Letter Wind Farm Ltd

Letter Wind Farm

Strategic Flood Risk Assessment (SFRA)

603680-R1 (02)

RSK

August 2023

RSK GENERAL NOTES

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CONTENTS

List of Tables

INTRODUCTION

RSK Ireland was commissioned to carry out a Flood Risk Assessment by Jennings O Donovan (the Client) on behalf of Letter Wind Farm Limited (the Developer/s). The assessment is in support of the planning application for the Letter Wind Farm (the Development) in Co. Leitrim.

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 Development for flood risk purposes only.

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- Project Manager & Lead Author: Sven Klinkenbergh – B.Sc. (Environmental Science), P.G.Dip. (Environmental Protection). Current Role: Principal Environmental Consultant. Experience c. 9 years
- Project Scientist: Jayne Stephens - B.S.c (Environmental Science), PhD (Environmental and Infection Microbiology). Current Role: Environmental Consultant. Experience c. 5 years
- Project Scientist: Lissa Colleen McClung - B.Sc. (Hons.) Environmental Studies, M.Sc. (Hons.) Environmental Science. Current Role: Graduate Project Scientist

SOURCES OF INFORMATION

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.

Desk Study

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].

Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Shannon Catchment Flood Risk Management Plan (CFRAM) Study were investigated to determine present-day

[1] EPA Unified GIS Application (2022)

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

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), Letter*, Co. Leitrim, Ireland. 52°11’48.95” N 8°44’58.77” W, Eye alt 2.95 km. Places layers. SIO, NOAA, US Navy, NGA, GEBCO.

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].

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)

SITE DESCRIPTION

Location

Site Name: Letter Wind Farm

Site Irish Transverse Mercator (ITM) Reference: 587,642.45E, 824,049.26N

The Site is located in the townland of Letter, Knocknacoska and Stangaun, approximately 2.9 km West of Drumkeeran, Co. Leitrim. The Site is located within a cutaway peatland landscape near the Corry Mountains, Co. Leitrim. It is characterised by primarily by mixed use as both commercial forestry and upland grazing. The area in which the turbines will be located, within the setback buffer, ranges in elevation from c. 170 to 260 metres above datum (mAOD).

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

Site Hydrology

Surface water networks draining the Site, Turbine Delivery Route and Grid Connection Route are mapped and presented in **Figure 9.2.**

Surface water networks associated with particular turbine locations are presented in the Surface Water Flow Chart in **Figure 9.3a**

The Letter wind Farm Project is situated within the Upper Shannon ID_26. Area_km^2 =604.47. The Northern part of the and Grid Connection Route is situated in the Sligo Bay Catchment (ID: 35, Area: 1605.94 km^2). The Turbine Delivery Route passes through the Donegal Bay North Catchment (ID:37, Area: 807 km^2), the Erne Catchment (ID:36, Area: 3440.55 km^2) the Sligo Bay Catchment (ID: 35, Area: 1605.94 km^2), the Upper Shannon Catchment (ID: 26B, Area: 674.13km^2), the Upper Shannon Catchment (ID: 26; Area: 604.47km^2) near the red line boundary of the Site.
Surface water runoff associated with the Site drains into two sub catchments and/or three river sub basins, or three no. rivers, 1 no. lough:

- Sub Catchment: Owengar (Leitrim)_SC_10, River Sub Basins: Owengar (Leitrim)_SC_010 and Diffagher_10, Rivers: Owengar (Leirtim)_010, Owengar (Leitrim)_020, Diffagher_010
- Sub Catchment: Shannon Upper_SC_020; River Sub Basin: Shannon Upper_040, Lough: Lough Allen

All surface waters draining from the Site eventually combine in Lough Allen, from which waters eventually flow to the Upper River Shannon, through Lough Corry, Tao North and Lough Boderg, Lough Ree and Lough Forbes before entering the Lower River Shannon and Lough Derg, finally the waters enter the Upper and Lower Shannon Estuary through to The Mouth of the Shannon and into the south-western Atlantic Seaboard.

In terms of local drainage and non-mapped surface water features the site characterised by extensive artificial drainage networks including in association with forestry works.

Site Soil & Subsoil Geology

The following Soils description is referenced from **EIAR Chapter 8 Soils and Geology**

Soils

The underlying soil cover, according to the National Soil database (GSI, 2022), of the site is predominately categorised as blanket peatlands, turbary, mature forestry and isolated areas of semi-improved grassland throughout the redline boundary.

The Grid Connection Route has a similar soil composition to that of the site with mainly; 'land principally occupied by agriculture with natural vegetation', 'transitional woodland scrub', 'peat bogs'.

The Turbine Delivery Route traverses the previously described land use as well as areas of 'discontinuous urban fabric', 'continuous urban fabric', 'pastures', 'beaches, sand dunes', 'intertidal flats', and 'industrial and commercial units'. However, the Turbine Delivery Route does not require any intrusive ground works.

Site Hydrogeology

The following description pertaining to bedrock aquifers underlaying the Site is referenced from **EIAR Chapter 9: Hydrology and Hydrogeology**.

Consultation with GSI Groundwater maps (2022) indicates that the entire portion of the Development (encompassing the location of T1, T2, T3 and T4) is underlain by 'Poor Aquifer (PI)' that is, bedrock which is generally unproductive except for local zones **Figure 9.7a**.

The Grid Connection Route is underlain by the same classification of aquifers 'Poor' (Pu), Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones (PI) **Figure 9.7b.**

Refer to **EIAR Chapter 8 Soils and Geology**, for more information on geology features in the area.

Groundwater Vulnerability & Recharge

Presented in **EIAR Chapter 9** - **Figure 9.8a - Groundwater Vulnerability Overview,** of Chapter 9 in the EIAR.

Consultation with the GSI Groundwater Map Viewer (2022) indicates that the Wind Farm Site is underlain by areas classified as 'Moderate (M)' vulnerability rating (Baseline – Bedrock Aquifer Vulnerability). The proposed locations of T1, T2, T3 and T4 have been mapped as areas with 'Moderate (M)' vulnerability.

The Grid Connection Route similarly traverse land with groundwater vulnerability ratings ranging from 'Low Vulnerability' to 'Extreme Vulnerability', **Figure 9.8b.**

Groundwater vulnerability for the Turbine Delivery Route is presented in **Figure 9.8c,** however as the Turbine Delivery Route does not require any intrusive ground works, the groundwater vulnerability along the route does not pertain to the scope of the project for assessment.

Areas of the Site underlain by Poor Aquifer (PI) which possesses a maximum annual recharge capacity of 100mm effective rain fall.

The Site is characterised by low recharge rates across the site and moderate to low recharge capacity in the underlying bedrock aquifer, which can be seen in **EIAR Chapter 9** - **Figure 9.9a - 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.

Proposed Development

The Development is comprised of 4 no. proposed turbines, one permanent meteorological mast, an on-site substation along with civil and electrical infrastructure and associated ancillary infrastructure (turbine foundations, turbine hardstands, 2 No. battery arrays, site access roads, drainage infrastructure etc.). Further details of the Development are detailed in **Chapter 2**: **Project Description.**

FLOOD RISK ASSESSMENT

Introduction

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

As per Flood Risk Management (FRM) Guidelines the purpose of Stage 1 is 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 local area plans (LAP's) or a development 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 development, 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.

