9 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

Hydro-Environmental Services (HES) was engaged by Jennings O'Donovan (JOD) to carry out an assessment of the potential effects of the proposed Tirawley Wind Farm (the 'Proposed Development') on the hydrological and hydrogeological environment.

This Chapter assesses the effects of the Proposed Development on the hydrological and hydrogeological environment. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the following phases of the Proposed Development:

- Construction of the Proposed Development
- Operation of the Proposed Development
- Decommissioning of the Proposed Development

Common acronyms used throughout this EIAR can be found in **Appendix 1.4**. This Chapter of the EIAR is supported by Figures provided in Volume III and by the following Appendix documents provided in Volume IV of this EIAR:

- **Appendix 9.1: Flood Risk Assessment**
- **Appendix 9.2: Laboratory Reports**
- **Appendix 9.3: WFD Compliance Assessment Report**

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This document will be developed into a Site-Specific Tirawley Wind Farm CEMP post consent/pre-construction once a contractor has been appointed and will cover construction of the Proposed Development. It will include all of the mitigation recommended within the EIAR.

9.1.1 Development Description

The Proposed Development comprises the erection of 18 no. wind turbines and associated Turbine Hardstands and Turbine Foundations. 18 no. Vestas V117 turbines are proposed and will have a blade tip height of 135 m.

The Proposed Development also includes a meteorological mast, a 110 kV onsite electrical substation and 2 no. control buildings, the installed of battery arrays adjacent to the Onsite Substation (20 no. container units), 2 no. Temporary Construction Compounds, Battery Energy Storage System (BESS), a Permanent Operations Compound, 19 no. permanent onsite spoil deposition areas and the construction of new internal Site Access Tracks

(~10.41 km) and the upgrade of existing Site Access Tracks and public roads (2.28 km of private Access Tracks and 2.82 km of public roads long the TDR).The Proposed Development includes 6 no. new site entrances and the upgrade of 9 no. existing site entrances. Approximately 40.24 ha of coniferous forestry will be felled to facilitate the Proposed Development.

Planning permission is being sought for an onsite 110 kV Substation and an underground Grid Connection to the existing Tawnaghmore 110 kV Substation located in Killala Business Park. This infrastructure will become an asset of the national grid under the management of EirGrid and will remain in place upon decommissioning of the Wind Farm.

A second connection option considered in this EIAR is a 110 kV underground Interconnector cable between the Proposed Development (Tirawley Wind Farm) and a Proposed Hydrogen Plant known as the Killala Energy Hub, recently consented by Mayo County Council (Planning Reference No. 2360266). Both connections follow the same cable route from the Wind Farm Site to the townland of Tawnaghmore Lower, where the existing EirGrid 110 kV substation and the Proposed Killala Energy Hub are located.

The Proposed Development also includes all associated site preparation and drainage works. Furthermore, the Proposed Development EIAR also considers three possible Turbines Delivery Routes (TDRs) (from Galway/Killybegs/Foynes Port).

A full description of the Proposed Development is provided in **Chapter 2: Development Description** of this EIAR.

Please note that for the purposes of this chapter, where:

- the 'Proposed Development' and 'Proposed Development Site' are referred to, this relates to all elements of the Proposed Development as described in **Chapter 2: Development Description** and includes all site infrastructure, the Grid Connection Route and all works required along TDR.
- the 'Wind Farm Site' or 'the Site' is referred to, this relates to the primary study area and includes lands which fall within the Redline Boundary, which is the boundary line of all works to be completed but does not include the Grid Connection Route (GCR) or the TDR.
- the 'Grid Connection' is referred to, this related to the proposed 110 kV underground grid cable connection between the proposed Onsite Substation to the existing

Tawnaghmore 110 kV substation or the proposed Killala Energy Hub. The grid connection is ~13.55 km in length.

- the 'Turbine Delivery Route' is referred to, this relates to the proposed turbine delivery route from Killybegs (Option 1), Galway Port (Option 2) and Foynes Port (Option 3) to the Wind Farm Site. This EIAR has assessed the above three options with a particular focus on the final leg of the TDR between the Wind Farm Site and the Northern part of Ballina town Co. Mayo
- the 'Construction Haul Route' is referred to, this relates to the proposed routes from local quarries and supplies to the Site.

The potential zone of impact of the Proposed Development on the water environment is limited within the Water Study Area as defined on **Figure 9.1**. These are the surface water catchments within which the Proposed Development is located. The main water courses within the Water Study Area are the Heathfield, Cloonalaghan and Cloonaghmore Rivers.

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

- Establishment of the 2 no. Temporary Construction Compounds, which will involve the minor regrading of peat/soils/subsoils and the emplacement of the compound. Welfare facilities will be provided at the compound. Wastewater effluent will be collected in a wastewater holding tank and periodically emptied by a licensed contractor.
- Upgrade of existing Site Access Tracks, public access roads and the construction of new Site Access Tracks will use the excavate and replace technique. These works have the potential to effect surface water quality.
- Construction of the crane hardstand areas and turbine assemblage areas will utilise ground bearing foundations. Construction of these areas has the potential to effect surface water quality.
- Construction of the 18 no. Turbine Foundations which will involve the removal of peat/subsoil/bedrock and will require large volumes of concrete. The use of large concrete volumes could affect surface and groundwater quality.
- Construction of the new proposed 110 kV Gas Insulated Switchgear (GIS) substation and associated compound, including 2 no. control buildings with welfare facilities.
- Construction of a Battery Energy Storage System (BESS) compound to the east of the GIS substation.
- Change of use of an existing residential site to a Permanent Operations Compound. This will involve the change of use of the existing dwelling to an operations office,

providing meeting rooms and welfare facilities for the operational and maintenance staff.

- Construction of a meteorological mast. Construction has the potential to effect surface water quality.
- Construction of the underground grid cable trench between turbines and the proposed onsite substation. This will involve the excavation of a shallow trench (approximately 1.3 m 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 affect surface water quality.
- Works along the GCR which will consist of 13.55 km of underground grid connection (of which 12.43 km is located along the public road corridor and 1.12 km is located within the Killala Business Park grounds). The Grid Connection will be constructed to the requirements and specifications of EirGrid.
- 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 the Site where required. Bottled water will be used for potable supply.
- Tree felling (40.24 ha) and replanting works, with all works to be done in accordance with Forest Service Guidelines. Felling works can result in potential surface water quality effects.
- Temporary works will be required to accommodate the delivery of turbine components along sections of the TDR.

9.1.1.1 Wind Farm Site Drainage

Runoff control and drainage management are key elements in terms of mitigation against potential effects on surface water bodies.

Two distinct methods will be employed to manage drainage water. The first method involves 'keeping clean water clean' by avoiding disturbance to existing drainage features, minimising any works in or around 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 drains.

During the construction phase, all runoff from works areas (i.e., dirty water) will be attenuated and treated to a high quality prior to being released.

The proposed wind farm drainage will not significantly alter the existing drainage regime at the Site. Any existing drains will be routed under/around the proposed Site Access Tracks using culverts as required. Runoff from Site Access Tracks, turbine bases, and developed areas (construction compounds, met mast) will be collected and treated in local (proposed) silt traps and settlement ponds/swales and then discharged over buffered outfalls.

The Proposed Development also includes a total of 15 no. watercourse crossings within the Wind Farm Site. Many of these crossings are located at existing culvert and bridge crossings. The Proposed Development includes 6 no. new watercourse crossings at the Wind Farm Site (3 no. new culvert crossings along public roads where widening is proposed and 3 no. new culvert crossings along the Site Access Tracks). In addition, the 33 kV internal cable collector within the Wind Farm Site will cross the Carn River by directional drilling. The locations of the watercourse crossings are detailed in **Section 9.4.2.7**.

9.1.1.2 Grid Connection

The Grid Route and the associated construction methodologies are detailed in **Chapter 2: Development Description**.

The proposed Tirawley Wind Farm development will be connected to the exiting Tawnaghmore 110 kV substation via underground cabling (UGC). The Grid Route generally follows local public roads to connect the proposed onsite substation in the townland of Barroe to the existing Tawnaghmore 110 kV substation located ~2 km south of Killala village. The overall length of the Grid Connection between the substation and the existing Tawnaghmore 110 kV substation is 13.55 km, of which, of which 12.43 km is located along the public road corridor and 1.12 km is located within the Killala Business Park grounds. The Grid Connection will be constructed to the requirements and specifications of EirGrid. The electricity will be transmitted as a three-phase power supply meaning there will be three individual conductors in each cable circuit. The three conductors will be laid in separate ducts which will be laid in accordance with EirGrid functional specifications (CDS-GFS-00-001-R1[1]) for 110 kV underground cables.

[1] https://www.eirgridgroup.com/site-files/library/EirGrid/110kV-Underground-Cable-Functional-Specification-General-Requirements.pdf

Along the Grid Connection there are a total of 10 no. existing watercourse crossings. The locations of the watercourse crossings along the Grid Connection are detailed in **Section 9.3.3.2**.

9.1.1.3 Turbine Delivery Route

This EIAR considered 3 no. possible TDRs. Option 1 considers a route from Killybegs Port, Option 2 is from Galway Port and Option 3 is from the port of Foynes. The EIAR has assess the above 3 no. options with particular focus on the final leg between Ballina town and the Wind Farm Site which will approach the Wind Farm Site from the West.

The works along the TDR and associated construction / work methodologies are detailed in full in **Chapter 2: Development Description**.

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 area of expertise and experience is hydrology and hydrogeology. We routinely work on hydrogeological assessments for groundwater supplies.

The chapter of the EIAR has been prepared by Michael Gill, Conor McGettigan and Jenny Law.

Michael Gill is an Environmental Engineer, Hydrologist and Hydrogeologist with 22 years' environmental consultancy experience in Ireland. Michael has an MSc in Engineering hydrology from TCD (peatland hydrology) and an MSc in Applied Hydrogeology from Newcastle University. He has completed numerous (100+) hydrological and hydrogeological assessments relating to groundwater supplies across Ireland. Michael is an approved hydrogeologist on the Irish Water Hydrogeologist Framework, and he has completed several water supply/groundwater projects in Munster.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 4 years' experience in the environmental sector in Ireland. Conor holds an M.Sc. in Applied Environmental Science and a B.Sc. in Geology from UCD. Conor has prepared the hydrology and hydrogeology chapter of environmental impact assessment reports for several wind farm developments. Conor also routinely prepares hydrological and hydrogeological assessment reports, WFD compliance assessment reports and flood risk assessments for a variety of development types including wind farms and quarries.

Jenny Law (BSc, MSc) is an environmental geoscientist holding a first honour's degree in applied environmental geosciences from the UCC (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 Assessment Structure

This chapter is structured in accordance with the EIA Directive and current EPA guidelines (EPA, 2022).

As outlined in the EPA Guidelines on the Information to be Contained in Environmental Impact Assessments (EPA, 2022) there are 7 stages in the preparation of an EIAR. The first 4 stages include Screening, Scoping, the Consideration of Alternatives and Project Description and these are dealt with in the preceding chapters of the EIAR.

Stage 5 refers to Describing the Baseline Environment: The EPA Guidelines state that this section should refer to the current state of the environmental characteristics and involves the collection and analysis of information on the condition, sensitivity and significance of relevant environmental factors which are likely to the significantly affected by the Development. The EPA guideline criteria require that the baseline environment is described in terms of the context, character, significance and sensitivity of the existing environment. The baseline hydrological and hydrogeological environment is described in **Section 9.3** of this chapter.

Stage 6 refers to the Assessment of Effects. This section should identify, describe and present an assessment of the likely significant effects of the Proposed Development on the environment. This section includes potential effects arising from all phases (construction, operation and decommissioning phases) of the Proposed Development as well as any potential cumulative effects which may arise as a result of the Proposed Development. The guideline criteria for the assessment of effects states that the purpose of an EIAR is to identify, describe and present an assessment of the likely significant effects. The likely effects are described with respect to their quality (positive, neutral or negative), significance (imperceptible to profound), extent (i.e. size of area or number of sites effected), context (is the effect unique of being increasingly experienced), probability (likely or unlikely), duration (momentary to permanent), frequency and reversibility. The descriptors used in this environmental impact assessment are those set out in the EPA (2022) Glossary of effects as shown in **Chapter 1: Introduction** of this EIAR. The potential likely significant effects of the Proposed Development on the hydrological and hydrogeological environment are detailed and assessed in **Section 9.4**.

Stage 7 refers to Mitigation and Monitoring and should describe the measures envisaged to avoid, prevent, reduce or offset any identified significant adverse effects on the environment. The section may also present any post-consent monitoring proposed to ensure that the Proposed Development performs as intended. Mitigation measures and post mitigation residual effects for the Proposed Development in relation to the hydrological and hydrogeological environment are included in **Section 9.5**.

In summary the structure of this Hydrology and Hydrogeology chapter is as follows:

- Outline of the Assessment Methodology and Significance Criteria.
- Description of baseline conditions at the Proposed Development site.
- Identification and assessment of potential likely and significant effects on the hydrological and hydrogeological environment associated with the Proposed Development, during the construction, operational and decommissioning phases of the Proposed Development.
- Mitigation measures to avoid or reduce the potential effects.
- Identification and assessment of residual effects of the Proposed Development considering the implementation of the proposed mitigation measures.
- Identification and assessment of cumulative effects if and where applicable.

9.2 ASSESSMENT METHODOLOGY AND SIGNIFICANT CRITERIA

9.2.1 Assessment Methodology

The following calculations and assessments were undertaken in order to evaluate the potential effects of the Proposed Development on the hydrology and hydrogeology aspects of the environment at the location of the Proposed Development.

- Characterise the topographical, hydrological and hydrogeological regime of the Proposed Development site from the data acquired through desk study and onsite surveys.
- Undertake preliminary water balance calculation.

- Undertake preliminary flood risk evaluations.
- Undertake a WFD Compliance Assessment for the Proposed Development.
- Consider hydrological or hydrogeological constraints together with the Proposed Development design.
- Consider drainage issues, or issues with surface water runoff quality as a result of the Proposed Development, its design and methodology of construction.
- Assess the combined data acquired and evaluate any potential likely and significant effects on the hydrological and hydrogeological environment.
- Where effects are identified, measures are described that will mitigate or reduce the identified effect.
- The findings are presented and reported in a clear and logical format that complies with EIAR reporting requirements.

9.2.2 Relevant Legislation

The requirements of the following legislation are complied with:

- S.I. No. 349/1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84/1994, S.I. No. 101/1996, S.I. No. 351/1998, S.I. No. 93/1999, S.I. No. 450/2000 and S.I. No. 538/2001, S.I. No. 134/2013 and the Minerals Development Act 2017), the Planning and Development Act, and S.I. No. 600/2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/337/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment.
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive).
- Planning and Development 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. 94/1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive).

- S.I. No. 293/1988: Quality of Salmon Water Regulations.
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722/2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for the implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("WFD"). The WFD was given legal effect in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003).
- S.I. No: 122/2010: European Communities (Assessment and Management of Flood Risks) Regulations, resulting from EU Directive 2007/60/EC.
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive).
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended.
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

9.2.3 Relevant Guidance

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

- Environmental Protection Agency (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements.
- DoE/NIEA (2015): Wind farms and groundwater impacts - A guide to EIA and Planning considerations".
- OPW (2009) The Planning System and Flood Risk Management.
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Wind Farm Development Guidelines for Planning Authorities (2006).
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses.

- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010).
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note).
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note).
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006).
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001.
- Land Types for Afforestation (Forest Service, 2016b).
- Forest Protection Guidelines (Forest Service, 2002).
- Forest Operations and Water Protection Guidelines (Coillte, 2013).
- Forestry and Water Quality Guidelines (Forest Service, 2000b).
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018).

9.2.4 Desk Study

A desk study of the was completed in the Summer of 2022 to collect all relevant hydrological, hydrogeological and meteorological data for the Site and the surrounding area. The desk study was completed to supplement site walkover surveys and site investigations (refer to **Section 9.2.5**). The desk study information has been checked and updated, where necessary, in November and December 2024 and again in July 2025.

The desk study involved consultation with the following sources:

- Environmental Protection Agency databases (www.epa.ie).
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie).
- Met Eireann Meteorological Databases (www.met.ie).
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie).
- Water Framework Directive Map Viewer (www.catchments.ie).
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 6 ;Geological Survey of Ireland (GSI, 1999).
- Geological Survey of Ireland - Groundwater Body Characterisation Reports.
- OPW Flood Mapping (www.floodinfo.ie).
- Environmental Protection Agency – "Hydrotool" Map Viewer (www.catchments.ie).

9.2.5 Site Investigations

Hydrological walkover surveys were undertaken by HES on 3rd – 5th August 2022, 29th November – 1st December 2022, 30th March 2023 and 20th April 2023. These surveys were completed by Conor McGettigan and Jenny Law (refer to **Section 9.1.2** for qualifications and relevant experience). These site investigations included detailed drainage mapping, peat probing at proposed infrastructure locations, surface water flow monitoring and field hydrochemistry. In addition, grab sampling was completed during the March and April 2023 site visits. The sampling in March 2023 was preceded by a wet period with significant rainfall while the sampling completed in April 2023 occurred during a dry period with low rainfall.

The hydrological and hydrogeological data used in this assessment includes:

- HES walkover surveys and drainage mapping at the Site on 3rd – 5th August 2022, 29th November – 1st December 2022, 30th March 2023 and 20th April 2023 whereby water flow directions and drainage patterns were recorded.
- The surveys included field hydrochemistry and stream flow monitoring of watercourses draining the Site, and along the Grid Connection, in order to determine the origin and nature of surface water flows.
- A total of 20 no. surface water grab samples were taken (March and April 2023) to determine the baseline water quality of the primary surface waters originating from the Site and the Grid Connection.
- HES completed 50 no. peat probes at proposed infrastructure locations.
- A total of 21 no. peat probes were completed by Whiteford Geoservices Ltd. at the Site.
- HES completed a Flood Risk Assessment for the Proposed Development (refer to **Appendix 9.1**).
- A WFD Compliance Assessment Report has been completed for the Proposed Development and is included as **Appendix 9.3**.
- A Peat Stability and Landslide Risk Assessment (PSRA) was completed for the Proposed Development by (Whiteford, 2023) (refer to **Appendix 8.1**).
- JoD completed a Peat and Spoil Management Plan for the Proposed Development (January 2024) (refer to **Appendix 2.1**).

