APPENDIX 9-1

SSFRA FOR PROPOSED WIND FARM AND PROPOSED ONSITE SUBSTATION

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PROPOSED BALLYDERMOT WIND FARM AND PROPOSED ONSITE SUBSTATION, CO. KILDARE & CO. OFFALY

SITE-SPECIFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

BORD NA MÓNA POWERGEN LTD.

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO Ireland (MKO), on behalf of Bord Na Móna Powergen Ltd, (BnM) (the Applicant) to undertake a Site-Specific Flood Risk Assessment (SSFRA) for the Proposed Ballydermot Wind Farm (i.e., the Proposed Project).

The Proposed Project is described in full in Chapter 4 of this Environmental Impact Assessment Report (EIAR). The Proposed Project encompasses the Proposed Wind Farm and the Proposed Grid Connection. The Proposed Project Site relates to the Planning Application Boundary as shown on Figure A.

This SSFRA has been prepared to assess the flood risk at the Proposed Project Site relating to the Proposed Wind Farm and the Proposed Onsite Substation. Note that a separate FRA (EIAR Appendix 9-2) has been prepared for the Proposed Grid Connection underground electrical cable route and the Proposed Offsite Substation. The Proposed Project has been separated for ease of reporting.

The Proposed Wind Farm site represents the area encompassing the Proposed Wind Farm and the Proposed Onsite Substation; this area spans a large suite of bogs, comprising of a total of 14 no. individual bog basins, which form part of the Allen Bog Group. The Proposed Wind Farm site is located between the towns of Rathangan and Allenwood, Co. Kildare and Edenderry, Co. Offaly. The Proposed Wind Farm and the Proposed Onsite Substation are located on BnM cutover peat bogs, which have been extensively modified and drained as a result of historical peat extraction.

This SSFRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009) (hereafter referred to as the Guidelines (DoEHLG, 2009)). This SSFRA is also completed in accordance with the flood policies and objectives as detailed in the local county development plans:

- Flood Risk Management policies (CAEP-53 to CAEP-63) and the policies in relation to Peatlands (CAEP-16 to CAEP20) detailed in the Offaly County Development Plan (2021-2027).
- Flood Risk Management policies and objectives (IN P5 and IN 31 to IN O38) and the policies and objectives in relation to surface water drainage (IN P4; IN O20 to IN O30) as detailed in the Kildare County Development Plan (2023-2029).

1.2 STATEMENT OF QUALIFICATIONS

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

Our core area of expertise and experience is hydrology and hydrogeology, including flooding assessment and surface water modelling. HES 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 23 years' environmental consultancy experience in Ireland. Michael has completed numerous geological, hydrological and hydrogeological impact assessments of wind farms and renewable projects on peatlands in Ireland. He has substantial experience in surface water drainage design and SUDs design, flood modelling, and surface water/groundwater

interactions. For example, Michael has worked on the Environmental Impact Assessment Reports (EIARs) and associated Flood Risk Assessments for over 100 wind-farm related projects. These projects included several wind farms on BnM lands including Lemanaghan WF, Littleton WF, Ballivor WF, Cloncreen WF and Derrinlough Wind Farm.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 5 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 completes FRAs for a wide variety of projects including wind farms, quarries and proposed residential developments. Conor has prepared FRAs for 20 no. wind farm developments on peatlands including Ballivor WF, Lemanaghan WF and Littleton WF.

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

1.3 REPORT LAYOUT

This SSFRA report has the following format:

- Section 2 describes the setting of the Proposed Wind Farm, including the Proposed Onsite Substation, and details of the Proposed Project relative to this FRA;
- Section 3 details the hydrological and geological characteristics of the local area;
- Section 4 deals with a SSFRA undertaken for the Proposed Wind Farm, and the Proposed Onsite Substation, which was carried out in accordance with the above-mentioned guidelines. This section includes a detailed assessment of the flood risk at the Proposed Wind Farm site and discusses the potential impact that the Proposed Wind Farm, and the Proposed Onsite Substation, may have on the downstream flood risk;
- Section 5 presents a Justification Test for the Proposed Wind Farm and the Proposed Onsite Substation; and,
- Section 6 presents the SSFRA report conclusions.

2. BACKGROUND INFORMATION

2.1 PROPOSED WIND FARM SITE LOCATION AND TOPOGRAPHY

The Proposed Wind Farm site is located approximately 2.2km south-southeast of Edenderry Co. Offaly, 3.3km west of Allenwood Co. Kildare, 2km north of Rathangan Co. Kildare and 1.7km east of Clonbullogue Village Co. Offaly. The Proposed Wind Farm will be located on the Allen Bog Group and comprises 14 no. bogs on the border of County Offaly and County Kildare. The bogs include Ticknevin, Glashabaun North, Glashabaun South, Codd 1, Codd 2, Ballydermot North, Ballydermot South, Blackriver, Lullymore, Lullybeg, Barnaran, Killina, Derrybrennan and Lodge.

The Planning Application Boundary (which includes the Proposed Grid Connection) has a total area of 5,157ha. The approximate centre of the Proposed Wind Farm site is X666946, Y725714 in Irish Transverse Mercator (ITM) coordinates. A site location map is shown below as **Figure A**. The individual bogs which comprise the Proposed Wind Farm site are shown in **Figure B**. The Proposed Wind Farm layout, including the Proposed Onsite Substation is shown on **Figure C**.

The Proposed Wind Farm site is located in a low-lying rural landscape. The Proposed Wind Farm site measures approximately 10 km in length from north to south, and approximately 10.7km from east to west, at its widest point.

The topography today ranges between 82 metres above Ordnance Datum (mOD) at its highest point to approximately 68mOD at its lowest point. Topography at the Proposed Wind Farm site has been modified through industrial peat extraction activities and all ancillary works including associated drainage works. Today the highest elevations are found at headlands and remnant peat banks which create a boundary berm, forming a basin effect within the former extraction areas of the bog. These remnant peat banks and headlands provide an approximation (albeit drained and subsided) of the original ground elevations which existed across the Proposed Wind Farm prior to the commencement of any peat extraction activities.

The Proposed Wind Farm site is generally accessible via the local road network branching from the R402 to the north, the R403 to the east, the R401 to the west and the R414 to the south, with the latter cutting through the southeast of the Proposed Wind Farm site.

Current land use within the Proposed Wind Farm site comprises natural recolonisation of cutaway and degraded bog public road corridor, and land principally used for agriculture.

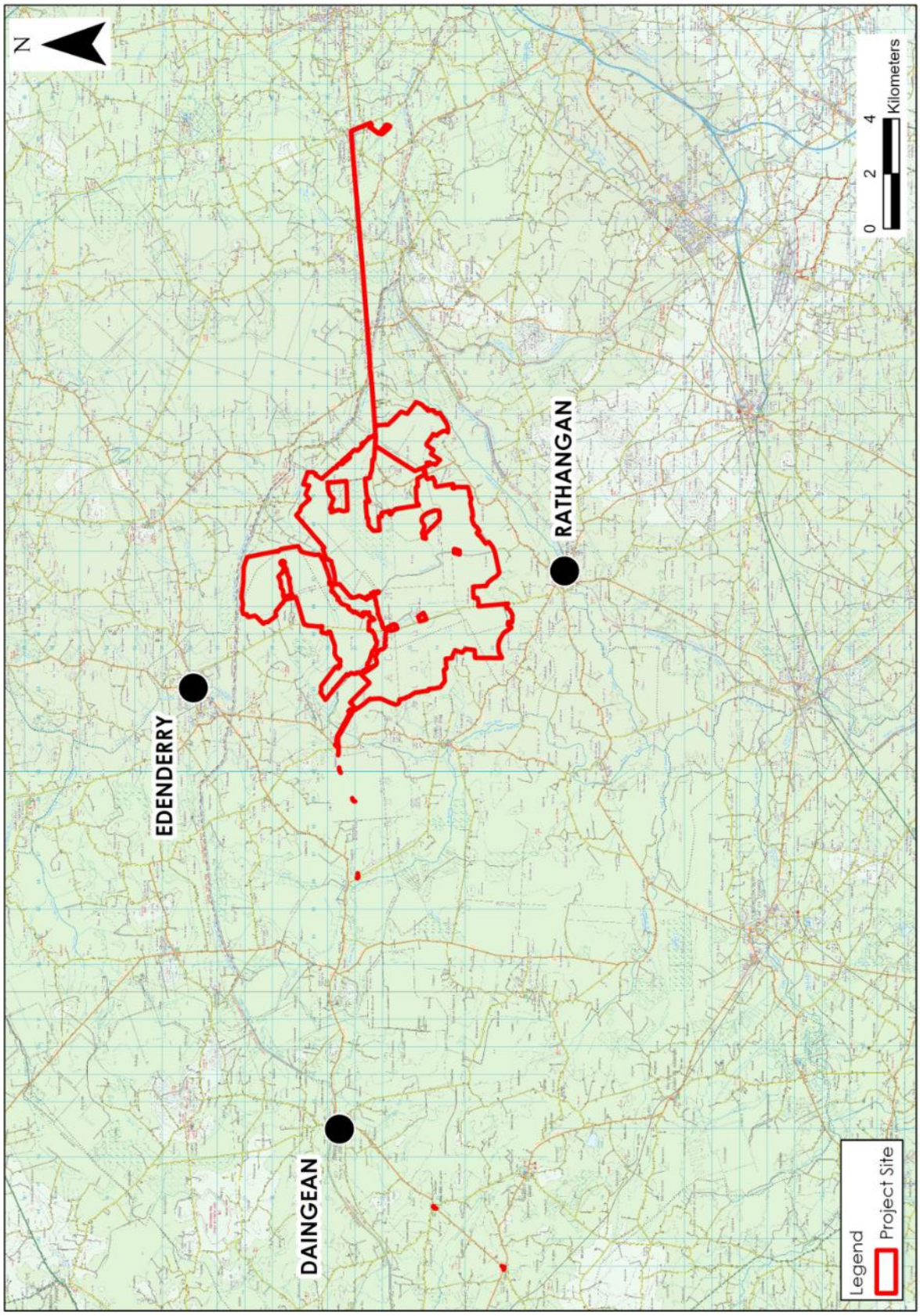


Figure A: Site Location Map

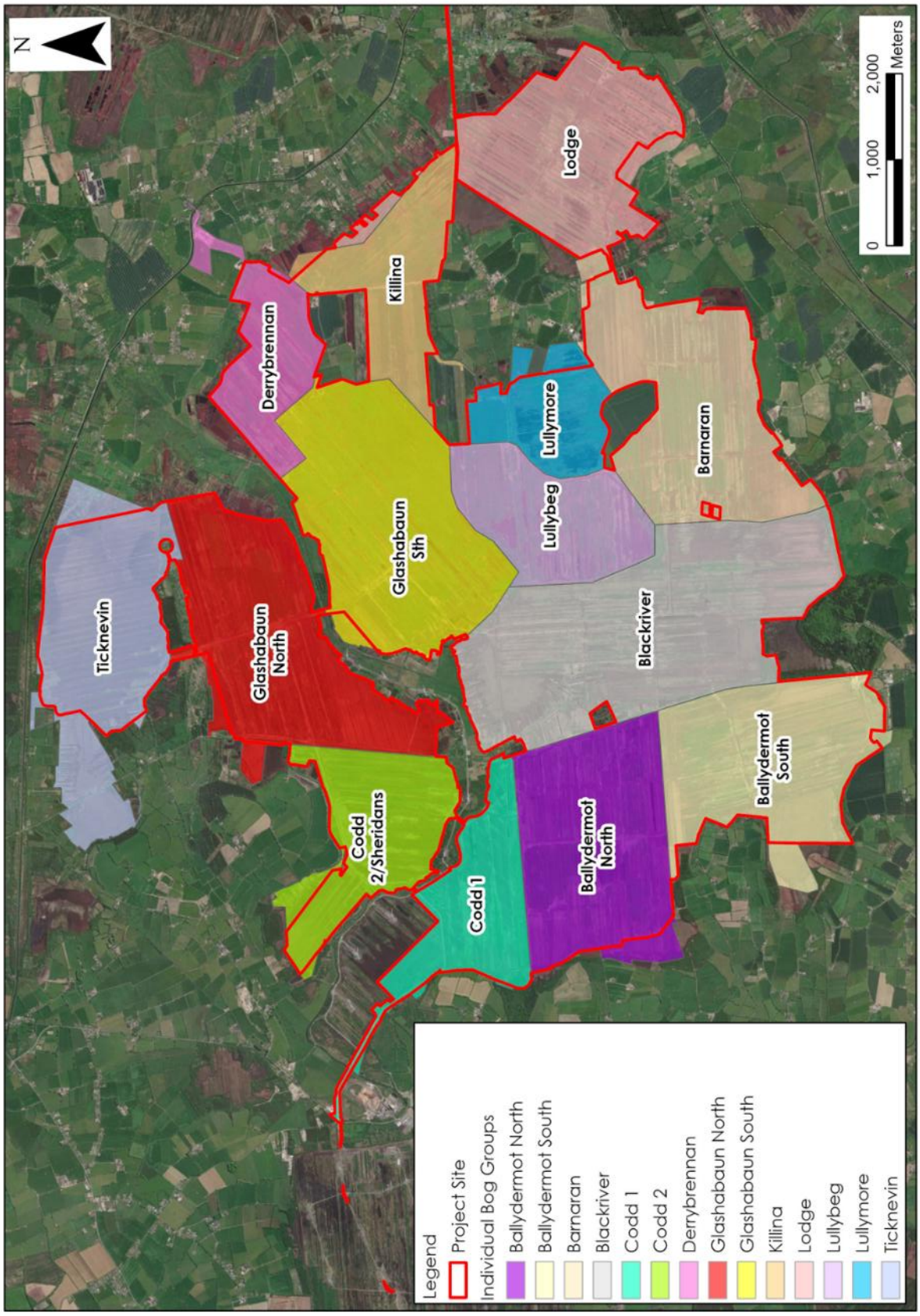


Figure B: Individual Bogs Comprising the Proposed Wind Farm Site

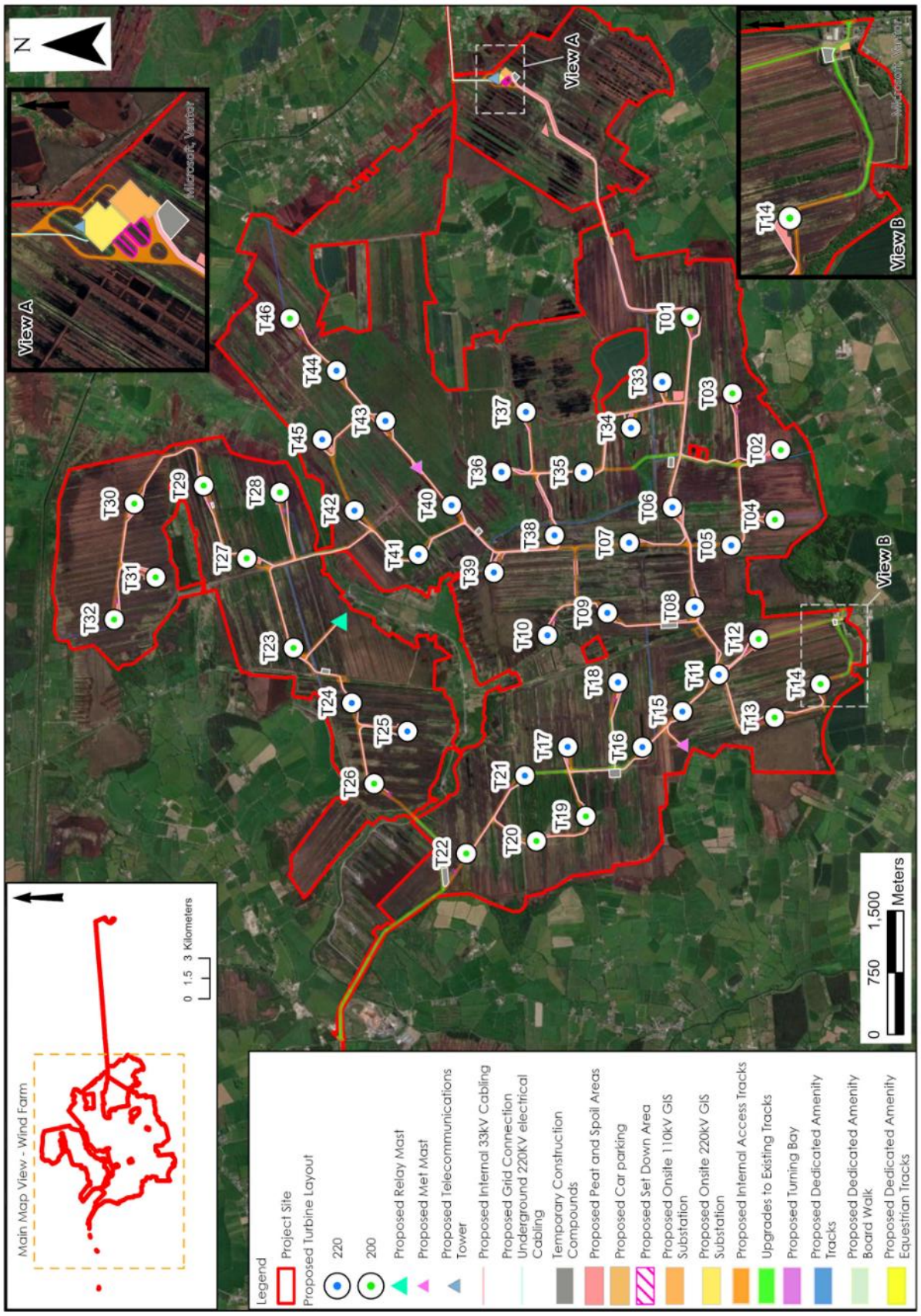


Figure C: Proposed Wind Farm Layout Map

2.2 PROPOSED PROJECT DETAILS

The Proposed Project consists of 46 no. wind turbines and associated infrastructure including hardstands, 2 no. meteorological masts, 10 no. temporary construction compounds, 10 no. temporary security cabins, the provision of new internal site access roads, the upgrade of existing internal site access roads, the provision of dedicated amenity access tracks and amenity carparks (4 no.), 1 no. relay mast, watercourse crossings, biodiversity enhancement, tree felling and vegetation removal, peat and spoil areas, and all associated development and drainage works.

