FEHILY TIMONEY

DESIGNING AND DELIVERING A SUSTAINABLE FUTURE

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED LITTLETON WIND FARM, CO. TIPPERARY

Volume 2 - Main EIAR

Chapter 9 - Hydrology, Hydrogeology and Water Quality

Prepared for:

Littleton Wind Farm DAC

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9. HYDROLOGY, HYDROGEOLOGY AND WATER QUALITY

9.1 Introduction

Hydro-Environmental Services (HES) was engaged by Fehily Timoney (FT) to carry out an assessment of the potential likely and significant effects of the Proposed Development on the hydrological and hydrogeological aspects of the receiving environment.

The Proposed Development is described in full in Chapter 4 of this Environmental Impact Assessment Report (EIAR).

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

As detailed in Section 4.1 of Chapter 4, for the purposes of this EIAR, the various components of the development are described and assessed using the following references: 'Proposed Development', 'Proposed Wind Farm', the 'Site (i.e. the site of the Proposed Wind Farm), 'Proposed Grid Connection ('GC'), 'Turbine Delivery Route (TDR)' and the 'Biodiversity Enhancement and Management Plan Lands (BEMP lands)'.

9.1.1 Statement of Authority

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

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

This chapter of the EIAR was prepared by Michael Gill and Conor McGettigan and HES.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer/Hydrologist with over 24 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 Slievecallan Wind Farm, Cahermurphy (Phase I & II) Wind Farm, Carrownagowan Wind Farm, Garrane Green Energy Project and over 100 other wind farm related projects across the country.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 5 years' experience in the environmental sector in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016) from University College Dublin. Conor routinely prepares the hydrology and hydrogeology chapters of environmental impact assessment reports for wind farm developments. Conor has worked on the EIARs for over 20 no. wind farms projects across the country, including Ballivor Wind Farm, Seskin Wind Farm, Lackareagh Wind Farm, Knockshanvo Wind Farm, Garrane Green Energy Project and Gannow Renewable Energy Development.

9.1.2 Study Area

The Water Study Area for the hydrological and hydrogeological impact assessment is defined by the regional surface water catchment and groundwater bodies within which the Proposed Wind Farm, proposed GC route and TDR are located.

A regional hydrology map showing WFD surface water catchments and sub-catchments is included as Figure 9-1. The relevant surface water catchments within which the Proposed Wind Farm, the proposed GC route are located are detailed in Section 9.3.3. In addition, the bedrock aquifers and groundwater bodies which underlie the Proposed Wind Farm and proposed GC route are detailed in Section 9.3.9. The BEMP lands are located within the Site and have been considered in the delineation of the Water Study Area.

Note that the TDR has not been considered in the delineation of the Water Study Area due to the temporary, minor and short-duration of the works along the TDR. The TDR temporary accommodation works are detailed in Table 4-4 of this EIAR and include removal of road signs, street furniture and vegetation clearance. These works would have no potential to result in significant effects on the water environment and do not warrant inclusion in the water study area. Nevertheless, for the purposes of an ultra-conservative assessment, Section 9.4.2.3 presents an assessment of these temporary accommodation works.

9.2 Assessment Methodology

9.2.1 Relevant Legislation

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

The requirements of the following legislation are also complied with:

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

- Planning and Development Acts, 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 94/1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended and S.I. No. 288/2022 European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2022;
- S.I. No. 722/2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for the implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("WFD"). The WFD was given legal effect in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003);
- S.I. No: 122/2010: European Communities (Assessment and Management of Flood Risks) Regulations, resulting from EU Directive 2007/60/EC;
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended; and,
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

9.2.2 Relevant Guidance

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

- Environmental Protection Agency (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- DoE/NIEA (2015): Wind farms and groundwater impacts - A guide to EIA and Planning considerations";
- OPW (2009) The Planning system and Flood Risk Management;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Department of Housing, Local Government and Heritage Wind Farm Development Guidelines for Planning Authorities (2006);

- Department of Housing, Local Government and Heritage (November 2009) The Planning System and Flood Risk Management - Guidelines for Planning Authorities;
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- Irish Wind Energy Association (2012) Best Practice Guidelines for the Irish Wind Energy Industry;
- Good Practice During Wind farm Construction (Scottish Natural Heritage, 2010);
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001;
- Land Types for Afforestation (Forest Service, 2016b);
- Forest Protection Guidelines (Forest Service, 2002);
- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b); and,
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018).

9.2.3 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. Matters raised by Consultees in their responses with respect to the water environment are summarised in Table 9-1 below.

Further details of project scoping and consultation can be found in Chapter 2 of this EIAR.

Table 9-1: Summary of Water Environment Scoping Responses

Consultee	Description	Adressed in Section
Uisce Éireann	Where the development proposal has the potential to impact an IW Drinking Water Source the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to IWs Drinking Water Source during construction and operational phases of the development. It is a requirement of the Water Framework Directive that waters used for the abstraction of drinking water are protected so as to avoid deterioration in quality.	An assessment of the potential effects on drinking water resources is presented in Section 9.2.4.1.11.
	Mitigation proposed for any potential negative impacts on any water source(s), in proximity including the environmental management plan and incident response	Mitigation measures are presented in Section 9.5.1.1.10 and in the Surface Water Management Plan (SWMP).

Consultee	Description	Adressed in Section
	Any and all potential impacts on the nearby reservoir as public water supply water source is assessed, including any impact on hydrogeology and any groundwater/ surface water interactions.	Addressed in Section 9.4 for all phases of the Proposed Development.
	Impacts of the development on the capacity of water services (do existing water services have the capacity to cater for the new development if required). This is confirmed by IW in the form of a Confirmation of Feasibility (COF). If a development will require a connection to either a public water supply or sewage collection system the developer is advised to submit a Pre Connection Enquiry (PCE) enquiry to IW to determine the feasibility of connection to the Irish Water network.	No connection to UÉ infrastructure is required. Water required for the Operational Phase will be sourced from rainwater harvesting as detailed in Section 9.4.3.1.4.
	Any up-grading of water services infrastructure that would be required to accommodate the development.	No upgrades required.
	In relation to a development that would discharge trade effluent – any upstream treatment or attenuation of discharges required prior to discharging to an IW collection network	There will be no discharge of untreated or unattenuated water associated with the Proposed Development
	Any potential impact on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence/ present a risk to the quality of the water abstracted by IW for public supply.	An assessment of the potential effects on drinking water resources is presented in Section 9.2.4.1.11.
GSI	In relation to Geological Heritage, the GSI note that Littleton Bog CGS is located in the vicinity of the proposed Littleton Wind Farm.	The potential effects on the integrity of these CGS are presented in Chapter 8 of this EIAR.
	Proposed developments need to consider any potential impact on groundwater abstractions and groundwater resources.	All groundwater abstractions have been identified in Section 9.3.15. The potential effects on public and group supplies are presented in Section 9.4.2.1.10 and potential effects on private groundwater well supplies are presented in Section 9.4.2.1.11.

9.2.4 Desk Study

A desk study of the study area was completed in Autumn 2023 to collect all relevant hydrological, hydrogeological and meteorological data. The desk study was completed to supplement site walkover surveys, drainage mapping and site investigations. The desk study information has been checked and updated, where necessary, in December 2023 and January 2024, and subsequently in November 2025. The desk study was completed by Conor McGettigan and Michael Gill of HES.

The desk study involved consultation with the following sources:

- Environmental Protection Agency Databases (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 18; Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- OSI 6" and 25" base mapping;
- BnM (Bord na Móna) lidar topographic survey data for the Site;
- OPW Flood Mapping (www.floodmaps.ie).
- Cutaway Bog Decommissioning and Rehabilitation Plan - Littleton 2026;
- Cutaway Bog Decommissioning and Rehabilitation Plan - Longfordpass 2026; and,
- Lanespark, Ballybeg & Derryvella Bog Cutaway Bog Decommissioning and Rehabilitation Plan 2025.

9.2.5 Baseline Monitoring and Site Investigations

Hydrological walkover surveys, including detailed drainage mapping and peat probing, were completed by HES on several dates between 2023 and 2025. These surveys were completed by Michael Gill and Conor McGettigan (please refer to Section 9.1.2 for qualifications and experience).

The HES surveys supplemented the intrusive site investigations completed by Ground Investigations Ireland (GII) during 2022 and 2023. GII completed at total of 41 no. trial pits and 7 no. rotary core boreholes at the Site. The results of these site investigations are detailed in the 3 no. ground investigation reports included as **Appendix 8.2** of this EIAR.

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

- HES completed walkover surveys, drainage mapping at the Site on 28th February 2023, 16th January 2024, 16th January 2025, and 17th September 2025 whereby water flow directions and drainage patterns were recorded;
- HES completed peat probing (on the above dates also) at all proposed infrastructure locations in order to determine the depth of peat and the nature of the underlying subsoils;
- HES completed an inspection of the existing and proposed watercourse/drain crossings within the Site on 17th September 2025;
- HES completed surveys of the proposed GC route on 17th September 2025;

- GII completed a total of 28 no. trial pits in July and August 2022, with 20 of these trial pits located within the Site. Note that the other 8 no trial pits were completed in Longfordpass Bog which does not form part of the final Site boundary. The results of these site investigations are presented in GII's October 2022 Ground Investigation Report (**Appendix 8.2**):
- GII completed an additional 12 no. trial pits in April 2023. The results of these site investigations are presented in GII's June 2023 Ground Investigation Report (**Appendix 8.2**);
- GII completed additional site investigations comprising of 10 no. trial pits and 7 no. rotary core boreholes at the proposed borrow pit and onsite substation locations in October, November and December 2023. The results of these site investigations are presented in full in GII's March 2024 Ground Investigation Report (**Appendix 8.2**);
- Triturus completed baseline aquatic monitoring, including macroinvertebrate sampling, on a total of 30 no. river sites in September 2023. The results are presented in the Triturus March 2024 Aquatic Baseline Report (**Appendix 6.7**); and,
- FT completed a Peat and Spoil Management Plan for the Proposed Development (FT, 2025) (**Appendix 8.1**).

In 2018, Bord na Móna produced Cutaway Bog Decommissioning and Rehabilitation Plans for the Longfordpass, Littleton and Lanespark bogs located within the Application Site in accordance with Condition 10 of the IPC licence. Bord na Mona has prepared Rehabilitation Review Reports which assess the successfulness of the Cutaway Bog Decommissioning and Rehabilitation Plans and the status and completeness of all the rehabilitation measures as outlined in the original 2018 plans.

Rehabilitation Phase 1 works was completed in Littleton, Longfordpass, Lanespark Bogs and the nearby Ballybeg and Derryvella Bogs between 2018-2012 with extensive drain-blocking and hydrological management. The key objective of peatland rehabilitation is environmental stabilisation. The rehabilitation works that have been completed and commenced in Phase 1 are described in the Cutaway Bog Decommissioning and Rehabilitation Plans (Appendix 2-1) and in Section 2.2 of Chapter 2.

The conditions created by the Phase 1 rehabilitation measures which have been implemented form part of the hydrological baseline and as such form an inherent component of the baseline environment considered in the impact assessment.

9.2.6 Impact Assessment Methodology

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

The assessment of effects follows the description of the baseline environment and is Step 6 of the information which must be included in an EIAR. The guideline criteria for the assessment of effects states that the purpose of an EIAR is to identify, describe and present an assessment of the likely significant effects. The likely effects are described with respect to their quality (positive, neutral or negative), significance (imperceptible to profound), extent (i.e. size of area or number of sites effected), context (is the effect unique of being increasingly experienced), probability (likely or unlikely), duration (momentary to permanent), frequency and reversibility. The descriptors used in this environmental impact assessment are those set out in the EPA (2022) Glossary of effects and in IGI (2013) (Guidance for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statement).

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

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

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

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

Importance	Criteria	Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale.	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation - NHA status. Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes.

9.2.7 Overview of Impact Assessment Process

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

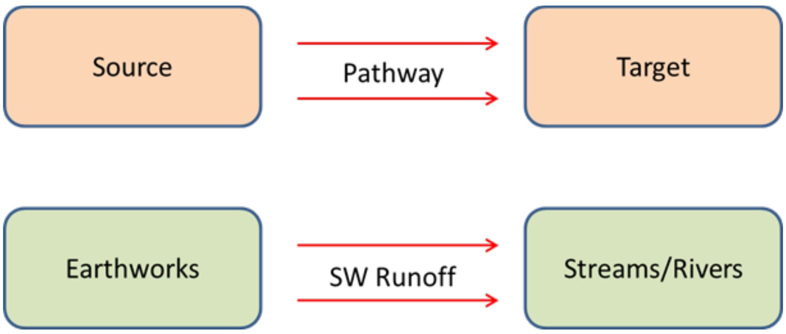

Figure 9-1: Source Pathway Target Model

Where potential effects are identified, the classification of effects in the assessment follows the descriptors provided in the Glossary of Impacts contained in the Environmental Protection Agency (May 2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

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

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

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

Table 9-4: Impact Assessment Process Steps

Step 6a	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 6b	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which potential impacts are generated.
Step 6c	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 6d	Pre-mitigation Effect:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 6	Proposed Mitigation Measures:	Control measures 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.
Step6f	Post-Mitigation Residual Effect:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 6g	Significance of Effects:	Describes the likely significant post-mitigation effects of the identified potential impact source on the receiving environment.

9.2.8 Limitations and Difficulties Encountered

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

9.3 Receiving Environment

9.3.1 Site Description and Topography

9.3.1.1 Proposed Wind Farm

The site of the Proposed Wind Farm (i.e. the 'Site') is located in east Co. Tipperary, with the Tipperary-Kilkenny county border located approximately 4.6km to the northeast. The closest settlements to the Site are Urlingford (approximately 5 km to the north-east), Gortnahoe (approximately 2.5 km to the east), Twomileborris (approximately 2 km to the west), Littleton (approximately 2.5 km to the west) and New Birmingham (approximately 2 km to the east). The town of Thurles is located approximately 9km to the west of the Site.

The Site boundary extends for approximately 12km from north to south and ranges between 1km (at northern end) and 3km (at southern end) from east to west. The Site consists of 3 no. Bord na Móna bogs which form part of the Littleton Bog Group. The bogs comprising the Site include Ballybeg Lanespark Derryvella Bog in the south, Littleton Bog towards the centre and Longfordpass Bog (Popes Bog) in the north. These bogs were historically used for peat extraction, with peat extraction ceasing in 2018. Today the Site comprises of cutover peat bogs with a large proportion of the Site consisting of revegetating cutaway (heath, scrub and woodland habitats) but also includes some open areas with large bodies of open water. Some areas have also been planted with coniferous forestry plantations. The proposed borrow pit is located on agricultural lands to the east of Littleton Bog in the townland of Longfordpass South. A small disused quarry is located adjacent to the proposed borrow pit. The total area of the Site is 1,177ha (11.77km^2).

There is an extensive network of roads in the local areas. The M8 motorway and the R639 run to the northwest/west of the Site. The R689 and R690 run to the east and the L4101 runs to the south. The main access points are at the northern and southern ends of Littleton Bog adjacent to the Bord na Móna railway line. A Bord na Móna works area lies in the south of Ballybeg Lanespark Derryvella Bog, in the townland of Killeen and contains offices, storage sheds, roads and a peat loading area.

The current topography of the Site is relatively flat with elevations ranging between 120 and 130m OD (metres above Ordnance Datum). Topography at the Site has been modified through the previous peat extraction activities and associated drainage. The highest elevations are found at the headlands and remnant peat banks which create elevated boundary berms, forming a basin effect within the former extraction areas of the bogs.

9.3.1.2 Proposed Grid Connection

The proposed Grid Connection (GC) route extends from the proposed onsite 110kV electrical substation in the north of Littleton Bog to the existing Ballyragget 110/220kV substation within the townland of Ballyragget, Co. Kilkenny. The proposed GC route measures 30.9km in length and is located primarily within the curtilage of the public road corridor (28.4km). The proposed GC route is described in full in Chapter 4 Section 4.4.2.

Ground elevations along the proposed GC route is variable with topography ranging from ~80 to ~140mOD.

9.3.1.3 Turbine Delivery Route

The TDR travels from the port of entry of Foynes to Junction 4 of the M8 Motorway to the Site entrance on the R639 at Longfordpass. Temporary accommodation works will be required at selected locations along the TDR to facilitate the delivery of large components to the site. These comprise the placement of temporary load bearing surface to public road verges, and temporary removal of street furniture and signage within the public road corridor to facilitate oversized loads associated with wind turbine component deliveries. No modifications to existing watercourse crossings are proposed along the TDR. For further details of the TDR please refer to Chapter 15 - Material Assets.

9.3.2 Water Balance

9.3.2.1 Proposed Wind Farm

Long term Annual Average Rainfall (AAR) and evaporation data were sourced from Met Éireann (www.met.ie). The 30-year AAR (1981-2010) recorded at Littleton rainfall station, located approximately 1km southwest of Site are presented in Table 9-5. The long-term AAR at this station is 958mm/year.

Met Éireann also provide a grid of AAR for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the AAR at the Site ranges from 934 to 1,004mm/year, with the greatest values in Ballybeg Lanespark Derryvella Bog in the south. The conservative AAR for the Site is taken to be 1,004mm/year (this is considered to be the most accurate estimate of AAR from the available sources).

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

Station		X-Coord		Y-Coord		Ht (mOD)		Opened		Closed		
Littleton Rainfall Station		219700		153400		122		1950		1982		
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
98.3	72.1	74.2	63.5	67.0	68.7	65.1	78.9	76.4	108.9	91.3	93.8	958.1
Site (X-Cord: 217000, Y-Cord: 150000)												
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
100	77	74	66	66	74	71	83	78	106	105	105	1,004

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Kilkenny, ~26km east of the Site. The long-term average PE for this station is ~459mm/year. This value is used as a best estimate of the PE at the Site. Actual Evaporation (AE) is estimated as ~436mm/year (which is 0.95 × PE).

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

Effective Rainfall (ER) = Average Annual Rainfall (AAR) – Actual Evaporation (AE)

= 1,004mm/year – 436mm/year

ER = 568mm/year

The GSI estimate that the groundwater recharge coefficient for the Site is 4% (www.gsi.ie), with this estimate being provided based on the occurrence and extent of basin peat. Based on this recharge coefficient (4%) the average annual groundwater recharge for the Site is estimated to be ~23mm/year (i.e. 4% of the effective rainfall (568mm) for the Site). This means that the hydrology of the Site is characterised by very high surface water runoff rates and very low groundwater recharge rates. This is supported by on-site observations made during the site walkover surveys whereby a high density of drains were recorded within the Site.

Therefore, conservative annual recharge and runoff rates for the Site are estimated to be 23mm/yr and 545mm/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 3.92mm/day and 2.34mm/day respectively in Co. Tipperary. In a 4°C world, the average winter and summer precipitation rates in Co. Tipperary are projected to be 4.31mm/day and 2.08mm/day respectively.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. Table 9-6 presents return period rainfall depths for the area of the Site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 50-year, 100-year). These extreme rainfall depths will be the basis of the Proposed Wind Farm drainage hydraulic design.

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

	Return Period (Years)			
Storm Duration	**1**	**5**	**30**	**100**
5-mins	3.8	6.2	10.3	14.2
15-mins	6.2	10.2	17.0	23.2
30-mins	8.1	13.0	21.2	28.7
1-hour	10.6	16.7	26.6	35.5
6-hours	21.0	31.4	47.5	61.5
12-hours	27.4	40.2	59.5	76.0
24-hours	35.7	51.4	74.6	93.9
2-days	43.7	60.6	84.7	104.2

9.3.2.2 Proposed Grid Connection

The AAR along the proposed GR route ranges from a minimum of 924mm/yr in the vicinity of the Ballyragget substation to a maximum of 958mm/yr northeast of Urlingford. The conservative AAR for the proposed GC route is taken to be 958mm/year.

Groundwater recharge estimates from the GSI along the proposed GC route range from 4 to 85%. The areas of lowest groundwater recharge (4-22%) occur in the west, in the vicinity of the Site where peat is mapped in the townland of Longfordpass and along the R639 to the south of Urlingford. Further to the east groundwater recharge rates range from 60-85% due to the presence of permeable subsoils and well-draining soils. 60% groundwater recharge rates are mapped by the GSI between Woodsgift and Freshford. The highest rates of groundwater recharge (85%) are mapped between Freshford and Ballyragget, along the R694 and the N77, and are associated with highly permeable glaciofluvial sands and gravels.

9.3.3 Regional and Local Hydrology

9.3.3.1 Proposed Wind Farm

The Site is located in River Suir surface water catchment within Hydrometric Area 16 of the South Eastern River Basin District. The Suir Catchment includes the area drained by the River Suir and all stream entering the tidal water between Drumdowney and Cheekpoint, Co. Waterford. The catchment has a total area of 3,542km^2. In the vicinity of the Site, the main tributary of the River Suir is the Drish River. This river discharges into the River Suir to the south of Thurles and ~7.7km west of the Site. The River Suir then continues to flow to the south, past Cahir, before it veers to the east and flows through Clonmel. Downstream of Clonmel, the River Suir becomes tidal in the vicinity of Carrick-on-Suir. A regional hydrology map is shown in Figure 9-2 (refer to Volume 4 of this EIAR).

More locally the Site is located in the Suir_040 WFD sub-catchment (Suir_SC_040) and is drained by the Drish River and its tributaries. This Site is mapped within a total of 8 no. WFD river sub-basins as detailed in the succeeding paragraphs. A local hydrology map is included as Figure 9-3.

The southwest of Ballybeg Lanespark Derryvella Bog is mapped in the Breagagh (Tipperary)_010 WFD river sub-basin. The closest mapped watercourses to this area of the Site is the Ballyley River, referred to on the EPA online mapping as the Breagagh River (EPA Code: 16B03) (note that for consistency this watercourse will be referred to as the Breagagh River within this chapter). This watercourse flows to the northwest ~140m from the Site. Further downstream, the Breagagh River discharges into the Drish River (EPA Code: 16D02) near Archerstown Bridge to the south of Thurles, just upstream of its confluence with the River Suir.

The north of Ballybeg Lanespark Derryvella Bog is mapped in the North Glengoole_010 WFD river sub-basin. The closest mapped watercourses to this area of the Site is the EPA named North Glengoole Stream (EPA Code: 16N28) which is a tributary of the Black River, referred to by the EPA as the Black [Tow Mile Borris] River (EPA Code: 16B01). The North Glengoole Stream flows to the northwest along the northern boundary of Ballybeg Lanespark Derryvella Bog. A small lake waterbody, known as Lough Doire Bhile, is mapped to the northeast of the bog and to the northeast of the North Glengoole Stream. There is no hydraulic connection between the Site and this lake, with the North Glengoole Stream separating it from Lanespark Bog to the south and the Black (Two Mile Borris) acting as a hydraulic barrier between the lake and Littleton Bog to the north.

A large area in the south of Littleton Bog is mapped in the Black (TwoMileBorris)_010 WFD river sub-basin. This area is drained by the Black (Two Mile Borris) River. The EPA map the Black (Two Mile Borris) River to flow to the south/southeast along the eastern boundary of Littleton Bog. The Black (Two Mile Borris) River continues to flow to the northwest and discharges into the Drish River to the north of Twomileborris.

Much of the centre of Littleton Bog is mapped in the Clover_010 WFD river sub-basin. The EPA map 2 no. watercourses to flow to the northwest from this area of Littleton Bog. One of these streams is referred to as the Derheen River on local basemaps and is not assigned a name by the EPA). The other stream is referred to as the Clover Stream (EPA Code: 16C04) on the EPA blueline database. These streams merge downstream of the Site, forming the Clover River. The Clover River discharges into the Black (Two Mile Borris) River to the north of the village of Twomileborris.

A small area in the northwest of Littleton Bog is mapped in the Clover_020 WFD river sub-basin. An unnamed stream is mapped to originate at the western boundary of the bog and flows to the west before discharging into the Clover River.

The northeast of Littleton Bog is mapped in the Drish_010 WFD river sub-basin. This area of the Site is drained by the Drish River (EPA Name: 16D02) which flows to the north. It is noted that this watercourse is referred to as the Black River on local base maps and Discovery Series maps, and is only referred to as the Drish River downstream of Ballyduff Bridge near Shanballyduff. Note for the purposes of this chapter the EPA naming will be utilised for this watercourse (i.e. the Drish River) which will avoid confusion with the Black (Two Mile Borris) River.

A small area in the north of Littleton Bog is mapped in the Drish_020 WFD river sub-basin. The Drish River flows to the northwest ~1.3km from this area of the Site. The northwest of the Site, including an area of Longfordpass Bog (Popes Bog) is mapped in the Drish_050 WFD river sub-basin. An unnamed stream is mapped by the EPA to flow along the western boundary of this area of Longfordpass Bog (Popes Bog) before it discharges into the Drish River.

Table 9-7 summarises the location and receiving waterbodies of each of the 3 no. bogs which comprise the Site in accordance with the Water Framework Directive (WFD) terminology.

Table 9-7: WFD Catchments, sub-catchments and river sub-basins

Bog Name	Proposed Development Infrastructure	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
Longfordpass Bog (Popes Bog)	Internal site access tracks & amenity carpark	Drish_050	Suir_SC_040	River Suir Catchment
Littleton Bog	Internal site access tracks & construction compound	Drish_050		
	North of BP	Drish_020		
	T1, T2, peat deposition areas, amenity tracks & internal site access tracks	Drish_010		

Bog Name	Proposed Development Infrastructure	WFD River Sub-Basin	WFD Sub-Catchment	WFD Regional Surface Water Catchment
	Onsite 110kV electrical substation, peat deposition areas, SW of BP, access tracks, T3, T4, T5, construction compound, amenity tracks	Clover_010		
	No infrastructure	Clover_020		
	T6, T7, T8, internal site access tracks, amenity tracks, met mast & construction compound	Black (Twomileborris)_010		
Ballybeg Lanespark Derryvella Bog	Internal site access tracks, amenity tracks, peat deposition areas, T9, T10 & T11	North Gengoole_010		
	Internal site access tracks, construction compound, T9 & T10	Breagagh_010		

9.3.3.2 Proposed Grid Connection

On a regional scale, the majority of the proposed GC route is located in the River Nore surface water catchment. The area in the vicinity of the Site is located in the River Suir surface water catchment. There are a total of 11 no. crossings over watercourses along the proposed GC route.

Within the River Suir Catchment, there is 1 no. watercourse crossing proposed over an EPA mapped watercourse. This is situated at an existing crossing where a local road passes over the Drish River (EPA Code: 16D02) within the Drish_020 WFD river sub-basin.

Within the River Nore surface water catchment, the proposed GC route is mapped across a total of 9 no. WFD river sub-basins with a total of 9 no. watercourse crossings over EPA mapped watercourses. There is also 1 no. crossing at a watercourse which is not included in the EPA blueline database. All crossing locations are situated at existing bridge/culvert locations as follows with the exception of 1 no. new crossing under the River Nore:

- There is an existing road bridge crosses over the Goul River (EPA Code: 15G02) to the southwest of Urlingford along the R639 in the Goul_202 WFD river sub-basin;
- An existing road bridge crossing along the R639 at Urlingford over the Ardreagh Stream (EPA Code: 15A03) in the Ardreagh_010 WFD river sub-basin;
- 2 no. existing crossings (road bridges) along the R693 over the Borrisbeg Stream (EPA Code: 15B18) in the Goul_030 WFD river sub-basin;
- A crossing along the R693 over the EPA mapped Clomantagh Lower Stream (EPA Code: 15C91) in the Nuenna_010 WFD river sub-basin. However, site inspections could not identify a watercourse at this location. This crossing is included in the impact assessment for the purposes of a conservative assessment;
- There are 2 no. existing crossings located in the Nuenna_020 WFD river sub-basin in the vicinity of Freshford. These crossings occur along the R693 over the Gorteenahilla Stream (EPA Code: 15G08) and along the R694 over an unmapped watercourse;
- An existing road bridge crossing over the Lismaine Stream (EPA Code: 15L16) along the R694 in the Nore_150 WFD river sub-basin;
- An existing crossing over the Lisdowney Stream (EPA Code: 15L02) along the R694 in the Nore_140 WFD river sub-basin; and,
- A new proposed crossing under the River Nore in the vicinity of Ballyragget substation.

