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PROPOSED WINDFARM DEVELOPMENT AT LYRENACARRIGA, CO. WATERFORD/CO. CORK

SITE SPECIFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:
Innogy Ltd

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO Ireland, on behalf of Innogy Ltd, to undertake a site specific, Stage II Flood Risk Assessment (FRA) for a proposed windfarm development at Lyrenacarriga, Tallow, Co Waterford/Co. Cork. A site location map is shown below as **Figure A**.

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

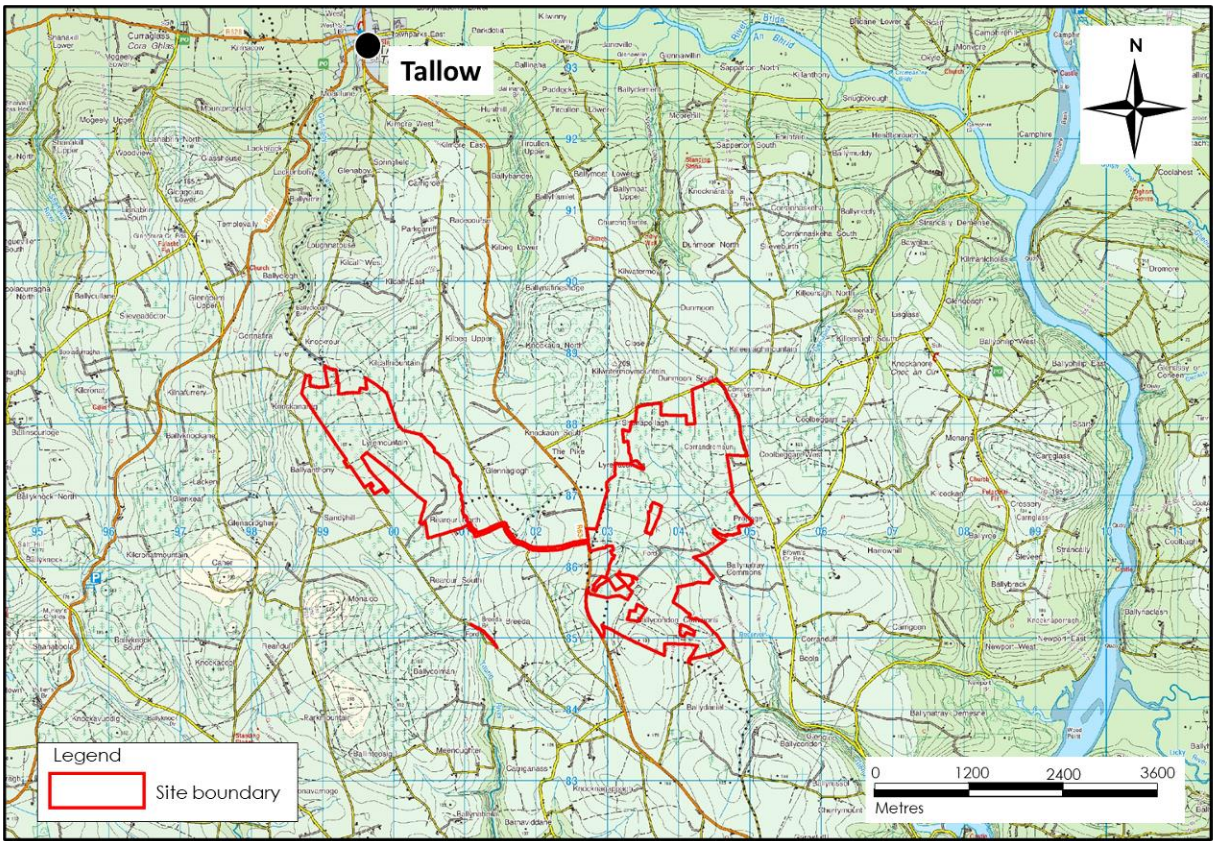

Figure A: Site Location Map

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 is an Environmental Engineer with 17 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.

David Broderick is a hydrogeologist with over 13 years environmental consultancy experience across Ireland. David has completed numerous Flood Risk Assessments for all types of developments, and he regularly uses HEC-RAS and FlowMaster modelling software.

1.3 REPORT LAYOUT & METHODOLOGY

This Stage II FRA report has the following format:

- Section 2 describes the proposed site setting and details of the proposed development;
- Section 3 outlines the hydrological and geological characteristics of the local surface water catchments in the vicinity of the proposed development site;
- Section 4 deals with a site-specific flood risk assessment (FRA) and Justification Test for the proposed development which was carried out in accordance with the above-mentioned guidelines; 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) maps on superficial deposits;
- EPA hydrology maps;
- CFRAM Preliminary Flood Risk Assessment Maps; and,
- Site Walkover, drainage mapping and flow monitoring.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the proposed site along with a description of the proposed development.