The Proposed Grid Connection comprises the Proposed Onsite Substation, Proposed Offsite Substation, 13.1km 220kV underground cabling connection from the Proposed Onsite Substation to the Proposed Offsite Substation, and overhead line (OHL) connecting to the existing Maynooth-Dunstown 220kV OHL, and all ancillary works and apparatus.

As stated above the only elements of the Proposed Grid Connection assessed in this SSFRA are those located within the Proposed Wind Farm site, i.e., the Proposed Onsite Substation. A separate SSFRA has been prepared for the Proposed Grid Connection underground electrical cable route and the Proposed Offsite Substation; provided as Appendix 9-2.

Please refer to Chapter 4 of the EIAR for a full description of the Proposed Project.

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

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

3.2 HYDROLOGY

3.2.1 Regional and Local Hydrology

The vast majority of the Proposed Wind Farm site is located in the River Barrow surface water catchment within Hydrometric Area 14 of the South Eastern River Basin District. A small area in the north of the Ticknevin Bog located in the River Boyne surface water catchment within Hydrometric Area 07 of the Eastern River Basin District.

Regionally, within the River Barrow surface water catchment, the Proposed Wind Farm site is located in 3 no. river sub-catchments. The majority of the Proposed Wind Farm site is located within the Figile_SC_010 river sub-catchment, the southwest of the Proposed Wind Farm site is located within the Figile_SC_020 river sub-catchment and the south and southeast are located within the Slate_SC_010 river sub-catchment.

Within the Figile_SC_010 river sub-catchment, the Proposed Wind Farm site is mapped in 3 no. WFD river sub-basins: the Abbeylough_010, Figile_020 and Figile_030 WFD river sub-basins.

- Within the Abbeylough_010 WFD river sub-basin, the Abbeylough Stream (EPA Code: 14A01) flows to the west along the northern boundary of Derrybrennan Bog where it discharges into the Figile River (EPA Code: 14F01).
- Within the Figile_020 WFD river sub-basin, the Figile River flows to the west, between Glashabaun South and Glashabaun North bogs. A tributary of the Figile River, referred to by the EPA as the Lullymore East Stream (EPA Code: 14L11) is mapped to flow to the west from the western boundary of Lodge Bog. This stream dissects the northern sections of Lullymore and Lullybeg bogs and forms the boundary between Blackriver Bog to the west and Glashabaun South Bog to the east before it discharges into the Figile River. A smaller stream, referred to by the EPA as the Lullybeg Stream (EPA Code: 14L13), flows around the eastern, southern and western perimeter of Lullybeg Bog before it discharges into the Lullymore East Stream. Another stream, assigned the same name (Lullybeg) on the EPA database, flows from south to north through the western section of Blackriver Bog before it discharges into the Figile River.
- Within the Figile_030 WFD river sub-basin, the Figile River flows to the northwest, separating Codd 1 in the south from Codd 2 in the north. A small tributary of the Figile River, the Clonbrown Stream (EPA Code: 14C32) is mapped to flow to the north along the eastern boundary of Ballydermot North Bog before it discharges into the Figile River close to the east of Codd 1 Bog. The EPA also map a stream referred to as the Cloncant Stream (EPA Code: 14C41) to flow to the southwest, dissecting Codd 2 Bog before discharging into the Figile River. Further north, Ticknevin Bog is drained by 2 no. streams which merge at its southern boundary to form the Codd Stream (EPA Code: 14C44). The Codd Stream flows to the south, along the northwestern boundary of Glashabaun North before it flows to the west and discharges into the Ballyleakin Stream (EPA Code: 14B22). This stream discharges into the Figile River to the northwest of Codd 1 Bog.

Within the Figile_SC_020 river sub-catchment, the Proposed Wind Farm site is mapped within the Figile_050 WFD river sub-basin. Within this WFD river sub-basin Figile River is mapped to flow to the south ~2km west of the Proposed Wind Farm site. Several streams are mapped to originate at the western boundary of the Proposed Wind Farm site. The Clonbullogue Stream (EPA Code: 14C53) to the west of Ballydermot North Bog and the Ballygarrett Stream (EPA

Code: 14B30) to the west of Ballydermot South Bog. These streams merge just upstream of their confluence with the Figile River.

Within the Slate_SC_010 river sub-catchment, the Proposed Wind Farm site is mapped within the Slate_050 and Slate_060 WFD river sub-basins. Within the Slate_050 WFD river sub-basin, the Killinagh Upper Stream (EPA Code: 14K17) is mapped to flow along the southeastern boundary of Lodge Bog before it discharges into the Slate River (EPA Code: 14S01). A second tributary of the Slate River is mapped to originate at the western boundary of Lodge Bog, referred to by the EPA as the Drumsru Stream (EPA Code: 14D19). The Slate River flows to the southwest, ~80m from the south of Lodge Bog. Within the Slate_060 WFD river sub-basin, the Slate River is located ~1km south of Barnaran Bog. There are no watercourses mapped in the immediate vicinity of the Proposed Wind Farm site within this WFD river sub-basin.

Further downstream, the Slate River flows through Rathangan and confluences with the Figile River ~6.6km southwest of the Proposed Wind Farm site. The Figile River continues to flow to the south before it discharges into the River Barrow to the north of Monasterevin.

Within the River Boyne surface water catchment, the Proposed Wind Farm site is located within the Boyne_SC_010 river sub-catchment and the Boyne_010 WFD river sub-basin. The Clonkeen Stream (EPA Code: 07C36) is mapped to flow along the northern boundary of Ticknevin Bog before it flows to the northwest and discharges into the River Boyne (EPA Code: 07B04) ~2km north of the Proposed Wind Farm site. The River Boyne continues to flow to the northwest before it veers to the northeast close to its confluence with the Yellow River (~7km northwest of the Proposed Wind Farm site).

The proposed accommodation works along the Turbine Delivery Route are located in the Figile_010, Figile_020 and Tullamore_010 river sub-catchments. The Proposed Turbine Delivery Route accommodation works are generally distant from any EPA mapped watercourses. However, a works area is located ~30m southeast of the EPA mapped Rathvilla or Rathclonbrackan Stream (EPA Code: 14R12). All other wors areas are located in excess of 50m from natural watercourses.

A regional hydrology map is included as **Figure D**.

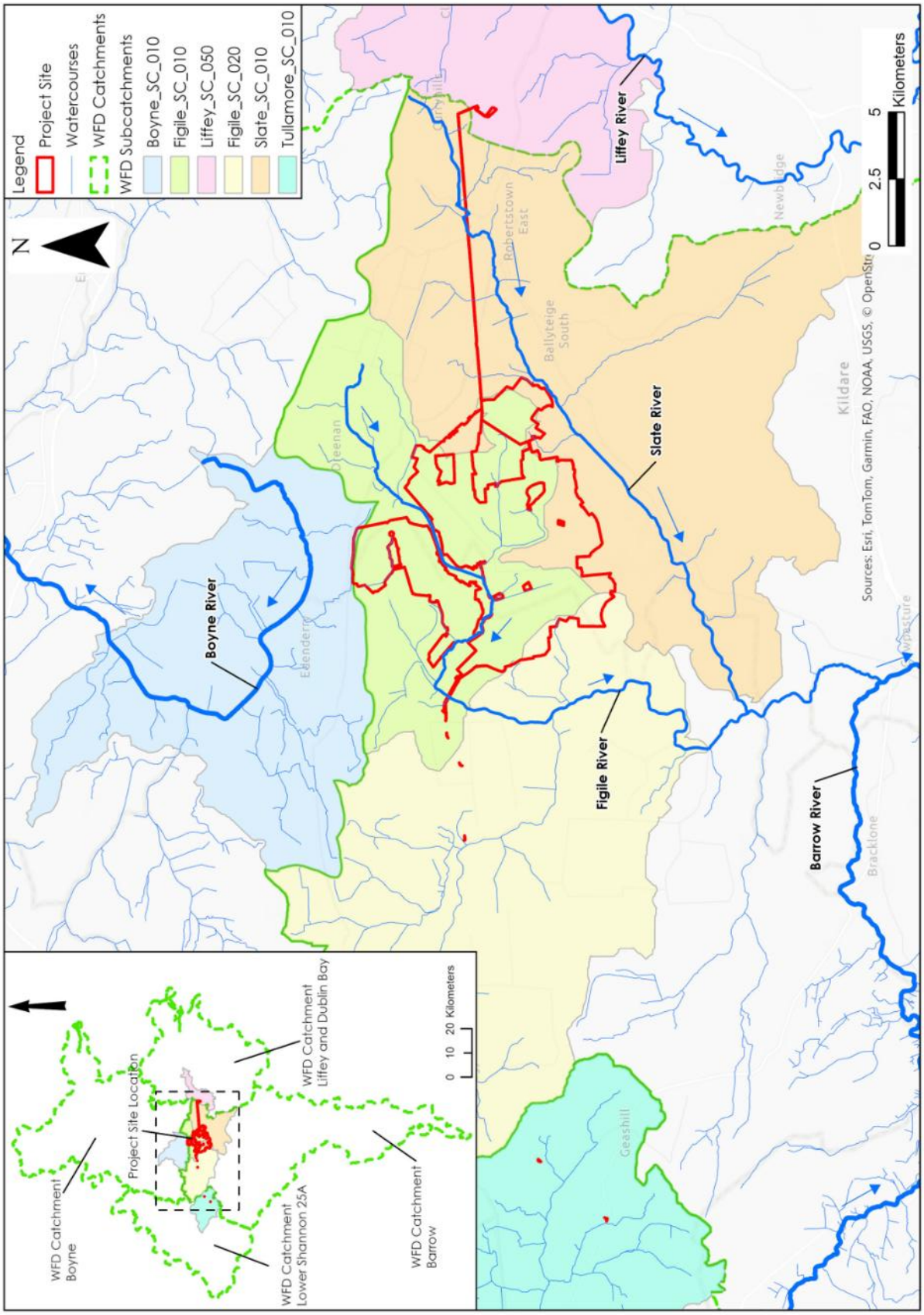


Figure D: Regional Hydrology Map

3.2.2 Rainfall and Evaporation

The closest rainfall station to the Proposed Wind Farm is located at Lullymore (AGR.RES.STN) situated adjacent to Lullymore Bog. The data from this rainfall station indicates an AAR of 834mm (for the years between 1963 and 1990).

Met Éireann provide a grid of Average Annual Rainfall (AAR) for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the 30-year AAR (1991-2020) assigned to location E267000, N226000 (close to the centre of the Proposed Wind Farm) is 880mm/yr. The AAR ranges from 876mm/yr (E264000 N222000 (Irish Grid)) to 894mm/yr (E267000 N231000 (Irish Grid)). The lowest modelled AAR is in the southwest of the Proposed Wind Farm with the highest values in Ticknevin Bog in the north.

The average potential evapotranspiration (PE) at Mullingar, approximately 30km to the northwest of the Proposed Wind Farm site, is taken to be 445.8mm/yr (www.met.ie). The actual evapotranspiration (AE) is calculated to be 423.5mm/yr (95% PE). Using the above values the effective rainfall (ER)[1] for the area is calculated to be (ER = AAR – AE) ~456.5mm/yr.

Based on recharge coefficient estimates from the GSI (www.gsi.ie), an estimate of 5% recharge is taken for the Proposed Wind Farm as an overall average. This value is for "Peat" with a "Low" to "Moderate" vulnerability rating. Areas where peat is absent may have slightly higher recharge rates, but on the Proposed Wind Farm site, these areas are generally very small and localised. The high drainage density in the area would also suggest that recharge rates are very low.

The lowest value in the available range was chosen to reflect the large coverage of blanket peat and high drainage density. Therefore, annual recharge and runoff rates for the Proposed Wind Farm, and the Proposed Onsite Substation, are estimated to be 18.26mm/year and 438.2mm/year respectively.

Table A below presents return period rainfall depths for the area of the Proposed 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). These extreme rainfall depths will be the basis of the Proposed Wind Farm drainage hydraulic design as described in Section 3.6 below.

Table A: Proposed Wind Farm Site - Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	4.4	8	14.9	21.9
15 mins	6.4	11.2	19.8	28.3
30 mins	8.1	13.8	23.8	33.3
1 hour	10.3	17	28.5	39.1
6 hours	19.3	29.4	45.4	59.4
12 hours	24.5	36.3	54.3	69.8
24 hours	31.2	44.8	65.1	82
2 days	37.6	52.7	74.5	92.3

**Estimated using growth factors as data not available from (www.met.ie)*

3.3 PEAT/ SOILS AND SUBSOILS

The soils and subsoils present at the Proposed Wind Farm site have been verified during site walkover surveys and intrusive site investigations. The results of these site investigations are detailed in Chapter 8 of the EIAR.

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

The published Teagasc soils map (www.gsi.ie) for the local area shows that the Proposed Wind Farm site is mapped to be almost exclusively overlain by cutover/cutaway peat except for small area in the northeast of Derrybrennan Bog which is mapped as mainly basic poorly drained mineral soils (BminPD). Soils mapped in the surrounding lands comprise largely of basic deep well drained mineral soil (BminDW), mineral poorly drained (Mainly basic) (BminPD) and basic shallow well drained mineral soil (BminSW). Mineral alluvium (AlluvMIN) is mapped along the Figile River to the southwest and Slate River to the southeast of the Proposed Wind Farm site.

The published GSI subsoils map (www.gsi.ie) shows that the Proposed Wind Farm site is underlain predominantly by cut over raised peat (Cut) with small areas in the northeast of Derrybrennan Bog mapped to be underlain by till derived from limestones (TLs). The area surrounding the Proposed Wind Farm is mapped to be underlain by tills derived from limestones (TLs), cut over raised peat (Cut) and bedrock outcrop or subcrop (Rck). Meanwhile, some esker sands and gravels (BasEsk) and gravels derived from limestones (GLS) are also mapped to the northeast of the Proposed Wind Farm. Alluvium subsoils are mapped along the Figile River to the southwest and Slate River to the southeast.

All Proposed Wind Farm infrastructure, and the Proposed Onsite Substation, are mapped in areas underlain by cutover peat. This has been verified by the site-specific site investigations which are detailed in Chapter 8 of this EIAR.

3.4 BEDROCK GEOLOGY

A total of 4 no. bedrock geological formations are mapped to underlie the Proposed Wind Farm site (www.gsi.ie). These include the Ballyadams Formation (crinoidal wackestone/packstone limestone), the Lucan Formation (dark limestone and shale (`calp')), Allenwood Formation (thick-bedded limestone, locally peloidal) and the Waulsortian Limestones (massive, unbedded lime-mudstone).

