Prepared for;

Jennings O'Donovan

Gortyrahilly Windfarm (GWF)

Site Specific Flood Risk Assessment (SFRA)

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CONSULTING ENGINEERS

Project no. 603679 (03) GWF

ISO 9001 ISO 14001 OHSAS 18001 DNV REGISTERED
INVESTORS IN PEOPLE

RSK

AUGUST 2022

RSK GENERAL NOTES

Project No.: 603679 (03)

Title: Gortyrahilly Windfarm (Wind Farm Site) Flood Risk Assessment

Client: Jennings O'Donovan

Date: 01/07/2022

Office: RSK Dublin

Status: FINAL

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1 INTRODUCTION

RSK Ireland was commissioned to carry out a Flood Risk Assessment by Jennings O’Donovan & Partners (JOD, the Client) on behalf of FuturEnergy Ireland and SSE (the Developer). The assessment is in support of the planning application for the Gortyrahilly Wind Farm (GWF, the development) in Co. Cork.

This flood risk assessment has been carried out in accordance with the Department of Housing and Local Government (DEHLG) and the Office of Public Works (OPW) document *“The Planning Process and Flood Risk Management Guidelines for Planning Authorities”* published in November 2009. This Assessment identifies and sets out possible mitigation measures against potential risks of flooding from various sources. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater and human/mechanical error. This report provides an assessment of the subject site for flood risk purposes only.

RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public & private sectors. More information can be found at www.rskgroup.com. The principal members of the RSK EIA team involved in this assessment include the following persons;

- Project Manager & Lead Author: Sven Klinkenbergh – B.Sc. (Environmental Science), P.G. Dip. (Environmental Protection). Current Role: Principal Environmental Consultant. Experience c. 8 years
- Project Scientist: Lissa Colleen M^{c}Clung - B.Sc. (Environmental Studies), M.Sc. (Environmental Science). Current Role: Graduate Project Scientist

2 SOURCES OF INFORMATION

2.1 Introduction

Reliance has been placed on factual and anecdotal data obtained from the sources identified. RSK cannot be held responsible any omissions, misrepresentations, errors or inaccuracies with the supplied information. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report in whole or in part.

All opinions expressed are based upon current design standards and policies in force at the date of this report. These standards may be subject to change with the passage of time.

The opinions expressed herein are intended to provide general guidance as to how a problem related to a particular development might be resolved. Given the paucity of the original information, and the often-indirect nature of information received, they should not be relied upon as absolute or definitive guidance as to any particular solution. Such conclusions can only sensibly be arrived at upon detailed design.

As a consequence of the above, RSK Ltd. will not be held liable for any consequential losses, howsoever caused, as a consequence of inaccurate missing, incomplete, or erroneous data contained in this report, nor any data capable of being subject to variable interpretation by means of its generalised nature.

2.2 Desk Study

2.2.1 EPA

The Environmental Protection Agency (EPA) Maps Application was consulted to identify to local hydrology around the vicinity of the site along with specific Water Framework Directive (WFD) statuses and risks [1].

2.2.2 Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Lee, Cork Harbour & Yaughal Bay Catchment Flood Risk Management Plan (CFRAM) were investigated to

[1] EPA Unified GIS Application (2022)

determine present-day risks to flooding in relation to the proposed Development. The Office of Public Works (OPW) mapping study for Ireland is available on their website[2]

2.2.3 Google Earth Pro

National Grid Reference and topography mapping of the study site setting was drawn from Google Earth Pro (2022) *TerraMetrics; version 7.3 (beta),* Gortyrahilly, Cahir Co. Cork, Ireland. 51°53'48.34" N 9°13'46.76" W, Eye alt 4.65 km. Places layers. SIO, NOAA, US Navy, NGA, GEBCO.

2.2.4 GSI

Geological Survey Ireland Spatial Resources from the Department of the Environment, Climate and Communications, were utilised to determine the Site's hydrogeology, site-specific aquifer and vulnerability, borehole/well information, soil and subsoils data as well as Corine 2018 land use classification.[3].

2.2.5 OSI

Records from the National mapping agency of Ireland, the Ordnance Survey, were studied, on the websites interactive GeoHive Map Viewer (i.e., First Edition 6-inch map (1839-1842)) to determine the Site's flood history [4].

[2] OPW Flood Maps and Catchment Flood Risk Assessment and Management (CFRAM) Programme (2022)

[3] Geological Survey Ireland Spatial Resources (2022)

[4] Government of Ireland and Ordnance Survey Ireland (2022)

3 SITE DESCRIPTION

3.1 Location

Site Name: Gortyrahilly Windfarm (Wind Farm Site)

Site Address: Carrigalougha Hill, Shehy Mountains, Inchi More, Co. Cork,

Site National Grid Reference: 111903 E, 064418 N.

The proposed site is situated on Carrigalougha Hill, in the Shehy Mountains in Co. Cork. The site is characterised by relatively complex (hilly) topography with associated elevations ranging between c. 230 to 423 metres above datum (maOD) (Carrigalougha peak; 423maOD). Topography at the Site is highly variable. Some areas possess severe slopes and some areas possess complex topography (e.g. significant rocky outcrops with severe slopes and sheer faces).

The existing site topography is shown in **EIAR Chapter 9 – Figure 9.1 – Site Location**, of Chapter 9 in the EIAR.

In terms of land use the Site is comprised mainly of agricultural, forestry and peatland with existing roads and some dwellings and farms / yards in the locality.

3.2 Site Hydrology

Surface water networks draining the site are mapped and presented in **EIAR Chapter 9 - Figures 9.2 (a – c) and Figure 9.4.**

The Development is situated within the Lee, Cork Harbour and Youghal Bay Catchment (ID: 19, Area: 2182km^2).

Surface water runoff associated with the Site drains into three sub catchments and/or four river sub basins, or four (4no.) rivers;

- Sub Catchment: Lee (Cork) SC 010, River Sub Basin: (Lee Cork) 010
- Sub Catchment: Lee (Cork) SC 020; River Sub Basin: Toon 010
- Sub Catchment: Sullane SC 010; River Sub Basins: Sullane 010 and Douglas (Sullane) 010.