2.2 SITE LOCATION AND TOPOGRAPHY

The Proposed Development site consists of two separate clusters of turbines which are located between approximately 3.5 and 6.5km to the south and southeast respectively of Tallow, Co. Waterford and ~9km northwest of Youghal, Co. Cork. The turbine clusters are referred to herein as the western and eastern clusters.

The eastern cluster and northern portion of the western cluster are located in Co. Waterford while the southern portion of the western cluster is located in Co. Cork (11 no. turbines are located in Co. Waterford and 6 no. in Co. Cork).

The two clusters will be connected via a 3.3km underground collector cable connection which will mainly cross grassland and also short multiple sections of public roads (0.7km) that run between the two clusters.

The western cluster, which has an area of approximately 206a, is located ~3.5 km south of Tallow town, at Lyremountain and Kilcalfmountain townlands, which exist between the R627 and R634. The northern part of the western cluster is largely coniferous forestry while the southern part is agricultural grassland. It is proposed that 6 no. turbines will be located in the western cluster (3 no. in forestry and 3 no. in grassland area). The forestry is accessible via a network of existing forest tracks. Ground elevation ranges from approximately 203m OD at the topographic peak of Kilcalfmountain north of the western cluster to ~130 m OD near the south of the western cluster, with the overall slope (gentle to moderate) is to the south – southeast.

The eastern cluster , which has an area of approximately 518a, is located ~1.7km to the southwest of the western cluster (~6.5km to the southeast of Tallow) and comprises mainly coniferous forestry with areas of grassland in the central and south-eastern parts of the eastern cluster. The eastern cluster is located immediately east of the R634 and has a ground elevation range between 200 m OD at the south of the cluster, and 120 m OD along the eastern boundary with the overall ground slope (gentle to moderate) to the east. It is proposed that 11 no. turbines will be located in the eastern cluster (7 no. in forestry and 4 no. in grassland).

The grid connection will be made to the existing 110kv Over Head Line (OHL) which passes through the eastern cluster at the location of the proposed 110kv substation via a loop in connection. The western cluster will be connected to the 110kv substation via the underground collector cable as described above.

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

2.3 PROPOSED DEVELOPMENT DETAILS

The proposed development comprises the following:

- 17 no. turbines;
- Electrical substation building;
- 1 Meteorological mast;

- ~3km underground collector cable connecting the two landholdings;
- 2 no. construction compound areas;
- 3 no. borrow pits;
- 1 staff welfare and storage facility
- New access roads and upgrade of existing access roads;
- Communications antennae;
- Underground cables;
- Surface water drainage measures; and,
- Ancillary development.

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTIC

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics in the area of the proposed forest access road.

3.2 BASELINE HYDROLOGY

3.2.1 Regional and Local Hydrology

On a regional scale, the Proposed Development site is located in the River Blackwater surface water catchment within Hydrometric Area 18 of the South Western International River Basin District (SWIRBD). The River Blackwater, which is transitional (i.e. estuarine) at this location, flows in a southerly direction approximately 5km to the east of the eastern cluster at its closet point.

In terms of local hydrology, the northern half of the western cluster and the north-eastern tip of the eastern cluster are located (~20% of the overall site) in the River Bride surface water sub-catchment (Bride(Waterford)_SC0_30). The River Bride flows in an easterly direction approximately 4km to the north of the western cluster and is a major tributary to the River Blackwater.

In terms of proposed wind farm infrastructure, there is 1 no. turbine (T12) and 1 no. borrow pit from the western cluster located in the River Bride sub-catchment. The western cluster drains to the River Bride via the Glenaboy River (Glenaboy_010) and Kilbeg Stream with all the aforementioned proposed infrastructure being located in the Glenaboy River. There is no proposed development in the Kilbeg Stream catchment.

There is no proposed windfarm infrastructure from the eastern cluster located in the River Bride catchment.

The remainder of western and eastern cluster are located in the Tourig River and Glendine River surface water sub-catchments respectively (collectively these catchments are referred to as the Tourig_SC_010).

A summary of the local hydrology with respect the proposed windfarm infrastructure is shown in **Table A** below.