9.2.6 Evaluation of Potential Effects

The conventional source-pathway-target 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 Development.

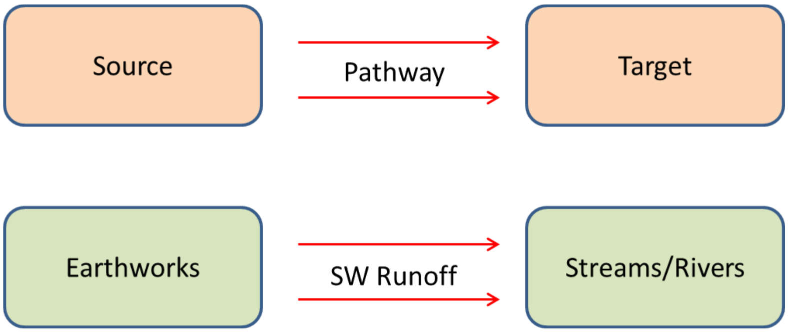


Plate 9.1: The conventional source-pathway-target model

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

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

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

The assessment of effects is Stage No. 6 of 7 in the EIAR process. In order to provide an understanding of the stepwise assessment process applied, a summary guide is presented below, which defines the steps (Steps 6a to 6g) taken in each element of the assessment of effects process (refer to **Table 9.1** below). The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model, and the EPA impact descriptors are combined.

Using this defined approach, the assessment of effects process is then applied to all wind farm construction, operation and decommissioning activities (including the substation and grid connection) which have the potential to generate a significant adverse effect on the hydrological and hydrogeological environment.

Table 9.1: Steps in Assessment Stage 6 (Assessment of Effects) and Stage 7 (Mitigation Measures)

Stage 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.

Stage 6b	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which potential impacts are generated.
Stage 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.
Stage 6d	Pre-mitigation Effect:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Stage 7a	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.
Stage 7b	Post-Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Stage 7c	Significance of Effects:	Describes the likely significant post-mitigation effects of the identified potential impact source on the receiving environment.

9.2.6.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development (EPA, 2022). The EPA provides guidance on the assessment methodology, including defining general descriptive terms in relation to magnitude of effects however, in terms of qualifying significance of the receiving environment the EPA guidance also states that:

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

Potential affects arising by a proposed development in terms of hydrology and hydrogeology will likely extend beyond the Site boundary. In describing the sensitivity of the water environment it is appropriate to rate the receptors while considering the value of the receiving environment. To facilitate the qualification of hydrological and hydrogeological attributes, guidance specific to hydrology and hydrogeology as set out by National Roads Authority (NRA), and guidance specific to landscape as set out by Scottish National Heritage (SNH) has been used in conjunction with EPA guidance.

Levels of importance are defined for **Table 9.2** for hydrology and **Table 9.3** for hydrogeology and are used to assess the potential effect that the Development may have on them (NRA, 2008).

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, significance 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, significance 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, significance 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, significance 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	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.

Importance	Criteria	Typical Example
	value on an international scale.	
Very High	Attribute has a high quality, significance 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, significance 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, significance 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, significance or value on a local scale.	Poor Bedrock Aquifer Potable water source supplying <50 homes.

9.2.6.2 Magnitude

The magnitude of potential effects arising as a product of the Proposed Development are defined in accordance with the criteria provided by the EPA, as presented in **Table 9.4**. These descriptive phrases are considered general terms for describing potential effects of the Proposed Development, and provide for considering baseline tends, for example; a *Moderate* impact is one which *is consistent with the existing or emerging trends*.

Table 9.4: Describing the Magnitude of Effects

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

9.2.6.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential effects, rating of significant environmental effects is done in accordance with relevant guidance in **Table 9.5**. This matrix qualifies the magnitude of potential effects based on weighting same depending on the importance and/or sensitivity of the receiving environment.

Table 9.5: Weighted Rating of Significant Environmental Effects

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

9.2.7 Scoping and Consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. Consultation response relating to the hydrological and hydrogeological environment were received from the Inland fisheries Ireland (IFI) and the Office of Public Works (OPW). Details of these scoping responses and the actions taken to address them are summarised in **Table 9.6**.

Table 9.6: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response
Inland Fisheries Ireland (IFI)	12th June 2023	IFI have requested that the following hydrological/hydrogeological items are assessed as part of the EIAR: A number of watercourses and drains may exist on site which are not marked on the OSI maps and must be subject to the proposed aquatic buffer zones – *Response: HES completed detailed drainage mapping of the Site and buffers have been applied to all natural watercourses and manmade field drains identified during the walkover surveys.*

Consultee	Type and Date	Summary of Consultee Response
		A construction and operational phase water quality monitoring programme must be put in place – *Response: Drainage design for the construction and operational phases are detailed below and include monitoring of surface water quality.* The location of turbines and main construction works must avoid high groundwater vulnerability areas – *Response: Key development infrastructure avoids areas mapped as having Extreme groundwater vulnerability. Refer to Section 9.4.2.9 for an assessment of the Development on local groundwater quality.* Assessment of the impacts on the hydrology of the site due to excavations and any dewatering of excavations – *Response: Refer to Section 9.4.2.2 and Section 9.4.2.1.* Works at watercourse crossings should be assessment and must not result in any effects on fish passage – *Response: Refer to Section 9.4.2.7 and Section 9.4.2.11.*
Office of Public Works	8th March 2023	*The Office of Public Works (OPW) Moy Drainage have no maintainable channels in the area of the proposed Tirawley Windfarm development located 2.5km east of Ballycastle and 4.7km northeast of Killala, Co. Mayo. The potential cable route of the ESB transmission line is located north of OPW Moy Drainage scheme channels in this area, this office would request to be consulted on locations and measure to protect the proposed ESB transmission line.* *There is an existing Drainage District in the area identified as Lough Dalla Drainage District, This office would recommend that contact be made with Mayo County Council as they are the statutory Authority with responsibility for maintenance of Drainage Districts.* The OPW has no record flooding or past flood events within the above townlands. Under Section 50 of the 1945 Arterial Drainage Act & SI No. 122 of 2010, 2010 no person, including a body corporate, shall construct any new bridge or alter, reconstruct, or restore any existing bridge over any watercourse without the consent of the Commissioners or otherwise than in accordance with plans previously approved by the Commissioners. Where the development intends to install a culvert or bridge over a watercourse as part of the development Section 50 approval will be required in advance from the Commissioners of Public Works, The OPW office recommends that no flooding should occur during or after construction of the proposed wind farm. *Response: Refer to Section 9.4.3.1 and the Flood Risk Assessment attached as Appendix 9-1.*

9.2.8 Limitations and Difficulties Encountered

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

9.3 BASELINE ENVIRONMENT

9.3.1 Site Description and Topography

9.3.1.1 Wind Farm Site

The Wind Farm Site is located ~14.5 km northwest of Ballina Town, ~5.2 km northwest of the village of Killala and ~2.4 km east of Ballycastle village in north Co. Mayo. The Wind Farm Site has a total area of ~119.12 ha.

The Wind Farm Site is comprised of blanket bog, coniferous forestry, transitional woodland scrub and agricultural pastures. Land cover at the Wind Farm Site is mapped by Corine (2018) as inland wetland peat bogs, with some smaller areas of coniferous forestry, semi natural areas and agricultural pastures (www.epa.ie). No significant land use changes have been recorded by historic Corine mapping (1990-2018). Land cover at the Wind Farm Site has been verified by site walkover surveys completed by HES. The Wind Farm Site is comprised of agricultural pastures with fields typically separated by hedgerows and stonewalls. Local pockets of coniferous forestry and peat bogs are also located within the Wind Farm Site. A former abandoned quarry is also located in the northeastern section of the Wind Farm Site in the townland of Castlelackan Demense.

The Wind Farm Site is accessed via several local roads which branch off the R314 which joins Killala in the southeast to Ballycastle in the northwest. These local roads serve numerous dwellings and associated farm buildings scattered in lands surrounding the Wind Farm Site.

Topography across the Wind Farm Site is variable, ranging from ~20 to 155 mOD (metres above Ordnance Datum). The north and center of the Wind Farm Site are located on elevated ground. The greatest elevations are found in the north of the Wind Farm Site, which is situated on the southeastern slopes of Knockboha Hill, which stands at an elevation of ~186 mOD. There are also several other local high points further to the south which range in elevation from ~108 to 137 mOD. Meanwhile, the southern section of the Wind Farm Site is located on lower ground with topography sloping gently to the southeast towards Cloonaghmore Estuary and Killala Bay.

In terms of the Proposed Development infrastructure a total of 10 no. turbines are located at elevations in excess of 100 mOD. These turbines are largely situated towards the north and center of the Wind Farm Site. Further to the south, 8 no. turbines and the proposed substation location are located on lower ground with elevations of less than 100 mOD.

9.3.1.2 Grid Connection

The Grid Connection is ~13.55 km in length. The Grid Connection generally follows local public roads which connect the proposed onsite substation, in the townland of Barroe, to the existing Tawnaghmore 110 kV substation, located ~2 km south of Killala village.

The Grid Connection contains some "off road" sections. In the northern section of the Grid Connection and within the Wind Farm Site, in the townland of Barroe, there is a small off-road section in the immediate vicinity of the proposed Onsite Substation. The Grid Connection then travels east and south along the local road network before it joins the R314 to the southeast of St. Patricks' College at Lackan Cross. The Grid Connection then travels to the southeast along the R314, crossing the Cloonaghmore River at Palmerstown Bridge. The Grid Connection then veers to the south along the local road network before turning to the east at Magherabrack. The Grid Connection then briefly travels along the R314 before entering Killala Business Park from the east and the existing business park entrance. The Grid Connection approaches Tawnaghmore substation from the north.

At bridge locations it is proposed to achieve crossings through the installation of cable ducting in the roadside verge (or within the road itself) or through the use of horizontal directional drilling (HDD). The lands along the Grid Connection are screened throughout the EIAR and considered as part of this assessment.

9.3.2 Rainfall and Evapotranspiration

Long term Annual Average Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall recorded at the Ballycastle Garda Station rainfall station, located ~3 km west of the Wind Farm Site, are presented in **Table 9.7**.

Met Éireann also provide a grid of AAR for the entire country for the period of 1991 to 2020. Based on these, more site-specific modelled rainfall values, the AAR at the Wind Farm Site ranges from 1,354 to 1,437 mm/year. The AAR is 1,395 mm/yr (this is considered to be the most accurate estimate of AAR from the available sources). An example of the 1991-2020 rainfall data for the Wind Farm Site is presented in **Table 9.7** for Easting 116,000 and Northing 336,000).

Table 9.7: Local Average Long-term Rainfall Data (mm)

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened			Closed	
Ballycastle		110,600		337,400		43		1942			1988	
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
158	122	125	83	82	79	88	103	123	160	158	175	1,456
Wind Farm Site (E 116,000, N 336,000) (1991-2020)												
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
149	122	105	82	82	85	97	107	109	138	159	165	1,399

The closest synoptic[2] station where the average potential evapotranspiration (PE) is recorded is at Belmullet, ~45 km west of the Wind Farm Site[3]. The long-term average PE for this station is 527 mm/year. This value is used as the best estimate of the Wind Farm Site PE. Actual Evaporation (AE) is estimated as 501 mm/year (which is 0.95 × PE).

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

Effective rainfall (ER) = AAR – AE

= 1,399 mm/year – 501 mm/year

ER = 898 mm/year

Groundwater recharge coefficient estimates are available from the GSI (www.gsi.ie). Within the Wind Farm Site recharge coefficients range from ~4-85 %. The majority of the Wind Farm Site is mapped in areas of low groundwater recharge (10 - 22.5 %) due to the presence of peat and moderately permeable subsoils. Some areas in the northeast of the Wind Farm Site, in the vicinity of the abandoned quarry, have higher percentages of groundwater recharge (85 %) due to the presence of rock close to or at the surface.

An estimate of ~135 mm/year average annual recharge is given for the Wind Farm Site. This calculation is based on a recharge coefficient of 15 %. A recharge coefficient at the lower end of the GSI scale was chosen due to the coverage of peat and poorly draining soils across much of the Wind Farm Site, the sloping nature of the area and the low to moderate permeability of the underlying Poor and Locally Important bedrock aquifers. This means that the hydrology of the Wind Farm Site is characterised by relatively high surface water runoff rates and low rates of groundwater recharge. This is supported by onsite

[2] 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.
[3] Please note this is the only PE data available, and the next nearest station where PE is recorded is at Claremorris, ~60km southeast of the Wind Farm Site.

observations made during the site walkovers surveys whereby a high density of streams and drainage features were recorded.

Therefore, conservative annual recharge and runoff rates for the Wind Farm Site are estimated to be 135 mm/yr and 763 mm/yr respectively.

Met Éireann's Translate Project (https://www.met.ie/science/translate) provides projections for a range of future climate change scenarios, as Ireland's future climate will depend on global greenhouse gas emissions reductions. The severity of any future climate change will depend on the degree of future warming. In relation to precipitation chances, the models show that summer rainfall may decrease by approximately 9 % and winter rainfall could increase by up to 24 %. In a 1.5 °C world, average winter and summer precipitation rates are projected to be 5.36 mm/day and 3.10 mm/day respectively in Co. Mayo. Meanwhile, in a 4 °C world, the average winter and summer precipitation rates in Co. Mayo are projected to be 6.08 mm/day and 2.86 mm/day respectively.
In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. A summary of various return periods and duration rainfall depths for the Wind Farm Site are presented in **Table 9.8**.

Table 9.8 Return Period Rainfall Depths

Return Period (Years)				
Storm Duration	1	5	30	100
5 mins	3.8	6.7	12.0	17.1
15 mins	6.2	11.0	19.6	28.1
30 mins	8.1	14.0	24.6	34.8
1 hour	10.6	17.9	30.8	43.0
6 hours	21.1	33.8	55.0	74.4
12 hours	27.5	43.3	68.9	91.9
24 hours	35.8	55.3	86.3	113.7
2 days	45.0	66.6	99.7	128.1

9.3.3 Regional and Local Hydrology

9.3.3.1 Wind Farm Site

On a regional scale, the Wind Farm Site is located in the Blacksod-Broadhaven Bay surface water catchment within Hydrometric Area 33 of the Western River Basin District. The Blacksod-Broadhaven catchment includes the area drained by all streams entering tidal water in Blacksod and Broadhaven Bays and between Corraun Point and Benwee Head, Co. Mayo, draining a total area of 1,302 km² (EPA, 2021). The Wind Farm Site is also mapped in the Glencullin River sub-catchment (Glencullin[NorthMayo]_SC_010) according to WFD mapping. A regional hydrology map is attached as **Figure 9.1**.

More locally the Wind Farm Site is mapped in 3 no. WFD river sub-basins:

- The majority of the Wind Farm Site is located in the Cloonalaghan_010 WFD river sub-basin. This area is drained by the Carn River and several 1st and 2nd order streams all of which discharge into the Cloonalaghan River.
    - The southern section of this WFD river sub-basin is drained by the Cloonavarry Stream and the Carn River. The Cloonavarry Stream flows to the southeast ~130 m south of wind turbine AT02. The Carn River flows the southeast ~430 m northeast of wind turbine AT04. These watercourses confluence to form the Cloonalaghan River which flows to the northeast ~130 m east wind turbine AT01.
    - The northern section of this WFD river sub-basin is drained by several mapped tributaries of the Cloonalaghan River. These include:
        - the Ballymurphy Stream which is located ~100 m north of wind turbine AT01;
        - the Lissadrone Stream which is located ~70 m south of wind turbine AT10;
        - the Keeloges Stream which is mapped ~180 m east of wind turbine AT11; and,
        - the Conaghra Stream, located ~130 m north of wind turbine AT12.
    - All waters draining this area of the Wind Farm Site eventually end up in the Cloonaghan River which discharges into Lackan Bay.
- The northeast of the Wind Farm Site is located in the Knockboha_010 WFD river sub-basin. This area of the Wind Farm Site is drained by several 1st order streams which flow downslope to the east into Lacken Strand. The watercourses in the vicinity of the Wind Farm Site are locally unnamed but have been assigned names by the EPA. One stream is referred to by the EPA as the Castletown stream. This watercourse is mapped to originate ~250 m northeast of wind turbine AT17.
- The northwest of the Wind Farm Site is located in the Gortmore Stream_010 WFD river sub-basin. This area is drained by a small stream, referred to by the EPA as the Lecarrowntemple Stream. A tributary of this stream referred to by the EPA as the Barhill Stream is mapped ~90 m northeast of wind turbine AT08. The Lecarrowntemple Stream itself flows to the east ~150 m north of wind turbine AT08 before discharging into the Heathfield River to the west. The Heathfield River, referred to as the Gortmore Stream by the EPA, flows to the north before discharging into Bunatrahir Bay.

A local hydrology map is attached as **Figure 9.2** and a site drainage map is included as **Figure 9.3**. Many of the streams draining the Wind Farm Site have been assigned names by the EPA, however only the larger watercourses of the Heathfield, Carn and Cloonalaghan rivers are named on local OSI maps. The names of many of the streams referred to in the preceding text have been assigned by the EPA. Please note that Heathfield River is referred to as the Gortmore Stream by the EPA. A summary of the location of the Proposed Development's infrastructure with respect to WFD catchments, sub-catchments and river sub-basins is presented in **Table 9.9**.