All surface waters draining from the Site eventually combine in Carrigadrohid Reservoir, from which waters eventually flow to Cork Harbour and into the Celtic Sea.

In terms of local drainage and non-mapped surface water features the site characterised by extensive artificial drainage networks including in association with agricultural and land reclamation / improvement works, forestry drainage networks, and cut drains in peat and peat cutting activities.

3.3 Site Soil & Subsoil Geology

Consultation with published soil maps compiled by GIS/SIS and the EPA specify that soil types across the Site include Peat and Loamy Drift while large portions of the site are indicated as 'Rock at surface'; soils are presented in **EIAR Chapter 8 - Figure 8.4a.**

Consultation with available subsoil maps, shown in **EIAR Chapter 8 - Figure 8.4b**, indicate that subsoil types across the Site include; Bedrock at or near the surface across the majority of the Site, significant deposits of Sandstone Till at lower elevations, with some minor pockets of Blanket Peat at higher elevations and one area of blanket peat at lower elevation along the north-western boundary of the Site.

Observations and data obtained during site investigation surveys coincide with the findings of the desk study as stated in the preceding paragraphs. Peat and Loamy Drift cover the vast majority of the Site with the exception of significant rocky outcrops, particularly at higher elevations. Furthermore, many minor rocky outcrops were also observed across the Site, particularly at higher elevations. Thin peat and exposed rock were observed at numerous existing cut and fill locations along the existing Site tracks and hardstands associated with agricultural and forestry practices in the area.

3.4 Site Hydrogeology

The bedrock aquifers underlying the proposed Development have been assigned the GSI aquifer classifications ranging from Poor Aquifer (PI) (northern portion), that is; bedrock which is generally unproductive except for local zones, and Locally Important Aquifer (LI) (southern portion), that is; bedrock which is moderately productive only in local zones. Aquifers associated with the site are presented in **EIAR Chapter 9 - Figure 9.6 b –Bedrock Aquifer Overview.**.

There are no mapped karst features within 10 km of the Development.

3.5 Groundwater Vulnerability & Recharge

Presented in **EIAR Chapter 9** - **Figure 9.6 a – Bedrock Aquifer Vulnerability Overview**, consultation with the GSI Groundwater Map Viewer indicates that the site is underlain by areas classified predominantly by Rock at or Near Surface (X) vulnerability rating particularly at higher elevations, with some areas mapped as Extreme (E) vulnerability rating which tend to be at lower elevations.

Areas of the Site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 200 mm effective rain fall. Areas underlain by Poor Aquifer (Pu) possess a maximum recharge capacity of 100 mm effective rainfall per annum.

The Site is characterised by low to very low recharge rates in overburden (soils/subsoils) and very low recharge capacity in the underlying bedrock aquifer, which can be seen in **EIAR Chapter 9** - **Figure 9.6c - Groundwater Recharge Overview**. This implies that, particularly during seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the Site will drain off the site as surface water runoff, and the rejected recharge water volumes will likely discharge to surface waters relatively rapidly and locally. As such, the surface water network associated with the Site is characterised as having a rapid hydrological response to rainfall.

3.6 Proposed Development

The proposed Wind Farm Development, is comprised of: 14 no. proposed turbines, a temporary construction compound, one (35-year life cycle) meteorological mast, two permanent on-site borrow pits, new permanent internal Site Access Roads and upgrade of existing Site Access Roads, and the development of a site drainage network, one permanent 110 kV substation. There will be additional works, upgrading the Turbine Delivery Route which will include a temporary bridge over the Sullane river. Furthermore, works will also include all associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation and associated with the permanent connection of the wind farm to the national electricity grid comprising 27.8km of 110 kV underground cable. More detail on the development description is presented in **EIAR Chapter 9 Section 9.1.1.**

4 FLOOD RISK ASSESSMENT

4.1 Introduction

4.1.1 Guidelines for FRAs

The Flood Risk Assessment Report RSK Ireland will prepare follows the guidelines set out in the DEHLG/OPW *Guidelines on the Planning Process and Flood Risk Management* published in November 2009. This assessment will address where surface water and groundwater within or around the site boundary comes from (i.e., the source), how and where it flows (i.e. the pathways) and the people and assets affected by it (i.e., the receptors). This stage aims to quantify the risk posed to the development and to the surrounding environment by this development.

In line with DEHLG Guidelines for Planning Authorities – Flood Risk Management (2009);

Flood Risk Assessment Stage 1, or Preliminary Drainage Assessment

Stage 1 Flood risk identification – to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and LAP's or a proposed development site that may warrant further investigation at the appropriate lower level plan or planning application levels;

Flood Risk Assessment Stage 2

Stage 2 Initial flood risk assessment – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped; and

Flood Risk Assessment Stage 3

Stage 3 Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

4.1.1.1 Sources of Flooding

The components to be considered in the identification and assessment of flood risk are:

- Tidal –flooding from high sea levels
- Fluvial –flooding from water courses
- Pluvial –flooding from rainfall / surface water
- Ground Water –flooding from springs / raised ground water
- Human/mechanical error –flooding due to human or mechanical error

4.1.2 Scoping & Assessing Flood Risk

The two components of flood risk, as outlined in the FRM Guidelines, are the likelihood of flooding and the potential consequences arising from planned works; expressed as:

Flood Risk = Probability of flooding x Consequences of flooding

- *Likelihood of flooding is normally defined as the percentage probability of a flood of a given magnitude or severity occurring or being exceeded in any given year. For example, a 1% probability indicates the severity of a flood that is expected to be exceeded on average once in 100 years, i.e., it has a 1 in 100 (1%) chance of occurring in any one year.*
- *Consequences of flooding depend on the hazards associated with the flooding (e.g., depth of water, speed of flow, rate of onset, duration, wave- action effects, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g., the age profile of the population, the type of development, presence and reliability of mitigation measures etc).*

4.1.3 Assessing Likelihood of Flood Risk

In the FRM Guidelines, the likelihood of a flood occurring in an area is identified and separated into Flood Zones **Figure 4.1 - Indicative Flood Zone Map,** which indicate a high, moderate or low risk of flooding from fluvial or tidal sources, defined as follows:

- Flood Zone A - Where the probability of flooding is highest (greater than 1% Annual Exceedance Probability (AEP) or 1 in 100 for river flooding and 0.5% AEP or 1 in 200 for coastal flooding) and where a wide range of receptors would be located and therefore vulnerable;
- Flood Zone B - Where the probability of flooding is moderate (between 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 for coastal flooding); and

- Flood Zone C - Where the probability of flooding is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding).