There are 3 no. faults mapped within the Proposed Wind Farm site. One fault is running north-south in the centre of the Proposed Wind Farm site, another fault is running northwest-southeast in the centre of the Proposed Wind Farm site and one fault is running west-east in the east of the Proposed Wind Farm site. These bedrock geological faults were active millions of years ago and are of no consequence for the Proposed Project.

Further details on the local geology are provided in Section 8.3.4 of Chapter 8 of the EIAR.

3.5 DESIGNATED SITES

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

The Long Derries, Edenderry SAC/pNHA is located in the lands between Glashabaun North and Ticknevin bogs. A small area of the Proposed Wind Farm, comprising of a machine pass between the bogs overlaps with the mapped extent of the SAC. No infrastructure associated with the Proposed Wind Farm is located within the SAC.

The Grand Canal pNHA (Site Code: 002104) is also mapped adjacent to the north of the Ticknevin Bog. The Proposed Wind Farm does not encroach upon the mapped extent of this pNHA.

The River Barrow and River Nore SAC (Site Code: 002162) is located ~9.8km southwest of the Proposed Wind Farm. This SAC is located downstream and downgradient of the Proposed Wind Farm. The length of the hydrological flowpath between the Proposed Wind Farm and the SAC is ~20km.

The River Boyne and River Blackwater SAC (Site Code: 002299) and SPA (Site Code: 004232) is located ~14km to the north of the Proposed Wind Farm. This SAC/SPA is downstream of the Proposed Wind Farm along the River Boyne. The length of the hydrological flowpath between the boundary of the Proposed Wind Farm and the SAC/SPA is ~22km. However, it is noted that there is no surface water outfall from the bog with this catchment. All water from Ticknevin Bog is directed to the south and discharges via several settlement ponds to the Codd Stream, a tributary of the Figile River.

All designated sites within 10km of the Proposed Wind Farm site are identified in Section 9.3.14 of Chapter 9 of the EIAR.

3.6 PROPOSED WIND FARM SITE DRAINAGE

3.6.1 Existing Drainage

Due to the historic industrial peat extraction activities carried out at the 14 no. bogs comprising part of the Allen Bog Gorup, the Proposed Wind Farm site has been artificially drained in order to lower the peat water table. Drainage ditches were first inserted into the upper surface of each of the bogs comprising the Proposed Wind Farm site prior to the commencement of peat extraction. The timing of the initial site preparation works (vegetation clearance and drainage insertion) varied across the Proposed Wind Farm. The site preparation works were first completed in 1935 at Lullymore, Lullybeg and Killina bogs, whilst the last bogs which underwent site preparation and drainage works were Ticknevin and Codd 2 bogs in 1973 (estimated date based on available aerial imagery).

Currently surface water (or runoff water) is drained from the Proposed Wind Farm site via a network of field drains typically spaced at 15 to 20m intervals, piped drains, main drains, headland drains, and silt ponds. Much of the Proposed Wind Farm site is drained by gravity however, there are 10 no. existing pumps located around the bogs. These include pumping stations in each of the following bogs; Ticknevin Bog, (P37/010), Glashabaun North Bog (P37/008), Codd 1 Bog (P37/012), Ballydermot South Bog (P37/011) and Blackriver Bog (P37/007). Several of these locations contain more than 1 no. pump. Pumping stations have also been decommissioned at Lodge (P37-013) and Codd 1 (P37-014). Following industrial peat extraction activities, drainage by gravity in the areas (i.e. areas of the Proposed Wind Farm which have pumping stations) was no longer feasible as the water level in the surrounding streams was higher than the water level within the Proposed Wind Farm site. The field drains discharge to main drains which flow via gravity, or are pumped, towards the perimeter of the Proposed Wind Farm site where they discharge via larger headland drains to large silt (settlement) ponds. The silt ponds are used to trap sediment and prevent elevated levels of suspended sediment arising in effluent from the drained peatland. Treated surface water is then discharged at outfall points where the effluent flows into off-site drainage channels which in turn discharge into the local stream and river network.

Drainage at the Proposed Wind Farm site is currently operating under the Integrated Pollution Control (IPC) licence from the EPA (P0503-01) with all drainage water from the bogs discharged via an appropriately designed silt pond treatment into outfall drains surrounding the bogs.

A detailed hydrological audit of flowpaths from each bog to its eventual discharge point at the regional catchment scale was completed for the Proposed Wind Farm site. The drainage system is summarised on **Figure E** and the flowpaths from each bog to downstream watercourses are shown on **Figure F**.

There are a total of 26 no. surface water discharge locations across the Proposed Wind Farm site. The vast majority of the bogs comprising the Proposed Wind Farm site discharge directly into the Figile River or smaller tributary streams of the Figile River. Meanwhile, the drainage from Lodge Bog, which the onsite substation is located, discharges into a local stream which is a tributary of the Slate River. Downstream of the Proposed Wind Farm site, the Slate River

discharges into the Figile River. Therefore, all surface waters from the Proposed Wind Farm site eventually end up in the Figile River, and the River Barrow further downstream.

Table B below presents the respective outfalls and their pipe elevations. Outfalls generally discharge into outfall drains with the flowpaths along these outfall drains to the nearest EPA mapped watercourse ranging from 15m to 1.32km. Several of the EPA mapped watercourses have been integrated into the existing bog drainage system. The EPA map natural watercourses upstream of several IPC licence settlement ponds. These sections of the streams have been altered and integrated into the existing bog drainage system, upstream of the settlement ponds. Note that SW68, SW69 and SW70 in Ticknevin Bog are located along EPA mapped watercourses. These watercourses have been integrated into the existing bog drainage system. Similarly, SW65 and SW65A in Blackriver Bog are located in close proximity (15-20m) to the EPA mapped Lullybeg 14 Stream. Note that this stream is mapped to extend into the bog and has also been integrated into the existing bog drainage system, upstream of these outfall locations.

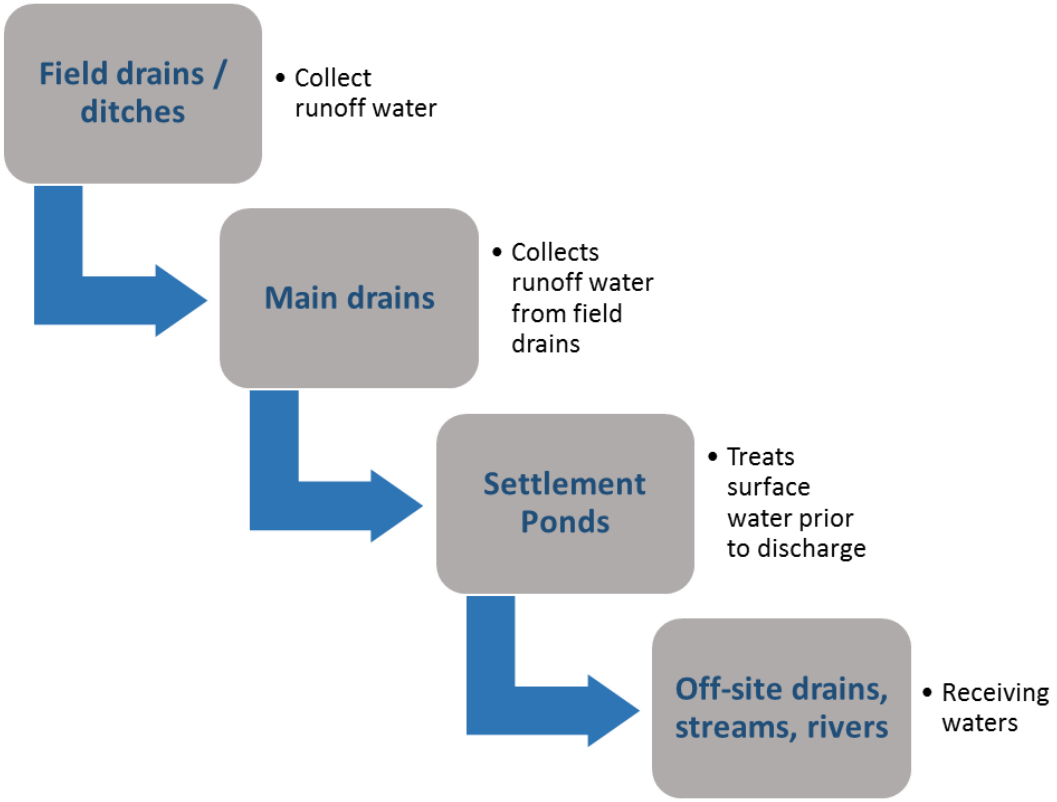


Figure E: Process Flow Diagram for the Existing Site Drainage System

Table B: BnM Outfall Elevations

Outfall ID	Easting	Northing	Bog Name	Outfall Pipe Elevation (mOD)	Receiving EPA Mapped Watercourse	Length of Flowpath from Outfall to Watercourse (m)
SW45	663527.78	726653.71	Codd 1	66.16	Figile River	95
SW45A	662256.19	726971.90	Codd 1	68.40	Figile River	1,325
SW47	669131.73	728060.14	Glashabaun South	72.70	Figile River	780
SW48	668758.20	728217.78	Glashabaun South	71.12	Figile River	1,040
SW49	668988.62	728084.73	Glashabaun South	71.94	Figile River	1,190
SW50	669212.32	727966.35	Glashabaun South	72.47	Figile River	1,300
SW51	666403.40	726805.68	Glashabaun South	67.45	Figile River	320
SW52	666465.51	726531.67	Glashabaun South	67.30	Lullymore East Stream	380
SW53	666612.12	726351.97	Glashabaun South	67.63	Lullymore East Stream	240
SW56	668389.31	725645.95	Lullybeg	68.36	Lullymore East Stream	20
SW60	673194.35	724739.05	Lodge	72.46	Killinagh Upper Stream	140
SW61	673091.43	724411.58	Lodge	72.43	Killinagh Upper Stream	55
SW62	667936.06	723654.44	Barnaran	67.94	Lullybeg 14 Stream	480
SW65	665875.07	724954.12	Blackriver	67.0	Lullybeg 14 Stream	15
SW65A	665458.68	725293.01	Blackriver	66.54	Lullybeg 14 Stream	20
SW67	664392.87	725678.79	Codd South	66.91	Figile River	450
SW67A	664442.55	723287.69	Ballydermot South	67.50	Ballygarrett Stream	140
SW68	666729.17	729690.42	Ticknevin	70.66	Unnamed Stream	0
SW69	666201.27	729620.71	Ticknevin	71.64	Unnamed Stream	0
SW70	665703.89	729959.63	Ticknevin	69.58	Unnamed Stream	0
SW71	664995.88	728219.88	Glashabaun North	69.26	Cloncant Stream	25
SW72	664234.47	727749.54	Codd 2	68.22	Cloncant Stream	20
SW73	663537.72	727291.52	Codd 2	66.42	Cloncant Stream	40
SW74	663647.75	726742.12	Codd 2	65.91	Figile River	55
SW75	663766.63	726597.55	Codd 2	65.91	Figile River	130
SW76	664406.66	726320.81	Codd 2	65.59	Figile River	140

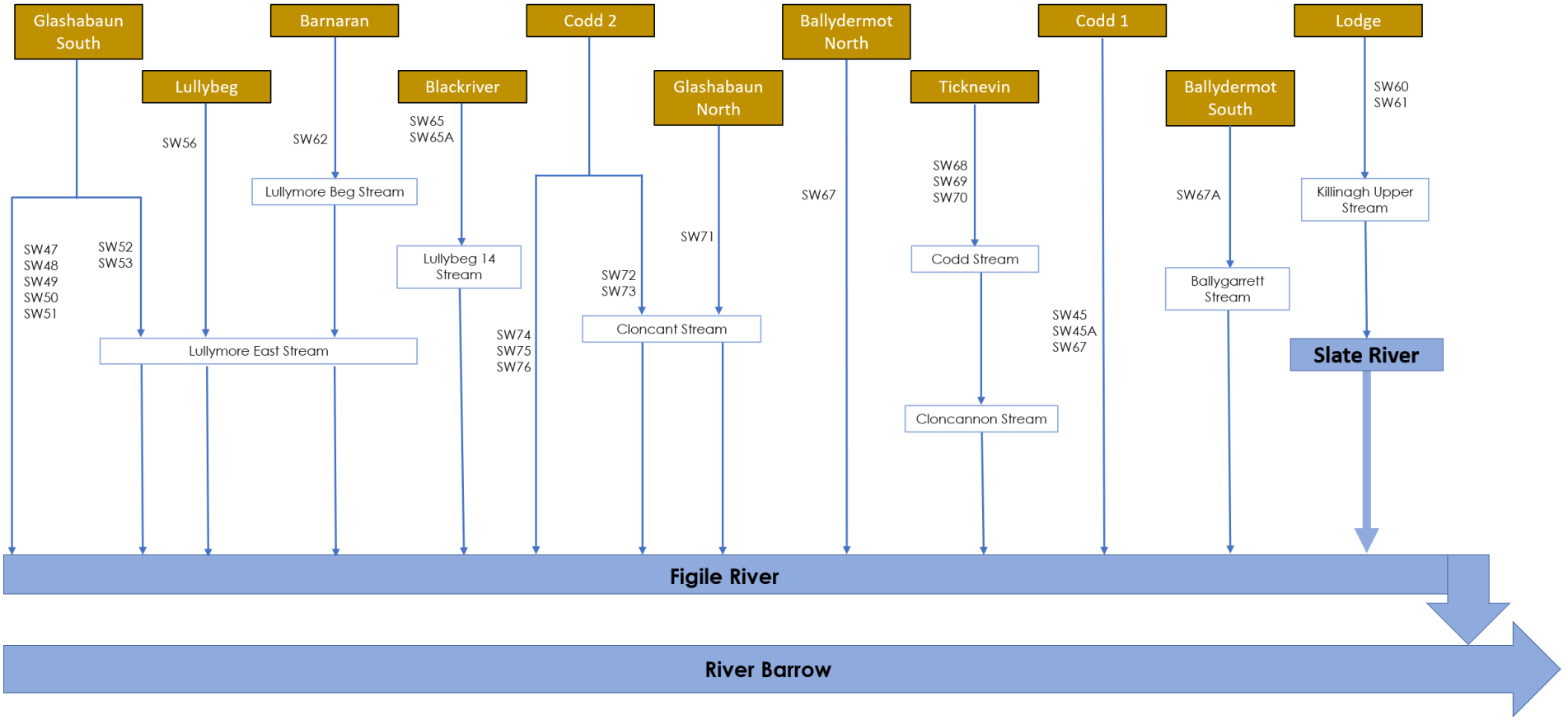


Figure F: Flow Pathways from Bogs Comprising the Proposed Wind Farm site

3.6.2 Proposed Wind Farm Drainage

The proposed drainage system for the Proposed Wind Farm will be integrated with the existing bog drainage network and has been designed to avoid significant alteration of the existing drainage regime. Existing field drains and main drains will generally be maintained, with flows conveyed beneath or around access tracks using culverts where required.

Interceptor drains will be installed up-gradient of proposed infrastructure, where required, to intercept clean surface water runoff and divert it around works areas before redistributing it to downstream field drains. Collector drains will be installed downstream of infrastructure to collect runoff from access roads, turbine hardstands and other developed areas and convey this runoff to local treatment measures.

Treatment measures will include silt traps, check dams, vegetated areas and settlement ponds. Settlement ponds will provide both treatment and attenuation by temporarily retaining runoff during periods of high rainfall, thereby reducing peak hydraulic loading on the existing downstream drainage network.

Treated runoff will discharge to the existing field drain and main drain network. All surface water runoff from the Proposed Wind Farm will ultimately pass through the existing IPC-licensed settlement ponds at the bog outfalls prior to onward discharge to the surrounding stream and river network.

Further details are provided in **Section 4.4.8** below.

