9 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

This chapter assesses the impacts of the Development (**Figure 1.2**) on the hydrology and hydrogeology resources of the Site. Where negative effects are predicted, this chapter identifies appropriate mitigation strategies. The assessment will consider the potential effects during the following phases of the Development:

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

The Development refers to all elements of the application for the construction, operation and decommissioning of the Dyrick Hill Wind Farm (**Chapter 2: Development Description**).

Common acronyms used throughout this EIAR can be found in **Appendix 1.2**
This chapter of the EIAR is supported by Figures provided in **Volume III** and the following Technical Appendices provided in Volume IV of this EIAR:

- **Appendix 9.1** Photographic Plates
- **Appendix 9.2** Laboratory Certificates
- **Appendix 9.3** Water Framework Directive Compliance Assessment

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This CEMP will be a key construction contract document, which will ensure that all mitigation measures, which are set out in the EIAR and considered necessary to protect the environment are implemented. For the purpose of this application, a summary of the mitigation measures is included in **Appendix 17.1**.

9.1.1 Statement of Authority

This chapter of the EIAR was prepared by David Parkinson (BSc., MIEMA, CEnv) and was reviewed by Andrew Garne. David is the Principal Environmental Consultant of EcoQuest Environmental with over a decade of environmental consultancy experience in Ireland and Australia. David has completed numerous hydrological and hydrogeological impact assessments, is a Full Member of the Institute of Environmental Management and Assessment (MIEMA) and is a Chartered Environmentalist (CEnv). David's experience spans multiple industry sectors or disciplines, including numerous windfarm projects, flood alleviation schemes, infrastructure projects, transport, aviation, wastewater schemes, contaminated land

and advisory on emerging contaminants. He has extensive experience in carrying out water quality assessments on major Irish rivers or their tributaries such as the Shannon, Dodder, Morell, Corrib, Broadmeadow, Finisk, Bandon and Garavogue rivers. In addition to nationwide water quality assessment experience, David has also assisted with water quality management of sensitive wetlands of international significance in Australia. David also has a background in water and wastewater chemistry laboratory analytical roles which help form the scientific basis of his environmental assessment expertise.

Andrew Garne (B.Sc., M.Sc., P.Geo) is an independent Engineering Geologist who specialises in hydrogeological, geotechnical and geological impact assessment. Andrew is a Full Member of the Institute of Geologists of Ireland (MIGI) and is a registered professional geologist (P.Geo). Andrew has worked on multiple EIAR impact assessments, including multiple windfarm developments, across the disciplines of hydrogeology, geology and soils. He also has extensive experience of windfarm peat stability assessments, geotechnical earthworks designs, geotechnical inspections and supervision, contaminated land assessments, slope stability assessments, site investigation design, procurement and supervision, soil and rock core logging, and writing of geotechnical advisory reports. Andrew has worked in tandem with David throughout the duration of this project, including in the field, at virtual meetings and through extensive collaboration. Andrew has provided input to, and has reviewed, this Chapter of the EIAR.

9.1.2 Assessment Structure

In line with the EIA Directive and the Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (2022), the structure of this Hydrology and Hydrogeology chapter is as follows:

- Details of methodologies utilised for both desk and field studies;
- Description of baseline conditions at the Site;
- Identification and assessment of impacts to hydrology and hydrogeology associated with the Development, during the construction, operational and decommissioning phases of the Development;
- Mitigation measures to avoid or reduce the impacts identified;
- Identification and assessment of cumulative impacts if and where applicable;
- Identification and assessment of residual impact of the Development considering mitigation measures;
- Summary of Significant Effects and Statement of Significance.

9.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

9.2.1 Assessment Methodology

The following calculations and assessments were undertaken in order to evaluate the potential impacts of the Development on the hydrological and hydrogeological aspects of the environment at the Dyrick Hill Wind Farm Site:

- Characterise the topographical, hydrological and hydrogeological regime of the Site from the data acquired through desk study and on-site surveys;
- Undertake water balance calculations;
- Undertake flood risk evaluations;
- Consider hydrological or hydrogeological constraints together with development design;
- Consider drainage issues, or issues with surface water runoff quality as a result of the Development, its design and methodology of construction;
- Assess the combined data acquired and evaluate any likely impacts on the hydrological and hydrogeological aspects of the environment;
- If impacts are identified, consider measures that would mitigate or reduce the identified impact;
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

9.2.2 Relevant Legislation and Guidance

This study complies with the EIA Directive, as amended, which requires Environmental Impact Assessment for certain types of major development before development consent is granted. The EIA Directive, as amended, is transposed inter alia by the Planning and Development Act 2000, as amended, and by the Planning and Development Regulations 2001, as amended.

In addition to this planning legislation, other environmental legislation relevant to hydrological and hydrogeological aspects of the environment were referred to:

- S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations 1988;
- S.I. No. 722 of 2003: European Communities (Water Policy) Regulations 2003;
- S.I. No. 106 of 2007: European Communities (Drinking Water) Regulations 2007;
- S.I. No. 684 of 2007: Waste Water Discharge (Authorisation) Regulations 2007;
- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009;

- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009;
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010;
- S.I. No. 499 of 2013: European Communities (Birds and Natural Habitats) (Amendment) Regulations 2013;
- S.I. No. 122 of 2014: European Union (Drinking Water) (No. 2) Regulations 2014;
- S.I. No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018;
- European Union Water Framework Directive (2000/60/EC), as amended; and,
- Directive 2006/118/EC on the protection of groundwater against pollution and deterioration (2006/118/EC) (the "Groundwater Directive").

The Water Framework Directive (WFD), which was passed by the European Union (EU) in 2000, and came into legal effect in December 2015, is wide-reaching legislation which replaces a number of the other water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the WFD. The fundamental objective of the WFD aims at maintaining "high status" of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least "Good" in relation to all waters by 2027 (WFD).

This study has been prepared using, inter alia, the following guidance documents, which take account of the aforementioned legislation:

- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines;
- Office of Public Works (OPW) (2019), Environmental Guidance: Drainage Maintenance and Construction;
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A Guide;
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry;

- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1;
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance;
- The Waterford City and County Development Plan 2022 – 2028.

The following additional sources of information have also been reviewed as part of this assessment:

- Environmental Protection Agency (2022) 3rd Cycle Draft Blackwater Munster Catchment Report (HA18);
- Department of Housing, Planning and Local Government (2018) River Basin Management Plan for Ireland, 2018 – 2021;
- Met Eireann (2007), Technical Note 61, Estimation of Point Rainfall Frequencies, D.L. Fitzgerald, 2007;
- Met Éireann (2012) A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14; and,
- Hunter Williams, N.H., Misstear, B.D., Daly, D. and Lee, M. (2013) Development of a National Groundwater Recharge Map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology.

9.2.3 Desk Study

A desk study consisting of a review of all available datasets, information, and literature resources relevant to the Site has been completed. The most current datasets and information maintained by the Environment Protection Agency (EPA), Geological Survey of Ireland (GSI) and the Office of Public Works (OPW) were reviewed to assist in establishing the hydrological and hydrogeological characterisation of the Site.

Relevant documents and datasets used to assist in compiling the desk study included EPA water quality data, topography maps and GSI hydrogeological data. The following full list of sources and information were utilised to establish the baseline environment:

- Department of Housing, Planning and Local Government, National River Basin Management Plan 2018-2021 https://www.housing.gov.ie/water/water-quality/river-basin-management-plans/river-basin-management-plan-2018-2021

- Department of Housing, Planning and Local Government, Draft River Basin Management Plan 2022-2027 https://www.gov.ie/en/consultation/2bda0-public-consultation-on-the-draft-river-basin-management-plan-for-ireland-2022-2027/
- EPA Map Viewer, Water Framework Directive (WFD), surface water and hydrogeological features https://gis.epa.ie/EPAMaps/Water
- EPA HydroNet, Surface water levels, flows and groundwater levels http://www.epa.ie/hydronet/#Water%20Levels
- Office of Public Works (OPW), Preliminary Flood Risk Assessment (PFRA) https://www.gov.ie/en/publication/1c7d0a-preliminary-flood-risk-assessment-pfra
- Office of Public Works (OPW), National Flood Information Portal https://www.floodinfo.ie
- Ordnance Survey Ireland, Map Viewer http://map.geohive.ie/mapviewer.html
- National Parks and Wildlife Service (NPWS), Protected Sites Map-Viewer https://www.npws.ie/protected-Sites
- The Geological Survey of Ireland (GSI), groundwater data and maps https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx
- The Geological Survey of Ireland (GSI), karst features database https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-irish-karst/Pages/Karst-databases.aspx
- Myplan.ie; National Planning Application Map Viewer https://myplan.ie/national-planning-application-map-viewer
- Sustainable Energy Authority of Ireland (SEAI), Wind Atlas https://www.seai.ie/technologies/seai-maps/wind-atlas-map/
- Met Éireann Meteorological Data https://www.met.ie/climate/available-data/historical-data
- Department of Housing, Planning and Local Government, EIA Portal https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal
- Map of Irish Wetlands (2021) http://www.wetlandsurveysireland.com/wetlands/map-of-irish-wetlands--/map-of-irish-wetlands---map/

9.2.4 Field Work

A preliminary field investigation and hydrological survey to inform the baseline hydrological conditions of the Site was undertaken by David Parkinson (BSc., MIEMA, CEnv) and Andrew Garne (B.Sc., M.Sc., MIGI, P.Geo) on 12th/13th of July 2021. Two subsequent rounds of field investigation surveys were conducted on 1st/2nd of July 2022 and on 2nd/3rd of December 2022. The field investigations consisted of the following works:

- Walkover surveys of the Site to identify and record hydrological features. The locations of surface water features including rivers, drainage patterns, ditches, wetlands and flow directions etc. were recorded;
- Field hydrochemistry measurements were recorded on surface water features at multiple locations across the Site for parameters including Ph, electrical conductivity (EC), dissolved oxygen (DO), total dissolved solids (TDS) and temperature. These measurements were taken to assist in informing the origin of the surface water and also to provide an overview of the baseline water quality conditions at the Site;
- Collection of surface water samples at representative locations across the Site and transportation to an Irish National Accreditation Board (INAB) accredited laboratory for analysis.

  Upon completion of the field surveys, the data collected was reviewed and mapped for further analysis against applicable water quality screening criteria. The captured field data was overlain against the publicly available datasets listed in Section 9.2.3 such as those from the EPA, GSI, OPW, OSI and catchments.ie in September 2022.

9.2.5 Evaluation of Potential Effects

9.2.5.1 Sensitivity

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

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

To facilitate the qualification of hydrological and hydrogeological attributes, guidance specific to hydrology and hydrogeology as set out by National Roads Authority (NRA) 2008, has been used in conjunction with EPA guidance. The following table presents rated categories and criteria for rating Site attributes (NRA, 2008).

Table 9.1: Criteria for Rating Site Attributes – Hydrology and Hydrogeology Specific

Importance	Criteria	Typical Examples
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 Natural Habitats Regulations, the Birds Directive or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988. • 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, significance or value on a regional or national scale	• River, wetland or surface water body ecosystem protected by national legislation – NHA status • Regionally important potable water source supplying >2500 homes Quality Class A (Biotic Index Q4, Q5) • Flood plain protecting more than 50 residential or commercial properties from flooding • Nationally important amenity Site for wide range of leisure activities • Regionally Important Aquifer with multiple wellfields • Inner source protection area for regionally important water Source.
High	Attribute has a high quality, significance or value on a local scale	• Salmon fishery • Locally important potable water source supplying >1000 homes • Quality Class B (Biotic Index Q3-4) • Flood plain protecting between 5 and 50 residential or commercial properties from flooding • Locally important amenity Site for wide range of leisure activities • Regionally Important Aquifer • Groundwater provides large proportion of baseflow to local rivers.
Medium	Attribute has a medium quality, significance or value on a local scale	• Coarse fishery • Local potable water source supplying >50 homes • Quality Class C (Biotic Index Q3, Q2- 3) • Flood plain protecting between 1 and 5 residential or commercial properties from flooding • Locally Important Aquifer • Outer source protection area for locally important water source.
Low	Attribute has a low quality, significance or value on a local scale	• Locally important amenity Site for small range of leisure activities • Local potable water source supplying < 50 homes • Quality Class D (Biotic Index Q2, Q1) • Flood plain protecting 1 residential or commercial property from flooding • Amenity Site used by small numbers of local people • Poor bedrock aquifer.

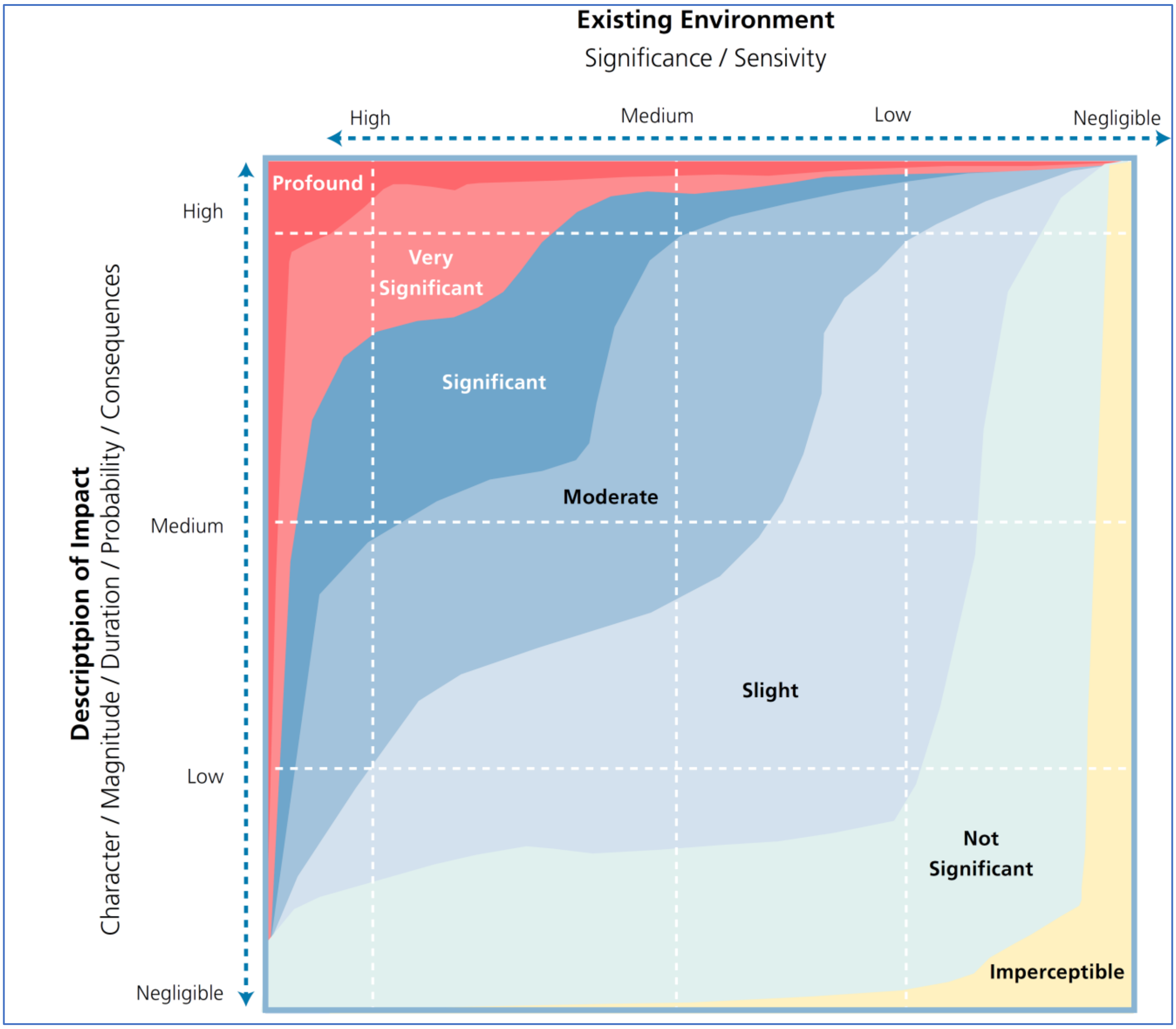
The sensitivity of the receiving hydrological and hydrogeological environment is defined by the baseline quality, as well as its potential to absorb change and for substitution, as defined in **Table 9.2** and **Figure 9.1**. The sensitivity of each receptor has been assessed using professional judgement and described with a standard semantic scale. The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the receiving aquatic and geological environment, including international and national designations, surface water, groundwater and soil quality information, waterbody status from the WFD review work undertaken to date by the EPA, consultations and professional judgement.

Table 9.2: Receptor Sensitivity Criteria

Sensitivity	Definition	Example Criteria
High	Receptor with national or international importance (i.e. SAC or SPA), a high quality and rarity on a regional or national scale and limited potential for substitution or replacement	• Surface water WFD class of "High" • European Commission (EC) designated Salmonid or Cyprinid waters • Drinking water protected area (DWPA) • Regionally important aquifer with abstractions for public drinking water supply • GSI groundwater vulnerability "Extreme" classification • Supporting a Site protected under EC habitat legislation / species protected by EC legislation • Protected bathing water area • Active floodplain • Highly Groundwater Dependent Terrestrial Ecosystems (GWDTE) • Qualifying characteristics for class 1 priority peatland habitat, all vegetation cover indicates priority peatland habitat all soils are carbon rich soils and deep peat
Medium	Receptor with regional or county level importance with a medium quality and rarity on a regional scale and limited potential for substitution or replacement	• Surface water WFD class of "Good" or Moderate • GSI groundwater vulnerability "High" classification • Locally important aquifer • Local or regional ecological status /locally important fishery • Contains some flood alleviation features • Moderately GWDTE • Qualifying characteristics for peatland habitat, most vegetation cover indicates priority peatland habitat; all soils are carbon rich soil and deep peat
Low	Receptor is of limited or local importance only on a Site or in proximity to a Site with low quality and rarity on a localised scale. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.	• Surface water WFD class of "Poor" • Fish only sporadically present • No abstractions for public or private water supplies • GSI groundwater vulnerability "Low" or "Medium" classification • Aquifer importance is "Poor" • No natural flood alleviation features • Qualifying characteristics for vegetation cover does not indicate priority peatland habitat

Considering the above categories of sensitivity and associated criteria, the diagram shown in **Figure 9.1** presents how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact (EPA, 2022).

Figure 9.1: Comparison of the Character of the Predicted Impact to the Sensitivity of the Receiving Environment (EPA, 2022)



9.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in **Table 9.3** (EPA, 2022). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline tends, for example, a "*Moderate"* impact is one which is consistent with the existing or emerging trends.

Table 9.3: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An effect capable of measurement but without noticeable consequences
Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate	An effect that alters the character of the environment in a manner consistent with existing and emerging baseline trends
Significant	An effect, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
Very significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
Profound	An effect which obliterates sensitive characteristics.

In terms of hydrology and hydrogeology, magnitude is qualified in line with relevant guidance, as presented in the following tables (NRA, 2008). These descriptive phrases are considered development specific terms for describing potential effects of the Development, and do not provide for considering baseline trends and therefore are utilised to qualify impacts in terms of weighting impacts relative to Site attribute importance, and scale where applicable.

Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes

Magnitude of Impact	Description	Examples
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	• Loss or extensive change to a waterbody or water dependent habitat, or • Calculated risk of serious pollution incident >2% annually, or • Extensive loss of fishery
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Partial reduction in amenity value, or • Calculated risk of serious pollution incident >1% annually, or • Partial loss of fishery
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Slight reduction in amenity value, or • Calculated risk of serious pollution incident >0.5% annually, or • Minor loss of fishery
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• Calculated risk of serious pollution incident <0.5% annually

Magnitude of Impact	Description	Examples
Minor Beneficial	Results in minor improvement of attribute quality	• Calculated reduction in pollution risk of 50% or more where existing risk is <1% annually
Moderate Beneficial	Results in moderate improvement of attribute quality	• Calculated reduction in pollution risk of 50% or more where existing risk is >1% annually
Major Beneficial	Results in major improvement of attribute quality	• Reduction in predicted peak flood level >100mm

Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes

Magnitude of Impact	Description	Example
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	• Removal of large proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems, or • Potential high risk of pollution to groundwater from routine run-off.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Removal of moderate proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems, or • Potential medium risk of pollution to groundwater from routine run-off.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Removal of small proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems, or • Potential low risk of pollution to groundwater from routine run-off.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• Calculated risk of serious pollution incident on hydrogeological attributes <0.5% annually.

9.2.5.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential impacts, rating of significant environmental impacts is carried out in accordance with relevant guidance as presented in the **Table 9.6** below (NRA, 2008). This matrix qualifies the magnitude of potential effects based on weighting factors depending on the importance and/or sensitivity of the receiving environment. In terms of Hydrology and Hydrogeology, the general terms for describing potential effects **(Table 9.3: Describing the Magnitude of Impacts**) are linked directly with the development specific terms for qualifying potential impacts (**Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes** and **Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes**).Therefore, qualifying terms (**Table 9.6**) are used in describing potential impacts of the Development.

Table 9.6: Weighted Rating of Significant Environmental Impacts

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

9.2.5.4 Scoping Responses and Consultation

Information has been provided by a number of consultee organisations during the assessment, the responses with relevance to this chapter have been summarised in

Table 9.7. The response to each point raised is also presented within the table, demonstrating where the design of the Development has addressed responses to specific issues raised.