Figure 4.1: Indicative flood zone map (OPW, 2009)

As outlined in the FRM Guidelines, future developments must avoid where possible areas at risk of flooding, as such, essential infrastructure including electricity substations should be located within Flood Zone C. Presented in **Figure 4.2,** from the OPW (2009), a Justification Test is a guiding document that aims to determine the appropriateness of a particular development in areas that may be at risk of flooding. A Justification Test is required to assess such proposals in the light of proper planning and sustainable development objectives.

	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

Figure 4.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test (OPW, 2009)

4.2 Stage 1 – Flood Risk Identification

The flood risk identification stage was carried out in order to establish whether a flood risk exists within the boundaries of the proposed Development or the surrounding vicinity as well as the Turbine Delivery Route and Grid Connection Route.

4.2.1 Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. First Edition 6-inch map (1839-1842) indicate that neither the Wind Farm Development site and associated Turbine Delivery Route or Grid Connection Route are susceptible to flooding. The National Flood Hazard Mapping database operated by the OPW also confirms there are no areas represented as being low, medium or high probability risk to flood areas within Site boundaries or immediately downgradient of the Site. Furthermore, there have been no recorded flood events on the OPW Database in the immediate vicinity of the proposed Development Site. There have been 2 no. past flood events along the Grid Connection Route, just northwest of the Wind Farm. These events have been recorded as 'Flooding at Coolea, Lumnagh More 2015: ID-13965' and 'Flooding at Coolea, Scrahanagown, 2015: ID-13963'.

Flood risk screening has indicated that the location of the temporary bridge on the Sullane River and associated ancillary infrastructure is situated within a probable flood zone and has had recorded flood events; 'Sullane Ballyvourney 1986: ID-2406' and 'Flooding at Ballyvourney 2015: ID-13473' approximately 500 m east, downstream of the proposed bridge location.

4.2.2 Tidal Flooding

Tidal flooding is caused by elevated sea levels or overtopping by wave action. No coastal flood zones are identified at the site or surrounding area. Bantry Bay is located 40 km northeast of the Site. Due to both the inland nature and significant elevation of the proposed Development Site, Grid Connection Route and Turbine Delivery Route, the residual risk from tidal flooding is considered low.

4.2.3 Fluvial Flooding

Fluvial flooding is caused by rivers, watercourses or ditches overflowing. Historic flood maps dating (1839-1842), were reviewed for all the proposed Development areas and did not indicate a history of flooding at the site from small streams or tributaries found within or near Site boundaries Grid Connection Route of Turbine Delivery Route. Furthermore, recent, comprehensive flood-maps, produced by the OPW (2018) under the Lee, Cork Harbour & Yaughal Bay Catchment Flood Risk Management Plan (CFRAM) programme do not indicate any flood extents within the proposed Site boundaries, nor its immediate surrounding vicinity. All areas outside the 0.1% AEP flood extent (the proposed Development), are classified as residing in Flood Zone C. Therefore, CFRAM flood-maps confirm that the proposed Development Site resides in Flood Zone C and is a suitable development for this area.

In regards to the Grid Connection Route (GCR), consultation with the National Indicative Fluvial Mapping (NIFM)- Future River Flood Extents Scenarios maps, **Figure 4.3** forecasts 'low' (0.1% AEP) and 'medium' (1% AEP) the for the Sullane where the GCR will cross, using HDD, at the following locations: Culvert 115, Bridge 2 (Droichead Barr Duinse) and Bridge 3 (Droichead Ui Mhathuna), seen within the red frame. Considering the nature of the works there will be minimal land take required and no significant impact to runoff rates, however considering the scale or length of this part of the development flood risk will be anticipated, particularly at watercourse crossing locations.

