# APPENDIX 9-1

***Flood Risk Assessment Report***

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**KILLOSHULAN WIND FARM,**
**CO. KILKENNY**

# SITE SPECIFIC FLOOD RISK ASSESSMENT

## FINAL REPORT

Prepared for:

**KILLOSHULAN RENEWABLE ENERGY LIMITED**

Prepared by:

**HYDRO-ENVIRONMENTAL SERVICES**

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# 1. INTRODUCTION

## 1.1 BACKGROUND

Hydro-Environmental Services (HES) was engaged by MKO Ireland, on behalf of Killoshulan Renewable Energy Limited, to complete a Flood Risk Assessment (FRA) for the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) at Killoshulan and adjacent townlands near Freshford, Co. Kilkenny.

This FRA is written to accompany Chapter 9 of the Environmental Impact Assessment Report (EIAR) for the Proposed Project. The Proposed Project (Proposed Wind Farm and Proposed Grid Connection) is described in full in Chapter 4 of the EIAR. For the purposes of this FRA, and consistent with the EIAR, the various components are described and assessed using the following references: 'Proposed Project', 'Proposed Wind Farm', Proposed Grid Connection' and the 'Site'.

This FRA 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 FRA is also completed in accordance with the flood policies and objectives (Section 10.2.6.1 of the County Development Plan) and surface water drainage requirements (Section 10.2.6.3 of the County Development Plan) as detailed in the Kilkenny City and County Development Plan (2021-2027).

## 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. We routinely work on surface water monitoring and modelling and prepare flood risk assessment reports.

This FRA was prepared by Nitesh Dalal, David Broderick and Michael Gill.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management in India and over 2 years environmental consultancy experience in Ireland. 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).

David Broderick (P. Geo., BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 20 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the FRAs for Clonberne Wind Farm, Ballyouskill Wind Farm, and Cooloo Wind Farm, and over 60 other wind farm related projects across the country. David worked on his first wind energy project in 2010, and he has continued to work on similar projects since then.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer/Hydrologist with over 26 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Glenard Wind Farm, Ballydermot Wind Farm, and Seven Hills Wind Farm, and over 100 other wind farm related projects across the country. Michael worked on his first wind energy project in 2003, and he has continued to work on similar projects since then.

## 1.3 REPORT LAYOUT

This FRA report has the following format:

- Section 2 describes the Site setting and details of the Proposed Project;
- Section 3 outlines the hydrological and geological characteristics of the surface water catchment and existing site drainage;
- Section 4 presents a site-specific flood risk assessment (FRA) undertaken for the Proposed Project which was carried out in accordance with the above-mentioned Guidelines (DoEHLG, 2009);
- Section 5 presents the proposed flood impact prevention measures associated with the Proposed Project; and,
- Section 6 presents the FRA report conclusions.

The assessment methodology involves researching and collating flood related information from the following data sources:

- Historical 6" and 25" basemaps (www.geohive.ie);
- Geological Survey of Ireland (GSI) maps on superficial deposits (www.gsi.ie);
- EPA/WFD hydrology maps (www.catchments.ie);
- OPW Past Flood Events, CFRAM and National Indicative Fluvial Mapping (NIFM) (www.floodinfo.ie);
- Kilkenny City and County Development Plan 2021 – 2027; and,
- Site walkover surveys, drainage mapping, site investigations and baseline monitoring as detailed in Section 9.2.2 of the EIAR.

# 2. BACKGROUND INFORMATION

## 2.1 SITE LOCATION AND TOPOGRAPHY

The Proposed Wind Farm site is located approximately 4km west of the village of Freshford and 3.7km northeast of the village of Urlingford, Co. Kilkenny.

The Proposed Wind Farm site, which is 573ha (hectares) in area, comprises predominately agricultural grassland on the southern half, while the northern half is predominately coniferous forestry with some grassland on the northeastern portion. Five Proposed Turbines are located on grassland (T1 to T4 and T9) while five are in forestry (T5 to T8 and T10).

The topography of the Proposed Wind Farm site is hilly with a number of separate high points/peaks ranging in elevations from approximately 300 to 316m OD (metres above Ordnance Datum). The summit ridge of Spa Hill (310m OD) defines the northwestern boundary of the Proposed Wind Farm site. Clomantagh Hill (349m OD) is located to the southwest of the Proposed Wind Farm site.

The surrounding wider landscape is generally flat and low-lying (<150m OD). The Nuenna River valley is located to the southeast of the Proposed Wind Farm site, where the ground elevation along the channel of the river ranges from approximately 100 to 120m OD.

The southern half of the Proposed Wind Farm site slopes steadily in an easterly/southeasterly towards the Nuenna River. The ground elevation at the Proposed Wind Farm site entrance on the R693 Regional Road at the southeast of the Proposed Wind Farm site is at approximately 120m OD. The northern half of the Proposed Wind Farm site slopes in more moderate manner in an easterly/ northeasterly direction from the summit of Spa Hill (310m OD) at the northwestern Site boundary down to an elevation of approximately 220m OD at the Proposed 110kV Substation and Battery Energy Storage System (BESS) location, on the northeast of the Proposed Wind Farm site.

The Proposed 110kV Underground Cabling, which measures approximately 12.6km in length, will connect into the existing Ballyragget 110kV Substation, located approximately 10km to the northeast of the Proposed Wind Farm site ('as the crow flies'). The Proposed 110kV Substation and BESS is located on improved grassland in the northeast of the Proposed Wind Farm site at an elevation of 220m OD.

Approximately 1.5km of the Proposed 110kV Underground Cabling is within the Proposed Wind Farm internal road network, approximately 9.6km is proposed within Local Roads, 770m of the proposed 110kV Underground Cabling route is proposed within National Roads (N77), 653m proposed within private agricultural lands in Moatpark, Co. Kilkenny.

In the townland of Ballyconra, the Proposed 110kV Underground Cabling route will leave the N77 National Road public road and travel east through agricultural land for 60m before passing beneath the River Nore via a Horizontal Directional Drilling (HDD) mechanism.

Turbine Delivery Route (TDR) temporary accommodation areas are required at 4 no. locations along the R693 to the south of the Proposed Wind Farm site.

## 2.2 PROPOSED PROJECT

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

The Proposed Project consists of 10 no. wind turbines and associated infrastructure including hardstands, 2 no. temporary construction compounds, new site access tracks, an on-site Proposed 110kV Substation and BESS compound, 1 no. spoil management area, cabling

between the turbines and the on-site Proposed 110kV Substation, 12.6km of underground cabling between the Proposed 110kV Substation and the existing Ballyraggett 110kV Substation and works along the turbine delivery route.

A Site location map is included as **Figure** A below.