Sources of Flooding

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

- Tidal –flooding from high sea levels. Flooding occurs when sea levels along the coast or in estuaries exceed neighbouring land levels, or overcome coastal defences where these exist, or when waves overtop the coastline or coastal defences.
- Fluvial –flooding from water courses. Flooding occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains). This can arise where the runoff from heavy rain exceeds the natural capacity of the river channel, and can be exacerbated where a channel is blocked or constrained or, in estuarine areas, where high tide levels impede the flow of the river out into the sea. While there is a lot of uncertainty on the impacts of climate change on rainfall patterns, there is a clear potential that fluvial flood risk could increase into the future.
- Pluvial –flooding from rainfall / surface water. Flooding occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural or man-made hollows and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system. This type of flooding is driven in particular by short, intense rainstorms.
- Ground Water –flooding from springs / raised ground water. 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 results from the interaction of site-specific factors such as local geology, rainfall infiltration routes and tidal variations. While the water level may rise slowly, it may cause flooding for extended periods of time. Hence, such flooding may often result in significant damage to property or disruption to transport. In Ireland, groundwater flooding is most commonly related to turloughs in the karstic limestone areas prevalent in particular in the west of Ireland.
- Human/mechanical error –flooding due to human or mechanical error. Flooding can also be caused by the failure or exceedance of capacity of built or man-made

infrastructure, such as bridge collapses, from blocked piped sewerage networks, or the failure or over-topping of reservoirs or other water-retaining embankments (such as raised canals).

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).*

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 1)** 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).

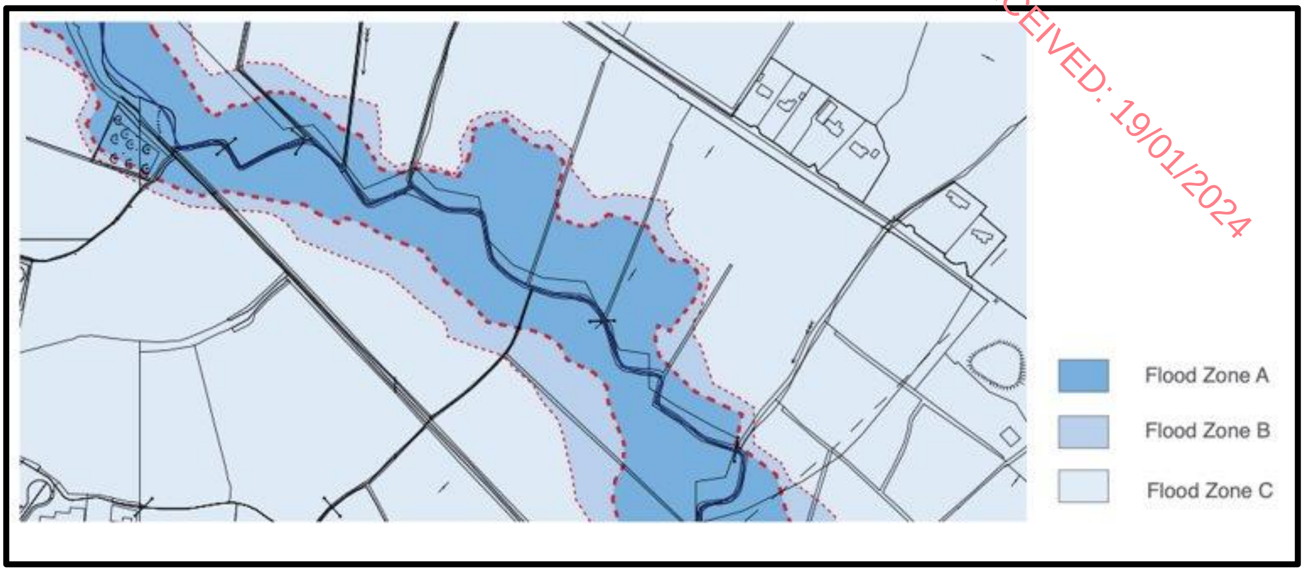


Figure 1: Indicative flood zone map from (Department of Housing, Local Government and Heritage 2009).

As outlined in the FRM Guidelines, future developments must avoid where possible areas at risk of flooding, The FRM Guidelines categorises all types of development as either; 1. Highly Vulnerable, 2. Less Vulnerable and 3. Water Compatible e.g. flood infrastructure, docks, amenity open space **(Figure 2)**. As the Development of the Letter Wind Farm Project is essential infrastructure including electricity substations, it is considered a 'Highly vulnerable development' and should be located within Flood Zone C.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding;
	Hospitals;
	Emergency access and egress points;
	Schools;
	Dwelling houses, student halls of residence and hostels;
	Residential institutions such as residential care homes, children's homes and social services homes;
	Caravans and mobile home parks;
	Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and
	Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions;
	Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans;
	Land and buildings used for agriculture and forestry;
	Waste treatment (except landfill and hazardous waste);
	Mineral working and processing; and
	Local transport infrastructure.
Water-compatible development	Flood control infrastructure;
	Docks, marinas and wharves;
	Navigation facilities;
	Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location;
	Water-based recreation and tourism (excluding sleeping accommodation);
	Lifeguard and coastguard stations;
	Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and
	Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).

*Uses not listed here should be considered on their own merits

Figure 2: Classification of vulnerability of different types of development (OPW,2009).

Presented in **(Figure 3),** 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 3: Matrix of vulnerability versus flood zone to illustrate appropriate development and that are required to meet the Justification Test (OPW, 2009).

As outlined in **(Figure 4)** there is a sequential approach to mechanism in planning process (OPW, 2022), depending on the Flood Zone and the Justification Test.

Figure 4: Sequential approach mechanism in planning process (OPW,2022)

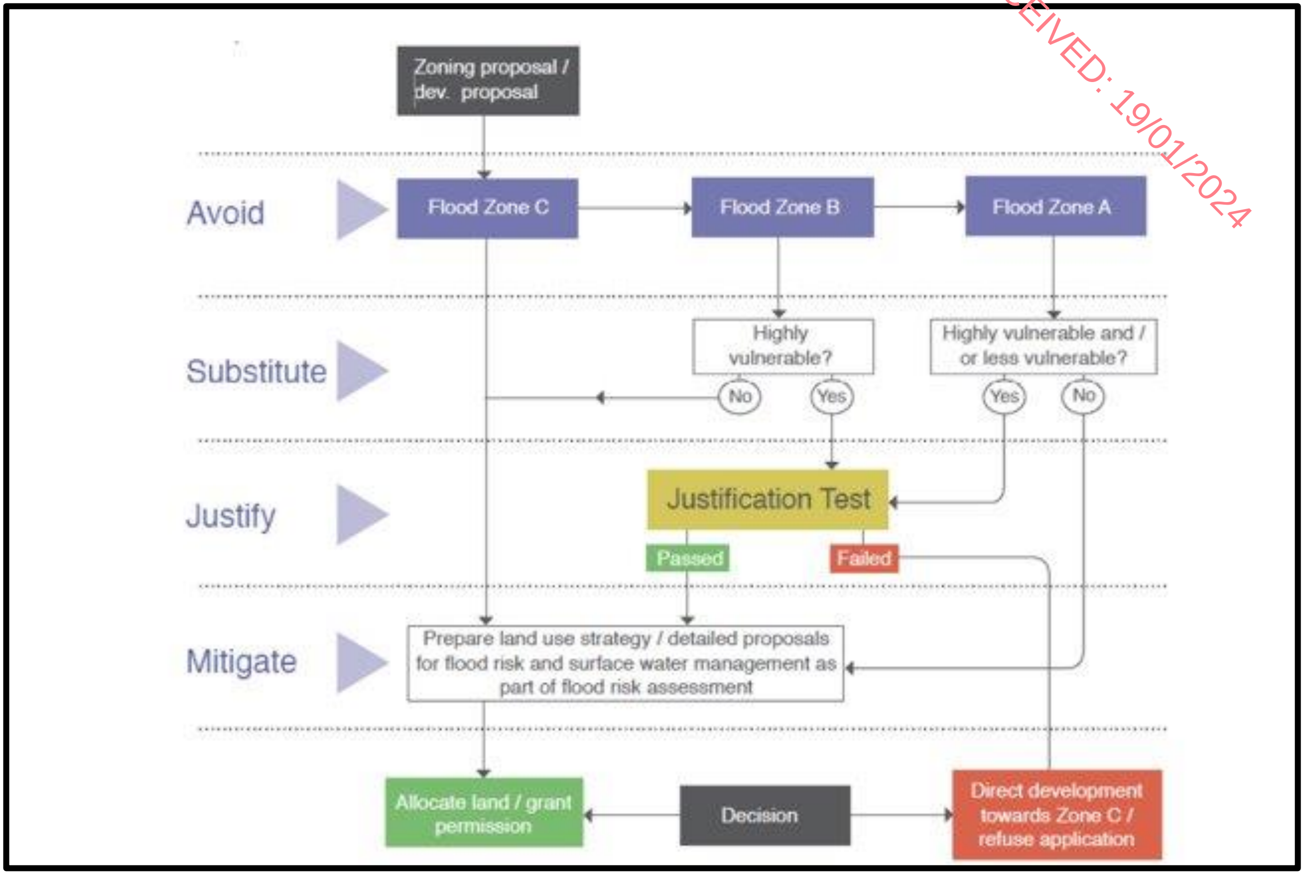


Figure 5: Sequential approach mechanism in planning process (OPW,2022)

Stage 1 – Flood Risk Identification

The flood risk identification stage was carried out in order to establish whether a flood risk exists within the redline boundary of the Site or the surrounding vicinity.

Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. First Edition 6-inch map (1839-1842) showed no historical hydrological features to note.

The National Indicative Fluvial Mapping database (Present Day) operated by the OPW has identified all surface waterbodies draining the Site: Owengar (Leitrim)_010, Diffagher_010 as being both low (0.1% AEP) and medium probability (1% AEP) risk to flood **(Figure 5).** There is one recorded reoccurring flood event on the OPW Database; Drummanfaughnan

Drumkeeran Recurring, located c.3.65km, south-east of the Site due to low-lying lands and river flooding incidents.

Figure 6: National Indicative Fluvial Maps, Present day, not considering Climate Change (OPW,2023).

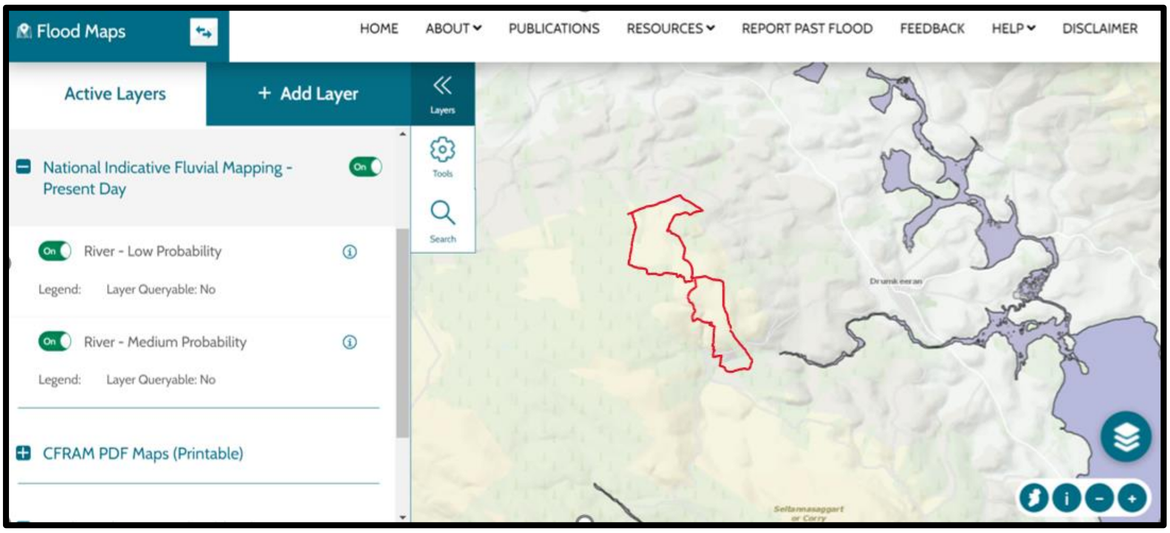


Figure 7: National Indicative Fluvial Maps, Present day, not considering Climate Change (OPW,2023).

Tidal Flooding

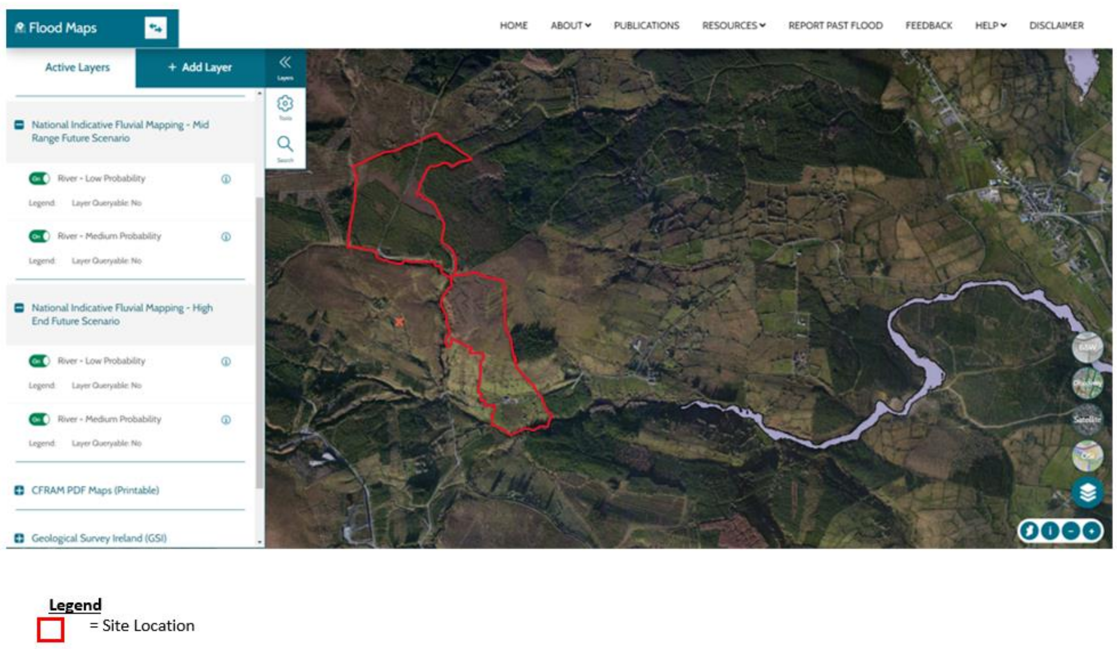
Tidal flooding is caused by elevated sea levels or overtopping by wave action. No coastal flood zones are identified at the Site or surrounding area. Sligo Bay is located 47.5 km north-west of the Site. Due to both the inland nature and elevation of the Site, the residual risk from tidal flooding is considered low.

Fluvial Flooding

Fluvial flooding is caused by rivers, watercourses or ditches overflowing. Historic flood maps dating (1839-1842), were reviewed for the Development and did not indicate a history of flooding at the site from small streams or tributaries found within or near Site boundaries.

The most recent, comprehensive flood-maps, produced by the OPW (2016) under the Shannon Catchment Flood Risk Assessment and Management (CFRAM) programme do not indicate any flood extents within the redline boundary, therefore all areas outside the

0.1% AEP flood extent (the Development), are classified as residing in Flood Zone C. CFRAM flood-maps confirm that the Development resides in Flood Zone C and is a suitable development for this area **(Figures 6 & 7).** It must be noted, that further downstream of both the Owengar (Leitrim)_010, Owengar (Leitrim)_020 (draining the Site), is mapped as a significant flood risk from fluvial sources near the town of Drumkeeran.



Site Name: Letter Wind Farm Project, Co. Leitrim	**Project No.**	603680	**Drawn By:**	Jayne Stephens Environmental Consultant
	Client:	**Jennings O Donovan**		
Figure Name: National Indicative Fluvial Maps, considering Climate Change(OPW,2023)	**Date:**	13/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Figure 8: National Indicative Fluvial Maps, considering Climate Change (OPW,2022).