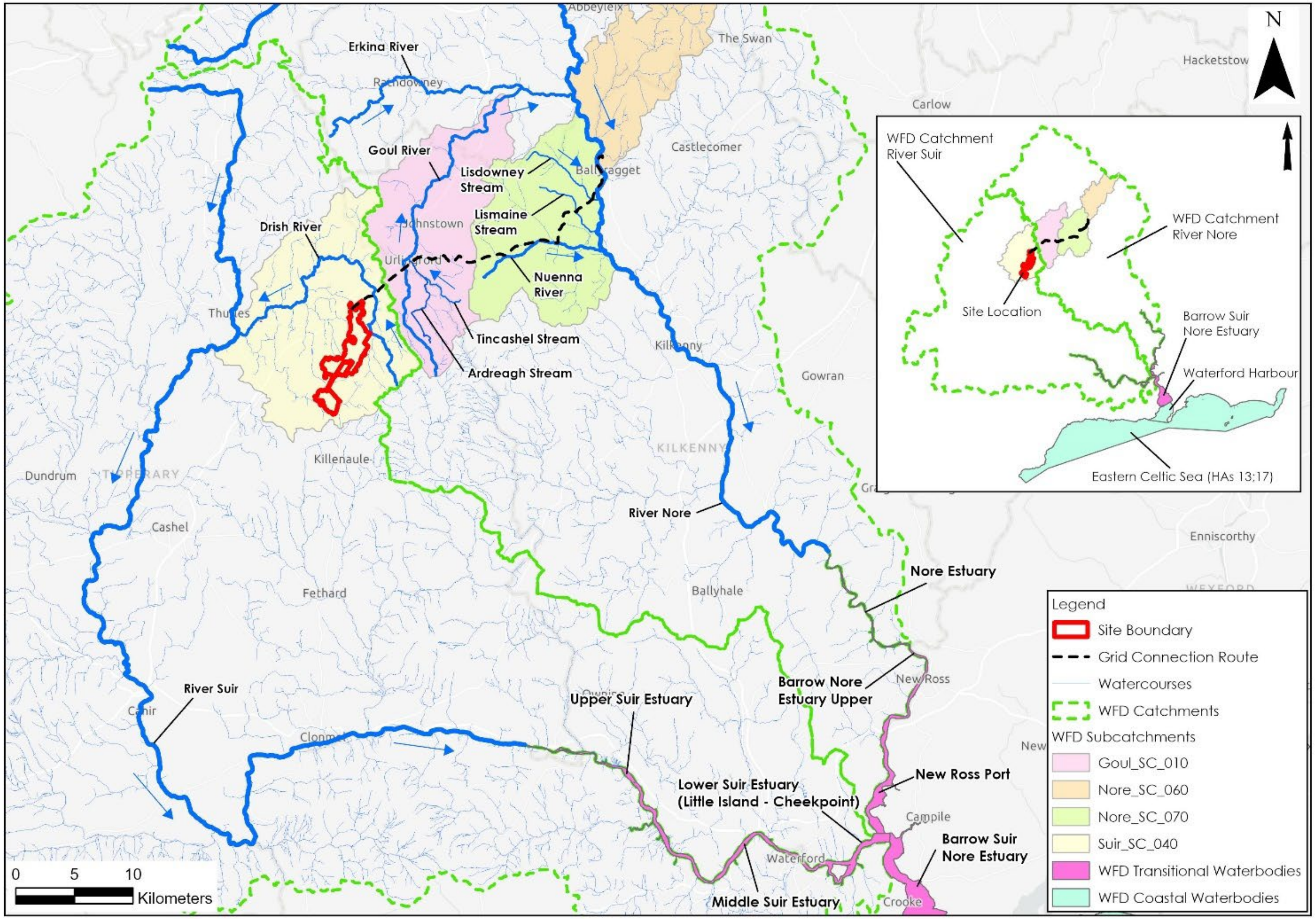

Figure 9-2: Regional Hydrology Map

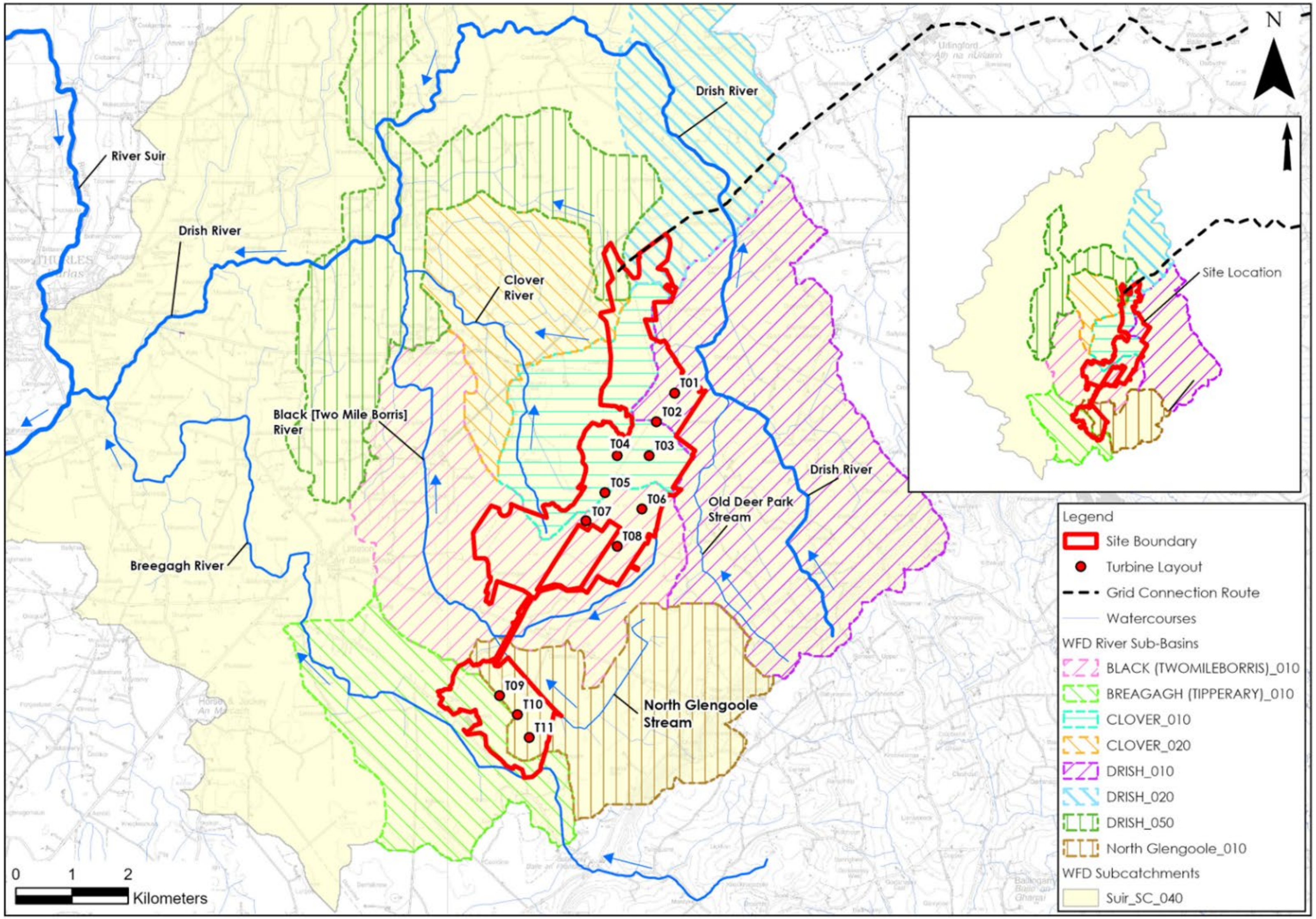

Figure 9-3: Local Hydrology Map

9.3.4 Site Drainage

Due to the historic peat extraction activities at the Site, the bogs have been artificially drained in order to lower the peat water table. Drainage ditches were inserted into the upper surface of the bogs at different stages. Littleton Bog was the first bog within the Site to be cleared and drained in 1941. Longfordpass Bog (Popes Bog) was drained in 1947 whilst Ballybeg Lanespark Derryvella Bog was drained in 1968.

Drainage of the Site and the wider Littleton Bog Group is currently operating under licence from the EPA (Integrated Pollution Control Licence Ref. No. P0499-01). The drainage system has been operating in accordance with this existing Integrated Pollution Control licence, with all drainage water being discharged from the bogs passing through an appropriately designed silt pond treatment arrangement prior to discharge.

In 2018, Bord na Móna produced Cutaway Bog Decommissioning and Rehabilitation Plans for the Longfordpass, Littleton and Lanespark bogs located within the Application Site in accordance with Condition 10 of the IPC licence. Rehabilitation Phase 1 works were completed in Littleton, Longfordpass, Lanespark Bogs and the nearby Ballybeg and Derryvella Bogs between 2018-2012 with extensive drain-blocking and hydrological management. The key objective of peatland rehabilitation is environmental stabilisation. The rehabilitation works that have been completed and commenced in Phase 1 are described in the Cutaway Bog Decommissioning and Rehabilitation Plans (Appendix 2-1) and in Section 2.2 of Chapter 2. These works have created localised flooded areas within the site, adjacent to the drain blocking. The conditions created by the Phase 1 rehabilitation measures which have been implemented form part of the hydrological baseline and as such form an inherent component of the baseline environment considered in the impact assessment.

Currently surface water (or runoff water) is drained from the Site via a network of field drains typically spaced at 15 to 20m intervals, piped drains, main drains, headland drains, and silt ponds. Drainage of the Site was historically assisted by pumping stations located within the Site (P47/01 - P47/03) (it is noted that 12 no. pumps were active in Littleton Bog in 1988). These pumping stations discharged to small streams to the west of the Littleton Bog which merged downstream to form the Clover River. The pumping stations are no longer active. Silt ponds are used to trap sediment and prevent elevated levels of suspended sediment arising in effluent from the drained peatland. Treated surface water is then discharged at outfall points where the effluent flows into off-site drainage channels which in turn discharge into the local stream and river network.

A flow diagram of the existing drainage system is shown in Figure 9-4 below. Existing drainage map for the bogs comprising the Site are attached as Figure 9-6.

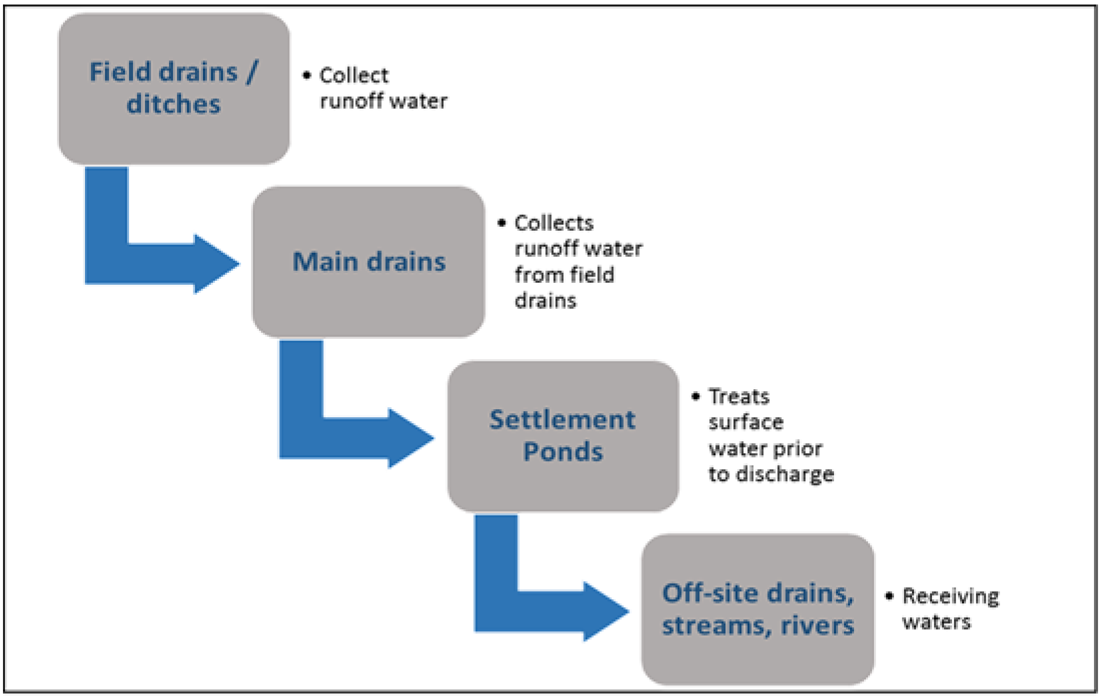

Figure 9-4: Process Flow Diagram for the Existing Site Drainage System

Detailed hydrological audit of flow paths from each bog to its eventual discharge point at the regional catchment scale was conducted for the 3 no. bogs comprising the Site. The flowpaths have been traced using the EPA mapping and Bord na Móna drainage mapping. The flowpaths are shown as Figure 9-5 below.

The small section of Longfordpass Bog (Popes Bog) which is included in the Site drains to a small stream which is mapped along the western boundary of the Site. This stream is not assigned a name by the EPA and discharges into the Drish River ~4.8km downstream of the Site.

The drainage network in Littleton Bog is of variable orientation, with northeast to southwest orientated drains in the main bog area and northwest to southeast orientated drains in the northern section of the bog. Drainage of this bog was historically facilitated by pumping stations as the previous peat extraction activities resulted in much of the bog being unable to drain by gravity due to the lowering of the ground elevations. The pumping stations were predominantly located in the west of Littleton Bog and discharged to small streams which merge further downstream to form the Clover River. These pumping stations are no longer active. There remains 1 no gravity outfall to the Clover River at the western boundary of the bog. This outfall now drains much of the bog area including the large, flooded area which is present in the northwest of Littleton Bog. This flooded area drains to the south via a large drain and is directed into the central part of Littleton Bog. Some areas of Littleton Bog no longer drain by gravity and water pools in these limited areas. There may be some very limited recharge to ground in these areas. It is also noted that some small areas in the northeast of Littleton Bog drain by gravity and discharge to local drains which connect downstream to natural watercourses.

Ballybeg Lanespark Derryvella Bog is drained by a series of drains spaced at approximately 15m intervals. Lanespark Bog is drained by field drains of northwest to southeast orientation. Drainage within the bog is directed to several settlement ponds located around the perimeter of the bog. In the north a settlement pond discharges to a local drain which in turn discharges to the North Glengoole Stream. To the south, 2 no. settlement ponds discharge to local drains which are hydrologically connected to the Breagagh River which flows to the south of the bog.

The proposed borrow pit is located outside of the peat bogs, on agricultural lands to the east of Littleton Bog in the townland of Longfordpass South. Drainage in this area is facilitated by a network of agricultural field drains which direct surface water runoff towards the Drish River.

All watercourses draining the Site eventually discharge into the Drish River and the River Suir further downstream.

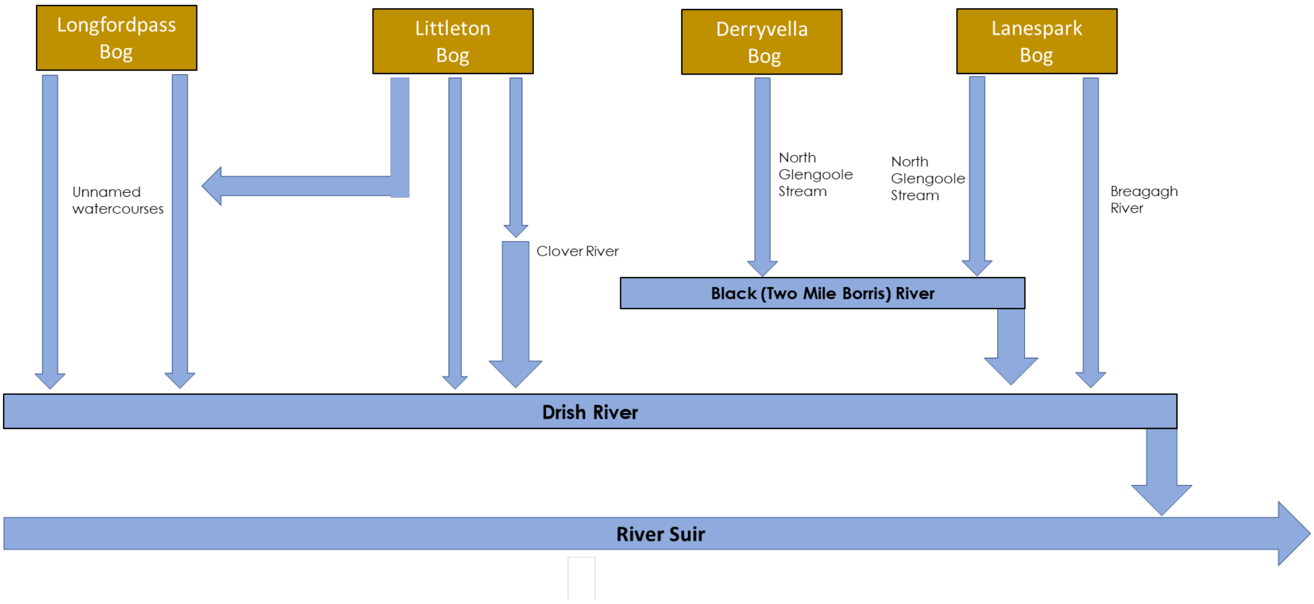

Figure 9-5: Hydrological Flowpaths for the Site

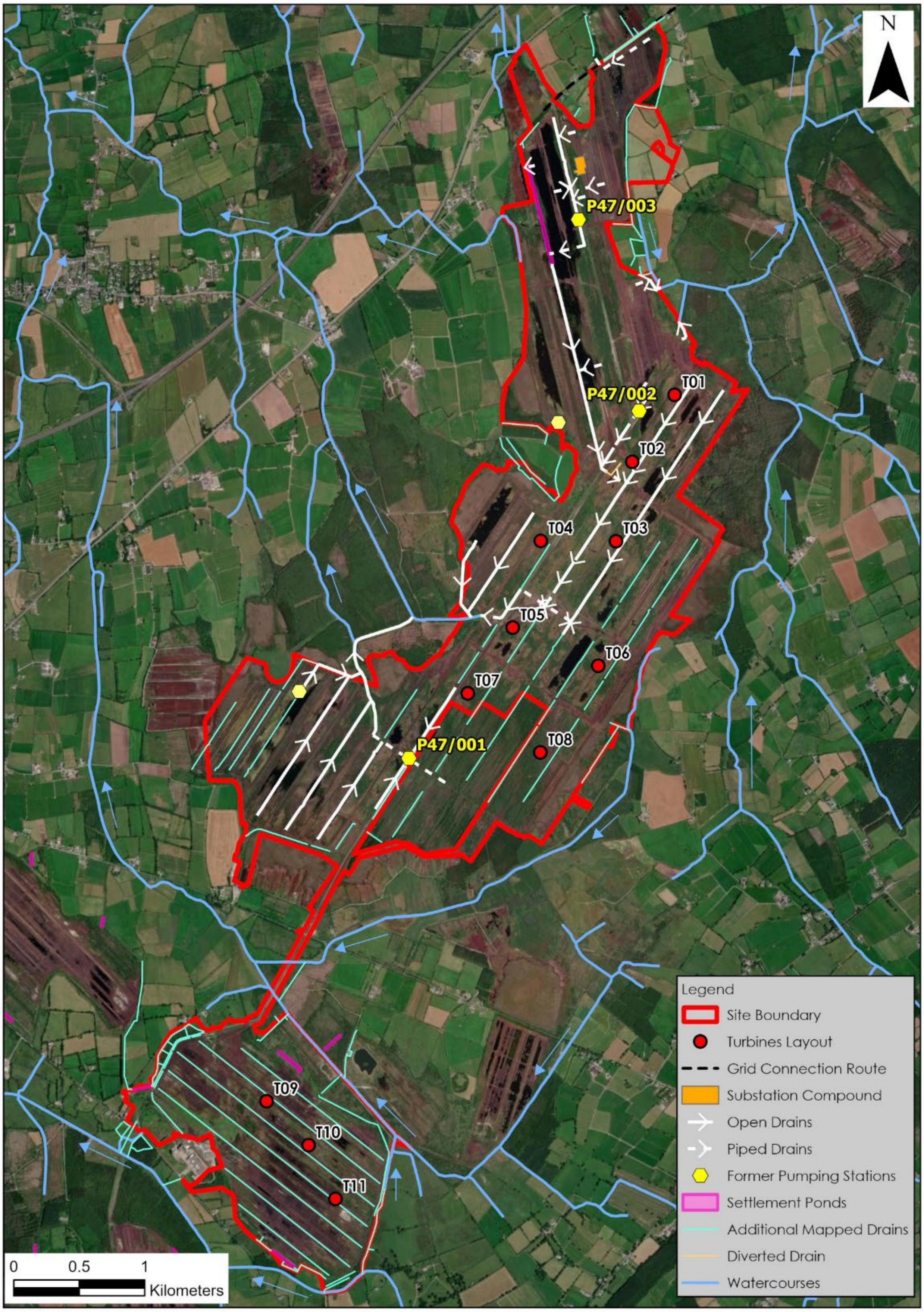

Figure 9-6: Existing Site Drainage Map

9.3.5 Baseline Assessment of Site Runoff

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

The rainfall depths used in this water balance, are long-term averages. Please note that the long term averages are not used in the design of the sustainable drainage system for the Proposed Development as described in Section 9.4.1 below. The extreme rainfall depths shown in Table 9 5 above will be the basis of the Proposed Development drainage design which is described in Section 9.4.1.

The water balance calculations are carried out for the month with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (Table 9-8). It represents, therefore, the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the Site pre-wind farm development. The surface water runoff co-efficient for the Site is estimated to be 96% based on the coverage of low permeability peat (refer to Section 9.3.2).

The highest long-term Met Éireann modelled monthly rainfall recorded at the Site occurs in the month of December, at 105mm. The average monthly evapotranspiration for the synoptic station at Kilkenny in December is 0mm. The water balance presented in Table 9-9 indicates that a conservative estimate of surface water runoff for the Site during the highest rainfall month is approximately 1,532,160m^3/month or 49,424m^3/day.

Table 9-8: Water Balance and Baseline Runoff Estimates for Wettest Month (December)

Water Balance Component	Depth (m)
Average December Rainfall (R)	0.105
Average December Potential Evapotranspiration (PE)	0
Actual Evapotranspiration (AE = PE * 0.95)	0
Effective Rainfall December (ER = R - AE)	0.105
Recharge (4%)	0.0042
Runoff (96%)	0.1008

Table 9-9: Baseline Runoff for the Site

Study Area	Area (ha)	Baseline Runoff in Wettest Month (m^3)	Baseline Runoff per day (m^3/day) in wettest month
Site	1,520	1,532,160	49,424

9.3.6 Surface Water Flows

The closest OPW gauging station to the Site which records surface water flow volumes is located along the Drish River at Athlummon (Station number: 16001). The 95%tile (percentile) flow at this station is 0.185m^3/s (185l/s) (refer to Table 9-10) which means that 95% of the time the flow in the Drish River at this location is greater than or equal to 185l/s.

Table 9-10: Flow Volumes in the Drish River at Athlummon

Flows Equalled or Exceeded for the Given Percentage of time (m^3/s)								
1%	5%	10%	25%	50%	75%	90%	95%	99%
11.139	6.474	4.738	2.649	1.358	0.69	0.424	0.185	0.079

The EPA's Hydrotool, available on www.catchments.ie, was also consulted in order to estimate the baseline flow volumes in the local area. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several nodes were consulted in the vicinity and downstream of the Site to provide an estimate of surface water flow volumes for these local watercourses. Figure 9-7 below presents a flow duration curve for each of the consulted nodes downstream of the Site.

As described above a 95%tile flow relates to the flow which will be exceeded within the river 95% of the time. The local watercourses immediately downstream of the Site have 95%tile flow volumes less than 0.08m^3/s (80l/s). For example, the Drish River to the south of Longfordpass Bridge has a 95%tile flow volume of 0.072m^3/s (Hydrotool Node: 16_2636) and the Blackwater River downstream of Twomileborris has a 95%tile flow volume of 0.076m^3/s (Hydrotool Node: 16_4109). The Clover (Hydrotool Node: 16_2399) and Breagagh rivers (Hydrotool Node: 16_4113) have 95%tile flow volumes of 0.049m^3/s and 0.035m^3/s downstream of the Site respectively. The flow volumes in the Drish River increase progressively downstream, with the 95%tile flow modelled to be 0.397m^3/s upstream of its confluence with the River Suir (Hydrotool Node 16_525). Flow volumes increase further in the River Suir due to the significantly increased catchment size.

Meanwhile, the flow volumes at the outfalls from the Site range from 0.01 – 0.1m^3/s. Therefore, based on the above, the waterbodies in the vicinity of the Site, with smaller flow volumes, would have had the greatest potential to be impacted by the Proposed Development. The potential for effects decreases progressively downstream due to the dilution effect associated with increasing flow volumes and larger upstream catchment areas. It is important to note that the Proposed Development does not in any way rely upon the assimilation capacity or dilution capacity of any downstream watercourse. The mitigation measures prescribed in Section 9.5 ensure the protection of all watercourses in the vicinity and downstream of the Site.

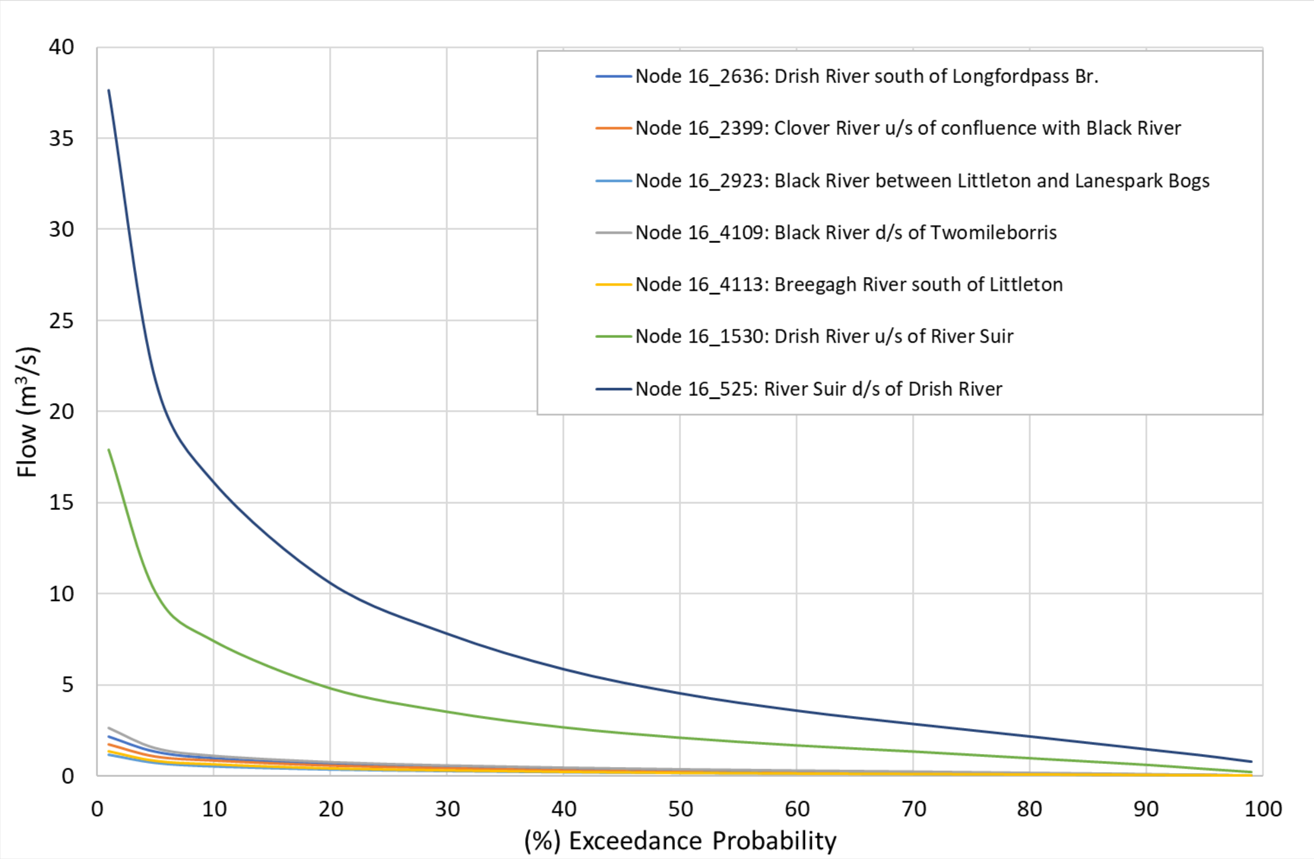

Figure 9-7: EPA Hydrotool Node Flow Duration Curves for Watercourses Downstream of the Site

9.3.7 Surface Water Quality

9.3.7.1 EPA Monitoring

9.3.7.1.1 Proposed Wind Farm

Biological Q-rating data for EPA monitoring points in the local watercourses downstream of the Site are shown in Table 9-11 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 most recent available data dates from 2023 and the Q-status of the watercourses in the vicinity of the Site ranges from 'Poor' to 'Good' Q-status. The EPA monitoring locations are shown on Figure 9-8.

No recent EPA biological monitoring has been completed on the Breagagh River in the vicinity of the Site. Meanwhile, the Black (Two Mile Borris) River achieved a Q3 rating ('Poor' Q-status) at Black River Bridge between Littleton and Ballybeg Lanespark Derryvella bogs in 2023 (Station ID: RS16B010030). Further downstream the Black (Two Mile Borris) River also achieved 'Poor' Q-status in 2023 at a bridge west of Twomileborris (Station ID: RS16B010100). To the west of Littleton Bog, the Clover River achieved a Q3 rating ('Poor' status) at a bridge at Turnpike (Station ID: RS16C040100) and 'Moderate' Q-status (Q3-4) upstream of its confluence with the Drish River (Station ID: RS16C040300).

To the north of the Site, the Drish River achieved a Q3 rating ('Poor' status) at a bridge upstream of Longfordpass Bridge (Station ID: RS16D020040) and at a bridge northeast of Castletown (Station ID: RS16D020070) in 2023. Further downstream the Drish River achieved a Q3-4 rating ('Moderate' status) at Boolabeha Bridge (Station ID: RS16D020100). Downstream of the Clover and the Black (Twomileborris) rivers, the Drish River achieved a Q4-rating ('Good' Status) at a bridge south of Athlummon (Station ID: RS16D020200). Downstream of the Breagagh River, the Drish River achieved a Q3-4 rating in 2023 (Station ID: RS16D020400). Further downstream the River Suir achieved 'Moderate' Q-status at Cabragh Bridge to the south of Thurles in 2023.

Table 9-11: EPA Water Quality Monitoring Q-Rating Values (Site)

Watercourse	Station ID	Easting	Northing	Year	EPA Q-Rating
Drish River	RS16D020040	225175	159924	2023	Q3 (Poor)
Drish River	RS16D020070	221735	163526	2023	Q3 (Poor)
Drish River	RS16D020100	219081	161949	2023	Q3-4 (Moderate)
Clover River	RS16C040100	221411	157582	2023	
Clover River	RS16C040300	219661	159263	2023	Q3-4 (Moderate)
Black (Two Mile Borris)	RS16B010030	221462	152911	2023	Q3 (Poor)
Black (Two Mile Borris)	RS16B010100	219241	157908	2023	Q3 (Poor)
Drish River	RS16D020200	217661	159405	2023	Q4 (Good)
Drish River	RS16D020400	213730	157058	2023	Q3-4 (Moderate)
River Suir	RS16S020900	211235	156066	2023	Q3-4 (Moderate)

9.3.7.1.2 Proposed Grid Connection

Within the River Suir surface water catchment the Drish River achieved a Q3 rating ('Poor' status) upstream of Longfordpass Bridge in 2023 (Station ID: RS16D020040).

Within the River Nore surface water catchment, the Goul River achieved 'Moderate' status (Q3-4) downstream of the proposed GC route at a bridge west of Johnstown (Station ID: RS15G020200). Further to the east, the proposed GC route is drained by the Nuenna River which achieved a Q3-4 rating ('Moderate' status) at a bridge downstream of Clomantagh (Station ID: RS15N020100) and a Q3 rating ('Poor' status) at Freshford (Station ID: RS15N020200). The River Nore achieved a Q4 rating at a bridge in Ballyraggett (Station ID: RS15N011450) and a Q3-4 rating downstream of its confluence with the Nuenna River (Station ID: RS15N011700).

EPA monitoring locations along the proposed GC route are shown in Figure 9-8. Biological Q-rating data for EPA monitoring points in the local watercourses downstream of the proposed GC route are shown in Table 9-12 below.