Table 9.7: Scoping Responses and Consultation with Relevance to this Chapter

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
Irish Peatland Conservation Council (IPCC)	Letter in response to Scoping Report Received 18 July 2022	• *"We are legally bound by National and European legislation (The Wildlife Acts, EU Habitats and Bird's Directives) and international conventions (Ramsar, Bern Convention, Convention on Biological Diversity) to do our utmost to protect peatlands now and for future generations."* • *"In particular, developments have the potential to disrupt the hydrology of peatland and even small impacts to the water table may have disastrous consequences for specialised peatland species that live within minimal ranges of chemical and hydrological limits, such as the Vertigo whorl snails."* • *"An appropriate distance from the proposed project area, depending on the possible source of detrimental influence (such as hydrology) has to also be included within any proposed plan that has the potential to disrupt the natural environment."* • *"The proposed development needs to account for nitrogen within pre-planning coupled with a nitrogen monitoring agenda which could highlight possible pathways of nutrient enrichment"* • *"Ireland has legal obligations under the WFD to ensure that all rivers and lakes are of "Good Ecological Status" by 2027. Please ensure that the proposed development will not adversely impact on the water quality and lower Ireland's standing with our legal obligations in protecting our waterways. Silt runoff and chemical/construction pollution can be disastrous for aquatic wildlife and this should also be factored into the management and construction plans of the proposed development. The monitored rivers surrounding the proposed development area range from "Moderate", "Good" and "High". The proposed development should not be allowed to go*	• The site has been surveyed, due to the absence of any detected peat deposits at the site, the area is not considered to be "*peatlands*". Full survey details are outlined in **Chapter 8: Lands, Soils and Geology.** • The site has been surveyed, due to the absence of any detected peat deposits at the site, the area is not considered to be "*peatlands*". Full survey details are outlined in **Chapter 8: Lands, Soils and Geology.** • **Section 9.3.20** outlines how a self-imposed buffer zone of 50m between the proposed works and all watercourses will be implemented. • Total nitrogen, nitrite as NO_2 and Nitrate as NO_3 have all formed part of the water quality monitoring programme as is discussed in **Section 9.3.10** where possible pathways for nutrient enrichment is also addressed. The same parameters would continue to be monitored during the operational phase of the water quality monitoring programmes as discussed in **Section 9.5.2.11**. • There are no lakes located within the proposed Site boundary nor adjacent to the proposed grid connection route to Killadangan as can be seen on **Figure 9.3** in **Volume III**. All rivers and streams within and adjacent to the site boundary have been mapped in addition to those located along the proposed grid connection route to Killadangan. Mitigation measures for potential impacts on water sources are contained in **Section 9.5**. A water quality monitoring programme has been carried out as is discussed in **Section 9.3.10**. A Water Framework

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		ahead if any degradation of the aquatic habitats is possible as an outcome. There may also be rivers or waterways that are not monitored by the Environmental Protection Agency and these should also be evaluated ecologically and hydrologically to and included in pathways of influence assessments." • *"It is IPCC's understanding that the peat soils will still be drained while the turbine (hardstands) are being constructed and operational. What will be the impact of this on the Water Framework Directive and carbon storage compared to straight restoration of the habitat, such as forestry removal and drain blocking?*	Directive Compliance Assessment has also been prepared, it is attached to **Appendix 9.3.** With the implementation of the proposed mitigation measures, a deterioration in WFD status is not anticipated in any waterbody. • The site has been surveyed, it is not considered to be located on peatland as is outlined in **Chapter 8: Lands, Soils and Geology.** Mitigation measures for potential impacts on water sources are contained in **Section 9.5**.
Geological Survey of Ireland (GSI)	Letter in response to Scoping Report Received 26 April 2022	• *"Geological Survey Ireland would encourage use of and reference to our datasets. Please find attached a list of our publicly available datasets that may be useful to the environmental assessment and planning process. We recommend that you review this list and refer to any datasets you consider relevant to your assessment."* • *"Proposed developments need to consider any potential impact on specific groundwater abstractions and on groundwater resources in general. We recommend using the groundwater maps on our Map viewer which should include: wells; drinking water source protection areas; the national map suite - aquifer, groundwater vulnerability, groundwater recharge and subsoil permeability maps."* • *"We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in your EIAR to assess potential impacts to groundwater."* • *"A Groundwater Protection Scheme provides guidelines for the planning and licensing authorities in carrying out their functions, and a framework to assist in decision-making on the location, nature and*	• All relevant GSI datasets have been thoroughly investigated, assessed and mapped, including aquifer vulnerability mapping (**Figure 9.14)**, groundwater body mapping (**Figure 9.15**), wells, springs, boreholes and source protection areas (**Figure 9.16**). The GSI Map Viewer has been reviewed and referenced for groundwater recharge and subsoil permeability in carrying out the water balance calculations in **Section 9.3.7**. • Groundwater abstraction and resources has been assessed in **Section 9.3.12** (Wells) and in **Section 9.3.19** (Water Resources). Mitigation measures for the protection of groundwater are outlined in **Section 9.5.2.8**. The GSI Map Viewer has been reviewed and referenced for groundwater recharge and subsoil permeability in carrying out the water balance calculations in **Section 9.3.7**. • GSI data has been utilised to produce the groundwater vulnerability map as shown on **Figure 9.14** and groundwater vulnerability is assessed in **Section 9.3.13**. • The Co. Waterford Groundwater Protection Scheme Report has been reviewed. Inner and outer source protection areas in the region have been identified and are mapped as shown on **Figure 9.1.6** with an assessment also provided in Section **9.3.19**.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		control of developments and activities in order to protect groundwater." • *"Tellus is a national-scale mapping programme which provides multi-element data for shallow soil, stream sediment and stream water in Ireland. At present, mapping consists of the border, western and midland regions. Data is available at https://www.gsi.ie/en-ie/data-and-maps/Pages/Geochemistry.aspx."*	• The Tellus programme has been reviewed for both "*stream sediment*" and "*stream water*". Coverage of the Site area and grid connection route are not provided for under this programme at the time of preparing this Chapter.
Uisce Éireann (Formerly Known as Irish Water)	Letter in response to Scoping Report Received 20 October 2022	• *"Where the development proposal has the potential to impact an Irish Water Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Irish Waters Drinking Water Source(s) during the construction and operational phases of the development. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified as part of the report."* • *"Mitigations should be proposed for any potential negative impacts on any water source(s) which may be in proximity and included in the environmental management plan and incident response."* • *"Any and all potential impacts on the nearby reservoir as public water supply water source(s) are assessed, including any impact on hydrogeology and any groundwater/ surface water interactions."* • *"Impacts of the development on the capacity of water services (i.e. do existing water services have the capacity to cater for the new development)."*	• Waterford County Council and Irish Water were consulted for information pertaining to public and private water supplies at the Site and along the grid connection route. An assessment of public and private water supplies that could potentially be impacted by the proposed Development is outlined in **Section 9.3.19**. Potential impacts on public or private water mains networks are expected to be negligible. The hydrological/hydrogeological pathways from the proposed Development and the locations of water supply zones, source protection areas, GSI mapped boreholes, wells and springs; relative to the proposed site and the grid connection route, are mapped in **Figure 9.16** in **Volume III**. Further details on the hydrological / hydrogeological pathways from the proposed Development are outlined in the Water Framework Directive Compliance Assessment contained in **Appendix 9.3**. • Mitigation measures are outlined in Section 9.5 and in the Construction Environmental Management Plan (CEMP) appended to the EIAR in **Appendix 2.1**. • An assessment of public and private water supplies that could potentially be impacted by the proposed Development is outlined in **Section 9.3.19**. • **Section 9.3.22** confirms that the extraction of groundwater from boreholes for water supply will not be required for either the construction or operational phase of the project. All

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
			potable water will brought to site via a tank truck.
		• *"When considering a development proposal, the applicant is advised to determine the location of public water services assets, possible connection points from the applicant's site / lands to the public network and any drinking water abstraction catchments to ensure these are included and fully assessed in any pre-planning proposals. Details, where known, can be obtained by emailing an Ordnance Survey map identifying the proposed location of the applicant's intended development to datarequests@water.ie."*	• An assessment of public and private water supplies that could potentially be impacted by the proposed Development is outlined in **Section 9.3.19**. The hydrological / hydrogeological pathways from the proposed Development and the locations of water supply zones, source protection areas, GSI mapped boreholes, wells and springs; relative to the proposed site and the grid connection route, are mapped in **Figure 9.16** in **Volume III** and in **Appendix 9.3**.
		• *"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 Irish Water for public supply should be identified within the report."*	• An assessment of public and private water supplies that could potentially be impacted by the proposed Development is outlined in **Section 9.3.19**.
		• *"Mitigation measures in relation to any of the above ensuring a zero risk to any Irish Water drinking water sources (Surface and Ground water)."*	• Mitigation measures are outlined in **Section 9.5** and in the Construction Environmental Management Plan (CEMP) appended to the EIAR in **Appendix 2.1**
Waterford County Council	Email response to Scoping Report Received 23 November 2022	• *"The site is immediately east of the Blue Dot Subcatchment of the Glenshelane River."* • *"Direct and indirect impacts on water quality from excavation and soil stability shall be given particular attention. The EIAR needs to demonstrate how the proposed development will impact on the objectives for protection of Blue Dot Catchments under the Water Framework Directive."*	• The westernmost extent of the Site drains to the Farnane River, none of the proposed development features are within the subcatchment area of the Glenshelane River as is mapped and outlined in and in **Appendix 9.3.** The proposed Development is not likely to result in a reduction of WFD status in any waterbody as is outlined in **Appendix 9.3.** • Direct and indirect impacts on water quality from excavation and soil stability are discussed in **Section 9.5**. The proposed Development is not likely to result in a reduction of "*High*" WFD status (i.e. Blue Dot waterbodies), or a reduction in any other WFD status in any waterbody as is outlined in **Appendix 9.3.**

9.3 BASELINE DESCRIPTION

9.3.1 Introduction

Planning permission is being sought by the Developer for the construction of 12 wind turbines, a permanent met mast, 110Kv on-site substation and all ancillary works and the construction of an underground grid connection to Dungarvan 110Kv Substation, Co. Waterford.

- Erection of 12 no. 6.0-7.2 MW wind turbines (Note* this is the current output available for the turbine of this size. It is possible that, with improvements in technology, the output may increase at the time of construction.) with an overall ground tip height of 185m. The candidate wind turbines will have a 162m rotor diameter and a hub height of 104m.
- Construction of Crane Hardstand areas and Turbine Foundations.
- Construction of new internal Site Access Tracks and upgrade of existing Site roads, to include passing bays and all associated drainage.
- Construction of a new wind farm Site entrance with access onto the R671 regional road in the townlands of Lickoran.
- Improvement of existing Site entrances with access onto local roads in the townlands of Broemountain.
- Improvements and temporary modifications to existing public road infrastructure to facilitate delivery of abnormal loads and turbine delivery.
- Construction of one Temporary Construction Compound with associated temporary site offices, parking area and security fencing.
- Development of on-site Borrow Pit.
- Installation of one Permanent Meteorological Mast up to a height of 110m.
- Development of a Site drainage network.
- Construction of one permanent 110 kV Substation.
- All associated Wind Farm Internal Cabling connecting the wind turbines to the Onsite Substation.
- All works associated with the connection of the wind turbines to the national electricity grid, which will be via 110 kV underground cable connection approximately 16.1km in length to the existing Dungarvan 110 kV Substation.
- Upgrade works on the Turbine Delivery Route from Waterford Port.
- Ancillary forestry felling to facilitate construction and operation of the Development.

A 15-year planning permission and 40-year operational life from the date of commissioning of the entire wind farm is being sought.

9.3.2 Site Description

The proposed wind farm Development is located within an area of farmland, forestry and upland heath, and is located within the townlands of Ballynaguilkee Upper, Broemountain, Corradoon, Dyrick, Lickoran, Lickoranmountain, Lisleagh, Lisleaghmountain, Lyrattin and Scartmountain. The Site is located 43km west of Waterford City, 55km northeast of Cork City, and 12.9km northwest of Dungarvan. The proposed grid connection passes through the townlands of Broemountain, Lyrattin, Farnane Lower, Farnane Upper, Castlequarter, Mountaincastle South, Carrigaun (Mansfield), Langanoran, Sleadycastle, Knockaunnaglokee, Garryduff, Colligan More, Garryclone, Colliganwood, Ballymacmague North, Ballymacmague South and Killadangan.

The Site is located across land which is predominantly underlain by sandstone rock and brown podzolic or podzol soils of coarse loamy drift with siliceous stones of the Knockmealdown, Knockboy and Ballycondon series. According to the Soil Information System National Soils Map, pockets of peat may exist at the north-western extent of the site although no peat has been identified at the site during the geotechnical surveys of the site which is discussed in **Chapter 8: Lands, Soils and Geology.** The National Soils Hydrology Map classifies the majority of the site as being poorly drained, particularly in the western and northern areas. The remainder of the site is classified as being well drained with the majority of these areas being located in the eastern and southern areas of the Site.

The proposed Site is located beyond the south-eastern extent of the Knockmealdown Mountains mountain range. The western, northern and southern extents of the site are typically more elevated than the central and eastern extents of the Site. The site is broadly surrounded by the three main peaks of Knocknasheega (428m) west of the Site boundary, Broemountain (429m) in the northern extent of the site and Dyrick Hill (286m) within the southern central portion of the site. The eastern and central extents of the site are generally relatively flat with elevations typically ranging from between 130m to 190m. The proposed Site extends to 462 hectares (ha).

Forestry and agricultural land uses, including dairy and sheep farming are the predominant land uses within the study area. Forestry plantations border the western extent of the proposed Site on an area of commonage land. Additional areas of forestry exist within the central, north-eastern and southern extents of the proposed Site. The Site is intersected by Broemountain Road (L5058) which is a narrow local secondary road. The Farnane River, which is a tributary of the Finisk River, rises near the north-western extent of the Site and flows along the western extent of the Site. The Lisleagh Stream, which is also a tributary of the Finisk River, rises in the central portion of the Site and flows in a south-easterly direction until it merges with the Finisk River, north of the townland of Woodhouse. The Aughkilladoon Stream, another tributary of the Finisk River rises at the south-eastern extent of the Site and flows in a south-easterly direction until it merges with the Finisk River, east of the townland of Woodhouse.

9.3.3 Topography

The topography of the Site is variable, and it is broadly surrounded by or is partially overlapping three elevated areas. These include Knocknasheega (428m) west of the Site boundary, Broemountain (429m) in the northern extent of the site and Dyrick Hill (286m) within the southern central portion of the site. The western, northern and southern peaks of the site are more elevated than the central and eastern extents of the Site which are relatively flat with lower elevations ranging from between 130m to 190m. The Site is generally topographically elevated in the north / north-west and generally topographically low lying in the south and east with the exception of Dyrick Hill (286) near the southern extent of the site. The steepest incline across the Site occurs at the northern extent of the Site near the proposed T8 position. A peat stability risk assessment (PSRA) has not been prepared due to the absence of observed peat at the site during the site surveys which are discussed in the **Lands, Soils and Geology (Chapter 8)**.

The Farnane River, the Lisleagh Stream and the Aughkilladoon Stream are the main surface water bodies that drain the site. All of these surface waters are tributaries of the Finisk River which flows to the east and south-east of the proposed Site. The site is also drained by a network of artificial drainage ditches, many of which are located adjacent to field boundaries, particularly in the central and western extents of the Site. A number of small natural and artificial drains also exist at the western commonage area of the proposed Site. Two potential wetlands exist at the site, located east and west of the proposed T4 position. The Map of Irish Wetlands (2021) identifies these locations as "Other/Unsurveyed", it was notable that highly saturated ground was evident at these locations during the site surveys. Further information on these potential wetland sites is provided in **Chapter 6: Biodiversity**.

There are no lakes within the site boundary with the closest being a small reservoir north of Mt. Melleray Monastery, approximately 5Km west of the proposed Site boundary.
With the exception of Knocknasheega, Broemountain and Dyrick Hill, elevations typically range from between 140m and 300m across the majority of the Site with areas of relatively

flat ground existing within the central and eastern areas of the Site. Elevation contours are included within a 3-D hydrological flow map outlined in **Figure 9.6** in **Volume III**.

9.3.4 Rainfall and Evapotranspiration

Long term rainfall and evaporation data for the study area were sourced from Met Éireann. The World Meteorological Organisation (WMO) recommends that climate averages are computed over a 30-year period of consecutive records. This is the same frequency adopted by Met Éireann who reference the period from 1981 to 2010 (inclusive) as the baseline 30 year period for the calculation of long term averages. The closest weather station where 30 year rainfall data is available is at Ballinamult Weather Station, Co. Waterford, approximately 1.4km to the east of the Site. Ballinamult Weather Station is located at an altitude of 168m. However, much of the Site is located on ground typically ranging from 140 – 300m in elevation with some areas extending in excess of 400m in elevation. The Ballinamult weather station data is therefore not considered to be an accurate reflection of the likely rainfall estimates for the Site since rainfall propensity generally increases with increasing altitude.

Met Éireann has published computer modelled "*1981-2010 Rainfall Grids*" estimates of monthly, seasonal and average rainfall totals (mm) with grid references for every 1-kilometre square grid in Ireland. Methods for estimating monthly rainfall amounts and temperatures for Ireland on a 1km grid were developed using point based data from approximately 500 rainfall stations and from over 80 temperature stations. The number of stations varies each year, as stations open and close. The interpolation techniques weight the surrounding measured values to derive estimates for unmeasured locations. The modelled rainfall estimates have been developed with cognisance to "*A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Walsh S., 2012*". Using this methodology for calculating water balance is considered to be more accurate than sourcing rainfall data from the closest weather station to the Site which may not be as closely representative of the site specific conditions. The Met Éireann 1 kilometre square grid rainfall estimate has been applied to a mid-altitude(260m) position of the site, approximately 160m southeast of the proposed T10 turbine location. A total average of 1426mm rainfall per year is estimated to occur at this location which is taken to be the best available site specific rainfall estimate for the Site and full details of this rainfall estimate are outlined in **Table 9.8**.

Table 9.8 Site Specific Average Rainfall Estimate Based on Met Éireann 1km Square Grid Modelling

1km Grid Rainfall Estimate Position (Irish National Grid)									Point Altitude Estimate		Distance from Closest Turbine	
East				North								
215000				105000					160m		160m Southeast of T10	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
145	109	116	96	95	97	93	117	114	163	139	143	**1426**

The closest weather station to the Site where potential evapotranspiration (PE) is measured is at Moore Park, Fermoy, County Cork, although the dataset for this site does not extend to 30 years. The closest synoptic weather station where the average PE over an uninterrupted 30 year long-term-average (LTA) period is recorded is at Cork Airport Weather Station, County Cork, approximately 62km southwest of the Site. The LTA data covers a continuous 30-year period from 1981 to 2010 (inclusive). The long-term average annual PE for Cork Airport Weather station is 516.3mm/yr and is outlined in **Table 9.9**. This value is taken to be the best available long-term average estimate of the Site PE in the absence of long-term-average PE data being available at other weather stations closer to the Site.

Table 9.9 Potential Evapotranspiration Data (mm) for Cork Airport Weather Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2022	13.9	20.6	43.4	58.0	76.3	79.3	93.6	96.6	49.9	25.7	12.7	10.7	580.7
2021	11.4	17.0	32.5	59.9	70.2	88.3	94.3	72.1	42.9	24.9	15.4	12.4	541.3
2020	10.7	19.6	36.1	57.4	83.9	78.4	85.3	70.0	47.5	28.2	11.9	11.0	540.0
2019	13.0	16.0	35.3	51.6	81.0	79.4	87.6	67.7	47.0	27.1	13.9	11.5	531.1
LTA	12.8	20.1	32.1	52.5	71.2	81.7	81.3	69.1	46.1	24.7	13.8	10.9	516.3

https://www.met.ie/climate/available-data/monthly-data

The long term average PE for Cork Airport Weather Station is 516.3 mm/yr and the Actual Evapotranspiration (AE) at the Site is dependent upon the drainage of the soil. AE is limited by the amount of moisture available in the soil. Estimates of AE are derived from calculated values of PE and soil moisture deficits (SMD). Annual AE is estimated as 95% of P.E. to allow for seasonal moisture deficits (Hunter-Williams et al, 2013). Therefore, actual evapotranspiration at the Site is calculated to be 490.4 mm/yr which is 95% PE. The Effective Rainfall (ER) represents the water available for runoff and groundwater recharge and the annual ER for the Site is calculated via the following equation:

Effective Rainfall = Annualised Average Rainfall – Actual Evapotranspiration

1426 mm/yr – 490.4 mm/yr = 935.6 mm/yr

It is noted that the GSI National Groundwater Recharge Map provides an alternative computer modelled method for estimating effective rainfall at any point in Ireland. The GSI Map Viewer modelling estimates effective rainfall across Ireland with a result of 952.3 mm/yr estimated for the position adopted as the site estimated outlined in Table 9.8, approximately 160m south-east of T10. The GSI map viewer modelled estimate for effective rainfall is only 16.7 mm/yr greater than the result from the methodology applied above which is a difference of 1.7% between the two methodologies.

According to the GSI National Groundwater Recharge Map, various recharge coefficient (RC) estimate ranges exist for the Site, including 22.5%, 60% and 85%. Till derived chiefly from Devonian sandstones has been chosen in the model as the dominant hydrogeological setting and various aquifer vulnerabilities exist across the Site (i.e. moderate, high, extreme and bedrock at or near the surface). Areas of extreme aquifer vulnerability may have slightly higher recharge rates than other areas. However, at the Site, these areas are predominantly located on slopes with very poor natural drainage. The lowest value in the available range (22.5%) has therefore been chosen to reflect the National Soils Hydrology Map classification for the majority of the site as being poorly drained, particularly in the western and northern areas. The moderate stream density in the area and the potential presence of two separate wetlands at the Site also suggests that recharge rates are comparatively low overall. Annual recharge and runoff rates for the Site are estimated to be 210.5 mm/year (22.5% of ER) and 725mm/year respectively. The baseline hydrology of the Site can therefore be characterised as having a moderately flashy network of streams/rivers and by low - moderate surface water runoff rates. Evidence of the comparatively low recharge and runoff rates is particularly evident at the potential wetland areas of the Site as was observed during a site visit in July 2021 and is shown in **Plate 9.1**.

Plate 9.1: Low Recharge and Runoff Rates at the Potential Wetland Area of the Site (East of T4)

Met Éireann have undertaken a study for the Office of Public Works (OPW) through the Flood Studies Update (FSU) which provides a depth duration frequency (DFF) model. The model allows for the estimation of point rainfall frequencies across a range of durations for any location in Ireland to be predicted. The model consists of an index (median) rainfall and a log-logistic growth curve which provides a multiplier of the index rainfall. The modelling allows for the drainage system at the Site to be designed with the capacity of accommodating a rainfall event likely to be exceeded only once in a specified number of years (i.e. a return period). The proposed drainage system at the Site will be designed with the capacity to accommodate a 1 in 100-year 6-hour return period rainfall event. The modelling provides an estimation of rainfall depths at the centre of the Site for multiple storm frequency durations which are outlined in **Table 9.10**.

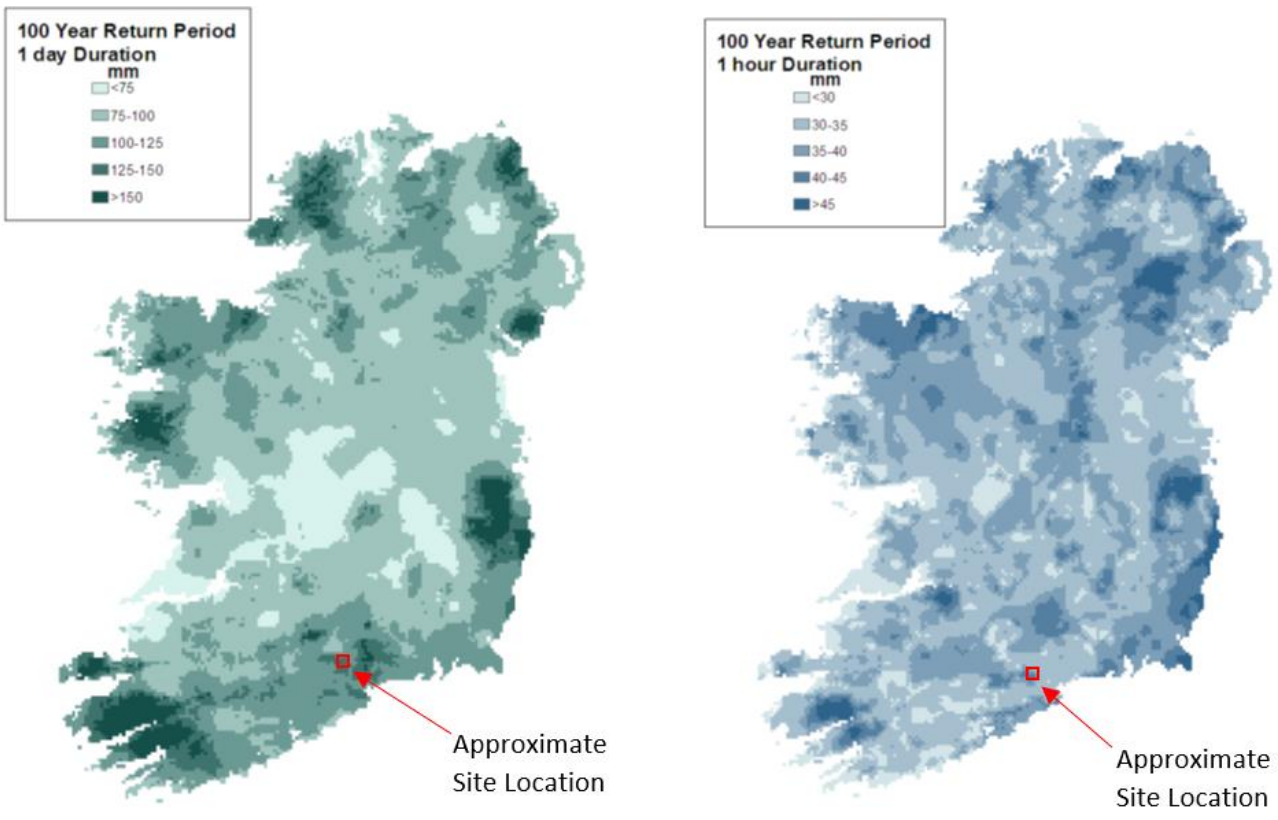
Table 9.10: Storm Duration and Return Period Rainfall Depths (mm) at the Site

Duration (Mins/ Hours/ Days)	Return Period Near the Centre of the Site (Irish Grid)						
	Easting: 215390			Northing: 105209			
	5 Years	10 Years	20 Years	30 Years	50 Years	75 Years	100 Years
5 mins	5.9	6.8	7.9	8.5	9.4	10.2	10.7
10 mins	8.2	9.5	11.0	11.9	13.1	14.2	15.0
15 mins	9.6	11.2	12.9	14.0	15.4	16.7	17.6
30 mins	13.0	15.1	17.4	18.8	20.8	22.4	23.7
1 hours	17.5	20.4	23.4	25.4	28.0	30.2	31.9
2 hours	23.6	27.5	31.6	34.2	37.7	40.7	43.0
3 hours	28.1	32.7	37.6	40.7	44.9	48.5	51.2

Duration (Mins/ Hours/ Days)	Return Period Near the Centre of the Site (Irish Grid)						
	Easting: 215390				Northing: 105209		
	5 Years	10 Years	20 Years	30 Years	50 Years	75 Years	100 Years
4 hours	31.8	37.0	42.5	46.0	50.8	54.9	57.9
6 hours	37.8	44.0	50.6	54.8	60.5	65.3	69.0
9 hours	45.0	52.4	60.3	65.3	72.0	77.8	82.1
12 hours	51.0	59.3	68.2	73.8	81.5	88.0	92.9
18 hours	60.7	70.6	81.2	87.9	97.0	104.8	110.6
24 hours	68.7	79.9	91.9	99.5	109.8	118.6	125.2
2 days	82.2	94.4	107.3	115.3	126.2	135.4	142.3
3 days	93.6	106.7	120.4	128.9	140.3	150.0	157.3
4 days	103.8	117.7	132.2	141.1	153.1	163.2	170.7

Site specific rainfall modelling data shown in **Table 9.8** indicates that the Site could potentially receive approximately 163mm/month of rainfall during the average wettest month (October), or approximately an average of 5.4mm of rainfall per day during the wettest month. For extreme weather events, or worst case scenarios, data from the FSU which is outlined in **Table 9.10**, indicates that the Site could potentially receive 125.2mm of rainfall per day, and potentially 31.9mm of rainfall per hour during a 100-year return period (or a 1 in 100 year storm event). The FSU modelling outlined in **Table 9.9** is consistent with the generalised graphic modelling shown in **Figure 9.2** which indicates that between125 – 150mm of rainfall per day, and potentially between 35 - 40mm of rainfall per hour could be received by the Site during a 100-year return period.

