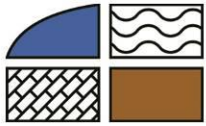




APPENDIX 9-1

Flood Risk Assessment



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PROPOSED COOLOO WIND FARM CO. GALWAY

STAGE 2 - FLOOD RISK ASSESSMENT

DRAFT REPORT

Prepared for:

MKO

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

DOCUMENT INFORMATION

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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 Flood Risk Assessment (FRA) for the Proposed Wind Farm and Proposed Grid Connection (Proposed Project), at Cooloo Co. Galway. A site location map is attached 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.

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 that 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 in 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. Michael has worked on the EIS/EIAR for Oweninny WF, Cloncreen WF, Seven Hills WF and over 100 other wind farm related projects across the country.

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 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 surface water catchment and existing site drainage;
- Section 4 presents a site-specific flood risk assessment (FRA) undertaken for the Proposed Project which was carried out in accordance with the above-mentioned guidelines;
- Section 5 presents Planning policy and responses to those policies outlined in this FRA; and,

- Section 6 presents the Stage 2 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;
- Galway County Development Plan 2022 – 2028 (including Strategic Flood Risk Assessment);
- Lidar data for the project site; and,
- Site walkovers and surveys conducted by HES on 15th August and 24th October 2022, 23rd and 28th March 2023, 20th and 21st August 2024, 22nd May and 8th July 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 Site, which is 355ha (hectares) in area, comprises areas of intact raised bog, cutover raised bog, forestry, agricultural grassland and scrubland. The Site is located approximately 2.5km to the east of Barnaderg Village, Co. Galway.

The topography of the Proposed Wind Farm site is undulating with gentle slopes typical of a low-lying raised bog setting with surrounding local hills. The elevation of the Proposed Wind Farm site ranges from approximately 65m OD (metres above Ordnance Datum) to 80m OD, with slopes falling to the north and southeast from a high point located centrally with the Proposed Wind Farm site which also coincides with a surface water catchment topographic divide between the Grange River to the north and the Abbert River to the south.

The lower parts of the Proposed Wind Farm site are in the west and the north and this is also where most of the bog coverage is. The higher elevated part of the Proposed Wind farm site centrally is mainly undulating grassland.

The Proposed Wind Farm site is drained by several 1st order watercourses that emerge from the peatland areas. There is also a high density of man-made drainage associated with the peatland and grassland areas. The man-made drainage density is evident on the OSI 6", 25" mapping and aerial imagery. This indicates significant efforts to drain and reclaim the former peat bog land as well as improve adjacent grassland.

The Proposed Wind Farm site is currently accessible via a network of local public roads, bog roads and farms tracks. The proposed construction entrance to the Proposed Wind Farm site and Proposed Grid Connection 110kV substation is off the R332 which runs to the southwest of the Proposed Wind Farm site. Approximately 1.3km of existing tracks will be upgraded as part of the Proposed Project.

With regard the main elements of the Proposed Wind Farm site infrastructure, proposed turbine locations T1, T3, T4, T6, T7 and T8 are located on grassland, while turbines T2, T5 and T9 are located on cutover raised bog.

The proposed temporary construction compound, located in the southwest of the Proposed Wind Farm site, is in grassland. The proposed 4 no. peat repositories areas and 5 no. spoil repository areas are located on both grassland and bog.

The Proposed Wind Farm access roads are mainly on grasslands, but cutover bog and an approximately 0.5km section of intact raised bog will be crossed by the proposed roads. The proposed access road to turbine T7 will require crossing 0.5km of intact raised bog.

The Proposed Grid Connection 110kV underground cabling route, which measures approximately 21km in length, will connect into the existing Cloon 110kV substation near Tuam town, located approximately 10km to the west of the Proposed Wind Farm site. The 110kV on-site substation is located on improved grassland in the southwest of the Proposed Wind Farm site.

On leaving the on-site substation location at the Proposed Wind Farm site, the Proposed Grid Connection cabling route initially follows a farm track for approximately 1km, followed by Proposed Wind Farm access road for approximately 1.5km before exiting the Proposed Wind

Farm site on the R332. The Proposed Grid Connection cabling route then follows public roads for the remainder of the distance to the Cloon 110kV substation.

Turbine Delivery Route (TDR) junction works are required on the N63/R332 junction where a temporary road will be required just south of Horesleap Lough. There is also an overrun area on the R332 at the proposed construction site entrance.

A site location map is shown as **Figure A**.

2.3 PROPOSED PROJECT DETAILS

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

Where the 'Proposed Wind Farm site' is referred to, this refers to turbines and associated foundations and hard-standing areas, meteorological mast, access roads, temporary construction compound, underground cabling, peat and spoil management, site drainage, biodiversity enhancement, turbine delivery route (TDR) accommodation works and all ancillary works and apparatus.

The 'Proposed Grid Connection' relates to the 110kV onsite substation, battery energy storage system and 110kV underground cabling connecting to the existing Cloon 110kV substation, and all ancillary works and apparatus. The 110kV onsite substation is located on the south of the Proposed Wind Farm site.

