9 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

This chapter assesses the impacts of the Development (**Chapter 1**) on Hydrology and Hydrogeology. The Development refers to all elements of the application for the construction of Gortyrahilly Wind Farm (**Chapter 2: Project Description**). Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Development:

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

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

- Site Specific Flood Risk Assessment in **Appendix 9.1**
- Photographs in **Appendix 9.2**
- Surface Water Hydrochemistry Database in **Appendix 9.3**
- Lab Certification in **Appendix 9.4**
- Safety Material Datasheet – Clearbore in **Appendix 9.5**
- Conceptual and Info Graphics in **Appendix 9.6**

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This document will be a key construction contract document, which will ensure that all mitigation measures, which are considered necessary to protect the environment are implemented. It will include and apply all of the mitigation described within the EIAR where relevant, and by relevant competent engineers at the detailed construction design phase of the development. For the purpose of this application, a summary of the mitigation measures is included in **Appendix 17.1**.

9.1.1 Development Description

9.1.1.1 Wind Farm Site

The Development will consist of the following main components:

- Construction of 14 No. wind turbines with an overall ground to blade tip height ranging from 179m to 185m inclusive. The wind turbines will have a rotor diameter ranging from 149m to 155m inclusive and a hub height ranging from 102.5m to 110.5m inclusive.
- Construction of permanent turbine hardstands and turbine foundations.

- Construction of one temporary construction compound with associated temporary site offices, parking areas and security fencing.
- Installation of one (35-year life cycle) meteorological mast with a height of 110m and a 4m lightning pole on top.
- Development of two on-site borrow pits.
- Construction of new permanent internal site access roads, upgrade of existing internal site access roads and upgrading of the L-34011-20 road (which forms part of the Beara-Breifne Way) and lies within the site, to include passing bays and all associated drainage infrastructure.
- Development of an internal site drainage network and sediment control systems.
- Construction of 1 no. permanent 110 kV electrical substation including 2 no. control buildings with welfare facilities, all associated electrical plant and equipment, security fencing and gates, all associated underground cabling, wastewater holding tank, and all ancillary structures and works.
- All associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation.
- Ancillary forestry felling to facilitate construction of the development.
- All works associated with the permanent connection of the wind farm to the national electricity grid comprising a 110 kV underground cable in permanent cable ducts from the proposed, permanent, on-site substation, in the townland of Gortyrahilly and onto the townlands of Derree, Derreenaculling, Lumnagh Beg, Lumnagh More, Scrahanagown, Bardinch, Milleeny, Inchamore, Derreenaling, Derryreag, Cummeenavrick, Glashacormick, Clydaghroe and Cummeennabuddoge to the existing Ballyvouskill 220 kV Substation in the townland of Caherdowney.
- All associated site development works including berms, landscaping, and soil excavation.
- Improvement of an entrance to an existing private road off the L-7405-0 local road to include localised widening of the road and creation of a splayed entrance to facilitate the delivery of abnormal loads and turbine component deliveries.
- Improvement of an existing site entrance off the L-3402-36 local road to include removal of existing vegetation for visibility splays to facilitate the use of it for the delivery of construction materials to the site.
- Upgrade works on the turbine delivery route to include the following:
    - Construction of a temporary bridge over the Sullane River to allow access to the L-3400-79 from the N22 in Ballyvourney for the duration of the construction works.
    - Localised widening of the L-3405-0 road to a width of 4.5m, from the junction with the L3400-79 road to the junction with the L-7405-0 road.

- Localised widening of the L-7405-0 road to a width of 4.5m, from the junction with the L-3405-0 to the entrance to an existing private road off the L-7405-0.
- The construction of a temporary access road off the N22 in the townland of Cummeenavrick to facilitate a 180 degrees turning manoeuvre by the turbine delivery vehicles.

A 10-year planning permission and 35-year operational life from the date of commissioning of the entire wind farm is being sought. This reflects the lifespan of modern-day turbines.

A permanent planning permission is being sought for the Grid Connection and substation as these will become an asset of the national grid under the management of EirGrid and will remain in place upon decommissioning of the wind farm.

Watercourse Crossings

Watercourse crossings over mapped rivers at the Site include the following;

- Clear Span Bridge WC1 New ITM 517402.1 572884.6
- Clear Span Bridge WC2 New ITM 517129.5 572612.1
- Clear Span Bridge WC3 Existing ITM 517686.0 572430.5
- Clear Span Bridge WC4 Existing ITM 516525.4 572206.6
- Clear Span Bridge WC5 New ITM 517,477.4 573,002.3
- Clear Span Bridge WC6 Existing ITM 516618.5, 574259.1
- Clear Span Bridge WC7 New ITM 516954.4, 574528.2

New watercourse crossings are associated with the proposed new Site Access Roads. Existing watercourse crossings are associated with existing Site Access Roads and will require upgrading.

Watercourse crossings listed above, namely new clear span bridge locations are identified by means of assessing the Site layout and where it intersects existing drainage mapped as part of this assessment. There remains the potential for locations of clear span bridges as part of the detailed design, to be positioned in different locations, particularly if associated with minor drainage which will be subject to modification and diversion in some instances.

9.1.1.2 Grid Connection Route

The Grid Connection Route description and associated construction methodology is presented in **Appendix 2.4**.

The Gortyrahilly Wind Farm will be connected to the existing Ballyvouskill 220kV substation via underground cabling (UGC). The UGC route is approximately 27.8km in length and traverse in a west to south westerly direction from the existing Ballyvouskill 220kV substation to the Gortyrahilly Wind Farm substation location utilising public local road networks, existing access tracks and private forestry access tracks.

The underground cable route initially begins within the townland of Caherdowney, Co. Cork where from Ballyvouskill 220kV substation compound, the UGC departs the substation on the northwestern boundary, converging onto a permanent access track to be constructed as part of this development within agricultural lands and traverses on an upward trajectory for approximately 950m prior to entering into forested plantations propertied by Coillte.

The UGC will consist of three 160mm diameter HDPE power cable ducts and two 125mm diameter HDPE communications ducts. These ducts will be installed in an excavated trench c. 600mm wide by 1,315mm deep; variations in the UGC design will be implemented for the adaptation of bridge, service and watercourse crossings. It has been determined that no more than 100m section of trench will be excavated at a time and it is anticipated to take (1 no.) day to complete each 100m excavation, installation of ducting and reinstatement of material. In its entirety, the UGC will have a total of 36 No. Cable Joint Bays (CJBs) and 144 No. water course crossing in the form of 130 No. identified culvert crossings, 3 No. identified bridge crossings which have insufficient clearance within each structure and will require a Horizontal Directional Drill method to cross, as well as a 3 No. stream crossing and a further HDD location to traverse Culver 115, giving a total number of 7 no. HDD crossings of surface water bodies. An additional HDD crossing will be required to cross the N22, however this crossing is not affiliated with a surface waterbody.

With reference to **Appendix 2.4**:

- Section 1 of the UGC (from Ballyvouskil 220kV substation to N22 Road HDD Crossing), will contain (21 No.) joint bays and 107 No. culvert crossings. This section also has 3 No. watercourse crossings which will require Horizontal Directional Drilling (HDD) as well as the additional HDD pit to cross the N22 for a total of 4 No. HDD locations.
- Section 2 of the UGC (from N22 Road HDD Crossing to Gortyrahilly Wind Farm Site location), will contain 15 No. joint bays and 23 No. culvert crossings. This section will have 4 No. watercourse and bridge crossings in total.

Data pertaining to the UGC is as follows:

- Excavation, Installation and Reinstatement Process: Average of one. day to complete a 100m section.
- 'Pulling' the Cable: Approximately one day between each joint bay; the jointing of cables taking approximately one week per joint bay location.
- UGC Ducting: 1.3mbGL x 600mm width.
- Joint Bays: Installed approximately every 650mm-850mm along UGC route.
- Joint Bay Dimensions: 2.5m x 6m x 1.75m (pre-cast concrete).
- HDD Launch and Reception Pit Dimensions: 1m x 1mx 2m
- Approximate Depth of Drilling: 1.5mbGL

Cable Joint Bays

It is estimated that CJBs will be installed c. every 650m - 850m along the UGC route which will be divided into two sections that will be joined together. CJBs will be typically 2.5m x 6m x 1.75m pre-cast concrete structures installed below finished ground level. It is envisioned that CJBs will be located in the non-wheel and weight bearing strip of roadways, however given the narrow profile of local roads this may not always be possible.

Watercourse Crossings

The Grid Connection Route will include up to 144 No. identified surface water crossings in the form of 130 No. culverts, 7 No. service crossings, 7 No. of bridge / watercourse crossings requiring HDD. These crossings are described in **Appendix 2.4**. The crossing of the N22 will also require HDD, however it is not affiliated with a surface waterbody.

Construction of new, or upgrading of existing watercourse crossings will involve similar impacts as described in previous and following sections e.g., excavations and earthworks and entrainment of suspended solids, etc. However, considering the proximity to surface water associated with this type of infrastructure the risk is elevated.

The design of new bridges or watercourse crossings could potentially result in significant changes in flow, erosion and deposition patterns and rates in the watercourse, which can potentially lead to flow being restricted leading to increased risk of flooding locally, or water diverting and increasing the risk of flooding elsewhere, if adequate detail is not given during the design stage. These effects would likely be significant adverse and permanent. However, with reference to the design plan drawings of watercourse crossings (WCs 1-7), presented in **6225-PL-WC1** to **WC7**, if the new bridge is well designed and facilitates or maintains the watercourses' characteristics, including for excessive flow events e.g., 1 in 100-year etc, such adverse effects would likely be temporary.

Horizontal Directional Drilling

Crossing the 130 no. existing culverts will be implemented using open trenching with either an undercrossing or an overcrossing, depending on the depth of the culvert. All bridges to be crossed have been surveyed with the result of insufficient clearance existing within each structure. Horizontal Directional Drilling (HDD) will be utilized in order to achieve satisfactory clearance along the cable route. Additionally, the remaining watercourse crossings and the crossing of the N22 will require HDD methodology.

Horizontal Direction Drilling (HDD) is a method of drilling under obstacles such as bridges, and water courses in order to install cable ducts below the obstacle. This method is employed where installing the ducts using standard installation methods is not possible. This is a trenchless technology technique, routinely used as an alternative to conventional open cut and cover trenching. There are eight locations along the UGC route which will require HDD, however only 7 No. deal with a watercourse crossing. The necessity of HDD is due to there being insufficient cover and depth in bridges to cross within the bridge deck, the drilling under existing culverts and the crossing of the N22:

- **Stream 1 (ITM: 521700.29, 582994.75)**; JB-07
- **Stream 2 (ITM: 518274.58, 583447.85)**; JB-12
- **Stream 3 (ITM: 517786.76, 583242.64)**; JB-12
- **N22 Crossing (ITM: 513895.4, 580877.4)**; JB-21; **Note, not a watercourse crossing*
- **Bridge 1 (ITM: 513619.0, 577823.5)** Na Doirí Watercourse (W1) JB-28
- **Culvert 115 (ITM: 513833.97, 576685.27)**; JB-29
- **Bridge 2 (ITM: 513977.2, 576135.1)** Barr Duínse Watercourse (W3) JB-30
- **Bridge 3 (ITM: 514221.2, 575350.5)** Droichead Uí Mhathúna Sullane Watercourse (W2) JB-31

HDD will require the excavation of entry and exit pits (1m x 1m x 2m) on either side of the watercourse and the bore path will be drilled to an estimated 1500mm beneath the waterway; additional bridge foundations will be required. The depth of the bore path has been based on locating a suitable clay/silt formation for HDD. It is noted that the required depth may increase subject to geotechnical investigations. Approximate depth of drilling is unknown at this time.

9.1.1.3 Turbine Delivery Route

The Turbine Delivery Route will require road widening, one temporary bridge (ITM: E519298, N577600), and one turning point along the N22 (**Appendix 2.6**). The temporary bridge will have a clear span of 32.0m and entails no instream works (see Drawing No.'s

6225-PL-810 and 6225-PL-811). The chosen location of the bridge provides for the shortest required span of 9m at riverbed level with 20m from top of bank to top of bank. Concrete abutments will be provided to support the deck and will be set back 5m from the river edge (top of bank), this allows for the avoidance of instream works. The estimated excavation amounts for the Turbine Delivery Route, including the turning point, equates to approximately 15, 306m^2 (refer to **Table 2.1, Management Plan 4 Appendix 2.1** of the **CEMP).**

It is anticipated that deliveries of turbines to the Wind Farm will be completed over a period of approximately 9 months. When deliveries are completed, the temporary bridge will be dismantled and removed. This portion of the Development and associated construction impacts are similar to those described for the construction of the wind farm infrastructure. Particular attention is required in relation to the design and methodology of the temporary bridge and associated risks working within a surface water buffer zone and mitigation measures laid out in this Chapter.

9.1.2 Statement of Authority

Minerex Environmental Ltd. (MEL) is an independent, Irish owned consultancy providing environmental services in the hydrogeological and environmental disciplines. The company was established in 1994 and continues to thrive, providing consultancy to clients in both the public and private sectors. The members of the MEL EIA team involved in this assessment include the following persons:

- Cecil Shine – Project Director – B.Sc. (Geology), M.Sc (Water & Soil), PGeo, EurGeol – Technical Director and Project Director with >25 years industry experience in the preparation of hydrological and hydrogeological reports.
- Sven Klinkenbergh – Project Manager and Lead Author – B.Sc. (Environmental Science), P.G.Dip. (Environmental Protection) – Associate, Project Manager and EIA Lead Author with c. 10 years industry experience in the preparation of hydrological and hydrogeological reports.
- Jen Caleno – Project Technician with c. 5 years industry experience.
- Dr. Chris Fennel – Project Technician with c. 4 years industry experience.
- Lissa Colleen McClung - Project Scientist: - B.Sc. (Environmental Studies), M.Sc. (Environmental Science). Current Role: Graduate Project Scientist

9.1.3 Assessment Structure

In line with the EIA Directive as amended and current EPA guidelines the structure of this Hydrology and Hydrogeology chapter is as follows:

- Assessment Methodology and Significance Criteria.

- 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 residual impacts of the Development considering mitigation measures.
- Identification and assessment of cumulative impacts if and where applicable.

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 hydrology and hydrogeology aspects of the environment at the Gortyrahilly Site:

- Characterise the topographical, hydrological and hydrogeological regime of the Site from the data acquired through desk study and onsite surveys.
- Water balance calculation.
- 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.
- Assessment of the combined data acquired and evaluation of any likely impacts on the hydrology and hydrogeology aspects of the environment.
- Where impacts are identified, measures are described that will mitigate or reduce the identified impact.
- Findings are presented and reported 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 development before development consent is granted.

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

- Drinking Water Directives (98/83/EC) on the Quality of Water Intended for Human Consumption and resultant SI No. 122 of 2014 (Drinking Water) Regulations and SI No. 464 of 2017 (Amendment) Regulations
- Quality Required of Surface Water Intended for Abstraction of Drinking Water (75/440/EEC) and European Communities Environmental Objectives (Surface Waters) Regulations 2009 SI No. 272 of 2009 as amended (S.I. No. 327 of 2012, S.I. No. 386 of 2015, S.I. No. 77 of 2019)
- Dangerous Substances Directive (76/464/EEC) and resultant SI No. 12 of 2001: Water Quality (Dangerous Substances) Regulations
- Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life (78/659/EEC) and resultant SI No. 293 of 1988: Quality of Salmonid Waters Regulations
- SI No. 258 of 1998: Water Quality (Phosphorous Regulations)
- The Water Framework Directive (2000/60/EC) and resultant regulations
- European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003) as amended
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009) as amended
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)
- European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011)
- European Union (Water Policy) Regulations 2014 (S.I. No. 350 of 2014)

The Water Framework Directive (WFD), which was passed by the European Union (EU) in 2000, requires all Member States to protect and improve water quality in all waters so that we achieve good ecological status by 2015, is a wide-reaching piece of 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 Water Framework Directive. The fundamental objective of the Water Framework Directive aims at maintaining "high status" of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least "good status" in relation to all waters by 2021* (WFD). (*Current RBMP cycle).

The Cork County Development Plan (2022-2028) was also consulted as part of the EIA process.

This study has been prepared using the following guidance documents, which take account the current legislation and policy:

- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) Environmental Good Practice on Site (fourth edition) (C741)
- Enterprise Ireland (n.d.) "Best Practice Guide (BPGCS005) Oil Storage Guidelines"
- Environmental Protection Agency (EPA) (2014) "Guidance on the Authorisation of Direct Discharges to Groundwater".
- EPA (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015 (Supersedes 2003 version)
- EPA (2017) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports – DRAFT May 2017 (Supersedes 1997 and 2002 versions)
- Exploration & Mining Division, Minerals Ireland, Dept. of Communications, Climate Action & Environment (2019) "Exploration Drilling – Guidance on Discharge to Surface and Groundwater".
- Inland Fisheries Ireland (IFI) (2016) "Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters" *Inland Fisheries Ireland*
- 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
- Law, C. and D'Aleo, S. (2016) Environmental Good Practice on Site Pocket Book. (C762) 4th edition. CIRIA
- Masters-Williams, H. et al. (2001) "Control of Water Pollution From Construction Sites. Guidance for Consultants and Contractors (C532)
- Murnane, E., A. Heap, A. and Swain, A. (2006) "Control of Water Pollution from Linear Construction Projects, Technical guidance (C648)" CIRIA
- Murnane, E., A. Heap, A. and Swain, A. (2006) "Control of Water Pollution from Linear Construction Projects, Site Guide (C649) CIRIA
- Murphy, D. (2004) "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites" Eastern Regional Fisheries Board
- 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

- NRA (2008) "Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes"
- Office of Public Works (2009) "The Planning System and Flood Risk Management, Guidelines for Planning Authorities"
- Office of Public Works (OPW) (2013) "Construction, Replacement or Alteration of Bridges and Culverts" Office of Public Works
- Scottish Environment Protection Agency (SEPA) (2010) "Engineering in the Water Environment: Good Practice Guide – River Crossings" *Scottish Environment Protection Agency*
- Scottish National Heritage (SNH) (2018) Environmental Impact Assessment Handbook – Version 5
- Transport Infrastructure Ireland (TII) (2014) "Drainage Design For National Road Schemes - Sustainable Drainage Options".

9.2.3 Desk Top Study

Desk top study assessments were undertaken of the hydrology and hydrogeology aspects of the proposed development site before and after field investigations. This involved the following components:

- Acquisition and compilation of all available and relevant maps of the Development.
- Study and assessment of the proposed locations of turbines and access roads relative to available data on site topography and slope gradients.
- Study and assessment of the proposed locations of turbines, access roads and other associated infrastructure units relative to available data on hydrology and hydrogeology.
- Study of geospatial data obtained from various sources including; Environmental Protection Agency (EPA), Geological Survey Ireland (GSI), Teagasc, Ordinance Survey Ireland (OSi), National Parks and Wildlife (NPWS) overlain with the Development plan drawings using a Graphic Information System (GIS). Data was assessed at a regional, local and site-specific scale.
- Assessment of relevant additional data was obtained where relevant, for example, rain data obtained from Met Eireann, and river discharge rates and synoptic data sets obtained from the EPA.
- Assessment of site-specific aerial data (Blue Sky Lidar data (1m)).

9.2.4 Field Work

Field inspections were carried out at the site of the proposed development during 2020 and 2021.These works consisted of the following:

- Site walk over including recording and digital photography of significant features.
- Drainage distribution and catchment mapping.
- Field hydrochemistry of the drainage network (electrical conductivity, pH and temperature).
- Recording of GPS co-ordinates for all investigation and monitoring points in the study.
- Baseline sampling of surface water for analytical laboratory testing. Four baseline sampling events were carried out i.e., targeting low and high flow conditions.
- Baseline sampling and estimating of surface water flow and discharge rates during baseline surface water sampling events.

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 [1]. 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.*"[2]

To facilitate the qualification of hydrological and hydrogeological attributes, guidance specific to hydrology and hydrogeology as set out by National Roads Authority (NRA) [3], and guidance specific to landscape as set out by Scottish National Heritage (SNH) [4], has been used in conjunction with EPA guidance.

The following table presents rated categories and criteria for rating site attributes:

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

Importance	Criteria
Extremely High	Attribute has a high quality or value on an international scale.
Very High	Attribute has a high quality, significance or value on a regional or national scale.
High	Attribute has a high quality, significance or value on a local scale.
Medium	Attribute has a medium quality, significance or value on a local scale.
Low	Attribute has a low quality, significance or value on a local scale.

[1] Environmental Protection Agency (EPA) (2017) Guidelines on the information to be contained in Environmental Impact Assessment Reports
[2] Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements DRAFT September 2015. Environmental Protection Agency, Ireland
[3] National Roads Authority (NRA) (2008) Guidelines on the information to be contained in Environmental Impact Assessment Reports
[4] Scottish National Heritage (SNH) (2018) Environmental Impact Assessment Handbook V5

Considering the above categories of rating importance and associated criteria, the following table presents rated sensitivity categories (SNH, 2013):

Table 9.2: Criteria for Rating Site Sensitivity - Landscape Character Specific

Importance	Criteria
High Sensitivity	Key characteristics and features which contribute significantly to the distinctiveness and character of the landscape character type. Designated landscapes e.g. National Parks, Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs) and landscapes identified as having low capacity to accommodate proposed form of change, that is; sites with attributes of **Very High Importance**.
Medium Sensitivity	Other characteristics or features of the landscape that contribute to the character of the landscape locally. Locally valued landscapes which are not designated. Landscapes identified as having some tolerance of the proposed change subject to design and mitigation, that is, sites with attributes of **Medium to High Importance**.
Low Sensitivity	Landscape characteristics and features that do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape type. Landscapes identified as being generally tolerant of the proposed change subject to design and mitigation, that is, sites with attributes of **Low Importance**.

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 the following table[5]. 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 impact capable of measurement but without noticeable consequences.
Slight	An impact that alters the character of the environment without affecting its sensitivities.
Moderate	An impact that alters the character of the environment in a manner that is consistent with the existing or emerging trends.
Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics.

In terms of hydrology and hydrogeology, magnitude is qualified in line with relevant guidance, as presented in the following tables [6]. These descriptive phrases are considered development specific terms for describing potential effects of the Development, and do not

[5] Environmental Protection Agency (EPA) (2017) Guidelines on the information to be contained in Environmental Imapct Assessment Reports
[6] National Roads Authority (NRA) (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes

provide for considering baseline tends 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	Example/s
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
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 a loss 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.

Magnitude of Impact	Description	Example
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

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 done in accordance with relevant guidance as presented in **Table 9.6**. This matrix qualifies the magnitude of potential effects based on weighting same 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. This is largely driven by the potential for effects to extend down gradient, beyond the boundaries of the site of the Development in terms of Hydrology and Hydrogeology.

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, and this is summarised in **Table 9.7**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has changed in response to specific issues indicated by respective consultees.

Scoping responses are set out in **Appendix 1.1: Consultation Responses**.

Table 9.7: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response	
Irish Water	Response to GORTYRAHILLY WIND FARM EIAR Scoping Report Request; 14.10.2021	a) Where the development proposal has the potential to impact an IW Drinking Water Source the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to IWs Drinking Water Source during construction and operational phases of the development. It is a requirement of the Water Framework Directive that waters used for the abstraction of drinking water are protected so as to avoid deterioration in quality. b) A waste sampling strategy for the proposed development to ensure the material is inert. c) Mitigation proposed for any potential negative impacts on any water source(s), in proximity including the environmental management plan and incident response. d) Any and all potential impacts on the nearby reservoir as public water supply water source is assessed, including any impact on hydrogeology and any groundwater/ surface water interactions. e) Impacts of the development on the capacity of water services (do existing water services have the capacity to cater for the new development if required). This is confirmed by IW in the form of a Confirmation of Feasibility (COF). If a development will require a connection to either a public water supply or sewage collection system the developer is advised to submit a Pre Connection Enquiry (PCE) enquiry to IW to determine the feasibility of connection to the Irish Water network. All pre-connection enquiry forms are available from https://www.water.ie/connections/get-connected/ f) Any up-grading of water services infrastructure that would be required to accommodate the development. g) In relation to a development that would discharge trade effluent – any upstream treatment or attenuation of discharges required prior to discharging to an IW collection network h) In relation to the management of surface water; the potential impact of surface water discharges to combined sewer networks & potential measures to minimise/stop surface waters from combined sewers i) Any physical impact on IW assets – reservoir, drinking water source, treatment works, pipes, pumping stations, discharges outfalls etc. including any relocation of assets j) If you are considering a development proposal, it is best practice to contact us in advance of designing your proposal to determine the location of public water services assets. Details, where known, can be obtained by emailing an Ordinance 3 **Uisce Éireann** Irish Water	(a) The Development has the potential to impact (2 no.) IW Drinking Water sources during the construction of the Turbine Delivery Route and the Underground Cabling Route (**Section 9.3.1.4**). However as part of the constrains mapping a 100m groundwater buffer zone has been place around these abstraction points in line with governing industry guidelines for proposed access tracks and cable trenches i.e. shallow excavations. Additional proposed Groundwater Contamination Mitigation Measures are outline under **Section 9.5.2.10** (b) Refer to the Material and Waste Management **Section 8.5.2.7 of EIAR Chapter 8 Soils & Geology** (c) Mitigation proposed for any potential negative impacts on any water source are outline in the site-specific Construction Environmental Management Plan (CEMP), in particular the Surface Water Management Plan (SWMP)

Consultee	Type and Date	Summary of Consultee Response	
		Survey map identifying the proposed location of your intended development to datarequests@water.ie. Other indicators or methodologies for identifying infrastructure located within your lands are the presence of registered wayleave agreements, visible manholes, vent stacks, valve chambers, marker posts etc. within the proposed site. k) Any potential impacts on the assimilative capacity of receiving waters in relation to IW discharge outfalls including changes in dispersion /circulation characterises l) Any potential impact on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence/ present a risk to the quality of the water abstracted by IW for public supply. m) Where a development proposes to connect to an IW network and that network w f m g w w "p "/ v area, consideration as to whether the integrity of the site/conservation objectives of the site would be compromised. n) Mitigation measures in relation to any of the above ensuring zero risk to any IW drinking water sources (Surface and Ground water). *This is not an exhaustive list.* Please note ▪ The Confirmation of Feasibility from IW, to the applicant, should be issued prior to applying for planning permission. ▪ Irish Water will not accept new surface water discharges to combined sewer networks	(**Management Plan 3 appended to the CEMP**). A separate emergency response system has been developed for the construction phase of the project (**Management Plan 1 – Environmental Incident and Emergency communication Response Plan**) (d) To mitigate any increased hydraulic in the area, mitigation measures have been outlined in **Section 9.5.3.1**. Pending the successful implementation of those measures, the development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrological network in terms of hydraulic loading. (e, f, g, h) Wastewater from sanitation facilities will be mitigated by use of temporary and portable sanitary facilities that are self-contained. These facilities will not interact with the existing hydrological environment in any way and they will be maintained, serviced and removed from site at the end of the construction phase. (i) Any physical impact on an IW

Consultee	Type and Date	Summary of Consultee Response	
			assets, discussed in the SSFRA (**Appendix 9.1),** i.e., Increasing or altering the hydrological regime and response to rainfall in regard to drainage network has been assessed as having a Positive to neutral mitigated outcome. (j, k, l, m, n) Do not apply under the scope of proposed works for the Development.
Inland Fisheries Ireland	GORTYRAHILLY WIND FARM Scoping report Consultation; 23.11.2020	The site of the proposed development encompasses the upper River Lee catchment and tributaries, significant salmonid fisheries. In this context IFI would ask that the following requirements should be taken into consideration: There should be no drainage or other physical interference with the bed or bank of any watercourse without prior consultation with IFI. Suspended solids and or hydrocarbon contaminated site run-off waters must be controlled adequately so that no pollution of surface waters can occur. More specifically IFI feels the following issues should be addressed: i. Identifying and zoning the project for environmental impact should a peat slip occur ii. Setting out contingency plan should a peat movement occur. iii. Setting out a plan for the control of silt in such a scenario, including measures to be put in place at the initial stages of construction. In the event of any watercourse crossings being bridged or culverted the following general criteria should apply, (i) The free passage of fish must not be obstructed. (ii)The original slope of the river bed should be maintained with no sudden drops on the downstream side. Design details on any proposed crossing should be incorporated at planning stage (iii) Bridges are preferable to culverts. (v) All instream works should be carried out only in the May-September period.	All proposed watercourse crossings are detailed at the beginning of this Chapter under **Section 9.1.1.** Proposed mitigation measures involving these watercourse crossings, have been outlined under **Section 9.5.2.8**. Furthermore, a constrains map with buffer zones along surface waterbodies can be referred to in **Figures 9.8 (a-k),** and constraint details are outlined in **Section 9.5.1.3.** To ensure no suspended solid or hydrocarbon contamination, site run-off waters have been designed to be handled by both 'passive' and 'active' treatment trains **Appendix 9.6 – Tile no. 7, 8 and 9, to** manage and treat construction water along with emergency

