Prepared for; Jennings O' Donovan

Jennings O' Donovan

Moanmore Lower Windfarm (MLWF)

Site Specific Flood Risk Assessment (SFRA)

Project no. 604009 (01) MLWF

March 2025

RSK GENERAL NOTES

Project No.: 604009 (01)

Title: Moanmore Lower Windfarm (Wind Farm Site) Flood Risk Assessment

Client: Jennings O'Donovan

Date: 20th March 2025

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Status: FINAL

Author	Jayne Stephens	**Technical reviewer**	Sven Klinkenbergh/ David Kiely
Signature		Signature	
Date:	24/09/2024 04/10/2024	Date:	04/10/2024 20/03/2025

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

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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 the Developer. The assessment is in support of the planning application for the Moanmore Lower Wind Farm (MLWF, the Project) in Co. Clare.

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.

1.1 Statement of Authority

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: Jayne Stephens - B.S.c (Environmental Science), PhD (Environmental and Infection Microbiology). Current Role: Senior Environmental Consultant
- Principal Environmental Consultant: Sven Klinkenbergh - B.Sc. (Environmental Science), P.G. Dip. (Environmental Protection). Current Role: Principal Environmental Consultant, Experience c. 10 years

2 SOURCES OF INFORMATION

2.1 Desk Study

2.1.1 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].

2.1.2 Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Kilrush Catchment Flood Risk Management Plan (CFRAM) were investigated to 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]

2.1.3 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].

2.1.4 OSI

Records from the National mapping agency of Ireland, the Ordnance Survey and historic mapping (6inch and 25inch maps from 1925), were studied, on the websites interactive GeoHive Map Viewer[4].

2.1.5 Limitations

Reliance has been placed on factual and anecdotal data obtained from the sources identified. RSK cannot be held responsible any omissions, misrepresentations, errors or

1 EPA Unified GIS Application (2022), Water Framework Directive (WFD), surface water and hydrogeological features https://gis.epa.ie/EPAMaps/Water [Accessed, 25/07/2024]

2 OPW Flood Maps and Catchment Flood Risk Assessment and Management (CFRAM) Programme (2024)

3 Geological Survey Ireland Spatial Resources (2024)

4 Government of Ireland and Ordnance Survey Ireland (2024)

inaccuracies with the supplied information. This Flood risk assessment has been completed with the objective to ensure flood risk is minimised where possible and mitigated against effects from the Project. It is based on current site conditions as surveyed on 29/6/2022, 25/08/2023, 14/03/2024 and the available information provided by the client, the OPW maps and EPA maps. 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. However, conclusions can only sensibly be arrived at upon detailed design stages. 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.

3 SITE DESCRIPTION

3.1 Location

Site Name: Moanmore Lower Windfarm (Wind Farm Site)

Site Address: Moanmore Lower Windfarm Site, Kilrush Co. Clare

Site National Grid Reference: 098156 E, 158171 N

The proposed site is situated c. 5 km north-west of Kilrush in Co. Clare.

In terms of land use, the Site is comprised mainly of agricultural lands and peatland, with existing roads and some dwellings/ farms/ yards in the locality. The area is characterised by relatively flat lying topography with associated elevations ranging between 8 to 16mAOD and an average slope of 2.5°, ranging from between 0.1 and 24.5°.

The Site refers to the windfarm site. Assessed in this Flood Risk Assessment is the Redline Boundary (RLB), which includes the GCR and TDR works; to note there are minimal works associated with the GCR and TDR works (Blade transfer area and vertical alignment) and works will take place within existing roads. The total Redline Boundary for the Project is c. 36.76Ha or 367663m².

3.2 Site Hydrology

The Project (RLB) is situated within the Shannon Estuary North Catchment (ID: 27, Area: C. 1651.27 km^2). Surface water runoff associated with the Site drains into Wood SC 010 sub catchments and the Moyasta_010 River Sub Basin. Surface waters drain from the Site and eventually combine in the Mouth of the Shannon, which eventually flow to Atlantic Sea. In terms of local drainage and non-mapped surface water features, the windfarm site is characterised by artificial drainage networks including agricultural and land reclamation / improvement works, and cut drains in peat and peat cutting activities.

3.3 Site Soil & Subsoil Geology

Consultation with published soil maps compiled by GSI, Teagasc and the EPA, specify that soil types across the Site includes cut over raised peat. The site is indicated as "Low" to "Moderate" Groundwater Vulnerability.

Consultation with available subsoil maps, indicate that subsoil types across the Site includes till derived from Namurian Sandstone, shale and cutover raised peat. A small area east of T1 is marked with eskers comprised of gravels of acidic reaction (AcEsk), which is associated with higher groundwater vulnerability[5].

Observations and data obtained during site investigation surveys, as outlined in the Peat Stability Risk assessment, support the findings of the desk study, as stated in the preceeding paragraphs. Pockets of raised peat were observed south of T2, with high water content observed at numerous existing peat cutting locations around T2. Till was observed along the existing Site tracks to T1 and T3, which is associated with agricultural practices in the area[6]..

3.4 Site Hydrogeology

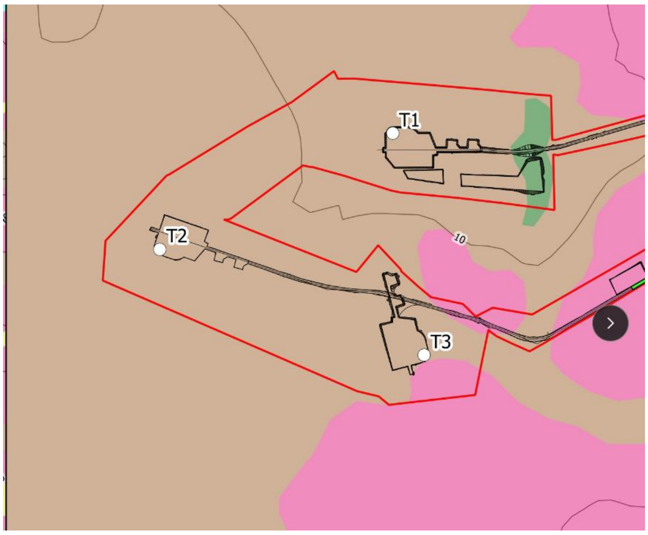
Consultation with GSI Groundwater maps indicates that the Site is underlain by a locally important aquifer (LI) which is moderately productive only in local zones.
There are no mapped karst features within 32km of the Development.

3.5 Groundwater Vulnerability & Recharge

Consultation with the GSI Groundwater Map Viewer indicates that the site is predominantly underlain by Moderate Groundwater Vulnerability.

Areas of the Site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 27 mm effective rain fall.

[5] https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228
[6] https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228



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**.** This implies that 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. As such, the surface water network associated with the Site is characterised as having a rapid hydrological response to rainfall, with the exception of the area east of T1 and southeast of T3 which has a high recharge rate. The subsoil permeability across the Site is low except in the area east of T1, where the esker sands and gravels has high subsoil permeability.

3.6 Proposed Development

The proposed Development, MLWF is comprised of 3 no. proposed wind turbines. Each portion of the site is connected via existing and proposed access tracks, including connection to the on-site substation. The proposed Development site is situated amongst rural agricultural land.

4 FLOOD RISK ASSESSMENT

4.1 Introduction

4.1.1 Guidelines for FRAs

This Flood Risk Assessment Report follows the guidelines set out in the DEHLG/OPW *Guidelines on the Planning Process and Flood Risk Management* published in November 2009. This assessment addresses 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.