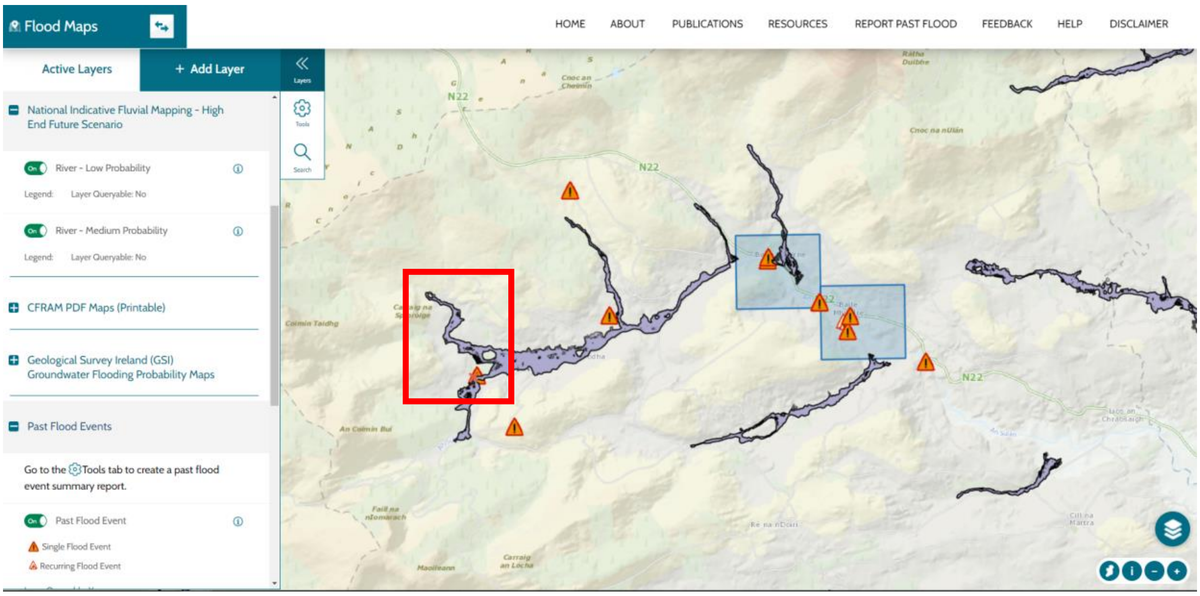
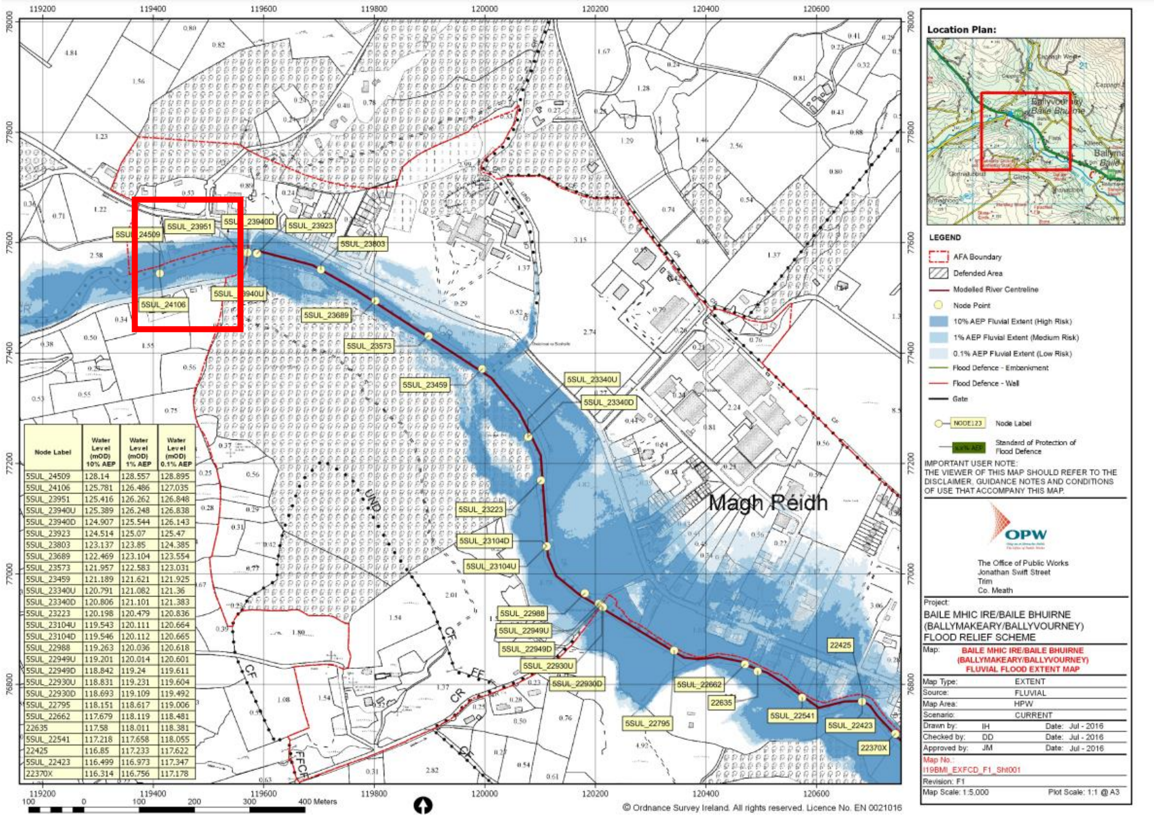


Figure 4.3: National Indicative Fluvial Mapping (NIFM) River Flood Extents- High-End Future Scenario (worst case) with recorded past flood events depicted (OPW, 2022).

In regard to the turbine delivery route, flood risk screening indicates that the location of the temporary bridge on the Sullane River and associated ancillary infrastructure is situated within a probable flood zone (**Figure 4.4**) with recorded flood events as mentioned above. This portion of the development is temporary and therefore no significant impact to runoff rates are identified.



Node Label	Water Level (mOD) 10% AEP	Water Level (mOD) 1% AEP	Water Level (mOD) 0.1% AEP
5SUL_24509	128.14	128.557	128.895
5SUL_24106	125.781	126.486	127.035
5SUL_23951	125.416	126.262	126.848
5SUL_23940U	125.389	126.248	126.838
5SUL_23940D	124.907	125.544	126.143
5SUL_23923	124.514	125.07	125.47
5SUL_23803	123.137	123.85	124.385
5SUL_23689	122.469	123.104	123.554
5SUL_23573	121.957	122.583	123.031
5SUL_23459	121.189	121.621	121.925
5SUL_23340U	120.791	121.082	121.36
5SUL_23340D	120.806	121.101	121.383
5SUL_23223	120.198	120.479	120.836
5SUL_23104U	119.543	120.111	120.664
5SUL_23104D	119.546	120.112	120.665
5SUL_22988	119.263	120.036	120.618
5SUL_22949U	119.201	120.014	120.601
5SUL_22949D	118.842	119.24	119.611
5SUL_22930U	118.831	119.231	119.604
5SUL_22930D	118.693	119.109	119.492
5SUL_22795	118.151	118.617	119.006
5SUL_22662	117.679	118.119	118.481
22635	117.58	118.011	118.381
5SUL_22541	117.218	117.658	118.055
22425	116.85	117.233	117.622
5SUL_22423	116.499	116.973	117.347
22370X	116.314	116.756	117.178

Figure 4.4: Flood extents (all possibilities) for the Ballymakeery / Ballyvourney area (OPW, 2022).

