APPENDIX 9-1

FLOOD RISK ASSESSMENT

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CAHERMURPHY WEST WIND FARM, CO. CLARE

SITE SPECIFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

MKO

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

DOCUMENT INFORMATION

Document Title:	**Cahermurphy West Wind Farm, Co. Clare Site Specific Flood Risk Assessment**
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Signed:	 ______________________________ **Michael Gill B.A., B.A.I., M.Sc., MIEI Managing Director – Hydro-Environmental Services**

Disclaimer:
This report has been prepared by HES with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our terms and conditions and taking account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. The flood risk assessment undertaken as part of this study is site specific and the report findings cannot be applied to other sites outside of the survey area which is defined by the site boundary. This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) was engaged by MKO to undertake a Stage II Site Specific Flood Risk Assessment (FRA) for the Proposed Cahermurphy West Wind Farm and Grid Connection (Proposed Project) near Kilmihil in Co. Clare. A site location map is shown below as **Figure A.**

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

Where the 'Proposed Wind Farm' is referred to, this relates to all components within the Wind Farm Application under Section 37E of the Planning and Development Act 2000, as amended, as described in Section 4.1 of Chapter 4 of the EIAR and all associated lands.

The 'Proposed Grid Connection' relates to all components within the Proposed Grid Connection Application under Section 182A of the Planning and Development Act 2000, as amended, as described in Section 4.1 of Chapter 4 of the EIAR and all associated lands.

Refer to Section 2.3 below for a summary of the Proposed Project.

The following assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009).

1.2 STATEMENT OF QUALIFICATIONS

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

Our core area of expertise and experience is hydrology and hydrogeology, including flooding assessment and surface water modelling. We routinely work on surface water monitoring and modelling and prepare flood risk assessment reports.

Michael Gill P.Geo (BA, BAI, Dip Geol., MSc, MIEI) is a Civil/Environmental Engineer and Hydrogeologist with over 24 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. In addition, he has substantial experience in geological characterisation, peatland morphology, and surface water drainage design and SUDs design and surface water/groundwater interactions.

David Broderick (BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with 19 years environmental consultancy experience in Ireland. David has completed numerous hydrological and hydrogeological assessments for various developments across Ireland. David has significant experience in surface water drainage issues, SUDs design, flood modelling and flood risk assessment.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management in India. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016).

1.3 REPORT LAYOUT

This FRA report has the following format:

- Section 2 describes the Site setting and details of the Proposed Project;
- Section 3 outlines the hydrological and geological characteristics of the receiving environment;
- Section 4 presents a site-specific flood risk assessment (FRA) undertaken for the Proposed Project and then determines the requirement for a Justification Test;
- Section 5 reviews local authority planning policy; and,
- Section 6 presents the FRA report conclusions.

As stated above, this FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009). The assessment methodology involves researching and collating flood related information from the following data sources:

- OPW Flood Studies Update (FSU) Web Portal;
- Geological Survey of Ireland (GSI) maps on superficial deposits;
- EPA/WFD hydrology maps;
- OPW National Indicative Fluvial Mapping (NIFM) and CFRAM mapping;
- Clare County Development Plan 2023 – 2029 (including Strategic Flood Risk Assessment);
- Lidar data for the project site; and,
- Site walkovers and surveys conducted by HES on 11th September and 21st November 2019, 28th and 29th March, 26th April, 18th July 2024, and 29th July and 2nd October 2025.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Site along with a description of the Proposed Project.

2.2 SITE LOCATION AND TOPOGRAPHY

The Proposed Wind Farm site is located approximately 4.3km northwest of Kilmihil and 4.7km northeast of Creegh, Co. Clare.

The Proposed Wind Farm site is accessed via local roads from the R483 Regional Road, which travels north-south ~3.2km to the west of the Site, the R484 Regional Road which travels east-west between Kilmihil and Creegh and the L-2048 local road, which travels in a northeast-southwest direction between Kilmaley and Creegh.

The Proposed Wind Farm site itself is served by several kilometres of existing forestry tracks that enter mainly from the west. These existing forestry tracks have been in operation for a significant number of years. It is proposed that up to 5km of these existing tracks will be utilised by the Proposed Wind Farm.

The Proposed Wind Farm site comprises mainly of coniferous forestry planted on thin blanket bog with some poorly draining agricultural land on the east of the Site along with turbary peat cutting. Cahermurphy Phase I Windfarm is located immediately to the east of the Proposed Wind Farm site.

The elevation of the Proposed Wind Farm site, which has a total area of ~375ha, ranges between approximately 80 – 150m OD (metres above Ordnance Datum) with the overall drop in elevation towards the west. The Proposed Wind Farm site infrastructure is located across an east–west orientated ridge which slopes away to the north, south and west within the Proposed Wind Farm site. The majority of the ridge slopes steadily in a south-westerly direction from the topographic high point which exists on the east of the Proposed Wind Farm site (150m OD). The north facing aspect of the ridge slopes more steeply to the northwest. The lower-lying lands to the north and south of the ridge have a more undulating topography.

The Proposed Grid Connection includes the underground 110kV electrical cabling from the proposed on-site 110kV electrical substation within the Proposed Wind Farm site to the existing Moneypoint 110kV electrical substation in the townlands of Carrowdotia South and Carrowdotia North, south County Clare. The underground cable route measures approximately 25km in length and is located mainly within the corridor of third-class public roads along with some agricultural lands.

The proposed Turbine Delivery Route (TDR) to the Proposed Wind Farm site is from Shannon Foynes Port, via the N68 National Secondary Road. This will require accommodation works such as minor road widening (4 no. locations) and temporary access road construction through agricultural land (3 no. locations) between the N68 and the proposed Wind Farm site, including works at Kilmihil village.

A total of 123.74ha of Hen Harrier Enhancement lands are being proposed for the benefit of hen harrier. The proposed Hen Harrier Enhancement lands comprise areas of heath/bog, forestry, scrub and grassland located to the northeast of the Proposed Wind Farm site, just south of Doo Lough. The proposed lands comprise 3 no. separate parcels of forestry dominated land and 4 no. agricultural parcels that extend approximately 7km to the northwest of the Proposed Wind Farm .

2.3 PROPOSED PROJECT DETAILS

The Proposed Project (Proposed Wind Farm site and Proposed Grid Connection) is described in full in Chapter 4 of the accompanying EIAR.

Where the 'Proposed Wind Farm' is referred to, this refers to the 8 no. turbines and associated foundations and hard-standing areas, turbine delivery route (TDR) accommodation works, access roads, 2 no. temporary construction compounds, met mast, underground cabling, on-site 110kV substation, peat and spoil storage areas, wind farm drainage, tree felling, 2 no. borrow pits, Hen Harrier enhancement areas and all ancillary works.