A local hydrology map of the area is shown as **Figure B.**

Table A: Summary of Local Hydrology and Proposed Infrastructure

Regional Catchment	Sub-catchment	Main Development Infrastructure	Primary Drainage Features
River Blackwater	Tourig	5 no. turbines, 1 no. borrow pit, 1 no. temporary compound and the collector cable (3.3km)	Tourig River
	Bride	1 no. turbine and 1 no. borrow pit	Glenaboy River
	Glendine	11 no. turbines, 1 no. borrow pit, 1 no. temporary construction compound, 110kv substation and the OHL grid connection loop-in	Glendine River

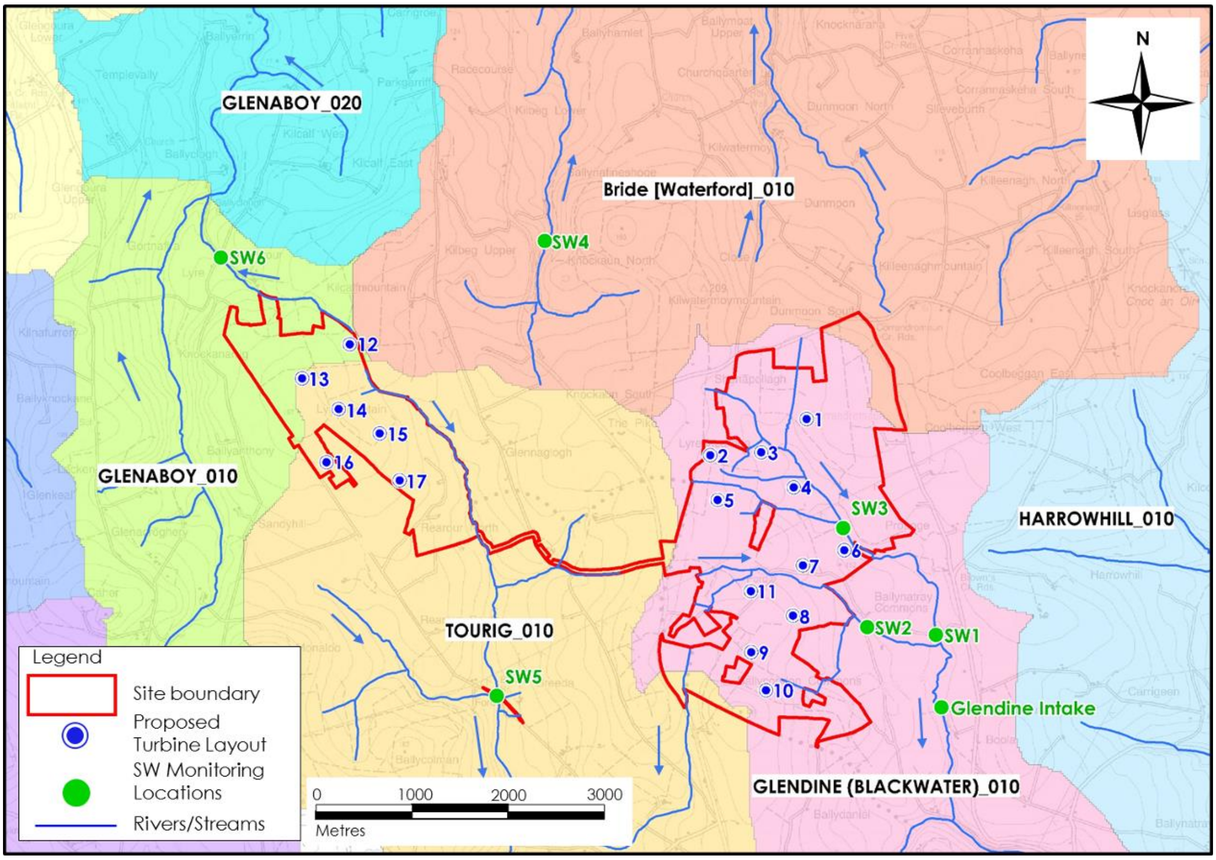

Figure B: Local Hydrology Map

3.2.2 Site Drainage

The eastern cluster is drained by a relatively dense network of mainly first and second order streams, many of which are headwater streams of the Glendine River. One headwater stream emerges from the west and also from the south of the eastern cluster which flow towards the Tourig River. Most of the headwater streams of Glendine River (within the eastern cluster) emerge close to the northern and western boundaries and flow the full distance through the cluster landholding in a general south-easterly direction. The headwater streams of the Glendine River converge into two main stream channels before leaving the eastern cluster landholding area at the south-eastern corner. The streams then merge approximately

300m downstream of the eastern cluster landholding boundary to form the upper reach of the Glendine River.

Due to the slightly more elevated nature of the western cluster and the steeper sloping topography, the natural stream density is relatively low compared to the eastern cluster area. Two main headwater streams emerge from the western cluster. The stream emerging from the northwest of the cluster is a headwater stream of the Glenboy River (Bride catchment) and the stream emerging from the east is a headwater stream of the Tourig River. The north-eastern section of the western cluster slopes towards the Kilbeg Stream which emerges approximately 0.5km to the east of the western cluster.