Consultee	Type and Date	Summary of Consultee Response	
			response and intervention. Constrains involving peat, i.e., peat slips are discussed in **EIAR – Chapter 8 – Soils & Geology**
Geological Survey Ireland	Request for Scoping Opinion Ref No. 20/289; 20.11.2020	The Groundwater Vulnerability map indicates the proposed wind farm area is of variable vulnerability. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' which can be used to inform appropriate mitigation measures. Our project is a groundwater flood monitoring and mapping programme aimed at addressing the knowledge gaps surrounding groundwater flooding in Ireland. Although primarily focused on karst areas, this may provide information to benefit the proposed wind farm development. We recommend using our tools found under our programme activities (in conjunction with OPW data), to this end.	The underlying bedrock aquifer is discussed in **Section 9.3.10** and its subsequent Groundwater Vulnerability & Recharge under **Section 9.3.11**. While there are no mapped karst features within 10km of the Development, mitigation measures to be followed under **Section 9.5.2.10** will minimise potential risk to groundwater contamination. In an unlikely contamination event, **Section 9.5.2.14** details emergency response procedures, and a separate 'Management Plan 1 – Environmental Incident and Emergency communication Response Plan' has been developed as part of the CEMP. A Site-Specific Flood Risk Assessment (SSFRA) has been developed utilizing the necessary and relevant data pertaining to the Development. This separate Assessment is

Consultee	Type and Date	Summary of Consultee Response	
			appended to this EIAR in **Appendix 9.1**
Cork County Council, Planning Department, Ecology Office	Pre-Planning / General Scoping; 03.02.2021	Potential for the project to give rise to negative effects on freshwater habitats and having particular regard to potential impacts on Fresh water pearl Mussel and Salmon. To this end, there should be a focus at design stage on providing for an appropriately designed surface water management system which minimises risk of release of contaminants to surface waters and ensures that there is no increase in surface water run-off from the site. Avoidance of disturbance of peat based habitats will greatly assist with this.	Descriptive mitigation measures relating to the release of suspended solids (**Section 9.5.2.5,** and associated Conceptual and Information graphics in **Appendix 9.6**) outlined in this report will be applied to the development design and construction methodologies with a view to avoiding and/or minimising any potential adverse impacts to water quality on the receiving surface water network. Details on how such measures will be applied (objectives, design considerations, layout) have been detailed in a separate Surface Water Management Plan (SWMP) (**Management Plan 3** appended to the CEMP).
Department of Culture, Heritage and the Gaeltacht	Request for Scoping Opinion; 19.04.2021	Turbines 1, 2 and 4 appear to be within the catchment of the River Lee, and turbine 6 within the catchment of the Toon River, both upstream of the Gearagh Special Area of Conservation (SAC) (Site Code. 000108), designated by the European Union Habitats (The Gearagh Special Area of Conservation 000108) Regulations 2019 (S.I. No. 523 of 2019). Conservation objectives for this site are available at https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000108.pdf. A NIS is recommended because of in-combination effects of wind farm drainage with other wind farm, forestry and land drainage, on potential downstream erosion and peat siltation of the Gearagh cSAC. The proposed wind farm is mostly within the catchment of the River Sullane, which, in addition to fish species of conservation importance (please consult Inland Fisheries Ireland for scoping), contains a population of	In regards to the ecological sensitivities associated with the Site, in particular the Freshwater Pearl Mussel (discussed in **Sections 9.3.1.8; 9.4.3.2;** and **9.4.3.3**), baseline hydrochemistry data collection was carried out prior to works commencing and as part of this reporting stage (**Section 9.3.9**). To ensure the (high) water quality

Consultee	Type and Date	Summary of Consultee Response	
		the freshwater pearl mussel. The (high) water quality requirements of this species should be taken into account in designing siltation control measures. The combination of clean water diversion, lined multicelled stone-constructed sediment ponds which can be cleaned by suction rather than excavated out, an environmental management plan, alarmed autosamplers, and previous best-practice upland construction experience indicates that a sediment control system could control sediment release such that it will not have an adverse effect on freshwater life downstream. Reliance on post-planning approval of detailed works (e.g. river crossings), and monitoring design, by the National Parks & Wildlife Service (NPWS) of the Department, should be avoided as (a) it may indicate inadequacies of assessment by the EIAR, and (b) staff may not be available to support this in the time frame of an active construction project	requirements for the species, monitoring guidelines have been outlined in this Chapter (**Section 9.5.2.12)** for both construction and post construction phases of the Development. Additionally, **Chapter 9 – Appendix 9.6 – Tile no. 7, 8 and 9** present indicative layout and specification for both passive treatment trains (clean water interceptor drains), active management treatment trains (management and treatment of construction water) and emergency response and intervention to minimize the risk of suspended solids entering any surface waterbody course. A separate NIS has been carried out and submitted along with this application in relation to the Geeragh SAC
OPW	Scoping Opinion GORTYRAHILLY WIND FARM Ref No. 332-2021; 22.09.2021	If any new culverts or bridges (or modifications to any existing culverts or bridges) are required to cross watercourses as part of the development or on proposed or existing access roads to serve or access the development, you should be aware that these require consent from the Commissioners of Public Works. This is a requirement of Section 50 of the Arterial Drainage Act of 1945 as amended. The current required design standard for bridges or culverts is based on the flood with an annual exceedance probability of 1% (often referred to as the 100-year flood), increased by 20% to cater for the effects of Climate Change. Bridges or culverts are required to be able to convey this design flood without significantly altering the hydraulic characteristics of the watercourse	All proposed watercourse crossings are detailed at the beginning of this Chapter under **Section 9.1.1.** Proposed mitigation measures involving these watercourse crossings, included the requirement for consent from the Commissioners of the Public Works have been outlined

Consultee	Type and Date	Summary of Consultee Response	
		With regard to the proposed Grid Connection Route, which is not indicated in your documentation, it is possible that this route will cross several watercourses. If the cable and ducting are to be buried in the road, as they cross bridges over the watercourses, and there is no interference with the opening in the bridge spanning the watercourse, then there is no issue. On the other hand, if it is proposed to pass the cable in its ducting through the opening of any bridge or culvert, this would be considered to be a modification of a bridge and it would require the consent of the Commissioners under Section 50 as mentioned above. Similarly, if it is proposed to carry the cable in its ducting across watercourses on new support structures spanning the watercourses, these should be treated as if they are bridges, and the consent of the commissioners under Section 50 should be obtained. If the cable and ducting is to be buried under the natural bed of the watercourses being crossed, Section 50 would not apply, and we would recommend that the duct be buried a sufficient distance below the natural bed to allow for erosion and mobility of the streambed. We would recommend that a flood risk assessment be carried out with regard to the proposed development and its construction. This should consider all sources, pathways and receptors of flood risk. This should be carried out in accordance with the principles set out in the guideline document "The Planning System and Flood Risk Management" as published by the Minister for the Environment, Heritage and Local Government and the Office of Public Works. In terms of the preparation of an EIA, the matters referred to above principally relate to the Hydrology Section, and the Risk of Flooding on a development such as this can impact on Landscape (e.g. landslides that have been reported in recent years), Infrastructure (roads and bridges) and people and their homes, among other things. The aim of the Section 50 process, and the Flood Risk Assessment, which is recommended, would be to mitigate any increased risk of flooding and the consequences of same, as arising from the proposed development.	under **Section 9.5.2.8.** Furthermore, mitigation measures outlined in **Section 9.5.2.8.2** relate to works being carried out instream, as well as **Section 9.5.2.9** for works involving Horizontal Directional Drilling along the Grid Connection Route, where bridge incorporation was not feasible. Regarding the recommendation of a Flood Risk Assessment; a Site-Specific Flood Risk Assessment (SSFRA) has been developed in line with guidelines published in "The Planning System and Flood Risk Management" by the Minister for the Environment, Heritage and Local Government and the Office of Public Works (November, 2009). This document is appended to this EIAR in **Appendix 9.1** To mitigate any increased hydraulic loading and the consequences of same (i.e., flood risk), arising from the proposed development (discussed under **Section 9.4.3.1),** mitigation measures have been outlined in **Section 9.5.3.1.** Pending the successful implementation of those measures, the development is

Consultee	Type and Date	Summary of Consultee Response	
			not considered to significantly contribute to cumulative adverse impacts to the associated hydrological network in terms of hydraulic loading.
Department of Transport	Request for Scoping Opinion; 26.11.2020	The EIAR should indicate whether it is proposed to use public roads to connect the wind farm to the grid and if that is the case specify the extent of the works required including drainage, diversions, relocation of services and road re-instatement. The EIAR should also address the future maintenance requirements related to the installation of the cables in public roads and the cost implications for the relevant local authority.	As detailed in **Section 9.4.3.1,** minimal land take is required for the both the Turbine Delivery Route and Grid Connect Route, considering a majority of the routes will traverse already existing road ways i.e., existing access tracks, public and local road networks and privately owned forestry access tracks. Mitigation measures to be adhered to during these works are outline in **Section 9.5.2.2.**

9.3 BASELINE DESCRIPTION

9.3.1 Introduction

The Site is situated on Carrigalougha Hill, in the Shehy Mountains in Co. Cork. The Development is 'novel' relative to the Site, which is characterised as being rural agricultural land. However, there are a number of established wind farms in the region including Derragh Wind Farm, 189m to the southeast and Grousemount Wind Farm c. 5km west of the Site (**Appendix 2.3 Wind Farms within 20km of Proposed Turbines**)

9.3.2 Site Description

The Development (**Figure 9.1a**), is comprised of 14 No. proposed turbines, one met mast and associated ancillary infrastructure (Turbine Foundations, Site Access Roads, Turbine Hardstands, drainage infrastructure etc.) (**Chapter 2: Project Description**). Each portion of the Site is connected via existing and proposed Site Access Roads which includes for connection to a substation at the Site. The Site is characterised by relatively complex (hilly) topography with associated elevations ranging between c. 230 to 423 metres Above Ordnance Datum (m AOD) (Carrigalougha peak; 423m AOD).

The Development will be connected to the national grid at Ballyvouskill Substation. The Grid Connection Route is approximately 27.8km and comprised of wind farm / forest tracks (20km), public roads (6.8km) and ESB access track (1km). The Grid Connection cable will be buried, with intermittent cable joint bays and other ancillary infrastructure where required.

9.3.2.1 Site Walk Over and Observations

Site walk over surveys were tailored in line with the Site layout and conducted between c. June 2020 and June 2021. Photographs obtained during site surveys are presented in **Appendix 9.2.**

9.3.2.2 Field Work Restrictions

Access at the Site was generally good, however in some afforested areas access was limited. For example, proposed locations for T3, T4, T5, and T10 are situated within afforested areas (**Figure 9.1**). Therefore, access to those locations was limited to firebreaks, access roads, and some cleared (brashing) linear pathways through thicker growth provided by the client.

9.3.3 Topography

Topography at the Site is highly variable. Some areas possess severe slopes and some areas possess complex topography (e.g. significant rocky outcrops with severe slopes and sheer faces). Topography is discussed in greater detail in relation to stability and constraints in **Chapter 8: Soils and Geology**.

9.3.4 Land Use & Environmental Pressures

With reference to **EIAR Chapter 8: Soils and Geology - Section 8.3.3 Land Use**, land use practices on the site include mostly agriculture and commercial forestry. Both these land uses present environmental pressures on the hydrological and hydrogeological environmental. The main issue associated with these practices is nutrient loading through deposition of waste, and concentrations will spike through the liberation of nutrients in soils through erosion soils for example livestock movements or clear-felling forested areas. As such, for the purposes of this assessment, the impact of nutrient loading in the receiving water environments is coupled with entrainment of solids in runoff, also referred to as Total Suspended Solids.

Mapped land use or the entire Development is presented in Error! Reference source not found.**.**

9.3.5 Rainfall and Evapotranspiration

Rainfall data for the region associated with the Development site has been assessed in terms of the following parameters:

- Historical average and max monthly rainfall and effective rainfall. Effective rainfall is calculated as being rainfall minus evapotranspiration equals effective rainfall, or the amount of rainfall which will contribute to surface water runoff discharge volumes and/or groundwater recharge.
- Potential significant storm events including events with a 1 in 100 year return period over 1 hour duration, 25 day duration and 30 day or month duration (inferred using available data).
- Daily 2020 rain (specifically in relation to meteorological conditions at the time of site surveys).

Data from the meteorological stations listed in

Table 9.8: Meteorological Stations are used in this assessment[7].Using data presented in **Table 9.9: Met Éireann Return Period Rainfall Depths (Irish Grid; 116028, 72371)**, storm event of 30 days duration with a 1 in 100 year return period is inferred to be 580.5mm. For the purpose of this environmental impact assessment, predicted extreme or worst-case values are used, as presented in **Table 9.10: EIA Specific Assessment Data**. Rain fall amounts in the three days preceding baseline sampling events are presented in **Table 9.11: Rainfall Prior to Baseline Sampling Events.**

Rainfall trends are presented in **Figure 9.3**.

Table 9.8: Meteorological Stations [8]

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	M.BALLINGEARY 1948-2020	4
Rainfall (2020/21 Monthly/Daily)	M.BALLINGEARY 1948-2020	4
Evapotranspiration	Cork Airport – 2016-2019 Minimum	50

[7] Met Eireann, Historical Data, Available at; www.met.ie, Accessed; 03rd March 2021
[8] Met Éireann

Table 9.9: Met Éireann Return Period Rainfall Depths (Irish Grid; 116028, 72371)[9]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 116028, Northing: 72371,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	3.2,	4.1,	4.5,	5.1,	5.6,	5.9,	6.9,	7.9,	8.6,	9.5,	10.3,	10.9,	11.8,	12.4,	13.0,	N/A ,
10 mins	4.4,	5.6,	6.3,	7.2,	7.7,	8.2,	9.6,	11.0,	12.0,	13.2,	14.3,	15.2,	16.4,	17.3,	18.1,	N/A ,
15 mins	5.2,	6.6,	7.4,	8.4,	9.1,	9.6,	11.3,	13.0,	14.1,	15.6,	16.9,	17.8,	19.3,	20.4,	21.3,	N/A ,
30 mins	7.3,	9.3,	10.3,	11.7,	12.6,	13.3,	15.5,	17.8,	19.2,	21.2,	22.9,	24.1,	26.0,	27.5,	28.6,	N/A ,
1 hours	10.3,	13.0,	14.3,	16.2,	17.5,	18.4,	21.3,	24.3,	26.2,	28.8,	31.0,	32.6,	35.1,	37.0,	38.5,	N/A ,
2 hours	14.6,	18.2,	20.0,	22.5,	24.2,	25.4,	29.2,	33.2,	35.7,	39.1,	42.0,	44.1,	47.3,	49.8,	51.7,	N/A ,
3 hours	17.9,	22.2,	24.3,	27.3,	29.2,	30.7,	35.2,	39.9,	42.8,	46.8,	50.1,	52.6,	56.4,	59.2,	61.5,	N/A ,
4 hours	20.6,	25.5,	27.9,	31.3,	33.5,	35.1,	40.1,	45.4,	48.7,	53.1,	56.9,	59.7,	63.8,	67.0,	69.5,	N/A ,
6 hours	25.2,	31.1,	33.9,	37.9,	40.5,	42.4,	48.3,	54.5,	58.4,	63.6,	67.9,	71.2,	76.1,	79.7,	82.6,	N/A ,
9 hours	30.9,	37.8,	41.2,	45.9,	49.0,	51.2,	58.2,	65.5,	70.0,	76.0,	81.1,	85.0,	90.6,	94.8,	98.2,	N/A ,
12 hours	35.6,	43.5,	47.3,	52.6,	56.1,	58.6,	66.4,	74.6,	79.6,	86.4,	92.0,	96.3,	102.6,	107.3,	111.1,	N/A ,
18 hours	43.6,	52.9,	57.5,	63.8,	67.8,	70.8,	80.0,	89.6,	95.5,	103.3,	110.0,	114.9,	122.2,	127.6,	132.0,	N/A ,
24 hours	50.3,	60.9,	66.0,	73.1,	77.6,	81.0,	91.3,	102.0,	108.6,	117.3,	124.7,	130.2,	138.3,	144.4,	149.3,	165.4,
2 days	65.8,	78.3,	84.3,	92.5,	97.7,	101.6,	113.3,	125.3,	132.6,	142.4,	150.5,	156.5,	165.4,	172.0,	177.2,	194.7,
3 days	79.1,	93.1,	99.8,	109.0,	114.8,	119.0,	132.0,	145.1,	153.1,	163.7,	172.5,	179.0,	188.5,	195.6,	201.2,	219.8,
4 days	91.1,	106.6,	113.9,	123.9,	130.2,	134.8,	148.8,	162.9,	171.5,	182.8,	192.2,	199.1,	209.3,	216.8,	222.8,	242.4,
6 days	113.2,	131.1,	139.5,	150.9,	158.1,	163.3,	179.1,	195.0,	204.6,	217.2,	227.7,	235.4,	246.6,	254.8,	261.4,	282.9,
8 days	133.6,	153.6,	162.9,	175.7,	183.5,	189.4,	206.8,	224.2,	234.7,	248.4,	259.8,	268.1,	280.3,	289.2,	296.3,	319.5,
10 days	152.9,	174.9,	185.1,	198.9,	207.5,	213.8,	232.7,	251.5,	262.8,	277.6,	289.7,	298.7,	311.6,	321.2,	328.8,	353.4,
12 days	171.5,	195.3,	206.3,	221.2,	230.4,	237.2,	257.3,	277.4,	289.5,	305.2,	318.1,	327.6,	341.4,	351.4,	359.5,	385.5,
16 days	207.2,	234.3,	246.7,	263.6,	273.9,	281.5,	304.1,	326.5,	340.0,	357.4,	371.7,	382.1,	397.3,	408.3,	417.2,	445.7,
20 days	241.6,	271.6,	285.4,	304.0,	315.4,	323.8,	348.5,	373.0,	387.7,	406.6,	422.1,	433.4,	449.9,	461.9,	471.4,	502.1,
25 days	283.3,	316.8,	332.1,	352.7,	365.3,	374.5,	401.8,	428.7,	444.7,	465.4,	482.3,	494.6,	512.4,	525.5,	535.8,	569.0,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

[9] Met Éireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods , Accessed; 3rd March 2021

Table 9.10: EIA Specific Assessment Data [10]

Category	Value
Average Annual Effective Rainfall (Long term) (mm/year)	1,323.41
Max monthly effective rainfall (mm/month)	680.2
1 in 100 Year Rainfall Event (30 day duration) (mm/month)	580.5
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	32.6
Minimum monthly evapotranspiration (mm/month)	9.7

Table 9.11: Rainfall Prior to Baseline Sampling Events [11]

Event No.	Date	Rainfall on days leading up to sampling event (Day 0)				Total Rain in 3 no. days prior to sampling. (Days 1-3)	Event Category	Weather Station
No.	Sampling Date (Day 0)	Day 3	Day 2	Day 1	Day 0	mm / 3 days		
		mm/day	mm/day	mm/day	mm/day			
1	12/08/2020	0.0	0.0	0.0	14.6*	0.0	Dry	Ballingeary
2	26/08/2020	2.3	53.4	4.0	4.0	59.7	Wet	Ballingeary
3	24/02/2021	0.5	14.1	33.2	4.8	47.8	Wet	Cork Airport
4	16/03/2021	8.1	0.0	0.0	0.0	8.1	Dry	Cork Airport
* Sampling occurred ahead of recorded rainfall for the day. Lead up to sampling event was dry.								

9.3.6 Regional and Local Hydrology

Surface water networks draining the site are mapped and presented in **Figures 9.2 (a - c).**

Surface water networks associated with particular turbine locations are presented in the Surface Water Flow Chart in **Figure 9.4**

The Development is situated within the Lee, Cork Harbour and Youghal Bay catchment (ID: 19, Area: 2182km^2).

Surface water runoff associated with the Site drains into three sub catchments and/or four river sub basins, or four no. rivers:

- Sub Catchment: Lee (Cork) SC 010, River Sub Basin: (Lee Cork) 010
- Sub Catchment: Lee (Cork) SC 020; River Sub Basin: Toon 010
- Sub Catchment: Sullane SC 010; River Sub Basins: Sullane 010 and Douglas (Sullane) 010.

[10] Met Éireann
[11] Met Éireann

All surface waters drainage from the Site eventually combine in Carrigdrohid Reservoir, from which waters eventually flow to Cork Harbour and into the Celtic Sea.

9.3.7 Site Drainage

The Site is characterised by a relatively extensive network of non-mapped natural and artificial drainage channels. Drainage channels identified during desk study assessment and during site surveys are presented in **Figure 9.5a**. Photographs of some significant features are presented in **Appendix 9.2**.

In line with the extensive drainage network identified, the number of existing surface water crossings (culverts and/or bridges) is also relatively high. Existing surface water crossings associated with surface water features and relatively significant drainage features are also identified are presented in **Figure 9.5a**.

Note: Mapping of minor natural or artificial drainage channels has been completed it is limited in places due to some site access constraints (afforested areas). Considering the nature of the areas in question, afforested areas, it is presumed that these areas possess extensive forestry drainage channels. Similarly, there are likely to be additional culverts associated with afforested areas or with minor existing access trails and minor drainage channels. Aerial lidar survey data (topographical elevation data, accuracy 1m) and recent aerial photography was interrogated and some additional drains were identified, however none were material to the impact assessment for the development. It is likely any residual undetected drainage features are minor in scale.

9.3.8 Water Framework Directive Water Body Status, Risk & Objectives

Details in relation to the Water Framework Directive (WFD) 2013-2018 status assigned to surface waterbodies associated with the Site are presented in **Figures 9.2.1** and **Figure 9.4**

The WFD status (2013-2018) for surface water bodies / rivers and streams directly draining the Site range from Good to High.

Further downstream, the WFD 2013-2018 status for rivers deteriorates to Moderate in places due to significant pressures in hydro-morphology from channelisation and hard infrastructure such as reservoirs, weirs, embankments and culverts.[12]

[12] Environmental Protection Agency (2021) "3rd Cycle Draft Lee, Cork Harbour and Youghal Bay Catchment Report (HA 19)" Catchment Science & Management Unit. Version no.(1).

Lake water bodies associated with the surface water network possess WFD 2013-2018 status ranging from moderate (e.g., Carrigdrohid Reservoir) to poor (e.g., Allua Lough). According to the EPA (2021) the WFD statuses associated with the lake water bodies are due to the following actions:

The Carrigdrohid is designated as a heavily modified water bodies (HMWB) in the catchment due to power generation, in addition to 'significant unknown anthropogenic pressures' impacting Carrigdrohid. Agriculture, in particular, forestry is a significant pressure on lake waterbody (Allua). The issues arise from forestry activities taking place (particularly on poorly draining soils) that include clear-felling and drainage, which have resulted in excess nutrients in the lake. Both lake waterbodies (Carrigdrohid & Allua) are At Risk of not achieving "Good' status.

Surface water bodies (rivers and streams) draining the Site, or immediately downgradient are generally not at risk of deteriorating (WFD), however some connected downstream waterbodies are at risk of deteriorating (**Figure 9.2.2**) from significant pressures in hydro-morphology as previously stated.

9.3.9 Surface Water Hydrochemistry

Baseline surface water sampling was carried out at six locations, that can be seen in **Figure 9.5a** which are representative of drainage and surface water network channels associated with the Site (**Figure 9.4).** Data on surface water flow at representative baseline sampling locations at the time of sampling is presented in **Appendix 9.3: Surface Water Hydrochemistry Database,** and laboratory certificates are presented in **Appendix 9.4: Laboratory Certification**.

Surface water quality observed at all six monitoring locations is of similar standard and is generally of good quality when screened against relevant reference concentrations, however the following is noted:

- Ammoniacal Nitrogen as N was elevated above the relevant reference concentration (0.02mg/l Ammoniacal Nitrogen as N) at all monitoring locations (Min Max Range; 0.0168 – 0.068mg/l Ammoniacal Nitrogen as N). Elevations occurred during at least two out of four monitoring events for all monitoring, ranging up to four of four monitoring events at a number of locations.
- Nitrate as NO_3 was elevated above relevant reference concentration (0.05mg/l Nitrate as NO_3) at SW5 (0.139mg/l Nitrate as NO_3) during the 12/08/2021 sampling event.
- pH was more acidic than the relevant reference range (pH 6 – 9) at SW2 (pH 4.87) during the 12/08/2021 sampling event.

Elevated concentrations of Nitrogen compounds (Ammoniacal Nitrogen, and Nitrate) as observed at all monitoring locations is indicative of current land practices at the Site, agriculture and forestry (see Photographs **in Appendix 9.2)**.

Low pH in surface water, (see **Appendix 9.3 – Surface Water Hydrochemistry Database),** can be attributed to a range of environmental characteristics and pressures, including the presence of humic and fulvic acids associated with peat (**Chapter 8: Soils and Geology**).

9.3.10 Hydrogeology – Bedrock Aquifer

Consultation with GSI Groundwater maps indicates that the entire Development is underlain by aquifers with classifications ranging from Poor Aquifer (Pl) (northern portion of the Wind Farm and majority of the Grid Connection Route and Turbine Delivery Route), that is; bedrock which is generally unproductive except for local zones, and Locally Important Aquifer (LI) (southern portion of the Wind Farm), that is; bedrock which is moderately productive only in local zones (**Figure 9.6b - Bedrock Aquifer)**.

There are no mapped karst features within 10km of the Development.

9.3.11 Groundwater Vulnerability & Recharge

Vulnerability depends on the quantity of contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels. These factors are controlled by the types of subsoil that overlie the groundwater, the way in which the contaminants recharge the geological deposits (point or diffuse source) and the unsaturated thickness of geological deposits from the point of contaminant discharge.

Where low permeability subsoil overlies the bedrock, it is the thickness of subsoil between the release point of contaminants and bedrock that is considered when assessing vulnerability of bedrock aquifers, regardless of whether the low permeability materials are saturated or not. The GSI vulnerability mapping guidelines allow for the assignment of vulnerability ratings from "extreme" to "low", depending upon the subsoil type and thickness. With regard to sites where low permeability subsoil is present, the following thicknesses of unsaturated zone are specified.[13]

[13] Geological Survey Ireland (2022) Story Map Series. Available at: <https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228>

Table 9.12: Groundwater Vulnerability Ratings

Vulnerability Rating	Thickness of unsaturated zone (m)
Rock at or Near Surface (X)	0
Extreme (E)	0 to 3
High (H)	3 to 5
Moderate (M)	5 to 10
Low (L)	>10

Consultation with the GSI Groundwater Map Viewer indicates that the Wind Farm Site is underlain by areas classified predominantly by Rock at or Near Surface (X) vulnerability rating particularly at higher elevations, with some areas mapped as Extreme (E) vulnerability rating which tend to be at lower elevations. Both the Turbine Delivery Route and Grid Connection Route traverse land with groundwater vulnerability ratings ranging from 'Moderately Vulnerable' to 'Extreme Vulnerability' (**Figure 9.6a – Bedrock Aquifer Vulnerability**).

The potential groundwater recharge rate (recharge coefficient) for the local area, as mapped by GSI, ranges significantly depending on the underlying soil / subsoil type and varies significantly relative to the thickness of overburden or aquifer vulnerability and corresponds to the recharge capacity of the underlying bedrock aquifer as presented in **Section 9.3.10**. The underlying bedrock aquifers are classified as Poor or Locally Important and will therefore have an inferred maximum recharge capacity per annum assigned, that is; effective rainfall available for recharge but in excess of maximum recharge capacity will form rejected recharge once conditions become saturated. Peat has very low permeability, however peat stores large amounts of water, that is; bog water levels in intact peatland areas are generally near the surface[14]. Combining these factors results in the site being characterised by low recharge rates and high surface water runoff rates.

In peat areas associated with the Site the mapped groundwater recharge coefficient is as low as 20% of effective rainfall. This recharge coefficient is considered very low [15]. Whereas areas where bedrock is at or near the surface the mapped groundwater recharge coefficient is 85% of effective rainfall. This recharge coefficient is considered very high. However, the maximum recharge capacity of the aquifer will limit recharge to groundwaters.

[14] Labadz J, et al (2010) Peatland Hydrology. Draft Scientific Review, IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. UK.
[15] Williams N. H., et al. (2011) A NATIONAL GROUNDWATER RECHARGE MAP FOR IRELAND. National Hydrology Conference 2011, Ireland.

Areas of the Site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 200mm effective rain fall. Areas underlain by Poor Aquifer (Pu) possess a maximum recharge capacity of 100mm effective rainfall per annum (**Figure 9.6c**). For additional context, the maximum recharge capacity of 200mm or 100mm per annum equates to a recharge coefficient of approximately 15% or 7.5% of effective rainfall respectively, in line with peat which is considered highly impermeable with a recharge coefficient <20%.

Considering all of the above, the Site is characterised by low to very low recharge rates in overburden (soils/subsoils) and very low recharge capacity in the underlying bedrock aquifer. This implies that, particularly during seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the Site will drain off the site as surface water runoff, and the rejected recharge water volumes will likely discharge to surface waters relatively rapidly and locally. As such, the surface water network associated with the Site is characterised as having a rapid hydrological response to rainfall. This is indicative of lands comprising of blanket peat or catchments with elevated peat cover [16] [17].

9.3.12 Baseline Site Run-off Volumes

There are limited hydrometric stations situated on the above river systems and limited data where available. Therefore, preliminary water balance calculations will use approximate 'micro-catchment' areas **(Figure 9.5b)** associated with the Site upstream of baseline surface water sampling locations (**Figure 9.5a)** to estimate baseline storm runoff discharge rates at the Site.