Figure 9.2: One in a 100 Year Rainfall Events – Extreme Storm Events (Fitzgerald, D.L., 2007)



9.3.5 Regional and Local Hydrology

This section describes the available desktop information on the local and regional surface water hydrological environment. The European Communities Directive 2000/60/EC established a framework for community action in the field of water policy known as the Water Framework Directive (WFD). Ireland has published the draft River Basin Management Plan (2022-2027) which defines the actions that will be taken to improve water quality and achieve "good" ecological status in rivers, lakes, estuaries and coastal waters by 2027. The WFD is the overarching mechanism by which water quality management areas are divided and assessed. This section identifies the geographical distribution of WFD management areas and provides an assessment of the available water quality information relative to the proposed Site.

The proposed wind farm Site, and current grid connection route are located within the Blackwater (Munster) and Colligan Mahon catchment areas in Hydrometric Areas 18 and 17 respectively. The proposed wind farm Development and grid connection to Dungarvan Substation at Killadangan are located within three WFD sub-catchments. These include the Blackwater (Munster) (SC_140), Finisk (SC_010) and Colligan (SC_010) subcatchments. None of these three sub-catchments are listed as a *Margaritifera* Sensitive Area in accordance with Annex II and Annex V of the EU Habitats Directive. All of the proposed wind farm Development and grid connection route are located within the National River Basin District (RBD) as defined by the 3rd Cycle of the WFD (2022 - 2027). Figures illustrating the catchment and subcatchments areas relative to the proposed Site and grid connection route are illustrated in **Volume III.**

At the western extent of the site is the Farnane River which rises to the east of an area of upland forestry between Knocknasheega and Broemountain at an altitude of 290m. Two small unnamed streams merge with the Farnane River from both the east and west near the townland of Graigueavurra, approximately 1.3km southeast of the Site boundary. An additional small unnamed stream merges from the west of the Farnane River at Graigueavurra, approximately 2km southeast of the Site boundary. The total length of the Farnane River and its tributaries is 9.1km and it covers a catchment area of 8.1km^2. The Farnane River flows in a south-easterly direction near parallel to the western Site boundary and then continues further to the south-east until it merges with the Finisk River at Millstreet, County Waterford.

The Lisleagh Stream rises near the central extent of the Site in an area mapped as a potential wetland to the northwest of the proposed T4 position. Further information on the two potential wetland sites is provided in **Chapter 6: Biodiversity**. According to the EPA maps for the area, an unnamed stream is located immediately west of the proposed T04 position which is mapped as flowing in a north-easterly direction for approximately 390m until it merges with the Lisleagh Stream. However, during all site survey visits, there were no indications that this stream was present. It was initially suspected that this stream could be ephemeral, however it was not visible at the site even after periods of heavy rainfall. It could also be the case that land drainage practices, or the construction of an unpaved road near the stream, have resulted in its removal or alteration of its course over time. The Lisleagh Stream flows in south-easterly direction from its source for approximately 1.8km kilometres where it merges with a small unnamed stream that rises near the townland of Corradoon, approximately 1.5km north of this confluence. To the northeast of the proposed T05, at the north-eastern Site boundary, an additional unnamed stream flows in an easterly direction for approximately 660m until it merges with the unnamed stream mentioned above which ultimately merges with the Lisleagh Stream.

At the south-eastern extent of the Site, the Aughkilladoon Stream rises in the townland of Lickoranmountain. The Aughkilladoon Stream flows along the south-eastern site boundary and continues in a south-easterly direction for approximately 2km until it merges with the

Finisk River, east of the townland of Woodhouse. Beyond the northern site boundary, five small unnamed streams flow in a north-easterly direction and merge with the Boolahallagh River. The Boolahallagh River flows along the boundary of Counties Waterford and Tipperary until it merges with the Aughavanlomaun Stream at Priestown Bridge, approximately 1.7km north-east of the Site. Beyond the western site boundary, to the west of Knocknasheega, the Glenshelane River rises to the east of Knocknanask. The Glenshelane River flows in a southerly direction between Knocknansk and Knocknasheega until it merges with the Blackwater River south of Cappoquin. Northeast of Coolagortboy and north of Scarthmountain, an unnamed stream rises approximately 670m west of the Site boundary and flows in a south-westerly direction until it merges with the Glenshelane River.

The proposed Site and its surrounds are located upstream of the Finisk River, into which all rivers and streams within the Site boundary ultimately drain. The Finisk River rises between the Knockmealdown and Monavullagh Mountains to the northeast of the proposed Site. The catchment area of the Finisk River covers an area of approximately 128km^2. It flows in a south-westerly direction, to the south of the proposed site, before ultimately joining the Blackwater River approximately 3km south of Cappoquin. The Finisk River is a large tributary of the Blackwater River which is a designated Special Area of Conservation (SAC) as the Blackwater River (Cork/Waterford) SAC. As one of the larger tributaries of the Blackwater River, the Finisk River is therefore also designated as a part of the Blackwater River (Cork/Waterford) SAC. As a result, all of the rivers which flow through the Site boundary are considered to have tenuous hydrological connectivity to the Blackwater River (Cork/Waterford) SAC via the Finisk river and various tributaries of it described above. The hydrological flow paths from all turbine and handstand areas have been mapped in a 3-D hydrological flow model which is presented in **Figure 9.6** in **Volume III**.

In addition to the named and unnamed rivers and streams discussed above, there are also numerous natural and artificial drainage ditches located within the proposed Site and its surrounds, examples of these are shown in **Plate 9.2**, **Plate 9.3** and in **Appendix 9.1**. These channels facilitate the flow of surface water runoff into the streams and rivers within the Site boundary. The density of natural drainage channels is significantly greater in the northern/western commonage areas of the Site, artificial roadside and field drains are more prevalent at the central, southern and eastern extents of the site. The forestry drainage network at the north-east and western extents of the Site are largely influenced by the gradient and topography in these forests. The forestry plantation structure, location of firebreaks and subsoils also have a bearing on the forestry drainage network. The forestry drainage network is the main drainage vector for the hydraulic movement of water from the forests at the Site to the surrounding natural waterbodies of the Farnane River and the Lisleagh Stream which are the primary receiving waters of the forestry drainage network at the Site. The Aughkilladoon Stream receives runoff from the open fields and associated drainage networks at the south-eastern extent of the site.

Appendix 2.2 contains the Grid Connection Study which confirms that the preferred grid connection route (Option B) to Dungarvan Substation at Killadangan will traverse three existing bridge crossings. Horizontal direction drilling (HDD) is required at two of these bridge crossings and at a cattle underpass, the existing infrastructure will be utilised to facilitate the grid connection crossing at one bridge. One watercourse crossing is proposed at the main Site, the design layout has adhered to the principle of mitigation by avoidance wherever possible, thus reducing the need for more than one watercourse crossing at the Site. The locations of the watercourse crossings, and the one cattle underpass, are outlined in **Figure 9.7** in **Volume III**. With the exception of the locations outlined in **Table 9.11**, the grid connection route will be constructed via trenching adjacent to the public roadway in its entirety. The type of proposed crossing and the approximate centre point coordinates for each crossing is outlined in **Table 9.11**.

Table 9.11: Watercourse and Cattle Underpass Crossings and Coordinates

Crossing Number	Crossing Type	Crossing Location Description	Approximate Centre Coordinates of Crossings (Irish National Grid)	
			Easting	Northing
1	River	Culverted crossing of the Aughkilladoon Stream at the main Site in the townland of Lickoranmountain, Co. Waterford	217062	104381
2	Two Rivers	HDD near the confluence of Finisk and Farnane Rivers at Mountain Castle Bridge, Millstreet, Co. Waterford	217281	101203
3	River	HDD of Killeagh Stream in the townland of Knockaunnaglokee, Co. Waterford	219536	101482
4	River	Use of Existing Infrastructure on Kildangan Bridge over Colligan River in the townland of Killadangan, Co. Waterford	223226	95124
5	Cattle Underpass	Cattle underpass on L5068 local road, in the townland of Garryclone, Co. Waterford	220536	99663

9.3.6 Wind Farm Site Drainage

Plate 9.2: Example of Natural Drainage Channels at the Western Commonage Area of the Site

Plate 9.3: Example of Poor Drainage and Ponding at the Existing Roadside Forestry Drainage Near the T5 Hardstand Area of the Site

9.3.7 Water Balance Assessment

A water balance assessment has been carried out for the Site which is outlined in **Table 9.12**. The water balance assessment utilises site specific rainfall estimates for the highest average monthly rainfall (October) at the Site. Combined with long-term potential evapotranspiration (PE) data from Met Éireann, GSI recharge coefficient estimates, associated runoff estimates, and Site area(m^2) input variables; the assessment provides an estimate of the average volume of surface water expected to occur during the average October period. The water balance assessment is carried out for the estimated baseline runoff conditions and the estimated post Development conditions at the Site. A comparison is made between these two results to predict the estimated changes that the development will have on surface water runoff rates at the Site during the average wettest month of the year.

The Met Éireann 1981-2010 one km^2 grid estimates provide modelled average rainfall totals near the centre of the site as is outlined in **Table 9.8** with a result of 163mm estimated for the average October month. The minimum October potential evapotranspiration during the same period of 1981-2010 at Cork Airport Weather Station occurred in October 1988 at 22.2 mm PE, this has been adopted as a conservative estimate for PE. A range of GSI recharge coefficient and runoff estimates exist for the site with 22.5% and 77.5% respectively being adopted as site wide averages. The water balance assessment conservatively estimates that the volume of surface water runoff at the Site during the average wettest month would be 511,168m^3/month or 16,489m^3/day. For the post development runoff scenario, the water balance assessment conservatively assumes that all hardstand areas and access roads would be fully impermeable. This is most unlikely to be the case in reality and can be considered as a worst-case scenario. Assuming fully impermeable road and hardstand surfaces are constructed as a worst-case scenario, the surface water runoff at the site is estimated to increase by 0.42% when compared to the pre-Development baseline runoff rates which is considered to be a negligible increase in terms of potential downstream impacts.

9.3.8 Assessment of Changes in Site Run-off Volumes

Table 9.12: Preliminary Water Balance Analysis

Variable	Data Description	Site Assessment	Units
Average Wettest Month (October) Estimated Water Balance			
Site Specific Average Wettest Monthly Rainfall Total (R)	Met Éireann 1981-2010 1 km^2 Grid Estimates of Wettest Monthly Average Rainfall Totals (October)(R)	163	mm
October Minimum Potential Evapotranspiration (PE)	Cork Airport 30 Year October Minimum PE (1981-2010) (October 1988)	22.2	mm
Minimum October Actual Evapotranspiration (AE = PE x 0.95)	AE = PE*0.95 (Hunter-Williams et al, 2013)	21.09	mm
Max Effective Rainfall (October) (ER = R - AE)	R - AE	141.91	mm
Range of GSI Recharge Coefficient Estimates (RC) for the Site (22.5%, 60% and 85%)	The lowest value in the GSI range (22.5%) has been adopted as a site wide average to reflect the National Soils Hydrology Map classification for the majority of the site as being poorly drained, particularly in the western and northern areas.	22.5	%
Estimated Recharge Coefficient	22.5% of ER	31.93	mm
Estimated Runoff	77.5% of ER	110	mm
Average Wettest Month (October) Runoff Estimates			
Site Area	EIAR Boundary File GIS Geometry Calculation	4,647,820	m^2
Baseline Wettest Month Monthly Runoff	Estimated Average Monthly Baseline Runoff During Wettest Month	511,168	m^3/month
Baseline Wettest Month Daily Runoff	Estimated Average Daily Baseline Runoff During Wettest Month	16,489	m^3/day
Estimated Changes to Baseline Runoff Post Development During the Average Wettest Month (October)			
Hardstand Development Area (DA)	EIAR Chapter 2 Description of Development (Sum of all Hardstand Areas)	67,129	m^2
100% Runoff Scenario from Hardstand Area	DA*ER/1000	9,526	m^3
77.5% Runoff Scenario from Hardstand Area	DA*(ER*0.75)/1000	7,383	m^3
Net Monthly Runoff Increase	Estimated Monthly Runoff Increase Versus Baseline Conditions	2,143	m^3/month
Net Daily Runoff Increase	Estimated Daily Runoff Increase Versus Baseline Conditions	69	m^3/day
Percentage Runoff Increase	Percentage Runoff Increase Compared to Baseline Conditions	0.42	%

9.3.9 Flood Risk Identification

Flood risk identification is the first stage in a flood risk assessment (FRA) process that is required to be carried out for proposed developments in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities (DHPLG/OPW, 2009).

The scope of this flood risk identification includes both the proposed wind farm Site and the proposed grid connection route. Flood risk identification was conducted in order to assess the potential flood risks posed to the Development and to downstream receptors. A review of historic flooding within the study area has been undertaken. Multiples sources were consulted to identify the areas being potentially at risk of flooding, including the following:

- Catchments.ie (www.catchments.ie);
- Office of Public Works (OPW) Catchment Flood Risk Assessment and Management (CFRAM);
- National Flood Hazard Mapping (www.floodmaps.ie);
- Department of Environment, Community and Local Government on-line planning mapping (www.myplan.ie);
- The Planning System and Flood Risk Management - Guidelines for Planning Authorities (DHPLG/OPW, 2009);
- Ordnance Survey Ireland, Map Viewer http://map.geohive.ie/mapviewer.html.

The OPW's interactive flood maps and Catchment Flood Risk Assessment and Management (CFRAM) are currently the main source of reference for flood risk identification in Ireland. The interactive maps are indicative flood risk maps and the interactive National Indicative Fluvial Mapping (NIFM) supersede the Preliminary Flood Risk Assessment (PFRA) maps. The "Past Flood Events" dataset has been reviewed on the OPW's website at www.floodinfo.ie. This dataset includes records of all available flood events held by the OPW, local authorities and other national organisations such as the EPA, Teagasc and the Department of Communications, Climate Action and Environment (DCCAE). No historical single or recurring flood events have been recorded within the EIAR Site boundary. One recurring flood event has been recorded along a section of the N72 road which the proposed grid connection route will traverse near the Dungarvan Substation at Killadangan. In the townland of Ballymacmague East, also on the R671 road, another recuring flood event has been recorded approximately 300m south of the proposed grid connection route. An additional recurring flood event has been recorded west of the townland of Mountaincastle South, along the R671 road, approximately 430m north of the proposed grid connection route. Details of these recurring flood events are outlined in **Table 9.13** and their locations relative to the proposed Site and grid connection route are also mapped on **Figure 9.11** in **Volume III**.

Rainfall run-off from the proposed development will be captured for attenuation in the Site's designed drainage system, which will include settlement ponds that will be designed for a 1 in 200-year 30-minute return period rainfall event. The settlement ponds will be strategically located at turbine bases and/or hardstand areas which will facilitate the treatment of run-off water through the settling out of sediments before eventual discharge to the existing bog drainage environment. The proposed drainage system will result in increased attenuation of rainwater during heavy rainfall events prior to ultimately being discharged to the surrounding environment for natural recharge. Natural recharge will occur via seepage to groundwater, diverted to topographically low points such as drains via the undulating topography. Any trenching works which will be carried out will be temporary in nature with no additional hardstand being proposed. As a result, runoff characteristics will be effectively unchanged when compared to the existing surfaces along the proposed grid connection route. The proposed grid connection route will therefore not change flood risk potential upstream or downstream of the proposed grid connection.

Table 9.13: Recurring Floods Recorded Along the Proposed Grid Connection Route.

Flood ID	Flood Location Description	Flood Type	Flood Source	Distance to Project Location
3812	Colligan River, Kildangan Bridge. A combination of heavy rain and high tides causes overbank flow from the Colligan River on a recurring basis. A factory and the N72 road are flooded periodically	Recurring	River	Along the N72 Road which the grid connection route will traverse, approximately 450m west of Dungarvan Substation
3813	Ballymacmague East. The flood described at Kildangan bridge above extends to Ballymacmague on the R672 Regional Road. One house is periodically flooded	Recurring	River	On the R672 Regional Road, approximately 300m south of the grid connection route
3837	River Finisk just upstream of Millstreet. The R671 regional road is regularly impassable due to recurring flooding from the Finisk	Recurring	River	On the R671 Regional Road, approximately 430m north of the proposed grid connection route

The National Indicative Fluvial Mapping interactive maps have also been consulted with reference to fluvial (rivers and streams) flooding for both current day and future case scenarios. The medium and low probability present day scenarios relate to an annual exceedance probability (AEP) of 1% and 0.1% respectively. The medium and low probability present day scenarios reflect the odds of a theoretical extreme flood event occurring in a given year being 1:100 and 1:1000 respectively. There are no present day 1% or 0.1% AEP fluvial flood events predicted to occur at any of the main site features such as turbine locations, hardstand areas, met mast, substation or borrow pits etc. A theoretical 0.1% and a 1% AEP fluvial flood event could potentially occur at the south-eastern EIAR boundary where the site access road will merge with the pre-existing R-671 road (at the main site access point). The R-671 intersects the floodplain of the Finisk River in the townland of Woodhouse. The site access road is the only feature of the project to be constructed in this area and it would be positioned at the outermost extremity of the Finisk River flood plain, approximately 1.8km south-east of the nearest turbine position (T02). This site access road will be temporary and only used for construction, then it will be reverted back to the existing substrate. Potential temporary fluvial flooding of the pre-existing R-671 road, and by extension of a small section of the site entry road is expected to have a negligible impact on the Development and on downstream receptors.

In terms of the grid connection route, at Mountain Castle Bridge, the Finisk River is also predicted to flood in a possible present day 1% AEP fluvial flood event on the L-1034 Local Road where a pre-existing bridge crosses the Finisk River and which the grid connection route will traverse. No additional 1% or 0.1% AEP present day scenario fluvial flood events are predicted to occur along the grid connection route. The grid connection trenching works will be temporary, and surfaces will be replaced with like for like surfaces. Given that the proposed drainage system outlined in the **Surface Water Management Plan** attached to **Appendix 2.1.** will result in increased attenuation of rainwater during heavy rainfall events, the potential risk of exacerbating a theoretical 1% or 0.1% AEP fluvial flood downstream of the proposed Site or along the grid connection route is expected to be negligible. The predicted extent of the present day fluvial flood extents have been mapped on **Figure 9.13** in **Volume III**.

In an assessment of potential future flooding impacts on the proposed Development, the NIFM's "*High-End Future Scenario*" which models a 30% increase in rainfall resulting from climate change has been adopted as a precautionary approach. The medium probability scenarios (AEP of 1%) has been reviewed at the Site for additional conservatism. There are no high-end future scenario fluvial flood events predicted to occur at any of the main site features such as turbine locations, hardstand areas, met mast, substation or borrow pits etc. Similar to the current day scenario described above, a theoretical 0.1% and a 1% AEP high-end future scenario fluvial flood event could potentially occur at the south-eastern EIAR boundary where the site access road will merge with the pre-existing R-671. In the high-end future scenarios, the site access road could potentially flood by approximately an additional 10 metres in length in a worst case scenario in comparison to the present day scenarios. A temporary increase of this magnitude is expected to represent a negligible impact on the Development. The closest turbine position (T02) or hardstand area would remain approximately 1.8km north-west of any future fluvial flood events.

Along the grid connection route at Mountain Castle Bridge, the L-1034 Local Road is also predicted to flood during a medium probability high end future scenario flood event. No further flood events are predicted to occur during a medium probability high end future scenario flood event along the grid connection route. The predicted extent of this High-End Future Scenario has been mapped on **Figure 9.12** in **Volume III**. Similar to the current day scenario, the proposed drainage system outlined in the **Surface Water Management Plan** attached as **Appendix 2.1** will result in increased attenuation of rainwater during heavy rainfall events. Surface water runoff from the developed areas of the Site will be directed to a stormwater drainage system designed in accordance with the principles of Sustainable Drainage Systems (SuDS). The management of surface water runoff will limit discharge from the Site to near greenfield runoff rates. The potential risk of exacerbating theoretical downstream high end future scenario fluvial flood events is therefore expected to be negligible.

The Geological Survey of Ireland (GSI) groundwater flooding probability maps were also reviewed at https://www.floodinfo.ie/map/floodmaps/. There are no low, medium or high probability instances of groundwater flooding predicted to occur at the proposed Site or along the proposed grid connection route. The closest area to the Site which is mapped for potential groundwater flooding impacts is located approximately 25km north-east of the Site near Mauganstown, County Tipperary. Ordnance Survey Ireland's (OSI's) National Townland and Historical 6 and 25 inch maps were also consulted for potential evidence of historical references to flooding at the Site. These historical maps do not provide any references to lands within or adjacent to the Site boundary being prone to flooding.

The OPW's database on Arterial Drainage Schemes (ADS) benefiting areas associated with the schemes constructed under the Arterial Drainage Acts 1945 & 1995 was also reviewed. The benefited lands database identifies land that was drained as part of the Arterial Drainage Schemes, which typically was performed to improve land for agricultural purposes. The benefitting lands database can be indicative of land that has historically been subject to flooding, or which had poor drainage. There are no mapped OPW benefited lands located within the proposed Site boundary or along the proposed grid connection route. The closest mapped benefited lands to the proposed Site are located near the townland of Clonderkin, approximately 9.7km south of the Site. Drainage from the Site is not predicated to have any influence on the benefitted lands at this downstream location due to the absence of proximity to the Site and the attenuation of water during periods of heavy rainfall which is incorporated into the drainage design contained in the **Surface Water Management Plan** attached as **Appendix 2.1**.

In addition to the proposed drainage design, a fundamental component of the Site's flood mitigation strategy will be achieved via mitigation through avoidance. All proposed design elements such as access roads, turbine locations, construction compound, substation, borrow pits and met mast etc. will all be positioned a minimum distance of 50m away from the Site's rivers and streams wherever possible. The pre-existing access tracks at the site would be utilised to facilitate the construction phase. The Site access roads will have only limited use during the operational phase due to the nature of the proposed Development. None of the surface waters which drain the site area are predicted to flood during any of the current or future scenario extreme fluvial flood events. No significant risk of flooding has been identified within the project area which is primarily due to the elevated nature of the Site relative to the surrounding area.

The flood risk identification has not identified any significant flood risk at the Site and the potential for exacerbating existing recurring flood events along the grid connection route is considered to be negligible. The drainage design will ensure that surface water run-off from the Site will not increase the risk of flooding to downstream receptors. Mitigation by avoidance through design will also alleviate the risk of any potential flood risks. Having assessed the potential risks in the context of the Development and in accordance with the guidelines, it is considered that there is no requirement to proceed further in the staged process of the flood risk assessment.

9.3.10 Surface Water Hydrochemistry

The Environmental Protection Agency (EPA) conducts an ongoing monitoring programme as part of Ireland's requirements under the WFD. The monitoring programme involves assessment of river water quality and trends with respect to ecological criteria and to physico-chemical water quality standards. All of Ireland's major rivers and their more important tributaries are included within the programme. As part of the physico-chemical monitoring programme, approximately 1,500 rivers are assessed annually. The monitoring programme includes an assessment of biotic indices (biological quality ratings ranging from 1-5) known as Q-Values. Historical and ongoing monitoring data from EPA monitoring points does not exist for surface waters within the Site boundary.

