9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an assessment of the potential likely and significant effects of the proposed Maughanaclea Renewable Energy Development (the Proposed Project), Co. Cork on water aspects (hydrology and hydrogeology) of the receiving environment.

The 'Proposed Wind Farm' refers to the 14 no. turbines and supporting infrastructure, including the proposed 110kV onsite substation (detailed description provided in Chapter 4 of this EIAR). The 'proposed turbines' refers to the 14 no. turbines associated with the Proposed Wind Farm.

The 'Proposed Grid Connection' refers to the 110kV underground cabling connection from the proposed 110kV onsite substation to the existing Dunmanway 110kV substation, and all ancillary works and apparatus. The Proposed Grid Connection has a length of 20.5km and will facilitate the connection of the Proposed Wind Farm to the national electricity grid.

Where 'the Site' is referred to, this relates to the primary study area for the Proposed Project EIAR, as delineated by the EIAR Site Boundary and includes both the Proposed Wind Farm and Proposed Grid Connection route.

The 'Proposed Wind Farm site' refers to the portion of the Site surrounding the Proposed Wind Farm but excluding the portion of the Site surrounding the Proposed Grid Connection underground cabling route.

The objectives of the assessment are:

- Produce a baseline study of the existing water environment (surface water and groundwater natural resources) in the area of the Proposed Project;
- Identify likely significant effects of the Proposed Project on surface water and groundwater natural resources during the construction, operational and decommissioning phases of the Proposed Project;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects; and,
- Assess the cumulative effects of the Proposed Project itself as well as other local developments (as described in Chapter 2 of this EIAR).

The Water Study Area for assessing the potential zone of impact and cumulative effects assessment is the Owvane River and Mealagh River catchments, which contains the Proposed Wind Farm and a section of the Proposed Grid Connection cable route, along with the Bandon River catchment which only contains the Proposed Grid Connection cable route.

The proposed Turbine Delivery Route (TDR) from Ringaskiddy Port to the Proposed Wind Farm site has been screened out of this assessment, as it will not require any interventions outside of the existing national/regional road network.

The Water Study Area is shown on ***Figure 9-1*** below (Regional Hydrology Map).

9.1.2 Statement of Authority

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

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

This chapter of the EIAR was prepared by Michael Gill, David Broderick and Nitesh Dalal.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer/Hydrologist with over 26 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Glenard Wind Farm, Cahermurphy Wind Farm, and Seven Hills Wind Farm, and over 100 other wind farm related projects across the country.

David Broderick (P. Geo., BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 19 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Carrigarierk Wind Farm, Curraglass Wind Farm, Esk Wind Farm and Shehymore Wind Farm, and over 60 other wind farm related projects across the country.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management. Nitesh holds an M.Sc. in Environmental Science (2024) from University College Dublin. Nitesh also holds a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and a B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016). Since joining HES Nitesh has assisted in the preparation of the hydrology and hydrogeology chapter of environmental impact assessments for a wide range of development types including wind farm developments.

9.1.3 Scoping and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the list of Consultees is outlined in Section 2.5 of this EIAR. Matters raised by Consultees in their responses with respect to the water environment are summarised in **Table 9-1** below.

In addition to a scoping document, a Data Request was issued to Uisce Éireann regarding surface water abstractions in the Water Study Area along with follow up e-mail correspondence on 17th April 2025 regarding surface water abstractions immediately downstream of the Proposed Project.

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

Consultee	Matters Raised - Description	Addressed in Sections
Department of Housing, Rural Government and Heritage	*"A detailed site drainage map would be required and should show all existing watercourses, drainage ditches, flushes, lakes or ponds; new drainage ditches; all outfall points to watercourses or lakes; and all settlement ponds. The EIAR would have to demonstrate that the proposed development will not pose any threat to surface waters and associated species".* *"Any impact on water table levels or groundwater flows may impact on wetland sites some distance away. The EIAR should assess cumulative impacts with other plans or projects, if applicable. Where negative impacts are identified suitable mitigation measures should be detailed as appropriate".* *The associated impacts of quarrying or extraction should be included among the considerations at the earliest stages of project planning and design, and should be assessed fully in the EIAR. Reinstatement or restoration plans would be required for any quarries or borrow pits on-site and should be included in the EIAR. As with any other part of the development, all borrow pits (existing or proposed) to be used in construction would have to be included within the application area for the proposed development.* *"The site is within the Margaritifera Sensitive catchment for Freshwater Pearl Mussel categorised as Catchments of SAC populations listed in S.I. 296 of 2009 Bandon/Caha Catchment. A comprehensive assessment of the potential impacts of the proposed development on the Freshwater Pearl Mussel is required".*	Sections 9.3.5, 9.3.9.1, 9.3.9.2, 9.3.13.1, 9.3.15 9.6.2.3 and 9.6.2.15. **Drainage Plan – Appendix 4-4**
Uisce Éireann	*"The majority of the windfarm site is located within the drinking water abstraction catchment for Zone1 Kealkill Water Supply, with the site located 1.3km from the abstraction point in the Owengar River (Owengar (Cork)_10).* *A small portion of the southern part of the of the windfarm site is located within the drinking water abstraction catchment for zone1 Bantry Cahernacrin, with the site located 8.5km from the Inchilough abstraction point in the Mealagh_020).* *The cabling route is located within the drinking water abstraction catchment for Zone 2 Bandon Regional Water Supply, with the abstraction*	Sections 9.3.14.3 and 9.6.2.13

Consultee	Matters Raised - Description	Addressed in Sections
	point located 22km downstream on the Bandon River. *As noted above, there are 3 no UE surface water receptors that represent a risk with particular reference to the Kealkill Water Supply as the wind farm area covers a significant portion of the drinking water abstraction catchment and given the proximity to the abstraction point. The main risk would be during construction and decommissioning activities, however, if the applicant adopts appropriate mitigation measures, these would eliminate any potential risk.* *Where the development proposal has the potential to impact an Uisce Éireann Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Uisce Éireann's Drinking Water Source(s) during the construction and operational phases of the development. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified as part of the report".*	
HSE	*"The proposed development has the potential to have a significant impact on the quality of both surface and ground water. All drinking water sources, both surface and ground water, must be identified. Public and Group Water Scheme sources and supplies should be identified in addition to any private wells supplying potable water to houses in the vicinity of the proposed development. Measures to ensure that all sources and supplies are protected should be described".* *"The National Environmental Health Service recommends that a walk over survey of the site is undertaken in addition to a desktop analysis of Geological Survey of Ireland data in order to identify the location of private wells used for drinking water purposes. Any potential significant impacts to drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, aquifers and catchment areas should be considered when assessing potential impacts and any proposed mitigation measures".*	Sections 9.3.14, 9.6.2.13 & 9.6.2.14
Inland Fisheries Ireland (IFI)	*"Suspended solids and or hydrocarbon contaminated site run-off waters must be controlled adequately so that no pollution of surface waters can occur".*	Sections 9.5, 9.6.2.1, 9.6.2.2, 9.6.2.4 & 9.6.2.5

Consultee	Matters Raised - Description	Addressed in Sections
	"In the event of any watercourse crossings being bridged or culverted the following general criteria should apply: *I. The free passage of fish must not be obstructed;* *II. The original slope of the river bed should be maintained with no sudden drops on the downstream side;* *III. Design details on any proposed crossing should be incorporated at planning stage;* *IV. Bridges are preferable to culverts;* *V. All instream works should be carried out only in the July-September period.* *Full cognisance should be given to IFI "Guidelines on protection of fisheries during construction works in and adjacent to waters".*	
Waterways Ireland	*"This is not within any Zone of Influence of our waterways so we will not be commenting".*	n/a

9.1.4 Relevant Legislation

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

The requirements of the following legislation are also complied with:

- Planning and Development Act 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (as amended) which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 477/2011: European Communities (Birds and Natural Habitats) Regulations as amended, 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);
- S.I. No. 684/2007 Waste Water Discharge (Authorisation) Regulations 2007;
- S.I. No. 99/2023: European Communities Environmental Objectives (Drinking Water) (Amendment) Regulations 2023;
- S.I. No. 287/2022: European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2022;
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended;

- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Water) Regulations 2009 as amended;
- S.I. No. 77/2019: European Communities Environmental Objectives (Surface Water) (Amendment) Regulations 2019; and,
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (as amended).

9.1.5 Relevant Guidance

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

- Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Environmental Protection Agency (2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2022);
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- DoE/NIEA (2015): Wind farms and groundwater impacts - A guide to EIA and Planning considerations;
- OPW (2009) The Planning System and Flood Risk Management;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Wind Energy Development Guidelines for Planning Authorities, 2006 (the Guidelines);
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010);
- GPP5 – Works or Maintenance Near Water (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001;
- Land Types for Afforestation (Forest Service, 2016b);
- Forest Protection Guidelines (Forest Service, 2002);
- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b); and,
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2023-2027 (DAFM, 2023).

9.2 Methodology

9.2.1 Desk Study

A desk study of the Site and the Water Study Area was completed where all relevant hydrological, hydrogeological and meteorological data. The desk study was completed to supplement site walkover surveys, drainage mapping and site investigations.

The desk study involved consultation with the following sources:

- Environmental Protection Agency Databases (www.epa.ie);
- Environmental Protection Agency's Hydrotool Database (www.catchments,.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);

- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- OPW Flood Mapping (www.floodmaps.ie);
- GSI Groundwater Flood Mapping (www.gsi.ie); and,
- Aerial Photography, 1:5000- and 6-inch base mapping.

9.2.2 Baseline Monitoring and Site Investigations

Geological/hydrological/hydrogeological baseline monitoring and site investigations of the Site were undertaken by David Broderick of HES (refer to Section 9.1.2 above) on 5th & 6th September 2024 and 26th February, 13th March & 9th April 2025.

A Geotechnical and Peat Stability Risk Assessment and Peat and Spoil Management Plan were undertaken by Fehily Timoney and Company (FTC, 2026) for the Proposed Project. Refer to **Appendix 8-1** and **Appendix 4-2** of this EIAR, respectively.

A ground investigation was carried out at the Site by Irish Drilling Limited (IDL) under the supervision of FT during January and March 2025. Ground investigation in the form of trial pits (16 no.) were carried out on 29th and 30th of January and on 4th and 5th February 2025.

The trial pits (16 no. in total) were carried out at various locations across the Proposed Wind Farm site to provide information on the ground conditions and depth to bedrock. In addition, rotary coring drilling was carried out at 3 no. of the 4-no. proposed borrow pit locations (BP1, BP2 & BP3) between 19th and 26th March 2025.

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) along with turbidity (NTU) were taken at 5 no. surface water sampling locations over 2 no. monitoring rounds completed on 26th February and 9th April 2025 within surface watercourses draining and directly downstream of the Site.

The combined geological and hydrological dataset collected from the geotechnical ground investigations and from ground truthing site walkovers completed by IDL, FT, HES and MKO have been used in the preparation of this Hydrology & Hydrogeology chapter.

Site investigations and assessments to address the Water Section of the EIAR included the following:

- Walkover surveys and hydrological mapping of the Site area was undertaken by HES whereby water flow directions and drainage patterns in local watercourses were recorded;
- Surface water drainage flow path analysis/mapping using Lidar data and modelling software;
- A total of 640 no. peat probes were undertaken by HES, MKO, FT and Enerco to determine the thickness and geomorphology of peat overlying parts of the Site;
- Trial pitting (16 no.) by IDL and gouge cores (10 no.) by HES to investigate soil, peat and mineral subsoil lithology as well as depth to bedrock;
- Shear vane strength testing was carried out in-situ using a Geonor H-60 Hand-Field Vane Tester;
- Investigation drilling by IDL (3 no. boreholes) to determine the full geological profile at the proposed borrow pit locations (i.e. peat, mineral subsoil and bedrock profile) and groundwater conditions;
- Laboratory testing of rotary core and trial pit samples;

- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken on 2 no. occasions at 5 no. locations to determine the origin of surface water flows;
- Surface water sampling and laboratory analysis (2 no. rounds at 5 no. locations) for baseline and hydrological/hydrogeological characterisation purposes; and,
- Surface water flow measurements of the primary streams that drain the Site.

9.2.3 Impact Assessment Methodology

The guideline criteria (EPA, 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e., negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment are those set out in the EPA, 2022 classification of effects as shown in Section 1.7.2 Chapter 1 of this EIAR.

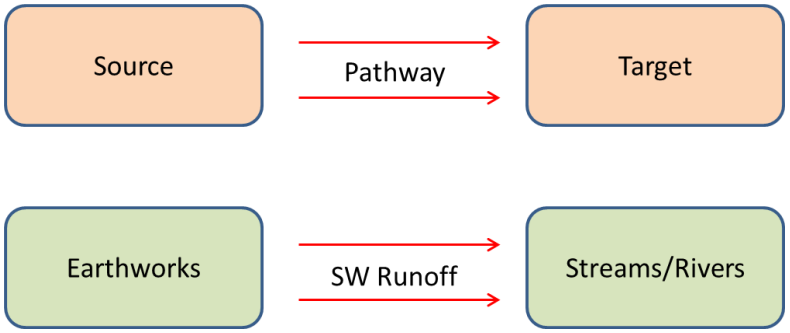
In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in **Table 9-2** are used to assess the potential effect that the Proposed Project may have on them.

Table 9-2 Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk).

Sensitivity of Receptor	
Not sensitive	Receptor is of low environmental importance (e.g. surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability "Low" – "Medium" classification and "Poor" aquifer importance.
Sensitive	Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability "High" classification and "Locally" important aquifer.
Very sensitive	Receptor is of high environmental importance or of national or international value i.e. NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability "Extreme" classification and "Regionally" important aquifer

9.2.4 Overview of Impact Assessment Process

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



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

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

In order to provide an understanding of the stepwise impact assessment process applied below (Section 9.5), we have firstly presented below a summary guide that defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA, 2022 impact descriptors are combined.

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

Step 1	Identification and Description of Potential Impact Source: This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a potential impact is generated.
Step 3	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by engineering design.

Step 1	Identification and Description of Potential Impact Source: This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a potential impact is generated.
Step 6	Post Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	Significance of Effects:	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

9.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Hydrology & Hydrogeology Chapter of the EIAR. The site investigations and seasonal monitoring carried out were detailed and comprehensive.

9.3 Receiving Environment

9.3.1 Site Description and Topography

The Proposed Wind Farm site is located within a rural setting in west Co. Cork, approximately 2.3 km east of the village of Kealkill, 9.5km northeast of the town of Bantry, and 12.2km west of Dunmanway, and within the Maughanaclea Hills which is an upland area characterised by rocky outcrops, upland peat and forestry plantations. At lower elevations on these hills there is typically a transition into improved grassland and wet heathland.

The Proposed Wind Farm site comprises two turbine clusters of turbines which are separated by the Owngar River Valley which drains westerly towards Kealkill village.

The northern turbine cluster, which has 6 no. proposed turbines (T1 – T6), is dominated by open upland peat and improved grassland with a smaller section of coniferous forestry on the upper elevations. The proposed turbines are distributed across a southwest-northeast trending topographic ridgeline where the ground slopes steadily both to the north and south of the ridgeline.

Ground elevations within the northern turbine cluster of Proposed Wind Farm site range between approximately 212m OD to 348m OD (metres above Ordnance Datum) at the proposed turbine cluster. Two turbines (T1 & T2) are located in coniferous forestry while the other four are located in upland peat/heathland/improved grassland.

The southern turbine cluster of the Proposed Wind Farm site, which has 8 no. proposed turbines (T7 – T14), is dominated forestry and open upland peat with a smaller section of improved grassland. The proposed turbine locations straddle a topographic ridgeline extending to the west of the Maughanaclea Hills where ground elevations at the proposed turbine locations in the southern turbine cluster ranging between 212m and 376m OD, which slopes away to the north and south of the ridgeline.

Five turbines are located in forestry (T7 – T11), two in improved grassland (T12 & T13) and one in upland peat (T14). The two turbine clusters of the Proposed Wind Farm site will be connected by 33kV underground cabling that will require a new watercourse crossing on the Owngar River.

The Proposed Grid Connection connects the proposed 110kV onsite substation located in the Proposed Wind Farm site's southern turbine cluster to the existing 110kV substation at Dunmanway, located approximately 13km to the southeast of the Proposed Wind Farm site ('as the bird flies'). The Proposed Grid Connection, which is 20.5km in length, follows public roads R585, L4909, L4609, L4615, R587, and the R586.

Current land-use on the Proposed Wind Farm site is predominantly commercial forestry, with agricultural pastures and rough grazing also present. Current land-use along the Proposed Grid Connection comprises of the public road corridor, public open space, pastures, and private land principally used by agriculture.

Land-use on the wider landscape comprises a mix of pastoral agriculture, low-density residential, and small-scale commercial properties.

9.3.2 Water Balance

Long term Average Annual Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (AAR) (1981-2010) recorded at Kealkill (Maughanaclea) ~1km southwest of the Proposed Wind Farm site is 1,939mm/year, as presented in **Table 9-3**.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Proposed Wind Farm site ranges from 1,898 to 2,150 mm/year. The overall average annual rainfall is

2,024mm/year (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

Table 9-3 Local Average long-term Rainfall Data (mm)

Station		**Easting (IG)**		**Northing (IG)**		**Ht (MAOD)**		**Year Start**		**Year End**		
Kealkill (Maughanaclea)		**109500**		**57000**		**152**		**1978**		**1993**		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
235.5	179.5	157.1	129.8	118.4	110.9	102.5	138.2	146.9	211.3	192.6	216.1	1938.8

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Cork Airport, ~54km east of the Proposed Wind Farm. The long-term average PE for this station is 513mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Proposed Wind Farm is estimated as 487mm/year (which is 0.95 × PE).

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

Effective rainfall (ER) = AAR – AE

= 2,024 mm/year – 487mm/year

ER = 1,537mm/year

Based on groundwater recharge coefficient estimates from the GSI (www.gsi.ie) an estimate of 200mm/year maximum annual recharge is given for the area of the Proposed Wind Farm (recharge coefficient of ~13%). Recharge is capped at 200mm/year due to the poorly productive nature of the underlying bedrock aquifer (refer to Section 9.3.9 which deals with Site hydrogeology).

This means that the hydrology of the Proposed Wind Farm is characterised by high surface water runoff rates (87%) and low groundwater recharge rates (13%). Therefore, conservative annual recharge and runoff rates for the Proposed Wind Farm are estimated to be 200mm/yr and 1,337mm/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 4.66mm/day and 2.94mm/day respectively in Co. Cork. In a 4°C world, the average winter and summer precipitation rates in Co. Cork are projected to be 5.23mm/day and 2.68mm/day respectively.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. **Table 9-4** below presents return period rainfall depths for the area of the Proposed Wind Farm. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (5-year, 10-year, 30-year and 100-year).

The 10-year rainfall depths are the basis of the Proposed Wind Farm drainage hydraulic design as described further below.

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

Table 9-4: Return Period Rainfall Depths (mm) for the Proposed Wind Farm.

Return Period (Years)				
Storm Duration	5	10	30	100
5 mins	6.2	7.1	8.7	10.8
15 mins	8.7	11.7	14.3	17.6
30 mins	13.7	15.8	19.3	23.8
1 hour	18.5	21.3	26.0	32.0
6 hours	40.1	46.0	56.2	69.3
12 hours	54.0	62.0	75.7	93.4
24 hours	72.8	83.6	102.0	128.8
2 days	88.9*	100.8	120.7	145.9

9.3.3 Regional and Local Hydrology

Regionally, the Proposed Wind Farm site is located in the WFD Dunmanus-Bantry-Kenmare Surface Water Catchment within Hydrometric Area No. 21 of the South Western River Basin District. A regional hydrology map is shown as **Figure 9-1** below.

