APPENDIX 9-1

FLOOD RISK ASSESSMENT

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PROPOSED KNOCKSHANVO WIND FARM, CO. CLARE

FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

MKO

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

DOCUMENT INFORMATION

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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 on behalf of FuturEnergy Knockshanvo DAC to undertake a Flood Risk Assessment (FRA) for the proposed Wind Farm development at Knockshanvo, Co. Clare. The proposed Wind Farm Site is located ~11km north of Limerick City and ~4km northeast of Sixmilebridge, Co. Clare.

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 EXPERIENCE

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 (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous geological, hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design and surface water/groundwater interactions. For example, Michael has worked on the EIS for Carrownagowan WF, Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 3 years' experience in environmental consultancy in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016) from University College Dublin. Conor has prepared the Land, Soils and Geology and Hydrology and Hydrogeology Chapters for numerous wind farm EIAR projects. Conor routinely competes Flood risk Assessments for a wide variety of projects including wind farms, quarries and proposed residential developments.

1.3 REPORT LAYOUT

This FRA report has the following format:

- Section 2 describes the site setting and details of the Proposed Development;
- Section 3 outlines the hydrological and geological characteristics of the local area;
- Section 4 presents a site-specific flood risk assessment;
- Section 5 presents the Proposed Development in the context of the local development plan and completed a justification test for the Proposed Development; and,
- Section 6 presents the FRA report conclusions.

2. BACKGROUND INFORMATION

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

2.1 SITE LOCATION AND TOPOGRAPHY

The Wind Farm Site is located ~4km northeast of the village of Sixmilebridge, ~3km south of the small village of Broadford and ~3.5km southeast of Kilkishen in southeast Co. Clare. The Wind Farm Site is situated ~11km north of Limerick City. The Wind Farm Site is elongated along the crest of a hill and is located in the townland of Knockshanvo and adjacent townlands. The Grid Reference co-ordinates for the approximate centre of the site are E554266 N669733. The Wind Farm Site has a total area of 1,072hectares (ha).

The Wind Farm Site is comprised of existing commercial forestry plantations, dominated by Sitka Spruce and Lodgepole Pine. The Wind Farm Site also contains areas which are unplanted and comprises of wet heath habitats or unplanted areas along riparian buffer zones. Other areas of the Wind Farm Site have been felled and are reverting naturally to wet heath.

The Wind Farm Site is served by an existing network of forestry roads. The Wind Farm Site is accessed via local roads from the R465 Regional Road, which travels in a north-south direction between Broadford and Ardnacrusha, the R471 Regional Road which travels east-west between Sixmilebridge and Clonlara and the Crag Local Road, which travels in a northeast-southwest direction between Sixmilebridge and Broadford.

Topography of the Wind Farm Site is highly variable, ranging from ~160 to 310mOD (metres above Ordnance Datum). The Wind Farm Site is located in the Slieve Bernagh Mountain Range in east, Co. Clare and is located on an elevated east-west orientated ridge. The Wind Farm Site contains several local peaks, the highest of which is Knockanuarha (~310mOD). The north of the Wind Farm Site slopes to the north and northwest while the south slopes to the south and southeast away from this elevated ridge.

The Grid Connection to Ardnacrusha is ~9.2km in length. This Grid Connection will originate from the proposed onsite 110kV electrical substation in the townland of Drumsillagh Co. Clare. This underground Grid Connection travels to the south along a local road as far as Ardnacrusha. Elevations along Grid Connection range from ~180mOD at the proposed onsite 110kV electrical substation to ~20mOD in the vicinity of Ardnacrusha 110kV Electrical Substation. The Grid Connection will utilise the existing public local road networks, existing Coillte forestry access tracks, private forestry access tracks and private agricultural lands.

The Turbine Delivery Route (TDR) begins at Foyne Port and travels along the N69 passing through Limerick City. To the north of Limerick City, the TDR follows Corbally Road, the R463 and the R465 before entering the Wind Farm Site in the townland of Kilmore, Co Clare. Minor works, comprising road widening, are required along the R465 to the south of the Wind Farm Site. Meanwhile, a temporary transition compound will also be constructed along the N69 in the townland of Court, Co. Limerick.

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

2.2 PROPOSED DEVELOPMENT DETAILS

The Proposed Development includes 9 no. proposed turbines, an on-site 110kV electrical substation, new site access roads, upgrade of existing roads, 1 no. meteorological mast, 3 no. temporary construction compounds, underground cabling, temporary transition compound, 5 no. onsite borrow pits, amenity proposals and biodiversity enhancement areas. The

Proposed Development will connect to the national grid via an underground 110kV electrical connection from the proposed onsite substation to the existing Ardnacrusha 110kV substation. The Proposed Development also includes all associated site preparation and drainage works. Furthermore the Proposed Development includes works along the TDR.

A full description of the Proposed Development is provided in Chapter 4 of the EIAR.

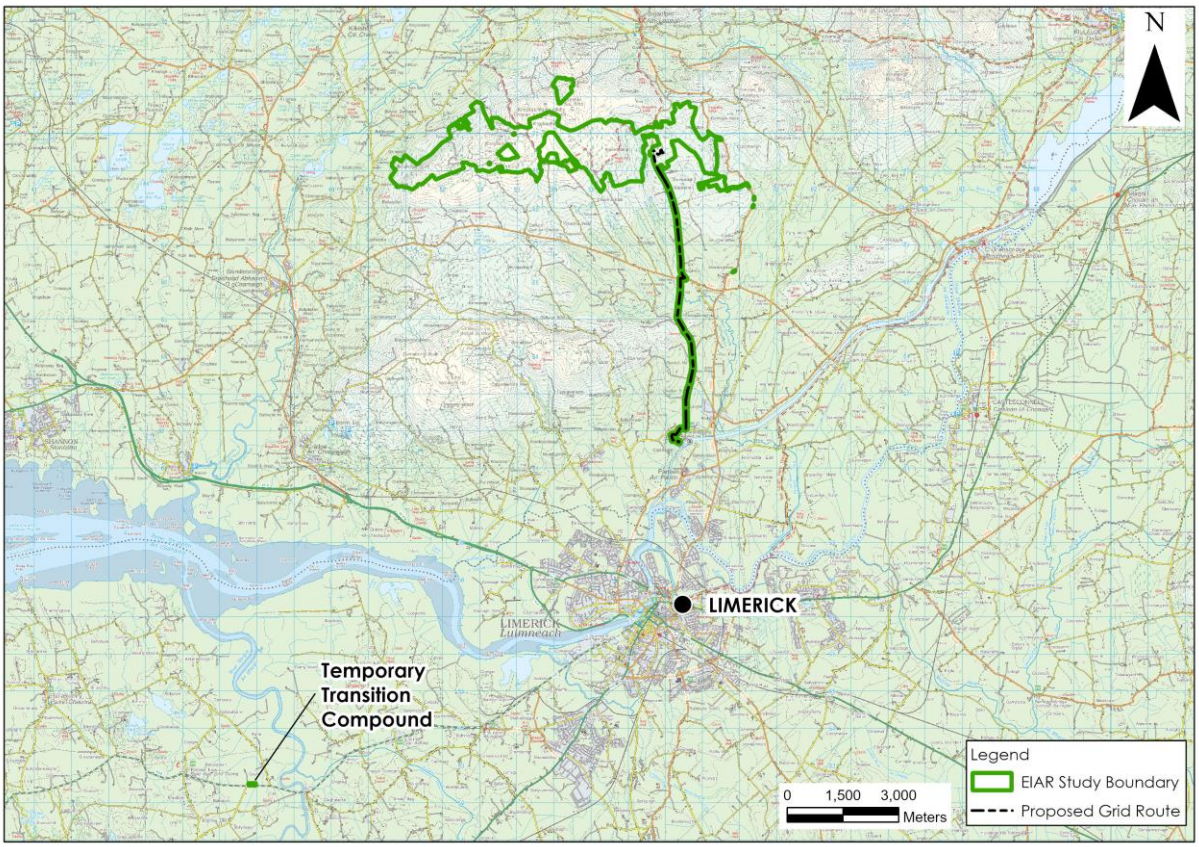

Figure A: Site Location Map

3. EXISTING ENVIRONMENT AND CACTHMENT CHARACTERISTICS

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

3.1 BASELINE HYDROLOGY

3.1.1 Regional and Local Hydrology

The Wind Farm Site is located across 2 no. regional surface water catchments. The east and south of the Wind Farm Site is located in the Lower Shannon surface water catchment and Hydrometric Areas 25D. Meanwhile, the northwest of the Wind Farm Site is located in the Shannon Estuary North surface water catchment and Hydrometric Area 27. Both regional surface water catchments are located in the Shannon River Basin District.