The "Proposed Grid Connection" relates to the ~25km underground 110kV cabling route to Moneypoint 110kV electrical substation and all associated infrastructure where the route is primarily along public roads.

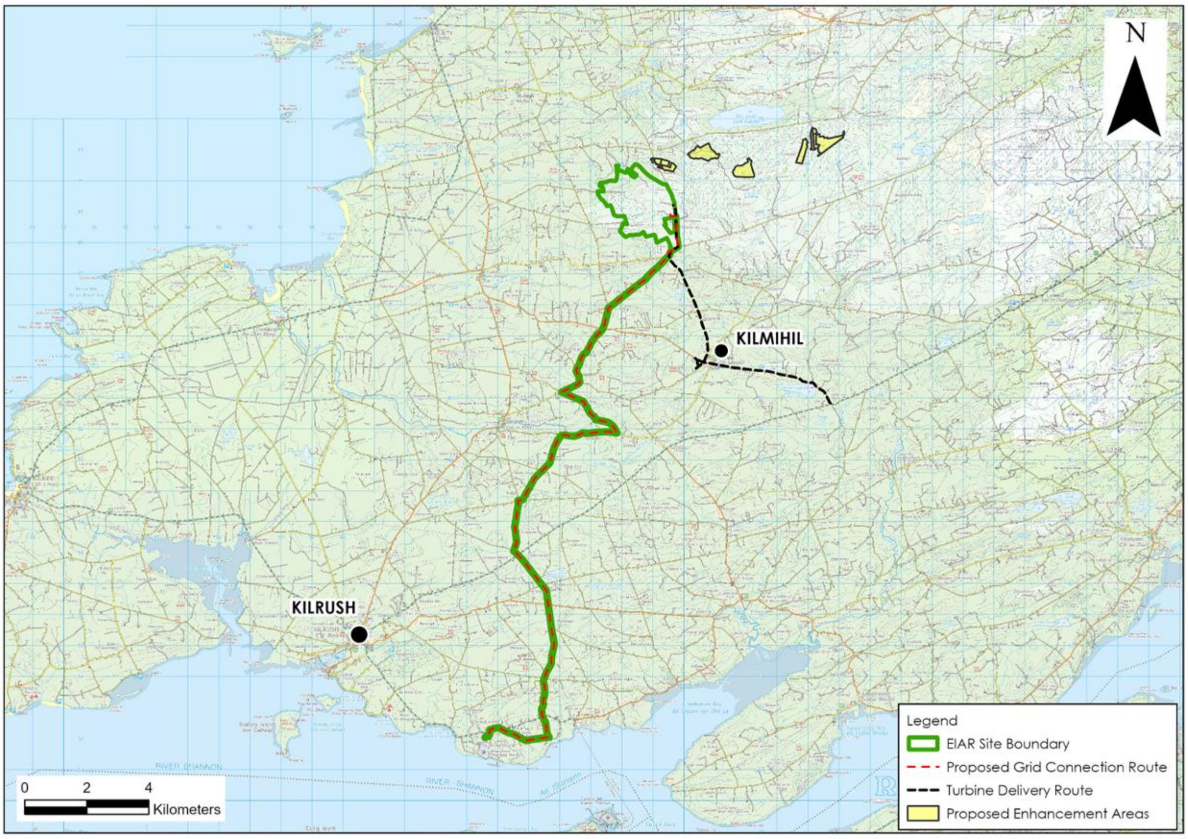

Figure A: Site Location Map

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics of the region and the Proposed Project site.

3.2 HYDROLOGY

3.2.1 Regional and Local Hydrology

Based on WFD/EPA regional catchment mapping, the Proposed Wind Farm is located in the Mal Bay catchment, while the Proposed Grid Connection exists within the Mal Bay catchment and the Shannon Estuary North catchment located further to the south.

The TDR exists only within the Mal Bay catchment, as well as the proposed Hen Harrier Enhancement lands.

On a more local scale the northern portion of the Proposed Wind Farm site (including 2 no. proposed turbine locations; T1 and T2) is located within the Annageeragh River sub-catchment (Annageeragh_SC_010) while the southern portion of the Proposed Wind Farm site (including 6 no. proposed turbines; T3 to T8 and the proposed Substation) is located within the Creegh River sub-catchment (Kiltumperstream_SC_010).

The Annageeragh River originates from Doo Lough which is located approximately 2.6km to the northeast of the Proposed Wind Farm site. There is no Proposed Wind Farm infrastructure within the Doo Lough catchment apart from the proposed Hen Harrier Enhancement lands which are located to the south of Doo Lough and drain to the north towards the lough.

On leaving the proposed Substation at the Proposed Wind Farm site, the Proposed Grid Connection cable passes through the Creegh River catchment (6.2km distance), the Doonbeg River catchment (10.2km distance), the Wood River catchment (4.2km distance) and the Crompaun River catchment (4.4km distance).

Temporary works area associated with the TDR are located Creegh River catchment and Doonbeg River catchment.

