to the presence of glacial till and the underlying Poor Bedrock Aquifer. The local watercourses flow downslope from the valley sides towards the Tullaroan Stream. Thick deposits of sands and gravels are present along a thin strip along the banks of this watercourse. Some streams lose water as they flow across these permeable sands and gravels. The surface water in the Tullaroan Stream and the groundwater in the hydrologically connected overburden aquifer flow southwards.

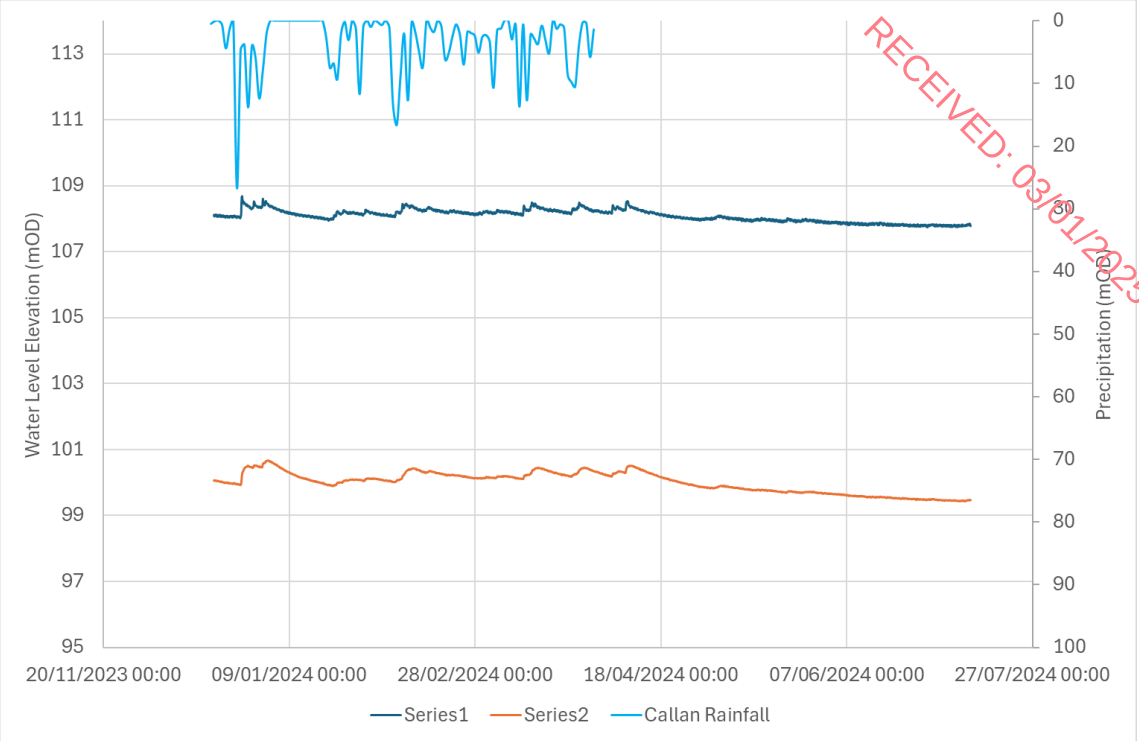


Figure 9-8: Continuous Groundwater Level Monitoring

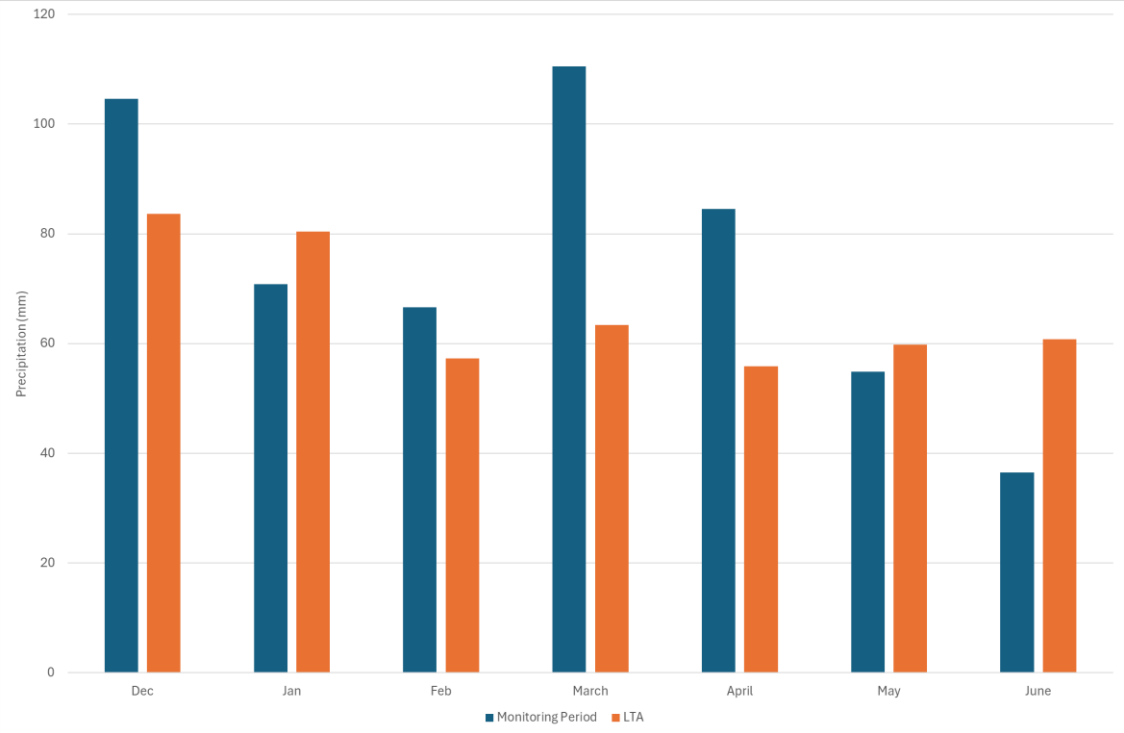


Figure 9-9: Monthly Rainfall Values for Oak Park Rainfall Station. Co. Carlow (www.met.ie)

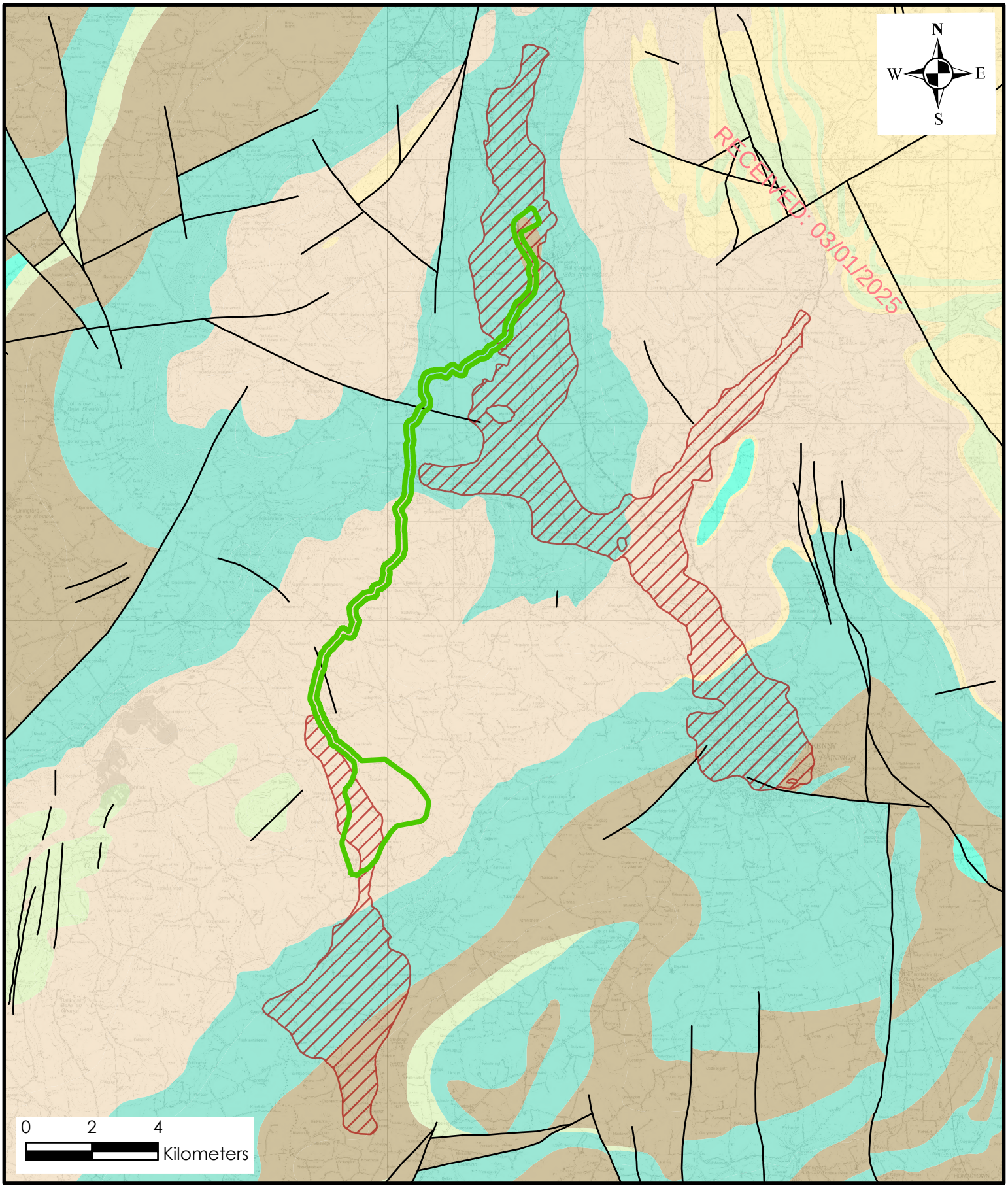
9.3.8.2 Proposed Grid Connection

The southern section of the Proposed Grid Connection is underlain by Poor bedrock aquifers. Meanwhile, in the vicinity of the Proposed Wind Farm site ~800m of the Proposed Grid Connection underground cabling route and the proposed onsite 38kV substation are underlain by the Regionally Important Gravel Aquifer in the valley of the Tullaroan Stream. Meanwhile, the northern section of the Proposed Grid Connection underground cabling route, between Freshford and Ballyragget, is underlain

by a Regionally Important Aquifer – karstified (diffuse). In the valley of the River Nore, the Proposed Grid Connection underground cabling route (~4.63km) is also underlain by a Regionally Important Gravel Aquifer.

In terms of GWBs, the Proposed Grid Connection is underlain by a total of 4 no. GWBs:

- The southern section of the Proposed Grid Connection underground cabling route, in the vicinity of the Proposed Wind Farm site, and the proposed onsite 38kV substation are underlain by the Kilmanagh Gravels and Ballingarry GWBs (described above).
- Further to the north of Proposed Grid Connection underground cabling route is underlain by the Durrow Karstic GWB and the Kilkenny-Ballynakill Gravels GWB.



Legend

- EIAR Site Boundary
- Sand and Gravel Aquifers
  - Regionally important gravel aquifer
- Bedrock Aquifer
  - Rkd - Regionally Important Aquifer - Karstified (diffuse)
  - Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
  - Lk - Locally Important Aquifer - Karstified
  - Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
  - Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
  - Pu - Poor Aquifer - Bedrock which is Generally Unproductive
  - Mapped Faults

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Bedrock and Overburden Aquifers Map

Figure No: 9-10

Drawing No: P1657-0-0824-A4-910-00A

Scale: 1:150,000

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9.3.9 Groundwater Vulnerability

9.3.9.1 Proposed Wind Farm

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

The vulnerability rating at the Proposed Wind Farm site is mapped by the GSI (www.gsi.ie) to range from Low to Extreme. The area of Extreme vulnerability is mapped in the more elevated areas in the northeast of the Proposed Wind Farm site. 2 no. turbines (T01 and T02), a construction compound and the proposed borrow pit are proposed in this area of Extreme groundwater vulnerability. Some areas in the valley of the Tullaroan Stream are mapped as having High vulnerability including 1 no. turbine (T07), spoil management areas and a construction compound. This area is mapped as having high groundwater vulnerability due to the presence of permeable glaciofluvial sand and gravel subsoils.

Site investigations at the Proposed Wind Farm site comprising of trial pits and the drilling of monitoring wells have revealed that the depth to rock ranges from 13.4 to 18.7m on the lower ground in the vicinity of the Tullaroan Stream to 0.4 to 3.3m on the elevated ground in the east of the Proposed Wind Farm site. Across the majority of the Proposed Wind Farm site, the subsoils comprise of glacial tills of low permeability. Furthermore, due to the low permeability nature of the underlying bedrock aquifers, groundwater flowpaths are likely to be short (30 – 300m), with recharge emerging close by and discharging into local surface water streams. This means there is a low potential for groundwater dispersion and movement within the bedrock aquifer, therefore surface water bodies such as drains and streams/rivers are more vulnerable (to contamination from human activities) than groundwater across much of the Proposed Wind Farm site. Meanwhile, in the vicinity of the Tullaroan Stream, the groundwater in the overburden aquifer is more vulnerable to contamination.

Table 9-13: Groundwater Vulnerability and Subsoil Permeability and Thickness (Groundwater Protection Schemes Report 1999)

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

The proposed onsite 38kV substation is mapped in an area of Low groundwater vulnerability.

Groundwater vulnerability along the Proposed Grid Connection underground cabling route ranges from Low to Extreme. Approximately 2.59km of the Proposed Grid Connection underground cabling route is mapped in areas of Extreme groundwater vulnerability, with an additional ~1.1km mapped in areas of High vulnerability.

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

Groundwater will be most vulnerable to potential effects in areas of High and Extreme vulnerability which are located in the Regionally Important Karst Aquifer or Gravel Aquifers.