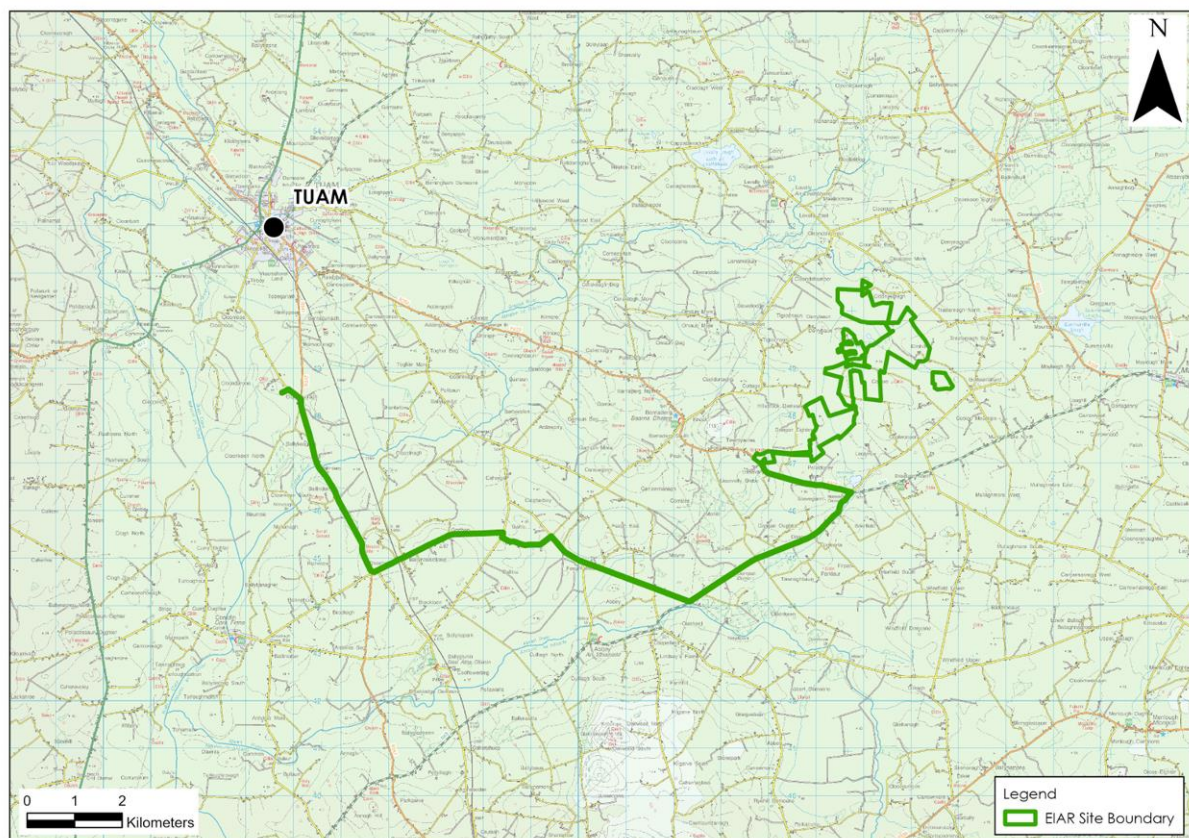


Figure A: Site Location Map

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.

3.2 HYDROLOGY

3.2.1 Regional and Local Hydrology

The Site is located in the regional Lough Corrib (Corrib_030) surface water catchment within Hydrometric Area 30 of the Western River Basin District (WRBD). Lough Corrib is located approximately 24km to the west of the Proposed Wind Farm site.

On a more local scale the Site is located in the River Clare catchment wherein it exists within two surface water sub-catchments according to WFD/EPA mapping.

The northern portion of the Proposed Wind Farm site which includes 7 no. turbine locations (T3, T4, T5, T6, T7, T8 and T9) is located in the Clare[Galway]_SC_040. Within this sub-catchment the Proposed Wind Farm site drains to the River Clare via the Grange River which flows less than 1km to the north of the Proposed Wind Farm site.

The southern portion of the Proposed Wind Farm site is located in the Clare[Galway]_SC_050 where 2 no. turbines T1 and T2, the temporary construction compound and the construction site entrance are proposed. Within this sub-catchment the Proposed Wind Farm site drains to the River Clare via the Abbert River which flows approximately 3km to the south of the Proposed Wind Farm site.

(Please note that whilst the proposed turbine T3 is mapped by the EPA to be located in the Clare[Galway]_SC_050, this location actually drains into the Clare[Galway]_SC_040 sub-catchment as observed from on-site drainage mapping.

The Proposed Grid Connection passes through both the Clare[Galway]_SC_040 (for 7.5km) and Clare[Galway]_SC_050 (for 13.4km) sub-catchments, while the onsite 110kV substation element is located entirely in the Clare[Galway]_SC_050 sub-catchment at the Proposed Wind farm site.

Similar to the Proposed Wind Farm site, the Proposed Grid Connection cable route drains locally to the Grange River and Abbert River within the respective sub-catchments.

The TDR Junction works on the N63/R332 junction and on the R332 at the proposed construction site entrance are located in the Clare[Galway]_SC_050 (Abbert River catchment).