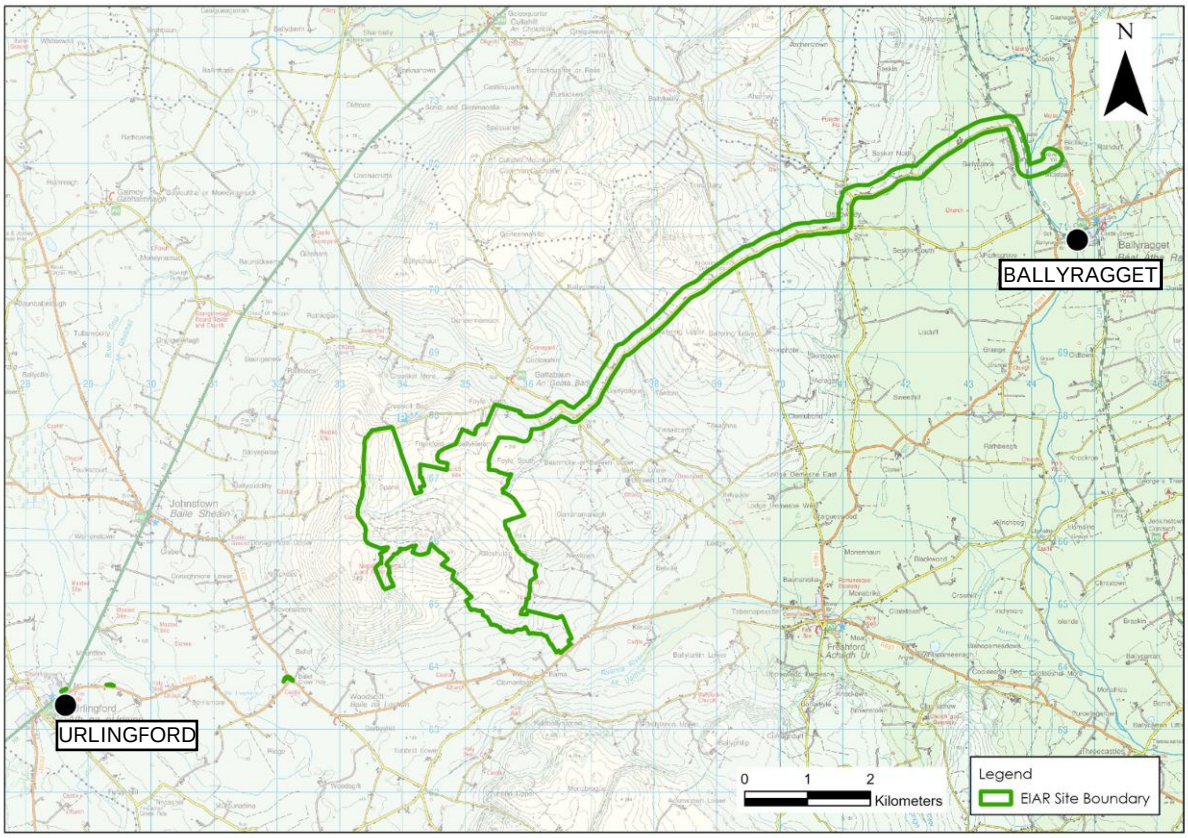



**Figure A: Site Location Map**

# 3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

## 3.1 INTRODUCTION

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

## 3.2 HYDROLOGY

### 3.2.1 Regional and Local Hydrology

The Site is located in the regional River Nore catchment within Hydrometric Area 15 of the South-Eastern River Basin District (SERBD). The River Nore flows in a southerly direction approximately 9km to the east of the Proposed Wind Farm site.

On a more local scale the Proposed Wind Farm site and Proposed Grid Connection are mainly located in the Nore_SC_070 sub-catchment. Within the Nore_SC_070, the Proposed Wind Farm site and approximately 4.8km (of the total 12.6km) of the Proposed 110kV Underground Cabling are located within the Nuenna River catchment (Nuenna_010, Nuenna_020 and Gorteenahilla_010 sub-basins).

The Nuenna River flows in an easterly direction approximately 0.6km to the southeast of the Proposed Wind Farm site prior to merging with River Nore approximately 9km further downstream.

The remainder of Proposed 110kV Underground Cabling (7.8km) is located in the Lisdowney_010, Nore_120, Nore_140 and Nore_150 sub-basins which drain directly into the River Nore downstream of Ballyragget town.

The TDR accommodation areas are located in the Goul_SC_010 within the Goul_030 sub-basin. The existing Ballyragget 110kV Substation is located in the Nore_SC_060 sub catchment within the Nore_020 sub-basin.