Historical Q-value scores do exist for multiple surface waters both upstream and downstream of the Site. The water quality in the majority of the rivers upstream and downstream of the Site has in general been historically classified as "*Good*" to "*High*" with some "*Moderate*" Q-value scores also having been recorded. The most recent assessment of the Glenshelane River to the east of the site, was carried out in 1994 which indicated that the river had a Q-Value score of 4-5 or "High Status" at that time. The Glenshelane River monitoring point is the closest historical EPA monitoring point to the proposed site at approximately 442m west of the Site boundary. The most recent assessment of the Faranae River occurred downstream of the site at Millstreet in 2021 and indicated that this river also had a Q-Value score of 4-5 or "High Status" at this point in time. Details of the closest EPA monitoring points to the Site and the latest Q-Values are outlined in **Table 9.14**.

Table 9.14: EPA Monitoring Points and Latest Available Q-Values

Station ID	RS18G110100	RS18F020190	RS18F020090	RS18F020100	RS18F060300
Station Name	Glenshelane - Br South of Knocknascullоge	Finisk - Br WNW of Tinalira	Br u/s Ballinamult Br	Finisk - Ballinamult Br	D/s Derry Br Millstreet
WFD Waterbody Code	IE_SW_ 18G110300	IE_SW_1 8F020300	IE_SW_ 18F020100	IE_SW_ 18F020100	IE_SW_ 18F060300
Type	River	River	River	River	River
Latest Monitoring Year	1994	2006	2021	1990	2021
Latest Status	High	Good	Good	Moderate	High
Latest Q-Value	4-5	4	4	3 - 4	4 - 5
Approximate Distance from Site Boundary	442m	1km	1.7km	2km	2.4km
Easting	212865	218684	217408	218129	217235
Northing	106781	103971	107163	106741	101210
Local Authority	Waterford County Council	Waterford County Council	Waterford County Council	Waterford County Council	Waterford County Council

To assist in further characterising the watercourses surrounding the proposed Site, three rounds of water quality monitoring were carried out. The monitoring rounds included analysis of parameters requiring laboratory analyses and field hydrochemistry measurements on unstable parameters including pH, dissolved oxygen (DO), electrical conductivity, total dissolved solids (TDS) and temperature. The three water quality monitoring rounds were conducted across the following dates.

Table 9. 15: Water Quality Monitoring Rounds and Dates

Monitoring Round	Monitoring Dates
Round 1	12th/13th of July 2021
Round 2	1st/2nd of July 2022
Round 3	2nd/3rd of December 2022

In total, 11 different water quality monitoring locations were analysed throughout the monitoring programme for a wide variety of laboratory and field measured parameters. The water quality monitoring locations have been mapped and are shown on **Figure 9.4** in **Volume III.** Monitoring location FM7 is located down a steep embankment that was heavily overgrown with vegetation on the eastern side of the L-5058 Local Road and could not be safely accessed during any of the monitoring rounds. A number of water quality parameters are physically or chemically unstable and must be analysed in-situ immediately after collection with a field monitoring multi-parameter meter. The pH values across the Site ranged from between pH 4.58 at FM9 during monitoring round 1 to pH 7.96 at FM1, also during monitoring round 1. The majority of the pH concentrations recorded were relatively pH neutral or slightly acidic. Slightly acidic conditions were consistently recorded at FM9 where relatively low pH concentrations ranged from pH 4.58 to pH 4.33 across the three monitoring rounds. Slightly acidic pH concentrations are not uncommon in waterbodies of a catchment containing upland forestry plantations such as those located to the west of FM9 which is positioned along the upper reaches of the Farnane River. Small pockets of localised acidic peatland soils could also potentially be influencing the pH near the upper reaches of the Farnane River.

Electrical conductivity is a measure of the ability of an aqueous solution to carry an electrical current. Conductivity is useful as a general measure of water quality, it is primarily used as an indicator of saline intrusion although it also increases if contamination by most ionic species is present in a waterbody. There are no nationally recognised environmental quality standards (EQS) for electrical conductivity in surface waters with an EQS of 2,500 μS/cm being the upper acceptable concentration for drinking water. Significantly elevated electrical conductivity can indicate that unknown pollutions have entered the waterbody. Conductivity values recorded across the three monitoring rounds ranged from between 33 μS/cm at FM9 during monitoring round 1 to 354 μS/cm at FM4, also during monitoring round 1. The relatively low electrical conductivity values recorded during the four monitoring rounds did not indicate the presence of polluted surface waters.

Concentrations of total dissolved solids (TDS) ranged from 23 mg/L at FM9 during monitoring round 1 to 248 mg/L at FM4, also during monitoring round 1. TDS are made up of inorganic salts, as well as a small amount of organic matter and are linked to electrical conductivity as a general indicating measure of the presence of pollutants in surface waters. TDS originate from a number of sources, both natural and as a result of human activities such as agricultural, urban runoff, wastewater discharges, industrial wastewater and salt that is used to de-ice roads. Total dissolved solids in rivers can range from between 20 – 20,000 mg/L and higher TDS results can often indicate that the water is saline. If the concentration of TDS in water is elevated, it can reduce the clarity of the water, contributing to a decrease in photosynthesis, compounds react with heavy metals, and cause an increase in water temperature. TDS concentrations are also used as an indicator of the aesthetic characteristics of the water and as an indicator of the number of very small particles. As a result of the very low concentrations of TDS recorded at each sample location across the three monitoring rounds, the presence of dissolved pollutants was not indicative at any of the monitoring locations.

Dissolved oxygen (DO) concentrations ranged from 8.37 mg/L at FM9 during monitoring round 2 to 11.53 mg/L at FM11 during monitoring round 3. Water temperature influences DO concentrations in a river or stream, DO generally increases as the water temperature decreases. The flow rate or movement of water in a river or stream can also impact upon the DO concentration. Rapidly moving water, such as in rivers or streams, tends to contain higher DO concentrations since the movement of the water allows for a greater mixing of air whereas stagnant water typically contains lower DO concentrations. Lower concentrations of DO in stagnant water is also due to the enhanced consumption of dissolved oxygen by plants and microbial life. Water at lower altitudes can hold more dissolved oxygen than water at higher altitudes. The majority of the recorded DO concentrations across the three monitoring rounds were within the ≥ 9 mg/L mandatory value as set out in the *Salmonid Water Regulations* 1988. In terms of % saturation, all of the recorded DO results across the three month monitoring period were within the 80 – 120% range as set out in the *European Communities Environmental Objectives (Surface Water) Regulations 2009*.

Surface water temperatures ranged from between 7.81°C at FM9 during monitoring round 3 to 15.53°C at FM9 during monitoring round 1. This equates to a difference of 7.72°C between the maximum and minimum recorded results. Increases in surface water temperature resulting from human activities may exceed the thermal tolerances of aquatic biota that are adapted to colder environments. The *European Communities Environmental Objectives (Surface Water) Regulations 2009* and the *European Communities (Quality of Salmonid Waters) Regulations, 1988* screening criterion for temperature both relate to thermal discharges to waters with the capacity to increase the surface water temperate by a maximum of 1.5°C. The proposed Development is not expected to require any thermal discharge activities and this screening criteria is therefore of limited value. The significant temperature differential of 7.72°C between the maximum and the minimum results across the three monitoring rounds is representative of natural seasonal surface water temperature fluctuations with air temperature being the dominant factor in influencing seasonal surface water temperatures.

Table 9.16: Field Hydrochemistry Results from Monitoring Round 1

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	12/07/2022	7.96	146	102	10.17	12.76
FM2	12/07/2022	7.52	131	92	9.42	14.41
FM3	12/07/2022	7.49	136	95	9.92	13.67
FM4	12/07/2022	7.32	354	248	8.7	13.97
FM5	12/07/2022	7.48	57	48	9.78	14.22
FM6	12/07/2022	6.99	47	33	9.32	14.90
FM7*	12/07/2022	N/A	N/A	N/A	N/A	N/A
FM8	12/07/2022	7.45	64	44	9.65	15.53
FM9	12/07/2022	4.58	33	23	8.69	12.11
FM10	12/07/2022	7.93	148	104	9.97	12.47
FM11	12/07/2022	7.49	148	103	10.01	13.66
FM12	12/07/2022	7.59	128	90	10.01	14.25

* Monitoring location FM7 could not be safely accessed during any of the monitoring rounds due to the presence of steep terrain and overgrown vegetation

Table 9.17: Field Hydrochemistry Results from Monitoring Round 2

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	01/07/2022	7.63	134	94	10.64	11.54
FM2	01/07/2022	7.54	38	27	10.44	12.38
FM3	01/07/2022	7.46	112	78	10.39	12.06
FM4	01/07/2022	7.34	161	113	9.81	12.82
FM5	01/07/2022	7.48	95	67	10.67	11.41
FM6	01/07/2022	6.94	89	63	10.41	11.72
FM7*	N/A	N/A	N/A	N/A	N/A	N/A
FM8	01/07/2022	7.31	86	60	10.58	11.44
FM9	01/07/2022	4.94	198	139	8.37	12.13
FM10	01/07/2022	7.77	116	82	10.83	11.08
FM11	02/07/2022	7.62	189	133	10.80	11.28
FM12	02/07/2022	7.25	126	88	10.34	12.13

* Monitoring location FM7 could not be safely accessed during any of the monitoring rounds due to the presence of steep terrain and overgrown vegetation

Table 9.18: Field Hydrochemistry Results from Monitoring Round 3

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	02/12/2022	7.43	127	89	11.43	9.52
FM2	02/12/2022	7.04	115	80	10.41	10.04
FM3	02/12/2022	7.26	123	86	11.34	10.08
FM4	02/12/2022	6.79	176	123	9.81	10.95
FM5	02/12/2022	7.2	88	62	11.19	8.83
FM6	02/12/2022	6.81	67	47	10.73	9.22
FM7*	N/A	N/A	N/A	N/A	N/A	N/A
FM8	02/12/2022	7.16	67	47	11.05	8.83
FM9	02/12/2022	5.33	100	70	9.74	7.81
FM10	02/12/2022	7.52	124	87	11.46	9.57
FM11	03/12/2022	7.46	126	88	11.53	9.44
FM12	03/12/2022	7.22	125	88	11.53	10.10

* Monitoring location FM7 could not be safely accessed during any of the monitoring rounds due to the presence of steep terrain and overgrown vegetation

A total of 18 surface water samples were also collected at multiple locations for laboratory analysis on a broad range of parameters during the three monitoring rounds. Copies of the laboratory certificates from each round of monitoring are contained in **Volume IV**. The results from the laboratory analysis from the three monitoring rounds are compared to various screening criteria in **Table 9.19**, **Table 9.20**, **Table 9.21** below. The sample locations have been mapped and are shown on **Figure 9.4** in Volume III. It should be noted that two separate laboratories were utilised for analyses across the three monitoring rounds. As a result, the laboratory limits of detection may vary slightly for particular analyses.

Biochemical Oxygen Demand (BOD) concentrations were below the laboratory limit of detection in all samples analysed during monitoring round 1. During monitoring round 2, all six simples had BOD concentrations above the limit of detection with a maximum concentration of 4.8 mg/L being recorded during round 2. None of the BOD concentrations recorded during monitoring round 2 met the "*High*" status threshold and 4/6 of the BOD concentrations recorded during round 2 did meet the "*Good*" status threshold limits for BOD as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009*. During monitoring round 3, two of the recorded BOD concentration were above the limit of detection at 1 mg/L and 1.3 mg/L. All BOD concentrations recorded during monitoring round 3 were within both the "*Good*" and "*High*" status threshold values as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009.*

Total suspended solids (TSS) were reported below the laboratory limit of detection in 8 out of 18 samples analysed across the three monitoring rounds. A maximum concentration of 30 mg/L TSS was recorded at monitoring location SW5 during monitoring round 1. A concentration of 29 mg/L TSS was recorded at monitoring location SW4 during monitoring round 2. Both of these results exceeded the mandatory threshold value of ≤ 25 mg/L TSS as set out in the *Salmonid Water Regulations 1988*. All 16 of the remaining recorded concentrations for TSS were within the ≤ 25 mg/L TSS as set out in the *Salmonid Water Regulations 1988*.

Concentrations of total nitrogen were below the laboratory limit of detection (0.5 mg/L) in 5 out of the 18 samples analysed across the three monitoring rounds. A maximum concentration of 5.91 mg/L was recorded at location SW4 during monitoring round 1. There are no applicable EQS against which to compare the total nitrogen results. However, some of the recorded results for total nitrogen are above what would be expected for natural background concentrations which indicates that land use activities in the wider catchment may potentially be contributing to slight nitrogen loading in the surrounding surface water network.

Concentrations of nitrate were below the laboratory limit of detection in 10 out of the 18 samples analysed across the three monitoring rounds. A maximum concentration of 22.1 mg/L for nitrate was recorded at monitoring location SW4 during monitoring round 3 which is below the 50 mg/L threshold value set out in the *European Union Drinking Water Regulations 2014.* For nitrite, all results were below the laboratory limit of detection in all 18 samples analysed with the exception of SW2 during monitoring round 1 where a concentration of 0.075 mg/L was recorded which exceeds the ≤0.05 mg/L as set out in the *Salmonid Water Regulations 1988.*

Concentrations of total phosphorus were below the laboratory limit of detection in all 18 samples analysed across the three monitoring rounds. There are no applicable screening criteria for rivers against which to compare total phosphorous, however, since all concentrations were below the laboratory limit of detection, it can be concluded that the total phosphorous concentrations were not elevated. Orthophosphate concentrations ranged from below the laboratory limit of detection to a maximum of 0.203 mg/L at SW5 during monitoring round 1 and 6 out of 18 samples were above the laboratory limit of detection. All of these detections occurred during monitoring round 1 only. Each of the 6 detectable orthophosphate concentrations recorded during monitoring round 1 exceeded both the

"*Good"* and *"High*" status criteria as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009*.

Chloride concentrations ranged from between 9.33 mg/L at SW5 during monitoring round 2, to 22.1 mg/L at SW4 during monitoring round 3. The maximum detected concentration for chloride did not exceed the 250 mg/L threshold value set out in the *European Union Drinking Water Regulations 2014*. The ammonia as N concentrations were detected below the laboratory limit of reporting for both laboratories utilised (0.05 mg/L and 0.01 mg/L) in all 18 of the samples across the monitoring rounds. All of the recorded ammonia as N concentrations were below both the "*Good*" status of 0.065 mg/L. The "High" Status criteria as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009* is 0.04 mg/L which is lower than the laboratory limit of detection for one of the laboratories that was utilised for the analyses.

Table 9.19: Surface Water Results from Round 1 Monitoring on 13 July 2021

Parameter	Sample ID						EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989[1]	European Union (Drinking Water) Regulations 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
	SW1	SW2	SW3	SW4	SW5	SW6				
Biochemical Oxygen Demand (mg/L)	<2	<2	<2	<2	<2	<2	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	4	16	6	3	30	<2	50	-	-	≤25
Total Nitrogen as N (mg/L)	<2.50	3.67	3.43	5.91	<2.50	<2.50	-	-	-	-
Total Phosphorus as P (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-
Chloride (mg/L)	12.1	12.9	13.7	18.7	<10	<10	250	250	-	-
Nitrate as NO_3 (mg/L)	<8.90	<8.90	<8.90	18	<8.90	<8.90	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.066	0.075	<0.066	<0.066	<0.066	<0.066	-	0.5	-	≤ 0.05
Orthophosphate as PO_4-P (mg/L)	0.09	0.161	0.062	0.061	0.203	0.155	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Note[1] - *EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989* is superseded by *EC Environmental Objectives Surface Water Regulations 2009*. Environmental Quality Standards from both regulations have been listed for comparison purposes only.

Table 9.20: Surface Water Results from Round 2 Monitoring 1 July 2022

Parameter	Sample ID						EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989[1]	European Union (Drinking Water) Regulations 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
	SW1	SW2	SW3	SW4	SW5	SW6				
Biochemical Oxygen Demand (mg/L)	2.8	4.2	4.4	4.8	1.5	1.5	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	15	8	8	29	<5	<5	50	-	-	≤25
Total Nitrogen as N (mg/L)	1.16	2.44	2.5	3.18	1.16	1.09	-	-	-	-
Total Phosphorus as P (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-
Chloride (mg/L)	11.5	11.6	13.9	16.2	10.1	9.33	250	250	-	-
Nitrate as NO_3 (mg/L)	<4.4	8.723	4.991	7.829	<4.4	<4.4	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	-	0.5	-	≤ 0.05
Orthophosphate as PO_4-P (mg/L)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Note[1] - *EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989* is superseded by *EC Environmental Objectives Surface Water Regulations 2009*. Environmental Quality Standards from both regulations have been listed for comparison purposes only.

Table 9.21: Surface Water Results from Round 3 Monitoring on 2 December 2022

Parameter	Sample ID						EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989[1]	European Union (Drinking Water) Regulations 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
	SW1	SW2	SW3	SW4	SW5	SW6				
Biochemical Oxygen Demand (mg/L)	<1	<1	1	<1	1.3	<1	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	<5	20	<5	<5	<5	<5	50	-	-	≤25
Total Nitrogen as N (mg/L)	1.4	3.0	1.8	5.0	<1	<1	-	-	-	-
Total Phosphorus as P (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-
Chloride (mg/L)	13.1	12.5	14.1	22.1	10.4	9.46	250	250	-	-
Nitrate as NO_3 (mg/L)	4.578	11.824	6.939	22.382	<4.4	<4.4	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	-	0.5	-	≤ 0.05
Orthophosphate as PO_4-P (mg/L)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Note[1] - *EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989* is superseded by *EC Environmental Objectives Surface Water Regulations 2009*. Environmental Quality Standards from both regulations have been listed for comparison purposes only.

9.3.11 Hydrogeology

The underlying bedrock within the Site boundary and along the majority of the grid connection route consists of continental redbed facies; sandstone, conglomerate and siltstone. The bedrock formations underlying the Site are classified by the GSI as Locally Important (LI), bedrock which is moderately productive only in local zones. These underlying Knockmealdown groundwater body (GWB) rocks have no intergranular permeability, groundwater flow occurs in faults and joints. Most groundwater flow probably occurs in an upper shallow weathered zone. Below this, in the deeper zones, water-bearing fractures and fissures are less frequent and less well connected. The water table is generally within 10m of the surface with an average annual fluctuation of up to 6 metres occurring across the GWB. Groundwater in this GWB is generally unconfined. Local groundwater flow is towards the rivers and streams, and the flow path will not usually exceed a few hundred metres in length. Owing to the generally poor productivity of the aquifers in this body, it is unlikely that any major groundwater surface water interactions occur. The poorly permeable aquifer can support only local scale flow systems. Baseflow to rivers and streams is likely to be relatively low. There are no known karst features recorded in close proximity to the Site nor along the grid connection route. The closest evidence of karstification to the Site is recorded within a series of swallow holes and springs located east of Cappoquin, approximately 5km south of the Site.

In addition to the Knockmealdown GWB, the grid connection route also traverses through the Kilrion, Ballyknock and Dungarvan groundwater bodies. According to the GSI, these GWBs are categorised as poorly productive bedrock, productive fissured bedrock and karstic respectively. The Dungarvan GWB is a Registered Protected Area (RPA) for Shellfish as this GWB intersects with Designated Shellfish Zones under S.I. No. 55/2009 European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009. Potential impacts on groundwater from the proposed wind farm Site are discussed in detail in subsequent sections of this Chapter.

9.3.12 Wells

Mapping and searches of the EPA WFD and GSI well databases confirms that there are no known groundwater abstraction wells located within the Site boundary. The closest GSI mapped boreholes are located in close proximity to the southern site boundary near the townlands of Lickoran and Lyrattin. Both of these boreholes are classified as being utilised for agricultural and domestic use and have been drilled to depths of 36.6m and 40.5m. Multiple other boreholes have been mapped beyond the north-eastern site boundary and beyond the western site boundary near Knocknanask and Crow Hill. The location of these wells are outlined on **Figure 9.16** in **Volume III**.

The Knockmealdown GWB (IE_SW_G_047) underlies the Site boundary and much of the grid connection route. The underlying aquifer is a poorly permeable aquifer and can support only local scale flow systems.

Groundwater flow paths can be up to a few tens or hundreds of metres long, and may be significantly shorter where the water table is very close to the surface. Overall groundwater flow is to the surface water channels of this GWB. This underlying bedrock aquifer, which is classified as being locally important by the GSI, could potentially be capable of supplying good well yields of 100-400 m^3 per day. Given that the existing GSI groundwater well database is an incomplete dataset, it should be assumed for the purpose of conservatism that all dwellings located within or in close proximity to the Site boundary have the potential to maintain a groundwater well for abstraction. Potential risks to groundwater quality and drinking waters sources are discussed in Section 9.4.4.1.a.i.15.

9.3.13 Groundwater Vulnerability

Groundwater vulnerability is a measure of the inherent geological and hydrogeological characteristics which determine the ease at which groundwater may potentially become contaminated via human activities at the surface. The vulnerability of groundwater is dependent upon multiple factors. These include the intrinsic toxicity of the contaminants in question, the quantity of contaminants that can reach the groundwater, the rate at which contaminants can flow to the groundwater and the attenuating capacity of the subsoils and bedrock through which the water travels.

The GSI groundwater vulnerability rating for the aquifer within the Site boundary ranges from "*Extreme*" and "*Rock at or Near the Surface*" across elevated areas of the Site to predominantly "*High*", and "*Extreme*" vulnerability across lower lying areas of the Site. The GSI aquifer vulnerability classifications broadly aligns with changes in elevation across the main Site with higher altitude areas in the north, west and south generally being characterised as more vulnerable than less elevated areas in the east of the Site. The high and extreme vulnerability classifications across the Site indicate that the combined thickness of subsoils in these areas ranges from 0 – 5m as is outlined in **Table 9.22** below. The extreme and high vulnerability classifications are also generally consistent with bedrock outcrops at the surface and the shallow soil depths which are dominant across the Site. Extensive soil probing at the Site confirmed that the depth to the top rock did not exceed

0.5m across 347 probe locations. This is consistent with the GSI groundwater vulnerability classification for the Site of Extreme and High.

The Devonian old red sandstones bedrock that underlies much of the Knockmealdown GWB are characterised by permeability that generally decreases rapidly with depth. However, many areas of the Site are characterised by well-draining soils which indicates that recharge rates are moderate in some areas, particularly in the central and eastern fields. Across the remainder of the Site, low permeability materials and poorly draining soils protect underlying groundwater and restricts recharge. Where sufficiently thick, such low permeability materials may confine groundwater. Flow paths are expected to be short with groundwater discharging rapidly to nearby streams and small springs, thus restricting the potential for significant groundwater flux to the uppermost part of the aquifer. In the event that contaminants were to be accidentally released on Site, it is expected that their mobility within the groundwater would be limited and would remain relatively localised to the source of contamination. It is more likely that contaminants released on the steep slopes near turbine or hardstand areas would flow to nearby watercourses within surface runoff rather than to groundwater. As a result, surface waters such as rivers, lakes, streams and drains are likely to have a higher vulnerability to potential contamination at the Site than groundwater. An exception to this scenario would be if spills were to occur in low lying areas of the site with well drained soils that are not located in close proximity to any drains or watercourses. The GSI mapped groundwater vulnerability for the Site is shown in **Figure 9.14** in **Volume III.**

Table 9.22: Groundwater Vulnerability Classes

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil permeability (type) and thickness			Unsaturated zone	Karst features
	High permeability (sand/gravel)	Moderate permeability (e.g. sandy till)	Low permeability (e.g. clayey till, clay, peat)	Sand/gravel aquifers only	(<30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High (H)	>3.0m	3.0m – 10.0m	3.0m – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0m – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Source: Strive Report Series No. 6, Water Framework Directive – Recharge and Groundwater Vulnerability, Environmental Protection Agency, 2008

Similar to the proposed wind farm Site, a range of GSI groundwater vulnerability classifications have been mapped along the proposed grid connection route to the Dungarvan Substation. The majority of the proposed grid connection route is underlain by aquifer vulnerabilities classified as "*Extreme*" and "*High*" with multiple "*Rock at or Near the*

Surface" also mapped along the proposed route. Shallow trenching which will be backfilled is expected to be required for the proposed grid connection in addition to horizontal directional drilling (HDD) at three locations along the route. The shallow trenching is not expected to breach the groundwater table and will be excavated upon the overburden.