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

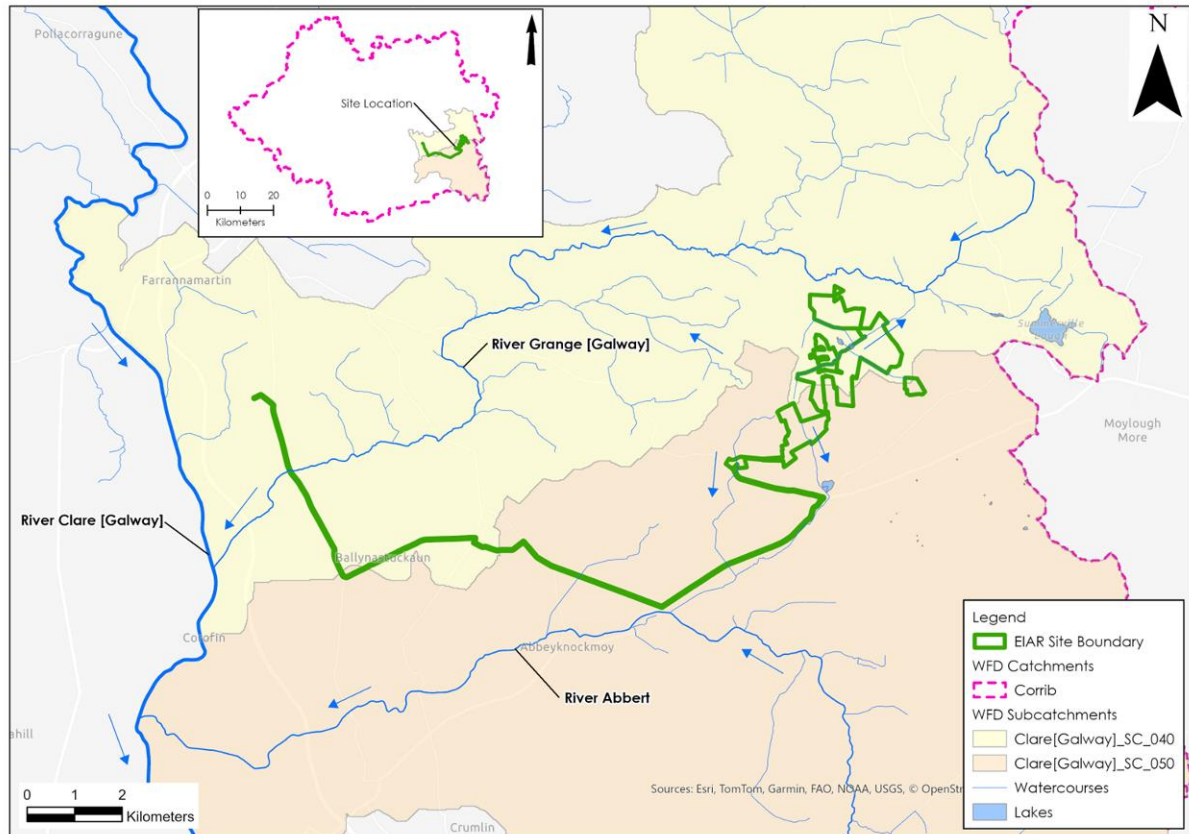


Figure B: Local and Regional Hydrology Map

3.2.2 Rainfall and Evaporation

Met Éireann 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 1,170 to 1,180mm/year. This is considered to be the most accurate estimate of average annual rainfall from the available sources.

The average potential evapotranspiration (PE) at Claremorris (~42km northwest from the site) is taken to be 408mm (www.met.ie). The actual evapotranspiration (AE) is calculated to be 388mm (95% PE). Using 1,180mm/year, the effective rainfall (ER)¹ for the area is calculated to be (ER = SAAR – AE) 792mm/yr.

According to the GSI subsoil permeability mapping, the Proposed Wind Farm site is dominated by Low permeability subsoils (50% of Proposed Wind Farm site) followed by Moderate permeability subsoils (43% of Site), which represents the peat and glacial subsoils respectively. Subsoil permeability influences the recharge characteristics of a site along with subsoil thickness. The subsoil permeability for 7% of the Site is unmapped.

Based on groundwater recharge coefficient estimates from the GSI, an estimate of 4% recharge is assigned for a 50% of the Site (mapped as “low vulnerability - basin peat”), while areas mapped as “moderate vulnerability – moderate permeability subsoil overlain by poorly draining soil” (30% of Site) and “moderate vulnerability – moderate permeability subsoil overlain by well draining soil” (13% of Site) are assigned a recharge coefficient of 22% and 60% respectively.

Areas mapped as “where rock is at ground surface or karst feature” (7% of the Site) are assigned a recharge coefficient estimate of 85%. There are no areas of exposed rock or karst features mapped by the GSI at the Proposed Wind Farm site. This recharge coefficient is used

¹ ER – Effective Rainfall is the excess rainfall after evaporation which produces overland flow and recharge to groundwater.

for watercourses that emerge from the Site which is a groundwater vulnerability mapping practice used by the GSI in karst landscapes.

The weighted average recharge coefficient for the Proposed Wind Farm site is calculated to be 15%. The Site hydrology is therefore characterised by high surface water runoff rates (85%) and relatively low groundwater recharge rates.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. **Table A** below presents return period rainfall depths for the area of the wind farm site. These data are taken from <https://www.met.ie/climate/services/rainfall-return-periods> and they provide rainfall depths for various storm durations and sample return periods (1-year, 5-year, 30-year, 100-year).

Table A. Cooloo Wind Farm– Return Period Rainfall Depths (mm)

Return Period (Years)				
Storm Duration	1	10	30	100
5 mins	3.6	7.6	10.6	14.9
15 mins	5.8	12.5	17.4	24.5
30 mins	7.6	15.9	21.8	30.3
1 hour	9.9	20.1	27.2	37.4
6 hours	19.7	37.2	48.7	64.7
12 hours	25.7	47.1	61	80
24 hours	33.5	59.7	76.4	98.9
2 days	42.2	70.6	88	110.8

3.3 GEOLOGY

Based on the Teagasc soils mapping (www.gsi.ie), the Proposed Wind Farm site is predominantly covered by cutaway/cutover peat, peaty poorly drained mineral soil (BminPDPT), deep well drained mineral soil (BminDW) along with some localised deep poorly drained mineral soil (BminPD). Geomorphologically, the peat at the Proposed Wind Farm s is raised bog, also known as basin peat.