In addition, within both landholding areas there are numerous manmade drains that are in place predominately to drain the forestry plantations. The current internal forestry drainage pattern is influenced by the topography, soil type, layout of the forest plantation and by the existing road network. Overall, the site has relatively good natural drainage (see recharge/runoff relationship below section) and no significant flows were noted in any of the forestry drains.

3.2.3 Rainfall and Evaporation

The SAAR (Standard Average Annual Rainfall) recorded at Glendine (E206400, N83900) which is located approximately 2km southeast of the proposed site, is 1,222mm (**www.met.ie**). The average potential evapotranspiration (PE) at Cork Airport, approximately 40km southeast of the proposed site, is taken to be 513mm (**www.met.ie**). The actual evapotranspiration ("AE") is calculated to be 488mm (95% PE). Using the above figures the effective rainfall ("ER")[1] for the area is calculated to be (ER = SAAR – AE) 734mm.

Based on recharge coefficient estimates from the GSI, an estimate of 60% recharge is taken for the site as an overall average. This value is for "moderate permeability subsoil overlain by well-drained soil". Smaller localised areas where poorly drain grey soils are present may have slightly lower recharge rates (22.5%), while areas with bedrock outcrop/subcrop will have higher values (85%), but the recharge coefficient value of 60% is assumed to fairly reflect the majority of the site as an overall average.

The recharge coefficient of 60% was used to calculate values for key hydrological properties. Therefore, annual recharge and runoff rates for the site are estimated to be 440mm/year and 294mm/year respectively.

Table B below presents return period rainfall depths for the area of the proposed Lyrenacarriga wind farm site. These data are sourced from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (10-year, 50-year, 100-year). These extreme rainfall depths will be the basis of the proposed wind farm drainage hydraulic design as described further below.

Table B: Return Period Rainfall Depths

Duration	10-year Return Period	50-Year Return Period	100-Year Return Period
15 min	11	15.3	17.5
1 hour	20	27.7	31.7
6 hour	43.2	59.9	68.6
12 hour	58.1	80.6	92.4
24 hour	78.3	108.6	124.4
48 hour	94.4	127.6	144.6

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

3.3 GEOLOGY

The published soils map (www.epa.ie) for the area show that the majority of the soils within the Proposed Development site are formed from tills (subsoils) derived from Devonian sandstone (described below).

Deep, well drained, mainly acidic mineral soil (AminDW) is the dominant soil type at the western cluster of the Proposed Development site with some localised areas of poorly drained mineral soils (AminPD) on the lower eastern section of the cluster.

At the eastern cluster, AminDW soils are mapped on the more elevated north-eastern and south-western sections of the cluster with AminPD mapped in the lower-lying north-western and south-eastern sections of the cluster. Alluvium is mapped along the watercourses particularly along the lower-lying central and south-eastern sections of the eastern cluster.

A map of the local subsoil cover is attached as **Figure C** (www.gsi.ie). This shows the mapped distribution of subsoil deposits around the proposed development site. The majority (>90%) of both clusters areas are mapped to be overlain by tills derived from Devonian sandstone with localised areas of rock subcrop or outcrop on the most elevated parts. A localised area of cutover bog is mapped on the southwestern corner of the eastern cluster. The mapped cutover bog does not intercept any of the proposed development footprint.

In general, site mapping, observations of exposed soils and trial pits confirms these mapped conditions.