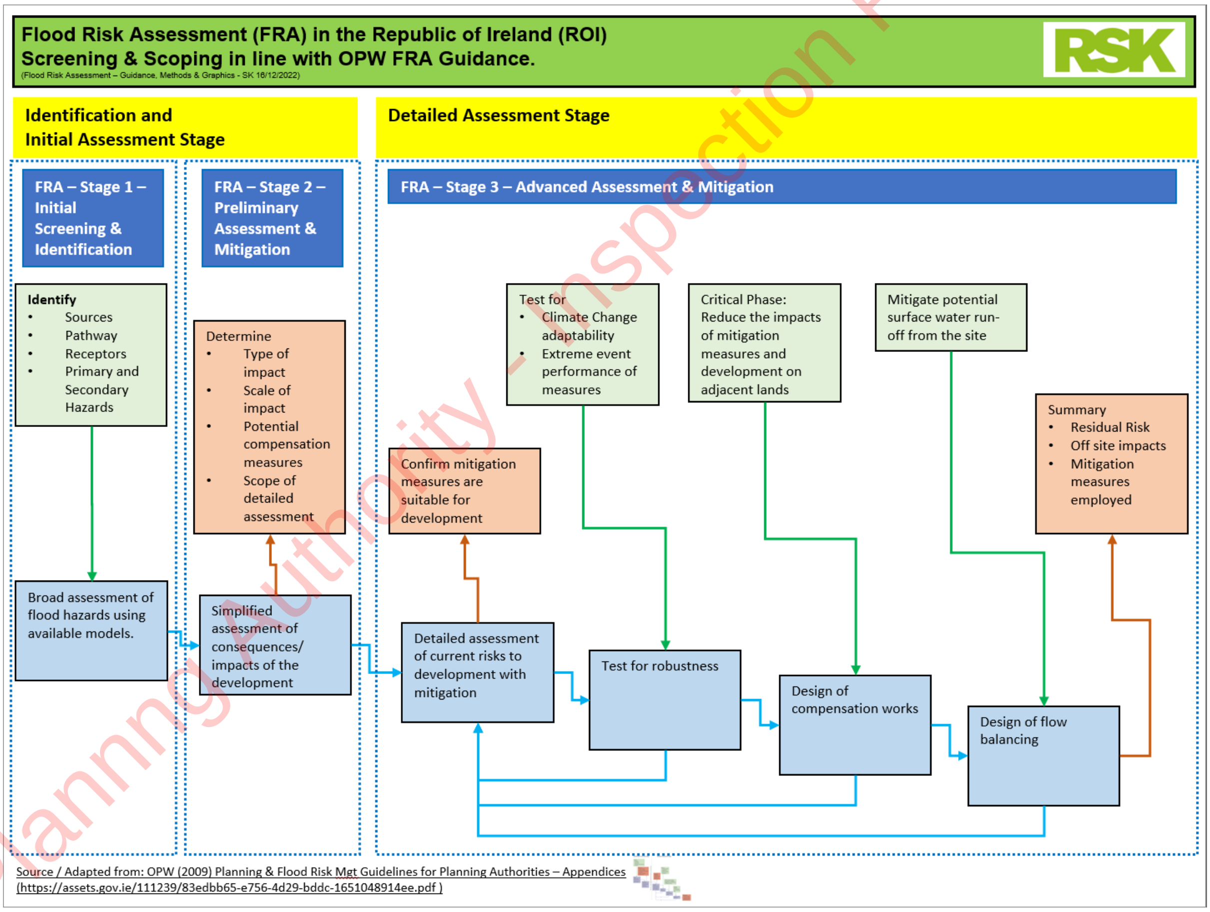


Figure 4.1: Scoping and Screening for an FRA

Flood Risk Assessment comprises up to three stages in line with DEHLG Guidelines for Planning Authorities – Flood Risk Management (2009). These are set out as follows:

Flood Risk Assessment Stage 1,

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 (**Figure 4.1**);

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.

4.1.2 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).

4.1.3 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).*

4.1.4 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 4.2 – Typical 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 4.2: Typical 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. 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. As the development of the Moanmore Lower Wind Farm Development is essential infrastructure including electricity substations, it is considered a 'Highly vulnerable development'.

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 4.3: Classification of Vulnerability of Different Types of Development (OPW, 2009)

Presented in **Figure 4.4,** 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 4.4: Matrix of Vulnerability Versus Flood Zone to Illustrate Appropriate Development and that Required to Meet the Justification Test (OPW, 2009)

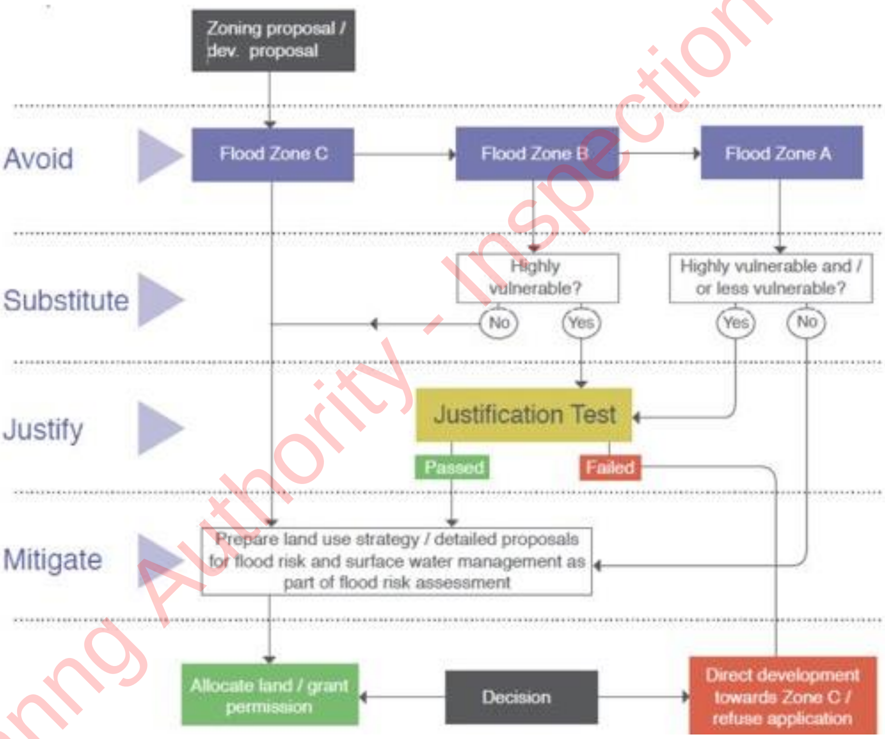


Figure 4.5: Sequential Approach to Mechanism in Planning Process (OPW, 2022)

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. **Table 4.1** summaries the preliminary screening of flood maps provided by the OPW.

4.2.1 Flood Risk Management Plans

The Site is not situated in an area that is included and assessed under OPW (2018) flood risk management plan, nor is the Site situated within the Area for Further Assessment (AFA) identified in flood risk management plan for the area.

4.2.2 Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. First Edition 6-inch map (1839-1842) and the Map Genie 25-inch map indicates that the site itself does not flood (Figure 4.6). However, downstream of the site, close to the mouth of the Shannon (coastal waterbody), there is an area which is liable to flooding (**Figure 4.7**). At that location, which is approximately 2.7 kilometres downstream of the site, a flood event was recorded on the Moyasta in 2014. A second historic flood event occurred in 2015/2016 winter flood which is located 1.27km downstream of the site (**Figure 4.7**).