The majority of the grassland areas surrounding the bog on the north are mapped to have BminPDPT soil. Deep well drained mineral soils are limited to grassland areas on the far south of the Proposed Wind Farm site.

The GSI subsoils map (www.gsi.ie) also shows that the Proposed Wind Farm site has a large coverage of cutover raised peat (50%) which in turn is surrounded predominately by limestone tills (47%) with the remaining 3% mapped as alluvium, bedrock subcrop and water. The GSI mapped cutover bogs areas also includes areas of grasslands which suggests these grassland areas are improved/reclaimed.

The Proposed Wind Farm site is mapped to be underlain by Dinantian Pure Bedded Limestone bedrock which is susceptible to karstification.

Based on the trial pit and drilling investigations carried out to date, the overburden conditions are generally variable across the Proposed Wind Farm site, and comprise Peat, Lacustrine

Marl (CLAY/SILT), Cohesive Glacial Till (CLAY/SILT) and Granular Glacial Till (SAND/GRAVEL) layers overlying typically competent, massive LIMESTONE bedrock.

The primary subsoil type encountered at the Proposed Wind Farm site was a CLAY/SILT dominant subsoil.

Bedrock was confirmed in 14 no. of the 26 no. trial pits, which included 7 no. of the proposed 9 no. turbine locations (T1, T2, T3, T4, T5, T6 & T8).

Depth to bedrock at the trial pit locations ranged from 0.8m to 3.6m with an average of 2.2m. LIMESTONE was encountered in all trial pits which terminated on rock. The deepest overburden depth was encountered at BH1 where 4.9m of CLAY subsoil was encountered.

A local subsoil map is shown as **Figure C** below.

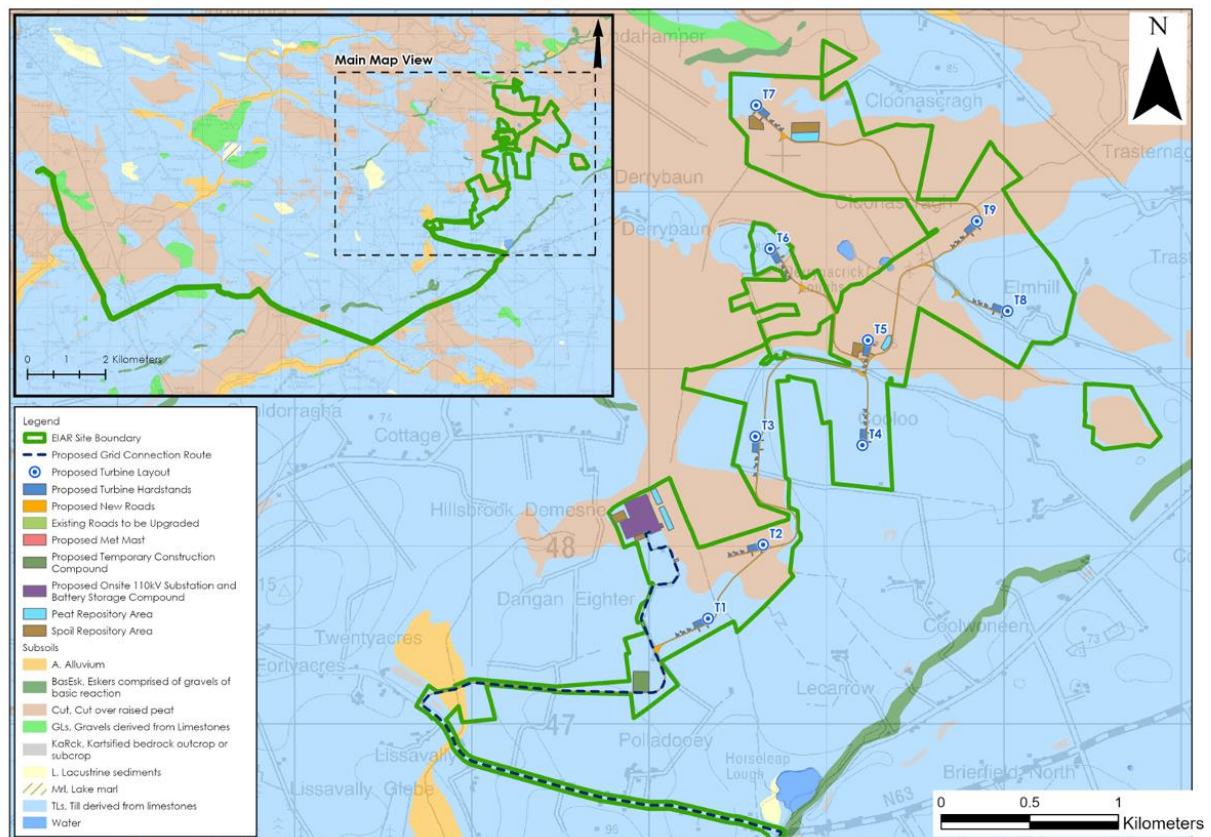


Figure C: Local GSI Subsoils Map

3.4 SITE DRAINAGE

3.4.1 Existing Site Drainage

The northern portion of the Proposed Wind Farm Site, within the Clare[Galway]_SC_040 sub-catchment (i.e. the Grange River), is drained by the Dangan Eighter Stream (EPA Code 30D35) which flows into the Grange River approximately 1km downstream of the Proposed Wind Farm site.