Table 9.9: WFD Catchments, Sub-Catchments and River Sub-Basins of the Wind Farm Site

Catchment	Sub-Catchment	River Sub-Basin	Proposed Development Infrastructure
Blacksod - Broadhaven Bay	Glencullin [NorthMayo]_SC_010	Cloonalaghlan_010	AT01, AT02, AT03, AT04, AT05, AT06, AT09, AT10, AT11, AT12, AT13, AT14, AT15, AT16, spoil deposition areas, substation, 2 no. temporary construction compounds, operations building and met mast. Note that AT18 is located on the boundary between this sub-basin and the Knockboha_010 sub-basin.
		Knockboha_010	AT17 and spoil deposition areas. Note that AT18 is located on the boundary between this sub-basin and the Cloonalaghlan_010 sub-basin.
		Gortmore Stream_010	AT07 and AT08

9.3.3.2 Grid Connection

The northern section of the Grid Connection, in the vicinity of the Wind Farm Site, is located in the Blacksod-Broadhaven Bay surface water catchment. Further south, the vast majority of the Grid Connection is located in the Moy and Killala Bay surface water catchment within Hydrometric Area 34. A regional hydrology map is attached as **Figure 9.1**.

Within the Blacksod-Broadhaven Bay surface water catchment, all surface watercourses along the Grid Connection flow to the southeast towards the Cloonalaghan River. In this catchment, there is 1 no. crossing over an EPA mapped watercourse and 1 no. crossing over a non-EPA mapped watercourse. These crossings occur on the local road which extends northwards from the R314 at Lackan Cross. 1 no. watercourse crossing is an existing bridge crossing over the EPA mapped Cloonalaghan River, with a box culvert crossing over a watercourse which is not recorded on the EPA database.

Further to the south, within the Moy and Killala Bay surface water catchment, there are a total of 8 no. existing watercourse crossings. The western section of the Grid Connection is drained by the Cloonaghmore River and its tributaries. The Grid Connection crosses the Cloonaghmore River (EPA Code: 34C03) along the R314 at Palmerstown Bridge. 2 no. additional crossings occur over smaller watercourses, referred to by the EPA as the Rathbaun stream (EPA Code: 34R33) and the Rathcash Stream (EPA Code: 34R30). Further south, there is an existing bridge crossing over a small stream (EPA Code: 34R25) in the townland of Rathowen East and another crossing over the Magherabrack stream (EPA Code: 34M16).

The eastern section of the Grid Connection is mapped in the Abbeytown sub-catchment. There are a total of 3 no. existing watercourse crossings mapped in the vicinity of Killala Business Park. 2 no. crossings exist over the Moyne Stream, with an additional crossing over the Meelick Stream (EPA Code: 34M20), a small tributary of the Moyne Stream.
All watercourse crossings along the Grid Connection are identified in **Figure 9.4**.

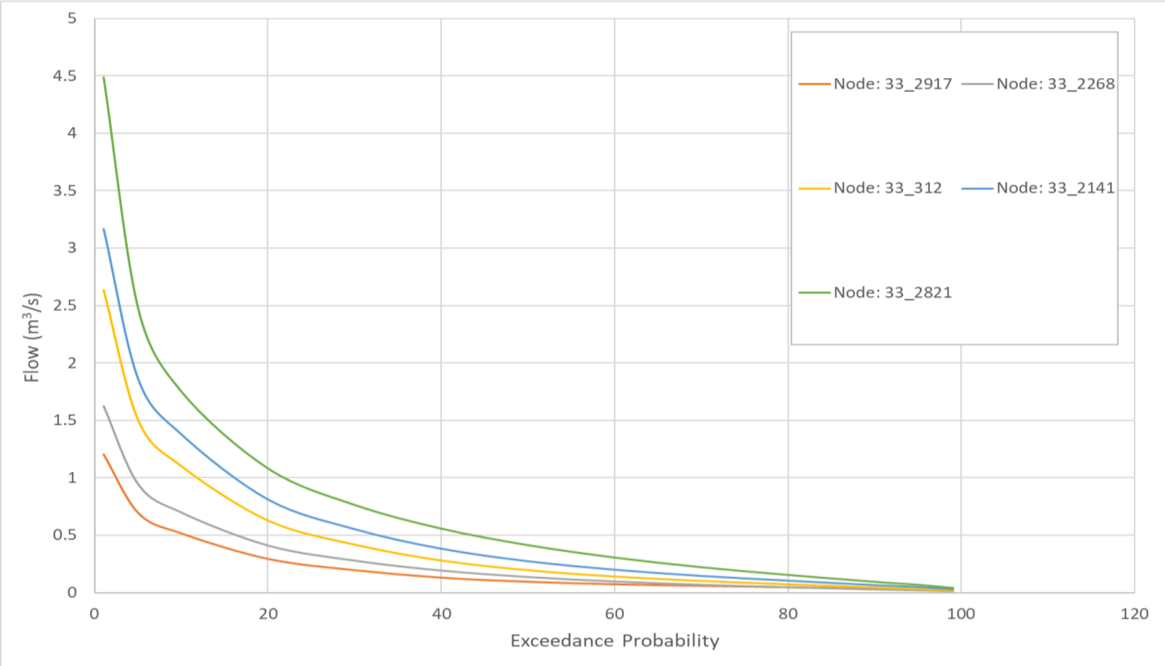
9.3.3.3 Surface Water Flows

There are no OPW gauging stations located downstream of the Wind Farm Site (www.hydronet.ie).

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 downstream of the Wind Farm Site and **Plate 9.2** below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes. No estimated flow volumes were available for any of the 1st or 2nd order streams which directly drain the Wind Farm Site. The locations of the consulted nodes are shown on the Local Hydrology Map attached as **Figure 9.2**.

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 33_2917 on the Carn River, upstream of its confluence with the Cloonalaghan River, is modelled to be 0.023 m^3/s (23l/s). This indicates that 95 % of the time, the flow at this location is estimated to be at or above 0.023 m^3/s. Flow volumes increase progressively downstream due to increasing catchment size. For example, the 95 %ile flow at Node 33_2821 on the Cloonalaghan River, upstream of its discharge point into Lackan Bay, is 0.067 m^3/s (67 l/s). Therefore, flow volumes increase progressively downstream of the Wind Farm Site, associated with the increased upstream catchment areas of the respective watercourses.

Plate 9.2: EPA Hydrotool Node Flow Duration Curves



9.3.4 Wind Farm Site Drainage

As discussed above, the Wind Farm Site is drained by several small streams. Many of these natural watercourses originate in the vicinity of the Wind Farm Site and flow downslope before discharging into the Cloonalaghan River to the southeast, the Heathfield River to the west or directly into Lackan Bay. A wind farm site drainage map is included as **Figure 9.3**.

In places, the natural drainage is further facilitated by a network of manmade drains. The nature of these drains depends on the local land use in the vicinity of the Wind Farm Site.

In agricultural lands, drainage is facilitated by manmade field drains that are typically routed along hedgerows and field boundaries. These drains discharge locally to nearby streams.

In forested areas of the Wind Farm Site, drainage is enhanced by forestry drains. The forestry plantations are generally drained by a network of mound drains which typically run perpendicular to local topographic contours 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 15 m and 2 m respectively. As illustrated in **Plate 9.3** below, interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of forestry access tracks. Culverts are generally located at stream crossings and at low points under access tracks which drain runoff onto down-gradient forest plantations. A schematic of a typical standard forestry drainage network and one which is representative of the forested areas of the Wind Farm Site is shown as **Plate 9.3**. The forestry drains flow towards and discharge into natural streams downstream of the plantations.

Two rounds of surface water flow monitoring were completed at the main streams draining the Wind Farm Site and Grid Connection and the results are shown in **Table 9.10** below. The measured flows at most of the monitoring locations are typical of seasonal flows for small streams. Meanwhile, the flows recorded at SW4 on the Heathfield River, SW7 on the Cloonalaghan River and SW9 on the Cloonaghmore River are representative of larger watercourses. The monitoring locations are shown in **Figure 9.7**.

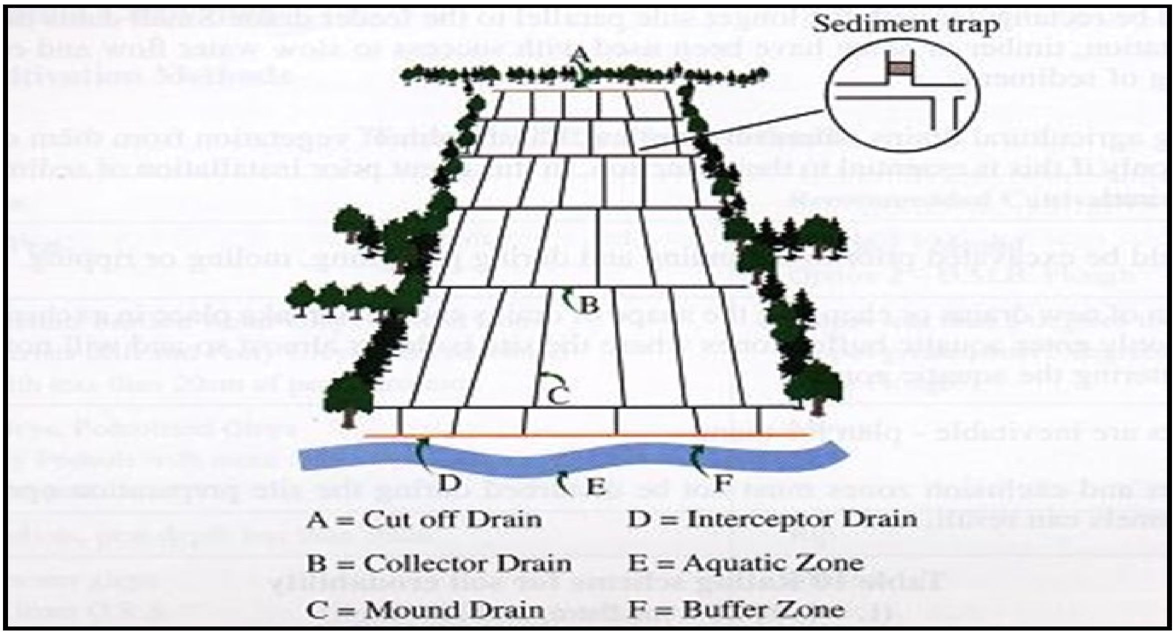


Plate 9.3: Process flow diagram for the Existing Forestry Drainage System

Table 9.10: Surface Water Flow Monitoring (L/S)

Location	Easting (Irish Grid)	Northing (Irish Grid)	EPA Watercourse Name (EPA Code)	Flow on 30th March 2023 (l/s)	Flow on 20th April 2023 (l/s)
SW1	116142	339771	Knockboha (33K03)	~15	~8
SW2	112941	340927	Killeen (33K07)	~12	~8
SW3	115038	336586	Lecarrowntemple (33L13)	~8	~2
SW4	112350	337788	Gortmore (Stream) [Mayo] (33G04)	~80	~50
SW5	115870	336936	Conaghra (33C54)	~15	~10
SW6	117463	335756	Lissadrone East (33L01)	~12	~8
SW7	116849	333196	Cloonalaghan (33C01)	~30	~30
SW8	117644	337791	Castlelacken (33C22)	~5	~2
SW9	118543	327693	Magherabrack (34M16)	~10	~12
SW10	117326	331420	Cloonaghmore (34C03)	~1,000	~1,000

9.3.5 Baseline Assessment of Wind Farm Site Runoff

This section undertakes a long-term water balance assessment and surface water runoff assessment for the baseline conditions at the Wind Farm Site.

The following water balance assessment gives a preliminary indication of the highest monthly average volume of surface water runoff expected. The calculations are carried out for the month with the highest average recorded rainfall versus evapotranspiration, in terms of subsoil and recharge.

The rainfall depths used in this water balance are long-term averages and are not used in the design of the sustainable drainage system for the Proposed Development.

The water balance calculations are carried out for the month with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (**Table 9.11**). It represents, therefore, the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the Site pre-development.

The surface water runoff co-efficient for the Wind Farm Site is estimated to be 85 % (this is based on an average recharge coefficient of 15 % as described in **Section 9.3.2** above). Surface water runoff rates are relatively high due to the presence of peat and moderately permeable subsoils and the low permeability of the bedrock aquifers.

The highest long-term average monthly rainfall modelled at the Wind Farm Site by Met Éireann is taken to occur in the month of December at 165 mm (refer to **Table 9.7** above). The average monthly evapotranspiration for the synoptic station at Belmullet in December was 8.5 mm. The water balance presented in **Table 9.12** indicates that a conservative estimate of surface water runoff for the Wind Farm Site during the highest rainfall month is 167,066 m^3/month or 5,389 m^3/day.

Table 9.11: Water Balance and Baseline Runoff Estimates for Wettest Month (December)

Water Balance Component	Depth (m)
Average December Rainfall (R)	0.165
Average December Potential Evapotranspiration (PE)	0.0085
(Actual Evapotranspiration (AE) = Potential Evapotranspiration (PE) x 0.95)	0.0081
Effective Rainfall December (ER = R – AE)	0.1569
Recharge (15 %)	0.0235
Runoff (85 %)	0.1333

Table 9.12: Baseline Runoff for the Wind Farm Site

Study Area	Approx Area (ha)	Baseline Runoff per Wettest month (m^3)	Baseline Runoff per day (m^3) in wettest month
Wind Farm Site	119.12	167,066	5,389

9.3.6 Flood Risk Identification

9.3.6.1 Wind farm Site

A Flood Risk Assessment of the Wind Farm Site has been carried out by HES, the findings of which are presented in full in **Appendix 9.1** and are summarised below.

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

Identifiable text on local available historical 6" or 25" mapping does not identify any lands that are "liable to flood" in the immediate area of the Wind Farm Site.

The OPW Past Flood Events Maps have no records of recurring or historic flood instances within the Wind Farm Site **(Figure 9.5**). The closest mapped recurring flood event (Flood ID: 10231) to the Wind Farm Site is recorded in the Lackan Strand area, ~1 km east of

AT18. Regarding this flood event, the local area engineers report (available at www.floodinfo.ie) states that a local road here floods regularly due to high tides.

The GSI 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 across the country. The flood map for this event does not record any flood zones along the streams and watercourses which drain the Wind Farm Site.

No CFRAM fluvial or coastal mapping has been completed for the area of the Wind Farm Site. The closest mapped CFRAM fluvial flood zones are located at Ballina and Crossmolina. The closest CFRAM coastal flood zones are mapped on the River Moy Estuary.

The National Indicative Flood Mapping (NIFM) for the Present-Day Scenario (**Figure 9.6**) shows flooding along the Heathfield, Carn and Cloonalaghan rivers in the vicinity and downstream of the Wind Farm Site. However, these flood zones do not encroach upon the Wind Farm Site which is entirely mapped in Fluvial Flood Zone C (Low Risk).

The closest mapped NIFM fluvial flood zones are located along the Carn River ~20-30m from the Wind Farm Site. The infrastructure proposed in this area comprises of an internal Wind Farm Site grid cable connection between wind turbine AT04 and the proposed onsite substation. The proposed internal grid cable connection crossing is located upstream of the NIFM modelled fluvial flood zones. Nevertheless, the works proposed comprise solely of temporary excavations and horizontal directional drilling under the Carn River and there will be no displacement of waters or increase in downstream flood risk.

The Mid-Range and High-End scenarios model potential flood zones associated with climate change and an increase in rainfall of 20 % and 30 % respectively. These modelled flood zones do not differ significantly from the Present Day Scenario discussed above.

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

Pluvial flooding may pose a risk in some flat areas of the Wind Farm Site which are overlain by poorly permeable soil and peat. Many of these areas are forested and drainage is facilitated by a series of forestry drains. In addition, much of the Wind Farm Site is located on sloping ground and water is likely to runoff and enter nearby watercourses. However, following periods of intense or prolonged rainfall, local surface water ponding may occur. Despite this the overall risk of pluvial flooding is considered to be low.

In general, the risk of flooding at the Wind Farm Site is low due to the elevated and sloping nature of the land and the high density of streams and drainage features.

9.3.6.2 Grid Connection

The Onsite Substation, associated Temporary Construction Compound and 0.1 km of the Grid Connection are located within the Wind Farm Site and as such, are addressed in the preceding section.

The OPW's Past Flood Event Layer (**Figure 9.5**) records a recurring flood event (Flood ID: 10228) in the Kilgobban area just to the east of the Grid Connection. Here the R314 is noted to flood once or twice a year due to high tides. Further recurring coastal flood events (Flood ID: 10229 and 10227) are mapped to the north of Killala. Meanwhile, recurring fluvial flood events (Flood ID: 587 and 10226) are recorded on the Cloonaghmore River ~3 km west of the Grid Connection in the townland of Tonrehown.

The CFRAM River Flood Extents mapping was reviewed along the length of the Grid Connection. There are no areas along the Grid Connection mapped within the CFRAM River Flood extent mapping.

The NIFM was also reviewed along the length of the Grid Connection (**Figure 9.6**). The Grid Connection crosses the mapped fluvial flood zones along the Cloonaghmore River at Palmerstown Bridge. Flood zones are also mapped to the west of the Grid Connection in the townland of Magherabrack.

No historic or modelled groundwater flood zones are mapped along the Grid Connection.
In summary, there are areas along the Grid Connection at existing watercourse crossings which may be prone to flooding. Due to the depth of the underground electrical cabling route, this will have no effect during the operational phase of the Proposed Development. During the construction phase, works along the underground electrical cabling route may have to be postponed following heavy rainfall events which could cause flooding in these areas.

9.3.7 Surface Water Quality

Biological Q-rating data for EPA monitoring points on the Cloonalaghan, Heathfield and Cloonaghmore Rivers downstream of the Wind Farm Site / Grid Connection are shown in **Table 9.13** 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).

Q-ratings are not available for many of the small watercourse draining the Wind Farm Site. Downstream of the Wind Farm Site the Heathfield River achieved a Q-rating of Q4 (i.e. Good status) at a bridge west of Gortmore in the 2020 monitoring round (Station Code: RS33G040800). To the southeast and downstream of the Wind Farm Site the Cloonalaghan River also achieved a Q-rating of Q4 (Station Code: RS33C010700).

In terms of the Grid Connection, the north of the route drains to the Cloonalaghan River which achieved a Q4 rating as detailed above. Much of the route drains to the Cloonaghmore River which also achieved a Q-rating of Q4 in 2022, ~1.2 km upstream of Palmerstown Bridge (Station Code: RS34C030270).

A map of local EPA monitoring stations is attached as **Figure 9.7**.