9.3.10 Karst Features

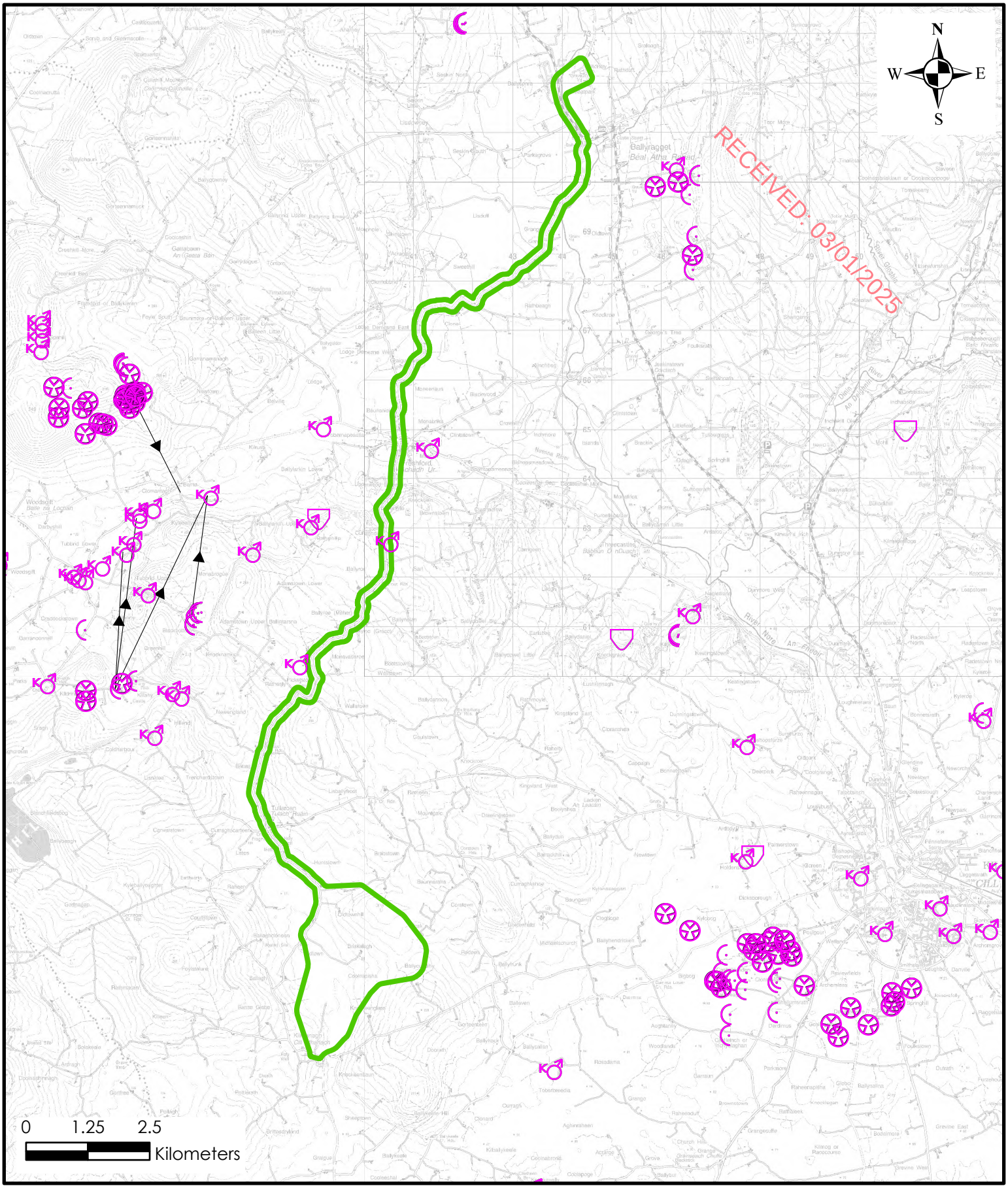
Karst features are mapped by the GSI and available through the GSI online viewer (www.gsi.ie).

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

However, as stated above, a section of the Proposed Grid Connection underground cabling route, ~11km in length, is underlain by a Regionally Important Karst Aquifer. Several karst features are mapped in the vicinity of the Proposed Grid Connection underground cabling route as detailed below:

- A spring is mapped at the source of the Tullaroan Stream ~1.8km to the northwest;
- A spring is mapped ~300m west of the Proposed Grid Connection underground cabling route along the Arigna River;
- A spring is mapped in the immediate vicinity of the Proposed Grid Connection underground cabling route in the townland of Curraghduff;
- A spring is mapped in the valley of the Nuenna River ~600m east of the Proposed Grid Connection underground cabling route; and,
- Several enclosed depressions, springs and swallow holes are located ~1.4km southwest of Ballyragget.

A map of karst features along the Proposed Grid Connection underground cabling route is shown below as Figure 9-11.



Legend

- EIAR Site Boundary
- Cave
- Enclosed Depression
- Estavelle
- Spring
- Swallow Hole
- Traced Underground Connection

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: GSI Mapped Karst Features map

Figure No: 9-11

Drawing No: P1657-0-0824-A4-911-00A

Scale: 1:100,000

Drawn By: GA

Sheet Size: A4

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9.3.11 Groundwater Hydrochemistry

9.3.11.1 Proposed Wind Farm

The GSI's Characterisation Report for the Ballingarry GWB states that the bedrock strata of this GWB are siliceous in nature. Meanwhile, the GSI's Characterisation Report for the Kilmanagh GWB states that the waters of this gravel body are "Hard" and have an average EC of around 650 (µs/cm). The chemical is regarded as Calcium-Bicarbonate and it is therefore likely that the gravels are mostly Calcareous.

Data on groundwater hydrochemistry is also available within the Zone of Contribution report for the Callan PWS. The data presented in this report is summarised as follows:

- Groundwater is very hard (>350mg/l CaCO3) with a strong calcium-bicarbonate hydrochemical signature. Some samples have high levels of magnesium indicating that the spring waters have mixed with waters from a deep magnesium rich dolomite aquifer;
- Analysis of raw water samples have revealed that only nitrate (3 of 34 samples analysed between 1993 and 1998) and faecal coliforms (10 samples between 1993 and 2000) were in excess of European maximum admissible concentrations.
- Reported nitrite levels are slightly elevated but not in excess of GSI guideline values.

Groundwater sampling of the 2 no. monitoring wells was completed on 10th July 2024. The field chemistry data, taken with a calibrated YSI ProDSS, are presented in and are largely similar for both wells (Table 9-14).

The pH ranges between 7.37 – 7.42, while dissolved oxygen ranges between 2.16 – 4.64mg/L. The conductivity ranged 506 – 570µS/cm is typical of groundwaters within a gravel aquifer derived from limestones and is in line with available data from the Kilmanagh GWB characterisation report.

Table 9-14: Summary of field chemistry from GWS sample locations and from River Clare

Location	Date	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH [H+]
MW01	10/07/2024	11.1	2.16	506	7.37
MW02	10/07/2024	11.6	4.64	570	7.42

The laboratory data of the samples recovered from MW01 and MW02 indicates that the water is typically of an acceptable chemical quality relative to the Groundwater Regulations (S.I 9 of 2010). pH was neutral. Ammonia ranges between <0.05 to 0.075, while nitrite is below the limit of detection in both samples at <0.01mg/L. Nitrate ranges between 1.76 and 2.48 mg/L, below the drinking water threshold value for groundwaters of 37.5mg/L. Chloride ranges between 13.1 and 14.8mg/L, below the EQS threshold of 24mg/L (S.I. 9/2010). No elevated concentrations of heavy metals were recorded. However, coliforms were recorded in MW02. Summary results are presented in Table 9-15 whilst the full laboratory reports are included in Appendix 9-2.

Table 9-15: Groundwater Sampling Laboratory Results (10/07/2024)

Parameter	EQS	Sample ID	
		MW01	MW02
Ammonia (mg/l)		0.075	<0.05
Nitrite – N (mg/l)	0.5*/0.1+	<0.01	<0.01
Ortho-phosphate (mg/l)	0.035*	0.012	0.053
Nitrate – NO_3 (mg/l)	37.5+	2.48	1.76
Chloride (mg/l)	24*/250+	14.8	13.1
BOD (mg/l)		<1	1.2
pH	6.5-9.5	7.1	7.0
Total Coliforms (cfu/100ml)	0	0	356
E. Coli (cfu/100ml)	0+	0	186
Iron (µg/L)	200*+	<5	<5
Magnesium (mg/L)	50*	13.7	11.8
Manganese (µg/L)	50*+	15.8	5.28
TDS (mg/L)	-	315	356
Sulphate (mg/L)	187.5*/250+	9.31	7.34

(*) S.I. No. 9/2010 – Groundwater Regulations
(+) S.I. 99/2023 – Drinking Water Regulations

9.3.11.2 Proposed Grid Connection

The GSI's Characterisation Report for the Durrow GWB states that waters are typically 'hard' to 'very hard', with a neutral pH and calcium and bicarbonate as the dominant ions. This signature is thought to reflect the generally shallow nature of flows within the karst aquifer. The average conductivity is 643 µs/cm. This aquifer is calcareous.

9.3.12 Water Framework Directive Water Body Status & Objectives

The River Basin Management Plan was adopted in 2018 and 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 development must not in any way prevent a waterbody from achieving at least good status by 2027.

9.3.12.1 WFD Groundwater Bodies

Local Groundwater Body (GWB) status information is available from (www.catchments.ie) and is summarised in Table 9-16.

The Kilmanagh Gravels, Kilkenny-Ballynakill Gravels and Ballingarry GWBs all achieved 'Good' status in all 3 no. WFD cycles. The status of these GWBs is defined based on the quantitative status and chemical status of each GWB. Meanwhile, the Durrow GWB which underlies the Proposed Grid Connection achieved 'Poor' status in the last 2 no. WFD cycles. In the latest cycle this GWB achieved poor chemical status and is deemed to be "at risk" of failing to meet its WFD objectives. This GWB is listed as being under significant pressure from agriculture.

Table 9-16: WFD Groundwater Body Status

GWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Ballingarry	Good	Good	Good	Under review	None
Kilmanagh Gravels	Good	Good	Good	Not at risk	None
Durrow	Good	Poor	Poor	At risk	Agriculture
Kilkenny-Ballynakill Gravels	Good	Good	Good	At risk	None

9.3.12.2 Surface Water Body Status

A summary of the WFD status and risk result for Surface Water Bodies (SWBs) in the vicinity and downstream of the Proposed Project are shown in Table 9-17 below.

The Tullaroan Stream (_020 and _030 SWBs), Munster_030 SWB and King's (Kilkenny)_030 SWB downstream of the Proposed Wind Farm site all achieved 'Good' status in the latest WFD cycle. Meanwhile, the status of the SWBs along the Proposed Grid Connection range from 'Poor' to 'Good'. The Nuenna_020 SWB is of 'Poor' status whilst the Argina (Kilkenny)_010, Tullaroan Stream_010 and Nore_120 SWBs achieved 'Moderate' status. The other SWBs (Nore_130, _140 and _150) along the Proposed Grid Connection were deemed to be of 'Good' status.

A total of 3 no. SWBs in the vicinity of the Proposed Project were deemed to be 'at risk' of failing to meet their respective WFD objectives. These at risk SWBs are located along the Proposed Grid Connection and include the Argina (Kilkenny0_010, Nuenna_020 and Nore_120 SWBs. The risk status of the other SWBs are either under review or these SWBs are 'not at risk'.

The 3rd Cycle Nore Catchment Report (EPA, 2021) states that excess nutrients remain the most prevalent issue in the Nore Catchment and that the significant pressure affecting the greatest number of waterbodies within the catchment is agriculture. Agriculture is noted to be a significant pressure on 2 no. SWBs (Arigna (Kilkenny)_010 and Nuenna_020) in the vicinity of the Proposed Grid Connection. With regard to agriculture, the catchment report states that phosphorus loss to surface waters, high nitrate concentrations and sediment have been identified as issues within the catchment. Rubanrunoff is listed as a significant pressure on the King's (Kilkenny)_030 SWB. This is associated with runoff from Callan with nutrient and organic pollution being the significant issues. Urban wastewater is listed as a significant pressure on the King's (Kilkenny)_030 and Nuenna_020 SWBs with the issues associated with the Callan and Freshford wastewater agglomerations respectively. Meanwhile, industry is listed as a significant pressure on the Nore_120 SWB which is associated with nutrient issues resulting from Glanbia Ireland IPC emission at Ballyragget.

Table 9-17: WFD Surface Waterbody Status

SWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Tullaroan Stream_010	Unassigned	Poor	Moderate	Under review	None
Tullaroan Stream_020	Good	Good	Good	Not at risk	None
Tullaroan Stream_030	Good	Good	Good	Under review	None
Munster_030	Good	Good	Good	Not at risk	None
King's (Kilkenny)_030	Good	Moderate	Good	Under review	Other, urban runoff and urban wastewater
Arigna (Kilkenny)_010	Good	Moderate	Moderate	At risk	Agriculture
Nuenna_020	Poor	Moderate	Poor	At risk	Agriculture and urban wastewater
Nore_120	Unassigned	Good	Moderate	At risk	Industry
Nore_130	Good	Good	Good	Not at risk	None
Nore_140	Unassigned	Good	Good	Not at risk	None
Nore_150	Good	Good	Good	Not at risk	None

9.3.13 Designated Sites and Habitats

9.3.13.1 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 designated site map for the area is shown as Figure 9-12.

The Proposed Wind Farm is not located within any designated conservation site, however there are downstream hydrological connections with some designated sites as described below:

- The River Barrow and River Nore SAC (Site Code: 002162) is located ~5.9km downstream of the Proposed Wind Farm site and includes the lower reaches of the Tullaroan Stream. This SAC is hydrologically connected to the Proposed Wind Farm site via the Tullaroan Stream. This SAC consists of the freshwater stretches of the Barrow and River Nore catchment as far upstream as the Slieve Bloom Mountains and it also includes the tidal elements and estuary.
- The River Nore SPA (Site Code: 004233) is located ~14.1km downstream of the Proposed Wind Farm site and is hydrologically connected via the Tullaroan Stream, Munster River and King's River. This SPA includes the King's River downstream of Callan.

Other designated sites in close proximity to the Proposed Wind Farm site include:

- Ballykeefe Wood pNHA (Site Code: 000400) is located ~1.8km southeast (straight line distance) of the Proposed Wind Farm site. There are no hydrological connections between the Proposed Wind Farm site and this pNHA.

We also note that the Nore surface water catchment is noted as being a Margaritifera Sensitive Area. Meanwhile, the closest identified protected Salmonid waters are along the River Nore. These salmonid waters are located ~28km downstream of the Proposed Wind Farm site.

9.3.13.2 Proposed Grid Connection

The new proposed crossing along the Proposed Grid Connection underground cabling route over the River Nore also crosses the River Barrow and River Nore SAC, the River Nore SPA and the River Nore / Abbeyleix Woods Complex pNHA near Ballyragget. All other watercourses draining the Proposed Grid Connection also eventually discharge into these designated sites.