3 no. unnamed 1st order streams merge within the Proposed Wind Farm site to form the Dangan Eighter Stream. The 3 no. streams merge close to the location of Derrynacrick Loughs.

Derrynacrick Loughs comprise two small, connected loughs that are located within a raised bog area on the northern portion of the Proposed Wind Farm site.

None of the 3 no. unnamed streams flow into the larger, furthest upstream lough. 2 no. of the streams flows into the smaller downstream lough, while 1 no. unnamed stream flows into the Dangan Eighter Stream downstream of both loughs. The catchment area of the 3 no. streams comprises both peatland and agricultural land. Proposed turbine locations T3 to T9 drain into the Dangan Eighter Stream via a network of bog and land drains.

The southern portion of the Proposed Wind Farm site, within the Clare[Galway]_SC_050 sub-catchment, is drained by the EPA named Lecarrow 30 Stream (EPA Code 30L49) and the Forty Acres Stream (EPA 30F16), both of which are headwater streams of the Abbert River which flows approximately 5km downstream of the Proposed Wind Farm site.

The majority of the southern portion of the Proposed Wind Farm site (including proposed turbine locations T1 and T2 as well as the temporary construction compound) drain to the Lecarrow 30 Stream. The Lecarrow 30 Stream then flows to the south before discharging into Horseleap Lough which is located 1km to the south of the Proposed Wind Farm site. Horseleap Lough is a wetland with significant reed vegetation. Lecarrow 30 Stream exits from the southern side of Horseleap Lough and flows for approximately 4km prior to merging with the Abbert River.

The southwestern portion of the Proposed Wind Farm site, which includes the construction site entrance and access road, drains to the Forty Acres Stream. The Forty Acres Stream flows for approximately 3km prior to merging with the Lecarrow 30 Stream at a location 3km downstream of Horseleap Lough. The Substation element of the Proposed Grid Connection also drains to the Forty Acres Stream.

Aside from natural streams draining the Proposed Wind Farm site as described above, there is also a high density of man-made drains located within the cutover bog, grassland, and forestry areas. The grassland and forestry areas typically comprise peaty or poorly draining soil (underlain by SILT and CLAY-dominated/low to moderate permeability glacial tills).

As stated previously, the route of the Proposed Grid Connection outside of the Proposed Wind Farm site is entirely along public roads.

Along the Proposed Grid Connection cable route there are 4 no. crossings over EPA mapped watercourses within the Clare[Galway]_SC_050 sub-catchment. These include 3 no. crossings on the Forty Acres Stream (1 no. proposed new culvert at construction site entrance and 2 no. existing bridge/culvert crossings) and 1 no. existing crossing on the Feagh East Stream (EPA Code 30F17) which is a 1st order tributary of the Abbert River.

Within the Clare[Galway]_SC_040 sub catchment, there is an existing crossing at 1 no. EPA mapped watercourse which is the Grange River itself.

3.4.2 Proposed Site Drainage

The Proposed Wind Farm drainage will not significantly alter the existing drainage regime at the Proposed Wind Farm site. Moreover, the proposed drainage system will be fully integrated into the existing bog, forestry and agricultural drainage systems.

Existing drains will be routed under/around the Proposed Wind Farm site access tracks using culverts as required.

Runoff from access tracks, turbine bases, and developed areas (construction compounds, sub-station, met masts etc) will be collected and treated in local (proposed) silt traps and settlement ponds and then discharged to existing local drains.

All new proposed watercourse crossings at the Proposed Wind Farm site will be designed to accommodate a 100-year fluvial flood with allowance for climate change (20 - 30%).

A schematic of the proposed wind farm drainage is shown in **Figure D** below.

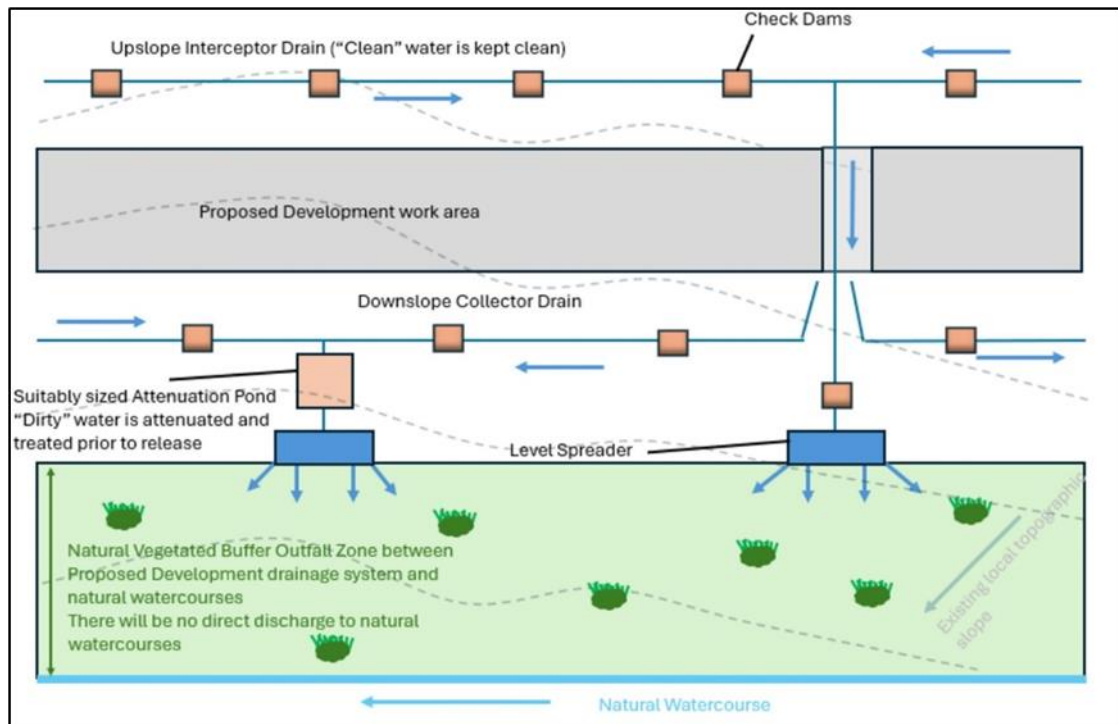


Figure D: Schematic of Proposed Wind Farm Drainage

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 (SAC) and Special Protection Areas (SPAs).