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

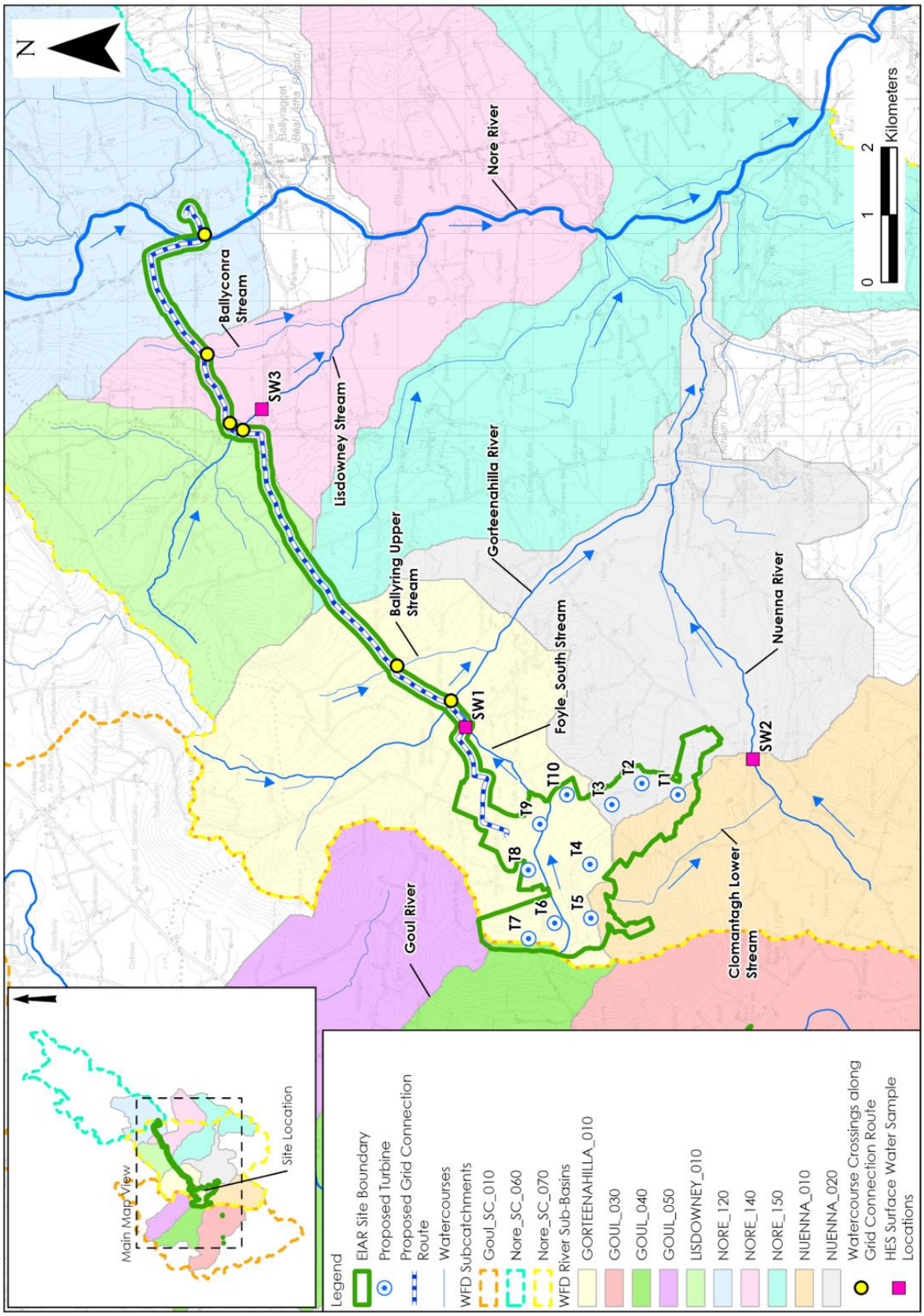



**Figure B: Local Hydrology Map**

### 3.2.2 Existing Site Drainage

The northern half of the Proposed Wind Farm site is drained by the EPA mapped Foyle South Stream (EPA Code: 15F07) which rises south of Spa Hill located on the northwest of the Proposed Wind Farm site. The Foyle South Stream flows easterly off-site and into the Nuenna River approximately 6.5km downstream of the Proposed Wind Farm site. Proposed turbine locations T4 to T10, borrow pit, spoil storage area and Proposed 110kV Substation and BESS are mapped within Foyle South Stream catchment (Gorteenahilla_010 sub-basin). There are 3 no. proposed watercourse crossings on the Foyle South Stream required for Proposed Wind Farm infrastructure.

In addition to the Foyle South Stream, there is also a high-density of manmade drainage on the north of the Proposed Wind Farm site associated with the forestry and agricultural lands which have naturally poorly draining soils and subsoils. The lands on the north of the Proposed Wind Farm site have poor natural drainage due to be underlain by mudstone/siltstone bedrock which has low permeability (i.e. low groundwater recharge rates).

In contrast, the southern portion of the Proposed Wind Farm site has little or no surface water drainage because of high groundwater recharge rates (high rainfall infiltration/acceptance) due to be underlain by limestone of regional aquifer importance.

The EPA mapped Clomantagh Lower Stream emerges from southerly facing forested slopes on the south of the Proposed Wind Farm site. However, shortly after leaving the Proposed Wind Farm site, the Clomantagh Lower Stream shortly drains to ground (i.e. losing stream) when the watercourse flows off the mudstone bedrock and onto the more permeable limestone. Please note there is no Proposed Wind Farm development within the Clomantagh Lower Stream catchment (Nuenna_010 sub-basin).

The valley further downstream of the Clomantagh Lower Stream sink, which runs to the southeast of the Proposed Wind Farm site, is largely dry (due to underground drainage) except after heavy rainfall events. The Clomantagh Lower Stream valley drains south (largely underground) towards the Nuenna River where several GSI mapped karst springs are located. These springs are well documented in a number of GSI/EPA source protection reports for group water schemes in this area. These springs are known to contribute to a high portion of the Nuenna River flows.

There are also several enclosed depressions/dolines and 4 no. swallow holes (i.e. karst features) on the south half of the Proposed Wind Farm site which were previously mapped by the GSI, prior to further field-based mapping by HES and FT.

However, due to the elevated topography and sloping nature of the Proposed Wind Farm site, the swallow holes only act as a very localised drainage function (i.e. they do not act as sinks for streams/watercourses, just very localised runoff). All surface mapped karst features at Proposed Wind Farm site (swallow holes and enclosed depressions) have been avoided by the proposed infrastructure.

All Proposed Turbines on the south of the Proposed Wind Farm site (i.e. T1 to T4) are at least 30m from a surface mapped karst feature (enclosed depression or sink hole). GSI apply a 30m buffer for groundwater vulnerability rating mapping and for land spreading exclusion zones.

Along the Proposed 110kV Underground Cabling route there are 6 no. EPA mapped watercourse crossings, with 5 no. being existing bridges/culverts along public roads and the 6th a proposed HDD crossing of the River Nore near Ballyragget.

### 3.2.3 Rainfall and Evaporation

Long term rainfall and evaporation data were sourced from Met Éireann (www.met.ie). The 30-year annual average rainfall (1980 - 2010) recorded at Johnstown Garda Station rainfall station, located ~3.3km west of the Proposed Wind Farm Site, is 868mm/year.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Proposed Wind Farm site ranges from 960 to 1,007mm/year (this is considered to be the most accurate estimate of average annual rainfall from the available sources). The maximum average of 1,007mm/year of is used in the below water balance assessments.

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Kilkenny, ~16km southeast of the Proposed Wind Farm site. The long-term average PE for this station is 459mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Site is estimated as 436mm/year (which is 0.95 × PE).

The effective rainfall (ER)[2] represents the water available for runoff and groundwater recharge. The ER for the Proposed Wind Farm site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,007mm/year – 436mm/year

ER = 571mm/year

The GSI groundwater recharge coefficient estimate (www.gsi.ie) for the Proposed Wind Farm Site range from 22% to 85%. The estimated recharge range largely reflects the variation in the bedrock geology, with the northern half of Proposed Wind Farm site mapped as Namurian shales (22% recharge) and the southern half pure bedded limestones (85% recharge).

Met Éireann's Translate Project (https://www.met.ie/science/translate) provides projections for a range of future climate change scenarios, as Ireland's future climate will depend on global greenhouse gas emissions reductions. The severity of any future climate change will depend on the degree of future warming. In a 1.5°C world, average winter and summer precipitation rates are projected to be 3.54mm/day and 2.15mm/day respectively in Co. Kilkenny. Meanwhile, in a 4°C world, the average winter and summer precipitation rates in Co. Kilkenny are projected to be 3.90mm/day and 1.93mm/day respectively.

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

[1] *Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.*
[2] *ER – Effective Rainfall is the excess rainfall after evaporation which produces overland flow and recharge to groundwater.*

**Table A. Proposed Wind Farm site – Return Period Rainfall Depths (mm)**

| | Return Period (Years) | | | |
|---|---|---|---|---|
| **Duration** | **1** | **5** | **30** | **100** |
| **5 mins** | 4.2 | 7 | 11.8 | 16.4 |
| **15 mins** | 6.3 | 10.2 | 16.8 | 22.8 |
| **30 mins** | 8.2 | 13 | 21 | 28.1 |
| **1 hours** | 10.7 | 16.6 | 26.1 | 34.6 |
| **6 hours** | 21.2 | 31.1 | 46.3 | 59.3 |
| **12 hours** | 27.5 | 39.7 | 57.8 | 73 |
| **24 hours** | 35.8 | 50.6 | 72.2 | 89.9 |
| **2 days** | 44.4 | 60.6 | 83.4 | 101.6 |

## 3.3 GEOLOGY

Based on the GSI/Teagasc soils mapping (www.gsi.ie), the southern portion of the Proposed Wind Farm site is overlain by shallow well drained mineral soil (BminSW), while the northeastern portion is mapped as poorly drained mineral soil (AminPD) and the northwestern portion mapped as shallow well drained mineral (AminSW).

The GSI subsoils mapping (www.gsi.ie) shows subsoils are thin or absent on the southern portion of the Proposed Wind Farm site, where karstified bedrock subcrop or outcrop is mainly mapped. The northeastern portion of the Proposed Wind Farm site is mapped mainly as Till derived from Namurian sandstones and shales (glacial tills), with bedrock subcrop or outcrop [non karstified] mapped on the northwest of the Proposed Wind Farm site at Spa Hill.