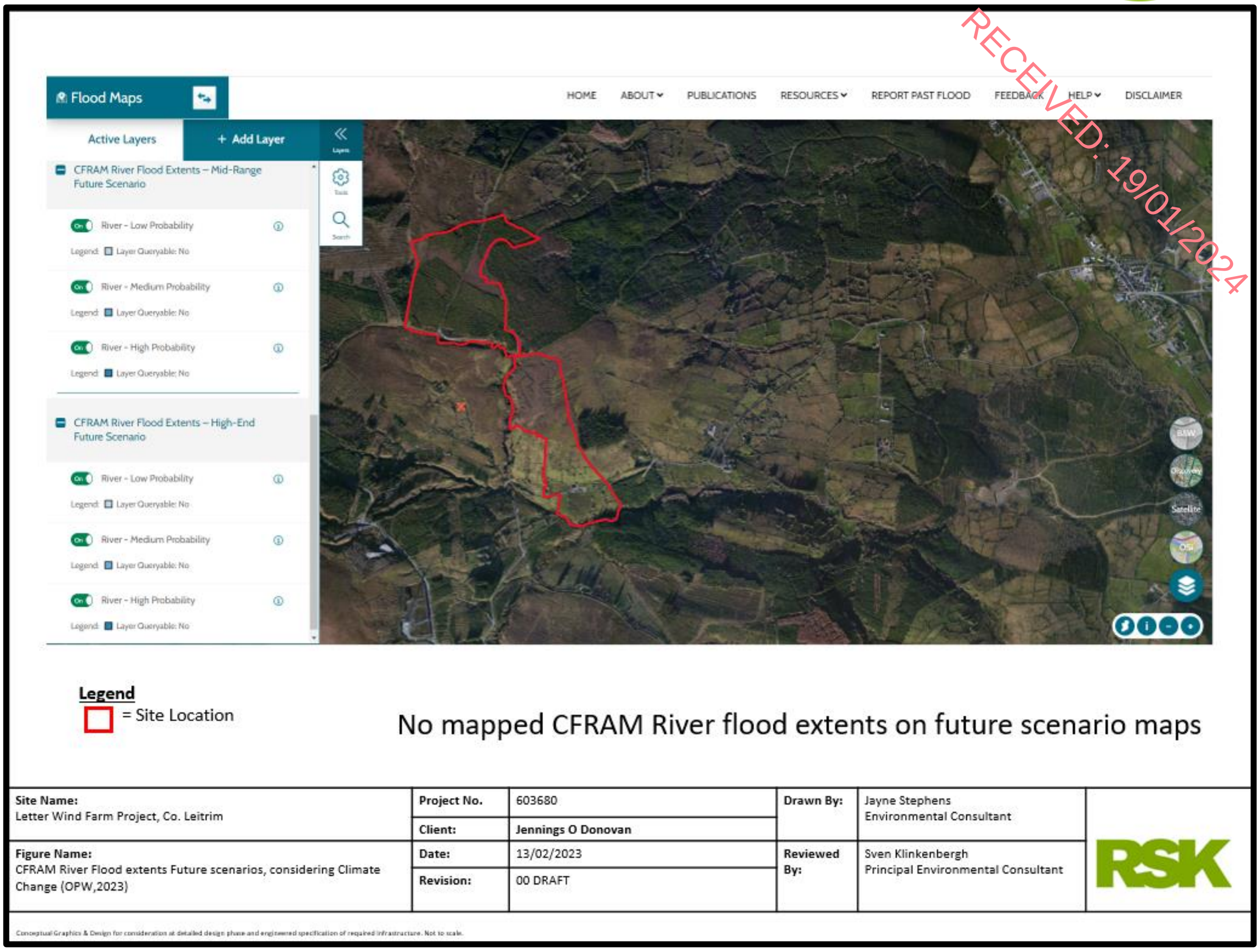


Figure 9: CFRAM River Flood extents scenarios, considering Climate Change (OPW, 2023).

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 Site, or surrounding area **(Figure 8)**. Therefore, the residual risk from pluvial flooding is considered low.

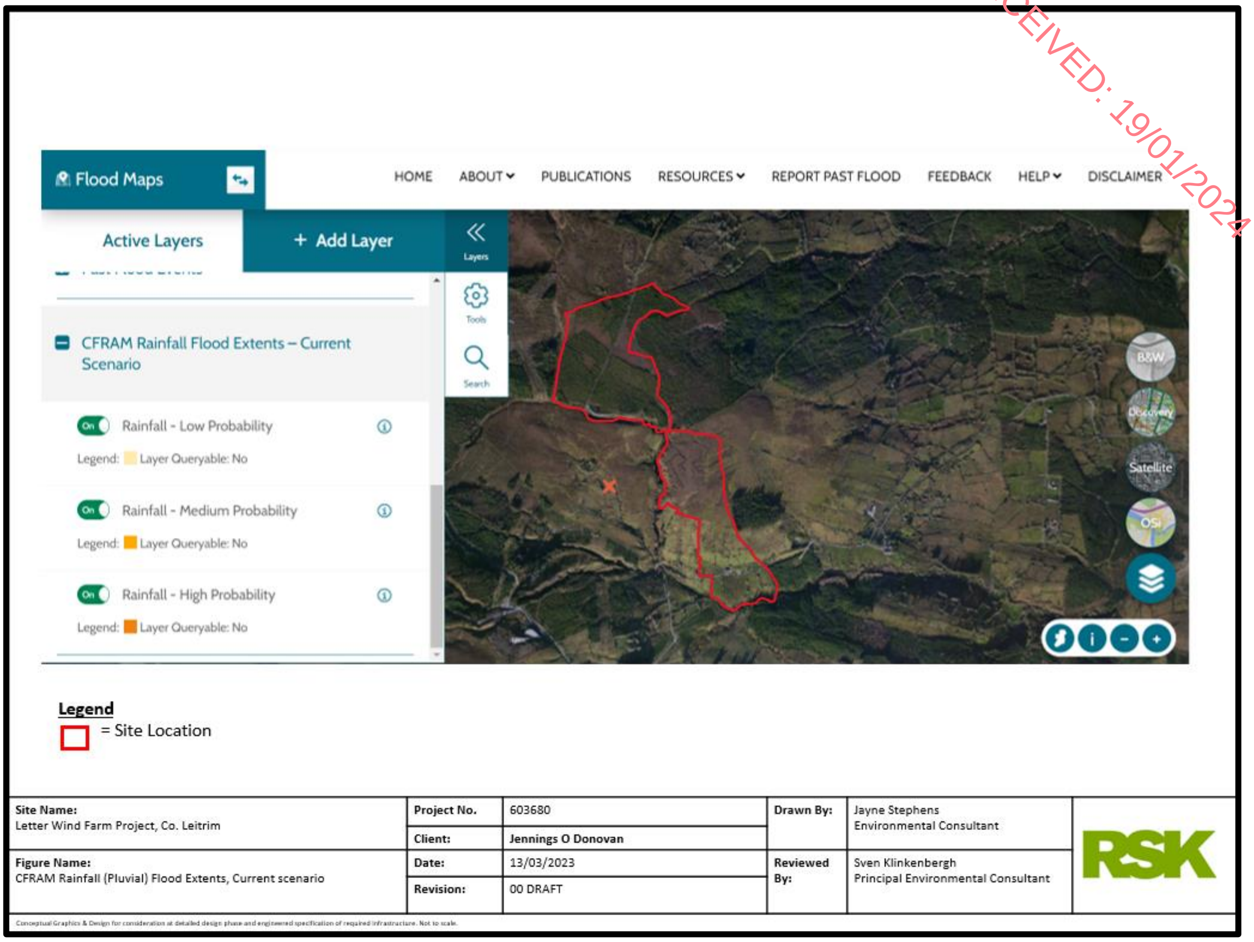
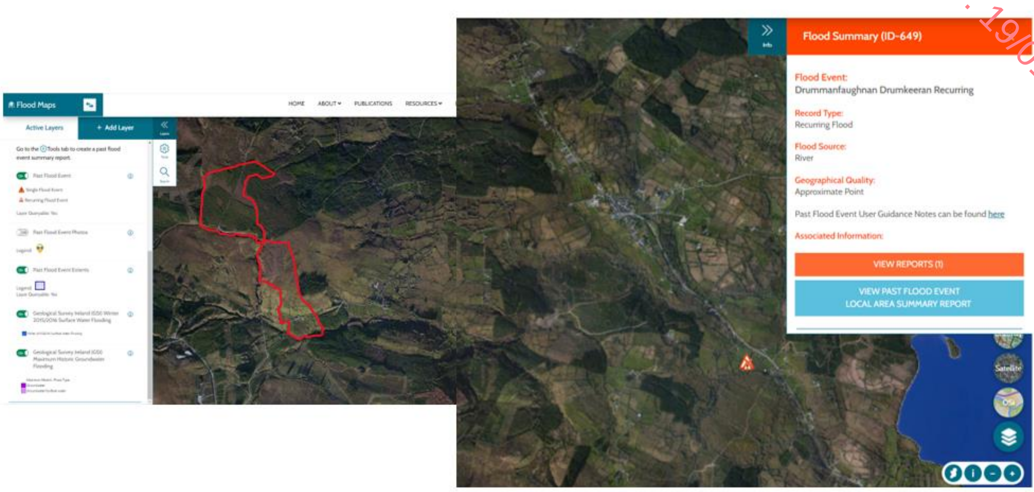