Table 9-12: EPA Water Quality Monitoring Q-Rating Values (Grid Connection)

Watercourse	Station ID	Easting	Northing	Year	EPA Q-Rating
Drish River	RS16D020040	225175	159924	2023	Q3 (Poor)
Goul River	RS15G020200	228302	166794	2022	Q3-4 (Moderate)
Nuenna River	RS15N020100	236268	163711	2022	Q3-4 (Moderate)
Nuenna River	RS15N020200	219661	159263	2022	Q3 (Poor)
River Nore	RS15N011450	244524	170820	2022	Q4 (Good)
River Nore	RS15N011700	245821	162679	2022	Q3-4 (Good)

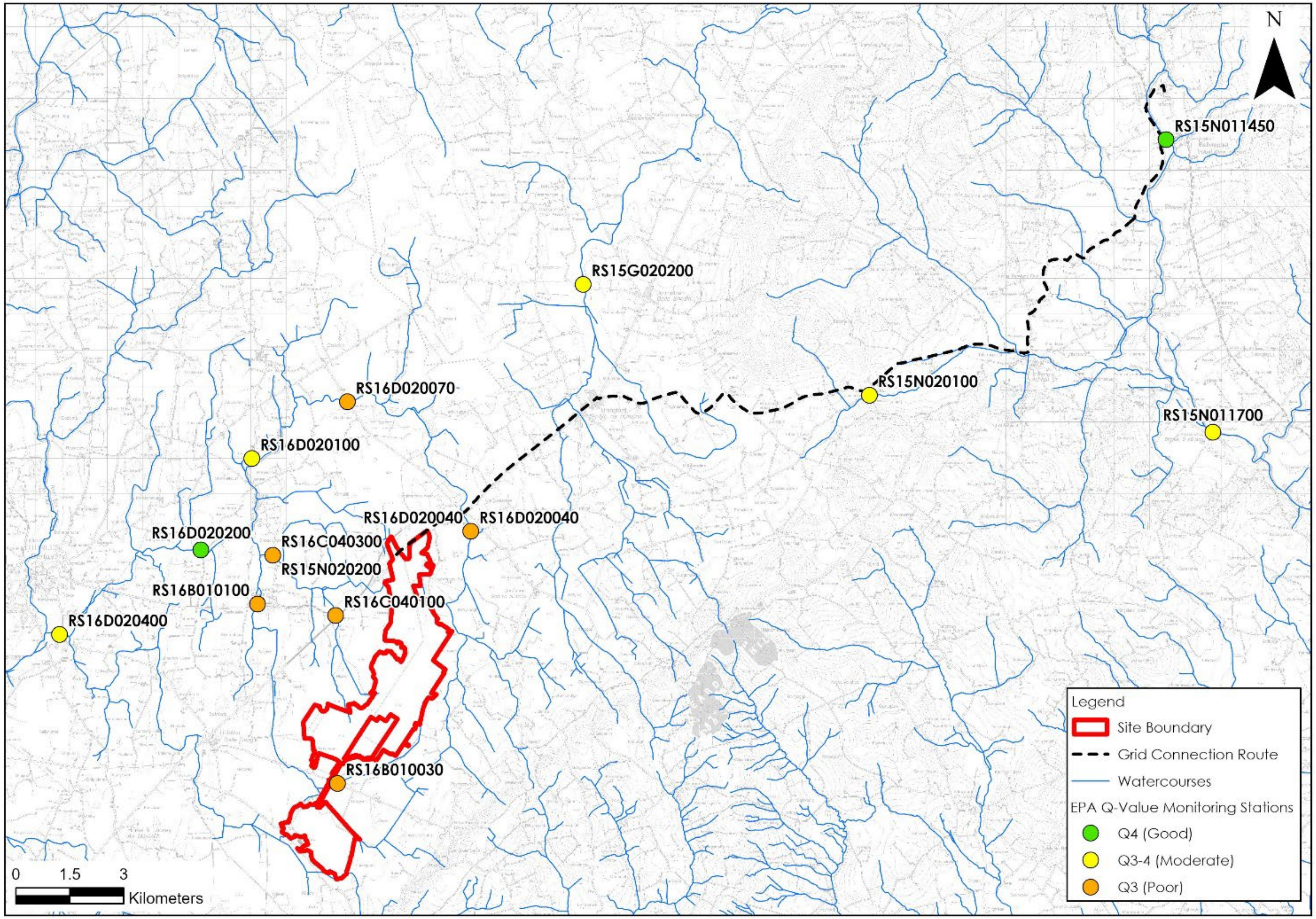

Figure 9-8: EPA Monitoring Locations

9.3.7.2 Triturus - Biological Monitoring

Triturus Environmental Ltd completed baseline aquatic monitoring on watercourses downstream of the Site in September and October 2023 (Triturus, 2024). The aquatic surveys included a total of 30 no. survey locations downstream of the Site and also along the proposed GC route. The report is included as **Appendix 6.7**, Volume 3 of this EIAR.

The study found that 3 no. monitoring sites (the Drish River downstream of the Site and the Gorteenahilla River and the Lisdowney Stream along the proposed GC route achieved 'Good' status. 4 no. locations achieved 'Moderate' status (Drish River, Breagagh River (2 no. sites) and River Nore) whilst 1 no. location achieved 'Bad' status (Clomantagh Lower Stream). All other locations were found to be of 'Poor' status.

The aquatic baseline report concludes that at the majority of monitoring locations the biological water quality was unsatisfactory and was not meeting the good status targets. However, the report also notes that low summer flows also influenced the September 2023 monitoring.

9.3.7.3 IPC Licence Monitoring

Bord na Móna have been conducting monitoring of emissions to water from the Site drainage system from 2000 to the present as set out in IPC Licence P0499-01 which came into effect in 2001.

Stormwater (i.e., rainwater run-off from roof and non-process areas such as carparks) derived on-site is released into a local waterbody following basic treatment. The IPC licence requires that stormwater (from roof and non-process areas such as carparks) is managed to ensure that no pollutants are released into the receiving environment. Where run-off comprises of only roof water it is directed directly to a drain. Runoff from other areas such as carparks is passed through a hydrocarbon interceptor before discharge. The waterbodies which are listed as receiving stormwater run-off at this site are the Breagagh, Drish and Black (Two Mile Borris) rivers. Discharges (from roof and non-process areas such as carparks) are inspected and sampled on a monthly basis. The primary treatment criteria used to define adequate treatment of stormwater is COD mg/l. Monthly sampling was completed with results being generally well below the COD trigger levels. Occasionally elevated concentrations occurred when machinery had been washed down immediately prior to sampling and subsequent results returned to satisfactory levels.

The EPA licence has also required that wastewater at the Site be managed to ensure no pollution results when wastewaters were discharged into local surface waterbodies. Two types of wastewaters were produced at the Application Site: Process wastewater from the activities associated directly with peat harvesting operations and sanitary wastewater from toilets and canteens. All process wastewater from peat extraction areas is treated via a silt pond drainage system which has been inspected and maintained in accordance with Condition 6 of the IPC Licence. Treated wastewater is released into the Clover, Black (Two Mile Borris) and Breagagh rivers. IPC Licence requirements comprise of quarterly grab samples on a select number of silt pond outlets.

Annual Environmental Reports (AERs) are available for the entire Littleton Bog Group including the bogs comprising the Site. A review of recent AERs (2024, 2023, and 2022) revealed that discharge from the bogs is compliant with regards to suspended solids concentrations (<35mg/l). Trigger levels are also set for Total Ammonia (4mg/l) and COD (100mg/l). All samples across the 3 no. recent years were below the trigger level for total ammonia whilst the samples were found to be 98% and 90% compliant with regards to COD in 2024 and 2023 respectively.

9.3.7.4 Recent EPA Water Monitoring

HES has reviewed the available recent water quality monitoring data (2017-2025), completed in accordance with the requirements of the Water Framework Directive, for the waterbodies in the vicinity and downstream of the Site. During this time period a total of 31 no. samples were taken on the Clover River, 41 no. samples on the Breagagh River, 41 no. samples on the Black (Two Mile Borris) River and 48 no. samples on the Drish River (at multiple monitoring locations). The data is available for download at https://www.catchments.ie/data.

EPA monitoring began on the watercourses in the local area in 2007, during the later part of the Peat Extraction Phase and continues to the present day. Note that data is not available to download for all watercourses in the vicinity of the Application Site. Table 9-13 below presents summary data of the water quality monitoring with respect to BOD, ortho-phosphate and ammonia and presents the results alongside the relevant EQS as set out in S.I. 272/2009. The results are summarised as follows:

- With respect to ortho-phosphate, the mean concentration from 2017 to Present was of High Status (≤0.025) in the Black(Twomileborris)_010 and the Drish_0202 SWBs. The Clover_010 and Drish_050 SWBs exceeded the Good status threshold ((≤0.035mg/l).
- With respect to BOD, the mean concentrations in all of the consulted waterbodies exceeded the Good status threshold of ≤1.5mg/l from 2017 to Present.
- With respect to ammonia, the mean concentrations were found to be of Good status (≤0.065mg/l) in the Breagagh (Tipperary)_010, Black(Twomileborris)_010 and the Drish_020 SWBs.

Suspended solid concentrations have not been monitored continuously across many of the SWBs in the vicinity and downstream of the Site. However, the available data indicates that concentrations of suspended solids are well below the 25mg/l ELV.

Table 9-13: EPA Water Quality Monitoring Data Summary (2017 to Present)

River Waterbody	Parameter	Status Threshold (S.I. 272/2009)	Mean Conc. (2017-Present)
Clover_010	Ortho-P	High ≤0.025, Good ≤0.035	0.08
	BOD	High ≤1.3, Good ≤1.5	2.43
	Total Ammonia	High ≤0.04, Good ≤0.065	0.27
Breagagh (Tipperary)_010	Ortho-P	High ≤0.025, Good ≤0.035	0.030
	BOD	High ≤1.3, Good ≤1.5	1.62
	Total Ammonia	High ≤0.04, Good ≤0.065	0.057
Black (Twomileborris)_010	Ortho-P	High ≤0.025, Good ≤0.035	0.022
	BOD	High ≤1.3, Good ≤1.5	1.76
	Total Ammonia	High ≤0.04, Good ≤0.065	0.044
Drish_020	Ortho-P	High ≤0.025, Good ≤0.035	0.018
	BOD	High ≤1.3, Good ≤1.5	1.61
	Total Ammonia	High ≤0.04, Good ≤0.065	0.062

River Waterbody	Parameter	Status Threshold (S.I. 272/2009)	Mean Conc. (2017-Present)
Drish_050	Ortho-P	High ≤0.025, Good ≤0.035	0.051
	BOD	High ≤1.3, Good ≤1.5	2.48
	Total Ammonia	High ≤0.04, Good ≤0.065	0.31

9.3.8 Summary Flood Risk Assessment

9.3.8.1 Proposed Wind Farm

This section provides a summary of the Flood Risk Assessment (FRA) which has been undertaken by HES for the Proposed Wind Farm. The full FRA report is attached as **Appendix 9.1**, Volume 3. The FRA is completed in line with the guidelines provided in “The Planning system and Flood Risk Management” (OPW, 2009).

To identify those areas as being at risk of flooding, OPW’s River Flood Extents Map, the National Indicative Fluvial Mapping (NIFM), Past Flood Event Mapping (www.floodinfo.ie) and historical mapping (i.e. 6” and 25” base maps) were consulted.

No recurring flood incidents or instances of historical flooding were identified within the Site on historic OS maps. Identifiable map text on local available historical 6” or 25” mapping for the Site does not identify any lands that are “liable to flood”.

Based on the EPA/GSI soil map for the area no regions of alluvium are mapped within the site boundaries. However, some alluvium (fluvial deposits) is recorded along many of the local streams and rivers downstream of the Site.

The OPW Past Flood Events Map has no records of historic or recurring flood events within the Site. The closest mapped recurring flood event to the Site is located ~1.9km west of Littleton Bog (Flood ID: 4373) at Garryclogh. Here a local road is reported to flood approximately every 2 years, with surface water runoff listed as the source of the flooding. A recurring flood event is also mapped ~2.5km west of Ballybeg Lanespark Derryvella Bog (Flood ID: 3759) at Ballymurreen Bridge, associated with flooding of the Breagagh River. Further downstream recurring flood events are also recorded on the Drish River (Flood ID: 3752) and the River Suir (Flood ID: 3748) in the vicinity of Thurles. The OPW also record several historic flood events. Several historic flood events dating from 2012 are mapped to the east of Littleton Bog along the Drish River.

The GSI's Winter 2015/2016 Surface Water Flood Map shows surface water flood extends for this winter flood event. This flood event is recognised as being the largest flood event on record in many areas. This flood map shows several areas of surface water ponding within the Site. This flooding was associated with pluvial flooding following rainfall events. These flood zones correspond with large areas of surface water ponding which were recorded during the site walkover surveys. No infrastructure is proposed in any of these flooded areas.

Where complete, the CFRAM OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the PFRA maps. No CFRAM mapping has been completed for the area of the Site. The closest mapped CFRAM fluvial flood zones are located along the River Suir near Thurles, ~8.7km west of the Site.

The NIFM for the Present-Day Scenario records some flood zones within the northern section of Ballybeg Lanespark Derryvella Bog. These modelled flood zones are associated with Black (Two Mile Borris) River and a small tributary which runs along the northern boundary of the bog. However, these flood zones do not encroach significantly upon the Site and are in excess of 750m from the closest proposed turbine location (T9). The only infrastructure proposed in the vicinity of the flood zones comprises of internal site access tracks. Existing watercourse crossings (large diameter culverts) already exist at these locations as the Bord na Mona railway line, and an adjacent machine pass, cross these watercourses. NIFM fluvial flood zones are also mapped along the Drish River to the northeast of Littleton Bog. However, these flood zones do not encroach upon the Site.

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

The main risk of flooding is via pluvial flooding due to the low permeability of the peat soils and subsoils. The surface of the cutover bog contains an extensive network of peat drains with surface water outfalls from the bog. This existing drainage network has reduced the risk of pluvial flooding across much of the Site. However, following periods of intense or prolonged rainfall localised surface water ponding is still likely to occur. The proposed infrastructure will be raised above existing ground levels by approximately 1m, therefore the risk from pluvial flooding is negligible.

The proposed onsite 110kV electrical substation is particularly sensitive to flooding. A site-specific flood analysis has been completed for the substation location. Conservative volumetric analysis has determined the peak flood levels at the proposed substation site for 100-yr and 1000-yr rainfall events to be 124.35 and 124.42mOD respectively. The primary control in the analysis is the expanse of the bog in Littleton which needs to fill with pluvial flood water before the substation site can flood. It is therefore recommended to give the substation a floor level of >124.72mOD (124.42mOD + 0.3m freeboard). At this elevation the risk of flooding at the substation site is negligible.

9.3.8.2 Proposed Grid Connection

In addition to the Flood Risk Assessment completed for the Proposed Wind Farm, the potential for flooding along the proposed GC route has also been assessed.

The OPW Past Flood Events map records a recurring flood event to the east and north of the proposed GC route in the townlands of Borrismore and Balief Lower. This recurring flood event (Flood ID: 742) is associated with a turlough (i.e. groundwater flooding). The local OSI base map identifies a hydrological feature called 'The Loughane" in this area. Recurring flood events are also mapped along the proposed GC route at Freshford and at Ballyragget. At Freshford the recurring flooding is associated with flooding of the Nuenna River (Flood ID: 2814) whilst the River Nore is noted to flood near Ballyragget (Flood ID: 2813).

The GSI’s Winter 2015/2016 Surface Water Flood Map records fluvial flooding along the River Nore to the east of the N77, west of Ballyragget.

The GSI's Maximum Historic Groundwater Flood Map identifies a large area of groundwater flooding to the east and north of the proposed GC route in the townlands of Borrismore and Balief Lower. A small area of groundwater flooding was also recorded to the north of the R693 near Woodsgift. The GSI's Groundwater Flooding Probability Maps show the expected extend of groundwater flooding in limestone regions. The predictive groundwater flood extends are mapped in the townlands of Borrismore and Balief Lower. However, the groundwater flood event associated with a return period of 1,000 years does not encroach upon the public road network (i.e. the proposed GC route).

CFRAM flood zones are mapped along the proposed GC route at Freshford and Ballyragget. The CFRAM fluvial flood zones along the proposed GC route are associated with the Nuenna River and its tributaries in Freshford and the River Nore near Ballyragget.

The National Indicative Fluvial Flood Mapping for the Present Day Scenario shows fluvial flooding along many of the watercourse mapped in the vicinity of the proposed GC route. NIFM fluvial flood zones are mapped along the R694 to the north of Freshford and along the Nuenna River to the west of Freshford. Fluvial flood zones are also mapped along the R693 at Urlingford over the Goul River, the Ardreagh Stream and further to the east over the Borrisbeg Stream. Fluvial flood zones are also mapped along the Drish River within the River Suir surface water catchment. Existing roads and watercourse crossings exist at all of these locations.

In summary, the vast majority of the proposed GC route is at low risk of flooding. However, there are areas which may be prone to flooding, principally at existing watercourse crossings. Due to the depth of the proposed GC underground cabling, this will have no impact during the operational phase. During the construction phase, works along the proposed GC route may have to be postponed following heavy rainfall events which could cause flooding in these areas.

9.3.9 Hydrogeology

9.3.9.1 Proposed Wind Farm

The bedrock underlying the Proposed Wind Farm is mapped predominantly as the Ballysteen Formation in the north and the Waulsortian Limestones in the south. Waulsortian Limestones comprise of massive, unbedded lime-mudstones whilst the Ballysteen Formation is noted by the GSI to consist of dark, muddy limestones and shale. A small area in the north of Littleton Bog, and the proposed borrow pit location, is mapped to be underlain by the Lisduff Oolite Member (oolitic limestone). Meanwhile, the southeast of Ballybeg Lanespark Derryvella Bog is mapped to be underlain by the Crosspatrick Formation, which consists of pale-grey cherty crinoidal limestone, and the Aghmacart Formation, which consists of dark, shaly, micritic, peloidal limestone. The Site's bedrock geology is presented in Figure 8.2, Chapter 8.

In terms of hydrostratigraphic rock units, the Aghmacart Formation forms part of the Dinantian Upper Impure Limestones (DUIL) whilst the Crosspatrick Formation and the Lisduff Oolite Member are Dinantian Pure Bedded Limestones (DPBL). The Waulsortian Limestones are Dinantian Pure Unbedded Limestones (DPUL) whilst the Ballysteen Formation forms part of the Dinantian Lower Impure Limestones (DLIL).

The Ballysteen Formation and the Aghmacart Formation are classified by the GSI as being a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones. The Waulsortian Limestones are classified as being a Regionally Important Aquifer - Karstified. The Lisduff Oolite Member and the Crosspatrick Formation are classified as Locally Important Aquifers - Bedrock which is Generally Moderately Productive. A bedrock aquifer map is included as Figure 9-9.

In terms of Groundwater Bodies (GWBs) the Site is underlain by the Templemore and Thurles GWBs.

According to the GSI's GWB characterisation report for the Templemore GWB (GSI, 2003), this GWB extends from Templemore towards Tipperary town. This area is very low lying with the River Suir meandering through a wide valley. East of the Suir topographic gradients are low. The GSI state that there is a major NNW-SSE fault complex in the area and a large syncline which runs between Twomileborris and Thurles. Diffuse recharge will occur to this GWB where subsoils are thinnest and most permeable. There are also several karst features which provide point recharge to this GWB. The GSI state that the key sources of data used to estimate the aquifer characteristics are based on data from the Karst aquifer and are not representative of the whole GWB which also contains Silurian and Devonian rocks. The permeability in the aquifers depends on the development of faults, fissures, and fractures. Regionally the groundwater flow direction is towards the River Suir and its tributaries. Groundwater flow in the karst aquifer is confined to conduits, which have developed by the dissolution or fissures. Groundwater flow in these conduits will be fast. The nature of the karst hydrogeology will be ultra variable even on a local scale. Discharge from this GWB occurs via springs, which flow towards the surface water bodies or via baseflow directly into the rivers (GSI, 2003).

The area of the Site mapped to be underlain by the Templemore GWB is comprised of Locally Important Aquifers associated with the Ballysteen Formation, the Lisduff Oolite Member and the Aghmacart Formation.

The Thurles GWB is located northeast of Thurles. the extent of dolomitised Waulsortian Limestone and the Crosspatrick Formation define the area of the GWB to the north, west and south. Groundwater flow is from east to west. Flow is likely through fractures, which have been enlarged by karstification and dolomitisation. Recharge to the aquifer is directly from rainfall and discharge is via springs in the southwest of the GWB near Thurles (GSI, 2003).

The area of the Site mapped to be underlain by the Thurles GWB is comprised of a Regionally Important Aquifer (Waulsortian Limestones) and a Locally Important Aquifer (Crosspatrick Formation).

9.3.9.1.1 Site Specific Hydrogeology

The site-specific hydrogeological regime at the Site has been characterised by detailed walkover surveys, extensive peat probe investigations and intrusive site investigations comprising of trial pits and rotary core borehole drilling. Full details of the geology of the Site are presented in Chapter 8 of the EIAR.

In summary, the trial pit excavations and borehole drilling completed within the bog areas of the Site encountered peat depths ranging from 0.3 to 4.5mbgl (metres below ground level). The peat was found to be typically underlain by cohesive deposits consisting of grey, slightly sandy, slightly gravelly clayey SILT or a grey, slightly sandy, slightly gravelly, silty CLAY. Granular deposits were also recorded beneath the peat at some locations and underlying the cohesive deposits elsewhere and were described as grey, slightly sandy, silty, clayey, subangular to subrounded, fine to coarse GRAVEL with occasional cobbles and boulders.

During the trial pit investigations, groundwater strikes were recorded in most trial pit excavations at depths ranging from 0.7 to 4.5mbgl. The groundwater strikes were typically described as seepages. Fast inflows were only recorded in 5 of the 50 no. trial pits excavated at the Site. These fast inflows occurred at depths of 2.9 to 4.0mbgl and were associated with granular gravel deposits. Note that many of the trial pits only encountered seepages in the granular deposits. Of the 6 no. trial pits excavated the proposed borrow pit location (which extended to depths of 0.8 to 4.1mbgl), groundwater was only recorded in 1 no. excavated, described as a seepage at 2.8mbgl in TP-B4.

The site investigations completed at the site indicate that the hydrological regime is typically dominated by high rates of surface water runoff and very low rates of groundwater recharge due to the low permeability of the subsoil peat and the underlying cohesive clay and silt deposits. Groundwater recharge rates will be slightly higher where the peat is underlain directly by granular deposits and at the borrow pit location where peat is absent.

A total of 7 no. rotary core boreholes were drilled at the Site by GII.

- BH01, BH02 and BH03 were drilled in the vicinity of the proposed onsite substation. BH03 extended to a maximum depth of 12.4mbgl whilst BH01 and BH02 terminated at 6.5mbgl. No bedrock was encountered at BH01 or BH02. Bedrock was encountered at a depth of 9.1mbgl in BH03 and was described as medium strong to strong, bedded, dark grey, fine to coarse grained, fossiliferous argillaceous LIMESTONE. No groundwater strikes are recorded on the drilling logs. Subsequent groundwater monitoring was completed in March 2024 at BH01 and BH03, with the groundwater levels recorded at 0.85 and 1.12mbgl respectively, and again in December 2024, with the groundwater levels recorded at 0.92 and 1.25mbgl respectively. Experience from water level monitoring at other bog sites indicates that there is only small seasonal fluctuations in groundwater levels, and these data recorded at Littleton are consistent with that experience.
- A total of 4 no. boreholes were drilled at the proposed borrow pit location (BH-B1 to BH-B4). These boreholes extended to a maximum depth of 8mbgl and encountered bedrock at depths of 0.5 to 3.0m. The bedrock described as medium strong, massive, medium to coarse grained dolomitic LIMESTONE in BH-B1 and BH-B4 with strong fossiliferous argillaceous LIMESTONE encountered in BH-B2 and BH-B3. No groundwater strikes are recorded on the drilling logs. Subsequent groundwater monitoring completed in March 2024 recorded groundwater levels to range from 5.19 to 6.23mbgl (refer to Table 9-14). BP-BH1 was dry in December 2024.

Table 9-14: Summary Borehole Details

Proposed Development Location	BH ID	Total Depth (m)	GW Stike During Drilling	Depth to Rock (m)	Dipped GW Level (mbgl) (01-03/2024)	Dipped GW Level (mbgl) (16/12/2024)
Substation	BH01	6.5	None	-	0.85	0.92
	BH02	6.5	None	-	-	-
	BH03	12.4	None	9.1	1.12	1.25
Borrow Pit	BH-B1	6.5	None	1.5	5.81	6.08 (dry)
	BH-B2	6.5	None	0.5	5.19	-
	BH-B3	7.0	None	1.0	5.63	-
	BH-B4	8.0	None	3.0	6.23	-

9.3.9.2 Proposed Grid Connection

The bedrock underlying the proposed GC route is mapped as the Ballysteen Formation, the Waulsortian Limestones, the Crosspatrick Formation and the Aghmacart Formation between the Site and Urlingford. To the east of Urlingford a small section of the proposed GC along the R693 is mapped to be underlain by the Durrow Formation which is comprised of shaly fossiliferous and oolitic limestone. Much of the centre and east of the proposed GC route are underlain by the Ballyadams Formation which consists of crinoidal wackestone/packstone limestone. A small section of the N77 is also mapped to be underlain by the Durrow Formation.

In terms of bedrock aquifers, the majority of the proposed GC route is mapped to be underlain by a Regionally Important Aquifer - Karstified (diffuse). These areas include ~1.9km along the R639 to the southwest of Urlingford which corresponds to the mapped extent of the Waulsortian Limestones. The vast majority of the proposed GC route to the east of Woodsgift (~17.5km) is also mapped to be underlain by a Regionally Important (Karst) Aquifer corresponding to the Ballyadams Formation. In the vicinity of the Site and near Urlingford, the proposed GC is underlain by a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones (Ll). A small section along the R639 to the southwest of Urlingford is also mapped to be underlain by a Locally Important Aquifer - Bedrock which is Generally Moderately Productive (Lm).

An overburden aquifer is also mapped along the proposed GC route in the Nore Valley. ~4.9km of the proposed GC route is mapped to be underlain by a Regionally Important Gravel Aquifer which overlies the bedrock aquifer. The aquifers mapped along the proposed GC are shown in Figure 9-9.

In terms of GWBs, the proposed GC route is underlain by a total of 6 no. GWBs.

In the vicinity of the Site, the proposed GC route is underlain by the Templemore GWB. The characteristics of the Templemore GWB are detailed above.

Further to the west a section of the R639 to the southwest of Urlingford is underlain by the Shanahoe GWB, which is characterised by karstic limestone bedrock. According to the GSI's GWB Characterisation Report (GSI, 2003), the Shanahoe GWB is defined to the north by the extent of dolomitised Waulsortian limestone and to the south by the Crosspatrick Limestone Formation. The southwestern boundary is defined by the Nore/Suir catchment boundary. The dolomitisation of the original limestones has resulted in increased porosity. Subsequently other processes such as faulting, development of joints and karstification enhanced this porosity. The end product is a rock that is quite porous and permeable and which has been reduced in some places to the consistency of sand. Groundwaters in the outcrop areas of this aquifer are unconfined, except for a number of small, low-lying areas which are confined by till or peat (GSI, 2003).

The area immediately to the east of Urlingford is underlain by the Rathdowney GWB which is characterized by poorly productive bedrock. The GSI's GWB Characterisation Report (GSI, 2003) states that the GWB in north Kilkenny and south Laois consists of the locally important aquifers of the Ballysteen Limestone and the "Calp-like" limestones of the Durrow and Aghmacart formations. Most groundwater flow is considered to take place within the top 15m from the surface where the bedrock is fractured. The available borehole water level data suggest the aquifer may be more developed towards the south, where a deeper groundwater flow with a higher fluctuation in water level is found, and this is more typical of a karstic conduit flow regime (GSI, 2003).

A small section of the proposed GC route (~2.3km) is mapped to be underlain by The Loughlans Turlough GWDTE (SAC000407). This GWB is associated with a Groundwater Dependent Terrestrial Ecosystem (GWDTE) and the Special Conservation Area (SAC) of The Loughlans Turlough. This GWB is characterized by a karstic flow regime (www.gsi.ie). The Site Synopsis Report for the Loughans Turlough (NPWS) states that the basin associated with the turlough has a predominantly level floor, but swallow holes and subsidence holes are present. The turlough floods regularly and retains a permanent central pond in summer.

Much of the eastern section of the proposed GC route is underlain by the Durrow GWB which is also characterised by a karstic flow regime. According to the GSI's GWB Characterisation Report (GSI, 2003), this GWB is defined to the southwest and northeast by the boundary of the Nore Basin. The extent of the Ballyadams and Clogrenan Formations define the other boundaries of the GWB. The pure nature of the limestone also means that the rocks are susceptible to dissolution. Coupled with the probability of extensive fracturing, this means that the aquifer is likely to be karstified. This is supported by the presence of many recorded karst features. Karstification is predominantly a near-surface phenomenon, and is likely to concentrate within 20m of the top of the rock in this formation (Cawley, 1990). Most groundwater flow is likely to be concentrated in this upper zone. Some portions of the Ballyadams Formation are dolomitised, which is likely to enhance the development of permeability. Where the aquifer is protected from dissolution by the presence of the Namurian shale above it, significant karstification and permeability is not believed to exist. Similarly, where the Namurian has been eroded away in only recent geological times, karstification and permeability are also likely to be limited (GSI, 2003).

Meanwhile, ~4.9km of the proposed GC route is mapped to be underlain by the Kilkenny - Ballynakill Gravels GWB in the Nore valley. This GWB is associated with the gravels which have been deposited in the vicinity of the River Nore.

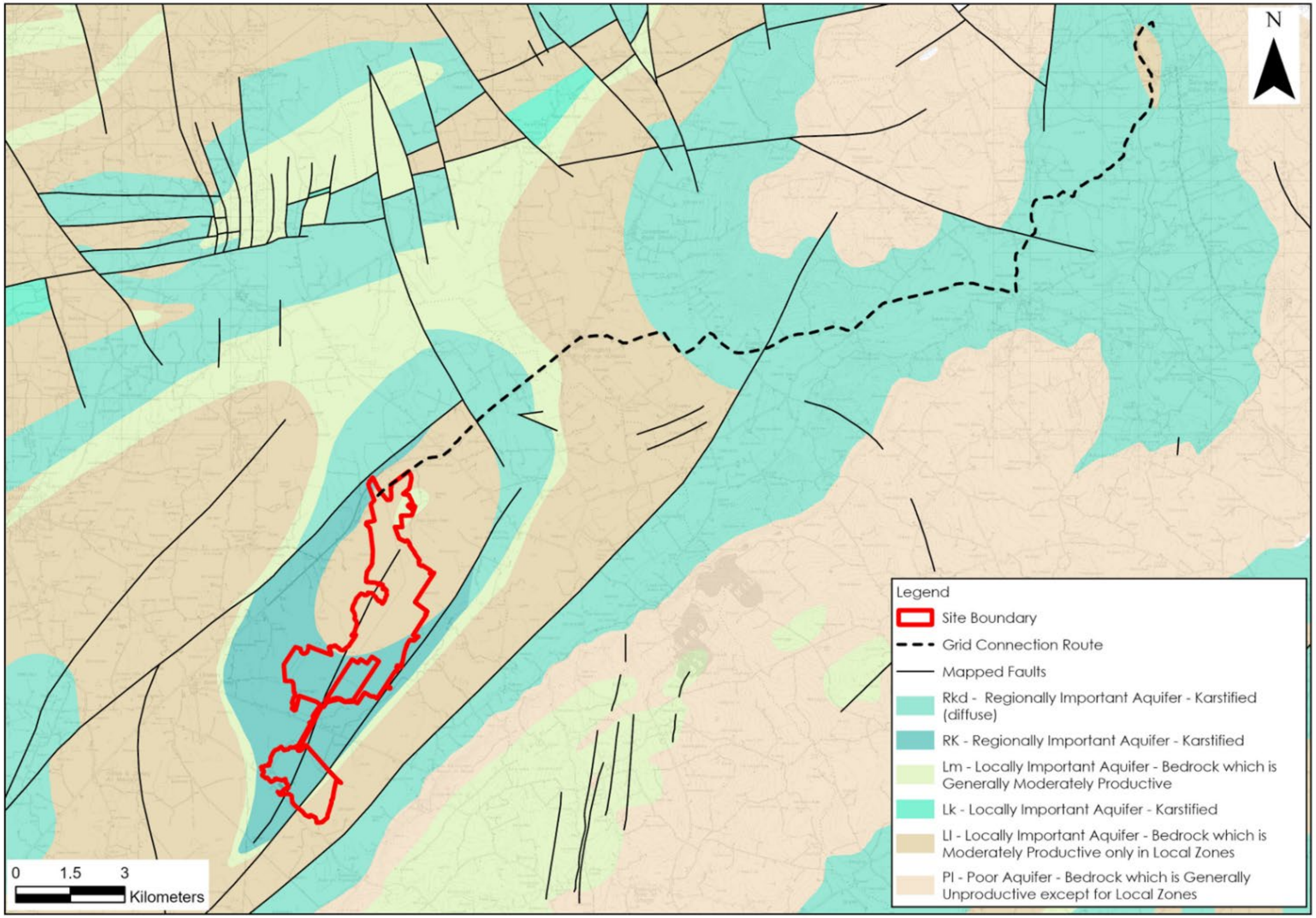

Figure 9-9: Bedrock Aquifer Map

9.3.10 Karst Features

9.3.10.1 Proposed Wind Farm

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

There are no karst features mapped within the Site due to the coverage of peat and glacial subsoils. However, there are several karst features mapped in the surrounding lands. Mapped karst features within 5km of the Site include:

- 2 no. swallow holes in the townland of Poyntstown, ~1.6km east of the Site. These are located ~2km from the closest turbine (T8);
- 2 no. swallow holes are also mapped ~3.2km to the west of the Site in the townland of Ballymurreen. These are located ~3.9km from the closest turbine (T9);
- A clay infilled fissure was recorded in a borehole at a depth greater than 38m, ~4.3km to the south of the Site. This is located ~4.7km from the closest turbine (T11); and,
- An enclosed depression is location ~4.4km northeast of the Site in the townland of Urard. This is located ~4.8km from the proposed borrow pit.