Other designated sites in close proximity to the Proposed Grid Connection include:

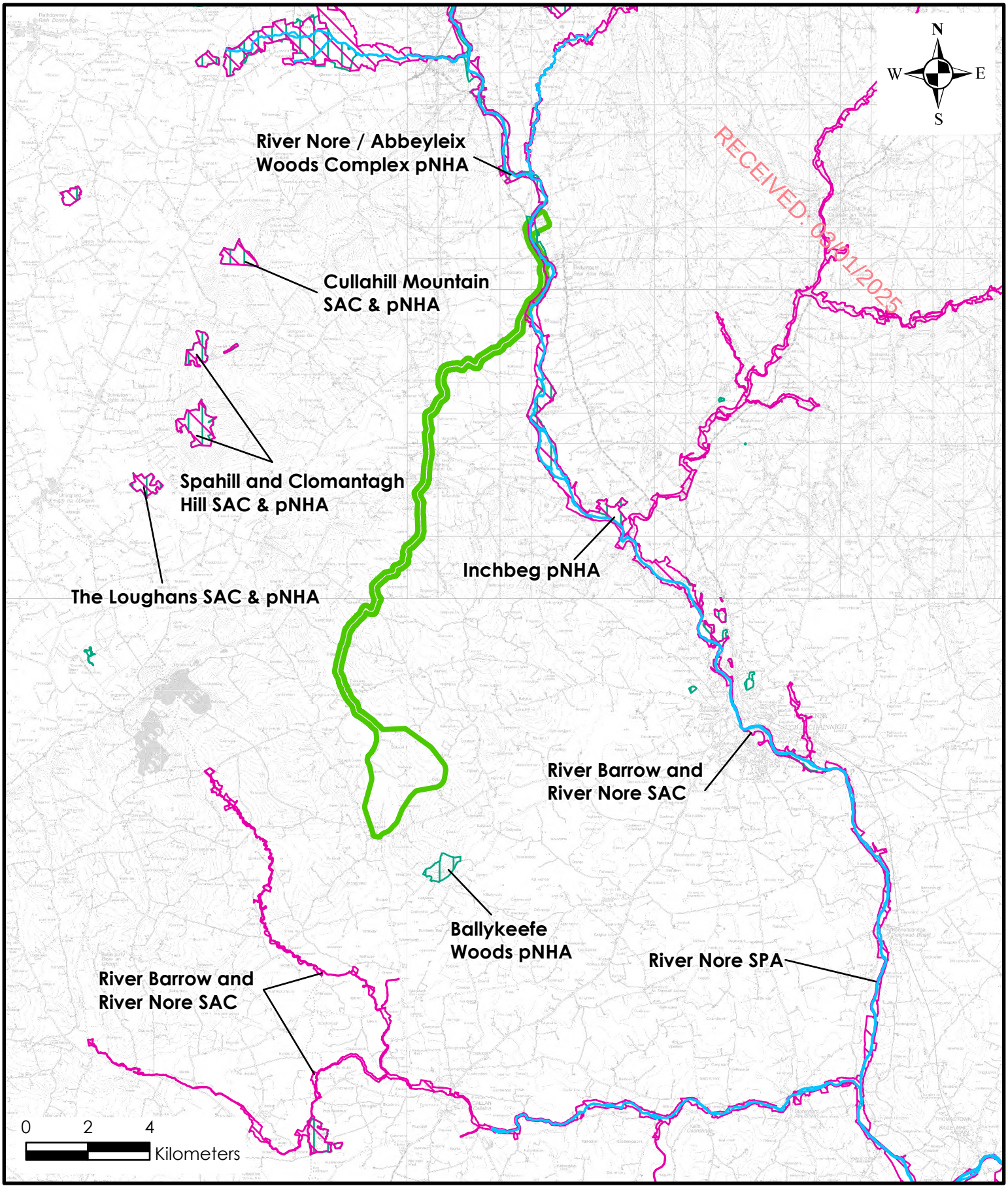
- Inchbeg pNHA (Site Code: 000836) is also located downstream of the Proposed Grid Connection along the River Nore.

Figure 9-13 presents a simplified hydrological flowpath diagram between the Site and downstream designated sites and details the length of each hydrological connection.

Table 9-18: Summary of Distances and Connectivity to Designated Sites

Designated Site	Hydrological connectivity to Designated/European Sites	Groundwater connectivity to Designated / European Sites
River Barrow and River Nore SAC	The Proposed Wind Farm site is hydrologically connected to the SAC via the Tullaroan Stream and the Munster River. The length of this hydrological connection is ~5.9km. The Proposed Grid Connection crosses this SAC. All watercourses draining the Proposed Grid Connection discharge to the River Nore. The new proposed crossing over the River Nore crosses this SAC	Some connectivity between the Proposed Wind Farm and the SAC via the Kilmanagh Gravels GWB.
River Nore SPA	The Proposed Wind Farm site is hydrologically connected to the SAC via the Tullaroan Stream, the Munster River and the King's River. The length of this hydrological connection is ~14.1km. The new proposed crossing over the River Nore along the Proposed Grid Connection crosses this SAC. All watercourses draining the Proposed Grid Connection discharge to the River Nore.	No direct connectivity. Indirect connectivity via the Kilmanagh Gravels GWB and the King's River.
Ballykeefe Woods pNHA	No, there is no hydrological connection between the Proposed Project and this pNHA. The Tullaroan Stream acts as a hydrological barrier.	There is no groundwater connectivity. This pNHA is not underlain by the Kilmanagh Gravels GWB.
River Nore / Abbeyleix Woods Complex pNHA	No hydrological connection with the Proposed Wind Farm site. The new proposed crossing over the River Nore along the Proposed Grid Connection crosses this pNHA.	Hydrogeological connection with the Proposed Grid Connection
Inchbeg pNHA	No hydrological connection with the Proposed Wind Farm site.	Limited connectivity – all water will likely discharge as surface water due to the proximity to the Nore.

Designated Site	Hydrological connectivity to Designated/European Sites	Groundwater connectivity to Designated / European Sites
	pNHA is located ~2.34km downstream of the Proposed Grid Connection.	



Legend

- EIAR Site Boundary
- pNHA
- SAC
- SPA

Client: EBriskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Designated Sites map

Figure No: 9-12

Drawing No: P1657-0-0824-A4-912-00A

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Drawn By: GA

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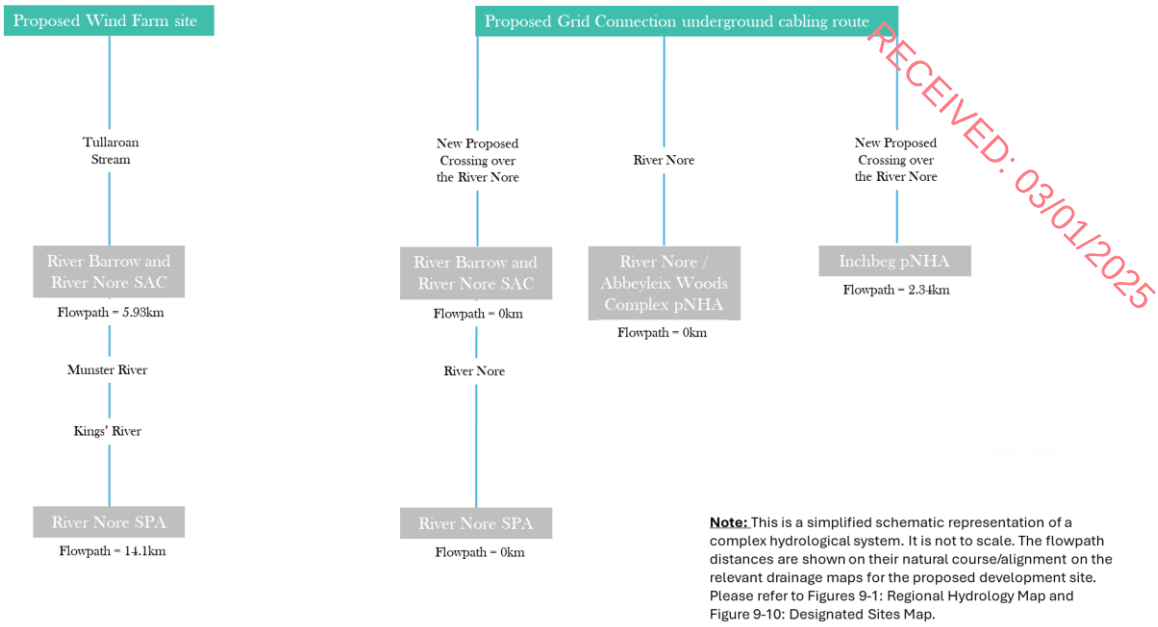


Figure 9-13: Hydrological Flowpaths between Site and Downstream Designated Sites

9.3.14 Water Resources

9.3.14.1 Groundwater Resources

The Proposed Wind Farm site is mapped within the Outer Source Protection Area of the Callan Public Water Supply (PWS). In terms of the proposed infrastructure a total of 5 no. turbines, spoil management areas, onsite substation, construction compounds, new roads and existing roads for upgrade within the Proposed Wind Farm are mapped within this source protection area. In addition, ~3.9km of the Proposed Grid Connection underground cabling route is mapped in this area. Further details on this PWS are provided in Section 9.3.14.1.1.

Furthermore, the source protection area associated with the Ballycallan Shale Group Water Scheme (GWS) and the Ballycallan Sand and Gravels GWS are mapped in the very south of the Proposed Wind Farm site. Approximately 150m of new proposed road is mapped in this area of the Site. Meanwhile, the source protection area associated with the Ballycallan Limestone is mapped ~900m southeast of the Proposed Wind Farm site.

The Proposed Grid Connection (~1.1km) is also mapped to overlie the source protection area associated with the Tullaroan GWS.

Other source protection areas associated with PWS/GWS in close proximity to the Proposed Grid Connection include:

- The Clomantagh GWS: The source protection area is mapped ~1.8km to the northwest of the Proposed Grid Connection. The Proposed Grid Connection is located downgradient of this GWS and therefore there is no connectivity.
- The Balief GWS: The source protection area is mapped ~2.5km to the west of the Proposed Grid Connection. The Proposed Grid Connection is located downgradient of this GWS and therefore there is no connectivity.
- The Barna_Kilrush GWS is mapped ~2.3km west of the Proposed Grid Connection at Freshford. This GWS is located upgradient of the Proposed Grid Connection and therefore there is no connectivity.
- Seskin GWS is mapped ~1.8km northwest of Ballyragget substation. This GWS is located upgradient of the Proposed Grid Connection and therefore there is no connectivity.
- The source protection area associated with the Ballyconra PWS is mapped ~800m west of Ballyragget substation. This PWS is located upgradient of the Proposed Grid Connection and therefore there is no connectivity.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). Several wells have been mapped by the GSI within the Proposed Wind Farm site, with a high density of wells mapped in the south near Kilmanagh. One well associated with the Ballycallan Group Scheme is reported to have an excellent yield class with a yield of 489m^3/day. A well in the very north of the Proposed Wind Farm site is also listed as having an excellent yield class (480m^3/day). Both of these wells with excellent yield classes are situated in close proximity to the Tullaroan Stream and are likely sourced from the associated sand and gravel aquifer. Several other wells in the vicinity of the Proposed Wind Farm site are being used for agricultural and domestic uses with poor to moderate yields.

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 as identified in Chapter 5 of this EIAR: Population & Human Health.

A map of nearby mapped wells, PWS and GWS is included as Figure 9-14.

9.3.14.1.1 Callan Public Water Supply

The County Kilkenny Groundwater Protection Scheme, Volume II: Source Protection Zones (May 2002) was consulted for additional information (this report is available for download from www.gsi.ie).

This report states that the public drinking water source for Callan Town is a spring located in the townland of Westcourt South, ~1.5km to the northwest of Callan. This source was developed in 1934 and has an estimated total discharge of 1,440m^3/day. The spring is located ~9.15km south of the closest proposed turbine (T7).)

The main aquifers influencing water flowing at the spring are the Kilmanagh sands and gravels and a dolomite aquifer associated with the regionally important Waulsortian limestone aquifer which has been up lifted due to faulting underneath the spring.

The sands and gravels associated with the Kings' River and the Tullaroan Stream stretch from Callan to Tullaroan, are believed to be unconfined between Tullaroan and Kilmanagh (i.e. in the area of the Proposed Wind Farm site) and are considered to supply the medium through which the bedrock aquifers supply groundwater to the Callan Spring. Further south, the sands and gravels are confined by a layer of till. The GSI state that most of the recharge to the overburden aquifer occurs in the unconfined portion of the aquifer between Kilmanagh and Tullaroan (in the vicinity of the Proposed Wind Farm site). Much of the groundwater in this area is expected to discharge back to the Tullaroan Stream close to Kilmanagh with some flowing southwards into the confined glaciofluvial deposits.

The report states that the flows within the sand and gravel aquifer near Callan are forced to the surface as a spring as a result of constriction in the extent of the gravels and the addition of flow from the deep dolomite aquifer below.

Areas of the Proposed Wind Farm Site are mapped in the delineated outer protection zone which is bounded by the complete catchment to the source with the boundary being marked by the extent of the sand and gravel aquifer and encompass an area of 30km^2. Meanwhile, the inner protection zone is the area defined by the 100 day time of travel to the source and is delineated to protect against the effects of potentially contaminating activities which may have an immediate include on water quality at the source. The GSI calculate the inner protection zone to be 40m from the source (therefore a significant distance from the Proposed Wind Farm site).

9.3.14.1.2 Ballycallan Water Supply

The GSI's Establishment of Groundwater Zones of Contribution to the Ballycallan (Muintir) GWS, Co. Kilkenny (May 2018) was consulted for additional information (this report is available upon request from the GSI).

The Ballycallan GWS is supplied by a borehole located at the eastern end of the settlement of Kilmanagh and ~40m west of the Tullaroan Stream. The scheme serves a population of 320 and the average usage is ~165m^2/day. The scheme pumps to a 455m^3 capacity reservoir to the east of Kilmanagh. The pump is set to operate at c. 15.5 m^3/hr, and pumps for an average of c.10.5 hours per day.

The GWS is sourced from poorly productive shale aquifer and the top of a regionally important karstified limestone aquifer. The borehole may also abstract some groundwater from the overlying sand/gravel deposits but there is some uncertainty as to whether this occurs. Groundwater flows through fissures and fractures in the shale, through enlarged fractures (conduits) in the karstified limestone and in the spaces between the grains in the sand/gravel aquifer.

3 no. separate zone of contributions have been delineated by the GSI using hydrogeological mapping and topography for the shale bedrock, the limestone bedrock and the overlying sands and gravels. The GSI also completed recharge and water balance calculations for each of the aquifers and found that the

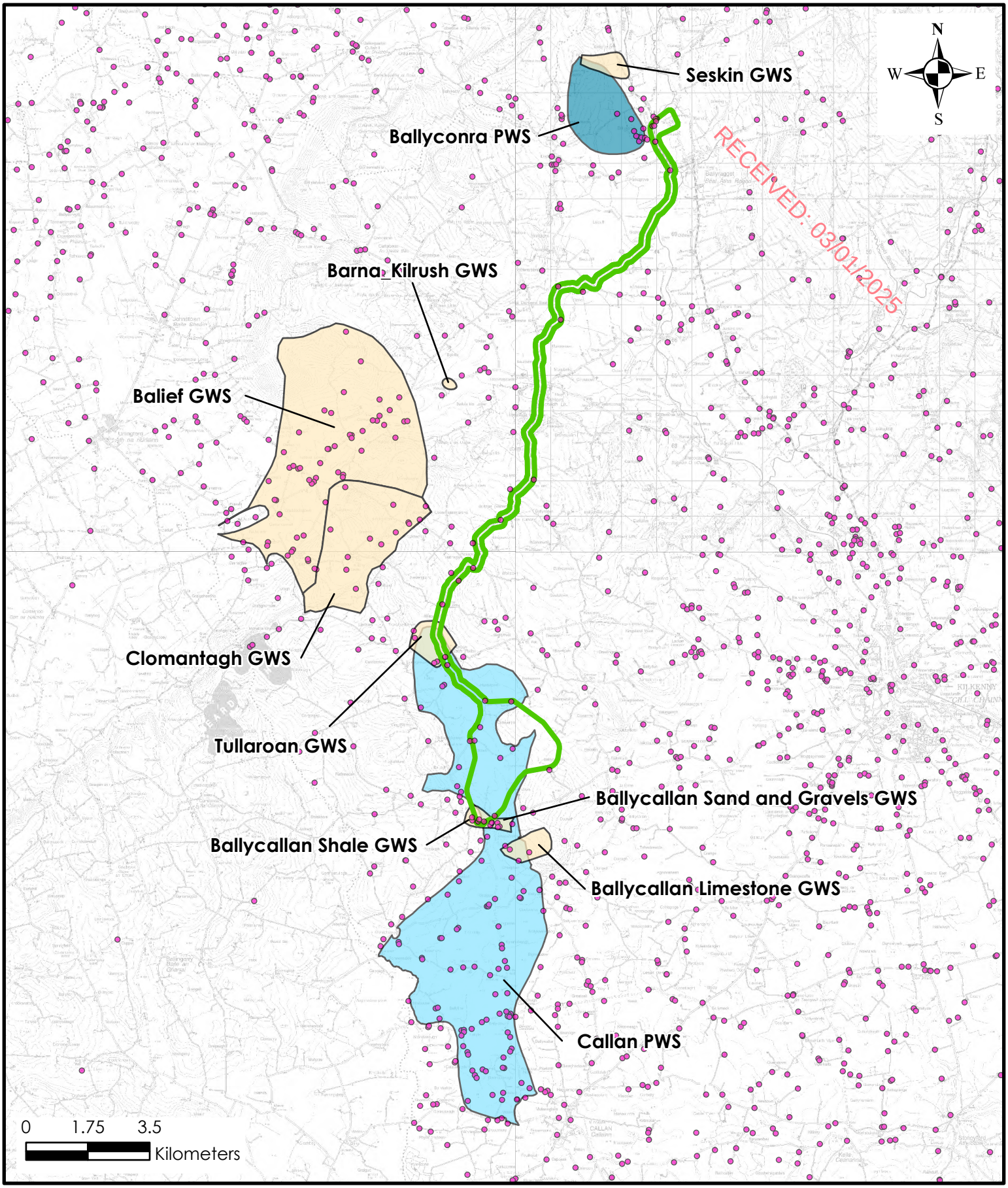
associated zone of contribution required to support a conservative abstraction rate of 383m^3/day was somewhat smaller than the zones mapped using the hydrogeological mapping.