Locally, the Proposed Wind Farm site is contained within 2 sub-catchments**;** the Coomhola_SC_010 and the Mealagh_SC_010 where there are 11 no. and 3 no. proposed turbines respectively. A local hydrology map is shown as **Figure 9-2** below.

Within the Coomhola_SC_010, the Proposed Wind Farm site drains into the Owvane River catchment with 11 no. proposed turbines located in this catchment (T1 – T9, T12 and T13). The Owvane River drains into Bantry Bay approximately 10km downstream of the Site.

Within the Mealagh_SC_010, the Proposed Wind Farm site drains into the Mealagh River catchment with 3 no. proposed turbines located in this catchment T10, T11 and T14). The Mealagh River also drains into Bantry Bay approximately 10km downstream of the Site.

Within the Owvane River catchment, the northern turbine cluster is located within 2 river sub-basins: the Owvane (Cork)_010 and the Owngar (Cork)_010, while the southern turbine cluster is located only in the Owngar (Cork)_010. Two turbines (T1 and T2) are located in Owvane (Cork)_010 and nine turbines (T3 – T9, T12 and T13) in the Owngar (Cork).

As stated above, the Owngar River valley separates the northern and southern turbine cluster of the Proposed Wind Farm site. The Owngar River flows into the Owvane River approximately 2km downstream of the Proposed Wind Farm site.

Within the Mealagh River catchment, the southern turbine cluster is located in the Mealagh_010 sub-basin only.

With the exception of 2.9km length at the Proposed Wind Farm, the Proposed Grid Connection cable route is located mainly in the Bandon River catchment where it passes through the Bandon_SC_010 to Bandon_SC_030 sub-catchments. The 2.9km length of Proposed Grid Connection cable at the Proposed Wind Farm, including the proposed 110kV onsite substation, is located in the Coomhola_SC_010 which drains locally to the Owngar River (Owngar (Cork)_010).

A local hydrology map is shown as **Figure 9-2**.

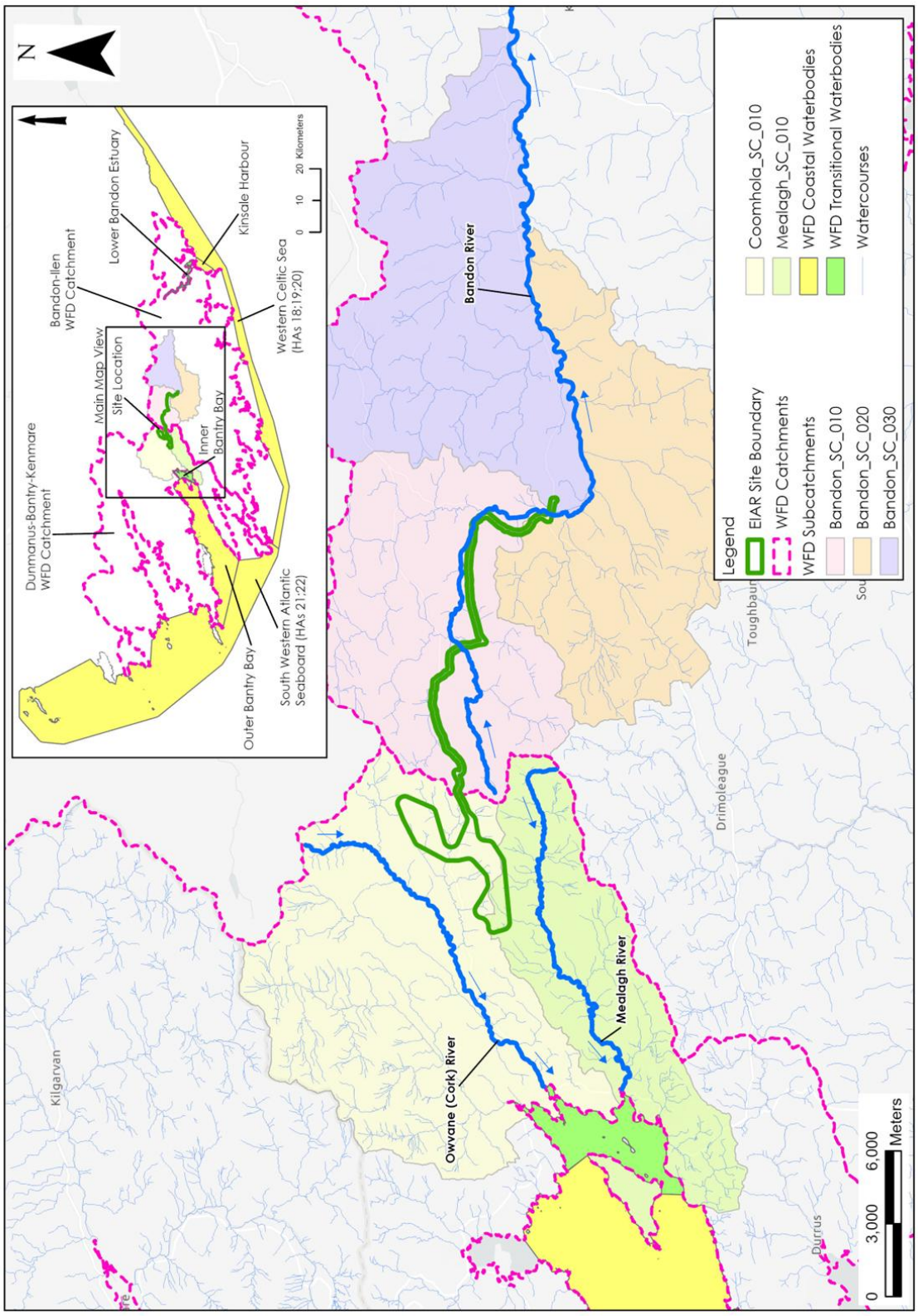


Figure 9-1: Regional Hydrology Map.

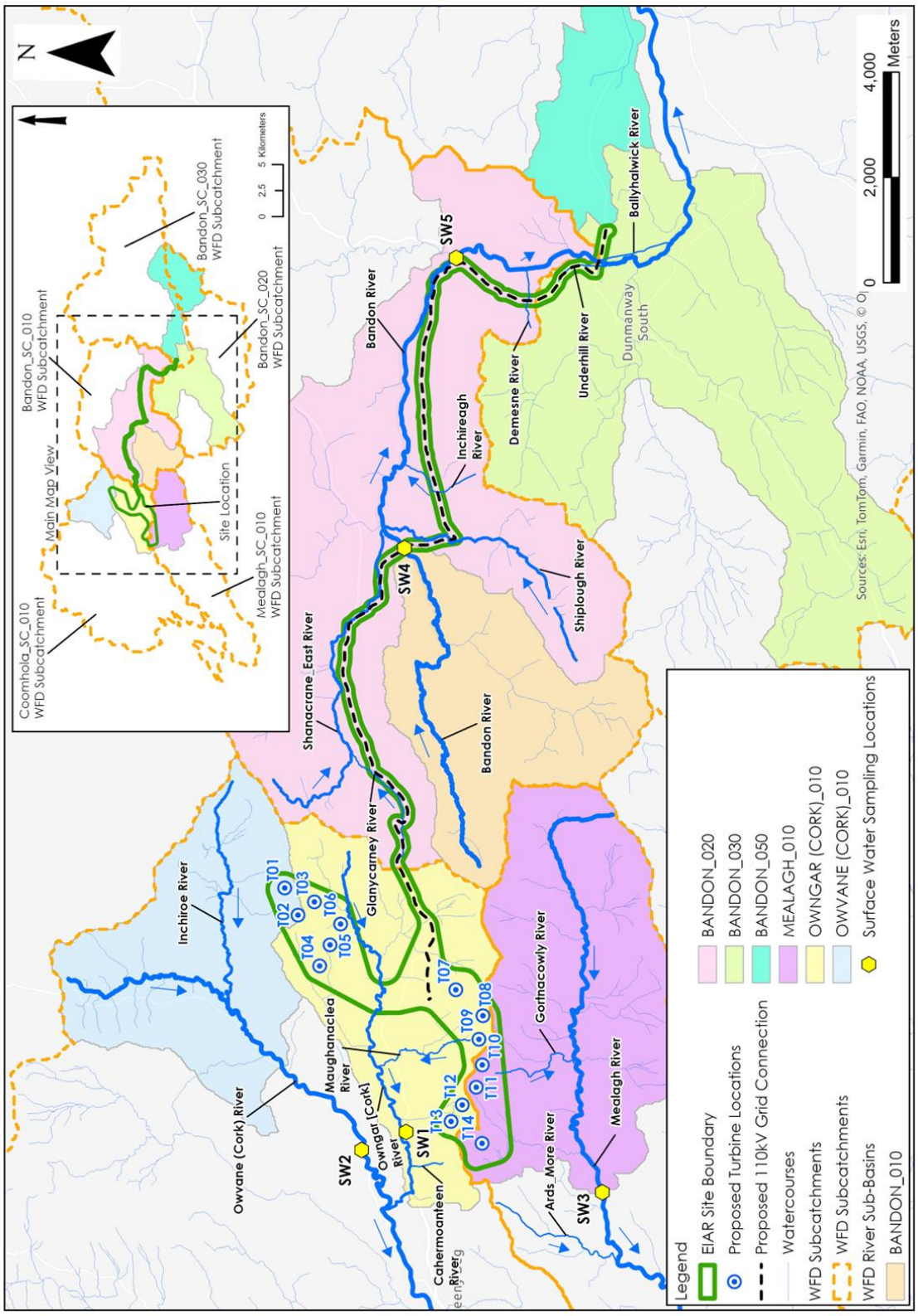


Figure 9-2: Local Hydrology Map.

9.3.4 Surface Water Flows

There are no OPW gauging stations located in the immediate vicinity of the Proposed Wind Farm. The closest gauging station is located downstream on the Owvane River, upstream of its confluence with Bantry Bay at Ballylickey (Station Code: 21003). Here the 95%ile flow is estimated to be 0.250m^3/s. This means that 95% of the time the flow in the Owvane River at this location is equal to or exceed 0.250m3/s (250l/s).

On the Bandon River, there are OPW gauging stations at Ardcahan Bridge (Station code: 20015) and Dunmanway (Station code: 20008) but no percentile flows are provided.

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

Figure 9-3 below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Proposed Wind Farm in the Dunmanus-Bantry-Kenmare catchment.

A 95%ile flow relates to the flow which will be exceeded within the river 95% of the time. For example, the 95%ile flow at Node 21_2974 on the Owngar (Cork) stream, downstream of the Proposed Wind Farm, is estimated to be 0.023m^3/s (23l/s). This indicates that 95% of the time, the flow at this location is estimated to be at or above 23l/s. Due to the increased catchment size, the 95%ile flow at the nodes at Owngar (Cork) stream, upstream of its confluence with the Owvane (Cork) river is estimated to be 0.059m^3/s (59l/s). This indicates that 95% of the time, the flow at this location is estimated to be at or above 59l/s.

Further downstream, the 95%ile flow in the Owvane River at Node: 21_688, is estimated to be 0.141m^3/s (141l/s) The progressively increasing flow volumes downstream of the Proposed Wind Farm are associated with the increased upstream catchment of the respective waterbodies.

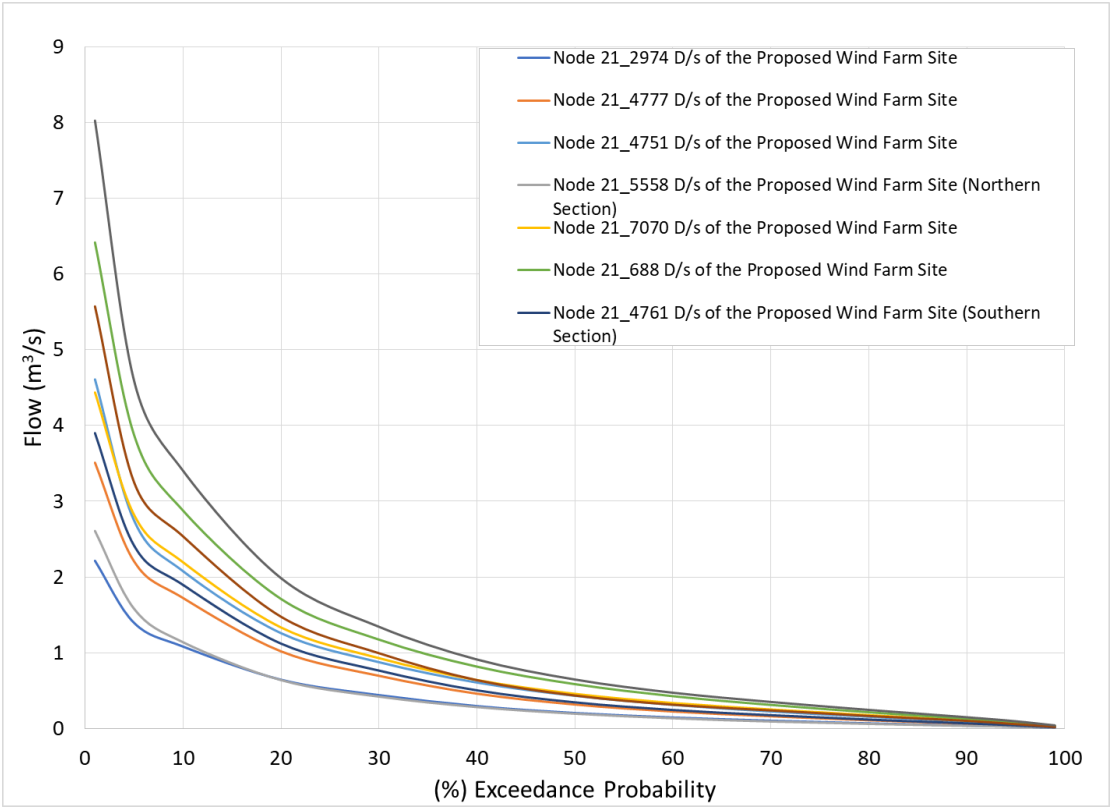


Figure 9-3: EPA Hydrotool Node Flow Duration Curves.

9.3.5 Existing Site Drainage

An existing drainage map for the Proposed Wind Farm site is shown as **Figure 9-4.**

Due to the elevation of Proposed Wind Farm, natural watercourses that emerge from the Site are small 1st order watercourses (i.e. headwater mountain streams draining localised catchments).

The northern turbine cluster of the Proposed Wind Farm has 4 no. unnamed 1st order streams that drain the Site. The 3 no. streams draining south / south-westerly are headwater streams of the Owngar River and the other 1 no. headwater stream drains northeasterly into the Gortloughra River which is a tributary of the Owvane River. There is 1 no. proposed new watercourse crossing in the northern turbine cluster which is on a headwater stream of the Owngar River.

The southern turbine cluster of the Proposed Wind Farm sits on catchment divide between the Owngar River to the north and the Mealagh River to the south. There are several headwater streams emerging from the southern turbine cluster that enter the Owngar River and Mealagh River within a 1km distance of leaving the Site boundary.

There are 3 no. existing watercourse crossings along forestry tracks (proposed for upgrade for Proposed Wind Farm site access) in the southern turbine cluster where these streams drain northerly into the nearby Owngar River.

There are 3 no. proposed new watercourse crossings, where 2 no. drain northerly into the Owngar River and 1 no. draining south-westerly into the Mealagh River.

In addition to the above, there is a proposed new watercourse crossing on the Owngar River itself to facilitate the proposed site entrance and delivery of turbine components to the Proposed Wind Farm's northern turbine cluster, as well as the 33kV cable connecting the Proposed Wind Farm's northern and southern turbine clusters. There is also an existing bridge crossing on the R585 along the 33kV cable route.

Refer to Section 9.6.2.8 below of the impact assessment for further details on watercourse crossings.

In places the natural drainage is further facilitated by a network of manmade drains. These manmade drains are concentrated within the areas of coniferous forestry and along sections of the existing forestry access roads. Manmade drains were also recorded along the boundaries of some of the agricultural lands during walkover surveys.

The forest plantations at the Proposed Wind Farm site are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation. Mound drains and ploughed ribbon drains are generally spaced approximately every 15m and 2m respectively. Interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of forestry access roads. Culverts are generally located at stream crossings and at low points under access roads which drain runoff onto down-gradient forest plantations.

A schematic of a typical standard forestry drainage network and one which is representative of the site drainage network is shown as **Figure 9-5.** The forestry drains are the primary drainage routes towards the natural streams, but the flows in the higher elevated drains are generally very low or absent most of the time.

In addition, the drainage mapping was created using Lidar ground surface elevation data. Lidar data allows detailed mapping on the topographic contours of the Proposed Wind Farm site, thereby allowing

identification of potential drainage pathways at the Proposed Wind Farm that are greater than 150m in length.

The 150m drainage pathways are not permanent watercourses but potential drainage pathways for surface water runoff after rainfall events. Based on this assessment the main drainage pathways at the Proposed Wind Farm site are shown and the connectivity (i.e., pathways and outlet points) of these flowpaths with the on-site mapped streams. Refer to the drainage plan drawings (**Appendix 4-4**) for the 150m drainage pathway mapping.

Along the Proposed Grid Connection cable route, there are 11 no. EPA mapped watercourses. This includes no. 2 existing culvert/bridge crossings in the Owngar (Owvane) River catchment and 9 no. existing culvert/bridge in the Bandon River catchment (which includes 2 no. bridge crossings over the Bandon River itself).

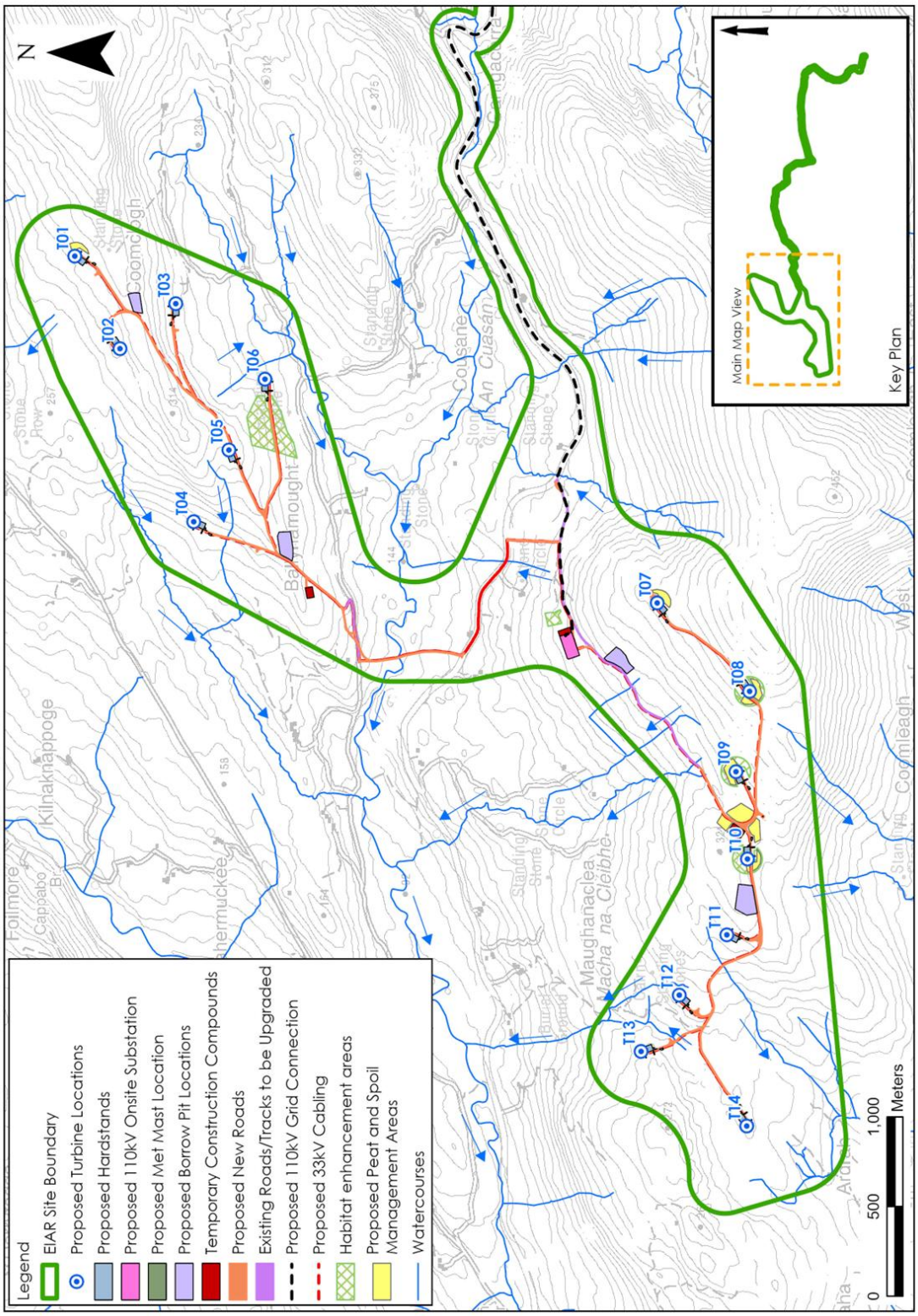


Figure 9-4: Proposed Wind Farm Existing Drainage Map.