A regional and local hydrology map is attached as **Figure B.**

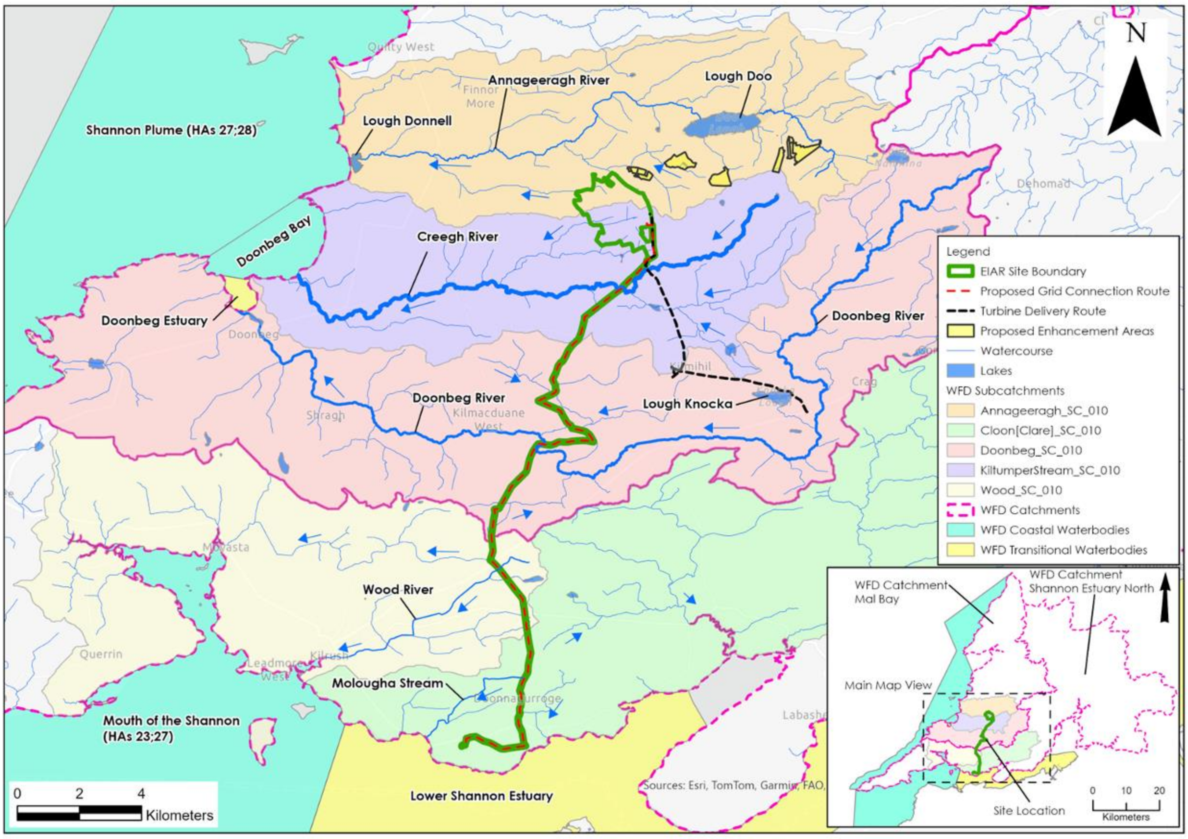

Figure B: Regional and Local Hydrology Map

3.2.2 Rainfall and Evaporation

The 30-year standard annual average rainfall (SAAR) (1981 - 2010) recorded at Inagh (Mount Callan), approximately 11km north of the Proposed Wind Farm site is 1,697mm/year (www.met.ie).

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Proposed Wind Farm Site ranges from 1,380 to 1,490mm/year. This rainfall data is more representative for the Site. The highest value is used in the below water balance.

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded at Shannon Airport. The long-term average PE for this station is 543mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Site is estimated as 516mm/year (which is 0.95 × PE).

Using the above figures, the effective rainfall (ER)[2] for the Site is calculated to be (ER = SAAR – AE) 974mm/year.

In addition to average rainfall data, extreme value rainfall depths are available from Met Eireann. **Table A** below presents return period rainfall depths for the area of the Proposed Wind Farm site.

[1] *Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.*
[2] *ER – Effective Rainfall is the excess rainfall after evaporation which produces overland flow and recharge to groundwater.*

These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (10-year, 50-year, 100-year).

Table A. Return Period Rainfall Depths (mm)

Duration	10-year	50-Year	100-Year
15 min	12.5	18.7	22.1
1 hour	19.6	27.8	32.1
6 hour	35	46.3	52
12 hour	43.9	56.4	62.6
24 hour	54.9	68.8	75.5
48 hour	68.2	83.7	91.1

3.3 GEOLOGY

A detailed description of the geology of the Site is presented in Chapter 8 of the EIAR (Land, Soils and Geology Chapter).

Regional baseline geological data is available from the GSI through their online map viewer (www.gsi.ie). The bedrock across the Proposed Wind Farm site is mapped as the Gull Island Formation (SILTSTONE and SANDSTONE). Subsoils are predominantly mapped as blanket peat and Namurian sandstone and shale tills. Similar bedrock and subsoils exist along the Proposed Grid Connection route.

A subsoil geology map for the Proposed Project site is shown as **Figure C** below.

The Proposed Wind Farm site investigations and geotechnical assessments were extensive and consisted of 583 peat depth probes, 36 no. trial pits and 2 no. bedrock boreholes. The geological setting of the Proposed Wind Farm site has been thoroughly assessed, and the geological/hydrogeological setting is fully understood.

Site investigations and geotechnical assessments at the Proposed Wind Farm (including the Hen Harrier Enhancement lands) are summarised as follows:

- Peat depths recorded across the Proposed Wind Farm (including the Hen Harrier Enhancement Lands) ranged from 0.0 to 6.1m with an average depth of 0.7m, which is considered shallow for blanket bog;
- Approximately 55% of recorded peat depth were less than 0.5m, 74% less than 1m and with 91% of less than 2.0m;
- The average peat depths recorded at the turbine locations varied from 0.25 to 1.6m with an overall average depth of 1.0m (this is considered shallow peat;
- With respect to the new proposed access roads, peat depths are typically less than 1.0m (average 0.55m) and therefore most roads will be constructed by excavate and replace method;
- At the 2 no. proposed borrow pit locations, peat depths are shallow (<0.5m);
- The geotechnical hand vane results indicate undrained shear strengths in the range 8 to 56kPa, with an average value of about 30kPa;
- The strengths recorded would be typical of well drained peat as is present on the Proposed Wind Farm site;

- Mineral subsoils were typically described as firm to stiff, slightly sandy gravelly SILT/CLAY or SILT over silty sandy GRAVEL which is underlain by presumed bedrock or cobbles and boulders at some locations;
- Obstruction (refusal) on possible bedrock (presumed) was recorded in 17 of the 36 nos. trial pits (47%). The bedrock was typically described as weathered and presenting as angular gravel and cobbles of shale/siltstone;
- Obstruction on boulders was recorded at another 7 no. locations which indicates the top of bedrock is close underneath;
- Bedrock was presumed to be met at 4 no. turbine locations (T2, T3, T5 and T6) with depth ranging from 0.8m to 3m below ground level. Where bedrock was not presumed, refusal was typically on dense cobbles and boulders suggesting top of bedrock is close;
- The investigations indicate that deep excavations will not be required due to the shallow depth of competent bedrock strata;
- Bedrock drilling encountered competent, strong SILTSTONE or SANDSTONE at shallow depths ranging from 2.6 to 3.9mbgl; and,
- No bedrock joints, fissures, fractures faults (groundwater bearing structures) were identified by the investigation drilling.

