APPENDIX 7-1

Flood Risk Assessment

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SUBSTITUTE CONSENT FOR DEVIATIONS AT MEENBOG WINDFARM, CO. DONEGAL

STAGE I - FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:
MKO

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

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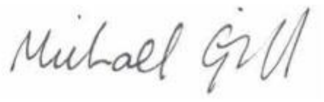
SIGNED:	 **Michael Gill B.A., B.A.I., M.Sc., MIEI Managing Director – Hydro-Environmental Services**

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) were requested by MKO Ireland (MKO), on behalf of Planree Ltd, to undertake a Flood Risk Assessment (FRA) for the substitute consent for deviations at Meenbog Windfarm, Co. Donegal.

As described in Section 1.4.1 of the rEIAR, this FRA uses the following terminology: the 'Site', the 'Permitted Development', the 'Subject Development' and the 'Meenbog Windfarm'.

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

1.2 STATEMENT OF EXPERIENCE

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

Our core 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.

This report was prepared by Michael Gill, Conor McGettigan and John Twomey.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 22 years environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological assessments for various developments across Ireland. Michael has significant experience in surface water drainage issues, SUDs design, and flood risk assessment. Michael worked on the original EIS for Meenbog Windfarm.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 3 years' experience in the environmental consultancy sector in Ireland. Conor holds an MSc in Applied Environmental Science and a BSc in Geology. Conor has completed flood risk assessments for numerous proposed wind farm developments in Ireland.

John Twomey (BSc) is a recent graduate of Earth and Ocean Science from UG and is in the process of training to become an Environmental Scientist. He has recently assisted in the preparation of several hydrogeological and hydrological impact assessments and flood risk assessments on quarries, windfarms and industrial developments.

1.3 REPORT LAYOUT & METHODOLOGY

This FRA report has the following format:

- Section 2 describes the site setting and details of the Site;
- Section 3 outlines the hydrological and geological characteristics of the local surface water catchments in the vicinity of the Site;
- Section 4 presents the current site-specific flood risk conditions at the Site;
- Section 5 assesses the potential change in flood risk conditions (from the baseline) at the Site, as a result of the Subject Development; 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 and field surveys:

- Base maps – Ordnance Survey of Ireland;
- OPW Flood Hazard Maps and flooding information for Ireland, www.floodmaps.ie;
- Office of Public Works (OPW);
- Geological Survey of Ireland (GSI) online databases (www.gsi.ie);
- EPA hydrology databases (www.catchment.ie); and,
- Site Walkover, drainage mapping and flow monitoring.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Site along with a description of the Subject Development.

2.2 SITE DESCRIPTION AND TOPOGRAPHY

The site of the Meenbog Windfarm development (i.e. Site) is located in Co. Donegal, situated ~8km to the southwest of the towns of Ballybofey and Stranorlar, and ~12km northeast of Donegal Town. The eastern and southern boundaries of the Site are defined by the Northern Ireland border. The closest town in Northern Ireland is Castlederg which is located ~19km to the southeast. The Site has a total area of ~903ha (~9km2) in area.

The Site comprises of a mix of conifer forestry, blanket bog and the partially constructed Meenbog Wind Farm. The elevation of the Site ranges between ~145 and 312 mOD (metres above Ordnance Datum). The majority of the Site slopes in a north-westerly direction towards the Bunadaowen River which flows through the Site. The southern section of the Site slopes to the southeast towards the Northern Ireland border.