Horizontal directional drilling is the method of cable installation which will be used at three bridge crossings and at a cattle underpass. The locations of the two HDD watercourse crossings, and the one cattle underpass HDD location, are outlined in **Figure 9.7** in **Volume III**. Horizontal directional drilling is a drilling technique whereby a hole is drilled under a feature so that the cable installation avoids disturbance of the feature, in this case, the features are three watercourses and one cattle underpass. This methodology requires the excavation of two pits; a launch pit and a reception pit. Approximate dimensions for the excavations would be 4m long x 3m wide x 2m deep. The sides of the launch and reception pits will be battered with no requirement for sheet piling. HDD involves the drilling of a pilot hole from a drilling machine positioned at one side of the obstacle to be crossed. A pipe is inserted into the drilled hole which acts as a duct through which the cable is pulled. The horizontal directional drilling will require a drilling fluid to cool and lubricate the drill head. The drilling fluid used during the works will be Clearbore which is a polymer-based product that is designed to instantly break down and become chemically inert in the presence of small quantities of calcium hypochlorite. Clearbore is not toxic to aquatic organisms and is biodegradable. Typical depths for horizontal directional drilling will be in the range of between 5m to 10m although the actual depth will ultimately be determined by the ground profile at each HDD location.

During the HDD process, there is potential for groundwater to be encountered. There is also potential for sediment laden run-off to arise from the launch pit excavation works. The loss of drilling fluid can occur as a result of the geological formation that is being drilled through. A brecciated or fractured formation will result in the loss of drilling fluid through cracks, voids and fractures. Potential receptors include the Finisk River, Killeagh Stream, the Colligan River and/or the localised groundwater bodies. If a frac-out occurs, there will be a loss in drilling pressure, this is a signal to the operator that an issue has arisen with the drilling process. Clearbore drilling fluid is used to minimise the risk to the environment in the case of a frac-out. Therefore, the risk of frac-out occurring during the HDD process which could result in contamination of the surrounding watercourses with drilling fluids is unlikely. Mitigation measures to minimise potential risks to surface water and groundwater quality are outlined in **Section 9.5**. Guidance and mitigation measures recommended by statutory consultees during the consultation process have been incorporated into the design. As a result, potential impacts on groundwater or surface water along the proposed grid connection route is expected to be negligible.

9.3.14 Groundwater Levels

The Knockmealdown GWB is composed mainly of poorly permeable sandstone, the water table is generally expected to be within 10m of the surface with an average annual fluctuation of up to six metres. The presence of groundwater at or very near the surface was not observed when gouge cores were advanced at each of the turbine locations. Gouge coring at turbine locations is discussed in **Chapter 8: Soils and Geology.** Seepage was observed within trial pits t11, t12 and t13 above 1.5m, however these observations were considered to be localised perched water rather than an indication of the general water table depth.

9.3.15 Groundwater Hydrochemistry

There is no groundwater hydrochemistry data available for the proposed wind farm Site, limited GSI groundwater hydrochemistry data is available for the wider region. Groundwater quality monitoring is generally not conducted for proposed wind farm developments due to the limited excavation nature of such developments. Impacts on groundwater quality are also generally not expected to occur from such developments. Old red sandstone bedrock underlies the Site boundary and from the available GSI data, alkalinity typically range from 10 – 300 mg/L ($CaCO_3$) and hardness ranges from 40 to 220 mg/l (moderately soft to moderately hard).

The Old Red Sandstone formations largely contain calcium bicarbonate type water. This indicates that these groundwaters largely contain the more readily dissolved ions such as calcium and bicarbonate. Conductivities in these units are relatively low ranging from 125 to 600 μS/cm, with an average of 300 μS/cm. Iron and manganese commonly occur in groundwater derived from sandstone and shale formations due to their dissolution from the sandstone/shale where reducing conditions occur (GSI, 2004). Only shallow trenching which will be backfilled is expected to be required for the proposed grid connection. The shallow trenching is not expected to breach the groundwater table and will be excavated upon the overburden. As a result, potential impacts on groundwater along the proposed grid connection route is expected to be negligible. Mitigation measures to minimise potential risks to groundwater quality are outlined in **Section 9.5**.

9.3.16 Water Framework Directive Water Body Status & Objectives

The Water Framework Directive (WFD) surface water body status (2013 – 2018) and the associated objectives assigned for the surface water network both within and surrounding the Site have been reviewed. The wider Blackwater (Munster) Catchment is amongst the largest catchment areas in Ireland spanning over 3,300km^2. The WFD status of river water bodies associated with the Blackwater (Munster) Catchment range from "*High*" to "*Poor*" with the majority of river water bodies ranging from "*Good*" to "*Moderate*". The Farnane River, the Lisleagh Stream and the Aughkilladoon Stream are the main surface water bodies that drain the site. All of these surface waters are tributaries of the Finisk River which flows to the east and south-east of the proposed Site. The majority of the Finisk River immediately upstream and downstream of the Site is assigned a WFD status of "*Moderate*". All of the surface waters which drain the proposed Site have a WFD status of "*Moderate*" with the exception of the Farnane River which is assigned as "*High*" status under the WFD. Beyond the northern Site boundary, the Boolahallagh River and its tributaries are currently assigned as "*Good*" status under the WFD.

Surface water bodies with "*Good*" or "*High*" status have an overall objective to retain this status, i.e. no deterioration in water quality is the objective for these water bodies. Surface water bodies assigned "*Moderate*" status are "*At Risk*" of not meeting objectives The target for these surface waters is to restore the status to at least "*Good*" status by 2027 under the third cycle of the WFD. The Farnane River which rises at Broemountain and drains the western extent of the Site is classified as "*Not at Risk*" of achieving at least "*Good*" status by 2027.

The Lisleagh Stream and the Aughkilladoon Stream which drain the central and eastern extents of the site are currently assigned "*Review*" status in terms of risk of achieving at least "*Good*" status by 2027. Waterbodies may be categorised as "*Review*" either because additional information is needed to determine their status before resources and more targeted measures are initiated or measures have already been undertaken although the outcome hasn't yet been measured/monitored. Beyond the northern Site boundary, the Boolahallagh River and its tributaries are currently classified as "*Not at Risk*" of achieving at least "*Good*" status by 2027.

9.3.17 Groundwater Body Status

The Knockmealdown groundwater body which underlies the Site boundary and the wider region is assigned "*Good*" status under the current cycle of the WFD. This classification is based on an assessment of the chemical and quantitative status of the GWB. The Kilrion, Ballyknock and Dungarvan groundwater bodies which underlie sections of the grid connection route have also both been assigned "*Good*" status under the WFD. The status is derived from representative monitoring points selected specifically for the WFD groundwater monitoring programme. The Knockmealdown groundwater body underlying the Site is currently assigned "*Review*" status in terms of risk of achieving at least "*Good*" status by 2027. The Kilrion, Ballyknock and Dungarvan groundwater bodies which underlie sections of the grid connection route are categorised as "*Not at Risk*" of failing to meet their WFD objectives by 2027.

The risk of not meeting WFD objectives is determined by assessment of monitoring data, data on the pressures and data on the measures that have been implemented. Groundwater bodies that are "*At Risk*" are prioritised for implementation of additional measures and resources to mitigate potential impacts. The implementation of such additional measures do not apply to the GWBs underlying the proposed Site or the proposed grid connection route since none of these GWBs are currently categorised as "*At Risk*".

9.3.18 Designated Sites & Sensitive Areas

Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), referred to as "*European Sites*" or "*Natura 2000 Sites*", are the means by which European legislation protects threatened or rare habitats and species. Candidate Sites (i.e. cSAC or cSPA) have the same level of protection as fully designated sites under Irish Law. Candidate Sites are those that are currently under consideration by the Commission of the European Union for SAC or SPA status in accordance with the Habitats Directive. Natural heritage areas (NHAs) are designated areas that are protected under the *Wildlife Act 2000* for areas considered important for the habitats present or which hold species of plants and animals whose habitat needs protection. Proposed natural heritage areas (pNHAs) are sites not yet offered the same statutory protection as NHAs but which may become NHAs in due course and are sites of significance for wildlife and habitats. The proposed Site is not located within any of the aforementioned categories of designated areas of conservation.

The proposed Site and its surrounds are located upstream of the Finisk River, into which all rivers and streams within the Site boundary ultimately drain. The Finisk River rises between the Knockmealdown and Monavullagh Mountains to the northeast of the proposed Site. The Finisk River is a large tributary of the Blackwater River which is part of a designated Special Area of Conservation (SAC), namely the Blackwater River (Cork/Waterford) SAC (Site Code 002170). As one of the larger tributaries of the Blackwater River, the Finisk River is therefore also designated as a part of the Blackwater River (Cork/Waterford) SAC. As a result, the rivers and streams which drain the Site, including the Farnane River, the Lisleagh Stream and the Aughkilladoon Stream, are considered to have tenuous hydrological connectivity to the Blackwater River (Cork/Waterford) SAC as tributaries of the Finisk river.

The Blackwater River Estuary and pNHA (Site Code 000072) forms part of the Blackwater River to the southwest of Cappoquin, approximately 12km downstream of the Site. Therefore, the Farnane River, the Lisleagh Stream and the Aughkilladoon Stream which drain the Site are considered to have very tenuous hydrological connectivity to the Blackwater River Estuary and pNHA via the Finisk river. The grid connection route also traverses over the Finisk River at Mountaincastle Bridge along the existing L-1034 Local Road. The grid connection route will terminate at Dungarvan Substation at Killadangan. Approximately 600m south-east of the existing Dungarvan Substation, is the Dungarvan Harbour pNHA and the Dungarvan Harbour SPA.

The Glenshelane River rises near the foothills of Knocknasculloge, approximately 1.4km northwest of the Site and flows in a southerly direction towards Cappoquin where it merges with the Blackwater River. As a tributary of the Blackwater River, the Glenshelane River to the west of the Site is designated as part of the Blackwater River (Cork /Waterford) SAC. Knocknasheega (428m) and significant areas of forestry plantation separate the western site boundary from the Glenshelane River. None of the turbine positions or hardstand areas are hydrologically connected to the Glenshelane River. It is therefore considered that there is no potential for the Glenshelane River to act as a vector for the potential transfer of contaminants from the Site to the Blackwater River (Cork /Waterford) SAC or the Blackwater River Estuary and pNHA.

Glenboy Wood pNHA (Site Code 000952) is located approximately 2.5km beyond the north-western site boundary in a sperate catchment area, namely the Suir Catchment Area. There is no hydrological connectivity between the proposed site and the Glenboy Wood pNHA. Lismore Woods pNHA (Site Code 000667) is located approximately 9km southwest of the Site. The Lismore Woods pNHA is located upstream of the Blackwater River and Estuary pNHA into which surface waters at the Site ultimately drain via the Finisk River. It is therefore considered that there is nil potential for the surface waters draining the site to act as a vector for potential contamination of the Lismore Woods pNHA.

The Lower River Suir SAC (Site Code: 002137) is located approximately 6.5km north of the Site in the Suir Catchment Area, and is not hydrologically connected to the Site. The Comeragh Mountains SAC (Site Code: 001952) and the Comeragh Mountains pNHA (Site

Code: 001952) are located approximately 7.7km west of the site in the Colligan-Mahon Catchment Area. The Nier Valley Woodlands SAC (Site Code: 000668) and the Nier Valley Woodlands pNHA (Site Code: 000668) are located approximately 7.9km northeast of the Site in the Suir Catchment Area with no hydrological connectivity to the Site. Due to the absence of hydrologic connectivity to the Site, it is considered that there is nil potential for the Lower River Suir SAC, the Comeragh Mountains SAC/pNHA or the Nier Valley Woodlands SAC/pNHA to be adversely impacted by potential contaminants migrating from the Site via waterbodies.

Neither the Site nor any of the grid connection route are located in catchments that are designated as *Margaritifera* Sensitive Areas in accordance with the EU Habitats Directive. There are no protected bathing water locations near the site nor along the grid connection route. Neither the site nor the grid connection route are hydrologically connected to drinking water rivers or lakes as delineated in accordance with *European Union (Drinking Water) Regulations 2014 (S.I. No. 122/2014)*. All WFD GWBs nationally have been identified as Drinking Water Protected Areas (DWPA) due to the potential for qualifying abstractions of water for human consumption as defined under Article 7 of the WFD.

Neither the main Site nor the grid connection route, nor the surface waters which drain them are located within a Shellfish Area as defined in the *European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009*. Neither the Site, nor the vast majority of the grid connect route are located within groundwater bodies intersecting with Designated Shellfish Zones under *S.I. No. 55/2009 European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009.* A small section of the grid connection route does intersect the Dungarvan GWB which is listed as a Designated Shellfish Zone under *S.I. No. 55/2009 European Communities (Quality of Shellfish Waters)*. However, the shallow trenching that will be required to construct the grid connection route is not expected to intersect the groundwater table at any location along the route. Horizontal directional drilling (HDD) will be not be required within the Dungarvan GWB.

There are no salmonid rivers or streams which intersect the Site or grid connection route that are offered additional protection status as designated in the *Salmonid Waters under S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988*. The closest surface waters to the Site which are designated under these regulations is the Blackwater River and Estuary, approximately 12km downstream from the Site via the tributaries of the Finisk River which drain the Site. Hydrological connectivity between the Site and the nearest surface waters designated in the *Salmonid Waters under S.I. No.*

293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988 is therefore highly tenuous.

There are no designated nutrient sensitive rivers, lakes, transitional waterbodies or groundwater bodies which intersect the site or the grid connection route as designated under the *Urban Waste Water Treatment (UWWT) Directive 91/271/EEC on Urban Waste Water Treatment and S.I. 254 / 2001, S.I. 440/2004 and S.I. 48/2010*. The closest connected surface water to the Site designated under these regulations is a section of the Finisk River commencing at Modelligo Bridge, approximately 4.5 km downstream from the Site via the Aughkilladoon Stream, which is a tributary of the Finisk River. The nature of the proposed development as a windfarm site is not expected to result in excess nutrient loading to the surrounding surface water or groundwater bodies during either the construction or operational phases.

The proposed site is not located within a Priority Area for Action (PAA) under the 3rd Cycle of the WFD. PAAs are areas that are to be prioritised for restoration or actions to restore water quality or areas that have been previously restored and where a focus is now on protecting and maintaining these improvements. The grid connection route does intersect one area for restoration, namely the Colligan-Bricky-Dungarvan Harbour Area for Restoration. The catchment locations surrounding the Site area mapped in **Figure 9.9** and the Designated Sites in the wider region are mapped in **Figure 9.5,** both of these figures are contained in **Volume III.**

9.3.19 Water Resources

Surface waters within the Site boundary or downstream in the Finisk River are not abstracted for drinking water purposes and these rivers are not designated by the EPA as having a particular recreational use. There are nine surface waterbodies in the wider Blackwater (Munster) Catchment identified as Drinking Water Protected Areas (DWPA) based on water abstraction data on the abstraction register. The closest surface water DWPA to the Site are a series of small streams that rise in the Knockmeal Mountains which are headwaters of the Glengalla River, approximately 4km northwest of the Site boundary. These DWPA rivers are located in the Suir Catchment Area and are not hydrologically connected to the Site. None of the rivers which drain the site or which intersect the grid connection route are hydrologically connected to DWPA river or lake.

The EPA maintains a register of water abstractions in accordance with the *Water Environment (Abstractions and Associated Impoundments) Act 2022 (S.I. No. 48 of 2022)*. All persons that abstract a volume of 25 cubic metres (25,000 litres) per day or more from rivers, lakes and groundwater are required to register. The EPA does not publish a detailed public abstraction register as it may contain personal or commercially sensitive information or other information that could jeopardise the security of water supplies. A limited publicly available version of the abstraction register is available from the EPA upon request. This request was made. The data received does not include information on water abstractions where the abstraction purpose has been identified as being for drinking water. Additionally, grid references are rounded to the nearest kilometre to protect the identity of individual households and businesses, who may also use the abstracted water for private domestic use.

The publicly available abstraction register was received from the EPA on October 11th, 2022. It does indicate that there are a two groundwater wells or boreholes located within approximately 3.5km south and north of the Site respectively. One groundwater well or borehole within c. 3.5km north of the Site, and one groundwater well or borehole within c. 400m south of the site are both listed on the abstraction register as being used primarily for "*Agriculture (Drinking consumption, parlour and herd washing)*". Since grid references on the publicly available abstraction register are rounded to the nearest kilometre, the estimates of distances from abstraction register points to the Site boundary should be regarded as generalised approximate distances only.

As discussed in section 9.3.12, the GSI well databases indicate that there are no known groundwater abstraction wells located within the Site boundary. The closest GSI mapped boreholes are located within a few hundred metres of the southern site boundary near the townlands of Lickoran and Lyrattin. Both of these boreholes are classified as being utilised for agricultural and domestic use and have been drilled to depths of 36.6m and 40.5m. Multiple other boreholes have been mapped beyond the north-eastern site boundary and beyond the western site boundary near Knocknanask and Crow Hill. There is one dwelling located within the Site boundary, the use of this building is intended to change from residential to commercial use. Consultation with Irish Water and the Waterford City and County Council has confirmed that there are no public water supplies (PWS) in existence in the area surrounding the Site. Irish Water maintains records of Water Supply Zones (WSZ's) through which water is delivered to each tap from a particular WSZ. A WSZ is a defined supply area served by a single source or group of connected sources. There are no WSZs located within the main Site Boundary area according to Irish Water's publicly available WSZ data which was last updated in November 2020. The Touraneena WSZ does intersect the eastern EIAR Site boundary along which only minor road upgrades are proposed to facilitate the delivery of turbines to the main Site. The existing road network along which the grid connection route will traverse intersects two WSZs, namely, the Carrowgarriff WSZ and the Dungarvan WSZ. Due to the shallow trenching nature of the grid connection works, and the minor road upgrades that will occur within the Touraneena WSZ, no impacts on these WSZs are anticipated.

There are no National Federation of Group Water Schemes (NFGWS) located within 15km of the Site or the grid connection route. The Site is located within the Electoral Division (ED) of Ballynamult which contained 58 households according to the 2016 census. A review of the 2016 census data for the ED of Ballynamult has been carried out to establish the percentage of the 58 households in the ED that source their water from either public or private sources. Privately sourced water supplies accounted for 87.9% (or 51/58 households) within the ED in 2016 with the remainder consisting of either public mains, or public and private group scheme water supplies.

Waterford County Council and Irish Water were also consulted for information pertaining to public and private water supplies at the Site and along the grid connection route. Irish Water provided data which indicates that there are a number of water mains supply lines which traverse the existing road network which the grid connection route will traverse. These roadway locations include along the L-1034 near the townland of Knockaunnaglokee, along the L-5068 near the townland of Colligan More, along the R-672 between the townlands of Ballymacmague North to Ballymacmague South, and along the N72 west of Dungarvan Substation. These public water main supply lines are enclosed and protected in sealed pipes. Underground service searches will be carried prior to any trenching works that will be required along this section of the route to ensure that impacts on the water mains are avoided. As a result, potential impacts on public or private water mains networks are expected to be negligible. The locations of water supply zones, source protection areas, GSI mapped boreholes, wells and springs; relative to the proposed site and the grid connection route, are mapped in **Figure 9.16** in **Volume III**.

9.3.20 Receptor Sensitivity

All water-based receptors associated with the Development, such as streams, rivers and groundwater, are considered to be highly sensitive in accordance with the criteria set out in **Table 9.2**. A key basis for this consideration is due to the hydrological connectivity of the water bodies at the Site which are tributaries of the Finisk River that form part of the Blackwater River (Cork/Waterford) SAC. The characterisation of the local water courses as highly sensitive is further indicated by the "*High*" WFD status of local rivers such as the Farnane River which drains the western extent of the Site, and the "*Moderate*" WFD status of the other rivers and streams at the Site which have connectivity to down-gradient designations (sensitive protected areas), associated sensitive habitats and species associated with same. Ultimately, all surface water and groundwater associated with the Site are considered sensitive and must be protected as per numerous legislative instruments relating to same. However, risk to receptors must consider both the hazard and likelihood of adversely impacting on any given sensitive receptor, and therefore parameters such as distance from the potential source of hazard to receptor, pathway directness and/or connectivity, and assimilative capacity of the receiving water body should also be considered.

In terms of surface water sensitivity, as is noted in **Section 9.3.13**, the majority of potential contaminants or adverse impacts would likely partially of fully infiltrate to surface water bodies rather than to groundwater bodies across most areas of the Site. However, sensitive receptors are of variable distance to proposed turbine locations as is discussed in **Section 9.3.5**, and the pathways are of variable condition for each proposed turbine location and/or any part of the Development. Extensive surface water mitigation measures are outlined in **Section 9.5** to ensure protection of all downstream receiving water bodies. Mitigation measures will ensure that surface water runoff from the Site will be of a high quality and will therefore not impact on the quality of downstream receiving waters. The proposed drainage design for the Site will mimic the existing hydrological regime and will therefore significantly reduce potential changes to flow volumes leaving these areas.

A 50m buffer zone from all waterbodies will be maintained during the construction phase. The only exceptions to this rule will be where the grid connection route traverses existing bridges, that are already located within the 50m buffer zone, where horizontal directional drilling is required and where one crossing will be constructed at the eastern extent of the site (see **Section 9.4.4.1.a.i.6**). The significant buffer zone distance of 50m from sensitive watercourses will ensure that sensitive watercourses will not be impacted as a result of excavations or other construction works such the construction of access roads. The buffer zone will also ensure adequate space is available for the proposed drainage mitigation measures to be suitably constructed up gradient of natural drainage features at the Site. This approach will allow for attenuation of surface water runoff to be diffuse and effective. In instances where implementation of a 50m buffer zone is unavoidable, such as at crossings or HDD locations, the use of sediment fences or straw bales will be implemented to reduce the potential for surface water run-off to sensitive watercourses. The proposed 50m buffer zone relative to the surface waters at the Site is mapped in **Figure 9.8** in **Volume III.** It is noted through experience and consultation with Inland Fisheries Ireland on other windfarm developments that their recommendation has typically been for a minimum 15m buffer zone from all watercourses to be implemented. Implementation of a 50m buffer zone can therefore be considered to be a conservative approach.

The nature of the proposed Development as a wind farm will necessitate near surface construction activities which would generally result in negligible groundwater impacts. Although all groundwater associated with the Site is protected as a source of drinking water, the bedrock aquifer underlying the Site and surrounding area is likely to be poorly permeable aquifer and can support only local scale flow systems. As the proposed construction works at the Site will not be located within close proximity to any dwellings, the risk of potential adverse impacts to groundwater will be highly limited to localised zones. Furthermore, it is considered that the majority of any potential contaminants such as fuel/chemical spills or seepage from cementitious materials would likely partially or fully infiltrate to surface water systems rather than recharge via percolation into groundwater. Potential impacts during the construction phase are common to all construction Sites. All potential contamination sources will be carefully managed during the construction and operational phases. Mitigation measures are proposed in **Section 9.5** to ensure that such potential impacts are appropriately managed. Based on the above factors and on the sensitivity criteria outlined in **Figure 9.1** and **Table 9.2**, groundwater at the Site can be classed as medium sensitivity from potential adverse effects.

9.3.21 Turbine Delivery Route

It is proposed that the turbine nacelles, tower hubs and rotor blades will be landed in Waterford Port. From there, they will be transported to the Site via the N29 to the north-east of Slieveroe, then via the N25 as far west as Ballymacmague South before veering north onto the R672. At the Clooncogaile Crossroads, the haul route veers west onto the L-5071 as far as Millinacoorka Bridge before veering northwest onto the L-5060 as far as Ballynaguilkee Lower where the haul route veers onto the L-1030 for a short distance to the Site. There will be few changes to the existing public roads, temporary widening may be required along the haul route at some locations to allow a load bearing surface and temporary changes to some roundabouts along the haul route. No additional bridges or temporary crossings will be constructed to facilitate these deliveries along the proposed haul route to the Site. Potential impacts on surface waters and groundwater resulting from use of the pre-existing road network to allow for deliveries to the Site are expected to be negligible. The proposed haul route is shown on **Figure 2.5** in **Volume III**. There are three areas on the haul route that will require works in third party lands. These are shown on Table 2.5 in Chapter 2 Development Description.

9.3.22 Other Infrastructure - Borehole/s

The proposed Development will not require the installation of boreholes for groundwater extraction purposes during the construction or operation phase. Drilling of boreholes in general is not considered to have potentially significant impacts on groundwater. There is no potential for the Development to impact on groundwater due to drilling of boreholes for extraction purposes.