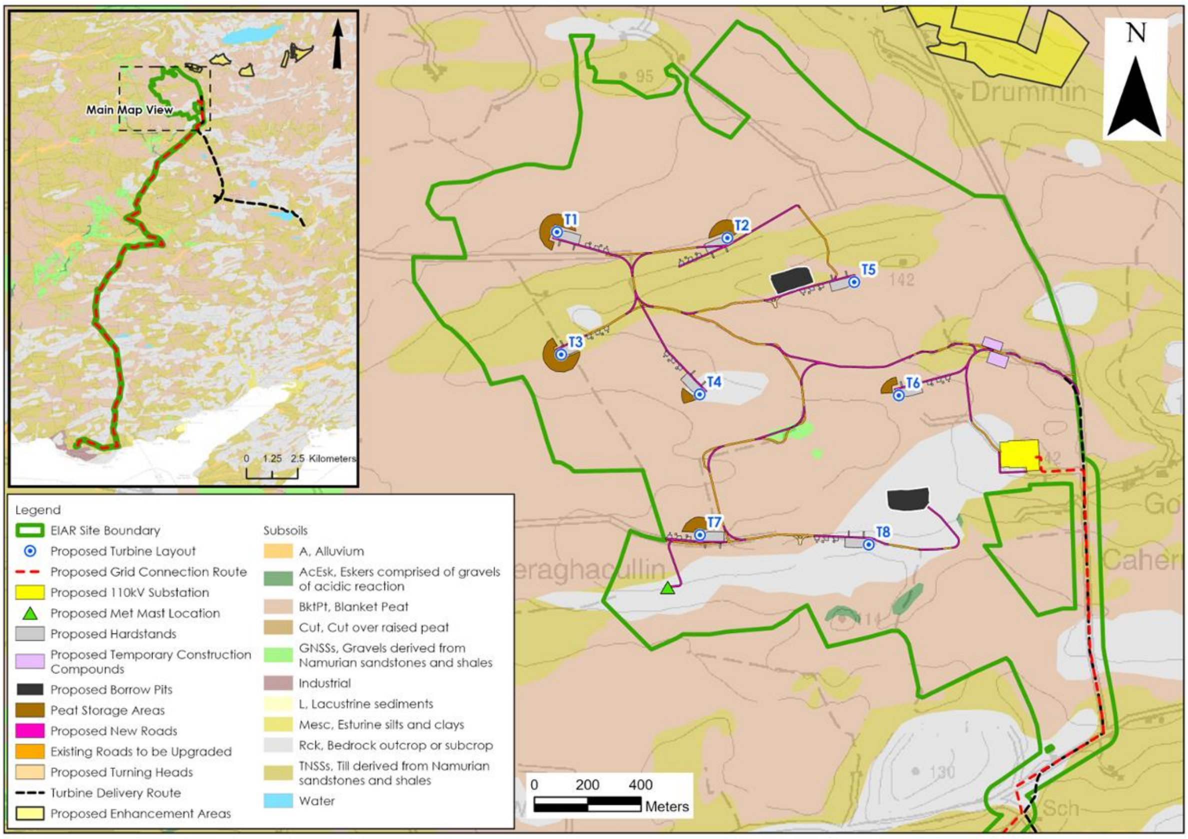

Figure C: Local Subsoil Map (www.gsi.ie)

3.4 SITE DRAINAGE

3.4.1 Existing Site Drainage

An existing drainage map for the Proposed Wind Farm site is shown as **Figure D** below.

The majority of the Proposed Wind Farm drains in a south-westerly direction towards the Creegh River which is located approximately 3.5km downstream (south) of the Proposed Wind Farm.

There are four main first order streams which emerge from the southern section of the Proposed Wind Farm and flow towards the Creegh River.

Stream S1, which is an EPA mapped watercourse, flows through the main central catchment area of the Proposed Wind Farm site in which proposed turbine locations T3, T4, T5 and T6 are located.

Two smaller streams (S2 and S3) rise from the southern section of the Proposed Wind Farm and merge at the southwestern boundary prior to flowing towards the Creegh River. Proposed turbines T7 and T8 are located in the catchment area of Stream S2.

Stream S3 originates upstream of a small on-site lake located in the southwestern corner of the Proposed Wind Farm. There is no Proposed Wind Farm development infrastructure in the catchment of stream S3.

The southeastern corner of the Proposed Wind Farm is drained by stream S4 which emerges to the southwest of proposed Borrow Pit 1. Stream S4 flows in a southerly direction towards the Creegh River.

The northern section of the Proposed Wind Farm site, which includes turbine locations T1 and T2, is drained by a singular EPA mapped headwater stream (S5) of the Annageeragh River. Stream S5 emerges from a forested area between turbine locations T1 and T2.

As part of the Proposed Wind Farm development there is the requirement for only 2 no. watercourse crossings along proposed access roads. Both crossings are on Stream S1.

Refer to **Table B** below for hydrological data for each watercourse at the proposed crossing location. Only 1 no. crossing is proposed over an EPA mapped watercourse (WC1). WC2 is at a small ephemeral stream.

The proposed works includes 1 no. upgrade of existing crossing (WC1) at an EPA mapped watercourse and 1 no. new crossing at WC2. Refer to **Figure D** for the proposed crossing locations.

Table B: Proposed Wind Farm Watercourse Crossing Locations - Hydrological Information

Crossing ID	Easting (IG)	Northing (IG)	Catchment Area (km^2)	Q_{med} Flow (m^3/sec)	100-year Flow (m^3/sec)
WC1	108370	168848	0.74	0.67	1.68
WC2	108970	169210	0.18	0.16	0.41