Table 9.13: Latest EPA Water quality Monitoring Q-Rating Values

Watercourse	Station ID	Easting	Northing	EPA Q-Rating
Heathfield River	RS33G040800	111000	339522	Q4
Cloonalaghan River	RS33C010700	117080	334271	Q4
Cloonaghmore River	RS34C030270	116677	330545	Q4

Field hydrochemistry measurements of unstable parameters including electrical conductivity (µS/cm), pH (pH units) and temperature (°C) along with turbidity (NTU) were taken at 10 no. surface water sampling locations over 2 no. monitoring rounds completed on 30th March and 20th April 2023. The results are presented in **Table 9.14** below. The monitoring locations are shown in **Figure 9.7** and are located in the main watercourses draining the Site.

Electrical conductivity values for the watercourses draining the Site ranged between 160 µS/cm and 747 µS/cm which is typical of freshwater streams and rivers. pH values were basic, ranging from 7.3 to 8.3. Turbidity ranged from <0.01 NTU to 8.5 NTU.

Table 9.14: Field Hydrochemistry

Location	Watercourse	EC (µS/cm)	Ph (H^+)	Temperature (°C)	Turbidity (NTU)
SW1	Knockboha	161 – 272	7.7 – 8	9.8	4.2 – 4.9
SW2	Killeen	455 – 648	7.9 – 8.2	11.1	3.8 – 4.2
SW3	Lecarrowntemple	227 – 386	7.3 – 7.6	8.4	1.8 – 4.1
SW4	Gortmore (Stream) [Mayo]	274 – 472	7.8 – 8.2	10.8	1.2 – 4.1
SW5	Conaghra	278 – 382	7.3 – 7.6	9.1	2.2 – 3.4
SW6	Lissadrone East	483 – 575	7.6 – 7.8	9.7	<0.01 – 0.07
SW7	Cloonalaghan	301 – 426	7.7 – 7.9	9.5	1.3 – 8.5
SW8	Castlelacken	220 – 323	7.5 – 7.8	8.5	0.6 – 3.7
SW9	Magherabrack	631 – 721	7.7 – 7.9	9.6	0.1 – 0.3
SW10	Cloonaghmore (34C03)	452 – 747	7.9 – 8.3	10	0.6 – 0.9

Surface water grab samples were also taken at these locations for laboratory analysis. The results are shown alongside relevant water quality regulations in

Table 9.15 below. Original laboratory reports are attached as **Appendix 9.2**.

Suspended solid concentrations ranged from <5 to 29 mg/l. Suspended solid concentrations were below the S.I 293 (of 1988) threshold limit of 25 mg/l in 19 of the 20 no. samples. A suspended solids concentration of 29 mg/l was recorded at SW1 on 30th March and likely resulted from disturbance of the riverbed during sampling.

Ammonia was found to be at or below the level of detection of the laboratory (0.02 mg/l) in 15 no. samples. All samples were below the threshold value for Good status (≤0.065 mg/l) as set out in SI 272 of 2009. BOD ranged between <1 to 3 mg/l. A total of 18 no. samples were above the High status threshold value of ≤1.3 mg/l. 2 of 20 no. results for BOD exceeded the "Good Status" and "High Status" threshold values. Nitrate concentrations were found to be below the level of detection of the laboratory in all samples (<5.0mg.l NO_3). Meanwhile, chloride concentrations ranged from 21.1 to 79.6 mg/l. For orthophosphate, 18 no. samples were found to be of "High" status and below the threshold of ≤0.025 mg/l, with 2 no. samples exceeding the Good status threshold of ≤0.035 mg/l.

Table 9.15: Surface Water Quality Data

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([4])**	**≤ 1.3 to ≤ 1.5([5])**	**-≤ 0.035 to ≤0.025([2])**	**-**	**-≤0.065 to ≤ 0.04([2])**	**-**
SW1	<5 - 29	<1 - 1	<0.02 - 0.08	<5	<0.02 - 0.04	25.5 – 28.5
SW2	<5	<1 - 1	<0.02	<5	<0.02 - 0.02	35 – 44.2
SW3	<5 - 8	<1 - 3	<0.02	<5	0.03 - 0.04	24.9 – 28.3
SW4	<5	<1 - 1	<0.02	<5	<0.02	21.1 – 26
SW5	<5	1	<0.02	<5	<0.02 - 0.02	23.3 - 25.8
SW6	<5	<1	<0.02	<5	0.02	27 – 27.6
SW7	<5 - 13	1 - 2	<0.02 - 0.08	<5	0.02 - 0.05	25.4 – 26.6
SW8	<5 - 7	<1 - 1	<0.02	<5	<0.02 - 0.02	28.9 – 33.6
SW9	<5	<1	<0.02	<5	<0.02 - 0.04	25.2 - 25.9
SW10	<5	<1	<0.02	<5	<0.02	26.7 – 79.6

9.3.8 Hydrogeology

9.3.8.1 Wind Farm Site

The bedrock geology underlying the Wind Farm Site is mapped predominantly as Dinantian Sandstones, Shales and Limestones of the Downpatrick Formation which is classified by the GSI as being a Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones (PI). Meanwhile, the Moyny Point Limestone Member is mapped ~500 m north and ~700 m southwest of wind turbines AT08 and AT14 respectively. The Moyny Point Limestone Member is classified as a Locally Important Aquifer – Karstified (Lk). In addition, some areas in the northeast and south of the Wind Farm Site are underlain by the Dinantian Sandstones of the Mullaghmore Sandstone Formation. This bedrock formation is classified as a Locally Important Aquifer – Bedrock which is Generally Moderately Productive (Lm). A bedrock aquifer map is included as **Figure 9.8**.

The majority of the Wind Farm Site is underlain by the Belmullet Groundwater body (GWB) which is characterised by poorly productive bedrock. The Belmullet GWB comprises northwest Mayo, extending from Broadhaven to Achill Island. The northern, western and southern boundaries of this GWB are bounded by the Atlantic coastline while the eastern boundary is an upland area dividing water draining to the west from water draining to the

4 S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations
5 S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended by S.I. No. 296/2009; S.I. No. 386/2015; S.I. No. 327/2012; and S.I. No. 77/2019 and giving effect to Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2000/60/EC establishing a framework for Community action in the field of water policy).

east towards Killala Bay. The GWB is comprised of primarily low transmissivity rocks. Groundwater flows will be concentrated in weathered zones and in the vicinity of faults. Groundwater recharge is limited due to the presence of peat and low permeability bedrock with most available recharge entering nearby surface water streams. Flow paths in this GWB will be short (30 - 300 m) and groundwater flow will follow surface topography (GSI, 2004).

Meanwhile, the northeast and south of the Wind Farm Site is underlain by the Killala North GWB which is characterised by productive fissured bedrock. This GWB occupies the area around Killala with surface topography sloping to the east. The northern and eastern parts of the GWB are bounded by the coastline while the northwestern boundary is a faulted contact against the Belmullet GWB. The GWB is comprised of Dinantian sandstones which have a potential for relatively high fissure permeability. Transmissivity is estimated to be ~100 - 120 m^2/day but may be higher in the vicinity of faults. Groundwater flow will be concentrated in weathered zones and in faults. Recharge occurs diffusely through the soils with flowpaths likely to be in the order of up to 2 km. Groundwater flow directions will follow surface topography and flow towards the coast (GSI, 2004).

As described in the Belmullet GWB and Killala North GWB characterisation reports (summarised above) groundwater flow in this area will be concentrated in the vicinity of faults. The GSI (www.gsi.ie) maps several bedrock faults underlying the Wind Farm Site and these will act as preferential flowpaths for groundwater movement.

In relation to the Locally Important Aquifer – Karstified (Lk), no karst features are mapped by the GSI (www.gsi.ie) within the Wind Farm Site or in the surrounding lands. Furthermore, no karst features were recorded during the site walkover surveys completed by HES.

In terms of the Proposed Development infrastructure, the majority of the turbines are underlain by a Poor Aquifer which is unproductive and the Belmullet GWB. Meanwhile, in the northeast, 2 no. turbines (wind turbine AT17 and wind turbine AT18) are underlain by a Locally Important Aquifer and the Killala North GWB. In addition, in the south 6 no. turbines (wind turbines AT01, AT02, AT03 and AT04), the Onsite Substation and construction compound and the Met Mast are also underlain by a moderately productive Locally Important Aquifer and the Killala North GWB.

9.3.8.2 Grid Connection

The north of the Grid Connection is underlain by Dinantian Sandstones of the Mullaghmore Sandstone Formation. These rocks are classified by the GSI as a Locally Important Aquifer – Bedrock which is Generally Moderately Productive (Lm). A small area of the Grid Connection in the townland of Castlereagh is underlain by Dinantian Pure Bedded Limestones of the Killala Oolite Member. This is also classified as a Locally Important Aquifer – Bedrock which is Generally Moderately Productive (Lm). The south of the Grid Connection is underlain by the Dinantian Upper Impure Limestones of the Ballina Limestone Formation. These rocks are classified as being a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones (Ll).

In terms of WFD GWBs, the north of the Grid Connection is underlain by the Killala North GWB. The main features of this GWB are summarised above.

Further south the Grid Connection is underlain by the Killala South GWB. This GWB occupies the land around Killala and Killala Bay which is relatively low-ling and sloping to the east. This GWB is composed of Dinantian Sandstone which is considered to have potential for relatively high fissure permeability. Transmissivity ranges from 100-150 m^2/day but may be higher in the vicinity of faults. Groundwater flow will be concentrated in faults with recharge occurring diffusely through the soils and subsoils. Groundwater flowpaths are relatively long, with groundwater flow directions following topography (GSI, 2004).

The southern section is underlain by the Bellacorick-Killala GWB. This GWB comprises of the low-lying areas between Bellacorick and Killala. The GWB is comprised of low transmissivity rocks and most groundwater flow will be in the upper weather zone. Groundwater recharge is limited by peat and low permeability bedrock and much of the available recharge will discharge rapidly to nearby streams (GSI, 2004).

9.3.9 Groundwater Vulnerability

9.3.9.1 Wind Farm Site

Groundwater Vulnerability is 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 determines 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. Groundwater vulnerability is mapped by the GSI (www.gsi.ie).

The mapped vulnerability rating of the bedrock aquifer underlying the Wind Farm Site ranges from Extreme (X) to Moderate. Extreme vulnerability is mapped where rock is located at or near the ground surface. Where thick peat or subsoil deposits the vulnerability rating is Moderate.

In terms of key Proposed Development infrastructure, the Permanent Operations Compound towards the north of the Wind Farm Site is mapped by the GSI in an area of Extreme vulnerability. However, the development at this location (i.e. the conversion of an existing dwelling to a Permanent Operations Compound) will not result in a change in the local groundwater vulnerability rating. All other proposed key infrastructures, including all proposed turbine locations, are mapped by the GSI to be located in areas of High vulnerability.

Wind turbine AT18, and the adjacent spoil storage areas, are proposed within an existing abandoned quarry in the northeast of the Wind Farm Site. Site walkover surveys have revealed that bedrock is exposed on the floor of this quarry. Whilst the GSI map the proposed location of wind turbine AT18 as having High groundwater vulnerability, the presence of exposed bedrock results in an Extreme vulnerability rating.

9.3.9.2 Grid Connection

Groundwater vulnerability along the Grid Connection is mapped by the GSI to range from High to Extreme. High vulnerability is recorded in the vicinity of the Wind Farm Site while Extreme vulnerabilities are mapped along much of the Grid Connection, in the townlands of Castlereagh, Rathcash, Rathowen East and Mullafarry.

Table 9.16: 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.

9.3.10 Groundwater Hydrochemistry

9.3.10.1 Wind Farm Site

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

The GSI's Belmullet GWB Characterisation Report (GSI, 2004) states that hydrochemical data is limited for this GWB. Groundwaters have a Ca - Mg HCO_3 signature with alkalinity reported to range between 14-400 mg/l (as $CaCO_3$). Total hardness in this GWB ranges from 46 - 412 mg/l while conductivity ranges from 160 - 752 µS/cm.

Groundwater data is also limited for the Killala north GWB (GSI, 2004). However, the GWB Characterisation Report states that groundwaters will have a calcium – bicarbonate ($CaHCO_3$) signature and conductivity ranges from 648-765 µS/cm.

9.3.10.2 Grid Connection

Groundwaters within the Killala South GWB will have a $CaHCO_3$ signature. The available data indicates that this water is very hard with a median value of 356 mg/l. Alkalinity ranges from 33 - 372 mg/l (as $CaCO_3$) and conductivity values range from 348 - 803 µS/cm (GSI, 2004).

The GSI's Bellacorick-Killala GWB Characterisation Report (GSI, 2004) states that the groundwater has a $CaHCO_3$ signature. The available data is sparse and is restricted to Dinantian Upper Impure Limestones. Within these rocks alkalinity ranges from 150 - 408 mg/l (as $CaCO_3$), total hardness ranges from 22 - 420 mg/l and conductivity is reported to range from 700 - 824 µS/cm.

9.3.11 Water Framework Directive

The Water Action Plan 2024: A River Basin Management Plan for Ireland outlines the new approach that Ireland will take as it works to protect and restore its rivers, lakes, estuaries and coastal waters over the 3rd Cycle of the EU Water Framework Directive (WFD). The Water Action Plan was published in September 2024 and build on the lessons learned from the previous river basin management plans.

The following evidence-based priorities have been adopted for the 3rd river basin planning cycle:

- Ensure full compliance with relevant EU legislation.

- Prevent deterioration.
- Meet the water standards and objectives for designated protected areas.
- Protect high-status waters.
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at (1) targeting water bodies close to meeting their objectives and (2) addressing more complex issues that will build knowledge for future cycles.

The above priorities have been integrated into the design of the Proposed Development. 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 Groundwater Body Status

Local Groundwater Body (GWB) and Surface water Body (SWB) status information is available from (www.catchments.ie).

All GWBs underlying the Wind Farm Site and Grid Connection achieved "Good" status in the latest WFD cycle (2016-2021) (
Table 9.17). This status is based on the quantitative status and chemical status of each GWB. The GWBs have been deemed to be "Not at Risk" of failing to meet their respective WFD objectives. No significant pressures have been identified to be impacting these GWBs.

Table 9.17: WFD Groundwater Body Status

GWB	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Belmullet	Good	Good	Not at Risk	None
Killala North	Good	Good	Not at Risk	None
Killala South	Good	Good	Not at Risk	None
Bellacorick-Killala	Good	Good	Not at Risk	None

9.3.13 Surface Waterbody Status

A summary of the WFD status and risk result for Surface Water Bodies (SWBs) in the vicinity and downstream of the Wind Farm Site and Grid Connection are shown in

Table 9.18.

All river waterbodies in the vicinity and downstream of the Wind Farm Site or Grid Connection achieved "Good" status in the latest WFD cycle. In terms of transitional waterbodies, Bunatrahir Bay achieved "Good" status while the Cloonaghmore Estuary remains unassigned with regards WFD status (2016-2021). In terms of coastal waterbodies, Killala Bay achieved "Good" status while the Western Atlantic Seaboard SWB achieved "High" status.

No SWBs downstream of the Wind Farm Site or Grid Connection are listed as being "at risk" of failing to meet their WFD objectives. Furthermore, no significant pressures have been identified on any downstream SWBs.

A WFD Compliance Assessment is included as **Appendix 9.3**.

Table 9.18: WFD Surface Waterbody Status

SWB	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Wind Farm Site				
Knockboha_010	Good	Good	Under Review	None
Gortmore Stream (Mayo)_010	Good	Good	Not at Risk	None
Cloonalaghan_010	Good	Good	Not at Risk	None
Bunatrahir Bay	Good	Good	Not at Risk	None
Western Atlantic Seaboard	High	High	Not at Risk	None
Grid Connection				
Cloonalaghan_010	Good	Good	Not at Risk	None
Cloonaghmore_050	Good	Good	Not at Risk	None
Cloonaghmore_060	Good	Good	Not at Risk	None
Cloonaghmore Estuary	High	Unassigned	Not at Risk	None
Killala Bay	Good	Good	Not at Risk	None

9.3.14 Designated Sites & Habitats

9.3.14.1 Nature Conservation Designations

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).

Lackan Saltmarsh and Kilcummin head SAC (Site Code: 000516) is located ~1.2 km east of the Wind Farm Site. This designated site is located at Lackan Bay and includes an excellent diversity of coastal habitats including mature dunes, saltmarsh, rocky sea cliffs, dune grasslands and estuarine sandflats. The site is designated as an SAC due to the presence of several habitats listed on Annex I/II of the E.U. Habitats Directive. Many of these protected habitats are water dependent. The SAC includes Lackan Bay and the lower reaches of the Cloonalaghan River along which an extensive saltmarsh has formed. The Wind Farm Site is hydrologically connected with this designated site via the Cloonalaghan River and several other smaller watercourses which drain the east of the Wind Farm Site.
The area around Lackan Bay and the lower reaches of the Cloonalaghan River also form part of the Killala Bay / Moy Estuary SPA (Site Code: 004036). This designated site comprises the Moy River estuary and the inner part of Killala Bay, including Lackan Bay and Rathfran Bay. The site is also of special conservation interest for Wetland and Waterbirds. The Wind Farm Site is hydrologically connected with this designated site via the Cloonalaghan river. Further south the Grid Connection is also hydrologically connected with this SPA via the Cloonaghmore River.

Killala Bay and the Moy Estuary are also designated as an SAC (Site Code: 000458) due to the presence of several habitats and species listed in Annex I/II of the E.U. Habitats Directive. Many of these protected habitats and species are water dependent. The Grid Connection is hydrologically linked with this SAC via the Cloonaghmore River. There is no hydrological connection between the Wind Farm Site and this SAC as the Cloonalaghan River acts as a hydrological barrier. This SAC does not include Lackan Bay.

There are no NHAs located downstream or downgradient from the Wind Farm Site or Grid Connection.

However, there are several pNHAs located in the vicinity of the Wind Farm Site:

- The closest pNHA is Lackan Saltmarsh and Kilcummin Head pNHA (Site Code: 000516) located ~1.2 km east of the Wind Farm Site. This pNHA is hydrologically connected with the Wind Farm Site via the Cloonalaghan River and its tributaries.