Table 9.13: Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)

Micro Catchment	Approximate Area (m^2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity. Percentage of Effective Rainfall (Conservative Value for Water Balance Calc's)	Rejected Recharge/ Runoff (m/hour Rain)	Runoff Discharge Rate (m^3/hour)	Runoff Discharge Rate (m^3/sec)
SW1	2,649,544.78	0.0326	20.00%	0.02608	69,100.13	19.19
SW2	1,302,740.30	0.0326	20.00%	0.02608	33,975.47	9.44
SW3	938,127.00	0.0326	20.00%	0.02608	24,466.35	6.80
SW4	176,428.42	0.0326	20.00%	0.02608	4,601.25	1.28
SW5	479,458.47	0.0326	20.00%	0.02608	12,504.28	3.47
SW6	1,425,986.26	0.0326	20.00%	0.02608	37,189.72	10.33
				Total	**181,837.20**	**50.51**

[16] Misstear B., Brown L. (2008) Water Framework Directive – Recharge and Groundwater Vulnerability. EPA STRIVE Report, EPA, Ireland.
[17] Jennings S. (2008) Further Characterisation Study: An Integrated Approach to Quantifying Groundwater and Surface Water Contributions of Stream Flow, RPS, Ireland

The above extreme runoff discharge rates provide context in terms of the hydrological response representative of the Site. Potential impacts of the Development in terms of run-off and flood risk are assessed using the same meteorological and hydrogeological conditions but focus on the net increase in runoff associated with the footprint of the of the Development, i.e. the installation of hardstand surface area which is granular and typically has a 'c' value of 0.6 – 0.8. Net increase in runoff as a function of the Development will be compared to Baseline Runoff Volumes (1 in 100 Year Hour Storm Event).

9.3.13 Flood Risk Identification

A Site Flood Risk Assessment (SFRA) Stages 1 & 2 for the Wind Farm Site is presented in **Appendix 9.1 – GWF Flood Risk Assessment**. Conclusions are summarised as follows:

- The site is not within a probable flood zone.
- The development at the site will lead to a net increase in runoff equating to 0.319m^3/second or 0.63% relative to the site area. This is considered an adverse but imperceptible impact of the development.
- The associated drainage will be attenuated for greenfield run-off and the proposed development will not increase the risk of flooding elsewhere in the catchment.

Consultation with OPW Flood Maps (Accessed; March 2022) indicates there are no areas mapped as being low, medium or high probability flood areas within or immediately downgradient of the of the Site. Similarly, there are no recorded past flood events within or directly downgradient of the Site.

The closest mapped probable flood areas are associated with:

- The Lee (Cork) (030) river approximately four kilometres south of the site at Ballingeary town.
- The Sullane (030) river approximately four kilometres to the north-east of the site near Ballymakeery town.

Both the above flood risk areas identified extend along the respective rivers and continue after the two rivers merge in Carrigdrohid Reservoir.

Flood Relief Schemes for both Ballingeary and Ballymakeery towns (flood areas identified above) include Measures Applicable in All Areas, which includes:

- Sustainable Drainage Systems (SuDS). Objective: Planning authorities will seek to reduce the extent of hard surfacing and paving and require the use of sustainable drainage techniques to reduce the potential impact of development on flood risk downstream.

- Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

Broad stroke objectives such as the above are relevant to the Development whereby any development within the catchment of a Flood Relief Scheme should aim for a minimal or neutral impact in terms of net change in surface water runoff and in turn impacts downstream. Furthermore, any mitigation which promotes beneficial impacts, i.e., net-decrease in runoff or delaying the hydrological response to rainfall, contributes to the objectives of the Flood Relief Schemes and ultimately the WFD.

In regard to the turbine delivery route, flood risk screening (SFRA Stage 1, **Appendix 9.1**) indicates that the location of the temporary bridge on the Sullane River and associated ancillary infrastructure is situated within a probable flood zone (**Appendix 9.1 Figure 4.4**) with recorded flood events situated approximately 500m downstream of the bridge location (**Section 4.2.1 Appendix 9.1**). This portion of the development is temporary and therefore no significant impact to runoff rates are identified, however the risk of flooding on site is important to consider in the design and management of this part of the Development.

In regard to the Grid Connection Route (GCR), There have been 2 no. past flood events along the Grid Connection Route, (**Section 4.2.1 Appendix 9.1**). Consultation with the National Indicative Fluvial Mapping (NIFM)- Future River Flood Extents Scenarios maps, (**Figure 4.3 Appendix 9.1**) forecasts 'low' (0.1% AEP) and 'medium' (1% AEP) the for the Sullane where the GCR will cross, using HDD, at the following locations: Culvert 115, Bridge 2 (Droichead Barr Duinse) and Bridge 3 (Droichead Ui Mhathuna). Considering the nature of the works there will be minimal land take required and no significant impact to runoff rates, however considering the scale or length of this part of the development flood risk will be anticipated, particularly at watercourse crossing locations.

9.3.14 Wells

Consultation with GSI (2022) well database indicates there are no mapped wells within the Site boundary. Governing industry guidelines stipulate a buffer zone of 250m is required of from boreholes used for drinking water abstraction when assessing excavations for turbine foundations. The closest mapped wells are more than 400m from the boundary of the Site, suggesting that any potential impact from the Development is low risk for wells in the immediate vicinity. Further consultation identified a well which belongs to a demolished property and is now used for agriculture, 270m north-west of T12. The coordinates of such are 516,553.5E 573,369.5N.

With reference to the Baseline Description in this report, the groundwater aquifer underlying the Gortyrahilly Wind Farm Site is generally divided into two classes: a Poor Aquifer (PI) – Bedrock which is generally unproductive except for local zones, and a Locally Important Aquifer (LI) – Bedrock which is Moderately Productive only in Local Zones.

The majority of the Grid Connection Route traverses land underlain by a LI aquifer with only c. 9km traversing a PI aquifer. Similarly, a small portion of the TDR, c. 300m, is underlain by a PI, the remaining track has been routed over a LI aquifer. Any identified boreholes along these routes will highlight the significant potential for the proposed developments to impact groundwater supplies in local zones.

Consultation with GSI (2022) Groundwater Abstraction Well database has identified two individual mapped wells along the proposed Grid Connection Route and Turbine Delivery Routes **(Figure 9.7b).** Governing industry guidelines stipulate a groundwater buffer zone of 100m is required of from boreholes used for drinking water abstraction in relation to the proposed Site Access Roads and cable trenches i.e. shallow excavation.

- The Turbine Delivery Route is associated with one 1 no. borehole: E'117330, N'74780 (ITM) (GSINAME: 1107SWW029) that is sourced for domestic use only.
- Along the Grid Connection Route, a borehole: E' 115180, N'74010 (ITM) (GSINAME: 1107SWW039) is sourced for agriculture and domestic use.

9.3.15 Groundwater Levels, Flow Direction & Groundwater Hydrochemistry

With reference to **Appendix F of Appendix 8.1,** groundwater observations during SI rotary core drilling to bedrock depths indicate that the underlying bedrock is weathered to a minor degree only, with minor volumes of groundwater perched on top of bedrock in the subsoil underlying the site. This is of importance for a groundwater dependent ecosystem such as the superficial peat observed on Site, that grows in the saturated zone. No significant water strikes were encountered, as would generally be the case in the absence of folding and faults, (maximum drill depth was approximately 10m).

Groundwater flow patterns, or the water table of an entire aquifer, can often mimic surface water flow patterns. Overall, groundwater will follow the regional topographical gradient of a given area, moving along flow paths from areas of recharge to areas of discharge, i.e., surface waterbodies. Therefore, groundwater flow directions at the Site are presumed to follow the topography of the area, and flow paths are considered to be short due to the poorly productive underlying bedrock aquifer. Groundwater flow likely circulates in the upper overburden saturated zone, recharging and discharging in local zones with a high flowrate; thus the groundwater is considered to be young. The implications for 'young' groundwater is that it will be more vulnerable in terms of water quality from a pollution incident.

Due to the absence of any recorded groundwater quality data within or proximal to the study area, no published data on groundwater quality for the Site is available. However, the 2013-2018 WFD Groundwater status for groundwater underlaying the Site is 'Good' (Groundwater unit: Ballinhassig West) and is considered not at risk.

Peat at the Site is generally thin / superficial (**Appendix A** of **Appendix 8.1**). Furthermore, extensive drainage and general topography conditions indicate that bog water levels in line with for example Active Blanket Bog, are impacted to a very minor extent, with the exception of isolated pockets of deeper intact peat areas.

9.3.16 Designated Sites & Habitats

Designated and Protected Areas associated with the Development are detailed in **Figure 9.4** and presented in **Figure 9.7a**.

The Site is not positioned within or directly adjacent to or immediately upstream of any designated or protected area (SPA, SAC, NHA). The nearest downstream designated areas include the following as outlined in **Figure 9.4** and **Figure 9.7a**

- Lough Allua Proposed NHA (EPA Site Code: 001065) situated on Lough Allua approximately 4km south of the site.
- The Gearagh SAC (EPA/NPWS Site Code: 000108), The Gearagh SPA (EPA/NPWS Site Code: 00409), The Gearagh NHA (EPA/NPWS Site Code: 000108), The Gearagh Nature Reserve and The Gearagh Biogenetic Reserve (NPWS, 2022) are situated on Carrigdrohid Reservoir approximately 12km east of the site.
- Cork Harbour SPA (EPA/NPWS Site Code: 004030) situated c. 66km east of the Site.

Sections of the proposed grid connection route cross certain watercourses that flow into designated Natural Heritage Areas (NHA) and Special Area of Conservation (SAC) of Killarney National Park. Horizontal Directional Drilling (HDD) will be utilised, where standard trenching methodologies cannot be applied, to facilitate underground cabling in order to mitigate the impact to the surrounding ecology through minimising vegetation cutting in the designated area.

9.3.17 Water Resources

Drinking water rivers designated in accordance with European Communities (Drinking Water) (No. 2) Regulations 2007 (SI no. 278/2007) which are protected for the purposes of drinking water abstraction are presented **Figure 9.7b**.

Surface water bodies designated for drinking water within the site boundary include:

- Lee (Cork) 030 (EU Type: Article 7 Abstraction for Drinking Water). This designation continues along the Lee (Cork) river up to Lough Allua. Lough Allua is not designated for drinking water however the lake discharges to the downstream section of the Lee (Cork) 030 river which is designated for drinking water.

Surface water bodies designated for drinking water downstream of the Site include:

- Lee (Cork) 050. The Toon 010 river, which drains some southern portions of the site, flows into the Lee (Cork) 050 river approximately eight kilometres east of the site. The Lee (Cork) 050 river continues east and flows into Carrigdrohid Reservoir and Inniscarra Reservoir which are not designated however the reservoir discharges to the downstream section of the Lee (Cork) river (090) which is designated for drinking water, **Figure 9.4- Surface Water Flow Chart**.

Groundwater in the entire area (nationally) is protected under the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. no. 278/2007).

9.3.18 Receptor Sensitivity

All receptors associated with the Development i.e., groundwater, streams and rivers, are considered highly sensitive receptors when considering:

- Water Framework Directive (WFD) status (2013-2018) generally ranging from Good to High, with some sections ranging to Poor. The principal objective of the WFD is to achieve good status or higher in all waters and to ensure that status does not deteriorate in any waters.
- The down-stream designations (sensitive protected areas e.g., SAC, SPA) associated with the catchment and the sensitive habitats and species associated with same (i.e., Freshwater Pearl Mussel (FWPM)), Refer to **Section 9.4.3.3** of this Report for further information on FWPM as well as **EIAR Chapter 6 – Aquatic Biology**.
- The designation of all waterbodies within the boundary of the Site and downstream surface water bodies and all groundwater bodies as sources of drinking water.

Ultimately, all surface waters and groundwaters associated with the Site are considered sensitive and important attributes in their own right and must be protected in accordance with the WFD to achieve and maintain at least 'Good' status. However, waterbodies associated with additional receptor sensitivities such as designated and protected areas (e.g. FWPM, SAC, SPA), should be considered at the highest level on the sensitivity scale, due to the increased risk associated with specific additional ecological attributes they possess. For instance, while a potential effect, e.g. sediment stock pile collapse into a surface waterbody, could have a temporary impact on the river or stream itself where suspended solids would be washed away from the incident and 'diluted' with the assimilative capacity of the river; on the other hand, the effects could be long lasting and potentially lead to the collapse of a species (FWPM).

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 potential source of hazard to receptor, pathway directness and/or connectivity, and assimilative capacity of the receiving water body will also be considered.

In terms of groundwater sensitivity and susceptibility, as discussed in previous sections, all groundwater associated with the Site is protected as a source of drinking water, under the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. no. 278/2007). However, the bedrock aquifers underlying the site and surrounding area range from Poor aquifer except for local zones (PI) to Locally Important (LI), which can be expressed as an aquifer with relatively poor production and low connectivity (PI) and relatively low to moderate production and connectivity (LI) respectively, and therefore the risk of potential adverse impacts on groundwater will be limited to localised zones within the Site. It is however noted, with reference to **Section 9.3.14,** 2 no. wells have been identified within the 100m buffer zone of shallow excavations; 1 no. each along the Turbine Delivery Route and Grid Connection Route.

In terms of surface water sensitivity, as stated above, the vast majority of potential contaminants or unmitigated adverse impacts will infiltrate to surface water bodies, however sensitive receptors are of variable distance from the Development and the pathways are of variable condition for each proposed turbine location and for any part of the Development.

9.4 ASSESSMENT OF POTENTIAL EFFECTS

9.4.1 Assessing the Magnitude of Potential Effects

The receiving environment associated with the proposed development is considered as ranging from Low to Very High Sensitivity. With reference to **Section 9.2.5**, receptor sensitivity is qualified as follows:

- Surface Water; Very High
- Groundwater; Bedrock Aquifer; Low
- Bog Water - In areas of cut over peat, forestry or where existing drainage networks exist; Medium
- Bog Water - In areas of intact habitat and/or designated areas e.g., blanket bog / SAC; Very High

These items are discussed further in the following sections.

To account for this, the potential impacts associated with the proposed development will be limited to Magnitudes associated with respective environmental characteristics, as presented in the **Table 9.14.**

Table 9.14: Magnitude of potential impacts relative to receptor sensitivity

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (Imperceptible)	Small Adverse (Slight)	Moderate Adverse (Moderate)	Large Adverse (Significant to Profound)
Very High (Surface water, Bog water in intact or designated peat)	Imperceptible	Significant / Moderate	Profound / Significant	Profound
Medium (Bog water in existing impacted areas)	Imperceptible	Slight	Moderate	Significant
Low (Groundwater, relative to the scale of the site)	Imperceptible	Imperceptible	Slight	Slight / Moderate

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

9.4.2 Do Nothing Impact

Assessments of the baseline hydrological and hydrogeological conditions at the site indicate that parts of the site have already experienced impacts to baseline conditions through the planting of commercial forestry (**Appendix 9.2 – Plate 12**), and peat harvesting across portions of the site (**Appendix 9.2 – Plate 9**), and the installation of drainage networks associated with commercial forestry, peat harvesting, and for agricultural purposes (**Appendix 9.2 – Plate 7, 8**).

Planting of commercial forestry, peat harvesting and agriculture / land reclamation activities (reconstitution of soils and drainage) have had a significant impact to the site relative to *absolute* baseline or (hypothetically) *perfect natural conditions* with regard to the hydrology or hydrogeology of the site in terms of drainage infrastructure in particular. Those activities are likely to apply pressure to the receiving surface water network and potentially regularly contribute nutrients and/or suspended solids to the receiving surface water systems. Release of contaminants will likely peak on occasion particularly during intrusive activities such as felling or peat cutting, or after heavy rainfall events.

Should the proposed development not proceed, the existing land-use practice of commercial afforestation, peat harvesting, and agricultural activities will continue with associated gradual alteration of the existing environment and associated pressures on surface water and groundwater quality.

9.4.3 Assessing the Potential Magnitude of Potential Effects – Surface Water

9.4.3.1 Increased Hydraulic Loading & Flood Risk

The Development has the potential to result in increased volumes of runoff during the operational phases of the Development relative to baseline conditions. This is a function of the progressive excavation and removal of vegetation cover and replacement with hardstanding surfaces (effectively or assumed impermeable) and installation of constructed drainage along the Development footprint and thus removing the hydraulic absorption / buffer control from this part of the Site.

Increased runoff, or an increased hydrological response to rainfall has the potential to exacerbate flooding events and impact on hydro morphology of waterbodies downstream of the development, and/or to exacerbate flooding and erosion within the boundary of the Site.

The installation of constructed drainage for the purposes of collecting either clean water or construction run off have the potential to also drain sensitive areas of the site, specifically areas of intact or designated peat or water dependent terrestrial ecosystems.

Considering baseline characteristics of the Site and the 'Very High' sensitivity and importance of the associated surface water bodies downstream, including areas with probable flood risk areas and respective flood management schemes, any net increase in runoff (<15%, or small scale impact) or hydrological response to rainfall is considered a potentially Moderate to Significant adverse impact.

With appropriate environmental engineering controls and mitigation measures, i.e. attenuation features, these potential impacts can be significantly reduced. Furthermore, if considered adequately mitigation measures have the potential to have a positive impact on the hydrological response to rainfall at the site, whereby, if the development can reduce discharge rates at the site below estimated *greenfield* or baseline runoff rates, the development will have a beneficial impact by reducing the site hydrological response to rainfall and mitigate against potential flood events downstream. Additionally, these measures promote the recovery and development of blanket peat habitats (e.g., Wet Heath and Blanket Bog). This is considered a beneficial impact in areas of existing cutover peat and a neutral impact in areas of intact blanket peat habitats.

Minimal land take is required for the both the Turbine Delivery Route and Grid Connect Route, considering a majority of the routes will traverse already existing roadways (i.e., existing Site Access Roads, public and local road networks and privately owned forestry access tracks. There are some areas of the delivery route that will require the widening of existing portions of roads which traverse greenfield / green verge areas, however considering the small scale of disturbance (shallow excavation, superficial paving) the impact is considered negligible to slight. Similarly, there is unlikely to be an increase in the rate of runoff from the construction of both these routes due to utilization of pre-existing road infrastructure.

In regard to the Turbine Delivery Route and the temporary bridge crossing on the Sullane River at Ballyvourney, Co. Cork, the works required here are within a probable flood risk area, meaning that any infrastructure, equipment or materials within the flood zone extents are at risk of high-water levels during flood events. In terms of hydrology, materials such as fuel or loose/exposed soils are considered sources of contamination which are readily mobile under saturated or high-water conditions.

9.4.3.2 Release of Contaminants

The Development has the potential to result in the release of contaminants, particularly suspended solids during the construction phase of the project, and to a lesser extent during the operational phase relative to baseline conditions.

Release of Suspended Solids

- Excavation and construction activities, such as stockpiling material and vehicular movements of plant machinery introduce the risk of solids being entrained in runoff. Runoff contaminated with suspended solids will add turbidity to the receiving surface water body, can block fish gills and smother spawning grounds, reduce light penetration for flora growth, and promote bacteria and algae production. Nutrients that are associated with the solids (inorganic nutrients such as phosphorus and organic such as hydrocarbons, and sewage if present) can lead to eutrophication of the water environment and eventually to fish-kills due to lowering of oxygen supply. Some ecological receptors such as Freshwater Pearl Mussels are particularly sensitive to perturbations in water quality, and in particular suspended solids.
- The degree to which inorganic solids are entrained in runoff is related to the particle sizing of the soil components. Smaller inorganic particles (e.g. clay) will be easily entrained and will remain in suspension for a longer period than larger particles (silt / sand), and will require lower flow rates and longer retention rates to settle out of the water column when given the opportunity. Peat, comprising mostly of organic matter, will behave in a similar manner to a fine grained soil whereby much of the material will remain in suspension for a relatively long period of time, but will also dissolve and degrade within the water body, dramatically impacting on water quality.
- Forestry operations will continue at the Site (**Appendix 2.2**). With reference to **Chapter 8: Soil and Geology**, forestry operations, harvesting and planting, will likely lead to a release of solids and nutrients entrained in surface water runoff.
- Release of suspended solids can be attributed to enhanced nutrient enrichment. This is highly dependent on the type of soil, for example peat released in water will disintegrate and most of the constituents of the peat material (carbon) will eventually dissolve in to the water column and / or be consumed by micro-organisms. However, peat and other soils / subsoils will contribute varying degrees of loading of various compounds and nutrients, including Nitrogen (N) and Phosphorous (P) compounds, which are attributed to Nutrient Enrichment, or excessive loading of N and P in waters leading to eutrophication and potentially profound adverse impacts on ecological attributes downstream of the site.

    - Given the historical land use of the Site, i.e., agricultural forestry, there is likely to be trace amounts of fertiliser in the vicinity of the afforested site. Teagasc (2017) has stated routine fertiliser application is undertaken following chemical analysis of foliar (tree leaf) samples. If thresholds aren't met, fertiliser is applied manually between the months of April and August, avoiding drains and a 20m buffer zones to waterlogged and aquatic areas. Ground Rock Phosphate (GRP) is used in two forms: Granulated Rock Phosphate (c. 11% P) and Ungranulated Rock Phosphate (c. 14% P), in application process, given there are no adverse environmental impacts, e.g. deterioration in water quality status.[18]
    - Peat soils behave differently to mineral soils, when it comes to some nutrients such as phosphorous. High organic matter soils (OM > 20%, i.e. peat) do not adsorb P in the same way that mineral soils do. Therefore, P does not bind to peat soil particles, however mineral soils associated with forestry do have the capacity to build up or increase the store of phosphorous they hold.[19]
- Runoff laden with sediments from HDD pose the risk of potential perturbations within surface waterbodies, which are hydrologically linked to various SAC and pNHAs.

Release of Hydrocarbons and Storage

- Plant equipment and vehicles associated with excavation, material transport, and construction activities introduce the risk of hydrocarbon (fuel and oil) spillages and leaks, particularly in relation to regular refuelling which in turn implies the requirement of a fuelling station which will likely include fuel storage on site or will be supplied by fuel tanker scheduled to refuel the plant machinery directly.
- Similar to suspended solids arising from excavation activities, hydrocarbons accidentally introduced to the environment will likely be intercepted by drainage and surface water networks associated with the Development.
- Hydrocarbons are a pollutant risk due to their toxicity to all flora and fauna organisms. Hydrocarbons chemically repel water and sparingly dissolve in water. The majority of hydrocarbons are light non-aqueous phase liquids (L-NAPL's) which means that they are less dense than water and therefore float on the water's surface (whether surface water or groundwater). Hydrocarbons adsorb ('stick') onto the majority of natural solid objects they encounter, such as vegetation, animals, and earth materials such as soil. They burn most living organic tissue, such as vegetation, due to their volatile chemistry. They are also a nutrient supply for adapted micro-organisms, which can deplete

[18] Teagasc (2017) "Forestry Fertiliser" *Agriculture and Food Development Authority.*
[19] Teagasc (2021) "Environment - Phosphorus Use on Peat Soils" *Agriculture and Food Development Authority*.

dissolved oxygen at a rapid rate and thus kill off water based vertebrate and invertebrate life.

Release of Horizonal Directional Drill Materials

In terms of the HDD process, drilling will involve plant machinery which will be powered by hydrocarbons, therefore risk during the refuelling process as stated previously remains the same. The risk of hydrocarbon spills stems primarily from broken hydraulic hoses used during the drilling/boring process. Small-scale quantities of greases known as 'drilling fluids' are also commonly used during the drilling process to keep components of the drill rig cool and lubricated. These drilling fluids are commonly composed of a mixture of bentonite clay, which can be harmful to the environment[20]. Therefore, there is a risk of a potential oil leak from horizontal directional drilling (HDD) along the grid connection route. It is unspecified at this time which drilling lubricant will be used during UGC route works. From experience in the industry the use of Clearbore is recommended when working beneath watercourses. Clearbore is a single component polymer-based product that is designed to instantly break down and become chemically destroyed in the presence of small quantities of calcium hypochlorite. The product is not toxic to aquatic organisms and is biodegradable.

An accidental contaminant spillage, would have a significant, long term to permanent, negative impact on soil quality on the Site. However, this potential impact is considered to be localised, naturally reversible (natural attenuation over a relatively medium to long term period of time), or theoretically reversible (through remediation and restoration activities over a relatively short to medium term period of time). With appropriate environmental engineering controls and measures, this potential risk can be significantly reduced.

Drill Arisings

Spoil arising from drilling activities will require temporary stockpiling and has the potential to be entrained by surface water runoff (suspended solids). Spoil arising from drilling activities could be mobilised by large volumes of water which would rapidly traverse overland if not managed appropriately and has the potential to mobilise additional solids via eroding soils, or other contaminants, and infiltrate the receiving surface water bodies, or groundwater bodies.

[20] Moore Group (2016) "Appropriate Assessment of Cork Lower Harbour Main Drainage Project Estuary Crossing by Horizontal Directional Drilling", Moore Group Environmental Services on behalf of Irish Water, Ref No. 15184.

In consultation with Drilling Supplies Europe[21], following the polymer break down, cuttings will then settle out of the drill fluid which will form approximately 20% of the volume, the liquid phase will form about 80% of the volume. It is noted that settlement can be done overnight in a pit or holding tank, to leave a fluid phase of less than 400 ppm suspended solids.[21] As has been seen in the past, the remaining water phase can be decanted and disposed of to a wastewater treatment facility or in the sewerage infrastructure, with appropriate discharging licenses from relevant authorities; and the sludge/solids can be disposed of as semi-dry waste to landfill at a reduced cost.[21]

Quantities of drillings cuttings have not been specified to date, however it is noted that in each entry and exit pit associated with HDD, a 1m x 1m x 2m steel box will be installed to contain any drilling fluid returns from the borehole. The drilled cuttings will be flushed back by drilling fluid to the steel box in the entry pit. It has been determined that drilling rig and fluid handling units will be located on one side of each bridge and will be stored on double bunded 0.5mm PVC bunds which will contain any fluid spills and storm water run-off. Upon completion of the HDD process, the steel boxes will be removed, with the drilling fluid disposed of to a licensed facility.

Breakout and Drilling Fluid Returns

It is assumed that a drilling fluid similar to Clearbore will be used and the Material Safety Datasheet (**Appendix 9.5**) for any fluid used must be followed.

Generally speaking, drilling fluids used in HDD practices are released at the beginning (launch) and termination (reception) sites of a borehole path, collected and disposed of properly. However, breakouts can in theory occur as a result of unstable conditions within the drilled bore due to low cohesion; for example, 1) the swelling and hydration of clay materials, 2) the movement and dispersion of clay minerals, 3) water blocks, and 4) low-permeability of mud cakes.[22,23] Drill fluid returns/frackouts can occur as a result of: poor drilling methods, and/or improper mud formulation used in bore drilling which can cause stability issues within the bore[24]. Given the local lithology of the site with underlying sandy, clayey gravel and tills, potentials for breakouts must be considered. Breakouts can lead to failure in returns at either end of the bore path and

[21] Drilling Supplies Europe (2022) "ClearBore" *Drilling Supplies Europe.* Available at: <https://www.drillingsupplieseurope.com/drilling-fluids/clearbore/>
[22] Willoughby, D. A. (2005) "Horizontal Direction Drilling Utility and Pipeline Applications" *McGraw-Hill Civil Engineering Series,* ISBN: 978-0-07-150213-9.
[23] Bennett, D. and Wallin, K. (2008) "Step by Step Evaluation of Hydrofracture Risks for Horizontal Directional Drilling Projects", In: International Pipelines Conference, Atlanta, GA. American Society of Civil Engineers. Available at: <https://doi.org/10.1061/40994(321)74>.
[24] Unity Water (2021) "Pr9788 – Specification for Horizontal Directional Drilling", Infrastructure Technical Standards Committee, Doc No. Pr9788; Rev No. 8.

subsequent drill mud being released outside the bore to the receiving environment (i.e., soils, subsoils, ground and/or surface waters).

In the case of a major spill, the leak should be stopped if safe to do so, contained and prevented from entering drains or water courses. Any recoverable product will be collected, similar in means of a hydrocarbon spill, and disposed of properly. If a significant quantity of material enters drains or watercourses, emergency services will be advised immediately.

Drill Fluid Disposal

It has been advised that Clearbore drilling fluid will be used in drilling operations. In consultation with Drilling Supplies Europe[25], Clearbore is an environmentally friendly, High Performance Water-Based Mud suitable for tunnelling and drilling operations and is known to have a 10-fold volume to volume rheology comparison to high-yielding bentonite[22].

Drilling mud containing spoil recovered from the bored path can be retrieved at the launch and reception sites of the bore. This bentonite contaminated spoil can be treated in one of two ways. It can either be transferred off-site to an approved and authorized EPA license facility (in accordance with the Waste Management Act 1996 as amended) to be properly disposed of; or the spoil can be pumped to a mechanical separation container. This involves drill mud being stored within a holding tank until separation of particulates can be achieve only then can the fluid be discharged to the surrounding area.

Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite at sufficient rates. To address this, it is recommended that flocculant is used to promote the settlement of finer solids prior to discharging to surface water networks. Flocculant 'gel blocks' are passive systems, self-dosing and self-limiting, however they still require management as per the manufactures instructions. Flocculants are made from ionic polymers. Cation polymers (positive charge) are effective flocculants; however, their positive charge makes them toxic to aquatic organisms. Anionic polymers (negative charge) are also effective

[25] Drilling Supplies Europe (2022) "ClearBore" Drilling Supplies Europe. Available at: <https://www.drillingsupplieseurope.com/drilling-fluids/clearbore/>

flocculants, and are not toxic i.e., environmentally friendly.[26] Therefore, if flocculants are deployed the material used must be made from anionic polymers.