EIA Reports should be compliant with current best practice guidelines but also proportional to the nature, scale and significance of effects. With reference to **Chapter 8: Soils and Geology**, drilling of boreholes and mechanical geotechnical testing have not been carried out as part of this assessment, as these types of analyses are not considered proportional to the nature, location and size of the project and the limited significance of its effects on the surrounding hydrogeological environment. However, a detailed Site investigation (DSI) will be carried out at the pre-construction phase which will include drilling of boreholes and geotechnical testing of the underlying bedrock.

9.4 POTENTIAL EFFECTS AND MITIGATION MEASURES

9.4.1 Assessing the Magnitude of Potential Effects – Surface Water

The receiving environment in terms of **SURFACE WATER** associated with the Development is considered as being of **Very High Importance** and **Highly Sensitive**, and therefore classification of any potential impacts associated with the Development will be limited to Magnitudes associated with **Very High Importance**, as presented in the following table.

Table 9.23: Weighted Rating of Significant Environmental Impacts – Surface Water Systems – Limited to Very High

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

In terms of determining and assessing the magnitude of impacts on surface water features, categories of magnitude relate to the potential effect on the status of the attribute, that is; the attribute driving the classification of sensitivity such as the WFD status, and condition of the surface water feature/s, the risk of not reaching WFD objectives and the potential for the surface water system to support, or function as part of designated and protected areas (SAC, SPA, NHA etc).

9.4.2 Assessing the Magnitude of Potential Effects – Groundwater

The receiving environment in terms of **GROUNDWATER** associated with the Development is considered as being of **Medium Importance** and **Medium Sensitivity**, therefore classification of any potential impacts associated with the Development will be limited to Magnitudes associated with Medium Importance as a conservative approach which is presented in the following table.

Table 9.24: Weighted Rating of Significant Environmental Impacts – Groundwater Systems – Limited to Medium

Sensitivity (Importance of Attribute/s)	Magnitude of Impact			
	Negligible (Imperceptible)	Small Adverse (Slight)	Moderate Adverse (Moderate)	Large Adverse (Significant to Profound)
Medium	Imperceptible	Slight	Moderate	Significant

In terms of determining and assessing the magnitude of impacts on groundwater features, categories of magnitude relate to the potential effect on the status of the attribute, i.e. the attribute driving the classification of sensitivity is the aquifer potential classification and use as a drinking water source, the proximity of the Site to groundwater wells, condition of the groundwater feature/s, the risk of not reaching WFD objectives, the GSI groundwater vulnerability classification and the potential for the groundwater system to support, or function as part of designated and protected areas (SAC, SPA, NHA etc).

9.4.3 Do Nothing Impact

If the proposed wind farm development does not proceed, current land use practices such as agricultural grazing will continue. There are no significant impacts to the hydrological and hydrogeological environment in the do-nothing scenario.

9.4.4 Construction Phase Potential Effects

1. Assessment of Effects - Increased Hydraulic Loading

The proposed wind farm Development has the potential to result in increased rates of runoff during the construction phase relative to baseline conditions. Such an increase in surface water runoff from the proposed Development has the potential to result in increased hydraulic loading to the receiving drainage network and ultimately to the surface water network at the Site. Preliminary water balance calculations indicate that the Development will lead to a net increase of surface water runoff of approximately 2,143 m^3/month (or 0.42% relative to the area of the Site) during the average wettest month of the year. This is considered to be a likely, negative, imperceptible or not significant, imperceptible weighted significance, permanent impact of the Development. The increase in hardstand area associated with the Development will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered a likely, negative, imperceptible or not significant, Imperceptible weighted significance, permanent impact of the Development.

2. Assessment of Effects - Earthworks

The construction phase of the proposed Development will involve the following excavations activities which may have the potential to adversely impact on surface water and groundwater:

- Construction of Site Access Tracks and amenity roads;
- Temporary construction compound;
- Turbine foundations and hardstand areas;
- Foundations for the proposed substation;
- Foundations for the proposed met mast;
- Trenching for underground electrical cabling, including along the proposed grid connection route; and,
- Temporary and permanent stockpiling of subsoils and bedrock.

All of the abovementioned excavations which will be required will necessitate the removal of vegetation, topsoil and mineral subsoils. Such excavations and associated ground disturbance may increase the risk of either point source or diffuse sediment laden run-off to sensitive receptors via drainage channels and discharge routes. The proposed earthworks therefore have the potential to result in the release of elevated suspended solids to surface waters, particularly during prolonged heavy rainfall events. The release of elevated suspended solids to watercourses would adversely affect water quality and potentially negatively affect aquatic habitats or fish stocks downstream of the discharge source point if not mitigated against. The most vulnerable areas to surface water quality deterioration through the release of elevated suspended solids are considered to be:

- Proposed crossing points of drainage channels;
- Turbine hardstand and infrastructure development, particularly at moderate to high upgradient slopes of existing waterways;

- The permanent placement of spoil at the proposed spoil storage areas.

The potential release of elevated suspended solids to surface waters is considered to be a direct, negative, potentially moderate to significant, potentially significant / profound weighted significance, impact of the Development. This potential impact is considered to be temporary and in contrast to baseline conditions, with the exception of existing cattle accessing rivers at the Site which has the potential to disturb riverbanks resulting in increased sediment laden run-off. Although this impact is likely to be temporary, considering the mobility characteristics of surface waters to downstream receptors, it is not considered reversible. However, with appropriate mitigation measures in place and via the implementation of environmental engineering controls, this impact will be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this chapter.

Potential localised soil stability issues, and erosion or degradation of soil such as by vehicular movements have the potential to increase the potential for entrainment of suspended solids in surface water runoff, impact or obstruct established drainage networks, and increase the amount of excavation works required generally which in turn increases the potential for standard effects associated with earthworks. This is considered an unlikely, direct, negative, potentially moderate to significant, potentially significant / profound weighted significance impact on receiving surface waters, assuming mitigation measures described in **Chapter 8: Soils and Geology** and in this Chapter are implemented and adhered to. This potential impact is considered to be in contrast to baseline conditions, but is also temporary.

A potential worst-case scenario associated with earthworks activities is the potential for significant stability issues leading to mass soil or peat movement or landslides. As discussed in **Chapter 8: Soils and Geology**, the risk of significant stability issues leading to mass movement or landslides has been assessed. In the event of such an occurrence, there is the potential to greatly increase entrainment of suspended solids in surface water runoff, impact or obstruct established drainage or surface water networks. Such an occurrence could potentially adversely impact upon sensitive aspects of the environment, and increase the amount of excavation works required, including for emergency remediation, which in turn would increase the potential for standard effects associated with earthworks. This is considered an unlikely, indirect, negative, potentially profound, potentially profound weighted significance impact. This potential impact is considered to be in contrast to baseline conditions and also potentially permanent.

Table 9.25: Impact Summary – Earthworks

Impact Description	Type	Quality	Significance	Weighted Significance	Context	Probability	Duration / Frequency	Reversible
Entrainment of suspended solids during earthworks	Direct	Negative	Moderate to Significant	Significant / Profound	Contrast to baseline	Likely	Temporary	No but can be minimised
Increased entrainment of contaminants and other impacts arising due to localised stability issues	Direct	Negative	Moderate to Significant	Significant / Profound	Contrast to baseline	Unlikely[1]	Temporary	No but can be minimised
Catastrophic impacts arising from significant stability issues (Landslide – worst case)	Indirect	Negative	Potentially Profound	Potentially Profound	Contrast to baseline	Unlikely[1]	Permanent	No

[1] Assuming mitigation measures described in **Chapter 8 – Soils and Geology** and in this chapter are implemented and adhered to, localised stability issues are unlikely to give rise to impacts on surface water networks associated with the proposed development.

3. *Monitoring*

Monitoring of topsoil, subsoils, bedrock and material management during the construction phase of the Development will be fundamentally important in ensuring that potential suspended solid entrainment in surface waters is minimised. With comprehensive planning and preparation, and implementation of relevant mitigation measures contained in the Construction Environmental Management Plan (CEMP) appended to the EIAR in **Appendix 2.1**, the potential for elevated suspended solids to be released to surface waters via runoff is likely to be minimal. Monitoring of surface water quality is discussed in greater detail in **Section 9.5.2.11** of this chapter.

4. *Assessment of Effects – Excavation Dewatering*

The dewatering of excavations during construction is likely to have significant adverse effects on surface water runoff quality in the absence of mitigation measures. Should dewatering of open excavations or turbine foundations etc. be required, the receiving engineered drainage and attenuation features will likely receive water discharges elevated in suspended solids. The potential overflow of such sediment laden water into the receiving downstream surface waters is considered to be a likely, direct, negative, potentially moderate to significant, potentially significant / profound weighted significance of the Development. This impact is considered to be in contrast to baseline conditions although it is also temporary. Although temporary, considering the mobility characteristics associated with flowing surface waters, it is not considered reversible. However, with the implementation of appropriate mitigation measures and environmental engineering controls, this potential impact can be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this report.

Potential dewatering through drainage in advance of excavation activities, or dewatering via pumping during excavation activities, will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered to be a likely, negative, slight, slight weighted significance, localised impact of the Development which is in contrast to the baseline conditions. The potential effects on groundwater during the proposed operational phase of the development is considered to be negligible to low. Contaminated land has not been identified at the Site and therefore the potential for sources of contamination other than elevated suspended solids to be released to surface waters through dewatering activities is not anticipated.

5. Diversion and Enhancement of Drainage

The Development will result in the diversion, alteration and/or enhancement of the existing drainage networks at the Site during the construction of the project relative to baseline conditions. The existing drainage network at the Site is mapped and presented in **Figure 9.3** in **Volume III.** Considering that pre-existing natural and artificially established drainage networks are present at the Site, the diversion, enhancement or introduction of additional drainage features is considered a likely, negative, moderate, localised impact of the Development which conforms to baseline conditions. However, there are potential risks associated with the earthworks required to carry out such drainage works. The potential impacts of excavations are addressed in Section 2 and in **Chapter 8: Soils and Geology.**

6. Watercourse Crossings

At the Site, one new watercourse crossing / culvert will be constructed. Three crossings of existing water courses will be required along the grid connection route. The locations of the proposed crossings are mapped in **Figure 9.7** in **Volume III.**

Release of elevated suspended solids to surface waters due to excavations or other earthworks etc., or the accidental release of any form of anthropogenic contaminant such as fuels or chemicals during construction of the grid connection route over existing watercourse crossings are both potential significant adverse effects. This is considered an unlikely, negative, significant, but temporary impact of the Development which contrasts to baseline conditions. The impacts relating to the release of contaminants during earthworks is addressed in **Section 2** of this Chapter.

Poor planning, design and construction methodology over existing watercourse crossings can potentially result in significant changes in flow, erosion and deposition patterns and rates associated with the surface water feature. This in turn can potentially lead to flow being restricted, leading to increased risk of flooding locally. In the absence of mitigation measures at existing crossings, these impacts are considered an unlikely, negative, significant, profound weighted significance, localised impact of the Development which contrasts to baseline conditions.

7. Removal of Forestry and Afforestation

The Development Site contains approximately 66.7 hectares of commercial forestry. To facilitate the construction of access tracks, civil works and turbine hardstands, approximately 8.1 hectares of forestry will need to be clear-felled and ultimately replanted through afforestation. Detailed consideration of the approach to afforestation requirements associated with the Project is attached in **Appendix 2.2**. In terms of hydrology, the primary potential impacts which could arise due to tree felling and afforestation include:

- Disturbance to the existing gravel access tracks that intersect areas of forestry from the movement of heavy vehicles resulting in the potential release of suspended sediments becoming entrained in surface water runoff and discharging to the downstream surface water network;
- Disturbance of topsoil and subsoils from the movement of heavy vehicles resulting in the potential release of suspended sediments becoming entrained in surface water runoff and discharging to the downstream surface water network;
- Acidification or release of nutrients due to tree felling and soil disturbance, especially phosphates and nitrates leading to potential increased eutrophication in the downstream surface water network.

The potential release of elevated suspended solids and the potential increase in acidification or eutrophication of surface waters are considered to be a direct, negative, potentially moderate to significant, potentially significant / profound weighted significance, impact of the Development. These potential impacts are considered to be temporary and in contrast to baseline conditions. Considering the mobility characteristics of surface waters to downstream receptors, these potential impacts are not considered reversible. However, with appropriate mitigation measures in place and via the implementation of environmental engineering controls, these potential impacts will be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this chapter.

8. *Potential Effects on Surface Water and Groundwater Quality*

9. *Assessment of effects - release of suspended solids*

The proposed Development has the potential to result in the release of suspended solids during the construction phase of the project relative to baseline conditions. Runoff of suspended solids will increase turbidity concentrations in surface waters which can smother spawning grounds, reduce light penetration for flora growth, block fish gills, and promote algal growth in surface waters.

Nutrients associated with the solids entrained in run-off such as phosphorus, nitrogen and other potential contaminants such as hydrocarbons can lead to eutrophication of the water environment and eventually to fish-kills due to lowering of the dissolved oxygen concentration. Some aquatic species are particularly sensitive to changes in water quality, and in particular elevated suspended solids. **Chapter 6: Biodiversity** of this EIAR outlines further information on particular ecological sensitivities in the study area.

In addition to potentially direct adverse impacts on ecological sensitivities down-gradient of the Site, runoff of suspended solids will potentially impact on the WFD status and objectives associated with the surface water networks both within and downstream of the proposed development. Considering the “*High*” and “*Moderate*” quality of the baseline surface waters draining from the Site, in addition to the sensitivity and ‘*Very High*’ importance of the associated surface water networks, any introduction of contaminants is considered an adverse impact of high significance. The release of suspended solids is considered a direct, negative, potentially moderate to significant, potentially significant / profound weighted significance impact of the Development. This impact is considered to be in contrast to baseline conditions but also temporary in nature. Considering the long ranging mobility of surface waters, this potential impact is not considered reversible. However, with the implementation of mitigation measures and appropriate environmental engineering controls, this impact can be reduced to within water quality regulatory limits.

It is considered that the release of suspended soils does not have significant potential to adversely impact on groundwater due to the natural process of filtration associated with percolation of water through soils.

10. *Assessment of effects – release of hydrocarbons and storage*

Hydrocarbons are a pollutant risk due to their inherent toxicity to all flora and fauna organisms. Hydrocarbons chemically repel water and do not readily dissolve in polar solvents such as water. Most hydrocarbons are light non-aqueous phase liquids (L-NAPL's) that are less dense than water. If hydrocarbons are accidentally released to water, they will therefore float on the water's surface. Hydrocarbons adsorb onto the majority of natural solid objects they come in contact with, such as soil, vegetation and animals. Hydrocarbons will burn most living organic tissue they come in contact with due to their volatile chemistry. Hydrocarbons also represent a nutrient supply for adapted micro-organisms, this process in turn can rapidly deplete dissolved oxygen and thus result in fish kills or mortality of water based vertebrate and invertebrate life.

During the construction phase, vehicles and plant associated with excavation, material transport, and construction activities introduce the risk of hydrocarbon spillages and leaks from fuels and oils. The risk is increased when regular refuelling is required which in turn implies the requirement of a designated refuelling area which will likely require fuel storage on Site. Alternatively, the fuel could be supplied by fuel tanker scheduled to refuel the plant and equipment directly.

Hydrocarbons or any other forms of toxic chemicals such as paints or adhesives etc. accidentally released to the environment will likely be intercepted by drainage and surface water networks at the Site. The moderate permeability subsoils beneath the Site will inhibit the spatial distribution and temporal variation of hydrocarbon mass and concentration should an accidental spill occur. This results in a moderately limited potential for contaminant movement through subsoils as recharge is restricted. Therefore, the risk to deeper subsoils is somewhat limited, and in turn the risk to groundwater at a significant scale is also somewhat limited.

With regards to surface waters at the Site and along the grid connection route, an accidental hydrocarbon spillage is considered a likely, negative, significant to potentially profound, profound weighted significance, medium to long term impact of the Development, which is in contrast to baseline conditions.

In terms of groundwater associated with the Site and along the grid connection route, an accidental hydrocarbon spillage is considered to be a likely, negative, significant, significant weighted significance, localised medium to long term impact of the Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

11. Assessment of effects – release of wastewater sanitation and livestock contaminants

The Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto soils and ultimately into surface waters during the construction phase of the project. There is also potential for existing livestock at the site such as cattle and sheep which have been observed grazing at the Site to cause bacteriological contamination of surface waters during the construction stage. Sanitation facilities will be provided at the 110Kv substation with a cesspit which will require servicing and offsite waste removal during the operational phase.

The potential for livestock such as cattle and sheep to cause bacteriological contamination of surface waters will be controlled through the implementation of strict grazing control zones, site perimeter fencing and exclusion zones around all open excavations. Sanitation facilities such as portaloos used during the construction phase will be self-contained and supplied with water by tank trucks. Portaloos will contain water storage tanks and separate wastewater storage tanks which will be routinely emptied by vacuum removal for off Site disposal via a tank truck. Accidental release of wastewater to surface waters would likely result in an increase in biochemical oxygen demand (BOD) which in turn would lower the dissolved oxygen concentration and adversely impact on aquatic life. Wastewater sanitation chemicals are also pollutant risks due to their inherent toxicity to aquatic flora and fauna and their potential to adversely impact on the productivity or status of surface water systems. The level of risk posed by such temporary facilities is dependent upon the following key factors:

- The location of the proposed temporary sanitation facilities relative to sensitive receptors;
- The condition, emptying schedule and maintenance of the facilities; and,
- The level of toxicity of the chemical agents used to aquatic flora and fauna.

A potential worst-case scenario(s) associated with wastewater sanitation is the potential for wastewater or sanitation chemicals to accidentally spill or leak and to be intercepted by surface water drainage features, ultimately discharging to surface waters. This is considered to be an unlikely, negative, significant, profound weighted significance, medium to long term impact of the Development, which is in contrast to baseline. With the implementation of appropriate mitigation measures, these potential risks can be significantly reduced.

12. Assessment of effects – construction or cementitious materials

The construction phase of the Development has the potential to result in the accidental spillage or deposition of construction waste into soils. This in turn has the potential for waste materials to leach out toward preferential drainage flow paths that may ultimately be connected to the surrounding surface water network.

The accidental leaching of cementitious wastes such as concrete, lean mix or cement etc., can result in an adverse change to hydrochemistry which can adversely impact on sensitive aquatic flora and fauna. Cementitious materials are highly alkaline and if accidentally released to surface waters can significantly elevate the pH concentration above the tolerance range of fish such as cyprinid and salmonid species. Freshly poured or wet concrete has greater potential to leach out towards preferential flow paths when compared to set concrete which is considered inert in comparison, the risk from wet concrete is further increased during periods of heavy rainfall. Surface water runoff that comes into contact with concrete will be impacted to a lesser extent than water percolating through lean mix concrete which will be impacted significantly. Regardless of the nature of the construction waste in question, the deposition of any construction materials or waste deposited at the Site that does not form part of the constructed development, even if inert, is considered contamination.

The accidental spillage or deposition of construction materials such as wet or lean mix concrete which is intercepted by drainage or surface water networks is considered a direct, negative, moderate to significant, significant / profound weighted significance, temporary to medium term impact of the Development, which is in contrast to baseline.
With the implementation of appropriate mitigation measures and environmental engineering controls described in **Section 9.5**, these potential risks can be significantly reduced and are considered unlikely.

13. Potential Effects on Hydrologically Connected Designated Sites

The proposed Site is situated up stream of the following Designated Sites which are discussed in detail in **Section 9.3.18**:

- Blackwater River (Cork/Waterford) SAC (Site Code 002170); and,
- The Blackwater River Estuary and pNHA (Site Code 000072).

The pre-existing Dungarvan Substation at Killadangan where the grid connection route will terminate is not located within a designated area of conservation. It is located approximately 600m northwest of the Dungarvan Harbour pNHA and the Dungarvan Harbour SPA. A small section of the grid connection route intersects the Dungarvan GWB which is listed as a

Designated Shellfish Zone under *S.I. No. 55/2009 European Communities (Quality of Shellfish Waters)*. However, the shallow trenching that will be required to construct the grid connection route is not expected to intersect the groundwater table at any location along the route. Horizontal directional drilling (HDD) will not be required within the Dungarvan GWB.

Any accidental release of potential contaminants to the environment as a result of the Development will likely be intercepted by the drainage and surface water network at the Site. Therefore, any contaminants released may subsequently impact on a downstream designated site. The potential of the Development to introduce contaminants to surface waters and in turn impact on the designated areas downstream is considered to be a negative, significant to profound, significant / profound weighted significance, potentially temporary to long-term impact of the Development which is in contrast to the baseline.

However, with the implementation of appropriate mitigation measures and environmental engineering controls, these potential risks can be significantly reduced and are considered unlikely. Furthermore, considering the geographical scale of the site, the Finisk River and the Blackwater River, the assimilative capacity of the surface water systems will buffer against any potential contaminants introduced. In the event of accidental release of contaminants to surface waters at the Site, they will become more diluted in receiving waterbodies as the distance from the Site increases. This principle does not lessen potential adverse impacts in the immediate vicinity, and it does not reduce the need for robust mitigation measures to be implemented.

14. Drilling of Boreholes and Extraction of Groundwater

The bedrock formations underlying the Site are predominantly classified by the GSI as Locally Important (LI), bedrock which is moderately productive only in local zones. Locally important (L) aquifers are capable of good well yields of between 100 and 400m^3 per day. Drilling of boreholes in general is not considered to have potentially significant impacts on groundwater. Extraction of groundwater is considered to have potentially significant impacts on groundwater and on associated sensitive receptors. The proposed Development will not require the installation of boreholes for groundwater extraction purposes during the construction or operation phase. All fresh water required during the construction phase of the project will be delivered to the Site via tank trucks. Therefore, there is no potential for the Development to impact on groundwater due to drilling of boreholes for extraction purposes.

15. Potential Effects on Local Groundwater Supplies (Wells)

The bedrock formations underlying the Site are classified by the GSI as Locally Important (LI), bedrock which is moderately productive only in local zones. There are a number of known groundwater wells located to the north and south of the Site boundary as is discussed in **Section 9.3.12**. There are two GSI mapped boreholes located in close proximity to the southern site boundary near the townlands of Lickoran and Lyrattin. Both of these boreholes are classified as being utilised for agricultural and domestic use and have been drilled to depths of 36.6m and 40.5m. The GSI well database is incomplete and accuracy of well positions in the database can vary. However, it is considered that the closest well to any proposed turbine position is likely to be approximately 900m to the southwest of T2. The locations of the mapped GSI wells, and their varying degrees of location accuracy, in the vicinity of the Site are mapped on **Figure 9.16** in **Volume III**. The underlying aquifer is poorly permeable and can support only local scale flow systems. Groundwater flow paths can be up to a few tens or hundreds of metres long and may be significantly shorter where the water table is very close to the surface. Local groundwater flow is towards the rivers and streams, and flow path will not usually exceed a few hundred metres in length. It is considered that any potential impacts to groundwater, that could occur at the T2 turbine or hardstand area, would likely attenuate prior to any potential interaction with the closest boreholes located approximately 900m beyond the south-eastern Site boundary.

Multiple other boreholes have been mapped by the GSI beyond the north-eastern site boundary and beyond the western site boundary near Knocknanask and Crow Hill. However, groundwater flow directions from the nearest turbine positions or hardstand areas, relative to these borehole locations are expected to differ. Groundwater flows from the northern and western turbine positions are predominantly expected to be discharged to the nearest surface water features such as the Farnane River, Lisleagh Stream or unnamed tributaries of the Boolahallagh River beyond the north-eastern Site boundary rather than to flow towards the boreholes beyond the western and northern Site boundary.

Given the incomplete nature of the GSI well database and the rural location, it has been assumed for the purpose of conservatism that all dwellings in the vicinity of the Site are utilising a private groundwater well and that groundwater flow direction in the underlying aquifer mimics the local topography. In other words, the groundwater flow paths are expected to be from topographic high points to lower elevated discharge points at streams, springs and rivers. Utilising this conceptual model of groundwater flow, dwellings that are located down gradient of the Site can be identified as potential receptors. The groundwater flow direction at the Site is expected to be predominantly in a north to south direction in the northern extent of the Site. The central, southern and western extents of the Site are expected to have groundwater flows that predominantly flow westward to south-westward. The eastern extent of the Site is expected to have groundwater flows that tend to flow in an east to south-easterly direction.

There is currently one dwelling (H106) located within the redline Site boundary, 114 dwellings are located within 2km of the Site. However, the closest dwelling to a proposed turbine position (T09) is situated approximately 700m southeast of T09. Similarly, the closest dwellings to the proposed substation and meteorological mast are located approximately 440m and 696m respectively to the southwest of these structures. It is anticipated that any potential groundwater impacts will have significantly attenuated across these distances in the underlying poorly productive aquifer. Excavations required for roads, grid connection route, met mast and substations etc. will be relatively shallow and are not anticipated to intercept the groundwater table. No significant potential to impact on groundwater supplies from such excavations are anticipated to occur at any area of the Site.