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

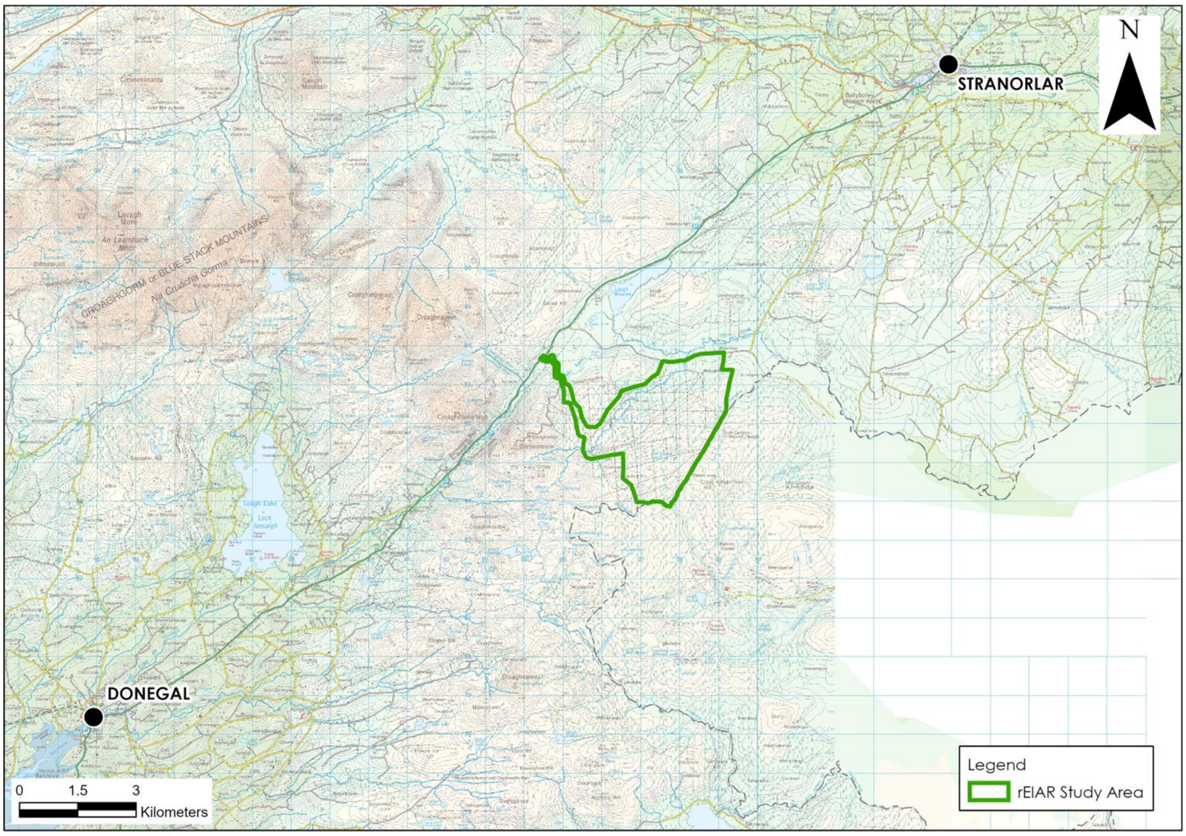

Figure A: Site Location Map

2.3 SUBJECT DEVELOPMENT DETAILS

The Subject Development is described in full in Chapter 3 of the rEIAR.

The Subject Development comprises of 25 no. deviations from the windfarm permitted under ABP-300460-17 (amended by ABP-303729-19). The Subject Development relates to wind farm roads and hardstand areas, peat storage and containment measures, borrow pits, environmental and water quality mitigation measures, and ancillary works. The Subject Development is located in the townlands of Meenbog and Croaghnoagh, near the twin towns of Ballybofey and Stranolar, Co. Donegal. The Subject Development has a total development footprint of 8.8ha.

3. EXISTING ENVIRONMENT

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics in the area of the Site.

3.2 BASELINE HYDROLOGY

3.2.1 Regional and Local Hydrology

The vast majority of the Site is located in the Foyle River surface water catchment within Hydrometric Area 1. This river basin district is an international river basin district with ~3% of this district located in Northern Ireland. Meanwhile, a small area in the northwest of the Site is mapped in the Donegal Bay North regional surface water catchment, with Hydrometric Area 37 of the North Western River Basin District.

Within the Foyle River catchment, the Site is located in the Mourne Beg River sub-catchment (MourneBeg_SC_010). The Mourne Beg River , a tributary of the Mourne River, flows to the southeast from Lough Mourne, situated ~2km northeast of the existing wind farm site entrance. The Mourne Beg River flows to the east, ~150m north of the Site boundary before it crosses into Northern Ireland. Further downstream, this watercourse discharges into the River Derg, ~15km to the east. The River Derg continues to the east. The Mourne River is formed at the meeting of the River Derg and the River Strule, ~27km east of the Site. The Mourne River then flows to the north, through the town of Strabane. Downstream of Strabane, it confluences with the Finn River to form the River Foyle.

In terms of WFD river sub-basins, the Site is located in a total of 5 no. WFD river sub-basins within the Mourne Beg River sub-catchment.