Potential Effects

A worst-case scenario could possibly occur whereby the proposed works of HDD could result in a direct, negative, potentially significant, impact of the Development. This impact could result from any number of indirect anthropogenic sources, most commonly would be from: inadvertent drill returns containing bentonite clay, as mentioned above or by spillages of oil, fuel, or drilling fluid disposal. Such spillages could potentially affect either surface water or groundwater depending on the nature of the contamination issue, and to varying degrees depending on the hydrological and hydrogeological characteristics of the Site area.

Potential incidents of release contaminants at the Site will likely be short lived or temporary, however the potential impacts to downstream receptors can be long lasting, or permanent. With appropriate environmental engineering controls and mitigation measures these potential impacts can be significantly reduced.

Release of Construction or Cementitious Materials

- The Development has the potential to result in the accidental spillage or deposition of construction waste into soils and in turn impact on surface water runoff, or accidental spillages directly intercepted by drainage or surface water networks associated with the Development.
- Depending on the material in question, the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitivities such as ecology. For example, the introduction of cementitious material (concrete / cement / lean mix etc.) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete. Fresh or wet concrete is a much more significant hazard when compared to old or set concrete which is considered inert in comparison, however it should also be noted that any construction materials or non-natural materials deposited, even if inert, are considered contaminants.
- Surface water runoff coming into contact with concrete structures will be impacted to a degree, however water percolating through lean mix will be impacted significantly.

[26] USEPA (2013) "Stormwater Best Management Practice: Polymer Flocculation" *United States Environmental Protection Agency: Office of Water*, 4203M.

Release of Wastewater or Sanitation Contaminants

- The Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto soils, and into the drainage network during the construction phase of the project.
- Wastewater and waste water sanitation chemicals are pollutant risks due to their potential impact on the ecological productivity or chemical status of surface water systems, and toxicity to water-based flora and fauna.
- The level of risk posed by such facilities is dependent on the condition and upkeep of the facilities that are put in place, and the chemical agents used if applicable.
- The worst-case scenario/s associated with waste water sanitation is the potential for sanitation chemical, particularly related to porta-loos, accidentally spilling or leaking and being intercepted by surface water drainage features and in turn surface water networks associated with the proposed development.

In addition to direct adverse impacts on ecological sensitivities downgradient of the Site, runoff of suspended solids and/or other contaminants will potentially impact on the WFD status and objectives associated with the receiving surface water networks associated with the Development.

Considering the quality of the surface water draining from the site (baseline), and the 'Very High' sensitivity and importance of the associated surface water networks downstream, any introduction of contaminants is considered a potentially profound adverse impact of the Development.

Potential incidents of release contaminants at the Site will likely be short lived or temporary, however the potential impacts to downstream receptors can be long lasting, or permanent.

With appropriate environmental engineering controls and mitigation measures these potential impacts can be significantly reduced. Furthermore, if considered adequately, mitigation measures implemented to address the capacity of contaminants have the potential to have a beneficial impact on the hydrological response to rainfall at the site through attenuation.

9.4.3.3 Hydrologically Connected Sensitive Receptors

Designated Sites

Contaminants arising as a product of the Development will potentially be intercepted by the drainage and surface water network associated with the Site. The Site is situated in close proximity and upstream of designated site/s (**Figure 9.7a**) where maintaining surface water quality is a key component of environmental objectives, and therefore any contaminants arising will potentially adversely impact on downstream designated site/s. Similarly, contaminants will potentially adversely impact on surface water bodies designated for drinking water purposes.

- Works related to culverts in the northeast portion of the grid connection route near existing Ballyvouskill 220kV substation within JB-01 and JB-04 connect with the surface waterbody Garrane [Lee] (EPA Code: 19G03), which is hydrologically linked to the Mullaghanish to Musheramore Mountains SPA.
- Works along the portion of the Grid Connection Route that traverses a southwest-to northeast direction in Co. Kerry, encompassing the HDD locations for Stream 1, Stream 2, Stream 3 and the N22 HDD crossing within JB-04-JB-21, are hydrologically linked to the Killarney National Park, Macgillycuddy's Reeks And Caragh River Catchment SAC and pNHA via the Flesk [Kerry] River (EPA Code: 22F02).
- Bridge 1, Bridge 2, Bridge 3 along with Culvert-115, relate to Sullane_010 River (EPA Code:19S02) which drain the proposed works, in addition to the Turbine Delivery Route (TDR); this receptor flows through St. Gobnet's Wood SAC and pNHA, c. 100m east of the proposed temporary suspended bridge of the TDR works.

Contaminants arising as a product of the Development will likely be intercepted by the drainage and surface water network associated with the Site, and therefore any contaminants arising will likely impact on a designated site.

The potential of the Development to introduce contaminants to surface waters and in turn impact on the designated areas downstream is considered a negative, significant / profound significance, potentially temporary to long-term impact of the Development. With appropriate environmental engineering controls and measures, these potential risks can be significantly reduced and considered unlikely.

Drinking Water

The geographical scale of catchments upstream of designated areas downstream of the Site (**Figure 9.7a**) should be considered in terms of the assimilative capacity of the surface water systems which will buffer against any potential contaminants introduced at the Site, that is; contaminants will be 'diluted' in receiving waterbodies. This does not lessen potential adverse impacts in the immediate vicinity of the Site and does not reduce the need for mitigation measures to be implemented but is considered a 'last line of defence' for the protection of designated areas downstream of the Site. However, in this instance the same cannot be applied to drinking water rivers associated with the Site, whereby the headwaters of the Lee (Cork) 030 river (designated for drinking water) are within the site boundary (**Figure 9.7b**.

Surface waters, under the scope of the objectives of the WFD are considered attributes with the 'Very High' sensitivity and importance and will be protected in their own right. Although potential contamination incidents will be temporary in terms of the waters themselves, it is important to consider the potentially long lasting or potentially permanent impact/s of contaminants on the ecological attributes dependent on the surface water bodies associated with designated areas. Similarly, potential impacts on drinking waters do not override the necessity to protect the river in its own right due to the fact that any abstracted water will be treated regardless of varying low levels of contaminants, but it is important to consider the societal impact of a catastrophic environmental incident whereby waters are potentially unsuitable for abstraction for a period of time due to excessive contaminant loading.

Freshwater Pearl Mussel

The Freshwater Pearl Mussel (FPM), while considered to be one of the most endangered animals in Europe, also serves as a keystone species in Ireland. Known to have a disproportionately large effect on its natural environment relative to its abundance, FPMs are responsible for filtering the waters associated with their habitats and improving the quality of water for other species.[27] Highlighting the species fragility, FPMs are highly sensitive to direct disturbance and to flow, sediment and nutrient stresses. For these reasons, it is important to draw attention to their potential as a sensitive receptor when considering works involving within and near surface waters. Direct impacts to beds of surface waters through acute disturbance can directly influence the habitat crucial to the FPMs existence and those habitats located further downstream. The FPM is addressed in further detail in the Ecology Section of this EIAR.

9.4.4 Assessing the Potential Magnitude of Potential Effects – Groundwater

9.4.4.1 Bog Water Levels

Peatlands in Ireland, have been fragmented and drained by a long history of exploitation. Drawdowns in groundwater levels in peatbog lands areas are directly linked to peripheral drainage in peatland area. Deep-cut drainage channels have been observed intercepting regional groundwater flows and identified as a zone for continuous groundwater discharge[28]. As was noted over a 28-year record, Clara Bog demonstrated the impact of

[27] Paine, R. T. (1995) "A Conversation on Refining the Concept of Keystone Species." *Conservation Biology* 9 (4) pp.962–64.
[28] Regan, S., Flynn, R., Gill, L., Naughton, O. and Johnston, P. (2019). "Impacts of groundwater drainage on peatland subsidence and its ecological implications on an Atlantic raised bog", *Water Resources Research.* Vol 55(7) pp. 6153-6168.

peripheral groundwater drainage (caused by marginal peat cutting) on uncut raised bog hydrology which revealed an elongated groundwater catchment area with a lateral hydraulic gradient underlying the bog[25]. The actual scale of impact of cut drains on groundwater levels can be highly variable at any particular location, ranging from <5m to >100m, as was seen at Clara Bog; despite the bog having little in the way of surface drainage, groundwater subsidence levels of >1m were measured up to 170m from the bog margin and decrease to >0.1 up to 900m at varying locations. The development has the potential to impact on bog water levels proximal to excavations and/or drainage channels. Existing drainage at the site, particularly in cutover peat, forestry and agricultural areas, are intended to drain the respective area, however existing tracks and adjacent drains can also impact on bog water levels. Lowering of the water table in peat lowers the potential for peat growth i.e., sub-optimal conditions. This will lead to the gradual decline in productivity in the acrotelm (living layer of peat), and in time the degradation of the drained peat area, potentially leading to erosion.

The scale of the impact is dependent on the depth of the excavation in question and subsequent lowering of the water table at the location. This can vary depending on the underlying characteristics of the development. In peat the impact can be minimal in scale initially but over time and as the acrotelm layer degrades and recedes the impact can continue to progress slowly/chronically, potentially leading to profound impacts in worst case scenarios. However, it is noted that the site is characterised by shallow peat or peaty soil generally with isolated pockets of deeper saturated peat (**Chapter 8: Soils and Geology**). Therefore, the scale of such impact is likely limited to the extent of those isolated pockets if impacted. Furthermore, the site is generally characterised as having extensive existing drainage features, and therefore impacts arising from drainage can be in line with baseline conditions.

With appropriate environmental engineering controls and measures (i.e., Mitigation measures), these potential risks can be significantly reduced. Furthermore, in areas impacted by draining activities, if considered adequately, mitigation measures have the potential to have a positive impact on bog water levels, particularly in places already impacted by drainage.

9.4.4.2 Groundwater Levels

Groundwater levels are unlikely to be impacted to a significant extent due to:

- Baseline conditions (**Section 9.3**) i.e., upland area, poor aquifer with low productivity and low groundwater recharge (indicative of low groundwater levels). Site investigation data indicates (**Appendix D of Appendix 8.1**), that in most instances trial pits (in line with construction depths) were dry. Shallow groundwater encountered (**Appendix F of Appendix 8.1**) is associated with areas of deeper peat (bog water) and perched groundwater (perched on bedrock or bedrock troughs).

- Characteristics of the development i.e., excavations will generally be shallow and any potential dewatering will likely be for short duration. Deeper excavations will potentially encounter groundwater. However due to the Baseline character, volumes will likely be low and dewatering of such locations will not impact groundwater levels to a significant extent.

9.4.4.3 Local Groundwater Levels and Supplies (Wells)

The development has the potential to impact on ground water levels proximal to excavation and dewatering activities. Dewatering of excavations in particular can create a relatively significant cone of depression or lowering of the water table in the surrounding area. The degree to which the water table is lowered is dependent on the baseline static water level, is proportional to the depth of the particular excavations and/or depth at which the pump is placed, and the hydrogeological characteristics of the surrounding geology / aquifer.

The potential productivity and connectivity of groundwater in the underlying bedrock aquifer/s is considered low (Baseline, **Section 9.3**) however the availability of groundwater in a social or agricultural sense is considered important, therefore the importance of groundwater quantities underlying the Site is considered 'Medium to High' sensitivity and importance. Any impact to the availability of groundwater for use (lowering of water level in wells) is considered a potentially significant adverse impact of the Development.

Contaminants released due to an environmental incident have the potential to infiltrate soils/subsoils potentially reaching the water table and in turn adversely impacting on groundwater quality. However, it is noted that proposed developments (UGC and TDR) do not interfere with any Public Source Protection Areas as mapped by GSI (2022) or Zones of Contribution under the National Federation of Group Water Schemes as outlined and mapped by the EPA and GSI (2022).

Considering the quality of the groundwater underlying the Site (Baseline, **Section 9.3**), and the 'Very High' sensitivity and importance associated with groundwaters nationally, any introduction of contaminants is considered a potentially profound adverse impact of the Development.

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 and bedrock (Potential exception: Karst geology. There is no indication of karst geology underlying the site (Baseline, **Section 9.3**). Hydrocarbons (e.g., diesel) pose the most significant risk to groundwater quality and can persist for many years.

It is noted:

- Excavations will generally be c. 2.85m depth for Turbine Foundations (refer to **Management Plan 4, Appendix 2.1)**. Some deeper excavations will occur, for example proposed borrow pits. (See Drawing No. **6225-PL-804**).
- The recommended buffer distance determined by relevant Industry Guidance (**Section 9.2.2)**, for existing wells in relation to Turbine Foundations (2.85m) is 250m. There are no mapped wells within the Site, or with 400m of the Site.
- Governing Industry Guidelines (**Section 9.2.2)** stipulate a groundwater buffer zone of 100m is required of from wells used for drinking water abstraction in relation to the proposed Site Access Roads and cable trenches i.e., shallow excavations.
- The underlying bedrock aquifer is classified as Poor with low productivity except for local zones.

Considering the baseline data and Development characteristics, the risk of lowering groundwater levels to a significant extent is not considered likely. Furthermore, there are no mapped wells (see **Figure 9.7b**) within the site boundary, and only 2 no. mapped wells were identified within a 100m buffer along the proposed UGC and Turbine Delivery Routes;

- The Turbine Delivery Route: E'117330, N'74780 (ITM), sourced for domestic use only.
- Along the UGC, a borehole: E' 115180, N'74010 (ITM), sourced for agriculture and domestic use.

There are no ground water source protection areas within the hydrogeological catchment of the UGC or TDR Development. However, the south-west portion of the Wind Farm Development (refer to the Surface Water Flow Chart in **Figure 9.4),** T1, T2, Borrow Pit A and T3 are encompassed in the Lee [Cork]_SC_010 which also encompasses the Carraignadoura GWS (DW Code: 0500PUB2311).

9.4.5 Construction Phase Potential Effects

9.4.5.1 Release of Suspended Solids

The construction phase of the Development will invariably involve earthworks including; removal of vegetation cover, excavation of borrow pits, roads, etc. to facilitate the installation of turbine foundations etc., and temporary stockpiling of subsoils and bedrock.

During excavation, storage and reuse of materials, it is likely that a high volume of suspended solids will be entrained by surface water runoff and intercepted by surface water networks associated with the proposed development, particularly during sustained rainfall events.

The most vulnerable aspects to surface water quality deterioration are:

- Exposed soils / peat generally, including new drainage channels, temporary stockpiles.
- Turbine hardstand and infrastructure development, particularly in relatively close proximity to surface water receptors, and in areas characterised by extensive existing drainage networks which present a direct connection to mapped surface water features.
- Construction of infrastructure within surface water buffer zones (site tracks and internal cabling will cross buffers in a perpendicular direction i.e., to minimise any potential effects), and/or instream works associated with proposed watercourse crossing locations.

Vehicular movements and excavation works associated with the construction phase (earthworks) of the Development have the potential to impact on soil stability particularly at a localised scale. The risk associated with stability issues varies depending on the degree of the issue at hand e.g., peat depth at a particular location. Earthworks in relation to reinstatement must also be considered.

Localised stability issues, and erosion or degradation of soil by e.g., 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.

The worst-case scenario associated with earthworks activities is the potential for significant stability issues leading to mass movement or landslides in close proximity to and intercepted by the surface water network associated with the Site.

Chapter 8: Soils and Geology indicates that peat depths are generally low and the risk of significant stability issues leading to mass movement or landslides is low.

The Development will invariably alter drainage at the Site which if unmanaged has the potential to create new preferential pathways for runoff potentially leading to erosion of soils / construction materials and entrainment of solids in runoff in the process.

Mechanism/s:	• Construction activities; Excavation, handling/transport, temporary storage of soils / subsoils / bedrock, vehicle tracking. • Erosion in areas impacted by construction activities. • Erosion in areas with newly formed preferential pathways for water runoff. • Peat / slope stability, significant or localised. • Reinstatement activities; similar to construction.
Impact	• Release of suspended solids entrained in runoff, intercepted by surface water network.
Receptor/s:	• Surface Water. Surface water quality, ecological sensitivities and WFD status.
Pre-Mitigation Potential Effect:	• Negative, direct, profound, likely, long-term to permanent.

9.4.5.2 Release of Hydrocarbons and Storage

During the construction phase of the Development, plant equipment and vehicles associated with excavation, material transport, and construction activities introduce the risk of hydrocarbon (fuel and oil) spillages and leaks, particularly in relation to regular refuelling which in turn implies the requirement of a fuelling station which will likely include fuel storage on site OR will be supplied by fuel tanker scheduled to refuel the plant machinery directly.

Similar to suspended solids arising from excavation activities, hydrocarbons accidentally introduced to the environment will likely be intercepted by drainage and surface water networks associated with the Development Site.

Mechanism/s:	• Lubricants and other construction consumables – minor in scale. • Fuel leak from personnel vehicle – minor in scale.

- Fuel leak from plant machinery – minor in scale.
- Fuel spill during refuelling – significant in scale.
- Fuel leak from storage - significant in scale.

Impact

- Release of hydrocarbons in runoff, intercepted by surface water network.
- Release of hydrocarbons to ground, intercepted by groundwater.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater quality for the purposes of extraction.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.
- Groundwater - Negative, direct but limited, significant, likely, long-term to permanent.

9.4.5.3 Release of Waste Water Sanitation Contaminants

Welfare facilities will be required at the Site during the Construction phase. The level of risk posed by such facilities is dependent on the condition and upkeep of facilities that are put in place, and the chemical agents used if applicable, and therefore can range from a potentially significant to insignificant impact in direct correlation to the type of sanitation used (e.g. septic tank versus port-a-loo). It is proposed that porta-loos will be used for this Development.

Mechanism/s:

- Waste water leak – minor in scale.
- Chemical leak – minor in scale

Impact

- Release of waste water / chemicals in runoff, intercepted by surface water network.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater quality for the purposes of extraction.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, moderate to significant, likely, short to medium term.
- Groundwater - Negative, direct but limited, imperceptible, likely, short to medium term.

9.4.5.4 Release of Construction or Cementitious Materials

The Development will require concrete structures, including in relation to portions of the development which are in close proximity receptors e.g., surface water crossings.

Depending on the material in question, the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g., ecology. For example, the introduction of cementitious material (concrete / cement / lean mix etc.) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete can further impact water quality. Fresh or wet concrete is a much more significant hazard when compared to set or precast concrete which is considered inert in comparison, however it should also be noted that any construction materials or waste deposited, even if inert, is considered contamination. Surface water runoff, or groundwater coming into contact with concrete will be impacted to a degree, however water percolating through lean mix concrete will be impacted significantly.

The production / acquisition, transport of material and management of plant machinery must also be considered.

Mechanism/s:

- Accidental spillage or unmanaged deposition of construction materials such as wet concrete which is intercepted by drainage or surface water networks associated with the Development.
- Dust generation in relation to the production of concrete and management of raw materials.
- Transport of material on Site and washout of plant machinery.
- Pouring, forming, deposition of concrete during construction.
- Generation of waste.

Impact

- Release of cementitious material in runoff, intercepted by surface water network.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.

- Groundwater. Groundwater quality for the purposes of extraction.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.
- Groundwater - Negative, direct but limited, imperceptible, likely, short to medium term.

9.4.5.5 Excavation Dewatering & Construction Water

Dewatering of excavations during the construction phase of the Development is likely to have significant adverse effects on surface water runoff quality, that is; if dewatering of an open excavation is necessary, the receiving engineered drainage and attenuation features will likely be loaded with a surge of water elevated in suspended solids.

Unmitigated, overflow of such water into the receiving surface water systems is considered a profound adverse temporary impact on the quality of the receiving surface water.

Direct discharge of such water directly into the receiving surface water network is an EPA licenced activity.

Dewatering by means of drainage concurrent with excavation activities or dewatering by pumping during excavation activities will likely temporarily impact on groundwater and hydrogeological flow regimes at a localised scale. With reference to previous sections, the scale of impact in peat is likely to be insignificant.

Mechanism/s:

- Dewatering of open excavations.

Impact

- Release of suspended solids, intercepted by surface water network
- Significant surge release of suspended solids, intercepted by surface water network.
- Lowering of bog / groundwater table.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater quantity for the purposes of extraction. Groundwater / bog water quantity for water dependent terrestrial habitats.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.
- Groundwater - Negative, direct but limited, imperceptible, likely but temporary, short to medium term.

9.4.5.6 Diversion and Enhancement of Drainage

The Development will result in diversion and enhancement of existing drainage networks during the construction of the proposed project relative to baseline conditions, particularly in areas of cutover peat, commercial forestry and agriculture. Significant features associated with the drainage network at and around the Site are mapped and presented in **Appendix 9.5a**. These include watercourses, watercourse crossings, drains, contours, deep eroded channels and natural stilling ponds.

The diversion and enhancement of existing drainage has the potential to impact on the hydrological regime at the site. Potential impacts include the restricting or enhancing of runoff volumes from the site relative to baseline conditions, draining of saturated peat areas relative to baseline conditions, or vice versa.

Construction of drainage channels poses similar implications, including impacts associated with earthworks and the mobilisation of sediments in runoff intercepted by the associated surface water network.

Poor design or if unmanaged during construction the installation of drainage channels and associated infrastructure such as culverts or attenuation features can potentially cause erosion leading to entrainment of solids in runoff and potentially to localised or significant soil / slope stability issues at the site (**EIAR Chapter 8: Soils and Geology**).

Mechanism/s:

- Significant changes to the hydrological regime at the Site.
- Construction activities (Earthworks, addressed under Release of Suspended Solids)
- Construction activities (Earthworks) within existing drainage channels.
- Connecting new and existing drainage channels.
- Poor design and/or installation of drainage network
- Poor design and/or installation of drainage infrastructure including culverts.

- Upgrading of existing culverts where necessary.
- Poor design and/or installation of drainage infrastructure including culverts attenuation features.

Impact

- Drying - Lowering of bog / groundwater table proximal to respective drainage features.
- Wetting – Excess discharge in a particular area (local flooding)
- Increasing hydrological response to rainfall.
- Release of suspended solids, intercepted by surface water network.
- Significant surge release of suspended solids, intercepted by surface water network.

Receptor/s:

- Surface Water. Surface water quantity and flood risk. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater / bog water quantity for water dependent terrestrial habitats.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.
- Groundwater - Negative, direct but limited, ranging from imperceptible to significant, likely but ranging from temporary to medium to long term.

9.4.5.7 Watercourse Crossings

Surface Water Crossings - Bridges & Culverts over Mapped Rivers and Non-Mapped Drains

In terms of mapped streams and rivers there are a number of existing bridges at the site are associated with the development footprint. The development will also require a number of new bridges.

In terms of non-mapped surface water features and drains there are a number of existing culverts at the site are associated with the development footprint. The development will also require a number of new drainage culverts under the proposed access track, particularly in areas of extensive existing drainage (**Figure 9.5a**). Although more minor in scale, and less significant in terms of ecological importance and sensitivity, such culverts must be considered similarly to watercourse crossings in terms of potential impacts associated with poor design and construction. Note; existing culverts presented in **Figure 9.5a** were observed during site surveys and/or from desk top assessment of aerial imagery and site drainage mapping, including recent Lidar and Aerial Survey data (BlueSky) available for the site. There is potential for buried stone culverts/ land drains to be present on Site which are not mapped here and which could be discovered during excavations.

Mechanism/s:

- Significant changes to the hydrological regime at the Site.
- Construction activities (Earthworks, addressed under Release of Suspended Solids)
- Construction activities (Earthworks) within existing drainage channels and/or streams and rivers.
- Connecting new and existing drainage channels.
- Poor design and/or installation of watercourse crossings.
- Poor design and/or installation of culverts.
- Upgrading of existing bridges where necessary.
- Upgrading of existing culverts where necessary.
- Poor design and/or installation of drainage infrastructure including culverts attenuation features.

Impact

- Release of suspended solids or other contaminants, intercepted by surface water network.
- Significant surge release of suspended solids, intercepted by surface water network.
- Altering hydrological regime at a particular location. Potentially leading to erosion / deposition not in line with baseline conditions.
- Restricting water flow.

Receptor/s:

- Surface Water. Surface water quantity and flood risk. Surface water quality, ecological sensitivities and WFD status.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.

Wind Farm

The Development has been assessed at EIA stage in terms of the intersection of the Development footprint and existing surface water and drainage features at the Site. With particular reference to culvert locations identified **(**Error! Reference source not found., these locations relate to where the Development footprint intersects existing drainage, and it must be noted that the actual drainage design will include some degree of drainage diversion and relocation and / or removal of some the listed *culvert* locations, however all must be considered in terms of maintaining the hydrological regime at the site. Similarly, each existing watercourse crossing will be further assessed by a competent engineer in terms of structural integrity and suitability for the development, for example; existing culverts will require upgrading to clear span bridges.

Regarding WFD or EPA mapped rivers, watercourse crossing locations identified are listed here:

There are seven <u>new</u> watercourse crossing locations included as part of the proposed Development (**Figure 9.5a**).

- WC1 is situated on the Douglas (Sullane) 010 river southeast of the proposed location of T13 and west of the proposed location of T14 (refer to **Appendix 9.2 – Photographs – Plates 13** and **Section 4** of **Management Plan 2: Water Quality Management Plan of the CEMP Appendix 2.1).** At the crossing point the river is characterised as an upland river segment with little existing modification. The river at this location spans approximately 1.0 to 1.5m in width and is observed to discharge water throughout the year, potentially with the exception of prolonged dry periods during summer months where there is the potential for the river to be at very low levels or dry. The banks of the river are low and the adjacent lands are characterised as agricultural (pasture) on the southern side and mountain heath / blanket bog to the north. A Clear Span Bridge is proposed at this location with the following design plan: 10m width, 3.5m water depth (flood level), 0.3m freeboard, and standard length, that is; in line with width of Site Access Road.
- WC2 is situated on the Douglas (Sullane) 010 river east of the proposed location of T11 and west of the proposed location of T14 (refer to **Section 4** of **Management Plan 2: Water Quality Management Plan of the CEMP Appendix 2.1)**. At the crossing point it is characterised similarly to WC1 which is situated approximately 400m downstream. A Clear Span Bridge is proposed at this location with the following design detail: 9m width, 2.7m water depth (flood level), 0.3m freeboard and standard length, that is; in line with width of Site Access Road.
- WC3 is located south of the proposed location of T14 towards the southeast boundary of the Site and along (refer to **Section 4** of **Management Plan 2: Water Quality Management Plan of the CEMP Appendix 2.1)**. Upon close inspection of a historic *6 Inch Cassini* map, the surface water feature is a culverted located at the headwater of the Toon River (EPA). A Clear Span Bridge is proposed at this location.
- WC4 is north of the proposed locations of T4 and T5 and upstream from WC1 on the Douglas (Sullane) River (refer to **Appendix 9.2 – Photographs – Plates 13** and

Section 4 of **Management Plan 2: Water Quality Management Plan of the CEMP Appendix 2.1)**. This existing crossing is a closed culvert design. Proposed design details are to upgrade the structure to a Clear Span Bridge with the following specs: 8m width, 2.4m water depth (flood level), and 0.3m freeboard.

- WC5 is at the entrance to the proposed location of T14 Turbine Hardstand (refer to **Section 4** of **Management Plan 2: Water Quality Management Plan of the CEMP Appendix 2.1)**. A Clear Span Bridge is proposed for this location with the following design details: 4m width, 3.35m water depth (flood level), and 0.3m freeboard, and length is approximately 70m. This feature is significant due to the length. The length is as a result of fill required with T14 hardstand.

Two additional watercourse crossings have been identified as part of the development design, WC6 and WC7 which are both situated along the Turbine Delivery Route. WC7 is located on the Douglas (Sullane) 010 River while WC6 is located on a drainage tributary that flows directly into the Douglas (Sullane) 010 (refer to **Section 4 of Management Plan 2: Water Quality Management Plan** of the CEMP **(Appendix 2.1**)). Both these structures will be clear spanned bridges.