No infrastructure associated with the Proposed Wind Farm is located in close proximity to these local karst features. Groundwater flow in the karstic Thurles GWB is towards the River Suir and discharges at several springs near Thurles (GSI, 2003). Therefore, the karst features to the east of the Site have been screened out of the impact assessment. The karst aquifer and features to the west will be included for the purposes of a conservative assessment.

9.3.10.2 Proposed Grid Connection

As stated above, much of the proposed GC route, ~19.4km in length, is underlain by a Regionally Important Karst Aquifer.

Karst features are mapped by the GSI in the vicinity of the proposed GC route are discussed below:

- 2 no springs mapped along the course of the Borrisbeg River just to the north of the R693 in the townland of Borrismore. According to the GSI database one of these springs is associated with the Urlingford/Johnstown Water Supply;
- An enclosed depression located ~70m to the east of the R693 in the townland of Borrismore;
- A turlough mapped ~200m to the east of the R693 in the townland of Borrismore;
- A swallow hole mapped ~190m to the northwest of the R693 in the townland of Balief Lower;
- Further to the east, several springs are mapped along the Nuenna River to the south of the proposed GC route in the townlands of Tubrid Lower and Clomantagh Lower. These springs are in excess of 400m from the proposed GC route;
- One of these springs is associated with the Clomantagh Killahulan GWS Spring which is mapped ~660m to the south of the proposed GC route; and,
- In the townland of Tobernapeastia a spring is mapped along the Nuenna River in close proximity to the R693 (~70m to the south).

A map of karst features along the proposed GC route is shown on Figure 9-10.

Tracing studies have been completed at several of these springs in order to understand groundwater flow directions in the underlying bedrock. These tracer studies were carried out by the GSI (study completed in 2011, www.gsi.ie). These tracer studies show that groundwater flow direction in the area to the east of Woodsgift is to the south, towards the Nuenna River. No tracing studies have been completed for the karst features at Borrismore and Balief Lower.

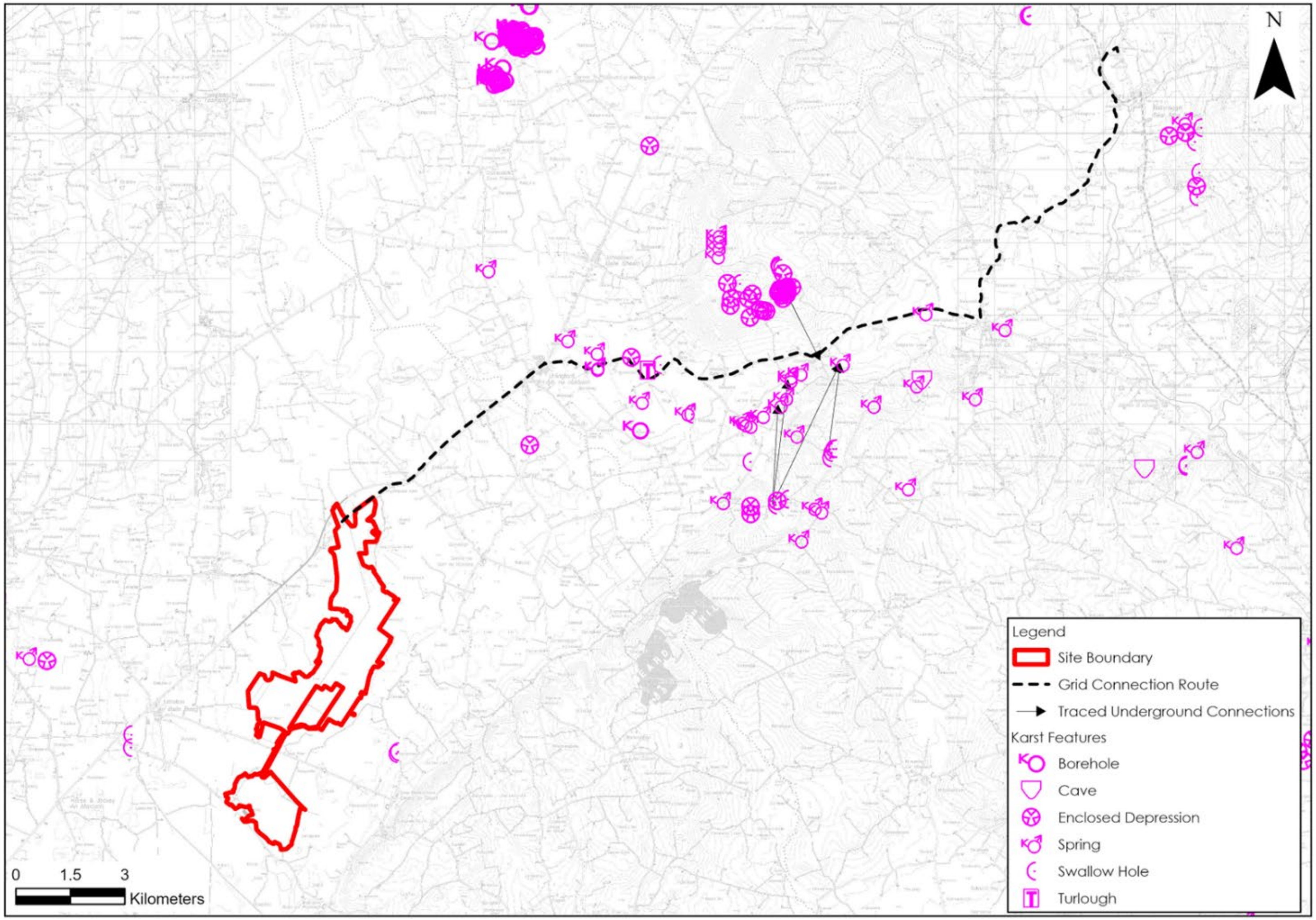

Figure 9-10: Karst Features

9.3.11 Groundwater Vulnerability

9.3.11.1 Proposed Wind Farm

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

The GSI mapped vulnerability rating of the bedrock aquifer underlying Site ranges from 'Low' to 'Extreme'. The areas of high vulnerability are mapped at the perimeter of the bog, with the majority of the Site mapped as having 'Moderate' vulnerability. Only 1 no. turbine (T04) and the met mast are mapped in areas of 'High' groundwater vulnerability. The area of the 'Extreme' vulnerability is mapped in the agricultural lands where the borrow pit is proposed to the northeast of Littleton Bog. The proposed onsite 110kV electrical substation is mapped in an area of 'Low' vulnerability. A map of groundwater vulnerability at the Site is included as Figure 9-11.

Extensive peat probing and site investigations (trial pits and boreholes) have shown that the Site is overlain by low permeability peat deposits which are in turn typically underlain by low permeability SILTs and CLAYs. The cohesive deposits are in turn underlain by granular deposits comprising of GRAVELs. The peat in some areas towards the centre and south of Littleton Bog is underlain directly by granular deposits (sands). These deposits allow for some infiltration into the underlying bedrock aquifers. The areas of groundwater recharge are likely to be limited in extent and recharge rates will be relatively slow.

No rock was encountered in any of the trial pits completed within the bog areas which extended to a maximum depth of 4.5mbgl. BH3 drilled at the proposed substation location encountered bedrock at a depth of 9.1mbgl (metres below ground level). BH1 and BH2, also drilled in the vicinity of the proposed substation, extended to maximum depths of 6.5mbgl and did not encounter bedrock. The bedrock in BH3 was described as medium strong to strong bedded dark grey fine to coarse grained argillaceous LIMESTONE. Given the depth to bedrock and the nature of the subsoils, groundwater vulnerability in the bog areas is considered to be 'Moderate' (refer to Table 9-15).

The proposed borrow pit location is situated on agricultural lands to the east of the bog and is overlain by TOPSOIL. The topsoil is underlain by CLAYs which are in turn underlain by GRAVELs. Bedrock was encountered at depths of 0.5 to 3mbgl and was described as medium strong to strong bedded dark grey fine to coarse grained argillaceous LIMESTONE. Given the depth to bedrock and the nature of the subsoils, the groundwater vulnerability in the area of the proposed borrow pit is considered to be 'High' to 'Extreme'.

Table 9-15: Groundwater Vulnerability and Subsoil Permeability and Thickness

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

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

9.3.11.2 Proposed Grid Connection

Groundwater vulnerability along the proposed GC route ranges from 'Low' to 'Extreme', with the majority of the proposed GC route mapped in areas of 'High' vulnerability.

The areas mapped as having 'Extreme' vulnerability total ~3.59km and are mapped in the townlands of Clone, Clomantagh Lower, Balief Upper, Borrismore, Mountfinn, Fennor and Longfordpass East. A total of ~21km of the proposed GC route is mapped in areas of 'High' groundwater vulnerability.

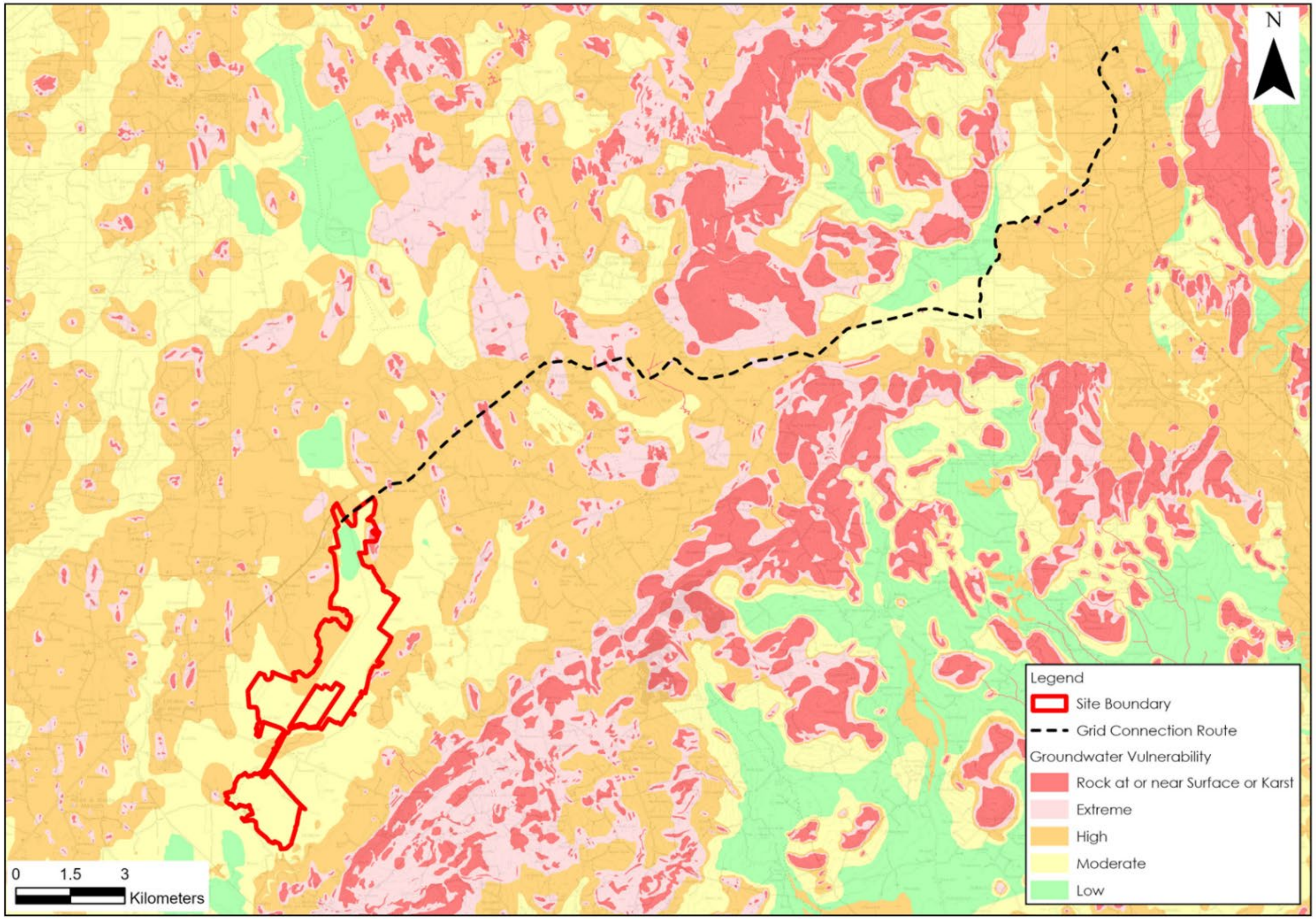

Figure 9-11: GSI Mapped Groundwater Vulnerability

9.3.12 Groundwater Hydrochemistry

9.3.12.1 Proposed Wind Farm

There is no groundwater quality data for the Site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting, as groundwater quality impacts would not be anticipated. The Proposed Development comprises typically of shallow, near surface construction activities with limited potential for effects on local groundwater quality. Nevertheless, the potential effects on groundwater quality from the use of piled foundations, excavation dewatering (including the proposed borrow pit), hydrocarbons and cement-based products are assessed in impact assessment included in Section 9.4.

With regards to the disused quarry in the vicinity of the proposed borrow pit, it is to the best of the author's knowledge that no groundwater quality issues have been recorded in the local area or in the Longford Pass GWS.

The GSI's Initial Templemore GWB Characterisation Report (GSI, 2003) states that groundwaters in this GWB will have a calcium bicarbonate chemical signature. Water sampling by the EPA shows that these waters are very hard with typical values of 400mg/l $CaCO_3$ and have a high electrical conductivity of around 800µS/cm.

The GSI's Initial Thurles GWB Characterisation Report (GSI, 2003) states that the groundwaters in this GWB also have a calcium-bicarbonate signature and that the hardness could be classified as being "excessively hard" (373-453mg/l $CaCO_3$).

9.3.12.2 Proposed Grid Connection

The GSI's Initial Shanahoe GWB Characterisation Report states that the dolomite areas in the Nore are indicated to be very hard waters with a high Mg/Ca ratio (GSI, 2003).

Groundwaters within the Durrow GWB are typically hard to very hard, with a neutral pH and a calcium-bicarbonate signature. The average conductivity is reported to be 643µS/cm (GSI, 2003).

The Rathdowney GWB is reported to have a calcium bicarbonate geochemical signature. The limited available data shows that the groundwaters are very hard. Typical electrical conductivities are around 700 µS/cm (GSI, 2003).

9.3.13 Water Framework Directive

The EU Water Framework Directive (2000/60/EC), as amended by Directives 2008/105/EC, 2013/39/EU and 2014/101/EU ("WFD"), was established to ensure the protection of the water environment. The Directive was transposed in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003).

The Water Action Plan 2024 was published in September 2023 and is Ireland's 3rd River Basin Management Plan. It's objectives include the following:

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

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

9.3.13.1 Surface Waterbody Status

9.3.13.1.1 Proposed Wind Farm

Local Groundwater Body (GWB) and Surface water Body (SWB) status information is available from (www.catchments.ie). A summary of the WFD status and risk result for Surface Water Bodies (SWBs) in the vicinity and downstream of the Site are shown in Table 9-16 below.

The upper sections of the Drish River in the vicinity of the Site (Drish_010, Drish_020 and Drish_030 SWBs) achieved "Poor" status in the most recent monitoring cycle (2019-2024). Meanwhile an improvement in WFD status was recorded in the Drish_040 and Drish_050 SWBs which increased from 'Poor' to 'Moderate' and 'Good' status respectively. Further downstream the Drish_060 SWB which achieved "Moderate" status in the latest WFD cycle (2019-2024). The Clover_010 SWB to the west of Littleton Bog achieved "Poor" status while the Clover_020 SWB is of "Moderate" status. The North Glengoole_010, Breagagh_010 and Black (Twomileborris)_010 SWBs achieved "Poor" status. Meanwhile, the Breagagh_020 and Suir_070 SWBs all achieved "Moderate" status.

In terms of risk status, most SWBs have been deemed to be "at risk" of failing to meet their respective WFD objectives. The risk status of the North Glengoole_010 and Breagagh_020 SWBs is currently "under review".

The 3rd Cycle Suir Catchment Report (EPA, 2024) states that excess nutrients remain the most prevalent issue in the Suir catchment, with agriculture being the significant pressure effecting the greatest number of waterbodies. Downstream of the Site agriculture is listed as being a significant pressure on the Drish_020, Drish_050, Clover_020 and Suir_070 SWBs. Agricultural issues in the Suir catchment related to phosphorus loss to surface waters from, for example; direct discharges or runoff from yards, roadways or other compacted surfaces, or runoff from poorly draining soils. High nitrate concentrations have been identified in many waterbodies across the catchment and sediment is also a problem from land drainage works, bank erosion from animal access or stream crossings.

Forestry is listed as being a significant pressure on the Drish_020 and Clover_010 SWBs. Forestry activities including clear felling and drainage have resulted in heavy siltation and excess nutrients. Peat is also listed as a significant pressure on several waterbodies in the vicinity and downstream of the Site. The Catchment Report states that the main issues relating to peat drainage are elevated ammonia concentrations, increased sedimentation and morphological impacts. Lisheen mine has been identified as a significant pressure on the Drish_040 SWB resulting in elevated ammonia, increased sedimentation and morphological effects. The Suir_070 SWB is listed as being under significant pressure from urban wastewater. This pressure is associated with the Thurles wastewater treatment plant.

Table 9-16: WFD Surface Waterbody Information (Site)

SWB	Overall Status (2013-2018)	Overall Status (2016-2021)	Overall Status (2019-2024)	3rd Cycle Risk Status	WFD Pressures
Drish_010	Poor	Poor	Poor	At risk	Forestry
Drish_020	Poor	Poor	Poor	At risk	Agriculture, forestry & peat
Drish_030	Poor	Poor	Poor	At risk	Peat
Drish_040	Poor	Poor	Moderate	At risk	Peat & mines and quarries
Drish_050	Poor	Poor	Good	At risk	Agriculture & peat
Clover_010	Poor	Poor	Poor	At risk	Forestry & Industry
Clover_020	Moderate	Moderate	Moderate	At risk	Agriculture
North Glengoole_010	Poor	Poor	Poor	Under Review	None
Black (Twomileborris)_010	Moderate	Moderate	Poor	At risk	Peat
Drish_060	Moderate	Moderate	Moderate	At risk	Other
Breagagh_010	Moderate	Poor	Poor	At risk	Peat
Breagagh_020	Good	Moderate	Moderate	Under Review	None
Suir_070	Moderate	Moderate	Moderate	At risk	Agriculture, urban runoff & urban wastewater

9.3.13.1.2 Proposed Grid Connection

A summary of the WFD status and risk result for SWBs in the vicinity and downstream of the proposed GC route are shown in Table 9-17 below.

The Drish__010, Drish_020, Goul_020 and Nuenna_020 SWBs in the vicinity of the proposed GC route achieved "Poor" status in the latest WFD cycle (2019-2024). The Goul_030, Nuenna_010, Ardreagh_010 and the Nore_120 SWBs achieved "Moderate" status. The River Nore downstream of Ballyragget is of "Good" status.

In terms of the risk status, a total of 5 no. SWBs along the proposed GC route have been deemed to be at risk of failing to meet their respective WFD objectives. These include the Drish_020, Goul_030, Nuenna_010, Nuenna_020 and Nore_120 SWBs.

The 3rd Cycle Nore Catchment Report (EPA, 2021) states that excess nutrients remain the most prevalent issue in the Nore River Catchment. In the vicinity of the proposed GC route, agriculture is listed as a significant pressure of the Drish_020, Nuenna_010 and Nuenna_020 SWBs. The Nuenna_020 SWB is also under pressures from urban wastewater associated with the Freshford wastewater treatment plant. Meanwhile, the Nore_120 SWB is under pressure from a point discharge associated with a Glanbia Ireland plant in Ballyragget which is causing nutrient issues.

Table 9-17: WFD Surface Waterbody Information (Proposed GC Route)

SWB	Overall Status (2013-2018)	Overall Status (2016-2021)	Overall Status (2019-2024)	3rd Cycle Risk Status	WFD Pressures
Drish_020	Poor	Poor	Poor	At risk	Agriculture, forestry & peat
Goul_020	Good	Poor	Poor	Under review	None
Goul_030	Moderate	Moderate	Moderate	At risk	Agriculture
Ardreagh_010	Moderate	Moderate	Moderate	Under review	None
Nuenna_010	Moderate	Moderate	Moderate	At risk	Agriculture
Nuenna_020	Moderate	Poor	Poor	At risk	Agriculture & urban wastewater
Nore_120	Good	Moderate	Moderate	At risk	Industry
Nore_130	Good	Good	Good	Not at risk	None
Nore_140	Good	Good	Good	Not at risk	None
Nore_150	Good	Good	Moderate	Not at risk	None

9.3.13.2 Groundwater Body Status

9.3.13.2.1 Proposed Wind Farm

Both the Thurles and Templemore GWBs underlying the Site achieved "Good" status in all WFD cycles. The Thurles GWB has been deemed to be not at risk whilst the Templemore GWB is at risk of failing to meet its WFD objectives. No significant pressures have been listed on these GWBs.

Table 9-18: WFD Groundwater Body Information (Site)

GWB	Overall Status (2013-2018)	Overall Status (2016-2021)	Overall Status (2019-2024)	3rd Cycle Risk Status	WFD Pressures
Thurles	Good	Good	Good	Not at risk	None
Templemore	Good	Good	Good	At risk	None

9.3.13.2.2 Proposed Grid Connection

All GWBs along the proposed GC route are of "Good" status (2019-2024). The Templemore and Durrow GWBs have been deemed to be at risk of failing to meet their respective WFD objectives. Agriculture is listed as a significant pressure on the Durrow GWB.

Table 9-19: WFD Groundwater Body Information (Proposed GC Route)

GWB	Overall Status (2013-2018)	Overall Status (2016-2021)	Overall Status (2019-2024)	3rd Cycle Risk Status	WFD Pressures
Templemore	Good	Good	Good	At risk	None
Shanahoe	Good	Good	Good	Not at risk	None
Rathdowney	Good	Good	Good	Not at risk	None
Durrow	Poor	Poor	Good	At risk	Agriculture
Lisdowney	Good	Good	Good	Not at risk	None
Kilkenny-Ballynakill Gravels	Good	Good	Good	Not at risk	Agriculture
GWDTE - the Loughans Turlough (SAC000407)	Good	Good	Good	Not at risk	None

9.3.14 Designated Sites and Habitats

9.3.14.1 Proposed Wind Farm

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC), Special Protection Areas (SPAs) and proposed Special Protection Areas (pSPAs). A designated site map for the area is shown in Figure 9-12.

There are no designated sites located within or in close proximity to the Site.

The Lower River Suir SAC (Site Code: 002137) is located ~9.4km west of the Site and is hydrologically connected to the Site via the Drish River (and its associated tributaries). This SAC consists of the freshwater stretches of the River Suir immediately south of Thurles and the tidal stretches as far as the confluence with the Barrow and Nore near Cheekpoint, Co. Waterford. The length of the shortest hydrological flowpath between the Site and the SAC is greater than 17km.

The Cabragh Wetlands pNHA (Site Code: 001934) is located ~10km west of the Site and is hydrologically connected to the Site via the Drish River and the River Suir. The length of the hydrological flowpath between the Site and the pNHA is greater than 18km.

Other designated sites within 10km of the Site include:

- Kilcooly Abbey Lake pNHA (Site Code: 00958) located ~5km to the east. This pNHA is located in the River Nore surface water catchment. Therefore, there is no hydrological connection between the Site and this pNHA.
- The Loughans SAC and pNHA (Site Code: 00407) is located ~8.5km to the northeast. This SAC is located River Nore surface water catchment. Therefore, there is no hydrological connection between the Site and this SAC.
- Spahill and Clomantagh Hill SAC and pNHA (Site Code: 000849) is located ~10km northeast of the Site. This designated site is located in the River Nore surface water catchment. Therefore, there is no hydrological connection between the Site and this SAC.
- Killough Hill pNHA (Site Code: 000959) is located ~8.5km west of the Site. The Breagagh and Black (Two Mile Borris) rivers act as hydrological barriers between the Site and this designated site.
- Laffansbridge pNHA (Site Code: 000965) is located ~4km south of the Site. The Breagagh River acts as a hydrological barrier between the Site and this pNHA.

9.3.14.2 Proposed Grid Connection

The proposed GC route is located in close proximity to several designated sites.

The Loughans SAC/pNHA (Site Code: 000407) is located immediately to the north and east of the R693 and the proposed GC route in townlands of Borrismore and Balief Lower. The Loughans is a turlough situated in flat land about 3km east of Urlingford, below the Slieve Ardagh Hills, in Co. Kilkenny. The basin is slightly undulating, with banks and hummocks of glacial drift around which the water rises. It has a level floor for the most part, but swallow holes and subsidence hollows are present. The turlough floods regularly, despite some drainage. In summer, it retains a permanent central pond and there are several subsidiary wet hollows at the eastern end.

The proposed GC route runs under the River Barrow and River Nore SAC (Site Code: 002162) at the proposed crossing under the River Nore to the west of Ballyragget substation (to be completed by HDD). Further to the south, ~3km of the proposed GC route along the R694 is located immediately adjacent to the SAC boundary. The greatest potential for effects will occur where works are located in close proximity to the SAC. Furthermore, all watercourses draining with proposed GC route within the River Nore surface water catchment will eventually discharge into this SAC.

The proposed GC route crosses the River Nore SPA (Site Code: 004233) at the proposed crossing at the River Nore. The entire proposed GC route within the River Nore surface water catchment drains towards the SPA.

The River Nore downstream of the proposed GC route is also recognised as a salmonid river by the WFD.

The proposed cable crossing at the River Nore also crosses under the River Nore/Abbeyleix Wood Complex pNHA (Site Code: 002076) (to be completed by HDD).

The Inchbeg pNHA (Site Code: 000836) is located downstream of the proposed GC route along the River Nore and in the vicinity of the confluence of the Nore and Nuenna rivers. The length of the shortest hydrological flowpath between the proposed GC route and the pNHA is ~2.3km from the crossing over the Lisdowney Stream at Grange Bridge. The length of the flowpath between the HDD crossing under the River Nore is ~5.5km.

The Curragh and Goul River Marsh pNHA (Site Code: 00420) is located downstream of the proposed GC route along the Goul River to the west of Durrow. The length of the hydrological flowpath between the proposed GC route and the pNHA is ~22km along the Goul River.

Within the River Suir surface water catchment, the Lower River Suir SAC (Site Code: 002137) is located downstream of the proposed GC route. The length of the hydrological flowpath from the proposed GC route to the SAC is ~24km.

Other designated sites located within 10km of the proposed GC route include the following:

- The Spahill and Clomantagh Hill SAC/pNHA (Site Code: 000849) is located ~1.4km to the north of the proposed GC route. This SAC/pNHA is located topographically upgradient of the proposed GC route and tracing studies have shown that groundwater in this area flows to the south/southeast towards the Nuenna River; and,
- The Cullahill Mountain SAC/pNHA (Site Code: 000831) is located ~6.6km north of the proposed GC route. This SAC/pNHA is located topographically upgradient of the proposed GC route and tracing studies have shown that groundwater in this area flows to the south/southeast towards the Nuenna River.

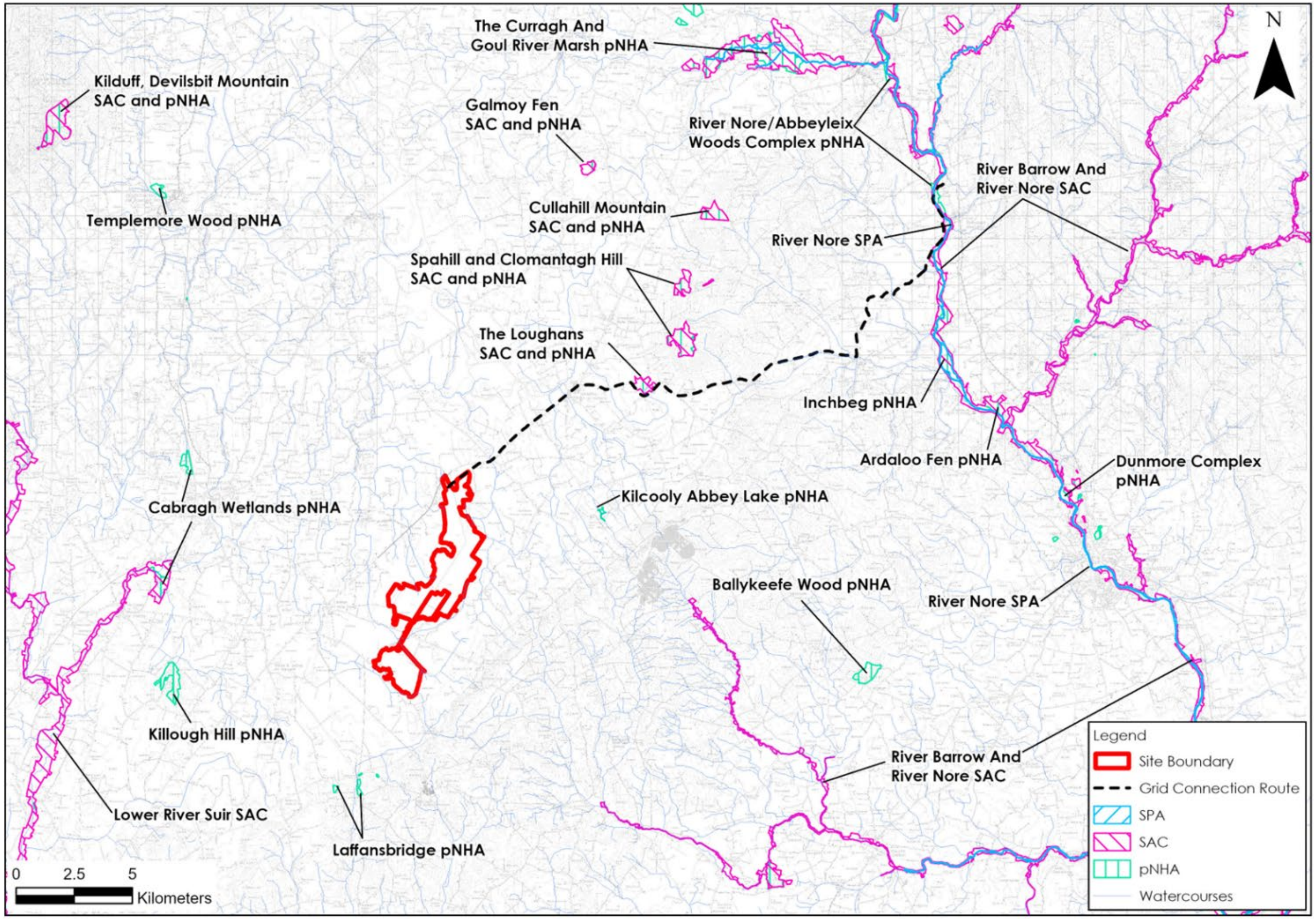

Figure 9-12: Designated Sites

9.3.15 Water Resources

9.3.15.1 *Surface Water Resources*

Proposed Wind Farm

There are no SWB DWPA (Drinking Water Protected areas) located in the area or immediately downstream of the Site. The closest DWPA is the Suir_140 SWB located near Cahir. The length of the hydrological flowpath between the Site and this DWPA is in excess of 50km.