Figure 10: CFRAM Rainfall (Pluvial) Flood Extents, Current scenario

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. There has been no previously documented groundwater flooding within the redline boundary **(Figures 9 & 10).** According to the Geological Survey Ireland (GSI), Groundwater Flooding Probability Maps (2016-2019), there is no evidence of a Low, Medium or High Probability groundwater flooding event within the Site or near its vicinity **(Figure 11).** Therefore, the residual risk from groundwater flooding is considered low.



Legend

☐ = Site Location

Site Name: Letter Wind Farm Project, Co. Leitrim	**Project No.**	603680	**Drawn By:**	Jayne Stephens Environmental Consultant
	Client:	**Jennings O Donovan**		
Figure Name: Past flood events not considering Climate Change(OPW,2023)	**Date:**	27/02/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Figure 11: Past Flood events not considering Climate Change (OPW, 2023).

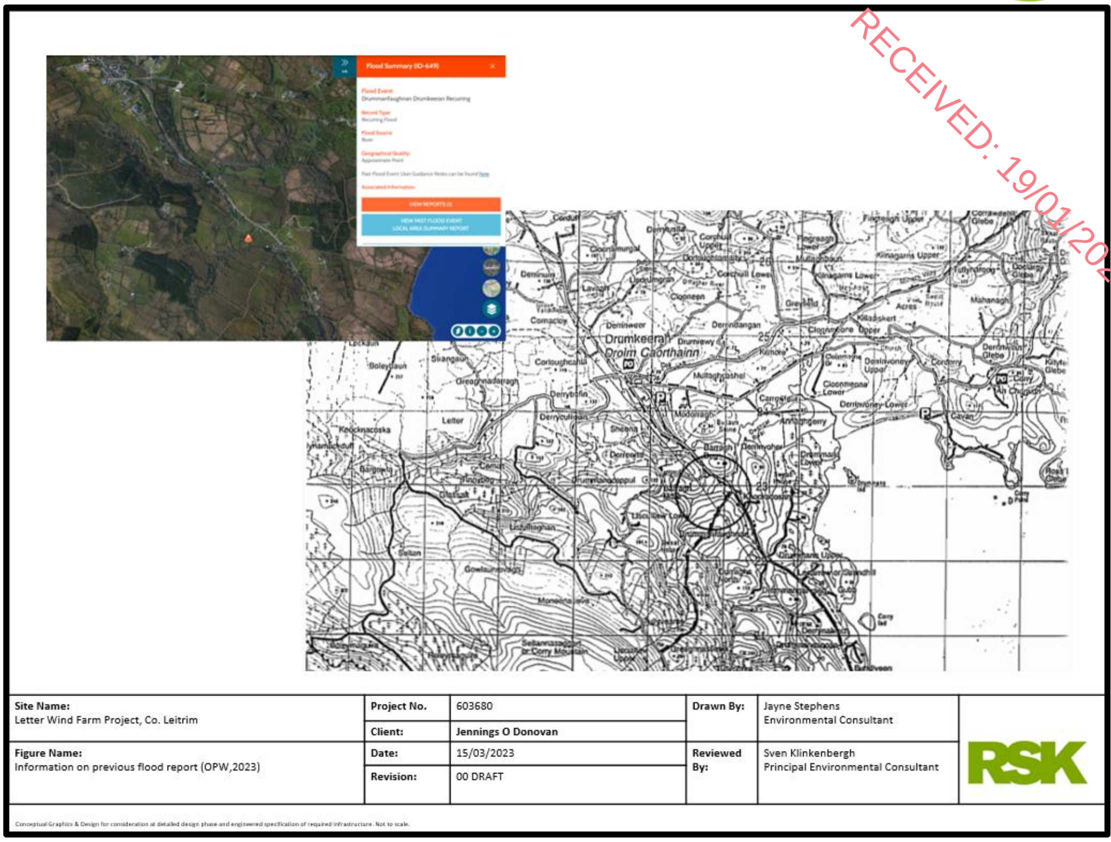


Figure 12: Information from previous flood report (OPW,2023).

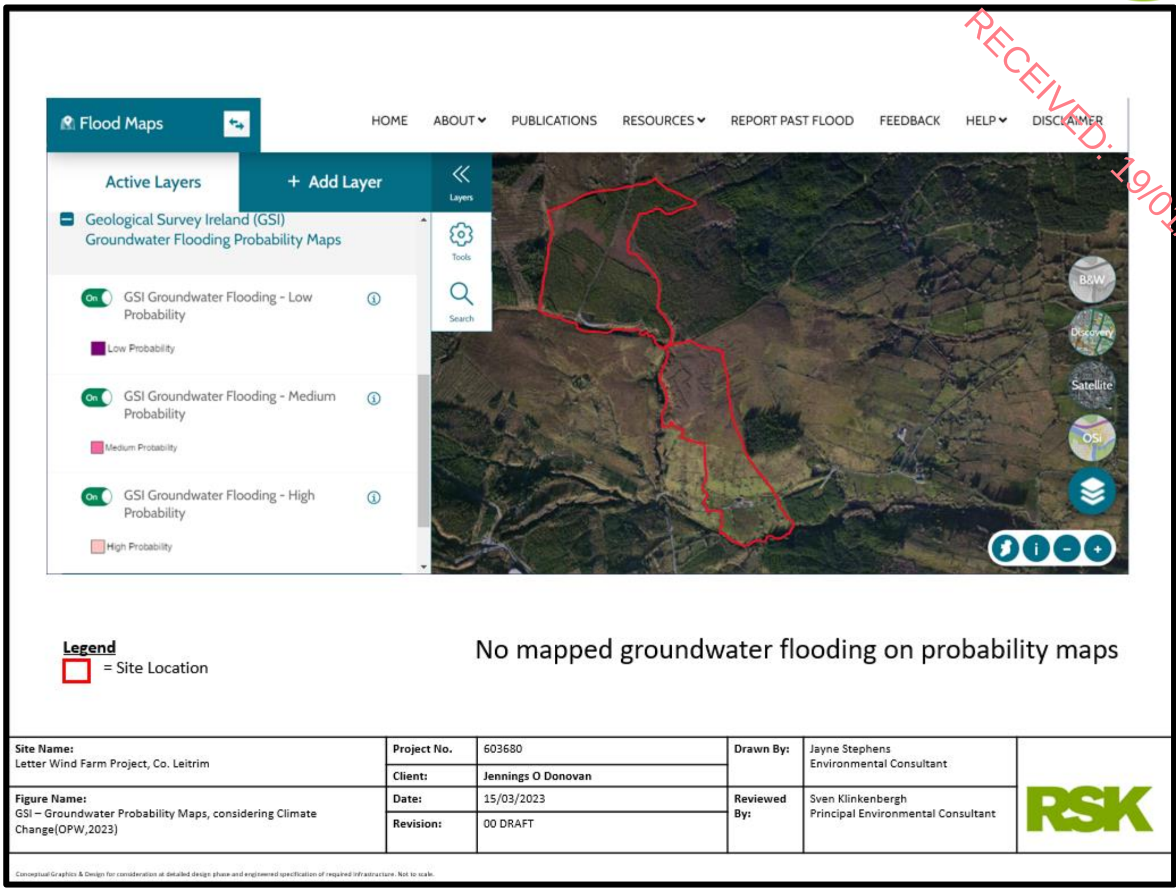


Figure 13: GSI - Groundwater Probability Maps, considering Climate Change (OPW, 2023).