The closest designated site to the Proposed Wind Farm site is Lough Corrib SAC (Site Code: 000297) which includes sections of the Grange River and Abbert River downstream of the Site. Downstream distance to Lough Corrib SAC in the Grange River is 3km and 5.5km in the Abbert River.

The Proposed Grid Connection cable route briefly intercepts Lough Corrib SAC where it crosses over the Grange River via an existing bridge on the R347 approximately 9km to the west of the Proposed Wind Farm site.

Derrinlough Bog SAC (Site Code: 002197) is located approximately 3.5km to the northeast of the Proposed Wind Farm site, while Levally Lough SAC (Site Code: 000295) is located 3.5km to the north.

To the south of the Site, Killaclogher Bog NHA is located approximately 2.5km to the southeast of the Proposed Wind Farm site where it is located upstream in the Abbert River catchment.

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, 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 Historical OSI Mapping

To identify those areas as being potentially at risk of flooding, historical mapping (i.e. 6" and 25" base maps) were consulted.

Identifiable map text on local available historical OSI 6" or 25" mapping does not identify any lands that are "liable to flood" within the Proposed Wind Farm site. The closest lands to the Site mapped as "liable to flood" are low-lying lands located immediately to the southeast and northwest of Horseleap Lough.

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, alluvium deposits are mapped only in the western side of the Proposed Wind Farm Site, along the Abbert_030 river.

4.3.3 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 recurring flood incidents within the Proposed Wind Farm site were identified from OPW's Past Flood Event Mapping (Refer to **Figure E** below).

The nearest mapped past flood events to the Proposed Wind Farm include recurring flood events in low lying lands 0.5km to the south of the Proposed Wind Farm site at Polladooey (Flood ID: 1813), 0.5km to the southwest of Horseleap Lough (Flood ID: 1814) and 1.2km to the northwest of the Proposed Wind Farm site at Cloondahamper (Flood ID: 1840). Mapped Flood ID 1815 is located along the Proposed Grid Connection.

The Tuam West Area Engineer Meeting Minutes states that these recurring flood events relate to "Low lying land floods every year after heavy rain". The area engineers meeting minutes are available to view at www.floodinfo.ie.

According to the OPW (www.floodinfo.ie), parts of the Proposed Wind Farm site are classified as OPWs Arterial Drainage Schemes (ADS) – Benefitted Lands.

The Benefited land identifies land that was 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.