4.2.4 Pluvial Flooding

Pluvial flooding is usually caused by intense rainfall that may only last a few hours, often referred to as flooding from surface water. Surface water flooding can also occur as a result of overland flow or ponding during periods of extreme prolonged rainfall. During pluvial flooding events, water follows natural valley lines, creating flow paths along roads, through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low lying areas. It is generally noted, areas at risk from fluvial flooding will almost certainly be at risk from pluvial flooding. Pluvial flood maps produced as part of the OPW's CFRAM do not indicate pluvial flood zones at the any portion of the Development Site (TDR and GCR included). Therefore, the residual risk from pluvial flooding is considered low.

4.2.5 Groundwater Flooding

Groundwater flooding can occur on some sites in connection with high water tables and increased recharge following long periods of wet weather. Groundwater flooding typically occurs in areas underlain by limestone and where underlying geology is highly permeable with high capacity to receive and store rainfall. The groundwater underneath the site is located within both a *Locally Important* Aquifer- Bedrock which is Moderately Productive only in Local Zones and a *Poor* Aquifer- Bedrock which is generally unproductive except for local zones.

Groundwater observations during SI rotary core drilling indicate that the underlying bedrock is weathered to a minor degree only, with minor volumes of groundwater perched on top of bedrock in the subsoil underlying the site, and no significant water strike encountered (maximum drill depth was approximately 10m). Groundwater flow directions are presumed to follow the topography of the area. Groundwater flow paths are considered to be short due to the underlying bedrock aquifer being poorly productive. From reviewing available water level records, and taking into account the elevation of the site, and additional consultation with the Geological Survey Ireland (GSI) Groundwater Flooding Probability Maps, there is no evidence of groundwater flooding within the Development Site or associated Grid Connection or Turbine Delivery Routes.

4.2.6 Proposed Development

The proposed development associated with the Grid Connection Route and Turbine Delivery route will require minimal land take through the use of existing roads, therefore there are no impacts to increase hydraulic loading anticipated. The proposed Wind Farm Development comprising of new access tracks, hardstands and associated ancillary infrastructure will include land take (Agriculture / Forestry / Peatlands) and the replacement of vegetated lands and soils with relatively impermeable surfaces presents the potential for a net decrease in recharge potential (rain percolating through soils to groundwater) and increase in the hydrological response to rainfall (quantity and rate of surface water runoff) at the site, which will potentially adversely impact on flood risk areas within or downstream of the site.

4.2.7 Human and/or Mechanical Error

Construction of drainage channels and enhancement of existing drainage associated the Development have the potential to impact the hydrological regime at the Site. In particular human error related to poor design, or if poorly managed during construction phase of a development, the installation of drainage channels and associated infrastructure such as culverts or attenuation features can lead to excessive *wetting and/or drying* in areas of the site which does not conform to baseline conditions i.e., localised flooding or excessive draining.

4.2.8 FRA Stage 1 Conclusions

This Flood Risk Assessment was compiled and based on data presented in public records, in accordance with the guidelines set out in the DEHLG/OPW *Guidelines on the Planning Process and Flood Risk Management* published in November 2009. From reviewing the available records there was no evidence of historic flooding at the Site. Furthermore, comprehensive floodmaps produced by the OPW under the Lee, Cork Harbour & Yaughal Bay Catchment Flood Risk Management Plan (CFRAM) confirm that the proposed Development resides in a Flood Zone C.

The nature of the development is industrial as opposed to residential or leisure, and as such, this type of development is categorized as a 'Less Vulnerable Development', according to FRM Guidelines. Therefore, the development is considered an 'appropriate' development for Flood Zone C.

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has identified no flood hazards for the proposed Development.

The proposed Development has the potential to lead to a net decrease in recharge potential and net increase in the hydrological response to rainfall at the site, potentially leading to adverse impacts on flood risk areas downstream of the site. The extent of the risk of flooding and potential impact of a development on flooding elsewhere (downstream) requires FRA Stage 2.

4.3 Stage 2 – Initial Flood Risk Assessment

4.3.1 Assessing Potential Impacts of Development – Sites Downgradient

While the Catchment Flood Risk Management Plan (CFRAM) programme did not indicate any flood extents within the proposed Site boundaries, nor its immediate surrounding vicinity, downgradient of the site, there are probable flood areas. The closest mapped probable flood areas are associated with;

- The Lee (Cork) (030) river approximately four kilometres south of the site at Ballingeary town.
- The Sullane (030) river approximately four kilometres to the northeast of the site near Ballymarkeery town.

To highlight again, there are no recorded localised flood events between the Site and the mapped probable flood areas.

4.3.2 Assessing Potential Effects of Development – Increased Hydraulic Loading

4.3.2.1 Rainfall and Evapotranspiration

Rainfall data for the region associated with the Development site has been assessed in terms of the following parameters;

- Historical average and max monthly rainfall and effective rainfall. Effective rainfall is calculated as being rainfall minus evapotranspiration equals effective rainfall, or the amount of rainfall which will contribute to surface water runoff discharge volumes and/or groundwater recharge.
- Potential significant storm events including events with a 1 in 100-year return period over 1 hour duration, 25 day duration and 30 day or month duration (inferred using available data).
- Daily 2020 rain (specifically in relation to meteorological conditions at the time of site surveys).

Data from the meteorological stations listed in Error! Reference source not found. are used in this assessment[5]. Using data presented in Error! Not a valid bookmark self-reference., storm event of 30 days duration with a 1 in 100-year return period is inferred to be 580.5mm. For the purpose of this environmental impact assessment, predicted extreme or worst-case values are used, as presented in **Table 4.2: EIA Specific Assessment Data**. Rain fall amounts in the three days preceding baseline sampling events are presented in **EIAR Chapter 9 - Table 9.11: Rainfall Prior to Baseline Sampling Events.**

Rainfall trends are presented in **EIAR Chapter 9 - Figure 9.3**.