A process flow diagram for the Proposed Wind Farm site drainage system is provided as **Figure G.**

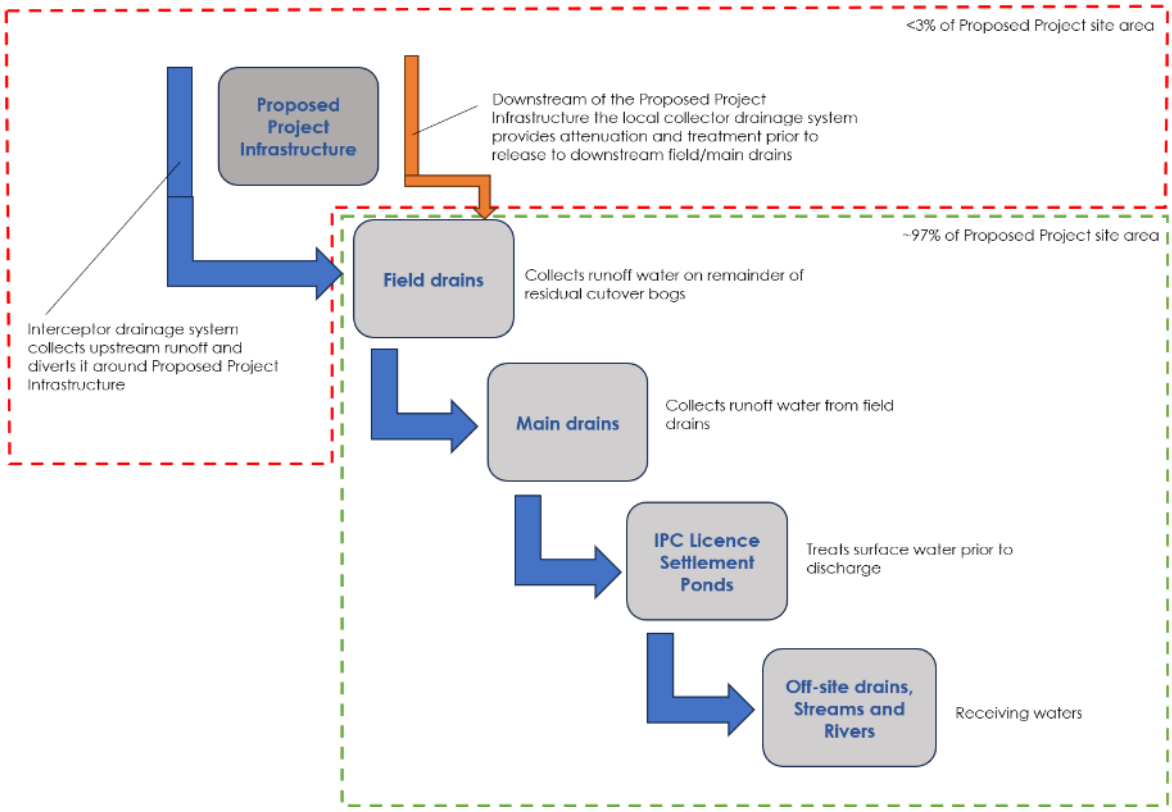


Figure G: Process Flow Diagram for the Proposed Wind Farm site Drainage System

4. SITE-SPECIFIC FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following assessment is carried out in accordance with the Guidelines (DoEHLG, 2009). The basic objectives of these guidelines are to:

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

4.2 FLOOD RISK ASSESSMENT PROCEDURE

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

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

As per the Guidelines (DoEHLG, 2009), there are essentially two major causes of flooding:

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

- High tide level;

- Storm surges caused by low barometric pressure exacerbated by high winds (the highest surges can develop from hurricanes); and,

- Wave action, which is dependent on wind speed and direction, local topography and exposure.

Coastal Flooding is not applicable to the Proposed Wind Farm site due to its distant location from the coast.

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

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

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

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

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

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

The Guidelines (DoEHLG, 2009) recommend a precautionary approach when considering flood risk management and the core principle of the Guidelines (DoEHLG, 2009) is to adopt a risk based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for inland and coastal flooding.

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

There are three types or levels of flood zones defined within the Guidelines (DoEHLG, 2009):

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

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

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

Once a flood zone has been identified for a site, the Guidelines (DoEHLG, 2009) set out the different types of development appropriate to each identified zone (pg 25, Table 3.1 of the Guidelines (DoEHLG, 2009)). Exceptions to the restriction of development due to potential flood risks are provided for through the application of a Justification Test, where the planning need

and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

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

- The first is the **Plan-making Justification Test** described in Chapter 4 of the Guidelines (DoEHLG, 2009) and used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding. Plan-making Justification Tests are made at Plan/Policy development stage such as County Development Plans, or Local Area Plans.

- The second is the **Development Management Justification Test** described in chapter 5 of the Guidelines (DoEHLG, 2009) and used at the planning application stage where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land. For example, application of Development Management Justification Test would be required at a site-specific level, such as for this FRA assessment, if a Justification Test is required.

4.3 FLOOD RISK IDENTIFICATION

4.3.1 Historical Mapping

To identify areas at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) was consulted.

The local 6" base map for the local area states that the Figile River in the vicinity of the Proposed Wind Farm is "liable to flood". The areas identified as liable to flooding are located to the south of Glashabaun North and Codd 1 bogs and to the north of Blackriver and Codd 2 bogs. Downstream of the Proposed Wind Farm, text on the local 6" base maps also record lands which are "liable to flood" along the length of the Figile River.

Lands which are "liable to flood" are also recorded along the EPA mapped Ballygarrett Stream downstream of the Proposed Wind Farm and to the southeast of Clonbullogue.

Meanwhile, lands along the Slate River are also mapped as liable to flooding downstream of Rathangan.

4.3.2 Soils Maps - Fluvial Maps

A review of the soil types in the vicinity of the Proposed Wind Farm was undertaken as soils can be a good indicator of past flooding in an area. Based on the EPA/GSI soil map for the area, the Proposed Wind Farm site is predominately underlain by cutover peat. Historically the Proposed Wind Farm site would have been prone to high water table levels with poorly draining and waterlogged peaty soils. However, extensive drainage has occurred in the area for industrial scale peat production and extraction.

Due to past flooding of rivers deposits of transported silts/clays, referred to as alluvium build up within the floodplain, the presence of these soils is a good indicator of potentially flood-prone areas. Based on the EPA/GSI soil map, alluvium soils (fluvial deposits) are recorded in the northeast of the Figile River corridor, between Glashabaun North and Glashabaun South and Derrybrennan bogs. The mapped extent of the alluvial deposits does not encroach upon the Proposed Wind Farm site.

Alluvial soils are also mapped along the Figile River near Clonbullogue and along the Ballyragget and Clonbullogue streams to the west of Ballydermot South and Ballydermot North bogs respectively.

Alluvial soils are mapped to the south of Lodge Bog on the Slate River outside of the planning boundary. The alluvial soils do not encroach upon the Proposed Wind Farm site.

No infrastructure at the Proposed Wind Farm site is mapped on alluvial soils.

4.3.3 Arterial Drainage Schemes

Arterial Drainage Schemes (ADS) were carried out under the Arterial Drainage Act, 1945 to improve land for agriculture and to mitigate flooding. Rivers, lakes weirs and bridges were modified to enhance conveyance, embankments were built to control the movement of floodwater and various other work was carried out under Part II of the Arterial Drainage Act, 1945. The purpose of the schemes was to improve land for agriculture, to ensure that the 3 – year flood was retained in bank this was achieved by lowering water levels during the growing season to reduce waterlogging on the land beside watercourses known as callows. Flood protection in the benefiting lands was increased as a result of the Arterial Drainage Schemes.

According to OPW mapping (www.floodinfo.ie) the northern section of Ticknevin Bog is mapped as "Benefiting Lands" and an ADS channel is located along the northern boundary of the bog. No Proposed Wind Farm infrastructure is mapped in the area identified as benefited land.

4.3.4 Drainage Districts

Drainage Districts were carried out by the Commissioners of Public Works under a number of drainage and navigation acts from 1842 to the 1930s to improve land for agriculture and to mitigate flooding. Channels and lakes were deepened and widened, weirs removed, embankments constructed, bridges replaced or modified and various other work was carried out. The purpose of the schemes was to improve land for agriculture, by lowering water levels during the growing season to reduce waterlogging on the land beside watercourses known as callows.

According to OPW mapping (www.floodinfo.ie) the Figile River and the Slate River in the vicinity of the Proposed Wind Farm site form part of these drainage districts. However, the benefitted land does not overlap with the Proposed Wind Farm site.

4.3.5 OPW Past Flood Events Mapping

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

No recurring or historic flood events are mapped by the OPW within the Proposed Wind Farm site.

The closest mapped recurring flood events are located approximately 600m north of the Proposed Wind Farm site, i.e., Ticknevin Bog at Blundell Aqueduct (Flood ID: 2785). The local area engineers report states that low lying land floods here every year after heavy rain due to inadequate drainage and flat terrain.

A recurring flood event is also mapped along the Figile River at Clonbulloge (Flood ID: 2769), where the Figile River is noted to flood most winters. This recurring flood event is located ~2.1km to the west of the Proposed Wind Farm site.

A recurring flood event is also mapped further downstream along the Figile River at Derrygarran (Flood ID: 2772). This flood event is located ~2.4km to the southwest of the Proposed Wind Farm site.

A recurring flood event is mapped to the east of the Proposed Wind Farm site at Killinagh (Flood ID: 1280). The local area engineers report states that this area floods every year after heavy rainfall as a culvert of a stream under the Grand Canal can't take the volume of water. This OPW mapped recurring flood event is located ~1.8km to the east of the Proposed Wind Farm site.

Recurring flood events are also recorded along the Slate River at Cloncurry (Flood ID: 1485) and Rathangan (Flood ID: 1484).

The OPW Past Flood Events Map for the local area is included as **Figure H** below.

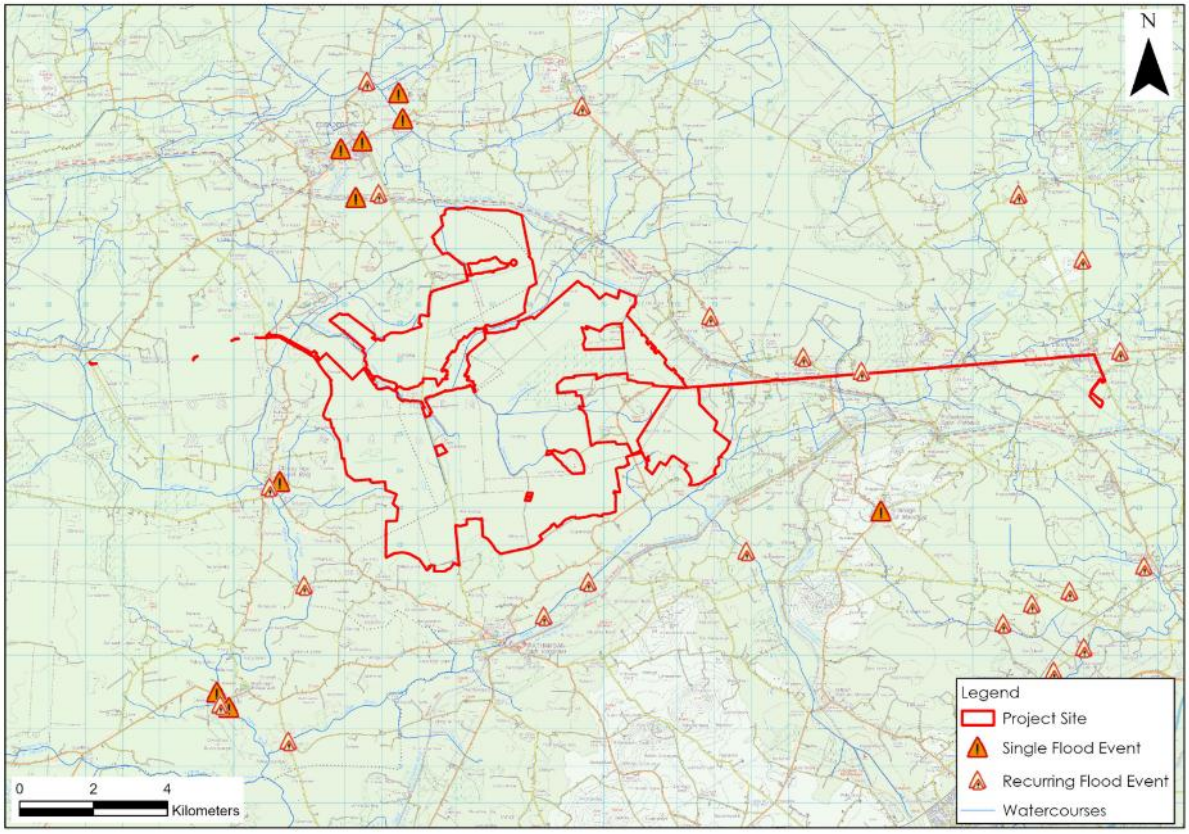


Figure H: OPW Past Flood Events Map (www.floods.ie)

4.3.6 GSI 2015/2016 Surface Water Flooding

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.

The flood map for this event records some historic surface water flooding within the Proposed Wind Farm site. These historic flood zones are located in the west of Glashabaun North Bog, in the north/northeast of Codd I Bog, in the north and east of Ballydermot North Bog and towards the centre of Lodge Bog. These historic flood zones correspond with some of the lower lying peat fields within the Proposed Wind Farm site.

The hardstand associated with T23 is located within the mapped historic surface water flood zone. Some small sections of access roads and electrical cabling are mapped to overlap with the GSI mapped historic flood zones in Lodge and in Glashabaun North bogs (near T23).

All other infrastructure including the proposed turbine locations and the Proposed Onsite Substation are located outside of these GSI mapped historic surface water flood zones. The flood zones in Lodge Bog are located >500m to the south of the Proposed Onsite Substation.

The TDR accommodation works areas are not mapped within any GSI historic surface water flood zone.

The GSI Winter (2015/2016) Surface Water Flood Mapping is shown as **Figure I**.

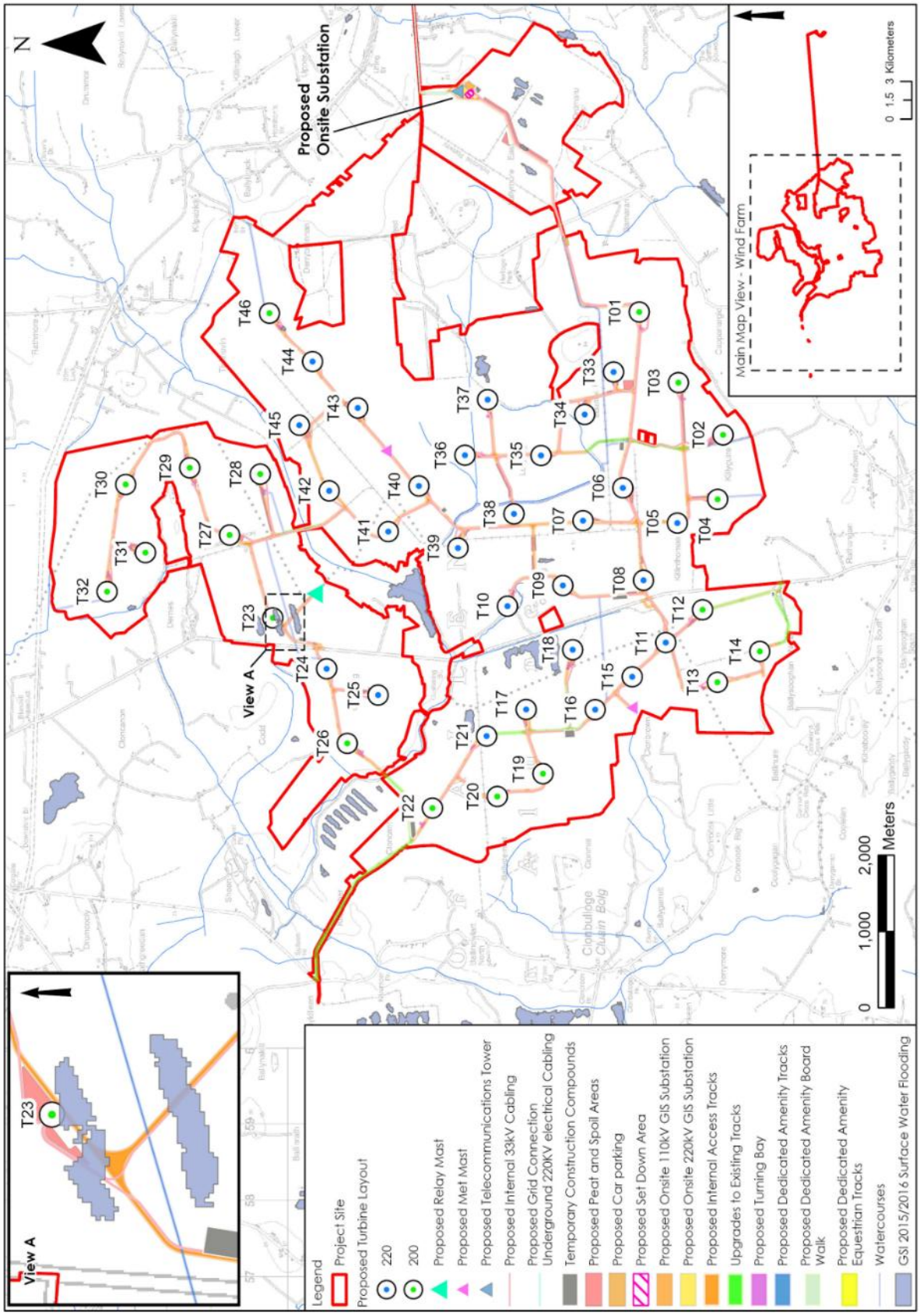


Figure I: GSI Historical Surface Water Flood Map

4.3.7 CFRAM Fluvial Flood Mapping

Catchment Flood Risk Assessment and Management (CFRAM) OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PRFA maps.