- The northwest of this area of the Site is located in the Mourne Beg_010 river sub-basin. This area is drained by the Mary Breen's Burn stream (EPA Name: Croaghonagh) which flows to the northeast and discharges into the Mourne Beg River, ~1.8km to the northeast of the Site. A tributary of the Mary Breen's Burn Stream (Croaghonagh) is mapped to originate ~25m west of Deviation 2;

- A small area in the northeast of the Site is also mapped in the Mourne Beg_010 river sub-basin. Here, the Mourne Beg River is located ~100m north of the Site;

- Much of the Site is located in the Bunadaowen_010 river sub-basin. This area is drained by the Bunadaowen River and several of its tributaries. There is a high density of mapped watercourses in this area;

- A small area in the northeast of the Site is mapped in the Mourne Beg River (Derrygoonan) sub-basin. In this area the Shruhangarve Stream flows to the northeast, ~130m northwest of Deviation 22, before it discharges into the Mourne Beg River; and,

- The southeast of the Site is located in the Glendergan River sub-basin. A tributary of the Glendergan River flows to the south ~50m from Deviation No 9. The Glendergan River itself forms the southeastern boundary of the Site. This watercourse discharges into the River Derg ~3.7km to the southeast.

Meanwhile, within the Donegal Bay North surface water catchment, a small section in the west of the Site is mapped in the Eske sub-catchment (Eske_SC_010). Within this area, a tributary of the Lowerymore River flows to the southwest ~200m west of Deviation 1. The

Lowerymore River flows to the southwest, through Barnesmore Gap, before discharging into Lough Eske (Eske) ~8.7km to the southwest.

3.2.2 Rainfall and Evaporation

Long term rainfall and evaporation data were sourced from Met Éireann (www.met.ie). The 30-year annual average rainfall (1981-2010) recorded at Ballybofey (Lough Mourne), located ~2km northwest of the Site. The average annual rainfall at Ballybofey (Lough Mourne) is 1,931m/year.

However, the rainfall data from Lough Mourne is likely to underestimate the actual average annual rainfall at the Site due to elevation differences. Lough Mourne rainfall station stands at an elevation of 101mOD whilst the topography at the Site ranges from ~145 to 312mOD.

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 Project Development site ranges from 2,004 to 2,185mm/year. The average annual rainfall is 2,095mm/yr (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

The average potential evapotranspiration (PE) at Belmullet (36km to the west) is taken to be 527.1mm (www.met.ie). The actual evapotranspiration (AE) is calculated to be 500.7mm (95% PE). Using the above figures, the effective rainfall (ER)[1] for the area is calculated to be (ER = SAAR – AE) 1,594mm/yr.

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 windfarm 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: Site - Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	4.9	5.9	8.7	10.7
15 mins	8.1	9.7	14.3	17.6
30 mins	10.9	13.8	19.3	23.7
1 hours	14.8	18.7	26.1	32.1
6 hours	32.2	40.7	56.9	70.0
12 hours	43.6	55.1	77.0	94.7
24 hours	59.0	74.6	104.2	128.2
2 days	76.78	90.1	125.6	150.4

3.3 GEOLOGY

The published Teagasc soils map (www.gsi.ie) for the local area shows that the Site is predominantly overlain by blanket peat (BktPT), with small local areas of mainly acidic, shallow, rock, peaty mineral soils (AminSRPT). In terms of the Subject Development, all deviations are mapped in areas of blanket peat. Meanwhile, areas of AminSRPT soils are mapped immediately to the northwest of Deviation 1. Acid deep well drained mineral soils are also mapped to the north of Deviation 1 but are located outside of the Site boundary.

The published subsoils map (www.gsi.ie) shows that the Site is underlain almost entirely by blanket peat (BktPt), with some small local areas of bedrock outcrop or subcrop (Rck) and till

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

derived from metamorphic rocks (TMp). In terms of the Subject Development, all deviations are mapped to be underlain by blanket peat. Meanwhile, some areas of bedrock outcrop and till derived from metamorphic rocks are mapped in the vicinity of Deviation 1.

Based on the GSI bedrock mapping (www.gsi.ie), the Site is underlain by a total of 3 no. bedrock geological formations. Much of the Site is underlain by Lough Eske Psammite Formation comprising of feldspathic psammite, quartzite and marble. The southern section is underlain by the Lough Mourne Formation which is noted to comprise of coarse and feldspathic pale pink psephites in a pale green chloritic matrix. Meanwhile, a small area in the west of the Site, at the existing entrance is underlain by the Barnesmore Granite.

The Site is underlain by 1 no. mapped structural geological feature. A northeast-southwest orientated fault is mapped in the vicinity of the existing Site entrance, ~40m northwest of Deviation 1.