With regard the Proposed Grid Connection, the Proposed 110kV Substation and BESS at the Proposed Wind Farm site is located in an area mapped as Namurian glacial tills (shales and sandstones) with some localised alluvium. The Proposed 110kV Underground Cabling route between the Proposed 110kV Substation and the existing Ballyragget 110kV Substation, has variable subsoils mapped which comprise mainly Namurian tills with limestone tills and limestone gravels (fluvial deposits) within the Nore River valley near Ballyragget.

TDR accommodation areas along the R693 to the south of the Proposed Wind Farm site are mapped on limestone tills.

Site investigations (geophysical surveys, trial pits and boreholes) have verified the nature of soils, subsoils and bedrock at the Proposed Wind Farm site. Details of these site investigations are provided in Section 8.3.3 of the EIAR.

According to the GSI bedrock mapping, the southern half of the Proposed Wind Farm site is underlain by Dinantian Pure Bedded Limestones, while the northern half is mapped as Namurian Shales. The Dinantian Pure Bedded Limestones within the Proposed Wind Farm site are mapped as the Ballyadams Formation and the Clogrenan Formation. The Ballyadams Formation, which is mapped on the far south of the Proposed Wind Farm site, comprises Crinoidal wackestone/packstone limestone. The Clogrenan Formation is mapped to the north of the Ballyadams Formation and comprises cherty, muddy, calcarenitic limestone. The Namurian Shale bedrock within the Proposed Wind Farm site is mapped as the Killeshin Siltstone Formation which is described as muddy siltstone and silty mudstone.

The bedrock underlying the Proposed 110kV Underground Cabling route is mapped as the Killeshin Siltstone Formation at the Proposed Wind Farm site, with the Bregaun Flagstone Formation (sandstone/siltstone) mapped along the central section and the Ballyadams Formation at the eastern end of the proposed route near Ballyragget.

Site investigations (geophysical surveys, trial pits and boreholes) have verified the depth to bedrock and the nature of the bedrock at the Proposed Wind Farm site. Details of these site investigations are provided in Section 8.3.4 of the EIAR.

## 3.4 HYDROGEOLOGY

The northern portion of the Proposed Wind Farm site (including Proposed Turbine locations T5 - T10, borrow pit, Proposed 110kV Substation and BESS) is located in the poorly productive Lisdowney Groundwater Body (GWB) which comprises Namurian Shales bedrock. Within the Lisdowney GWB, the Namurian Shales are classified by the GSI as a Poor Aquifer (Pl -bedrock which is generally unproductive except for local zones).

The southern portion of the Proposed Wind Farm site (including Proposed Turbine locations T1 – T4) is located in the karstic Durrow Groundwater Body (GWB) which comprises Dinantian Pure Bedded Limestones. Within the Durrow GWB, the Dinantian Pure Bedded Limestones are classified by the GSI as a Regionally Important Karstified Aquifer (diffuse flow).

Further details on regional and local hydrogeology are presented in Sections 9.3.8 and 9.3.9 of the EIAR.

## 3.5 DESIGNATED SITES & HABITATS

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

Ramsar sites are wetlands of international importance designated under the Ramsar Convention (adopted in 1971 and came into force in 1975), providing a framework for the conservation and wise use of wetlands and their resources.

Spahill and Clomantagh Hill SAC (Site Code:000849) is located immediately to the northwest and southwest of the Proposed Wind Farm site. Proposed Wind Farm infrastructure is setback more than 0.3km from this designated site, with the closest turbine being T5 on the southwest of the Proposed Wind Farm site.

On the northwest of the Proposed Wind Farm site, the closest turbine (T7) is setback 0.55km from the SAC. Spahill and Clomantagh Hill SAC has no water dependant habitants. Nonetheless there is no hydrological or hydrogeological connectivity between the Proposed Wind Farm site and this SAC. To the southwest of the Proposed Wind Farm site, the SAC occupies the summit of Clomantagh Hill which is higher in elevation than any of the adjacent Proposed Wind Farm site infrastructure.

The Proposed Wind Farm site and the SAC are also separated by the Clomantagh Lower Stream catchment to the southwest. To the northwest of the Proposed Wind Farm site, the SAC occupies an area of Spa Hill that is located within a separate surface water catchment (i.e. River Goul) to that of the Proposed Wind Farm infrastructure. There is no potential for surface water or groundwater flows towards the SAC to the northwest of the Proposed Wind Farm site. Also, please note the northwestern and southwestern portion of the Proposed Wind Farm site is underlain by mudstone and therefore there is no risk of karstification.

Cullahill Mountain SAC, which is also not a water dependent habitat, is located 2.7km to the northwest of the Proposed Wind Farm site. The Proposed Wind Farm site and Cullahill Mountain SAC are separated by a tributary of the River Goul which runs in a valley to the northwest of the Proposed Wind Farm site.

The Loughans SAC (Site Code:000407), which is a turlough (karst) and a groundwater dependent terrestrial ecosystem (GWDTE), is located approximately 2.7km to the southwest of

the Proposed Wind Farm site. However, for the reasons presented in Section 9.3.14 of the EIAR (groundwater flow directions and topography), there is no hydrological or hydrogeological connectivity between the Proposed Wind Farm site and The Loughans SAC.

The River Barrow and River Nore SAC (Site Code:0002162) is located approximately 9km to the east and downstream of the Proposed Wind Farm site via the Nuenna River.

The Proposed 110kV Underground Cabling crosses under the River Nore near Ballyragget where horizontal directional drilling (HDD) will be employed to place the cable below the river channel to avoid any physical contact with the river, or the River Barrow and River Nore SAC.

# 4. SITE-SPECIFIC FLOOD RISK ASSESSMENT

## 4.1 INTRODUCTION

The following flood risk 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 development. 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 development; and,
- *Detailed flood risk assessment – quantitative appraisal of potential risk to a proposed development*.

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.

Due to its inland location, coastal flooding is not applicable to the Site.

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

- Overland flow occurs when the amount of rainfall exceeds the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural hollows

and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall and eventually enters a piped or natural drainage system.

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

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

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

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

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

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

There are three types or levels of flood zones defined within the Guidelines (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 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 those areas as being potentially at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) were consulted.

There was no identifiable map text on local available historical 6" or 25" mapping for the Proposed Wind Farm site that would identify lands that are "liable to flood" within the EIAR site boundary or immediately downstream.

Meanwhile, the local 6" Casini basemap records an area which is "liable to flood" on the eastern banks of the River Nore. In this area the Proposed 110kV Underground Cabling route is proposed to cross the River Nore via directional drilling. There are no other areas identified as "liable to flooding" along the Proposed Grid Connection site.

### 4.3.2 Soils Maps - Fluvial Maps

A review of the soil types in the vicinity of the Site was undertaken as soils can be a good indicator of past flooding in an area. Due to past flooding of rivers, deposits of transported silts/clays referred to as alluvium build up within the flood plain and hence the presence of these soils is a good indicator of potentially flood prone areas.

Based on the EPA/GSI soil map for the area, alluvium soils is mapped in the northeastern part of the Proposed Wind Farm site. The southern section of the Proposed 110kV Substation and BESS compound and the temporary construction compound are mapped on these alluvial soils. These alluvial soils are not associated with any EPA mapped watercourse and no stream or river was recorded in this area during the site walkover surveys. Due to the elevated and drained nature of the Proposed Wind Farm site at the Proposed 110kV Substation location there is low risk of significant surface water flooding/ponding.