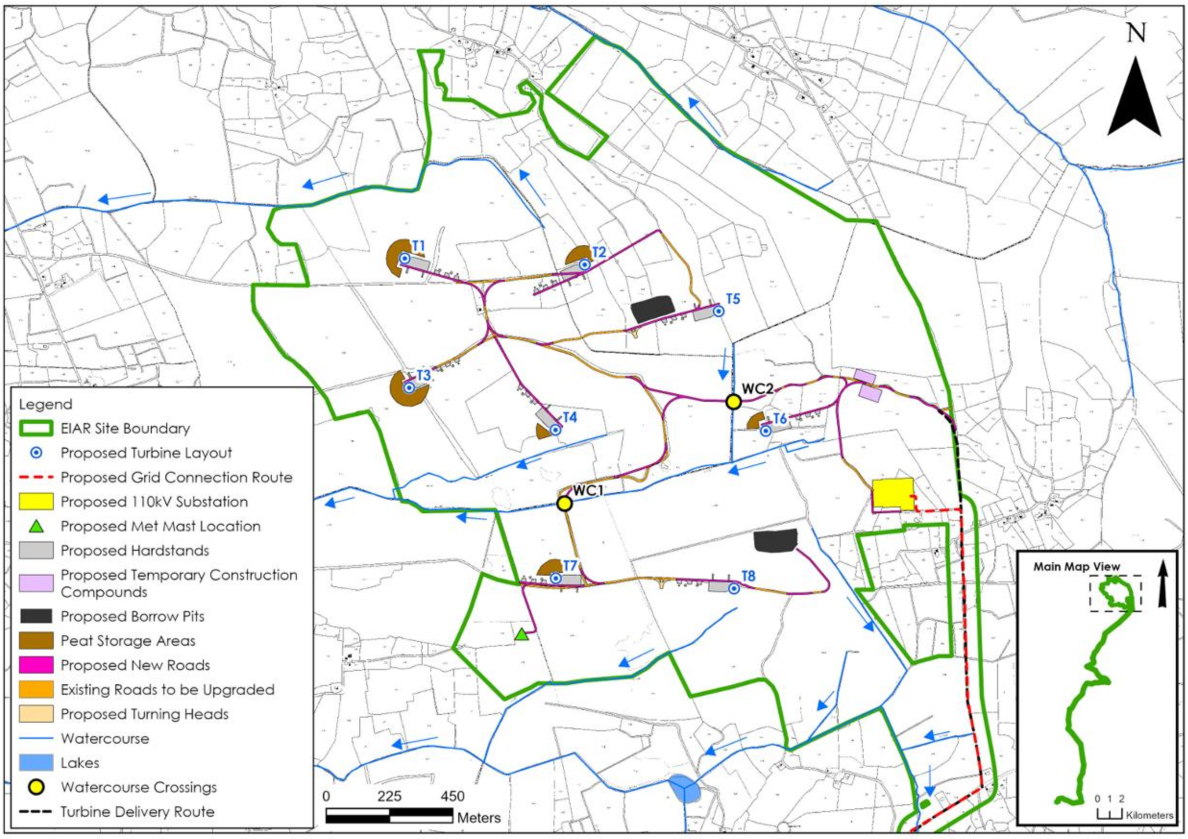

Figure D: Proposed Wind Farm Site Drainage Map

3.5 DESIGNATED SITES & HABITATS

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). The Proposed Project site does not directly interact with any designated site.

Designated sites downstream of the Site include the Mid-Clare Coast SPA (Site Code 004182), Carrowmore Point to Spanish Point and Islands SAC (Site Code 001021), White Strand/Carrowmore Marsh pNHA (Site Code 001007) and Lower River Shannon SAC (i.e. Shannon Estuary). These designated sites are located approximately 7.5km to the west of the Proposed Wind Farm site.

The Cragnashingaun Bogs NHA (Site Code: 002400) is located 2.3km east of the Proposed Wind Farm site.

4. SITE SPECIFIC FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following flood risk assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). The basic objectives of these guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders; and,
- Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

4.2 FLOOD RISK ASSESSMENT PROCEDURE

This section of the report details the site-specific flood risk assessment carried out for the Proposed Project and surrounding area. The primary aim of the assessment is to consider all types of flood risks and the potential impact on the development. As per the relevant guidance (DOEHLG, 2009), the stages of a flood risk assessment are:

- *Flood risk identification* – identify whether there are surface water flooding issues at a site;
- *Initial flood risk assessment* - confirm sources of flooding that may affect a proposed development; and,
- *Detailed flood risk assessment – quantitative appraisal of potential risk to a proposed development*.

As per the Guidelines, there are essentially two major causes of flooding:

Coastal flooding which is caused by higher sea levels than normal, largely as a result of storm surges, resulting in the sea overflowing onto the land. Coastal flooding is influenced by the following three factors, which often work in combination:

- High tide level;
- Storm surges caused by low barometric pressure exacerbated by high winds (the highest surges can develop from hurricanes); and,
- Wave action, which is dependent on wind speed and direction, local topography and exposure.

Due to its inland location (>7.5km), coastal flooding is not applicable to the Site.

Inland flooding which is caused by prolonged and/or intense rainfall. Inland flooding can include a number of different types:

- Overland flow occurs when the amount of rainfall exceeds the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural hollows and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall and eventually enters a piped or natural drainage system.

- River flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying areas (the floodplain). This can occur rapidly in short steep rivers or after some time and some distance from where the rain fell in rivers with a gentler gradient.

- Flooding from artificial drainage systems results when flow entering a system, such as an urban storm water drainage system, exceeds its discharge capacity and the system becomes blocked, and / or cannot discharge due to a high water level in the receiving watercourse. This mostly occurs as a rapid response to intense rainfall. Together with overland flow, it is often known as pluvial flooding. Flooding arising from a lack of capacity in the urban drainage network has become an important source of flood risk, as evidenced during recent summers.

- Groundwater flooding occurs when the level of water stored in the ground rises as a result of prolonged rainfall to meet the ground surface and flows out over it, i.e. when the capacity of this underground reservoir is exceeded. Groundwater flooding tends to be very local and results from interactions of site-specific factors such as tidal variations. While water level may rise slowly, it may be in place for extended periods of time. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life.

- Estuarial flooding may occur due to a combination of tidal and fluvial flows, i.e. interaction between rivers and the sea, with tidal levels being dominant in most cases. A combination of high flow in rivers and a high tide will prevent water flowing out to sea tending to increase water levels inland, which may flood over river banks.

The Flood Risk Management Guidelines provide direction on flood risk and development. The guidelines recommend a precautionary approach when considering flood risk management and the core principle of the guidelines is to adopt a risk based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for inland and coastal flooding.

Flood zones are geographical areas within which the likelihood of flooding is in a particular range and they are a key tool in flood risk management within the planning process as well as in flood warning and emergency planning.

There are three types or levels of flood zones defined within the guidelines:

Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);

Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding); and,

Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Once a flood zone has been identified for a site, the guidelines set out the different types of development appropriate to each identified zone (pg 25, Table 3.1 of the Guidelines). Exceptions to the restriction of development due to potential flood risks are provided for through the application of a Justification Test, where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

The Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that, for the reasons outlined above, are being considered in areas of moderate or high flood risk. The test is comprised of two processes.

- The first is the **Plan-making Justification Test** described in chapter 4 of the Guidelines and used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding. Plan making Justification Tests are made at Plan/Policy development stage such as County Development Plans, or Local Area Plans.

- The second is the **Development Management Justification Test** described in chapter 5 of the Guidelines and used at the planning application stage where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land. For example, application of Development Management Justification Test would be required at a site-specific level, such as for this FRA assessment, if a Justification Test is required.

4.3 FLOOD RISK IDENTIFICATION

4.3.1 OPW Past Flood Event Mapping

To identify those areas as being potentially at risk of flooding, OPW's Past Flood Event mapping (www.floodinfo.ie) were consulted.

No single or recurring flood incidents within the Site were identified from OPW's Past Flood Event mapping (refer to **Figure E** below).

The closest OPW mapped past flood event is located 5km downstream of the Proposed Wind Farm on the Annageeragh River (Flood ID-4656). This is a recurring fluvial flooding event.

There is also one single historic flood event recorded on the Creegh River (Flood ID-12561) at Creegh, approximately 5km downstream of the Proposed Wind Farm site. According to the OPW Flood Hazard Mapping area engineer notes the R483 is flooded and impassable over a length of 50m and maximum depth of c 900mm. This flooding event occurs once/twice per year due to rainfall/ runoff and stream capacity.

There is also one single flood event recorded on the 10th September 2015, at Creegh, approximately 5.5km downstream of the Site on the Creegh River (ID-12561).

According to the OPW (www.floodinfo.ie), no parts of the Proposed Wind Farm site are classified as OPWs Arterial Drainage Schemes (ADS) – Benefitted Lands.

Benefited land identifies lands that were drained as part of the scheme. Bogland and other lands are identified separately. In the early schemes, large areas of bog were drained which facilitated peat extraction for fuel and horticulture.