The Lower Shannon Catchment (HA 25D) covers a total area of 1,041km^2 and includes the lower reaches of the River Shannon to Limerick City and the catchment of the Mulkaer River. The catchment is underlain by mostly impure limestones in low lying areas and the sandstone and metamorphic rocks in the uplands of the Slieve Bernagh and Arra Mountains in the northwest, and the Silvermines and Slieve Feilim Mountains in the east (EPA, 2018).

Within the Lower Shannon surface water catchment, the Wind Farm Site is located in the Shannon[Lower]_SC_100 sub-catchment. More locally this section of the Wind Farm Site lies within the catchment of the Blackwater (Clare) River. Several 1st and 2nd order streams drain the Wind Farm Site and flow to the south before discharging into the Blackwater River. These tributaries of the Blackwater River include the O'Neill's, Mountrice, Drumsillagh rivers, the Sruffaunageeragh stream and several additional unnamed streams. The Blackwater River flows to the east ~3.2km to the south of the Wind Farm Site before it veers to the south and discharges into the River Shannon ~10.5km to the southeast.

The Shannon Estuary North catchment (HA 27) includes the area drained by the River Fergus and all streams entering the tidal waters between Thomond Bridge and George's Head Co. Clare and drains a total area of 1,658km^2 (EPA, 2018).

Within the Shannon Estuary North surface water catchment, the Wind Farm Site is located in the Owenogarney_SC_010 sub-catchment. This area of the Wind Farm Site drains to the north and northwest towards the Owenogarney River via several unnamed streams and the Broadford River. The northeast of the site drains to the Broadford River which flows to the northwest before it discharges into Doon Lough ~3.3km to the north of the Wind Farm Site. The Ahaclare River outflows from Doon Lough and is referred to as the Owenogarney River to the west of the Wind Farm Site. Meanwhile, the west of the Wind Farm Site drains via several 1st and 2nd order streams, which flow to the northwest and discharge directly into the Owenogarney River. Downstream of the Wind Farm Site, the Owenogarney River discharges into Ballymulcashel Lough and Castle Lake. Further downstream, the Owenogarney River continues to the south, flowing through the village of Sixmilebridge, and past Bunratty before eventually discharges into the Shannon Estuary ~10km to the southwest.

The Grid Connection to Ardnacrusha is mapped within the Lower Shannon surface water catchment and Hydrometric Area 25D. There are a total of 4 no. crossings over EPA mapped watercourses. These include 2 small tributaries of the Mountrice Stream and the Blackwater River to the south of the R471. Further south the route crosses an unnamed watercourse. This watercourse is a tributary of the Blackwater River and is referred to by the EPA as the Glenlon south watercourse. These watercourse crossings are situated at existing bridge and culvert crossings.

Works are proposed in 3 no. WFD river sub-basins along the TDR. These include minor haul route works at 3 no. locations and a temporary transition compound.

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

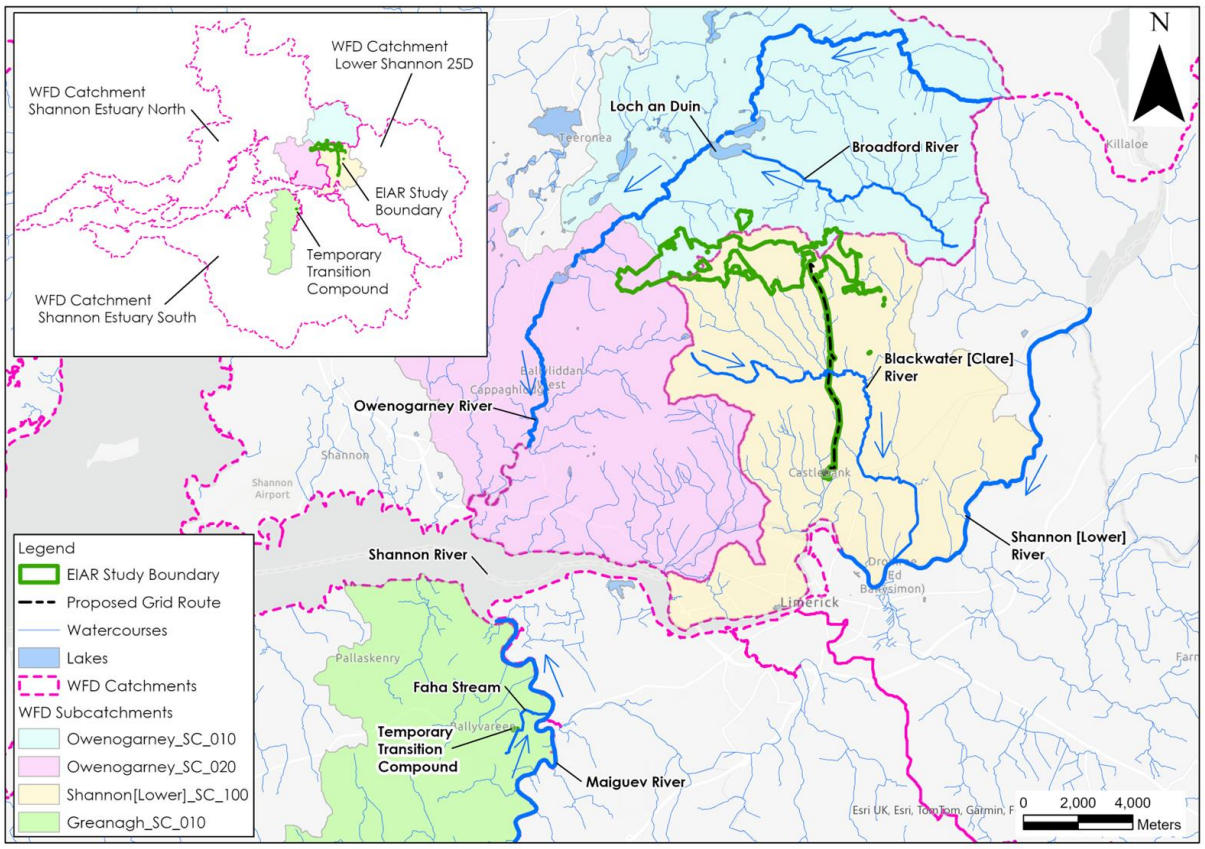

Figure B: Local Hydrology Map

3.1.2 Wind Farm Site Drainage

The Wind Farm Site is drained by several 1st and 2nd order streams. These natural watercourses originate within the Wind Farm Site boundary and flow downslope before discharging into the Owenogarney River to the northwest and the Blackwater River to the south.

In places the natural drainage is further facilitated by a network of manmade drains. These manmade drains are concentrated within the areas of coniferous forestry and along sections of the existing forestry access roads.

The forest plantations 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 15m 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 forestry access roads. Culverts are generally located at stream crossings and at low points under access roads which drain runoff onto down-gradient forest plantations. The forestry drains are the primary drainage routes towards the natural streams, but the flows in the higher elevated drains are generally very low or absent most of the time.