With regards to the Proposed Grid Connection, alluvium soil is mapped at 4 no. locations along the Proposed 110kV Underground Cabling route. Alluvial soils are mapped at existing

crossings over the Gorteenahilla, Ballyring Upper, Lisdowney and Ballyconra streams. The proposed HDD crossing location at the River Nore is also mapped in an area of alluvial soils.

No alluvial soils are mapped in the vicinity of the TDR accommodation areas.

### 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 Site is not mapped in an ADS.

### 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 Site is not mapped in a Drainage District.

### 4.3.5 OPW Past Flood Event Mapping

To identify those areas as being potentially at risk of recurring flooding, OPW's Past Flood Event mapping (www.floodinfo.ie) were consulted.

No recurring or past flood incidents within the Site were identified from OPW's Past Flood Event Mapping.

The closest past flood event to the Proposed Wind Farm site is at The Loughans Turlough (Flood ID 742), located 2.7km to the southwest of the Proposed Wind Farm site. The flooding is reported as recurring and the source is the groundwater (i.e. turlough).

There are 3 no. past flood events mapped near Freshford, located 3.5km to the east of the Proposed Wind Farm site. Single flood events were recorded on 27/12/2015 (Flood ID: 13446) and 16/03/2018 (Flood ID: 13620), with the reported source being the river. A recurring flood event (Flood ID: 2814) is also recorded at Freshford with the source also being fluvial (i.e. river).

The closest recurring flood event to the Proposed Grid Connection is located along the River Nore at Ballyragget. This recurring flood event (Flood ID: 2813) is located ~1km downstream of the proposed HDD crossing under the River Nore.

Past flood events mapped in the vicinity of the Site are shown on **Figure** C below.

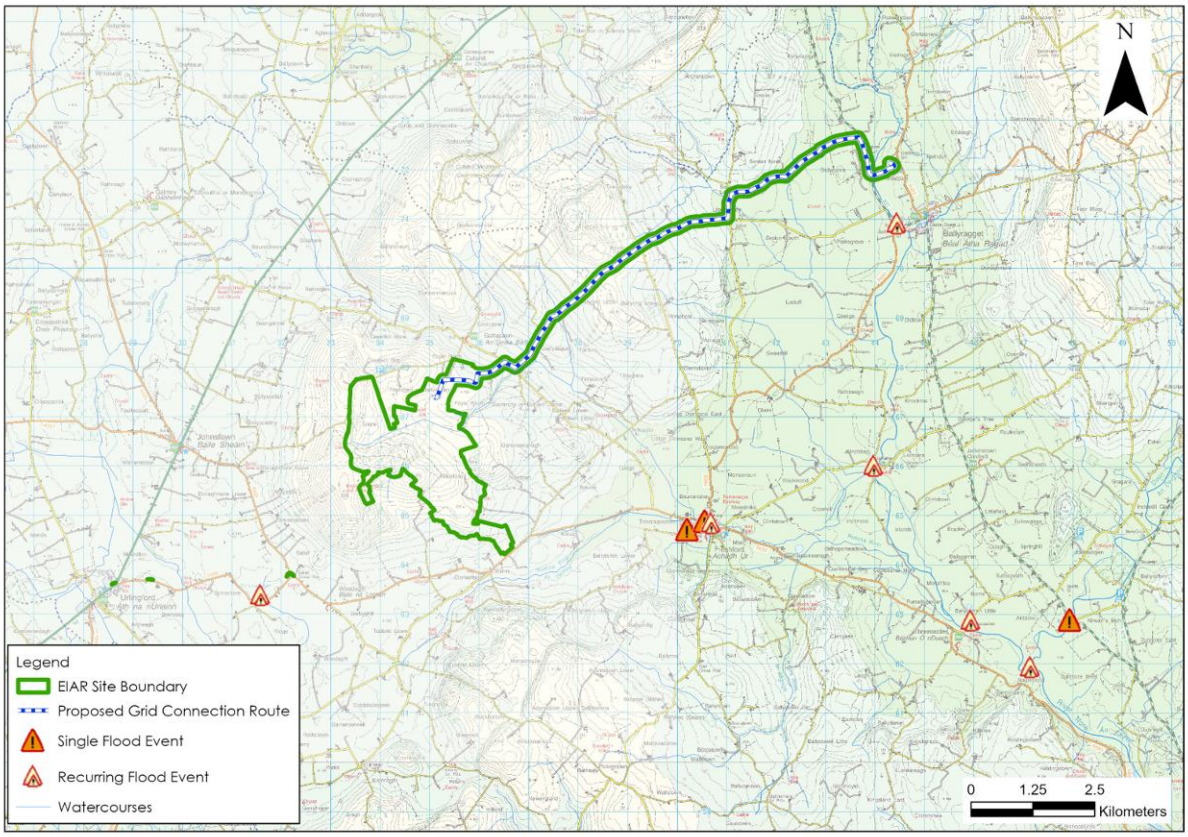



**Figure C: OPW Past Flood Event Map**

### 4.3.6 GSI Winter (2015/2016) Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding Map[3] 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.

No Winter (2015/2016) Surface Water Flood zones are mapped within the Proposed Wind Farm site. The closest Winter 2015/2016 Surface Water Flooding to the Proposed Wind Farm site is mapped at Freshford, 3.5km to the east of the Site.

GSI Winter (2015/2016) Surface Water Flood zones are mapped close to the proposed HDD crossing of the River Nore.

GSI Winter (2015/2016) Surface Water Flood zones are shown in **Figure** D.

[3] GSI *Historical flood mapping principally developed using Sentinel-1 Satellite Imagery from the European Space Agency Copernicus Programme as well as any available historic records (from winter 2015/2016 or otherwise)*