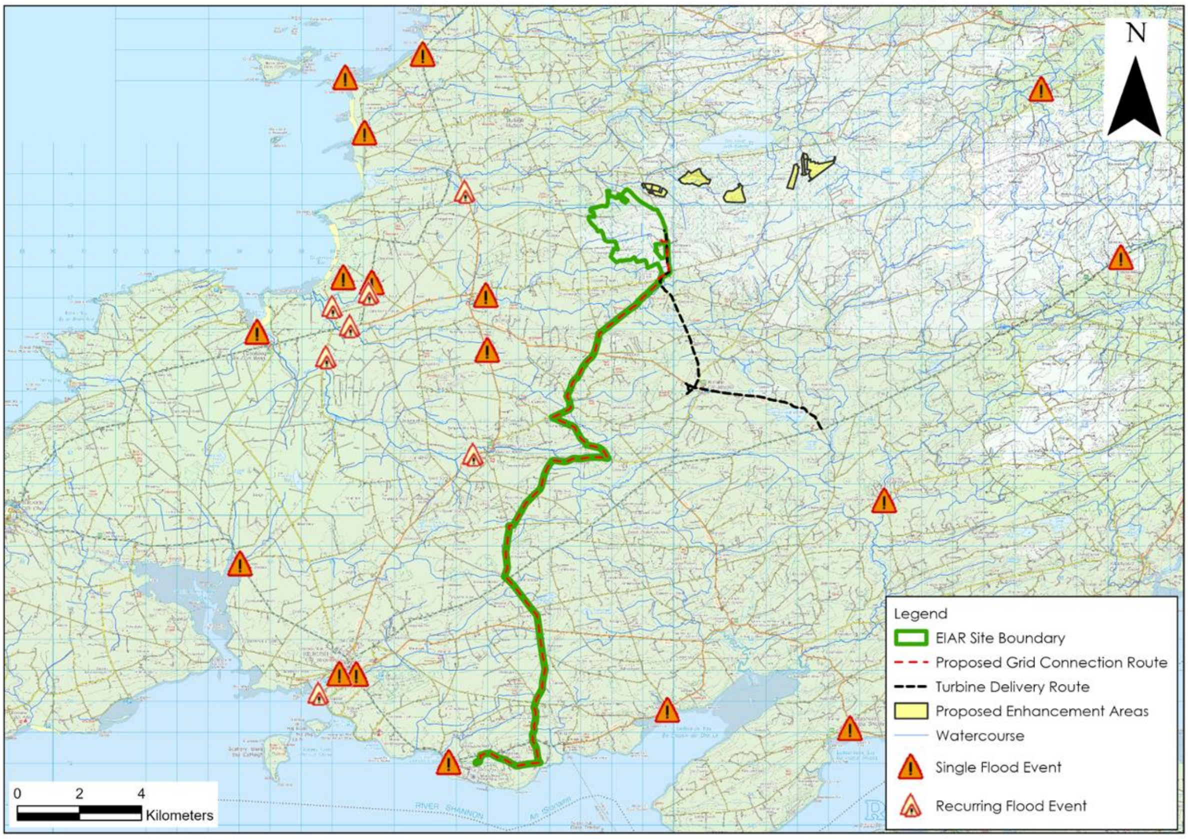

Figure E: OPW Past Flood Event Map

4.3.2 Soils Maps - Fluvial Maps

A review of the soil types in the vicinity of the Site was undertaken as soils can be a good indicator of past flooding in an area. Due to past flooding of rivers, deposits of transported silts/clays referred to as alluvium build up within the flood plain and hence the presence of these soils is a good indicator of potentially flood prone areas.

Based on the EPA/GSI soil map for the local area (refer to **Figure C** above), no fluvial or lacustrine deposits are mapped within the Proposed Wind Farm site. There are no soils present that indicate areas where flooding may have occurred in the past. The nearest alluvium soils are mapped along the main channel of the Creegh River southwest and downstream of the Site.

4.3.3 Historical Mapping

To identify those areas as being at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) were consulted. There was no identifiable map text on local available historical 6" or 25" mapping for the Proposed Wind Farm site that would identify lands that are "liable to flood" within or in the vicinity of the Site.

4.3.4 CFRAM Mapping – Fluvial and Pluvial Flooding

Catchment Flood Risk Assessment and Management (CFRAM)[3] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland.

CFRAM mapping has not been completed for the area of the Site as the catchments are too small.

4.3.5 National Indicative Fluvial Mapping (NIFM)

The National Indicative Fluvial Mapping (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments greater than 5km^2 for which flood maps were not produced under the CFRAM Programme.

The Present-Day Scenario has been generated using methodologies based on historic flood data and does not consider the potential changes due to climate change. The potential effects of climate change on flooding have been separately modelled (see Section 4.3.9 below.)

NIFM for the Present Day Scenario does not map any flood zones within the Proposed Wind Farm Site. However, low and medium probability river flood zones are mapped in close proximity to the north and south of the Proposed Wind Farm site.

As such, the entire Proposed Wind Farm site, including all proposed infrastructure is located in Fluvial Flood Zone C, where the probability of fluvial flooding is low (less than 0.1%). A fluvial map showing the NIFM for the present-day scenario is included as **Figure F** below.

NIFM flood zones are also mapped along the Proposed Grid Connection cable route at watercourse crossings over the Creegh River and the Doonbeg River, but this potential flooding has no consequence for the Proposed Project due to the underground nature of the Proposed Grid Connection cable inside these potential fluvial flood zones.

[3] CFRAM is Catchment Flood Risk Assessment and Management. The national CFRAM programme commenced in Ireland in 2011 and is managed by the OPW. The CFRAM Programme is central to the medium to long-term strategy for the reduction and management of flood risk in Ireland.