Therefore, even with the conservative approach taken during source protection zone mapping, all key proposed infrastructure are distant from the delineated zone of contribution to the GWS.

9.3.14.2 Surface Water Resources

The 3rd Cycle Nore Catchment Report (EPA, 2021) states that there are 6 no. SWBs in the Nore Catchment which have been identified as Drinking Water Protected Areas (DWPAs). The closest DWPA downstream of the Proposed Wind Farm site is the Nore_220 SWB. This SWB is located ~28km downstream of the Proposed Wind Farm site and downstream of the confluence of the King's and Nore rivers. According to the EPA abstraction register, there is an abstraction from the Nore_220 SWB for Mount Juliet Estate (Registration No: R01462-01). Th EPA database also records abstractions for the Thomastown Water Supply on the western banks of the Nore downstream of the town. However, according to the Thomastown Source Protection Zone Report (GSI, 2002) the town's supply was from infiltration galleries in the gravels in the banks of the Nore prior to 1991. Currently the source is from 2 no. deep boreholes (i.e. a groundwater source).

Meanwhile, the Nore_120 SWB in the vicinity of the Proposed Grid Connection is also listed as a DWPA. According to the EPA abstraction register, Glanbia have several abstractions in this area. Furthermore, the Ballyragget water supply uses an abstraction near the River Nore. The source of the raw water source is an infiltration gallery adjacent to the River Nore. Raw water is pumped from the infiltration gallery to a collection chamber/pump sump beside the Water Treatment Plant. There is no direct surface water abstraction from the River Nore itself.



Legend

- EIAR Site Boundary
- Group Water Schem

Public Water Supply

- SI-Inner Protection Area
- SO-Outer Protection Area
- GSI Mapped Wells (accuracy 1-50m)

Client: Briskalagh Ltd.

Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Groundwater Resources Map

Figure No: 9-14

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9.3.15 Receptor Sensitivity

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 wind farm developments (and associated grid connections), 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 Site would be from cementitious materials, hydrocarbon spillage and leakages, and 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, operational and decommissioning 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 respectively (refer to Table 9-3);
- The Regionally Important Gravel Aquifer at the Proposed Wind Farm site. This overburden aquifer can be considered to be of Very High Importance;
- The Poor Bedrock Aquifers, the Regionally Important Gravel Aquifers and the Regionally Important Aquifer – karstified (diffuse) along the Proposed Grid Connection. The Poor Bedrock Aquifer is of Low Importance whilst the Regionally Important Aquifers are of Very High Importance;
- The WFD status of the GWBs underlying the Proposed Wind Farm site (i.e. Ballingarry and Kilmanagh Gravels GWBs) and the Proposed Grid Connection (Ballingarry, Kilmanagh Gravels, Durrow Karstic and Kilkenny-Ballynakill Gravels GWBs);
- The Callan PWS and the Ballycallan Sand and Gravel GWS, BallyCallan Shale GWS and BallyCallan Limestone GWS in the vicinity of the Proposed Wind Farm site;
- The Tullaroan GWS in the vicinity of the Proposed Grid Connection; 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. A quantitative analysis of flow volumes has shown that due to dilution no effects associated with the Proposed Wind Farm will occur downstream of EPA HydroTool Node 15_1733 on the King's River immediately upstream of Callan.

The following surface water receptors are identified for impact assessment:

- The Tullaroan River and its associated tributaries, the Munster River and the King's River downstream as far as Callan. These watercourses can be considered as being of Very High Importance (refer to Table 9-2) based on their assigned Q-ratings (Q4).
- All watercourses along the Proposed Grid Connection including the Tullaroan Stream, Arigna, Nuenna and Nore Rivers and the Lisdowney Stream.

- The WFD status of all SWBs downstream of the Proposed Project; and,
- The Nore_120 DWPA in the vicinity of the Proposed Grid Connection.

In terms of designated sites, only those designated sites which are hydrologically/hydrogeologically linked with the Site will be included in the impact assessment. These include:

- The River Barrow and River Nore SAC;
- The River Nore SPA;
- River Nore / Abbeyleix Woods Complex pNHA; and,
- Inchbeg pNHA.

9.4 Characteristics of the Proposed Development

The Proposed Project is defined in full in Chapter 4.

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

- Establishment of the 3 no. temporary construction compounds within the Proposed Wind Farm site, which will involve the excavation of spoil (2,763m^3) and the emplacement of the construction compounds. Runoff from these construction areas have the potential to effect surface water quality.
- Construction of the new proposed internal site access roads (6.4km) and upgrades of existing roads (1.8km). These activities have the potential to impact on surface water quality.
- Opening of the proposed onsite borrow pit to win rock for the Proposed Project. The excavation of spoil material and the extraction of rock has the potential to impact 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 will be completed with a ground bearing foundation. Wastewater effluent will be collected in an underground concrete holding tank and periodically emptied by a licenced contractor for the operational phase of the Proposed 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 spoil generated by construction is estimated to be 33,845m^3. The movement of large volumes of 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 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 underground electrical cabling between the proposed onsite 38kV substation and the Ballyragget 110kV substation will involve the excavation of a trench, 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. A groundwater well may also be installed adjacent to the substation, and it will be drilled and installed in accordance with the Institute of Geologists Ireland, Guide for Drilling Wells for Private Water Supplies (IGI, 2007). Alternatively, bottled water will also be used for potable supply.
- Storage of excavated spoil within the 5 no. proposed spoil management areas within the Proposed Wind Farm site has the potential to impact surface water quality.

- Tree felling and replanting of forestry at alternative replacement lands. It is estimated that ~4.7ha of forestry will be felled to accommodate T7 and its associated infrastructure. While this work will be done with Forestry Service licences and approvals, the works could result in soil/subsoils erosion. All forestry replanting will occur outside of the hydrological catchments within which the Site is located.

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 Site. The first method involves 'keeping clean water clean' by avoiding disturbance to existing drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas. The second method involves collecting any drainage waters from works areas within the Site that might carry silt or sediment, and nutrients, to route them towards new proposed silt traps and settlement ponds (or stilling ponds) prior to controlled diffuse release into the existing drainage network. There will be no direct discharges to the existing hydrological features (forestry and agricultural drains or natural watercourses).

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 9-15: below. A detailed drainage plan showing the layout of the proposed drainage design elements is shown in Appendix 4-3 of the EIAR.

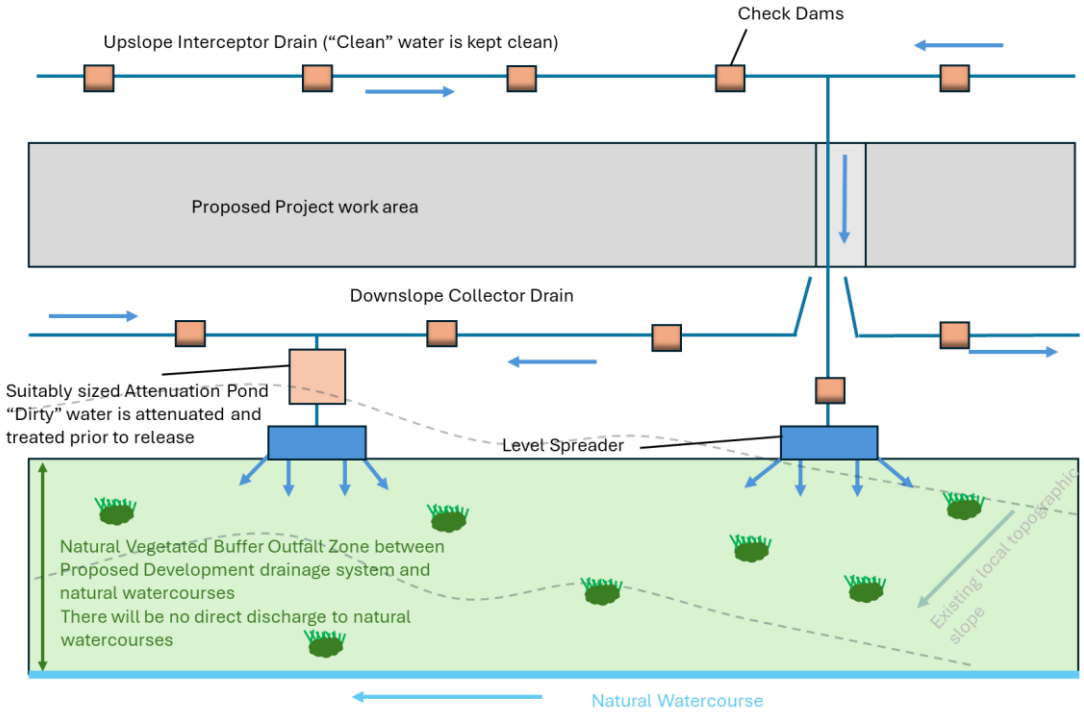


Figure 9-15: Schematic of Proposed Site Drainage Management

9.4.2 Proposed Project Interaction with the Existing Drainage Network

In relation to hydrological constraints, a self-imposed buffer zone of 50m has been put in place for on-site streams and rivers. Manmade forestry and agricultural drains at the Proposed Wind Farm site are

not considered a hydrological constraint and therefore no buffering of these drains has been undertaken.

The general design approach to wind farm layouts is to utilise and integrate with the existing drainage 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). The existing forestry and agricultural drains have no major ecological or hydrological value and can be readily integrated into the Proposed Wind Farm drainage scheme.

In order to integrate the Proposed Wind Farm drainage with the existing forestry drainage (as per the drainage plans included in **Appendix 4-3**) the following design approach has been implemented:

- Lidar data 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;
- Lidar 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;
- Cut-off (interceptors drains) are included to locally re-route existing farm and forestry drains where required;
- 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 construction of the Proposed Wind Farm commencing are identified on the drainage plans.

[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 commercial forestry and agricultural land. Landuse along the Proposed Grid Connection underground cabling route would remain unchanged from its present condition. In terms of hydrology, the existing surface water drainage regime would continue to function and may be extended in places.

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 Kilkenny'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.

Furthermore, the opportunity to new create a riparian buffer zone comprising native species adjacent the Tullaroan stream within the Proposed Wind Farm site, increase the ecological condition of over 3.5km of existing hedgerow and to plant approximately 270m of new native hedgerow. Please see Appendix 6-4 Biodiversity Management and Enhancement Plan for details.

In the Do Nothing Scenario, there may be a slight decrease in average annual rainfall at the Proposed Wind Farm 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 4.7ha of forestry will have to be permanently felled within and around the footprint of T07 and its associated infrastructure. Felling of trees along hedgerows will also be completed at the Proposed Wind Farm site to facilitate the construction of the Proposed Wind Farm.

Felling of coniferous plantations 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 watercourses;
- 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 watercourses;
- 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 (Tullaroan Stream, Munster and King's rivers) 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:

Tree felling 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)
- 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)
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018)
- Coillte Planting Guideline SOP
- 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 9-19.

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 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 9-19: 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 soils disturbance;
- All machinery will be operated by suitably qualified personnel;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of 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 mineral soil disturbance and erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal should take place when they become heavily used and worn. Provision should 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 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. Check dams and silt traps will 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, but care will be taken to avoid removing natural debris deflectors.

Silt Traps:

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

Pre-emptive Site Drainage Management :

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

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

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

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

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

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

Timing of Proposed Project Felling Works:

Felling will only be carried out during periods of no or 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. where an impact has been shown).

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

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

Also, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

Residual Effect: 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 foundation/hardstanding construction, construction compound construction, met mast construction, substation construction, the opening of the proposed onsite borrow pit, storage of spoil in the designated spoil management areas

and the underground cabling works will require varying degrees of earthworks resulting in excavation of soils and subsoils. In addition, the planting of the riparian buffer zone (~1.7Ha) on the banks of the Tullaroan stream will have the potential to release suspended solids to surface waters. 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 (Tullaroan Stream, Munster and King's rivers) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection.

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 proposed 38kV substation, the upgrading of an existing watercourse crossing, new watercourse crossing and upgrades to existing site access tracks. Additional control measures, which are outlined further on in this section, 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:

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, 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 and agricultural drains already exist, 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, 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 some of the Proposed Wind Farm site roads already exist (as agricultural tracks) and are proposed for upgrade (~1.8km). 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:

The majority of the Proposed Grid Connection underground cabling route is >50m from any nearby watercourse, sections within 50m of the Proposed Grid Connection underground cabling route are confined to existing watercourse crossings at bridges and culverts and a new proposed crossing over the River Nore. 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 is a total of 13 no. watercourse crossings (10. no. crossings over EPA mapped watercourses and an additional 3 no. crossings over watercourses which are not included in the EPA database) along the Proposed Grid Connection underground cabling route. All the crossings are existing bridges and culverts along the public road.

No in-stream works are required at any of these crossings, however due to the proximity of the streams to the construction work at the crossing locations, there is a potential for surface water quality impacts during trench excavation work. Mitigation measures are outlined 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 construction works (new road/hardstand, turbine foundation installs or upgrade of existing roads) the following key temporary drainage measures will be installed:

- All existing land and 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 that have surface water flows; 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 Wind Farm 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 4-3.

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.

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.

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

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

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

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

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

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

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

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

Management of Runoff from the Spoil Management Areas:

It is proposed that excavated soil/subsoil (spoil) will be used to reinstate the proposed borrow pit and any excess spoil will be placed in the designated spoil management areas within the Proposed Wind Farm site and in linear berms along access roads and turbine hardstands where appropriate. The spoil management areas are located outside the 50m hydrological buffer zone.