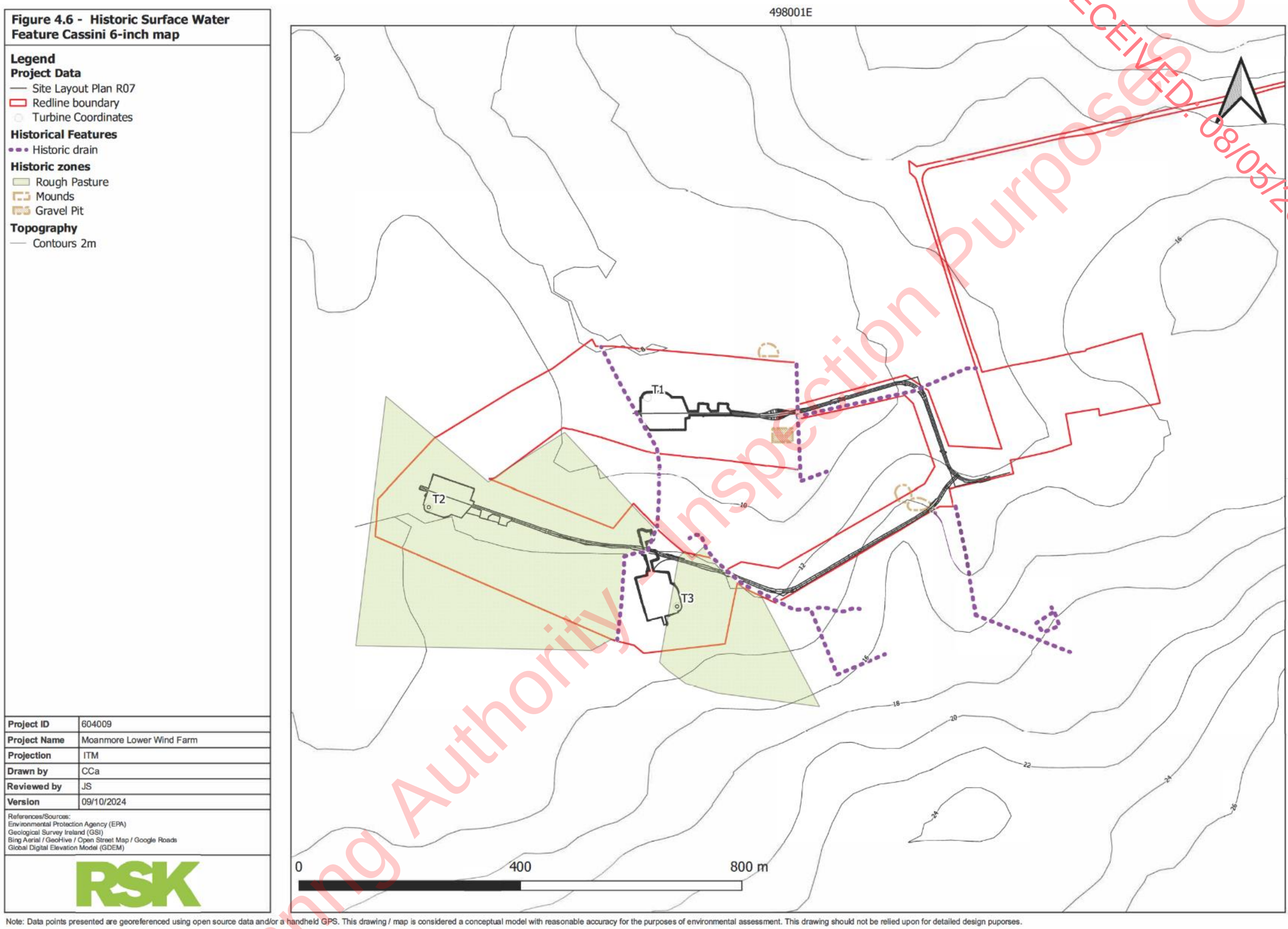


Figure 4.6: Historic surface water feature Cassini 6-inch map

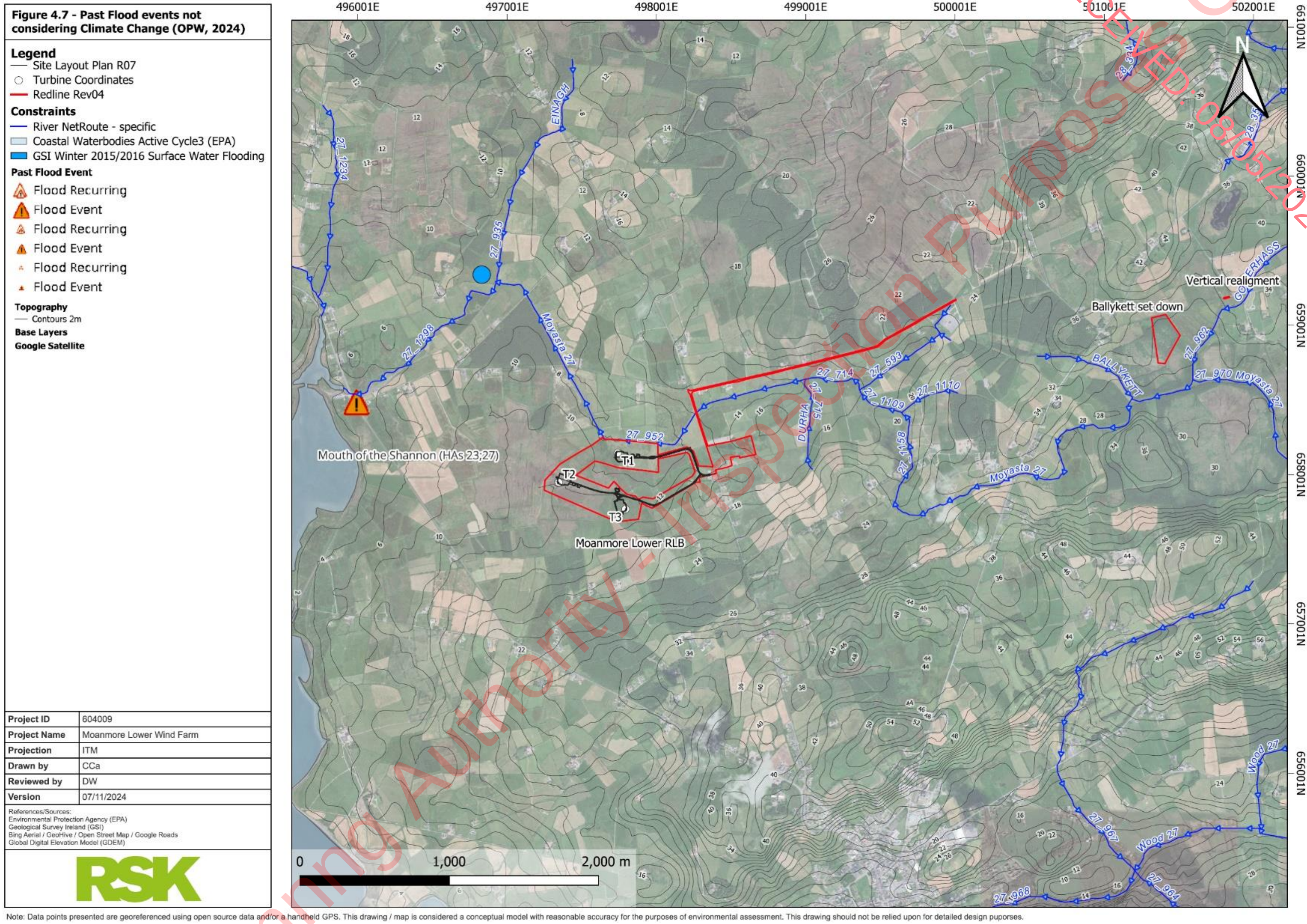


Figure 4.7: Past flood events not considering climate change (OPW, 2024)

4.2.3 Tidal Flooding

Tidal flooding is caused by elevated sea levels or overtopping by wave action. There has been tidal flooding recorded approximately 5 km from the site in Kilrush, but none on site. Tidal flood risk is now screened out of this assessment.

4.2.4 Fluvial Flooding

Fluvial flooding is caused by rivers, watercourses or ditches overflowing. National indicative fluvial mapping present day scenarios at low and medium probability, indicate flooding within the proposed Site Boundaries (**Figure 4.8 & 4.9**). The National indicative Flood Mapping for future scenarios database operated by the OPW also confirms there are areas represented as being low, medium or high probability risk to flood areas within Site boundaries (**Figure 4.10**). However, a recent, comprehensive flood-map, produced by the OPW (2018) under the Kilrush Catchment Flood Risk Management Plan (CFRAM) programme has not indicated flood extents within the proposed Site boundaries.