3.1.3 Rainfall and Evaporation

The SAAR (Standard Average Annual Rainfall) recorded at Ardnacrusha, the closest rainfall station to the Wind Farm Site with long term SAAR data, is 1,128.1mm (www.met.ie). Ardnacrusha rainfall station is located ~7km south of the Wind Farm Site. However, the SAAR at Ardnacrusha is likely to underestimate rainfall at the Wind Farm Site due to elevation differences whereby the Wind Farm Site stands at an elevation of 160-310mOD and Ardnacrusha rainfall station is at ~28mOD.

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 Wind Farm Site ranges from 1,239 to 1,364mm/year. The average annual rainfall is 1,315mm/yr (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

The average potential evapotranspiration (PE) at Shannon Airport (~15km southwest of the Wind Farm Site) is taken to be 543.2mm (www.met.ie). The actual evapotranspiration (AE) is calculated to be 516.0mm (95% PE). Using the above figures, the effective rainfall (ER)[1] for the area is calculated to be (ER = SAAR – AE) 799mm/yr. This is also considered to be the best estimate of effective rainfall along the Grid Connection.

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 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. Knockshanvo – Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	4.0	6.4	10.3	14.0
15 mins	6.5	10.4	17.0	22.9
30 mins	8.5	13.4	21.2	28.3
1 hours	11.1	17.1	26.6	35.0
6 hours	22.0	32.2	47.6	60.6
12 hours	28.7	41.2	59.5	74.9
24 hours	37.5	52.6	74.6	92.6
2 days	46.4	63.6	88.0	107.5

3.2 GEOLOGY

Wind Farm Site

The published Teagasc soils map (www.gsi.ie) for the local area shows that the Wind Farm Site is overlain by a mosaic of soil types. Soils within the Wind Farm Site comprise of blanket peat (BktPt), acid shallow well drained mineral soils (AminSW), acid deep well drained mineral soils (AminDW) and acid shallow poorly drained mineral soils (AminSP).

The published subsoils map (www.gsi.ie) shows that the Wind Farm Site is underlain by bedrock outcrop or subcrop (Rck), blanket peat (BktPt) and till derived from Devonian sandstones (TDSs). There is also some till derived from Lower Palaeozoic sandstones and shales (TLPSsS). In terms of the proposed turbine locations, a total of 7 no. turbines are mapped in areas of bedrock outcrop or subcrop. Meanwhile, T8 is mapped in an area of blanket peat and T7 is underlain by a till derived from Devonian sandstones.

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

The soils and subsoils at the Wind Farm Site have been verified by site investigations comprising of peat probes and trial pits.

The GSI bedrock geology map shows the Wind Farm Site to be underlain by Devonian Old Red Sandstones, Ordovician Metasediments and Silurian Metasediments and Volcanics. The Wind Farm Site is underlain by a total of 4 no. bedrock geology formations with the bedrock in this area being heavily folded and faulted.

The centre and east of the Wind Farm Site is underlain largely by Old Red Sandstones which comprise of red mudstones, siltstones and sandstones, and poorly sorted, polymict pebble and conglomerates and breccias. Meanwhile, the west of the Wind Farm Site is heavily faulted and, in addition to the Old Red Sandstones, is underlain by the Broadford, Ballymalone and Cornagnoe bedrock geology formations. The Broadford Formation consists of fine to conglomeratic greywackes. Meanwhile, the GSI provide the following lithological description of the Ballymalone Formation: "red to black coloured shales and buff grey coloured cherts. The shales locally contain graptolites". The Cornagnoe Formations contains two principal lithologies, grey mudstones and mottled siltstones and mudstones.

Based on the GSI mapping, there is a multitude of faults mapped within and to the north of the Wind Farm Site. There is no discernible preferential fault orientation. The GSI map the presence of bedrock outcrop in the local area, with several exposures mapped in the centre and east of the Wind Farm Site.

Grid Connection

According to the Teagasc soil mapping (www.gsi.ie) , the majority of the Grid Connection is overlain by mainly acidic poorly drained mineral soils (AminPD). Meanwhile, the northern section, in the vicinity of the Wind Farm Site is overlain by shallow, rocky, peaty mineral soils (AminSRPT). Alluvium is also mapped along the Blackwater River. Made ground is mapped in the south of the Grid Connection, in the vicinity of Ardnacrusha.

In terms of subsoils, the GSI (www.gsi.ie) map till derived from Devonian sandstones (TDSs) underlying much of the Grid Connection. Bedrock outcrop or subcrop (Rck) is mapped in the vicinity of the Wind Farm Site and further south in the townland of Knockdonagh. Other subsoils mapped along the Grid Connection include till derived from Lower Palaeozoic sandstones and shales (TLPSsS) and mineral alluvium along the Blackwater River.

Much of the Grid Connection is mapped by the GSI to be underlain by Old Red Sandstones (undifferentiated) (www.gsi.ie). Meanwhile, in the townland of Knockdonagh, the Grid Connection is mapped to be underlain by the Cratloes Formation. The southern section is underlain by the Lower Limestone Shales and the Ballysteen Formation to the north of Ardnacrusha. The Waulsortian Limestones underlie Ardnacrusha and the southernmost section of the Grid Connection.

Turbine Delivery Route

According to the Teagasc soil mapping (www.gsi.ie), the works areas along the R465 are overlain by acid poorly drained mineral soils. The mapped subsoils in this area comprise of till derived from Devonian sandstones. The temporary compound along the N69 is overlain by alluvial soils and basic poorly drained mineral soils. This area is underlain by alluvium and till derived from limestones.

In terms of bedrock geology, the temporary transition compound along the N69 is underlain by Waulsortian Limestones. Meanwhile, bedrock geology underlying the works areas along the R465 is mapped as Old Red Sandstone.

3.3 DESIGNATED SITES & HABITATS

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

The Wind Farm Site is not located within a designated conservation site, however there are several designated sites in close proximity and downstream of the Wind Farm Site.

Gortacullin Bog NHA (Site Code: 002041) is located immediately to the north of the Wind Farm Site in the townlands of Hurdlestown, Ballykelly and Gortacullin. However, this NHA is located upgradient of all proposed works.

Within the Shannon Estuary North surface water catchment there are several designated sites which are located downstream of the Wind Farm Site. These include Doon Lough NHA, Danes Hole Poulnalecka SAC/pNHA, Castle Lake pNHA, Ratty River Cave SAC, the Lower Shannon SAC. The Fergus Estuary and Inner Shannon, North Shore pNHA and the River Shannon and Fergus Estuary SPA. The Wind Farm Site is hydrologically connected to these designated sites via the Owenogarney River and its tributaries.

Meanwhile, within the Lower Shannon surface water catchment, the Wind Farm Site is hydrologically connected to both the Glenomra Wood SAC/pNHA and the Lower River Shannon SAC.

Along the TDR, the Temporary Transition Compound is located upstream of the Lower River Shannon SAC (Site Code: 002165), the River Shannon and River Fergus Estuaries SPA (Site Code: 004077) and the Inner Shannon Estuary – South Shore pNHA (Site Code: 000435).

No designated sites are mapped along the Grid Connection. The Grid Connection is located upstream and is hydrologically connected to the Lower River Shannon SAC.

4. FLOOD RISK IDENTIFICATION

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.

A Stage 1 assessment of flood risk requires an understanding of where the water comes from (i.e. the source), how and where it flows (i.e. the pathways) and the people and assets affected by it (i.e. the receptors). It is necessary to identify whether there may be any flooding or surface water management issues related to the proposed site that may warrant further detailed investigation.

As per the guidance (DOEHLG, 2009), the stage 1 of a flood risk assessment comprises:

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

Further to this, a Stage 2 assessment involves the confirmation of sources of flooding, appraising the adequacy of existing information and determining what surveys and modelling approach may be required for further assessment.

4.2 FLOOD ZONE MAPPING

Flood zones are geographical areas within which the likelihood of flooding is in a particular range. There are three types or levels of flood zones defined for these purposes according to OPW 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.