Identified surface water crossings, whether existing or new, are listed in Error! Reference source not found.. **Table 9.16** lists new and existing culvert locations of crossings over non-mapped drains. Surface water crossings are detailed in **Figure 9.5a.**

Table 9.15: Surface Water Crossings – Mapped Rivers (WFD / EPA)

Surface Water Crossings - Mapped Rivers (WFD/EPA)					Comment
Category	JOD ID	Description	Easting ITM	Northing ITM	
Bridge	WC1	New	517402.1	572884.6	Situated on the Douglas (Sullane) 010 river between proposed turbines T13 and T14. At the crossing point the river is characterised as an upland river segment with little existing modification. The river at this location spans approximately 1.0 to 1.5m in width and is observed to discharge water throughout the year, potentially with the exception of prolonged dry periods during summer months where there is the potential for the river to be at very low levels or dry. The banks of the river are low and the adjacent lands are characterised as agricultural (pasture) on the southern side and mountain heath / blanket bog to the north **Clear Span Bridge: 10m Wide,**

Surface Water Crossings - Mapped Rivers (WFD/EPA)					Comment
Category	JOD ID	Description	Easting ITM	Northing ITM	
					3.5m Water Depth (Flood Level), 0.3m Freeboard
Bridge	WC2	New	517129.5	572612.1	Situated on the Douglas (Sullane) 010 river between proposed turbines T11 and T14. At the crossing point it is characterised similarly to SWC-01 which is situated approximately 400m downstream **Clear Span Bridge: 9m Wide, 2.7m Water Depth (Flood Level), 0.3m Freeboard**
Bridge	WC3	Existing	517686.0	572430.5	Existing Culvert on the headwaters of the Toon River; **Clear Span Bridge: 3m Wide, 1.3m Water Depth (Flood Level), 0.3m Freeboard**
Bridge	WC4	Existing	516525.4	572206.6	Existing Closed Culvert **Clear Span Bridge: 8m Wide, 2.4m Water Depth (Flood Level), 0.3m Freeboard**
Bridge	WC5	New	517416.4	573027.5	Watercourse Crossing over the Douglas (Sullane) 010 River at the entrance to T14 hardstand area; **Clear Span Bridge: 4m Wide, 3.35m Water Depth (Flood Level), 0.3m Freeboard**
Bridge	WC6	Existing	516618.5	574259.1	Located along Turbine Delivery Route and situated on a drainage ditch / tributary to the Douglas (Sullane) 010 River; **Clear Span Bridge: 4m Wide x 2m Deep (internal), 1.3m Water Depth (Flood Level), 0.35m Freeboard, 0.5m Embedment Depth**
Bridge	WC7	Existing	516954.4	574528.2	Located along Turbine Delivery Route and situated on the Douglas (Sullane) 010 river; **Clear Span Bridge: 8m Wide, 2.35m Water Depth (Flood Level), 0.3m Freeboard**

Table 9.16: Surface Water Crossings – Non-Mapped Drains

Surface Water Crossings – Non-Mapped Drains				
Category	**EIA ID**	**Description**	**Easting ITM**	**Northing ITM**
Culvert	CULV-01	New	516616.0	572470.2
Culvert	CULV-02	New	516686.2	573191.4
Culvert	CULV-03	New	515035.4	572078.0
Culvert	CULV-04	New	514857.5	571954.2
Culvert	CULV-05	New	515577.7	572622.7
Culvert	CULV-06	New	515805.2	572786.5
Culvert	CULV-07	New	515544.0	572622.3
Culvert	CULV-08	New	515473.9	572620.3
Culvert	CULV-10	New	517473.6	572796.3
Culvert	CULV-11	New	517295.6	573114.6
Culvert	CULV-12	New	516388.6	571730.8
Culvert	CULV-13	New	516285.6	572532.4
Culvert	CULV-14	New	516248.6	571816.1
Culvert	CULV-15	New	517451.3	573120.6
Culvert	CULV-16	New	516575.1	572420.1
Culvert	CULV-17	New	517152.6	573363.8
Culvert	Ex.Culv-01	Existing	515679.8	572724.0
Culvert	Ex.Culv-02	Existing	515640.5	571733.5
Culvert	Ex.Culv-03	Existing	515889.0	572908.8
Culvert	Ex.Culv-04	Existing	515764.9	572800.6
Culvert	Ex.Culv-05	Existing	515923.5	573073.2
Culvert	Ex.Culv-06	Existing	515837.4	573059.2
Culvert	Ex.Culv-07	Existing	516253.8	573167.4
Culvert	Ex.Culv-08	Existing	516025.8	573082.9
Culvert	Ex.Culv-10	Existing	516388.6	573255.1
Culvert	Ex.Culv-11	Existing	515891.1	573654.5
Culvert	Ex.Culv-12	Existing	516899.5	573533.6

Underground Cabling Route

The Development of the Grid Connection Route (GCR) will include up to 144 No. identified watercourse crossings (**Appendix 2.4**). This includes 7 No. service crossings, 130 No. culvert crossings and 7 No. watercourse/bridge crossings. The approach taken at each of these locations requires detailed planning and consideration to ensure potential impacts are assessed adequately and in turn mitigated against. An additional HDD location is required for the crossing of the N22, however it does not interfere with a surface waterbody.

With reference to **Figure 9.2b** and **Section 9.4.3.3**, works along the GCR related to culverts in the northeast portion of the route (JB-01 and JB-04) are hydrologically linked to the surface waterbody Garrane [Lee] (EPA Code: 19G03). UGC works within JB-05 and JB-21 encompassing the HDD locations for Stream 1, Stream 2, Stream 3 and the N22 HDD are hydrologically linked to the Flesk [Kerry] River (EPA Code: 22F02). The final portion of the UGC involving the works of Bridge 1, Bridge 2, Bridge 3 along with Culvert-115, relate to Sullane_010 River (EPA Code:19S02).

Turbine Delivery Route

The Turbine Delivery Route will require road widening and one temporary bridge (ITM: E519298, N577600) (**Appendix 2.6**). The temporary bridge will have a clear span of 32.0m and entails no instream works (see Drawing No.'s 6225-PL-810 and 6225-PL-811). Concrete abutments will be provided to support the deck and will be set back 5m from the river edge (top of bank), this allows for the avoidance of instream works. The estimated excavation amounts for the Turbine Delivery Route equates to approximately 15, 306m^2 (refer to **Table 2.1, Management Plan 4 (Appendix 2.1**)). Works relating to the TDR will be hydrologically linked to the Sullane_010 River (EPA Code:19S02).

This portion of the Development and associated construction impacts are similar to those described for the construction of the wind farm infrastructure. Construction of any new watercourse crossing or modification of any existing watercourse crossing will have inherent risk given the level of disruption (e.g. excavations, heavy plant machinery) involved with construction activities, and the proximity to the primary sensitive receptor, that is; the watercourse itself.

Potential impacts on hydrology and water quality associated with the construction or upgrading of water course crossings include;

- Alteration of flow regime potentially leading to erosion and/or flooding.
- Potential loss of natural feature e.g., closed culverts implies the replacement of river/stream bed with the invert of the culvert structure, and the loss of riparian / vegetated banks.
- Potential loss of ecological function or service e.g., relatively long span structures have the potential to block light and lower soil moisture, in turn leading to loss in vegetation and bank stability through erosion.
- Harmful discharges during construction and operation, in particular the release of suspended solids.
- Other impacts associated with ecological sensitivities.

Unmitigated, the alteration of watercourse crossings poses a high level of risk and adverse but imperceptible to slight impact adverse, potentially permanent impacts on the quality and flow characteristics of the receiving surface water feature.

The main contributing factors for achieving worst-case scenario/s associated with installation of new watercourse crossings include:

- The potential for poor planning and construction methodology,
- Potential for poor design of new watercourse crossings,

Poor design and construction can potentially result in significant changes in flow, erosion and deposition patterns and rates associated with the surface water feature, which can potentially lead to flow being restricted leading to increased risk of flooding locally.

Horizontal Directional Drilling

With reference to **Section 9.1.1.2**, there are 8 No. locations along the Grid Connection Route which will require HDD due to there being insufficient cover and depth in the bridge to cross within the bridge deck, unnamed watercourses and the N22;

- **Stream 1 (ITM: 521700.29, 582994.75)**; JB-07
- **Stream 2 (ITM: 518274.58, 583447.85)**; JB-12
- **Stream 3 (ITM: 517786.76, 583242.64)**; JB-12
- **N22 Crossing (ITM: 513895.4, 580877.4)**; JB-21; **Note, not a watercourse crossing*
- **Bridge 1 (ITM: 513619.0, 577823.5)** Na Doirí Watercourse (W1) JB-28
- **Culvert 115 (ITM: 513833.97, 576685.27)**; JB-29
- **Bridge 2 (ITM: 513977.2, 576135.1)** Barr Duínse Watercourse (W3) JB-30
- **Bridge 3 (ITM: 514221.2, 575350.5)** Droichead Uí Mhathúna Sullane Watercourse (W2) JB-31

Depending on the drill material in question, etc. the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g., ecology. For example, the introduction of bentonite-based clay material can lead to changes water quality as opposed to a non-toxic single component polymer-based product.

Drilling Fluid

Horizontal Directional Drilling (HDD) requires the use of a drilling fluid to assist with lubricating and mobilising drill arisings during the drilling process and is also used to promote sealing and stabilising the borehole.

There are a number of types of HDD fluid for example, polymers and bentonite. Differing fluids or fluid additives provide different functions; including:

- Lost Circulation Materials e.g., Calcium Carbonate, Mica, Nutshells, SuperSealer
- Viscosifiers / Fluid loss additives e.g., Bentonite, Guar Gum

- Weighting Agents e.g. Dolomite
- Miscellaneous e.g., Biocide, Gypsum, Lime.

For this Development it is envisaged that Clearbore is the most likely drilling fluid to be used, only in small concentration during the HDD process. In consultation with Drilling Supplies Europe.[29] Clearbore is a high-performance water-based mud with a high carrying capacity, this makes it appropriate for tunnelling and drilling operations. Borehole stability and cuttings removal are exceptional in various ground conditions when Clearbore is used. It has been field tested in the UK, Ireland and the Middle East and has been to the satisfaction of drilling operations and managers.

Clearbore is environmentally friendly. It is produced using free flowing polymers. The fluid is composed of a blend of natural and synthetic biopolymers which will biodegrade between 4 to 52 weeks into oxides of nitrogen and carbon. Approval by the EPA required the product to be subjected to a 5-day technical scoping study to investigate the potential toxicity and environmental impact. The tests were carried out on juvenile daphnids in a Clearbore solution in laboratory conditions. The results for toxicity tests at a concentration of 1:10,000 showed a mortality rate in juvenile daphnids of 10% mortality. At this concentration (1:10,000), toxicity is stated to be "negligible". These results were below a level that would be considered an environmental threat i.e., normal use of the product, and does not include significant accidental release.[18]

Clearbore (or similar) products are characterised by a number of health and safety hazards, including low pH, which renders the material as irritant and harmful if ingested.

Fuel and Oil Spillages

Drilling will involve plant machinery which will be powered by hydrocarbons, therefore risk during the refuelling process as stated previously remains the same. The risk of hydrocarbon spills stems primarily from broken hydraulic hoses used during the drilling/boring process. Small-scale quantities of greases known as 'drilling fluids' are also commonly used during the drilling process to keep components of the drill rig cool and lubricated. These drilling fluids are commonly composed of a mixture of bentonite clay, which can be harmful to the environment. Therefore, there is a risk of a potential oil leak from horizontal directional drilling (HDD) along the grid connection route. The drilling lubricant used during GCR works will be Clearbore.

[29] Drillingsupplieseurope.com. 2022. ClearBore | Drilling Supplies Europe. [online] Available at: <https://www.drillingsupplieseurope.com/drilling-fluids/clearbore/>

Drilling Fluid Spillages

With reference to the appended (**Appendix 9.5**) Materials Safety Data Sheet for the drilling fluid to be used (or similar), in the case of a major spill, the leak should be stopped if safe to do so, contained and prevented from entering drains or water courses. Any recoverable product should be collected, similar in means of a hydrocarbon spill, and disposed of properly. If a significant quantity of material enters drains or watercourses, emergency services will be advised immediately

In consolation with the example Safety Material Data Sheet (SMDS) for Clearbore, while it is noted Clearbore is biodegradable. It is an organic acid which is harmful if swallowed, comes in direct contact with skin or eyes and if it is inhaled. This product is recyclable if unused or has not been contaminated. It may be possible to reclaim the product by filtration or distillation. If these options are unavailable this product should be incinerated or sent to landfill.

Drill Arisings

Spoil arising from drilling activities will require temporary stockpiling and has the potential to be entrained by surface water runoff (suspended solids). Spoil arising from drilling activities could be mobilised by large volumes of water which would rapidly traverse overland if not managed appropriately and has the potential to mobilise additional solids via eroding soils, or other contaminants, and infiltrate the receiving surface water bodies, or groundwater bodies in areas possessing karst geology and features such as swallow holes. With reference to the baseline section of this Chapter (**Sections 9.3.10 and 9.3.11**) the risk to groundwater bodies in areas underlain by poor aquifers is considered low, however drilling poses a significant risk to groundwater in areas underlain by regionally important aquifers, and within water source protection zones.

In consultation with Drilling Supplies Europe[30], ClearBores polymeric chains are designed to instantly break down and become chemically destroyed in the presence of small quantities of calcium hypochlorite. Following the polymer break down, cuttings will then settle out of the drill fluid which will form approximately 20% of the volume, the liquid phase will form about 80% of the volume. It is noted that settlement can be done overnight in a pit or holding tank, to leave a fluid phase of less than 400 ppm suspended solids[27]. As has been seen in the past, the remaining water phase can be decanted and disposed of to a wastewater treatment facility or in the sewerage infrastructure, with appropriate discharging

[30] Drillingsupplieseurope.com. 2022. ClearBore | Drilling Supplies Europe. [online] Available at: https://www.drillingsupplieseurope.com/drilling-fluids/clearbore/.

licenses from relevant authorities; and the sludge/solids can be disposed of as semi-dry waste to landfill at a reduced cost.[27]

According to the Original Construction Environmental Management Plan (2021), it is anticipated that 4m³ of spoil will be excavated for each 100-metre run of 4 pipes. This spoil will be largely subsoil material. The majority of the arisings will exit the launch pit within the bentonite slurry mixture. Therefore, for each 100-metre length of crossing approximately 4m³ of arising will need to be catered for. A mobile bunded tank will be located next to the launch pit into which the arisings will be pumped. This will be stored outside of the 25 metre watercourse buffer zone.

Breakouts and Drilling Returns

Generally speaking, drilling fluids used in HDD practices are released at the beginning (launch) and termination (reception) sites of a borehole path, collected and disposed of properly. However, breakouts can in theory occur as a result of unstable conditions within the drilled bore due to low cohesion; for example, 1) the swelling and hydration of clay materials, 2) the movement and dispersion of clay minerals, 3) water blocks, and 4) low-permeability of mud cakes.[31] Drill fluid returns/frackouts can occur as a result of: poor drilling methods, and/or improper mud formulation used in bore drilling which can cause stability issues within the bore. Given the local lithology of the site with underlying sandy, clayey gravel and tills, potentials for breakouts must be considered. Breakouts can lead to failure in returns at either end of the bore path and subsequent drill mud being released outside the bore to the receiving environment (i.e., soils, subsoils, ground and/or surface waters).

Drilling Fluid Disposal

It has been advised that Clearbore drilling fluid will be used in drilling operations. In consultation with Drilling Supplies Europe, Clearbore is an environmentally friendly, High Performance Water-Based Mud suitable for tunnelling and drilling operations and is known to have a 10-fold volume to volume rheology comparison to high-yielding bentonite.

Drilling mud containing spoil recovered from the bored path can be retrieved at the launch and reception sites of the bore. This bentonite contaminated spoil can be treated in one of two ways. It can either be transferred off-site to an approved and authorized EPA license facility (in accordance with the Waste Management Act 1996 as amended) to be properly disposed of; or, the spoil can be pumped to a mechanical separation container. This

[31] Willoughby, D. A. (2005) "Horizontal Direction Drilling Utility and Pipeline Applications" *McGraw-Hill Civil Engineering Series,* ISBN: 978-0-07-150213-9.

involves drill mud being stored within a holding tank until separation of particulates can be achieve only then can the fluid be discharged to the surrounding area.

Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite at sufficient rates. To address this, it is recommended that flocculant is used to promote the settlement of finer solids prior to discharging to surface water networks. Flocculant 'gel blocks' are passive systems, self-dosing and self-limiting, however they still require management as per the manufactures instructions. Flocculants are made from ionic polymers. Cation polymers (positive charge) are effective flocculants; however, their positive charge makes them toxic to aquatic organisms. Anionic polymers (negative charge) are also effective flocculants, and are not toxic i.e., environmentally friendly.[32] Therefore, if flocculants are deployed the material used must be made from anionic polymers.

Worst Case Scenario

A worst-case scenario could possibly occur whereby the proposed works of HDD could result in a direct, negative, potentially significant, impact of the development. This impact could result from any number of indirect anthropogenic sources, most commonly would be from: inadvertent drill returns containing drilling fluid, breakouts of drilling fluid during drilling operations (underground) and by spillages of oil, fuel, or drilling fluid. Such spillages could potentially affect either surface water or groundwater depending on the nature of the contamination issue, and to varying degrees depending on the hydrological and hydrogeological characteristics of the Site area. Considering the proximity to surface water associated with this type of infrastructure the risk is elevated.

Land Take

Minimal land take is required for the grid route connection considering the line will principally be buried in or directly adjacent to existing roadways. Some of the grid connection route options possess minor portions which traverse greenfield / green verge areas. Any such impact is described similarly to general land take described above, however considering the small scale of disturbance (shallow cable trench) the impact is considered negligible to slight.

[32] USEPA (2013) "Stormwater Best Management Practice: Polymer Flocculation" *United States Environmental Protection Agency: Office of Water*, 4203M.

Vehicular Movement

During the construction phase of the proposed development, vehicles will cross over or excavate into areas in order to construct the proposed access tracks and hardstands, and gain access to the proposed development areas. There is the potential for soil compaction, erosion and degradation during such vehicular movements. This is considered to be a direct, negative, medium to long term, moderate, slight weighted significance, localised impact of the proposed development.

Assessment of Effects – Operational Phase

The risk associated with bedrock aquifers underlying the grid connection route will remain a baseline risk however there are no significant sources of contamination associated with the operational phase with the exception of in-frequent maintenance works.

Mechanism/s:	• Construction activities (Earthworks, addressed under Release of Suspended Solids) • Construction activities (Earthworks) within surface water buffer zones. • Construction activities (Earthworks, addressed under Release of Hydrocarbons), and/or chemical spill. • Poor design and/or installation of HDD bore path.
Impact	• Release of suspended solids, intercepted by surface water network. • Significant surge release of suspended solids, intercepted by surface water network. • Release of hydrocarbon and/or chemical intercepted by surface water network.
Receptor/s:	• Surface Water. Surface water quality, ecological sensitivities and WFD status.
Pre-Mitigation Potential Effect:	• Surface Water - Negative, direct, profound, likely, short to long-term.

9.4.5.8 Operational Phase Potential Effects

9.4.5.9 Assessment of Effects - Increased Hydraulic Loading

Assessment of hydraulic loading changes is presented in **Appendix 9.1**.

Considering the existing infrastructure associated with the site, water balance calculations allow for the addition of the area of hardstand required (land take) for the construction of the Development. The resulting 1 in 100 year scenario net increase of surface water runoff associated with the Development is calculated to be c. 0.319m^3/second, or 0.63% relative to the Site area alone, (Note: assessment at catchment scale presumes the same environmental conditions across the entire catchment during the event).

This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but imperceptible to slight impact of the development. However, considering the cumulative impacts in regard to increased runoff generally (catchment / national scale), the potential for increasing rainfall amounts and frequency (climate change), and considering the sensitive receptors a relatively short distance downstream (probable flood risk areas), any net increase in runoff is considered a significant impact.

Mechanism/s:

- Significant changes to the hydrological regime at the Site.
- Replacement of vegetated land with respective recharge capacity with impermeable (assumed) hardstand surfaces. Introduction of constructed drainage intercepting greenfield runoff. Construction activities (Earthworks) within existing drainage channels and/or streams and rivers.
- Connecting new and existing drainage channels.

Impact

- Increase in runoff at the Site.
- Increase in hydrological response to rainfall at the Site and in downstream surface water bodies.

Receptor/s:

- Surface Waters. Site hydrological response to rainfall and potential downstream flood risk areas.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, significant, likely, permanent.

9.4.6 Decommissioning Phase

No new unique or additional impacts are anticipated to arise during the decommissioning phase of the project on the hydrological and hydrogeological environment. **Management Plan 6 of the CEMP, Appendix 2.1.** All anticipated impacts are similar in nature to those already highlighted during the Construction Phase of the Development, (**Section 9.4.5**) i.e., release of hydrocarbons, wase water / sanitation and suspended soils through the excavation of material in order to remove cabling from joint bay locations.

9.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

9.5.1 Design Phase

9.5.1.1 Mitigation by Avoidance

A process of "mitigation by avoidance" was undertaken by the EIA team during the design of the turbine and associated infrastructure layout. Arising from the results of this study, a constraints map was produced that identifies areas where hydrological / hydrogeological constraints could make parts of the Site less suitable for development. The constraints map is presented in **Figure 9.8 a**.

Sven Klinkenbergh, Project Manager from Minerex Environmental Ltd., in consultation with the design team has reviewed the layout plan and has identified it as the best 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 as detailed in this EIAR.

9.5.1.2 Mitigation by Design & Mitigation Objectives

The descriptive mitigation measures outlined in this report will be applied to the development design and construction methodologies with a view to avoiding and/or minimising any potential adverse impacts to water quality in the receiving surface water network. Details on how such measures will be applied (objectives, design considerations, layout) will be contained in a Surface Water Management Plan (SWMP) (see Management Plan 3 appended to the CEMP, **Appendix 2.1**). The aims and examples of important considerations in relation to mitigation measures described in the EIAR are further clarified here.

CONSTRUCTED DRAINAGE:

Drainage features constructed at a site as part of a wind farm development have the potential to significantly adversely impact on the baseline hydrological regime, particularly in areas of intact habitat such as Wet Heath or Blanket Bog, but equally in peatland areas impacted by peat cutting there is the potential for the development to have a beneficial impact to the hydrological regime and to peatland regeneration. Peatland groundwater levels are generally dependent on rainfall. Rainfall infiltrates and percolates into peat/soil (recharge), initially through vegetated / root conduits in the acrotelm peat (living vegetated layer) or upper soil horizons, however percolation and/or permeability rates in peat, particularly the catotelm (decomposing lower layer) are poor and therefore peatland areas are characterised by rapid hydrological responses to rain fall i.e., rapid surface water runoff intercepted by the receiving drainage and surface water network. Due to this characteristic, peatlands require consistent rainfall to ensure adequate wetting of water dependant blanket peat habitats such as Wet Heath and Blanket Bog.

Poor drainage design has the potential to drain excess surface water runoff and draw water away from areas of peatland, thus reducing the potential of recharge to ground in those areas, and creating an even greater hydrological response to rain fall in the receiving surface water network via more direct connections to the surface water network i.e., bypassing the peatland. Furthermore, uncontrolled surface water runoff interacting with the development footprint has the potential to lead to adverse impacts including the development of new preferential pathways, erosion and peat degradation – particularly during and immediately after construction phase whereby unvegetated soils are exposed and wetting and/or drying of peat areas potentially occurs.

The drainage design for the proposed site (**Sections 4 – 5** of **Management Plan 3, Appendix 2.1**) will be such that drains are positioned adjacent to the footprint of the development, therefore the proposed drainage infrastructure can be considered part of the Development footprint. The scale of the impact a shallow drain poses on the surrounding peatland area is minor particularly in areas impacted as baseline. Therefore, the potential magnitude or scale of impact to waters posed by the introduction of the proposed drainage extends to a minor extent beyond the footprint of the development. However, it is important to consider the gradual degradation over time.

The design of the proposed drainage network will facilitate:

- The collection of surface water runoff from upgradient of the development footprint (clean runoff interceptor drains) and the buffered redistribution of clean runoff downgradient of the development footprint by means of culverts and buffered outfalls to vegetated areas with a view to maintaining or improving the hydrological regime at the site.
- The collection of surface water runoff from the footprint of the development i.e., the construction area (construction runoff interceptor drains) and management of

potentially contaminated runoff in the constructed treatment train. Where possible the buffered outfalls from the treatment train / stilling ponds will be redistributed with a view to maintaining or improving the hydrological regime at the site.

- Where extensive drainage networks exist, collected / diverted runoff will likely be diverted back into the existing network. In such instances it is important to include the existing drainage network in designing and specifying the treatment train and attenuation features, including improving, modifying, and constructing attenuation features in drainage channels. Similar to considerations for newly constructed drainage channels, the modification and/or improvements of existing drainage will be designed with a view to maintaining or improving the hydrological regime at the site.

Maintaining or improving the hydrological regime at the site implies achieving the objectives of the development Surface Water Management Plan (SWMP) i.e., mitigating against potential adverse impacts to the hydrological response to rainfall at the site (related to flood risk), and water quality in the receiving surface water network.

ATTENUATION FEATURES:

There remains the risk of the proposed drainage to increase the rate of runoff from respective upgradient areas, to reduce potential runoff to respective downgradient areas, and to increase the rate of hydrological response to rainfall in the receiving surface water system (increase hydrological response will also be driven by introduction of nearly impermeable hardstand).

Mitigation measures to address surface water runoff and drainage include in line attenuation features such as check dams and stilling ponds and buffered outfalls). Both check dams and stilling ponds provide mitigation against potential impacts to water quality, erosion, and discharge velocity, however they also facilitate buffered and diffuse percolation of surface water runoff into the receiving environment along the permitter of the development footprint.

CHECK DAMS:

Check dams will be constructed along the length of constructed drainage at regular intervals in line with relevant guidance (**Section 9.2.2)**. Check dams (**Appendix 9.6– Tiles 3-6, Section 5.6 of Management Plan 2 Appendix 2.1**), will be permanent (for the life of the project / drainage network), made of suitable locally sourced coarse aggregate (similar geology), and are intended to attenuate (impede) surface water runoff in the drainage channel, therefore slowing the velocity of the runoff in turn reducing the potential for erosion in the channel and allowing suspended solids to settle out if present. At low velocity, the runoff has increased opportunity to percolate through the coarse aggregate and into the surrounding peat area, effectively contributing to bog water levels at that location.

STILLING PONDS:

Stilling ponds with buffered outfalls will be constructed at drainage outfalls associated with the construction runoff drainage network (**Figure 9.1a, Section 5.7 of Management Plan 2 Appendix 2.1**). Buffered outfalls will be established at intervals along the clean runoff drainage network. Multiple outfalls along the drainage routes facilitates the strategic management of runoff with a view to maintaining the baseline hydrological regime in so far as possible. Similar to check dams; stilling ponds will be permanent (for the life of the projects / drainage network), made of suitable coarse aggregate, and are intended to attenuate surface water runoff in the drainage channel, slowing the velocity of the runoff before discharging to vegetated areas (buffered outfall). Slowing the water velocity allows suspended solids to settle out if present. At low velocity the runoff has increased opportunity to percolate through the coarse aggregate and into the surrounding peat area. Through both forms of discharge (buffered outfall and percolation through aggregate) the stilling ponds will contribute to bog water levels at their locations. Stilling ponds are designed to provide attenuation to greenfield run-off rates, refer to detail drawings (**Drawing No. 6225-PL-303).**

PROMOTION OF PEATLAND HABITATS

Excavated peat will be deposited with a view to restore infilled excavation areas associated with the site e.g., adjacent to hardstand areas and borrow pits. The deposition of peat, particularly in cutover peat areas, once successfully restored / revegetated will promote the recovery and development of blanket peat habitats (e.g., Wet Heath and Blanket Bog). This is considered a beneficial impact in areas of existing cutover peat and a neutral impact in areas of intact blanket peat habitats.

Improvements to the hydrological regime as a function of the Development will promote the recovery and development of blanket peat habitats, particularly in significantly impacted areas, such as existing cutover peat areas and areas adjacent to the development footprint. This is worth noting in the context of the impact/s posed by the Development on blanket peat habitats i.e., range from temporarily adverse to beneficial.

The Development layout and existing drainage network, and their interaction, are assessed in detail and a detailed constructed drainage and attenuation network layout has been provided (see **Management Plan 3 – Surface Water Management Plan and Drawings** appended to the CEMP, **Appendix 2.1**). This exercise and output will present the requirement, locations and conceptual function and objective of the drainage network and treatment train. This information has also been used to develop the SWMP and associated detailed design layout drawings have been submitted by the developer to the Planning Authority for review and approval.

9.5.1.3 Constraints

As part of mitigation by avoidance during the design phase of the Development, groundwater, surface water, and drainage buffer zones were established where applicable.

Buffer zones are intended to drive the design process by minimising or avoiding the risk to surface water features by restricting construction disturbance to outside these zones, in turn protecting riparian vegetation and providing potential for filtering of runoff from the Site and maintaining the baseline hydrological and drainage regime at the Site.

The prescription of surface water and groundwater buffer zones (sometimes referred to as setback distances), is in line with relevant guidance relating to forestry, agriculture, water resources, direct discharges and wind farm development guidance documents **(Section 9.2.2)**.

The available guidance stipulates that surface water buffer zones should be prescribed to mapped surface water bodies or aquatic zones i.e., defined as a permanent or seasonal river, stream or lake shown on an Ordnance Survey 6-inch map, however guidance also states any drainage features leading from the site and flowing into the receiving surface water network which may short circuit buffer zones must also be considered.

The available guidance stipulates varying surface water buffer widths depending on type of activity, receptor type and sensitivity, and riparian zone characteristics including topography (steepness). Recommended surface water buffer widths range from 5m to 50m depending on site specific and activity specific characteristics. For the purposes of this assessment the following conservative approach has been applied:

- 50m Surface Water Buffer Zone - Mapped surface water features i.e., mapped streams, rivers, lakes. Source for mapped surface water features; EPA.
- 15m Drainage Buffer Zone - Non-mapped drainage features i.e., non-mapped streams, natural and artificial drainage features. Source for non-mapped surface water features desk study and aerial photography assessment, Lidar topographic data and field observations. Significant drainage features have been identified and mapped in so far as practical. Some drainage features will likely not be recorded due to issues relating to access and complexity e.g., within afforested areas, and extensive turbary areas.

Such drainage features, while not mapped or prescribed buffer zones, will be treated with the same consideration as mapped drainage during the design and construction phase of the development i.e., mitigating for the potential for drainage connection to receiving surface water network.

Groundwater buffer zones are dependent on the characteristics of the receptor e.g., private well, or public supply source protection zone, and the characteristics of the underlying geology and associated aquifer e.g., poor unproductive aquifer, or regionally important karstified aquifer. Recommended groundwater buffer zones range from e.g., 15m (exclusion zone karst swallow holes) to entire catchments (source protection in regionally important karstified aquifer) depending on site specific characteristics. For the purpose of this assessment the following conservative approach has been applied:

- 100m Groundwater Buffer Zone – Groundwater abstraction points in relation to proposed access tracks and cable trenches i.e., shallow excavation. Source for mapped abstraction points: GSI. Not applicable, none within 100m of the Site. Applicable to the grid connection and turbine delivery routes.
- 250m Groundwater Buffer Zone – Groundwater abstraction points in relation to proposed borrow pits and foundations. Source for mapped abstraction points: GSI. Not applicable, none within 250m of the Site.