Proposed surface water quality protection measures regarding the spoil management areas are as follows:

- Where applicable the vegetative topsoil layer of the spoil management areas will be rolled back to facilitate placement of excavated spoil up to a maximum height of 1.0 metres, following which the vegetative-top soils layer will be reinstated;
- Where reinstatement is not possible, spoil management areas will be sealed with a digger bucket and seeded as soon possible to reduce sediment entrainment in runoff;
- An interceptor drain will be installed upslope of the identified spoil management areas to divert any surface water away from these areas where necessary;

- Silt fences and double silt-fences will be emplaced down-gradient of the designated spoil management areas and will remain in place throughout the entire construction phase, or until reseeding has been established to a sufficient level;
- The spoil management areas are an enclosed area and its drainage can be easily managed;
- Drainage from the borrow pit will be directed to settlement ponds as required or will overflow through controlled overflow pipes;
- Discharge from the borrow pit will be intermittent and will depend on preceding rainfall amounts; and,
- Once the spoil management area has been seeded and vegetation is established the risk to downstream surface water is significantly reduced.

Therefore, at each stage of the spoil management area development 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 4-2 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 Proposed Project will likely be built over a much shorter period (18-18 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.

Residual Effects: 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.

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 total of 6 no. watercourse crossings over natural watercourses (2 no. crossings along existing roads proposed for upgrade and 4 no. new proposed crossings) – refer to Section 9.5.2.9;
- Cut and fill associated with new proposed roads and existing roads to be upgraded;
- The construction of the proposed onsite 38kV substation associated with the Proposed Grid Connection which is located within the 50m buffer zone associated with a stream which was observed during site walkover surveys but it not recorded on the EPA databases;
- The western section of the temporary construction compound associated with the onsite substation and,
- Tree felling(~0.016ha of forestry and ~398m of hedgerow/tree lines).

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 manmade forestry and agricultural drains.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Tullaroan Stream, Munster and King's rivers) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

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 layout has been designed to limit the amount of works within the delineated hydrological buffer zones associated with natural watercourses. Several consultations between HES, MKO and the project design team completed in the spring and summer of 2024 resulted in several design iterations which had the overall aim of reducing the volume of works within the buffer zones.

In relation to Proposed Wind Farm access tracks, where possible, the Proposed Project design utilises the existing road network within the Site.

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 unless otherwise agreed with IFI and works will be postponed in the event of rainfall; and,
- The hedgerow along the watercourse to the west of the substation will be retained. This watercourse recharges to the sand and gravel aquifer downstream of the substation and does not directly discharge into the Tullaroan Stream. Sands and gravels are excellent natural filters.

Residual Effect: 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 groundwater/surface water seepages will likely occur in turbine foundation excavations, substation compound excavations, sections of the internal cabling trenches and borrow pit excavation, and this will create additional volumes of water to be treated by the runoff management system. Groundwater inflows will likely be small however larger volumes of water may occur where excavations encounter granular subsoils. 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, 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 therefore pollution issues are not anticipated in this respect.

Pathway: Overland flow and site drainage network.

Receptor:

Proposed Wind Farm: Surface waters (Tullaroan Stream, Munster and King's rivers) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

Proposed Grid Connection: All watercourses in the vicinity of the Proposed Grid Connection including the Tullaroan Stream, the Arigna, Nuenna and Nore rivers, the Lisdowney Stream and other small watercourses and associated water-dependent ecosystems.

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.

Residual Effect: 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

Dewatering of the borrow pit (as required) and other deep excavations (i.e. turbine foundations) have the potential to impact on local groundwater levels and flows. 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 much of the Proposed Wind Farm site. Any effects will be temporary and will be contained within the lower areas of the Proposed Wind Farm site i.e. within the valley of the Tullaroan Stream.

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

Pathway: Groundwater flowpaths.

Receptor: Groundwater levels within the underlying Ballingarry GWB and the Kilmanagh Gravels GWB.

Pre-Mitigation Potential Effect:

Negative, indirect, temporary, imperceptible unlikely effects on local groundwater levels within the bedrock aquifer at the Proposed Wind Farm site.

Negative, indirect, temporary, slight, unlikely effects on local groundwater levels within the overburden aquifer at the Proposed Wind Farm site.

Mitigation Measures / Impact Assessment:

The proposed borrow pit location is underlain by a Poor Bedrock Aquifer which is unproductive in terms of groundwater flow.

The topographical (location on the side of a hill) and hydrogeological setting of the proposed borrow pit location means no significant groundwater dewatering will be required during the excavation of the borrow pit during the construction phase. 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 temporarily 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. We consider that this example is very different in scale and operation from the proposed operation of a temporary shallow borrow pit on the side of a hill. In order to explain this thoroughly we will outline our reasoning in a series of bullet points as follows:

- Firstly, the borrow pit area is located on the side of a local hill where the ground elevations are between 182m and 189m OD and therefore are rock outcrops;
- These elevations are above the elevations of the local valleys and streams;
- The proposed borrow pit will be at approximately 9.5m below ground level which is notable. However, in the context of the topographical/elevated setting of the borrow pits, this depth range is relatively shallow;
- The local bedrock comprises schist and is known to be unproductive. This means that groundwater flows will be relatively minor;
- The flow paths (i.e. the distance from the point of recharge to the point of discharge) in this type of geology is short, localised, and will also be relatively shallow;
- No regional groundwater flow regime, i.e. large volumes of groundwater flow, will be encountered at these elevations;
- Therefore, shallow groundwater inflows will largely be fed by recent rainfall, and possibly by limited groundwater seepage form localised shallow bedrock;
- Site investigations show that there are no deposits of potentially water bearing granular subsoils in the area of the proposed borrow pit – the subsoils are dominated by glacial tills of relatively low permeability;
- The sloping nature of the ground on the hill where the borrow pit is proposed along with the coverage of low permeability soils means groundwater recharge is going to be very low in this area;
- This means that there will be a preference for high surface water runoff as opposed to groundwater recharge and flow; and,
- Hence, we consider that the management of surface water will form the largest proportion of water to be managed and treated at the proposed borrow pit location.

Some temporary dewatering may be required where excavations on the lower ground (i.e. in the valley of the Tullaroan Stream) encounter granular subsoils associated with the Kilmanagh Gravels GWB. However, any dewatering works will be temporary, and no significant or permanent excavations are proposed in this area of the Site. There will be no significant effect on groundwater quantity within the sand and gravel aquifer as the water will be returned to the aquifer once it has been treated via the Proposed Wind Farm drainage system.

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.

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 Release of Hydrocarbons During Construction and Storage

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

The potential release of hydrocarbons can occur during the works within the Proposed Wind Farm site and during works along the Proposed Grid Connection underground cabling route.

Whilst no oils are around the cables, a lubricant will be used during cable pulling. The lubricant to be used is Techlude PHD which is a pourable, non-flammable, non-toxic and substantially biodegradable water-based product that does not pose a threat to the environment (Techlube PHD Technical Information Datasheet: https://www.socomore.com/en/waterbased-lubricant-techlube-phd-20l-p-bk1.html).

Pathway: Groundwater flowpaths and Site drainage network.

Receptors:

Proposed Wind Farm: Surface waters (Tullaroan Stream, Munster and King's rivers), associated water-dependant ecosystems downstream of the Proposed Wind Farm site and underlying groundwater quality.

Proposed Grid Connection: All watercourses in the vicinity of the Proposed Grid Connection including the Tullaroan Stream, the Arigna, Nuenna and Nore rivers, the Lisdowney Stream and other small watercourses, associated water-dependent ecosystems and underlying groundwater quality.

Pre-Mitigation Potential Effect:

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

Indirect, negative, significant, short term, unlikely effect on surface water quality downstream of the 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 use at the Site.
- On-site re-fuelling will be undertaken using a double skinned bowser or a refuelling truck with spill kits kept onboard;
- Only designated trained operatives will be authorised to refuel plant on-site;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse;

- Fuels stored on Site will be minimised;
- Any diesel or fuel oils stored at the temporary construction compound will be bunded. The bund capacity will be sufficient to contain 110% of the storage tank's maximum capacity;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction and Environmental Management Plan (Appendix 4-2). Spill kits will be available to deal with accidental spillages.

Residual Effect: 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.

Batching of wet concrete at the Proposed Wind Farm and Proposed Grid Connection and washing out of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution. Placed concrete in foundations (turbine, met mast and substation foundations) and the use of leanmix concrete along the proposed Grid Connection underground cabling route can also have minor local effects on groundwater quality over time. However, due to the contained shuttering that concrete pours are put in, and the limited surface area of exposed concrete, the anoxic conditions below ground, and the higher rate of wider groundwater recharge and flow relative to the small volumes of shallow groundwater that would come in contact with the cured concrete, the potential for impacts are low.

Pathway: Site drainage network.

Receptors:

Proposed Wind Farm: Surface waters (Tullaroan Stream, Munster and King's rivers), associated water-dependant ecosystems downstream of the Proposed Wind Farm site and underlying groundwater quality.

Proposed Grid Connection: All watercourses in the vicinity of the Proposed Grid Connection including the Tullaroan Stream, the Arigna, Nuenna and Nore rivers, the Lisdowney Stream and other small watercourses, associated water-dependent ecosystems and underlying groundwater quality.

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

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; and,
- At turbine foundations, sand blinding, DPM, and lean-mix blinding are used to vertically contain the concrete. While the concrete is contained laterally by temporary/permanent shuttering. The concrete cures within 72hrs.

Residual Effect: 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 effect on 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. Welfare facilities will be located at the proposed temporary construction compounds at the Proposed Wind Farm site. Impacts on surface water quality could affect fish stocks and aquatic habitats.

Mobile welfare facilities with self-contained toilet units will be used during the construction of the Proposed Grid Connection underground cabling route. The temporary construction compound adjacent to the proposed onsite 38kV substation will also contain welfare facilities.

Pathway: Groundwater flowpaths and site drainage network.

Receptors: Surface waters (Tullaroan Stream, Munster and King's rivers), associated water-dependant ecosystems downstream of the Proposed Wind Farm site. All watercourses in the vicinity of the Proposed Grid Connection including the Tullaroan Stream, the Arigna, Nuenna and Nore rivers, the Lisdowney Stream and other small watercourses, associated water-dependent ecosystems and underlying groundwater quality.

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 (and along the Proposed Grid Connection underground cabling route as required), 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.

Residual Effects: 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 Watercourses within the Proposed Wind Farm

Within the Proposed Wind Farm site, there are a total of 6 no. watercourse crossing locations over natural watercourses (rivers and streams). The crossing locations are outlined below:

- An existing crossing along a road which is proposed for upgrade over a small stream immediately to the west of the proposed onsite substation location. This crossing is over a watercourse which is not mapped by the EPA but was encountered during the Site walkover surveys. It is likely that this feature recharges to the gravel aquifer in the vicinity of the Tullaroan Stream;
- An existing crossing along a road which is proposed for upgrade over a small stream ~315m to the southeast of the proposed substation location. This crossing is over a watercourse which is not mapped by the EPA but was encountered during the Site walkover surveys;
- A new proposed crossing over a tributary of the Tullaroan Stream, referred to by the EPA as the Briskalagh Stream (EPA Code: 15B98) ~200m south of T6;
- A new proposed crossing over a tributary of the Tullaroan Stream, which is not mapped by the EPA but was encountered during Site walkover surveys, ~95m to the southeast of T3;
- A new proposed crossing over the Tullaroan Stream ~350m northeast of T7; and,
- A new proposed crossing over the EPA mapped Remeen Stream (EPA Code: 15R27) ~440m northwest of the proposed onsite borrow pit.

In addition to the natural watercourses, there are manmade agricultural and forestry drains 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 (Tullaroan Stream, Munster and King's rivers), associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

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. This design 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 crossings are detailed below:

- The proposed new stream crossings and upgrade of an existing crossing will be clear span bridge crossings and the existing banks will remain undisturbed. No in-stream

excavation works are proposed at these locations and therefore there will be no direct impact on the stream at the proposed crossing locations. Abutments will be constructed from precast units combined with in-situ foundations;

- 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 side 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; and,
- All new 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.

Residual Effect: Proven and effective measures to protect water quality have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be - Negative, imperceptible, direct, long-term, unlikely effect on downstream water quality and aquatic habitats.

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

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

The Proposed Grid Connection underground cabling route includes a total of 13 no. crossings over watercourses (10 no. crossings over EPA mapped watercourses and an additional 3 no. crossings over

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

non-EPA mapped watercourses). These crossings are detailed above in Section 9.3.3.2 and comprise 12 no. existing bridge/culvert crossings and 1 no. new proposed crossing.

The potential proposed crossing methods are as follows:

- **Crossing Using Standard Trefoil Formation Over – Option A**
  Watercourses will not be directly impacted upon since no instream works or bridge/culvert alterations are proposed. Where adequate cover exists above a bridge/culvert or where a new bottomless box culvert or clear-span structure has been installed at a sufficient depth, the standard ESB approved trefoil 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.

- **Flatbed Formation Under– Option B**
  Where cable ducts are to be installed under an existing watercourse or service crossing where sufficient cover cannot be achieved by installing the ducts in a trefoil arrangement, the ducts will be laid in a much shallower trench, the depth of which will be determined by the location of the top of the obstacle or the depth of excavatable material under it. The ducts will be laid in this trench in a flatbed formation under the existing watercourse/ service and will be encased in 6mm thick steel galvanized plate with a 35N concrete surround as per ESB Networks specification.

- **Flatbed Formation over– Option C**
  Where cable ducts are to be installed over a watercourse or service crossing where sufficient cover cannot be achieved by installing the ducts in a trefoil arrangement, the ducts will be laid in a much shallower trench the depth of which will be determined by the location of the top of the obstacle or the depth of excavatable material over it. The ducts will be laid in this trench in a flatbed formation over the existing culvert and will be encased in 6mm thick steel galvanized plate with a 35N concrete surround as per ESB Networks specification.

  Where a bridge/culvert or service has insufficient cover depth to fully accommodate the required trench, the ducts can be laid in a flatbed formation partially within the existing road surface. Where this option is to be employed, the ducts will also be encased in steel with a concrete surround as per ESB Networks specifications. In order to achieve cover over these ducts and restore the carriageway of the road, it may be necessary to raise the pavement level locally to fully cover the ducts. The increased road level will be achieved by overlaying the existing pavement with a new wearing course as required. Any addition of a new pavement will be tied back into the existing road pavement at grade. After the crossing over the culvert has been achieved, the ducts will resume to the trefoil arrangement within a standard trench.

- **Horizontal Directional Drilling – Option D**
  The horizontal directional drilling method of duct installation is carried out using Vermeer D36 x 50 Directional Drill (approximately 22 tonnes), or similar plant. The launch and reception pits will be approximately 2.5mm wide, 2.5m long and 2.0m deep. The pits will be excavated with a suitably sized excavator. The drilling rig will be securely anchored to the ground by means of anchor pins which will be attached to the front of the machine. The drill head will then be secured to the first drill rod and the operator will commence to drill into the launch pit to a suitable angle which will enable him to obtain the depths and pitch required to the line and level of the required profile. Drilling of the pilot bore will continue with the addition of 3.0m long drill rods, mechanically loaded and connected into position.