CFRAM mapping has been completed for the Figile River to the west of the Proposed Wind Farm site and along the Slate River to the south/southeast. The modelled flood extents on the Slate River generally do not extend any significant distance from the river channel. The CFRAM flood zones along the Slate River bound the southeastern boundary of Lodge Bog but do not encroach upon the Proposed Wind Farm site.

More widespread flooding is located along the Figile River to the west, but these flood zones are distant from the Proposed Wind Farm site. The flood zones are 1.1km to the west of the Proposed Wind Farm site at their closest point. Widespread flooding is also located further downstream along the River Barrow.

No CFRAM flood zones are mapped in the area of the TDR accommodation works. The closest mapped CFRAM flood zones are associated with the Daingean River, located ~130m to the west of the TDR works along the L1003.

CFRAM fluvial flood zones are included in **Figure J**.

4.3.8 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 4.3.11** below.)

For the present-day scenario, low (1,000-year flood event) and medium (100-year flood event) probability fluvial flood zones are recorded along the Figile River and its tributaries in the immediate vicinity of the Proposed Wind Farm site. Some of these flood zones encroach upon the Proposed Wind Farm site. Low and Medium probability fluvial flood zones are mapped in the interior of Glashabaun South and Derrybrennan bogs to the south of the Figile River. Flood Zones also extend southwards from the Figile River along lower peat fields into Codd 1 Bog. Low probability fluvial flood zones are also mapped in the northern section of Blackriver Bog associated with tributary streams of the Figile River, referred to by the EPA as Lullybeg Stream (in the west) and the Lullymore East Stream in the east (which flows between Blackriver Bog and Glashabaun South Bog).

Several elements of the Proposed Wind Farm overlap with the NIFM fluvial flood zones. In total, ~7,821m^2 of infrastructure is mapped in the 100-year fluvial flood zone with an additional ~25,163m^2 if infrastructure mapped in the 1,000-year flood zone.

The elements of the Proposed Wind Farm mapped in the flood zones include infrastructure associated with 6 no. turbine hardstands (totalling ~18,976m^2 of which ~4,649m^2 is in the 100-year flood zone and ~14,327m^2 in the 1,000-year flood zone), 2 no. turning bays (~1,495m^2 in the 1,000-year flood zone), new proposed access roads (~8,346m^2 with ~1,123m^2 in the 100-year flood zone and ~7,222m^2 in the 1,000-year flood zone) and existing site roads/tracks to be upgraded (~4,168m^2 with ~2,049m^2 in the 100-year flood zone and ~2,119m^2 in the 1,000-year flood zone).

The Proposed Wind Farm infrastructure within the NIFM flood zones include the following:

- A total of 2 no. turbines (T42 and T45) in Glashabaun South Bog are in the 1,000-year fluvial flood zones. The northern section of the T45 hardstand (~2,573m^2) is within the flood zone whilst the majority of the hardstand associated with T42 is within the flood zone (4,244m^2). A section of new access road (~481m^2) towards T45 is also within the flood zone.
- 1 no. turbine (T46) is within the 1,000-year fluvial flood zone in Derrybrennan Bog. The turbine hardstand (~2,149m^2), a turning bay (~649m^2) and the new access road to the north and south of T46 (~1,745m^2) are also in this flood zone.
- 1 no. turbine (T38) in the east of Blackriver Bog is in the 100-year fluvial flood zone. The majority of the hardstand (~4,649m^2) is within the 100-year flood zone with an additional 43m^2 in the 1,000-year flood zone. ~753m^2 of new access road adjacent to T38 is in the 100-year flood zone, with ~3,153m^2 in the 1,000-year flood zone.
- 1 no. turbine (T10) in the west of Blackriver Bog is within the 1,000-year fluvial flood zone. The hardstand (~5,180m^2), a section of new access road (~1,572m^2) and a turning bay (~846m^2) are in this flood zone.
- The hardstand (~139m^2) associated with T22 encroaches upon the 1,000-year fluvial flood zone in Codd 1 Bog.
- Existing access roads/tracks to be upgraded at the Site Entrance 1A are in NIFM fluvial flood zones. ~1,834m^2 are mapped in the 100-year flood zone with ~2,098m^2 in the 1,000-year flood zone.
- An existing access road/track to be upgraded between T28 and T42 is also within the 100-year (~215m^2) and 1,000-year flood zones (~21m^2). An existing watercourse crossing over the Figile River exists at this location.
- A new access road between T22 and T26 is in the 100-year (~370m^2) and 1,000-year flood zones (~272m^2). A new watercourse crossing is proposed at this location.

The remainder of the Proposed Wind Farm and all other proposed infrastructure are located in Fluvial Flood Zone C.

The Proposed Onsite Substation is not located in any mapped fluvial flood zones.

The NIFM flood zones across the entire Proposed Wind Farm site are shown on **Figure J** below. NIFM flood zones within Codd 1 and Blackriver bogs are shown in **Figure K** alongside the Proposed Wind Farm. The flood zones in Glashabaun South and Derrybrennan bogs are shown in **Figure L** alongside the Proposed Wind Farm.

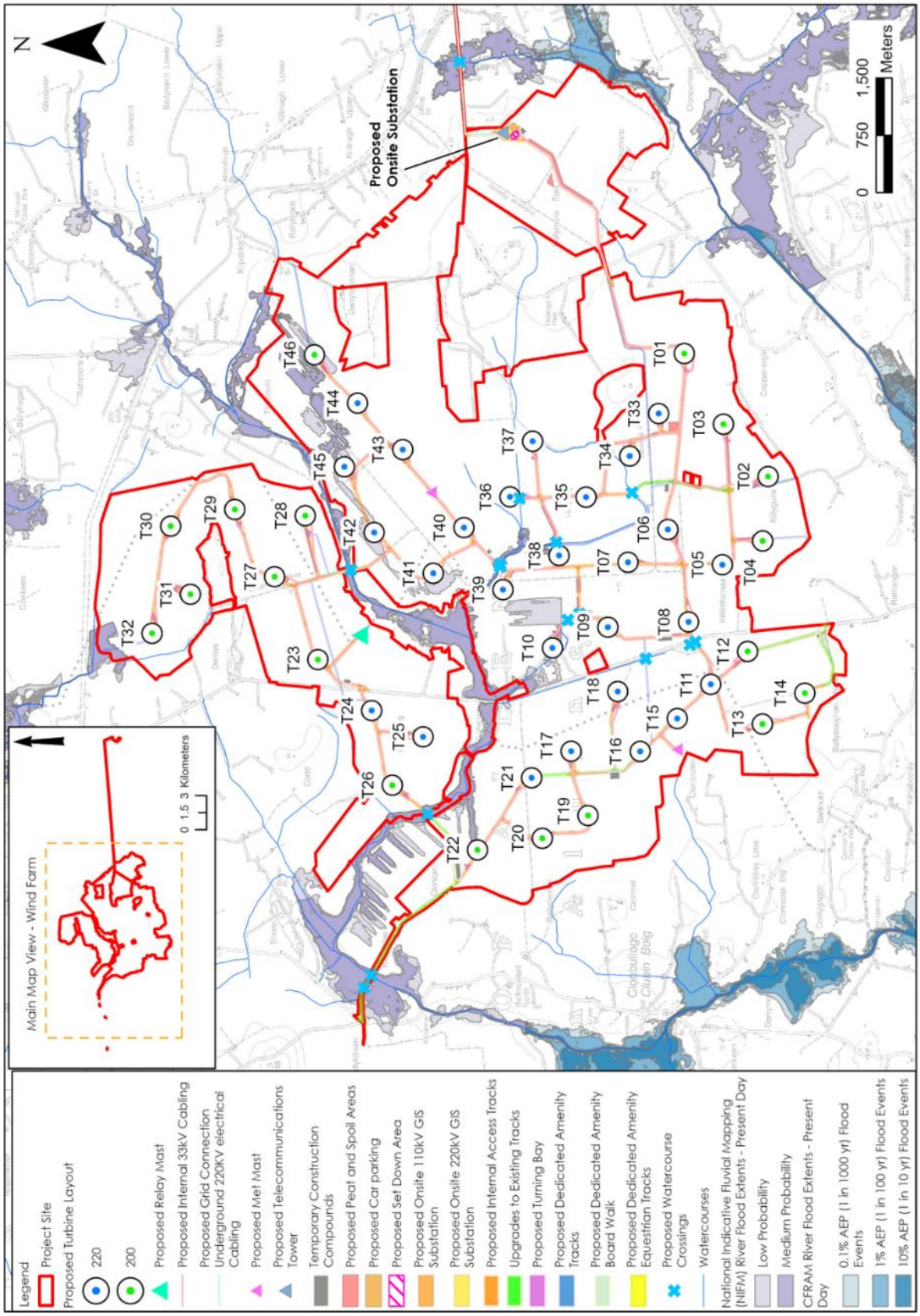


Figure J: CFRAM and NIFM Fluvial Flood Zones

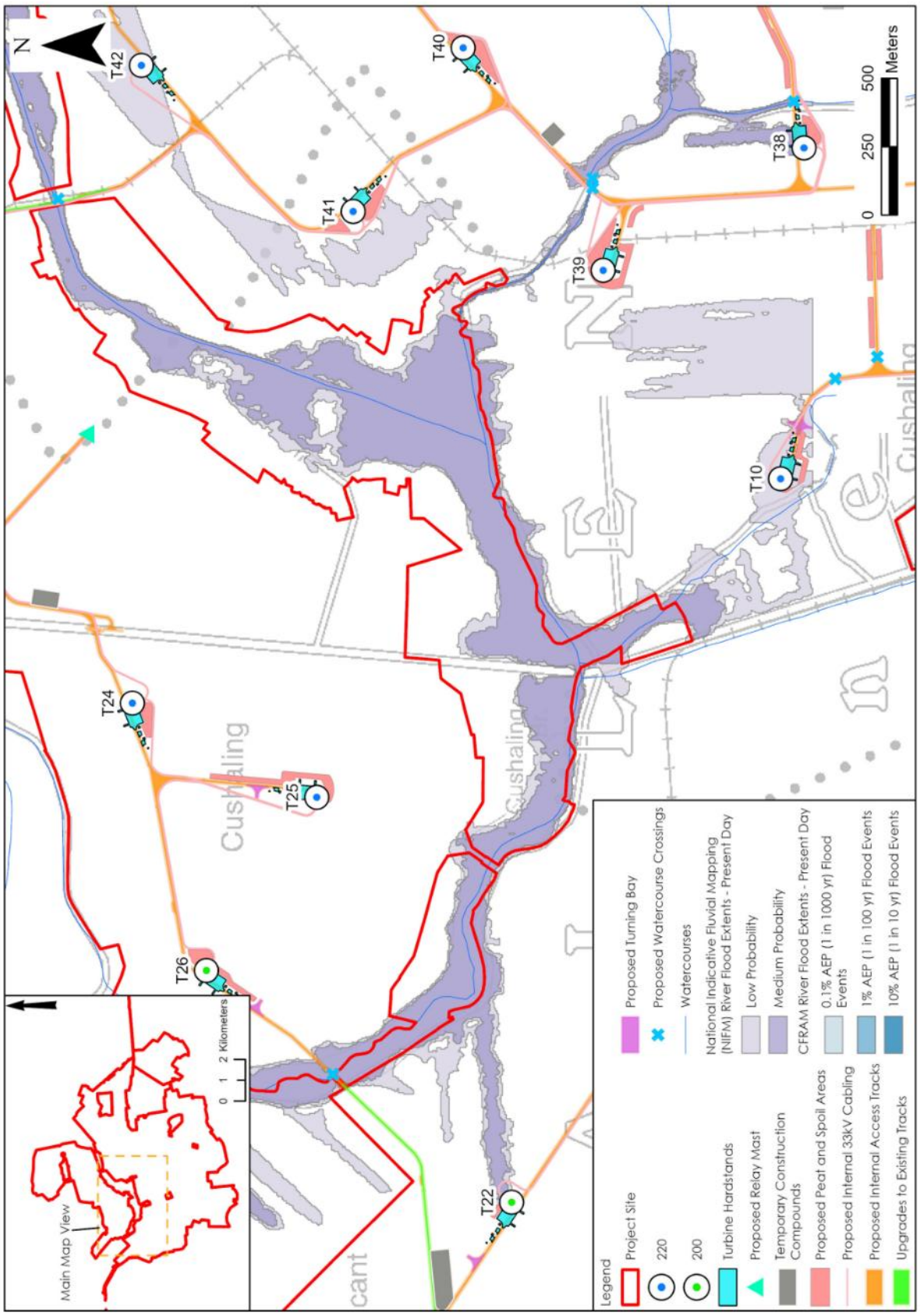


Figure K: NIFM Fluvial Flood Zones in Blackriver and Codd 1Bogs

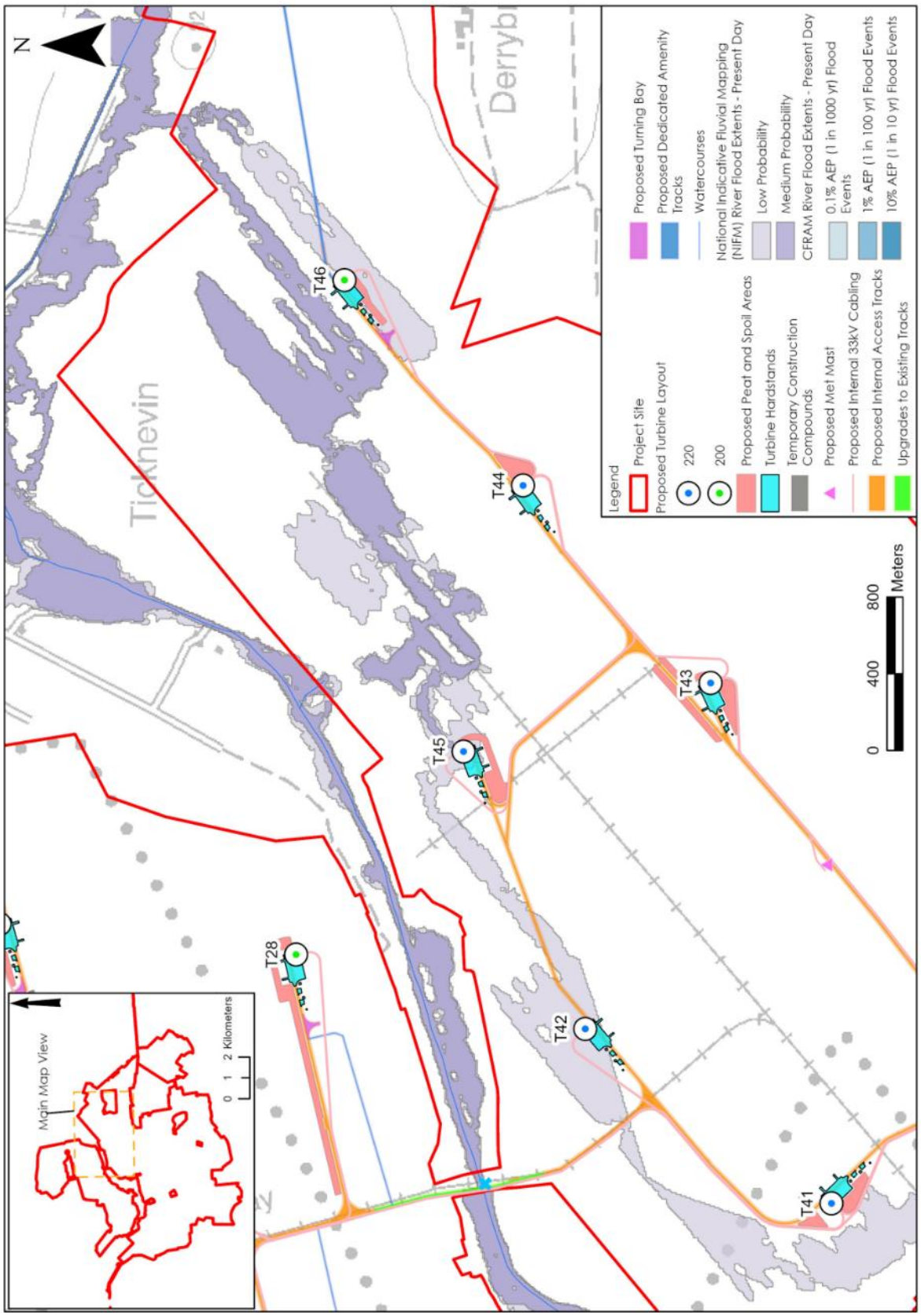


Figure L: NIFM Fluvial Flood Zones in Glashabaun South and Derrybrennan Bogs

4.3.9 Groundwater Flooding

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

The closest historic groundwater flood zones are approximately 6.7km to the northwest of Ticknevin Bog.