The soils and subsoils present at the Site have been verified during site walkover surveys and intrusive site investigation completed both as part of the baseline assessment for the Permitted Development and during the construction phase of the Meenbog Windfarm. Site investigations completed by Ionic Consulting (Ionic, 2021) found that the peat depths in the vicinity of the deviation locations range from 0.1 to 2.9m

Bedrock is exposed at a number of existing borrow pit and road cuttings across the Site, and these exposures generally confirm the mapped geology as outlined above. The bedrock was typically noted to be massive and very competent with a thin upper weathered zone at some locations.

3.4 HYDROGEOLOGY

The Site is mapped to be located above the Precambrian Quartzites, Gneisses and Schists (PQGSs) according to the GSI (www.gsi.ie). These rocks are classified by the GSI as being a Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones (PI) (www.gsi.ie). The Site is underlain by the Castlederg Groundwater Body (IEGBNI_NW_G_005).

There are no Group or Public Water Schemes within the Site or within the surrounding areas.

3.5 DESIGNATED SITES & HABITATS

Within the Republic of Ireland designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

The Subject Development is not located within any designated conservation site, however, there are designated sites within the Site boundary and in close proximity to some of the deviation areas. Small sections of Croaghonagh Bog SAC/pNHA (Site Code: 000129) and Cashelnavean Bog NHA (Site Code: 000122) are located within Site. The Subject Development is also hydrologically connected to some downstream designated sites including the Lough Eske and Ardnamona Wood SAC (Site Code: 000163) along the Lowerymore River and the River Finn SAC (Site Code: 002301) along the Mourne Beg River.

3.6 EXISTING SITE DRAINAGE

Prior to the construction of the windfarm development, the drainage within the Site comprised of numerous manmade drains that are in place predominately to drain the forestry plantations. This internal forestry drainage pattern is influenced by the local topography, peat cover, layout of the forest plantation and by the pre-existing forestry road network. The forestry plantations, which cover the majority of the Site are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation.

Mound drains and ploughed ribbon drains are generally spaced approximately every 15-20m and 2m respectively. Interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of existing forestry access roads. Culverts are located on existing access roads at stream and drain crossings and at low points under access roads which drain runoff onto down-gradient forest plantations.

Prior to the onset of construction works associated with the Meenbog Windfarm Development, drainage management system were inserted in accordance with the EIAR and CEMP. These drainage systems were inserted around the work area and integrated with the pre-existing forestry drainage network.

The Meenbog Windfarm drainage system has been designed to mitigate effects on surface watercourses by runoff control and drainage management:

- Firstly, 'clean water is kept clean' by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas.
- Secondly, drainage waters from works areas that might carry silt or sediment, and nutrients, are collected and routed towards settlement ponds (or stilling ponds) prior to controlled diffuse release over vegetated surfaces.
- There is no direct discharge from the work areas or from infrastructure footprint to surface waters.
- All runoff from works areas (i.e. dirty water) is attenuated and treated to a high quality prior to being released.

4. FLOOD RISK DEFINITION

4.1 INTRODUCTION

The following 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 ZONE PROCEDURE

This section of the report details the site-specific flood risk assessment carried out for the Site. The primary aim of the assessment is to consider all types of flood risks and the potential impact on the Subject 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 the 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.

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 stormwater 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 levels may rise slowly, they may be in place for extended periods. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life; and,

- Estuarial flooding may occur due to a combination of tidal and fluvial flows, i.e., the 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 riverbanks.

The Flood Risk Management Guidelines (DoEHLG, 2009) 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% (AEP) or 1 in 100 for river flooding or 0.5% (AEP) 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% (AEP) or 1 in 1000 and 1% (AEP) or 1 in 100 for river flooding and between 0.1% (AEP) or 1 in 1000 year and 0.5% (AEP) 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% (AEP) 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 (JT), where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

The Justification Test (JT) 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 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 local area that would identify lands that are "liable to flood" within or in the vicinity of the Site.

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 floodplain 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 area it appears that there are no areas of alluvium soils mapped within the Site. Based on the Teagasc soil map (www.gsi.ie) for the area, the Site is overlain by blanket peat with some pockets of bedrock at or close to the surface. These soils are not indicative of areas prone of fluvial flooding.