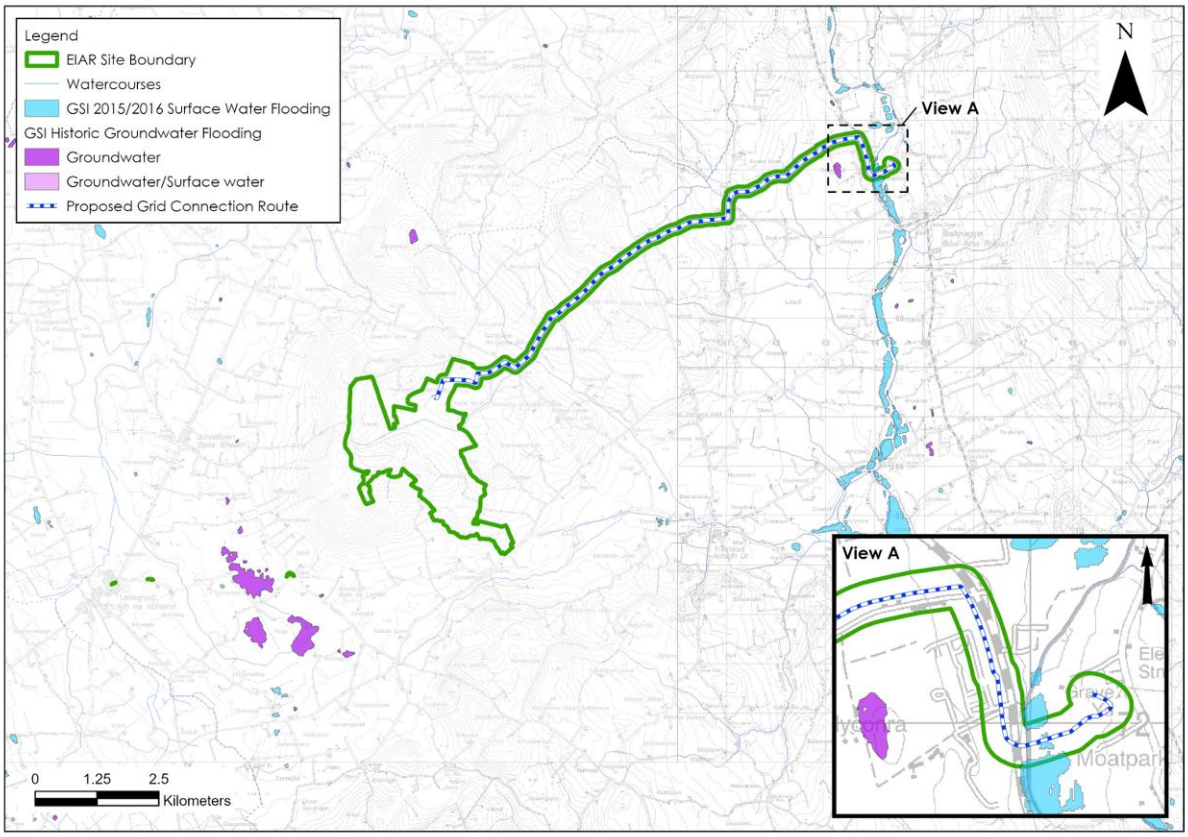



**Figure D: GSI Winter 2015-2016 Surface Water Flood and Historic Groundwater Flood Mapping**

### 4.3.7 CFRAM River Flood Extents Mapping

Catchment Flood Risk Assessment and Management (CFRAM)[4] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA[5] maps. CFRAM mapping of river flood extents are available at www.floodinfo.ie.

CFRAM mapping has not been completed for the area of the Proposed Wind Farm site. The nearest downstream CFRAM fluvial flood zones are mapped along the Nuenna River downstream of Freshford, 3.5km to the southeast of the Proposed Wind Farm site.

CFRAM flood zones are mapped along the River Nore at the Proposed 110kV Underground Cabling route HDD crossing location. No CFRAM flood zones are mapped in the vicinity of the TDR accommodation areas.

CFRAM Flood Mapping for the present-day scenario is included as **Figure E** below.

### 4.3.8 National Indicative Fluvial Mapping

National Indicative Fluvial Mapping (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments only greater than 5km$^2$ for which flood maps were not produced under the CFRAM Programme.

*[4] CFRAM is Catchment Flood Risk Assessment and Management. The national CFRAM programme commenced in Ireland in 2011 and is managed by the OPW. The CFRAM Programme is central to the medium to long-term strategy for the reduction and management of flood risk in Ireland.*
*[5] Preliminary Flood Risk Assessment mapping.*

The Present-Day Scenario has been generated using modelling 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, no medium (1 in 100) or low probability (1 in 1,000) fluvial flood zones have been mapped to encroach upon the Proposed Wind Farm site. The closest NIFM flood zone mapped along the Nuenna River, ~0.4km south of the Proposed Wind Farm site.

Some NIFM fluvial flood zones are mapped along the Proposed Grid Connection site at the watercourse crossing locations and along public roads. These flood zones are associated with the Gorteenahilla and Lisdowney streams.

No NIFM flood zones are mapped to overlap with the TDR accommodation areas.

NIFM fluvial flood zones for the present-day scenario are shown in **Figure E** below.

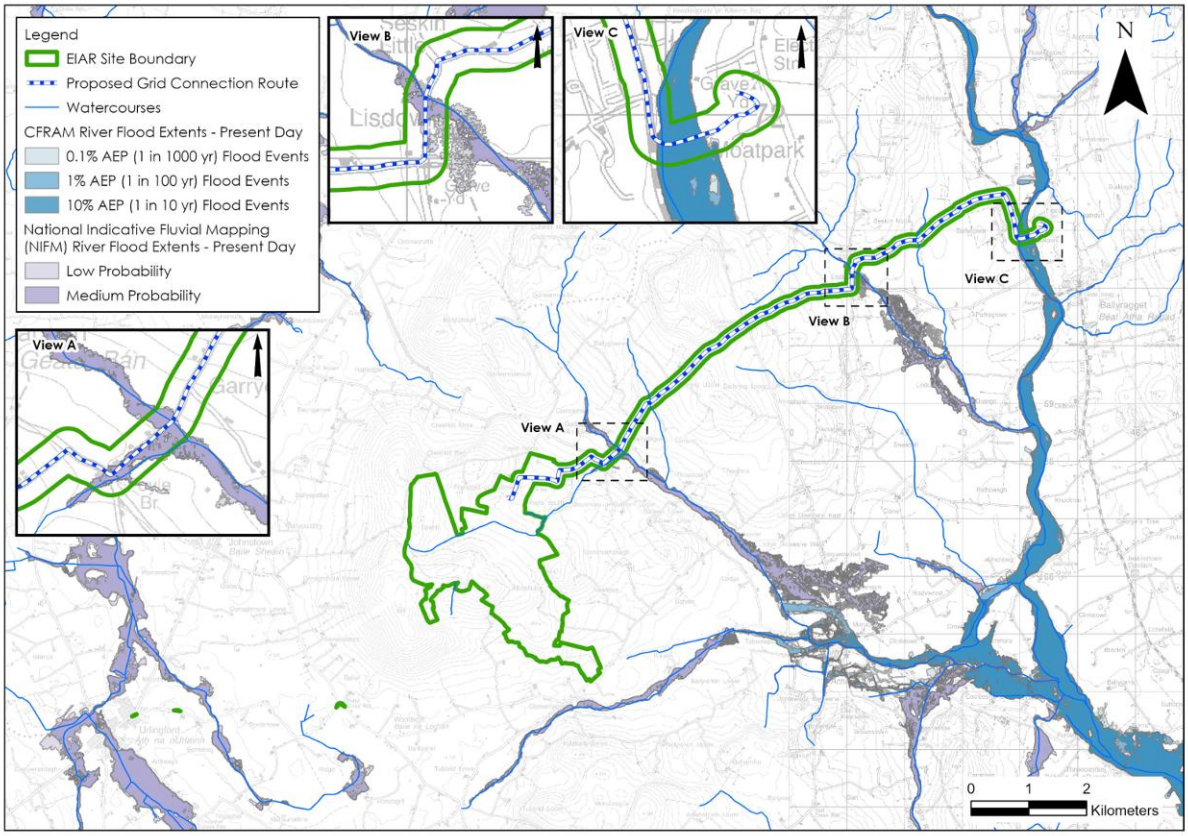



**Figure E: CFRAM and NIFM Flood Zones**

### 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 Site.

The nearest Maximum Historic Groundwater Flood to the Proposed Wind Farm site is mapped at The Loughans Turlough, 2.7km to the southwest of the Site. This flood zone is also located ~80m north of a TDR accommodation area.

GSI Historical Groundwater flood zones are shown in **Figure** D above.

### 4.3.10 Coastal Flooding

The Site is located in an inland setting, ~71km from the coast. Therefore, the Proposed Project is not at risk of coastal (tidal) flooding.

### 4.3.11 Climate Change

Fluvial flood modelling has also been completed to consider future climate scenarios where the potential effects of climate change can increase rainfall.