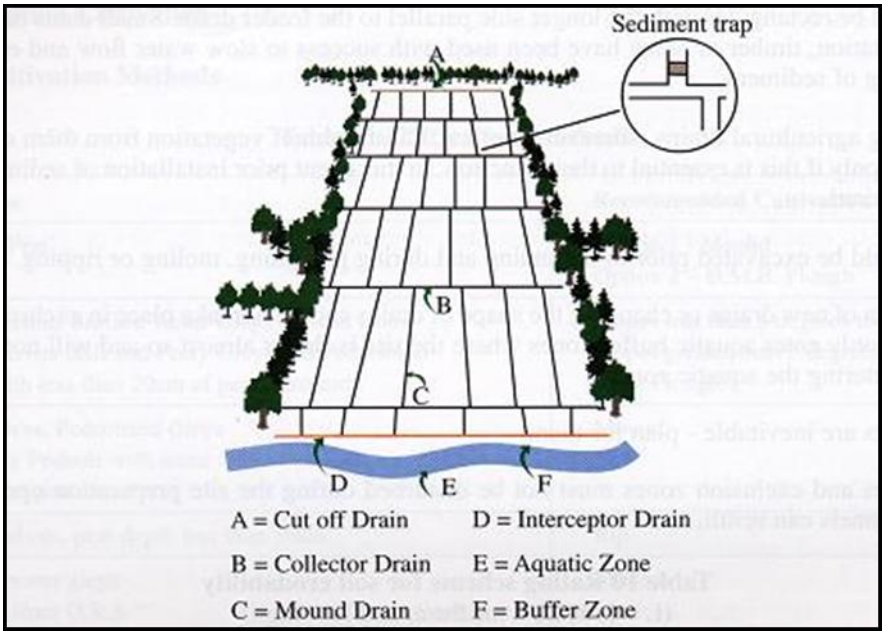


Figure 9-5: Schematic of Existing Forestry Drainage.

9.3.6 Baseline Assessment of Proposed Wind Farm Site Runoff

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

The water balance does not include the Proposed Grid Connection cable route as it follows public roads and therefore the Proposed Grid Connection cannot alter the hydrological regime along a route which is already a hardstand surface.

The rainfall depths used in this water balance, which are long term averages, are not used in the design of the sustainable drainage system for the Proposed Wind Farm. The Proposed Wind Farm drainage design is based on the 10-year return period rainfall event as described further in Section 9.5 below.

The water balance calculations are carried out for the month (December) with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (**Table 9-5**).

The water balance represents the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the Proposed Wind Farm pre-development. The surface water runoff co-efficient for the Proposed Wind Farm site is estimated to be 87% based on the GSI recharge characteristics (refer to Section 9.3.2 above).

The highest long-term average monthly rainfall (site-specific modelled rainfall values – 1991 to 2020) is 232mm over December. The average monthly evapotranspiration for the synoptic station at Cork Airport over the same period in December was 5.1mm. The effective rainfall depth and portion that contributes to runoff and recharge is shown in **Table 9-5** below.

The water balance presented in **Table 9-6** indicates that a conservative estimate of surface water runoff for the Proposed Wind Farm site during the highest rainfall month is 1,496,316m^3/month or 48,268m^3/day for the Site.

Table 9-5: Water Balance and Baseline Runoff Estimates for Wettest Month (December).

Water Balance Component	Depth (m)
Average Highest Monthly Rainfall (R)	0.232
Average Potential Evapotranspiration (PE)	0.0051
Average Actual Evapotranspiration (AE = PE x 0.95)	0.0048
Effective Rainfall (ER = R - AE)	0.227
Recharge (13% of ER)	0.0295
Runoff (87% of ER)	0.1975

Table 9-6: Baseline Runoff for the Proposed Wind Farm site.

Wate Balance Area	Baseline Runoff per Wettest month (m^3)	Baseline Runoff per day (m^3) in wettest month
Proposed Wind Farm	1,496,316	48,268

9.3.7 Flood Risk Assessment Summary

This section is a summary of a site-specific flood risk assessment (FRA) undertaken for the Site. The full FRA report is attached **Appendix 9-1**.

OPW's River Flood Extents Mapping (CFRAM), National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/), historical mapping (i.e. 6" & 25" base maps) and GSI Groundwater/Surface Water Flood Maps were consulted to identify those areas of the Site as being potentially at risk of fluvial, pluvial and groundwater flooding. Several walkover surveys were also conducted as part of the site-specific FRA.

There was no identifiable map text on local available historical 6" or 25" mapping for the Proposed Wind Farm site that identify lands that are "liable to flood" within or in the vicinity of the Site.

No recurring flood incidents within the Proposed Wind Farm site boundary were identified from OPW's Past Flood Event Mapping (Refer to **Figure 9-6).**

The closest recurring flood event to the Proposed Wind Farm site is recorded at Goulnacullin (Flood ID:2890) which is ~3km east of the Proposed Wind Farm site and in the Bandon River catchment. The source of the flooding is reported to be fluvial. The Proposed Wind Farm site is not located in the Bandon River catchment.

There are 2 no. single flood events recorded along the Owvane River downstream of the Proposed Wind Farm site, one at Bantry (Flood ID: 13339) in December 2015 and another at Ballylicky (Flood ID: 12094) in November 2009 and October 2013. The sources of flooding are reported to be the Owvane River.

There is no OPW River Flood Extents Mapping (CFRAM) available for the Owvane River, Owngar River and the Mealagh River catchments area of the Proposed Wind Farm site and therefore the National Indicative Fluvial Mapping (NIFM) was consulted which has mapped current and future scenario 100-year and 1000-year fluvial flood zones (refer to **Figure 9-7**).

No NIFM flood zones are mapped to encroach the Proposed Wind Farm site. Therefore, the Proposed Wind Farm site is located in Flood Zone C (Low risk).

The GSI Groundwater Flood Maps and Winter 2015/2016 Surface Water Flooding Maps have no groundwater or surface water flood zones mapped within the Proposed Wind Farm site.

CFRAM and NIFM flood zones are mapped along the Proposed Grid Connection cable route at watercourse crossing locations. OPW's Past Flood Event Mapping has numerous past flood events mapped at the eastern end of the route near Dunmanway.

However, due to the underground nature of the Proposed Grid Connection cable route, the Proposed Grid Connection has no potential to affect fluvial flooding. Fluvial flood risk along the Proposed Grid Connection is screened out and no further assessment is required.

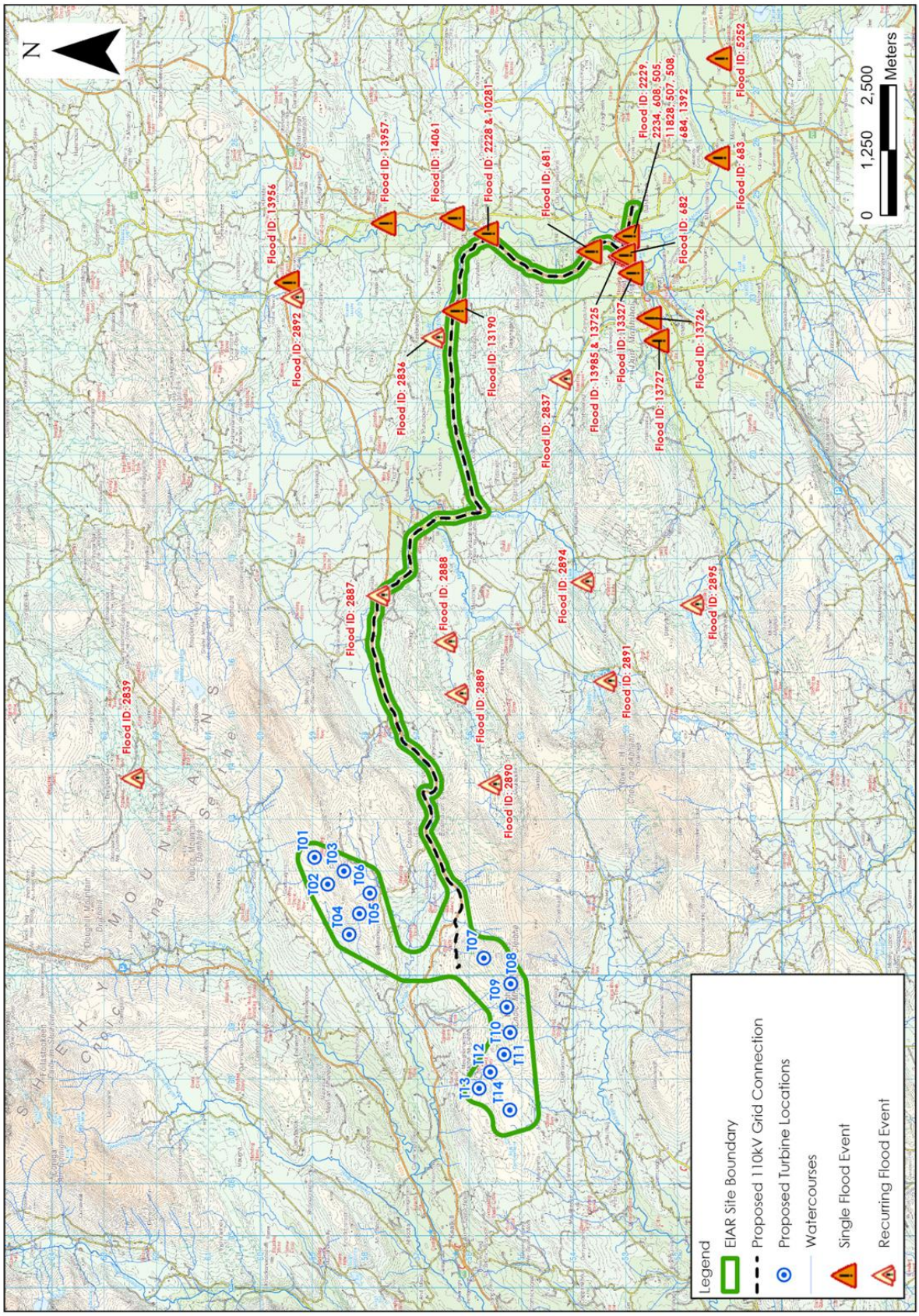


Figure 9-6: OPW Past Flood Event Mapping.

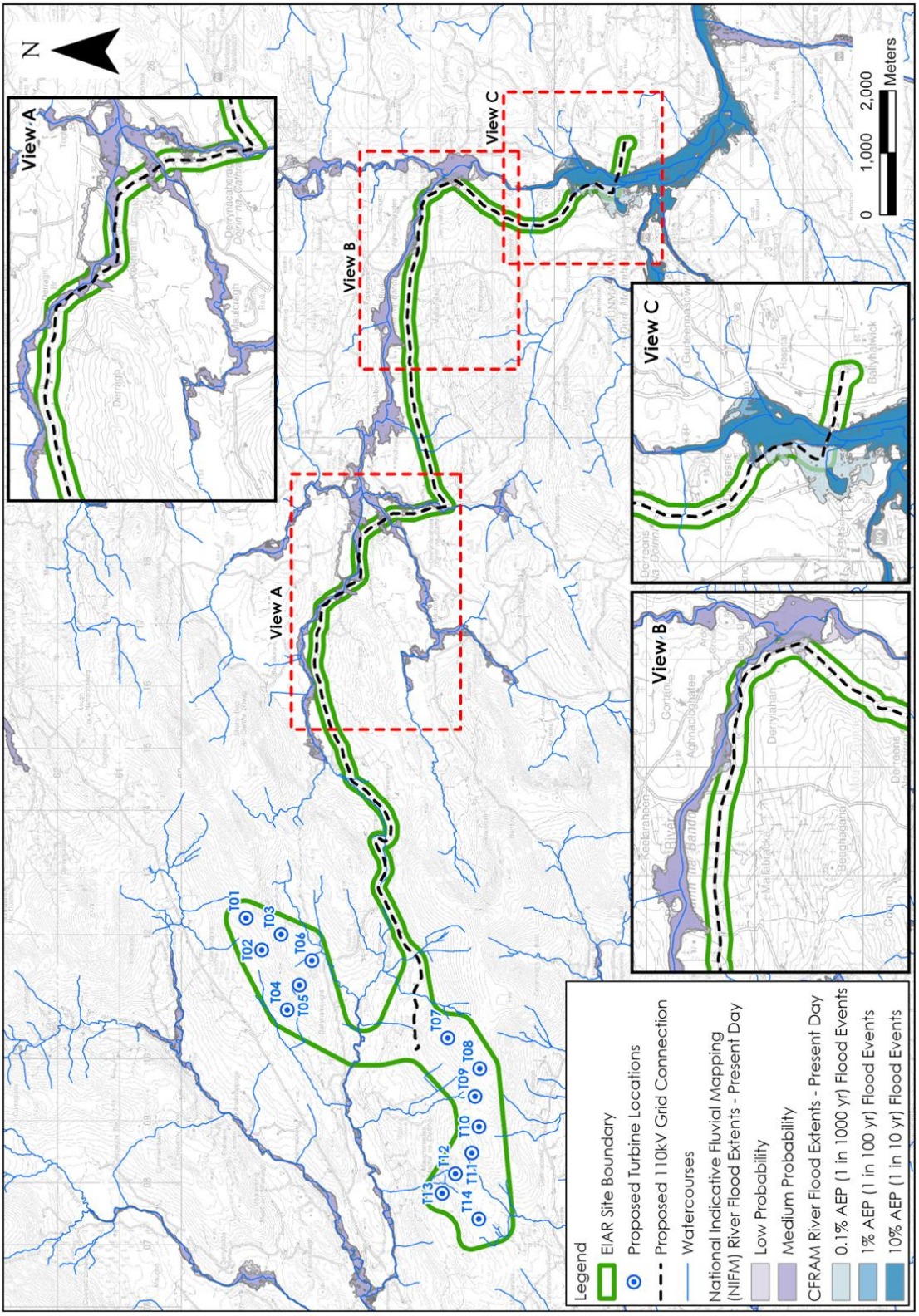


Figure 9-7: OPW CFRAM / NIFM Mapping.

9.3.8 Surface Water Quality

9.3.8.1 EPA Water Quality Monitoring

Biological Q-rating[2] data for EPA monitoring points in the local catchments downstream of the Proposed Wind Farm are shown in **Table 9-7** below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from Q1 (Bad) to 4-5 (High).

The latest EPA-Q Ratings Owngar River, Owvane River and Mealagh River are all Q4-5 (High).

Table 9-7: EPA Water Quality Monitoring Q-Rating Values Downstream of the Proposed Wind Farm.

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Owngar(Cork)	Cahermoanteen Br (RS21O040400)	106461	56637	2020	Q4-5 (High)
Owvane (Cork)	Br SW of Cappaboy (RS21O070200)	108849	59017	2020	Q4-5 (High)
Owvane (Cork)	Pierson's Br (LHS) (RS21O070400)	102393	54512.1	2020	Q4-5 (High)
Mealagh	Br S of Ards More (RS21M010200)	106502	52936	2020	Q4-5 (High)
Mealagh	Dunnamark Br (RS21M010400)	100575	49989	2020	Q4-5 (High)

The western section of the Proposed Grid Connection route is drained by the Owngar (Cork) river which discharges into the Owvane (Cork) River. Recent EPA monitoring along the Owngar (Cork) and Owvane (Cork) is described in **Table 9-7** above.

The majority of the Proposed Grid Connection route is in the Bandon River catchment. Downstream of the Proposed Grid Connection, latest EPA-Q Ratings range from Q3-4 (Moderate) to Q4-5 (High) as shown **Table 9-8** below.

Table 9-8: EPA Water Quality Monitoring Q-Rating Values Downstream of Proposed Grid Connection.

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Bandon	Bandon - Br E of Keenrath Ho (RS20B020050)	118718	56680.7	2024	Q4-5 (High)
Bandon	Ardcahan Br (RS20B020150)	124242.81	55701.51	2024	Q3-4 (Moderate)
Bandon	Bealboy Br (RS20B020300)	125677.46	51284.61	2020	Q3-4 (Moderate)
Bandon	Manch Br (RS20B020400)	129281.31	52079.94	2020	Q4 (Good)

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

9.3.8.2 HES Water Quality Monitoring

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) along with turbidity (NTU) were taken at 5 no. surface water sampling locations over 2 no. monitoring rounds completed on 26th February and 9th April 2025 within surface watercourses draining and directly downstream of the Site.

SW1 to SW3 are located downstream of the Proposed Wind Farm, while SW4 and SW5 are located downstream of the Proposed Grid Connection.

The field hydrochemistry results are shown in **Table 9-9** below. The monitoring locations are shown on **Figure 9-2** above.

Electrical conductivity values at the monitoring locations ranged between 36 and 145µS/cm which indicates the flow mainly comprises of surface water runoff (rainfall) from the peat / rocky surface rather than groundwater baseflow.

The pH values were slightly acidic, ranging between 5.8 and 6.9. Slightly acidic pH values of surface waters would be typical of peatland environments as the water is largely rainfall and also due to the decomposition of peat. Turbidity ranged from 0.1 to 2.73 NTU.

Dissolved oxygen saturation ranged between 80 and 98%. The dissolved oxygen levels would be typical for a High Status watercourse and largely exceed the required dissolved lower limit of 80% (Surface Water Regulations S.I. No. 272/2009 as amended).

Table 9-9: Field Parameters - Surface Water Chemistry Measurements (26th February and 9th April 2025).

Location ID	Temp °C	DO (% Sat)	EC (µS/cm)	pH	Turbidity (NTU)
SW1	9.7 – 13.9	89 – 98	58 – 74	6.2 – 6.8	0.26 - 2.09
SW2	9.8 – 13.9	92 – 98	36 – 58	5.8 – 6.2	1.43 - 2.73
SW3	9.8 – 11.5	80 – 92	67 – 98	6.6 – 6.8	0.77 - 1.09
SW4	9.7 – 12.5	84 - 97	80 - 120	6.8 – 6.9	0.1 - 0.86
SW5	9.7 – 12.8	84 - 96	85 - 145	6.3 – 6.9	0.8 – 1.5

Surface water grab samples were also taken at the 5 no. monitoring locations for laboratory analysis on the dates stated above.

Results of the laboratory analysis are shown alongside relevant water quality regulations are shown in **Table 9- 10** and **Table 9- 11** below. The laboratory reports are attached as **Appendix 9-2**.

Total suspended solids were <5mg/L in all samples which is below the European Communities (Quality of Salmonid Waters) Regulation value (S.I. No. 293 of 1988) of 25mg/L.