- Creevagh Head pNHA (Site Code: 000482) is located ~3 km north of the Wind Farm Site. No hydrological connections exist between this Wind Farm Site or Grid Connection and this pNHA other than via the Atlantic Ocean.
- Downpatrick Head pNHA (Site Code: 000494) is located ~5 km north-northeast of the Wind Farm Site. No hydrological connections exist between this Wind Farm Site or Grid Connection and this pNHA other than via the Atlantic Ocean.
- Killala Esker pNHA (Site Code: 001517) is located ~1 km north of Tawnaghmore substation. Killala Bay and the Moy Estuary are also designated as a pNHA downstream of the Grid Connection.
- The Glenamoy Bog Complex (Site Code: 000500) is located roughly 3.8 km west of Wind Farm Site. The Ballinglen River provides a hydrological barrier between the Wind Farm Site and this SAC. No hydrological or hydrogeological linkages exist.

The area of Killala Bay and Moy Estuary are also recognised as a Ramsar Convention Site *i.e.* wetlands that are of significant natural value.

A map of designated sites is included as **Figure 9.9**.

9.3.14.2 Bathing Waters

Those areas identified for protected as bathing waters are identified in the EU Water Framework Directive.

The closest designated bathing waters are located at Ross beach in Killala and at Enniscrone Beach in Co. Sligo.

9.3.14.3 Shellfish Areas

Those areas identified for protected as shellfish area are identified in the EU Water Framework Directive.

Killala Bay designated shellfish area is the closest designated shellfish area.

9.3.15 Water Resources

9.3.15.1 Surface Water

The 3rd Cycle Blacksod-Broadhaven Catchment Report (EPA, 2024) states that there are 2 no. SWBs in this catchment which are identified as Drinking Water Protected Areas (DWPAs). These are located at Carrowmore Lake and Acorrymore Lake. Neither of these waterbodies are hydrologically connected with the Proposed Development site.

Meanwhile, the 3rd Cycle Moy and Killala Bay Catchment Report (EPA, 2024) states that there are 9 no. SWBs in this catchment identified as DWPAs. However, no DWPAs are located downstream of the Wind Farm Site or the Grid Connection.

9.3.15.2 Groundwater

The GSI mapping does not indicate the presence of any National Federation registered Group Water Schemes (GWS) or Public Water Schemes (PWS) or an associated Source Protection Area (SPA) within the Proposed Development site or in the surrounding lands (www.gsi.ie).

The closest mapped GWS is the Crossmolina-Eskereagh GWS which is located along the N59 from Crossmolina to Bellacorick and ~15 km south of Tawnaghmore substation and the Grid Connection.

A search of private well locations (the search criteria was water wells with a locational accuracy of 1-100 m) was undertaken using the GSI well database (www.gsi.ie). The GSI map 1 no. borehole (GSI Name: 1133SWW002) with a locational accuracy of 100 m in the townland of Castletown ~700 m northeast of wind turbine AT17. This borehole is described as having agricultural and domestic uses and has a poor yield class of 16.4 m^3/day. A well (GSI name: 1133SWW004) with a locational accuracy of 50m is mapped ~1.8 km southwest of wind turbine AT02. This well is used for agricultural and domestic uses and is reported as having a good yield class. The GSI do not map any other additional wells with a locational accuracy of ≤100 m in the local area.

3 no. wells with a locational accuracy of 1 km are mapped to the northeast of the Wind Farm Site. The GSI state that these also have a poor yield class.

In additional several wells with a locational accuracy of 1km are mapped towards the south of the Grid Connection. One of these GSI mapped wells (GSI name: 1131NWW004) is reported to be associated with water supply for the village of Killala, ~1 km to the east. This borehole is reported to have a yield of ~27 m^3/day.

A map of local wells identified by the GSI is attached as **Figure 9.10**.

9.3.16 Receptor Sensitivity

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

9.3.16.1 Groundwater / Aquifers

Due to the nature of wind farm developments (and associated grid connections and TDR works) being near surface construction activities, effects on groundwater are generally negligible and surface water is the main sensitive receptor assessed during impact assessments.

However, general construction works have the potential to contaminate groundwaters with hydrocarbons and cement-based products being used at the Wind Farm Site and along the Grid Connection. The following sensitive groundwater receptors are identified for impact assessment:

- The underlying Poor and Locally Important Aquifers.
- All local private groundwater abstractions in the vicinity of the Wind Farm Site.
- The WFD status of the underlying GWBs (Belmullet, Killala North, Killala South and Bellacorick-Killala GWBs).

9.3.16.2 Surface Waters

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

All watercourses draining the Wind Farm Site are particularly vulnerable due to the nature of the proposed works in the catchments of these waterbodies. The watercourses which drain the Wind Farm Site include the Lecarrowntemple stream and the Heathfield River and Cloonalaghan River and its relevant tributaries including the Carn River and several additional locally unnamed natural watercourses. The Grid Connection is drained by the Cloonalaghan and Cloonaghmore river and several of their tributaries. These waters are considered to be of Very High Importance as they are of Good Q-ratings indicating that these waters are unpolluted and in satisfactory condition.

Further downstream the estuarine and coastal waters of Bunatrahir Bay, Cloonaghmore Estuary, Killala Bay and the Western Atlantic Seaboard are less susceptible to potential effects due to the saline nature of these waters and the large volumes of waters within these waterbodies.

The flowing surface water receptors are carried through to the impact assessment:

- The local surface waters downstream of the Wind Farm Site and the Grid Connection, including the Heathfield, Carn, Cloonalaghan and Cloonaghmore Rivers, associated tributaries and other small streams which drain the Proposed Development.
- The WFD states of these SWBs.

9.3.16.3 Designated Sites

In terms of designated sites, the only designated sites with the potential to be affected by the Proposed Development will occur downstream of the Wind Farm Site and Grid Connection along the Cloonalaghan, Cloonaghmore and Heathfield Rivers. Due to their designation these waters can be considered to be of Extremely High Importance. However, estuarine and coastal waters are less susceptible to potential water quality effects than freshwater in rivers due to the saline nature of the waters and the large volumes of water.

Based on the above the following designated sites are carried through to impact assessment:

- Lackan Saltmarsh and Kilcummin Head SAC and pNHA which is hydrologically linked with the Wind Farm Site via the Cloonalaghan River.
- Killala Bay / Moy Estuary SAC, SPA and pNHA which includes the lower reaches of the Cloonaghmore River which is hydrologically linked with the Wind Farm Site and the Grid Connection.
- Killala Esker pNHA located in close proximity to the Grid Connection.

The Proposed Development has the potential to affect water quality in the Cloonalaghan and Cloonaghmore Rivers and therefore affect the water-dependent qualifying interests of these designated sites.

9.4 POTENTIAL EFFECTS

9.4.1 Do Nothing Scenario

If the Proposed Development were not to proceed, the opportunity to generate renewable energy and electrical supply to the national grid 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 sources and the reduction of greenhouse gas emissions.

Should the Proposed Development not proceed, the existing land-use practices of commercial forestry, agricultural and small-scale peat harvesting activities will continue at the Wind Farm Site.

The forested areas of the Wind Farm Site would continue to function and may be extended to occupy a larger portion of the land. Coniferous forestry will be felled as forestry compartments reach maturity. Re-planting of these areas felled areas is likely. All forestry operations would conform with the best practice Forest Service regulations, policies and guidance documents.

The existing surface water drainage regime in the forested and agricultural lands will continue to function and may be extended in some areas.

In the 'Do Nothing Scenario', there may be a slight decrease in average annual rainfall at the 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.

9.4.2 Construction Phase Potential Effects

This section identifies the likely significant effects of the construction phase of the Proposed Development. It should be noted that the main potential effects on the hydrological and hydrogeological environment will occur during the construction phase.

9.4.2.1 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities including the construction of Site Access Tracks, upgrades to existing Site Access Tracks and public roads, turbine base/hardstanding construction, substation compound, construction of the BESS compound, the Temporary Construction Compounds, demolition of existing farm buildings, construction of Permanent Operations Compound (which will involve the change of land use of an existing dwelling) Met Mast construction and cable route excavations will require varying degrees of earthworks resulting in excavation of peat and mineral subsoil where present.

It is estimated that construction works will require the excavation of ~169,165 m^3 of peat and non-peat materials which will be a significant potential source of sediment laden water. Other potential sources of sediment laden water include:

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

These activities can 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 downstream water quality and fish stocks. Potential effects on all downstream watercourses could be significant if mitigation measures are not implemented. Potential impacts associated with works along the Grid Connection are dealt with separately in **Section 9.4.2.11** and **Section 9.4.2.12**.

Pathways: Drainage and surface water discharge routes.
Receptors: Downstream watercourses (Heathfield, Carn and Cloonalaghan Rivers and their associated tributaries and all other smaller watercourses draining the Wind Farm Site) and associated water dependent ecosystems.
Pre-Mitigation Potential Effect: Negative, significant, indirect, short-term, likely effect on the downstream surface water quality.

9.4.2.2 Excavation Dewatering and Potential Effects on Surface Water Quality

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, substation compound excavations, sections of the grid connection and internal cabling trenches, and this will create additional volumes of water to be treated by the runoff management system.

Due to the elevated topography of the Wind Farm Site (20 to 155 mOD) and the poor permeability of the bedrock aquifer, only minor groundwater inflows will occur. Furthermore, no significant groundwater inflows were recorded in a historic borrow pit located at the proposed spoil deposition area and at the location of wind turbine AT18, which stands at elevations in excess of 100 mOD.

Surface water runoff and shallow groundwater inflows may require some management and treatment in order to reduce suspended sediments. No contaminated land was noted at the Wind Farm Site and therefore pollution issues (resulting from previously contaminated soil/subsoils) will not occur in this respect. The main potential significant effects are as a result of turbidity and suspended solids in downstream surface watercourses.

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 groundwater flow paths.

Receptor: Downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site and Grid Connection) and associated water dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, short-term, unlikely effect on downstream surface water quality.

9.4.2.3 Potential Release of Hydrocarbons

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons can cause significant pollution risk to groundwater, surface water and associated aquatic ecosystems, and to terrestrial ecology. In addition, the accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbons have 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 the death of aquatic organisms.

Construction plant will be used at all elements of the Proposed Development, including site entrances works, Site Access Tracks works, upgrades to existing Site Access Tracks, turbine base/hardstanding construction, substation compound works, construction compound constructions, Met Mast construction and cable route excavations. Hydrocarbon storage will not occur during construction of the Grid Connection as these works are transient.

Pathways: Groundwater flowpaths and site drainage network.

Receptors: Surface water quality in downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site) and groundwater quality in the underlying bedrock aquifers.

Pre-Mitigation Potential Effects: Negative, slight, indirect, unlikely effect on local groundwater quality.

Negative, significant, indirect, short term, unlikely effect on downstream surface water quality.

9.4.2.4 Potential Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative effects on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ≥ 6 ≤ 9 is set in S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) 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 aquatic species and habitats.

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

Concrete will be used at all elements of the Proposed Development, including site entrances works, Site Access Tracks works, upgrades to existing Site Access Tracks, turbine base/hardstanding construction, substation compound works, construction compound constructions, Met Mast construction and cable route excavations. The largest volumes of concrete will be used at the turbine bases, and at the substation compound.

Pathway: Site drainage network.
Receptors: Peat water hydrochemistry and downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site) and the underlying bedrock aquifers and GWBs.
Pre-Mitigation Potential Effects: Negative, moderate, indirect, short term, unlikely effect on downstream surface water quality.
Negative, imperceptible, indirect, short-term, unlikely effect on local groundwater quality.

9.4.2.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from on-site temporary wastewater treatment systems has the potential to effect groundwater and surface water quality if site conditions are not suitable for an on-site percolation unit.

During the construction phase welfare facilities will be located at the Temporary Construction Compounds within the Wind Farm Site. There will be no requirement for the storage of wastewater along the Grid Connection.

Pathways: Groundwater flowpaths and site drainage network.
Receptors: Down-gradient well supplies, groundwater quality and downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site).
Pre-mitigation Potential Effects: Negative, significant, indirect, short-term, unlikely effect on downstream surface water quality.
Negative, slight, indirect, short-term, unlikely effect on local groundwater quality and down-gradient groundwater wells.

9.4.2.6 Potential Surface Water Quality Effects from Clear Felling

There is approximately 212 ha of forestry in the vicinity of the Wind Farm Site. Tree felling will be required as part of the Proposed Development. To facilitate the construction of Site Access Tracks, civil works and Turbine Hardstands a total of ~40.24 ha of forestry will be clear-felled. The proposed felling area is the minimum necessary to construct the Proposed Development.

Potential surface water quality effects during tree felling occur mainly from:

- Exposure of soil and subsoils due to vehicle tracking, compaction 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.
- Nutrient release.

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

No felling works will be required along the Grid Connection.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface water quality in downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site).

Pre-Mitigation Potential Effect: Negative, significant, indirect, short-term, likely effect on downstream surface water quality.

9.4.2.7 Morphological Changes to Surface Watercourses (Wind Farm Site)

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

Within the Wind Farm Site, there are a total of 15 no. crossings over natural watercourses. 8 of these crossings are located along existing public and private roads and there will be no requirement for the construction or upgrade of these crossings. Additionally, works will be required at 7 no. crossings.

No instream works are proposed at many of the existing watercourse crossing locations. The existing public and private road crossings are as follows:

- An existing public road crosses the Conaghra Stream (EPA Name / EPA Code: 33C54), ~260 m south of wind turbine AT14 and to the east of the Permanent Operations Compound. However, no works are proposed at the existing bridge location (i.e. this section of road is not proposed to be upgraded).
- An existing public road crosses the Glebe stream (EPA Name / EPA Code: 33G09), ~290 m south of wind turbine AT16. This crossing will include the internal Wind Farm grid cable route. There is an existing culvert at this location.
- An existing public road crosses the Lackanhill Stream (EPA Name / EPA Code: 33L02), ~530 m southeast of wind turbine AT16. This crossing will include the internal Wind Farm grid cable route. There is an existing culvert at this location.

- An existing public road to be upgraded crosses the Conaghra Stream (EPA Name / EPA Code: 33C54), ~200 m northeast of wind turbine AT12. This crossing will include the internal Wind Farm grid cable route.
- An existing public road crosses the Heathfield River (EPA Name: Gortmore Stream / EPA Code: 33G04), ~900 m southwest of wind turbine AT08.
- An existing public road to be upgraded crosses the Ballymurphy stream (EPA Name / EPA Code: 33B06), ~730 m west of wind turbine AT01. This crossing will include the internal Wind Farm grid cable route.
- An existing public road to be upgraded crosses the Ballymurphy stream (EPA Name / EPA Code: 33B06), ~600 m south/southeast of wind turbine AT06.
- There is an existing culvert crossing over the Carrickanass Stream (EPA Name / EPA Code: 33C50) ~350 m south of AT01.

The new proposed crossing locations or upgrades to existing watercourse crossings are as follows:

- It is proposed to widen the existing public road ~580 m to the southwest of AT18. This will require an upgrade to the existing culvert over a non EPA mapped watercourse.
- A new proposed Site Access Track over the Glebe Stream (EPA Name / EPA Code: 33G09), ~130 m south of wind turbine AT16 and joining wind turbine AT16 to wind turbine AT15. This crossing will include the internal Wind Farm grid cable route. It is proposed to install a culvert at this location.
- A new proposed Site Access Track over the Lissadrone East Stream (EPA Name / EPA Code: 33L01), ~80 m southeast of wind turbine AT10. This crossing will include the internal Wind Farm grid cable route. It is proposed to instal a culvert at this location.
- A new proposed Site Access Track over the Lissadrone East Stream ~230m to the west/southwest of AT10. It is proposed to instal a new culvert at this location.
- It is proposed to widen the existing public ~1 km west of AT07. This will require a new culvert crossing over the Aghaleague stream (EPA Name: / EPA Code: 33A11) upstream of its confluence with the Heathfield River.
- It is proposed to widen the existing public road ~700 m south of AT06. This will require a new culvert over the Carn Stream (EPA Name / EPA Code: 33C44).
- Internal grid cable connection over the Carn River (EPA Name: Cloonalaghan / EPA Code: 33C01) between AT04 and the onsite substation. It is proposed to cross this watercourse by HDD.

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

Pathways: Local drainage network.

Receptors: Surface water flows, stream morphology and water quality.

Pre-Mitigation Potential Effect: Negative, significant, direct, long-term, likely effect on the local drainage network.

9.4.2.8 Potential Effects on Groundwater Levels During Excavation Works

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

There are no GWS or PWS are mapped downgradient of the Wind Farm Site. Meanwhile, the GSI mapping shows several wells of varying locational accuracies in the surrounding lands. Any potential effect on water levels in these wells be temporary and are unlikely to be significant beyond 50 m from any excavation. We note that there are no dwellings within 200 m of any proposed turbine with most turbines in excess of 500 m from any residential houses or farm buildings which may contain groundwater wells. Only 2 no. turbines are located within 500 m of a dwelling that may contain a groundwater wells.

- A dwelling exists ~365 m south of wind turbine AT14. However, there is limited potential for effects on any potential groundwater well at this location due to the presence of the Conaghra stream. This watercourse acts as a hydrological barrier between the proposed turbine location and this dwelling and all groundwater flow in the local area will discharge to this watercourse due to the low permeability of the underlying bedrock. Furthermore, as part of the Proposed Development this dwelling will be converted to a permanent operations building.
- A dwelling exists ~320 m south of wind turbine AT01. However, there is limited potential for effects on any potential groundwater well, as the proposed turbine location is located downgradient in terms of groundwater flow from this dwelling. All groundwater at the

proposed wind turbine AT01 location will flow to the north towards the Ballymurphy stream.

Furthermore, no groundwater level impacts are predicted from the construction of the Grid Connection, Site Access Tracks, substation, compound, TDR works or Met Mast due to the shallow nature of the excavation (i.e. 0 - ~1.2 m).