4.3.10 Coastal Flooding

The Proposed Wind Farm is located in the Irish midlands and a significant distance (~47km) from the coast. There is no risk of coastal flooding.

4.3.11 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 2 no. future climate change scenarios. The Mid-Range and High-End Future Scenario flood extents were generated using an increase in rainfall of 20% and 30% respectively. The extent of the CFRAM flood zones increase slightly for each future scenario. However, the modelled flood extents are similar to the flood zones described for the Present-Day Scenario in **Section 4.3.7** above.

Similarly, NIFM mapping has been modelled for the 2 no. potential future climate change scenarios. Both of these modelled flood extents show similar flood zones to the Present-Day Scenario discussed above in **Section 4.3.8**.

Therefore, flood zones at the Proposed Wind Farm site are unlikely to be significantly impacted by future climate change.

4.3.12 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, it would appear that parts of the Proposed Wind Farm site are affected by fluvial flooding. While the majority of the Proposed Wind Farm site is located in the Flood Zone C, the GSI historical surface water flood map and the NIFM mapping indicates that some area of the Proposed Wind Farm site are mapped in Fluvial Flood Zones A and B. Flooding in these areas is due to low lying peat fields and overbank flooding of local watercourses. As stated above some elements of the Proposed Wind Farm encroach upon the mapped flood zones.

Due to the permeability of the soils and subsoils at the Proposed Wind Farm site, pluvial flooding and surface water ponding may also be an issue.

The Proposed Onsite Substation associated with the Proposed Grid Connection is located in Flood Zone C and is considered to be at low risk of flooding.

4.4 DETAILED FLOOD RISK ASSESSMENT

4.4.1 Site Surveys

Hydrological walkover surveys and observations on the site drainage patterns were undertaken by HES on 3rd June 2020, 6th, 15th, and 22nd October 2020 and the 5th, 10th, 12th and 18th November 2020, 16th April 2021, 20th and 26th January 2022, 23rd September and 11th December 2025 and 15th May 2026.

During the site walkover land use across the Proposed Wind Farm site was noted as comprising of cutover bog where industrial peat extraction has previously occurred. Note that peat extraction formally ceased at the Proposed Wind Farm site in June 2020. The bogs are drained by regularly spaced field drains which drain towards larger arterial drains. Meanwhile certain areas have become overgrown, with peat production ceasing prior to 2020 in these areas, allowing vegetation to recover and recolonise the bare peat fields. At the boundaries of the bogs, surface water draining from the Proposed Wind Farm site is routed via large settlement ponds prior to discharge to off-site drainage channels which flow into the local rivers and streams.

During the site walkover surveys, low lying areas of the bogs were observed to hold surface water following heavy rainfall, but ponding only occurs to very shallow depths, (<0.2m) and only in certain localised areas does ponded water persist in drier periods (these areas generally correspond with the GSI mapped 2015/2016 Surface Water Flood Zones). Due to the low lying and relatively flat nature of the site, the observed flooding is shallow.

4.4.2 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Proposed Wind Farm 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 Wind Farm, is fluvial flooding along the local watercourses in combination with pluvial flooding during significant rainfall events. The potential receptors in the local area include infrastructure and land.

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 can be determined that flooding will likely pose a risk to certain areas of the Proposed Wind Farm site. The potential sources of flood risk for the Proposed Wind Farm site are outlined and assessed in **Table C.**

Table C: S-P-R Assessment of Flood Sources for the Proposed Wind Farm site

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the Figile and Slate Rivers and smaller tributaries such as the Lullymore Stream.	Land, People, property, infrastructure, River Barrow and River Nore SAC	Fluvial flood zones are mapped to encroach upon the Proposed Wind Farm site associated with flooding along the Figile River and its tributaries. The vast majority of the Proposed Wind Farm is located in Flood Zone C (low risk of flooding). The elements of the Proposed Wind Farm mapped in the flood zones include sections of 6 no. turbine hardstands (totalling ~18,976m^2 of which ~4,649m^2 is in the 100-year flood zone and ~14,327m^2 in the 1,000-year flood zone), 2 no. turning bays (~1,495m^2 in the 1,000-year flood zone), new proposed access roads (~8,346m^2 with ~1,123m^2 in the 100-year flood zone and ~7,222m^2 in the 1,000-year flood zone) and existing site roads/tracks to be upgraded (~4,168m^2 with ~2,049m^2 in the 100-year flood zone and ~2,119m^2 in the 1,000-year flood zone). The Proposed Onsite Substation is located in Fluvial Flood Zone C (refer to **Section 4.4.5** below).
Pluvial	Ponding of rainwater on site	Land, People, property.	The Proposed Wind Farm site is generally low lying and flat and given the nature of the soils/subsoils (cutover peat), localised shallow pluvial flooding is very likely after heavy or prolonged rainfall.
Surface water	Surface ponding/ Overflow	Land, People, property.	Same as pluvial above.
Groundwater	Rising groundwater levels	Land, People, property	Based on the local hydrogeological regime and GSI groundwater flood mapping, there is no apparent risk of groundwater flooding at the Proposed Wind Farm site.
Coastal/tidal	Overbank flooding	Land, People, property	The Proposed Wind Farm site is located in an inland setting and there is no risk of coastal flooding.
Human/ mechanical	Ponding of rainwater on site	Site land	Mechanical error at pumping stations will increase depth of pluvial flooding but will not impact upon downstream fluvial flooding risks.

4.4.4 Requirement for a Justification Test

A matrix of vulnerability versus flood zone is shown in **Table D**. This table is used to illustrate appropriate development types or indicate when a Justification Test[2] is required.

It may be considered that the majority of the components of the Proposed Wind Farm can be categorised as a "Highly Vulnerable Development" as they are electricity generating

[2] *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).*

infrastructure (refer to Table 3.1 in the Guidelines (DoEHLG, 2009)). The vast majority of the "Highly Vulnerable Development" infrastructure, including the Proposed Onsite Substation and 41 no. Proposed Turbines are located in Flood Zone C (Low risk) and can therefore be considered as appropriate from a flood risk perspective.

However, as stated above, some key development infrastructure including 6 no. turbine hardstands (totalling ~18,976m^2 of which ~4,649m^2 is in the 100-year flood zone and ~14,327m^2 in the 1,000-year flood zone), 2 no. turning bays (~1,495m^2 in the 1,000-year flood zone), new proposed access roads (~8,346m^2 with ~1,123m^2 in the 100-year flood zone and ~7,222m^2 in the 1,000-year flood zone) and existing site roads/tracks to be upgraded (~4,168m^2 with ~2,049m^2 in the 100-year flood zone and ~2,119m^2 in the 1,000-year flood zone) are mapped in fluvial flood zones. Consequently, the Proposed Wind Farm is potentially at risk of flooding and would require further justification from a planning perspective.

Furthermore, site-specific modelling in respect of the Proposed Onsite Substation is outlined in **Section 4.4.5**. It needs to be demonstrated that this particularly sensitive element of the Proposed Project is located in Flood Zone C. Further analysis of the elements of the Proposed Wind Farm which are located in the mapped NIFM flood zones is also presented in **Section 4.4.6**.

Table D: 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** (Proposed Onsite Substation)
Less vulnerable development	**Justification test** (T38 hardstand and access road, road to be upgraded between T28 and T42, road between T22 and T26, roads to be upgraded at Site Entrance 1A)	**Appropriate** (Turbine/turbine hardstands (T10, T22, T38, T45, T46, T22)), turning heads, access roads, roads to be upgraded)	**Appropriate** (Turbine hardstands, access roads, peat and spoil areas, temporary construction compounds, met masts)
Water Compatible development	Appropriate	Appropriate	Appropriate

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

4.4.5 Detailed Flood Risk Assessment for the Proposed Onsite Substation

Due to the sensitivity of the Proposed Onsite Substation, HES have completed a detailed assessment to determine a proposed formation level that is above the predicted 1-1,000yr pluvial flood level.

The Proposed Onsite Substation is located within Lodge Bog in the east of the Proposed Wind Farm site. The existing ground levels at the Proposed Onsite Substation location vary between ~73.27 to ~76.87 mOD, with an average elevation of ~75.04mOD. A drainage map of the area of the Proposed Onsite Substation in Lodge Bog is provided in **Figure M**.

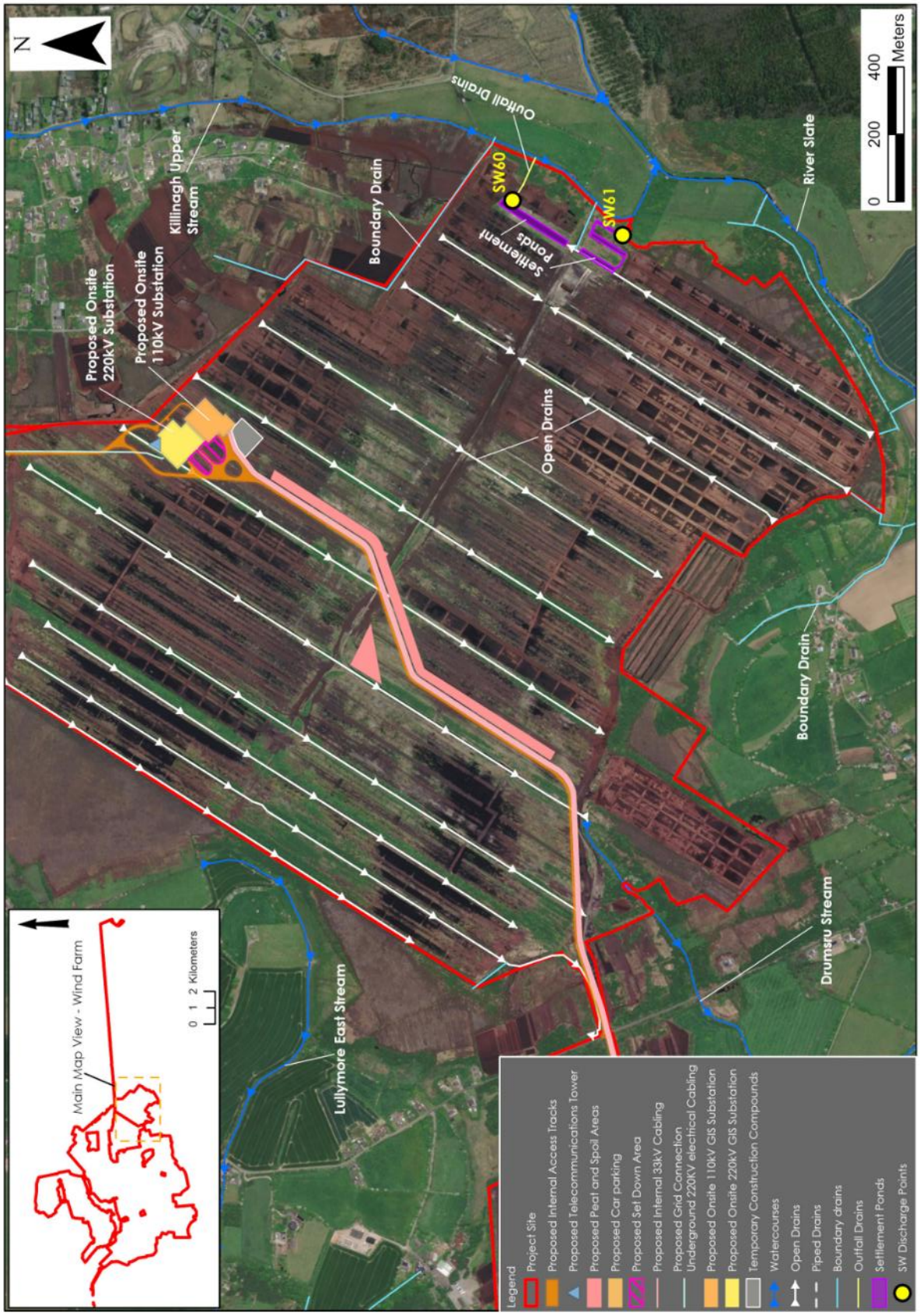


Figure M: Existing Drainage at the Proposed Onsite Substation Area in Lodge Bog

Lodge Bog currently drains via IPC settlement ponds located in the southeast with discharge to the Killinagh Upper Stream (over a distance of ~200m), a tributary of the Slate River. The mapped invert of the outfalls is 72.46mOD (SW60) and 72.43mOD (SW61) (refer to **Table B**).

No part of the Proposed Onsite Substation is mapped in any flood zone from the available flood mapping (National Indicative Flood Mapping, CFRAM, GSI Groundwater flood mapping). There are some GSI Groundwater flood mapping within Lodge Bog (Winter 2015/2016 and SAR mapping), but it is not mapped in the area of the Proposed Onsite Substation.

To determine if the Proposed Onsite Substation location is above the 1,000-year flood level (*i.e.* Low Probability) HES modelled flood levels by applying 1,000-yr rainfall depths (including a climate change factor of +20%) to the surface water catchment within the area of the Proposed Onsite Substation. Based on available topography and the existing drainage regime in this area of the bog, the area within catchment A is the only catchment area that can contribute to flooding of the Proposed Onsite Substation. To be conservative, HES included the total area of Lodge Bog (which includes catchment A) in the following analyses, as this catchment outfalls to the same drain as the Proposed Onsite Substation (catchment A). The area of catchment B is 4.3km^2.

For a catchment area of 4.3km^2, the mean annual flood (Using Institute of Hydrology Report 124) discharge from Lodge Bog is calculated at 1.286m^3/sec. The estimated 100-year and 1,000-year flood flows (using growth factors and applying a climate change factor of 1.2) from the Lodge Bog catchments are (Q100) 2.951m^3/sec and (Q1000) 4.01m^3/sec respectively.

Extreme rainfall depths for the Proposed Wind Farm site were determined using the Met Éireann 20 km by 20 km model of rainfall depth-duration-frequency model (www.met.ie). The rainfall totals at different durations and return periods are presented below in **Table A**.

A lidar survey (data provided by BnM) at a 2m grid interval of the entire Lodge Bog unit was used to determine the flood volume available in catchment B at various water elevations. This information is presented in **Table F**.

Table F shows that significant hydrological (water) storage is available within Lodge Bog, and this is due to the expanse of the open bog area (4.3km^2), the flat nature of the ground (small increases in water level requires large volumes of water), and the shallow field drains that were created by the previous peat extraction works. It is noted that The Peatland Climate Action Scheme (PCAS) was completed on Lodge Bog, a total of 365.7 ha was rehabilitated. The rehabilitation measures implemented consisted of Deep Peat (98.4 ha), Dry Cutaway (55.6 ha), Wetland (120.1 ha), Additional Works (targeted drain blocking) (52.0 ha), Marginal (39.6 ha) and the removal of the pumping regime. These measures represent enhanced peatland rehabilitation, additional to the rehabilitation requirements under Condition 10 of the IPC Licence. The main drains will remain open and discharge from the bog will continue (albeit at a slower rate) to the tributary of the Slate River. The PCAS have increased surface water attenuation and have slowed the discharge of water from Lodge Bog. However, the PCAS have not and will not alter the total storage capacity of the bog.