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 that would identify lands that are "liable to flood" within or in the vicinity of the Wind Farm Site or Grid Connection.

4.3.2 Soils Maps - Fluvial Maps

A review of the soil types in the vicinity of the Wind Farm 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, no fluvial or lacustrine deposits are mapped within the Wind Farm Site. There are no soils present that indicate areas where flooding may have occurred in the past. Meanwhile, downstream of the Wind Farm Site, mineral alluvium is mapped along many watercourses including the Owenogarney River and the Blackwater (Clare) River. These deposits do not encroach upon the Wind Farm Site and are located a significant distance from any proposed infrastructure. Meanwhile, the Temporary Transition Compound along the TDR route is overlain by alluvial soils and basic poorly drained mineral soils. This area is underlain by alluvium and till derived from limestones.

In terms of the Grid Connection, alluvium deposits are mapped to the south of the R471 in the townland of Cloghera along the Blackwater River. This section of the Grid Connection is located along an existing public road and the route crosses the watercourse at Trough Bridge.

4.3.3 OPW 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 are recorded within the Wind Farm Site. However, several flood events have been recorded in the surrounding lands.

Within the Shannon Estuary North surface water catchment, the closest mapped historic flood event is located ~1.5km to the southwest of the Wind Farm Site (Flood ID: 4480) where a local road flooded in 2005 due to heavy rainfall. With respect to recurring flood events, a flood event is recorded along the Glenomra stream (Flood ID: 4695), ~2.2km northeast of the Wind Farm Site along the R466. A second recurring flood event (Flood ID: 4699) is recorded ~2.3km north of the Wind Farm Site at Woodfield Bridge along the Ahaclare River. Further downstream several recurring flood events (Flood ID: 4485, 4479, 4498) are also located downstream of Sixmilebridge where roads are noted to flood in the vicinity of the Owenogarney River due to heavy rainfall and/or tidal backup.

Meanwhile within this catchment, a historic flood event (Flood ID: 4480) is recorded ~1.5km southwest of the Wind Farm Site. This flood event dates from 2000 where the road flooded due to the shear volume of rainfall following an exceptional rainfall event.

Within the Lower Shannon surface water catchment, a historic flood event (Flood ID: 4697) is mapped immediately to the east of the Wind Farm Site. This event dates from 2005 with the flooding resulting from a rare rainfall event (1 in 20-year event) which caused flooding along the R465 from Broadford to Limerick. With respect to mapped recurring flood events, the

nearest flood event downstream of the Wind Farm Site is mapped ~10km to the south and in the vicinity of Limerick City. Several historic flood events are also mapped in this area, associated with flooding along the River Shannon. No historic or recurring flood events are mapped in the TDR work areas.

In terms of the Grid Connection, the OPW Past Flood Events map does not record any historic or recurring flood events in the vicinity of the Grid Connection. However, several historic flood events are recorded downstream along the River Shannon in the vicinity of Limerick City.

The OPW Past Flood Events Map is presented as **Figure C** below.

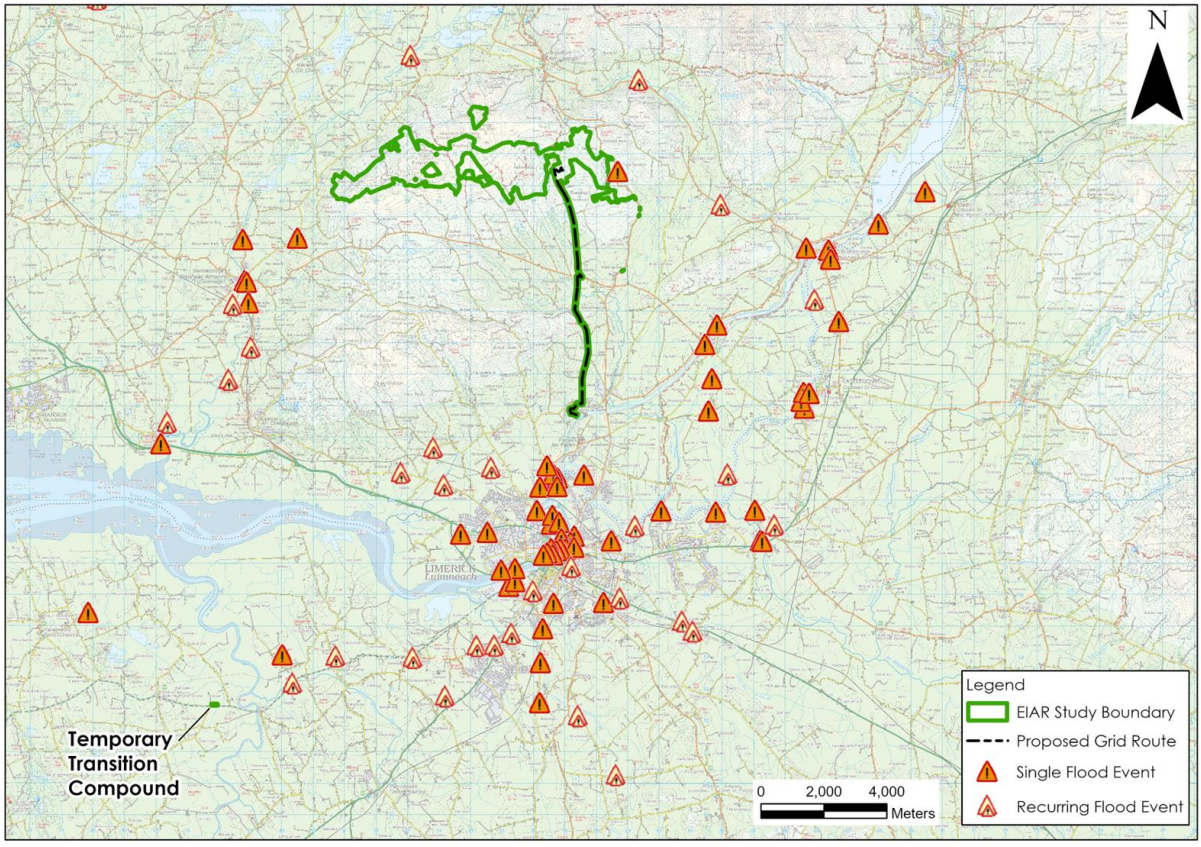

Figure C: OPW Past Flood Events Map (www.floodinfo.ie)

4.3.4 GSI Historic 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 flood map for this event does not record any flood zones along the streams and watercourses which drain the Wind Farm Site. Further downstream, some flooding was recorded along the Owenogarney River, concentrated in the vicinity of Doon Loughs and Castle Lake. Meanwhile to the south a small area of surface water flooding was recorded at a small lake waterbody located ~2km south of the Wind Farm Site near Cloghoolia. Further downstream extensive flooding was recorded along the River Shannon. Some historic flood zones are mapped along the Maigue Estuary to the east of the Temporary Transition Compound along the TDR.

The GSI do not record any flood zones along the Grid Connection for this historic flood event. Historic surface water flooding is mapped further downstream along the River Shannon and at Ardnacrusha canal.

4.3.5 CFRAM Mapping – Fluvial and Pluvial 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 Wind Farm Site. The closest mapped CFRAM fluvial flood zones within the Lower Shannon surface water catchment are located near Ardnacrusha, ~10km south of the Wind Farm Site. Meanwhile, the closest CFRAM fluvial flood zones in the Shannon Estuary North catchment are located on the Owenogarney river downstream of Castle Lake and in the vicinity of Sixmilebridge.

CFRAM flood mapping has been completed on the Maigue Estuary downstream of the Temporary Transition Compound along the TDR. The mapped flood zones are located ~500m east of the proposed Temporary Transition Compound and are limited to the immediate vicinity of the river channel.