The closest mapped alluvium deposits are mapped along the Lowerymore River, ~650m southwest of deviation 1. There are no alluvium deposits mapped along the Bunadaowen River or the Mourne Beg River in the vicinity of the Site.

4.3.3 Past Flood Events Mapping

To identify those areas as being at risk of flooding, OPW's Past Flood Events Map was consulted (www.floodinfo.ie).

No recurring or historic flood incidents were identified within or in the vicinity of the Site from OPW's Flood Hazard Mapping (refer to **Figure B** below).

The closest mapped downstream recurring flood event is located ~4.2km to the southwest (Flood ID: 4194). This flood event is located along the Lowerymore River in the Barnesmore Gap.

Flood Maps (NI) were also consulted to identify downstream historic flood events in Northern Ireland. The Historical Flood Map illustrates areas that are known to have flooded in the past. The closest mapped historic flood zones downstream of the Site are located on the River Derg, ~8km from the Site.

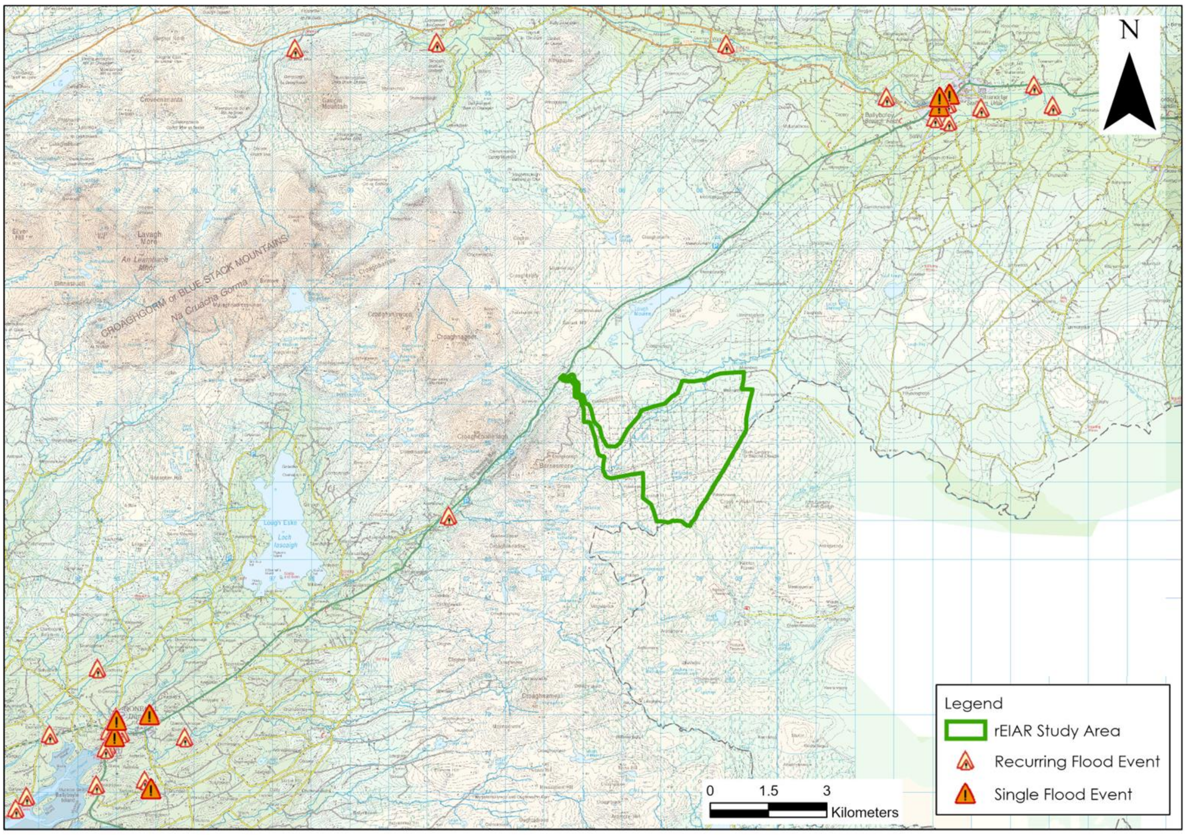

Figure B: OPW Flood Hazard Mapping (www.floods.ie)

4.3.4 GSI Historical Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding map 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. This surface water flood map is available to view at www.floodinfo.ie.

This historic flood map does not record any flood zones along the stream or rivers which drain the Site. 1 no. small area of surface water flooding is mapped within the Site. This flood zone corresponds to the location of Carrickaduff Lough and is situated ~350m from the closest element of the Subject Development.