Not applicable to this site:

- Source Protection Areas – The entire area mapped as a public or group groundwater supply protection area. Source: EPA. This is not applicable.
- Entire Catchment (Karst aquifer) – The entire catchment associated with a public or groundwater supply protection area which is underlain with a karstified aquifer. This will be assessed in detail as applicable. Not applicable.
- Karst Features – Not applicable. No karst features were identified on Site.

While not applicable to this Development, some of the Development infrastructure footprint could typically fall within buffer zones due to the unique and limiting circumstances associated with the Site and the Development, such as constraints related to other environmental disciplines including; ecology, ornithology, etc. restricted due to the proposed infrastructure itself whereby the proposed turbines require a minimum distance from each other to ensure the potential for wind turbulence impacting on downwind locations is minimised.

None of the proposed turbines or Turbine Hardstands fall within a buffer zone associated with a mapped stream / river, with the exception of T14. The Turbine Hardstand and fill material associated with the T14 is within the Sullane River surface water buffer zone.

The proposed Site Access Roads, associated widening where required, at watercourse crossings etc. naturally fall within buffer zones associated with mapped streams / rivers.

Some of the proposed Turbine Hardstands, and Site Access Tracks fall within buffer zones associated with existing natural and constructed drainage features at numerous locations (**Figure 9.8a-k**). These features pose an elevated risk in terms of connectivity to surface water receptors; streams and rivers, and also means that some of these features will require diversion.

Following site surveys significant natural and artificial drainage features observed which are relatively well connected to the mapped surface water network have been included in considering constraints. Given the extensive drainage network existing at the Site the construction activities associated with the development will invariably be in close proximity to surface water / drainage features, including within the buffer zones such that there will be a requirement for further mitigation measures.

No groundwater buffer zones are required for the proposed GWF development, refer to the baseline section of this report. **NOTE:** With reference to **Appendix 8.1 and Appendix H (a - c),** areas have been identified as Geo-Hazards and an effective drainage buffer zone will be applied whereby it is intended to divert runoff away from those areas. The areas in question are characterised as having steep incline, potential for deep till deposits and iron pan. These have elevated stability risk particularly in potential instances where hydrogeological conditions are adversely impacted, i.e., where the enhancement of recharge of groundwater and the perching of groundwater occurs in higher risk areas increasing pore water pressure against potentially parallel failure planes. Particular areas are discussed in **Chapter 8: Soils and Geology**, however in terms of drainage constraints, mapped High Landslide Susceptibility (GSI) (**EIAR Figure 8.5a**) is used to indicate constraints in relation to hydrogeology and stability (**Appendix 8.1 and supporting Appendices A-I**), which is overlaid with hydrological buffer zones as presented in **Figure 9.8 a-k** For example, areas which are particularly sensitive include:

- The portion of the site north of T2 and T3. This area possesses high landslide susceptibility (GSI), extensive existing drainage channels, evidence of deeply eroded drainage channels in till with evidence of iron pan.

- The portion of the site north of T12. This area is characterised similar to the above scenario but without deep till deposits.

In the scenarios above, the Turbine Hardstands and associated drainage will divert runoff away from these higher risk areas and design the drainage network to place buffered outfalls in more favourable areas adjacent to the Development footprint.

Some of the Development footprint will fall within buffer zones due to the unique and limiting circumstances associated with the Site and the Development, including; the proposed infrastructure itself whereby the Grid Connection Route traverses a relatively large distance and is limited to public and local road networks and privately owned forestry access tracks.

Portions of the Grid Connection Route pass through numerous surface water and 1 no. groundwater buffers. Of note are the several watercourse crossings, which by their nature will be withing surface water buffer zones. Given the extensive drainage network existing at the Site the construction activities associated with the development will invariably be in close proximity to surface water / drainage features, including within the buffer zones.

As discussed above, special attention and planning is required for construction activities within surface water buffer zones. Procedures in relation to mitigating against adverse impacts in areas in close proximity to surface water / drainage or within buffer zones are detailed in a Surface Water Management Plan (SWMP), Management Plan 3 of the CEMP (**Appendix 2.1**). The mitigation measures described in the following sections will also be applied.

9.5.2 Construction Phase

9.5.2.1 Earthworks Proposed Mitigation Measures – General / Wind Farm

Management and mitigation for earth works is covered in further detail in **Chapter 8: Soils and Geology**. Mitigation measures to reduce the potential for adverse impacts arising from earth works and management of spoil the following:

- Management of excavated material – A Peat and Spoil Management Plan has been prepared and forms **Management Plan 4** of the Construction & Environmental Management Plan (CEMP, **Appendix 2.1**). It incorporates provision on materials management with a view to establishing material balance (reuse of excavation arisings) during the proposed construction phase, thus minimising the potential for or the length of time excavated materials are exposed and vulnerable to entrainment by surface water runoff.

- No permanent stockpile will remain on the site during the construction or operational phase of the Development. Excavated materials will be stored temporarily adjacent to the excavation sites (**Management Plan 4, Appendix 2.1**). Geohazards described under **Chapter 8: Soils and Geology, Appendix H,** have also been considered.
- Earthworks will be limited to seasonally dry periods and will not occur during sustained or intense rainfall events. Similar to measures outlined in relation to ground stability during excavation works (**Chapter 8: Soils and Geology**), an emergency response system has been developed for the construction phase of the project (see **Management Plan 1 – Environmental Response Plan and Section 5.10 of Management Plan 3, Appendix 2.1**), particularly during the early excavation phase. This involves 24-hour advance meteorological forecasting (downloadable from Met Éireann) linked to a trigger-response system. When a pre-determined rainfall trigger levels is exceeded (e.g., sustained rainfall (any foreseen rainfall event longer than 4-hour duration) and/or any yellow or greater rainfall warning (>25mm/hour) issued by Met Éireann), planned responses will be undertaken. These responses will include; cessation of construction until the storm event including storm runoff has passed over, assessment of construction areas and infrastructure by Ecological Clerk of Works, and confirmation no additional escalation of response is required. All construction works will cease during storm events such as yellow warning (Met Éireann) rainfall events. Following heavy rainfall events, and before construction works recommence, the Site will be inspected and corrective measures implemented to ensure safe working conditions, for example, dewatering of standing water in open excavations, repair works to drainage features if necessary.
- Exposed soils/peat (exposed temporary stockpiles) will be covered with plastic sheeting during all heavy rainfall / storm events and during periods where works have temporarily ceased before completion at a particular area (e.g., weekends, overnight, etc).
- All drainage infrastructure (as per drainage design, **Sections 4 and 5 of Management Plan 3, Appendix 2.1**) required for the management of surface water runoff or draining peat ahead of excavation works will be established before excavation works commence. Similarly, mitigation measures related to surface water quality will be implemented before excavation works commence.
- Conceptual and information graphics presented in **Appendix 9.6 – Tile no. 7, 8 and 9** present indicative layout and specification for both passive treatment trains (clean water interceptor drains), active management treatment trains (management and treatment of construction water) and emergency response and intervention.

9.5.2.2 Earthworks Proposed Mitigation Measures – Grid Connection Route

The Grid Connection Route will require excavation of cable trenches in existing roadways as well as forestry tracks and private lands. With reference to general excavation practices discussed above, excavation of cable trenches in close proximity to surface water features will require special consideration in terms of managing movements, spoil arising from excavations, and entrainment of solids and contaminants in surface water runoff.

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

- In sensitive areas, excavation of material will be conducted in a controlled manner whereby any temporary deposit of the material in buffer zones can be minimised. For example, vacuum excavation techniques or similar will be used for excavations within Surface Water Buffer zones and other sensitive areas (constraints) (**Figure 9.8 a-k)**. Excavated soil will be removed to temporary storage areas.
- Management of excavated material will adhere to the measures related to the management of temporary stockpiles outlined in **Chapter 8: Soils and Geology**, a Peat and Spoil Management Plan has been established and forms part of the Construction & Environmental Management Plan (CEMP, **Appendix 2.1, Management Plan 4**) with a view to establishing material balance during the proposed construction phase, thus minimising the potential for, or the length of time excavated materials are exposed and vulnerable to entrainment by surface water runoff. No permanent, or semi-permanent stockpile will remain on the site during the construction or operational phase of the Development.
- All spoil from trenches in public roadways will be removed form Site as it is excavated and transported to a licenced facility for soil and stones. (The locations of four such facilities are shown on **Figure 15.5.** Road surfacing materials will be stored in a ship for recycling by adding bitumen.
- Temporary stockpile locations will be situated outside of Surface Water Buffer Zones (as seen in **Figure 9.8 a-k)**. Temporary Spoil stockpiles shall have side slopes battered back to a safe angle of repose, e.g., 1:1. Silt fencing is to be erected around the base of the temporary mound. Soil will be reinstated on completion of drilling and jointing operations. Temporary storage areas will require bunding and management of runoff likely contaminated with suspended solids (**Appendix 9.6 – Tile 7**). Management of construction waters is discussed in following sections.
- Earthworks will be limited to meteorologically dry periods and will not occur during sustained or intense rainfall events. Similar to measures outlined in relation ground stability during excavation works (**Chapter 8: Soils and Geology**), and as discussed

in this chapter, an emergency response system has been developed for the construction phase of the project (see **Management Plan 1** appended to the CEMP, **Appendix 2.1**), particularly during the early excavation phase. This, at a minimum, will involve 24 hour advance meteorological forecasting (Met Éireann download) linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g., 1 in 100 year storm event or 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 surge has passed over. Following heavy rainfall events, and before construction works recommence, the site will be inspected and corrective measures implemented to ensure safe working conditions, for example dewatering of standing water in open excavations and transfer to treatment train.

9.5.2.3 Construction Water Management, Dewatering, Treatment & Discharge of Trade Effluent

Mitigation measures to reduce the potential for adverse impacts arising from earth works / management of spoil and associated entrainment of solids in runoff and construction water will include the following:

- Conceptual and information graphics presented in **Appendix 9.6 – Tiles no. 7, 8 and 9** present indicative layout and specification for Active Management treatment trains (containment, management and treatment of construction water) and emergency response and intervention (recycling or diversion of poor-quality runoff to the Active Management portion of the treatment train). Continuous real time monitoring is also detailed.
- Management of excavations, that is areas of soil / subsoils to be excavated will be drained ahead of excavation works by sumps, in a stepped / phased approach whenever necessary, with the aim of temporarily lowering groundwater levels to allow excavation to be carried out in dry and stable conditions. For example, saturated areas of peat, thus reducing the volumes of water encountered during excavation works.
- Engineered drainage and attenuation features (discussed in following sections) will be established concurrent with excavation works.
- Dewatering flow rate or pumping rate will be controlled by an inline gate valve or similar infrastructure (**Appendix 9.6- Tile 8**) This will facilitate reduction of loading on the receiving drainage and attenuation network, thus enhancing the attenuation and settlement of suspended solids. All pumped water will be discharged to constructed drainage and in line treatment train or to a vegetated surface through a silt bag (**Appendix 9.6 – Tile 10**) outside of surface water buffer zones **(Management Plan 3, Appendix 2.1 and Appendix 9.6 – Tiles 7 and 9).** Dewatering is a dynamic process

and will require continuous monitoring and modification depending on conditions encountered (**Appendix 9.6 – Tile 8, refer to Section 9.5.2.12**).

- In some areas of the Development constraints related to incline and/or stability, or construction activities within the prescribed buffer zones, will likely limit the potential for installation of engineered attenuation features. In such instances water arising from dewatering activities will be directed or pumped to a settlement tank (**Appendix 9.6 – Tile 8**) before being discharged to the receiving drainage network, OR pumped to an area of the site where the installation of attenuation features is suitable. Areas with such constraints are presented in **Figure 9.8 a-k**.
- No extracted or pumped water will be discharged directly to the drainage or surface water network associated with the Site (This is in accordance with the Local Government (Water Pollution) Act, 1977 as amended).

9.5.2.4 Construction Water Management, Dewatering, Treatment and Discharge of Trade Effluent

9.5.2.4.1 Active Construction Water Management

In all instances where construction water, or runoff has the potential to entrain solids during excavation and other construction activities, runoff will be contained by means of temporary berms (lined geotextile of similar), bunds (lined) and sumps. This will be referred to as Dewatering. Construction water (contaminated) will be pumped to the Treatment Train (**Appendix 9.6)**.

Contaminated water arising from construction works, namely; excavations, drilling and temporary stockpiling, will be contained and treated prior to release or discharge. The schematic presented here is a conceptual model of measures implemented to manage arisings and runoff (Letter headings align with **Appendix 9.6 – Tile 8**:

A. Arisings. Arisings from the launch / reception pit, or any other significant excavation (e.g., cable joint bays), will be directed the treatment train.
B. Temporary Bund. Arising control area i.e., a temporary bund. Gross solids will be temporarily deposited here. Water arising with the material will be allowed to drain to sump.
C. Sump / Pump. Sump will discharge by gravity / pumped to stilling pond.
D. Temporary Stilling Pond. This can be constructed using soils for bunding in combination with an impermeable liner.
E. Outfall. The outfall from the stilling pond will be buffered (coarse aggregate) to dissipate energy and diffuse discharging water.

F. Silt Screen. A silt screen will be in place down gradient of the Stilling Pond outfall. This is a precautionary measure to mitigate peak loads or surcharges in the system.

G. Monitoring Location/s. Discharge quality will be monitored in real time using telemetry systems. Monitoring of discharge quality will be carried out at the outfall of the stilling pond i.e., before being actually discharged to surface vegetation or surface water (licenced).

H. Sump / Pump. Discharge By-Pass. If water discharging from the stilling pond exceeds quality reference limits water will be diverted (pumped) from the stilling pond to the settlement / treatment tank.

I. Stilling Pond By-Pass. Similar to Discharge By-Pass, if conditions dictate water can be diverted directly to Settlement / Treatment Tank.

J. Settlement / Treatment Tank. A settlement tank will in line and ready to use if required i.e., water quality at stilling pond outfall fails to meet quality reference limits. The tank will be equipped with treatment systems which will be activated as the need arises, for example, very fine particles which are very slow to settle can be treated with a flocculant agent to promote settlement of particles.

K. GAC Vessel/s. As a precautionary measure, GAC (Granulated Activated Carbon) vessel/s will be in line and ready to use if required. GAC vessels are used to filter out low concentrations of hydrocarbons. Significant hydrocarbon contamination is only envisaged under accidental circumstances. If a hydrocarbon spill does occur, normal operations will pause and the treatment train will be utilised to remediate captured contaminated runoff.

L. GAC Vessel By-Pass. If the quality of the water is acceptable in terms of hydrocarbon contamination.

M. Treated water will be discharge by gravity / pump to the stilling pond for additional clarification, monitoring and buffered discharge to vegetated area.

N. Silt Bag. A silt bag can be used as alternative to stilling ponds. However, silt bags must only be used as primary method in lower risk areas i.e., outside of buffer zones, etc. Stilling ponds will be the primary method (D, N) is circumstances where risk is elevated, however a gate vale and silt bag can be included in the treatment train and used as an emergency discharge route in the event that the stilling pond needs remediation or maintenance.

In all instances, stilling ponds (D), Silt Bags (N) and outfalls (E) will be situated outside of surface water buffer zones. At many locations, particularly at HDD locations works will be within buffer zones. In these instances, waters can be pumped to the treatment train which can be positioned upgradient along the road (Grid Connection Route) where discharge to vegetated areas / roadside drains can be managed.

Discharge of non-contaminated storm runoff to vegetated land within a site red line boundary is not a licenced activity however this methodology is possible only under relatively low flow conditions (e.g., <2 litres per second (l/sec) typical of runoff over a relatively small site area. In the event that the expected incoming flow rate or dewatering rate is relatively high (>2 l/sec) a discharge licence will be acquired, and trade effluent will be discharge directly to the surface water network. The latter will include all works associated with HDD.

The discharge points will be identified during the licence application process. As discussed previously, the main components of the treatment will be positioned outside of the 50m surface water buffer zone where possible. The developer will identify suitable locations for the establishment of temporary infrastructure considering other variable such as traffic and access management. Similarly, the preferred location of discharge points will be outside of buffer zones and into minor or non-mapped surface water / drainage features where possible. The subject drain will be inspected to ensure connection to the mapped network (not blocked).

The quality of the water being discharged will be monitored. If discharge water quality is poor (e.g., >25mg/l) additional measures will be implemented, for example, pausing works as required and treating construction water by dosing with coagulant to enhance the settlement of finer solids – this can be done in a controlled manner by means of a suitably equipped settlement tank. Collected and treated construction water will be discharged by gravity / pump to a vegetated area of ground within the Site. Silt fences will be established at the discharge area to ensure potential residual suspended solids are attenuated and the potential for erosion is reduced. The discharge area will be outside of 50m surface water buffer areas (similar to dewatering of excavations. The quality of water discharged will be in line with licence discharge limits assigned by the Council and will be monitored in real time (telemetry with 15 min sampling rate), as well as laboratory samples taken, analysed and reported and the frequency indicated in the licence. Daily sampling is recommended given the short duration and temporary nature of the works.

Discharging of construction water (trade effluent) directly to surface waters or groundwater is a licenced activity. (This is in accordance with Local Government (Water Pollution) Act, 1977 as amended).

9.5.2.4.2 Passive Construction Water and Runoff Management

Passive management systems (**Appendix 9.6 – Tile 7,** refer also to diagrams in **Management Plan 3, Appendix 2.1**) include some of the features described in Active Management treatment trains. These include:

- Spoil bunds and/or temporary berms. Spoil bunds and/or berms will be constructed using either crushed rock or clean soils and overlain or lined with an impermeable layer e.g., geotextile or plastic membrane. These features are intended to control the movement of construction water / runoff with a view to;
  - Containing contaminated water (e.g., drilling / excavation spoil and runoff laden with solids). Temporary bunds will be used to manage spoil arising from drilling operations or saturated spoil arising from excavations in sensitive areas e.g., within SW buffer zones.
  - To divert runoff i.e., divert clean/storm runoff during construction works or contaminated construction water away from sensitive receptors such as drains/surface waters directly adjacent to construction areas.
- Silt screens. These will be utilised in a similar sense to berms whereby, silt screens will be installed between construction areas and sensitive receptors, including:
  - At the outfall of the treatment train where discharging to vegetated ground or within non-mapped drains (within redline boundary).
  - Along the permitter of construction areas which are directly adjacent to watercourses or within surface water buffer zones. This includes all watercourse crossings and sections of Grid Connection Route alongside adjacent watercourses.

Passive systems are intended to function with minimal supervision, however in the management of construction water on this site or development, in many cases the diverted water will likely require active management to ensure sensitive receptors are protected. For example, diverted storm water, if clean can discharge to the receiving vegetated areas or existing drains, but any construction waters impacted by contaminants on the site must be managed, and potentially active management / treatment is required.

9.5.2.5 Release and Transport of Suspended Solids Proposed Mitigation Measures

Conceptual and information graphics associated with mitigating runoff quality are presented in **Appendix 9.6 – Tiles 7 - 9.**

In order to mitigate the impact posed by release of suspended solids to the surface water environment, the following mitigation measures will be implemented.

The drainage, attenuation and other surface water runoff management systems will be installed concurrent with the main construction activities to control increased runoff and associated suspended solids loads in runoff during intensive construction activities e.g., excavation of turbine base. Vehicular movements will be restricted to the footprint of the Development and advancing ahead of any constructed hardstand will be minimised in so far as practical. For example, excavation ahead of established hardstands will be in line with expected phases of Turbine Hardstand and Site Access Road construction in terms of both delivery of and installation of material and site activity periods whereby excavations will not be opened ahead of site shut down periods. This will be done with a view to minimising soils / subsoils exposure to rain and runoff. Drainage infrastructure will be installed during meteorologically dry ground conditions **(Section 9.5.2.1**).

Diffuse surface water runoff will be managed as follows:

- With reference to **Management Plan 3, Appendix 2.1**, collector drains and/or soil berms will be established to direct/divert surface water runoff from development areas, including temporary stockpiles, and direct same into established treatment trains including stilling ponds, buffered discharge points or other surface water runoff control infrastructure as appropriate. This is particularly important for effective surface water management associated with proposed infrastructure within the varied surface water buffer zones. The drainage system will be permanent (see also **Appendix 9.6** for conceptual graphics).
- Silt fences will be established along the perimeter of source areas e.g., stockpiles, within the drainage network, and in existing natural drains and degraded peat areas which are likely to receive surface water runoff. Section 5.5 of the Surface Water Management Plan (**Management Plan 3, Appendix 2.1**) describes this in more detail. This will reduce the potential for surface water runoff loaded with suspended solids to rapidly infiltrate towards and be intercepted by drainage or significant surface water features. Where possible multiple silt fences will be installed at multiple locations in drains / treatment trains discharging to the surface water network. Double silt fences / screens will be deployed at outfalls within surface water buffer areas. Silt fences will be temporary features but will remain in place for a period following the completion of the Construction Phase (**Appendix 9.6 – Tiles 7 – 9**) until such time that site conditions are stable.

Waters arising as a product of excavation activities will be managed as follows:

- Waters arising from dewatering practices during excavation works will be significantly loaded with suspended solids. As such, constructed stilling ponds followed by buffered outfalls may be insufficient in controlling the release of suspended solids to the surface water network. Routine monitoring will prevent the possibility of clogging from significant volumes of settled or attenuated solids. Therefore, any water pumped from excavations, or any waters clearly heavily laden with suspended solids will be contained and managed and pumped through the preestablished Active Management treatment train (**Figure 9.6 – Tile no. 8 and 9).** This will include continuous active monitoring of water quality by turbidity measurement on an hourly basis.

Waters (likely loaded with suspended solids) intercepted by the established drainage network will be managed as follows:

- In line Stilling Ponds will buffer the run-off discharging from the drainage system during construction, by retaining water, thus reducing the hydraulic loading to watercourses. Stilling ponds are designed to reduce flow velocity to 0.3m/s at which velocity, silt particle settlement occurs. Stilling ponds will be permanent (life of development at minimum). The locations of stilling pond have been chosen as a part of the drainage design, refer to **Series 100 Site Layout Plans 6225-PL-100-107 planning drawings.** Flow control devices such as weirs and baffles will facilitate achieving better attenuation, particularly when considering fluctuating runoff rates (**Appendix 9.6 – Tiles 6 and 10**).
- In line Check Dams will be constructed across drains (**Appendix 9.6 - Tiles 3 – 6, Section 5.6 of Management Plan 3, Appendix 2.1)**. Check dams will reduce the velocity of run-off in turn facilitating the settlement of solids upstream of the dam. Check dams will also reduce the potential for erosion of drains. Rock filter bunds may be used for check dams however, wood or straw/hay bales (**Appendix 9.6 – Tile 11**) can also be used if properly anchored, that is; supported with rock or fitted timber to reduce potential for material to be swept away by incoming water. Multiple check dams will be installed, particularly in areas immediately downgradient of construction areas. Check dams will only be constructed in drainage infrastructure and not in significant surface water features i.e., streams or rivers. Check dams (comprised of rock) established will be permanent. The following will be implemented in the design of check dams and their deployment (CIRA, 2004):
    - Permanent rock filter bunds (coarse aggregate) will be used for check dams however, temporary wood or straw/hay bales can also be used if properly anchored and if the need arises. Permanent rock filter bunds are preferred as this will ensure that rapid surface water runoff is mitigated against for the life of the Development.

- Check dams will be installed at c. 20m intervals within the length of drainage channels. This is dependent on the slope angle and height of check dams constructed, refer to **Appendix 9.6 – Tile no. 3**.
- Check dams will include a small orifice / pipe at the base to allow the flow of water during low flow conditions i.e., maintain hydrological regime during low flow conditions. Note: the use of coarse aggregate will facilitate some infiltration.
- Erosion protection will be established on the downstream side of the check dam i.e., cobbles or boulder (100-150mm diameter) extending at least 1.2m (**Appendix 9.6 – Tile no. 3 and 4**.
- Check dams will be constructed as part of the drain i.e., reduce the potential for bypassing between the drain wall and check dam.
- Further details and design considerations are presented in **Appendix 9.6 – Tile no. 3 to 6,** refer also to **Section 5 of Management Plan 3, Appendix 2.1.**

- Surface water runoff will be discharged to land via buffered drainage outfalls (refer to **Appendix 9.6 Tiles 7 and 8**, see also **Figure 4.2** and **Drawing Nos. 6225-PL-301** and **6225-PL-100 to 107** in **Management Plan 3**, **Appendix 2.1**). Buffered drainage outfalls will contain hard core material of similar or identical geology to the bedrock at the site to entrap suspended sediment. In addition, these outfalls promote sediment percolation through vegetation in the buffer zone, removing sediment loading to acceptable levels any adjacent watercourses and avoiding direct discharge to the watercourse. A relatively high number of discharge points / buffered outfalls have been established as part of the design, thus decreasing the loading on any particular outfall. Discharging at regular intervals mimics the natural hydrology by encouraging percolation and by decreasing individual hydraulic loadings from discharge points.
- As per the drainage design (**Figure 2.6**), buffered drainage outfalls will be located outside of surface water buffer zones. Similarly, outfalls will not be positioned in areas with extensive existing erosion and exposed soils. Buffered outfalls will be fanned and be comprised of coarse aggregate (cobbles / boulders) (**Appendix 9.6 – Tile 11**). These structures will be akin to rip raps (coastal erosion defences/ outfall erosion defences). Silt fences (**Figure 2.6** and **Sections 4 and 5 of Management Plan 3, Appendix 2.1**) will be established downstream of buffered outfalls with a view to ensuring the effectiveness of the attenuation train, particularly during elevated flow events. Buffered outfalls established will be permanent.
- Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite the aforementioned measures. To address this, as required, flocculant will be used to promote the settlement of finer solids prior

to redistributing to the treatment train and discharging to surface water networks. Flocculant 'gel blocks' are available and can be placed in drainage channels upstream of stilling ponds. Gel blocks are passive systems, self-dosing and self-limiting, however they still require management (by the Contractor's Environmental Manager and supervised by the Developer appointed Ecological Clerk of Works (Ecological Clerk of Works (ECoW)) as per the manufacturer's instructions. Flocculants are made from ionic polymers. Cationic polymers (positive charge) are effective flocculants; however, their positive charge make them toxic to aquatic organisms. Anionic polymers (negative charge) are also effective flocculants, and are not toxic i.e., environmentally friendly [33]. Therefore, when flocculants are required, the material used must be made from anionic polymer. Gel blocks will be a temporary measure during the construction phase.

- Straw bales (similar to stone check dams) (**Appendix 9.6 - Tile 11**), and silt fences (discussed under diffuse runoff) can also be used within drainage channels for the purposes of attenuating runoff and entrained suspended solids, however these measures should be considered temporary and will be used mainly in managing potential acute contamination incidents (e.g. additional features to control runoff during excavation works) or to facilitate temporary works (e.g. corrective actions, discussed in later sections). Note; the installation of straw bales or silt fences will require checking on a daily basis by the Contractor's Environmental Manager and supervised by the Ecological Clerk of Works (ECoW) to ensure the bypassing does not occur. Coarse stone / boulders could be used in conjunction with these measures to address such issues.

The above measures, buffer zones, constructed drainage, check dams, two-stage stilling ponds design for attenuation, buffered outfalls are referred to as The Treatment Train, whereby the runoff will continuously be treated from source (construction area) to receptor (site exit, outfall of attenuation lagoon). Where necessary (>25mg/l suspended solids) the treatment train will be augmented through the use of anionic polymer gel blocks.

These measures reduce the suspended sediment and associated nutrient loading to surface water courses and mitigates potential impacts to water quality and on plant and animal ecologies downstream of the site.

The precautionary and mitigation measures listed here will avoid, reduce or remedy all potential impacts on water quality and will ensure that the sensitive receptors in the

[33] USEPA (2013) Stormwater Best Management Practice – Polymer Flocculation (Available at: http://www.siltstop.com/pictures/US_EPA_Polymer_Flocculant_Handout__3-14.pdf)

catchment of the development do not suffer any deterioration in water quality, either during construction, operation, or decommissioning. With reference to **EIAR Chapter 6: Aquatic Biology**, the populations of Freshwater Pearl Mussel in the lower catchments of the wind farm and along the grid connection route will not be negatively affected by the proposed Development. Therefore, the risk to sensitive receptors is low.

Particularly sensitive areas are identified and presented in **Figure 9.8 (a – k)** to inform the drainage design. The drainage design is presented on **JOD Drawings 6225-PL-100 to 6225-PL-107** and calculations are included in **Management Plan 3 – Surface Water Management Plan** appended to the CEMP, **Appendix 2.1**. The design indicates in detail the locations of treatment train features, and the specification required at each location.

9.5.2.6 Release of Hydrocarbons Proposed Mitigation Measures

To control and contain any potential hydrocarbon and other harmful substances spillage by vehicles during construction, the refuelling of plant equipment will be carried out at a location separate from the Development Site where possible, thus mitigating this potential impact by avoidance. However, given the remote nature of the Site, this is not likely to be a practical measure for large machinery such as cranes used during the Development.

Where fuelling offsite is impractical (e.g., bulldozers, cranes, etc.), and refuelling must occur on site, then a discrete "fuel station" (**Figure 2.16**) will be designated with the Contractor's compound for the purpose of safe fuel storage and fuel transfer to vehicles. This fuel station will be bunded to 110% volume capacity of fuels stored at the site. The bunded area will be drained by an oil interceptor and drainage of same will be controlled by a pent stock valve that will be opened to discharge storm water from the bund outside buffer zones. A suitably qualified management company will take responsibility for management and maintenance of the oil interceptor and associated drainage on a regular basis, including decommissioning following construction.