Table 4.1: Meteorological Stations (Met Eireann, 2021)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	M.BALLINGEARY 1948-2020	4
Rainfall (2020/21 Monthly/Daily)	M.BALLINGEARY 1948-2020	4
Evapotranspiration	Cork Airport – 2016-2019 Minimum	50

[5] Met EÉireann, Historical Data, Available at; www.met.ie, Accessed; 03rd March 2021

Table 4.2: EIA Specific Assessment Data (Met Eireann, 2021)

Category	Value
Average Annual Effective Rainfall (Long term) (mm/year)	1,323.41
Max monthly effective rainfall (mm/month)	680.2
1 in 100 Year Rainfall Event (30 day duration) (mm/month)	580.5
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	32.6
Minimum monthly evapotranspiration (mm/month)	9.7

Table 4.3: Met Eireann Return Period Rainfall Depths (Irish Grid; 116028, 72371)[6]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 116028, Northing: 72371,

	Interval		Years													
DURATION	6months	1year	2	3	4	5	10	20	30	50	75	100	150	200	250	500
5 mins	3.2	4.1	4.5	5.1	5.6	5.9	6.9	7.9	8.6	9.5	10.3	10.9	11.8	12.4	13.0	N/A
10 mins	4.4	5.6	6.3	7.2	7.7	8.2	9.6	11.0	12.0	13.2	14.3	15.2	16.4	17.3	18.1	N/A
15 mins	5.2	6.6	7.4	8.4	9.1	9.6	11.3	13.0	14.1	15.6	16.9	17.8	19.3	20.4	21.3	N/A
30 mins	7.3	9.3	10.3	11.7	12.6	13.3	15.5	17.8	19.2	21.2	22.9	24.1	26.0	27.5	28.6	N/A
1 hours	10.3	13.0	14.3	16.2	17.5	18.4	21.3	24.3	26.2	28.8	31.0	32.6	35.1	37.0	38.5	N/A
2 hours	14.6	18.2	20.0	22.5	24.2	25.4	29.2	33.2	35.7	39.1	42.0	44.1	47.3	49.8	51.7	N/A
3 hours	17.9	22.2	24.3	27.3	29.2	30.7	35.2	39.9	42.8	46.8	50.1	52.6	56.4	59.2	61.5	N/A
4 hours	20.6	25.5	27.9	31.3	33.5	35.1	40.1	45.4	48.7	53.1	56.9	59.7	63.8	67.0	69.5	N/A
6 hours	25.2	31.1	33.9	37.9	40.5	42.4	48.3	54.5	58.4	63.6	67.9	71.2	76.1	79.7	82.6	N/A
9 hours	30.9	37.8	41.2	45.9	49.0	51.2	58.2	65.5	70.0	76.0	81.1	85.0	90.6	94.8	98.2	N/A
12 hours	35.6	43.5	47.3	52.6	56.1	58.6	66.4	74.6	79.6	86.4	92.0	96.3	102.6	107.3	111.1	N/A
18 hours	43.6	52.9	57.5	63.8	67.8	70.8	80.0	89.6	95.5	103.3	110.0	114.9	122.2	127.6	132.0	N/A
24 hours	50.3	60.9	66.0	73.1	77.6	81.0	91.3	102.0	108.6	117.3	124.7	130.2	138.3	144.4	149.3	165.4
2 days	65.8	78.3	84.3	92.5	97.7	101.6	113.3	125.3	132.6	142.4	150.5	156.5	165.4	172.0	177.2	194.7
3 days	79.1	93.1	99.8	109.0	114.8	119.0	132.0	145.1	153.1	163.7	172.5	179.0	188.5	195.6	201.2	219.8
4 days	91.1	106.6	113.9	123.9	130.2	134.8	148.8	162.9	171.5	182.8	192.2	199.1	209.3	216.8	222.8	242.4
6 days	113.2	131.1	139.5	150.9	158.1	163.3	179.1	195.0	204.6	217.2	227.7	235.4	246.6	254.8	261.4	282.9
8 days	133.6	153.6	162.9	175.7	183.5	189.4	206.8	224.2	234.7	248.4	259.8	268.1	280.3	289.2	296.3	319.5
10 days	152.9	174.9	185.1	198.9	207.5	213.8	232.7	251.5	262.8	277.6	289.7	298.7	311.6	321.2	328.8	353.4
12 days	171.5	195.3	206.3	221.2	230.4	237.2	257.3	277.4	289.5	305.2	318.1	327.6	341.4	351.4	359.5	385.5
16 days	207.2	234.3	246.7	263.6	273.9	281.5	304.1	326.5	340.0	357.4	371.7	382.1	397.3	408.3	417.2	445.7
20 days	241.6	271.6	285.4	304.0	315.4	323.8	348.5	373.0	387.7	406.6	422.1	433.4	449.9	461.9	471.4	502.1
25 days	283.3	316.8	332.1	352.7	365.3	374.5	401.8	428.7	444.7	465.4	482.3	494.6	512.4	525.5	535.8	569.0

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

[6] Met Éireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods , Accessed; 3rd March 2021

4.3.2.2 Preliminary Water Balance Assessment

For the purposes of assessing changes in runoff at the site as a function of the development, the following data compiled from GIS mapping software is considered (**FRA Section 3 – Site Description** and **EIAR Chapter 9 – Section 9.3 Baseline Description**);

- Turbine foundation and hardstands = c. 9,000m2 x 14 no. = 126,000m2
- New access track / turning points / lay-by = c. 8,030m x 5m width = 40,150m2
- Substation / other Hardstand = c. 10,300m2 x 1 no.
- Compound = 2,150 m2 x 1 no.
- Met Mast = 100m2 x 1 no.
- 1 in 100-year rainfall event = c. 32.6mm of rainfall in 1 hour.
- Recharge capacity = 20% of Effective Rainfall (Note: This is considered a conservative value i.e., higher potential recharge coefficient in the range associated with the site. In areas of peat the recharge will be considerably less and considering the capped recharge of the underlying bedrock aquifer the rate of recharge will likely be considerably less across the site, particularly during wet / winter months associated with elevated flood risk generally).