Results for BOD, ammonia, nitrate, nitrite, nitrogen, phosphorus and orthophosphate were at or below the detection limit of the laboratory (i.e. very low levels).

All results for BOD, ammonia and orthophosphate achieved High Status with respect the European Communities Environmental Objectives (Surface Waters) Regulations (S.I. 272 of 2009 as amended).

Table 9- 10: Analytical Results of HES Surface Water Samples (26/02/2025).

Parameter	EQS	Sample ID			
		SW1	SW2	SW3	SW4
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	<0.02	<0.02	<0.02	<0.02
Nitrite NO_2 N (mg/L)	-	<0.01	<0.01	<0.01	<0.01
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 N (mg/L)	-	<1.0	<1.0	<1.0	<1.0
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10
Nitrogen (mg/L)	-	<1.0	<1.0	<1.0	<1.0
Chloride (mg/L)	-	12.4	7.8	13.1	13.7
BOD (mg/L)	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	<1	1	<1	<1

(+) 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).

Table 9- 11: Analytical Results of HES Surface Water Samples (09/04/2025).

Parameter	EQS	Sample ID				
		SW1	SW2	SW3	SW4	SW5
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5	<5
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	<5	<5	<5	<5	<5
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrogen (mg/L)	-	<1.0	<1.0	<1.0	<1.0	<1.0
Chloride (mg/L)		14.3	10.1	14.7	14.4	15.2

(+) 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).

9.3.9 Hydrogeology

9.3.9.1 Local Hydrogeology

The Proposed Wind Farm site is located in the Beara Sneem Groundwater Body (GWB) which is described by the WFD as 'poorly productive bedrock'. At the Proposed Wind Farm site, the underlying bedrock is mapped by the GSI as Dinantian Mudstones and Sandstones (Hydrostratigraphic Rock Unit Group Name). Refer to Chapter 8: Land, Soils and Geology of this EIAR for detailed bedrock formation descriptions.

The western section of the Proposed Grid Connection is also located in the Beara Sneem GWB (2.9km), but with the majority of the route (17.6km) is located in the Bandon GWB (the GWB

boundary coincides with Bandon River surface water catchment). The Bandon GWB is also described by the WFD as 'poorly productive bedrock'. Within the Bandon GWB the underlying bedrock is mapped mainly as Devonian Old Red Sandstones (ORS).

The Dinantian Mudstones and Sandstones are classified by the GSI as Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones (LI). The Devonian Old Red Sandstones are mapped as mainly as a Locally Important Aquifer (LI) with areas also mapped as Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones (PI).

Both the Dinantian Mudstones and Sandstones and Devonian Old Red Sandstones have no intergranular permeability; groundwater flow occurs in fractures and faults. Permeability is highest in the upper few metres but generally decreases rapidly with depth.

In general, groundwater flow is concentrated in the upper 15m of the aquifer, although deeper inflows from along fault zones or connected fractures can be encountered.

Groundwater levels are about 1.5-15m below ground level (mbgl) and flow direction will generally follow the topography (i.e. flow perpendicular to ground level contours). Close to the rivers and streams, water levels will be near ground level. Surface water features are considered to be in hydraulic continuity with the water table.

Groundwater flow distances will be very localised. Groundwater flow paths are generally short, typically 30-300m, with groundwater discharging to small springs, or to the streams and rivers that traverse the aquifer. Flow directions are expected to approximately follow the local surface water catchments. Groundwater is generally unconfined.

Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur. Baseflow to rivers and streams is likely to be relatively low.

9.3.9.2 Site Investigation Summary

A total of 16 no. trial pits were carried out by IDL at the Proposed Wind Farm site during January and February 2025. Refer to **Appendix 8-1** for the IDL factual report which includes the trial pit logs and rotary core drilling logs.

The dominant subsoil encountered was silty, sandy GRAVEL with occasional SILT and SAND dominated subsoil. The gravel in particular is likely to have originated from weathering of the underlying shallow bedrock.

Depth to bedrock is shallow at the Proposed Wind Farm site and ranged between 0.2m and 3.5m with an average of 1.5m across the 16 no. trial pit locations. This is consistent with the GSI subsoil mapping which shows bedrock outcrop or subcrop.

Any water inflows recorded during the trial pitting were typically between ground level and 1m below ground level (mbgl) and therefore are surface water rather than groundwater.

Rotary core drilling was carried out at the proposed borrow pit locations at the Proposed Wind Farm site. RC01 was drilled in the southern turbine cluster of the Proposed Wind Farm while RC02 and RC03 were drilled in the northern turbine cluster.

Bedrock was not encountered at RC01 at a depth of 6m below ground level (mbgl). At RC02 and RC03 approximately 4m of weathered rock over very strong locally strong thinly laminated grey slightly sandy fine-grained SANDSTONE and SILTSTONE respectively.

No bedrock joints, fissures, fractures faults (groundwater bearing structures) were identified by the investigation drilling at RC02 and RC03.

The drilling demonstrates that the bedrock proposed for extraction at the proposed borrow pits is strong at depth, competent and of low permeability. There will be no requirement for significant groundwater inflow management during construction, only management of surface water runoff.

Based on the investigations, it can be concluded that any groundwater flowpaths will be very shallow (within the weathered zone) and localised with groundwater gradients towards on-site watercourses that drain the Proposed Wind Farm site. The potential for groundwater flowpaths extending beyond the Site is very low.

9.3.10 Groundwater Vulnerability

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

The concept of groundwater vulnerability was mainly devised for assessing the risk of practices such as manure spreading and wastewater discharge as these are potential pollutants to groundwater. The concept of groundwater vulnerability in wind farms is not as applicable as there are no discharges of potential pollutants to groundwater. The vulnerability rating does, however, give information on depth to bedrock which is useful in wind farm design (i.e. earthworks for foundations etc).

The GSI groundwater vulnerability rating at the Proposed Wind Farm site is classified as “Extreme (X)” to “Extreme E” by the GSI (www.gsi.ie) with the former implying bedrock is close to or at the surface and the latter that 3m of overburden exists above bedrock.

The GSI groundwater rating for the Proposed Wind Farm site is generally consistent with the finding of the site investigations (summarised in Section 9.3.9.2 above).

However, due to the low permeability nature of the bedrock aquifer underlying the site, groundwater flow paths are likely to be short, with recharge emerging close by at seepages and surface streams. This means there is a low potential for groundwater dispersion and movement within the aquifer, therefore making surface water bodies such as drains and streams more vulnerable than groundwater at this site.

The groundwater vulnerability rating along the Proposed Grid Connection is also mainly in the Extreme category with areas of “High” vulnerability (3 – 5m of overburden) along the eastern end of the route which is more low-lying. Due to the nature of the Proposed Grid Connection cable route along public roads, the groundwater vulnerability concept does not apply.

9.3.11 Groundwater Quality Hydrochemistry

There is no site-specific groundwater quality data for the Proposed Wind Farm site. 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 given the lack of pollution sources, low potential for groundwater dispersion and movement within the aquifer as outlined in the preceding section.

Based on data from GSI on the Beara Sneem GWB and Bandon GWB, in these types of rocks groundwater alkalinity ranges between 10-300mg/L (as $CaCO_3$) and hardness ranges between 40-

220mg/L (moderately soft to moderately hard). In general, these sandstone formations largely contain calcium bicarbonate type water. Conductivities in these units are relatively low, ranging between 125-600µS/cm, with an average of approximately 300µS/cm. In general, high iron (Fe) and manganese (Mn) concentrations can occur in groundwater derived from sandstones and mudstones, due to the dissolution of Fe and Mn from the sandstone/shale where reducing conditions occur (GSI, 2004).

9.3.12 Groundwater Body Status

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

The Beara Sneem GWB and Bandon GWB achieved "Good" status in all 3 no. WFD cycles (refer to **Table 9-12** below.

The status of these GWBs is defined based on the quantitative status and chemical status of each GWB. Both GWBs have been deemed to be "Not at risk" of failing to meet its WFD objectives with no groundwater pressures reported.

Table 9-12: WFD Groundwater Body Status.

GWB	Overall Status 2013-2018	Overall Status 2016-2021	Overall Status 2019-2024	3rd Cycle Risk Status	WFD Pressures
Beara Sneem	Good	Good	Good	Not at risk	None
Bandon	Good	Good	Good	Not at risk	None

9.3.13 River Water Body Status

A summary of the WFD status and risk result for SWBs downstream of the Site are shown in **Table 9-13** below.

Please refer to the WFD Compliance Assessment report (attached as **Appendix 9-3**) for the complete WFD assessment.

The Proposed Wind Farm site situated within 2 no. Sub-catchments; the Coomhola_SC_010 and the Mealagh_SC_010.

Within the Coomhola_SC_010, the Proposed Wind Farm site is located within the Owngar (Cork)_010 and Owvane (Cork)_010 sub-basins. The Owvane (Cork)_020 and Owvane (Cork)_030 sub-basins are located further downstream of the Proposed Project.

Both the Owvane (Cork)_010 and Owngar (Cork)_010 achieved "High" status in the latest WFD cycle (2016-2021) and are "not at risk" of failing to meet WFD objectives. There are no reported pressures in these sub-basins.

Within the Mealagh_SC_010 sub-catchment, the Proposed Wind Farm site is located within the Mealagh_10 sub-basin. The Mealagh_20 sub-basin is located downstream of the Proposed Wind Farm.

In relation to the Transitional Waterbodies downstream of the Mealagh River and the Owvane River, the Inner Bantry Bay Transitional waterbody achieved "High" Status for the latest WFD 2019-2024 cycle, while Reenydonagan Lough achieved "Moderate" status. The Inner Bantry Bay TWB has been classified as being "Not at risk" of failing to meet the WFD objectives, while the Reenydonagan Lough TWB is classed as "Not at risk". Both the Mealagh River and the Owvane River drain into Bantry Bay.

The western end of the Proposed Grid Connection is located in the Owngar (Cork)_010 which is discussed above. The majority of the Proposed Grid Connection is located in the Bandon River catchment and within the Bandon_020 and Bandon_030 sub-basins.

The Bandon_020 and Bandon_030 achieved "Moderate" status in the latest WFD cycle and are "at risk". Agriculture is the identified significant pressure on the Bandon_020 while Urban Wastewater and Agriculture are the significant identified significant pressure on the Bandon_030.

Further downstream of the Proposed Grid Connection, the Bandon_040 to Bandon_100 have achieved "Good" status expect for the Bandon_060 which have achieved "Moderate" status in the latest WFD cycle. The Bandon_040, 070, 090 and 100 are "not at risk", the Bandon_050 and 080 are "under review" while the Bandon_060 is "at risk". There is no significant pressure identified on the Bandon_040, 050, 070 to 100 while Anthropogenic pressure is the significant pressure identified on the Bandon_060.

In terms of transitional water bodies downstream of the Bandon River, the Upper Bandon Estuary and the Lower Bandon Estuary have achieved "Poor" status and are "at risk" with Agriculture as identified significant pressure. In terms of Coastal water bodies, the Kinsale Harbour have achieved "Good" status and Western Celtic Sea (Has 18;19;20) have achieved "High" status. The coastal water bodies are "not at risk" with no identified significant pressures.

Table 9-13: River Waterbody Status and Risk (Proposed Project)

SWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	Overall Status 2019-2024	Risk Status 3rd Cycle	Pressures
Owvane (Cork)_010	High	High	High	High	Not at risk	None
Owngar (Cork)_010	High	High	High	High	Not at risk	None
Owvane (Cork)_020	Good	Good	Good	Good	Not at risk	None
Owvane (Cork)_030	Unassigned	High	Good	Good	Not at risk	None
Mealagh_010	High	High	High	High	Not at risk	Urban run-off, Urban Wastewater
Mealagh_020	High	High	High	High	Not at risk	None
Reenydonagan Lough	Unassigned	Unassigned	Moderate	Moderate	Review	None
Inner Bantry Bay	Unassigned	Unassigned	High	High	Not at risk	None
Outer Bantry Bay	High	High	High	High	Not at risk	None
South Western Atlantic Seaboard (HAs 21;22)	Unassigned	High	High	High	Not at risk	None
Bandon_020	Good	Good	Moderate	Moderate	At Risk	Agriculture
Bandon_030	Good	Moderate	Moderate	Moderate	At Risk	Urban Waste Water and Agriculture
Bandon_040	Good	Good	Good	Good	Not at Risk	None
Bandon_050	Good	Good	Good	Good	Under review	-
Bandon_060	Moderate	Moderate	Moderate	Moderate	At Risk	Anthropogenic
Bandon_070	Good	Good	Good	Good	Not at Risk	None
Bandon_080	Unassigned	Moderate	Good	Good	Under Review	-

Bandon_090	Good	Moderate	Good	Good	Not at risk	None
Bandon_100	Good	Moderate	Good	Good	Not at risk	None
Upper Bandon Estuary	Moderate	Moderate	Poor	Poor	At Risk	Agriculture
Lower Bandon Estuary	Moderate	Poor	Poor	Poor	At Risk	Agriculture
Kinsale Harbour	Good	Good	Good	Good	Not at Risk	None
Western Celtic Sea (HAs 18;19;20)	Unassigned	High	High	High	Not at Risk	None

9.3.13.1 Designated Sites and Habitats

Within the Republic of Ireland, designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). A map of designated sites in the local area is shown as **Figure 9-8** below.

The Proposed Wind Farm site is not located within or adjacent to any designated conservation site.

The nearest SAC to the Proposed Wind Farm site is Derryclogher (Knockboy) Bog SAC and pNHA (Site Code: 001873) which is located 7.6km to the northwest of the Site. The nearest NHA to the Proposed Wind Farm is Conigar Bog NHA (Code: 002386) which is located 5km to the northwest. The Proposed Wind Farm site has no hydrological or hydrogeological connections to these designates sites.

The Bandon River SAC is located 11.5km to the east of the Proposed Wind Farm site, but there is no hydrological connection due to the fact that Proposed Wind Farm site is not located in the Bandon River catchment.

Also, within the Mealagh River and Owvane River catchments, in which the Proposed Wind Farm site is located, there are no downstream designated sites along these watercourses.

The nearest SAC to the Proposed Grid Connection route is the Bandon River SAC. The Proposed Grid Connection intercepts the Bandon River SAC where it runs near the Bandon River, albeit the route is within the carriageway of regional roads at this location.

The next nearest designated site to the Proposed Grid Connection route is Bandon Valley South of Dunmanway (Code: 001035). The designated site is located immediately downstream of where the Proposed Grid Connection crosses the Bandon River at Dunmanway.

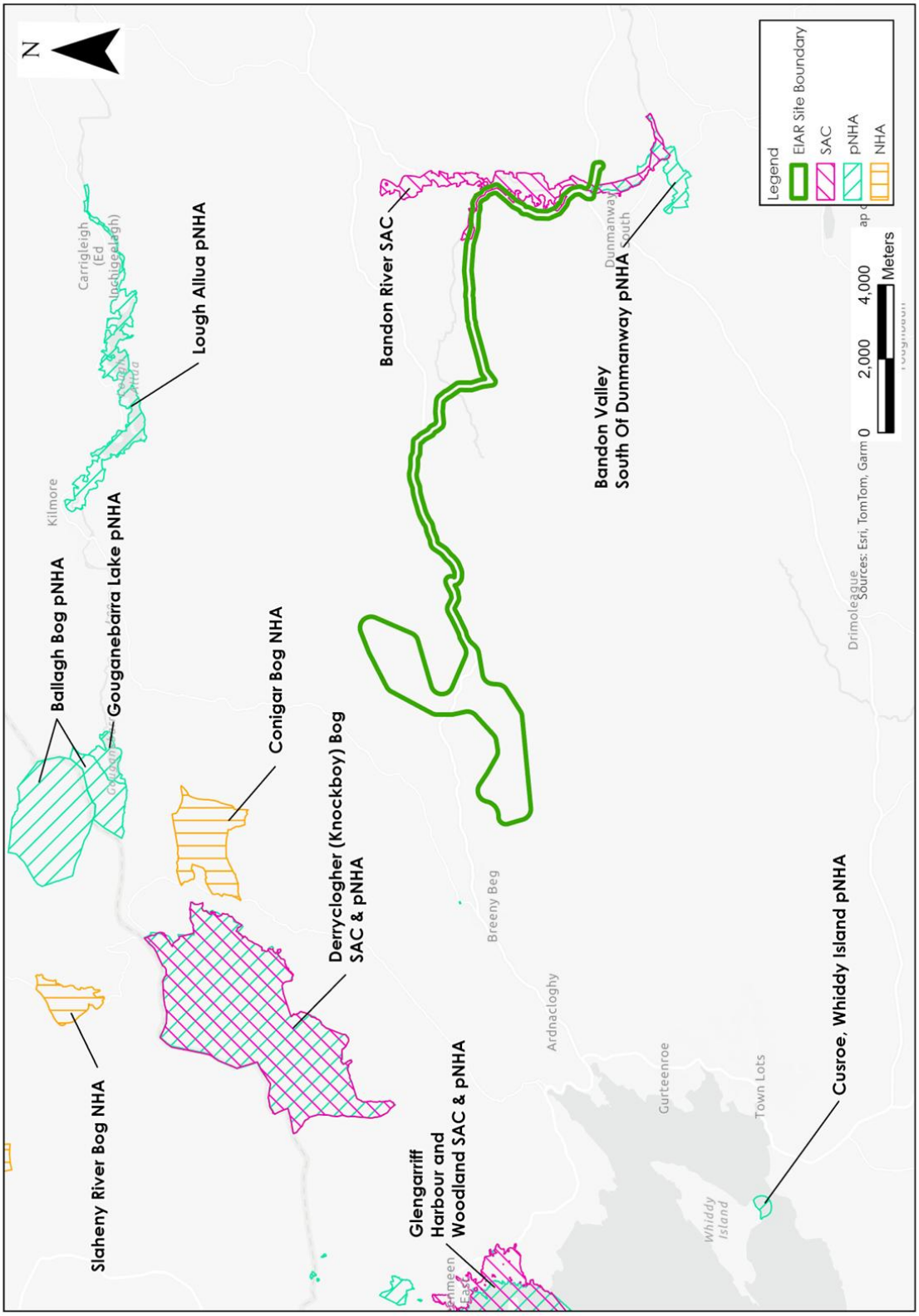


Figure 9-8 Local Designated Sites.

9.3.14 Water Resources

9.3.14.1 Public/Group Groundwater Schemes

There is no GSI mapped Group Water Scheme (GWS) or Public Water Supply (PWS) groundwater Source Protection Areas (SPAs) in the area of the Site.

9.3.14.2 Private Domestic Wells

A search of private well locations on GSI well database (www.gsi.ie) reveal no mapped private wells within 5km of the Proposed Wind Farm site.

Due to the nature of the Proposed Grid Connection underground cable being mainly within the carriageway of public roads outside the Proposed Wind Farm and the shallow nature of the works, no assessment on potential wells located along the cable route (public road or private land sections) was carried out due to the lack of potential affects.

As the GSI well database is not exhaustive in terms of the locations of all wells in the area (as the database relies on the submission of data by drillers and the public etc) it is assumed that every private dwelling down hydraulic gradient of the Proposed Project has a water supply well associated with it (this is unlikely to be the case but is a precautionary assessment).

The majority of these dwellings are remote to the proposed wind farm infrastructure (>580m) and given the bedrock geology type within the Proposed Wind Farm and the unproductive nature of the underlying aquifer there will be very limited hydraulic connection between any potential wells and groundwater flow from the Proposed Wind Farm.

The groundwater flow direction in the aquifer underlying the Proposed Wind Farm will mimic the local topography whereby flow paths will be from topographic high points to lower elevated discharge areas at streams and rivers. Therefore, the general groundwater flow direction at the Proposed Wind Farm is expected to be westerly.