Pathway: Groundwater flow paths.
Receptor: Groundwater levels within the underlying GWBs and at local groundwater wells.
Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, temporary, unlikely effect on local groundwater levels within the Wind Farm Site. No effect outside of the Wind Farm Site.

9.4.2.9 Potential Effects on Groundwater Quality in Well Supplies

The biggest risk to groundwater wells will be due to groundwater contamination due to the accidental release of hydrocarbons and cement-based products as a result of construction activities within the Wind Farm Site.
There are no downgradient public or group scheme groundwater supplies that can be impacted by the Proposed Development.

We have also completed an assessment of private wells within 1 km of the Wind Farm Site, following the assumption that all dwellings are likely to have a private groundwater well. There are a total of 284 no. houses within 2 km of the proposed turbine location. The closest inhabited dwelling to a turbine not associated with the Proposed Development is located 554 m from the nearest turbine (AT10). There is 1 no. disused vacant dwelling located c. 265 m southwest of AT14. This dwelling is under the control of the Developer and as part of the planning application, permission is sought for it to be converted and used as an operations building for the lifespan of the Proposed Development. There is 1 no. dwelling located 320 m southwest from AT01. This property is under the control of the Developer and the owner is a financial beneficiary of the Proposed Development. The owner has confirmed that this property will remain unoccupied for the operational lifespan of the Proposed Development.

We note that there are no dwellings within 200 m of any proposed turbine with most turbines in excess of 500 m from any residential houses or farm buildings which may contain groundwater wells.

A dwelling is situated ~265 m south of wind turbine AT14 and ~320 m southwest of wind turbine AT01. As stated previously, there is limited potential for effects on these dwellings due to the prevailing groundwater flow directions to the north at AT01 and the presence of the Conaghra stream as a hydrological barrier near AT14. Furthermore the closest dwelling to the spoil deposition areas adjacent to AT18 is ~400 m to the northeast. The closest dwellings to the proposed substation compound is ~150 m to the west.

Therefore, given the significant distances which exist between the local dwellings and proposed infrastructure locations, and the prevailing hydrogeological regime (short groundwater flowpaths and high rates of surface water runoff, there is limited potential for effects.

Due to the shallow nature of the proposed works (road upgrade and widening) along the Grid Connection, no effects on private groundwater well supplies will occur.

Pathway: Groundwater flowpaths.
Receptor: Down-gradient groundwater supplies (groundwater wells).
Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, long term, unlikely effect on down gradient water supplies.

9.4.2.10 Use of Siltbuster and Effect on Downstream Surface Water Quality

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

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

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of Siltbuster systems from northwest Mayo is provided in **Plate 9.4**. 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).

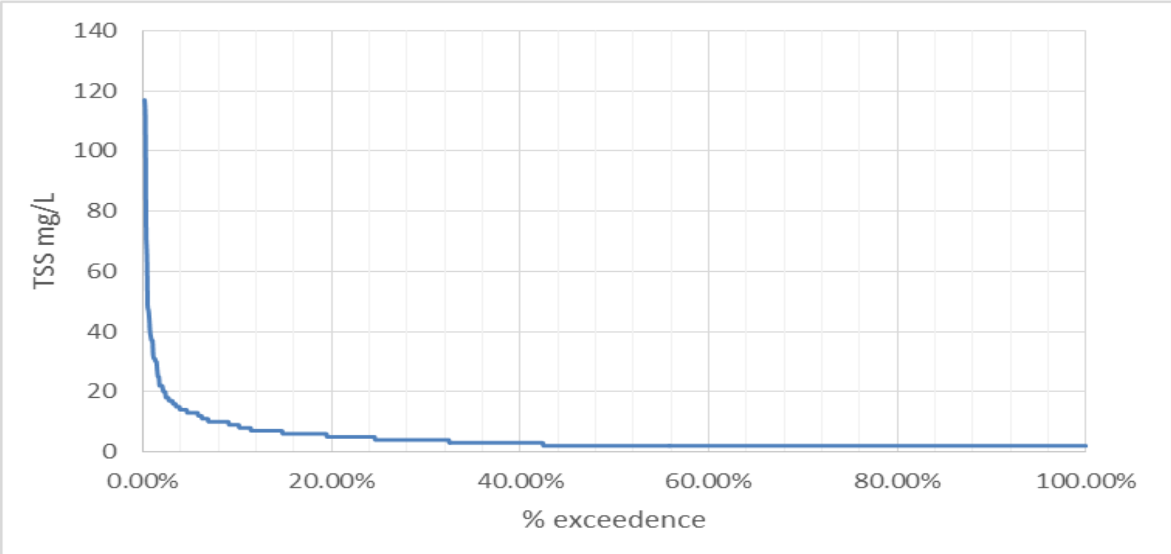


Plate 9.4: TSS treatment data using Siltbuster systems (with chemical dosing)

Pathways: Drainage and surface water discharge routes.
Receptors: Downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site) and associated water dependent ecosystems.
Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, unlikely effect on downstream surface water quality.

9.4.2.11 Potential Surface Water Quality Effects along Grid Connection

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

As stated in **Section 9.3.3.2** above, there are a total of 10 no. crossings over natural watercourses mapped along the Grid Connection. These crossings are located along public roads and **Chapter 2: Development Description** details the proposed construction methodology.

Pathway: Runoff and Surface water flows.
Receptors: Local watercourses including the Cloonaghmore River and its tributaries.
Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on downstream surface water quality.

9.4.2.12 Potential Surface Water Quality Effects During Directional Drilling

Surface water quality effects on local watercourses during drilling and groundworks associated with potential directional drilling at the bridge crossing locations. It is proposed that directional drilling under the bridge will be undertaken to prevent direct impacts on the watercourse. However, there is a risk of indirect impacts from sediment laden runoff during the launch pit and reception pit excavation works. There is also the unlikely risk of fracture blow out and contamination of the watercourse with drilling fluid.

Directional drilling will be required along the following 4 no. watercourse crossings:

- A new crossing over the Carn River between wind turbine AT04 and the onsite substation. This crossings will comprise of the internal grid cabling only.
- Along the Grid Connection at Palmerstown Bridge over the Cloonaghmore River.
- Along the Grid Connection over a small stream (EPA Code: 34R25) in the townland of Rathowen East.
- Along a local road to the south of Killala Business Park where the Grid Connection crosses the Moyne Stream.

Pathway: Surface water flows
Receptors: Local watercourses and the downstream Cloonalaghan and Cloonaghmore Rivers.
Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on downstream surface water quality.

9.4.2.13 Turbine Delivery Route Works

Minor earthworks are required along the TDR. The works along the TDR are described in **Chapter 2: Development Description** and are generally minor and comprise of road verge widening, hedge trimming, passing bays and all associated works. There works are minor and of a short duration and would have no potential to significantly impact local surface water quality.

Pathway: Surface water flows.
Receptors: Downgradient surface water quality.
Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect on downstream surface water quality.

9.4.2.14 Potential Effects on Hydrologically Connected Designated Sites

The Proposed Development is not located within any designated conservation site. However as stated above in **Section 9.3.14**, several designated sites are hydrologically linked with the Wind Farm Site and Grid Connection.

Lackan Saltmarsh and Kilcummin Head SAC/pNHA and Killala Bay / Moy Estuary SAC/SPA/pNHA are hydrologically linked with the Wind Farm Site and Grid Connection via the Cloonalaghan and Cloonaghmore Rivers and their associated tributaries.

Killala Esker pNHA is located in the vicinity of the Grid Connection. However there is no hydrological connection between the proposed work areas and this pNHA.

Pathway: Surface water flowpaths, and groundwater levels.
Receptor: Down-gradient water quality on the Lackan Saltmarsh and Kilcummin Head SAC/pNHA, Killala Bay / Moy Estuary SAC/SPA/pNHA and Killala Esker pNHA.
Pre-Mitigation Potential Effect: Negative, significant, indirect, short term, likely effect on the Lackan Saltmarsh and Kilcummin Head SAC/pNHA, Killala Bay / Moy Estuary SAC/SPA/pNHA and Killala Esker pNHA.

9.4.2.15 Potential Effects on Surface and Groundwater WFD Status

The WFD status for GWBs and SWBs are defined within **Section 9.3.12** and **Section 9.3.13**. The GWBs underlying the Development are all assigned "Good" Status. The SWBs downstream of the Development have an assigned status ranging from "Good" to "High" with 1 no. SWB listed as having an undefined status.

Changes in surface water or groundwater flow regimes and water quality has the potential to impact on the objectives and status of the associated GWBs and SWBs.

A detailed WFD Compliance Assessment Report is included as **Appendix 9.3**.

Pathways: Groundwater flowpaths and Surface Water Flowpaths.

Receptors: Underlying WFD GWBs and downstream WFD SWBs.

Pre-mitigation Potential Effects: Indirect, negative, moderate, temporary, unlikely effect on downstream SWBs. Indirect, negative, slight, temporary, unlikely effect on underlying GWBs.

9.4.3 Operational Phase Potential Effects

This section identifies the likely significant effects of the operational phase of the Proposed Development. It should be noted that the main potential effects on the hydrological and hydrogeological environment will occur during the construction phase.

9.4.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the peat or vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. This could potentially increase runoff from the Site and increase flood risk downstream of the Proposed Development. In reality, the access roads will have a higher permeability than the underlying peat. However, in the baseline scenario runoff rates are high as a result of the prevailing hydrogeological regime (85 % runoff). In order to assess the potential change as a result of access road and hardstand footprints we have increased the runoff rate to the maximum, i.e., 100 % (15 % higher than normal). The assessed footprint comprises turbine bases and hardstandings, Site Access Tracks, site entrances, substation and Temporary Construction Compounds. During storm rainfall events, additional runoff coupled with the increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

The emplacement of the proposed permanent development footprint (~9.93 ha within the Wind Farm Site), as described in **Chapter 2: Development Description**, (assuming emplacement of impermeable materials as a worst-case scenario which would result in an increase in the runoff from 85 % to 100 %) could result in an average total site increase in surface water runoff of approximately 2,457 m^3/month (**Table 9.19**). This represents a potential increase of approximately 1.47 % in the average daily/monthly volume of runoff from the Site area in comparison to the baseline pre-development site runoff conditions (**Table 9.11**). 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 9.93 ha, representing 8.34 % of the total study area of ~119.12 ha.

The calculations shown in **Table 9.19**Table 9.11 relate to the new Proposed Development footprint (permanent footprint) and represent a worst-case scenario whereas it is presumed that the footprint replaces natural ground at all development locations, and that the footprint of the infrastructure will be impermeable. In reality, the hardstand areas will not be fully impermeable. Therefore, the increase in runoff volumes will be less than that shown in **Table 9.19** below.

Table 9.19: Baseline Site Runoff V Development Runoff

Development Type	Site Baseline Runoff/ wettest month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100 % Runoff/month (m^3)	Hardstanding Area 85 % Runoff/month (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions across Site (m^3)
Wind Farm	167,066	5,389	99,274	16,380	13,923	2,457	79	1.47

The additional volume is low due to the fact that the runoff potential from the Wind Farm Site is naturally high. Also, the calculation assumes that all hardstanding areas will be impermeable which will not be the case as Site Access Tracks will be constructed of permeable stone aggregate. The increase in runoff from the Proposed Development will, therefore, be negligible. This is even before mitigation measures will be put in place.

Pathway: Site drainage network.
Receptor: Surface waters and dependent ecosystems.
Pre-Mitigation Potential Effect: Negative, slight, direct, long-term, likely effect on all downstream surface watercourses.

9.4.3.2 Runoff Resulting in Contamination of Surface Waters

During the operational phase, the potential for silt-laden runoff is much reduced compared to the construction phase. In addition, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of Wind Farm Site entrances, internal roads and hardstand areas. These works would be of a very minor scale and would be very infrequent.

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.

During such maintenance works there is a small risk associated with the release of hydrocarbons from site vehicles. However, no refuelling works will be undertaken on-site during the operational phase.

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

Pathways: Drainage and surface water discharge routes.
Receptors: Downstream watercourses (Heathfield, Carn and Cloonalaghan River and their associated tributaries and all other smaller watercourses draining the Wind Farm Site) and water dependent aquatic ecosystems.
Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, unlikely effect on downstream surface water quality.

9.4.3.3 Potential Effects from New Permanent Operations Compound

During the operational phase, a permanent control and operations building will be present at the Wind Farm Site.

The release of effluent from the on-site wastewater treatment systems has the potential to effect groundwater and surface water quality if site conditions are not suitable for an on-site percolation unit.

Pathways: Drainage and surface water discharge routes and groundwater recharge.
Receptors: Downstream watercourses and local groundwater quality.
Pre-Mitigation Potential Effect: Negative, significant, indirect, long-term, unlikely effect on downstream surface water quality.
Negative, slight, indirect, long-term, unlikely effect on local groundwater quality and down-gradient groundwater wells.

9.4.3.4 Potential Effects on WFD Objectives

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

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

A full assessment of the potential effects of the operational phase of the Proposed Development on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as **Appendix 9.3**.

9.4.4 Decommissioning Phase Potential Effects

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

The potential effects associated with decommissioning 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. Turbine and Met Mast foundations will remain and will be covered with earth and allowed to revegetate. Site Access Tracks will continue to be used as amenity pathways and will therefore not be removed. The underground cables will be cut and tied and the ducting will be left in place. Excavation and removal of this infrastructure would result in considerable disturbance to the local environment in terms of disturbance to underlying soils and an increased sedimentation (if turbine foundations and hardstands are being reinstated there is a risk of silt-laden run-off entering receiving waters) and an increased possibility of contamination of local groundwater.

A decommissioning plan will be agreed with Mayo County Council prior to decommissioning.

However, 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".
Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures. No significant effects on the hydrological and hydrogeological environment are envisaged during the decommissioning phase of the Proposed Development.

9.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

9.5.1 Construction Phase

9.5.1.1 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Proposed Mitigation by Avoidance: The key mitigation measure during the construction phase is the avoidance of sensitive hydrological features, by application of suitable buffer zones (i.e. 50 m to main watercourses, and 10 m to main drains).

Where possible all of the key Proposed Development areas (turbines, hardstands, construction compounds etc.) have been located significantly away from the delineated 50 m watercourse buffer zones. Where works are proposed within the buffer zone *i.e.* at watercourse crossings additional mitigation measures will be proposed and are detailed below.

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 the associated release of sediment.
- Avoid excavations within close proximity to surface watercourses.
- Avoid the entry of suspended sediment from earthworks into watercourses.
- 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.

Proposed Mitigation by Design: The Proposed Developments design has been optimised to utilise the existing infrastructure (roads and hardstands) where practicable. This design prevents the unnecessary disturbance of peat and spoil, significantly reducing the potential for elevated concentrations of suspended solids in runoff.

Presented below are temporary and long-term drainage control measures that will be utilised during the construction phase of the Proposed Development. As stated above there is an existing drainage network in some areas of the Wind Farm Site which comprises forestry drains and roadside drains and headwater streams. The measures outlined below will be used in conjunction with the existing drainage network to ensure the protection of all rivers and downstream watercourses.

Source controls:

- Interceptor drains, vee-drains, diversion drains, erosion and velocity control measures such as the use of sand bags, oyster bags filled with gravel, filter fabrics and other similar/equivalent or appropriate systems.
- Small working areas, covering temporary stockpiles, weathering off of side-cast peat/spoil, cessation of works in certain areas or other similar/equivalent or appropriate measures.

In-Line controls:

- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

Treatment systems:

- Temporary sumps and attenuation 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 the existing network of forestry drains present in some areas will be integrated and enhanced as required and used within the Proposed Developments drainage system. The integration of the existing forestry drainage network and the proposed wind farm network is relatively simple. The key elements are the upgrading and improvements to water treatment elements, such as in-line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls.

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

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion.
- Temporary silt traps will be placed in the existing drains downstream of construction works, and these will be diverted into proposed interceptor drains, or culverted under/across the works area.

- During the operational phase of the Wind Farm, runoff from individual Turbine Hardstanding areas will be not discharged directly into the existing drainage network but discharged locally at each turbine location through field drains, main drains, and existing settlement ponds.
- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across the bog surface and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site.
- Velocity and silt control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works.
- Existing culverts will be lengthened where necessary to facilitate access road widening.

Pre-Commencement Temporary Drainage Works: Prior to the commencement of road upgrades (or new road/hardstand or turbine base installs) the following key temporary drainage measures will be installed:

- All existing dry drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using forestry check dams/silt traps.
- Clean water diversion drains will be installed upgradient of the works areas.
- Check dams/silt fence arrangements (silt traps) will be placed in all existing forestry drains that have surface water flows and also along existing forestry roadside drains.
- 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. This will act to prevent entry to the existing drainage network of sand and gravel-sized sediment, released from the excavation of mineral sub-soils of glacial and glacio-fluvial origin and entrained in surface water runoff. Inspection and maintenance of these structures during the construction phase are critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase.

Silt Bags: Silt bags will be used where small to medium volumes of water need to be pumped from excavations (e.g. the proposed underpass locations). As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through.

Settlement Ponds: The Proposed Development's footprint will be divided into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates based on the 200-year return period rainfall event will be calculated for each catchment. These flows will then be used to design settlement ponds for each drainage catchment. The settlement ponds will either be designed for 4.1 hr or 24 hr retention times used to settle out medium silt (0.01 mm) and fine silt (0.004 mm) respectively (EPA, 2006). Settlement ponds along Site Access Tracks and at Turbine Hardstands will have 4.1 hr retention as there is additional in-line drainage controls proposed along Site Access Tracks and at hardstands.

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 Wind Farm Site to provide a polishing filter for the wind farm drainage prior to reaching the downstream watercourses.

Again, vegetation filters are not intended to be a single or primary treatment component for treatment of works area runoff. They are not 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: If the discharge water from construction areas fails to be of a high quality, 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 to all of the construction phase.

Pre-emptive Site Drainage Management: The works programme for the construction stage of the Proposed Development will also take account of weather forecasts and predicted rainfall in particular. Large excavations and movements of peat/subsoil or peat stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast. The following forecasting systems are available and will be used on a daily/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). 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). 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.
- 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.

Earthworks 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.