  During the drilling process, a mixture of a natural, inert and fully biodegradable drilling fluid such as Clear Bore™ and water is pumped through the centre of the drill rods to the

reamer head and is forced in to void and enables the annulus which has been created to support the surrounding subsoil and thus prevent collapse of the reamed length. Depending on the prevalent ground conditions, it may be necessary to repeat the drilling process by incrementally increasing the size of the reamers. When the reamer enters the launch pit, it is removed from the drill rods which are then passed back up the bore to the reception pit and the next size reamer is attached to the drill rods and the process is repeated until the required bore with the allowable tolerance is achieved.

The use of a natural, inert and biodegradable drilling fluid such as Clear Bore™ is intended to negate any adverse impacts arising from the use of other, traditional polymer-based drilling fluids and will be used sparingly as part of the drilling operations. It will be appropriately stored prior to use and deployed in the required amounts to avoid surplus. Should any excess drilling fluid accumulate in the reception or drilling pits, it will be contained and removed from the site in the same manner as other subsoil materials associated with the drilling process to a licensed recovery facility.
Backfilling of launch & reception pits will be conducted in accordance with the normal specification for backfilling excavated trenches. Sufficient controls and monitoring, as listed below, will be put in place during drilling to prevent frack-out, such as the installation of casing at entry points where reduced cover and bearing pressure exits.

- The area around the Clear Bore™ batching, pumping and recycling plants shall be bunded using terram and sandbags in order to contain any spillages;
- One or more lines of silt fences shall be placed between the works area and adjacent rivers and streams on both banks;
- Accidental spillage of fluids shall be cleaned up immediately and transported off site for disposal at a licensed facility; and,
- Adequately sized skips will be used for temporary storage of drilling arisings during directional drilling works. This will ensure containment of drilling arisings and drilling flush

Pathways: Runoff and surface water flowpaths.

Receptors: All watercourses in the vicinity of the Proposed Grid Connection including the Tullaroan Stream, the Arigna, Nuenna and Nore rivers, the Lisdowney Stream and other small watercourses and associated water-dependent ecosystems.

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:

- A double silt fence perimeter will be placed along the road verge on the down-slope side of works areas that are located inside the watercourse 50m buffer zone;
- The following mitigation measures are proposed for the grid connection crossing works:
  - No stockpiling of construction materials will take place along the grid route;
  - No refuelling of machinery or overnight parking of machinery is permitted in this area;
  - 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;
- Spill kits will be available in each item of plant required to complete the works; and,
- Silt fencing will be erected on ground sloping towards watercourses at the stream crossings if required.

Please note that mitigation measures for HDD are detailed in Section 9.5.2.13.

Residual Effect: 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 Private Groundwater Well Supplies

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 site.

No long term, permanent effects on groundwater levels / quantity will occur due to the lack of any proposed significant dewatering works, other than local temporary works at turbine/substation foundations and at the proposed borrow pit, are required for any excavations.

There are several public and group schemes that can be impacted by the Proposed Project. The effects of the works on the Callan PWS and the BallyCallan GWS is assessed separately in Section 9.5.2.17. With regard to private wells, there are a limited number of dwellings which are located in the immediate vicinity of the Proposed Wind Farm site. There is an inhabitable dwelling located within the Proposed Wind Farm site, ~600m southwest of T02. Possible inhabitable dwellings are also located ~700m to the west/southwest of T07 and ~1.2km south of T07.

Due to the shallow nature of the proposed work along the Proposed Grid Connection underground cabling 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 private water supplies.

Mitigation Measures / Impact Assessment:

All groundwater flow within the Proposed Wind Farm site will be towards the valley of the Tullaroan Stream. On the elevated ground in the east of the Proposed Wind Farm site, groundwater flowpaths will be short (~300m) due to the low permeability glacial till subsoils and the Poor Bedrock Aquifer. In these areas of the Proposed Wind Farm site, groundwater flow will follow local topography, flowing to the southwest, and will discharge into the local surface water streams which flow downslope into the Tullaroan Stream. Therefore, any private dwellings to the north and east of the Proposed Wind Farm site are located upgradient of the proposed works and have no potential to be impacted.

There is 1 no. farmhouse located within the Proposed Wind Farm site, ~600m southwest of T02. Whilst a potential groundwater well at this location may be downgradient of the proposed works, the separation distance is sufficient from the nearest proposed turbine location given the short groundwater flowpaths in this area of the Site. Note that intrusive site investigations did not encounter any significant sand or gravel subsoil deposits in this area of the Proposed Wind Farm site.

Similarly, due to the local topography, there is no potential for effects on any groundwater sources to the west of the Proposed Wind Farm Site, including the closest inhabitable dwelling to T07 (~700m to the west/southwest). T07 is located downgradient from these properties and there is no potential for effects,

In the valley of the Tullaroan Stream, groundwater and surface water will interact as the local sand and gravel aquifer is unconfined in this area. The closest downgradient dwellings are situated ~1.2km south of the nearest turbine (T07). Mitigation is provided in the preceding sections of this EIAR chapter to deal with typical construction phase surface and groundwater hazards such as oils and fuels. Furthermore, sands and gravels in themselves are excellent filters and will polish treated water within a couple of meters of flow.

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 private 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 9-16. This is a duration curve of downstream water quality data post siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

Note that the Siltbuster system will not be used under normal conditions during the construction phase. The mitigation proposed to protect water quality is already outlined above in Section 9.5.2.1 to 9.5.2.9.

The use of Siltbuster is only proposed as an emergency back up in the event of failure of all other proposed water treatment mitigation measures, e.g. in the event of landslide failure. The Siltbuster system is a proven and effective method of water quality treatment during these events. Given the absence of peat at the Proposed Wind Farm site, the risk of a landslide is considered to be low. Therefore, it is extremely unlikely that the Siltbuster system will be utilised.

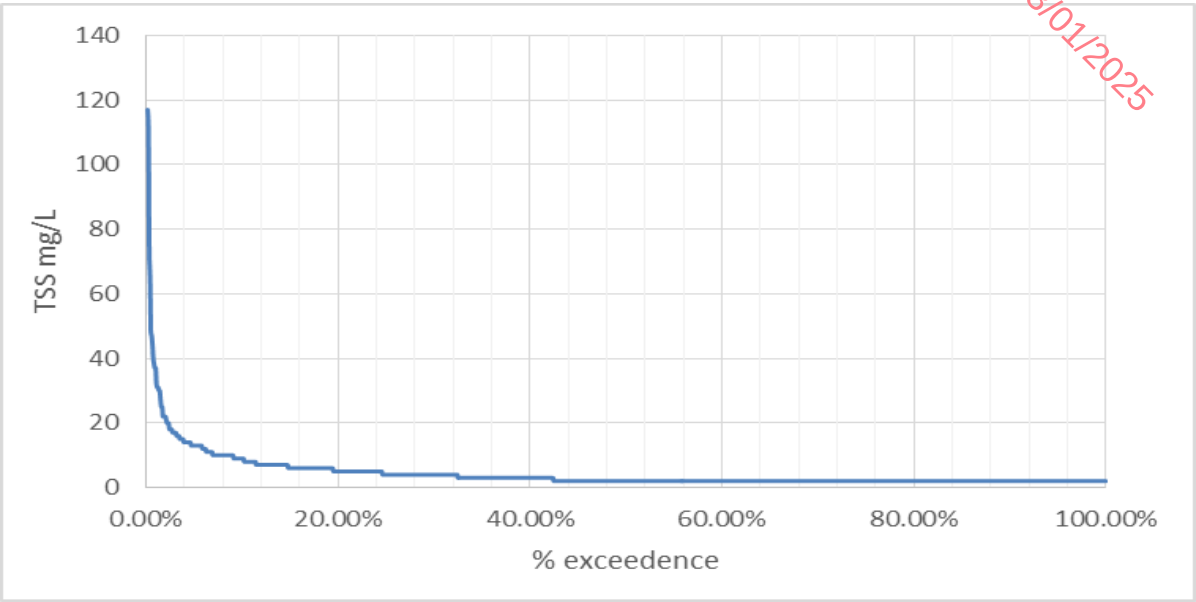


Figure 9-16: TSS treatment data using Siltbuster systems (with chemical dosing)

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Tullaroan Stream, Munster and King's rivers) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

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

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 reagents, so overdosing cannot 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 (i.e. adjacent to SACs).

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 During Directional Drilling along the Proposed Grid Connection Underground Cabling Route

Surface water quality effects on local watercourses may occur during drilling and groundworks associated with potential directional drilling at the 4 no. watercourse crossings along the Proposed Grid Connection to the existing Ballyragget 110kV substation.

It is proposed that directional drilling 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 underground cabling route.

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

Proposed Mitigation Measures:

- Although no in-stream works are proposed, the drilling works will only be done over a dry period between July and September (as required by IFI for in-stream works) to avoid the salmon spawning season and to have more favourable (dryer) ground conditions;
- The crossing works area will be clearly marked out with fencing or flagging tape to avoid unnecessary disturbance;
- There will be no storage of material / equipment or overnight parking of machinery inside the hydrological buffer zone;
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channels;
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse;
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages;
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area;
- Spills of drilling fluid will be cleaned up immediately and contained 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 settlement pond area at least 50m from the watercourse;
- The discharge of water onto vegetated ground 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 of cement along the Proposed Grid Connection underground cabling route;
- 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 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.

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 Associated with Piled Foundations

Piling foundations may be required at T7 (as no trial pit data is available at that location due to existing tree cover). The requirement for piling at T7 will be determined during post-consent ground investigations. Based on the available site investigation data piling works are not envisaged at the other proposed turbine locations, however, taking a precautionary approach an assessment of piling at all proposed turbines has been included below.

The following potential scenarios arise in respect of potential piling works at T7:

- Creation of preferential pathways, through lower permeability subsurface layers (if an aquitard such as silts and clays i.e. glacial till is present), to allow downward flow into the underlying bedrock aquifer;
- Creation of preferential pathways, through a low permeability subsurface layer (an aquitard such as silts and clays i.e. glacial till – if present), to allow upward migration of groundwater to the surface, thus potentially altering local hydrochemistry and therefore vegetation at the surface; and,
- Creation of a blockage to regional groundwater flow within the underlying aquifer due to placement of pile clusters.

These pathways are analogous to pathways described for piling works associated with contaminated land sites, as detailed in Environment Agency (2001). However, with respect to these pathways required for inclusion in the assessment, no upward or downward pathways were observed during the site investigations. Regional groundwater flow is the dominant groundwater flow pathway at this site and no upward or downward groundwater flowpaths exist as would occur in a bog setting.

Pathway: Groundwater flowpaths (upward and/or downward pathways, and regional groundwater flows).

Receptor: Groundwater quality in the underlying GWBs and groundwater hydrochemistry.

Pre-Mitigation Potential Effect: Negative, moderate, direct, short term, likely effect on groundwater quality/hydrochemistry.

Proposed Mitigation Measures:

The proposed mitigation measures designed for the protection of downstream surface water quality and groundwater quality will be implemented at all construction work areas.

- Mitigation measures for sediment control are detailed in Section 9.5.2.1, 9.5.2.2 and 9.5.2.4.
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.2.6.
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 9.5.2.7.

Proposed mitigation measures relative to piling works will comprise:

- Strict QA/QC procedures for piling works will be followed;
- Piles will be kept vertical during piling works;
- Good workmanship will be employed during all piling works; and,
- Where required use bentonite seal to prevent upward/downward movement of surface water/groundwater.

Impact Assessment:

Impact Assessment Associated with Potential Piling at T7:
For bored piles, as the temporary steel casing is removed, a steel reinforcement cage is added to the pile column and then concrete is added to the toe of the pile using a tremie pipe. Vermiculite is used to create a plug between the concrete and the displaced water, therefore the concrete seals the entire pile column and pushes the vermiculite plug to the surface as concrete is added. The temporary steel casing is removed carefully as the concreting works are being completed. This concreting process is similar to that used when grouting a water supply production well (IGI (2007), and EPA (2013)). This means that a direct long term pathway between the surface and the lower bedrock aquifer will not be sustained.

Scenario 1: Creating a Pathway for Downward Flow
To ensure downward flow of water and/or pollutants from the piling works does not occur, the concrete added to the bored pile will seal the pile annulus. As a result, the potential for the piling works to create pathways for downward flow of water or pollutants that could affect groundwater quality in the underlying aquifer is imperceptible.

Scenario 2: Creating a Pathway for Upward Flow
To ensure upward flow of underlying groundwater via potential pathways created by piling works does not occur, the concrete added to the bored pile will seal the pile annulus. As a result, the potential for piling works to create pathways for upward flow of groundwater to the surface is imperceptible.

Scenario 3: Blocking Regional Groundwater Flow
The piles have a very small footprint and if required would account for a very small percentage of the overall footprint associated with the Proposed Project. The proposed piles would not penetrate any great distance into the underlying bedrock aquifer, as they will likely find sufficient resistance upon reaching the top of bedrock. The ability of a single cluster of piles, to alter or affect local or regional groundwater flow in the bedrock aquifer is imperceptible. Similarly, there will be no potential for effects on groundwater flowpaths in the sand and gravel aquifer due to the small footprint of the piles. Groundwater in the sand and gravel aquifer will simply flow around the piles which will have a very small footprint in comparison to the total area of the sand and gravel aquifer.

Impact Assessment Associated with Potential Piling at Other Turbine Locations:
If piling is required at other turbine locations the potential for effects are further reduced in comparison to potential piling at T7 for the following reasons:

- Other turbines are located on the higher ground and further away from sensitive receptors including the Tullaroan Stream, the sand and gravel aquifer and the associated GWSs;
- These turbine locations are remote from the glaciofluvial sand and gravel deposits which are present along the floor of the valley of the Tullaroan Stream;
- Site investigations have shown that no significant sand and gravel deposits are present at these proposed turbine locations;
- The glacial tills present at these turbine locations will likely self-seal around a bored pile preventing the creating of pathways between the surface and the bedrock aquifer;
- Site investigations did not encounter any significant groundwater flows in these glacial till deposits. Where groundwater was recorded in the trial pit excavations it was described as 'slow' to 'very slow' within the glacial tills; and,
- All of these turbines are mapped on a Poor Bedrock Aquifer and groundwater flowpaths will be short and groundwater discharges rapidly to surface water streams. Therefore, the ability to block groundwater flowpaths will be very low.

Residual Effects: The proposed piling works potentially pose a threat to groundwater quality in the underlying regional groundwater system, and also could potentially create a pathway for upward migration of groundwater to the surface. These potential effects will not arise at the Proposed Wind

Farm site due to a combination of the prevailing ground conditions, groundwater conditions, and proposed mitigation measures that will ensure the potential pathways for interaction of shallow water and deeper groundwater are prevented from occurring. In additional, due to the small footprint of proposed pile clusters, and the significant spacing between turbine foundations, the potential for such pile clusters to block regional groundwater flow is imperceptible at that scale. The proposed piled foundations therefore have no potential to change the WFD status or impact the WFD objectives of the underlying GWB. The residual effect is considered to be Negative, imperceptible, indirect, short term, unlikely effect on groundwater flow, and ground quality/peat water hydrochemistry.

Significance of Effects: For the reasons given above, no significant effects on regional groundwater and the GWB will occur, and no significant effects on water hydrochemistry will occur from proposed piling works.