As stated in Section 9.3.9.1 above, groundwater flow paths are typically between 30 – 300m in length and given the fact that all dwellings are a minimum of 580m away from proposed turbine locations and the proposed borrow pits, there is a very low risk of impact. The potential effects on private wells is further assessed in Section 9.6.2.14 below.

9.3.14.3 Surface Water Abstractions

According to WFD mapping the Owngar River (Owngar(Cork)_010), the Mealagh River (Mealagh_020) and the Bandon River (Bandon_020) are listed as Surface Water Drinking Water Protection Areas under Article 7 Abstraction for Drinking Water. All these DWPAs are located downstream of the Proposed Project.

The following details were provided in the Uisce Éireann scoping response and follow up e-mail correspondence (refer to **Table 9-1** above):

> *"The majority of the windfarm site is located within the drinking water abstraction catchment for Zone1 Kealkill Water Supply, with the site located 1.3km from the abstraction point in the Owengar River (Owengar (Cork)_10).*
>
> *A small portion of the southern part of the of the windfarm site is located within the drinking water abstraction catchment for zone1 Bantry Cahernacrin, with the site located 8.5km from the Inchilough abstraction point in the Mealagh_020).*

The cabling route is located within the drinking water abstraction catchment for Zone 2 Bandon Regional Water Supply, with the abstraction point located 22km downstream on the Bandon River".

The Proposed Wind Farm site (including 9 no. of the proposed turbines and the proposed 110kV onsite substation) is located in the Owngar River catchment, while 3 no. proposed turbines are located in the Mealagh River catchment. The Proposed Grid Connection only is located in the Bandon River. Two turbine locations (T1 and T2) are not located within a drinking water catchment.

Refer to **Figure 9-9** for drinking water catchments in which the Proposed Project Wind Farm site is located.

The Owngar River/Kealkill PWS abstraction is located 0.7km to the northwest of the Proposed Wind farm southern turbine cluster which is approximately 2km downstream of the closest Proposed Wind Farm infrastructure (refer to **Figure 9-9**).

The Mealagh River abstraction is located approximately 8.5km downstream of the Proposed Wind Farm southern turbine cluster. The Proposed Grid Connection passes through the Bandon_020 sub-basin where the Bandon River abstraction is located.

The following information is available for the Kealkill PWS which is the source immediately downstream of the Proposed Wind Farm site on the Owngar River:

- The Kealkill Public Water Supply (PWS) supplies a population of 621;
- Abstraction is from the Owngar River;
- The scheme demand is approximately 317 m^3/day;
- Treatment includes slow sand filtration and chlorination;
- The Kealkill PWS is on the EPA's Remedial Action List for public water supplies (RAL) as a result of persistent trihalomethane failures; and,
- The treated water reservoir is located on-site and provides 1.25 days storage.

The Bandon Regional Water Supply (PWS) supplies an average of 4,256m^3/day of water serving a population of 9,170. Raw water is obtained from the River Bandon. Treatment includes coagulation, flocculation, rapid gravity filtration, pH correction, disinfection and fluoridation. Only the Proposed Grid Connection is located in the Bandon River catchment.

The Bantry Cahernacrin public water supply provides a daily volume of approximately 877m^3/day and serves a population of 2,278. The supply is sourced from the Mealagh River and Drombrow Lake. Treatment at the plant includes coagulation, flocculation, clarification, filtration, disinfection and fluoridation. The plant was constructed in 2009.

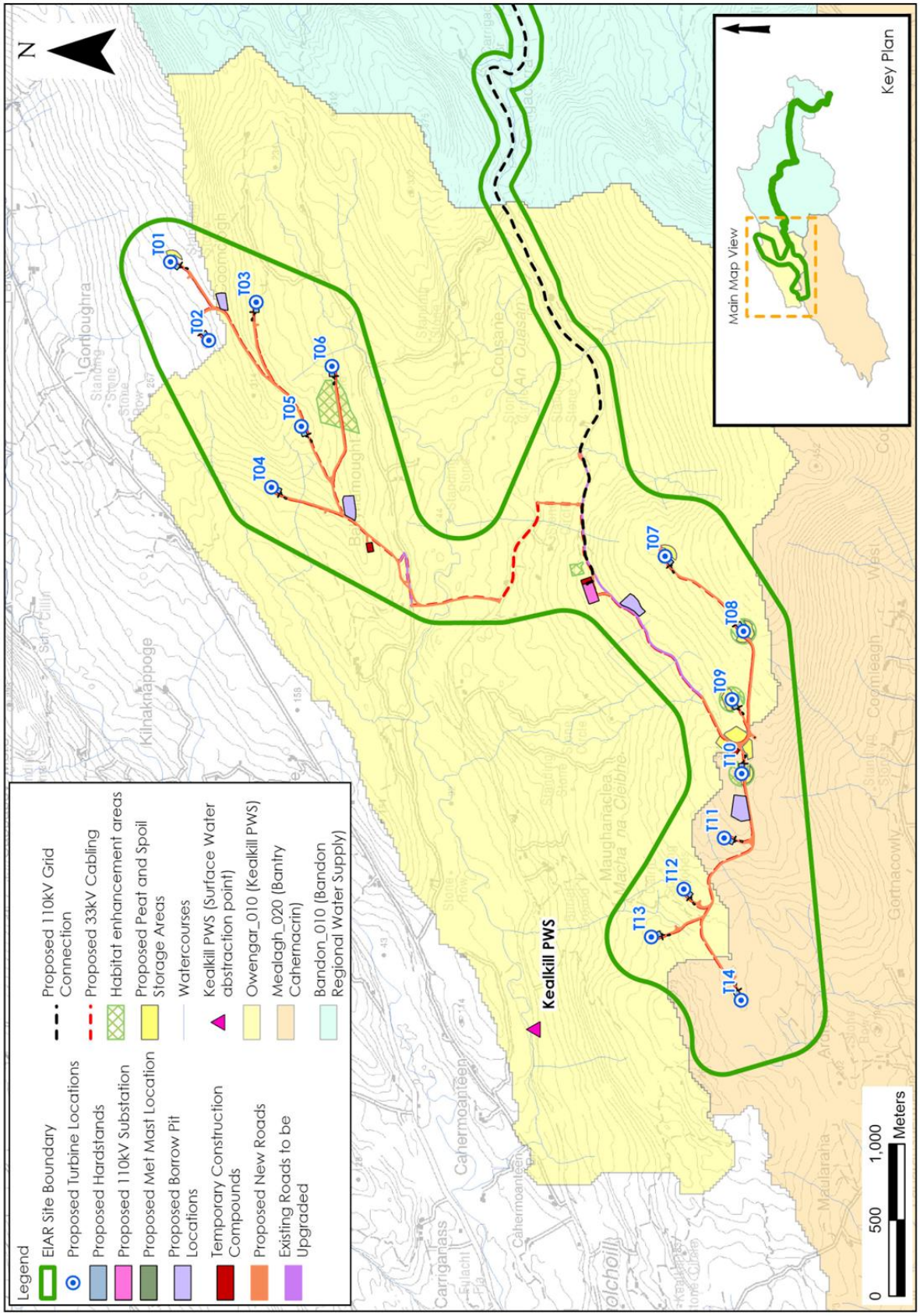


Figure 9-9: Public Water Supply Drinking Water Catchments.

9.3.15 Receptor Sensitivity

Due to the nature of wind farm and grid connection developments, being near surface construction activities, impacts on groundwater are negligible and surface water is generally the main sensitive receptor assessed during impact assessments.

The primary risks to groundwater at the Site would be from cementitious materials, hydrocarbon spillage and leakages. These potential significant effects are assessed in Section 9.6.2 below.

Some of these are common potential impacts on all construction sites (such as road works and industrial sites). All potential contamination sources will be carefully managed at the Site during the construction, operational and decommissioning phases of the development and mitigation measures are proposed below to deal with these potential impacts.

Based on criteria set out in **Table** 9-2 above, the Locally Important and Poor Aquifers can be classed as Sensitive to pollution. However, due to the underlying low permeability bedrock and localised groundwater flow paths, any contaminants which may be accidentally released on-site are more likely to travel to nearby streams within surface runoff.

Based on the local hydrogeology and setback distance from the Proposed Wind Farm site, local wells are considered to be Not Sensitive to impact.

Downstream designated sites such as Bandon River SAC and the public water supply drinking abstractions on the Owngar River, Mealagh River and Bandon River can be considered Very Sensitive to negative effects.

A hydrological constraints map for the Proposed Wind Farm site is shown as **Figure 9-10** below**.** A self-imposed minimum 50m buffer from streams was applied where possible during the project design and constraints mapping and will be maintained where possible during the construction phase. Refer to Section 9.5 below for details on watercourse buffers.

Comprehensive surface water mitigation and controls are outlined below to ensure protection of all downstream receiving waters. Mitigation measures will ensure that surface runoff from the developed areas of the Site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the Proposed Wind Farm site will mimic the existing drainage regime.

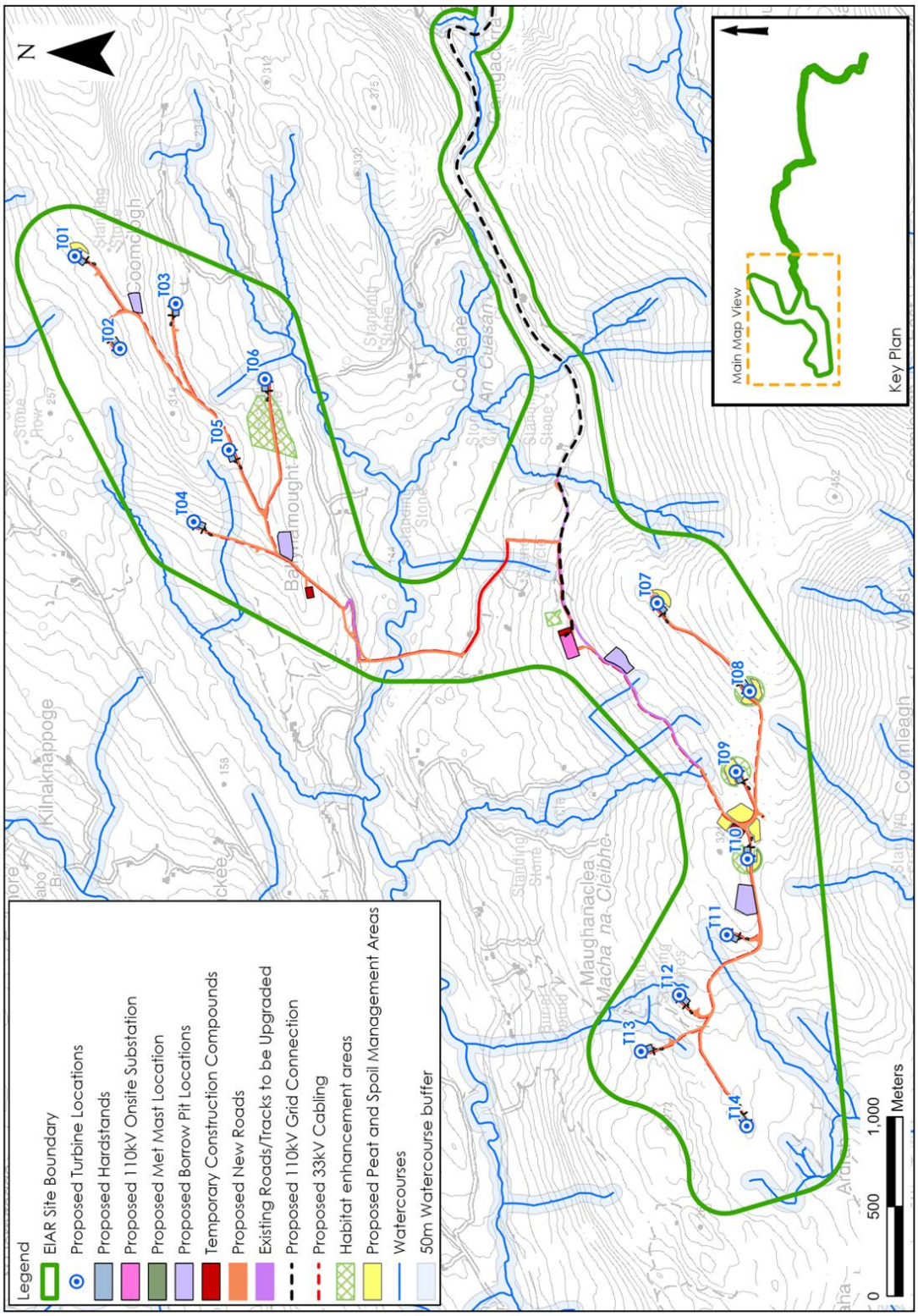


Figure 9-10: Hydrological Constraints Map.

9.4 Characteristics of the Proposed Project

Please refer to Section 4.1 of the EIAR for a description of the Proposed Project (i.e. Proposed Wind Farm and Proposed Grid Connection).

The main characteristics of the Proposed Wind Farm that could impact on hydrology and hydrogeology are:

- Construction of 14 no. turbine foundations, which will be of gravity foundation design;
- Establishment of 3 no. temporary construction compounds, which will involve minor regrading of peat/soil/subsoil and the emplacement of hardstand. Welfare facilities will be provided at the primary temporary construction compounds. Wastewater effluent will be collected in a wastewater holding tank and periodically emptied by a licenced contractor;
- Construction of the proposed 110kV onsite substation with a subsoil bearing foundation. Welfare facilities will be provided at the substation;
- Construction of the site access tracks will use the excavate and replace technique as well as the floating technique for an approximate 85m section in the southern turbine cluster of the Proposed Wind Farm. This will involve the use of aggregate from 4 no. proposed on-site borrow pits and imported from local quarries where required;
- Construction of the crane hardstand areas and turbine assemblage areas will utilise ground bearing foundations;
- Settlement ponds where constructed will be volume neutral, i.e. all material excavated will be used to form side bunds and landscaping around the ponds. There will be no excess material from settlement pond construction. The material will also be reinstated during decommissioning;
- Grey water will be supplied by rainwater harvesting and water tankered to site where required. Bottled water will be used for potable supply;
- Cabling between turbine locations and the proposed 110kV onsite substation will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling;
- Construction of 5 no. new watercourse crossing (clear span bridge design);
- Tree felling (approximately 44ha) for the purposes of turbine and access road construction clearance which will be carried out under felling licence;
- Establishment of peat and spoil management areas; and,
- Establish Biodiversity Management and Enhancement Areas (wet heath habitat and native tree planting).

The main characteristics of the Proposed Grid Connection that could impact on hydrology and hydrogeology are:

- Construction of approximately 20.5km of underground cabling route between the proposed 110kV onsite substation and the existing 110kV Dunmanway substation involving the excavation of a shallow trench (approximately 1.3m deep), placement of ducting and backfilling with aggregate, lean-mix concrete, and excavated material, as appropriate (depending on the location of the cable trench); and,
- Passing of the cable over/under 11 no. watercourse crossing using the existing bridge structure or by Horizontal Directional Drilling (HDD). No instream works are required at any of the Proposed Grid Connection crossing locations.

9.5 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the Site. The first method involves 'keeping clean water clean' by avoiding disturbance to natural drainage

features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas.

The second method involves collecting any drainage waters from works areas within the Site that might carry silt or sediment, and nutrients, to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters.

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. A schematic of the proposed site drainage management is shown as **Figure 9-11** below.

A minimum 50m watercourse buffer will be maintained where possible for proposed key Proposed Wind Farm infrastructure such as turbines, borrow pits, peat and spoil management areas and construction compounds.

However, with the exception of proposed turbine locations T6 and T12, all other turbine locations are actually more than 75m from a watercourse. Proposed borrow pits and peat and spoil management areas are also located more than 75m from a watercourse.

A detailed drainage plan showing the layout of the proposed construction and operational drainage design elements as shown in **Figure 9-11** and in **Appendix 4-4**.

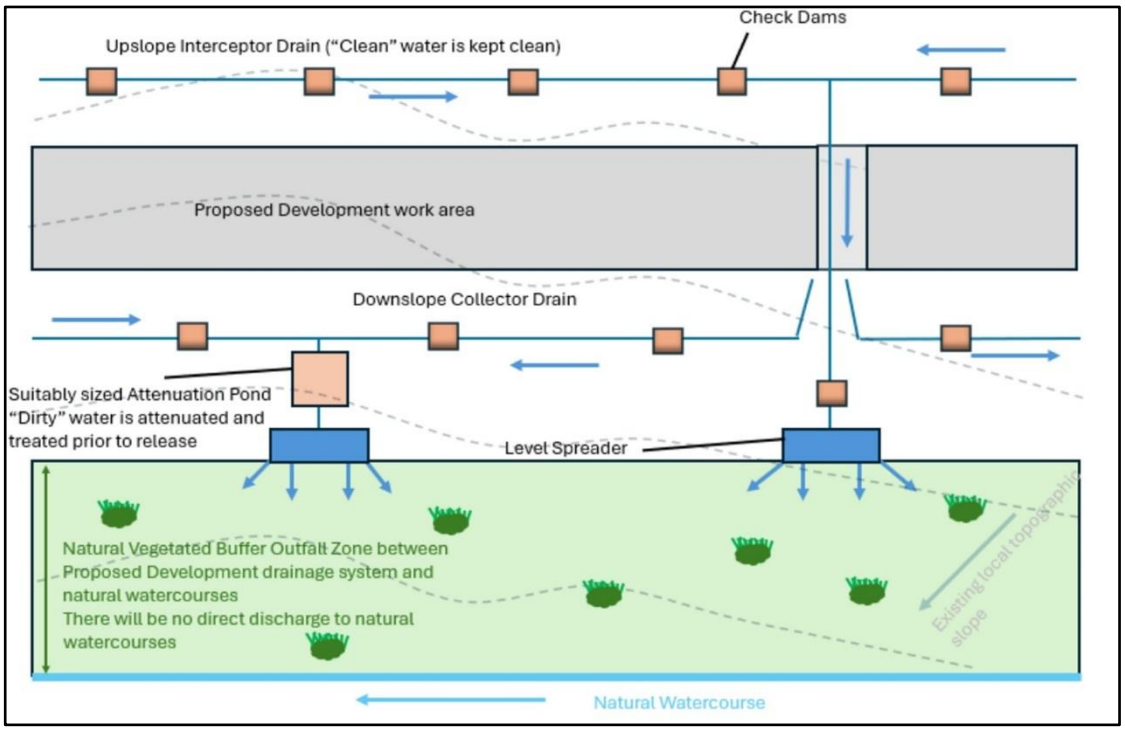


Figure 9-11: Schematic of the Proposed Drainage Management.

9.5.1 Proposed Project Interaction with the Existing Drainage Network

In relation to hydrological constraints, where possible a self-imposed minimum buffer zone of 50m has been put in place for on-site streams and rivers (note that 12 no. turbine locations are actually more than 75m from a watercourse. Manmade drains are not considered a significant hydrological constraint.

The general design approach to wind farm layouts is to utilise and integrate with the existing drainage infrastructure where possible whether it be existing access roads or the existing forestry / peat /

agricultural drainage network. Utilising the existing infrastructure means that there will be less of a requirement for new construction/excavations which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing forestry and agricultural drains have no major ecological or hydrological value and can be readily integrated into the Proposed Wind Farm drainage scheme.

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

- Lidar data was used to map in detail the existing farm and forestry drainage at the Proposed Wind Farm site and how the proposed infrastructure interacts with these existing manmade and natural drainage patterns;
- Lidar data and available aerial photography was used to digitise existing farm and forestry drainage and field drains within the Proposed Wind Farm site;
- The Proposed Wind Farm footprint was divided up into drainage catchments (based on topography, outfall locations, catchment size) and we have calculated stormwater runoff rates for each catchment based on the 10-year return period rainfall event. These flows are used to design settlement ponds for each drainage catchment;
- Cut-off (interceptors drains) are included to locally re-route existing farm and forestry drains where required;
- The proposed construction phase settlement ponds are designed for 11hr and 24hr retention times used to settle out medium silt (0.006mm) and fine silt (0.004mm) respectively (EPA, 2006)[3]; and,
- The proposed locations of temporary drainage measures that will be installed prior to construction of the Proposed Wind Farm commencing are identified on the drainage drawings included in **Appendix 4-4**.