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

- All open peat/spoil excavations will be secured and sealed.

- Temporary or emergency drainage will be created to prevent back-up of surface runoff.
- Working during heavy rainfall and for up to 24 hours after heavy events will not be allowed to ensure drainage systems are not overloaded.

Management of Runoff from Peat/Subsoil Storage Areas: Excavated material can be used onsite in several ways. Suitable excavation material can be used onsite for reprofiling and landscaping or it can be permanently reposited onsite in the proposed 19 no. spoil deposition areas.

During the initial placement of subsoil, silt fences, straw bales and biodegradable matting will be used to control surface water runoff from the spoil deposition areas.

Drainage from the spoil deposition areas will ultimately be routed to an oversized swale and a number of stilling ponds and a 'Siltbuster' with appropriate storage and settlement designed for a 1 in 200 year return period before being discharged to the onsite watercourses. Soil/subsoil deposition areas will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised soil/subsoil deposition areas will no longer be a potential source of silt laden runoff.

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.

Proposed Drainage and Water Quality Monitoring: An inspection and maintenance plan for the onsite drainage system will be prepared in advance of the commencement of any works and will be included in the CEMP. 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. Any excess build-up of silt levels at dams, the settlement ponds, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.
During the construction phase field testing (visual, supplemented with pH, electrical conductivity, temperature, dissolved oxygen and turbidity monitoring), sampling and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs will

be undertaken for each primary watercourse, and specifically following heavy rainfall events (i.e. weekly, monthly and event-based).

Allowance for Climate Change: Climate Change rainfall projections are typically for a mid-century (2050) timeline. The projected effects of climate change on rainfall are therefore modelled towards the end of the life cycle of the Proposed Development, as the turbines have a life span of ~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 200 year return flow. This approach is conservative given that the project will likely be built over a much shorter period (12-18 months), and therefore this in-built redundancy in the drainage design more than accounts for any potential short term climate change rainfall effects.

Additional Measures for Works within Buffer Zone: In addition to the above mitigation measures, where works are proposed within the delineated 50 m hydrological buffer zone the following additional mitigation measures will be implemented:

- Double row silt fences will be emplaced immediately down-gradient of the construction areas.

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

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on downstream surface water quality will occur.

9.5.1.2 Excavation Dewatering and Potential Effects on Surface Water Quality

Management of surface water and 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 Wind Farm 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 a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken.
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available onsite for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

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

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

9.5.1.3 Potential Release of Hydrocarbons

- All plant will be inspected and certified to ensure they are leak free and in good working order prior to use onsite.
- Vehicles will be refuelled offsite where possible.
- Onsite re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double axel custom-built refuelling trailer or truck will be re-filled offsite and will be towed/driven around the site to where machinery is located. The 4 x 4 jeep/fuel truck will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will

be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations.

- Fuel storage onsite will be minimised. Any fuels will be stores on the Temporary Construction Compound and will be bunded to at least 100 % of the capacity of the largest tank.
- The electrical control building will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals to ground or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor.
- The plant used will be regularly inspected for leaks and fitness for purpose.
- Only designated competent personnel will refuel plant and machinery.
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan. Spill kits will be available to deal with accidental spillages.

Post Mitigation Residual Effects: The potential for the release of hydrocarbons is a risk to surface water and groundwater quality. 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, imperceptible, indirect, short-term, unlikely effect on groundwater and surface water quality.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on surface water or groundwater quality will occur.

9.5.1.4 Potential Release of Cement-Based Products

- No batching of wet-cement products will occur onsite. Ready-mixed supply of wet concrete products and 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 onsite, only the chute will be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. A dedicated bunder area will be created to cater for concrete wash-out and this will be located in the Temporary Construction Compound.
- The contractor will use weather forecasting to plan dry days for pouring concrete.

- The contractor will ensure pour site is free of standing water and plastic covers will be ready in case of a sudden rainfall event.

No mitigation is required for potential groundwater effects as these are imperceptible at the outset.

Post Mitigation Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality. Proven and effective measures to mitigate the risk of releases cement-based products have been proposed 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 groundwater hydrochemistry and the hydrochemistry of downstream surface watercourses.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on groundwater or downstream surface water quality will occur.

9.5.1.5 Groundwater and Surface Water Contamination from Wastewater Disposal

- During the construction phase, a self-contained port-a-loo with an integrated waste holding tank will be used at each of the site construction compounds, maintained by the providing contractor, and removed from the 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 by a licensed contractor to be discharged at a suitable offsite treatment location, likely to be Killala or Ballycastle Waste Water Treatment Plants.
- No water or wastewater will be sourced on the Site, nor discharged to the site.

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

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on surface water or groundwater quality will occur.

9.5.1.6 Potential Surface Water Quality Effects from Clear Felling

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

Mitigation by Avoidance: There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document "Forestry and Water Quality Guidelines" are shown in **Table 9.20**.

With gentle to moderate slopes existing across much of the forested areas of the Wind Farm Site, a 10m setback will be established along aquatic zones. Furthermore, a 5m setback will be established along all relevant watercourses and water hotspots.

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

- Avoid physical damage (river/stream banks and river/stream beds) to watercourses and the associated release of sediment.
- Avoid peat/soil disturbance and compaction within close proximity to surface watercourses.
- Avoid the entry of suspended sediment from works into watercourses.
- 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 9.20: Recommended Minimum Buffer Zone Width

Average slope leading to the aquatic zone		Buffer zone width on either side of 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 will be chosen which are most suitable for ground conditions at the time of felling, and which will minimise soils disturbance. The harvester and the forwarder are designed specifically for the forest environment and are low ground pressure machines.
- Suitably qualified personnel will operate all machinery.
- Checking and maintenance of roads and culverts will be on-going through any felling operations. No tracking of vehicle through watercourses will occur, as vehicles will use

existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works.

- These machines will traverse the site along specified off-road routes (referred to as racks).
- The location of racks will be chosen to avoid wet and potentially sensitive areas.
- Brash mats will be placed on the racks to support the vehicles on soft ground, reducing peat and mineral soil disturbance and erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall.
- 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, preventing sediment from entering downstream watercourses. Accumulated sediment will be carefully disposed of at pre-selected peat disposal areas. Where possible, all new silt traps will be constructed on even ground and not on sloping ground.
- In areas particularly sensitive to erosion it will be necessary to install double or triple sediment traps and increase buffer zone width. These measures will be reviewed on-site during construction.
- Double silt fencing will also be put down slope of felling areas which are located in close proximity to natural watercourses and/or relevant watercourses.
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded.
- Timber will be stacked in dry areas, and outside watercourse buffer zones. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites.
- Works will be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water runoff.
- Refuelling or maintenance of machinery will not occur within 50 m of an aquatic zone or within 20 m of any other hydrological feature. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required.
- 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 of felling areas within forestry drains. The main purpose of the silt traps 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.

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.

Drain Inspection and Maintenance:

The following items shall be carried out during inspection pre-felling 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 shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall.
- Following tree felling all main drains shall be inspected to ensure that they are functioning.
- Extraction tracks near drains need to be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground.
- Culverts on drains exiting the Site will be unblocked.
- 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.

Post-Mitigation Residual Effects: Felling operations pose a risk to downstream surface water quality due to the release of suspended sediments and nutrient enrichment. 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 is considered to be - Negative, imperceptible, indirect, short-term, unlikely effect on downstream surface water quality.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on the downstream surface water quality will occur.

9.5.1.7 Morphological Changes to Surface Watercourses (Wind Farm Site)

The Proposed Development's design has been optimised to utilise the existing infrastructure (roads and hardstands) where practicable. This design prevents the unnecessary disturbance of the existing drainage network and prevents the requirement for widespread instream works.

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

- The crossing upgrades and the new proposed watercourse crossing will be via a bottomless or clear span culverts and the existing banks will remain undisturbed as much as possible.
- No instream excavation works are proposed and therefore there will be no direct effect on the stream at the proposed crossing location.
- Any guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland will be incorporated into the design of the proposed crossings.
- As a further precaution near stream construction work will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites", that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates and the risk of entrainment of suspended sediment in runoff.
- During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area. There will be no batching or storage of cement allowed on-site.
- All new road river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

Post Mitigation Residual Effects: The potential for the construction of watercourse crossings and associated in-stream works is a risk to downstream surface water quality. 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 will be - Negative, imperceptible, direct, long-term, unlikely effect on downstream surface water quality.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on downstream surface water quality will occur.

9.5.1.8 Potential Effects on Groundwater Levels During Excavation Works

All proposed infrastructure is underlain by Poor and Locally Important Aquifers.
An existing abandoned quarry was recorded at the proposed location of wind turbine AT18 and the adjacent proposed spoil deposition areas. This was inspected during the site walkover surveys and no significant groundwater inflows were noted.

The proposed turbine bases are predominantly located over bedrock, which is generally unproductive, whilst some areas of the Wind Farm Site are underlain by Locally Important Aquifers.

No significant groundwater dewatering will be required due to the relatively shallow nature of the excavations. Direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. For the avoidance of doubt, we would generally define dewatering as a requirement to permanently drawdown the local groundwater table by means of over pumping, e.g. as would be required for the operation of a bedrock quarry in a valley floor.

No significant effect on groundwater levels will occur due to the following reasons:

- There are no Regionally Important Aquifers underlying the Wind Farm Site.
- All proposed works overlie Poor and Locally Important Bedrock Aquifers, which are typically characterised by low productivity bedrock.
- Furthermore, no works are proposed overlying the Locally Important Karst Aquifer, no karst features are mapped by the GSI within the Wind Farm Site and no karst features were recorded during the site walkover surveys.
- A total of 12 no. turbines are underlain by a Poor Bedrock Aquifer and the Belmullet GWB. This GWB is composed of low transmissivity rocks, groundwater flow will be concentrated in the upper weathered zone of the aquifer and groundwater flowpaths will be short, discharge to local streams and rivers. No regional groundwater flow regime, *i.e.* large volumes of groundwater flow, will be encountered in these areas of the Wind Farm Site.

- 2 no. turbines in the northeast of the Wind Farm Site (wind turbines AT17 and AT18) are underlain by a Locally Important Aquifer and the Killala North GWB which is characterised by productive fissured bedrock. No significant groundwater dewatering will occur due to the topographic elevation of this area of the Wind Farm Site which stands in excess of 100 mOD. Furthermore, no significant groundwater inflows or faults were recorded in the existing abandoned quarry in the vicinity of wind turbine AT18.
- 4 no. turbines in the south of the Wind Farm Site (wind turbines AT01, AT02, AT03 and AT04) and the Substation are also underlain by the Killala North GWB and stand at lower ground elevations (40-60 mOD). However, no significant dewatering will be required due to the shallow nature of the excavations and the low-permeability of the local subsoils.
- Shallow groundwater inflows into turbine base excavations will be largely fed by recent rainfall.
- Any shallow groundwater seepage will be small in comparison to the expected surface water flows during heavy rainfall events.
- The management of surface water will form the largest portion of water to be managed and treated.

In terms of locally mapped and unmapped wells, the implementation of the drainage design measures will ensure that the recharge to the aquifers will not be altered, thus downgradient water levels will not be altered. As such there are no well supplies down-gradient of the Wind Farm Site that can be affected by temporary dewatering during turbine base construction.

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

Post Mitigation Residual Effects: Due to the significant elevation of much of the Wind Farm Site and the local hydrogeological regime (unproductive to moderately productive aquifers), along with the relatively shallow nature of the proposed works, the potential for water level drawdown effects at receptor locations is negligible. The residual effect is: Negative, imperceptible, indirect, short-term, unlikely effects on local groundwater levels.

Significance of Effects: For the reasons outlined above, and with the implementation of the above-listed mitigation measures, no significant effects on the local groundwater levels will occur.

9.5.1.9 Potential Effects on Groundwater Quality in Well Supplies

Regardless if private wells are located downslope of the Proposed Development or not (or if wells are installed in the future), the potential for effects is negligible for the following conclusive reasons:

- The Wind Farm Site is underlain by aquifers of relatively low or moderate permeability (Poor Aquifers and Locally Important Aquifers).
- Groundwater flowpaths are typically short (~300 m maximum).
- Consequently, the majority of groundwater flows within the Wind Farm Site emerge as springs/baseline along streams/rivers and leave the Site as surface water flows and not groundwater flows.
- Therefore, the potential to effect local wells (whether they are downslope or not) is very low as groundwater flowpaths between the Proposed Development's infrastructure and potential source typically do not exist due to the large setback distance.
- Nevertheless, mitigation is provided in the EIAR to deal with typical construction phase groundwater hazards such as oils and fuels.
- Therefore, based on our hydrogeological assessment of the Site with regard to groundwater user risk and the proposed mitigation measures, we can robustly say the potential to effect local wells/water supply sources is negligible.

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

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

9.5.1.10 Use of Siltbuster and Effect on Downstream Surface Water Quality

Measures employed to prevent overdosing and potential chemical carryover:

- The Siltbuster system comprises an electronic in-line dosing system which provides an accurate means of adding agents so overdosing does not occur.
- Continued monitoring and water analysis of pre and post treated water by means of an inhouse lab and dedicated staff, means the correct amount of chemical is added by the dosing system.
- Dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L and the vast majority of the chemical is removed in the deposited sediment.

- Final effluent not meeting the discharge criteria is recycled and retreated, which has a secondary positive effect of reducing carryover.
- Use of biodegradable chemical agents can be used at very sensitive sites (i.e. adjacent to SACs).

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

Significance of Effects: For the reasons outlined above, no significant effects on downstream surface water quality will occur. In fact, the use of Siltbuster systems will have a significant positive effect in respect of surface water quality.

9.5.1.11 Potential Surface Water Quality Effects along Grid Connection

Silt Fences/Roadside Drain Blocking:

Silt fences will be placed down-gradient of the proposed cable route during construction work. Silt fences are effective at removing larger particle sized solids. This will act to prevent entry to water courses of sand and gravel sized sediment released from excavation of mineral sub-soils of glacial and glacio-fluvial origin and entrained in surface water runoff. Inspection and maintenance of these structures during the 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 down-gradient of all construction areas inside the hydrological buffer zones.

Any road side drains will be temporarily blocked using sand bags in the area where trenching works is taking place.

Surplus Excavated Spoil:

Excavated spoil emanating from the trenches, where appropriate (i.e. when trenching within private tracks or the public road verge) will be used to backfill the trenches. Any excess will be disposed at an appropriate licenced facility. All excavated material emanating from trenches within the public road will be disposed at an appropriate licenced facility.

Timing of Site Construction Works:

Excavation of cable trench will not be undertaken during periods of high rainfall. This will minimise the risk of entrainment of suspended sediment in surface water runoff and transport via this pathway to surface watercourses.

Post Mitigation Residual Effect: Due to the nature of the works being within the corridor of public roads, the transient, spread out nature of the works, the requirement for no new watercourse crossings and the absence of instream works along with the proposed mitigation measures the effect will be negative, imperceptible, indirect, temporary, likely effect on downstream surface water quality.

Significance of Effects: For the reasons outlined above, and with the application of the mitigation measures no significant effects on downstream surface water quality will occur.

9.5.1.12 Potential Surface Water Quality Effects During Directional Drilling

- 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 15 m buffer zone.
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channel along the 15m buffer zone boundary.
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse.
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered.
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages.
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area.
- Spills of drilling fluid will be clean up immediately and stored in an adequately sized skip before been taken offsite.

- If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works).
- This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed percolation area at least 50 m from the watercourse.
- The discharge of water onto vegetated ground at the percolation area will be via a silt bag which will filter any remaining sediment from the pumped water. The entire percolation area will be enclosed by a perimeter of double silt fencing.
- Any sediment laden water from the works area will not be discharged directly to a watercourse or drain.
- Works shall not take place during periods of heavy rainfall and will be scaled back or suspended if heavy rain is forecasted.
- Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse.
- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied.
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion.
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated.
- There will be no batching or storage of cement allowed at the watercourse crossing.
- There will be no refuelling allowed within 100m of the watercourse crossing.
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.

<u>Fracture Blow-out (Frac-out) Prevention and Contingency Plan</u>:

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e., Clear Bore Drilling Fluid or similar will be used).
- The area around the drilling fluid batching, pumping and recycling plants will be bunded using terram and/or sandbags to contain any potential spillage.

- One or more lines of silt fencing will be placed between the works area and the adjacent river.
- Spills of drilling fluid will be cleaned up immediately and transported off-site for disposal at a licensed facility.
- Adequately sized skips will be used where temporary storage of arisings are required.
- The drilling process / pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology or local watercourse.
- This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur then drilling will be immediately stopped.
- Any frac-out material will be contained and removed off-site.
- The drilling location will be reviewed, before re-commencing with a higher viscosity drilling fluid mix.
- If the risk of further frac-out is high, a new drilling alignment will be sought at the crossing location.

Post Mitigation Residual Effect: Due to the avoidance of instream works, the works being mainly conducted in the corridor of a public road along with the proposed mitigation measures the effect will be negative, imperceptible, indirect, temporary, likely effect on surface water quality.

Significance of Effects: For the reasons outlined above and with the application of the mitigation measures no significant effects on surface water quality will occur.

9.5.1.13 Turbine Delivery Route Works

No significant effects will occur for the following reasons:

- All works are relatively minor and localised and cover very small areas.
- Excavation/earthworks will all be small scale.
- These works are distributed over a wide area.
- All works are temporary in nature.

Nevertheless, the "Pre-commencement Temporary Drainage Works" described in **Section 9.5.1.1** will be employed at all the TDR works areas.

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

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

9.5.1.14 Potential Effects on Hydrologically Connected Designated Sites

Mitigation measures for sediment control are detailed in **Section 9.5.1.1** and **Section 9.5.1.2**.

Mitigation measures for the control of hydrocarbons during construction works are detailed in **Section 9.5.1.3**.

Mitigation measures for the control of cement-based products during construction works are detailed in **Section 9.5.1.4**.

Implementation of these mitigation measures will ensure the protection of surface water quality in receiving waters.