Similarly, there are no CFRAM food zones mapped along the watercourses which drain the north of the Grid Connection. However, CFRAM fluvial flood mapping has been completed on the West Roo stream (EPA name) to the southwest of Ardnacrusha substation. The low probability (1 in 1,000-year) flood zone along this watercourse is mapped ~100m west of the existing substation and ~100m south of the Grid Connection. As seen in **Figure D**, the Grid Connection is not located within any CFRAM fluvial flood zone.

4.3.6 OPW National Indicative Fluvial Flood Mapping

The National Indicative Fluvial Flood Mapping (NIFM) (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.)

For the Present Day Scenario, no high probability (1 in 10-year), medium probability (1 in 100-year) or low probability (1 in 1,000-year) fluvial flood zones have been mapped within the Wind Farm Site. Within the Shannon Estuary North surface water catchment, fluvial flood zones are mapped along the Broadford River from Kilbane to Doon Lough with the nearest flood zones situated ~1km north of the Wind Farm Site. Downstream of Doon Lough, fluvial flood zones are mapped along the length of Owenogarney, ~1km northwest of the Wind Farm Site.

Meanwhile, within the Lower Shannon Catchment, fluvial flood zones are mapped along the Blackwater (Clare) River and several of its tributaries to the south of the Wind Farm Site. The closest mapped flood zone is located ~1.6km to the southeast along the Glenomra Wood Stream. The Temporary Transition Compound along the TDR is mapped within the medium probability (1 in 100-year) flood zone.

[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.*

In terms of the Grid Connection, the route crosses a modelled fluvial flood zone along the Blackwater River to the south of R471 in the townland of Cloghera. This is at an existing watercourse crossing.

The NIFM flood zones in the local area are shown on **Figure D** below.

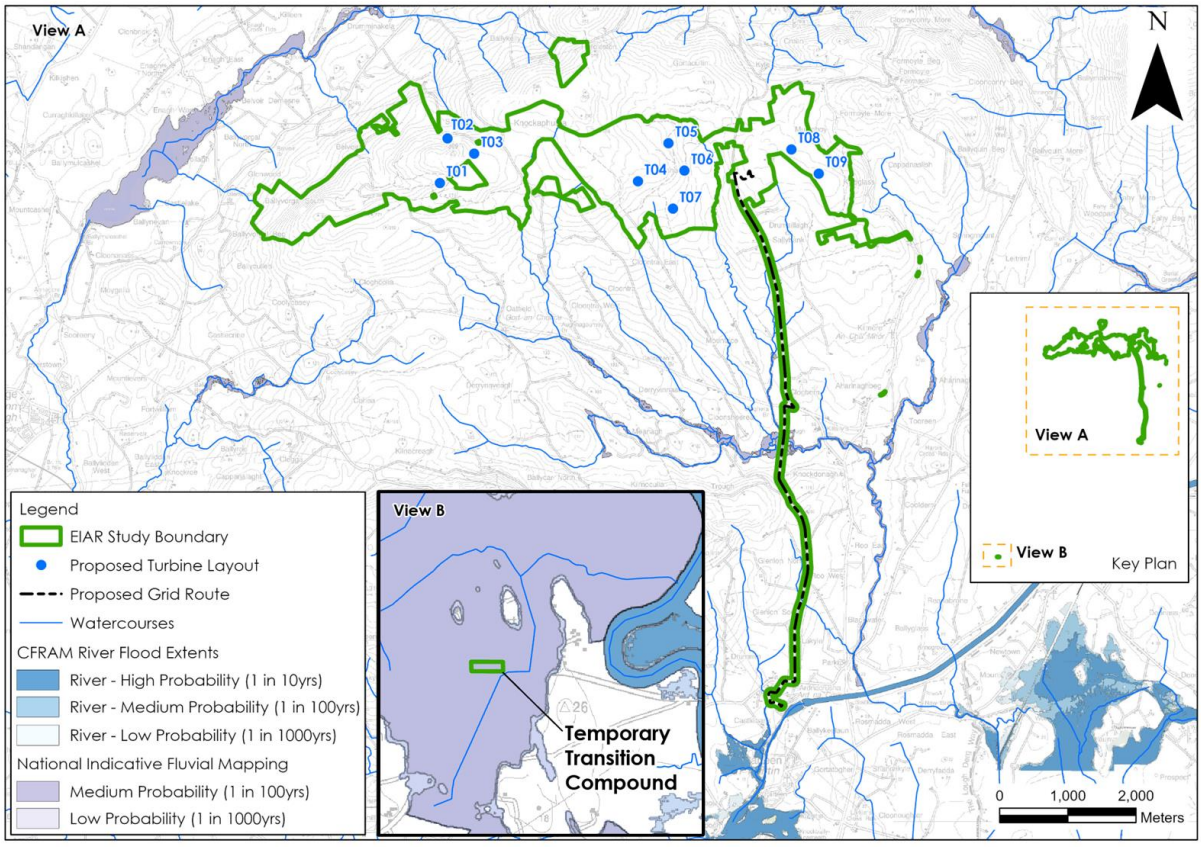

Figure D: CFRAM and OPW National Indicative Flood Mapping

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 Wind Farm Site or along the Grid Connection.

The closest historic and modelled groundwater flood extents are located ~7km west/northwest of the Wind Farm Site near Rosroe and Fin Loughs.

4.3.8 Coastal Flooding

The Wind Farm Site is located ~8km from the Upper Shannon Estuary and stands at a significant elevation above sea level (~70-310mOD). The closest mapped CFRAM coastal flood zones are mapped ~6.8km southwest of the Wind Farm Site. Therefore, the Wind Farm Site is not at risk of coastal (tidal) flooding.

Similarly no CFRAM tidal flood zones are mapped in the vicinity of the Grid Connection. The closest tidal flood zones are located near Parteen, ~1.3km south of Ardnacrusha substation.

Coastal CFRAM flood mapping has been completed in the vicinity of the Temporary Transition Compound along the TDR. The CFRAM flood zones do not encroach upon the proposed

Temporary Transition Compound for the Present Day Scenario or the Mid-Range Future Scenario (20% increase in rainfall and sea level rise of 0.5m). However, as shown in **Figure E** CFRAM coastal flood zones cover the location of the Temporary Transition Compound for the High-End Future Scenario (30% increase in rainfall and sea level rise of 1m.

Meanwhile, the National Coastal Flood Hazard Mapping (2021) shows the extent of land that may be flooded by the sea and associated flood depths during a theoretical flood event and represents the worst case scenario whereby no flood defences are considered. This flood mapping shows that the Temporary Transition Compound is mapped within the 1 in 10-year coastal flood zone, with modelled flood depths in excess of 2m at this locations.