[3] *Environmental Protection Agency (2006): Environmental Management in the Extractive Industry (Non-Schedule Minerals)*

9.6 Likely Significant Effects and Mitigation Measures

The potential impacts of the Proposed Project and mitigation measures that will be put in place to eliminate or reduce them are set out below.

9.6.1 Do Nothing Scenario

If the Proposed Project was not developed, the Proposed Wind Farm site will continue to function as it does at present, with no changes made to the current land-use of commercial forestry, agricultural pastures and rough grazing. Land-use along the Proposed Grid Connection would remain unchanged from its present condition. In terms of hydrology, the existing surface water drainage regime would continue to function and may be extended in places.

The impact of this is considered neutral in the context of the EIAR. If the Proposed Project were not to proceed, the opportunity to capture an even greater part of County Cork's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

Furthermore, the opportunity to create the new proposed areas of wet heath and native woodland within the Proposed Wind Farm site would be lost. Please see **Appendix 6-4** Biodiversity Management and Enhancement Plan for details.

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

9.6.2 Construction Phase – Likely Significant Effects and Mitigation Measures

The likely significant effects of the construction phase of the Proposed Project and mitigation measures that will be put in place to eliminate or reduce them are shown in this section. It should be noted that the main potential effects on the water environment will occur during the construction phase. The assessment considers the Proposed Project as a whole, i.e. both the Proposed Wind Farm and the Proposed Grid Connection. Where this is required to be assessed separately, this is noted in the text.

9.6.2.1 Clear Felling of Coniferous Plantation and Potential Surface Water Quality Effects (Proposed Wind Farm)

Felling works will only be required for the Proposed Wind Farm and not the Proposed Grid Connection. Only the Proposed Wind Farm is assessed herein.

Tree felling will be required within and around the Proposed Wind Farm infrastructure footprint to allow for the construction of the proposed turbines, access roads underground cabling, and the other ancillary infrastructure.

In total, approximately 44 hectares of forestry (conifer plantation (WD4)) will be felled to accommodate Turbines 1, 2, 3, 6, 7, 8, 9, 10, 11 and its associated infrastructure as well as at the proposed 110kV onsite substation, which accounts for 3ha of the total felling area.

Of the 44ha to be felled, only approximately 2ha is located inside a 50m watercourse buffer zone.

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

Potential impacts during tree felling occur mainly from:

- Exposure of soil and subsoils due to vehicle tracking or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface watercourses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;
- Damage to roads resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface watercourses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Owvane River, Owngar River and Mealagh River) and associated dependent ecosystems. There is no proposed tree felling in the Bandon River catchment.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, likely effect on surface water quality.

Proposed Mitigation Measures:

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 9-14**.

Table 9-14 : Minimum Buffer Zone Widths (Forest Service, 2000).

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

During the Proposed Project construction phase a self-imposed buffer zone of minimum 50 metres will be maintained for all natural watercourses where possible, with a buffer of 75m being maintained for most infrastructure. These buffer zones are shown on **Figure 9-10**.

Of the 44ha to be felled, only approximately 2ha is located inside the 50m watercourse buffer.

The large distance between the proposed felling areas and sensitive aquatic zones means that potential poor quality (sediment laden) runoff from felling areas will be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes.

Mitigation by Design:

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

- Machine combinations (i.e., handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicle through watercourses will occur, as vehicles will use road infrastructure and existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the proposed area to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and will avoid being placed at right angles to the contour;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the peat disposal areas. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;
- All drainage channels will taper out before entering the 50m buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;

- 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. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils 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;
- Timber will be stacked in dry areas, and outside a local 50 metre watercourse buffer. 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 run-off;
- Checking and maintenance of roads and culverts will be on-going through the felling operation;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted;
- 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;
- Crossing of streams will not be permitted;
- Trees will be cut manually from along streams and using machinery to extract whole tree; and,
- Travel only perpendicular to and away from stream.

Silt Traps:

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

Drain Inspection and Maintenance:

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

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

Surface Water Quality Monitoring:

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

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

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

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

Residual Effect: The potential for the release of suspended solids to watercourse receptors during tree felling is a risk to water quality and the aquatic quality of the receptor. Proven forestry best practice measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The mitigation measures will ensure that surface water runoff from the Proposed Wind Farm will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effect of the Proposed Wind Farm will be negative, imperceptible, indirect, temporary, likely effect on downstream water quality and aquatic habitats.

Significance of Effects: With the application of the mitigation outlined above, no significant effects on the surface water quality will occur.

9.6.2.2 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Waters (Proposed Project)

There will be earthworks required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Proposed Project construction phase activities that will require earthworks resulting in the removal of vegetation cover and excavation of peat and mineral subsoil (where present) are detailed in Chapter 4: Description of the Proposed Project. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from infrastructure excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of the underground cable trench resulting in the entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

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

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Owvane River, Owngar River, Mealagh River and Bandon River) and dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, significant, long-term, likely effect on surface water quality.

Mitigation by Avoidance:

The key mitigation measure during the construction phase of the Proposed Project is the avoidance of sensitive aquatic areas where possible From **Figure 9-10** it can be seen that all of the key areas of the Proposed Project infrastructure are actually significantly away from the 50m delineated buffer zones with the exception of existing road upgrades, new roads, proposed stream crossings and existing stream crossings requiring upgrading.

Additional control measures, which are outlined further on in this section, will be undertaken at these locations.

Proposed turbine locations T1 to T5, T7 to T11, T13 and T14 are actually setback more 75m from a watercourse.

The large setback distance from sensitive hydrological features by using the 50m buffer means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operated effectively. The proposed buffer zone will:

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

Mitigation by Design:

- Source controls:
    - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with gravel, filter fabrics, and other similar/equivalent or appropriate systems.
    - Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
- In-Line controls:
    - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, 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 for this Site is that an existing network of forestry, bog, field and roadside drains already exists, and these will be integrated and enhanced as required and used within the Proposed Project drainage system. The integration of the existing drainage network and the Proposed Project network is relatively simple. The key elements being the upgrading and improvements to water treatment elements, such as in line controls and treatment systems, including silt traps, stilling 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 Project drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works / tree felling is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- Runoff from individual turbine hardstanding areas will be not discharged into the existing drain network but discharged locally at each turbine location through stilling ponds and buffered outfalls onto vegetated surfaces;
- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site; and,
- Drains running parallel to the existing roads requiring widening will be upgraded, widening will be targeted to the opposite side of the road. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

Pre-commencement Temporary Drainage Works

Prior to the commencement of road upgrades (or new road/hardstand) 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 temporary 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 drains that have surface water flows and also along existing roadside drains; and,
- A double silt fence perimeter will be placed down-slope of works areas that are located inside the watercourse 50m buffer zones and at watercourse crossings.

Water Treatment Train:

A final line of defence will be provided by a water treatment train such as a “Siltbuster”. If the discharge water from construction areas fails to be of a high quality during regular inspections, then a filtration treatment system (such as a ‘Siltbuster’ or similar equivalent treatment train (sequence of water

treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase.

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 water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be placed within drains down-gradient of all construction areas inside the 50m hydrological buffer zones and at watercourse crossings.

Silt Bags:

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

Settlement Ponds:
The Proposed Project footprint has been divided into drainage catchments (based on topography, outfall locations, and catchment size) and stormwater runoff rates based on the 10-year return period rainfall event were calculated for various catchment areas in order to size the settlement ponds as shown in **Table 9-15** below.

The settlement ponds are designed to accommodate a 10-year return period event which was a recommendation by Inland Fisheries Ireland (IFI) on other wind farm developments such as Cahermurphy Wind Farm, Co. Clare (Clare Co. Co. planning ref: P20/658 and Croagh in County Leitrim/Sligo (Leitrim Co. Co. planning ref: P20/120).

These flows were then used to design settlement ponds for each drainage catchment. The settlement ponds are designed for 11hr or 24hr retention times used to settle out medium silt (0.006mm) and fine silt (0.004mm) respectively (EPA, 2006)[5].

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

Table 9-15 : Settlement Pond Design

POND SIZE W [M] X L [M] X D [M]			TRACK/HARDSTAND CATCHMENT SIZE (M^2)		
RETURN PERIOD	10 YRS	STORM DURATION	500	1000	2000
6HR RETENTION FOR COARSE SILT		6 HRS	3.4 X 10.6 X 1 M	4.8 X 15.0 X 1 M	6.9 X 21.0 X 1 M
11HR RETENTION FOR MEDIUM SILT		12 HRS	3.8 X 12.0 X 1 M	5.5 X 16.5 X 1 M	7.5 X 24.2 X 1 M
24HR RETENTION FOR FINE SILT		24 HRS	4.2 X 13.8 X 1 M	6.2 X 18.6 X 1 M	8.6 X 27.0 X 1 M

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 levelspreaders, the potential for ground erosion is significantly greater than not using them.

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

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

Pre-emptive Site Drainage Management

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

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

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

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

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

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

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,

- Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Management of Runoff from Peat and Spoil Management Areas:
It is proposed that excavated spoil and peat will be used for landscaping where required. The excess material will then be placed in the designated peat and spoil management areas within the Proposed Wind Farm site.

Additionally, once the required volume of rock has been extracted from the 4 no. borrow pit areas, it is intended to reinstate these areas with any surplus peat and spoil excavated from the works areas of the Proposed Wind Farm.

All proposed peat and spoil management areas and borrow pits are located outside of 50m watercourse buffers.

During the initial construction of peat and spoil management areas, silt fences, straw bales and biodegradable geogrids will be used to control surface water runoff from works areas.

Where applicable, the vegetative top-soil layer of the peat and spoil management areas will be rolled back to facilitate placement of excavated peat, following which the vegetative-top soils layer will be reinstated. Where reinstatement is not possible, peat and spoil management areas will be sealed with a digger bucket and seeded as soon possible to reduce sediment entrainment in runoff.

Drainage from peat and spoil management areas and borrow pits will ultimately be routed to an oversized swale and a number of stilling ponds pond with appropriate storage and settlement designed for a 1 in 10-year return period before being discharged to the on-site drains.

Peat and spoil management areas and reinstated borrow pits will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised peat and spoil management areas and reinstated borrow pits 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.

Monitoring:

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

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

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

Allowance for Climate Change

Climate change rainfall projections are typically for a mid-century (2050) timeline. The projected effects of climate change on rainfall are therefore modelled towards the end of the life cycle of the Proposed Wind Farm, as the proposed turbines have a life span of 35 years. It is likely that the long-term effects of climate change on rainfall patterns will not be observed during the lifetime of the Proposed Wind Farm. As outlined in the above sections we have designed settlement ponds for a 1 in 10-year return flow. This approach is conservative given that the Proposed Project will likely be built over a much shorter period (18-24 months), and therefore this in-built redundancy in the drainage design more than accounts for any potential short term climate change rainfall effects.

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

Residual Effect: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effects of the Proposed Project will be negative, imperceptible, indirect, short-term, likely effect on down-gradient rivers, water quality, and dependent ecosystems.

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

9.6.2.3 Potential Impacts on Groundwater Levels during Excavations (Proposed Project)

There will be excavations required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Dewatering of the borrow pits (as required) and other deep excavations (i.e., turbine bases) have the potential to impact on local groundwater levels temporarily during construction works.

However, groundwater level impacts will not be significant due to the local topographical, geological and hydrogeological regime as outlined below.

Pathway: Groundwater flowpaths.

Receptor: Groundwater levels (Beara Sneem GWB, Bandon GWB and local bedrock aquifers).

Pre-Mitigation Potential Effect: Direct, negative, slight, brief, likely effect on local bedrock aquifers. No significant effects on GWBs will occur due to the small dewatering requirements.

Impact Assessment:

The 4 no. proposed borrow pits are located in poorly productive bedrock (i.e. siltstone and sandstone) which is generally unproductive in terms of groundwater flow. This was confirmed by the investigation drilling carried out at the proposed borrow pit locations (refer to drilling log for RC-02 & RC03 in **Appendix 8-1**) which encountered 4m of weathered rock over very strong locally strong thinly laminated grey slightly sandy fine grained SANDSTONE and SILTSTONE respectively. The 14 no. turbine bases are also located in the same bedrock geology.

Also, the topographical and hydrogeological setting of the proposed borrow pit and turbine locations means no significant groundwater dewatering is anticipated to be required during the operation of the borrow pit or turbine base construction.

Moreover, direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. Any inflows from the upper weathered bedrock will essentially be surface water (i.e. rainfall) and not true groundwater. This was also confirmed by the trial pitting which typically recorded surface water inflows.

For the avoidance of doubt, we 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. We consider that this example is very different in scale and operation from the proposed operation of a temporary shallow borrow pit on the side of a hill. In order to explain this thoroughly we will outline our reasoning in a series of bullet points as follows:

- Firstly, the borrow pit areas and turbines are located on the top of rocky local hills where the ground elevation is between approximately 200 - 380m OD and therefore are rock outcrops or subcrops as mapped by the GSI;
- These elevations are above the elevations of the local valleys and streams;
- The proposed borrow pits will be between approximately 8 – 10m below ground level which is notable and the turbine bases 4mbgl. However, in the context of the topographical/elevated setting, this depth range is relatively shallow;
- The local bedrock comprises SILTSTONE/SANDSTONE and is known to be generally unproductive. This means that groundwater flows will be relatively minor;
- The flow paths (i.e. the distance from the point of recharge to the point of discharge) in this type of geology is short, localised, and will also be relatively shallow;
- No regional groundwater flow regime, i.e. large volumes of groundwater flow, will be encountered at these elevations;
- Therefore, shallow groundwater inflows will largely be fed by recent rainfall, and possibly by limited groundwater seepage from localised shallow bedrock;
- The sloping nature of the ground on the hills where the infrastructure is proposed along with the coverage of soil means groundwater recharge is going to be very low;
- As such the shallow groundwater flow system will be small in comparison to the expected surface water flows from the bog surface;
- This means that there will be a preference for high surface water runoff as opposed to groundwater recharge and flow; and,
- Hence, we consider that the management of surface water will form the largest proportion of water to be managed and treated.

No groundwater level impacts are predicted from the construction of the Proposed Grid Connection cable infrastructure due to the shallow nature of the excavations (i.e. 0 -~1.5m).

Residual Effect: Due to the prevailing geology at the Site, the local and temporary nature of the proposed works, the residual effects of the Proposed Project on groundwater levels will be negative, imperceptible, direct, brief and reversible.

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

9.6.2.4 Excavation Dewatering and Potential Impacts on Surface Water Quality (Proposed Project)

Pumping water from excavations may be required for both the Proposed Wind Farm and Proposed Grid Connection and therefore both are assessed herein.

Some minor groundwater/surface water seepages will likely occur in turbine base excavations and borrow pits, and this will create additional volumes of water to be treated by the runoff management system. Cable trenching might require removal of water prior to backfilling.

Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore baseline contamination does not occur.

Pathway: Overland flow and site drainage network.

Receptor: Down-gradient surface water bodies (Owvane River, Owngar River, Mealagh River and Bandon River).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short term, likely effect to surface water quality.

Proposed Mitigation Measures:

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

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a silt bags or silt buster;
- 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;
- At the borrow pits adequately sized settlement ponds will be constructed to treat pumped water prior to discharge into a local manmade drain; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be made available at the borrow pit locations for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

Residual Effect: 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 of the Proposed Project will be negative, imperceptible, indirect, short-term, likely effect on local surface water quality.

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

9.6.2.5 Potential Release of Hydrocarbons during Construction and Storage (Proposed Project)

Hydrocarbons will be required for both the Proposed Wind Farm and Proposed Grid Connection and therefore both are assessed herein.

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

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater and surface water (Owvane River, Owngar River, Mealagh River, Bandon River).

Pre-Mitigation Potential Effect:

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

Indirect, negative, moderate, short term, unlikely effect to surface water quality.

Proposed Mitigation Measures:

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:

- Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Where possible, off-site refuelling will occur at a controlled fuelling station;
- On-site re-fuelling will be undertaken using a refuelling truck with spill kits kept on site for accidental leakages or spillages;
- Only designated trained operatives will be authorised to refuel plant on-site;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- All fuel storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuels stored on-site will be minimised. All storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The transformer within the proposed 110kV onsite substation will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency response plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (which is contained in **Appendix 4-3**).

Residual Effect: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status or ecology of downstream waters. The residual effect of the Proposed Project will be negative, imperceptible, indirect, short-term, unlikely impact to local surface water and groundwater quality.

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

9.6.2.6 Groundwater and Surface Water Contamination from Wastewater Disposal (Proposed Project)

Wastewater management will be required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Release of effluent from domestic wastewater treatment systems has the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater quality and surface water quality (Owvane River, Owngar River, Mealagh River and Bandon River).

Pre mitigation Effect:

Indirect, negative, significant, temporary, unlikely effect to surface water quality.

Proposed Mitigation Measures:

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

Residual Effect: No residual effects of the Proposed Project.

Significance of Effects: No significant effects on surface water or groundwater quality will occur.

9.6.2.7 Release of Cement-Based Products (Proposed Project)

Cement will be required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

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

environment. Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to 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.

Pathway: Site drainage network.

Receptor: Surface water and peat water hydrochemistry.

Pre-Mitigation Effect: Indirect, negative, moderate, short term, likely effect to surface waters (Owvane River, Owngar River, Mealagh River, Bandon River).

Proposed Mitigation Measures:

- No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water will be undertaken at lined cement washout ponds located more than 50m from a watercourse;
- Weather forecasting will be used to plan dry days for pouring concrete;
- The pour site will be kept free of standing water and plastic covers will be ready in case of a sudden rainfall event; and,
- At proposed turbine foundations, sand blinding, DPM, and lean-mix blinding are used to vertically contain the concrete. While the concrete is contained laterally by temporary/permanent shuttering. The concrete cures within 72hrs.

Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status or ecology of downstream waters. The residual effect will be negative, imperceptible, indirect, short-term, unlikely effect to surface water quality.

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

9.6.2.8 Morphological and Hydrological Effects due to Watercourse Crossing Works (Proposed Wind Farm)

New watercourse crossings (i.e. bridges/culverts) or upgrades of existing culvert crossings will only be required at the Proposed Wind Farm. Only the Proposed Wind Farm is assessed herein as the Proposed Grid Connection is assessed separately in Section 9.6.2.9 below.

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

Within the Proposed Wind Farm site, there are a total of 5 no. watercourse new crossing locations over natural watercourses (rivers and streams). The crossing locations are outlined below:

- A new crossing is proposed over the Owngar River for the 33kV cabling and proposed access road;
- A new crossing on the proposed access road to turbine T4;
- A new crossing on the proposed access road between turbines T11 and T12;
- A new crossing on the proposed access road to turbine T13; and,
- A new crossing on the proposed access road between the proposed 110kV onsite substation and turbine T10.

Within the Proposed Wind Farm site, there are a total of 3 no. existing watercourse culvert crossing location that will require upgrading. The crossing locations are outlined below:

- 3 no. existing culverts along the forestry road between the proposed 110kV onsite substation and proposed turbine location T10.

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

Pathway: Site drainage network.

Receptor: Surface water flows (Owvane River, Owngar River and Mealagh River), stream morphology and water quality.

Pre-Mitigation Potential Impact: Negative, direct, slight, long term, likely effect on surface water flows and drainage patterns.