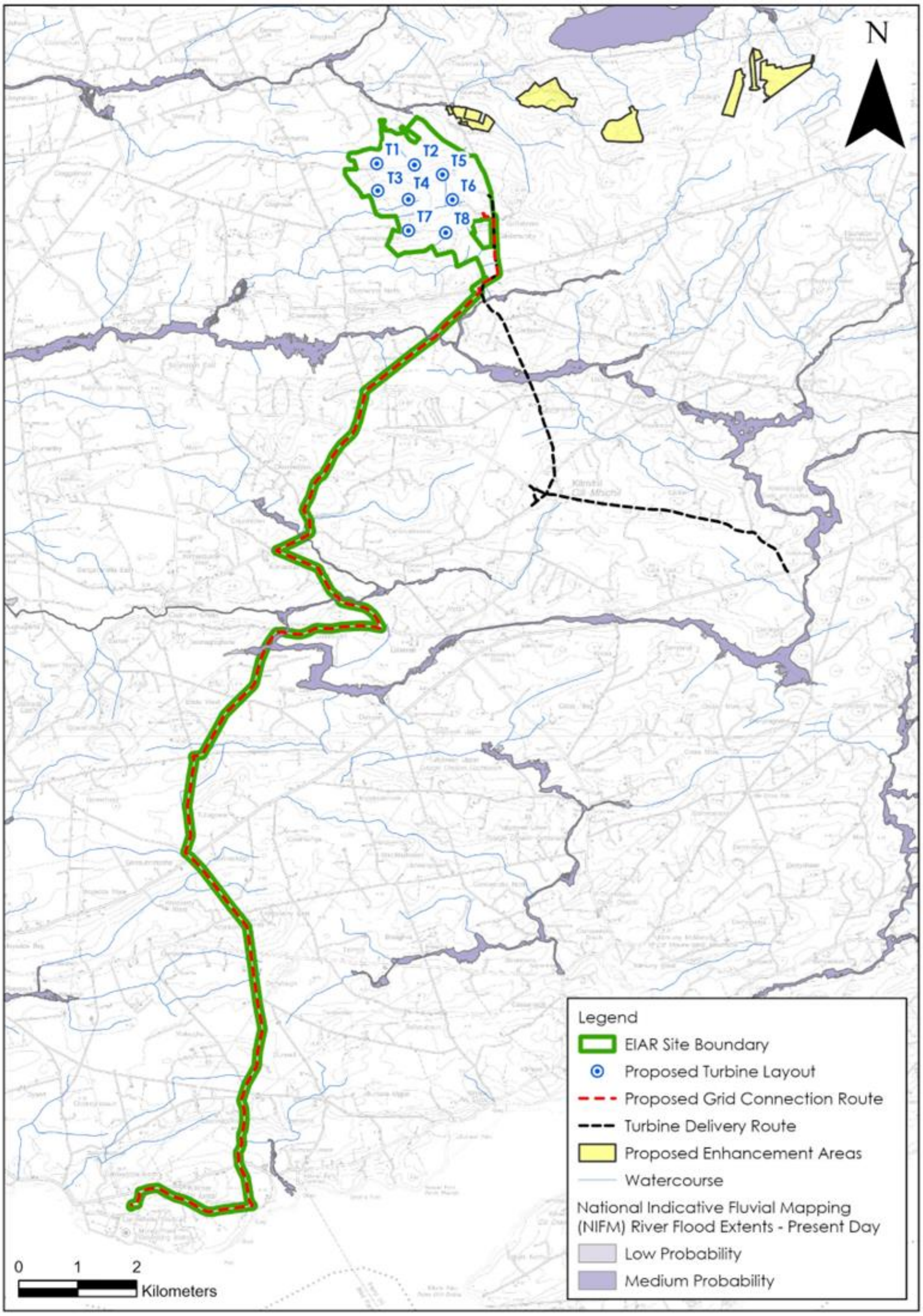

Figure F: OPW National Indicative Fluvial Mapping

4.3.6 GSI Winter (2015/2016) Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding Map[4] shows areas of fluvial and pluvial flood extents during the Winter 2015/2016 flood event, which was the largest recorded flood event in many areas.

The flood map for this event does not record any flood zones within the Proposed Wind Farm Site.

The nearest mapped flood zones are at lake waterbodies east and northeast of the Proposed Wind Farm site including Lough Boleyneg. Lough Nacrag, Lough Creevagh and Doo Lough. These lake waterbodies are all at a distance greater than 1.5km from the Site.

4.3.7 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the Proposed Wind Farm site or surrounding lands.

4.3.8 Coastal Flooding

The Proposed Wind Farm site is located 7.5km inland from the sea and sits at an elevation of 80 -150m OD. Therefore, the Proposed Wind Farm site is not at risk of coastal (tidal) flooding.

4.3.9 Climate Change

Fluvial flood modelling has also been completed to consider future climate scenarios where the potential effects of climate change can increase rainfall.

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood extents based on a 30% increase in rainfall.

Both of these modelled flood extents show similar flood zones to the Present-Day Scenario discussed above in Section 4.3.5 and remain remote from the site. Therefore, flood zones at the Site are unlikely to be significantly impacted by future climate change.

4.3.10 Summary – Flood Risk Identification

Based on the information gained through the flood identification process it is apparent that no part of the Proposed Wind Farm site is located in Fluvial Flood Zone A or B, therefore is located in Flood Zone C where there is at low risk of fluvial flooding.

Sections of the Proposed Grid Connection route pass through NIFM flood zones but this has no consequence or risk for the Proposed Project due to the underground nature of the proposed infrastructure.

The proposed on-site 110kV substation element of the Proposed Wind Farm is also located in Flood Zone C.

[4] GSI *Historical flood mapping principally developed using Sentinel-1 Satellite Imagery from the European Space Agency Copernicus Programme as well as any available historic records (from winter 2015/2016 or otherwise)*

4.3.11 Summary – Initial Flood Risk Assessment

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it has been determined that flooding is unlikely to pose a high risk within the Proposed Project site.

The sources of flood risk for the site are outlined and assessed in **Table C.**

Table C. S-P-R Assessment of Flood Sources for the Proposed Project

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the rivers and streams that are close to some of the wind farm infrastructures.	Land & infrastructure	The Proposed Wind Farm site is located in Fluvial Flood Zone C where there is a low risk of fluvial flooding. The 110kV substation element is located in Flood Zone C. Some areas of the Proposed Grid Connection route are located within Flood Zone A or B, but due to the underground nature of the infrastructure, are not risk.
Pluvial	Ponding of rainwater on site	Land & infrastructure	There is a low risk of significant pluvial flooding due to the extensive manmade drainage networks and sloping topography
Surface water	Surface ponding/ Overflow	Land & infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land & infrastructure	Based on local hydrogeological regime and GSI mapping, there is no apparent risk of groundwater flooding at the Site.
Coastal/tidal	Overbank flooding	Land, People, property	No coastal flooding will be possible at the Site due to distance to coast (>7.5km) and ground elevation.

4.4 REQUIREMENT FOR A JUSTIFICATION TEST

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test[5] is shown in **Table D** below.

It may be considered that the Proposed Wind Farm and its on-site 110kV substation can be categorised as "Highly Vulnerable Development", while the Proposed Grid Connection underground cable is a "Water Compatible Development" due to the subsurface nature of the sealed electrical cable.

Therefore, the Proposed Project is appropriate from a flood risk perspective, and a Justification Test is not required.

[5] *A 'Justification Test' is an assessment process designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk, (DoEHLG, 2009).*

Table D: Matric of Vulnerability versus Flood Zone

	Flood Zone A	**Flood Zone B**	**Flood Zone C**
Highly vulnerable development (including essential infrastructure) **'Proposed Wind Farm'**	Justification test	Justification test	**Appropriate**
Less vulnerable development	Justification test	Appropriate	Appropriate
Water Compatible development **'Proposed Grid Connection'**	**Appropriate**	**Appropriate**	**Appropriate**

Note: *Taken from Table 3.2 (DoEHLG, 2009)*
Bold: *Applies to this project.*

5. PLANNING POLICY

5.1 PLANNING POLICY & COUNTY DEVELOPMENT PLAN

The following policies (**Table E**) are defined in the Clare County Development Plan (2023-2029), which was adopted in March 2023, in respect of flooding and we have outlined in the column to the right how these policies are provided for within the Proposed Project design.