A portion of the site is inside Flood Zone A. 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 infrastructure located here would be vulnerable. Other areas of the site lie within Flood Zone B. 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).

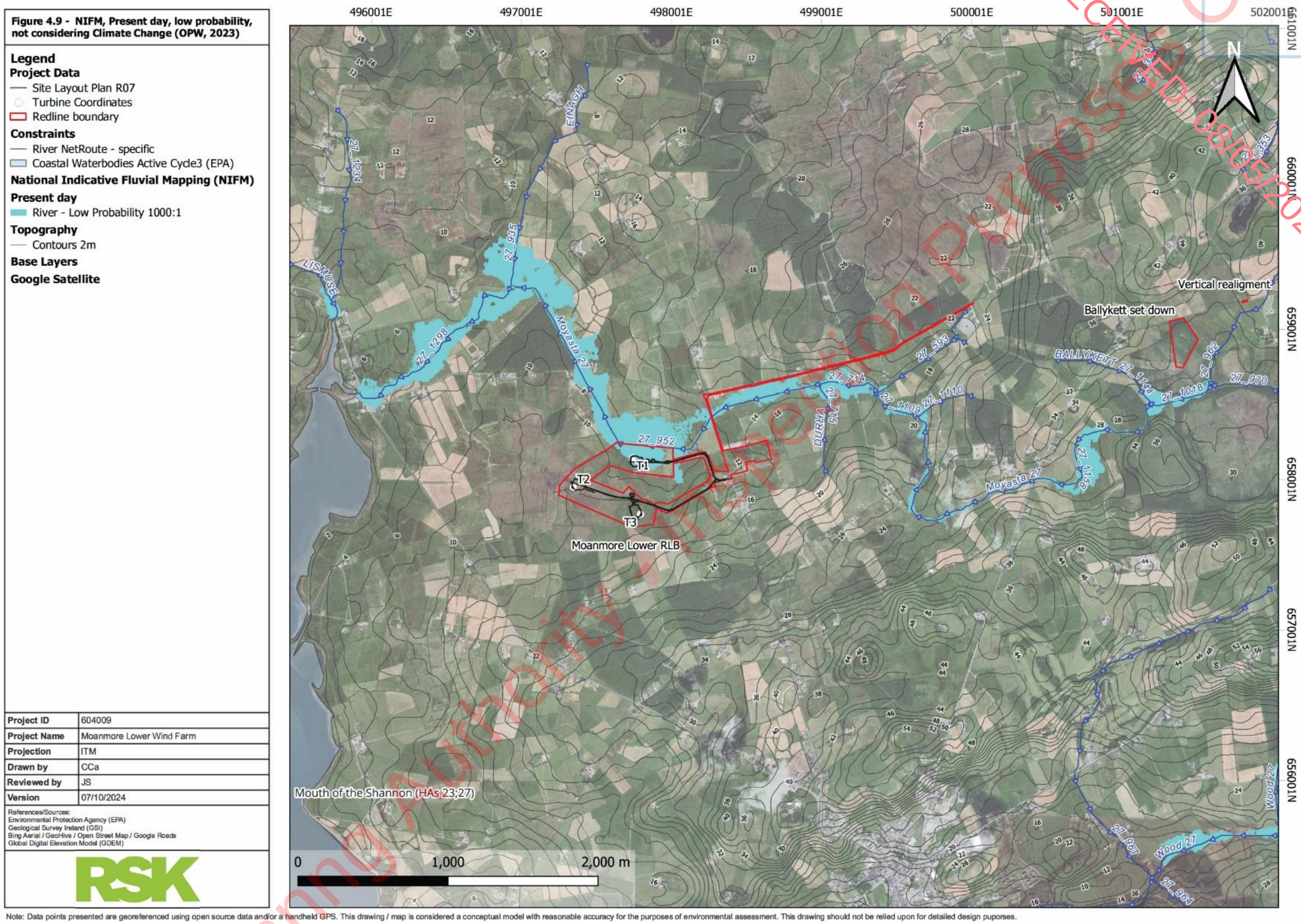


Figure 4.8: NIFM, Present day, low probability not considering climate change (OPW, 2023)

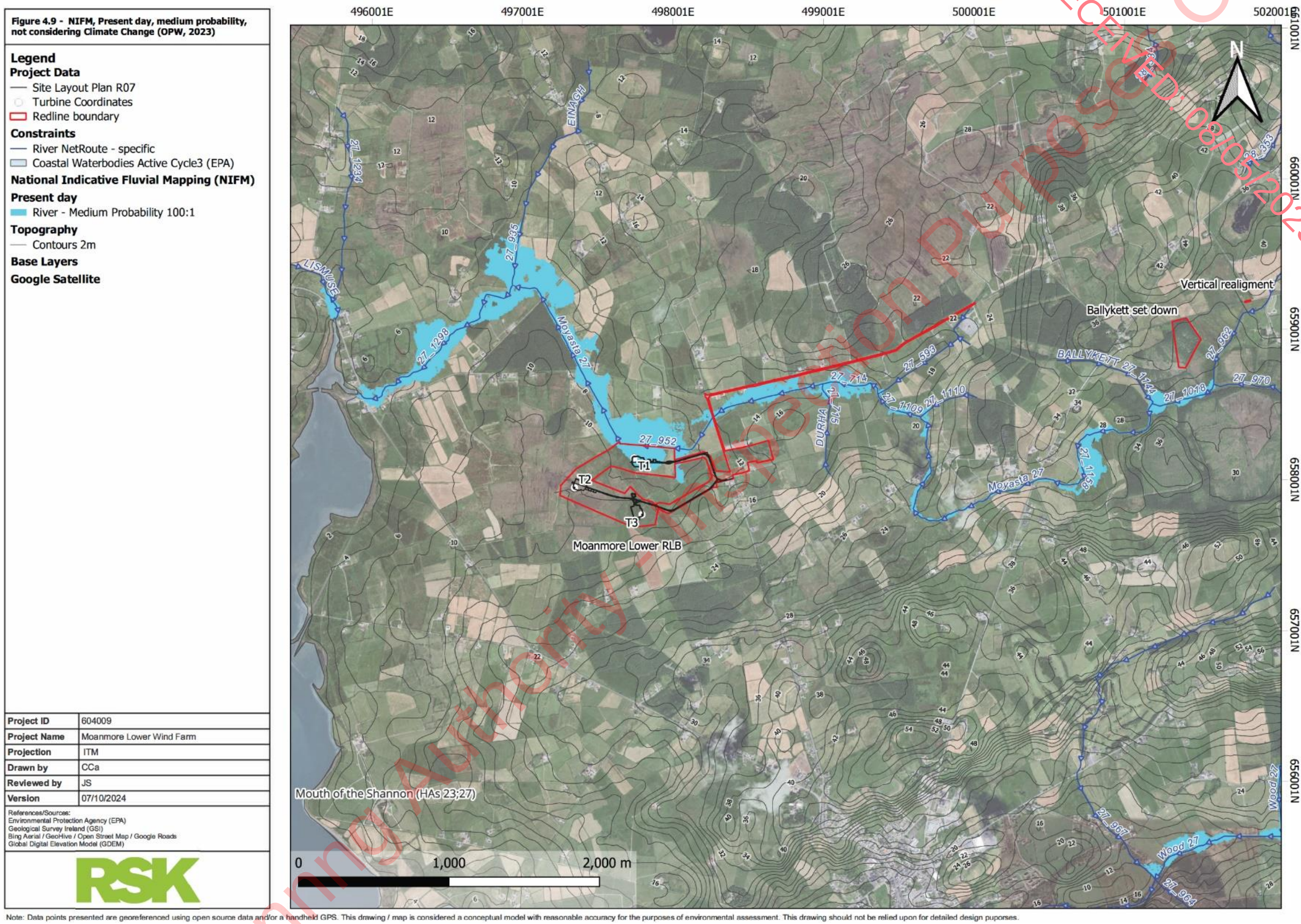


Figure 4.9: NIFM, Present day, medium probability not considering climate change (OPW, 2023)