Proposed Mitigation Measures:

- The proposed new stream crossings at the Proposed Wind Farm site will be clear span watercourse crossings, and the existing banks will remain undisturbed. No in-stream excavation works are proposed at these locations and therefore there will be no direct impact on the stream at the proposed crossing locations. Abutments will be constructed from precast units combined with in-situ foundations;
- All guidance / mitigation measures required by the OPW and/or the Inland Fisheries Ireland (IFI)[4] is incorporated into the design of the proposed crossings;
- All drainage measures will be installed in advance of the works;
- Plant and equipment will not be permitted to track across the watercourse;
- Once the foundations have been completed at both sides of the watercourse, the pre-cast concrete box culvert will be installed using a crane and there will be no contact with the watercourse;
- Where the box culvert is installed in sections, the joint will be sealed to prevent granular material entering the watercourse;
- As a further precaution, near stream construction work, will only be carried out during the period permitted by IFI for in-stream works according to the IFI (2016) guidance document 'Guidelines on protection of fisheries during construction works in and adjacent to waters', i.e., July to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);

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

- Where works are necessary inside the 50m buffer double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase;
- At the proposed culvert upgrade locations temporary damming and over pumping will be undertaken to manage flows in the watercourse; and,
- All new river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

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

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

In relation to the new proposed culverts and proposed culvert upgrades at field drain crossings, the culverts will be suitably sized for the expected peak flows in the relevant drain. All culverts will be installed with a minimum internal gradient of 1% (1 in 100). Smaller culverts will have a smooth internal surface. Larger culverts may have corrugated surfaces which will trap silt and contribute to the stream ecosystem. Depending on the management of water on the downstream side of the culvert, large stone may be used to interrupt the flow of water. This will help dissipate its energy and help prevent problems of erosion. Smaller water crossings will simply consist of an appropriately sized pipe buried in the sub-base of the road at the necessary invert level to ensure ponding or pooling does not occur above or below the culvert and water can continue to flow as necessary.

Residual Effect: With the application of the best practice mitigation outlined above, the residual effect will be negative, imperceptible, direct, long-term, unlikely impact on stream flows, stream morphology and surface water quality.

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

9.6.2.9 Potential Surface Water Quality Effects of the Proposed Grid Connection Earthworks Works and Watercourse Crossings

Along the Proposed Grid Connection route there are 11 no. EPA mapped watercourses. This includes no. 2 existing crossings in the Owngar River catchment and 9 no. in the Bandon River catchment.

The watercourse crossing methodologies for the Proposed Grid Connection at these locations are described in full in Chapter 4 (Section 4.9.2.6) and are summarised below.

- Crossing Using Standard Trefoil Formation – Option A
- Flatbed Formation Under Bridges/Culverts – Option B
- Flatbed Formation over Bridges/Culverts – Option C
- Horizontal Directional Drilling – Option D

In stream works are not required at any watercourse crossing along the Proposed Grid Connection and no significant effects on water quality in the Bandon River are expected.

Pathway: Surface water flowpaths/groundwater paths.

Receptor: Down-gradient water quality (Owngar River, Owvane River and Bandon River).

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

Proposed Mitigation Measures:

Pre-commencement Temporary Drainage Works:

Prior to the commencement of substation, cable trenching, access road or end mast works the following key temporary drainage measures will be installed:

- All existing roadside drains (where present) that intercept the proposed works area will be temporarily blocked down-gradient of the works using check dams/silt traps;
- Culverts, manholes and other drainage inlets (where present) will also be temporarily blocked; and,
- A double silt fence perimeter will be placed along the road verge on the down-slope side of works areas that are located inside the watercourse 50m buffer zone.

The following mitigation measures are proposed for the underground cabling watercourse crossing works:

- 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", i.e., May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);
- The crossing works area will be clearly marked out with fencing or flagging tape to avoid unnecessary disturbance;
- There will be no storage of material / equipment or overnight parking of machinery inside the hydrological buffer zone;
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channels;
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse;
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages;
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area;
- Spills of drilling fluid will be cleaned up immediately and contained in an adequately sized skip before been taken off-site;
- If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works);
- This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed settlement pond area at least 50m from the watercourse;
- The discharge of water onto vegetated ground will be via a silt bag which will filter any remaining sediment from the pumped water. The entire percolation area will be enclosed by a perimeter of double silt fencing;
- Any sediment laden water from the works area will not be discharged directly to a watercourse or drain;

- Works shall not take place during periods of heavy rainfall and will be scaled back or suspended if heavy rain is forecasted;
- Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse;
- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied;
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion;
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated;
- There will be no batching of cement along the Proposed Grid Connection;
- There will be no refuelling allowed within 100m of the watercourse crossing; and,
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.

Fracture Blow-out (Frac-out) Prevention and Contingency Plan:

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

Residual Effect: Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect of the Proposed Project will be negative, imperceptible, direct, long term, likely effect on surface water quality.

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

9.6.2.10 Potential Hydrological Effects on Designated Sites (Proposed Grid Connection)

Designated sites are located downstream of the Proposed Grid Connection only. Therefore, only the Proposed Grid Connection is assessed herein.

Bandon River SAC is located downstream of the Proposed Grid Connection cable route only. The Proposed Grid Connection cable intercepts the Bandon River SAC where it runs near the Bandon River, albeit the route is within the carriageway of regional roads at this location and does not directly affect the SAC.

Also, Bandon Valley South of Dunmanway pNHA (Code: 001035) is located immediately downstream of where the Proposed Grid Connection route crosses the Bandon River at Dunmanway.

Pathway: Surface water and groundwater flowpaths.

Receptor: Down-gradient water quality and designated sites (Bandon River SAC & Bandon Valley South of Dunmanway pNHA).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short-term, likely effect on Bandon River SAC and Bandon Valley South of Dunmanway pNHA.

Impact Assessment & Proposed Mitigation Measures:

Drainage mitigation measures for surface water quality protection during the construction phase are summarised again below: (Relevant sections are shown for the full description of these measures and how they will be applied).

- Avoidance of instream works at the proposed 11 no. EPA watercourse crossing locations (Section 9.6.2.9);
- Pre-commencement temporary drainage works (Section 9.6.2.9);
- Management of spoil during earthworks along the cable route trenching works (Section 9.6.2.9); and,
- Best practice measures with regard use of oils, fuels (Section 9.6.2.5) and cement based compounds (Section 9.6.2.7).

As stated in Section 9.6.2.2 above, there could potentially be a residual “imperceptible, short term, likely effect” on local streams and rivers but this would be very localised and over a very short time period (i.e. hours). Therefore, significant direct, or indirect impacts on the downstream Bandon River SAC and Bandon Valley South of Dunmanway pNHA will not occur.

Residual Impact: No effects on designated sites from the Proposed Grid Connection.

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

9.6.2.11 Effects of Construction Works on the WFD Status of Downstream Waterbodies (Proposed Project)

Both the Proposed Wind Farm and Proposed Grid Connection Route and the potential to effect WFD status. Therefore, both are assessed herein.

WFD status and Risk Results for downstream river waterbodies and the underlying GWBs are presented in Sections 9.3.12 & 9.3.13 above.

Due to the poorly productive nature of the underlying bedrock aquifer, the potential to negatively affect the WFD status of the GWBs is very low, even in the absence of mitigation.

Without mitigation the proposed construction works do have the potential to adversely impact on surface water quality which may negatively impact on the WFD status of these downstream surface waterbodies.

Our understanding of the objectives of the WFD 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. This is reflected in the strict mitigation measures in relation to maintaining a high quality of surface water from the Proposed Project will ensure that the status of surface waterbodies in the vicinity of the Proposed Project will be at least maintained regardless of their existing status.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Owvane River, Owngar River, Mealagh River and Bandon River) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, unlikely effect on river waterbody status. No effects GWBs WFD status will occur.

Proposed Mitigation Measures:

Comprehensive surface water mitigation and drainage controls are outlined in Section 9.6.2.1 (Felling of Coniferous Plantations), Section 9.6.2.2 (Earthworks), Section 9.6.2.4 (Excavation Dewatering), Section 9.6.2.5 (Hydrocarbons), Section 9.6.2.7 (Cement-based Products) and Sections 9.6.2.8 and 9.6.2.9 (Morphological Changes to Watercourses). These will ensure the protection of surface water quality and flows in all downstream receiving watercourses.

Residual Effect: The potential for the release of suspended solids, hydrocarbons, cement-based products or altered flows to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigation measures have been proposed and will break the pathway between the potential pollutant sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effect of the Proposed Project is negative, imperceptible, indirect, short-term, unlikely impact on down gradient rivers, water quality, and dependent ecosystems. No effects on the status of the GWB will occur.

Significance of Effects: For the reasons outlined above, and with the implementation of the proposed mitigation, no significant effects on waterbody WFD status will occur.

9.6.2.12 Use of Siltbuster and Impacts on Downstream Surface Water Quality (Proposed Project)

Both the Proposed Wind Farm and Proposed Grid Connection could benefit from the use of a siltbuster. Therefore, both are assessed herein.

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.

Proposed Project 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 about their use and control.

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of siltbuster systems from northwest Mayo is provided in **Figure 9-12.** This is a duration curve of downstream water quality data post siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

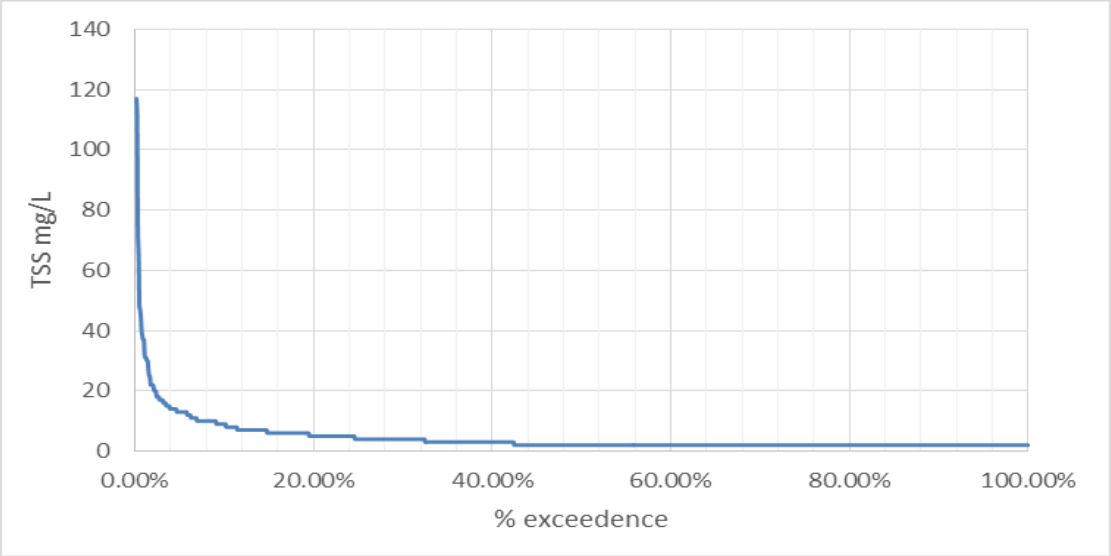


Figure 9-12: TSS treatment data using Siltbuster systems (with chemical dosing).

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Owvane River, Owngar River, Mealagh River and Bandon River) and designated sites and associated dependent ecosystems.

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

Mitigation Measures:

Measures employed to prevent overdosing and potential chemical carryover:

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

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

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur. In fact, we consider that the use of siltbuster systems has a significant positive effect in respect of surface water quality.

9.6.2.13 Potential Hydrological/Water Quality Effects on River Waterbody Drinking Water Supply Abstractions (Proposed Project)

The Proposed Wind Farm site (including 9 no. of its proposed turbines) is located in the Owngar River catchment and upstream of Kealkill PWS abstraction, while 3 no. proposed turbines are located in the Mealagh River catchment and upstream of the Zone 1 Bantry Cahernacrin abstraction. The Proposed Grid Connection is located upstream of Bandon RWS abstraction on the Bandon River.

The Kealkill PWS abstraction is located 0.7km to the northwest of the Proposed Wind Farm southern turbine cluster, which is approximately 2km downstream of the closest Proposed Wind Farm infrastructure.

The Mealagh River abstraction is located approximately 8.5km downstream of the Proposed Wind Farm southern turbine cluster. The Proposed Grid Connection passes through the Bandon_020 sub-basin where the Bandon River abstraction is located.

The sensitivity of these abstractions to surface water quality fluctuations (mainly turbidity) means effects of the Proposed Project could be significant if adequate drainage mitigation and pollution prevention measures are not put in place.

Pathway: Site drainage network and downstream watercourses.

Receptor: Kealkill PWS, Bantry PWS and Bandon RWS.

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

Impact Assessment & Proposed Mitigation Measures:

The Proposed Project design team were at all times aware that public water supply abstractions existed in the downstream watercourses, and as such all proposed mitigation and drainage design proposals were designed towards providing a "best in class" drainage management proposal for the Proposed Project considering the significant catchment sensitivities, particularly in relation to Kealkill PWS which is located immediately downstream of the Proposed Wind Farm and a short section of the Proposed Grid Connection.

During the layout optimisation process, all surface waters at the site were classified as Very Sensitive (the criteria for this are presented in **Table 9-2** of the EIAR). Very sensitive surface waters are receptors of high environmental importance such as designated sites (i.e. NHA or SAC) or a public drinking water supply source. The surface waters at the Site were given the highest possible sensitivity rating.

The mitigation measures detailed in this chapter are tried and tested, best-practice mitigation measures for the protection of the hydrological (surface water) and hydrogeological (groundwater) environment. These mitigation measures are used at construction sites across the country and have been used in the construction of the countless existing wind farm developments. Note that similar mitigation measures for the protection of the receiving water environment were proposed in the EIARs for the recently permitted Glenard Wind Farm (ABP Case No: 312659), Seven Hills Wind Farm (ABP Case No. 313750) and Curraglass Wind Farm (Cork County Council planning Ref: 25/6398).

In recent years many wind farms have been constructed using similar mitigation measures (as proposed for the Maughanaclea Renewable Energy Development) with respect to suspended solids, hydrocarbons, cement-based products, and wastewater during their construction and operational phases. These mitigation measures, the same of those detailed in the EIAR for the Proposed Project, have proven to be successful in the protection of the hydrological and hydrogeological environment.

Detailed drainage management design and pollution prevention measures proposed during the construction phase are presented above in Sections 9.5.1 and 9.6.2.2 above, and Section 9.6.3.1 below (operational stage). These proposals are "best in class" and in line with current best practice approaches for surface water quality protection on wind farm and forestry sites.

To emphasise the high level of attenuation and treatment that will be put in place during the construction phase, a process flow diagram for the following elements of the Proposed Wind Farm is provided **Appendix 9-4.**

- Borrow Pits
- Turbine bases
- Access Roads

The process flow diagrams demonstrate that while settlement ponds form an important element of the drainage proposals for the site, they are not sand alone but occur as part of a treatment train of systems that will be applied in series to ensure protection of downstream watercourses. The treatment of site runoff occurs before and also continues after the settlement ponds, with the "after" treatment also utilising natural elements of the site such as the existing vegetated ground. Therefore, the final "polished" discharge effluent quality will not be achieved until the discharge passes through the last element of the treatment series train which is the vegetated ground upslope of the local watercourse (i.e. compliance point). This is illustrated in the drainage design drawings in **Appendix 4-4** of this EIAR.

A final line of defence can be provided by a water treatment train such as a "Siltbuster" if required. 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 for all of the construction phase.

Daily inspections will be undertaken to assess the effectiveness of the water treatment trains and this will include a visual assessment of water quality and also portable probes for field hydrochemistry monitoring (turbidity, pH, electrical conductivity etc) will be used by the ECoW (Ecological Clerk of Works – see the CEMP in **Appendix 4-3** for further details) to make on the spot checks. Corrective measures will be carried out as appropriate (i.e. silt build-up removal or replacement/upgrade works) in the event treatment is ineffective.

An emergency response plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (which is contained in **Appendix 4-3**).

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

Significance of Effects: For the reasons outlined above, no significant effects will occur on Public Water Supply Abstractions.

9.6.2.14 Potential Effects on Local Groundwater Well Supplies from Excavations (Proposed Project)

There will be excavations required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

In the area of the Proposed Wind Farm site, private dwelling houses (potential well locations) are mainly located along the surrounding public roads.

The biggest risk to potential down-gradient wells will be from where deeper excavations are required such as the turbine bases and borrow pits.

Construction of the Proposed Grid Connection will not have the potential to effect local wells due to the shallow nature of the works along the cable route.

The closest distance between a proposed turbine or borrow pit location and a downstream dwelling house (potential well) is >580m. In order to be conservative and following the worst-case assumption, we have assumed that all dwellings in the surrounding lands have a private groundwater well.

However, due to the relatively shallow nature of the deepest excavations (3.5 -8m), the topography, hydrogeological regime and the >580m setback distance from potential wells, significant effects on private wells are unlikely.

Pathway: Groundwater flowpaths.

Receptor: Private Groundwater Supplies.

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, short-term, unlikely effect on local wells. In the absence of mitigation measures, there will be no significant effects on local groundwater well supplies.

Impact Assessment:

We are satisfied that the Proposed Project will not impact in any significant way on any potential down-gradient private wells for the following reasons:

- The large set back distances between proposed turbine and borrow pit locations and downstream potential well locations (>580m);
- The short groundwater flowpath distances (30 – 300m);
- The Proposed Project will involve relatively shallow excavations (3.5m -8mbgl) which are typically located on elevated ground where thereby lessens the true depth of the excavation;
- The moderate - low permeability of the glacial deposits in which the turbine gravity base foundations will be constructed;
- The low permeability and low recharge characteristics of the underlying SILTSTONE/SANDSTONE aquifer that underlies the Proposed Wind Farm site;
- Localised groundwater flow patterns in the glacial deposits which is towards local streams that flow through the Proposed Wind Farm site;
- Groundwater flow patterns are expected towards the internal watercourses that drain the Proposed Wind Farm site; and,
- The shallow excavation depths required for Proposed Grid Connection cable.

Post Mitigation Residual Effects: For the reasons outlined in the impact assessment above (separation distances, and prevailing hydrogeology, topography and groundwater flow directions), it has been assessed the Proposed Project has no potential to effect local groundwater wells.

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

9.6.2.15 Effects on Downstream Freshwater Pearl Mussel Populations (Proposed Grid Connection)

The Proposed Grid Connection is located in the Bandon River catchment which is Margaritifera Sensitive catchment. Freshwater Pearl Mussel are also a qualifying interest of the Bandon River SAC.

No part of the Proposed Wind Farm site is located in the Bandon River catchments and therefore the proposed works cannot affect Freshwater Pearl Mussel populations.

Pathway: Site drainage network.

Receptor: Freshwater Pearl Mussel.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, unlikely effect on Freshwater Pearl Mussel

Impact Assessment & Proposed Mitigation Measures:

Works with the Bandon River catchment is limited to the Proposed Grid Connection only. Due to the route of the Proposed Grid Connection along public roads, the transient nature of the works which will done in stages (i.e. limited to 100m of trenching per day) along with the absence of instream works the watercourse crossing locations, no significant effects on the Bandon River are expected and therefore no significant effects on freshwater pearl mussel populations will occur.

Drainage mitigation measures for surface water quality protection during the Proposed Grid Construction phase are summarised again below: (Relevant sections are shown for the full description of these measures and how they will be applied).

- Avoidance of instream works at the proposed 9 no. EPA watercourse crossing locations within the Bandon River catchment (Section 9.6.2.9);
- Pre-commencement temporary drainage works (Section 9.6.2.9);

- Management of spoil during earthworks along the cable route trenching works (Section 9.6.2.9); and,
- Best practice measures with regard use of oils, fuels (Section 9.6.2.5) and cement based compounds (Section 9.6.2.7).