As a preliminary assessment, a conservative volumetric (catchment area x rainfall depth for each return period and storm duration) and flood storage calculation with Q_{100} and Q_{1000} discharges from the catchment was undertaken for various rainfall durations. Under this scenario, with no discharge on day 1, the peak storage occurs for a 1-day duration rainfall events in both return periods (T_{100} and T_{1000}), with the storage required for longer duration events being exceeded by the discharge from the catchment over time (i.e. on day 2 and after beyond the peak of the flood event). A summary of these volumetric calculations is provided in **Table F.**

Using the stage-volume relationship presented in **Table E**, it is possible to calculate the flood elevation for each return period. These are shown in **Table G.**

Table E: Lodge Bog – Storage-Volume Relationship

Stage mOD (Malin)	Total Volume (m^3)	Volume above 73.3mOD (m^3)
73.3*	176,519.41	0.00
73.5	259,063.19	82,543.78
73.75	410,169.53	233650.12
73.85	489,202.58	312683.17
73.9	533,074.06	356554.65
74	629,723.59	453204.18
74.25	923,787.92	747268.51
74.5	1,293,671.70	1117152.29
74.74	1,744,829.40	1568309.99
75	2,273,262.20	2096742.79

** 73.3mOD is the estimated 1000-year flood level from available lidar and CFRAM flood modelling mapping (external to the site). The volume of storage available in the bog to 73.3mOD is calculated at 176.519m^3, but this elevation has been conservatively set at the zero level for flood storage in an extreme future flood event, in other words this external water level will control water levels within the bog, and there will only be storage available above this elevation.*

Table F: Lodge Bog - Storage Volumes in T_{100} and T_{1000} rainfall events

Rainfall Event Duration	T_{100} Residual Storage Volume (m^3)	T_{1000} Residual Storage Volume (m^3)
24hrs (1 day)	108,846	361,400
2 days	Discharge > Storage	58,208
3 days	Discharge > Storage	Discharge > Storage
4 days	Discharge > Storage	Discharge > Storage
25 days	Discharge > Storage	Discharge > Storage

Table G: Lodge Bog – Estimated Flood Levels for T_{100} and T_{1000} rainfall events

Rainfall Event	Estimated Peak Flood Level (mOD Malin)
T_{100}	~73.6
T_{1000}	~73.9

Summary – Detailed Flood Risk Assessment for Proposed Onsite Substation

As outlined above, a very conservative volumetric analysis has determined the peak flood levels at the Proposed Onsite Substation for 100-year and 1,000-year rainfall events.

The overriding factor in the analysis is the large area of available bog for pluvial water storage within Lodge Bog, and also the positive drainage outfall available to the southeast of the bog. In addition to the above analysis, a freeboard of 1m is added to the determined flood levels to define the required formation level for the Proposed Onsite Substation. Applying this to the T_{1000} flood level gives a required Proposed Onsite Substation formation level of **>74.9mOD**. At this elevation the Proposed Onsite is in flood zone C, and the risk of flooding at the Proposed Onsite Substation is negligible.

As long as the main drains east and west of the Proposed Onsite Substation and the south-eastern outfall drain from Lodge Bog are maintained, there will be positive drainage in this area and the risk of flooding at the Proposed Onsite Substation is negligible.

4.4.6 Detailed Flood Risk Assessment for the Proposed Infrastructure within the Mapped Flood Zones

As described in **Section 4.3.8** areas of the Proposed Wind Farm site are mapped in NIFM Fluvial Flood Zones A and B. In terms of the Proposed Wind Farm infrastructure, 6 no. turbine/turbine hardstands (T10, T22, T38, T42, T45 and T46) are mapped in the fluvial flood zones. Furthermore, 2 no. turning bays, new proposed site access roads and existing access roads/tracks for upgrade encroach upon the mapped fluvial flood zones.

The layout of the Proposed Wind Farm has been developed through a comprehensive and detailed design process. The design team was cognisant of the flooding constraints, and avoidance of these flood zones was prioritised wherever possible. However, the footprint of the Proposed Wind Farm infrastructure is not solely constrained by flooding but must consider a wide range of constraints including ecological, hydrological and geotechnical constraints as well as turbine spacing and planning constraints. The final Proposed Wind Farm design was chosen to limit all potential environmental effects that the construction and operation of the Proposed Wind Farm may have.

The avoidance of fluvial flood zones was prioritised during the layout design but in some locations, infrastructure encroaches upon the modelled flood zones. The scale of the footprint within the flood zones is very small in the context of the Proposed Project and the Site:

- The total footprint of the Proposed Wind Farm infrastructure mapped within the flood zones (3.29ha) represents only a very small percentage of the total footprint of the Proposed Wind Farm infrastructure (152ha).
- The total footprint of the Proposed Wind Farm infrastructure mapped within the flood zones (3.29 ha) is very small in comparison to the total area of the Proposed Wind Farm site (~5,139ha) and represents approximately 0.06% of the total Project Site (~5,157ha).

Furthermore, the Proposed Wind Farm site comprises a large cutover bog which is characterised by shallow topographic gradients, artificial drainage networks and modified hydrology. Cutover bogs are extensive low-lying areas whose surface topography has been lowered by previous peat extraction activities. These settings are therefore often susceptible to flooding, either fluvial flooding from local watercourses or pluvial flooding following intense or prolonged rainfall events. However, given the relatively flat topography and the extensive areas of cutover bog, flooding tends to be shallow and the existing drainage networks within the bogs reduce the flood sensitivity of the Site. Any flooding at the Proposed Wind Farm site will comprise slow moving and shallow waters which will spread out over a significant area, typically within lower peat fields. Any displacement of floodwaters, and associated increase in flood levels, by the Proposed Wind Farm will be small and retained within the Site (as demonstrated below).

The following sections present a detailed discussion/volumetric analysis for each element of the Proposed Wind Farm located within the flood zones. Due to the expansive nature of the Proposed Wind Farm site, the large separation distances between the infrastructure mapped within the flood zones and their location within different bog areas, with different surface water outfall locations and different flood sources (i.e. different streams), these elements are assessed separately.

Based on the quantitative volumetric assessments, the emplacement of the Proposed Wind Farm within the flood zones would result in an increase in floodwater level of between 0.02 and 0.29m locally. These increases are based on the extent of the modelled fluvial flood zones. Due to the flat expanse of the bogs, there is more than adequate capacity within the Proposed Wind Farm Site to absorb such increases in floodwater levels. The increases in water levels will be retained within the Site and there will be no increase in the downstream or upstream flood risk.

The calculations presented below are ultra-conservative and assume a flood depth of 1m at the proposed infrastructure locations. For example, the footprint of the T46 hardstand, the turning head and associated access roads within the flood zone are ~4,543m^2. Assuming a flood depth of 1m the displaced flood zone would be ~4,543m^3. This is an ultra-conservative assumption as the floodwaters within the cutover bog would likely be very shallow (0.01-0.3m). Therefore, the assessments presented below, which predict increases of between 0.02 and 0.29m, represent an extreme theoretical precautionary scenario. The analysis effectively demonstrates that the effects associated with the emplaced footprint within the flood zone are negligible in terms of increasing the flood risk elsewhere.

T46 Hardstand, Turning Head and Access Road

The hardstand associated with T46, its access road and turning head are located in the 1,000-year fluvial flood zones within Derrybrennan Bog. The footprint of the infrastructure proposed within the flood zone is ~4,543m^2.

These elements of the Proposed Wind Farm will be constructed above existing ground levels and will therefore displace fluvial floodwaters during a 1,000-year fluvial flood event. The total extent of the 1,000-year flood zone across Derrybrennan Bog is ~333,481m^2. The displacement of floodwaters associated with the proposed infrastructure (in a theoretical precautionary 1m flood depth scenario) would result in an increase of ~0.13m in the flood depth across the NIFM modelled flood zone. More realistically, if the depth of flooding was 0.3m, ~1,363m^3 of floodwater would be displaced by the proposed infrastructure which would result in a 0.04m rise in water levels across the flood zone.

Such increases in water levels will be absorbed within Derrybrennan Bog and there will be no increase in the upstream or downstream flood risk.

T42 Hardstand, Access Road and T45 Hardstand

These elements of the Proposed Wind Farm are located in the 1,000-year fluvial flood zones within Glashabaun South Bog. The footprint of the infrastructure proposed within the flood zone is ~7,298m^2.

These elements of the Proposed Wind Farm will be constructed above existing ground levels and will therefore displace fluvial floodwaters during a 1,000-year fluvial flood event. The total extent of the 1,000-year flood zone in Glashabaun South Bog is ~432,781m^2. The displacement of floodwaters associated with the emplacement of this infrastructure within Glashabaun South Bog (in a theoretical precautionary 1m flood depth scenario) would result in an increase of ~0.16m in flood depth across the flood zone within the bog. More realistically, if the depth of flooding was 0.3m, ~2,189m^3 of floodwater would be displaced by the proposed infrastructure which would result in a 0.05m rise in water levels across the flood zone.

Such increases in water levels will be absorbed within Glashabaun South Bog and there will be no increase in the upstream or downstream flood risk.

T38 Hardstand and Access Road

These elements of the Proposed Wind Farm are located in the 100-year fluvial flood zones within Blackriver Bog. The footprint of the infrastructure proposed within the flood zone is ~3,906m^2.

These elements of the Proposed Wind Farm will be constructed above existing ground levels and will therefore displace fluvial floodwaters during a 100-year fluvial flood event. As seen in **Figure K**, the NIFM flood zones near T38 appear to be restricted by the NIFM model boundary (note the abrupt southern termination of the NIFM flood zone). Therefore, lidar data was consulted to estimate the true extent of the flood zones in this area using the 69mOD elevation – the elevation of the northern boundary of the NIFM flood zone. Based on the site-specific lidar data, the extent of the flood zone is significantly larger (~233,100m^2) than indicated on NIFM

mapping. The displacement of floodwaters associated with the emplacement of this infrastructure at T38 (in a theoretical precautionary 1m flood depth scenario) would result in an increase of ~0.16m in flood depth across this flood zone. More realistically, if the depth of flooding was 0.3m, ~1,172m^3 of floodwater would be displaced by the proposed infrastructure which would result in a 0.05m rise in water levels across the flood zone.

Such increases in water levels will be absorbed within Blackriver Bog and there will be no increase in the upstream or downstream flood risk.

T10 Hardstand, Access Roads and Turning Head

These elements of the Proposed Wind Farm are located in the 1,000-year fluvial flood zones within Blackriver Bog. The footprint of the infrastructure proposed within the flood zone is ~7,598m^2.

These elements of the Proposed Wind Farm will be constructed above existing ground levels and will therefore displace fluvial floodwaters during a 1,000-year fluvial flood event. As seen in **Figure K**, the NIFM flood zones in Blackriver Bog appear to be restricted by the NIFM model boundary (note the abrupt southern termination of the NIFM flood zone). Therefore, lidar data was consulted to estimate the true extent of the flood zones in this area. Analysis showed that the wider area of cutover bog stands at a lower elevation than T10 and that the entire area of Blackriver Bog would need to flood before T10 floods. The displacement of floodwaters associated with the emplacement of this infrastructure at T10 (in a theoretical precautionary 1m flood depth scenario) would result in an increase of ~0.29m in flood depth across this flood zone. More realistically, if the depth of flooding was 0.3m, ~2,279m^3 of floodwater would be displaced by the proposed infrastructure which would result in a 0.08m rise in water levels across the flood zone.

Such increases in water levels will be absorbed within Blackriver Bog and there will be no increase in the upstream or downstream flood risk.

T22 Hardstand

These elements of the Proposed Wind Farm are located in the 1,000-year fluvial flood zones within Codd 1 Bog. The footprint of the infrastructure proposed within the flood zone is ~139m^2.

These elements of the Proposed Wind Farm will be constructed above existing ground levels and will therefore displace fluvial floodwaters during a 1,000-year fluvial flood event. The total extent of the 1,000-year flood zone in the vicinity of the infrastructure is ~69,852m^2. The displacement of floodwaters associated with the proposed infrastructure would result in an increase of ~0.02m in the flood depth across the flood zone (in a theoretical precautionary 1m flood depth scenario). Such increases in water levels will be absorbed within Codd 1 Bog and there will be no increase in the upstream or downstream flood risk.

Upgrade of Existing Site Access Roads at Site Entrance 1A

Existing site access roads are present at this location. Any proposed works will be of a minor nature, similar to roadworks which are being completed across the country and there will be no increase in the downstream flood risk.

Existing Watercourse Crossing between T28 and T42

An existing access road/track to be upgraded between T28 and T42 is also mapped within the 100-year (~215m^2) and 1,000-year flood zones (~21m^2). An existing watercourse crossing over the Figile River exists at this location. No instream works are proposed and there will be no displacement of floodwaters.

New Proposed Crossing between T22 and T26

A new access road between T22 and T26 is mapped in the 100-year (~370m^2) and 1,000-year flood zones (~272m^2). A new watercourse crossing is proposed at this location over the Figile

River. The crossing will be completed using a clear span bridge and no in stream works are proposed. There will be no potential to displace floodwaters.

4.4.7 Flood Risk Implications Associated with the Peatland Rehabilitation

As industrial peat extraction activity has ceased across the Allen Bog Group, BnM's Cutaway Bog Decommissioning and Rehabilitation Plans will be implemented, to the satisfaction of the EPA, in order to fulfil the requirements of Condition 10.2 of the IPC licence No. P0503-01.

The Plans are still in Draft and have not been finalised until such time that the EPA have *'a final validation report to include a certificate of completion for the Rehabilitation Plan, for all or part of the site as necessary, shall be submitted to the Agency within six months of execution of the plan. The licensee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment'*.

BnM have devised draft decommissioning and rehabilitation plans to stabilise and rehabilitate the peat bogs within which the Proposed Wind Farm, and part of the Proposed Grid Connection, is located. The plans use bespoke interventions designed to first stabilise the environment, and secondly to rehabilitate the bogs as much as possible by placing the existing peatland environments naturally functioning peatlands. Rehabilitation allows a site to naturally colonise with vegetation to stabilise the bare peat production fields and minimise potential downstream water pollution and surface water runoff.

The draft Cutaway Bog Decommissioning and Rehabilitation Plans for the Allen Bog Group (hereafter the 'Draft Rehabilitation Plans') including the proposed site drainage, has been prepared and are summarised below in **Table H** and provided as Appendix 2-4 to the EIAR. It is the intention of BnM to rehabilitate the Allen Bog Group in a phased approach under IPC Licence.

Several aspects of the Draft Rehabilitation Plans have already been implemented. Natural re-colonisation has been ongoing for some time in many areas of the Proposed Wind Farm site.

Improvements in attenuation and water quality can be achieved through bog rehabilitation and rewetting. The Draft Rehabilitation Plans will involve the rewetting and revegetation of the drained cutover bogs. The greatest hydrological/hydrogeological effects would be experienced in those areas selected for rewetting following ecological surveying. Rewetting would be achieved through measures such as drain blocking (the main drains will remain open but the smaller field drains will be blocked). The Draft Rehabilitation Plan will likely result in a positive effect on hydrogeology within the Allen Bog Group where groundwater tables in the peat bogs are stabilised and closer to the bog surface. Water storage capacity within the Proposed Wind Farm site will therefore improve and reduce the risk of flooding within the vicinity and downstream of the Proposed Wind Farm. Elsewhere, where rewetting is not suitable the drainage regimes will remain relatively unchanged.

In addition to the standard rehabilitation required by the IPC licence, BnM are also committed to Peatland Climate Action Scheme (PCAS) which is a programme of enhanced peatland rehabilitation measures with the primary aim of optimising climate action benefits of rewetting former industrial peat extraction areas by creating soggy peatland conditions that will allow compatible peatland habitats to redevelop. These measures are separate to those defined by the IPC Licence. PCAS is supported by Government through the Climate Action Fund and Ireland's National Recovery and Resilience Plan administered by the Department of Environment, Climate and Communications (DECC). The National Parks and Wildlife Service (NPWS) acts as the Scheme regulator and there is ongoing engagement with the EPA. To date the PCAS has rehabilitated approximately 20,955ha of peatland[3].