Development

The Development comprising of new access roads, hardstands and associated ancillary infrastructure will include land take (Forestry/Agriculture) and the replacement of vegetated lands and soils with relatively impermeable surfaces. This 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.

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. There is currently no mapped drainage on the OPW Drainage maps, that reside within the redline boundaries of the Site **(Figure 12).**

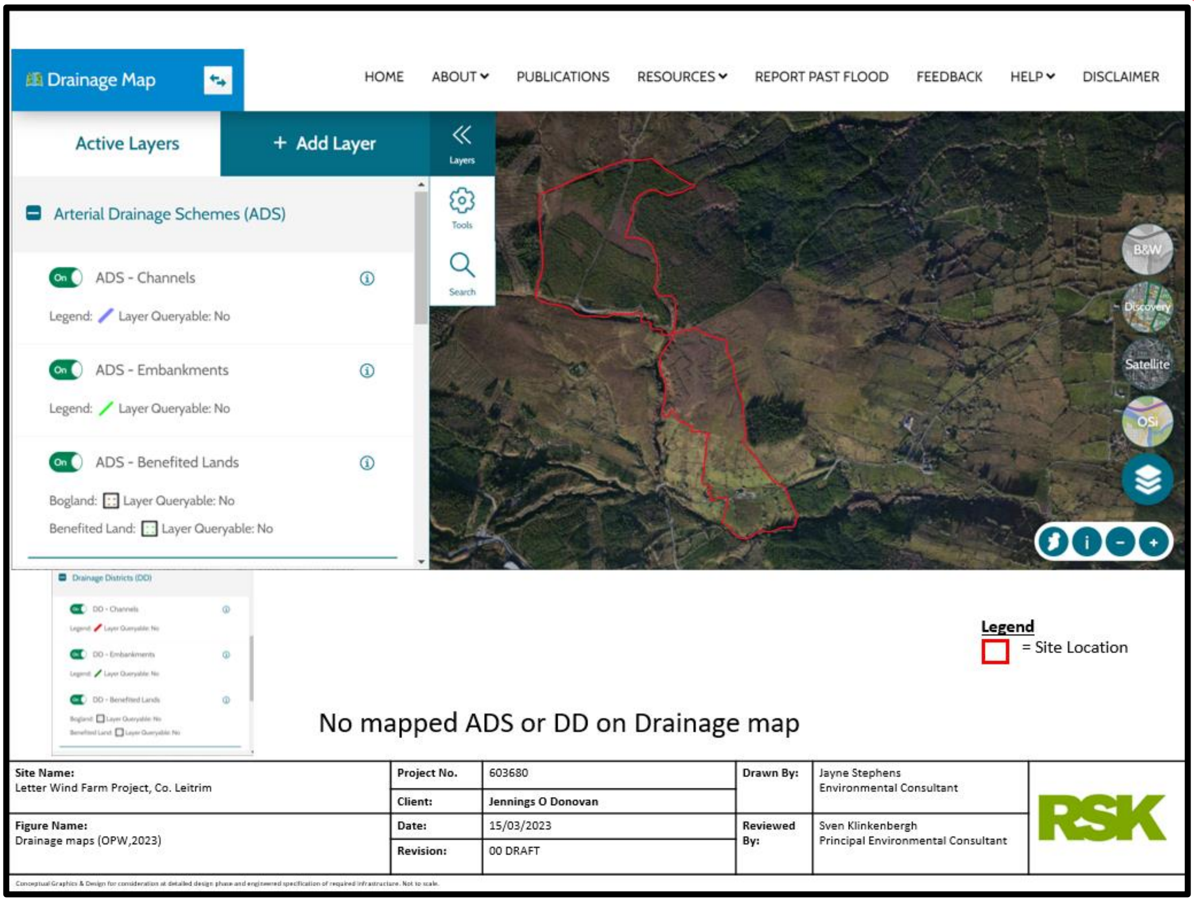


Figure 14: Drainage Maps (OPW, 2023).

Summary of Stage 1 Flood Risk Assessment

This Stage 1 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 is evidence of historic flooding in the areas south-east of the site (EIAR Chapter 9 Appendix 9.2 - Tile 2) **(Figure 9 & 10).** Comprehensive flood-maps, produced by the OPW (2016) under the Shannon Catchment Flood Risk Assessment and Management (CFRAM) programme confirm that the Site resides in a Flood Zone C.

Stage 1 Conclusion

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has identified no flood hazards for the Site. The nature of the development is industrial as opposed to residential or leisure, and as such, this type of development is categorised as a 'Less Vulnerable Development', according to FRM Guidelines. Therefore, the development is considered an 'appropriate' development for Flood Zone C.

The 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.

Stage 2 – Initial Flood Risk Assessment

Assessing Potential Impacts of Development

While the Shannon Catchment Flood Risk Assessment and Management (CFRAM) programme did not indicate any flood extents within the redline boundary of the Site, there are probable flood areas downstream of the Site. The closest mapped probable flood areas are associated with the Owengar_010 & Owengar_020 at;

- Beginning at Camalt townland approximately 0.5 kilometres south-east of the site which flows East towards Drumkeeran town.
- Barraghmore has a past and reoccurring flood event id: Drummanfaughnan Drumkeeran Recurring **(Figure 9 & 10).**
- Successive portions of Lough Allen and the Upper Shannon flowing South have been mapped with flood extents, they are:, Drumshanbo, Leitrim Town, Carrick on Shannon, Dromad, and Longford.

The number of recorded and reoccurring flood events downstream of the Site have the potential to be further adversely impacted should recommended mitigation measures not be put in place.

Assessing Potential Effects of Development – Increased Hydraulic Loading

Rainfall and Evapotranspiration

Rainfall data for the region associated with the Development 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.
- The above storm events plus allowance (+20%) accounting for climate change.

Data from the meteorological stations listed in **Table 1.1** are used in this assessment[5]. Using data presented in **Table 1.3,** storm event of 25 days duration with a 1 in 100 year return period is inferred to be 299.3mm. For the purpose of this assessment, predicted

[5] Met Eireann, Historical Data, Available at; www.met.ie, Accessed; February 2023

extreme or worst-case values are used, as presented in **Table 1.2: EIA Specific Assessment Data**.