Table E: Clare County Development Plan Objectives/Policies and Project Responses

CDP Policy Number:	Policy	Response
CDP 2.6	It is an objective of Clare County Council: To ensure development proposals have regard to the requirements of the SFRA and Flood Risk Management Guidelines; and where required are supported by an appropriately detailed hydrological assessment / flood risk assessment. To ensure that flood risk assessments include consideration of potential impacts of flooding arising from climate change including sea level rise and coastal erosion. To integrate sustainable water management solutions into development proposals.	This FRA has been prepared in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009). The potential effects associated with Climate Change are addressed in Section 4.3.9 The Proposed Wind Farm drainage system will ensure that runoff is attenuated and that volumes will be maintained at greenfield runoff rates.
CDP 2.8	It is an objective of Clare County Council: To support the implementation of the EU Floods Directive 2007/60/EC to manage flood risks; and, To implement the recommendation of the CFRAMS programme as it related to County Clare.	This FRA has been prepared in accordance with the EU Floods Directive 2007/6-/EC. The Proposed Project is not located within any mapped CFRAM Flood Zones.

5.2 PROPOSED DRAINAGE

The wind farm drainage system was designed integrally with the Proposed Project design layout as a measure to ensure that the proposal will not change the existing flow regime across the Proposed Project site, will not deteriorate water quality and will safeguard existing water quality status of the catchments from wind farm related sediment runoff.

Overland flow rates are likely to be significant and the drainage system must be designed and managed properly if it is to work effectively. A fundamental principle in the drainage design is that clean water flowing in the upstream catchment, including overland flow and flow in existing streams and drains, is allowed to bypass the works areas without being contaminated by silt from the works. The dirty water from the works areas is collected in a separate drainage system and treated by removing the suspended solids before discharging it to the downstream watercourse. This minimises the volume of dirty water requiring treatment.

Existing streams crossing the works area will be piped to isolate them from the works. New drains will be constructed to collect overland flow that is intercepted by the works areas or by new access roads. These will be constructed on the uphill side of the works and piped to the downhill side, bypassing the works areas. However, this will cause the normally dispersed flow to be concentrated at specific discharge points downstream of the works. In order to disperse this flow each clean water drain will be terminated in a discharge channel running parallel to the ground contours that will function as a weir to disperse the flow over a wider area of vegetation. This will prevent erosion of the ground surface and will attenuate the flow rate to the downstream receiving waters.

The resultant diversion of clean water runoff will ensure that the treatment system will only need to deal with construction related runoff. The treatment system consists of a series of settlement ponds that are located at each works site and at intervals along the access roads. The outflow from the settlement ponds will be allowed to disperse across vegetation and will become diluted through contact with the clean water runoff in the buffer areas before entering the downstream watercourses.

5.3 PROPOSED ON-SITE RUNOFF ATTENUATION

The creation of impermeable areas within a site has the effect of increasing rates of runoff into the downstream drainage system and this may increase flood risk and flood severity downstream. This applies particularly to urban areas that drain to closed pipe systems which do not have the capacity to cater for increased hydraulic loads. The Proposed Project is located within a large rural catchment with an open drainage system. The footprint of the impermeable areas and the associated increase in runoff rate is very small in the context of the catchment size and therefore represents a negligible increase in downstream flood risk. Notwithstanding the low increase in flood risk due to the Proposed Project, the drainage system has been designed to prevent any increase in discharge rates above that which already exist in the undeveloped site.

The volume of water requiring attenuation relates to direct precipitation on the roads and hard-standing footprint only. The aim of the storm water attenuation measures is to limit the flow rate from the developed area to that which prevails on the undeveloped site. This is achieved by limiting the flow rate to the downstream receiving waters and temporarily storing the excess water that accumulates as a result. The developed surfaces have some permeability and this reduces the attenuation requirement. Conventional attenuation systems use proprietary flow control units but these can become blocked with debris and vegetation and require regular maintenance. They are therefore not appropriate for use within a forestry environment or where routine maintenance would not be practical.

It is proposed to provide the temporary storage within the drainage channels by creating stone dams within them at regular intervals. The spacing of the dams is typically 100m but depends on the channel slope, with steeper channels requiring shorter intervals. The dams, which are constructed with small sized aggregate, also reduce the flow rate through the drainage system and are an effective means of providing flow control. Silt fence also provide storage and flow control.

All runoff from the developed areas will be routed through settlement ponds downstream. The outflow from the settlement ponds will be released in a controlled and diffuse manner. Therefore, the Proposed Project will not increase the magnitude of the hydrograph peak. The control measures are passive as opposed to mechanical and do not require maintenance to ensure their ongoing effectiveness.

6. REPORT CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Project. From this study:
    - No instances of historical flooding were identified in historic OS maps within the Proposed Wind Farm site;
    - No instances of recurring flooding were identified on OPW maps within the Proposed Wind Farm site;
    - The GSI Winter 2015/2016 Surface Water Flooding and Groundwater flood Mapping provides no evidence of historical flooding at the Proposed Wind Farm site;
    - No CFRAM or NIFM fluvial flood zones are mapped within the Proposed Wind Farm site;
    - Sections of the Proposed Grid Connection underground cable route pass through NIFM flood zones but this has no consequence or risk for the Proposed Project due to the underground nature of the infrastructure.
    - The on-site 110kV substation element of the Proposed Wind Farm is located in Flood Zone C at the Proposed Wind Farm site.
- Therefore, the Proposed Project is appropriate from a flood risk perspective; and,
- This FRA fulfils the requirements for a site-specific flood risk assessment and is consistent with the recommendations made in the Clare County Development Plan (2023-2029).

* *

7. REFERENCES

DOEHLG	2009	The Planning System and Flood Risk Management.
Natural Environment Research Council	1975	Flood Studies Report (& maps).
Cunnane & Lynn	1975	Flood Estimated Following the Flood Studies Report
Cawley, A.	1990	*The Hydrological Analysis of a Karst Aquifer System.* B.E., National University of Ireland.
CIRIA	2004	Development and Flood Risk – Guidance for the Construction Industry.
OPW	Not Dated	Construction, Replacement or Alteration of Bridges and Culverts. A Guide to Applying for Consent under Section 50 of the Arterial Act, 1945.
Institute of Hydrology	1994	Flood Estimation in Small Catchments.
Met Eireann	2023	Ireland's Climate Averages 1991-2020

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