For site cranes, refuelling will take place outside of buffer zones and a drip tray will be used. Spill kits will be available within the refuelling vehicle for any such refuelling activity.

Despite the management of refuelling and fuel storage, there remains the risk of leakage from vehicles and plant equipment during construction activity. The plant equipment used on site will require regular mechanical checks and audits to prevent spillage of hydrocarbons on the exposed ground (during construction).

As a precautionary measure, oil (hydrocarbon) absorbent booms will be installed in all surface water features associated with the Development, downstream of each of the proposed construction areas, and at principal surface water features draining the Site. 2 no. oil booms will be installed at each required location, this will facilitate changing out of booms if needed, without facilitating direct flow of floating product during such activities if present. Oil booms deployed will have sufficient absorbency relative to the hazard, for example the volume of fuel in a particular construction vehicle.

In the event of an accidental spill during the construction or operational phase of the Development, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. In this regard, spill kits will be kept in each vehicle associated with the Development i.e., spill kits will be readily available to all operators. Spill kits will contain a minimum of; oil absorbent granules, oil absorbent pads, oil absorbent booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter). No materials, contaminated or otherwise will be left on the Site. Spill kits will also be established at proposed construction areas, for example a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.

Once the above measures are implemented the risk of hydrocarbon contamination intercepting the surface water network will be significantly reduced, however there remains a level of risk, and therefore both precautionary measures and emergency response protocols have been established and specified in Management Plans 1 and 3 of the CEMP, **Appendix 2.1**.

9.5.2.7 Construction and Cementitious Materials Proposed Mitigation Measures

In order to mitigate the potential impact posed by the use of concrete and the associated effects on surface water in the receiving environment, the following precautions and mitigation measures are recommended:

- Precast concrete will be used wherever possible i.e., formed offsite. Elements of the Development where precast concrete will be used have been identified and are indicated in the CEMP, Appendix 2.1. Elements of the Development where the use of precast concrete will be used include structural elements of watercourse crossings (single span / closed culverts) as well as Cable Joint Bays. Elements of the development where the use of precast concrete is not possible includes turbine foundations and joint bay pit excavations. Where the use of precast concrete is not possible the following mitigation measures will apply.

- Lean mix concrete, often used to provide protection to main foundations of infrastructure from soil biome, can alter the pH of water if introduced, which would then require the treatment of acid before being discharged to the surrounding environment. The use of lean mix concrete will be minimized, limited to the requirement of turbine foundations. The risk of runoff will be minimal, as concrete will be contained in an enclosed, excavated area.
- The acquisition, transport and use of any cement or concrete on site will be planned fully in advance of commencing works by the Contractor's Environmental Manager and supervised at all times by the Developer appointed Ecological Clerk of Works (Ecological Clerk of Works (ECoW)). This entails minimising quantities on site, planning delivery routes and washout stations.
- Vehicles transporting such material will be relatively clean upon arrival on site, that is; vehicles will be washed/rinsed removing cementitious material leaving the source location of the material. There will be no excess cementitious material on the vehicle which could be deposited on trackways or anywhere else on site. To this end, vehicles will undergo a visual inspection prior to being permitted to drive onto the proposed site or progress beyond the Contractor's yard. Vehicles will also be in good working order.
- Any shuttering installed to contain the concrete during pouring will be installed to a high standard with minimal potential for leaks. Additional measures will be taken to ensure this, for example the use of plastic sheeting or other sealing products at joints.
- Concrete will be poured during metrological dry periods/seasons in so far as practical and reasonably foreseeable. This will reduce the potential for surface water run off being significantly affected by freshly poured concrete. This will require limiting these works to dry meteorological conditions i.e., avoid foreseen sustained rainfall (any foreseen rainfall event longer than 4-hour duration) and/or any foreseen intense rainfall event (>3mm/hour, yellow on Met Éireann rain forecast maps), and do not proceed during any yellow (or worse) rainfall warning issued by Met Éireann. This also will avoid such conditions while concrete is curing, in so far as practical.
- Ground crew will have a spill kit readily available, and any spillages or deposits will be cleaned/removed as soon as possible and disposed of appropriately.
- Pouring of concrete into standing water within excavations will not be undertaken. Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the treatment train and buffered surface water discharge systems in place.
- Temporary storage of cement bound sand (if required for construction of the substation building) will be on hardstand areas only where there is no direct drainage to surface

waters and where the area has been bunded e.g. using sand-bags and geotextile sheeting or silt fencing to contain any solids in run-off.

- No surplus concrete will be stored or deposited anywhere on site. Such material will be returned to the source location or disposed of off-site appropriately. Concrete washing will be contained and managed similarly.
- A designated skip(s) will be provided for washing out of concrete chutes. The contents will be allowed to settle and the supernatant will be removed off site by licenced generator to a licenced waste water treatment plant.

9.5.2.8 Watercourse Crossings Proposed Mitigation Measures

The Development of the Wind Farm includes the construction/upgrading of seven watercourse crossings (**Figure 9.5a**). The Grid Connection Route will encounter 130 no. culvert crossings, 7 no. watercourse crossings, and 7 no. service crossings (**Appendix 2.4**). These crossings require detailed planning and consideration to ensure potential impacts are assessed adequately and in turn mitigated against.

The proposed watercourse crossings are relatively near the head waters of the surface water network therefore, bridge or culvert specification and construction are envisaged to be of relatively low significance in terms of expected flow, etc. However, all watercourse crossings must be designed to facilitate peak, or storm discharge rates so as to avoid localised flooding and associated issues during storm events. Data presented in **Table 4.4** and **Table 4.5** of **Appendix 9.1 – GWF Flood Risk Assessment,** indicate potential surface water discharge rates during a 1 hour storm event and a 24 hour storm event with a 1 in 100 year return period. Note: Upstream catchment areas are estimated and delineated by assessment of mapped catchment boundaries, topographical contours and existing infrastructure and associated drainage.

The above assessment is a conservative estimation which does not consider evapotranspiration or recharge to ground, or base flow and groundwater discharge to the respective surface water features.

In relation to the design and construction of watercourse crossings risk assessment and prescription of mitigation measures have been designed in accordance with relevant guidance and reference documents (**Section 9.2.2).**

Regulation 50 of the European Communities (Assessment and Management of Flood Risks) Regulations 2010 SI 122 of 2010 requires that: "No Person, including a body corporate, shall construct any new bridge or alter, Reconstruct, or restore any existing bridge over any watercourse without the Consent of the Commissioners or otherwise than in accordance with plans previously approved of by the Commissioners."

The word "watercourse" includes rivers, streams, and other natural watercourses, and also canals, drains, and other artificial watercourses.

The word "bridge" includes a culvert or other like structure.

The OPW is responsible for the implementation of the regulations and consent to construct any bridge will be sought from the OPW via their application process. Details on the application process and guidance / requirements of the bridge design and considerations in terms of flow can be found in the OPW guide Construction, Replacement, or Alteration of Bridges and Culverts (A Guide to Applying for Consent under Section 50 of the EU (Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). The requirements of OPW have been incorporated into the design of the proposed watercourse crossings. Preliminary design details are included in Drawings ref. **6225-PL-WC 1-7**.

All crossings will have clear span structures.

Single span structures are structures which span the width of the channel with no associated instream support and do not affect the bed of the river or water body. This ensures that the bank and instream habitats are maintained and the river bed is not impacted.

Where existing closed culverts/pipes are in place at existing watercourse crossings (WC3, WC4, WC6 and WC7 from **Table 9.15**) extending the existing closed culvert will minimise construction activities required and in turn minimise potential impacts when compared to removal and replacing the entire watercourse crossing.

The discussion to use single span structures is in accordance with Engineering in the water environment: Good Practice Guide – River Crossings (SEPA, 2010) and Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes (NRA, 2008) for river waterbodies in upland or transitional river segments.

With reference to ecology, none of the proposed watercourse crossing locations are associated with areas, or immediately proximate to surface water features with significant ecological sensitivity or importance. The principal risk to ecological sensitivities associated with proposed watercourse crossing works is the potential for adverse impacts to water quality downstream of the Site, namely the potential for mobilisation of solids. It is also noted that watercourse crossing methodologies employed will ensure potentially long term / permanent impacts downstream (e.g. scouring etc) or upstream (e.g. passage of fish) will be avoided, in line with 'good practice' defined by SEPA.

Considering all of the above, and considering baseline conditions – including ecological sensitivity and importance of surface water features associated with each of the watercourse crossings, all crossings will be Clear Span Bridges.

This is in line with good practice as defined by relevant guidance (SEPA, 2010) whereby; the course of action serves a demonstrated need, minimises the potential for ecological harm.

- Considering the width of all waterbodies associated with crossings discussed here (<2m width) in stream supports will not be required for the construction of single span structures.
- The design facilitates adequate hydraulic capacity (**Volume III**). This ensures that the design will maintain the existing channel and will facilitate peak discharge events (storm events) without flow being constrained and contributing to flooding or other issues. Values presented **Appendix 9.1 – SFRA** indicate the potential discharge rate associated with each watercourse crossing during a 1 in 100 year storm event. For existing crossings, the channel width will be maintained.
- In line with the above design consideration, allowance will be made for the transport of sediment through the crossing, not just hydraulic capacity.
- The design facilitates adequate freeboard to OPW requirements. The design facilitates passage of woody debris. Freeboard to facilitate navigation and recreation is not applicable in relation to the development and associated surface water features.
- For single span structures, abutments will be set back from the river channel (**Appendix 9.6 – Tile 12**) and banks to allow the continuation of the riparian corridor underneath the structure. This helps to minimise or prevent the need for bed and bank reinforcement, reduces the risk of creating a barrier to fish passage and allows mammal passage under the structure. The distance between the bridge abutments will be as wide as possible and will maintain the bank habitat, maximising the riparian corridor and allowing the river some space to move. Foundations (of abutments) will be deep enough to minimise or prevent the need for bed or bank reinforcement or bridge weirs or aprons. This will maintain the natural bed material and bed levels, protecting habitat

and allowing fish passage. Foundations will be buried deep enough to allow for scour during high flows. Construction will be supervised by a suitably qualified engineer who will confirm that the depth is as per the design.

- The design minimises the potential for localised bank and bed erosion, refer to **Planning Drawing No. PL-WC-01, PL-WC-02, PL-WC-03, PL-WC-04, PL-WC-05, PL-WC-06 and PL-WC-07**.

In regard to the Turbine Delivery Route there:

- **Temporary Watercourse Crossings – Temporary Crossing on Sullane River = Single Span Structure**.
  - This is in line with good practice as defined by relevant guidance (SEPA, 2010) whereby; the course of action serves a demonstrated need, minimises the potential for ecological harm. This feature will require drilling/piling of abutment supports on approach to the river. These will be positioned as far back from the surface water feature as practical.
  - With reference to the proposed bridge design (**Drawing Ref. 6225-PL-810**), the design includes for the managed storage of arisings in designated areas, and the active management of runoff (refer to **Appendix 2.6**) with including interreceptor drainage, sumps, and silt fences.
  - With reference to **Section 9.3.13** Flood Risk Identification the site of the temporary crossing and ancillary infrastructure and materials is within a mapped probable flood zone. To mitigate against any potential for on-site flood risk and consequences, it will be a strict requirement to carry out works at this location during seasonally dry conditions. Exposed soils and fill materials will be reinstated and/or will have erosion control installed as part of the design and sufficient time as to be in place prior to the next seasonally wet period. This will minimise the potential for flood events to impact on the construction works, plant machinery or operators etc, and will minimise the potential for entrainment of soils or other materials in high water flow during potential flood events.

In regard to the Grid Connection Route:

There are 130 culvert crossings proposed for the Grid Connection Route.

(*** Note:** Likely to be additional minor culverts).

- With reference to **Section 9.3.13** Flood Risk Identification some portions of the Grid Connection Route are within a mapped probable flood zone. To mitigate against any potential for onsite flood risk and consequences, it will be a strict requirement to carry out works at this location during seasonally dry conditions. Exposed soils and fill materials will be reinstated and/or will have erosion control installed as part of the design and sufficient time as to be in place prior to the next seasonally wet period. This will minimise the potential for flood events to impact on the construction works, plant machinery or operators etc, and will minimise the potential for entrainment of soils or other materials in high water flow during potential flood events.

There remains the potential for the actual construction of such crossings to have significant adverse impacts on the receiving watercourse/s through general construction activities such as those outlined in **Section 9.5.2** i.e., the release of suspended solids and hydrocarbons for example. Relevant guidance documents **(Section 9.2.2)**, have been consulted and applicable mitigation measures have been incorporated into the design of the proposed bridges and construction methodology of same. These will be adhered to with a view to mitigating and reducing any potential impact on the receiving watercourse.

9.5.2.8.1 Instream Works

Infrastructure such as culverts over natural or artificial drainage channels and non-mapped rivers will require instream works. Where culverts are required and the subsequent in-stream works are necessary, the following will be implemented:

- Contracted operators will draft method statements and risk assessments in line with mitigation outlined in this report and in consultation with relevant guidance prior to commencing works (as part of the watercourse crossing consent application). Relevant guidance referenced is presented in **Section 9.2.2**. Method statements will be included in the CEMP, **Appendix 2.1.**
- The construction area will be isolated, this means; the water feature (streams / drains) will be temporarily dammed upstream of the watercourse crossing and flow will be diverted by means of a flume / pipe by gravity or pumped (this is referred to as over pumping, **Appendix 9.6 – Tile 1**) downstream of the watercourse crossing and construction area. Following the successful upstream damming, a downstream dam or barrier will also be established. The downstream barrier will ensure contaminated runoff in the isolated work area can be contained and managed and will block surface water back flow in lower lying or flatter areas. **Appendix 9.6 – Tile 1** presents a conceptual plan view of an isolated construction area within a surface water feature. Over pumping of a surface water feature is considered diversion of water runoff only and therefore considered similar to discharge of storm water runoff only to sewer (exempt from licensing), however it is imperative that controls are in place to ensure environmental impacts are minimised, particularly in relation to ecological sensitivities (for further information refer to Chapter 5), and also in relation to water quality.

- In order to ensure isolation and over pumping is carried out effectively, the methodology must ensure that dams are secure / sufficiently supported, and that pumping of water can continue uninterrupted and that pumps are capable of keeping up with the discharge rate of the surface water feature. Pumping systems will require backup and fail-safe protocols e.g., backup pumps and generator. At significant surface water features e.g., non-mapped streams, isolation and diversion of drainage will be implemented.
- Provided the construction water within the isolation area is managed effectively, over pumping of the surface water feature does not pose a significant risk to surface water quality downstream of the watercourse crossing. With reference to **Section 6.4.2 of Chapter 6: Aquatic Biology**, clear span design of the bridges/crossings will not affect instream aquatic habitat or interfere with the passage of fish or aquatic fauna
- Water ingress into the construction area will be managed and collected by established sumps immediately downstream of the works (upstream of the downstream barrier) (**Appendix 9.6 – Tile no. 1**). Runoff within the construction area will likely be heavily laden with suspended solids. Where required, dewatering (pumping out or extracting) of such waters will be discharged to an inline settlement tank, or preestablished stilling pond to remove suspended solids before being discharged (**Appendix 9.6 Tiles 8 and 9**). The quality of the water being discharged will be monitored. If discharge water quality is poor (e.g. >25mg/l) additional measures will be implemented, for example treating construction water by dosing with coagulant to enhance the settlement of finer solids – this can be done in a controlled manner by means of a suitably equipped settlement tank. Collected and treated construction water will be discharged by gravity / pump to a vegetated area of ground within the Site (an example is provided in **Appendix 9.6 – Tile 11**). Silt fences (**Management Plan 3, Appendix 2.1**), will be established at the discharge area to ensure potential residual suspended solids are attenuated and the potential for erosion is reduced. The discharge area will be outside of the surface water buffer areas (similar to dewatering of excavations). For further details refer to **Appendix 9.6 – Tiles 6 to 9**.
- Discharging of construction water (trade effluent) directly to surface waters is a licenced activity. No extracted or pumped or treated construction water from the isolated construction area will be discharged directly to the surface water network associated with the Site (This is in accordance with Local Government (Water Pollution) Act, 1977 as amended). It is noted that all runoff on the site will eventually discharge to the receiving surface water network, however with appropriate management the quality of runoff discharging to the surface water network will be acceptable e.g. <25mg/l Suspended Solids.

- Operation of machinery in-stream will be kept to an absolute minimum and avoided where possible. Where in stream works are required, the area will be isolated by means of over pumping or drainage diversion (**Appendix 9.6 Tile 1**), discussed further below.
- Works in relation to watercourse crossings will be carried out during periods of sustained dry meteorological conditions and will not commence if sustained wet conditions or if wet conditions are forecast (**Section 9.5.2.1**).
- Works in relation to watercourse crossings will be planned and carried out as efficiently as possible. This means work plans are agreed fully and all equipment and materials are prepared fully before in stream works commence. Works will be completed as quickly as possible and will not pause for the duration of the in stream works e.g., Installation of culverts (24 hour as necessary), with the exception of circumstances related to meteorological and/or health and safety conditions.
- Only precast concrete will be used for in stream works.
- Precautions will be made to mitigate the potential risk of a hydrocarbon spill. Further to measures outlined in **Section 9.5.2.4**, settlement tanks (will be adequately equipped with hydrocarbon removal functionality on standby, for example hydrocarbon absorbent booms, oil skimmers, and GAC (granulated activated carbon) filters, should they become necessary (**Appendix 9.6 – Tile 8**).

9.5.2.8.2 Diversion of Drainage

Diversion of artificial drainage channels will be required at locations where the development layout intercepts existing artificial drainage networks (**Figure 9.5a**), for example T9 and T5 and their associated hardstand area is overlain on an existing drainage feature.

Diversion of drainage will be done under similar conditions to that described above for instream works. Many of the existing constructed drainage channels are observed to be dry during sustained dry meteorological conditions which implies that over pumping or diverting of water flow may not be necessary, nonetheless the methodology described for instream works will be implemented to mitigate the risk of any flow through the construction area or for unforeseen wet meteorological events.

Any newly installed drain will be fully formed prior to the diversion of existing drainage.

Erosion control will be incorporated into the design (**Appendix 9.6– Tile 2**), this requires minimising the area of exposed soil in existing and newly established channels. This will include a combination of the use of coarse aggregate / crushed rock (non-friable / non-weak), engineered solutions and/or revegetation.

A series of temporary silt fences will be installed to mitigate against the entrainment and mobilisation of solids during key events during the construction process, for example, the initial use of the new diverted channel, or the infilling of the original channel made redundant (**Management Plan 3: Surface Water Management Plan, Appendix 2.1).** The use of silt screens as a form of mitigation during watercourse crossing works is considered a precautionary measure. Refer to **Appendix 9.6 – Tile 2** for further information on the recommended ordering of control measures.

9.5.2.9 Grid Connection Route – Excavation of Cable Trenches, Watercourse Crossings and Horizontal Directional Drilling

Excavation and installation of cable ducts within existing bridges (alteration) will require consent from the OPW and various mitigation measures. Mitigation measures outlined in this Report have been developed to minimise the environmental impacts of the grid connection route on the receptors of conservation importance that have been recorded in the area. Mitigation measures mentioned in this Report are included in the CEMP, **Management Plan 2- Water Quality Management Plan, Appendix 2.1**.

Detailed site investigations, method statements and risk assessments will be carried out with a view to identifying and qualifying risk associated with all watercourse crossings associated and in close proximity to the grid route connection corridor. In relation to directional drilling, and the general risk to groundwater during grid connection route construction, risk assessment and prescription of mitigation measures will be designed in accordance with relevant guidance and reference documents, **Section 9.2.2**.

Risk assessments involved identifying pathways and receptors for each potential source of contamination. This included each directional drilling location and is particularly important in relation to groundwater source protection zones and surface water bodies protected for the purposes of drinking water. Prescription mitigation measures are driven by the identification and qualified risk associated with each particular location and are as follow:

General Overview of Works Mitigation Measures

- The timing of grid connection cable laying will be carried out during metrologically dry seasons/periods.
- An Ecological Clerk of Works (Ecological Clerk of Works (ECoW)) should be onsite in order to lessen environmental disruption and ensure site integrity is maintained. The Ecological Clerk of Works (ECoW) will also be responsible for routine environmental monitoring and report writing.

- Methodology Statements of works, prepared by the Contractor, will be submitted to the local and relevant authorities associated with the Development.
- Any temporary access structures, put in place to allow machinery access to the area will be arranged in discussion with the Ecological Clerk of Works (ECoW) and the site will be fully restored post grid route connection (GRC) works.
- All chemical fluids used in the boring process are to be inert to the environment (environmentally safe) and follow the relevant legislation. The Contractor is to retain a chemical register and have Safety Data Sheet (SDS) documents available onsite during the operation. The Contractor will also be responsible for a Fluid Management procedure which should include:
  - Drilling Fluid program and MSDS
  - Management of spoil including volume on site, specialised site storage
  - Management of drilling fluid displacement (expected volumes and proposed storage)
- Considering the high volumes, high flow rates and high contaminant content (drilling spoil) of water arising for drilling activities, water will be managed and treated by means of a settlement tank and/or associated infrastructure (**Appendix 9.6 – Tile 8**). If a separation (recycling) system is to be used it must be adequately sized and bunded to handle the through-put of the drilling fluid so continuous drilling and reaming operation can be maintained. A separation system must be complete with screens and hydro - cyclones to separate the solids from liquid. Drilling fluids and drill spoils will be disposed off-site at an approved licensed location or discharged to the local surround area with approved licencing permits.

Good Practice of Plant Machinery

- All equipment used during HDD will be in good working order, checked regularly and maintained when necessary. Fluid return lines used in HDD process should be tested for leaks prior to use to check their reliability. Plant machinery not in use is required to have drip trays below engines as well as at refuelling points, if necessary.
- All practices involving bentonite will be monitored closely, that is: pumping pressure, drilling mud formulation i.e., drilling fluid volume and the volume of mud returns.
- Fuels, lubricants and hydraulic fluids for equipment use on Site will be carefully handled to avoid spillage, properly secured and provided with spill containment kits in case of incident to ensure best practice.
- Spill kits, hydrocarbon mats, oil booms etc., will be maintained at areas of works for emergency use and replaced when necessary.

Contingency Plan

- In the event that a drilling fluid spill or 'breakout' occurs, the Contractor shall cease drilling immediately, notify the Ecological Clerk of Works (ECoW) and Emergency Service Management Personnel.
- Emergency contact numbers for the Local Authority Environmental Section, Inland Fisheries Ireland, the Environmental Protection Agency and the National Parks and Wildlife Service will be displayed in a prominent position within the site compound. These agencies will be notified immediately in the event of a pollution incident.
- The Contractor is to draft and apply a Contingency Plan highlighting with the principal HDD risks. At minimum, the Contractor will have equipment and materials on standby to mitigate against the following risks associated with HDD[34]:
    - Hydro-lock (loss of fluid flow)
    - A hydro-fracture incident (loss of fluid pressure)
    - Fluid spill over
    - Hydrocarbon/fuel spill
    - Drill pipe rupture
    - Borehole path failure
    - Major workplace safety events in remote areas
- The HDD operators will need to be equipped with straw bales, stakes to secure bails, oil booms, silt fences, sandbags, shovels, pumps, and any other materials or equipment necessary to contain and clean up and properly dispose of unintentional releases.

9.5.2.10 Groundwater Contamination Proposed Mitigation Measures

As identified and discussed, the risk posed to groundwater quality by the Development is low, however mitigation measures to further reduce the risk will be implemented.

The main threat to groundwater quality is the introduction of hydrocarbons to the site. In order to mitigate groundwater contamination by hydrocarbons in particular, the following will be implemented:

- Minimum fuel storage will occur on site and re-fuelling of vehicles will occur off-site at a controlled fuelling station whenever possible.
- Where fuelling must occur on site due to logistical reasons, then a discrete "fuel station" will be used.
- For large machinery such as cranes, drip tray will be used and spill kits will be on hand.

[34] MDM (2018) "Rockabill System Specifications for Cable Installation", McMahon Design & Management Ltd. Consulting Engineers and Project Managers, Job no. 1319

The following mitigation measures will be implemented in relation to non-hydrocarbon potential contamination:

- Wastewater from sanitation facilities will be mitigated by use of temporary and portable sanitary facilities that are self-contained. These facilities will not interact with the existing hydrological environment in any way and they will be maintained, serviced and removed from site at the end of the construction phase.
- Inorganic nutrients such as nitrogen and phosphorus compounds (if present in excavated sediment and as discussed in discussed in **Section 9.4.3.2 with commercial forestry**) will be controlled by the attenuation of the suspended solids to which they adsorb to and by retention of discharge waters within stilling ponds to allow peak runoff to recede prior to discharge (refer to the next section, **9.5.2.12** for monitoring details). It is noted that the baseline surface water chemistry indicates elevated Ammoniacal Nitrogen and Phosphate.
- Bacteriological contamination arising from availability of nutrients (e.g. livestock etc.) will be mitigated by appropriate self-contained sanitation facilities (above) and livestock grazing control on the site overall, but particularly on areas zoned for excavation and development.
- There is low risk of mobilising trace metals that may naturally be present, refer to **Appendix D of Appendix 8.1** for recorded locations of iron pan. The potential impact may arise from introduced water percolation with excavated bedrock substrate[35]. Concentrations of trace metals are usually low in the natural environment; however, water quality will be checked for metals concentration before, during and after the construction phase as part of monitoring at river monitoring locations.

9.5.2.11 Groundwater Extraction Proposed Mitigation Measures

No significant potential impact identified.

9.5.2.12 Monitoring

9.5.2.12.1 Monitoring (Wind Farm Site)

To ensure effective implementation of mitigation measures, environmental auditing, and monitoring of environmental obligations of the Developer, an Environmental Clerk of Works (Ecological Clerk of Works (ECoW)) will be assigned by the Developer to carry out monitoring at the Site during the construction and operational phases of the Development. The role of the Ecological Clerk of Works (ECoW) will be to actively and continuously monitor site conditions and advise on environmental issues and monitoring compliance, and will not be responsible for implementing measures, the due duty of implementing measures

[35] Teagasc (n.d.) "Research Soils Special: Irish Soil Information System" *Agriculture and Food Development Authority*

will be held by the Developer / contracted construction operator. The Ecological Clerk of Works (ECoW) will have the authority to temporarily stop works in a particular area of the site to ensure corrective measures are implemented and adverse environmental impacts are minimised if not avoided.

Monitoring of pollution prevention and mitigation undertaken by the Ecological Clerk of Works (ECoW) assigned by the Developer will include:

- Monitoring site pollution prevention plan.
- Water quality monitoring.
- Advising on required pollution prevention measures (as described in this EIAR) and monitoring their effectiveness.
- Liaison with local authorities in relation to pollution instances if applicable.
- Considering the Ecological Clerk of Works (ECoW) will be responsible for monitoring a broad range of environmental factors at the Site, technical monitoring and advice will be sought such as from specialist consultants as the need arises e.g., installation and website for telemetry.

The following measures will be implemented for Site monitoring in relation to the hydrological and hydrogeological impacts:

- The baseline monitoring undertaken at the Site as part of this study will be repeated periodically before, during and after the construction phase of the Development to monitor any deviations from baseline water quality that occur at the Site. This monitoring along with the detailed monitoring outlined below will ensure that the mitigation measures that are in place to protect water quality are working. Specifically, a construction period and post construction monitoring programme for the Site will include the following:
- During the construction phase, daily inspection of silt traps, buffered outfalls and drainage channels and daily measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations on the Site (**Figure 9.5a**) (locations close to active working zones). Monitoring of same during times when excavations are being dewatered (likely high in solids) will be done in real time. In this regard, physiochemical properties will be monitored in real time by means of alarmed telemetry e.g., telemetric monitoring at baseline sampling locations and alarm thresholds established in line with water quality reference concentrations/limits which will be set using relevant instruments for example, Surface Water Quality Regulations, <25mg/l Total Suspended Solids (TSS).

- Continuous Monitoring will be carried out as part of Active Management of construction water management and treatment (**Appendix 9.6**. These monitoring systems will travel with the active construction areas / remain with the Active Management infrastructure. The purpose of this is to recycle water if quality is unfavourable and adjust the dewatering and treatment train accordingly until discharge quality is observed to be acceptable. A small degree of tolerance above reference concentrations is acceptable at this location but only if the discharge from the Active Management train discharges to another Passive Management system or to a non-sensitive vegetated area. If discharging within sensitive areas or buffer zones, the quality of discharge from the Active Management train will be in line with prescribed reference limits (e.g., 25mg/l TSS)
- Continuous Monitoring at downstream Baseline SW Monitoring Locations (**Figure 9.5a** will be carried out using telemetry during the construction phase. Triggering of the threshold at these locations will trigger emergency response and escalation of measures including immediate full site inspection to ascertain to the potential unknown source (bearing in mind that the quality of managed runoff at the site will be known by means of live telemetry and handheld meters). Continuous monitoring at Baseline SW Monitoring Locations will continue into the operational phase until stable conditions are observed e.g., stable conditions in line with baseline conditions for 6 months.
- Post construction: inspection of silt traps, buffered outfalls and drainage channels, measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations at the Site will be carried out at a reasonable frequency (weekly initially gradually reduced based on observed stability of conditions), and will also be scheduled following extreme metrological events (**Section 9.5.2.1**). During the operational phase of the project the stilling ponds and buffered outfalls will be periodically inspected e.g., weekly during maintenance visits to the Site initially and gradually reduced based on observed stability of conditions.
- During the construction phase of the project, the Development areas will be monitored daily for evidence of groundwater seepage, water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system so that it does not become blocked, eroded or damaged during the construction process. This monitoring will continue at a reasonable frequency (weekly initially gradually reduced based on observed stability of conditions) during the operational phase of the Development, however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.
- During the construction phase of the project, the Development areas and adjacent receiving drainage systems will be monitored daily for evidence of erosion and other

adverse impacts to natural drainage channels and existing degraded areas whereby soils/peat are exposed and prone to enhanced degradation. This monitoring will continue at a reasonable frequency during the operational phase of the Development, however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.