This assessment is considered a simple preliminary water balance assessment for the purposes of qualifying and adding context to potential impacts of the development in terms of hydrological response to rainfall and flooding. It considers and uses site specific data as well as associated downstream attribute data. (Note: This is not considered advanced modelling for flood risk assessment (FRA Stage 3)). The 'Micro-catchment' setting of these areas indicated in the following tables are presented in **EIAR Chapter 9 Figure 9.5b – Hydrology Mapping Micro-catchments.**

Table 4.4 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1 in 100-year storm event.

Table 4.5 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1 in 100-year storm event relative to baseline conditions.

Table 4.4: Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Storm)

Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)

Micro Catchment	Category	Unit	Approx. Area Per Unit	Approx. Quantity	Approximate Area (m2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity. Percentage of Effective Rainfall (Conservative Value for Water Balanace Calc's)	Rejected Recharge / Runoff (m/hour Rain)	Runoff Discharge Rate (m3/hour)	Net Increase Runoff Discharge Rate (m3/sec)	Runoff Discharge Rate (m3/sec)	Recharge Capacity. Percentage of Effective Rainfall (Hardstand Areas assumed impermeable)	Rejected Recharge / Runoff (m/hour Rain)	Runoff Discharge Rate (m3/hour)	Net Increase Runoff Discharge Rate (m3/sec)	Runoff Discharge Rate (m3/sec)	Net Increase (m3/sec)
SW1	Turbines Hardstand	No.	9000	5.5	49,500.00	0.0326	20.00%	0.02608	1,290.96	0.36		0.00%	0.0326	1,613.70	0.45		
SW1	New Access Track / hardstand	m	5	3500	17,500.00	0.0326	20.00%	0.02608	456.40	0.13		0.00%	0.0326	570.50	0.16		
SW1	**Subtotal**										0.49					0.61	**0.121**
SW2	Turbines Hardstand	No.	9000	4	36,000.00	0.0326	20.00%	0.02608	938.88	0.26		0.00%	0.0326	1,173.60	0.33		
SW2	Met Mast	No.	100	1	100.00	0.0326	20.00%	0.02608	2.61	0.00		0.00%	0.0326	3.26	0.00		
SW2	New Access Track / hardstand	m	5	580	2,900.00	0.0326	20.00%	0.02608	75.63	0.02		0.00%	0.0326	94.54	0.03		
SW2	**Subtotal**										0.28					0.35	**0.071**
SW3	Turbines Hardstand	No.	9000	2	18,000.00	0.0326	20.00%	0.02608	469.44	0.13		0.00%	0.0326	586.80	0.16		
SW3	Substation Hardstand	No.	10300	1	10,300.00	0.0326	20.00%	0.02608	268.62	0.07		0.00%	0.0326	335.78	0.09		
SW3	New Access Track / hardstand	m	5	1800	9,000.00	0.0326	20.00%	0.02608	234.72	0.07		0.00%	0.0326	293.40	0.08		
SW3	**Subtotal**										0.27					0.34	**0.068**
SW4	Turbines Hardstand	No.	9000	0	-	0.0326	20.00%	0.02608	-	-		0.00%	0.0326	-	-		
SW4	Compund	No.	2150	1	2,150.00	0.0326	20.00%	0.02608	56.07	0.02		0.00%	0.0326	70.09	0.02		
SW4	New Access Track / hardstand	m	5	300	1,500.00	0.0326	20.00%	0.02608	39.12	0.01		0.00%	0.0326	48.90	0.01		
SW4	**Subtotal**										0.03					0.03	**0.007**
SW5	Turbines Hardstand	No.	9000	0.5	4,500.00	0.0326	20.00%	0.02608	117.36	0.03		0.00%	0.0326	146.70	0.04		
SW5	New Access Track / hardstand	m	5	600	3,000.00	0.0326	20.00%	0.02608	78.24	0.02		0.00%	0.0326	97.80	0.03		
SW5	**Subtotal**										0.05					0.07	**0.014**
SW6	Turbines Hardstand	No.	9000	2	18,000.00	0.0326	20.00%	0.02608	469.44	0.13		0.00%	0.0326	586.80	0.16		
SW6	New Access Track / hardstand	m	5	750	3,750.00	0.0326	20.00%	0.02608	97.80	0.03		0.00%	0.0326	122.25	0.03		
SW6	**Subtotal**										0.16					0.20	**0.039**
													Total	**5744.12**	**1.60**	**1.60**	**0.319**

Table 4.5: Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes

(1 in 100 Year Hour Storm Event)

Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)								
Micro Catchment	**Approximate Area (m2)**	**1 in 100 Year Rainfall Event (m/hour Rain)**	**Capped Recharge Capacity. Percentage of Effective Rainfall** (Conservative Value for Water Balanace Calc's)	**Rejected Recharge / Runoff (m/hour Rain)**	**Runoff Discharge Rate (m3/hour)**	**Runoff Discharge Rate (m3/sec)**	**Net Increase (m3/sec)**	**Net Increase as percentage against baseline micro-catchment runoff (%)**
SW1	2,649,544.78	0.0326	20.00%	0.02608	69,100.13	19.19	0.121	0.63%
SW2	1,302,740.30	0.0326	20.00%	0.02608	33,975.47	9.44	0.071	0.75%
SW3	938,127.00	0.0326	20.00%	0.02608	24,466.35	6.80	0.068	0.99%
SW4	176,428.42	0.0326	20.00%	0.02608	4,601.25	1.28	0.007	0.52%
SW5	479,458.47	0.0326	20.00%	0.02608	12,504.28	3.47	0.014	0.39%
SW6	1,425,986.26	0.0326	20.00%	0.02608	37,189.72	10.33	0.039	0.38%
				Total	**181837.1988**	**50.51**	**0.319**	0.63%

Water balance calculations allow for the addition of area for hardstand infrastructure required (land take) during the construction and operational phases of the Development. A 1 in 100-year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be c. 0.319m^3/second, or 0.63% relative to the Site area (redline boundary). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but imperceptible or negligible impact of the development. With suitable mitigation measures, the pressure to the surface water bodies and sites downgradient can be reduced to a neutral impact.