Proposed Grid Connection

The Nore_120 SWB in the vicinity of Ballyragget substation is listed as a DWPA (Drinking Water Protected Area). According to the EPA abstraction register, Glanbia have several abstractions in this area. Furthermore, the Ballyragget water supply uses an abstraction near the River Nore. The source of the raw water is an infiltration gallery adjacent to the River Nore. Raw water is pumped from the infiltration gallery to a collection chamber/pump sump beside the Water Treatment Plant. There is no direct surface water abstraction from the River Nore itself. The proposed GC route crosses the Nore_120 DWPA.

Further downstream the Nore_160 SWB is also identified as a DWPA, associated with the Kilkenny City (Troyswood Supply). The shortest hydrological flowpath between the works along the proposed GC route and the Nore_160 DWPA is ~6.8km along the Nuenna River and the River Nore.

9.3.15.2 *Groundwater Resources*

Proposed Wind Farm

No source protection areas associated with any Public Water Supplies (PWS) or Group Water Schemes (GWS) are mapped within the Site. Local GSI groundwater resources are shown on Figure 9-13.

However, there are several public and group supplies in the surrounding lands:

- The closest mapped source protection area to the Site is associated with Leigh GWS. This source protection area is mapped immediately to the west of the Site in the townland of Leigh;
- The delineated source protection area associated with the Newhill GWS is located ~850m to the northwest of the Site;
- The delineated outer source protection area associated with the Two-Mile-Borris PWS is located ~2.7km to the west of Littleton Bog. According to the GSI's Groundwater Source Protection Zone Report (GSI, 2002) The water source is a borehole in the townland of Borris, at a T-junction in the middle of Twomileborris village, some 7 km east of Thurles. The daily abstraction rate is listed as 120m3/day. The report notes that the water table in the area is assumed to broadly reflect topography, with groundwater flowing in a wet-northwest direction, with this source drawing water from the Aghmacart Formation. The outer source protection zone delineates the complete catchment to the source i.e. the area required to support an abstraction from long-term recharge. The Site does not encroach upon this catchment;

- The outer source protection area associated with the Moyne GWS is located ~2.56km to the northwest of the Site. According to the EPA's Establishment of Groundwater Source Protection Zone Report for the Moyne Group Water Supply Scheme (EPA, 2010) this GWS is supplied by 2 no. wells in the townland of Kilmakill. Water is pumped in each borehole in alternative months, with the maximum abstraction rate from each well is 816m^3/day. The Report states that groundwater flows in a south-westerly direction towards the source and that the primary aquifer is the Aghmacart Formation. No area of the Site overlaps with the source protection areas;
- The source protection area associated with the Fethard Coalbrook PWS is located ~4km to the southeast of the Site. This PWS is located in the River Nore surface water catchment and in the Slieveardagh Hills GWB, and there is no potential surface or groundwater connectivity with the Site; and,
- The Fenor Inch GWS is located ~2.2km to the northeast of the Site. The Drish (Black) River acts as a hydraulic boundary between GWS and the Site.
- The Longford Pass GWS is located ~720m to the northeast of the proposed borrow pit.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). The GSI do not record any wells within the Site. Several wells with a locational accuracy ≥1km are mapped by the GSI in the surrounding lands. These wells are generally listed as having agricultural and domestic uses.

We accept that the GSI database does not include all potential water wells. As such, and in order to be conservative, for the purposes of assessment (as completed in Section 9.5.2.11), we assume that there is a groundwater well source at each local house location. All potential domestic well supplies are indicated on Figure 9-14.

An information request was submitted to Uisce Éireann for the location of all Uisce Éireann groundwater abstraction locations within 5km of the Site. No groundwater abstractions other than those listed above were identified.

As detailed in Chapter 4, the Site is located in a sparsely populated area. There are 101 no. properties (80 no. residential, 16 no. mixed use and 5 no. commercial) within 2km of the turbines. The closest residential receptor is 851m from the closest turbine (T11). The closest residential receptor from the onsite 110kV electrical substation is approximately 475m away.

<u>Proposed Grid Connection</u>

There are several GWS and PWS mapped along the proposed GC route as follows:

- The Fennor Inchorourke GWS is located ~340m to the northwest of the R693 in the townland of Fennor.
- ~1.79km of the proposed GC route overlaps with the source protection area for the Urlingford Johnstown PWS in the townlands of Borrisbeg and Borrismore.
- ~580m of the proposed GC route overlaps with the source protection area associated with the Balief GWS in the townland Balief Upper.
- ~4.2km of the proposed GC route overlaps with the source protection area associated with the Balief GWS in the townlands of Barna, Clomantagh Lower and Clomantagh Upper.
- ~300m of the proposed GC route overlaps with the source protection area associated with the Barna Kilrush GWS in the townland of Kilrush.
- The source protection area associated with the Ballyconra PWS is located ~280m to the west of the proposed GC route near Ballyragget.

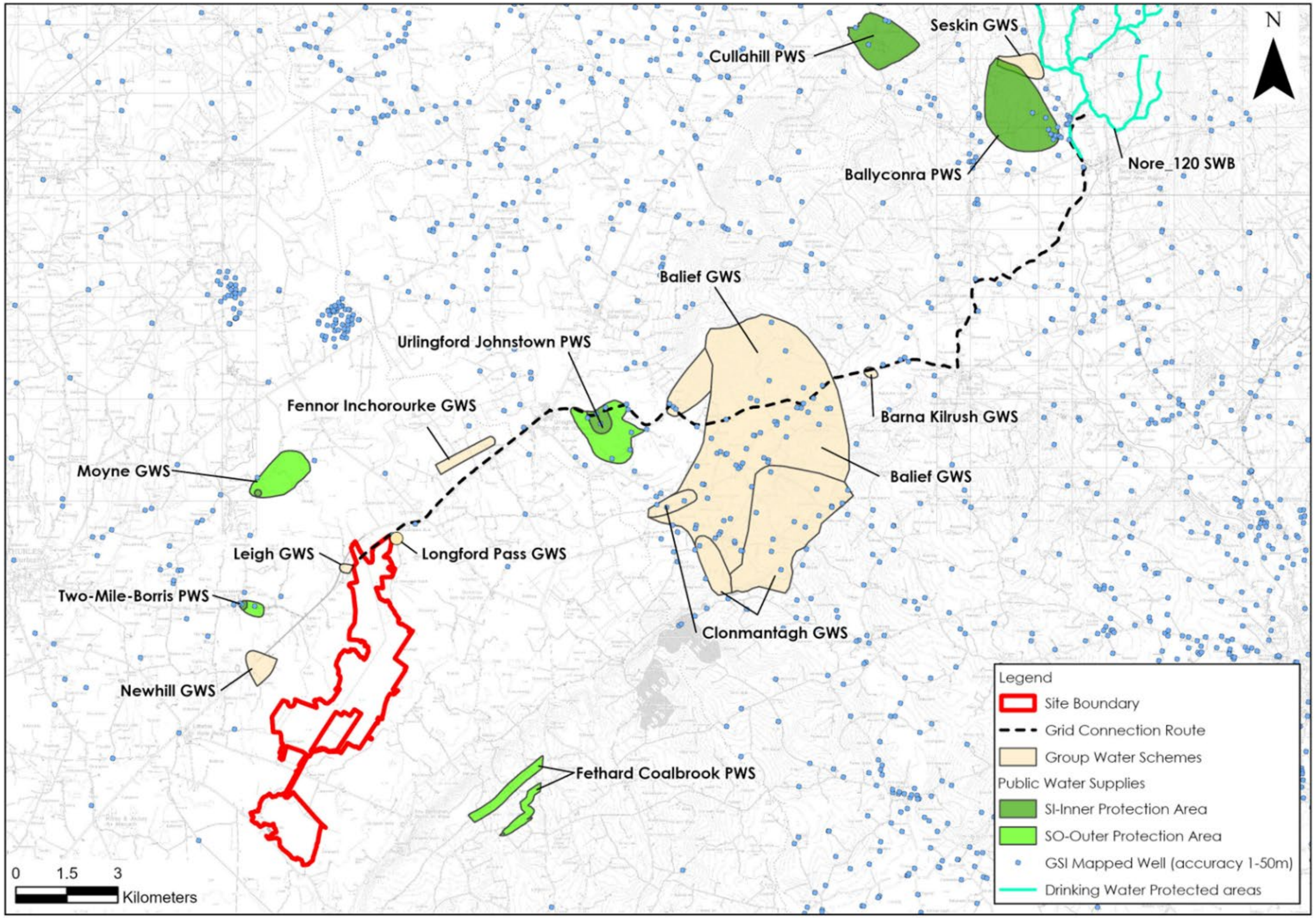

Figure 9-13: GSI Mapped Groundwater Resources

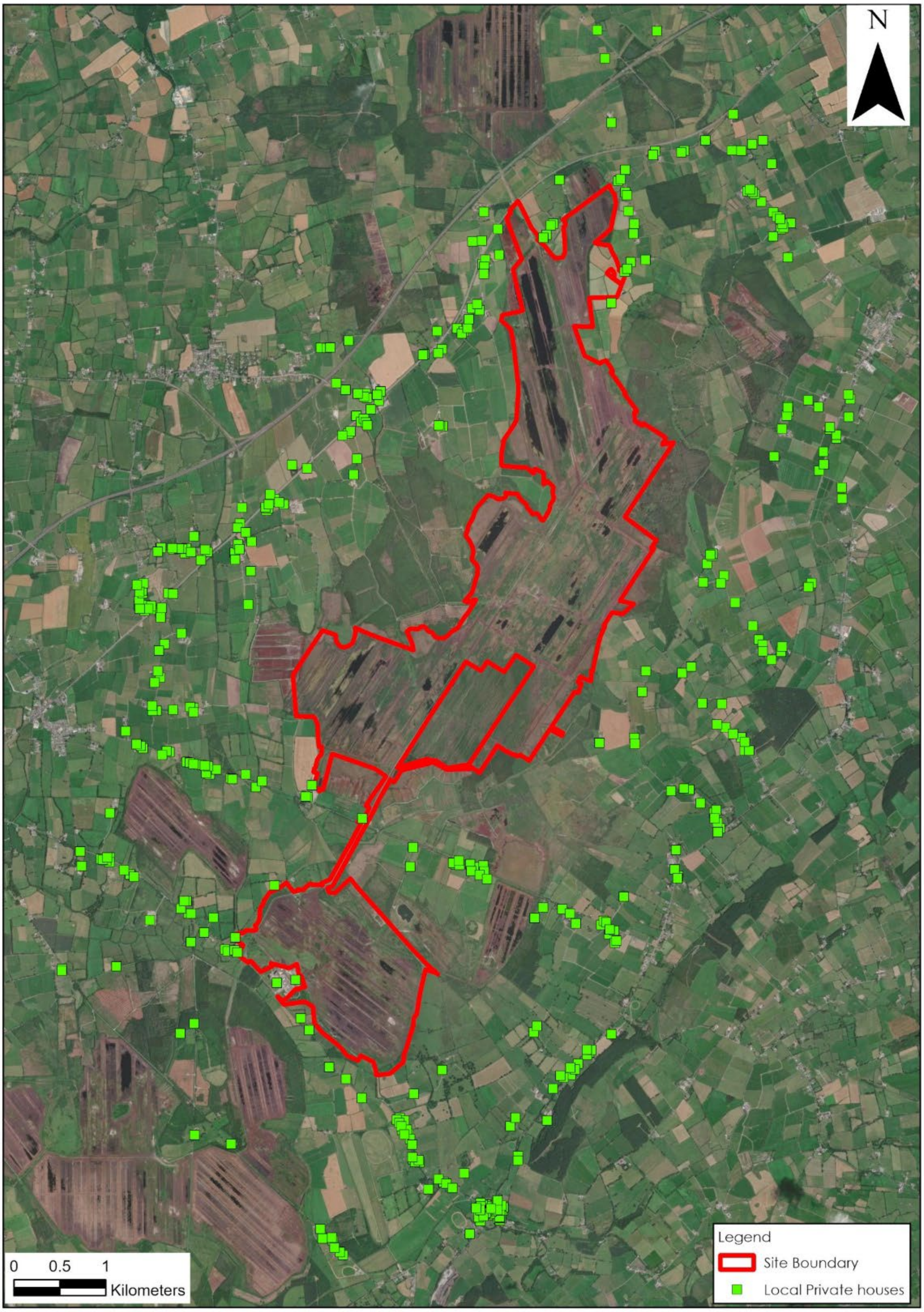

Figure 9-14: Local Private Dwellings with Potential Groundwater Well Supplies

9.3.16 Receptor Sensitivity and Importance

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

The primary receptors vary across the Site. As stated previously, there are existing discharges to surface waters in Longfordpass Bog (Popes Bog), Ballybeg Lanespark Derryvella Bog and Littleton Bog. Surface waters will be the primary sensitive receptors in these areas as the existing drainage regime discharges surface water from the bog into outfall drains which connect to downstream watercourses. However, there are no existing surface water discharges/outfalls in some small areas of Littleton Bog. Some limited groundwater recharge may be occurring in small areas of this bog where the peat is underlain by more permeable subsoil deposits. However, surface water is the primary receptor.

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

The following groundwater receptors are identified for impact assessment:

- The Locally Important Aquifer and the Regionally Important Aquifer - Karstified which underlie the Site. The Locally Important Aquifers are considered to be of Medium Importance whilst the Regionally Important Aquifer is of Very High Importance (refer to Table 9-3).
- The Regionally Important Aquifer - Karstified (diffuse) and the Locally Important Aquifers along the proposed GC route.
- The Regionally Important Gravel Aquifer which overlies the bedrock aquifer along the proposed GC route in the Nore valley.
- The WFD status of the GWBs underlying the Site (i.e. Thurles and Templemore GWBs) and the proposed GC route (Templemore, Durrow, Rathdowney, Shanahoe, The Loughlans Turlough GWDTE and Kilkenny-Ballynakill Gravels GWBs).
- The Longford Pass GWS, Leigh GWS, Newhill GWS, Two-Mile-Borris PWS and Moyne GWS in the vicinity of the Site (Note that all other PWS/GWS have been screened out of the assessment associated with the Proposed Wind Farm due to the lack of hydrogeological connectivity and the separation distances).
- Local private groundwater abstractions in the lands surrounding the Site.
- The Fennor Inchorourke GWS, Urlingford Johnstown PWS, Balief GWS, Barna Kilrush GWS and the Ballyconra PWS in the vicinity of the proposed GC route.
- The karst features mapped along the proposed GC route and karst features to the west of the Site.

With regards to surface waters, the primary potential contamination downstream surface waters are via elevated concentrations of suspended solids and nutrient enrichment.

The quantification of flow volumes presented in Section 9.3.6 indicates that the watercourses in the immediate vicinity of the Site will be most susceptible to potential effects. Further downstream, the watercourses will be less susceptible to potential effects due to increasing flow volumes which provide a greater dilution effect. A quantitative analysis of flow volumes has shown that due to dilution no effects associated with the Proposed Wind Farm will occur downstream of the confluence of the Drish and Suir Rivers.

The following surface water receptors are identified for impact assessment:

- The Drish River and its associated tributaries, including the Black (Twomileborris) River, the Clover River and the Breagagh River. These watercourses can be considered as being of Medium to High Importance based on their assigned Q-ratings (Q3, Q3-4) (refer to Table 9-2).
- All watercourses along the proposed GC route including the Drish (Black) River, Goul River, Ardreagh Stream, Borrisbeg Stream, Clomantagh Lower Stream, Nuenna River, Gorteenahilla Stream, Lismaine Stream, Lisdowney Stream, River Nore and unmapped watercourses.
- The WFD status of all SWBs downstream of the Site and the proposed GC route.
- The Nore_120 DWPA (Ballyragget supply) in the vicinity of the proposed GC route and the Nore_160 DWPA further downstream (associated with the Troyswood Supply).

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

- The Lower River Suir SAC and the Cabragh Wetlands pNHA downstream of the Site.
- The Loughans SAC/pNHA, the River Barrow and River Nore SAC, the River Nore SPA, River Nore / Abbeyleix Woods Complex pNHA and the Inchbeg pNHA in the vicinity and downstream of the proposed GC route.

All other designated sites downstream of the proposed GC route (including the Lower River Suir SAC and the Curragh and Goul River Marsh pNHA) have been screened out of the impact assessment due to their distant location from the works and due to the minor and transient nature of the proposed works.

9.4 Potential Effects

The Proposed Development is described in full in Chapter 4 of this EIAR. The Proposed Development includes a proposed water management system for the protection of the local water environment. This is described in full in the Surface Water Management Plan (**Appendix 9.3**), and is summarised below.

Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation measures to reduce potential effects on downstream surface water bodies. Drainage management within the Site will be risk based, and will employ various methods, building on the existing drainage systems within the Site. The main tenet of the proposed drainage plan is ensuring to 'keep clean water clean' by avoiding unnecessary or significant disturbance to existing drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas through the construction of interceptor drains. Where possible (depending on orientation), existing field drains can be used as interceptors drains. Otherwise new interceptors drains will be excavated and they will outfall to field drains downstream of the works areas.

The second method involves collecting any construction area drainage waters (from turbine base/hardstand areas, temporary construction compounds, and the substation) and routing that water through new proposed temporary Wind Farm settlement ponds (or stilling ponds) prior to controlled release into the existing field drain network. There will be no discharges to the existing field drains without prior treatment.

Within the Proposed Wind Farm layout there are sections of proposed floating road between turbine infrastructure. In these sections, and depending on intermediate topography, a collector drain (dirty water system as described above) may be used during construction stage, or over the edge (OTE) drainage will occur. Over the edge drainage allows runoff from access tracks to flow into local field drains and be managed via the existing site drainage system. OTE drainage will only occur where topography allows, and it is only proposed in areas of low risk and remote from outfall locations (at least 150m from bog outfall locations. Silt traps and check dams will be installed in field drains downstream of OTE drainage areas, and these will provide attenuation and treatment of dirty water.

During the construction phase, all runoff from works areas (i.e. dirty water) will be attenuated and treated within the Proposed Wind Farm site drainage system prior to being released within the existing bog drainage system. All drainage outfall from the Site is routed through existing settlement ponds that remain in-situ from the previous site use.

Development Interaction with the Existing Bog Drainage Network

The Proposed Development drainage will not significantly alter the existing drainage regime at the Site. Moreover, the proposed drainage system will be fully integrated into the existing bog drainage systems and can co-exist with the Phase 1 rehabilitation measures completed on site without comprising any wetlands areas already established. The SWMP prescribes the advanced review of the drainage by the project drainage engineer and ECoW ahead of setting-out, to identify any potential locations where the drainage may interfere (during construction or operations) with the rehabilitation drain block measures completed or the wetlands established. The SWMP also recommends measures that can be implemented on the ground in agreement with the ECoW to avoid such potential interferences.

Existing field drains and main drains will be routed under/around access tracks using culverts as required.

Runoff from access tracks, turbine bases, and developed areas (construction compounds, substation, met mast) will be collected and treated in local (proposed) silt traps and settlement ponds and then discharged to existing peat field drains. From there, this water will flow towards the relevant bog boundaries in existing field drains and main drains and then be treated further in the existing main (bog) settlement ponds prior to discharge from the Site.

Appendix 9.4 presents a schedule of watercourse crossings at the Site and along the Proposed Grid Connection.

9.4.1 Do-Nothing Scenario

If the Proposed Development were not to proceed, the Site would continue to be managed under the requirements of the relevant IPC licence and therefore the ongoing site management and environmental monitoring, peat stockpile removal, and wind measurement would continue. In addition, if the Proposed Development were not to proceed, the implementation of peatland rehabilitation plans as required under IPC License would continue to proceed. It is noted that the Phase 1 rehabilitation works are already completed at the site and that Phase 2 is only proposed at Derryvella and Ballybeg Bog (located adjacent to the Wind Farm Site). Therefore, the only works associated with the Cutover Bog Decommissioning and Rehabilitation Plans to be completed at the site relate to monitoring. Other existing land use practices including local small scale turbary activities and forestry would continue along the margins of the Site. These land uses and activities will also continue if the Proposed Development does proceed.

9.4.2 Construction

9.4.2.1 Proposed Wind Farm

9.4.2.1.1 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities will include:

- The construction of the internal site access tracks (15.44km of new internal site access tracks and the upgrade of 2.95km of existing bog operations tracks);
- The construction of the 11 no. turbine foundations and associated turbine base/hardstand areas;
- The upgrade of the existing bog operations access points and the construction of the new proposed access points;
- The construction of the 1 no. met mast and associated hardstand area;
- The construction of 5 no. temporary construction compounds;
- The construction of the recreational amenity trails (3.95km) and carparks;
- The construction of the onsite 110kV electricity substation and associated compound;
- The opening of 1 no. proposed onsite borrow pit;
- The storage of spoil in the 6 no. designated peat deposition areas;
- The construction of the onsite electrical cabling to the proposed substation; and,
- Construction of the onsite drainage system and all associated works.

These construction activities will require varying degrees of earthworks resulting in excavation of peat and mineral subsoil where present. It is estimated that construction works will require the excavation of approximately 114,146m^3 of peat and 283,849m^3 non-peat materials which will be a significant potential source of sediment laden water.

Other potential sources of sediment include:

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

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

Pathways: Drainage and surface water discharge routes.

Receptors: Surface water quality in the receiving streams/rivers (Breagagh River, North Glengoole Stream, Clover River, Black (Two Mile Borris) River) and downgradient watercourses (Drish River and its associated tributaries) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, likely effect on down-gradient rivers and associated dependent ecosystems. In the absence of mitigation measures there is the potential for a significant effects.

9.4.2.1.2 Potential Effects on Groundwater Levels During Excavation Works

1 no. borrow pit is proposed at the Site in the townland of Longfordpass South and associated dewatering works have the potential to effect local groundwater levels. There are no PWS/GWS in the immediate vicinity of the borrow pit. The closest GWS is the Leigh GWS which is located ~900m to the west. The proposed borrow pit location is separated from this GWS by Littleton Bog. There are several dwellings and farmhouses located to the east of the proposed borrow pit which may have private groundwater well supplies. However, temporary reductions in groundwater levels by temporary dewatering will be very localised and of small magnitude due to the nature and permeability of the local subsoil and bedrock geology, which comprises of moderate to permeability lacustrine and glacial deposits and a Locally Important Aquifer at the proposed borrow pit location. The subsoils encountered during the drilling of the boreholes at the proposed borrow pit location comprised largely of slightly sandy, slightly gravelly, silty CLAY. These cohesive deposits are of low permeability. It is noted from the 4 no. boreholes which were drilled at the proposed borrow pit location (BH-B1 to BH-B4) that the rock was described as medium strong, massive, medium to coarse grained dolomitic LIMESTONE and strong fossiliferous argillaceous LIMESTONE. No groundwater strikes are recorded on the trial pit logs or the drilling logs. Groundwater monitoring recorded groundwater levels to range from 5.19 to 6.23mbgl. The maximum depth of the borrow pit will be 11.5m with an average excavation depth of 6m. This will be below the local groundwater table but no significant inflows of groundwater will occur due to the competent nature of the limestone. Furthermore, no significant water bearing conduits were recorded during the drilling at the proposed borrow pit.

The installation of turbine bases in the underlying glacial deposits is also likely to require some temporary dewatering arrangements, where deeper excavations are required. However, due to the dominance of moderate to low permeability glacial till subsoils and lacustrine deposits below the bogs the effects on groundwater levels will be localized to the excavation and only for a temporary basis during the construction work. Water level impacts will be temporary and are unlikely to be significant beyond 50m from any excavation.

Pathway: Groundwater flow paths.

Receptor: Groundwater levels.

Pre-Mitigation Potential Effect: Slight, direct, negative, temporary, unlikely effects on local groundwater levels. In the absence of mitigation measures, there is no potential for significant effects.

9.4.2.1.3 Potential Effects on Surface Water Quality from Excavation Dewatering

Groundwater seepages will likely occur in turbine base, substation and construction compound excavations and at the borrow pit, and these will create additional volumes to surface water (i.e. rainfall water) to be treated by the drainage management system. Groundwater inflows may be more significant where lenses of sand and gravel are intercepted within the glacial till deposits.

Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the Site and therefore pollution issues are not anticipated in this respect. The main potential significant effects are as a result of turbidity and suspended solids on downstream surface water receptors such as the Drish River and its tributaries. Poor water quality in downstream streams and rivers has the potential to affect aquatic habitats and species (e.g. fish and invertebrates).

Pathway: Groundwater pumped into the site drainage network.

Receptor: Surface water quality in the receiving streams/rivers (Breagagh River, North Glengoole Stream, Clover River, Black (Two Mile Borris) River) and downgradient watercourses (Drish River and its associated tributaries) and associated water-dependent ecosystems.).

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, unlikely effects on surface water quality. In the absence of mitigation measures there is the potential for a significant effects.

9.4.2.1.4 Potential Effects Associated with Leakages or Spillages of Hydrocarbons

Accidental spillage of petroleum hydrocarbons during refuelling of construction plant can cause significant pollution risk to groundwater, surface water quality and associated aquatic ecosystems, and to terrestrial ecology (refer to Chapter 6). In addition, the accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbons have a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in the death of aquatic organisms.

Pathway: Groundwater flowpaths and site drainage network.

Receptors: Local groundwater quality and surface water quality in the receiving streams/rivers (Breagagh River, North Glengoole Stream, Clover River, Black (Two Mile Borris) River and downgradient watercourses (Drish River and its associated tributaries) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effects:

Negative, direct, slight, short term, likely effect on local groundwater quality in and below the peat bog.

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

In the absence of mitigation measures there is the potential for significant effects on surface water quality.

9.4.2.1.5 Potential Effects Associated with the Release of Cement-Based Products

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

Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to the introduction of high pH alkaline waters into the system. Batching of wet concrete on site and the washing out of concrete transport and placement machinery are the activities that will generate a risk of cement-based pollution.

Pathways: Site drainage network and groundwater flows.

Receptors: Peat water hydrochemistry and surface water quality in the receiving streams/rivers (Breagagh River, North Glengoole Stream, Clover River, Black (Two Mile Borris) River and downgradient watercourses (Drish River and its associated tributaries) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effects:

Negative, moderate, indirect, short term, likely effect to surface water quality.

Negative, imperceptible, indirect, short term, likely effect on peat water hydrochemistry.

In the absence of mitigation measures there is no potential for significant effects.

9.4.2.1.6 Potential Effects from Wastewater Disposal

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

Pathways: Groundwater flowpaths and site drainage network.

Receptors: Down-gradient well supplies, groundwater quality (Templemore and Thurles GWBs), surface water quality in the receiving streams/rivers (Breagagh River, North Glengoole Stream, Clover River, Black (Two Mile Borris) River and downgradient watercourses (Drish River and its associated tributaries) and associated water-dependent ecosystems.

Pre-mitigation Potential Effects:

Negative, significant, indirect, temporary, unlikely effect on surface water quality.

Negative, slight, indirect, temporary, unlikely effect on local groundwater.

In the absence of mitigation measures there is the potential for significant effects on surface water quality.

9.4.2.1.7 Potential Effects Associated with Piled Foundations

Due to the depth of peat at the proposed turbines locations, a range of foundation scenarios are proposed, including:

- Gravity foundations;
- Piled foundation with a configuration of up to 23 no. 900mm cylindrical bored piles. These piles could extend to a depth of between 5 to ~18metres below ground level.

The following potential scenarios arise in respect of proposed piling works:

- Creation of preferential pathways, through a low permeability subsurface layer (an aquitard such as lacustrine clay), to allow downward flow into the underlying aquifer;
- Creation of preferential pathways, through a low permeability subsurface layer (an aquitard such as lacustrine clay), to allow upward migration alkaline groundwater to the acidic bog surface, thus potentially altering local hydrochemistry and therefore vegetation at the bog surface; and,
- Creation of a blockage to regional groundwater flow within the underlying aquifer due to placement of pile clusters.

These pathways are analogous to pathways described for piling works associated with contaminated land sites, as detailed in Environment Agency (2001).

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

Receptor: Groundwater quality in the underlying GWBs (Templemore and Thurles GWBs) and groundwater hydrochemistry at the surface of the within the peat bog.

Pre-Mitigation Potential Effect: Negative, moderate, direct, short term, likely effect on groundwater quality/hydrochemistry. In the absence of mitigation measures there is no potential for significant effects.

9.4.2.1.8 Potential Effects from Morphological Changes to Surface Watercourses

Within the Site, there are a total of 2 no. watercourse crossing locations over natural EPA mapped watercourses. The crossing locations are in the north of Ballybeg Lanespark Derryvella Bog where an existing railbed and machine pass cross the Black (Two Mile Borris) River and the North Glengoole Stream. Inspections have revealed that the existing crossings are structurally sound and no upgrade works will be required.

Pathways: Surface water flowpaths, and groundwater levels.

Receptors: Down-gradient water quality in the North Glengoole Stream and the Black (Twomileborris) River.

Pre-Mitigation Potential Effect: No effect.

9.4.2.1.9 Potential Effects on Hydrologically Connected Designated Sites

The Site is not located within any designated conservation site.