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood extends based on a 30% increase in rainfall. Both of these modelled flood extents show similar flood zones to the Present-Day Scenario discussed above in **Section 4.3.8.** Therefore, flood zones at the Site are unlikely to be significantly impacted by future climate change.

The CFRAM flood mapping has also been completed for the Mid-Range and High-End Future Scenarios (20%/30% increase). Both of these modelled flood extents show similar flood zones to the Present Day Scenario discussed above in **Section 4.3.7**.

Therefore, flood zones at the 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, the Proposed Wind Farm site is not constrained by coastal, fluvial or groundwater flooding. The Proposed Wind Farm site, including all Proposed Turbine locations, is located in Fluvial Flood Zone C and is at low risk of fluvial flooding.

Most of the Proposed Grid Connection site is located in Flood Zone C along with the Proposed 110kV Substation and BESS.

However, some sections of the Proposed 110kV Underground Cabling route, in the vicinity of local watercourse crossings are mapped in CFRAM and NIFM fluvial flood zones. Due to the nature of the Proposed 110kV Underground Cabling, this will have no effect during the operational phase of the Proposed Project.

During the construction phase of the Proposed 110kV Underground Cabling, work may have to be postponed following heavy rainfall events which may cause flooding at these locations. Refer to Section 5.4 below for flood forecasting measures.

## 4.4 DETAILED FLOOD RISK ASSESSMENT

### 4.4.1 Site Surveys

Hydrological walkover surveys and observations on the site drainage patterns were undertaken by David Broderick of HES on 3rd August 2022, 17th January 2023 and 20th and 21st January, 4th June, 23rd September and 2nd October 2026.

No evidence of flooding or potential flood risk was recorded during these site visits.

The Proposed Wind Farm site is located on elevated sloping land with low potential for ponding, therefore pluvial flooding is unlikely to pose a significant flood risk.

### 4.4.2 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Site can be described using the Source – Pathway – Receptor Model (S-P-R).

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

**Table B: S-P-R Assessment of Flood Sources for the Site**

| Source | Pathway | Receptor | Comment |
|---|---|---|---|
| Fluvial | Overbank flooding of the rivers and streams that are in the vicinity of the Proposed Project. | Land & infrastructure | The Proposed Wind Farm site and most of the Proposed Grid Connection route including the Proposed 110kV Substation and BESS is located in Fluvial Flood Zone C where there is a low risk of fluvial flooding.<br><br>NIFM fluvial flood zones are mapped at existing watercourse crossings over the Gorteenahilla and Lisdowney streams along the Proposed 110kV Underground Cabling route. Flood zones are also mapped at the proposed HDD crossing under the River Nore. |
| Pluvial | Ponding of rainwater on site | Land & infrastructure | Within the Proposed Wind Farm site there is low risk of pluvial flooding. Due to the sloping nature of the land drainage moves relatively freely and connects to drainage features in the north of the Proposed Wind Farm site.<br><br>Meanwhile, most rainwater will recharge to ground on the south of the Proposed Wind Farm site and flow in the underlying bedrock aquifer. |
| Surface water | Surface ponding/ Overflow | Land & infrastructure | Same as above (pluvial). |
| Groundwater | Rising groundwater levels | Land & infrastructure | Based on local hydrogeological regime and GSI mapping, there is no apparent risk of groundwater flooding at the Site. Groundwater levels measured in the limestone bedrock are >10mbgl.<br><br>Also, the mudstone bedrock on the north of the Proposed Wind Farm site is poorly productive with low risk of groundwater flooding. |
| Coastal/tidal | Overbank flooding | Land, People, property | No coastal flooding will be possible at the Site due to distance to coast (~71km) and ground elevation above sea level. |

### 4.4.3 Requirement for a Justification Test

The matrix of vulnerability versus flood zone is shown in **Table C** to illustrate appropriate development types or indicate when a Justification Test[6] is required. The detailed flood risk assessment has determined that the Proposed Wind Farm site is within Flood Zone C along with most of the Proposed Grid Connection underground cabling. Sections of the Proposed Grid Connection underground cabling at larger watercourse crossings (i.e. River Nore, Gorteenahilla Stream and Lisdowney stream) are within CFRAM or NIFM mapped flood zones.

It may be considered that certain components of the Proposed Project can be categorised as a "Highly Vulnerable Development" as they are electricity generating infrastructure (refer to Table 3.1 in the Guidelines (DoEHLG, 2009)). The Proposed Wind Farm infrastructure, Proposed 110kV Substation and BESS can be considered "Highly Vulnerable Development".

All "Highly Vulnerable Development" infrastructure is located in Flood Zone C (low risk of flooding) and can therefore be considered as appropriate from a flood risk perspective.

In terms of the Proposed 110kV Underground Cabling route, this can be considered to be "Water Compatible Development". It is considered 'water compatible' due to the underground nature of the cable (and jointing) which will be sealed, insulated and watertight. The underground cable or joint bays will have no interaction with potential fluvial flooding when operational.

Further discussion on the works proposed within these CFRAM and NIFM fluvial flood zones along the Proposed 110kV Underground Cabling route is presented in Section 5.3 below.

**Table C: Matrix of Vulnerability versus Flood Zone**

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

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

[6] *A 'Justification Test' is an assessment process designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk, (DoEHLG, 2009).*

# 5. FLOOD IMPACT PREVENTION AND DRAINAGE MANAGEMENT

## 5.1 PROPOSED DRAINAGE

The site drainage system was designed integrally with the Proposed Project design layout as a measure to ensure that the proposal will not change the existing flow regime across the Site, will not deteriorate water quality and will safeguard existing water quality status of the catchments and groundwater from wind farm related sediment runoff.

A fundamental principle in the drainage design is that clean water flowing in the upstream catchment, including overland flow and flow in existing streams and drains, is allowed to bypass the works areas without being contaminated by silt from the works. The dirty water from the works areas is collected in a separate drainage system and treated by removing the suspended solids before discharge. This minimises the volume of dirty water requiring treatment.

Existing drains crossing the works area will be piped to isolate them from the works. New drains will be constructed to collect overland flow that is intercepted by the works areas or by new access roads. These will be constructed on the uphill side of the works and piped to the downhill side, bypassing the works areas. However, this will cause the normally dispersed flow to be concentrated at specific discharge points downstream of the works. In order to disperse this flow each clean water drain will be terminated in a discharge channel running parallel to the ground contours that will function as a weir to disperse the flow over a wider area of vegetation. This will prevent erosion of the ground surface and will attenuate the flow rate to the downstream receiving waters.

The resultant diversion of clean water runoff will ensure that the treatment system will only need to deal with construction related runoff. The treatment system consists of a series of settlement ponds that are located at each works site and at intervals along the access roads. The outflow from the settlement ponds will be allowed to disperse across vegetation and will become diluted through contact with the clean water runoff in the buffer areas before entering the downstream watercourses.

Also, due to the presence of enclosed depressions and swallow hole karst features at the Proposed Wind Farm site, all surface water drainage outfalls at level spreaders will be outside the 30m karst feature buffer zones of swallow holes and enclosed depressions. As stated previously, none of the enclosed depressions or swallow holes at the Proposed Wind Farm site show any hydrological/drainage function due to elevation and topography.