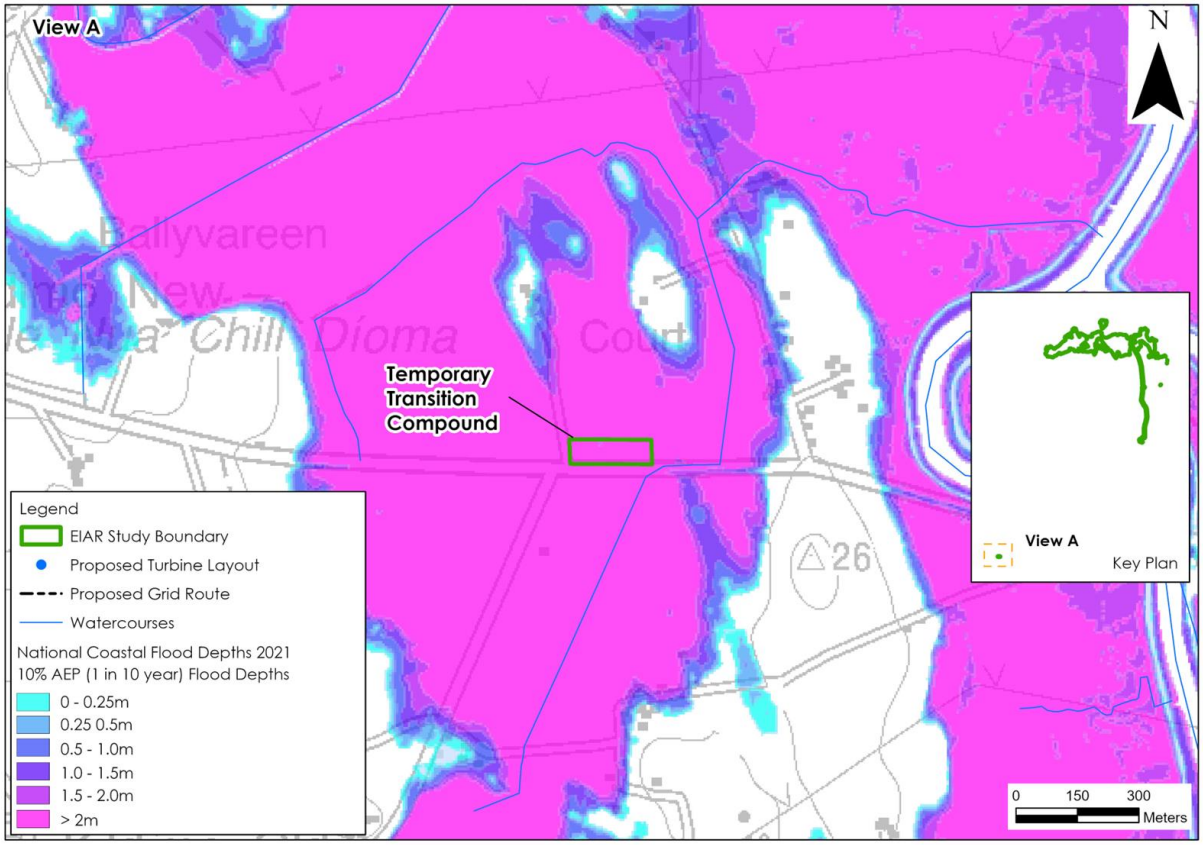

Figure E: National Coastal Flood Depths 2021 for a 1 in 10-year Flood Event

4.3.9 Climate Change

It is likely that climate change will have significant impacts on flooding and flood risk in Ireland due to rising sea levels, increased winter rainfall and more intense rainfall. The CFRAM Programme has modelled flooding associated with potential future climate change scenarios. However as stated above no CFRAM modelling has been completed in the vicinity of the Wind Farm Site.

National Indicative Fluvial Mapping has been completed for catchments greater than 5km^2 for which flood maps were not produced under the CFRAM Programme. These flood zones have also been modelled for 2 no. potential future climate change scenarios, with the Mid-Range and High-End Future Scenario flood extents generated using an increase in rainfall of 20% and 30% respectively.

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 Wind Farm Site or along the Grid Connection 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, the Wind Farm Site is not largely constrained by coastal, fluvial or groundwater flooding. The entire Wind Farm Site, including all proposed infrastructure locations, is located in Fluvial Flood Zone C and is at a low risk of fluvial flooding. Meanwhile, the Temporary Transition Compound along the TDR is mapped within Fluvial Flood Zone A.

Much of the Grid Connection is located in Flood Zone C. However a small section of the route to the south of the R471 is mapped in Flood Zone A due to its proximity to the Blackwater River. However, this section of the Grid Connection includes an existing crossing along a local road over the Blackwater River. Due to the nature of the underground electrical cable, this will have no effect during the operational phase of the Proposed Development. During the construction phase, works along the work may have to be postponed following heavy rainfall events which may cause flooding at this location.

4.4 INITIAL FLOOD RISK ASSESSMENT

4.4.1 Site Surveys

Detailed walkover surveys of the Wind Farm Site were undertaken by HES on 7th December 2022, 13th July 2023, 15th August 2023, 13th September and 12th October 2023.

The Wind Farm Site was noted to comprise of a mixture of forested and felled areas with an existing network of forestry tracks. As discussed above, several watercourses have their upper reaches within the Wind Farm Site and these flow rapidly downslope before discharging into the larger watercourses in the surrounding valleys.

During the walkover surveys and flow monitoring there was little evidence of previous out of bank flow from within the various river channels. During targeted visits following considerable rainfall in the prior day/s, high flows were observed within the rivers, with many estimated to be several multiples of the typical dry weather flow. No widespread or localized flooding was observed during these site visits, all flow was contained within the channels.

Monitoring of stream discharge in the main streams within and downstream of the Wind Farm Site was undertaken on 5 no. occasions at 8 no. monitoring locations (SW1-SW8) between December 2022 and October 2023. The data are presented in **Table B**. We note that the flow volumes are typical of mountainous streams which drain a forested peatland, with high flow volumes and a rapid response to rainfall events. Larger flow volumes were encountered at SW7 and SW8 respectively as these monitoring locations were on the Blackwater and Owenogarney rivers respectively. The flow volumes in these rivers are more typical of larger regional watercourses.

In summary, no areas of concern regarding flood risk within the Wind Farm Site were noted during the walkover surveys due to:

- The elevation of much of the Wind Farm Site located at elevations in excess of 100mOD;
- The sloping nature of the land with the Wind Farm Site being drained by numerous streams and rivers which flow rapidly downslope; and,

- The existing drainage regime in forested areas (forestry mound and ribbon drains) facilitates the movement of water downslope and into the existing natural drainage system and local streams/rivers.

Surveys were also completed along the Grid Connection and in the Temporary Transition Compound along the TDR. No issues or signs of flooding were recorded along the Grid Connection or in the TDR work areas along the R465.

Meanwhile, the site walkover surveys of the Temporary Transition Compound noted that the area was noted to be undulating, with some evidence of recent surface water ponding. A high density of surface water drains were noted in the local area and a small stream was noted to cross the N69 immediately to the southeast of the proposed Temporary Transition Compound.

Table B: Surface Water Flow Monitoring

Location / Date	07/12/2023	13/07/2023	15/08/2023	13/09/2023	12/10/2023
	Flow (l/s)	Flow (l/s)	Flow (l/s)	Flow (l/s)	Flow (l/s)
SW1	20	20	12	15	20
SW2	5	5	4	8	6
SW3	5	8	8	10	12
SW4	10	10	8	10	10
SW5	~50	~30	~30	~30	~50
SW6	8	6	4	8	15
SW7	~400	~300	~250	~300	~400
SW8	~2,000	~2,000	~1,500	~1,500	~1,500

4.4.2 Existing Site Drainage

The forestry drains are the primary drainage routes towards the natural streams on the Wind Farm Site, but the flows in these drains are generally very low. The integration of the existing main drains with the proposed Wind Farm Site drainage is a key component of the drainage design.

Within the Wind Farm Site there are numerous manmade drains that are in place predominately to drain the forestry plantations. Mound drains and ploughed ribbon drains are generally spaced approximately every 15m 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 forestry access roads. Culverts are generally located at stream crossings and at low points under access roads which drain runoff onto down-gradient forest plantations. A schematic of a typical standard forestry drainage network and one which is representative of the site drainage network is shown as **Figure F**.

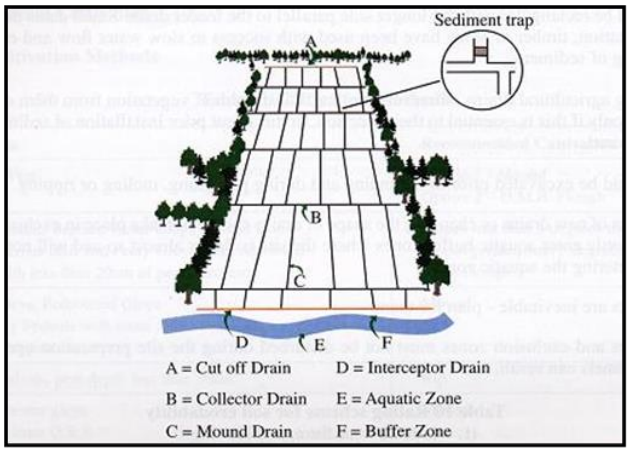

Figure F: Schematic of Typical Forestry Drainage Layout

4.4.3 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Wind Farm Site, along the Grid Connection and Temporary Transition Compound along the TDR 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 Wind Farm Site during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.4.4 Summary – Initial Flood Risk Assessment

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it would appear that flooding is unlikely to be problematic at the Wind Farm Site or along the Grid Connection. There is a higher risk of flooding at the proposed Temporary Transition Compound location along the TDR. The potential sources of flood risk for the proposed site are outlined and assessed in **Table C**.