The GSI Winter (2015/2016) Surface Water Flood Map for the local area is shown in **Figure C**.

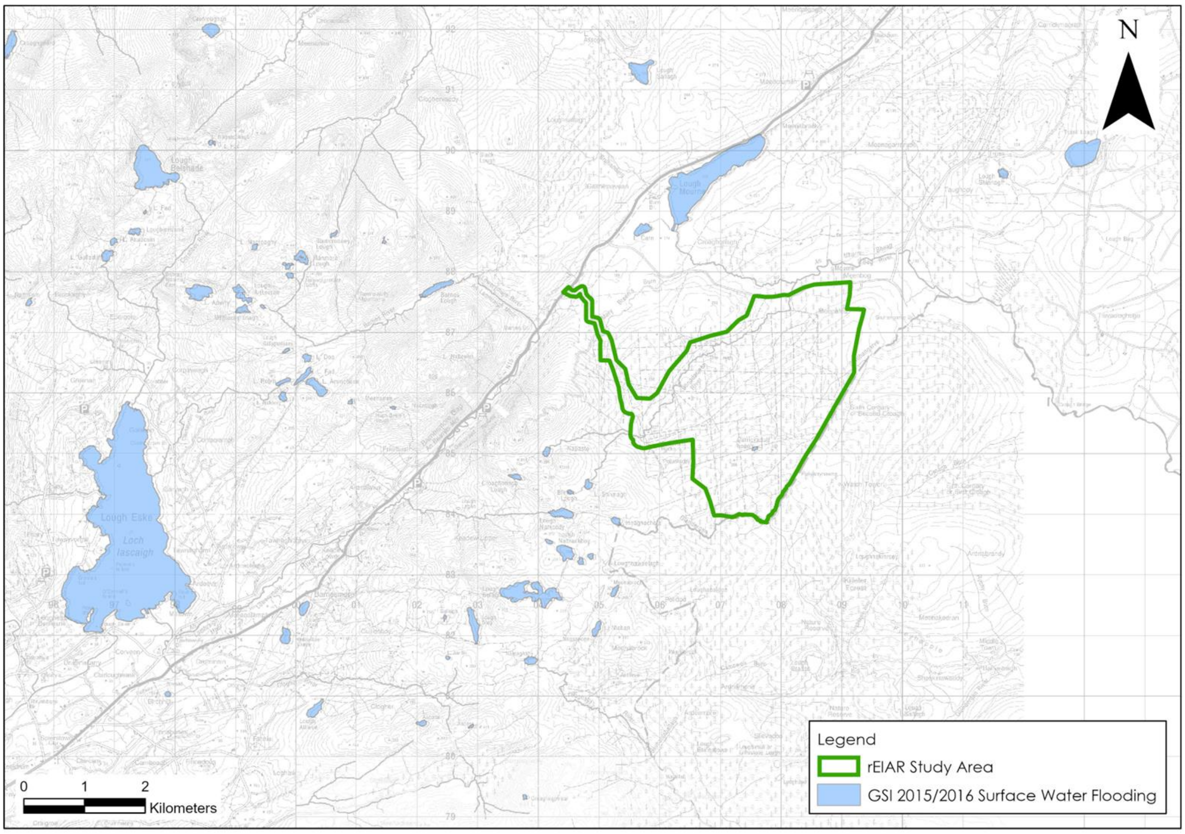

Figure C: GSI Historical Surface Water Flood Map

4.3.5 CFRAM Maps – Fluvial Flooding

Catchment Flood Risk Assessment and Management (CFRAM)[2] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA maps. CFRAM mapping of river flood extents are available at www.floodinfo.ie.

No CFRAM mapping has been completed for the area of the Site. The closest downstream mapped CFRAM fluvial flood zones are located at Donegal Town.

4.3.6 National Indicative Fluvial Flood Mapping

The National Indicative Fluvial Flood Mapping (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments greater than 5km^2, in the Republic of Ireland, 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 take into account 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.)

For the Present Day Scenario the medium (1 in 100-year) and low probability (1 in 1,000-year) fluvial flood zones have been mapped along the Bunadaowen River in the north of the Site. However, no elements of the Subject Development are located within the mapped fluvial flood zones. The low-probability flood zone (1 in 1,000-year flood event) is located ~60m

[2] *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.*

south of deviation 15. In this area the flood zones do not extend any significant distance from the river channel.