Piling works will not be carried out at turbine positions due to the presence of shallow rock across much of the Site. Excavations will be advanced to approximately 3m and mass reinforced concrete gravity bases will be constructed. Minimal excavation dewatering is expected to be required at turbine positions or hardstand locations. Excavations will occur in a moderate to low permeability environment which will have a containment effect on the localised groundwater. The potential for any possible contaminants to leach or migrate across long distances or to alter the localised groundwater chemistry will therefore be limited. A combination of an underlying GWB that is composed mainly of poorly permeable sandstones, the temporary nature of the construction works, moderate recharge rates, consideration of anticipated groundwater flow directions and the absence of near proximity to the closest known or assumed well locations; is expected to result in a likely, neutral to negative, slight to moderate significance, localised impact of the Development which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced to Imperceptible to Slight.

16. Potential Groundwater and Surface Water Effects due to the Grid Connection Cable Works

In addition to the Knockmealdown GWB, the grid connection route also traverses through the Kilrion, Ballyknock and Dungarvan groundwater bodies. According to the GSI, these

GWBs are categorised as poorly productive bedrock, productive fissured bedrock and karstic respectively.

The GSI well database has indicated that there are multiple known wells located along or within the vicinity of the proposed grid connection route. Shallow trenching, which will be backfilled is expected to be required for the proposed grid connection, the shallow trenching will not breach the groundwater table. Horizontal directional drilling will be required adjacent to three bridge locations along the grid connection route and at one existing cattle grid along the grid connection route. In the unlikely event that a brecciated or fractured formation were to occur, it could potentially result in the loss of drilling fluid through cracks, voids and fractures. If test pits and boreholes were located directly on, or extended through the proposed alignment, these areas could act as weak points that may serve as conduits where inadvertent fluid returns or frac out occurs. However, if a frac-out occurs, there will be a loss in drilling pressure, this is a signal to the operator that an issue has arisen with the drilling process and the drilling would be immediately ceased. The method for reducing the drilling fluid losses and thereby control the consumption of water and drilling fluid products is to identify the point of losses and seal the area off. Clearbore drilling fluid will be used during the drilling process which is not toxic to aquatic organisms and is biodegradable which further reduces the potential for adverse impacts in the event of frac-out occurring.

Due to the vast majority of the grid connection requiring shallow trenching which will be backfilled, the temporary nature of the construction works, the established HDD technique with controls and use of non-toxic fluids is expected to result in a neutral to negative, slight to moderate significance, localised impact of the Development which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced to Imperceptible to Slight.

17. Potential Groundwater and Surface Water Effects due to Internal Cable Works at the Site

The internal cable works at the main site will follow the hardstand and road alignment and will be predominantly buried within shallow cable tranches. There are no known groundwater wells located within the site boundary, the known wells located beyond the Site boundary are discussed in **Section 15**. The closest internal cable works at the Site to a mapped well is expected to occur at the T2 turbine location, approximately 900m northwest of the closest GSI mapped well. It has been assumed for the purpose of conservatism that all dwellings in the vicinity of the Site are utilising a private groundwater well and that groundwater flow direction in the underlying aquifer mimics the local topography. Excavations required for internal cable works will be relatively shallow and are not anticipated to intercept the groundwater table. No significant potential to impact on groundwater supplies from such excavations are anticipated to occur at any area of the Site.

The road alignment and associated internal cable works will only occur within 50m of one surface water which is mapped on **Figure 9.8**. Due to the alignment of the internal cable works with the proposed site access roads, the shallow trenching, the absence of proximal surface waters or groundwater wells and the sealed nature of the internal cable works at the proposed crossing, internal cable works are expected to result in a neutral to, slight significance, localised impact of the Development which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced to Imperceptible to Slight.

9.4.5 Reinstatement of Redundant Access Track, Hardstand Areas and Borrow Pits

Site access tracks and turbine hardstand areas, such as Site compound areas that will be utilised for the construction phase of the proposed Development will become redundant following the completion of construction activities at the Site. Reinstatement of redundant access tracks and hardstand areas will require the removal of the top layer of hardstand and temporary access tracks. The underlying soil will not be significantly exposed during such top layer surface removals. Any excess spoil from the top layer removals will be transported to the designated borrow pit.

There is potential for elevated suspended solids to become entrained by surface water runoff during the reinstatement of such areas. Any impacts to the receiving hydrological and hydrogeological environment during reinstatement are likely to be slight and infrequent with the implementation of the mitigation measures and precautions described in this report. Reinstatement of redundant infrastructure following the construction phase is considered a positive, or beneficial impact of the Development. Although reinstatement will not revert the areas in question to pre-existing baseline conditions, it will serve as a foundation for the promotion and establishment of new vegetation growth and associated ecological and biodiversity benefits.

9.4.6 Operational Phase Effects

The replacement of the vegetated surfaces at the Site with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. The completed Site footprint will comprise of turbine hardstand areas, site access tracks, substation and met mast. The borrow pit and spoil storage areas have been designed to ensure that all spoil placement areas are setback a minimum distance of 50m from all identified watercourses.

During prolonged heavy rainfall events, additional surface water runoff at increased flow velocity could increase hydraulic loading. This in turn has the potential to result in enhanced erosion of watercourses and adverse impact on aquatic ecosystems. However, with the implementation of the proposed drainage design discussed in the **Surface Water Management Plan** attached as **Appendix 2.1**, it is anticipated that such potential impacts are expected to be an imperceptible to slight, neutral, permanent impact during the operational phase. Nevertheless, the mitigation measures described in this report will be implemented in full as applicable.

Water supply for the substation sanitation facilities will be brought to Site and removed after use as wastewater from the Site by a licensed waste haulage contractor to be discharged at a suitable off-site treatment location. No water will be sourced on the Site or discharged to the Site during the operational phase. No operational phase effects are anticipated from water and wastewater sourcing and disposal.

9.4.7 Decommissioning Phase

Decommissioning of the Development will result in the cessation of renewable energy generation at the end of the operational life of the wind farm with the removal of various infrastructural elements. The decommissioning phase will involve the removal of the above ground elements of the wind farm which will require the following key elements:

- De-energising of the Site via a high voltage (HV) disconnection followed by low voltage (LV) disconnection of turbines;
- Removal of the substation building;
- Controlled dismantling of turbine components such as blades, tower and nacelle
- Controlled removal of the met mast; and,
- Removal of de-energised underground cables, electrical control systems and ducts.

It is anticipated that the following elements of the wind farm will be left in place after decommissioning:

- The reinforced concrete turbine foundations;
- The turbine hardstanding areas adjacent to the turbines;
- The site access roads;

- The hardstanding area for the substation; and,
- The site drainage network.

There will not be a requirement for additional drainage measures to be implemented during the decommissioning phase of the proposed Development. With the passage of time, the constructed drainage network will likely become full of deposited sediment and revegetation will naturally occur which will render the drainage system less effective over time. The Site will therefore revert over time to a more natural drainage regime that is similar to its current baseline environment. Given the relatively long operational lifespan of wind farms, the groundwater levels on the Site will have stabilised at a new equilibrium steady state condition when the decommissioning phase is required. As the efficiency of the drainage network is reduced over time, a gradual restoration of groundwater levels on the Site will occur. The works to be completed during the decommissioning phase are expected to result in an imperceptible to slight, neutral, permanent impact on the hydrological and hydrogeological setting surrounding the Site.

9.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

The Development has associated potential impacts as described in the previous sections of this report. The following sections outline mitigation measures to be implemented during the design, construction, operational and decommissioning phases of the Development. Potential residual effects after mitigation measures are implemented are also described in the following sections.

9.5.1 Design Phase

9.5.1.1 Mitigation by Avoidance

The fundamental mitigation measure to be implemented during each stage of the proposed Development will be avoidance of sensitive hydrological or hydrogeological receptors wherever possible, this key principle is referred to as "*mitigation by avoidance*". This principle has been adopted during the design of the turbine and associated infrastructure layout across multiple design iterations. Hydrological constraints maps have been developed which identified areas of the Site where surface water, groundwater and drainage constraints resulted in areas of the Site being deemed less suitable for development. The multiple constraints maps are presented in **Volume III**. The identified constraints have been extensively discussed in consultation with the design team. The final Site layout plan has been identified as the optimal layout design available for protecting the existing hydrological regime of the Site, while at the same time incorporating and overlaying engineering and other environmental constraints.

9.5.1.2 Constraints

As part of mitigation by avoidance principles applied during the design phase of the Development, a self-imposed 50m buffer zone around surface waters and significant drainage features was implemented. The 50m buffer zone is intended to inform the design process by minimising or avoiding the risk to surface water receptors and by restricting construction disturbance to outside these zones. The buffer zone will in turn provide enhanced potential for filtering capacity of runoff and will protect riparian zone vegetation. The implementation of 50m surface water buffer zones is not a legislative requirement, particularly for unmapped surface water features. However, it has been employed for identified areas of the Development which pose an elevated risk in terms of sensitive surface water receptors. A self-imposed 50m buffer zone can therefore be viewed as a conservative approach.

The layout of the Development itself is inherently restricted due to the proposed infrastructure requirements, such as the proposed turbines require a minimum distance from each other to ensure the potential for wind turbulence impacting on downwind locations is minimised. The vast majority of the proposed Development features will be situated outside of the 50m buffer zone, with the exception of the following unique and unavoidable circumstances:

- Two horizontal direction drilling locations along the grid connection route, use of existing infrastructure for the grid connection route at Kildangan Bridge, and one culverted crossing of the Aughkilladoon Stream at the eastern extent of the Site, the methodology for these works is described in **Section 9.5.2.4**.; and,
- Shallow cable trenching along the grid connection route where the existing road network is already located within the 50m buffer zone of multiple rivers and streams.

The principle of mitigation by avoidance during the design phase has been implemented to the fullest practical extent. However, additional consideration and planning measures as described in **Section 9.5.2.7** will be required for the abovementioned areas which could not be designed for positioning outside of the 50m surface water buffer zone. During the Site surveys discussed in **Section 9.2.4**, multiple natural and artificial drainage features were observed. Some of these drainage features are relatively well connected to the mapped surface water network, especially at lower altitude areas of the Site. Given that some pre-existing access tracks do exist in addition to an established drainage network at the Site, and the limited nature of the Development in terms of utilising the existing infrastructure (i.e. as a predominantly rural greenfield Site), some construction activities will invariably be required in close proximity to surface waters, including within the 50m buffer zone where one culverted crossing will be constructed at the south-eastern extent of the Site.

Careful consideration and special attention to planning is required for the identified locations within the surface water 50m buffer zone as described in **Section 9.5.2.7**. The **Surface Water Management Plan** attached as **Appendix 2.1** details multiple mitigation measures for works proposed within the 50m buffer zone. Each proposed construction location will possess unique characteristics and will require assessment on a case by case basis to ensure adequate measures are implemented.

9.5.2 Construction Phase

9.5.2.1 Earthworks Proposed Mitigation Measures

Mitigation measures to reduce the potential for adverse impacts arising from earthworks and management of spoil include the following:

- Management of excavated material will adhere to the measures related to the management of temporary stockpiles outlined in **Chapter 8: Soils and Geology**;
- No permanent or semi-permanent stockpiles will remain on the Site during the construction or operational phase of the Development. Excess spoil is to be taken to the designated borrow pit at the Site;
- Suitable locations for temporary stockpiles will be identified on an individual basis. The suitability of any particular location will consider Site specific characteristics, including;
    - The location of drainage networks in the vicinity;
    - The slope, incline and topography of the downgradient area; and,
    - Any other relevant characteristics which are likely to facilitate or increase the potential for entrainment by surface water runoff.
- Construction activities will not be carried out during periods of sustained significant rainfall events, or directly after such events. This will allow sufficient time for work areas to drain excessive surface water loading and discharge rates to be reduced;
- Following heavy rainfall events, and before construction works recommence, the Site will be inspected and any required corrective measures implemented;
- An emergency response plan will be developed for the construction phase of the project. The plan, at a minimum, will involve 24-hour advance meteorological forecasting linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded such as a very heavy rainfall at >25mm/hr, planned responses will be undertaken. These responses will include cessation of construction until the storm event, including storm runoff, has ceased;
- Sediment fencing will be erected along proximal and paralleling areas of watercourses, channels and drains spanned by the works to reduce the potential for sediment laden run-off to reach sensitive receptors;
- No direct flow paths between stockpiles and watercourses will be permitted at the Site;

- Excavated material will be backfilled to the excavation or transported to the spoil storage area as soon as is reasonably practicable to prevent long duration storage at the Site which increases the risk of adverse effects on aquatic environments; and,
- All mitigation measures related to surface water quality described throughout **Section 9.5** will be implemented before excavation works commence.

9.5.2.2 Excavation Dewatering Proposed Mitigation Measures

Mitigation measures to reduce the potential for adverse impacts arising from dewatering activities include the following:

- Management of excavations will adhere to the measures outlined in **Chapter 8: Soils and Geology**. Areas of subsoils to be excavated will be drained ahead of excavation works. This will reduce the volumes of water encountered during excavation works and will therefore reduce the volume of water that is required to be dewatered whilst excavations are being carried out;
- Engineered drainage and attenuation features outlined in the **Surface Water Management Plan** attached as **Appendix 2.1** will be established ahead of excavation works;
- Dewatering pumping rates will be controlled by an inline gate valve or similar infrastructure which will facilitate a reduction of loading on the receiving environment, thus enhancing the attenuation and settlement of suspended solids;
- The direct discharge of dewatered loads to surface waters will not be permitted under any circumstances;
- All dewatering will follow a strict procedure of pumping to a settlement tank and then to a dewatering bag, or settlement ponds prior to discharging to receiving environment for overland flow;
- Geofabric lined settlement ponds will buffer the run-off discharging from the drainage system which will reduce the hydraulic loading to watercourses. Settlement ponds will be designed to reduce flow velocity to 0.3 m/s at which velocity silt settlement generally occurs. In areas of the Site where the placement of settlement ponds is not feasible, other mitigation measures described below will be implemented;
- Check dams will be constructed across drains and will reduce the velocity of run-off which will in turn promote settlement of solids upstream of potential surface water receivers. An additional benefit of check dams is that they will reduce the potential for erosion of drains. Rock filter bunds may be used for check dams. Wood or hay bales can also be used if properly anchored. It is recommended that multiple check dams are installed, particularly in areas immediately down gradient of construction areas;

- Overland flow paths of the final dewatered discharge will be maximised to the greatest practical extent to avoid prematurely draining to drainage channels or surface waters. This approach will allow for enhanced settling out of suspended solids entrained in the run-off;
- All pumps, tanks, settlement ponds, dewatering bags and check dams used in the dewatering process will be regularly inspected and maintained as necessary to ensure surface water run-off is appropriately treated;
- Sediment fencing will be installed up gradient of water courses which may receive the final overland flow;
- The final treated dewatered discharge will be directed towards heavily vegetated areas to allow for further natural filtration of suspended solids;
- A programme of water quality monitoring will be implemented during the construction phase which is outlined in detail in **Section 9.5.2.11**;
- No extracted or pumped water will be discharge directly to the surface water network associated with the Site (this in accordance with the *Local Government (Water Pollution) Act 1977* as amended); and,
- Any discharges of sediment treated water should meet the requirements of the *Surface Water Regulations 2009*, as amended.

9.5.2.3 Release and Transport of Suspended Solids Proposed Mitigation Measures

The following mitigation measures to reduce potential impacts from the release of suspended solids to the surface waters will be implemented:

- Collector drains and soil berms will be implemented to direct and divert surface water runoff from construction areas such as temporary stockpiles into established settlement ponds, buffered discharge points and other surface water runoff control infrastructure. This planning and placement of these control measures will be of fundamental importance, especially for the areas where works within the 50m buffer zone will be unavoidable which is discussed in **Section 9.5.1.2**;
- Sediment control fences will be implemented significantly upgradient of potential receiving waters and as part of the drainage network. Sediment control fences will also be established upgradient of the Site's pre-existing natural and artificial drains. This practice will reduce the potential for elevated suspended solids entrained in surface water runoff to discharge to surface waters;
- Multiple silt fences will be used in drains discharging to the surface water network. This will be especially important for the areas where works within the 50m buffer zone will be unavoidable which is discussed in **Section 9.5.1.2**;

- The drainage, attenuation and other surface water runoff management systems will be installed prior to the commencement of construction activities. Whenever possible, drainage and attenuation control measures will be installed during seasonally dry conditions to limit the potential for sediment laden run-off to discharge to surface waters during the installation of these measures;
- Surface water runoff will be discharged to land via buffered drainage outfalls that will contain hardcore material of similar composition to the geology of the bedrock at the Site. This mitigation measure will promote the capture and retention of suspended sediment;
- Buffered drainage outfalls also promote sediment percolation through vegetation in the buffer zone, reducing sediment loading to adjacent watercourses and avoiding direct discharge to the watercourse;
- Buffered drainage outfalls will be placed outside of the 50m buffer zone and will not be positioned in areas with extensive erosion and degradation;
- A relatively high number of discharge points will be established to decrease the loading on any one particular outfall;
- Discharging at regular intervals mimics the natural hydrology by encouraging percolation and by decreasing individual hydraulic loadings from discharge points;
- A site-specific CEMP appended to the EIAR in **Appendix 2.1** has been developed which mandates regular inspections and maintenance of pollution control measures. Contingency measures outlining urgent protocols to repair or backup any breaches of designed mitigation measures are incorporated into the site-specific CEMP;
- In the event that mitigation measures are failing to reduce suspended solids to acceptable levels, construction works will cease until remediation works are completed;
- If fine solids or colloidal particles are very slow to settle out of waters, coagulant or flocculant will be used to promote the settlement of finer solids prior to discharging to surface water networks. Flocculant gel blocks can be placed in drainage channels, these are passive systems that are self-dosing, self-limiting and are environmentally friendly. Flocculant gel blocks bind elevated levels of silt and associated contaminants into masses that are easily separated, captured and then removed from the water; and,
- Surface water runoff controls will be checked and maintained on a regular basis and as soon as any signs of deterioration become visible. Surface water runoff controls, check dams and settlement ponds will be maintained and emptied on a regular basis and as soon as any signs of deterioration become visible.

The adoption of precautionary principles and the implementation of mitigation measures listed above will ensure that the risk of elevated suspended solids discharging to surface waters is low. This in turn will ensure that potential risks to sensitive receptors is also low. Nevertheless, should a significant discharge of suspended solids to surface waters occur, the absence of immediate proximity to designated sites and the assimilative capacity of the localised surface waters will act as a natural hydrological buffer in terms of suspended solids loading. Should such a discharge occur, the dilution and retention time of suspended solids in the localised surface water network will reduce potential impacts on highly sensitive downstream designated sites. It should be noted that this natural mitigation measure is not to be adopted as a first principle, and will not be relied upon to prevent adverse impacts on designated sites, it will be rather a last line of defence.

A detailed design of required drainage, collector drainage, stilling ponds and other listed mitigation infrastructure is contained in the **Surface Water Management Plan** in **Appendix 2.1**. Unsuitable and particularly sensitive areas are identified and presented in various figures contained in **Volume III**.

9.5.2.4 Horizontal Directional Drilling Mitigation Measures

The following mitigation measures to reduce potential impacts associated with horizontal directional drilling will be implemented:

- Clearbore, which is not toxic to aquatic organisms and is biodegradable will be the drilling fluid used;
- Mud mixing will be monitored to suit the ground conditions encountered and will initially be based on a mud programme developed by the specialised HDD Contractor, the drilling fluid supplier and an Environmental Clerk of Works;
- The drilling fluids will be constantly monitored, any changes required to the mix will be performed on site by a specialised HDD Contractor upon consultation with the drilling fluid supplier and Environmental Clerk of Works;
- Mud testing equipment will be available at all times during drilling operations to monitor key mud parameters;
- All equipment will be carefully checked on a daily basis by the Site Supervisor prior to use to ensure plant and machinery is in good working order with no leaks or potential for spillages;
- Spill kits, including an appropriate hydrocarbon boom, will be available on the site in the event of any unforeseen hydrocarbon spillages and all staff shall be trained in their use;

- All plant, materials and wastes will be removed from site following the HDD works;
- The launch pit will be reinstated to the original land surface condition and the normal duct trench will continue from this point;
- Should any dewatering be required, it will be carried out in accordance with the site-specific CEMP; and,
- Test pits and boreholes will not be located directly on, or extend through, the proposed alignment, as these weak points may serve as conduits where inadvertent fluid returns or frac outs occur. At least a 3m offset will be provided between the boreholes and pipe alignment.

9.5.2.5 Release of Hydrocarbons Proposed Mitigation Measures

The following mitigation measures to reduce potential impacts from the environmental release of hydrocarbons and other harmful chemicals to the surface waters will be implemented:

- Refuelling of vehicles will be carried out off site to the greatest practical extent. This refuelling policy will mitigate the potential for impacts by avoidance. Due to the remote location and nature of the Site, it is unlikely that implementation of this refuelling policy will be practical in all circumstances. In instances where refuelling of vehicles on Site is unavoidable, a designated and controlled refuelling area will be established at the Site. The designated refuelling area will enable low risk refuelling and storage practices to be carried out during the works. The designated refuelling area will contain the following attributes and mitigation measures as a minimum requirement:
    - The designated refuelling area will be located a minimum distance of 50m from any surface waters or Site drainage features;
    - The designated refuelling area will be bunded to 110% volume capacity of fuels stored at the Site;
    - The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund;
    - Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis;
    - Any oil contaminated water will be disposed of at an appropriate oil recovery plant or licensed tip site;
    - Any minor spillage during this process will be cleaned up immediately;
    - Vehicles will not be left unattended whilst refuelling;
    - All machinery will be checked regularly for any leaks or signs of wear and tear; and,

- Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed. Any waste oils or hydraulic fluids will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner.

Notwithstanding the management of refuelling and fuel storage at the designated refuelling area, the potential risk of hydrocarbon spills from plant and equipment or other general chemical spills at other areas of the Site remains. To mitigate against potential spills at other areas of the Site, the following mitigation measures will be implemented:

- Oil absorbent booms and spill kits will be available adjacent to all surface water features associated with the Development. The controls will be positioned downstream of each construction area and at principal surface water drainage features. Oil booms deployed will have sufficient absorbency relative to the potential hazard;
- Spill kits will also be available at construction areas such as at turbine locations, the temporary site compound, on-site substation, spoils storage areas and met mast location etc.;
- Spill kits will contain a minimum of oil absorbent pads, oil absorbent booms, oil absorbent granules, and heavy-duty refuse bags for collection and appropriate disposal of contaminated matter;
- Should an accidental spill occur during the construction or operational phase of the Development, such incidents will be addressed immediately, this will include the cessation of works in the area of the spillage until the issue has been resolved;
- Spill kits will be kept in each vehicle at the Site and will be readily available to all operators;
- No materials, contaminated or otherwise will be left on the Site;
- Suitable receptacles for hydrocarbon contaminated materials will also be available at the Site; and,
- A detailed spill response plan forms part of the site-specific CEMP appended to **Appendix 2.1** of this EIAR.

Implementation of the above mitigation measures will significantly reduce the risk of hydrocarbon contamination being released to the surface water network. Nevertheless, the potential risk cannot be entirely eradicated. Therefore, precautionary measures and emergency response protocols will be established and are included in the site-specific CEMP appended to the EIAR in **Appendix 2.1**.

9.5.2.6 Construction and Cementitious Materials Proposed Mitigation Measures

The following mitigation measures to reduce potential impacts posed from the use of concrete and the associated effects on surface water in the receiving environment are proposed:

- The procurement, transport and use of any cement or concrete will be planned fully in advance and supervised by appropriately qualified personnel at all times;
- Vehicles transporting cement or concrete to the Site will be visually inspected for signs of excess cementitious material prior to being granted access to the Site. This will prevent the likelihood of cementitious material being accidentally deposited on the site access tracks or elsewhere at the Site;
- Drivers of such vehicles will be instructed to ensure that all vehicles are washed down in a controlled environment prior to the departure of the source site, such as at concrete batching plants;
- Precast concrete will be used wherever possible, although the use of pre-cast concrete is not a viable option for large structures such as turbine foundations and so concrete will be delivered to the Site;
- Concrete will not be poured during periods of rainfall or if any kind of precipitation is forecast. This policy will limit the potential for freshly poured concrete to adversely impact on surface water runoff;
- Raw or uncured waste concrete will be disposed of by removal from the Site;
- Washout of concrete trucks shall be strictly confined to the batching facility and shall not be located within the vicinity of watercourses or drainage channels. Only the chutes will be cleaned prior to departure from Site, and this will take place at a designated area at the temporary site compound;
- Spill kits will be readily available to Site personnel, and any spillages or deposits will be cleaned up immediately and disposed of appropriately;
- Pouring of concrete into standing water within excavations will be avoided;
- Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place;
- Any surplus concrete will not be stored or deposited anywhere on Site and will be returned to the source location or disposed of appropriately at a suitably licensed facility; and,
- Any required shuttering installed to contain the concrete during pouring will be fully secured around its perimeter to minimise any potential for leaks.