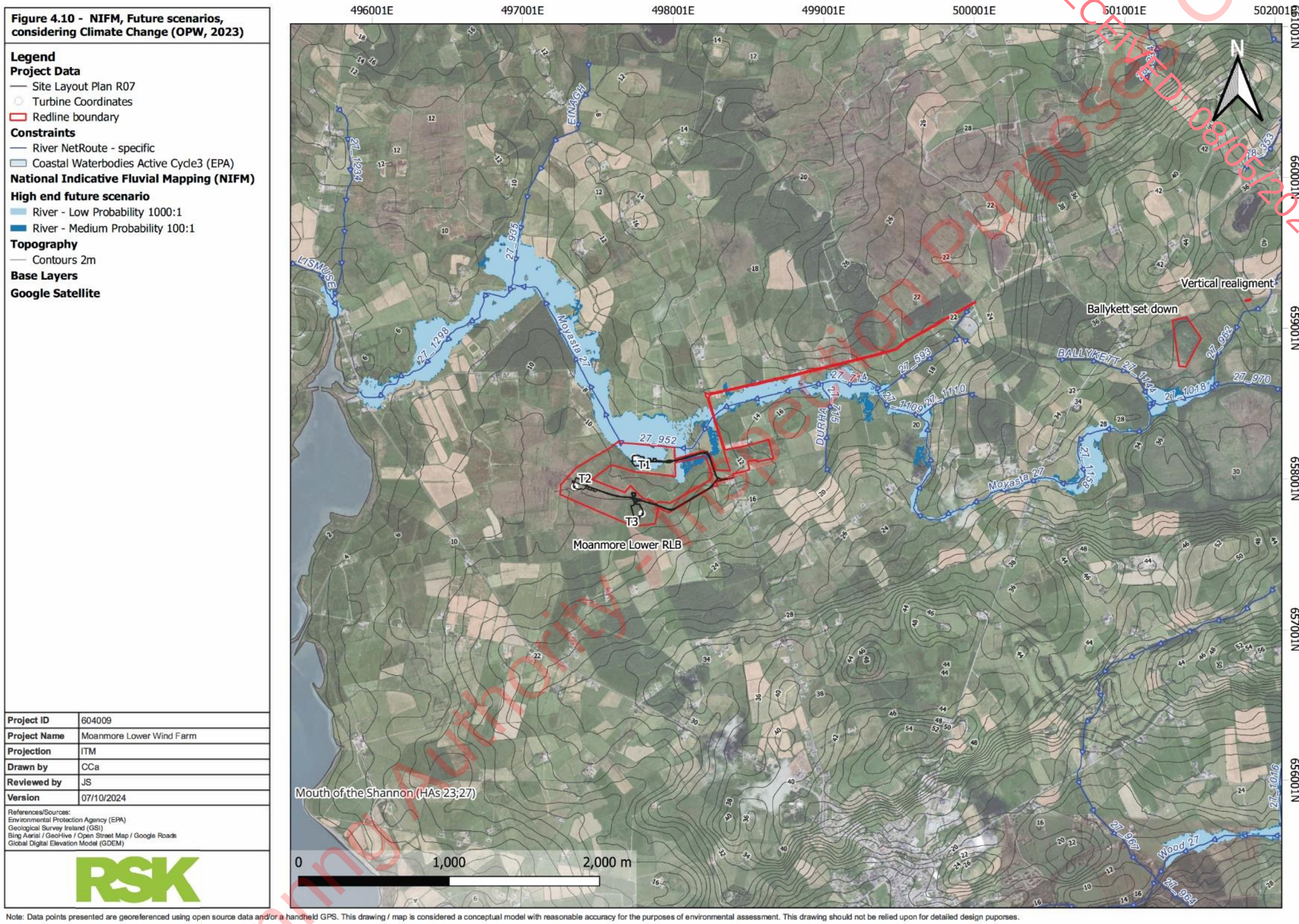


Figure 4.10: NIFM, Future scenarios, considering climate change (OPW, 2023)

4.2.5 Pluvial Flooding

Pluvial flood maps produced as part of the OPW's CFRAM do not indicate pluvial flood zones at the development Site and the GCRs, or surrounding area. Therefore, the residual risk from pluvial flooding is considered nil. 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 risk is potentially impacted by developments whereby changes in surfaces, ground sealing, and the introduction of drainage networks will fundamentally modify surface water runoff patterns and rates, potentially exacerbating pluvial, and fluvial risk at on site or downstream receptors.

4.2.6 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. There has been no previously documented groundwater flooding within the site boundary. 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 or the GCRs. Therefore, the residual risk from groundwater flooding is considered low. Groundwater flood risk is now screened out of this assessment.

4.2.7 Proposed Development

The proposed Development comprising of new access tracks, hardstands and associated ancillary infrastructure will include land take (Agriculture / Peatlands) and the replacement of vegetated lands and soils with relatively impermeable surfaces (86,931m²). 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. The nearest Hydrometric stations for river discharge rates are presented in **Figure 4.11**.