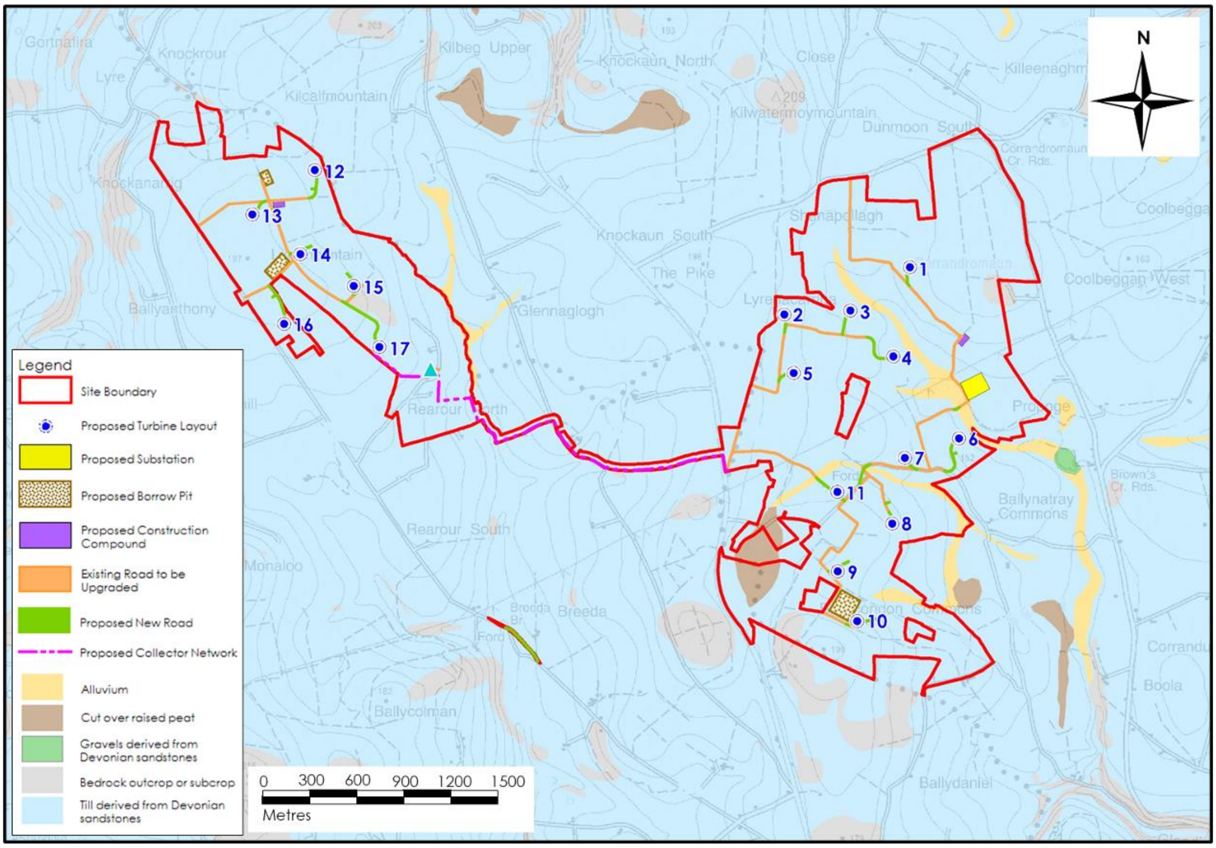

Figure C: Local subsoils map

3.4 DESIGNATED SITES & HABITATS

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 Proposed Development site is not located within any designated conservation-site.

The closest NHA to the site is the Blackwater River and Estuary (Site code: 000072). This is situated ~4.3km north of the western cluster, just north of Tallow, Co. Waterford.

The closest SAC to the site is the Blackwater River SAC (Sitecode: 002170) the boundary of which is located within 10 metres of the proposed development site boundary. This SAC includes the downstream section of the Glenaboy river near Tallow and also the River Bride.

The Blackwater River SAC continues south towards Youghal. The remainder of the landholding areas which are within the Glendine River and Tourig River catchments ultimately drain south towards the lower sections of the River Blackwater SAC and estuary.

4. SITE SPECIFIC FLOOD RISK ASSESSMENT

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.

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 stages of a flood risk assessment are:

- *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 the purposes of 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 Soils Maps – Fluvial Maps

A review of the soil types in the vicinity of the proposed 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 areas of mineral alluvium soils (fluvial deposits) mapped locally along various rivers/streams discussed above.

In general, however there does not appear to be any significant Alluvium deposition that would be associated with a flood plain or a large geographical area prone to flooding.

4.3.2 Historical Mapping

There is no text on local available historical 6" or 25" mapping for the proposed site that identify areas that are "*prone to flooding*".

4.3.3 OPW National Flood Hazard Mapping

No recurring flood incidents within the EIAR site boundary or immediately downstream were identified from OPW's Flood Hazard Mapping (refer to **Figure D** below). The closest mapped recurring flood events are located on the Bride River at Tallow bridge to the north and on the Glendine River (to the south) just upstream of where it merges with the Blackwater River/estuary.