9.5.2.7 Watercourse Crossings Proposed Mitigation Measures

At the Site, one new watercourse crossings / culverts of a the Aughkilladoon Stream will be constructed at the eastern extent of the Site as outlined in **Figure 9.7** in **Volume III**. It is possible that some small unmapped drainage channels could potentially require small culverts to be constructed to facilitate the construction of access roads. However, detailed planning and consideration as described below, to ensure potential impacts are assessed adequately and in turn mitigated against, will be implemented for these locations.

A detailed design stage assessment in terms of any small culvert design will be carried out that will have cognisance to locations including the characteristics of water flow at each drain location. The following mitigation measures will be implemented as minimum requirements to ensure any potential impacts of drainage feature crossings are minimised:

- The design of the proposed crossings and a method statement for the proposed construction will be prepared in advance of works taking place;
- This design of all crossings will adhere to relevant available guidance and will be reviewed through consultation with the OPW which will mitigate against any significant impact on surface water flow and in turn the risk of localised or downstream flooding;
- Crossings will be designed to minimise, in so far as practical and to the extent deemed acceptable by the competent authority, the disturbance or alteration of water flow, erosion and sedimentation patterns and rates;
- A Construction Environmental Management Plan has been prepared and is appended to the EIAR in **Appendix 2.1**. Adherence to this plan, which will be mandatory throughout the construction of the watercourse crossings, will include comprehensive details of the culvert design and construction methodology, including the environmental risk/s involved which have been identified and assessed in this EIAR. Detailed site-specific mitigation measures and best practice techniques will be contained in the construction management plan and Risk Assessment Method Statement (RAMS) for any proposed crossings of small unmapped drains;
- Vehicles used in the construction of small drain crossings will only be refuelled at the Site's bunded and designated refuelling area. No refuelling will be permitted within 50m of any watercourse at the Site; and,
- To mitigate against the potential risk of accidental leaks or spillages from plant and equipment, an emergency response plan for such incidents is contained in the CEMP appended to the EIAR in **Appendix 2.1**. Multiple spill kits will be maintained on the Site at all times within the cabs of vehicles and placed strategically at environmentally sensitive locations across the Site. Spill kits will be routinely inspected to ensure that

they are fully stocked with oil absorbent booms and pads at all times. Oil absorbent booms will be installed downstream of channel crossing work areas within 25m of the works location, prior to the commencement of works.

9.5.2.8 Removal of Forestry and Afforestation Proposed Mitigation Measures

Similar to other aspects of the proposed Development, a primary mitigation measure to avoid potential impacts associated with removal of forestry will be mitigation by avoidance. The design layout of the proposed Development will ensure that the pre-existing forestry road network, such as that leading towards the T05 position for example, is incorporated into the proposed Development. Similarly, the pre-existing manmade forestry drainage network, and the pre-existing fire breaks, will be utilised during the construction and operational phases to the greatest practical extent. Utilisation of the existing forestry infrastructure such as roads, drainage network and fire breaks will remove the need to construct new features that would perform the same function. A reduced construction footprint would in turn reduce the potential for adverse impacts to occur such as increased eutrophication resulting from nutrient runoff and/or the potential for sediment laden runoff to occur.

To further reduce the likelihood of enhanced eutrophication or elevated sediment laden runoff to occur, the construction methodology in areas of forestry will adhere to the best practice specifications listed in the following Guidelines:

- The Forestry Service (2000), Forestry and Water Quality Guidelines;
- The Forestry Service (2000), Forest Harvesting and Environmental Guidelines (2000);
- Forestry and Water Quality Guidelines (2000);
- EPA (2008), Forestry Operations and Eutrophication – PEnrich, Sytheseis Report;
- Department of Agriculture, Food and the Marine (2015), Forestry Standards and Procedures Manual;
- Department of Agriculture, Food and the Marine (2016), Environmental Requirements for Afforestation; and,
- Department of Agriculture, Food and the Marine (2019), Standards for Felling and Reforestation.

Prior to the commencement of felling or afforestation activities, all personnel, particularly machine operators, will be made aware of the locations of watercourses. Machine combinations will be selected which are the most suitable for ground conditions at the time of felling in terms of minimising the potential for soil disturbance. Brash mats will be placed on top of the soil to minimise the potential for soil disturbance within areas of felling and afforestation.

Drainage ditches which drain from the felling area towards existing surface waters will have check dams and silt strips installed. Direct discharges of sediment laden runoff to any drainage ditches will not be permitted. All sediment controls such as silt traps and check dams are to be regularly inspected and maintained as required to ensure that they remain effective throughout felling and afforestation activities.

A felling license will be obtained from the Forest Service of the Department of Agriculture, Food & the Marine prior to any felling activities being carried out. The associated afforestation of alternative lands equivalent in area to those lands being permanently clear-felled is also subject to licensing (i.e. 'afforestation licensing'). Compliance with all provisions set out in CEMP will be mandatory for all personnel.

Buffer zone guidelines for the protection of water quality and aquatic ecosystems is provided for in Table 1 of the Forestry and Water Quality Guidelines (2000). These buffer zone distances will be adhered to at the Site. It should be noted that with the exception of the pre-existing manmade forestry drains at the Site, none of the tree felling activities will be carried out within the self-imposed 50m buffer zone at the Site. Areas to be selected for afforestation will not be located within the 50m buffer zone of surface waters.

9.5.2.9 Groundwater Contamination Proposed Mitigation Measures

A combination of the underlying bedrock geology, the associated likely presence of only local scale flow systems, moderate permeability subsoils beneath the Site and moderate recharge rates has resulted in the risk posed to groundwater quality by the Development being considered as low risk. Nevertheless, mitigation measures to reduce potential risks to groundwater will be implemented. A primary risk to the underlying groundwater quality would be through the accidental release of hydrocarbons from fuels or oils during the construction phase of the Development. In order to mitigate against potential groundwater contamination by hydrocarbons, implementation of the following mitigation measures is proposed:

- In the first instance, no fuel storage will occur at the Site whenever feasible and refuelling of plant and equipment will occur off site at a controlled fuelling station;
- In instances where on Site refuelling is unavoidable, then the bunded on-Site designated refuelling area must be used. The designated refuelling area must be bunded to 110% volume capacity of fuels stored at the Site;

- The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund;
- Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis;
- Any oil contaminated water will be disposed of at an appropriate oil recovery plant or licensed tip site
- Any minor spillage during this process will be cleaned up immediately;
- Vehicles will not be left unattended whilst refuelling;
- A site-specific CEMP appended to the EIAR in **Appendix 2.1** will be enforced to ensure that equipment, materials and chemical storage areas are inspected and maintained as required on a regular basis; and,
- The mitigation measures outlined for the protection of surface waters as set out in **Section 9.5.2.5** will be also implemented which will inadvertently serve to protect groundwater from potential hydrocarbon contamination.

The following mitigation measures are proposed in relation to non-hydrocarbon potential contamination of groundwater:

- All other liquid-based chemicals such as paints, thinners, primers and cleaning products etc. will be stored in locked and labelled bunded chemical storage units;
- Temporary sanitation facilities such as portaloos used during the construction phase will be self-contained and supplied with water by tank trucks. Portaloos will contain water storage tanks and separate wastewater storage tanks which will be routinely emptied by vacuum removal for offsite disposal via a tank truck. All temporary sanitation facilities will be removed from the Site following the completion of the construction phase;
- The controlled attenuation of suspended solids in settlement ponds and check dams etc. will result in inorganic nutrients (if present in elevated concentrations) such as phosphorus and nitrogen being absorbed and retained by the solids in the water column. This will allow for a reduction of peak inorganic discharges in a controlled and stable run off rate. It is noted that the presence of elevated contaminants were not detected during any of the three surface water quality monitoring rounds which are discussed in **Section 9.3.10**;
- It is considered that there is a low risk of mobilising trace metals that may naturally be present in low concentrations in the baseline environment. The potential for mobilising trace metals is most likely to result from enhanced water percolation associated with excavated bedrock substrate. To mitigate against this potential impact, water quality

will be monitored for trace metal concentrations prior to, during and after the construction phase;

- The potential for livestock such as cattle and sheep which have been observed grazing at the Site to cause bacteriological contamination of groundwater will be controlled through the implementation of strict grazing control zones, site perimeter fencing and exclusion zones around all open excavations; and,
- The mitigation measures outlined for the protection of surface waters as set out in **Section 9.5.2.5** will be also implemented which will inadvertently serve to protect groundwater from potential non-hydrocarbon contamination.

9.5.2.10 Groundwater Extraction Proposed Mitigation Measures

The extraction of groundwater from boreholes for the purpose of potable water supply will not be required for either the construction or operational phase of the project. As a result, no potential effects are anticipated from the extraction of groundwater as a potable water supply.

9.5.2.11 Water Quality Monitoring

The following Site monitoring recommendations will be implemented to mitigate against potential impacts on the surface water and groundwater receiving environment:

- A programme of water quality monitoring outlining the selected parameters and monitoring frequency should be agreed with Inland Fisheries Ireland and Waterford City and County Council prior to the commencement of construction;
- In order to assist in the detection of any deviations from the baseline hydrochemistry conditions at the Site, regular periodic monitoring of the Site's surface waters will be carried out prior to and during construction;
- It is proposed that a programme of operational phase water quality monitoring is also implemented at a monitoring frequency agreed with the competent authority in order to aid the detection of any potential operational phase impacts on surface water quality;
- As a minimum requirement, field-measured parameters such as pH, conductivity, total dissolved solids (TDS), temperature, dissolved oxygen (DO) and turbidity will be included in the water quality monitoring programme. The results should be compared to the applicable EQS to determine if adverse impacts on water quality are occurring;
- It is also recommended that laboratory analyses for parameters such as total suspended solids, nitrogen, phosphorous, biochemical oxygen demand and trace metals etc. is implemented during and after the construction phase;

- Water quality monitoring locations will include both upstream and downstream points relative to the works locations. The locations of the water quality monitoring points will be flexible and will be moved as the construction phase progresses so that monitoring points remain representative of the most likely construction impact receptor points;
- The downstream monitoring locations will be positioned as close as possible downstream of the works location and another positioned further downstream. This approach will allow for an assessment of the dilution of potential contaminations (if present) as the distance from the point of diffuse source location increases;
- Watercourses which do not have year-round flows such as artificial drains, ditches or ephemeral streams will be avoided as water quality monitoring locations;
- During the construction phase, daily visual inspections of excavations, dewatering procedure, settlement ponds, silt traps, buffered outfalls and drainage channels etc. will be carried out by a suitably qualified person. Any excess build-up of sediment at settlement ponds, drains or at any other drainage features that may decrease the effectiveness of the drainage feature will be promptly removed;
- During the construction phase of the Development, all development areas will be monitored on a daily basis for evidence of groundwater seepage, water ponding and wetting of previously dry spots;
- Following the completion of the construction phase, silt traps, buffered outfalls and drainage channels will be periodically inspected during maintenance visits to the Site when the operational phase water quality monitoring will also be carried out;
- Any proposed crossings of small unmapped drains discussed in **Section 9.5.2.7** will be monitored daily during construction and during each Site visit during the operational phase. These small culvert crossings will be monitored in terms of their impacts (if any) on the receiving watercourses and in terms of their structural integrity to identify any signs of erosion or potential for sediment release
- It is proposed that a handheld turbidity meter is available at the Site to accurately measure the quality of water discharging from the Site. The meter will be maintained and calibrated before each use by a qualified Environmental Clerk of Works; and,
- Any discharges of sediment treated water should meet the requirements of the *Surface Water Regulations 2009*, as amended.

9.5.2.12 Emergency Response

Mitigation measures outlined in the previous sections of this Chapter will significantly reduce the potential for contamination of surface water or groundwater associated with the Development. Nevertheless, as is the case with all construction projects, a risk of accidental chemical spillages, sediment overloading of control measures or leaks of contaminants from plant or equipment remains a possibility. Emergency response procedures to potential contamination incidents are contained in the site-specific CEMP appended to the EIAR in **Appendix 2.1** and will be implemented at the Site prior to the commencement of the construction phase. The following is a non-exhaustive list of potential emergencies and respective emergency responses:

- Spill or leak of hazardous substances (less than 20 litres);
    - All spill incidents will be dealt with immediately as they arise;
    - Spill kits will be prepared and available in vehicles associated with the construction phase of the Development;
    - Spill kits will also be prepared and made available at primary work areas such as at proposed turbine, hardstand, substation, met mast and construction compound locations;
    - Disposal receptacles for hydrocarbon contaminated materials will also be available at the Site;
- Major spill of hazardous or toxic substance off Site or to environmentally sensitive areas;
    - Immediate escalation measures will be implemented for all major spill events;
    - Escalation measures may include installation of temporary sumps or drains to control the flow or migration of hydrocarbons or other chemicals;
    - Attempts to be made to limit or contain the spill using sandbags to construct a bund wall, use of absorbent material, temporary sealing of cracks or leaks in containers, use of geotextile or silt fencing to contain the spill;
    - Excavation and disposal of contaminated material will be immediately carried out following any such incidents;
    - Evacuation procedures will be implemented to remove non-essential personnel from the area;
    - Data gathering and an investigation will commence immediately after the emergency is contained;
    - If a significant hydrocarbon spillage does occur, the contractor on behalf of the developer must have an approved and certified clean-up consultancy available on 24-hour notice to contain and clean-up the spill;
    - All major spills of this nature will be reported to the competent authority immediately following such instances;
- Flooding of low lying areas of the Site;

  - Immediately remove all chemicals, fuels and other hazardous substances from low lying areas of the Site;
  - Immediately remove plant and equipment from low lying areas;
  - Recover materials washed from Site including sediment and other waste;
  - Review and address the potential for excess water entering the Site;
  - Review and maintain erosion and sedimentation controls;
- Spills of cementitious material;
  - Cement / concrete contamination incidents will be cleaned up immediately as they arise;
  - Spill kits will also be established at key construction areas and they will also be readily available in the cabs of plant and equipment; and,
  - Suitable receptacles for cementitious materials will also be available at the Site.

Emergency responses, including methodologies and all relevant contact details are specified in the site-specific CEMP appended to the EIAR in **Appendix 2.1**.

9.5.2.13 Construction Phase Residual Impacts

The residual impact on the surface water receiving environment resulting from the construction phase of the Development is anticipated to be a limited temporary decrease in water quality. A limited temporary decrease in water quality may arise due to a release of suspended solids and sediments to surface waters during excavations at the Site. The potential for release of elevated suspended solids is likely to be exacerbated following heavy rainfall events which occur after sustained dry periods. Any localised reduction in water quality is likely to be mitigated against by the extensive control measures outlined in this chapter and also by natural dilution as distance from the point or diffuse source of contamination increases with distance from the Site.

Mitigation by avoidance and the implementation of physical control measures will ensure that contaminant concentrations, particularly elevated suspended solids entrained in run-off are reduced to below the relevant legislative screening criteria and adopted EQS. The overall impact is anticipated to be a direct, negative, imperceptible, Imperceptible weighted significance and temporary.

9.5.3 Operational Phase

9.5.3.1 Increase in Hydraulic Loading Proposed Mitigation Measures

The proposed Development will lead to an increase in impermeable surface area through the construction of hard stand areas within the Site. This in turn will lead to an increase in hydraulic loading by surface water runoff. However, preliminary water balance calculations indicate that the worst-case net increase in surface water runoff volumes will be approximately 2,143 m^3/month, or 0.42% relative to the area of the Site. Therefore, this is considered an imperceptible, or not significant impact.

As a consequence of the estimated low significance of the impact of hydraulic loading during the operational phase, mitigation measures to facilitate a reduction in surface water runoff are limited to ensuring that pre-existing and newly established drainage infrastructure is sufficiently maintained for the discharge rates associated with all areas of the Site. Once identified, any and all blockages which may adversely impact upon the drainage regime at the Site will be immediately removed during the operational phase of the proposed Development. No other additional impacts are anticipated during the operational phase of the Development.

9.5.3.2 Operational Phase Residual Impacts

The residual impact on the receiving surface water environment during the operational phase of the Development is anticipated to be an increase in runoff of rainwater and an increase in drainage discharge. This is anticipated to occur as a result of the construction of mostly impermeable hardstand areas at the Site. Depending on the exact area of the Site in question, the finalised drainage design may result in some areas becoming more saturated, particularly at lower elevations, whilst other predominantly upland areas may result in a net drying effect being observed. This is considered a direct, neutral, localised impact of the Development, which contrasts to the baseline conditions.

9.5.4 Development Decommissioning and Restoration Phase/s

9.5.4.1 Decommissioning of Infrastructure

As discussed in **Section 9.4.7**, no new impacts on the surface water and groundwater receiving environment are anticipated during the decommissioning phase of the project. The decommissioning phase of the project will result in the removal of Site infrastructure such as wind turbines and the Met Mast etc. No new additional mitigation measures are required for the decommissioning phase of the proposed Development. The decommissioning phase and associated removal of major infrastructure components is anticipated to result in similar potential risks to surface water and groundwater as those that will be encountered during the construction phase of the proposed Development.

The excavation of soil is not expected to be required during the decommissioning phase. In addition, the movement of plant, vehicles and equipment on any unpaved surfaces is expected to be minimal during the decommissioning phase since all of the project's hardstand areas will be pre-existing by the time the decommissioning phase is being carried out. As a result, the risk of elevated suspended solids being discharged in surface water run-off to the downstream receiving environmental is expected to be low. However, the potential risk remains for spills of fuels or hazardous chemicals which is a common risk to all developments. The mitigation measures outlined in this chapter for the construction phase will be implemented during the decommissioning phase to reduce the potential for such impacts.

9.5.4.2 Reinstatement of Redundant Access Track and Hardstand Areas

Reinstatement of redundant site access tracks and turbine hardstand areas that may be required during the decommissioning phase has the potential to result in soil creep, associated erosion and potential entrainment of elevated suspended solids in surface water run-off. This in turn has the potential to impact on the receiving surface water environment. The potential for such impacts are likely to be increased at areas of the Site where steep slopes are present. As a result, additional care and attention to detail is required as follows:

- Mitigation measures described in this chapter to reduce the potential for run-off of elevated suspended solids will be implemented;
- Sediment fences will be implemented along the perimeter of all access tracks and hardstand areas during the reinstatement works;
- Additional precautions such as the implementation of check dams, secured straw bales, sandbags, or settlement ponds will be implemented at areas where surface water runoff is likely to be intercepted by both natural and artificial drainage features;
- Any drains or outfalls which have the potential to draw water from reinstatement areas, or promote preferential surface water runoff flow paths through reinstatement areas will be removed, blocked or decommissioned as required;
- The mitigation measures for the preparation of the hardstand area surfaces prior to material being deposited discussed in **Chapter 8: Soils and Geology** will be implemented; and,
- Monitoring and maintenance of the reinstated areas will be conducted regularly following the initial stages of establishment to ensure that the potential for excessive surface water runoff eroding deposited material along preferential pathways is minimised.

9.5.4.3 Reinstatement Residual Impacts

It is anticipated that the appropriate reinstatement of redundant site access track and hardstand areas will result in a net beneficial impact. This will be achieved through passive continuous improvements at the areas in question. Over time, the reinstated areas will become revegetated and will recover to become similar in appearance to the surroundings of the wider Site. The reinstatement of the Site areas will likely result in enhanced water storage at the Site. This will occur through the reintroduction of permeable layers at former hardstand areas which will in turn promote the filtration of potentially contaminated surface water runoff which may originate from reinstated areas. Therefore, the residual impact of reinstatement of site access tracks and former turbine hardstand areas is considered to be a positive, localised and permanent impact of the proposed Development.

9.5.5 Decommissioning and Restoration Phase – Physical Infrastructure

Restoration of physical infrastructure at the Site following the decommissioning phase has the potential to cause adverse impacts on the receiving hydrological and hydrogeological receiving environment. It is recommended that a benefit analysis should be carried out to determine the overall positive outcomes against any potential adverse effects prior to such activities being permitted. The assessment of all restoration activities will require an analysis across multiple other environmental disciplines (i.e. ecology, noise and human beings etc.) with the overall synergistic effects requiring evaluation. It is noted that the ecological environment surrounding the Site will also become altered over time across the operational lifetime of the proposed Development. It is therefore recommended that the potential for restoration activities following the decommissioning phase of the Development is evaluated in detail following the completion of the decommissioning phase.

9.5.6 Cumulative Effects

The only other major development or proposed developments within 10km is a permission to construct and operate the Coumnagauppul Wind Farm, approximately 9 kilometres to the north-east of the proposed Site. The Coumnagauppul Wind Farm is located within the Colligan-Mahon Catchment Area, it is also underlain by the Kilrion groundwater body. The proposed Dyrick Hill Wind Farm Site is located within the Blackwater (Munster) Catchment Area with only sections of the grid connection route, that are distant from the proposed Coumnagauppul Wind Farm, being located within the Colligan-Mahon Catchment Area. The proposed Dyrick Hill Wind Farm Site is also underlain by the Knockmealdown groundwater body with only a short section of the grid connection route underlain by the Kilrion groundwater body. Due to these two developments being predominantly located within and underlain by different catchment areas / groundwater bodies, and the significant distance between the two proposed Developments, no cumulative effects in relation to hydrology or hydrogeology are anticipated.

With respect to hydrology, the effects of the Development are considered to contribute to and add to the cumulative nature of adverse impacts imposed on the surface water network in the catchments associated with the Development. However, considering the pre-existing "*Moderate*" and "*High*" WFD status of the surface waters surrounding the proposed Development, and the generally high quality baseline water quality results outlined in **Section 9.3.10**, the potential for the Development to have adverse cumulative impacts on hydrology is limited to the construction phase. Any potential construction phase impacts on surface waters and/or groundwater that could arise from the proposed Development and from the abovementioned regional developments are most likely to be very short in duration and are most unlikely to occur simultaneously. In further consideration of the wider Blackwater (Munster) and Colligan-Mahon (grid connection) catchment areas, the associated large volumes of water in these catchments, particularly in Rivers Finisk downstream of the site and its associated assimilative capacity and the control measures which will be put in place, the Development in combination with other proposed/permitted/constructed development is not likely to have any significant cumulative effects.

With respect to hydrogeology, and the potential effects of the Development having been assessed as likely being localised due to the moderate subsoil permeability, expected short groundwater flow paths, moderate recharge rates, comparatively high run-off rates and moderate yielding underlying groundwater aquifer only in local zones, the Development is not considered to significantly contribute to cumulative effects.

9.6 SUMMARY OF SIGNIFICANT EFFECTS

During the construction, operational and decommissioning phases of the proposed Development, activities will take place at the Site that will have the potential to significantly affect the hydrological regime or water quality at the Site or its vicinity. These significant potential impacts generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cementitious substances, with hydrocarbons or chemicals spills to surface waters having the most potential for impact.

The implementation of mitigation through avoidance principles, pollution control measures, surface water drainage measures and other preventative measures have been incorporated into the project design in order to minimise potential significant adverse impacts on water quality at the Site. A self-imposed 50m stream buffer zone will be implemented at the Site wherever possible which will largely result in the avoidance of sensitive hydrological features. Direct discharges to surface waters of dewatered loads will not be permitted under any circumstances. This in turn will reduce the potential for adverse impacts on downstream designated Sites.

The drainage plan for the Site will be a key method through which sediment runoff arising from construction activities will be reduced and through which runoff rates will be controlled. Implementation of the control measures outlined in this EIAR are considered to result in a likely, neutral to negative, imperceptible to slight significance, imperceptible weighted significance impact of the Development which is in contrast to the baseline conditions. There will be minor localised changes to how water flows at the Site, this is considered a likely, neutral to negative, slight to moderate significance, localised impact of the Development which conforms to the baseline due to the pre-existing network of artificial field drains in existence at the Site. Development, once the mitigation measures outlined are implemented, is not likely to have significant effects.

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