Fluvial flood zones are also located on the Lowerymore River. These flood zones do not encroach upon the Site entrance and are located ~800m southwest of the existing site entrance.

Therefore, all elements of the Subject Development are located outside of the mapped flood zones and are located in Fluvial Flood Zone C, where the probability of fluvial flooding is low (less than 0.1%).

The National Indicative Fluvial Flood Mapping for the present day is included as **Figure D** below.

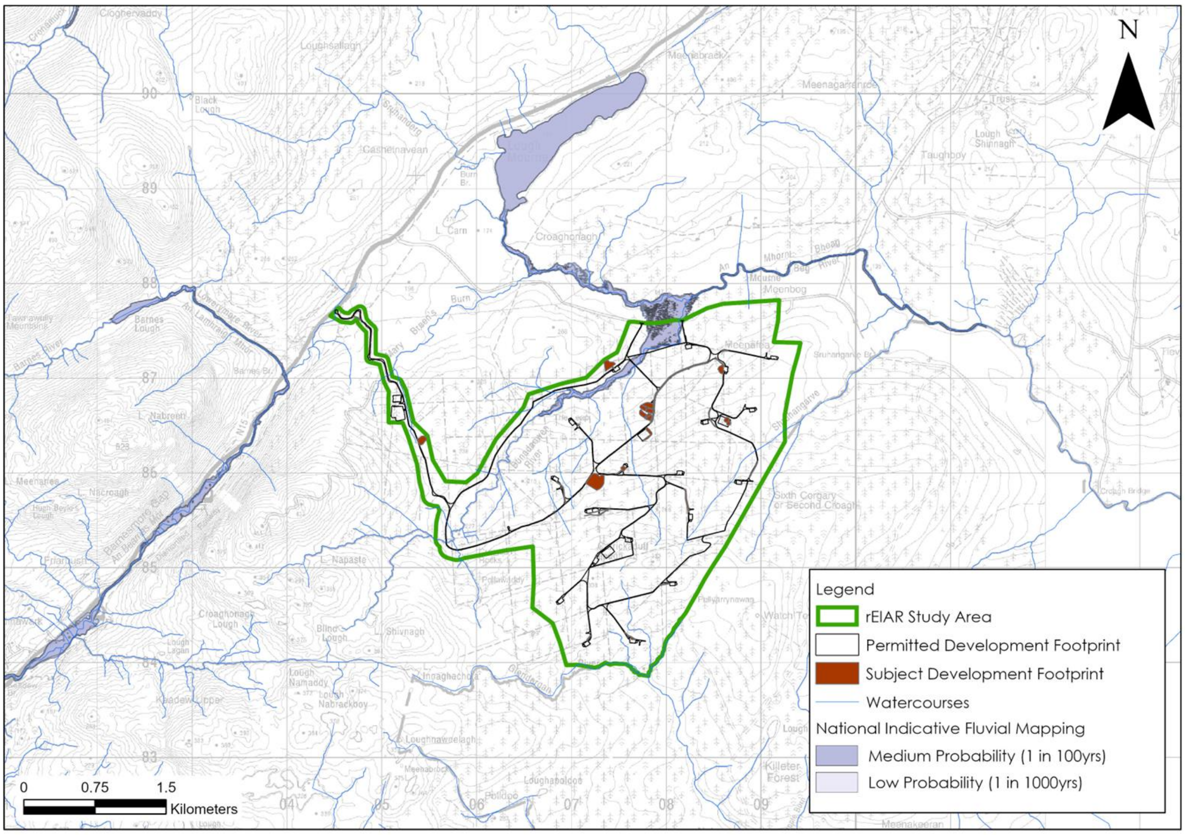

Figure D: OPW National Indicative Flood Mapping

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 Site or in the surrounding area.

4.3.8 Coastal Flooding

The Site is located ~14.5km from Donegal Bay and stands at a significant elevation above sea level (~145 to 312mOD). The closest mapped CFRAM coastal flood zones are mapped at Donegal Town. Therefore, the 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 etens 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 impacted by future climate change.

4.3.8 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, there is a small section of the Site that is located within Flood Zone B, located along the Bunadaowen River. However, no elements of the Subject Development are located within the any mapped flood zones. The Subject Development is therefore, located in Flood Zone C and is considered to be at low risk of flooding.