Post Mitigation Residual Effects: Construction activities pose a threat to designated sites hydrologically linked with the Proposed Development site. Proven and effective measures to mitigate the risk of surface and groundwater contamination have been proposed which will break the pathway between the potential source and each receptor. These mitigation measures will ensure that surface water runoff from the Proposed Development site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or the status or ecology of the protected species and habitats within the designated sites. The residual effect is considered to be Negative, imperceptible, indirect, short term, unlikely effect on the Lackan Saltmarsh and Kilcummin Head SAC/pNHA, Killala Bay / Moy Estuary SAC/SPA/pNHA.

Significance of Effects: For the reasons outlined above, no significant effects on any designated sites will occur.

9.5.1.15 Potential Effects on Surface and Groundwater WFD Status

Mitigation measures for sediment control are detailed in **Section 9.5.1.1** and **Section 9.5.1.2**.

Mitigation measures for the control of hydrocarbons during construction works are detailed in **Section 9.5.1.3**.

Mitigation measures for the control of cement-based products during construction works are detailed in **Section 9.5.1.4**.

Implementation of these mitigation measures will ensure the protection of surface water quality in receiving waters.

Post-Mitigation Residual Effects: Mitigation for the protection of surface and groundwater during the construction phase of the Proposed Development will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Proposed Development.
There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Development. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration.

No residual effect on Groundwater Body WFD status will occur.

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

Significance of Effects: For the reasons outlined above, no significant effects on WFD GWB or SWB status, risk status or objectives will occur as a result of the Proposed Development.

9.5.2 Operational Phase

9.5.2.1 Progressive Replacement of Natural Surfaces with Lower Permeability Surfaces

The Proposed Development design has been optimised to use the existing infrastructure (roads and hardstands) where practicable. Many of the existing local private and public roadways have been integrated into the design of the Proposed Development, thereby limited the requirement for an extensive network of new Site Access Tracks. In addition, the Permanent Operations Compound is located in an existing hardstand area. This design prevents the unnecessary creating of additional hardstand areas which would increase surface water runoff from the Wind Farm Site.

As part of the proposed wind farm drainage design, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed silt traps, settlement ponds and vegetated buffer areas prior to release into the existing site drainage network. The new proposed drainage measures will then create significant additional attenuation to what is already present. The operational phase drainage system will be installed and constructed in conjunction with the existing site drainage network and will include the following:

- 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 into downstream field drains.
- Collector drains will be used to gather runoff from Site Access Tracks and Turbine Hardstanding areas of the Wind Farm Site likely to have entrained suspended sediment, and channel it to new local settlement ponds for sediment settling.
- On sections of Site Access Tracks transverse drains ('grips') will be constructed where appropriate in the surface layer of the road to divert any runoff off the road into swales/roadside drains.
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40 mm non-friable crushed rock.
- Settlement ponds, emplaced downstream of Site Access Tracks 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 existing drains.
- Settlement ponds will be designed in consideration of the greenfield runoff rate.
- All surface water runoff from the development will have to pass through the proposed settlement ponds prior to release into the existing site drainage network.

Post-Mitigation Impact Assessment: As the part of the proposed wind farm drainage, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed silt traps, settlement ponds and vegetated buffer areas prior to release into the existing drainage network. The new proposed drainage measures will then in effect create significant additional attenuation to what is already present at the Wind Farm Site. The net effect of this will be a reduction in the overall runoff coefficient of the Wind Farm were there would no increase in daily runoff volumes from the Wind Farm Site in comparison to the baseline conditions. With the implementation of the proposed wind farm drainage system there will be no risk of exacerbated flooding down-gradient of the site as a result of the Proposed Development. The Proposed Development will in effect retain water for longer periods due to the proposed drainage system.

Post Mitigation Residual Effect: With the implementation of the proposed wind farm drainage measures as outlined above, and based on the post-mitigation assessment of runoff, we consider that residual effects are - Negative, imperceptible, direct, long-term, moderate probability effect on all downstream surface water bodies.

Significance of Effects: For the reasons outlined above, no significant effects on downstream flood risk will occur.

9.5.2.2 Runoff Resulting in Contamination of Surface Waters

Mitigation measures for sediment control are the same as those outlined in **Section 9.5.1.1** and **Section 9.5.1.2**.

Mitigation measures for the control of hydrocarbons during maintenance works are similar to those outlined in **Section 9.5.1.3**.

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

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

9.5.2.3 Potential Effects from New Permanent Operations Compound

- The existing welfare facilities (septic tank) at the existing dwelling which will undergo a change of use to a Permanent Operations Compound will be upgraded to meet the needs of the Proposed Development.
- These upgrades will include an appropriately sized effluent treatment system and percolation area all of which will be constructed and maintained in accordance with the relevant guidelines.
- There will be no discharge of untreated wastewater during the Operational Phase.

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

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on surface water or groundwater quality will occur.

9.5.2.4 Potential Effects on WFD Objectives

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

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

A full assessment of the potential effects of the operational phase on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as **Appendix 9.3**.

9.5.3 Decommissioning Phase

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures. No significant effects on the hydrological and hydrogeological environment are envisaged during the decommissioning phase of the Proposed Development.

9.5.4 Risk of Major Accidents and Disasters

The main risk of MADs at peatland sites is related to peat stability. A peat stability and landslide risk assessment has been completed for the Wind Farm Site and it concludes that with the implementation of the proposed mitigation measures that the risk of a peat failure at the Wind Farm Site is negligible/none.

Flooding can also result in downstream MADs. the increased flood risk associated with the Development is negligible/none. The potential health risks associated with flooding is also discussed in **Section 9.5.5** below.

9.5.5 Assessment of Potential Health Effects

9.5.5.1 Wind Farm Site

Potential health effects arise mainly through the potential for surface and groundwater contamination which may have negative effects on public and private water supplies. There are no mapped PWS or GWS in the area of the Proposed Development. Notwithstanding this, the Proposed Development design and mitigation measures ensures that the potential for effects on the water 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 Stage III Flood Risk Assessment has been caried out for the Wind Farm Site, summarised in **Section 9.3.6**. This Flood Risk Assessment, combined with the assessment of changes in permeable surfaces (**Section 9.5.2.1**) demonstrates that the risk of the proposed works contributing to downstream flooding is insignificant. Onsite (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

9.5.5.2 Grid Connection

In terms of the Grid Connection, no significant effects on public or private water supplies will occur and therefore no health effects will arise from the Proposed Development.

With respect to flooding, the Flood Risk Identification has shown that the risk of the proposed Grid Connection works contributing to downstream flooding is very low, as the footprint of the proposed works is small, the work are for the most part along existing roads, and the duration of the works is shirt. Onsite (construction phase) drainage control measures will ensure that there is no downstream increase in local flood risk.

9.5.6 Cumulative Effects

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

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

The primary potential for cumulative effects will occur during the construction phase of the Proposed Development as this is when earthworks and excavations will be undertaken. The potential for cumulative effects during the operational phase of the Proposed Development will be significantly reduced as there will be no exposed excavations, there will be no sources of sediment to reach watercourses, there will be no use of cementitious materials and fuels/oil will be kept to a minimum at the Proposed Development 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 in **Figure 9.11** attached. There will be no potential for cumulative effects beyond this cumulative study area as no hydrological linkages are possible outside of the catchments of the Heathfield and Cloonalaghan Rivers. The cumulative study area encompasses 3 no. WFD river sub-basins (Knockboha_010, Gortmore Stream_010 and Cloonalaghan_010) has a total area of ~5,728 ha.

A further assessment has been completed within a 200 m zone of the proposed Grid Connection. Due to the shallow nature of the underground cabling connection trench, a 200 m buffer zones is an appropriate scale when considering potential cumulative effects on the water environment.

9.5.6.1 Cumulative Effects with Commercial Forestry

The Wind Farm Site is situated in a rural catchment which drains to the Heathfield and Cloonalaghan Rivers and the Atlantic Ocean. According to Corine land cover mapping (www.epa.ie) (2018) there is a total of ~585 ha of coniferous forestry within the cumulative study area. This represents ~10 % of the total hydrological cumulative study area. The hydrological cumulative study area is shown as **Figure 9.11**. In addition, 445.1 ha of forestry are located within 2 km of the Proposed Wind Farm Site, with the Proposed Wind Farm Site containing ~212 ha of commercial forestry.

The most common water quality problems arising from forestry relate to the release of sediment and nutrients to the aquatic environment and impacts from acidification. Forestry may also give rise to modified stream flow regimes caused by associated land drainage.
Due to the close proximity of these forested areas to the Proposed Development and given that they drain to the same watercourses as the Proposed Development, the potential cumulative effects on downstream water quality and quantity need to be assessed.

However the mitigation measures detailed in **Section 9.5.1**, **Section 9.5.2** and **Section 9.5.3** for the construction, operation and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons we consider that there will not be a significant cumulative effect associated with commercial forestry activities.

9.5.6.2 Cumulative Effects with Agriculture

According to Corine land cover mapping (www.epa.ie) (2018) there is a total of ~3,575 ha of agricultural land within the hydrological cumulative study area. This represents ~62 % of the total hydrological cumulative study area.

Agriculture is the largest pressure on water quality in Ireland. Agricultural practices such as the movement of soil and the addition of fertilizers and pesticides can lead to nutrient losses and the entrainment of suspended solids in local surface watercourses. This can have a negative effect on local and downstream surface water quality.
In an unmitigated scenario the Proposed Development would have the potential to interact with these agricultural activities and contribute to a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

However the mitigation measures detailed in **Section 9.5.1**, **Section 9.5.2** and **Section 9.5.3** for the construction, operation and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons we consider that there will not be a significant cumulative effect associated with agricultural activities.

9.5.6.3 Cumulative Effects with Other Developments

A detailed cumulative assessment has been completed for all planning applications (granted and awaiting decisions) within the cumulative assessment area described above. The planning applications identified within the hydrological cumulative study area are for new dwellings or renovations of existing dwellings, as well as for the erection of farm buildings. Based on the scale of the works, their proximity to the Proposed Development and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Development (construction, operation and decommissioning phases).

9.5.6.4 Cumulative Effects with Other Wind Farms

Section 2.3.3 of the EIAR identified a total of 15 no. operational, consented and proposed wind farms within 20 km of the Proposed Development. In addition, there are 2 no existing domestic turbines located in the vicinity of the Wind Farm Site. No operational, consented and/or proposed wind farms are located in the cumulative hydrological study area.

Table 9.21 below identifies the surface water catchment and sub-catchment within which these wind farms are located. The Wind Farm Site is located in the Glencullin_SC_010 sub-catchment. A total of 2 no. wind farms at the pre-planning stage (Keerglen and Glenora) are located in the Glencullin sub-catchment. However, both of these wind farms are located to the east of the Ballinglen River which acts as a hydrological barrier between the Proposed Development and these other proposed developments. Furthermore, there is 1 no. domestic wind turbine (Knockboha) located ~1km north of the Site and within the Glencullin sub-catchment.

All other wind farms are located in separate catchments and have no potential for cumulative effects with the Proposed Development.

The EIARs for all the wind farm developments listed in **Table 9.21** detail potential hydrological and hydrogeological issues relating to the operation and decommissioning phases of these developments and propose a suite of best practice mitigation measures designed to ensure that the developments do not in any way have a negative effect on downstream surface water quality and quantity. Similarly, the mitigation and best practice measures proposed in this EIAR chapter will ensure that the Proposed Development does not have the potential to result in significant effects on the hydrological/hydrogeological environment.

Therefore, with the implementation of the proposed mitigation measures there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Development within the cumulative study area. Due to the lack of hydrological connectivity there is no potential for cumulative effects with other wind farm developments.

Table 9.21: Wind Farms within 20 km and Hydrological Connectivity

Name	No. Turbines	WFD Catchment (Sub-Catchment)	Hydrological Connectivity with Wind Farm Site
Killala Community Wind Farm (Phase 1)	5	Moy and Killala Bay (Abbeytown_SC_010 and Cloonaghmore_SC_030)	None
Killala Community Wind Farm (Phase 2)	1	Moy and Killala Bay (Abbeytown_SC_010 and Cloonaghmore_SC_030)	None
Lackan Wind Farm	3	Moy & Killala Bay (Leaffony_SC_010)	None
Oweninny (Phase 1)	29	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None
Oweninny (Phase 2)	31	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None
Oweninny (Phase 3)	18	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None
Dooleeg	1	Blacksod-Broadhaven (Owenmore_SC_020)	None
Bellacorrick	21	Blacksod-Broadhaven (Owenmore_SC_020)	None
Sheskin	8	Blacksod-Broadhaven (Owenmore_SC_010)	None
Sheskin South	18	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None
Glenora	22	Blacksod-Broadhaven (Glencullin_SC_010 and Owenmore_SC_010_)	None - Ballinglen River acts as a hydrological barrier
Knockboha (domestic turbine)	1	Blacksod-Broadhaven (Glencullin_SC_010)	**Yes**
Leadymore (domestic turbine)	1	Moy and Killala Bay	None
Gortnahurra	18	Moy and Killala Bay (Cloonaghmore_SC_010 & Deel_SC_020)	None
Keerglen Wind Farm	8	Blacksod-Broadhaven (Glencullin_SC_010)	None – Ballinglen River acts as a hydrological barrier

Name	No. Turbines	WFD Catchment (Sub-Catchment)	Hydrological Connectivity with Wind Farm Site
Keenagh, Owenboy and Trista Windfarm	36	Blacksod-Broadhaven (Owenmore_SC_020)	None

9.5.6.5 *Cumulative Effects with Proposed Afforestation*

The afforestation of alternative lands equivalent in area to those lands being permanently clear-felled will be completed as part of the Proposed Development. This afforestation is subject to licensing and the Proposed Development will not commence until an afforestation licence is in place.

The location of any replanting will be located in excess of 10 km from the Wind Farm Site and outside of the catchments of the Heathfield, Cloonalaghan and Cloonaghmore rivers. Therefore, there will be no potential hydrological connectivity between the Proposed Development and the associated afforestation. As a result there will be no potential for cumulative effects.

9.6 SUMMARY

This chapter assesses the likely significant effects that the Proposed Development may have on hydrology and hydrogeology and sets out the mitigation measures proposed to avoid, reduce or offset any potential significant effects that are identified.

Regionally, the majority of the Proposed Development is located in the Blacksod-Broadhaven Bay surface water catchment. The Wind Farm Site drains to the Heathfield River to the west, the Cloonalaghan River to the southeast and directly to the Atlantic Ocean via several smaller streams in the north. Meanwhile, the Grid Connection extends to the south from the Wind Farm Site into the Moy and Killala Bay surface water catchment and drains to the Cloonalaghan and Cloonaghmore rivers.

The surface of the Wind Farm Site is drained by a network of natural headwater streams which follow surface topography and flow rapidly downslope. In places, depending on the existing landuse, the natural drainage regime is supplemented by agricultural field drains or a network of forestry drains.

The bedrock underlying the majority of the Wind Farm Site is classified as a Poor Aquifer with some areas underlain by Locally Important Aquifer. The bedrock has little or no open cracks which means groundwater movement within the aquifer is very localised. However, the low potential for pollutant travel within the bedrock groundwater makes surface water bodies such as streams more sensitive to pollution than groundwater. There will be no effect on private wells as a result of the Proposed Development.

Designated sites located downstream of the Proposed Development include the Lackan Saltmarsh and Kilcummin Head SAC and pNHA and the Killala Bay / Moy Estuary SAC, SPA and pNHA. These designated sites can be considered very sensitive in terms of potential effects. Following implementation of the appropriate mitigation measures as outlined in the EIAR no significant effects on this designated site will occur as a result of the Proposed Development.

Due to the nature of wind farm developments, being near surface construction activities, effects on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater would be from oil spillage and leakages at turbine foundations or during construction plant refuelling. These are common potential impacts to all construction sites (such as road works and industrial sites). These potential contamination sources are to be carefully managed at the Site during the construction and operational phases of the Proposed Development and measures are proposed within the EIAR to deal with these potential minor local impacts.

During each phase of the Wind Farm Development (construction, operation, and decommissioning) a number of activities will take place at the Wind Farm Site, some of which will have the potential to significantly affect the hydrological regime or water quality at the Site or downstream. These significant potential effects generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement-based compounds. Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant effects on water quality and downstream designated sites. A self-imposed 50 m stream and lake buffer was used during the design of the Proposed Development, thereby avoiding sensitive hydrological features. The surface water drainage plan will be the principal means of significantly reducing sediment runoff arising from construction activities and to control runoff rates. The key surface water control measure is that there will be no direct discharge of wind farm runoff into local watercourses or into the existing site drainage network. This will be achieved by avoidance methods (i.e. stream buffers) and design methods (i.e. surface water drainage plan). Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the Construction and Environmental Management Plan.

No significant effects to surface water (quality and flows) and groundwater (quality and quantity, and any local groundwater wells) will occur as a result of the Proposed Development provided the proposed mitigation measures are implemented. This EIAR presents proven and effective mitigation measures to mitigate the release of sediment which will reduce the concentration of suspended solids to acceptable levels. The storage and handling of hydrocarbons/chemicals will be carried out using best practice methods which will ensure the protection of surface and groundwater quality. The proposed wind farm drainage system will be designed to slow surface water runoff from the Wind Farm Site by providing greater attenuation. This will ensure that the Proposed Development does not alter downstream surface water flows and will not contribute to downstream flooding.

A Water Framework Directive (WFD) Compliance Assessment has been completed for all waterbodies (surface water and groundwater bodies) with the potential to be impacted by the Proposed Development. With the implementation of the mitigation measures detailed in this EIAR there will be no change in the WFD status of the underlying groundwater body or downstream surface waterbodies as a result of the Proposed Development. The Proposed

Development has been found to be fully compliant with the WFD and will not prevent any waterbody from achieving its WFD objectives.

An assessment of potential cumulative effects associated with the Proposed Development and other developments on the hydrological and hydrogeological environment has been completed. With the implementation of the mitigation measures detailed in this EIAR, the cumulative assessment found that there will be no significant effects on the hydrological and hydrogeological environments.

No significant effects on the water environmental will occur during the construction, operation or decommissioning of the Proposed Development.

9.7 REFERENCES

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List of Figures