- During both the construction and operational phases of the project watercourse crossings will be monitored frequently (daily during construction and intermittently during operational phase i.e., weekly / monthly inspections initially and reduced gradually in line with observed stability and confidence in longer term data obtained. The water course crossings will be monitored in terms of structural integrity and in terms of their impact on respective watercourses.
- A detailed inspection and monitoring regime, including frequency is specified in the Construction Environmental Management Plan (CEMP), Management Plan 2: Water Quality Management Plan, **Appendix 2.1**. This includes an environmental risk register (**EIAR Chapter 16: Major Accidents and Natural Disasters**) e.g., constraints linked to the development construction schedule, routine reporting on the performance and effectiveness of drainage and attenuation infrastructure, and any actions taken to rectify or enhance the system.
- Site water runoff quality at all surface water monitoring locations will be monitored on a continuous basis during the construction phase of the Development. Monitoring will continue into the operational phase until such time that the Site and water quality have stabilised (stable conditions in line with baseline conditions for e.g., 8 consecutive quarterly monitoring events). This monitoring will be carried out at the downstream surface water baseline sampling location **(Appendix 9.6**)
- Continuous monitoring systems will be in place, particularly in principal surface water features draining the site. For example, remote sensing, or telemetric monitoring sensors (turbidity) will be employed in this regard.
- At construction areas requiring drilling (HDD) and/or significant excavations (launch pits, cable joint bays), and in the management of general excavations, arisings will be managed carefully with a view to containing and treating all drained water and runoff which will likely be laden with suspended solids. Active continuous monitoring will be required at these locations in line with the conceptual model presented in Appendix D – Tile 2. The monitoring location will be at the outfall or discharge point of the treatment train at any respective location. Continuous monitoring will include telemetry.
- Continuous Monitoring Locations or Telemetric Monitoring Stations (TMS) will use probes to monitor the following parameters:
    - Electrical Conductivity

  - Turbidity (Data obtained can be equated to estimated Total Suspended Solids (TSS) through calibration)
  - pH
  - Temperature
  - Capacity for additional probes.
- TMSs will be self-powered and will be comprised of the following components at a minimum:
  - Remote Telemetry Unit (RTU) – Modem / data hub and transmission.
  - Solar panel
  - Sensor – pH
  - Sensor – Turbidity
  - Sensor – Electrical Conductivity
  - Sensor Cleaning Device (SCD)(Turbidity probe)
  - Power Management Unit (PMU)
  - Power Bank (PB)
  - Website – presenting data trends over time.
  - Metal stand / frame and protective fencing.
  - The TMS will have capacity for additional parameters.
- Telemetric continuous monitoring sampling frequency is generally set at one data point per 15 minutes, however considering the intensive nature of the proposed works, particularly drilling activities, if possible it is recommended that sampling frequency is set at 5 minutes or less with a view to escalating responses to potential discharge quality issues in good time. Data is transmitted to a project website which will display data trends over time. Access to the website can be gained and shared via a website link.
- Telemetric Monitoring Systems will be used a key part of Active Management of runoff and construction water at the site, as presented in **Appendix 9.6 – Tiles no. 7 to 9**.
- A handheld turbidity meter will be available and used to accurately measure the quality of water discharging from the site at any particular location. The meter will be maintained and calibrated frequently (per the particular unit's calibration requirements / user manual), and will also be used to check and calibrate remote sensors if they are employed. Quality thresholds have been established for the purposes of escalating water quality issues as they arise.
- Rainfall will be monitored (1 no. rainfall gauge required). This unit will be connected with and displayed with other site water quality telemetry data via the telemetry website.
- Surface water runoff control infrastructure will be checked and maintained on an ongoing basis, and stilling ponds and check dams will be maintained (de-sludge / settle

solids removed) on an ongoing basis, particularly during the construction phase of the Development. It is important to minimise the agitation of solids during these works, otherwise it will likely lead to an acute significant loading of suspended solids in the drainage network. This can be achieved by temporarily reducing or blocking inkling flow and vacuum extracting settled solids or *sludge*. Where the drainage feature posses relatively significant flow rates, isolating and over pumping is the best course of action.

- As part of the Construction Environmental Management Plan (CEMP), Management Plan 2, regular checking and maintenance of pollution control measures are required (in line with frequencies outlined above), with an immediate plan for repair or backup if any breaches of design occur. In the event that established infrastructure and measures are failing to reduce suspended solids to an acceptable level, construction works will cease until remediation or upgrading works are completed.
- All details in relation to monitoring will be included in the Surface Water Management Plan (SWMP) (**Appendix 2.1**).

Monitoring of potential hydrological impact of the Development, particularly during the operational phase will be inherently linked to the ecological health of the blanket peat (as a functioning ecosystem) and therefore both hydrology and ecology will be considered, and monitored in tandem. For example, impacts to the hydrological regime at the Site can potentially impact on the ecological health or characterisation of the Site, and vice versa. Ecological indicators can potentially provide useful data in relation to the long-term impact of changes to the hydrological regime at the Site. However, as discussed in earlier section of this report (**Section 9.4**), changes to the management of runoff and in turn the hydrological regime at the site will lead to a positive impact overall when compared to the baseline conditions associated with the site e.g. introduction of intermittent buffered outfalls along the length of the drainage network is in contrast to baseline, this will promote a more even distribution runoff, attenuate runoff and reduce the hydrological response to rainfall, enhanced potential for recharge to ground, and in turn raising bog water levels resulting in wetting of blanket peat at the Site (**Section 9.5.1.2**).

9.5.2.12.2 Monitoring (Grid Connection Route and Turbine Delivery Route)

Monitoring will be carried out at each significant construction location (HDD, any excavation >2.0m, temporary bridge construction) and at significant environmental receptors including the following Environmental Monitoring Locations:

- Up stream and down stream of surface water crossings on mapped rivers.
- Operational wells within groundwater buffer zones associated with significant construction locations (namely SW Crossings).

- Groundwater abstraction points within buffer zones (mapped wells, source protection areas, and/or associated Regionally Important Karst Aquifer).

Monitoring proposed will be specified relative to the particular activity and associated risk at respective locations.

Routine Surface Water Monitoring

Similar to Wind Farm Site baseline monitoring, baseline surface water samples will be obtained at upstream and downstream sampling locations at each significant construction location over mapped rivers. Baseline surface water samples will be obtained at accessible locations such as existing bridges on public roads. Where upstream access is poor, the upstream baseline sampling location will be directly/immediately upstream of the construction location (e.g., existing bridge / culvert).

Routine Groundwater Monitoring

At Horizontal Directional Drilling (HDD) locations, any mapped wells identified in HDD groundwater buffer zones (250m) will be monitored to establish baseline, and routinely monitored during the construction and for a period into the operational phase of the development. All abstraction points associated with groundwater source protection areas and within Regionally Important Karst aquifers associated with the development will be monitored with the same frequency.

Continuous Monitoring of Active Construction Water Management and Discharge

At construction areas requiring drilling (HDD) and/or significant excavations (launch pits, cable joint bays), and in the management of general excavations, arisings will be managed carefully with a view to containing and treating all drained water and runoff which will likely be laden with suspended solids. Active continuous monitoring will be required at these locations in line with the conceptual model presented in (**Appendix 9.6)**. The monitoring location will be at the outfall or discharge point of the treatment train at any respective location. Continuous monitoring will include telemetry.

Continuous Monitoring Locations or Telemetric Monitoring Stations (TMS) will use probes to monitor the following parameters:

- Electrical Conductivity
- Turbidity (Data obtained can be equated to estimated Total Suspended Solids (TSS) through calibration)
- pH
- Temperature
- Capacity for additional probes.

TMSs will be self-powered and will be comprised of the following components at a minimum:

- Remote Telemetry Unit (RTU) – Modem / data hub and transmission.
- Solar panel
- Sensor – pH
- Sensor – Turbidity
- Sensor – Electrical Conductivity
- Sensor Cleaning Device (SCD)(Turbidity probe)
- Power Management Unit (PMU)
- Power Bank (PB)
- Website – presenting data trends over time.
- Metal stand / frame and protective fencing.
- The TMS will have capacity for additional parameters.

Telemetric continuous monitoring sampling frequency is generally set at one data point per 15 minutes, however considering the intensive nature of the proposed works, particularly drilling activities, if possible it is recommended that sampling frequency is set at 5 minutes or less with a view to escalating responses to potential discharge quality issues in good time. Data is transmitted to a project website which will display data trends over time. Access to the website can be gained and shared via a website link.

In line with monitoring objectives in relation to surface water quality, parameter value thresholds or limits will be established on the telemetry website, text and email alerts will be established which will notify relevant assigned persons of trend anomalies which require investigation, escalation, and corrective mitigation, for example:

- A threshold of 25mg/l Total Suspended Solids (TSS) will be applied at treatment train outfalls/discharge points, in line with legislative reference limits for surface water quality. Exceedance of such threshold will trigger further investigation and escalation of responses on site with a view to identifying potential uncontrolled sources of contaminants. Parameter trend analysis will also inform investigations and response, for example, intermittent spikes in concentrations in line with baseline conditions versus continuously elevated concentrations caused by an ongoing environmental incident.
- The website will be periodically checked and maintained on a weekly basis at a minimum. The client will also receive maintenance alerts in relation to the monitoring stations, for example, in the event data is not being received from a particular probe the client / assigned person/s will be notified by the system and maintenance call outs will be conducted.

9.5.2.12.3 Active Monitoring on Site

Handheld meters (Turbidity / Total Suspended Solids (TSS)) will used by the ECoW / competent operators during construction works. This will be done with a view to managing water treatment and anticipating potential surcharges in water or TSS loading within the treatment train. Handheld meters will also be used to monitor outfall/discharge quality in the event telemetry systems fail or during system maintenance. Handheld probes will be checked and calibrated regularly.

9.5.2.12.4 Monitoring Under Licence

Where a discharge licence is required, the conditions of the licence will stipulate monitoring requirements in line with licence parameters with associated emission limit values. The frequency of sampling will likely be daily or weekly. Sampling will include obtaining physical samples at an agreed discharge sampling point and will be sent an accredited laboratory for analysis. Where discharge licence is required, monitoring in line with the licence will be done in addition to the other monitoring regimes undertaken as described in sections above. Monitoring under licence conditions will not negate the requirement for the other regimes described.

9.5.2.12.5 Tailoring of Monitoring Requirements

Monitoring will be tailored at each location in terms of requirements set out in trade effluent discharge licence/s where relevant.

- The baseline monitoring undertaken at the proposed site as part of this study will be repeated periodically before, during and after the construction phase of the Development to monitor any deviations from baseline hydrochemistry that occur at the site. This monitoring along with the detailed monitoring outlined below will help to ensure that the mitigation measures that are in place to protect water quality are working. Specifically, a construction period and post construction monitoring programme for the Development site should include the following.
- During the construction phase; daily inspection of silt traps, buffered outfalls and drainage channels and daily measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations on the site. Monitoring of same during times when excavations are being dewatered (likely high in solids) should be done in real time.
- Post construction: at a reasonable frequency inspection of silt traps, buffered outfalls and drainage channels, measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations at the site. During the operational phase of the project the stilling ponds and buffered outfalls will be periodically inspected during maintenance visits to the site.

- During the construction phase of the project, the development areas should be monitored daily for evidence of groundwater seepage, water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system so that it does not become blocked, eroded or damaged during the construction process.
- During both the construction and operational phases of the project, watercourse crossings should be monitored frequently (daily during construction and intermittently during operational phase). The water course crossings should be monitored in terms of structural integrity and in terms of their impact on respective watercourses.
- A detailed inspection and monitoring regime, including frequency has been specified in the Construction and Environmental Management Plan (CEMP, **Appendix 2.1** Management Plan 2).

9.5.2.13 Clear Fell of Forestry

No new impacts or remediation measures are associated with forestry activities. However, good practices working in specific environments such as forested areas will be adhered to including working outside of surface water or other buffer zones, and risk assessing on a case by case basis in terms of drainage intercepting run off, ecological sensitivities, etc.

Further mitigation measures in regard to the management of forestry operations are detailed in application report Veon Ltd. (March 2022) Forestry Report – Proposed Wind Farm at Gortyrahilly Co. Cork (**Appendix 2.2**), including:

- Phased felling approach,
- Minimising erosion by use existing tracks and use of brash for off track areas,
- Follow all relevant forestry guidance and policies, including:
  - Forest Protection Guidelines
  - Forestry and Water Quality Guidelines
  - Forest Harvesting and Environmental Guidelines
  - Forestry and Freshwater Pearl Mussel Requirements - Site Assessment and Mitigation Measures
  - Forest Biodiversity Guidelines
  - Forestry and The Landscape Guidelines
  - Forestry and Archaeology Guidelines
- The permanent felling of 35.4 ha of forestry is subject to replacement obligations.
- Harvest site plans including extraction routes, fuelling areas, stacking areas, turning areas and drain crossings etc. and HIRA will be designed and implemented during all harvesting operations.

- All drains, either mound drains, culverts, water crossings crossed during extraction, if necessary, will be cleared of any debris to ensure no drainage issues will occur for the remining trees, which can be a major attributor to windblow.
- Felling and extraction of timber will, are to be undertaken in dry weather conditions.
- Harvesting operations are scheduled according to the nature of the soil with sites being categorised into winter and summer sites depending on ground conditions. Also, best practice is to suspend mechanised harvesting operations during and immediately after periods of particularly heavy rainfall.
- Waterways are particularly vulnerable to the effects of harvesting as silt from the movement of machinery can enter streams and rivers causing blockage of gravels which affects insect and fish life. Also nutrients released from decaying branches, particularly from large clearfelled sites, can cause enrichment of the waters which in turn causes pollution. To counteract these effects careful planning is required in carrying out harvesting operations. Some of the measures taken to avoid impacts include:
    - Limiting the size of the areas to be felled which reduces the amount of nutrients and silt released.
    - Minimising the crossing of drains and streams, but where necessary installing temporary structures (log bridges, pipes etc) to avoid machines entering the water.
    - Establishing buffer zones around waterways from which machines are excluded.

9.5.2.14 Emergency Response

Monitoring of the development during the construction and operational phase will potentially indicate weaknesses of the drainage and attenuation design, and/or the potential for excessive loading at particular locations etc. In such instances corrective actions will be taken to mitigate against any potential adverse impacts. Depending on the severity of the issue there is the potential that immediate action will be required, for example the introduction of straw bales to reduce flow / enhance attenuation at a particular location, erect silt fences etc., however such measures will be temporary. Any issue observed will require assessment by a specialist consultant and alternative mitigation design (in line with measures described in this EIAR) will be implemented to ensure the efficacy of the system during both the construction and operational phases of the Development. Scenarios where corrective action may be required, and proposed corrective mitigation measures include:

- Potential issue; Elevated concentrations of suspended solids in runoff during excavation activities during an unforeseen or low probability storm event, for example a 1 in 100 year event. Proposed measure; Cover exposed stockpiles in plastic sheeting and placement of straw bales and silt fences in associated drainage channels.

- Potential issue; Failure or degradation of stone check dam during a storm event with associated elevated runoff volumes. Proposed measure; Introduction of straw bales and silt fences in order to regain attenuation capacity of the drainage channel until the maintenance can be completed.
- Potential issue; Localised peat stability issue leading to deposit of peat within an active drainage channel. Proposed measure; Introduction of straw bales and silt fences directly downstream, of the area in order to attenuate gross solids isolate the area and over pump until remedial works and maintenance can be completed, divert all runoff from the area to Active Management area of the treatment train (**Appendix 9.6 – Tile no. 7 to 9**).
- Potential issue; Management of unexpected runoff patterns leading to excessive drying or wetting in a particular area, potentially leading to enhanced erosion and / or adversely impacting on the ecological health of blanket peat ecosystems. Proposed measure; This type of issue will require assessment on a case by case basis. Solutions might include; decommission, modification, introduction or relocation of buffered outfall, or diversion of runoff volumes to or away from the area. In regard to the potential for erosion and similar physical processes, any such issues will become apparent through monitoring relatively rapidly, whereas impacts to ecological sensitivities will become apparent relatively slowly in comparison. It is noted that much of the Site is impacted as part of baseline (**Section 9.3.7 and Section 9.4.4.1**) in this regard e.g. extensive existing artificial drainage networks.

Prior to commencement of construction, the Environmental Clerk of Works will prepare a register of corrective action and emergency response sub-contractors that can be called upon in the event of an environmental incident, and/or to give training on escalating incident where useful, including e.g. specialist hydrocarbon spill response, specialist hydrological and/or water quality response.

Mitigations measures as outlined in the previous sections will reduce the potential for contamination of waters during the construction phase of the proposed development, however there remains the risk of accidental spillages and or leaks of contaminants, and excessive loading of surface water mitigation infrastructure.

Emergency responses to potential contamination incidents will be established and form part of the CEMP, **Appendix 2.1**, Management Plan 1: Emergency Response Plan. Potential emergencies and respective emergency responses include:

- Hydrocarbon spill or leak – Hydrocarbon contamination incidents will be dealt with immediately as they arise. Hydrocarbon spill kits will be prepared and kept in vehicles associated with the construction phase of the proposed development. Spill kits will also be established at proposed construction areas, for example, a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.
- Significant hydrocarbon spill or leak – In the event of a significant hydrocarbon spillage, emergency responses will be escalated accordingly. Escalation can include measures such as installation of temporary sumps, drains or dykes to control the flow or migration of hydrocarbons and contaminated runoff will be contained, managed and pumped to a controlled area in line with Active Management including treatment through a suitably equipped treatment tank and Granular Activate Carbon (GAC) vessels. This process will be managed by the Ecological Clerk of Works (ECoW) in conjunction with a preidentified consultant (Ecological Clerk of Works (ECoW) specialist register) in regard to effective remediation, treatment and removal of hydrocarbon contaminated water and soils Excavation and appropriate disposal of contaminated soils will be required in this instance.
- If a significant hydrocarbon spillage does occur, the contractor on behalf of the developer will have an approved and certified clean-up consultancy available on 24-hour notice to contain and clean-up the spill. The faster the containment or clean-up starts, the greater the success rate, the lower the damage caused and the lower the cost for the clean-up.
- Cementitious material – Cement / concrete contamination incidents will be dealt with immediately as they arise. Spill kits will also be established at proposed construction areas, for example a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for cementitious materials will also be at hand.

In the event of a significant contamination or polluting incident the relevant authorities will be informed immediately.

9.5.2.15 Managing & Reporting Environmental Incidents

Environmental incidents including accidental spillages on soils (e.g., fuel), breeches of licence limits if applicable (discharge of trade effluent), and significant environmental incidents (e.g. landslide) will be reported to the Local Authority as part of emergency responses to such incidents. Incident notification will be escalated to relevant third parties where relevant e.g., Inland Fisheries Ireland (IFI) if surface water receptors are intercepted.

9.5.2.16 Construction Phase Residual Impacts

Mitigation measures outlined in this report lay down the framework to reduce all potential impact of the Development on Hydrological and Hydrogeological receptors. The *Mitigated Potential Impacts* lay down the achievable benchmarks provided measures are considered and implemented adequately.

Impact	**Mitigated Impact**
Release of suspended solids (and other associated contaminants e.g. nutrients) entrained in runoff, intercepted by surface water network.	Neutral to Negative, direct, imperceptible to slight, temporary.
Release of hydrocarbons in runoff, intercepted by surface water network.	Neutral to Negative, direct, imperceptible to slight, temporary.
Release of hydrocarbons to ground, intercepted by groundwater.	Neutral to Negative, direct, imperceptible to slight, long term.
Release of waste water / chemicals in runoff, intercepted by surface water network.	Neutral to Negative, direct, imperceptible to slight, temporary.
Release of waste water / chemicals in runoff, intercepted by groundwater.	Neutral to Negative, direct, imperceptible to slight, temporary.
Release of cementitious material in runoff, intercepted by surface water network.	Neutral to Negative, direct, imperceptible to slight, temporary.
Reaction between concrete and surface water / runoff and concrete adversely altering hydrochemistry.	Neutral to Negative, direct, imperceptible to slight, temporary.
Reaction between concrete and groundwater adversely altering hydrochemistry.	Neutral to Negative, direct, imperceptible, temporary.
Dewatering - Lowering of bog water / groundwater table proximal to relatively deep excavations.	Neutral to Negative, direct, imperceptible, temporary.

Impact	Mitigated Impact
Drying - Lowering of bog water / groundwater table proximal to respective drainage features.	Neutral to Negative, direct, imperceptible, temporary.
Wetting – Excess discharge in a particular area (local flooding)	Neutral to Negative, direct, imperceptible, temporary.
Increasing hydrological response to rainfall, or increase in runoff in regard to drainage network and downstream flood risk areas.	Positive to neutral through the use of 63 no. stilling ponds to be installed throughout the Development.
Altering hydrological regime at a particular location. Potentially leading to erosion / deposition not in line with baseline conditions.	Positive to neutral.
Altering hydrological regime at a particular location. Potentially leading to restricting water flow and flood risk.	Positive to neutral.

9.5.3 Operational Phase

9.5.3.1 Increase in Hydraulic Loading Proposed Mitigation Measures

The principles of the mitigation measures described under **Section 9.5.2.3** (check dams, stilling ponds, attenuation lagoons etc.) are based on the control and management of runoff discharge rates, which ensure the regulating the speed of runoff within the drainage network, buffering the discharge from the drainage network where possible, and maintaining the natural hydrological regime. As such, the measures described with a view to controlling the release of suspended solids also mitigate against the potential for rapid runoff and rapid hydrological responses to rainfall potentially leading to flooding and erosion of the drainage network or downstream of the development.

The same measures will be implemented with a view to mitigating against net increase surface water runoff arsing from the development. For example, the following conceptual model will be applied at a proposed turbine hardstand location:

- Collector drains; allowing for 0.5m depth, 1.0m width, presume semi-circular, sectional area; c. 0.4m^2. Presume 100m length of collector drain; up to 40m^3 capacity per 100m, by 50% allowing for gradient equates to 20m^3. Collector drains are not intended to store runoff, however the in line attenuation features, such as check dams and flow regulators will serve to reduce discharge rates dramatically, effectively backing up water and regulating the rate of discharge. The actual attenuation capacity of the drainage network and treatment trains will be calculated during the detailed design phase of the development. The actual attenuation capacity of the drainage network and treatment trains will be calculated during the detailed design phase of the development.

- Check dams at regular intervals throughout the drainage network (existing, new clean collector and new dirty collector drains) will attenuate runoff intercepted by respective drainage channels.
- Dirty water collector drains (associated with construction areas) will direct runoff to established stilling ponds. Stilling ponds will reduce the velocity of runoff, further reducing the hydrological response to rainfall.
- Buffered outfalls to vegetated areas will utilise the infiltration capacity of the ground prior to the rejected rainfall eventually being intercepted by the receiving surface water system.
- Clean water collector drains will intercept clean runoff (upgradient of construction areas) and will direct runoff around construction areas. The runoff will be attenuated by means of check dams and intermittent buffered outfalls (**Appendix 9.6 – Tile 7**).

The potential combined attenuation capacity of the proposed drainage infrastructure has been designed to attenuate net increase in water runoff during extreme storm events i.e. 1 in 100 year storm event plus a 20% allowance for global warming, as set out in **Appendix 9.1: SFRA**.

9.5.3.2 Operational Phase Residual Impacts

Impact	**Mitigated Impact**
Increase in hydrological response to rainfall at the Site and in downstream surface water bodies (increased runoff).	Positive to neutral with ecological value through restoring peatland via attenuation.

9.5.4 Development Decommissioning & Restoration

No significant excavations will occur during the decommissioning phase. No new impacts are anticipated during the decommissioning phase of the Project on the hydrological and hydrogeological environment therefore no additional mitigation measures are required, however the decommissioning of major infrastructure including proposed turbines, and, poses similar hazards and risks to the environment compared to that of the construction phase. Mitigation measures similar to the construction phase will be implemented.

In regard to decommissioning turbines, excavation of material is not anticipated, similarly vehicular movement on soil is not anticipated considering adequate hardstand will have been established, therefore the risk of release of suspended solids is low. Hardcore covering turbine foundations will be allowed to revegetate naturally. The risk of fuel or other contaminant spillages, or management of waste are valid hazards during the decommissioning phase of the proposed development.

In regard to cable ducting, for the grid route, cable joint bays will be left in-situ and cabling on site will be removed from the cable bays. The ground above original pulling pits/joint bays will be excavated to access the cable ducts using a mechanical excavator and will be fully re-instated once the cables are removed. Excavated material will be temporarily stored adjacent to the site of excavation at a height of less than 1m and outside of any surface water buffer zone.

Deconstruction works during the decommissioning phase of the proposed development pose similar hazards and risks associated with the construction phase but to a far lesser extent, for example the potential for fuel spills from vehicles is valid but there will likely be less vehicles required, for example, no excavators. The principle mitigation measures described in this EIAR chapter will be implemented by means of a Decommissioning Plan – see Management Plan 6 – Decommissioning Plan appended to the CEMP, **Appendix 2.1**.

9.5.5 Cumulative Effects

9.5.5.1 Water Quality – Wind Farm

The phasing/commencement of any other permitted developments in the locality could potentially result in the scenario where a number of other construction sites are in operation at the same time as the proposed development.

Considering the mitigation measures outlined in this report and the expected residual effect pending successful implementation of those measures i.e. neural impact to receptors, the development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrological network in terms of water quality

In the event of accidental or temporary contamination incidents, water quality in downstream receptors can potentially be adversely impacted, particularly during the construction phase. Such incidents will demand an emergency response on site and escalation of Active Management on site (**Appendix 9.6 Tiles 7 – 9).** Assuming other, similar developments, construction activities and potential adverse impacts in the area, there is the potential for such incidents to have a cumulative impact on water quality to some degree if such incidents occur on multiple sites in a short period of time and within the same hydrological catchments. However, it must be noted that similar sporadic natured impacts are part of baseline conditions at the site, including, land reclamation, excavation of drainage, commercial forestry, agricultural practices.

Allowing for worst case whereby a contamination incident occurs, the incident will likely be minor and temporary and therefore will unlikely contribute significantly to cumulative effects in the associated surface water network. The risk of a major landslide or mass movement to occur as a function of the development at the site is generally low (**Appendix 8.1**).

9.5.5.2 Hydraulic Loading

Due to a net increase in impermeable surface at the Site as part of the Development, a reduction in recharge to groundwater, and rapid transmission of runoff to surface water systems has the potential to significantly contribute to the cumulative / catchment hydrological response to rainfall.

Considering the mitigation measures outlined in this report and the expected residual effect pending successful implementation of those measures, the development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrological network in terms of hydraulic loading. In the event that there was no attenuation features included as part of the Development, due to the low recharge rates associated with the site, the net increase in runoff would be low relative to the scale of the associated catchments. However, with reference to **Appendix 9.1: SFRA**, the cumulative ground sealing nature of the entire built environment needs to be considered and therefore the Development in combination with other similar developments have the potential to have significant cumulative impacts to flood risk areas.

9.5.5.3 Groundwater Resource

The Development as a whole, including the Turbine Delivery Route and Grid Connection Route are not likely to significantly impact groundwater quantities or availability.

9.6 SUMMARY OF SIGNIFICANT EFFECTS

This chapter comprehensively assesses all scenarios within the Turbine Range which is described in **Section 9.1.1.1**. The potential impacts that could arise from the Proposed Development during the construction, operational and decommissioning phases relate to the potential for increased suspended sediment concentrations associated with site preparation activities and excavations for the infrastructure elements including the turbine foundations, cable trenches and watercourse crossings. There will be no change to the potential impacts or predicted effects irrespective of which turbine is selected within the Turbine Range.

This chapter identified the likely hydrological, and hydrogeological impacts of the proposed development. By summarising relevant guidance and legislation and outlining baseline information, it allowed for the assessment of the potential effects to be identified and their significance rated.

Elements of the design, construction and operation of the proposed Development that may potentially impact on the geological and water environment receptors have been identified and their pathways for impacts have been assessed. It has been determined that without mitigation, the proposed development would likely cause adverse impacts ranging from moderate to profound significance due to the sensitivity of the SAC hydrologically linked to elements of the Development. However, layout design amendments along with application of the specified mitigation during each phase of the development will reduce the potential significance to all receptors related to the development to 'neutral' or 'positive'. The proposed development will not impact upon any surface water or groundwater body as it will not cause a deterioration of the status of the body and/or it will not jeopardise the attainment of good status. The proposed development will not cause it to deteriorate and will not in any way prevent it meeting the biological and chemical characteristics for good status.

It is not considered likely that the proposed Development will have significant cumulative impact to the conservation status of ecological habitats and terrestrial mammals occurring in the surrounding countryside, over and above any pre-existing effect caused by historic land use practices.