4.3.3 Mitigation Measures Associated with the Development

Flood Relief Schemes, outlined by the OPW, are in place for both Ballingeary and Ballymarkeery towns (flood areas identified above). These include Measures Applicable in All Areas, which are detailed as:

- Sustainable Drainage Systems (SuDS). Objective: Planning authorities will seek to reduce the extent of hard surfacing and paving and require the use of sustainable drainage techniques to reduce the potential impact of development on flood risk downstream.
- Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

Under the 2013-2015 Work Programme of the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD), and in response to the 2012 Blueprint to Safeguard Europe's Water Resources proposals, the Working Group Programme of Measures has developed guidance for supporting the implementation of Natural Water Retention Measures (NWRM) in Europe (European Commission, 2015).

The OPW and EPA Catchments Unit in conjunction with Local Authorities are actively adopting and promoting NWRM as part of a broader suite of mitigation measures that could contribute to the achievement of environmental objectives (WFD) set out in the second River Basin Management Plan (RBMP) (EPA Catchment Unit, 2020).

Flood Relief Scheme and flood risk management Objectives such as Land Use Management and Natural Flood Risk Management are relevant to the proposed Development, whereby; the assessment and design of proposed Development will qualify and mitigate any potential adverse impact in terms of hydrological response to rainfall and flood risk within or downstream of the site. The objective of mitigation in this respect will be to achieve, at a minimum, a neutral impact, and to identify and promote beneficial impacts (net decrease in hydrological response to rainfall) at the site, particularly in terms of Natural Water Retention Measures (NWRM) as part of baseline conditions, namely; restoration of peatlands, wetlands and woodlands.

To mitigate any net change in hydraulic loading to surface waters during the construction and operational phase of the Development, the following examples can be utilised where appropriate;

- Check dams, dams, other flow restricting infrastructure
- Collector drains
- Permanent stilling ponds
- Attenuation lagoons
- Buffered outfalls to vegetated areas
- Rewetting peatlands
- Controlling dewatering flow/pump rates
- Restricting pumped water discharge directly to drainage or surface water networks.
- Offline storage ponds, overland sediment traps
- Floodplain and riparian woodland
- Riverbank restoration
- River morphology and floodplain restoration – removal of embankments, re-meandered river reach
- In stream structure – large woody debris
- Catchment woodlands
- Land and soil management practices – cover crops, cross contour hedgerows.

The Development has the potential to result in increased volumes of runoff during the operational phases of the Development relative to baseline conditions. However, with the appropriate environmental engineering controls and mitigation measures, previously outlined, these potential impacts will be reduced.

The combined attenuation capacity of the proposed drainage infrastructure will be designed to attenuate net increase in water runoff, including during extreme storm events relative to greenfield or baseline runoff rates. These mitigation measures required during the construction and operational phases will buffer the discharge rate and reduce the hydrological response to rainfall at the site, maintain (or improve) the hydrological regime at the site, in turn reducing loading on the receiving surface water drainage network. This will mitigate against the potential for rapid runoff and rapid hydrological responses to rainfall, lessening the likelihood to flooding of the drainage network or downstream of the development.

Mitigation measures will be considered and designed in line with engineering and construction best practices and methodologies, including the following guidance documents (non-exhaustive);

- Scottish Environment Protection Agency (SEPA) (2009) Flood Risk Management (Scotland) Act 2009 – Surface Water management Planning Guidance
- Scottish Environment Protection Agency (SEPA) (2015) Natural Flood Management Handbook
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) The SuDS Manual (C753)

The following observations and recommendations are made with a view to ensuring mitigation measures are designed and deployed effectively;

- The magnitude of potential net increase in runoff as a function for the Development at the Site is considered adverse but imperceptible, that is; quantifiable but without significant impact relative to the appropriate scale (flood risk areas downstream of the site and associated with a much larger catchment compared to the site boundary). Therefore, FRA Stage 3 including advanced flood modelling with a view to ensuring significant risks to flood risk areas are managed and minimised, is not deemed required as part of SFRA. However, in terms of detailed engineered design of the proposed Development and with a view to applying mitigation measures adequately, it is recommended that drainage, attenuation and associated infrastructure is designed and specified by a competent water infrastructure engineer, which might include modelling of runoff in site drainage, to ensure that all aspects ate sufficiently specified. Drainage modelling, including assessment of inundation rates, lag times and discharge rates, will be particularly useful in sensitive peatland areas, or where particularly sensitive environmental attributes exist downstream, for example; ecological attributes where surface water runoff and surface water quality are linked (**EIAR Chapter 9: Hydrology and Hydrogeology**).

- Detailed design and specification of drainage, attenuation and associated infrastructure will be included in a detailed Surface Water Management Plan (SWMP) prior to the commencement of the construction phase which will include detailed development drainage layout and details regarding construction, maintenance, monitoring and emergency response. It is recommended that this is done in conjunction with relevant stakeholders including relevant authorities and other stakeholders such as landholders etc. in line with River Basin Management practices i.e., engagement at local level.

4.4 FRA Stage 2 – Conclusions

A 1 in 100-year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be c. 0.336m3/second, or 0.66% relative to the Site area (redline boundary). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but imperceptible or negligible impact of the development.

The proposed development will include in its design and use the latest best practice guidance to ensure that flood risk within or downstream of the Site is not increased as a function of the Development, i.e., a neutral impact at a minimum. This means that the attenuation capacity in the constructed drainage network associated with the Development will have capacity to attenuate the calculated net increase during a 1 in 100-year storm event.

Considering the development does not acutely or significantly impact on a probable flood risk area, FRA Stage 3 including advanced flood modelling is not required.

However, it is recommended to include drainage modelling during the detailed design phase of the Development.

A detailed Surface Water Management Plan (SWMP) has been prepared, **Appendix 2.1**, with a view to ensuring that the surface water runoff at the site is managed effectively and does not exacerbate flood risk to the surrounding areas downstream.

As the associated drainage - some of which is permeant for the lifetime of the development, will be attenuated for greenfield run-off, the proposed development will not increase the risk of flooding elsewhere in the catchment. Based on this information, the proposed development complies with the appropriate policy guidelines for the area and is at no risk of flooding.

5 REFERENCES

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