However, as stated in Section 9.3.14 above, the Site is located in the River Suir regional surface water catchment. The Lower River Suir SAC is located downstream of the Proposed Wind Farm and is hydrologically connected via the Drish River and its tributaries. The surface water connections from the Site to the Drish River could transfer poor quality surface water that may affect the conservation objectives of the Lower River Suir SAC. However, the potential for effects is limited given the length of the hydrological flowpath (>17km) and the large volumes of water within the River Suir. The Cabragh Wetlands pNHa is also located >18km downstream of the Site along the River Suir. Groundwater flowpaths beneath Littleton Bog are to the west towards Thurles, where groundwater discharges as a series of springs.

Due to physical and hydrological and hydrogeological separation all other designated sites have no potential to be affected by the Proposed Wind Farm.

The potential effects of the Proposed Wind Farm on designated sites as also been completed as part of a detailed WFD Compliance Assessment Report and is included in **Appendix 9.2**.

Pathways: Surface water flowpaths, and groundwater levels.

Receptors: Down-gradient water quality in the Lower River Suir SAC and the Cabragh Wetlands pNHA.

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, short term, unlikely effect on the Lower River Suir SAC. In the absence of mitigation measures, there is no potential for significant effects.

9.4.2.1.10 Potential Effects on Local Public and Group Groundwater Supplies

As stated in Section 9.3.9 above, the groundwater flow in the mineral soil deposits (silts, sands and gravels) beneath the peat at the Site is expected to discharge into the local surface waterbody network, i.e. the existing bog drainage network which discharges to tributaries of the Drish River.

Using this conceptual model of groundwater flow an impact assessment for local PWS, GWS is undertaken below. This assessment is completed in accordance with "Wind farms and groundwater impacts - A guide to EIA and Planning considerations" (DoE/NIEA, 2015).

The Longford Pass GWS is located ~720m north of the borrow pit. No rivers or streams are mapped in the lands between the Site and this GWS. No source protection area has been delineated for this GWS. However, it is noted from the 4 no. boreholes which were drilled at the proposed borrow pit location (BH-B1 to BH-B4) that the rock was described as medium strong, massive, medium to coarse grained dolomitic LIMESTONE and strong fossiliferous argillaceous LIMESTONE. No groundwater strikes are recorded on the drilling logs. Groundwater monitoring recorded groundwater levels to range from 5.19 to 6.23mbgl.

The Leigh GWS is located immediately to the northwest of the Site. No rivers or streams are mapped in the lands between the Site and the delineated source protection area. However, this area of the Site is underlain by Locally Important Aquifers, groundwater flowpaths from the Site will be short and will discharge into the local surface water features, including the large boundary drains which exist along the perimeter of Littleton Bog. Furthermore, given the low permeability of the peat, soils and subsoils, groundwater recharge will be significantly restricted and the water in the peat bog is hydraulically isolated from groundwater in the surrounding lands.

The Newhill GWS is located ~850m to the west of the Site. The Clover and Black (Two Mile Borris) rivers which act as hydraulic barriers between the Site and this GWS. Furthermore, the water in the peat bog is hydraulically isolated from groundwater in the surrounding lands.

The Two-Mile-Borris PWS is located ~2.7km to the west of Littleton Bog. The Clover River acts as a hydraulic barrier between the Site and this PWS.

The Moyne GWS is located ~2.56km to the northwest of the Site. An unnamed tributary of the Drish River acts as a hydraulic barrier between the Site and this GWS.

The large separation distances, the shallow nature of proposed foundations works, the large geographical spread of proposed infrastructure, and the intermediate watercourses between proposed infrastructure and groundwater source locations significantly limit the potential for impact to occur.

Pathway: Groundwater flowpaths.

Receptor: Public and Group water supplies.

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, long term, unlikely effect. In the absence of mitigation measures there is no potential for significant effects.

9.4.2.1.11 Potential Effects on Local Private Groundwater Well Supplies

An assessment of the potential effects on local private groundwater well supplies has been completed in accordance with "Wind farms and groundwater impacts - A guide to EIA and Planning considerations" (DoE/NIEA, 2015).

In order to be conservative and following a precautionary approach, we have assumed that all dwellings in the surrounding lands have a private groundwater well. These private water supplies are reliant on groundwater flows in the deeper bedrock aquifer underlying the glacial deposits.

As detailed in Chapter 4, the Site is located in a sparsely populated area. There are 101 no. properties (80 no. residential, 16 no. mixed use and 5 no. commercial) within 2km of the turbines. The closest residential receptor is 851m from the closest turbine (T11). The closest residential receptor from the onsite 110kV electrical substation is approximately 475m away.

The biggest risk to groundwater wells will be where deep excavations are required such as at the borrow pit and turbines bases. Construction of internal site access roads, amenity track, underground cable route trench between the proposed turbines and the substation all associated infrastructure will not have the potential to affect local wells due to the shallow nature of the works.

The majority of key Proposed Development infrastructure elements (i.e. Proposed Development elements which have deep excavations and a potential to effect the regional groundwater system below the peat basin) are located a significant distance (>700m) from dwellings.

Due to the high drainage density of the peat bog and the surrounding lands, it is expected that the majority of groundwater flow will discharge to local watercourses, as well as to the larger drainage ditches around the perimeter of bog. These drainage systems and water bodies will act as hydraulic barriers between the proposed infrastructure locations and the location of potential groundwater wells.

Deep groundwater recharge from the Site to the underlying bedrock aquifers is minimal. The restriction of recharge relates to the generally impermeable layers which underlie much of Irelands' bogs leading to a 4% recharge coefficient for the bogs. Therefore, the majority of the groundwater drainage and seepage in the bog is via lateral flow, discharging into the perimeter drains and entering the surface water drainage network in the lands surrounding the Site.

Some deeper groundwater flow may occur where recharge enters the Regionally Important Karst Aquifer which underlies the south of Littleton Bog.

However, there are a number of dwellings situated in the vicinity of the proposed borrow pit (to the east, northeast and south). Groundwater flow direction in this area is assumed to be east/northeast towards the Drish River. Therefore, these dwellings are downgradient and within close proximity (150-600m) to the proposed borrow pit. There is no hydraulic boundary (local stream/watercourse) between these dwellings and the proposed borrow pit. Consequently, this excavation (maximum excavation depth of 11.5m deep, with an average excavation depth of 6m) has the potential to impact local groundwater wells if they are present. It is noted from the 4 no. boreholes which were drilled at the proposed borrow pit location (BH-B1 to BH-B4) that the rock was described as medium strong, massive, medium to coarse grained dolomitic LIMESTONE and strong fossiliferous argillaceous LIMESTONE. No groundwater strikes are recorded on the drilling logs. Groundwater monitoring recorded groundwater levels to range from 5.19 to 6.23mbgl. Therefore, some groundwater dewatering may be required but the quantities will likely be small due to the nature of the underlying bedrock (competent and no significant groundwater strikes during drilling).

Pathway: Groundwater flowpaths.

Receptor: Groundwater Supplies.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, long term, unlikely effect. In the absence of mitigation measures there is no potential for significant effects.

9.4.2.1.12 Potential Effects on WFD Status and Objectives

The WFD status for GWBs and SWBs underlying and downstream of the Proposed Wind Farm are defined in Section 9.3.13.2.1 and Section 9.3.13.1.1 respectively.

Any deterioration in surface water quality during the construction of the Proposed Wind Farm has the potential to effect the WFD status of the receiving SWBs. There is no potential for the Proposed Wind Farm to effect the overall status of the underlying GWBs due to the scale of the Thurles (90km^2) and Templemore (302km^2) GWBs and the local hydrogeological regime which is characterised by very low rates of groundwater recharge and high rates of surface water runoff.

A detailed WFD Compliance Assessment Report has been completed in combination with this EIAR Chapter and is included in **Appendix 9.2**.

Pathways: Groundwater flowpaths and surface water flowpaths within the Site.

Receptors: WFD status of underlying GWBs and downstream SWBs.

Pre-mitigation Potential Effect:

Indirect, negative, moderate, temporary, unlikely effect on downstream SWBs.

Indirect, negative, imperceptible, temporary, unlikely effect on the underlying Templemore and Thurles GWBs.

In the absence of mitigation measures, there is no potential for significant effects.

9.4.2.1.13 Potential Effects Associated with Biodiversity Enhancement

The Proposed Development includes a Biodiversity Enhancement and Management Plan (BEMP) (**Appendix 6.1**) which has been designed to protect and enhance existing habitats at the Site. All works associated with the BEMP are proposed in the northern section of Littleton Bog (shown in Figure 2-1 of the BEMP) and include the following:

- The planting of native tree species is proposed at a number of locations across the BEMP area, restricted to drier areas and the margins of existing woodland, and avoids areas of open peat which are likely to revert to semi-natural wetland/peatland habitats.
- Targeted drain blocking using coir plugs or other suitable biodegradable.
- Retention of the existing wetland which has developed in the cutover bog in the BEMP area, and maintaining water levels to provide continuity of the existing habitat resource for waders and waterbirds. Water levels will be monitored, with the option for discharge attenuation and control of water levels.
- Creation of shallow ponds/scrapes in areas of bare peat within the cutover bog to the south of the main PDA. This will accelerate re-wetting of the bog.
- Removal of eucalyptus trees.
- Establishment of grassland and dry-heath on the main PDS by planting with native grass seed to accelerate revegetation.
- The construction settlement ponds within the BEMP areas will be adapted to form permanent ponds, providing a suitable habitat for amphibians.
- The main temporary compound in the north of the Site will be surface with limestone, and covered with a shallow layer of soil to provide suitable conditions for the established of neutral/calcareous grassland.
- Areas of existing and translocated marsh fritillary within the BEMP area will be managed to prevent scrub encroachment.
- The BEMP also includes nest boxes, log piles, and refugia piles.

The majority of the above elements (planting, seeding, vegetation removal etc) have no potential to impact the water environment.

The elements of the BEMP which have the potential to impact on the water environment include drain blocking, the creation of ponds/scrapes and the retention of the wetland area. These measures will have a positive effect on the local hydrological regime, providing water attenuation and slowing the release of water from the Site. Any effects on groundwater levels associated will be localised to within the immediate vicinity of the enhancement areas. The BEMP works have no potential to increase the flood risk elsewhere.

The retention of the large, flooded wetland area in the northwest of Littleton Bog will not have a significant effect on the hydrological/hydrogeological environment as this waterbody forms part of the existing baseline environment.

Pathway: Water volume and peat water level rise.

Receptor: Local peat bog hydrology/hydrogeology.

Potential Pre-Mitigation Effect: Positive, direct, moderate, permanent, likely effect on the local peat bog hydrology/hydrogeology.

9.4.2.1.14 Potential Effects on Karst Aquifer / Karst Features

The south of Littleton Bog and much of Ballybeg Lanespark Derryvella Bog, including 4 no. turbines (T6, T8, T9 and T10) are underlain by a Regionally Important Karst Aquifer. As detailed in Section 9.3.10.1 several karst features are mapped to the west of the Site.

Some minor areas of Littleton Bog lack any surface water discharge and water in these small areas is likely to recharge slowly to ground where the peat is underlain by permeable subsoils deposits. This water will in turn recharge to the underlying karst aquifer and flow to the west towards the River Suir.

Any potential alteration in local groundwater quality or surface water quality in Littleton Bog has the potential (albeit limited) to impact the Karstic Bedrock Aquifer and downgradient local karst features. However, the potential for effects is limited due to the scale of works in comparison with the overall extent of the Thurles GWB (90km^2) and the separation distance to downgradient karst features.

Pathway: Groundwater recharge and surface water drainage.

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

Pre-Mitigation Potential Effect: Indirect, negative, slight, unlikely effect on karst features and karst aquifer. In the absence of mitigation measures there is no potential for significant effects.

9.4.2.1.15 Potential Effects from the Use of Siltbuster

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

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

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of siltbuster systems from northwest Mayo is provided in Figure 9 14. This is a duration curve of downstream water quality data post siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1,194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

Note that the Siltbuster system will not be used under normal conditions during the construction phase.

The use of Siltbuster is only proposed as an emergency back up in the event of failure of all other proposed water treatment mitigation measures, e.g. in the event of landslide failure. The Siltbuster system is a proven and effective method of water quality treatment during these events. Given the low-lying and flat nature of the Site, the risk of a landslide is considered to be very low. Therefore, it is extremely unlikely that the Siltbuster system will be utilised.

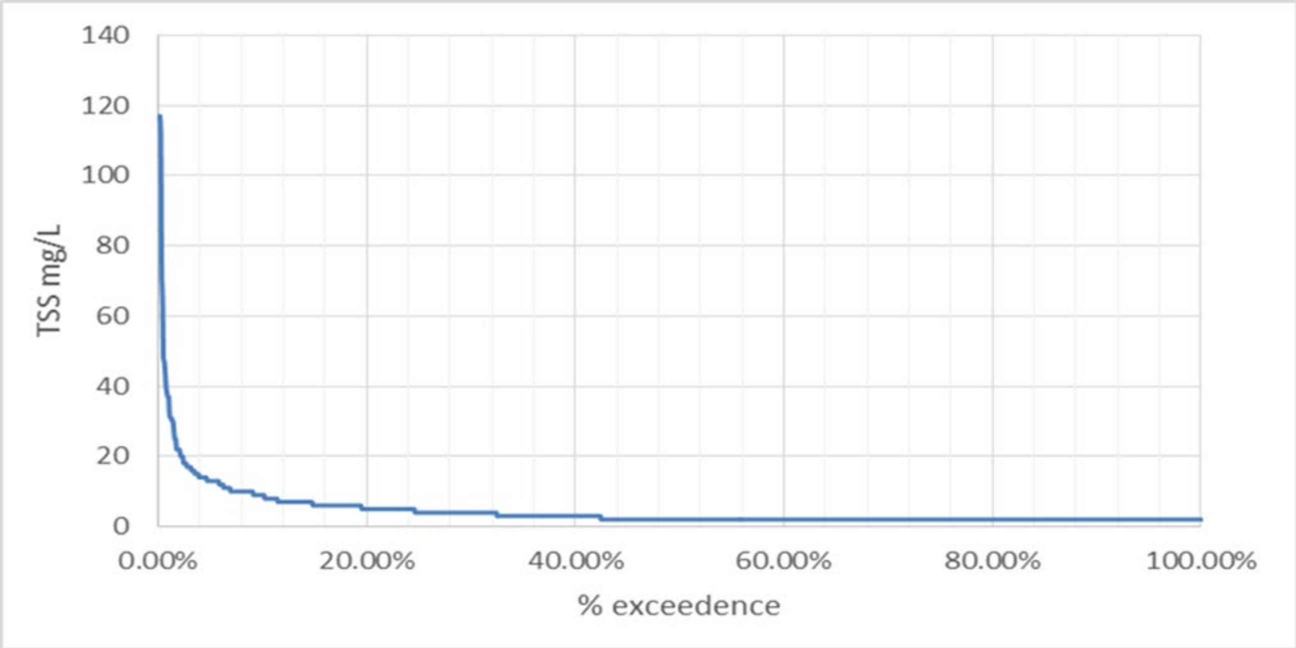

Figure 9-15: TSS Treatment Data using Siltbuster system (with chemical dosing)

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient well supplies, groundwater quality (Templemore and Thurles GWBs), surface water quality in the receiving streams/rivers (Breagagh River, North Glengoole Stream, Clover River, Black (Two Mile Borris) River) and downgradient watercourses (Drish River and its associated tributaries) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effects: Negative, slight, indirect, temporary, unlikely effect on downgradient water quality. In the absence of mitigation measures, there is no potential for significant effects.

9.4.2.2 Proposed Grid Connection

9.4.2.2.1 Potential Morphological Changes to Surface Watercourses

The proposed GC route includes a total of 10 no. crossings at EPA mapped watercourses. There is an additional crossing over a watercourse which is not included in the EPA blueline database to the north of Freshford. These crossings are detailed in Section 9.3.3.2 above and comprise largely of existing bridge and culvert crossings along the public road network. There is only 1 no. location where no existing crossing is present, located along the proposed GC route and associated with the River Nore. Any instream works would have the potential to impact stream morphology at the crossing location.

Pathways: Construction of watercourse crossings and interference with stream morphology.

Receptors: All watercourses along the proposed GC route including the Drish (Black) River, The Goul River, Ardreagh Stream, Borrisbeg Stream, Clomantagh Lower Stream, Nuenna River, Gorteenahilla Stream, Lismaine Stream, Lisdowney Stream and the River Nore.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on downstream surface water flows and surface water quality. In the absence of mitigation measures, there will be no potential for significant effects.

9.4.2.2.2 Potential Effects on Karst Features

Some karst features are mapped by the GSI along the proposed GC route. In total ~19.4km of the proposed GC route is underlain by a Regionally Important Aquifer – karstified (diffuse). The mapped karst features in the vicinity of the proposed GC route are detailed in Section 9.3.10.2 above.

Any potential alteration in local groundwater quality or surface water quality has the potential to impact the Karstic Bedrock Aquifer underlying the proposed GC route and the local karst features. However, the potential for effects is limited due to depth of excavation (<1.5m), and the scale and transient nature of the works along the proposed GC route.

Pathway: Groundwater recharge and surface water drainage.

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

Pre-Mitigation Potential Effect: Indirect, negative, slight, unlikely effect on karst features and karst aquifer. In the absence of mitigation measures there is no potential for significant effects.

9.4.2.2.3 Potential Effects on Hydrologically Connected Designated Sites

The proposed GC route is located in the immediate vicinity of the Loughans SAC/pNHA. Furthermore, the proposed GC route is mapped within the River Barrow and River Nore SAC, the River Nore SPA and the River Nore/Abbeyleix Woods Complex pNHA near Ballyragget. The proposed GC route is also located upstream and in close proximity to the Inchbeg pNHA (~4km).

Due to physical and hydrological and hydrogeological separation all other designated sites have no potential to be affected by the Proposed GG route.

The potential effects on designated sites as also been completed as part of a detailed WFD Compliance Assessment Report and is included in **Appendix 9.2**. The potential for effects is limited due to the scale and transient nature of the works.

Pathways: Surface water flowpaths, and groundwater levels.

Receptors: Down-gradient water quality in the Loughans SAC/pNHA, River Barrow and River Nore SAC, River Nore SPA, Inchbeg pNHA, River Nore/Abbeyleix Woods Complex pNHA.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, short term, likely effect on downstream designated sites. In the absence of mitigation measures there is no potential for significant effects.

9.4.2.2.4 Potential Effects on Surface Water Drinking Water Supplies

There are 2 no. DWPAs mapped in the vicinity and downstream of the proposed GC route. The identified DWPAs are the Nore_120 and Nore_160 SWBs associated with the Ballyragget PWS and the Kilkenny Troyswood supply respectively.

Any potential surface water quality effects which may arise as a result of the works along the proposed GC route may have the potential to effects these supplies. However, with regard to the Ballyragget PWS, given the nature of the source (i.e. an infiltration gallery), and the minor and transient nature of the proposed works, even in worst-case unmitigated scenarios, will be imperceptible. The effects on the Kilkenny Troyswood supply would also be imperceptible due to the large volumes of water flowing within the River Nore, and its significant downstream distance from any GC works (6.8km).

Pathway: Surface water flowpaths.

Receptor: Ballyragget Water Supply and Kilkenny (Troyswood) Supply.

Pre-Mitigation Potential Effects: Indirect, negative, imperceptible, short term, likely effect on downstream surface water abstractions. In the absence of mitigation measures there will be no potential for significant effects.

9.4.2.2.5 Potential Effects on Public and Group Groundwater Drinking Supplies

The Fennor Inchorourke GWS, Urlingford Johnstown PWS, Balief GWS, Barna Kilrush GWS and the Ballyconra PWS are all located in the vicinity of the proposed GC route.

Any potential groundwater quality effects which may arise as a result of the works along the proposed GC route may have the potential to effects these supplies. However, given the shallow, minor and transient nature of the proposed works, even in worst-case unmitigated scenarios, will be imperceptible. The proposed works are similar to roadworks, and water pipeline installations works, that are completed around the country.

Pathway: Groundwater flowpaths.

Receptor: The Fennor Inchorourke GWS, Urlingford Johnstown PWS, Balief GWS, Barna Kilrush GWS and the Ballyconra PWS.

Pre-Mitigation Potential Effects: Indirect, negative, imperceptible, short term, likely effect on groundwater supplies. In the absence of mitigation measures there will be no potential for significant effects.

9.4.2.2.6 Potential Effects on WFD Status and Objectives

The WFD status for GWBs and SWBs underlying and downstream of the proposed GC route are defined in Section 9.3.13.2.2 and 9.3.13.1.2 respectively.

Due to the shallow and short-term nature of the works along the proposed GC route, there is limited potential for effects which will change the overall status of a SWB or GWB.

A detailed WFD Compliance Assessment Report has been completed in combination with this EIAR Chapter and is included in **Appendix 9.2**.

Pathways: Surface water flowpaths along the proposed GC route.

Receptors: WFD status of downstream SWBs and underlying GWBs.

Pre-mitigation Potential Effect:

Indirect, negative, slight, temporary, unlikely effect on downstream SWBs.

No effects on WFD status of the underlying GWBs.

In the absence of mitigation measures there is no potential for significant effects.

9.4.2.2.7 Potential Effects During Directional Drilling

S total of 10 no. crossings will be completed by Horizontal Directional Drilling (HDD). It is proposed that HDD will be undertaken to prevent direct impacts on the watercourses. However, there is a risk of indirect impacts from sediment laden runoff during the launch pit and reception pit excavation works. There is also the unlikely risk of fracture blow out and contamination of the watercourse with drilling fluid.

Pathway: Surface water and groundwater flows.

Receptor: All watercourses and associated water-dependent ecosystems downstream of the Proposed Grid Connection underground cabling route.

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

9.4.2.3 Turbine Delivery Route

9.4.2.3.1 Potential Effects Due to Turbine Delivery Route Works

Temporary accommodation works will be required at selected locations along the TDR to facilitate the delivery of large components to the Site. These works include the removal of lighting columns, road signs, vegetation clearance etc. and the laying of a load bearing surface on the R693/R639 roundabout. All temporary accommodation works are listed in Table 4-4 of Chapter 4. These works are similar to very minor roadworks being completed across the country.

Due to the shallow nature of the temporary and permanent works effects on groundwater flows and levels are not anticipated. However there is a potential for effects on groundwater and surface water quality from fuels and other chemicals during the construction phase.

Pathway: Surface water and groundwater flow paths.

Receptor: Down-gradient water quality.

Pre-Mitigation Potential Effects:

Indirect, negative, slight, temporary, unlikely effect on surface water quality.

Indirect, negative, slight, temporary, unlikely effect on groundwater quality.

9.4.3 Operation

9.4.3.1 Proposed Wind Farm

9.4.3.1.1 Potential Effects from the Replacement of Natural Surfaces with Lower Permeability Surfaces

Progressive replacement of the peat or vegetated surface with impermeable surfaces will likely result in an increase in surface water runoff rates in the surface water drainage network. This could potentially increase discharge rates from the Site and increase flood risk downstream of the development. In reality, the site access tracks will have a higher permeability than the underlying peat. However, in the baseline scenario runoff rates are high as a result of the prevailing peat soils (96% runoff). In order to assess the potential change as a result of internal site access tracks and hardstand footprints we have increased the runoff rate to the maximum, i.e., 100% (4% higher than normal). The assessed footprint comprises turbine bases and hardstandings, internal access tracks, amenity links and carparks, site entrances, substation and temporary construction compounds. During storm rainfall events, additional runoff coupled with the increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on water quality.

The emplacement of the proposed permanent development footprint within the Site, as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials result in an increase from 96% to 100% runoff) could result in an average total site increase in surface water runoff of approximately 1,057m^3/month). This represents a potential increase of approximately 0.089% in the average daily/monthly volume of runoff from the site in comparison to the baseline pre-development site runoff conditions (Table 9-9). This is a very small increase in average runoff and results from the naturally high surface water runoff rates and the relatively small area of the Site being developed, the proposed total permanent development footprint being approximately 25.17ha (excluding PDAs and BP), representing 2.13% of the total Site of approximately 1,177ha.

Table 9-20: Baseline Site Runoff Versus Development Runoff

Baseline Runoff m^3/ month	Baseline Runoff m / day	Permanent Hardstand Area	Hardstand Area with 100% Runoff m / month	Hardstand Area with 96% Runoff m / month	Net Increase m / month	Net Increase m / day	% Increase from BAseline Conditions at Hardstand	% Increase from Baseline Conditions across the Site
1,186,416	38,271	25.17	26,433	25,376	1,057	34.1	4.16%	0.089

The additional water runoff volume is low due to the fact that the runoff potential from the Site is naturally high (96%). Also, the calculation assumes that all hardstanding areas will be impermeable which will not be the case as access tracks will be constructed of permeable stone aggregate. The increase in runoff from the Proposed Development will, therefore, be negligible. This is even before mitigation measures are considered. Therefore, there will be no risk of exacerbated flooding downstream of the Site.

The onsite substation and temporary construction compounds are located within the Site and, as such, as discussed above.

Pathway: Site drainage network.

Receptor: Surface waters and dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, direct, permanent, unlikely effect on all downstream surface water bodies. In the absence of mitigation measures, there is no potential for significant effects.

9.4.3.1.2 Potential Effects from Suspended Solids Entrainments Surface Waters

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

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

During such maintenance works there is a small risk associated with the 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 (Drish River and its associated tributaries) and dependent aquatic ecosystems in the Lower River Suir SAC.

Pre-Mitigation Potential Effect: Negative, slight, direct, temporary, unlikely effect. In the absence of mitigation measures there is no potential for significant effects.

9.4.3.1.3 Potential Effects from the Release of Cement-Based Products

Placed concrete in turbine bases and foundations can also have minor local effects on groundwater quality over time. However, due to the limited surface area of exposed concrete, the anoxic conditions below ground, and the high rate of dilution from the wider groundwater system relative to the small volumes of groundwater that would come in contact with the concrete, the potential for impacts considered to be imperceptible.

Pathways: Site drainage network and groundwater flows.

Receptors: Peat water hydrochemistry and downstream surface watercourses including the Drish River and its associated tributaries.

Pre-Mitigation Potential Effect:

Negative, slight, indirect, short term, likely effect to surface water quality.

Negative, imperceptible, indirect, short term, likely effect on peat water hydrochemistry.

In the absence of mitigation measures there is no potential for significant effects.

9.4.3.1.4 Potential Effects from the Water Supply At Substation

Water will be supplied by 2 no. proposed water supply bored wells in addition to 2no. rainwater harvesting tanks. The groundwater wells adjacent to the substation will be installed in accordance with the Institute of Geologists Ireland, Guide for Drilling Wells for Private Water Supplies (IGI, 2007). The wells will be flush to the ground and covered with a standard manhole. An in-well pump will direct water to a water tank within the roof space of the control building.

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

Pathway: Groundwater flowpaths

Receptor: Groundwater levels

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

9.4.3.1.5 Potential Effects from the Release of Wastewater

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

Pathways: Groundwater flowpaths and site drainage network.

Receptors: Down-gradient well supplies, groundwater quality and surface water quality in the Drish River and its associated tributaries.

Pre-mitigation Effects:

Negative, significant, indirect, temporary, unlikely effect on surface water quality.

Negative, slight, indirect, temporary, unlikely effect on local groundwater.

In the absence of mitigation measures there is no potential for significant effects.

9.4.3.1.6 Potential Effects on WFD Status and Objectives

Due to the nature of the works completed at the Site during the operational phase, limited to routine maintenance, there will be no potential to effect the WFD objectives and status of the relevant GWBs and SWBs.

A detailed WFD Compliance Assessment Report has been completed in combination with this EIAR Chapter and is included in **Appendix 9.2**.

Pathways: Groundwater flowpaths and surface water flowpaths within the Site.

Receptors: WFD GWBs and SWBs.

Pre-mitigation Potential Effect: Indirect, negative, moderate, temporary, unlikely effect on downstream SWBs. Indirect, negative, slight, temporary, unlikely effect on the underlying Templemore and Thurles GWBs. No potential for significant effects in the absence of mitigation measures.

9.4.3.2 Proposed Grid Connection

No works will be completed along the proposed GC route during the Operational Phase. Therefore, there is no potential for effects to occur on the water environment.

9.4.3.3 Turbine Delivery Route

No works will be completed along the TDR during the Operational Phase. Therefore, there is no potential for effects to occur on the water environment.

9.4.4 Decommissioning

9.4.4.1 Proposed Wind Farm

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

The potential effects associated with decommissioning will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works. Turbine and mast foundations will remain and will be covered with earth and allowed to revegetate. Site roads will continue to be used as amenity pathways and forestry purposes and will therefore not be removed. The underground cables will be cut and tied and the ducting will be left in place. Excavation and removal of this infrastructure would result in considerable disturbance to the local environment in terms of disturbance to underlying soils and an increased sedimentation (if turbine foundations and hardstands are being reinstated there is a risk of silt-laden run-off entering receiving waters) and an increased possibility of contamination of local groundwater.

The proposed onsite 110kV electrical substation will form part of the national grid and will be left in situ.

A decommissioning plan will be agreed with Tipperary County Council prior to decommissioning of the Proposed Wind Farm.

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".

9.4.4.2 Grid Connection

No works will be completed along the proposed GC route. The grid connection cable will be cut and tied and the duction will be left in place in the carriageway of the existing road network. Therefore, there is no potential for effects to occur on the hydrological or hydrogeological environment.

9.4.4.3 Turbine Delivery Route

No works will be completed along the TDR. Therefore, there is no potential for effects to occur on the hydrological or hydrogeological environment.

9.5 Mitigation Measures

9.5.1 Construction

9.5.1.1 Proposed Wind Farm

9.5.1.1.1 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Mitigation by Avoidance:

The layout of the Proposed Wind Farm reflects the outcome of iterative engineering and environmental constraints assessments. These included assessments completed during the design process aimed at eliminating or minimising adverse effects on the water environment. The key mitigation measure is the avoidance of sensitive hydrological features where possible, by application of suitable buffer zones (i.e. 50m to main watercourses, and 10m to main drains). All of the key development areas (turbines, hardstands, substation, construction compounds etc.) are located significantly away from the delineated 50m watercourse buffer zones except for the upgrading of the existing watercourse crossings, new drain crossings and upgrades to the existing site access tracks.

It is noted that the Proposed Wind Farm includes the use of 2 no. existing watercourse crossings. No upgrades to the crossings themselves will be required (refer to Section 9.5.1.1.8.).

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

- Minimise physical damage (river/stream banks and river/stream beds) to watercourses (where possible, this cannot be avoided at the watercourse crossing discussed above) and the associated release of sediment;
- Minimise excavations within close proximity to surface watercourses;
- Minimise the entry of suspended sediment from earthworks into watercourses; and,
- Minimise 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.

In addition, and as outlined above the Proposed Wind Farm drainage system will link into the existing bog drainage system, and discharge from each of the bog sites via existing large settlement ponds, which are some distance from the Proposed Development footprint. As such, there is significant distance for Proposed Development related surface water to travel before it reaches the edge of the bogs and is released from the existing bog drainage system into downstream watercourses.

Mitigation by Design:

There is an extensive network of drains already existing at the 3 no. bogs comprising the Site. The existing drainage infrastructure is operating in accordance with IPC licence requirements, with environmental monitoring and silt control measures being implemented at these bogs. The existing drainage system at the Site will be maintained and expanded locally as required for use within the Proposed Development drainage system. The key elements are the upgrading and improvements to water treatment elements, such as in-line controls and treatment systems, including wind farm related silt traps and settlement ponds.