As stated in Section 9.6.2.2 above, there could potentially be a residual "imperceptible, short term, likely effect" on local streams and rivers but this would be very localised and over a very short time period (i.e. hours). Therefore, significant direct, or indirect impacts on the downstream Bandon River SAC or freshwater pearl mussel populations will not occur.

Daily inspections will be undertaken to assess the effectiveness of the water treatment trains and this will include a visual assessment of water quality and also portable probes for field hydrochemistry monitoring (turbidity, pH, electrical conductivity etc) will be used by the Ecological Clerk of Works (ECoW) to make on the spot checks.

Post Mitigation Residual Effect: With the implementation of mitigation measures outlined above the residual effect will be a negative, temporary, direct, imperceptible, unlikely effect on downstream freshwater pearl mussel populations.

Significance of Effects: No significant effects on the freshwater pearl mussel populations will occur.

9.6.2.16 Biodiversity Management and Enhancement Plan (BMEP) and Potential Hydrological/Water Quality Effects

The BMEP (**Appendix 6-4**) sets out the measures to be implemented to ensure that the Proposed Project will result in a net gain in biodiversity. It is proposed to create a total of 4.7ha of Wet Heath Habitat. This will lead to the creation of over twice the amount of Annex I habitat that is being lost as part of the Proposed Wind Farm, and thus achieve Biodiversity Net Gain as a result of the Proposed Project.

In addition, an area of approximately 0.5ha of broadleaf native tree planting will be undertaken in the Proposed Wind Farm southern turbine cluster, adjacent to the proposed 110kV onsite substation. This will an expand an area of native forestry that currently exists at this location.

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Owvane River, Owngar River and Mealagh River) and designated sites and associated dependent ecosystems.

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

Mitigation Measures:

All proposed habitat management and enhancement works will be in accordance with the best practice Forest Service regulation, policies and strategic guidance documents as well as Coillte, DAFM and NatureScot guidance documents to ensure minimal potential negative effects on the local peat, soil and subsoil environment.

Given the nature of the restoration measures the following mitigation measures are proposed:

- Before any works are completed silt fences will be installed to limit the movement of entrained sediment in surface water runoff;
- Proposed off-road routes will be walked in advance of any machinery;
- All machinery operators will be experienced;

- The Proposed Wind Farm site will be walked before a machine goes off-road;
- Bog mats will be used where the excavator is required to travel over wet ground; and,
- A low ground pressure excavator with wide tracks (1.9m or greater) will be used to reduce compaction of the peat and subsoils.

Likely Residual Effect: With the implementation of mitigation measures outlined above there will be no negative residual effect.

Significance of Effects: No negative effects on surface water quality or hydrology will occur.

9.6.3 Operational Phase – Likely Significant Effects and Mitigation Measures

9.6.3.1 Removal of Vegetation Cover and Progressive Replacement of Natural Surface with Low Permeability Surfaces (Proposed Wind Farm)

Hardstand emplacement will only be required at the Proposed Wind Farm site and not the Proposed Grid Connection. Only the Proposed Wind Farm is assessed herein.

The water balance does not include the Proposed Grid Connection cable route as it follows public roads and therefore the underground cabling cannot alter the hydrological regime along the route which is already a hardstand surface.

The potential for increased surface water runoff is the primary potential impact during the operational phase of the Proposed Wind Farm.

Progressive replacement of the vegetated surface with impermeable surfaces will decrease the permeability of the ground within the Proposed Wind Farm footprint (i.e., turbine bases, hardstandings, and to a lesser extent the new access roads) and the proposed 110kV onsite substation. The permeability along the internal underground cabling route through the Proposed Wind Farm site will not be significantly altered.

The emplacement of the Proposed Project footprint, as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials as a worst-case scenario) could result in an average total site increase in surface water runoff of approximately 4,333m^3/month or 140m^3/day (**Table 9-16**).

This represents a potential increase of approximately 0.29% in the average daily/monthly volume of runoff from the Proposed Wind Farm site area in comparison to the baseline pre-development site runoff conditions.

This is a very small increase in average runoff and results from a relatively small area of the overall Proposed Wind Farm site being developed. Specifically, the Proposed Wind Farm permanent footprint is approximately 14.67ha, representing 1.25% of the overall Site.

The additional volume is low due to the fact that the runoff potential from the Site is naturally high (87%). Also, this calculation assumes that all hardstanding areas will be impermeable which considered to be a worst-case scenario. The increase in runoff from most of the development catchment will therefore be imperceptible and this is before mitigation measures will be put in place. This water balance assessment demonstrates that even in the absence of mitigation, the potential to alter the water balance of the Proposed Wind Farm site or downstream hydrology/morphology is imperceptible.

Table 9-16: Baseline Site Runoff V Development Runoff

Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Footprint Area (m^2)	Footprint Area 100% Runoff (m_3) (m^3)	Footprint Area 87% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions (m^3)
1,496,316	48,268	146,700	33,330	28,997	4,333	140	0.29

Pathway: Site drainage network.

Receptor: Surface waters (Owngar(Cork), Owvane (Cork) and Mealagh River) and dependent ecosystems.

Pre-Mitigation Potential Impact: Negative, imperceptible, indirect, long-term, likely effect on all downstream surface water bodies.

Proposed Mitigation by Design:

The proposed drainage philosophy outlined in Section 9.5 states that runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the Proposed Wind Farm. The first being 'keeping clean water clean' and the second involving the collection of any drainage waters from work area and to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. The second method relates to proposed design measures that will prevent road surface and other hardstand areas acting as preferential flowpaths. All development site runoff will be collected, attenuated, treated and then released in a diffuse and regular manner that does not significantly change the natural drainage regime/hydrology of the site.

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

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

These measures will ensure all surface water runoff from upgraded roads and new road surfaces (including hardstands and turbine base areas) will be captured and treated prior to discharge/release. Settlement ponds, check dams and buffered outfalls will prevent roads acting as preferential flowpaths by providing attenuation and water quality treatment.

Residual Impact: Direct, neutral, long term, likely effect of the Proposed Wind Farm on surface waters.

Significance of Effects: No significant effects on surface water quantity will occur during the operational phase of the Proposed Project.

9.6.3.2 Runoff Resulting in Suspended Solids Entrainment in Surface Waters

Site runoff will occur at both the Proposed Wind Farm and Proposed Grid Connection. Both are assessed herein.

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 are likely to be completed, such as maintenance of site entrances, internal roads and hardstand areas. These works will be of a very minor scale and will be very infrequent. Potential sources of sediment laden water will only arise from surface water runoff from small areas where new material is added during maintenance works.

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

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

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Owngar(Cork), Owvane (Cork) and Mealagh River) and associated dependent ecosystems.

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

Proposed Mitigation Measures:

The mitigation measures outlined in Sections 9.6.2.2 & 9.6.3.1 will ensure all surface water runoff from upgraded roads and new road surfaces (including hardstand and turbine base areas) will be captured and treated prior to discharge/release. Settlement ponds, checks dams and buffered outfalls will prevent roads acting as preferential flowpaths by providing attenuation and water quality treatment.

It is proposed that bedrock won from the on-site borrow pit (i.e. sandstone) will be used to construct the sub-base layer of proposed upgraded and new access roads, hardstand areas and turbine base areas. Once installed the subbase layer will be overlain by a clean capping layer of high-grade stone material which will be sourced from the borrow pit or local quarries.

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

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

9.6.3.3 Potential Hydrological/Water Quality Effects on River Waterbody Drinking Water Supply Abstractions (Proposed Project)

During the operational phase, there will be no potential for significant effects on the Kealkill PWS abstraction, Zone 1 Bantry Cahernacrin abstraction or the Bandon RWS abstraction on the Bandon River.

There will be no direct discharge from the Proposed Project to downstream receiving waters during the operational phase. All Proposed Wind Farm site drainage measures will be in place.

Peat and spoil management areas and reinstated borrow pits will be sealed, re-vegetated and will not be a potential source of silt laden runoff or organic carbon.

Receptor: Kealkill PWS, Bantry PWS and Bandon RWS.

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

Mitigation Measures:

Mitigation for the protection of surface water during the operational phase of the Proposed Project will ensure the qualitative status of the receiving SWBs will not be altered by the Proposed Project.

The mitigation measures outlined in Sections 9.6.2.2 & 9.6.3.1 will ensure all surface water runoff from upgraded roads and new road surfaces (including hardstand and turbine base areas) will be captured and treated prior to discharge/release. Settlement ponds, checks dams and buffered outfalls will prevent roads acting as preferential flowpaths by providing attenuation and water quality treatment.

Post-Mitigation Residual Effects: With the implementation of the proposed drainage measures as outlined above, and based on the post-mitigation assessment of runoff, no residual effects on surface water abstractions will occur.

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

9.6.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

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

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

The site access tracks will be kept and maintained following decommissioning of the turbine infrastructure, as these will be utilised by ongoing forestry works and by local farmers.

The electrical cabling connecting the site infrastructure to the proposed 110kV onsite substation will be removed, while the ducting itself will remain in-situ rather than excavating and removing it, as this is

considered to have less of a potential environmental impact, in terms of soil exposure, and thus on the possibility of the generation of suspended sediment which could enter nearby watercourses.

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

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

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

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

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

No significant effects on the hydrological and hydrogeological environment are envisaged during the decommissioning stage of the Proposed Project.

9.6.5 Risk of Major Accidents and Disasters (Proposed Project)

The main risk of Major Accidents and Disasters (MADs) at peatland sites is related to peat stability. A Geotechnical and Peat Stability Report (**Appendix 8-1**) has been completed for the Proposed Project and it concludes that the risk of a peat failure at the Site is low.

Flooding can also result in downstream MADs. However, due to the small scale of the Proposed Project footprint with regard the overall Site, the naturally high runoff rates, the avoidance of fluvial flood zones (see Section 9.3.7) and with the implementation of the proposed mitigation measures, the increased flood risk associated with the Proposed Project is imperceptible.

9.6.6 Assessment of Potential Health Effects (Proposed Project)

Potential health effects arise mainly through the potential for surface and groundwater contamination which can have negative effects on public and private water supplies. Portions of the Proposed Project are located in catchments upstream of public supply surface water abstractions. However, the tried and tested, best in class mitigation measures for the protection of the hydrological (surface water) and hydrogeological (groundwater) environment will ensure that the potential for negative effects on downstream surface water quality will not be significant.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues.

A detailed Flood Risk Assessment (**Appendix 9-1**) has been caried out for the Proposed Project, summarised in Section 9.3.7. This Flood Risk Assessment, combined with the assessment of changes in permeable surfaces (Section 9.6.3.1) demonstrates that the risk of the Proposed Project contributing to downstream flooding is imperceptible. On-site (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

9.6.7 Assessment of Cumulative Effects

9.6.7.1 Introduction

This section presents an assessment of the potential hydrological cumulative effects associated with the Proposed Project itself as well with other developments (existing and/or proposed), plans and land uses 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 local hydrogeological setting (i.e. poorly productive bedrock and localised groundwater flowpaths) and the near-surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Project are assessed as not likely.

The potential for cumulative effects will typically be much higher during the construction phase of the Proposed Project as this is when earthworks and excavations will be undertaken at the Site. Similarly, when assessing other developments for cumulative effects (i.e. proposed wind farms in the same catchment where the construction phase could overlap with the construction phase of the Proposed Project), the construction phase will be the worst-case period for potential effects.

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

The Water Study Area for assessing the potential zone of impact and cumulative effects assessment is the Owvane River and Mealagh River catchments, which contains the Proposed Wind Farm site along with a short section of the Proposed Grid Connection. The Bandon River catchment only contains the Proposed Grid Connection.

The fact that the Proposed Project is spread across these several catchments is very positive from a hydrological cumulative impact scenario as works are not concentrated in one catchment. This is a significant mitigating factor against significant cumulative effects occurring.

9.6.7.2 Cumulative Effects of the Proposed Project (Wind Farm and Grid Connection)

The potential for cumulative effects with regard elements of the Proposed Project itself (i.e. Proposed Wind Farm site and Proposed Grid Connection) is significantly diminished due to the fact that the Proposed Project is spread across several sub-catchments (i.e. Owvane River, Owngar River, Mealagh River and Bandon River).

With the exception of a 2.9km length at the Proposed Wind Farm site, the Proposed Grid Connection is located in the Bandon River catchment (17.6km). Therefore, cumulative effects of the Proposed Project on the Owvane River and Owngar River catchments is not likely.

Also, the fact that the Proposed Grid Connection is along existing roads (private and public), the lack in-stream works, the intermittent and transient nature of the trenching excavations, the Proposed Grid Connection is not expected to contribute to hydrological cumulative effects in the Owvane River and Owngar River catchments.

No significant cumulative effects on the hydrological and hydrogeological environment are envisaged during the construction phase of the Proposed Project.

9.6.7.3 Cumulative Effects with Other Wind Farm Developments

A list of other wind farm developments in the Proposed Wind Farm site Water Study Area is shown in **Table 9-17** below (i.e. Owvane River and Mealagh River).

In the Mealagh River catchment, where the Proposed Project has 3 no. proposed turbines, there is a proposed wind farm (Dereenacreenig WF) which has also 3 no. proposed turbines within the Mealagh River catchment.

In the Owvane River catchment where the Proposed Project has 11 no. proposed turbines, there are 4 no. proposed turbines relating to two proposed wind farms (Gortloughra WF and Curraglass WF).

The total number of turbines that could potentially be operating within the Owvane River catchment is 15 (11 no. from the Proposed Project, 1 no. from the Gortloughra Wind Farm and 3 no. from the proposed Curragglass Wind Farm. The total catchment area of the Owvane River is ~84km^2 and therefore this equates to one turbine for approximately every ~5.6km^2 which is considered imperceptible in terms of potential cumulative hydrological impacts.

The total number of turbines that could potentially be operating within the Mealagh River catchment is 6 (3 no. from the Proposed Project and 3 no. from the Dereenacreenig Wind Farm). The total catchment area of the Mealagh River is ~55km^2 and therefore this equates to one turbine for approximately every ~9km^2 which is considered imperceptible in terms of potential cumulative hydrological impacts.

Proposed Project works within the Bandon River catchment is limited to the Proposed Grid Connection cable route. Therefore, on this basis and given the size of the Bandon River catchment, the proposed grid route on the carriageway of public roads, the lack of instream works along the intermittent and transient nature of the trenching excavations, the potential for hydrological cumulative impacts within the Bandon River catchment is negligible.

Table 9-17: List of Other Wind Farm Developments Assessed for Hydrological Cumulative Effects.

Catchment	Development (Status)	Total Turbine No.	Turbine No. Catchment (Water Study Area
Owvane River	Gortloughra WF (Proposed)	8	1
	Curraglass WF (Proposed)	3	3
Totals for Owvane River Catchment			**4**
Mealagh River	Dereenacreenig WF (Proposed)	3	3
Totals for Mealagh River Catchment			**3**

9.6.7.4 Cumulative Effects with Agriculture

According to Corine land cover mapping (www.epa.ie) (2018) the Water Study Area catchments are largely agricultural catchment.

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

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

However, the mitigation measures detailed in Section 9.6 for the construction, operation and decommissioning phases of the Proposed Project 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.

9.6.7.5 Cumulative Effects with 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 works can also give rise to modified stream flow regimes caused by associated land drainage.

However, the mitigation measures detailed for the construction, operation and decommissioning phases of the Proposed Project will ensure the protection of downstream surface water quality.

With regard to non-wind farm related forestry activities at the Site and the potential for cumulative impacts, it is proposed that all scheduled tree felling or replanting will not take place the same time as the Proposed Project construction phase in order to prevent hydrological cumulative impacts. No scheduled tree felling will occur in the same local catchment where the Proposed Project construction is taking place.

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

9.6.7.6 Cumulative Effects with One Off Housing Developments

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

There are applications 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 Site and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Project (construction, operation and decommissioning phases).

9.7 EIA Classification Summary

Please see the below table for a summary of all identified impacts for the Proposed Project relating to water.

Table 9-18: Assessment Classification Summary

Topic	Pre-Mitigation Effect	Mitigation Section Reference	Residual Effect	Significance
Construction Phase				
Clear Felling of Coniferous Plantation and Potential Surface Water Quality Effects (Proposed Wind Farm)	Temporary, Slight, Negative	Section 9.6.2.1	Temporary, Imperceptible, Negative	Not Significant
Earthworks Resulting in Suspended Solids Entrainment in Surface Waters	Short Term, Significant, Negative	Section 9.6.2.2	Short-Term, Imperceptible, Negative	Not Significant
Potential Impacts on Groundwater Levels During Excavations	Brief, Slight, Negative	Section 9.6.2.3	Brief, Imperceptible, Negative	Not Significant
Excavation Dewatering and Potential Impacts on Surface Water Quality	Short-Term, Moderate, Negative	Section 9.6.2.4	Short-Term, Imperceptible, Negative	Not Significant
Potential Release of Hydrocarbons during Construction and Storage	**Local Groundwater Quality:** Short-Term, Slight, Negative **Surface Water Quality**: Short-Term, Moderate, Negative	Section 9.6.2.5	Short-Term, Imperceptible, Negative	Not Significant

Groundwater and Surface Water Contamination from Wastewater Disposal	Temporary, Significant, Negative	Section 9.6.2.6	No residual effect	Not Significant
Release of Cemment Base Products	Short-Term, Moderate, Negative	Section 9.6.2.7	Short-Term, Imperceptible, Negative	Not Significant
Morphologicla and Hydrological Effects due to Watercourse Crossing Works	Long Term Slight, Negative	Section 9.6.2.8	Long-Term, Imperceptible, Negative	Not Significant
Potential Surface Water Quality Effects of the Proposed Grid Connection Earthworks and Watercourse Crossings	Temporary, Slight, Negative	Section 9.6.2.9	Long-Term, Imperceptible, Negative	Not Significant
Potential hydrological Effects on Designated Sites (Proposed Grid Connection)	Short-Term, Moderate, Negative	Section 9.6.2.10	No residual effect	Not Significant
Effects of Construction Works on the WFD Status of Downstream Waterbodies	Temporary, Slight, Negative	Section 9.6.2.11	Short-Term, Imperceptible, Negative	Not Significant
Use of Siltbuster and Impacts on Downstream Surface Water Quality	Temporary, Slight, Negative	Section 9.6.2.12	Temporary, Imperceptible, Negative	Not Significant
Potential Hydrological/Water Quality Effects on River Waterbody Drinking Water Supply Abstractions (Proposed Project)	Short-Term, moderate, Negative	Section 9.6.2.13	Short-Term, Imperceptible, Negative	Not Significant
Potential Effects on Local Groundwater Well Supplies from Excavations (Proposed Project)	Short-Term, Imperceptible, Negative	Section 9.6.2.14- None required	No residual impact	Not Significant
Effects on downstream freshwater Pearl	Temporary, Slight, Negative	Section 9.6.2.15	Temporary, Imperceptible, Negative	Not Significant

Mussel Populations (Propsoed Grid Connection)				
Biodiversity Management and Enhancment Plan (BMEP) and potential hydroligcal/water Quality Effects	Temporary, Slight, Negative	Section 9.6.2.16	Temporary, Imperceptible, Negative	Not Significant
Operational Phase				
Removal of Vegetation Cover and Progressive Replacement of Natural Surface with Low Permeability Surface (Proposed Wind Farm)	Long-Term, Imperceptible, Negative	Section 9.6.3.1	Long-Term, neutral	Not Significant
Runoff resulting in Suspended Solids Entrainment in Surface Waters	Temporary, Slight, Negative	Section 9.6.3.2	Temporary, Imperceptible, Negative	Not Significant
Potential Hydrological/Water Quality Effects on River Waterbody Drinking Water Supply Abstractions (Proposed Project)	Long-Term, Imperceptible, Negative	Section 9.6.3.3	No residual effect	Not Significant
Decommissioning Phase				
Water	The potential impacts associated with decommissioning of the Proposed Project will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works.	Not Significant	Not Significant	Not Significant