4.3.9 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Site can be described using the Source – Pathway – Receptor Model ("S-P-R"). Given the typical sloping topography and ground elevations, the potential for pluvial flooding is generally low. The primary potential source of flooding in this area, and the one with most consequence for the Proposed Development, is fluvial flooding of the local streams which drain the Site during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.3.10 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 be problematic in the areas of the Subject Development. The potential 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 Site

Source	Pathway	Receptor	Comment
Tidal	Not applicable	Land and infrastructure.	The Site is located a significant distance from any estuary or tidal waterbody and at a significant elevation above sea level.
Fluvial	Overbank flooding of the Bunadaowen River and other smaller rivers and streams that drain the Site.	Land and infrastructure.	There is 1 no. mapped fluvial flood zones within the Site along the Bunadaowen River. However, all elements of the Subject Development are located outside of this flood zone and are considered to be at low risk of fluvial flooding (Flood Zone C).
Pluvial	Ponding of rainwater on Site	Land and infrastructure.	There is very little risk of pluvial flooding within the Site due to the sloping nature of the land. Drainage moves relatively freely downslope due to the sloping topography; the existing forestry drains and the high density of natural watercourses and streams. Therefore, there is little risk of pluvial flooding at the Site.
Surface water	Surface ponding/ Overflow	Land and infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land and infrastructure.	Based on local hydrogeological regime and GSI mapping, there is no apparent risk from groundwater flooding.

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[3] is shown in **Table C** below.

The Subject Development is located in Flood Zone C and is therefore appropriate from a flood risk perspective and would not require a justification test.

Table C: Matrix 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*

[3] *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. FLOOD IMPACT ASSESSMENT

This section presents an assessment of the flood risk caused by the Subject Development.

There will have been no change flood risk as a result of the Subject Development for the following reasons:

- The Subject Development is located outside of all mapped flood zones. Therefore the Subject Development has not and will not result in the displacement of flood waters;
- The Subject Development has been constructed in accordance with the drainage design principles detailed in the EIAR and the CEMP. We note that the Permitted Development was deemed to be appropriate from a flood risk perspective;
- The on-site wind farm drainage system has been designed to ensure that all surface water run-off is treated (water quality control) and attenuated (water quantity/flood management control);
- The drainage systems implemented at the Subject Development areas include attenuation of runoff. Runoff from the deviation areas is limited and temporarily stored to limit potential effects on surface water flow volumes;
- All runoff is routed through settlement ponds and outflow from the settlement ponds is released in a controlled and diffuse manner and pre-existing greenfield runoff rates;
- There was no release of untreated or unattenuated waters from the Subject Development areas;
- Therefore, the Subject Development has no potential to increase the magnitude of downstream hydrograph peaks; and,
- The change in runoff volumes associated with the Subject Development is considered to be equivalent to that which was assessed in the EIAR for the Permitted Development.

For these reasons, the Subject Development has not and will not result in any increase in downstream flood risk.

6. REPORT CONCLUSIONS

- A flood risk identification study was undertaken to identify existing flood risks associated with the Meenbog Windfarm, Co. Donegal and more specifically the deviations (i.e. the Subject Development) for which Substitute Consent is being sought. From this study:
  - No instances of historical flooding were identified in historic OS maps;
  - No instances of recurring flooding were identified on OPW maps within the Site;
  - The GSI Historical 2015/2016 Surface Water Flood Map records 1 no. area of surface water flooding within the Site. This relates to Carrickaduff Lough and is located a significant distance from the Subject Development;
  - The GSI Groundwater Flood Mapping does not record any historic or predictive groundwater flood zones within the Site; and,
  - No areas of the Site were identified within the OPW/CFRAM Flood Zones.
- The OPW National Indicative Flood mapping indicates that fluvial flooding does occur along the Bunadaowen River within the northern area of the Site. However, the modelled fluvial flood extents do not extent any significant distance from the river channel and do not encroach upon any of the Subject Development areas;
- The Subject Development is therefore located in Flood Zone C and is considered to be at low risk of flooding; and
- In addition, the risk of the Subject Development contributing to downstream flooding is very low. The inserted drainage systems retain and slow down drainage water prior to release. Robust drainage measures have been implemented at the Subject Development locations including swales, silt traps, check dams, settlement ponds and buffered outfalls. These are the same measures which were detailed in the EIAR and the CEMP for the Permitted Development.

* *

7. REFERENCES

AGMET	1996	Agroclimatic Atlas of Ireland.
DOEHLG	2009	The Planning System and Flood Risk Management.
Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.