Table 1.1 Meteorological Stations (Met Eireann, 2023)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	Drumkeeran (Voc.Sch) 1944 - 1987	2.5
Rainfall (Historical Monthly)	Dromahair (Market St)1960-2022	11
Rainfall (2022/23 Monthly/Daily)	Markree Castle 2005-2023	19.8
Evapotranspiration	Markree Castle 2005-2023	19.8

Table 1.2: EIA Specific Assessment Data (Met Eireann, 2023)

Category	Value (mm Rain)
Average Annual Effective Rainfall (Long term) (mm/year)	1,124
Max monthly effective rainfall (mm/month)	141.5
1 in 100 Year Rainfall Event (25 day duration) (mm/month)	299.3
1 in 100 Year Rainfall Event (25 day duration) (mm/month) +20% Accounting for Climate Change	359.16
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	39.3
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour) +20% Accounting for Climate Change	47.16

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Table 1.3: Met Eireann Return Period Rainfall Depths (Irish Grid; 188958, 32399)[6]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 188958, Northing: 32399,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	3.2,	4.3,	5.0,	5.9,	6.6,	7.0,	8.6,	10.4,	11.5,	13.2,	14.6,	15.7,	17.4,	18.7,	19.7,	N/A ,
10 mins	4.4,	6.1,	6.9,	8.3,	9.1,	9.8,	12.0,	14.5,	16.1,	18.3,	20.3,	21.8,	24.2,	26.0,	27.5,	N/A ,
15 mins	5.2,	7.1,	8.2,	9.7,	10.7,	11.5,	14.1,	17.0,	18.9,	21.6,	23.9,	25.7,	28.5,	30.6,	32.4,	N/A ,
30 mins	6.8,	9.3,	10.6,	12.5,	13.8,	14.8,	17.9,	21.4,	23.7,	26.9,	29.6,	31.8,	35.0,	37.6,	39.6,	N/A ,
1 hours	9.0,	12.1,	13.7,	16.1,	17.7,	18.9,	22.7,	26.9,	29.7,	33.5,	36.8,	39.3,	43.1,	46.1,	48.5,	N/A ,
2 hours	11.9,	15.8,	17.8,	20.7,	22.6,	24.1,	28.8,	33.9,	37.2,	41.7,	45.6,	48.6,	53.1,	56.6,	59.4,	N/A ,
3 hours	14.1,	18.5,	20.7,	24.0,	26.2,	27.8,	33.1,	38.7,	42.4,	47.4,	51.7,	55.0,	60.0,	63.8,	66.9,	N/A ,
4 hours	15.8,	20.6,	23.1,	26.7,	29.0,	30.8,	36.5,	42.6,	46.5,	51.9,	56.5,	60.1,	65.4,	69.4,	72.7,	N/A ,
6 hours	18.6,	24.1,	26.9,	30.9,	33.6,	35.6,	41.9,	48.7,	53.1,	59.0,	64.1,	68.0,	73.8,	78.3,	81.9,	N/A ,
9 hours	21.9,	28.1,	31.3,	35.9,	38.8,	41.1,	48.1,	55.7,	60.5,	67.1,	72.7,	77.0,	83.4,	88.2,	92.2,	N/A ,
12 hours	24.6,	31.4,	34.9,	39.8,	43.0,	45.5,	53.1,	61.3,	66.5,	73.5,	79.5,	84.1,	90.9,	96.1,	100.3,	N/A ,
18 hours	28.9,	36.7,	40.6,	46.2,	49.8,	52.5,	61.0,	70.1,	75.8,	83.5,	90.2,	95.2,	102.7,	108.3,	112.9,	N/A ,
24 hours	32.5,	41.0,	45.2,	51.3,	55.2,	58.1,	67.3,	77.1,	83.2,	91.5,	98.6,	103.9,	111.9,	117.9,	122.8,	139.3,
2 days	41.6,	51.4,	56.2,	63.0,	67.3,	70.5,	80.6,	91.1,	97.6,	106.4,	113.8,	119.4,	127.6,	133.8,	138.8,	155.6,
3 days	49.2,	60.0,	65.3,	72.6,	77.3,	80.8,	91.5,	102.7,	109.6,	118.8,	126.6,	132.4,	141.0,	147.4,	152.6,	169.8,
4 days	56.0,	67.7,	73.3,	81.2,	86.2,	89.9,	101.3,	113.0,	120.2,	129.9,	138.0,	144.0,	152.9,	159.5,	164.9,	182.6,
6 days	68.2,	81.4,	87.7,	96.4,	101.9,	106.0,	118.4,	131.1,	139.0,	149.3,	158.0,	164.4,	173.8,	180.9,	186.5,	205.1,
8 days	79.2,	93.6,	100.5,	109.9,	115.9,	120.3,	133.6,	147.2,	155.5,	166.5,	175.7,	182.4,	192.3,	199.7,	205.6,	225.0,
10 days	89.5,	105.0,	112.4,	122.5,	128.8,	133.5,	147.7,	162.0,	170.8,	182.3,	191.8,	198.9,	209.3,	216.9,	223.1,	243.2,
12 days	99.3,	115.8,	123.6,	134.3,	141.0,	145.9,	160.8,	175.9,	185.0,	197.0,	207.0,	214.3,	225.0,	233.0,	239.3,	260.1,
16 days	117.6,	136.0,	144.6,	156.4,	163.7,	169.1,	185.2,	201.5,	211.3,	224.2,	234.9,	242.7,	254.1,	262.6,	269.3,	291.2,
20 days	135.0,	155.0,	164.3,	177.0,	184.8,	190.6,	207.9,	225.3,	235.7,	249.3,	260.6,	268.9,	280.9,	289.7,	296.8,	319.7,
25 days	155.7,	177.5,	187.6,	201.3,	209.8,	216.0,	234.6,	253.1,	264.2,	278.7,	290.6,	299.3,	312.0,	321.4,	328.8,	352.8,

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 Eireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods , Accessed; March 2023

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. 6,960m^2
- New access road / turning points / lay-by = c. 8,790m^2
- Substation / other Hardstand = c. 53.56575m^2 x 1 no.
- 1 in 100 year rainfall event = c. 39.3mm of rainfall in 1 hour.
- Recharge capacity = 60% 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).
- There is limited river discharge rate (Q) including discharge percentile data available for surface water features associated with the site. However, consultation of the EPA Hydronet map viewer **(Figure 13)** indicates that the estimated River Discharge (Q) at

  - Owengar_010 Hydrometric station (ID: 26_1191) situated c. 1.2 kilometres downstream of the Site on the River Owengar has been observed to reach up to c. 0.333m3/second (December).
  - Diffaghar Hydrometric station (ID: 26_3435) situated c. 2.5 kilometres from Site, has been observed to reach c. 2.265m3/second (December).
  - Owengar_020 Hydrometric station (ID: 26_1312) situated c. 5.18 kilometres from the site has been observed to reach up to c. 4.334m3/second (January).

Figure 15: Hydrometric stations used for River discharge rates, (OPW, 2023).