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

- Interceptor drains will convey clean runoff water around works areas to the existing downstream drainage system (field drains and main drains). Where required, interceptor drains will be installed in advance of any construction works commencing. This will ensure that clean water is kept clear by diverting surface water flow around excavations, construction areas and temporary storage areas. Where possible (depending on orientation), existing field drains can be used as interceptors drains;
- Collector drains will be used to intercept and collect runoff from construction areas (from turbine base/hardstand areas, construction compounds, and the substation). During the construction phase temporary settlement ponds will be used to attenuate and treat runoff from the construction areas (from turbine base/hardstand areas, construction compounds, and the substation) and treated water will then discharge into existing field drains and main drains. Temporary settlement ponds will be removed at the end of the construction phase (end of high risk period), and wind farm runoff will discharge into existing field drains and main drains;
- During the construction phase, temporary silt traps (silt fences) will be used as an additional water protection measures around the existing bog drainage network, particularly where works are proposed within 50m of a natural watercourse. The silt fences will be placed in the existing drains downstream of construction works, and the associated construction area run-off water will be diverted into proposed interceptor drains, or culverted under/across the works area;
- During the construction phase, dewatering silt bags will also be used as required. They can be used downgradient of turbine bases, where temporary pumping is required. Discharge from dewatering silt bags will flow into settlement ponds and treated water from settlement ponds will outfall to existing field drains and main drains;
- Within the Site layout there are section of proposed floating road between turbine infrastructure. In these sections, and depending on intermediate topography, a collector drain (dirty water system as described above) may be used during construction stage, or over the edge (OTE) drainage will occur. Over the edge drainage allows runoff from access tracks to flow into local field drains and be managed via the existing site drainage system. OTE drainage will only occur where topography allows, and it is only proposed in areas of low risk and remote from outfall locations (at least 150m from bog outfall locations. Silt traps and check dams will be installed in field drains downstream of OTE drainage areas, and these will provide attenuation and treatment of dirty water; and,
- Culverts will be required where site roads and proposed hardstands cross the main bog drainage networks. These will be installed with a minimum gradient to reduce the entrainment of suspended solids. All culverts will be inspected regularly and maintained where appropriate. Culverts will remain in-situ during the Operational Phase of the Proposed Development.

Water Treatment Train:

If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a 'siltbuster' or similar equivalent treatment system) will be used to filter and treat all required surface discharge water collected in the dirty water drainage system. This will apply to all of the construction phase.

Silt Fences:

Silt fences will be located within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to the existing drainage network of sand and gravel-sized sediment, released from the excavation of mineral sub-soils of glacial and glacio-fluvial origin and entrained in surface water runoff. Regular inspection and maintenance of silt fences during the construction phase are critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase.

Silt Bags:

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

Adverse Weather Management:

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

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

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

Using the safe threshold of rainfall values given below will allow planned works to be safely executed (from a water quality perspective) or works to be postponed if a high rainfall intensity event is forecast.

Earthworks will be suspended if forecasting predicts any of the following is likely to occur:

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

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

- All open peat/spoil excavations will be secured and sealed;
- Temporary or emergency drainage will be created to prevent back-up of surface runoff; and,
- Working during heavy rainfall and for up to 24 hours after heavy events will not be allowed to ensure drainage systems are not overloaded.

Management of Runoff from Peat Deposition Areas:

It is proposed that excavated soil, peat and spoil will be used in landscaping around the proposed infrastructure, will be used to reinstate the proposed borrow pit or will be stored in the designated peat deposition areas. During the initial placement of peat and spoil, silt fences, straw bales and biodegradable geogrids will be used to control surface water runoff from the storage areas as required. Interceptor and collector drains will be used at storage areas. 'Siltbuster' treatment trains will be employed if previous treatment is not of a high quality.

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 low rainfall periods will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.

Proposed Drainage and Water Quality Monitoring:

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

Any excess build-up of silt sediment levels at dams, the settlement ponds, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

During the construction phase field testing (visual, supplemented with pH, electrical conductivity, temperature, dissolved oxygen and turbidity monitoring), sampling and laboratory analysis of a range of parameters[1] with relevant regulatory limits and EQSs will be undertaken for each primary watercourse, and specifically following heavy rainfall events (i.e. weekly, monthly and event-based). The data will be processed and analysed and works will cease if elevated turbidity concentrations are recorded. In this event, all upstream silt traps and drainage routes will be inspected to identify the cause of the elevated turbidity levels. Works will not recommence until any issues have been resolved and the turbidity concentrations have returned to background concentrations.

9.5.1.1.2 Potential Effects on Groundwater Levels During Excavation Works

Impact Assessment:

- There are large separation distances between proposed works and local houses, and potential groundwater private well supplies. The exception is the dwellings located approximately 50m to the east of the proposed borrow pit;
- Similarly, main streams and rivers are at least 150-500m away from any turbine bases, and at these distances potential effects will be imperceptible;
- The proposed internal cable trench is designed to be shallow and will only be approximately 1.2m in depth. At this depth, it will only potentially interact with shallow perched water within the peat profile. No interaction with deeper regional groundwater will occur. Therefore, no effects on the local groundwater table or flows will occur from this element of the development;
- The construction of the proposed onsite 110kV electrical substation, the temporary construction compounds, and roads will be relatively shallow and will only have the potential to interact with the shallow perched water table within the peat bog. No interaction with the deeper regional groundwater regime will occur. Therefore, no impacts on the local groundwater table or flows will occur; and,
- The potential effect of the proposed piling works on groundwater is assessed separately in Section 9.4.2.1.7.

Regarding the potential effects on any potential groundwater wells located in the vicinity of the proposed onsite borrow pit. The bedrock aquifer underlying this area is classified by the GSI as a Locally Important Aquifer - Bedrock which is Generally Moderately Productive. No groundwater strikes were encountered during the drilling of the 4 no. boreholes at the borrow pit and groundwater levels in March 2024 were noted to be in excess of 5mbgl. Some groundwater dewatering may be required but quantities will be small. Surface water inflows will likely form the main volume of water requiring treatment.

[1] example suite: pH (field measured), Electrical Conductivity (field measured), temperature (field measured), Dissolved Oxygen (field measured), Turbidity (NTU) (sonde measured), Flow (m/s), Total Suspended Solids (mg/l), Ammonia, Nitrite (NO_2) (mg/l), Ortho-Phosphate (P) (mg/l), Nitrate (NO_3) (mg/l), Phosphorus (unfiltered) (mg/l), Chloride (mg/l), and BOD (mg/l).

9.5.1.1.3 Potential Effects on Surface Water Quality from Excavation Dewatering

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

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation inflows will prevent the build-up of groundwater in the excavation;
- The interceptor drainage will be discharged to the existing drainage system or onto the bog surface within the overall bog drainage and treatment system;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas;
- There will be no direct discharge to the existing bog drainage network and therefore no risk of hydraulic loading or contamination will occur; and,
- Daily monitoring of excavations and the water treatment system 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 will be undertaken.

9.5.1.1.4 Potential Effects Associated with Leakages or Spillages of Hydrocarbons

- All plant will be inspected and certified to ensure they are leak free and in good working order prior to use on site;
- On-site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer or truck will be re-filled off site and will be towed/driven around the Site to where machinery is located. The 4x4 jeep/fuel truck will also carry fuel absorbent materials for the event of any accidental spillages. The fuel bowser will be parked in a designated location on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations ;
- Fuel volumes stored on site will be minimised. Any storage areas will be bunded appropriately for the fuel storage volume during the construction phase; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (**Appendix 4.3**). Spill kits will be available to deal with accidental spillages.

9.5.1.1.5 Potential Effects Associated with the Release of Cement-Based Products

- No batching of wet-cement products on-site is proposed. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will be the design approach;
- Where possible pre-cast elements for culverts and concrete works will be used;
- No washing out of the main body of any plant used in concrete transport or concreting operations will be allowed on-site;

- Where concrete is delivered on site, only the concrete truck chute will be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water will be isolated in temporary lined wash-out pits located near Site compounds. These temporary lined wash-out pits will be removed from the site their utility is no longer required or at the end of the construction phase;
- Any washing out of concrete pumping plant will also be into the temporary lined wash-out pits;
- Weather forecasts will be used to plan dry days for pouring concrete; and,
- Construction contractors will ensure each concrete pour site is free of standing water and plastic covers will be available in case of a sudden rainfall event.

No specific mitigation measures are required for potential groundwater impacts as the proposed mitigation measures will ensure minimal release of cement based products to ground. Furthermore the potential groundwater effects are imperceptible at the outset.

9.5.1.1.6 Potential Effects from Wastewater Disposal

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

9.5.1.1.7 Potential Effects Associated with Piled Foundations

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

- Mitigation measures for sediment control are detailed in Section 9.5.1.1.1;
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.1.1.4; and,
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 9.5.1.1.5.

Proposed mitigation measures relative to piling works will comprise:

- Where driven piles are used, they will have a cross section without re-entrant angles;
- Strict QA/QC procedures for piling works will be followed;
- Piles will be kept vertical during piling works;
- Good workmanship will be employed during all piling works; and,
- Where required use bentonite seal to prevent upward/downward movement of surface water/groundwater.

Impact Assessment:

The ground conditions at the Site can be typically categorised into the following deposits (based on data presented in Chapter 8):

- Peat – Typically described as orangish brown to dark brown amorphous to fibrous peat. Peat thicknesses from ranged from 0.3 to >4.5m;
- Cohesive Deposits – Typically described as grey, slightly sandy, slightly gravelly clayey SILT or a grey, slightly sandy, slightly gravelly, silty CLAY. The thickness of the layer is variable across the Site;
- Granular Deposits – Typically described grey, slightly sandy, silty, clayey, subangular to subrounded, fine to coarse GRAVEL with occasional cobbles and boulders. The thickness of the layer is variable across the Site; and,
- Groundwater - was recorded in 33 no. trial pit excavations on site.

Proposed piles will penetrate through peat deposits and lacustrine clay deposits where they occur, and then into underlying glacial tills. Where present the clay layer is likely to act as an aquitard/low permeability layer, through which only very small amounts of water can flow.

Peat water is perched above the regional groundwater table. Peat water occurs in the bog basins, while regional groundwater flow will occur in the underlying bedrock aquifer. Glacial tills that occur between the base of the peat/lacustrine clays may be permeable in local zones, but in general will have a moderate to low permeability. Therefore, the two main groundwater systems are the upper acidic peat water, and the lower regional bedrock groundwater water. As the underlying bedrock is mainly limestone, the groundwater occurring within this aquifer will be alkaline.

For the driven piles the clay and also the glacial tills are likely to 'self-seal' around the piles, meaning that a long term pathway between the upper peat/bog water and the lower bedrock aquifer will not be sustained.

Research indicates that provided the aquitard layer is of a reasonable thickness and the piles driven through have a cross section without re-entrant angles, the likelihood of creating preferential flow paths for downward migration of leachate (i.e. peat water) is very low. This hypothesis is consistent with the results obtained by Hayman et al (1993) and Boutwell et al (2000).

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

<u>Scenario 1: Creating a Pathway for Downward Flow</u>

To ensure downward flow of peat water and/or pollutants from the piling works does not occur, a bentonite seal will be used in a starter pit for each driven pile, and the mitigation measures outlined above will be implemented. The concrete added to the bored pile will seal the pile annulus. As a result, the potential for either piling work option to create pathways for downward flow of peat water or pollutants that could affect groundwater quality in the underlying aquifer is imperceptible.

Scenario 2: Creating a Pathway for Upward Flow

No upwelling of groundwater to the peat surface water recorded in any of the site investigation locations recorded across the Site.

Notwithstanding this, to ensure upward flow of underlying groundwater via potential pathways created by piling works does not occur, a bentonite seal will be used in a starter pit for each driven pile, and the mitigation measures outlined above will be implemented. The concrete added to the bored pile will seal the pile annulus. As a result, the potential for piling works to create pathways for upward flow of alkaline groundwater to the bog surface is imperceptible.

Scenario 3: Blocking Regional Groundwater Flow

The scale of the Site is important, and it means that the development footprint occurs over ~2.1% (25.17 Ha excluding the PDAs and BP) of the Site (1,177 Ha).

If a piling array of 23 no. 900mm piles is applied at each turbine base (as a worst case scenario), this combined area of piling footprint amounts to ~160.95m^2, or 14.63m^2 per turbine base. The area of the piles driven into the ground is distributed over a very large area, and that area only amounts to 0.06% of the development footprint (excluding the PDAs and the BP), or 0.0013% of the Site area. Also, none of the proposed piles would penetrate into the underlying bedrock aquifer, as they will find sufficient resistance, either in the over lying glacial tills/mineral subsoils or upon reaching the top of bedrock. At such wide separation distance, the ability of clusters of piles, with a plan area of ~14.63m^2 per turbine, to alter or affect regional groundwater flow is imperceptible. Groundwater will simply flow through and/or around these very localised insertions.

9.5.1.1.8 Potential Effects from Morphological Changes to Surface Waters

The Proposed Wind Farm design has been optimised to utilise the existing infrastructure (i.e. existing site roads) where practicable. No new crossings over EPA mapped watercourses are required. The Proposed Wind Farm uses existing crossings over the Black (Two Mile Borris) River and the North Glengoole Stream. Existing crossings exist at these locations and are associated with the Bord na Móna railway line and adjacent machine pass. The use of these existing crossings prevents the unnecessary disturbance of the existing site drainage network prevents the requirement for widespread instream works across the Site. No upgrade works are required at these crossing locations.

9.5.1.1.9 Potential Effects on Public and Group Groundwater Supplies

The design team were at all times aware that several public and group water supplies existed in the vicinity of the Site, and as such all proposed mitigation and design proposals were designed towards providing best in class drainage management for the Proposed Wind Farm.

Longford Pass GWS

There will be no significant quantitative effects on the Longford Pass GWS for the following reasons:

- The source of the GWS is located ~720m to the northeast of the proposed borrow pit;
- The proposed borrow pit is mapped to be underlain by a Locally Important Aquifer, and therefore, groundwater inflows will not be significant;
- The site investigations indicate that the bedrock underlying the proposed borrow pit is strong and there will be little groundwater inflows (no groundwater strikes were encountered during the drilling of the boreholes at the proposed borrow pit location);

- No groundwater inflows were recorded during the inspection of the historic quarry adjacent to the proposed borrow pit;
- The maximum depth of the proposed borrow pit is 11.5mbgl, with an average excavation depth of 6mbgl. This is relatively shallow and is not comparable to a large bedrock quarry which would require dewatering (i.e. over pumping to maintain a dry working quarry floor); and,
- Based on the above, no significant dewatering will be required and surface water inflows will likely be the main source of water requiring treatment at the proposed borrow pit.

There will be no significant qualitative effects on the Longford Pass GWS for the following reasons:

- A water management system will be implemented at the borrow pit which will be similar to those utilised at sand and gravel pits and quarries across the country; and,
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.1.1.4.

Newhill GWS

There will be no significant effects on the Newhill GWS for the following reasons:

- The source protection area associated with the Newhill GWS is located ~850m to the west of the Site;
- No infrastructure is located within the delineated source protection area;
- Water within the Site will discharge to local surface water features including the Clover and Black (Twomileborris) rivers; and,
- The mitigation described in Section 9.5.1.1.1 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products), Section 9.5.1.1.6 (wastewater) and Section 9.5.1.1.7 (piling works) will ensure the protection of groundwater quality during the construction phase.

Leigh GWS

There will be no significant effects on the Leigh GWS for the following reasons:

- The source protection area associated with the Leigh GWS is located immediately to the northwest of the Site;
- No infrastructure is located within the delineated source protection area;
- Water within the Site will discharge to local surface water features including the flooded areas in the northwest of the bog and the large boundary drains; and,
- The mitigation described in Section 9.5.1.1.1 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products), Section 9.5.1.1.6 (wastewater) and Section 9.5.1.1.7 (piling works) will ensure the protection of groundwater quality during the construction phase.

Two-Mile Borris PWS

There will be no significant effects on the Two-Mile Borris PWS for the following reasons:

- The source protection area associated with the Two-Mile Borris PWS is located ~2.7km to the west of Littleton Bog;
- No infrastructure is located within the delineated source protection area;
- The Clover River acts as a hydraulic barrier between the site and the PWS; and,
- The mitigation described in Section 9.5.1.1.1 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products), Section 9.5.1.1.6 (wastewater) and Section 9.5.1.1.7 (piling works) will ensure the protection of water quality during the construction phase.

Moyne GWS

There will be no significant effects on the Moyne GWS for the following reasons:

- The source protection area associated with the Moyne GWS is located ~2.56km to the northwest of the Site;
- No infrastructure is located within the delineated source protection area;
- An unnamed tributary of the Drish River acts as a hydraulic barrier between the site and this GWS; and,
- The mitigation described in Section 9.5.1.1.1 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products), Section 9.5.1.1.6 (wastewater) and Section 9.5.1.1.7 (piling works) will ensure the protection of water quality during the construction phase.

9.5.1.1.10 Potential Effects on Local Private Groundwater Well Supplies

No significant effects on local groundwater well supplies, public or private, will occur due to the separation distance between the key Proposed Wind Farm infrastructure and potential groundwater well supplies (with the exception of those located in close proximity to the proposed onsite borrow pit).

Nevertheless, detailed, tried and tested best practice mitigation measures have been prescribed in the preceding section for the protection of groundwater quality as follows:

- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.1.1.4;
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 9.5.1.1.5;
- Mitigation measures in relation to wastewater are detailed in Section 9.5.1.1.6; and,
- Mitigation measures in relation to piling works are detailed in Section 9.5.1.1.7.

The implementation of these mitigation measures will ensure the protection of local groundwater quality.

With regards to any private groundwater well supplies located in the vicinity (to the south and east) of the proposed borrow pit, there will be no potential for significant quantitative effects for the following reasons:

- The proposed borrow pit is mapped to be underlain by a Locally Important Aquifer, and therefore, groundwater inflows will not be significant;
- The site investigations indicate that the bedrock underlying the proposed borrow pit is strong and there will be little groundwater inflows (no groundwater strikes were encountered during the drilling of the boreholes at the proposed borrow pit location). The site investigations did not encounter any significant water bearing conduits in the limestone;
- No groundwater inflows were recorded during the inspection of the historic quarry adjacent to the proposed borrow pit;
- The maximum depth of the proposed borrow pit is 11.5mbgl, with an average excavation depth of 6mbgl. This is relatively shallow and is not comparable to a large bedrock quarry which would require dewatering (i.e. over pumping to maintain a dry working quarry floor); and,
- Based on the above, no significant dewatering will be required and surface water inflows will likely be the main source of water requiring treatment at the proposed borrow pit.

Furthermore, there will be no potential for significant qualitative effects on local private wells in the vicinity of the proposed borrow pit for the following reasons:

- The mitigation described in Section 9.5.1.1.1 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.6 (wastewater) will ensure the protection of groundwater quality during the construction phase.

9.5.1.1.11 Potential Effects on WFD Status and Objectives

- Mitigation measures for sediment control are detailed in Section 9.5.1.1.1 and 9.5.1.1.3;
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.1.1.4;
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 9.5.1.1.5;
- Mitigation to prevent the release of wastewater on site are detailed in Section 9.5.1.1.6;
- Mitigation relating to piled foundations are detailed in Section 9.5.1.1.7; and,
- Mitigation in relation to watercourse crossings are presented in Section 9.5.1.1.8.

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

Furthermore, mitigation measures with respect to groundwater quality are prescribed in the preceding sections as follows:

- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.1.1.4;
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 9.5.1.1.5;
- Mitigation measures in relation to wastewater are detailed in Section 9.5.1.1.6; and,
- Mitigation measures in relation to piling works are detailed in Section 9.5.1.1.7.

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

- The small footprint (25.17ha excluding PDAs and BP, and 51.28 including PDAs and BP)) of the Proposed Wind Farm in relation to the scale of the underlying GWBs (Thurles GWB has a total area of ~9,000ha and the Templemore GWB has a total area of 30,200ha;
- The Proposed Wind Farm does not involve any significant alteration of drainage patterns, therefore, the quantitative status of the receiving surface and groundwaters will remain unaltered;
- There will be no direct discharge from the Site to receiving waters; and,
- Mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the Proposed Wind Farm to ensure that there is no deterioration in local or downstream water quality. These mitigation measures will ensure the qualitative status the receiving waterbodies remains unaltered by the Proposed Wind Farm.

9.5.1.1.12 Potential Effects Associated with Biodiversity Enhancement

No specific mitigation measures are required in relation to the proposed biodiversity enhancement works. The proposed works will have a positive effect on bog hydrology/hydrogeology.

All works undertaken will be completed in accordance with 'best practice' procedures and the mitigation measures in relation to the protection of surface and groundwater quality are detailed in Section 9.5.1.1.1 to 9.5.1.1.6 above.

9.5.1.1.13 Potential Effects on Karst Aquifer / Karst Features

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

- The scale of the proposed works relative to the scale of the Thurles GWB (90km^2);
- Due to the flat nature of the site it will be easy to manage surface water drainage within the bog before there is any potential for recharge to ground;
- Groundwater recharge rates in Littleton Bog are likely to be slow and very limited in extent, and the existing large areas of standing water within the bog will act as supplementary large settlement ponds; and,
- Groundwater will also infiltrate though granular subsoils which are excellent natural filters before it encounters the underlying limestone bedrock.

Nevertheless, the following mitigation measures will be implemented:

- Site drainage will be put in place in order to prevent any poor quality drainage water reaching the karst bedrock (Section 9.5.1.1.1 and Section 9.5.1.1.3); and,
- Mitigation measures relating to hydrocarbons, cementitious materials and wastewater disposal as prescribed in Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products) and Section 9.5.1.1.6 (wastewater) will provide adequate protection to groundwater and surface water quality and will ensure that groundwater quality will not be impacted.

9.5.1.1.14 Potential Effects from the Use of Siltbuster System

Measures employed to prevent overdosing and potential chemical carryover:

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

9.5.1.2 Grid Connection

9.5.1.2.1 Potential Morphological Changes to Surface Watercourses

The construction methodology for the cable crossings over local rivers and streams was chosen to avoid in stream works and morphological changes to these watercourses.

A total of 10 no. crossings will be completed by Horizontal Directional Drilling with 1 no. crossing over the EPA mapped Clomantagh Stream to be completed within the road carriageway. The mitigation measures in relation to HDD are prescribed separately in Section 9.5.1.2.7.

The following mitigation measures will be implemented in relation to the crossing over the Clomantagh Stream which will be completed within the road carriageway:

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

9.5.1.2.2 Potential Effects on Karst Features

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

- The proposed works are minor and transient in nature;
- The works will be completed within the carriageway of the existing public road network; and,
- The proposed works are akin to roadworks/water pipeline works being completed across the country.

Nevertheless, the following mitigation measures will be implemented:

- Site drainage will be put in place in order to prevent any poor quality drainage water reaching the local karst features (Section 9.5.1.1.1 and Section 9.5.1.1.3); and,
- Mitigation measures relating to hydrocarbons, cementitious materials and wastewater disposal as prescribed in Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products) and Section 9.5.1.1.6 (wastewater) will provide adequate protection to groundwater and surface water quality and will ensure that groundwater quality will not be impacted.

9.5.1.2.3 Potential Effects on Hydrologically Connected Designated Sites

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 9.5.1.1.1 and Section 9.5.1.1.3 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products) and Section 9.5.1.1.6 (wastewater). Mitigation measures have also been proposed in relation to watercourse crossings along the proposed GC route in Section 9.5.1.2.1.

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

- The transient and minor nature of the works proposed along the proposed GC route;
- The only works which are located in the immediate vicinity of a designated site is the new proposed crossing over the River Nore along the proposed GC route. There will be no instream works at this location and the crossing will be achieved by directional drilling;
- The potential for effects on other designated sites is limited given the increasing volumes of water and associated dilution effect in downstream watercourses (River Nore); and,
- Nevertheless, mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the proposed GC route to ensure that there is no deterioration in local or downstream water quality.

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

9.5.1.2.4 Potential Effects on Surface Water Drinking Supplies

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 9.5.1.1.1 and Section 9.5.1.1.3 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products) and Section 9.5.1.1.6 (wastewater). Mitigation measures have also been proposed in relation to watercourse crossings along the proposed GC route in Section 9.5.1.2.1.

We summarise that there will be no significant effect on downstream surface water abstractions (Ballyragget PWS and the Kilkenny Troyswood supply) for the following reasons:

- The transient and minor nature of the works proposed along the proposed GC route;
- The only works which are located in the immediate vicinity of the River Nore are associated with the new proposed crossing on the River Nore. There will be no instream works at this location and the crossing will be achieved by directional drilling;
- The potential for effects on other designated sites is limited given the large volumes of water and associated dilution effect in downstream watercourses (River Nore); and,
- Nevertheless, mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the proposed GC route to ensure that there is no deterioration in local or downstream water quality.

For these reasons, and with the implementation of these mitigation measures the protection of downstream surface water drinking supplies will be ensured.

9.5.1.2.5 Potential Effects on Public and Group Groundwater Drinking Supplies

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 9.5.1.1.1 and Section 9.5.1.1.3 (suspended solids), Section 9.5.1.1.4 (hydrocarbons), Section 9.5.1.1.5 (cement-based products) and Section 9.5.1.1.6 (wastewater). Mitigation measures have also been proposed in relation to watercourse crossings along the proposed GC route in Section 9.5.1.2.1.

We summarise that there will be no significant effect on local public and ground groundwater drinking supplies (The Fennor Inchorourke GWS, Urlingford Johnstown PWS, Balief GWS, Barna Kilrush GWS and the Ballyconra PWS) for the following reasons:

- The transient and minor nature of the works proposed along the proposed GC route;
- The works will be completed within the carriageway of the existing public road network;
- The proposed works are akin to roadworks being completed across the country; and,
- Nevertheless, mitigation measures for the protection of surface and groundwater water quality will be implemented during the construction phase of the proposed GC route to ensure that there is no deterioration in local or downstream water quality.

For these reasons, and with the implementation of these mitigation measures the protection of local public and group groundwater drinking supplies.

9.5.1.2.6 Potential Effects on WFD Status and Objectives

Mitigation measures for the protection of surface water quality and groundwater quality are the same as those detailed in the preceding sections. There is no potential for significant effects on the underlying GWBs or downstream SWBs due to the short-term and transient nature of the proposed works along the proposed GC route.

9.5.1.2.7 Potential Effects During Directional Drilling

Mitigation Measures for Directional Drilling

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

- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied;
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion;
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated;
- There will be no batching or storage of cement allowed at the watercourse crossing;
- There will be no refuelling allowed within 100m of the watercourse crossing;
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing;
- The ECoW will monitor the implementation of all mitigation measures relating to HDD with regular reporting to the client; and,
- The Developer's Engineer will be present on site to supervise all HDD works.

Mechanical Stabilisation

Mechanical Stabilisation will be required where HDD is proposed in gravelly, non-cohesive subsoils. This will be managed by installing steel conductor casing through the shallow gravels to bypass the cover zone (i.e. the material above the bore depth) where fluid would be most likely to breach the surface. This casing acts as a physical barrier, protecting the riverbed from pressure spikes and ensuring returns are directed back to the entry pit rather than into the sensitive substrate. Note that mechanical stabilisation may only be needed on the River Nore 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). Biocompatible Drilling Fluids (European Standards) utilize NSF/ANSI Standard 60 or CE-marked additives which are high-performance, biodegradable viscosifiers and will be used to provide the necessary "gel strength" to suspend heavy gravel cuttings. Fluid loss will be controlled using biodegradable sealants, which create a thin, flexible filter cake on the borehole wall to prevent fluid migration into the aquifer. These products break down naturally, ensuring no permanent alteration to the hydraulic conductivity of the aquifer.
- 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;
- Real-time annular pressure monitoring will be completed. By keeping pressures below the Delft Equation limits, operators can detect lost circulation before it becomes a surface frac-out;

- 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.

The above mitigation measures are standard best practice measures for HDD works and have been successfully employed in multiple projects across Ireland.

9.5.1.3 Turbine Delivery Route

Mitigation measures for the protection of surface water quality and groundwater quality are the same as those detailed in the preceding sections. There is no potential for significant effects on the underlying GWBs or downstream SWBs due to the short-term and transient nature of the TDR accommodation works.

9.5.2 Operation

9.5.2.1 Proposed Wind Farm

9.5.2.1.1 Potential Effects from the Replacement of Natural Surfaces with Lower Permeability Surfaces

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

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed into downstream field drains;
- Collector drains will be used to gather runoff from internal site access tracks and turbine hardstanding areas of the Site likely to have entrained suspended sediment, and channel it to new local settlement ponds for sediment settling;
- On sections of internal site access tracks transverse drains (‘grips’) will be constructed where appropriate in the surface layer of the road to divert any runoff off the road into swales/roadside drains;
- Check dams will be used along sections of internal site access tracks drains to intercept silt at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;
- Settlement ponds, emplaced downstream of internal site access tracks 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 existing drains;
- Settlement ponds will be designed in consideration of the greenfield runoff rate, existing bog settlement ponds will also buffer discharges from the bogs; and,
- Finally, all surface water runoff from the development will pass through the existing settlement ponds at the existing bog outfall locations.

9.5.2.1.2 Potential Effects from Suspended Solids Entrainment in Surface Waters

Mitigation measures for sediment control are the same as those detailed in Section 9.5.1.1.1. Mitigation measures for the control of hydrocarbons during maintenance works are the same to those outlined in Section 9.5.1.1.3.

9.5.2.1.3 Potential Effects from the Release of Cement-Based Products

None required. The concrete in turbine bases sets within 3 days of concrete pour.

9.5.2.1.4 Potential Effects from the Water Supply At Substation

The abstraction rate for the proposed groundwater wells at the substation will be comparable to a domestic well, with a well supplying a single household typically abstracting less than $1m^3$/day. The well is proposed in a locally important aquifer which is moderately productive only in local zones. This aquifer forms part of the Templemore GWB which is comprised of poorly productive bedrock. Therefore due to the nature of the bedrock aquifer and the proposed extraction rate, no effects on local groundwater levels will occur. For these reasons no mitigation measures are required.

9.5.2.1.5 Potential Effects from the Release of Wastewater

It is proposed to install a sealed underground holding tank for effluent (wastewater) from the onsite 110kV electrical substation building. The tank shall be routinely emptied by a licensed contractor. A level sensor will be installed in the tank which shall be linked to the on-site SCADA system. If the level of the tank contents rise to a predetermined ‘high‘ level a warning shall appear on the overall SCADA system for the site and automatic notification shall be sent to the facility manager. A formal service agreement will be entered into with a suitably permitted waste contractor, in relation to the servicing and de-sludging of the wastewater holding tank on site. There will be no discharge of wastewater to ground at the Site, and therefore there is no potential to impact groundwater or surface water quality.

9.5.2.1.6 Potential Effects on WFD Status and Objectives

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

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

9.5.2.2 Proposed Grid Connection

No mitigation required.

9.5.2.3 Turbine Delivery Route

No mitigation required.

9.5.3 Decommissioning

9.5.3.1 Proposed Wind Farm

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures will be implemented during the Decommissioning Phase.