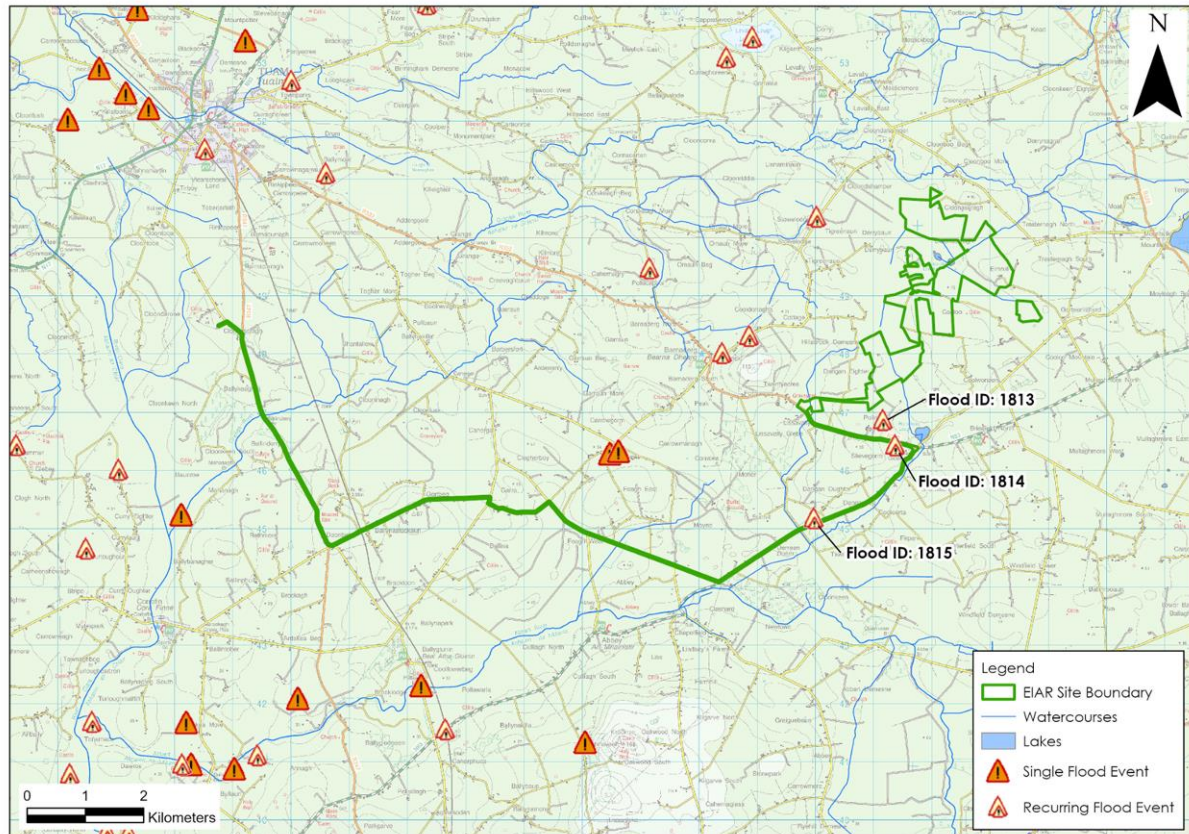


Figure E: OPW Past Flood Event Map

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

The GSI Winter (2015/2016) Surface Water Flooding Map² 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 GSI Winter 2015/2016 Surface Water Flooding Maps have no historic flood zones mapped within the Site. The nearest GSI mapped historic groundwater and surface water flood are the lands around Horseleap Lough.

4.3.5 CFRAM Mapping – Flood Extent Mapping

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

² 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)

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.

CFRAM mapping has not been completed for the area of the Site due to the small scale of the local catchments.

4.3.6 National Indicative Fluvial Flood Mapping (NIFM)

The National Indicative Fluvial Flood Mapping (NIFM) (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments greater than 5km² 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).

No NIFM flood zones are mapped within the Proposed Wind Farm site. NIFM flood zones are mapped further downstream of the Site along the Grange River, the Lecarrow 30 Stream and the Abbert River.

Sections of the Proposed Grid Connection 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.

National Indicative Fluvial Flood Mapping for the present-day scenario is included as **Figure F** below.

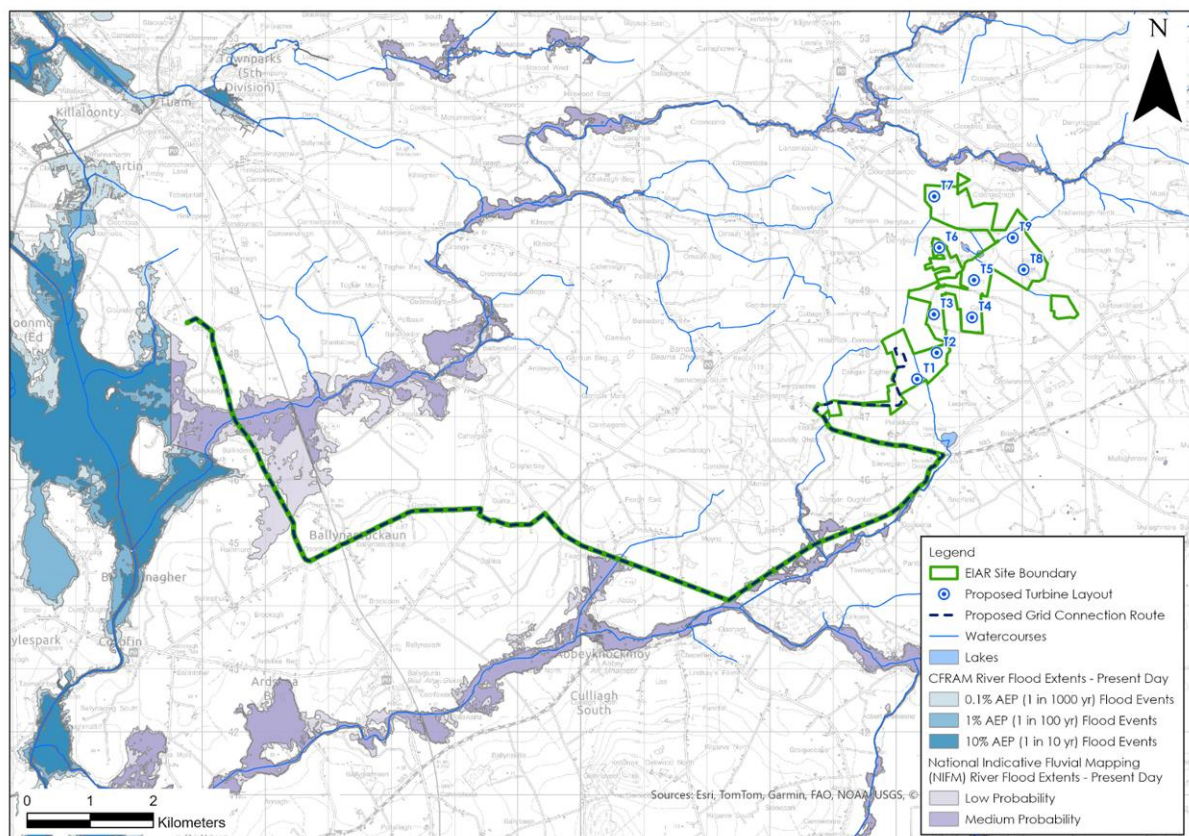


Figure F: OPW CFRAM AND NIFM Flood Mapping Extent

4.3.7 GSI Groundwater Flood Maps

The GSI Groundwater Flood Maps have no historic flood zones mapped within the Proposed Wind Farm site. The nearest GSI mapped historic groundwater floods are the lands around Horseleap Lough and on lands to the southeast of the Proposed Wind Farm site.

The GSI Groundwater Flood Probability Maps shows the probabilistic flood extent of groundwater flooding in limestone regions. These maps are focussed primarily (but not entirely) on flooding at seasonally flooded wetlands known as turloughs. It should be noted that the predictive maps are limited to locations where the flood pattern was detectable and capable of being hydrologically modelled to a sufficient level of confidence.