9.5.2.15 Potential Effects on 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, some karst features are mapped by the GSI along the Proposed Grid Connection underground cabling route. In total ~11km of the Proposed Grid Connection underground cabling route is underlain by a Regionally Important Aquifer – karstified (diffuse).

The closest GSI mapped karst feature is a spring in the townland of Knockdown, located ~40m to the east of the Proposed Grid Connection underground cabling route. However, according to the GSI database this feature is located in Siltstone bedrock and therefore karstification is highly unlikely in this area. The closest GSI mapped karst feature in limestone bedrock is a spring located ~600m east of the Proposed Grid Connection underground cabling route at Freshford in the townland of Toberlaghteen.

Any potential alteration in local groundwater quality or surface water quality has the potential to impact the Karstic Bedrock Aquifer underlying ~11km of the Proposed Grid Connection underground cabling route.

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:

- In limestone areas, there are no mapped karst features in the immediate vicinity of the Proposed Grid Connection; 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 the local karst features (Section 9.5.2.2 and 9.5.2.10).
- 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.

Residual Effect: Due to the minor and transient nature of the works along the Proposed Grid Connection 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 effects is an indirect, negative, imperceptible, short-term, unlikely effect.

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

9.5.2.16 Potential Effects on Downstream Surface Water Abstractions

As stated above in Section 9.3.14.2, there are 2 no. DWPAs mapped in the vicinity and downstream of the Proposed Project. The identified DWPAs are the Nore_120 and Nore_220 SWBs associated with the Ballyragget PWS and an abstraction for Mount Juliet Estate respectively. There is no potential for effects on the Nore_220 DWPA due to the length of the hydrological pathway between the Proposed Wind Farm site and this DWPA (~28km).

Any potential surface water quality effects which may arise as a result of the Proposed Grid Connection may have the potential to impact on the Ballyragget water supply. However, given the nature of the source (i.e. infiltration gallery), and the minor and transient nature of the proposed works along the Proposed Grid Connection any impacts, even in worst-case unmitigated scenarios, will be imperceptible.

Pathway: Surface water flowpaths.

Receptor: Ballyragget Water Supply.

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

Mitigation Measures / Impact Assessment:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 9.5.2.1, 9.5.2.2 and 9.5.2.3 (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 for watercourse crossing at the Proposed Wind Farm site and the Proposed Grid Connection respectively.

In relation to the Ballyragget water supply, the source of the raw water source is an infiltration gallery adjacent to the River Nore. There is no direct surface water abstraction from the River Nore and therefore the source is less sensitive to water quality in the River Nore. It is considered that due to the prescribed mitigation measures, the nature of the source (i.e. infiltration gallery), and the minor and transient nature of the proposed works along the Proposed Grid Connection, any impacts, even in worst-case unmitigated scenarios, will be imperceptible with neutral impacts to the Ballyragget Public Water Supply.

Residual Effect: Proven and effective measures to mitigate the risk of surface and ground water contamination have been proposed which will break the pathway between the potential source and the downstream receptor. It is considered that at due to the prescribed mitigation measures, the nature of the source (i.e. infiltration gallery), and the minor and transient nature of the proposed works along the Proposed Grid Connection, it is considered that the residual effect will be, a Negative, imperceptible, indirect, short term, unlikely effect on surface water abstractions.

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

9.5.2.17 Potential Effects on Public and Group Groundwater Supplies

Callan PWS

The Source Protection Area (which is essentially a surface water catchment) associated with this PWS overlaps with the following components of the Proposed Project:

- 5 no. proposed turbines and associated hardstands,
- 2 no. temporary construction compounds,
- 3 no. spoil management areas;
- Sections of 2 other spoil management areas;
- Onsite substation;
- 3.9km of the Proposed Grid Connection underground cabling route;
- New proposed roads;
- Existing roads for upgrade; and,
- Earthworks cut and fill.

The combined area of these components is 5.93ha, and the total area of the mapped Source Protection Area is ~3,200ha. The overlap accounts for 0.2% of the Source Protection Area.

Any potential local water quality/quantity effects could potentially effect this PWS.

BallyCallan Shale and BallyCallan Sand and Gravels GWSs

The Source Protection Areas associated with these GWS is located ~850m south of the nearest proposed turbine location (T07). The Source Protection Area overlaps with the following components of the Proposed Project:

- 0.15km of new proposed roads; and,
- 0.25km of existing roads proposed for upgrade.

The combined area of these two components is ~0.3ha, and the total area of the mapped Source Protection Area associated with the BallyCallan Sand and Gravel Region is ~37ha. The mapped Source Protection Area associated with the BallyCallan Shale region is ~35ha. Therefore, the overlap accounts for ~0.8% of the Source Protection Area of these GWSs. Any potential local water quality/quantity effects could potentially effect these GWS (however the scale of any potential effect is limited by the scale of the works proposed within the source protection areas).

BallyCallan Limestone GWS

The Source Protection Area associated with this GWS is located ~2km from the closest proposed turbine (T07). This GWS is sourced from the Clongrenan Formation, which is comprised of muddy, calcarenitic limestone, therefore it is sourced from a different bedrock aquifer than that which underlies the Proposed Wind Farm site. It is also located on the eastern side of the Tullaroan Stream, and is therefore on the other side of a groundwater divide. This GWS is also located upgradient (in terms of elevation as it flanks the hills to the east of the Tullaroan Stream valley) of the sand and gravel aquifer in the valley of the Tullaroan Stream. Therefore, there is no potential hydrological/hydrogeological connection between the Proposed Wind Farm site and this GWS. Therefore, for the reasons outlined here it is scoped out of further assessment.

Tullaroan GWS

The Source Protection Area associated with this GWS overlaps with ~1.1km of the Proposed Grid Connection underground cabling route. At its nearest point the grid is ~250m from the source well. Any potential local water quality/quantity effects along this section of the underground cable route could potentially effect this GWS (however the scale of any potential effect is limited by the scale of the

works proposed within the source protection area). This GWS is located upgradient of the Proposed Wind Farm site.

Pathway: Site drainage network.

Receptors: Callan PWS, BallyCallan Shale, BallyCallan Sand and Gravels and Tullaroan GWSs.

Pre-Mitigation Effect: Indirect, negative, moderate, short-term, likely effect on the Callan PWS and an indirect, negative, imperceptible, short-term, likely effect on the BallyCallan Shale, BallyCallan Sand and Gravels and Tullaroan GWSs.

Impact Assessment & Proposed Mitigation Measures:

The design team were at all times aware that public and group water supplies existed in the vicinity of the Site, and as such all proposed mitigation and drainage design proposals were designed towards providing a "best in class" drainage management proposal for the Proposed Project considering the sensitive nature of the hydrogeological and hydrological environment.

Callan PWS

No significant quantitative effects on the Callan PWS will occur for the following reasons:

- The proposed works areas within the delineated outer Source Protection Area is infinitely small in comparison with the overall Source Protection Area (3,200ha) and represent ~0.2% of the total area;
- The closest proposed turbine is located ~9.15km from the Callan Spring and ~9.1km from the inner Source Protection Area;
- The Proposed Project will not impact groundwater flowpaths in the sand and gravel aquifer as groundwater can move freely in these subsoil deposits and will easily migrate around any installed foundations or proposed infrastructure;
- The installed drainage regime will ensure that any rainfall falling on the Proposed Project footprint, which would have recharged to ground prior to the Proposed Project, will recharge to ground adjacent to the infrastructure location;
- Therefore, there will be no net loss of groundwater recharge to the sand and gravel aquifer as a result of the Proposed Project.

No significant effects on groundwater quality will occur for the following reasons:

- The proposed works area within the delineated Source Protection Area is infinitely small in comparison with the overall Source Protection Area (3,200ha);
- The mitigation measures described above 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 (morphological changes) will ensure the protection of water quality during the construction phase;
- The proposed drainage design will ensure the recharge of attenuated and treated water to the sand and gravel deposits;
- These sands and gravels in themselves are excellent filters and will polish treated water within a couple of meters of flow.

BallyCallan Shale and BallyCallan Sand and Gravels GWSs

No significant effects will occur for the following reasons:

- All works within the zone of contribution are relatively minor and localised and cover very small areas;

- The works overlap with ~0.8% of the Source Protection Areas associated with these GWSs;
- Excavation/earthworks will all be small scale;
- All works are temporary and transient in nature (road construction and upgrades);
- No deep or significant excavations are proposed in these areas;
- Mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the Proposed Project; and,
- These sands and gravels in themselves are excellent filters and will polish treated water within a couple of meters of flow.

Tullaroan GWS

No significant effects will occur for the following reasons:

- All works are relatively minor and localised and cover very small areas (linear trench of ~1.1km length and of 1.3m depth);
- All works are temporary and transient in nature and will take less than two weeks to complete (within the SPA footprint);
- All works will occur within an existing roadway; and,
- Mitigation measures for the protection of surface and groundwater water quality will be implemented during the Construction Phase along the Proposed Grid Connection underground cabling route.

Residual Effect: Proven and effective measures to mitigate the risk of surface and groundwater contamination 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 local public and group water supplies.

Significance of Effects: For the reasons outlined above, no significant effects will occur on local public and group water supplies.

9.5.2.18 Potential Effects on Hydrologically Connected Designated Sites

The River Barrow and River Nore SAC, the River Nore SPA, River Nore/Abbeyleix Woods Complex pNHa and the Inchbeg pNHA are hydrologically connected with the Site (Proposed Wind Farm and Proposed Grid Connection). The surface water connections from the Site could transfer poor quality surface water that may affect the conservation objectives of these designated sites.

The River Barrow and River Nore SAC is more susceptible to potential effects given its close proximity to the Proposed Wind Farm site (~5.9km). Meanwhile, the potential for effects on the River Nore SPA are reduced given the ~14.1km hydrological pathway between the Proposed Wind Farm site and the SPA. The potential for effects on the River Barrow and River Nore SAC, River Nore SPA, the River Nore/Abbeyleix Woods Complex pNHa and the Inchbeg pNHA associated with the Proposed Grid Connection are limited given the small scale and transient nature of the works and the large volumes of water within the River Nore.

All other downstream designated sites have been screened out (refer to Section 9.3.13 and Table 9-18) of the assessment due to their distance location from the Proposed Project and the increasing volumes of water within these downstream waterbodies which will dilute any potential effects associated with the Proposed Project.

Furthermore, other nearby designated sites have been screened out of the impact assessment due to the lack of hydrological and hydrogeological connectivity.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality with the River Barrow and River Nore SAC, the River Nore SPA, River Nore/Abbeyleix Woods Complex pNHa and the Inchbeg pNHA.

Pre-Mitigation Potential Effect: Indirect, negative, slight, short term, likely effect on the River Barrow and River Nore SAC/SPA. Indirect, negative, imperceptible, short-term, likely effect on the River Nore SPA, River Nore/Abbeyleix Woods Complex pNHa and the Inchbeg pNHA.

Mitigation Measures / Impact Assessment:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality within the Proposed Wind Farm site have been detailed in Section 9.5.2.1 (tree 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 (morphological changes). Mitigation measures have also been proposed along the Proposed Grid Connection in Section 9.5.2.10 and 9.5.2.13.

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).

We summarise that there will be no significant effect on downstream designated sites for the following reasons:

- The length of the hydrological flowpaths between the Proposed Wind Farm site and the downstream designated sites. The closest designated site (the River Barrow and River Nore SAC) is located ~5.6km downstream on the lower reaches of the Tullaroan Stream;
- The only works which are located in the immediate vicinity of a designated site is the new proposed crossing over the River Nore along the Proposed Grid Connection underground cabling route. There will be no instream works at this location and the crossing will be achieved by directional drilling;
- The potential for effects on other designated sites is limited given the increasing volumes of water and associated dilution effect in downstream watercourses (Munster, King's and Nore rivers downstream of the Proposed Wind Farm site and the River Nore downstream of the Proposed Grid Connection underground cabling route); and,
- Nevertheless, mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the Proposed Project to ensure that there is no deterioration in local or downstream water quality.

For these reasons, and with the implementation of these mitigation measures the protection of downstream designated sites will be ensured.

Residual Effect: 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 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 9.3.12.1 and Section 9.3.12.2 respectively.

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

Pathway: Surface water flowpaths.

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

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

Proposed Mitigation Measures:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality within the Proposed Wind Farm site have been detailed in Section 9.5.2.1 (tree 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 (morphological changes). Mitigation measures have also been proposed along the Proposed Grid Connection in Section 9.5.2.10 and 9.5.2.13.

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).

We summarise that there will be no significant effects on GWB or SWB WFD status for the following reasons:

- The small footprint (8.4ha) of the Proposed Project in relation to the scale of the underlying GWBs (Kilmanagh Gravels GWB has a total area of ~2,700ha whilst the Ballingarry GWB has a total area of 38,400ha);
- The Proposed Project does not involve any alteration of drainage patterns, therefore, the quantitative status of the receiving surface and groundwaters will remain unaltered;
- There will be no direct discharge from the Proposed Project site to receiving waters; and,
- Mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the Proposed Project to ensure that there is no deterioration in local or downstream water quality. These mitigation measures will ensure the qualitative status the receiving waterbodies remains unaltered by the Proposed Project.

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 WFD 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.

9.5.2.20 Potential Effects of the Proposed Turbine Delivery Route

No effects on the water environment along the turbine delivery route will occur as no earthworks are required.

9.5.3 Operational Phase – Likely Significant Effects and Mitigation Measures

9.5.3.1 Potential Effects from Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the 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. For the purposes of assessment, it is conservatively assumed that the Proposed Wind Farm access roads and hardstands (including the proposed onsite substation compound) are impermeable. The assessed Proposed Project footprint (87,415m^2) comprises turbine and met mast foundations and hardstandings, access roads, 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 underground cabling route. The works are predominantly 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 (Tullaroan Stream, Munster and King's rivers) 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.

Effect Assessment:

The emplacement of the proposed permanent development footprint, as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials as a worst-case scenario) could result in an average total site increase in surface water runoff of approximately 1,675m^3/month. Given the variable mapped recharge rates across the Site, and given the nature of the soils/subsoils encountered during the site investigations, an overall average of 20% groundwater recharge was taken for the overall Site. The assessment shows a potential increase of approximately 0.2% in the average daily/monthly volume of runoff from the Site area in comparison to the baseline pre-development site runoff conditions (Table 9-20). This is a very small increase in average runoff and results from the naturally high surface water runoff rates and the relatively small area of the site being developed, the proposed total permanent development footprint being approximately 8.7ha, representing 0.9% of the EIAR Site Boundary area of 955ha.

Table 9-20: 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 80% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions (m^3)
931,912	23,610	87,415	8,374	6,699	1,675	54	0.2%

The additional volume is low due to the fact that the runoff potential across the majority of the Site is naturally high (with only the areas in the vicinity of the Tullaroan Stream having high rates of groundwater recharge). 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 assessment does not consider the existing roads and hardstand areas present across the Site. The increase in runoff from the proposed development 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 4-3):

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground by means of a level spreader;
- Swales/road side drains will be used to collect runoff from access roads and turbine hardstanding areas of the Site, likely to have entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- On steep sections of access road transverse drains ('grips') will be constructed in the surface layer of the road to divert any runoff off the road into swales/road side drains;
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;
- Settlement ponds, emplaced downstream of road swale sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses; and,
- Settlement ponds 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 drainage is a key component of the proposed drainage management within the Proposed Project. By integration we mean maintaining surface water flowpaths where they already exist, avoid creation of new or altered surface water flowpaths, and maintaining the drainage regime (i.e. normal flow) within the agricultural lands and forested areas. Critically, there will be no alteration of the catchment size contributing to each of the main downstream watercourses. All wind farm drainage water captured within individual site sub-catchments will be attenuated and released within the same sub-catchments that it was captured.