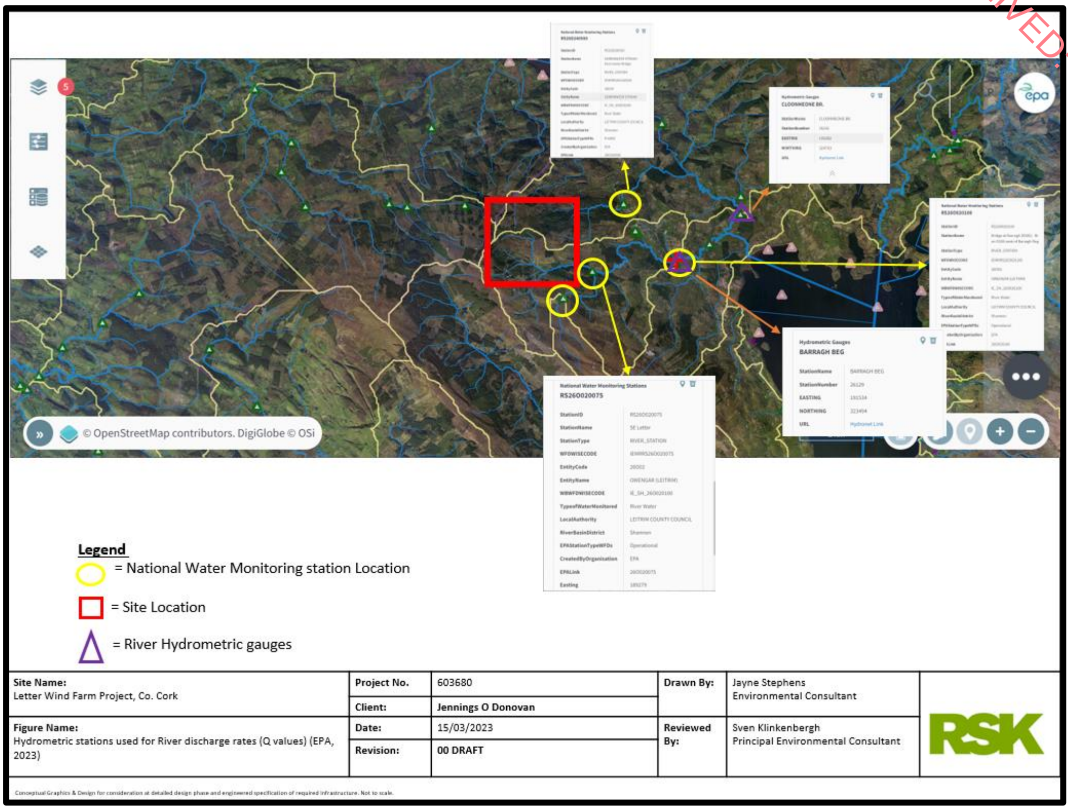

Figure 16: Hydrometric stations used for River discharge rates, (OPW, 2023).

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)).

Table 1.4 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1 in 100 year storm event.

Table 1.5 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 1.4: 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.	1740	1	1740	0.0326	20.00%	0.02608	45.38	0.01		0.00%	0.0326	56.72	0.02		
SW1	New Access Track / hardstand	m				0.0326	20.00%	0.02608	-	-		0.00%	0.0326	-	-		
SW1	**Subtotal**										0.01					0.02	**0.003**
SW2	Turbines Hardstand	No.	1740	1	1740	0.0326	20.00%	0.02608	45.38	0.01		0.00%	0.0326	56.72	0.02		
SW2	Met Mast	No.	240	1	240.00	0.0326	20.00%	0.02608	6.26	0.00		0.00%	0.0326	7.82	0.00		
SW2	New Access Track / hardstand	m			2,754.00	0.0326	20.00%	0.02608	71.82	0.02		0.00%	0.0326	89.78	0.02		
SW2	**Subtotal**										0.03					0.04	**0.009**
SW3	Turbines Hardstand	No.	1740	2	3,480.00	0.0326	20.00%	0.02608	90.76	0.03		0.00%	0.0326	113.45	0.03		
SW3	Substation Hardstand	No.	53.56575	1	53.57	0.0326	20.00%	0.02608	1.40	0.00		0.00%	0.0326	1.75	0.00		
SW3	New Access Track / hardstand	m			3,741.00	0.0326	20.00%	0.02608	97.57	0.03		0.00%	0.0326	121.96	0.03		
SW3	**Subtotal**										0.05					0.07	**0.013**
													Total	**448.20324**	**0.12**	**0.12**	**0.025**

Table 1.5: Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes

Proposed Dvelopment Baseline Run off Volumes (1 in 100 Year Hour Storm Event)

Proposed Development					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 (%)	Indicative High Water Discharge (Q) Rate <15km downstream. (m3/sec)	
Letter					445,000.00	0.0393	20.00%	0.03144	13,990.80	3.89	0.102	2.61%	20.00	0.51%
								Total	**13990.8**	**3.89**	**0.102**	2.61%	**20.000**	0.51%

Water balance calculations allow for the addition of area for hardstand infrastructure required (land take) during the construction and operational phases of the Development. This equates to approximately 17,228.57m^2. 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. 0.102m^3/second, or 0.26% 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.

Mitigation Measures Associated with the Development

Flood Relief Schemes, outlined by the OPW, currently in place downstream of the Site are listed below.

- Leitrim Village Flood Relief Scheme. Progress the development of a Flood Relief Scheme for Leitrim. – Downstream of site
- Carrick on Shannon Flood Relief Scheme. Stage I: Scheme Development and Preliminary Design. – Downstream of site

These include Measures Applicable in All Areas, which are detailed as:

- Sustainable Urban 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. A Hydrograph is presented in **(Figure 14)**, if SUDS measures are not in place following an increase in sealed land, rainfall and surface waters would peak following the blue peak. In development where SUDS measures are implemented the rainfall and surface water levels will follow the red line as water is retained and released and a slower discharge rate.
- 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 **(EIAR – Chapter 8: Soils and Geology)** (such as restoration of A wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.
  - There are currently no future Flood Relief Schemes proposed in Co. Leitrim.

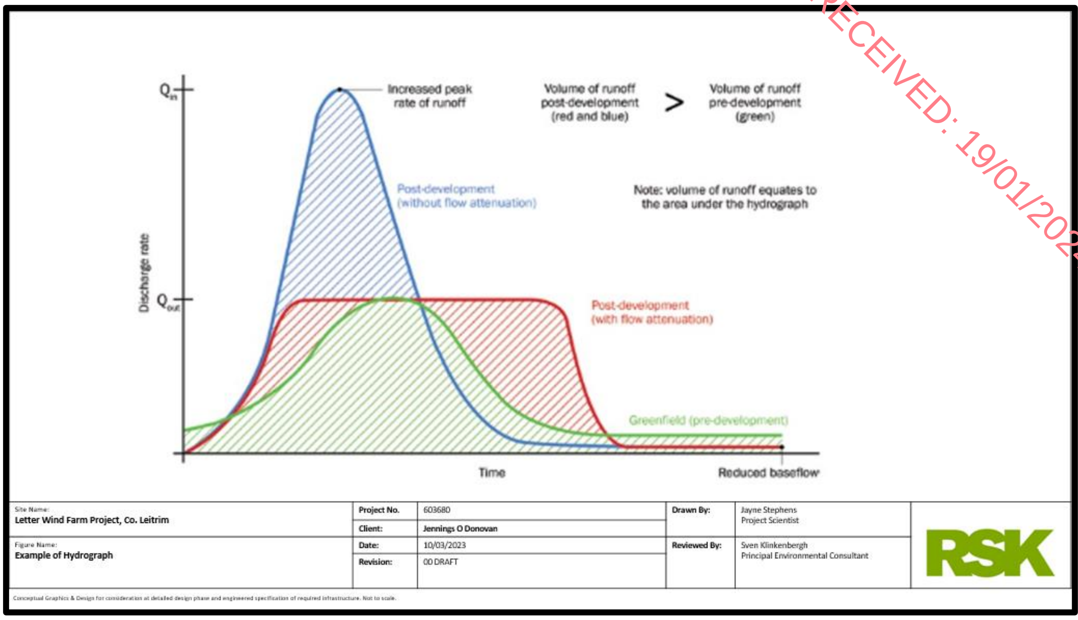

Figure 17: Example of a Hydrograph.

Under the 2019-2020 Work Programme of the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD) (European Union, 2018), the Working Group Programme of Measures has built on the previously 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).

In the 2019-2020 work programme of CIS for the WFD (European Union, 2018), it was identified that River Basin Management and flood Risk Management are key to achieving the goals set out in the Sustainable Development Goals (SDG6).

Flood Relief Schemes and flood risk management Objectives such as Land Use Management and Natural Flood Risk Management are relevant to the Development, whereby; the assessment and design of 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
- 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 as calculated in **Table 1.5,** 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
- UK Department for the Environment, Food, and Rural Affairs (DEFRA) (2010) Surface Water Management Plan Technical 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 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 5 & 6**).

- Detailed design and specification of drainage, attenuation and associated infrastructure have been included in a detailed Surface Water Management Plan (SWMP, **Management Plan 3** in the **CEMP**, **Appendix 2.1**) 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.

FRA Stage 2 – Conclusions

A 1 in 100 year storm event scenario results in a net increase of surface water runoff associated with the Site, calculated to be c. 0.102m3/second, or 0.26% 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 Development will 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.

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) (**Appendix 2.1, Management Plan 3)** has been prepared prior to the construction phase commencing, 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. It is recommended that this is done in consultation with relevant stakeholders.

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

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