PCAS is designed both to exceed/meet the standard requirements as defined by the IPC licence and to enhance ecosystem services by optimising climate action benefits. HES note that PCAS works are completed within Lodge Bog. The works include hydrological management, extensive re-wetting and drain blocking, modifying outfalls, creation of berms etc. These works will optimise hydrological conditions and will have benefits for water quality and storage attenuation as well as increased carbon storage and reduced emissions.

With the implementation of the rehabilitation plans and PCAS activities, surface water runoff from the bogs will be reduced, thereby decreasing the downstream flood risk.

Furthermore, the Proposed Project will be constructed with its own drainage system which will provide additional surface water attenuation.

The cumulative effect of the Proposed Project, the Draft Rehabilitation Plan and the PCAS works is that the 14 no. bogs will store more water following rainfall and as a result there will be a reduced risk of fluvial flooding downstream of the Proposed Wind Farm site.

Table H: Types of Rehabilitation Measures proposed for the 14 no. Allen Bog Group bogs comprising the Proposed Wind Farm site

Bog	Type	Description	Area (Ha)
Ballydermot (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	156.6
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	207.2
	Wetland Cutaway	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes	386.7
	Marginal Land	No work required	38.3
	Rehab Complete	Rehab Complete	68.1
	Silt Ponds	Silt Ponds	2.7
	Constraints	Constraints	20.2
	Total Area		**879.9**
Lodge (Final Plan)	Additional Land	Minimal/targeted works required	26.24
	Archaeological Constraint	Known archaeology	0.11
	Constraints	Ballydermot windfarm constraint	41.57
	Dry Cutaway	More intensive drain blocking (7/100 m) + blocking outfalls and managing overflows	55.66
	Deep Peat	More intensive drain blocking (7/100 m) + blocking outfalls and managing overflows with a controlled weir outfall	6.68
		Berms and field re-profiling (45m x 60m cell) + blocking outfalls and managing overflows + drainage channels for excess water + Sphagnum inoculation	90.24
	Marginal Land (MLT1)	No work required	29.29
	Marginal Land (MLT2)	More intensive drain blocking (max 7/100 m)	6.11
	Silt Ponds	No work required	1.59
	Wetland (WLT2)	Turn off or reduce pumping to re-wet cutaway + blocking outfalls and managing water levels with overflow pipes + Targeted blocking of outfalls within a site	60.63
	Wetland (WLT4)	More intensive drain blocking (max 7/100 m), + blocking outfalls and managing overflows + transplanting Reeds and other rhizomes	90.2

	Total Area		**408.3**
Barnaran (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	89.3
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	45.1
	Wetland Cutaway	Modifying outfalls and managing water levels with overflow pipes within low lying areas and depressions on shallow peat	295.2
	Marginal Land	No work required	39.0
	Silt Ponds	Silt Ponds	1.6
	Constraints	Constraints	17.2
	Total Area		**487.4**
Blackriver (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	79.3
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	54.4
	Wetland Cutaway	Modifying outfalls and managing water levels with overflow pipes within low lying areas and depressions on shallow peat	405.12
	Marginal Land	No work required	29.6
	Silt Ponds	Silt Ponds	3.7
	Constraints	Constraints	155.0
	Total Area		**727.7**
Codd (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	224.6
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	113.9
	Wetland Cutaway	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes	99.2
	Marginal Land	No work required	8.8
	Silt Ponds	Silt Ponds	6.1
	Constraints	Constraints	104.4
	Total Area		**556.9**
Derrybrennan (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	3.0
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	29.4
	Wetland Cutaway	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes	79.7
	Marginal Land	No work required	17.7
	Constraints	Constraint	52.4
	Total Area		**182.2**
Glashabaun (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	128.7
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	298.0
	Wetland Cutaway	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes	392.8
	Completed Rehab	Rehabilitation complete	15.3
	Marginal Land	No work required	37.2
	Silt Ponds	Silt Ponds	3.6
	Constraint	Constraints	189.8

	Total Area		**1065.4**
Killinagh (Draft Plan)	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	66.7
	Wetland Cutaway	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes	12.4
	Marginal Land	No work required	8.0
	Constraints	Constraint	155.3
	Total Area		**242.3**
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	0.1
	Wetland Cutaway	Modifying outfalls and managing water levels with overflow pipes to re-wet cutaway	216.4
	Constraints	Constraint Silt Pond	50.4
	Total Area		**266.9**
Lullymore (Draft Plan)	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	5.1
	Wetland Cutaway	Modifying outfalls and managing water levels with overflow pipes to re-wet cutaway	16.7
	Completed rehab	Completed rehabilitation	113.5
	Marginal Land	No work required	0.6
	Constraints	Constraint	38.5
	Total Area		**174.5**
Ticknevin (Draft Plan)	Deep Peat Cutover Bog	Regular drain blocking (3/100 m) + modifying outfalls and managing water levels with overflow pipes	149.6
	Dry Cutaway	Modifying outfalls and managing water levels with overflow pipes	3.2
	Wetland Cutaway	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes	154.0
	Marginal Land	No work required	42.0
	Silt Ponds	Silt Ponds	0.7
	Constraints	Constraints	106.6
	Total Area		**456.0**

4.4.8 Flood Impact Prevention and Drainage Management

The proposed drainage system for the Proposed Wind Farm will be integrated with the existing bog drainage network and has been designed to avoid significant alteration of the existing drainage regime. Existing field drains and main drains will generally be maintained, with existing drainage pathways conveyed beneath or around proposed access tracks using culverts where required.

The drainage design incorporates a separation between clean surface water runoff and runoff from developed areas. Interceptor drains will be installed up-gradient of proposed infrastructure, where required, to intercept clean surface water runoff and divert it around developed areas before redistributing it to downstream field drains. This will minimise the volume of clean runoff entering the drainage system associated with the proposed infrastructure.

Runoff from access roads, turbine hardstands and other developed areas will be collected locally using collector drains and conveyed to appropriate treatment and attenuation measures prior to discharge to the existing bog drainage network. These measures will include silt traps, check dams, vegetated areas and settlement ponds. Transverse drains ('grips') will also be incorporated along access tracks, where appropriate, to intercept road runoff and divert it to adjacent roadside drainage.

In addition to providing water-quality treatment, the proposed settlement ponds will provide temporary attenuation of runoff during rainfall events. Runoff will be temporarily retained, allowing discharge to occur after the peak of the storm hydrograph and thereby reducing peak hydraulic loading on the existing downstream field drain and main drain network.

Treated runoff will subsequently discharge to the existing bog drainage network and flow via existing field drains and main drains towards the bog boundaries. All surface water runoff from the Proposed Wind Farm will ultimately pass through the existing IPC-licensed settlement ponds at the bog outfall locations prior to onward discharge to the surrounding stream and river network. The proposed drainage arrangement therefore provides additional local treatment and attenuation upstream of the existing bog drainage and settlement pond system.

The construction-phase drainage infrastructure will generally form the basis of the operational drainage system, with collector drains and treatment and attenuation features retained and maintained where required. Some local or temporary treatment features may become redundant following completion of construction where they are no longer required for the effective operation of the drainage system.

The proposed drainage system will therefore not introduce an uncontrolled or rapid runoff pathway from the Proposed Wind Farm infrastructure to downstream receiving waters. Rather, runoff from developed areas will be locally collected and attenuated prior to entering the existing bog drainage network, with further attenuation provided by the existing drainage system and IPC-licensed settlement ponds. On this basis, the proposed drainage arrangements will not result in an increase in peak runoff from the Proposed Wind Farm site or an increase in downstream flood risk. This process flow system is illustrated on **Figure G**.

In summary the wind farm drainage system will comprise the following flowpaths:

A. Upstream clean water → interceptor drain → culvert/diversion drain → downstream field drain → downstream main drain → IPC Settlement Pond → discharge to receiving waters.
B. Runoff from Proposed project Infrastructure → downstream collector drain → local silt traps/check dams → local settlement pond → downstream field drain → downstream main drain → IPC Settlement Pond → discharge to receiving waters

5. JUSTIFICATION TEST

Box 5.1 (**Table I** below) of Guidelines (DoEHLG, 2009) outlines the criteria required to complete the "Justification Test".

Table I: 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 in Figure 20 [of Guidelines (DoEHLG, 2009)]:

1. The Proposed Wind Farm is currently in the planning process and has been deemed suitable for development by the Applicant. The applicant is aware of the fluvial and pluvial flood risks associated with the Proposed Wind Farm site and they have included design responses to ensure flood resilience for sensitive elements of the Proposed Wind Farm. The Proposed Onsite Substation is located in Flood Zone C and is located above the predicted fluvial and pluvial flood elevations.

2. The proposal for a 46 no. turbine wind farm and associated infrastructure including hardstands, 2 no. meteorological masts, 10 no. temporary construction compounds, 10 no. temporary security cabins, the provision of new internal site access roads, the upgrade of existing internal site access roads, the provision of dedicated amenity access tracks and amenity carparks (4 no.), 1 no. relay mast, watercourse crossings, biodiversity enhancement, tree felling and vegetation removal, peat and spoil areas, and all associated development and drainage works. These works have been the subject of Stage III SSFRA (this report) and this assessment has determined that:

    i. The Proposed Wind Farm has been assessed to have no significant potential to impact on flood risk upstream or downstream of the Proposed Wind Farm site.

    ii. The Proposed Wind Farm will not impede or accelerate the flow of surface water during extreme flood events. Drainage designs for the Proposed Wind Farm layout follows tried and tested SuDS principles. In addition, modelling has demonstrated that the Proposed Onsite Substation is above the 1,000-yr flood

level (proposed formation level >74.9mOD). There will be no increase in flood risk on lands upstream or downstream of the Proposed Wind Farm site.

The Proposed Wind Farm site will generally remain flood free, but on very rare occasions there is a risk of shallow inundation from pluvial/fluvial flooding. The flooding occurs on the lower peat fields, particularly during times when the pumps along the larger arterial drains are turned off. However, all turbine bases will be constructed a minimum of 500mm above existing ground level and therefore above the modelled extreme pluvial and fluvial flood levels.

Surface water discharges from the Proposed Wind Farm site will be attenuated to ensure reduction in peak hydraulic loading to the existing bog drainage network (field drains and main drains). Surface water will be held on-site, behind access tracks, in shallow wet areas, in low-lying areas, in silt traps, in settlement ponds, and upstream of pumping stations and bog outfalls.

Given the large area of the Proposed Wind Farm site (~5,139ha), the bogs comprising the Proposed Wind Farm site have an enormous capacity to store water following rainfall events, even if storage is only a couple of centimetres in depth, the volume of stored water will be very large.

During the operational phase of the Proposed Wind Farm, water is more likely to be held on-site (in comparison to the preconstruction phase due to the additional attenuation provided by the Proposed Wind Farm drainage system), and this will have a positive impact on downstream flooding events.

Turbine bases, hardstands and other flood-sensitive infrastructure will be constructed above the relevant design flood levels.

The Proposed Onsite Substation will be raised above the 1,000-year flood level as outlined above (i.e. >74.9mOD).

iii. The proposed infrastructure within the flood zones (turbine hardstands, turning heads, site access roads) will displace floodwater and as a result will increase the water depth locally within the bog during higher rainfall events. The total development footprint in these areas is ~3.29ha, and local increases in flood levels within the local bog areas arising from this displacement equates to between 0.02-0.29m for extreme flood events (assuming a worst case 1m flood depth scenario). There is no increase to downstream flood risk, as this water will be retained within the Proposed Wind Farm site. The bogs comprising the Proposed Wind Farm site have capacity to cater for such increases in floodwater levels.

For the remainder of the Proposed Wind Farm site, the SSFRA has shown that there will be no residual risks to the Proposed Wind Farm or local area.

All proposed infrastructure will be constructed above known flood levels, and there will be no potential impediment for access of Emergency Service vehicles; and,

iv. With respect to the above (flood risk management proposals), the Proposed Wind Farm is therefore compatible with the wider planning objectives of the area. It does not alter the flood risk upstream or downstream of the Proposed Wind Farm site.

6. WIND FARM SSFRA CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Wind Farm and the Proposed Onsite Substation. From this study:
    - No instances of historical flooding were identified in historic OS maps within the Proposed Wind Farm site or at the Proposed Onsite Substation. Text on local base maps indicates that the areas along the Figile River are liable to flood in the vicinity of the Proposed Wind Farm site;
    - No instances of recurring flooding were identified on OPW maps within the Proposed Wind Farm site or at the Proposed Onsite Substation;
    - The GSI Historical 2015/2016 flood map shows that some areas of the Proposed Wind Farm Site may be affected by surface water flooding. No GSI 2015/2016 surface water flood zones are mapped at the Proposed Onsite Substation;
    - The Proposed Wind Farm site is not mapped within any historic or predictive groundwater flood zones;
    - CFRAM maps for the local area do not show any fluvial flood zones within the Proposed Wind Farm site; and,
    - The National Indicative Fluvial Flood Maps do record some fluvial flood zones within the Proposed Wind Farm site. No flood zones are mapped at the Proposed Onsite Substation.
- CFRAM mapping shows fluvial flood zones on the Figile River downstream of the Proposed Wind Farm site and along the Slate River immediately to the south of the Proposed Wind Farm site. These flood extents do not encroach upon the Proposed Wind Farm site;
- The National Indicative Fluvial Flood Mapping records the presence of surface water flooding along the Figile River and its tributaries in the area of the Proposed Wind Farm site. Some of these fluvial flood zones encroach upon the Proposed Wind Farm site. Some elements of the Proposed Wind Farm infrastructure are mapped to encroach upon these flood zones. The flooding is likely to be a combination of fluvial and pluvial flooding due to the flat low-lying nature of the Proposed Wind Farm site and the low permeability of the soils and subsoils;
- Site walkover indicates the surface of the cutover bog contains an extensive network of peat drains with surface water outflows from the bogs. This existing drainage network has reduced the risk of pluvial flooding across much of the Site. However, following intense or prolonged rainfall events localised surface water ponding is still likely to occur in places. Fluvial flooding may also occur as the land has been lowered due to the previous peat extraction activities. Therefore, a minimum freeboard of 500 mm above existing ground level will be incorporated into the design of each turbine base, with a minimum freeboard of 300 mm applied to hardstands and internal access roads within the bog.;
- The Proposed Onsite Substation is particularly sensitive to flooding. Conservative volumetric analysis has determined the peak flood levels at the Proposed Onsite Substation site for 100-year and 1,000-year rainfall events to be 73.6 and 73.9mOD respectively. The primary control in the analysis is the expanse of the bog in Lodge Bog which needs to fill with pluvial floodwater before the Proposed Onsite Substation can flood. The Proposed Onsite Substation area drains to the south via main drains, and then to the southeast to the bog outfall to the River Slate. It is therefore recommended to give the Proposed Onsite Substation a formation level of >74.9mOD (73.9mOD + 1m freeboard). At this elevation the risk of flooding at the Proposed Onsite Substation location is negligible;

- It may be considered that the Proposed Wind Farm can be categorised as "Highly Vulnerable Development". Therefore, a Justification Test has been completed and concludes that the Proposed Wind Farm is designed and laid out in a manner that reduces flood risk, and that there is no significant potential for any increase in flood risk upstream or downstream of the Proposed Wind Farm site;
- Volumetric analysis has shown that the emplacement of the proposed infrastructure within the flood zones has no potential for significant effects and will only result in minor increase in floodwater levels within the Proposed Wind Farm site. The cutover bogs comprising the site are flat and extensive and have sufficient capacity to buffer the effect of any displaced floodwater;
- The Proposed Wind Farm drainage design provides attenuation and controls runoff such that there will be no significant increase in downstream flood risk. In the longer term, implementation of BnM's Draft Rehabilitation Plans is expected to provide additional attenuation through increased water retention across the rehabilitated bog areas. The Draft Rehabilitation Plan aims to stabilise and rehabilitate the peat bogs by placing the existing peatland environments on a path towards naturally functioning peatlands. With the implementation of the rehabilitation plans, surface water runoff from the Proposed Wind Farm site will be reduced, thereby decreasing the downstream flood risk; and,
- Furthermore, the Proposed Wind Farm will be constructed with its own drainage system which will provide additional surface water attenuation. The cumulative effect of the Proposed Wind Farm / part of the Proposed Grid Connection and the Draft Rehabilitation Plan is that there will be no significant potential for any increase in flood risk upstream or downstream of the Proposed Wind Farm site. There will be a reduced fluvial flood risk due to the greater surface water attenuation provided at the Proposed Wind Farm site.

* *

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