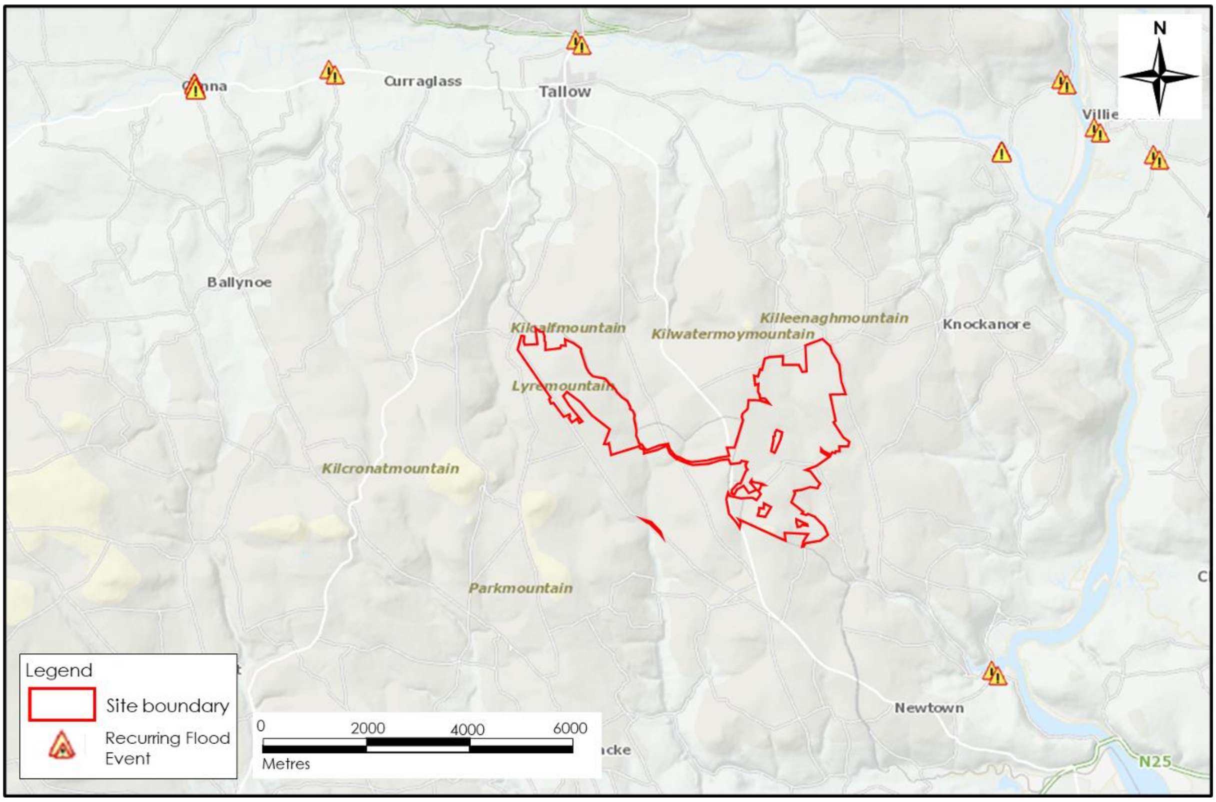

Figure D: OPW Indicative Floods Map (www.floods.ie)

4.3.4 Preliminary Flood Risk Assessment Maps – Fluvial and Pluvial Flooding

Where complete the CFRAM[2] Study OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the PFRAM maps. However, there is no CFRAM mapping available for the area of the wind farm site and therefore the PFRA mapping has been reviewed. The PFRA mapping is shown as **Figure E** below.

The PFRA mapped 100-year fluvial flood zones and extreme event flood zones within the wind farm site are typically constrained by topography and confined to land in close proximity of mapped watercourses flowing through the site. The proposed turbine locations, compounds (2 no.), substation or borrow pits (2 no.) are not within any PFRA mapped fluvial flood zone as these infrastructure elements are located at least 75m from main streams/ watercourse.

Proposed wind farm infrastructure located within a mapped fluvial flood zone is limited to 2 no. existing watercourse crossing locations in the eastern landholding (these existing crossings will be upgraded as part of the development).

Small localised areas of pluvial flooding are mapped within the site within areas of low relief and/or relatively poorly draining soils/subsoils. The mapped pluvial flood zones do not affect any of the proposed wind farm infrastructure.