## 5.2 PROPOSED ON-SITE RUNOFF ATTENUATION

The creation of impermeable areas within a site has the effect of increasing rates of runoff into the downstream drainage system and this may increase flood risk and flood severity downstream. This applies particularly to urban areas that drain to closed pipe systems which do not have the capacity to cater for increased hydraulic loads. The Proposed Project is located within a large rural catchment with an open drainage system. The footprint of the impermeable areas and the associated increase in runoff rate is very small in the context of the catchment size and therefore represents a negligible increase in downstream flood risk (refer to Section 9.5.3.1 of the EIAR Chapter 9 for runoff assessment). Notwithstanding the potential very low increase in runoff volumes (calculated to be 3.4%) due to the Proposed Project, the drainage system has been designed to prevent any increase in discharge rates above that which already exist in the undeveloped site.

The volume of water requiring attenuation relates to direct precipitation on the roads and hard-standing footprint only. The aim of the storm water attenuation measures is to limit the

flow rate from the developed area to that which prevails on the undeveloped site. This is achieved by limiting the flow rate to the downstream receiving waters and temporarily storing the excess water that accumulates as a result. The developed surfaces have some permeability and this reduces the attenuation requirement. Conventional attenuation systems use proprietary flow control units but these can become blocked with debris and vegetation and require regular maintenance. They are therefore not appropriate for use within a forestry environment or where routine maintenance would not be practical.

It is proposed to provide the temporary storage within the drainage channels by creating stone dams within them at regular intervals. The spacing of the dams is typically 100m but depends on the channel slope, with steeper channels requiring shorter intervals. The dams, which are constructed with small sized aggregate, also reduce the flow rate through the drainage system and are an effective means of providing flow control. Silt fence also provide storage and flow control.

All runoff from the developed areas will be routed through settlement ponds downstream. The outflow from the settlement ponds will be released in a controlled and diffuse manner.

Therefore, the Proposed Project will not increase the magnitude of the hydrograph peak These control measures operate passively and will be subject to routine inspection, sediment removal and repair to maintain their effectiveness.

## 5.3 FLOOD ZONES ALONG THE PROPOSED GRID CONNECTION

NIFM fluvial flood zones are mapped along the Proposed 110kV Underground Cabling route, associated with the Gorteenahilla and Lisdowney streams. At these locations, the Proposed 110kV Underground Cabling will cross the watercourses at existing road crossings. No in-stream works are proposed, and construction activities will be confined to the carriageway of the existing public road network.

The works will be temporary and localised, and subject to appropriate construction management and reinstatement. The works will not alter the conveyance of the watercourses or increase flood risk upstream or downstream.

CFRAM fluvial flood zones are mapped along the Proposed 110kV Underground Cabling route at the proposed crossing of the River Nore. This crossing will be undertaken using horizontal directional drilling (HDD), avoiding the need for in-stream works. Construction activities will be suspended where flooding or forecast flood conditions present a flood risk. The proposed HDD crossing will not result in an increase in the upstream or downstream flood risk.

## 5.4 FLOOD FORECASTING

Despite the high-risk flood zone mapping along the Proposed 110kV Underground Cabling route at the proposed underground crossing of the River Nore, the likelihood of an extreme flood event (i.e. >10-year return period) happening during the construction phase is very low. Also, the underground nature of the works, means that there will be no permanent or fixed project infrastructure at ground level that would be at risk of flooding itself or increasing flood risk downstream.

However, there is a flood risk to temporary works such as excavations, temporary stockpiles and also to people and plant.

The first point of mitigation is ongoing monitoring of weather forecasts and weather warnings. The project Environmental Manager (EM) or the site Ecological Clerk of Works (ECoW) will be responsible for monitoring weather forecasts during the construction phase.

When the forecast indicates rainfall exceeding any of the works-suspension thresholds set out above, or where a Met Éireann Status Yellow or higher rainfall warning is issued, the planned responses detailed below will be implemented.

A potential high intensity rainfall event would likely be identified 3-5 days in advance, with more accurate forecasts of severity within 24-48 hours of occurrence. Preparations for a flood event would begin from the initial indications that there may be a high rainfall event. This would allow time for the preparation and the implementation of additional emergency mitigation measures.

A managed retreat from the fluvial flood zone will be implemented in the event of a forecasted high intensity rainfall event and/or weather warning related to rainfall. This will include the following:

- Any areas where soil/subsoil is exposed at the surface will be compacted firmly with a digger bucket of a suitably sized excavator.
- Open trenches will be backfilled and compacted.
- Existing sediment control measures will be removed, as these may be washed away and deposited elsewhere by the floodwaters.
- All plant, machinery and equipment will be removed from the flood zones.
- Works will be postponed in the event of flood or high flows in the river.

Exposed spoil (exposed temporary stockpiles) will be covered with plastic sheeting during all relatively heavy rainfall events and during periods where works have temporarily ceased before completion at a particular area (e.g., overnight and weekends).

Cessation of all construction works until the storm event, including the storm runoff has passed. All construction works will cease during storm events such as yellow warning rainfall events. Following heavy rainfall events, and before construction works recommence, the project site will be inspected and corrective measures implemented to ensure safe working conditions e.g. dewatering of standing water in open excavations, etc.

# 6. CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Project. From this study:
    - No instances of historical flooding were identified in historic OS maps within the Proposed Wind Farm site. The proposed HDD crossing under the River Nore along the Proposed 110kV Underground Cabling is mapped as 'Liable to Flood';
    - No instances of recurring flooding were identified on OPW maps within the Site;
    - The GSI Winter 2015/2016 Surface Water Flooding and Groundwater flood Mapping provides no evidence of historical flooding at the Proposed Wind Farm site;
    - Some historic surface water flood zones are mapped along the Proposed Grid Connection underground cabling route along the River Nore;
    - No CFRAM or NIFM fluvial flood zones are mapped within the Proposed Wind Farm site;
    - The majority of the Proposed Grid Connection site is mapped in Fluvial Flood Zone C. However, some CFRAM and NIFM fluvial flood zones are mapped at existing crossings over the Gorteenahilla and Lisdowney streams and at the proposed HDD crossing under the River Nore; and,
    - The Proposed 110kV Substation and BESS is located in Flood Zone C at the Proposed Wind Farm site.
- During the walkover and drainage surveys at the Proposed Wind Farm site there was no evidence of out of bank flow from within the various stream/river channels. No widespread or even localized flooding was observed during these site visits;
- The risk of surface water ponding at the Proposed Wind Farm site is very low due to the elevated and sloping nature of the site;
- The Proposed Wind Farm infrastructure can be categorised as "Highly Vulnerable Development" with all proposed infrastructure located outside of areas mapped as Flood Zones and therefore the Proposed Wind Farm is appropriate from a flood risk perspective.
- The Proposed Grid Connection site can be categorised as "Water Compatible" and is appropriate from a flood risk perspective. Where the Proposed 110kV Underground Cabling is located within CFRAM and NIFM fluvial flood zones, there will be no instream works and the works will be completed within the carriageway of the existing public roads or via HDD at the River Nore;
- In addition, the risk of the Proposed Project contributing to downstream flooding is also very low, as the long-term plan for the Site is to retain and slow down drainage water rates prior to release. Robust drainage measures on the Site will include swales, silt traps, check dams, settlement ponds and buffered outfalls. Please refer to the Chapter 9 of the EIAR for further details.

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