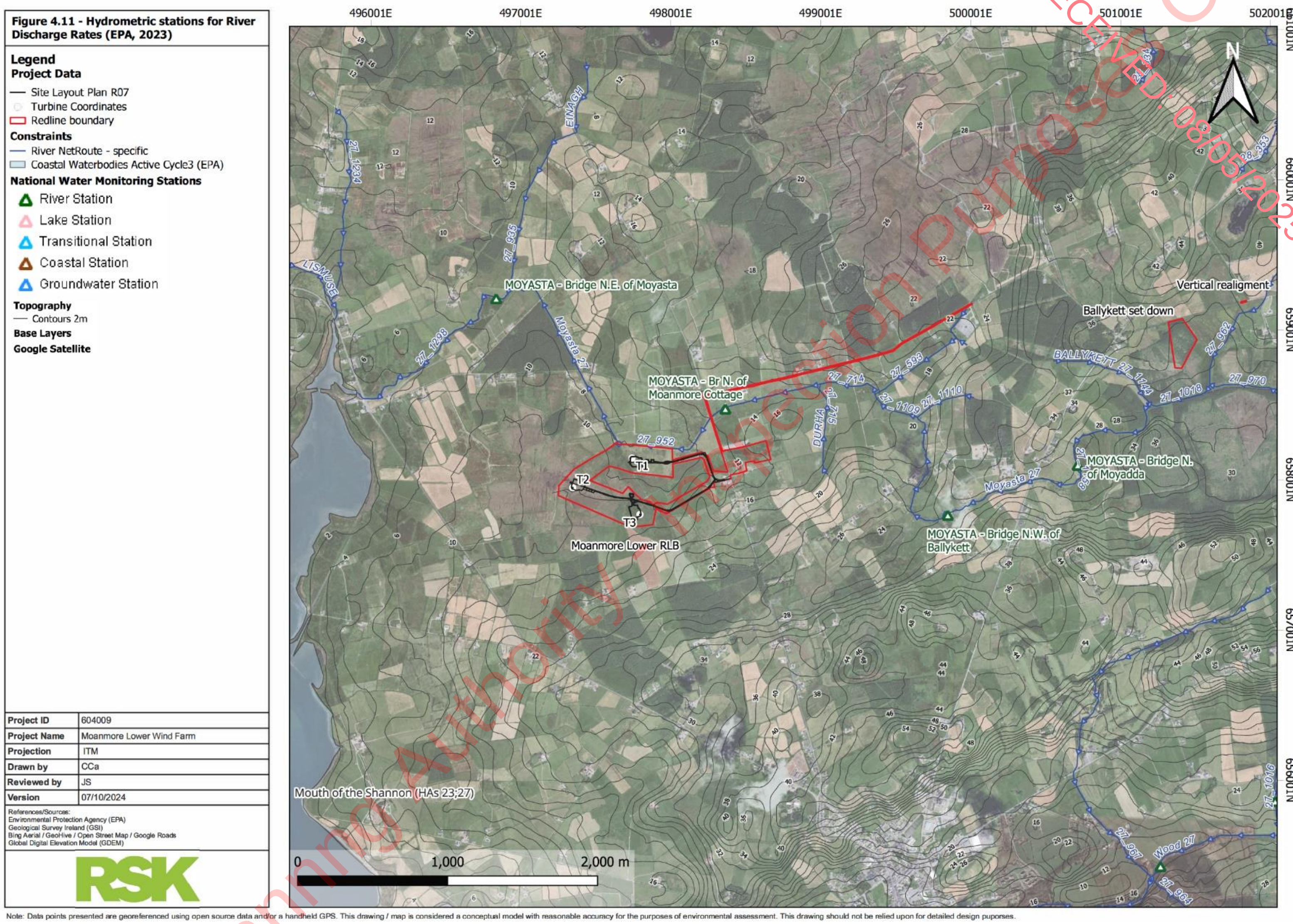


Figure 4.11: Hydrometric stations for River Discharge Rates (EPA, 2023)

4.2.8 Human and/or Mechanical Error

Construction of drainage channels and enhancement of existing drainage associated with the Development have the potential to impact the hydrological regime at the Site. 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.

Table 4.1: Preliminary Flood Risk Screening

Flood Risk Preliminary Screening
(RSK File Ref. 604009-Hydro-R01-(00))
(SK, JS 26/07/2024)

Category		Annual Exceedance Probability (%)	Chance of Occurrence in any Given Year	Return Period (Years)	Considers Flood Defences	Considers Climate Change	Site Assessment Screening result, flood zone on site?	Site Assessment Screening result, flood zone on GCR?	Site Assessment Screening result, flood zone on TDR works?
National Indicitive Fluvial Mapping Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed Yes	Yes	Yes	No
National Indicitive Fluvial Mapping Present Day	Medium Probability	1	1 in 200	100	Assumed Yes	Yes	Yes	Yes	No
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	Yes	Yes	No
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	Yes	Yes	No
National Indicitive Fluvial Mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	Yes	Yes	No
National Indicitive Fluvial Mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	Yes	Yes	No
CFRAM River (Fluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed No	No	No	No
CFRAM River (Fluvial) Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	No	No	No
CFRAM River (Fluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	No	No
CFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	No	No
CFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	No	No
CFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	Yes	No	No	No
CFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	No	No
CFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	No	No
CFRAM River (Fluvial) Flood Extents High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	Yes	No	No	No
Past flood events	single occurrence				Assumed Yes	No	Yes	No	No
Past flood events	reoccuring				Assumed Yes	No	No	No	No
Past flood events - Groundwater/Surface water	single occurrence				Assumed Yes	No	No	No	No
Past flood events - Groundwater	single occurrence				Assumed Yes	No	No	No	No
GSI Groundwater Flooding Maps	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	No	No
GSI Groundwater Flooding Maps	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	No	No
GSI Groundwater Flooding Maps	High Probability	10	1 in 10	10	Assumed Yes	Yes	No	No	No
CFRAM Coastal Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	No	No	No
CFRAM Coastal Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	No	No	No
CFRAM Coastal Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	No	No
CFRAM Coastal Flood Extents Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	No	No
CFRAM Coastal Flood Extents Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	No	No
CFRAM Coastal Flood Extents Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	Yes	No	No	No
CFRAM Coastal Flood Extents High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	No	No
CFRAM Coastal Flood Extents High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	No	No
CFRAM Coastal Flood Extents High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	Yes	No	No	No
CCFRAM Rainfall (Pluvial) Flooding Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	No	No	No
CCFRAM Rainfall (Pluvial) Flooding Present Day	Medium Probability	0.5	1 in 200	200	Assumed Yes	No	No	No	No
CCFRAM Rainfall (Pluvial) Flooding Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	No	No
CCFRAM PDF Maps					Assumed Yes	Yes	No	No	No

4.2.9 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 has been evidence of fluvial flooding on some of the areas on site and surrounding areas. Areas of the Site are within Medium (Flood Zone B) to High (Flood Zone A) probability Fluvial.

The nature of the Project is industrial as opposed to residential or leisure, and as such, this type of development is categorized as a 'Highly Vulnerable Development', according to FRM Guidelines. Therefore, the development requires a 'justification test' as it lies within Flood Zone A & B.

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has identified flood hazards for the proposed Development including the fluvial flooding event on the Moyasta.

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.

4.2.10 Proposed Development Design Implications

The Development includes various forms of infrastructure, some of which will be situated within identified Flood Zones A and B (Fluvial).

The Development will be comprised mostly by static infrastructure associated with renewable energy production. Development will include areas for hardstand and access track, some of which (T1 Hardstand and access track) will be situated within the identified flood zones including Flood Zones A and B. Therefore, the Stage 2 assessment will look to estimate the flood heights of the area and propose mitigation measures so as to minimise the risk to this critical infrastructure.

Given the nature of the Site i.e. greenfield site, the Development includes infrastructure which will lead to land take / ground sealing, in turn reducing the potential for recharge at the Site and increasing storm runoff rates. This can potentially adversely impact on the Site or downstream flood risk areas.

4.3 Stage 2 – Initial Flood Risk Assessment

4.3.1 Assessing Potential Impacts of Development

4.3.2 Sustainable Planning & Justification Test

In line with the Clare County Development Plan 2023-2029 – Volume 10c Strategic Flood Risk Assessment;

Where possible, development in areas identified as being at flood risk should be avoided. Exceptions to the development restrictions are provided for through the application of the Justification Test. This sequential approach to planning on a flood zone is presented in **Figure 4.12**.

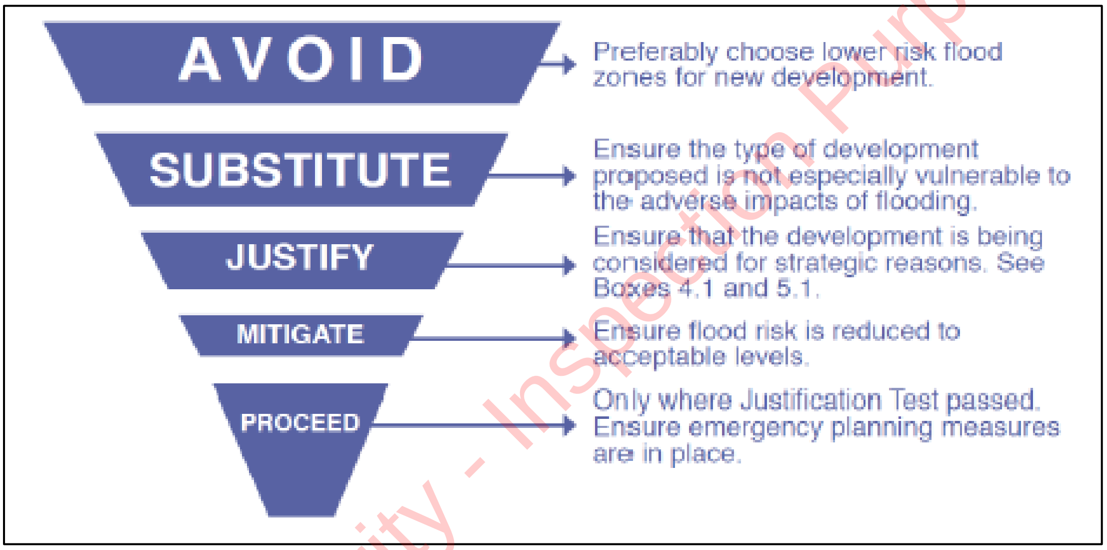


Figure 4.12: Sequential Approach Principles in Flood Risk Management (Source: The Planning System and Flood Risk Management (OPW))

In line with OPW (2018) Flood Risk Management Plan 2018 River Basin UoM27/28 (Shannon Estuary North & Mal Bay):

- Development should be avoided in floodplains unless there are demonstrable, wider sustainability and proper planning objectives that justify appropriate development and where the flood risk to such development can be reduced and managed to an acceptable level without increasing flood risk elsewhere (as set out through the Justification test).
- The Development Management Justification Test is used at the planning application stage where it is intended to develop land that is at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be considered inappropriate for that land.
- The proposed Development is comprised of energy producing and grid connection infrastructure. These elements of development are considered Highly Vulnerable (including; residential, essential infrastructure, emergency services).