Residual 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 Entrained Sediment

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.

Maintenance works will likely be contained within the Proposed Wind Farm site and no maintenance works will be required along the Proposed Grid Connection underground cabling route.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Tullaroan Stream, Munster and King's rivers) 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.

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 will be – 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.

9.5.3.1 Potential Effects from Release of Hydrocarbons

Accidental spillage during refuelling of operational 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.

During 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.

Furthermore, transformers within each of the 7 no. turbines will hold oil. Any leakage of oil could impact local surface and groundwater quality. Oil will also be stored within the substation.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater and surface water at the Proposed Wind Farm site and Proposed Grid Connection.

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, unlikely effect on local groundwater quality.

Indirect, negative, significant, short term, unlikely effect on surface water quality.

Proposed Mitigation Measures (by Design):

- Onsite re-fuelling of normal operational vehicles will not be carried out during the operational phase of the development. These vehicles will be refuelled offsite;
- Fuels stored on site will be minimised and any hydrocarbons stored on-site will be bunded. The bund capacity will be sufficient to contain 110% of the storage tank's maximum capacity;
- The substation will be bunded appropriately to the volume of oils likely to be stored, and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- Oil in the turbine transformers will be fully bunded within the enclosed turbine and as such, there is no potential pathway to the water environment i.e. the pathway has been blocked;
- Any plant used during the operational phase will be regularly inspected for leaks and fitness for purpose; and,
- Spill kits will be available to deal with accidental spillages.

Residual Effects: 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 is considered to be – Negative, indirect, imperceptible, short term, unlikely effect on surface water quality and groundwater quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality are anticipated during the operational phase of the Proposed Project.

9.5.3.2 Potential Effects from use of Water Supply at Substation

It is proposed to either install to either harvest rainwater from the roofs of the buildings or, alternatively, install a groundwater well adjacent to the substation in accordance with the Institute of Geologists Ireland, *Guide for Drilling Wells for Private Water Supplies* (IGI, 2007). The well will be flush to the ground and covered with a standard manhole. An in-well pump will direct water to a water tank within the roof space of the control building.

The proposed groundwater well and associated extraction has the potential to effect local groundwater levels in the surrounding lands.

Pathway: Groundwater flowpaths

Receptor: Groundwater levels

Pre-Mitigation Potential Effect: Direct, negative, imperceptible, permanent, likely effect on local groundwater levels.

Impact Assessment

The abstraction rate for the proposed groundwater well at the substation will be comparable to a domestic well, with a well supplying a single household typically abstracting less than $1m^3$/day. The well is proposed in a regionally important gravel aquifer which forms part of the Kilmanagh Gravels GWB. Due to the proposed abstraction rate, no effects on local groundwater levels will occur.

For these reasons no mitigation measures are required.

Residual Effects: Due to the scale of the proposed abstraction and the nature of the overburden aquifer, we consider the residual effect to be direct, negative, imperceptible, permanent, likely effect on local groundwater levels.

Significance of Effects: For the reasons given above, and with the implementation of the above mitigation measures, no significant effects on surface water quality or quantity, or groundwater 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 GWB 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.

9.5.3.4 Potential Effects on Public and Group Water Supplies

During the operational phase, there will be no potential for effects on the BallyCallan Shale Group Water Scheme (GWS), the BallyCallan Sand and Gravels GWS the Tullaroan GWS or the Callan PWS.

There will be no direct discharge from the Proposed Project to downstream receiving waters during the operational phase. All Proposed Wind Farm site drainage measures will be in place. 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 local PWS and GWS will not be altered by the Proposed Project.

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 masts will be dismantled, and all above ground components would be removed off-site for recycling.

The potential effects associated with decommissioning of the Proposed 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 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 foundations and hard standing areas. This will be done by covering with topsoil 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, as these will be utilised for forestry and other agricultural operations.

The electrical cabling connecting Site infrastructure to the 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 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.

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 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 onsite 38kV substation and electrical cabling will be retained as a permanent part of the national grid. 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.

A Decommissioning Plan has been prepared (Appendix 4-5) 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 Development has been fully assessed in the EIAR.

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

9.5.5 Risk of Major Accidents and Disasters

Flooding can also result in downstream Major Accidents and Disasters. 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 mapped public and group water scheme groundwater protection zones in the area of the Proposed Wind Farm site and several downgradient private groundwater well supplies. However, the Proposed Project design and mitigation measures ensure that the potential for effects on the hydrogeological environment will not be significant.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues. A detailed Flood Risk Assessment has also shown that the risk of the Proposed 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 Assessment of 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 associated with the surface water environment and the shallow hydrogeological environment (i.e. the sand and gravel aquifer). Due to the nature of the underlying bedrock (i.e. poor and generally unproductive bedrock aquifer) and the near surface nature of construction activities, cumulative effects with regard groundwater quality or quantity in the bedrock arising from the Proposed Project are assessed as not likely. Meanwhile, the sand and gravel aquifer discharges to the Tullaroan Stream, the Munster and King's Rivers and several large springs in the river valley. Therefore, the shallow overburden aquifer is linked to the local surface water environment.

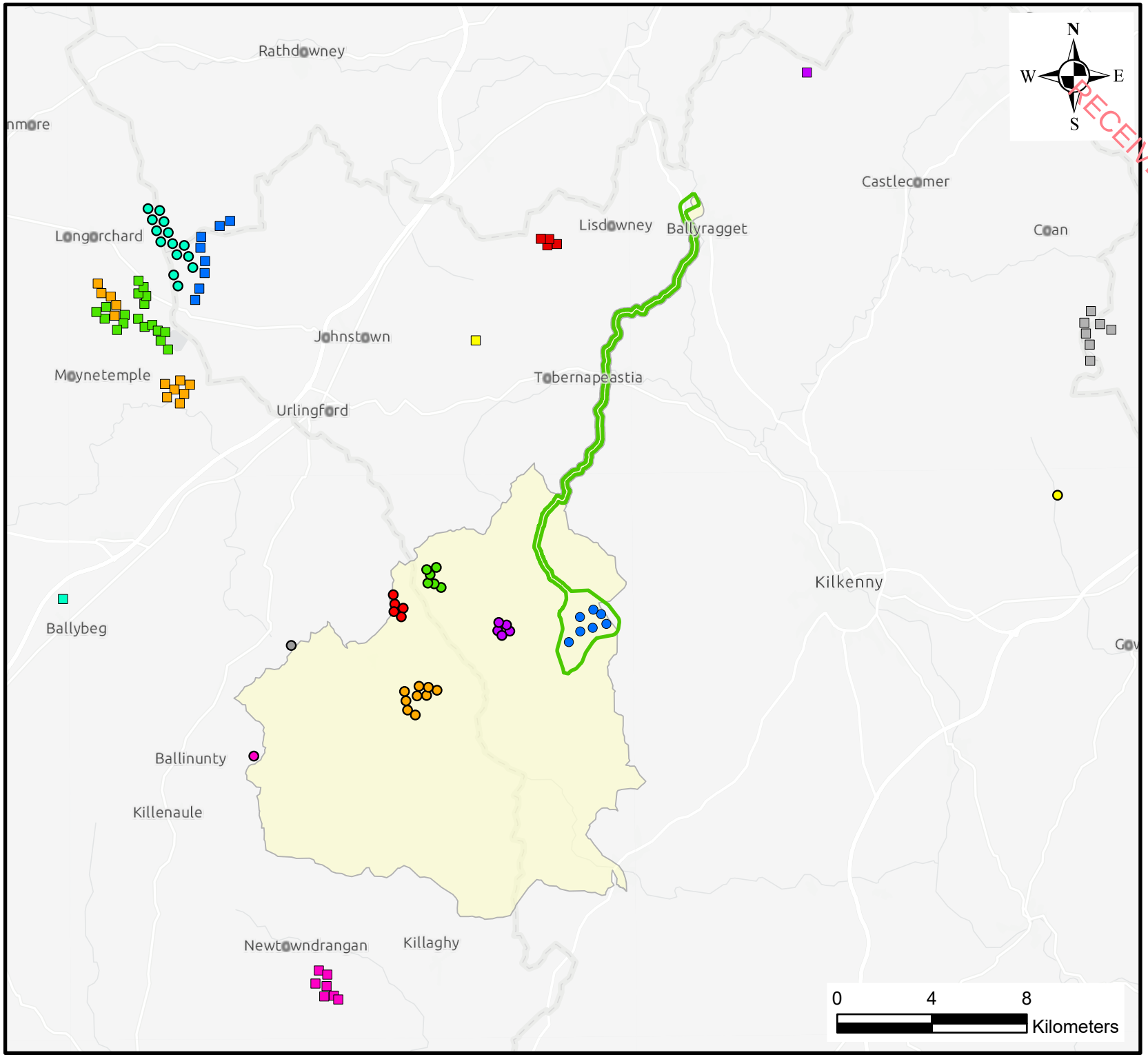
The primary potential for cumulative effects will occur during the construction phase of the Proposed Project as this is when earthworks and excavations will be undertaken at the Site. The potential for cumulative effects during the operational phase of the Proposed Project will be significantly reduced 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 has been delineated as shown below in Figure 9-17.

The hydrological cumulative study area is delineated as follows:

- The mapped extent of the Kilmanagh Gravels GWB;

- A quantitative assessment based on flow volumes obtained from the EPA HydroTool Nodes downstream of the Proposed Wind Farm site. This assessment concludes that the due to dilution no hydrological cumulative effects will occur beyond EPA Hydrotool Node 15_1733 on the King's River immediately upstream of Callan. At this location the King's River has a total upstream catchment area of 20,000ha. There will be no potential for cumulative effects beyond this cumulative study area due to increases in flow volumes (as the catchment area increases) and increasing distance from the Proposed Wind Farm site.
- A further assessment has been completed within a 200m zone of the Proposed Grid Connection. Due to the shallow nature of the underground cabling connection trench, a 200m buffer zones is an appropriate scale when considering potential cumulative effects on the water environment.



Legend

- EIAR Site Boundary
- Proposed Briskalagh WF Turbine Locations
- Hydrological Cumulative Study Area

Other WFs within 25km from the proposed development

- An Cnoc Wind Farm
- Ballincurry Wind Turbine
- Ballybay Wind Farm
- Bruckana Wind Farm
- Fahanrory Wind Farm
- Foyle Wind Farm
- Freneystown Wind Farm
- Gurteen Lower Wind Turbine
- Killoshulan Wind Farm
- Knockroe Wind Farm
- Lisdowney Wind Farm
- Lisheen Wind Farm I
- Lisheen Wind Farm II
- Lisheen Wind Farm III
- Littleton WF (Bord na Mona Powergen Ltd)
- Loughill Wind Farm
- White Hill Wind Farm

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Job: Briskalagh Renewable Energy Development, Co. Kilkenny

Title: Hydrological Cumulative Study Area

Figure No: 9-17

Drawing No: P1657-0-0824-A4-917-00A

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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 and the wider hydrological cumulative study area includes some forested areas.

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 Tullaroan Stream, the Munster River and the King's River, the potential cumulative effects on downstream water quality and quantity need to be assessed.

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 commercial forestry activities.

9.5.7.3 Cumulative Effects with Other Wind Farm Developments

A total of 4 no. existing / permitted wind farms have been identified within the cumulative hydrological study area.

- 4 no. existing turbines and 1 no. permitted turbine associated with the Foyle Wind Farm, Co. Kilkenny.
- 7 no. turbines (6 no. existing and 1 no. permitted) associated with the Ballybay Wind Farm, Co. Kilkenny.
- 5 no. turbines associated with the existing An Cnoc Wind Farm, Co. Tipperary.
- 9 no. turbines associated with the permitted Farranrory Wind Farm, Co. Tipperary.
- 2 no. turbines associated with the permitted Kyleballoughter Wind Farm, Co. Kilkenny.
- 1 no. turbine associated with the existing Ballincurry 1 turbine, Co. Tipperary.

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 downstream watercourses. However, a total of 15 of the 23 no. turbines within the cumulative hydrological study area are already operational, therefore there is no potential for the construction phases to overlap with the construction of these turbines.

Meanwhile, 8 no. turbines within the cumulative hydrological study area are permitted but have not yet been constructed. Potential cumulative effects could occur of the construction phases overlap.

However, the EIARs for the above wind farm developments detail potential hydrological and hydrogeological issues relating to the construction, 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 Connections

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

- ~300m overlap with the grid connection underground cabling route associated with the proposed Farranrory Wind Farm. The overlap occurs along the N77. Both grid connections are proposed to cross the Nore via HDD at different locations;

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

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

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

9.5.7.5 Cumulative Effects with EPA Licenced Wastewater Treatment Facilities

There are 5 no. EPA licenced wastewater treatment facilities within the hydrological cumulative study area.

These Wastewater Treatment Plants (WwTPs) have a population equivalent of <500:

- The Tullaroan WwTP (Registration No: A0156-01) serves a population equivalent of 6, with the plant designed for a population equivalent of 20. The WwTP provides primary treatment and discharges immediately upstream of the Proposed Wind Farm site along the Tullaroan Stream.
- The Kilmanagh WwTP (Registration No: A0145-01) serves a population equivalent of 30 people, with the WwTP designed to cater for a population equivalent of 50 persons. The WwTP provides secondary treatment and discharges to the Tullaroan Stream downstream of the Proposed Wind Farm site;
- The Commons WwTP (Registration No: A0427-01) serves a population of 168 people with the WwTP designed to cater for a population equivalent of 400 people. This WwTP provides secondary treatment and discharges to a tributary of the King's River.
- The Ballingarry WwTP (Registration No: A0407-01) serves a population of 352 people with the WwTP designed to cater for a population equivalent of 400 people. This WwTP provides secondary treatment and discharges to a tributary of the King's River.
- The Coalbrook WwTP (Registration No: A0513-01) serves a population of 15 people with the WwTP designed to cater for a population equivalent of 30 people. This WwTP provides secondary treatment and discharges to a tributary of the King's River.

The potential for cumulative effects associated with the Proposed Project is limited as 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 local WwTPs.

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 described above.

The planning applications identified within the study area for new dwellings or renovations of existing dwellings, associated wastewater treatment systems 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).

A desk study of planning applications within 200m of the Proposed Grid Connection 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. However, in the vicinity of Ballyragget substation there is a permitted application for the construction of a battery energy storage system. A hydrological and hydrogeological assessment report and drainage strategy was submitted along with the Environmental Report for the Power Reserve Project at Ballyragget. This

report detailed mitigation measures for the protection of the hydrological and hydrogeological environment through all phases of the development.

The works along the Proposed Grid Connection are minor and transient, similar to roadworks being completed across the country and have no potential for significant cumulative effects on the hydrological or hydrogeological environment.

9.5.8 Post Consent Monitoring

No monitoring is required.