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

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the rivers and streams that are close to some of the wind farm infrastructures and the rivers and streams that flow throughout the site	Land & infrastructure	Based on National Indicative Fluvial Flood Mapping, the Wind Farm Site is location in Fluvial Flood Zone C where there is a low risk of fluvial flooding. Due to the slope of the land, water flows rapidly downslope in the numerous 1st and 2nd order streams which drain the Wind Farm Site. There is little risk of fluvial flooding at the Wind Farm Site. A small section of the Grid Connection is mapped in Fluvial Flood Zone A and B, associated with fluvial flooding along the Blackwater River. However, an existing public road and watercourse crossing already exists at this location. Therefore, the Proposed Development will have no effect on flooding in this area. The Temporary Transition Compound is mapped in Fluvial Flood Zone A. Therefore, this location is within the 1 in 10-year fluvial flood zone and is at risk of flooding.
Pluvial	Ponding of rainwater on site	Land & infrastructure	There is very little risk of pluvial flooding within the Wind Farm 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 Wind Farm Site. Similarly, there is little risk of pluvial flooding due to the sloping nature of the land along the Grid Connection. The land at the Temporary Transition Compound is flat, low-lying and overlain by poorly drained soils and therefore may experience surface water ponding during periods of heavy rainfall,
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 risk of groundwater flooding at the Wind Farm Site, along the Grid Connection or at the Temporary Transition Compound.
Coastal/tidal	Overbank flooding	Land, People, property	The Wind Farm Site is located a significant distance from any estuary or tidal waterbody and at a significant elevation above sea level. Similarly the Grid Connection is located ~1.3km from any CFRAM coastal flood zone. The Temporary Transition Compound is mapped within Coastal Flood Zone A (i.e. within the 1 in 10-year coastal flood zone). Therefore, there is no risk of coastal/tidal flooding.

4.4.5 Requirement for a Justification Test

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test[3] is shown in **Table D** below.

It may be considered that the majority of the components of the Proposed Development can be categorised as "Highly Vulnerable Development" as they are electricity generating infrastructure. All "Highly Vulnerable Development" infrastructure including the onsite substation and turbines are located in Flood Zone C (Low risk) and can therefore be considered as appropriate from a flood risk perspective. However, some elements of the Proposed Development, comprising an existing watercourse crossing along the Grid Connection and the proposed Temporary Transition Compound, as stated above, are located in Fluvial Flood Zone A and Fluvial/Coastal Flood Zone A respectively. The elements of the Proposed Development which are located within the mapped flood zones are not considered to be Highly Vulnerable Developments. These elements of the Proposed Development can be considered to be "Less Vulnerable Developments".

Table D: 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.*

[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. DETAILED FLOOD RISK ASSESSMENT (TEMPORARY TRANSTION COMPOUND)

5.1 INTRODUCTION

This section assesses the flood risk of the Proposed Development with regard to Section 5.28 of the Flood Risk Management Guidelines. The assessment is made based on the NIFM flood zone mapping as this is modelled flood zones within which some areas of the Proposed Development Site are located (i.e. Temporary Transition Compound and watercourse crossing along Grid Connection).

This detailed flood risk assessment addresses potential flood concerns at the proposed Temporary Transition Compound. In relation to the Grid Connection, the section of the route which is mapped in a fluvial flood zone is located at an existing bridge crossing (i.e. Trough Bridge). There will be no in-stream works and the crossing will be completed by Horizontal Directional Drilling. Therefore, there is no potential for the displacement of floodwaters or an increase in flood risk at that location and this is not considered further.

5.2 REDUCTION IN FLOODPLAIN STORAGE AND FLOOD LEVEL IMPACTS

Construction of new above-ground structures within floodplains have the potential to reduce the storage capacity of the floodplain and increase flood risk locally or downstream. In this scenario, the downstream receiving water is the floodplain associated with the EPA mapped Faha Stream.

The Proposed Development infrastructure located within the mapped flood zone is comprised solely of the proposed Temporary Transition Compound. This component of the Proposed Development is not a permanent structure as it will only be used during the delivery of the turbine components and the area will be reinstated at the end of the construction phase. The Temporary Transition Compound will not be required for the entire duration of the construction phase which will take 18-24 months. It is estimated that the Temporary Transition Compound will be required for a total of 8 months.

The Temporary Transition Compound is mapped within the 1 in 100-year NIFM fluvial flood zone (1% AEP (annual exceedance probability)) and the 1 in 10-year National Coastal Flood Zone (10% AEP). Given that the Temporary Transition Compound is temporary and will be present for only ~8 months, the potential for effects are reduced in comparison to a permanent structure being built in the floodplain. It is less likely (0.7% probability (compared to 1%) of a fluvial flood event and 6.7% probability (compared to 10%) of a coastal flood event - worst case scenario) that a fluvial flood event of this magnitude (1 in 100-year flood event) will occur during the time period when the compound is present.

Furthermore, the Temporary Transition Compound has a limited footprint of (~1.2ha) in comparison to the overall area covered by the NIFM flood zone. The 1 in 100-year modelled NIFM fluvial flood zone has an approximate area of 623ha in the local area. Therefore, the Temporary Transition Compound equates to ~0.2% of the modelled NIFM flood zone.

To facilitate access from the local road, it is proposed to raise the existing ground levels at the Temporary Transition Compound by importing ~19,000m^3 of material. In a worst-case scenario whereby the entire compound is submerged, this will result in the displacement of an equivalent volume of floodwater. When spread across the local flooded area (of ~623Ha), the volume of displaced water equates to a rise in water levels of ~3mm. The modelled

coastal flood zones have a similar flooded extent to the NIFM flood zone and will therefore have a comparable imperceptible impact in terms of flood displacement and increase in flood levels.

5.3 INCREASED STORMWATER RUNOFF RATES

The construction of the Temporary Transition Compound means that there will be a temporary reduction in green areas/permeable surfaces and an increase in hardstand areas within the floodplain of the Faha Stream. During site walkover surveys it was noted that the local area is poorly drained, with several manmade surface water drains. According to the GSI online mapping is overlain by poorly drained gley soil. Therefore, the existing baseline environment has high rates of surface water runoff.

Given the small area of Proposed Development relative to the larger site area, there is limited potential for increase in runoff as a result of the proposed Temporary Construction Compound.

Nevertheless, it is proposed to implement an over the edge drainage management system which will treat and attenuate any surface water runoff from the temporary hardstand area. This system will ensure that there is no increase in surface water runoff rates and will provide protection for downstream waters. The toe of the proposed hardstand area will be surrounded by silt fencing.

5.4 MITIGATION MEASURES

It is proposed to construct the base and core of Temporary Construction Compound with coarse material of relatively high permeability, and use a capping material for the surface finish. Drainage stone can be used in the sections which will not be trafficked. The use of these materials, where practicable, will reduce the volume of displaced floodwaters. However, as discussed in Section 5.2, even if the compound is constructed with completely impermeable material, there will be no significant displacement of floodwaters.

5.5 JUSTIFICATION TEST FOR TEMPORARY TRANSITION COMPOUND

Box 5.1 (**Table E**) of "The Planning System and Flood Risk Management Guidelines" (PSFRM Guidelines) outlines the criteria required to complete the "Justification Test".