In line with The Planning System and Flood Risk Management guidance, Highly Vulnerable (including essential infrastructure) requires a Justification Test if positioned with Flood Zone A and/or Flood Zone B.

The Justification Test for development management includes the following criteria (in ***bold italics***);

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. ***The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.***

RESPONSE:

The Site is in an agricultural setting, it is a settled landscape with strong urban influences, the site is not within a exclusion zone, or vulnerable settlement zoning objective area. The area is identified as "open for consideration" for renewable energy developments.

As per the Clare County Development Plan (CCDP) Volume 6 Wind Energy Strategy, areas open to consideration – Page 33: Areas Open for Consideration for Wind Farms,

- The Project Site (Three turbines, wind farm infrastructure and GCR) is positioned within an area designated as Open for Consideration.

As per Clare County Development Plan (CCDP) Volume 5 Energy Strategy, – Grid Infrastructure states; proximity to the grid is an important factor and the current development strategy is to reinforce the existing grid infrastructure with a focus on upgrading and strengthening the capacity of the existing lines rather than building new infrastructure.

2. ***The proposal has been subject to an appropriate flood risk assessment that demonstrates:***

    i. ***The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;***

RESPONSE:

On site flood risk and potential net increase in runoff as a product of the proposed Development is identified and assessed as part of this report. Mitigation to protect critical units from residual on site flood risk through positioning above estimated flood levels (e.g. T1 turbine and some area of hardstand, critical infrastructure). This has occurred as part of the design associated with this proposal.

To mitigate against potential net increase in runoff and in line with general measures applicable in flood risk management plan areas, Sustainable Drainage Systems (SuDS) are included in the design of the Proposed Development. SuDS was considered and designed as Nature Based Solutions in order to reduce flood risk / hydrological response to rainfall at the Site as well as improving runoff and surface water quality and promoting recharge to ground.

The objective of SuDS is to maintain greenfield runoff rates i.e. neutralise any potential impact on runoff. SuDS features implemented in the design are over or generously specified with a view to achieving net gains or beneficial impacts in terms of attenuation of runoff and reduction in downstream flood risk,

ii. ***The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;***

RESPONSE:

The proposed Development is not situated within exclusion or settlement zones. The Proposed Development, through appropriate mitigation and SuDS design will not adversely impact on flood risk.

iii. ***The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and***

RESPONSE:

Considering the nature of the proposed Development i.e. a renewable energy project, the proposed Development will be monitored and managed throughout the construction, operational and decommissioning phases. This will include the application of mitigation measures identified in this and other environmental assessment reports, and the drafting and implementation of monitoring and emergency response plans, including a Flood Risk Emergency Response Plan for the Proposed Development. The proposed Development including two flood compensation areas are such that there will be no reduction in flood attenuation on the site. Note that these areas have been named as 'flood compensatory areas' to align with the terminology used in the 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009).

iv. ***The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.***

RESPONSE:

Good urban design and / or vibrant street scape is not applicable given the Development character and setting. The proposed Development does meet various design and placement considerations outlined in the Clare County Development Plan (CCDP) Volume 5 Energy Strategy, for example; lowland gently undulating topography, array is not fragmented, etc.

v. ***The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.***

RESPONSE:

As discussed above, the proposed Development is a renewable energy project which will be managed through all phases. Residual flood risk does not pose risk to people or settlements. The residual flood risk on site is a risk to the proposed Development infrastructure itself i.e. critical infrastructure, renewable energy and energy grid.

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

RESPONSE:

Not applicable.

Refer to section 5.28 in relation to minor and infill developments.

RESPONSE:

Not applicable.

This assessment has identified that the Justification Test criteria have been considered and satisfied through various measures outlined in this report.

4.3.3 Assessment of On Site Flood Risk

4.3.3.1 Fluvial Flooding

The OPW National Indicative Fluvial Maps (NIFM) interactive floodinfo.ie maps have been consulted with reference to fluvial (rivers and streams) flooding for both current day and future case scenarios. The medium and low probability present day scenarios relate to an annual exceedance probability (AEP) of 1% and 0.1% respectively. The medium and low probability present day scenarios reflect the odds of a theoretical extreme flood event occurring in a given year being 1:200 and 1:1000 respectively. Both a 1% and 0.1% AEP fluvial flood events are predicted within the Site boundary for the present-day scenario. These predicted flood extents continue downstream of the site to the Poulnasherry Bay. Given that the proposed drainage system outlined in the Surface Water Management Plan will result in increased attenuation of rainwater during heavy rainfall events, the potential risk of exacerbating a theoretical 1% or 0.1% AEP fluvial flood downstream of the proposed Site is expected to be negligible.

In an assessment of potential future flooding impacts on the proposed Development, the NIFM's "High-End Future Scenario", which models a 30% increase in rainfall resulting from climate change, has been adopted as precautionary approach. The medium probability scenario (AEP of 1%) has been reviewed at the Site. There is a 1% AEP extreme fluvial flood event modelled within the Site boundary for the high-end future scenario. Similar to the modelled present-day scenario, the flood extents reach back upstream for the entirety of the Moyasta River and downstream of the Site to Poulnasherry Bay.

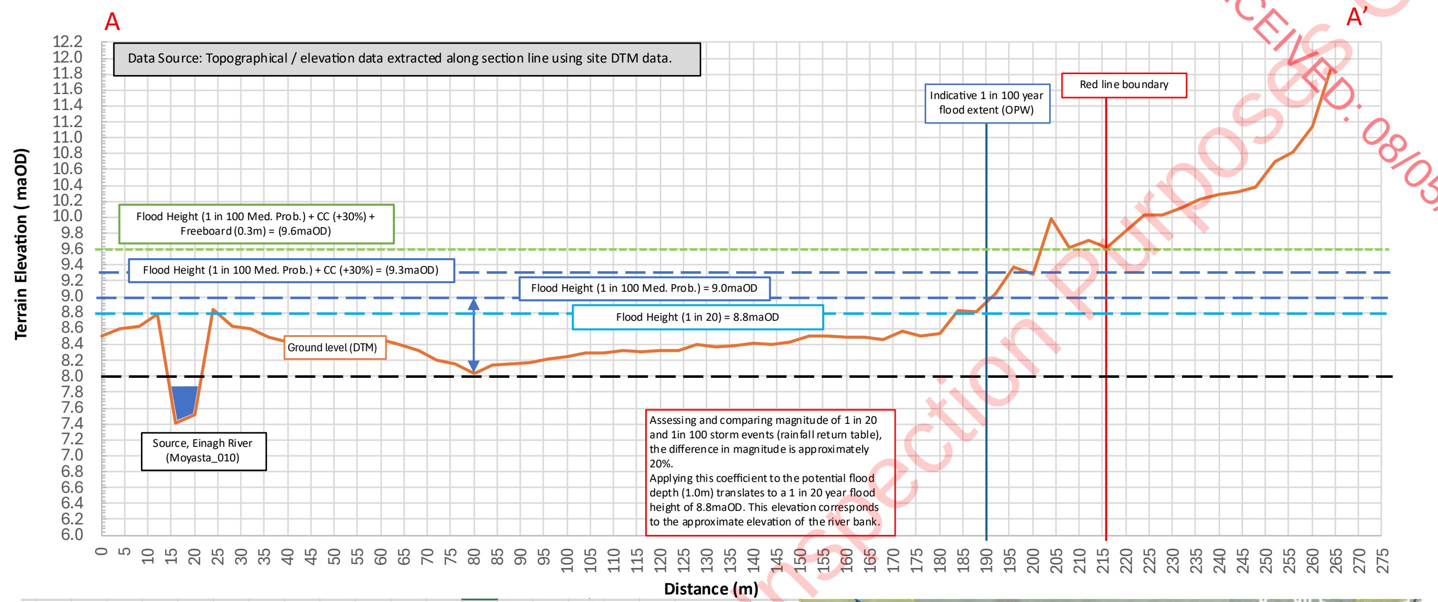
4.3.3.2 Estimation of Flood Extent and Heights