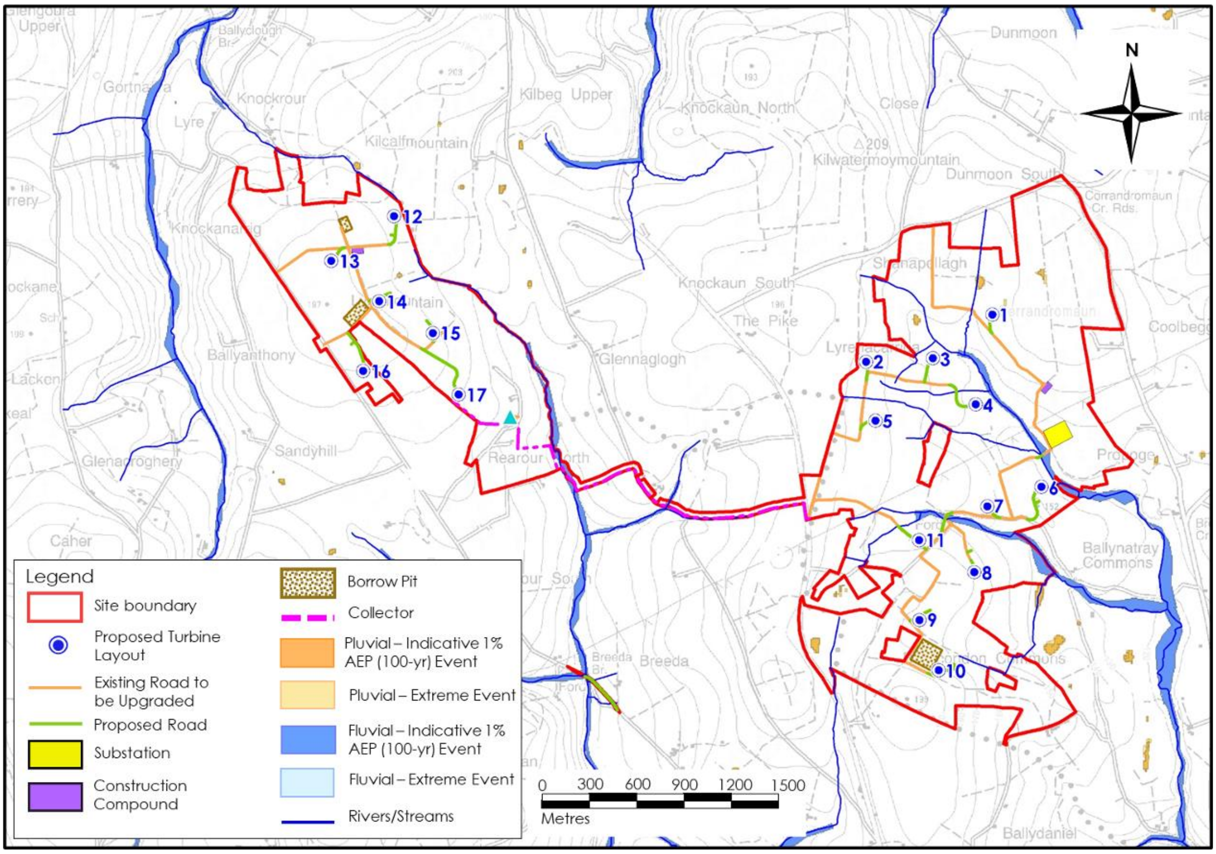

Figure E: PFRA Fluvial Flood Zone Mapping

[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.*

4.3.5 Summary – Flood Risk Identification

Based on the information gained through the flood identification process it would appear that parts of the site immediately surrounding the larger streams are within 1 in 100 year fluvial flood zones (Flood Zone A), however these mapped zones are limited in extent and do not coincide with areas of development (*e.g.* substation/turbines/compound etc). All proposed development locations (with the exception of watercourse crossings as discussed above) are at least 75m from main streams / watercourse and are therefore outside the PFRA mapped fluvial flood zones (i.e. they are located in Flood Zone C).

The mapped pluvial flood zones within the proposed site are very localised and do not affect any of the proposed wind farm infrastructure.

4.4 INITIAL FLOOD RISK ASSESSMENT

4.4.1 Site Survey

Detailed walkover surveys of the proposed site were undertaken by HES between August 2018 and May 2020 and the lands, specifically the areas identified from the PFRA mapping (discussed above) were surveyed for any signs or anecdotal evidence of flooding.

The forestry drains are the primary drainage routes towards the natural streams on the development site, but the flows in these drains are generally low and this is due to the relatively good natural drainage at the site.

As discussed above, several rivers have their upper reaches (mainly 1st /2nd order streams) within the proposed development site and these then merge to form the Glendine River and Tourig River.

Monitoring of stream discharge in the main streams downstream of the site was undertaken on several occasions at 6 no. monitoring locations (SW1 – SW6) between September 2018 and February 2019 and these data is presented in **Table C** below. Refer to **Figure B** above for the monitoring locations.

All the higher flows measured between November 2018 and February 2019 were in bank flows (i.e. contained within the channel).

Table C: Surface Water Flow Monitoring

Location/Date	17/09/2018	17/10/2018	06/11/2018	30/01/2019	05/02/2019
	Flow(l/sec)	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)
SW1	15	45	200	120	210
SW2	5	10	150	100	180
SW3	10	40	200	130	220
SW4	12	70	75	25	110
SW5	30	40	200	200	500
SW6	Dry	Dry	15	10	20

During the walkover surveys and flow monitoring of the site there was little evidence of past out of bank flow from within the various river channels. During 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.

4.4.2 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the proposed site can be described using the Source – Pathway – Receptor Model ("S-P-R"). The primary potential source of flooding in this area, and the one with most consequence for the proposed site, is fluvial. The primary potential pathways, in the most likely order of significance, would be overbank flooding of the main streams flowing through the site during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.4.3 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 in the areas of the site proposed for development. The potential sources of flood risk for the proposed site are outlined and assessed in **Table D**.