Table E: Format of Justification Test for Development Management

Box 5.1 Justification Test for Development Management (to be submitted by the applicant)
When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied: 1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines. 2. The proposal has been subject to an appropriate flood risk assessment that demonstrates: i. The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk; ii. The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible; iii. The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and iv. The development proposed addresses the above in a manner that is also compatible

	with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.
The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.	

Note: *this table has been adapted from Box 5.1 of "The Planning System and Flood Risk Management Guidelines", (2009).*

Referring to Point 1 and Points 2 (i) to (iv) inclusive:

Some of the Proposed Development is located in mapped fluvial and coastal flood zones. The elements of the Proposed Development located in the combined coastal and fluvial flood zone comprise a Temporary Transition Compound along the TDR. Furthermore, a small section of the Grid Connection is mapped within a fluvial flood zone along the Blackwater River.

In relation to the proposed Temporary Transition Compound, the closest third-party sensitive receptors are dwellings located ~300m to the northwest and east/northeast, and a dwelling located ~74m upstream of the watercourse crossing. A private business park is located ~160m to the southwest of the Temporary Transition Compound. Similar to the proposed location of the Temporary Transition Compound, these receptors are mapped within the medium probability NIFM fluvial flood zone.

There will be very minor displacement of floodwaters associated with the emplacement of the Temporary Transition Compound. The use of this site is temporary and it is estimated that it will be in place for a total of ~8 months. During flood events, the proposed new constructed platform would have the potential to displace floodwaters. The volume of displaced floodwater can be reduced through the use of coarse permeable material where practicable.

In relation to the Grid Connection, the section of the route which is mapped in a fluvial flood zone is located at an existing bridge crossing (i.e. Trough Bridge). There will be no in-stream works and the crossing will be completed by Horizontal Directional Drilling. Therefore, there is no potential for the displacement of floodwaters.

1. The Proposed Development has been the subject of a flood risk assessment (this report) and the following has been determined:

   i. Due to the relatively small footprint of the Proposed Development and given that the only portions of the development within modelled flood zones is a temporary compound and an existing bridge crossing along the Grid Connection, the Proposed Development is predicted to have no impact on flood water levels downstream. No increase in downstream flood risk will occur.
   ii. All proposed turbines and all other site infrastructure (aside from the small section of internal cabling) are located outside of the flood zones. These measures will mitigate against any potential disruption to the natural hydrology of the Wind Farm Site. No increase in flood risk to people, property, the economy or the environment during extreme flood events as a result of the Proposed Development is predicted due to the appropriate design measures which will result in unmeasurable/imperceptible upstream and downstream effects; and,
   iii. The Temporary Transition Compound, located within the modelled flood zone, will not have a significant effect on flood levels. This compound will be temporary, has a small footprint in comparison to the wider floodplain and will be constructed with permeable materials where practicable. Even in a worst case scenario, whereby the pad is impermeable, the volume of water displaced and the associated increase in water levels are insignificant.

6. FLOOD IMPACT PREVENTION AND DRAINAGE MANAGEMENT

6.1.1 Planning Policy and the County Development Plans

Table F below defines the policies in the Clare County Development Plan (2023-2029) and the Limerick County Development Plan (2022 – 2028) in respect of flooding and we have outlined in the column to the right how these policies are provided for within the Proposed Development design.

Table F: County Development Plans Objectives/Policies and Project Responses

CDP Policy Number:	Policy	Response
Clare County Development Plan (2023 – 2029)		
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 development is not located within any mapped CFRAM Flood Zones.
Limerick County Development Plan		
CAF P5	It is a policy of the Council to protect Flood Zone A and Flood Zone B from inappropriate development and direct developments/land uses into the appropriate lands, in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities 2009…… In Flood Zone C, the developer should satisfy themselves that the probability of flooding is appropriate to the development being proposed and should consider other sources of flooding, residual risks and the implications of climate change.	This FRA has been prepared in accordance with the guidelines. A justification test has been completed for the Temporary Transition Compound and the probability of flooding and the associated risk detailed in Section 5.

6.1.2 Proposed Drainage

The site drainage system was designed integrally with the Wind Farm layout as a measure to ensure that the proposal will not change the existing flow regime across the 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 very 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, 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.

6.1.3 Proposed On-Site Runoff Attenuation

The creation of impermeable areas within a development 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 Development 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 development, 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 proposal 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.

6.1.4 Flood Impact Screening for Designated Sites

Table G provides a flood impact screening for local designated sites.

Table G: Flood Impact Screening for Local Designated Sites

Name	Site Code	Flood Risk Screening
Gortacullin Bog NHA	002041	No increased flood risk, small development footprint and attenuation proposals outlined above.
Danes holes, Poulnalecks SAC	000030	No increased flood risk, small development footprint and attenuation proposals outlined above.
Castle Lake pNHA	000239	No increased flood risk, small development footprint and attenuation proposals outlined above.
Ratty River Cave SAC	002316	No increased flood risk, small development footprint and attenuation proposals outlined above.
Lower River Shannon SAC	002165	No increased flood risk, small development footprint and attenuation proposals outlined above.
River Shannon and Fergus Estuary SAC	004077	No increased flood risk, small development footprint and attenuation proposals outlined above.
River Shannon and River Fergus Estuaries SPA	004077	No increased flood risk, small development footprint and attenuation proposals outlined above.
Inner Shannon Estuary – South Shore pNHA	000435	No increased flood risk, small development footprint and attenuation proposals outlined above.

7. REPORT CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Development at Knockshanvo, Co. Clare. From this study:
    - No instances of historical flooding were identified in historic OS maps within the Wind Farm Site;
    - No instances of recurring or historic flooding were identified on OPW maps within the Wind Farm Site;
    - The GSI Historical 2015/2016 flood map does not record any historic flood zones in the area of the Wind Farm Site;
    - The Wind Farm Site is not mapped within any historic of predictive groundwater flood zone;
    - The Wind Farm Site is not identified as being within CFRAM Flood Zones; and,
    - The National Indicative Fluvial Food Mapping does not show any fluvial flood zones along the local watercourses within the Wind Farm Site;
- During the walkover surveys and flow monitoring at the Wind Farm Site there was no evidence of out-of-bank flow from within the various stream/river channels. No widespread or even localized flooding was observed during these site visits;
- The Wind Farm Site and all proposed infrastructure is mapped within Fluvial Flood Zone C and is at low risk of fluvial flooding;
- The Grid Connection is also largely located in Flood Zone C (including the proposed on-site 110kV substation and the existing Ardnacrusha substation). However, a small section of the route is located in mapped fluvial flood zones along the Blackwater River. A local road and watercourse crossing already exists at this location and the Proposed Development will have no effect on flooding or mapped flood zones;
- The Temporary Transition Compound along the TDR is located in Fluvial Flood Zone A and is also vulnerable to coastal flooding. However, this pad is temporary and will have a small, limited footprint. Flood displacement calculations have shown that there will be no significant flood impact associated with this aspect of the Proposed Development;
- The proposed Wind Farm can be categorised as "Highly Vulnerable Development", however, the proposed infrastructure is located outside of areas mapped as Flood Zones and therefore the Proposed Development is appropriate from a flood risk perspective;
- The overall risk of flooding at the Proposed Development site is estimated to be very low with the exception of the proposed Temporary Transition Compound location. A low risk would typically relate to the probability of being impacted by a 1,000-year flood. The entire area of the Wind Farm Site is located in Fluvial Flood Zone C where the flood risk has an estimated AEP of <0.1%; and,
- In addition, the risk of the Proposed Development contributing to downstream flooding is also very low, as the long-term plan for the site is to retain and slow down drainage water rates prior to release. Robust drainage measures on the site will include swales, silt traps, check dams, settlement ponds and buffered outfalls. Please refer to the hydrology Chapter of the EIAR for further details.

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8. REFERENCES

DOEHLG	2009	The Planning System and Flood Risk Management.
Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.
Clare County Council	2023	Clare County Council Development Plan 2023-2029
Limerick County Council	2022	Limerick County Council Development Plan 2022-2028

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