There are no Groundwater Flood Probability Maps for the area of the Proposed Wind Farm site.

4.3.8 Coastal Flooding

The Proposed Wind Farm Site is located ~30km inland from the sea and sits at an elevation of >66mOD. Therefore, the Proposed Project 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 extends 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 4.3.6**. 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 (higher risk areas). The entire the Proposed Wind Farm site is therefore located in Flood Zone C (low risk).

Sections of the Proposed Grid Connection 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 onsite 110kV substation element of the Proposed Grid Connection is located in Flood Zone C at the Proposed Wind Farm site.

4.4 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 be problematic within the Site.

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process the sources of flood risk for the site are outlined and assessed in **Table B**.

Table B. 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. 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
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

4.5 REQUIREMENT FOR A JUSTIFICATION TEST

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test⁴ is shown in **Table C** below.

It may be considered that the Proposed Wind Farm Site and onsite 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 cable.

Therefore, the Proposed Project is appropriate from a flood risk perspective, and a Justification Test is required.

Table C: Matric of Vulnerability versus Flood Zone

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification test	Justification test	Appropriate
Less vulnerable development	Justification test	Appropriate	Appropriate
Water Compatible development	Appropriate	Appropriate	Appropriate

Note: Taken from Table 3.2 (DoEHLG, 2009)

Bold: Applies to this project.

⁴ 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).

5. PLANNING POLICY

5.1 PLANNING POLICY & COUNTY DEVELOPMENT PLAN

The following policies are defined in the Galway County Council Development Plan (2022-2028) (**Table D**) in respect of flooding, it outlined in the column to the right how these policies are provided for within the Proposed Project design:

Table D: Galway CDP Policy on flooding and reference to relevant sections of this FRA report

No.	Policy	Development Response	Design
FL2	Comply with the requirements of the DoEHLG/OPW The Planning System and Flood Risk Management Guidelines for Planning Authorities and its accompanying Technical Appendices Document 2009 (including any updated/superseding documents).	As outlined in this FRA, and Section 4.5	
FL3	Shall implement the key principles of flood risk management set out in the Flood Risk Management Guidelines	As outlined in this FRA.	
FL6	Maintain and enhance, as appropriate, the existing surface water drainage system in the County. Ensure that new developments are adequately serviced with surface water drainage infrastructure and promote the use of Sustainable Drainage Systems in all new developments. Surface water runoff from development sites will be limited to pre-development levels and planning applications for new developments will be required to provide details of surface water drainage and sustainable drainage systems proposals	The Proposed Wind Farm drainage proposals incorporate numerous SuDS elements that reflect the requirements of this policy. 50m watercourse buffers applied for natural watercourses and 10m buffers for drains.	
FL7	Protect waterbodies and watercourses within the County from inappropriate development, including rivers, streams, associated undeveloped riparian strips, wetlands and natural floodplains. This will include protection buffers in riverine, wetland and coastal areas as appropriate.	The Proposed Wind Farm drainage proposals incorporate numerous mitigation measure for the protection of waterbodies. 50m watercourse buffers applied for natural watercourses and 10m buffers for drains.	
FL8	Protect Flood Zone A and Flood Zone B from inappropriate development and direct developments/land uses into the appropriate Flood Zone in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities 2009 (or any superseding document) and the guidance contained in Development Management Standard 69. Site-specific Flood Risk Assessment (FRA) is required for all planning applications in areas at elevated risk of flooding, even for developments appropriate to the particular flood zone. The detail of these site-specific FRAs will depend on the level of risk and scale of development. A detailed site specific FRA should quantify the risks, the effects of selected mitigation and the management of any residual risks. The Council shall have regard to the results of any CFRAM Studies in the assessment of planning applications	As outlined in this FRA. All highly vulnerable and vulnerable development will be completed in Flood Zone C.	
FL10	SFRAs and site-specific FRAs shall provide information on the implications of climate change with regard to flood risk in relevant locations. The 2009 OPW Draft Guidance on Assessment of Potential Future Scenarios for Flood Risk Management (or any superseding document) shall	As outlined in this FRA. Refer to Section 4.3.9 above.	

	be consulted with to this effect	
FL11	Flood risk may constitute a significant environmental effect of a development proposal that in certain circumstances may trigger a sub-threshold EIA. FRA should therefore be an integral part of any EIA undertaken for projects within the County.	This FRA is part of EIAR and is appended to Chapter 9 which provides a detailed risk assessment.
FL13	Take account of and incorporate into local planning policy and decision making, including possible future variations to this plan, CFRAM measures that may be published in the future, including planned investment measures for managing and reducing flood risk	As outlined in this FRA.
FL14	To ensure that applications pertaining to existing developments in flood vulnerable zones provide details of structural and non-structural risk management measures to include, but not be limited to specifications of the following - floor levels, internal layout, flood resilient construction, flood resistant construction, emergency response planning, access and egress during flood events.	Not applicable, since this is a proposed development
FL16	Applications for development on land identified as benefitting land may be prone to flooding, and as such site-specific flood risk assessments may be required in these areas.	As assessed in this FRA

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 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 onsite 110kV substation element of the Proposed Grid Connection 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 Galway County Development Plan 2022-2028.

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
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 (IH 124).
Fitzgerald & Forrestal	1996	Month and Annual Averages of Rainfall for Ireland 1961 – 1990.
Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.
Galway County Council	2022	Galway County Development Plan 2022-2028