Table D: S-P-R Assessment of Flood Sources for the proposed site

Source	Pathway	Receptor	Comment
Tidal	Not applicable	Land and infrastructure.	The proposed site is ~11km from the coast and there is no risk of coastal flooding.
Fluvial	Overbank flooding of the main streams passing through the site	Land and infrastructure.	With the exception of watercourse crossings, there is no proposed infrastructure mapped within a fluvial flood zone. All turbines, compounds, substation and borrow pits are at least 75m from main watercourses/streams.
Pluvial	Ponding of rainwater on site	Land and infrastructure.	There is very little risk of pluvial flooding within the proposed site as drainage moves relatively freely. However, some localised small areas of pluvial flooding are mapped.
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 PFRA mapping, there is no apparent risk from groundwater flooding.

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 E** below.

It may be considered that the proposed wind farm can be categorised as "Highly Vulnerable Development" However, as stated above, with the exception of watercourse crossings (many already existing), all proposed infrastructure, including the proposed substation, is located in Flood Zone C (Low Risk) and therefore the proposed development is appropriate from a flood risk perspective (refer to **Table E** below).

[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).*

Table E: 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*

5. FLOOD IMPACT PREVENTION AND DRAINAGE MANAGEMENT

5.1 RELEVANT LOCAL AUTHORITY SUDS GUIDANCE

Guidance in relation to surface water management and sustainable urban drainage is also provided in the Cork County Development Plan 2014. *Section 11.5* of the development plan requires that:

> *"The management of stormwater drainage should emphasise retention and infiltration at source, which reduces runoff volumes and slows the rates of runoff as well as providing partial treatment. The latter requirement reduces the pollution threat to watercourses and ground water. The Council will continue to require the provision of SuDS in residential and industrial developments."*
>
> *"The objective of SuDS in new developments is to replicate, as closely as possible, the surface water drainage regime of the predevelopment 'greenfield' situation. Therefore, the extent of impermeable surfaces such as road surfaces, parking areas, driveways, patios, etc, should be minimised by careful attention to site layout and the specification of porous surfacing materials where practicable."*

Surface water management and sustainable urban drainage guidance is also in the Waterford County Development Plan 2011 - 2017. Policy INF 20 of the development plan requires that:

> *"The Council will require compliance with best practice guidance for the collection, reuse, treatment and disposal of surface waters for all future development proposals. Development proposals must demonstrate adequate water conservation, water quality protection, and surface water run-off rate regulation measures to prevent the increase of flooding issues in the catchment".*

5.2 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.

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.

All new watercourses crossings structures and those existing proposed for upgrade will be designed to accommodate a 100-year flood event. A Section 50 application will be submitted to the OPW in advance of all crossing works proposed on OSI mapped watercourses.

5.3 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 Lyrenacarriga wind farm 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 onto the vegetation or forestry floor where selected forestry rills may be blocked to further promote diffusion of runoff. 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.

5.4 FLOOD IMPACT SCREENING FOR DESIGNATED SITES

Table F below provides a flood impact screening for local designated sites.

Table F: Flood Impact Screening for Local Designated Sites

Name	Site Code	Flood Risk Screening
Blackwater River SAC	002170	No increased flood risk, attenuation proposals outlined above.
Blackwater Estuary SPA/pNHA	N/A	No increased flood risk, no hydrological connection.

6. REPORT CONCLUSIONS

6.1 CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the proposed wind farm development at Lyrenacarriga, Co. Cork/Co. Waterford. 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 or immediately downstream of the proposed site; and,
  - Areas of the proposed site were identified with the PFRA Flood Zones as described below.
- The Preliminary Flood Risk Assessment (PFRA) mapping indicates that there are localised areas of the proposed site adjacent to watercourses that are located in fluvial Flood Zone A, however these areas (which are mainly watercourse crossings) do not coincide with proposed turbine locations, substation, compounds or borrow pits;
- All the proposed turbine locations, substation, compounds, borrow pits and the majority of the access roads are in Flood Zone C (Low Risk);
- Small localised areas of pluvial flooding are mapped within the site. These mapped pluvial flood zones do not affect any of the proposed wind farm infrastructure;
- During the walkover surveys and flow monitoring at the 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;
- It may be considered that the proposed wind farm can be categorised as "Highly Vulnerable Development", however with the exception of watercourse crossings, all proposed infrastructure is located in Flood Zone C (Low Risk) and therefore the proposed development is appropriate from a flood risk perspective;
- The overall risk of flooding posed at the development site is estimated to be low which relates to the probability of being impacted by a 1000-year flood (*i.e.* the majority of the proposed development footprint is located in fluvial Flood Zone C); and,
- In addition, the risk of the wind farm contributing to downstream flooding is also very low, as the long-term plan for the site is to retain and slow down drainage water 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.

* *

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.