9.5.3.2 Proposed Grid Connection

No mitigation measures are required.

9.5.3.3 Turbine Delivery Route

No mitigation measures are required.

9.6 Monitoring

9.6.1 Construction

9.6.1.1 Proposed Wind Farm

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

Any excess build-up of silt sediment levels at dams, the settlement ponds, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

During the construction phase field testing (visual, supplemented with pH, electrical conductivity, temperature, dissolved oxygen and turbidity monitoring), sampling and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs will be undertaken for each primary watercourse, and specifically following heavy rainfall events (i.e. weekly, monthly and event-based). The data will be processed and analysed and works will cease if elevated turbidity concentrations are recorded. In this event, all upstream silt traps and drainage routes will be inspected to identify the cause of the elevated turbidity levels. Works will not recommence until any issues have been resolved and the turbidity concentrations have returned to background concentrations.

9.6.1.2 Proposed Grid Connection

No monitoring is required due to the short-term, minor and transient nature of the works proposed along the proposed GC route.

9.6.1.3 Turbine Delivery Route

No monitoring required due to the short-term, minor and transient nature of the TDR accommodation works.

9.6.2 Operation

9.6.2.1 Proposed Wind Farm

No monitoring required.

9.6.2.2 Proposed Grid Connection

No monitoring required.

9.6.2.3 Turbine Delivery Route

No monitoring required.

9.6.3 Decommissioning

9.6.3.1 Proposed Wind Farm

Same as construction phase above.

9.6.3.2 Proposed Grid Connection

No monitoring required.

9.6.3.3 Turbine Delivery Route

No monitoring required.

9.7 Residual Effects

9.7.1 Construction

9.7.1.1 Proposed Wind Farm

9.7.1.1.1 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Post-Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of release of sediment have been proposed above and will reduce the concentration of suspended sediment to acceptable levels. The residual effect will be a negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality and aquatic habitats.

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

9.7.1.1.2 Potential Effects on Groundwater Levels During Excavation Works

Post-Mitigation Residual Effects: Due to large separation distances between proposed works and water wells and local streams and rivers, and the relatively shallow nature of the proposed works, and also the prevailing geology of the Site the potential for water level drawdown impacts at receptor locations are considered negligible. The residual effect will be an imperceptible, direct, temporary, unlikely effects on local groundwater levels.

Significance of Effects: For the reasons given above, no significant effects on groundwater levels are likely to occur.

9.7.1.1.3 Potential Effects on Surface Water Quality from Excavation Dewatering

Post-Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality of these receptors. Proven and effective measures to minimise the levels of sediment from the Site have been proposed above and will maximise the drainage pathway length between the potential sources and the receptor. The residual effect will be an imperceptible, indirect, temporary, unlikely effects on local surface water quality within the Drish River and its associated tributaries.

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

9.7.1.1.4 Potential Effects Associated with Leakages or Spillages of Hydrocarbons

Post-Mitigation Residual Effect: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be a negative, imperceptible, indirect, temporary, unlikely effect on groundwater quality within the peat bog and surface water quality in down-gradient rivers (Drish River and its associated tributaries).

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

9.7.1.1.5 Potential Effects Associated with the Release of Cement-Based Products

Post-Mitigation Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on the hydrochemistry of downstream surface watercourses including the Drish River and its associated tributaries, and a negative, indirect, imperceptible, long-term, unlikely effect on peat water hydrochemistry.

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

9.7.1.1.6 Potential Effects from Wastewater Disposal

Post-Mitigation Residual Effects: The potential for contamination resulting from wastewater disposal is a risk to surface and groundwater quality. This is a risk common to all construction sites containing staff welfare facilities. Proven and effective measures to prevent the release of wastewater on site have been proposed above and will the potential source and each receptor. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on surface water (Drish River and its associated tributaries) and groundwater quality (Templemore and Thurles GWBs).

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

9.7.1.1.7 Potential Effects Associated with Piled Foundations

Post-Mitigation Residual Effects: The proposed piling works potentially pose a threat to groundwater quality in the underlying regional groundwater system, and also could potentially create a pathway for upward migration of alkaline groundwater to the peat surface. These potential effects will not arise at the Site due to a combination of the prevailing ground conditions, groundwater conditions, and proposed mitigation measures that will ensure the potential pathways for interaction of shallow (acidic peat water) and deeper (alkaline) groundwater are prevented from occurring. In additional, due to the small footprint of proposed pile clusters, and the significant spacing between turbine bases where pile clusters are proposed, the potential for such pile clusters to block regional groundwater flow is imperceptible at that scale. The proposed piled foundations therefore have no potential to change the WFD status or impact the WFD objectives of the underlying Templemore and Thurles GWBs. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on groundwater flow, and ground quality/peat water hydrochemistry.

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

9.7.1.1.8 Potential Effects from Morphological Changes to Surface Waters

Post-Mitigation Residual Effect: Proven and effective measures to protect water quality have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, direct, long-term, unlikely effect on stream morphology.

Significance of Effects: For the reasons outlined above, no significant effects on stream morphology.

9.7.1.1.9 Potential Effects on Hydrologically Connected Designated Sites

Post-Mitigation Residual Effects: Construction activities at the Site pose a threat to designated sites hydrologically linked with the Proposed Development. Proven and effective measures to mitigate the risk of surface and groundwater contamination have been proposed which will break the pathway between the potential source and the downstream receptor. These mitigation measures will ensure that surface water runoff from the Site will be equivalent to baseline conditions and will therefore have no effect on downstream water quality. No adverse effects are anticipated on hydrologically connected Designated Sites. Please see Chapter 6 Biodiversity for details.

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

9.7.1.1.10 Potential Effects on Public and Group Groundwater Supplies

Post Mitigation Residual Effect: Proven and effective measures to mitigate the risk of surface and groundwater contamination have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on local public and group water supplies.

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

9.7.1.1.11 Potential Effects on Local Private Groundwater Well Supplies

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

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

9.7.1.1.12 Potential Effects on WFD Status and Objectives

Post-Mitigation Residual Effects:

There is no direct discharge from the Site to downstream receiving surface waters or the underlying GWBs. Mitigation for the protection of surface and groundwater during the construction phase of the Proposed Wind Farm will ensure the qualitative and quantitative status of the receiving waters will not be altered by the Proposed Wind Farm.

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

The residual effect on Groundwater Bodies will be - No residual effect.

The residual effect on Surface Water Bodies will be - No residual effect.

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

9.7.1.1.13 Potential Effects Associated with Biodiversity Enhancement

Post-Mitigation Residual Effects: Following the implementation of the proposed biodiversity enhancement, where drain blocking is proposed the Site will likely be wetter, will retain more water and will recolonise with vegetation slowly. As such, we consider the residual effects will be a moderate, positive, direct, permanent effect on local peat bog hydrology/hydrogeology.

Significance of Effects: For the reasons provided above, and with the implementation of the listed mitigation measures, no significant effects will occur

9.7.1.1.14 Potential Effects on Karst Aquifer / Karst Features

Post Mitigation Residual Effect: Due to the scale of the Proposed Wind Farm in comparison to the scale of the overall Thurles GWB, the flat nature of the Site which provides significant attenuation and settlement of solids, and the low infiltration rates, there is limited potential for effects on the underlying karst aquifer. Furthermore, the mitigation measures associated with drainage management and the protection of water quality will ensure that the residual effects is an indirect, negative, imperceptible, short-term, unlikely effect.

Significance of Effects: No significant effects on karst features or the underlying karst aquifer will occur.

9.7.1.1.15 Potential Effects from the Use of Siltbuster System

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

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will not occur. In fact, it is considered that the use of siltbuster systems has a significant positive effect in respect of protected surface water quality.

9.7.1.2 Proposed Grid Connection

9.7.1.2.1 Potential Morphological Changes to Surface Waters

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

Significance of Effects: For the reasons outlined above, and with the application of the mitigation measures no significant effects on stream morphology will occur.

9.7.1.2.2 Potential Effects on Karst Features

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

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

9.7.1.2.3 Potential Effects on Hydrologically Connected Designated Sites

Post Mitigation Residual Effect: Due to the minor and transient nature of the works along the proposed GC route there is limited potential for effects on local or downstream designated sites. Furthermore, the mitigation measures associated with drainage management and the protection of water quality will ensure that the residual effects is an indirect, negative, imperceptible, short-term, unlikely effect.

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

9.7.1.2.4 Potential Effects on Surface Water Drinking Supplies

Post Mitigation Residual Effect: Due to the minor and transient nature of the works along the proposed GC route there is limited potential for effects on downstream surface water abstractions. Furthermore, the mitigation measures associated with drainage management and the protection of water quality will ensure that the residual effects is an indirect, negative, imperceptible, short-term, unlikely effect.

Significance of Effects: For the reasons given above, no significant effects on any surface water abstraction sites will occur.

9.7.1.2.5 Potential Effects on Public and Group Groundwater Drinking Supplies

Post Mitigation Residual Effect: Due to the minor, transient and shallow nature of the works along the proposed GC route there is limited potential for effects on local public and group groundwater drinking supplies. Furthermore, the mitigation measures associated with drainage management and the protection of water quality will ensure that the residual effects is an indirect, negative, imperceptible, short-term, unlikely effect.

Significance of Effects: For the reasons given above, no significant effects on any public or group groundwater drinking supply will occur.

9.7.1.2.6 Potential Effects on WFD Status and Objectives

Post-Mitigation Residual Effects:

Mitigation for the protection of surface water during the construction phase of the proposed GC route will ensure the qualitative and quantitative status of the receiving waters will not be altered by the Proposed Grid Connection.

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

The residual effect on Groundwater Bodies will be - No residual effect.

The residual effect on Surface Water Bodies will be - No residual effect.

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

9.7.1.2.7 Potential Effects During Direction Drilling

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

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

9.7.1.3 Turbine Delivery Route

Post Mitigation Residual Effect: Due to the minor and transient nature of the accommodation works along the TDR there is limited potential for effects on the water environment. Furthermore, the mitigation measures associated with the protection of water quality will ensure that there is no residual effect.

Significance of Effects: No significant effects will occur.

9.7.2 Operation

9.7.2.1 Proposed Wind Farm

9.7.2.1.1 Replacement of Natural Surfaces with Lower Permeability Surfaces

Post Mitigation Impact Assessment

There are existing surface water control measures at the Site which comprise high level bog surface drains, low level main drains and settlement ponds. All these existing drainage measures offer some surface water attenuation during rainfall events. However, as part of the Proposed Development drainage, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed collector drains, silt traps and settlement ponds prior to release into the existing drainage network. The new proposed drainage measures will then in effect create significant additional attenuation to what is already present at the Site. The net effect of this will be a reduction in the overall runoff coefficient of the bog as demonstrated by the use of the Rational Method in Table 9-21 below. Based on a conservative reduction in the runoff coefficient from 0.96 to 0.85 for the Site, there would a potential 11% reduction in runoff volumes from the Site. This assessment demonstrates that there will be no risk of exacerbated flooding down-gradient of the Site as a result of the Proposed Development. The Proposed Development will in effect retain water within the bog for longer periods.

Table 9-21: Surface Water Runoff Assessment for Proposed Wind Farm Drainage

Site Area	C (Constant)	Area (m^2)	Runoff Coefficient	100-Yea 6hr Rainfall Depth (m)	Runoff Volume (m^3)	Total Site Runoff Volume (m^3)
Without Wind Farm Drainage Control						
Undeveloped Area	2.78	11,518,249	0.96	0.0615	1,891,504	1,933,545
Development Footprint	2.78	251,751	1.00	0.0615	43,041	
With Wind Farm Drainage Control						
Undeveloped Area	2.78	11,518,249	0.85	0.0615	1,673,883	1,714,773

Site Area	C (Constant)	Area (m^2)	Runoff Coefficient	100-Yea 6hr Rainfall Depth (m)	Runoff Volume (m^3)	Total Site Runoff Volume (m^3)
Development Footprint	2.78	251,751	0.95	0.0615	40,889	
Estimate Potential Reduction in Site Runoff Volume (%)						218,772

Post-Mitigation Residual Effect: With the implementation of the Proposed Development drainage measures as detailed above, and based on the post-mitigation assessment of runoff, we consider that the residual effect will be a negative, imperceptible, direct, long-term, likely effect on all downstream surface water bodies.

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

9.7.2.1.2 Runoff Resulting in Contamination of Surface Waters

Post-Mitigation Residual Effects: With the implementation of the Proposed Development drainage measures as detailed above, and based on the post-mitigation assessment of runoff, we consider that residual effects will be a negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality in the Drish River and its associated tributaries.

Significance of Effects: For the reasons given above, no significant effects on the surface water quality are likely to occur.

9.7.2.1.3 Release of Cement-Based Products

Post-Mitigation Residual Effect: Negative, imperceptible, indirect, long term, likely effect to surface water quality. Negative, imperceptible, indirect, long term, likely effect on peat water hydrochemistry.

Significance of Effects: For the reasons given above, no significant effects on the surface water quality are likely to occur.

9.7.2.1.4 Water Supply At Substation

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

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

9.7.2.1.5 Potential Contamination Due to Wastewater

Post-Mitigation Residual Effects: The potential for contamination resulting from wastewater disposal is a risk to surface and groundwater quality. This is a risk common to all wind farm sites containing staff welfare facilities. Proven and effective measures to prevent the release of wastewater on site have been proposed above and will the potential source and each receptor. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on surface water (Drish River and its associated tributaries) or groundwater quality (Templemore and Thurles GWBs).

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

9.7.2.1.6 Assessment of Potential Effects on WFD Objectives

Post-Mitigation Residual Effects:

There is no direct discharge from the Site to downstream receiving surface waters or the underlying GWBs. Mitigation for the protection of surface and groundwater during the construction phase of the Proposed Development will ensure the qualitative and quantitative status of the receiving waters will not be altered by the Proposed Development.

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

The residual effect on Groundwater Bodies will be - No residual effect.

The residual effect on Surface Water Bodies will be - No residual effect.

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

9.7.2.2 Proposed Grid Connection

No works will be completed along the proposed GC route during the Operational Phase. Therefore, there is no potential for effects to occur on the hydrological or hydrogeological environment.

9.7.2.3 Turbine Delivery Route

No works will be completed along the TDR during the Operational Phase. Therefore, there is no potential for effects to occur on the hydrological or hydrogeological environment.

9.7.3 <u>Decommissioning</u>

9.7.3.1 Proposed Wind Farm

The effects of the works completed during the decommissioning phase will be similar to the construction phase but of a reduced magnitude. Similar mitigation measures to the construction phase will be implemented to ensure that there are no significant effects on the receiving environment.

9.7.3.2 Grid Connection

Post-Mitigation Residual Effects: No residual effects will occur.

Significance of Effects: No significant effects on hydrological / hydrogeological environment will occur.

9.7.3.3 Turbine Delivery Route

Post-Mitigation Residual Effects: No residual effects will occur.

Significance of Effects: No significant effects on hydrological / hydrogeological environment will occur.

9.8 Cumulative Effects

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

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the hydrogeological setting of the Site (i.e. low permeability peat, silts and clays overlying a poor bedrock aquifer) and the near surface nature of construction activities, cumulative impacts with regard groundwater quality or quantity arising from the Proposed Development are assessed as not likely. It is noted that some very limited groundwater recharge may be occurring in Littleton Bog but the recharge rates are likely small and the zones of recharge are of limited extent (where the peat is underlain by permeable granular subsoils).

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

A cumulative hydrological and hydrogeological study area has been delineated based on a quantitative flow analysis. This assessment is based on flow volumed obtained from the EPA Hydrotool Nodes downstream of the Site. The assessment concludes that due to dilution, no hydrological cumulative effects will occur beyond EPA Hydrotool Node 16_3525 on the Drish River. In order to be conservative the cumulative area has been extended further downstream to the confluence of the Drish River and the River Suir (EPA Node: 16_1530). With the large flow volumes present in the Suir River, there will be no potential for cumulative effects downstream of this confluence. Therefore, the cumulative study area comprises the catchment of the Drish River and has a total area of ~205km^2. This area is also considered to be sufficient in terms of any potential cumulative groundwater effects as groundwater at the site flows to the west, towards the River Suir.

The cumulative study area for the proposed GC route is limited to a 200m buffer zone along the Grid Connection. This study area has been deemed sufficient from a hydrological perspective due to the minor nature of the proposed works along the proposed GC route. These works are similar to all common roadworks completed across the country. The combined cumulative study area is presented in Figure 9-16.

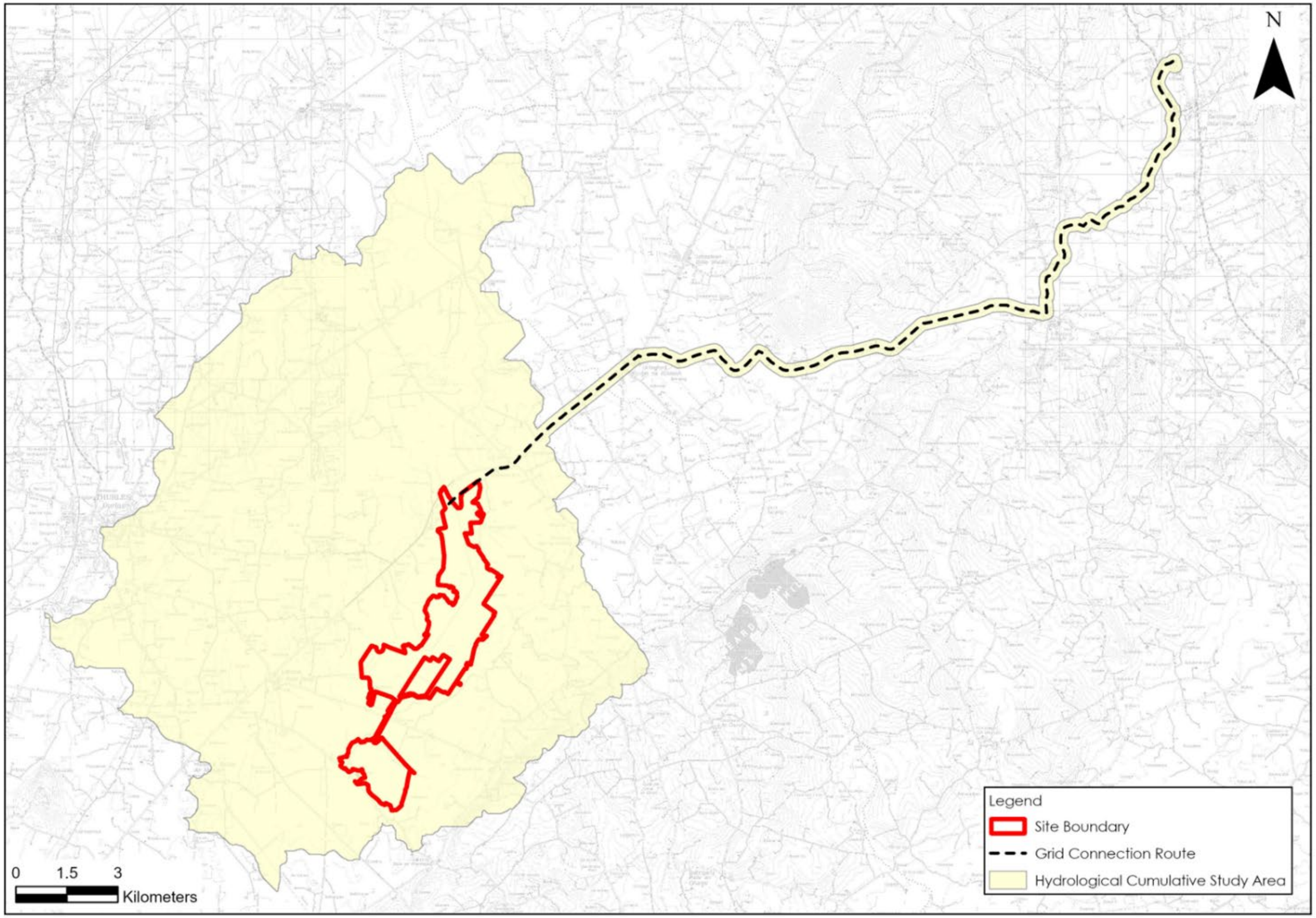

Figure 9-16: Cumulative Study Area

9.8.1 Cumulative Effects with Turbary Peat Cutting

Private peat cutting on turbary plots will likely continue at the Site. The construction phase of the Proposed Development may interact with these turbary activities and result in a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

However, the areas of private peat cutting will be infinitely small, significantly limiting the potential for cumulative effects to arise with the Proposed Development. Nevertheless, the mitigation measures detailed in Section 9.5.1, 9.5.2 and 9.5.3 for the construction, operation and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

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

9.8.2 Cumulative Effects with Agriculture

The Site is situated in the River Suir surface water catchment within which agriculture is the largest land use. Corine land cover maps (1990 – 2018) show that the majority of lands in the Suir catchment are being used for agricultural purposes.

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

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

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

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

9.8.3 Cumulative Effects with Commercial Forestry

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

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

Due to the close proximity of these areas of these forestry activities to the Site and given that they drain to the same river waterbodies (Drish River and its tributaries) as the Site, the potential cumulative impacts on downstream water quality and quantity need to be assessed.

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

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

9.8.4 Cumulative Effects with the Proposed Cutaway Bog Decommissioning and Rehabilitation Plans

Bord na Móna intend to utilise the Littleton Bog Group for both peatland rehabilitation and wind energy infrastructure in order to facilitate environmental stabilisation of the bog group.

Cutaway Bog Decommissioning and Rehabilitation Plans have been implemented in order to meet the requirements of the IPC licence. 3 no. separate Cutaway Bog Decommissioning and Rehabilitation Plans have been prepared for the bogs comprising the Site: Cutaway Bog Decommissioning and Rehabilitation Plan - Littleton (2026), Cutaway Bog Decommissioning and Rehabilitation Plan - Longfordpass (2026) and Lanespark, Ballybeg & Derryvella Bog Cutaway Bog Decommissioning and Rehabilitation Plan (2025). These plans detail the restoration and rehabilitation measures implemented to date and the proposed measures to be implemented, and have been subject to consultation as well as input from the EPA prior to their implementation. Activities associated with these plans have been implemented at the Site since the cessation of peat extraction activities in 2017. The activities completed to date include the Phase 1 Rehabilitation works and consisted of the removal of stockpiles, the removal of railway infrastructure (from Lanespark Bog). Extensive drain blocking has also been completed at the Site. Future Phase 2 Rehabilitation works, which include targeted drain blocking and fertiliser application, are only proposed with Derryvella and Ballybeg bogs, outside of the Site boundary. However, there is the potential for cumulative effects as Derryvella Bog and Lanespark Bog both have outfalls to the North Glengoole Stream.

The overall footprint of the Proposed Development is <2% of the total area of the total Site area (1,177ha). The Cutaway Bog Decommissioning and Rehabilitation Plans for each of the bogs comprising the Site will be updated to incorporate the Proposed Development infrastructure, with the key objectives of the rehabilitation plans i.e. rewetting and revegetation, occurring between and surrounding the Proposed Development infrastructure.

The main risk to downstream surface water quality and the underlying groundwater quality will occur whilst the restoration measures associated with the Phase 2 Rehabilitation works are being implemented. The construction phase of the Proposed Development will overlap with the implementation of the Phase 2 Rehabilitation works at Derryvella Bog. This will result in increased activity in the wider bog area. The increased activity will result in greater peat disturbance which has the potential to result in elevated concentrations of suspended solids in runoff. The increased activity will also heighten the risk of hydrocarbon spills and leaks. However, all works completed as part of the Cutaway Bog Decommissioning and Rehabilitation Plans, will be completed in accordance with IPC licence requirements and using standard best practice measures. This will ensure that there will be no negative effect on downstream surface water quality or quantity or underlying groundwater quality.

During the operational phase of the Cutaway Bog Decommissioning and Rehabilitation Plans, the remedial works, such as drain blocking, will have been completed and there will be little activity on-site with the exception of monitoring and maintenance. The additional volumes of surface water runoff created by the construction of the Proposed Development infrastructure will be further attenuated within the Site following the implementation of the rehabilitation measures. The rehabilitation plans will improve both surface water quality and attenuation within the Site and in the wider bog area, by slowing the movement of water and the stabilisation of substrates.

There will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Development and the existing Cutaway Bog Decommissioning and Rehabilitation Plans for the bogs comprising the Site.

9.8.5 Cumulative Effects with Other Wind Farm Developments

All consented, proposed and operational wind farms within 20km of the Site are detailed in Table 4-1 Chapter 4 of this EIAR. Of the identified wind farms only 3 no. wind farms are located within the delineated hydrological study area. These include the operational Lisheen Wind Farm 1, Lisheen Wind Farm 3 and Bruckana Wind Farm. These wind farms are located in the northern section of the delineated cumulative study area and drain towards the Drish River. All other wind farm development are located outside of the delineated cumulative study area and have no potential to result in in-combination effects with the Proposed Development.

Table 9-22 below identifies operational, consented and proposed wind farms within the hydrological cumulative study area. These wind farms have already been constructed, significantly reducing the potential for cumulative effects with the Proposed Development. The EIARs for these wind farms detail mitigation measures for both the operation and decommissioning phases to ensure that there will be no significant effects on the water environment. Similarly, this chapter details strict, tried and tested, best practice mitigation measures for the protection of the water environment during the construction, operation and decommissioning phases. Therefore, there is no potential for significant cumulative effects with other wind farm developments.

Table 9-22: Wind Farm Developments within Cumulative Study Area

Wind Farm Name	Status	Total No. Turbines	River Sub-Basin within study area
Lisheen Wind Farm Phase 1	Operational	18	Drish_040
Lisheen Wind Farm Phase 3	Operational	8	Drish_030
Bruckana Wind Farm	Operational	14	Drish_040

9.8.6 Cumulative Effects with Other Wind Farm Grid Connection Routes

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

- 300m overlap with the grid connection underground cabling route associated with the proposed Farranrory Wind Farm. The overlap occurs along the N77. Both grid connections are proposed to cross the Nore via HDD at different locations;
- ~10km overlap with the grid connection underground cabling route associated with the proposed Briskalagh Wind Farm. The overlap occurs along the R694 from Freshford to the N77, and along the N77 as far as the HDD crossing locations under the River Nore; and,
- The HDD crossing over the Nore is also located in the vicinity of the proposed HDD crossing for the grid connection associated with the proposed Seskin Wind Farm.

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

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

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

9.8.7 Cumulative Effects with Other Developments

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

The planning applications identified within the study area are typically for new dwellings or renovations of existing dwellings, associated wastewater treatment systems as well as for the erection of farm buildings. The planning applications have been reviewed based on their type, scale and proximity to the Site. 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 Development (construction, operation and decommissioning phases).

Other notable developments within the cumulative hydrological study area include the Midlands Trail Network which proposes to connect a recreational shared cycle path and walkway into the existing Loch Dhoire Bhile Loop (Planning Reference No: 2560154). Due to the scale of these works, and with the implementation of mitigation measures prescribed in this chapter, there would be no potential for significant cumulative effects with the Proposed Project.

A healthcare waste treatment and recycling facility has been granted permission at Kilronan (Planning Reference No: 2460978) and a biomethane and bio-based fertiliser production facility has been granted permission at the site of the former Lisheen Mine (Planning Reference No: 2460936). These sites are located within the cumulative study area and drain to the Drish River. The applications were accompanied by EIARs which prescribed detailed mitigation measures for the protection of the local water environment. Similarly, the mitigation and best practice measures proposed in this EIAR chapter will ensure that the construction of the Proposed Project does not have the potential to result in significant effects on the hydrological/hydrogeological environment. There is no potential for significant cumulative effects.

A desk study of planning applications within 200m of the proposed GC route was undertaken. The majority of these applications relate to the construction or renovation/extension of domestic dwellings, which will not generate potential cumulative effects due to their scale. However, in the vicinity of Ballyragget substation there are applications for the construction battery energy storage systems. A hydrological and hydrogeological assessment report and drainage strategy was submitted along with the Environmental Report for the Power Reserve Project at Ballyragget. This report detailed mitigation measures for the protection of the hydrological and hydrogeological environment through all phases of the development. Furthermore, Uisce Éireann propose to upgrade Togher Crescent Wastewater Pumping Station (WwPS) in Urlingford (Planning Ref No: 2460666) in close proximity to the proposed GC route. Other notable developments along the proposed GC route include the provision of the playing field at Emeralds GAA Club, Urlingford and associated works (Planning Reference Number: 2360102) and the construction of 43 no. dwellings at Freshford (Planning Reference Number: 2460183). An anaerobic digestion plant is also proposed at Glanbia, Ballyragget (Planning Reference Number: 22687).

However, the works along the proposed GC route are minor and transient, similar to roadworks being completed across the country and have no potential for significant cumulative effects on the hydrological or hydrogeological environment.

9.9 Major Accidents

The main risk of MADs at peatland sites is related to peat stability. However, there is no record of peat instability or historic peat slides at the Site. A peat stability risk assessment (**Appendix 8.1**) has been completed for the Site and it concludes that with the implementation of the proposed mitigation measures that the risk of a peat failure at the Site is negligible/none.

Flooding can also result in downstream MADs. However, the rehabilitation and restoration of the Site will increase surface water retention/attenuation at the Site through drain blocking, re-profiling and the restoration of the bog hydrogeological regime. This will reduce the risk of flooding downstream of the Site.

9.10 Assessment of Health Effects

Potential health effects arise mainly through the potential for surface and groundwater contamination which may have negative effects on public and private water supplies. The impact assessment presented in this chapter concludes that with the implementation of the prescribed mitigation measures that there will be no potential for significant effects on any surface water or groundwater supply.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues. A detailed Stage III Flood Risk Assessment has been caried out for the Proposed Development, summarised in Section 9.3.8. This Flood Risk Assessment, combined with the assessment of changes in permeable surfaces (Section 9.5.2.1.1) demonstrates that the risk of the Proposed Development contributing to downstream flooding is insignificant. On-site (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

9.11 References

CIRIA, 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006).

CIRIA, 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.

DoHLG, 2006: Wind Farm Development Guidelines for Planning Authorities.

DOE/NIEA (2015): Wind Farms and Groundwater Impacts – A guide to EIA and Planning Considerations

EPA (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports.

EPA (2024): 3rd Cycle Suir Catchment Report.

EPA (2024): 3rd Cycle Nore Catchment Report.

GSI (2004): Thurles GWB: Summary of Initial Characterisation.

GSI (2004): Durrow GWB: Summary of Initial Characterisation.

GSI (2004): Templemore GWB: Summary of Initial Characterisation.

GSI (2004): Shanahoe GWB: Summary of Initial Characterisation.

GSI (2004): Rathdowney GWB: Summary of Initial Characterisation.

IFI, 2016: Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters, Inland Fisheries Ireland (2016).

IGI, 2013: Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements, (Institute of Geologists Ireland, 2013).

NRA, 2008: Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, (National Roads Authority, NRA, 2008).

PPG1 - General Guide to Prevention of Pollution (UK Guidance Note).

PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note).

SNH, 2010: Scottish Natural Heritage report (SNH): Good Practice During Wind Farm Construction.

SNH, 2013: Scottish Natural Heritage report (SNH): Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms

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