The National Indicative Fluvial Flood mapping (NIFM) was compared to the elevation data associated with the site. Global Data Elevation Model (GDEM) (opensource, low accuracy) and detailed LiDAR information provided was used in the assessment. Ground level at the river bank / riparian zone ground level is approximately 8.0 - 8.5maOD.

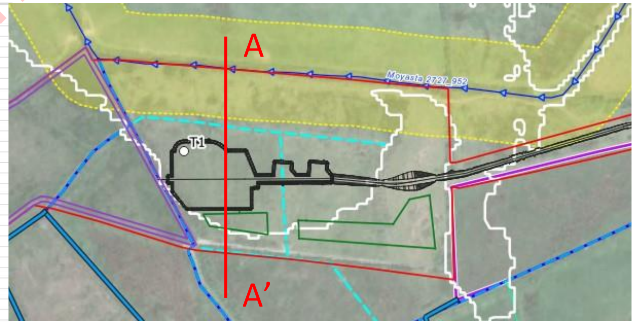
The indicative flood extents are observed to be approximately 9.0maOD (1:100 without climate change). Both GDEM and LiDAR elevation data generally aligns with this elevation. The actual 8.8maOD elevation (1:20) also is presented in **Figure 4.13: Cross section of Flood height estimation.**

An increased flood extent of 9.6 maOD (indicative worst case / considering climate change and including for 300mm of freeboard) is presented as the upper extent of the 'purple' elevation contour (**Figure 4.14: Flood extent at T1 with LIDAR**).

It is noted that both 9.0 and 9.6maOD flood heights will inundate relatively significant areas of flood plain. LiDAR data noise i.e. hedgerows and banks restrict accurate assessment of flood prone areas within the site boundary however, scrub or open spaces indicate that the flood extent within the site is limited in line with the traced OPW NIFM extent or conservatively. (Note: This is not considered advanced modelling for flood risk assessment (FRA Stage 3).



		Interval		Years														1 in 20 / 1 in 100
DURATION		6months	1year	2	3	4	5	10	20	30	50	75	100	150	200	250	500	
5	mins	2.8	3.8	4.3	5	5.5	5.9	7.1	8.5	9.4	10.6	11.6	12.4	13.6	14.6	15.4	N/A	0.685483871
10	mins	3.9	5.3	6	7	7.7	8.2	9.9	11.8	13	14.7	16.2	17.3	19	20.3	21.4	N/A	0.682080925
15	mins	4.6	6.2	7	8.3	9.1	9.7	11.7	13.9	15.3	17.3	19	20.4	22.4	23.9	25.2	N/A	0.681372549
30	mins	6.2	8.1	9.1	10.6	11.6	12.3	14.6	17.2	18.8	21.1	23	24.5	26.8	28.5	29.9	N/A	0.702040816
1	hours	8.2	10.6	11.8	13.6	14.7	15.6	18.3	21.3	23.2	25.7	27.9	29.6	32.1	34	35.5	N/A	0.719594595
2	hours	11	13.9	15.4	17.4	18.8	19.8	23	26.3	28.5	31.3	33.8	35.6	38.4	40.5	42.2	N/A	0.738764045
3	hours	13	16.3	17.9	20.2	21.6	22.8	26.2	29.8	32.1	35.2	37.8	39.8	42.7	44.9	46.7	N/A	0.748743719
4	hours	14.7	18.2	19.9	22.4	23.9	25.1	28.8	32.6	35	38.2	40.9	43	46	48.3	50.1	N/A	0.758139535
6	hours	17.4	21.3	23.2	25.9	27.6	28.9	32.8	36.9	39.5	42.9	45.8	47.9	51.1	53.5	55.4	N/A	0.770354906
9	hours	20.6	24.9	27	29.9	31.8	33.2	37.4	41.8	44.5	48.1	51.2	53.4	56.8	59.3	61.3	N/A	0.782771536
12	hours	23.2	27.8	30.1	33.2	35.1	36.6	41.1	45.7	48.5	52.3	55.4	57.7	61.2	63.8	65.8	N/A	0.79202773
18	hours	27.5	32.6	35	38.4	40.5	42.1	46.9	51.7	54.7	58.7	62	64.4	68	70.7	72.8	N/A	0.802795031
24	hours	31	36.4	39	42.6	44.8	46.4	51.4	56.5	59.6	63.7	67.1	69.6	73.3	76	78.2	85.3	0.811781609
2	days	39.2	45.7	48.7	52.9	55.6	57.5	63.3	69.2	72.8	77.5	81.4	84.3	88.5	91.6	94	102.2	0.820877817
3	days	46.3	53.7	57.2	61.9	64.9	67.1	73.6	80.2	84.2	89.5	93.8	97	101.7	105.1	107.8	116.8	0.826804124
4	days	52.8	61	64.9	70.1	73.4	75.8	83	90.2	94.6	100.3	105.1	108.6	113.7	117.4	120.4	130.2	0.830570902
6	days	64.7	74.4	78.9	85	88.9	91.7	100.1	108.5	113.5	120.2	125.6	129.7	135.5	139.8	143.2	154.4	0.836545875
8	days	75.8	86.8	91.9	98.8	103.1	106.3	115.8	125.2	130.9	138.3	144.5	149	155.5	160.3	164.1	176.6	0.840268456
10	days	86.2	98.5	104.1	111.8	116.6	120.1	130.6	141	147.3	155.4	162.2	167.1	174.3	179.6	183.8	197.4	0.843806104
12	days	96.3	109.7	115.9	124.3	129.5	133.4	144.8	156.1	162.9	171.8	179.1	184.5	192.3	198	202.5	217.2	0.846070461
16	days	115.7	131.3	138.5	148.3	154.3	158.7	171.9	184.9	192.8	203	211.4	217.5	226.4	232.9	238.1	254.9	0.850114943
20	days	134.3	152	160.2	171.2	178	183	197.8	212.5	221.3	232.7	242.1	249	258.9	266.2	272	290.8	0.853413655
25	days	157	177.2	186.5	199	206.7	212.3	229.1	245.7	255.7	268.6	279.1	286.9	298.1	306.3	312.8	333.8	0.856395957
													0.8209					



Site Name: Moanmore Lower Wind Farm	Project No.	604009	Drawn By:	CC, JS, CC Environmental Consultant
	Client:	Jennings O'Donovan		
Figure Name: Flood Risk Assessment, Height Assessment Section, Cross -section A	Date:	24/05/24	Reviewed By:	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00 DRAFT		

RSK

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

Figure 4.13: Flood Risk Assessment, height assessment section, Cross section A

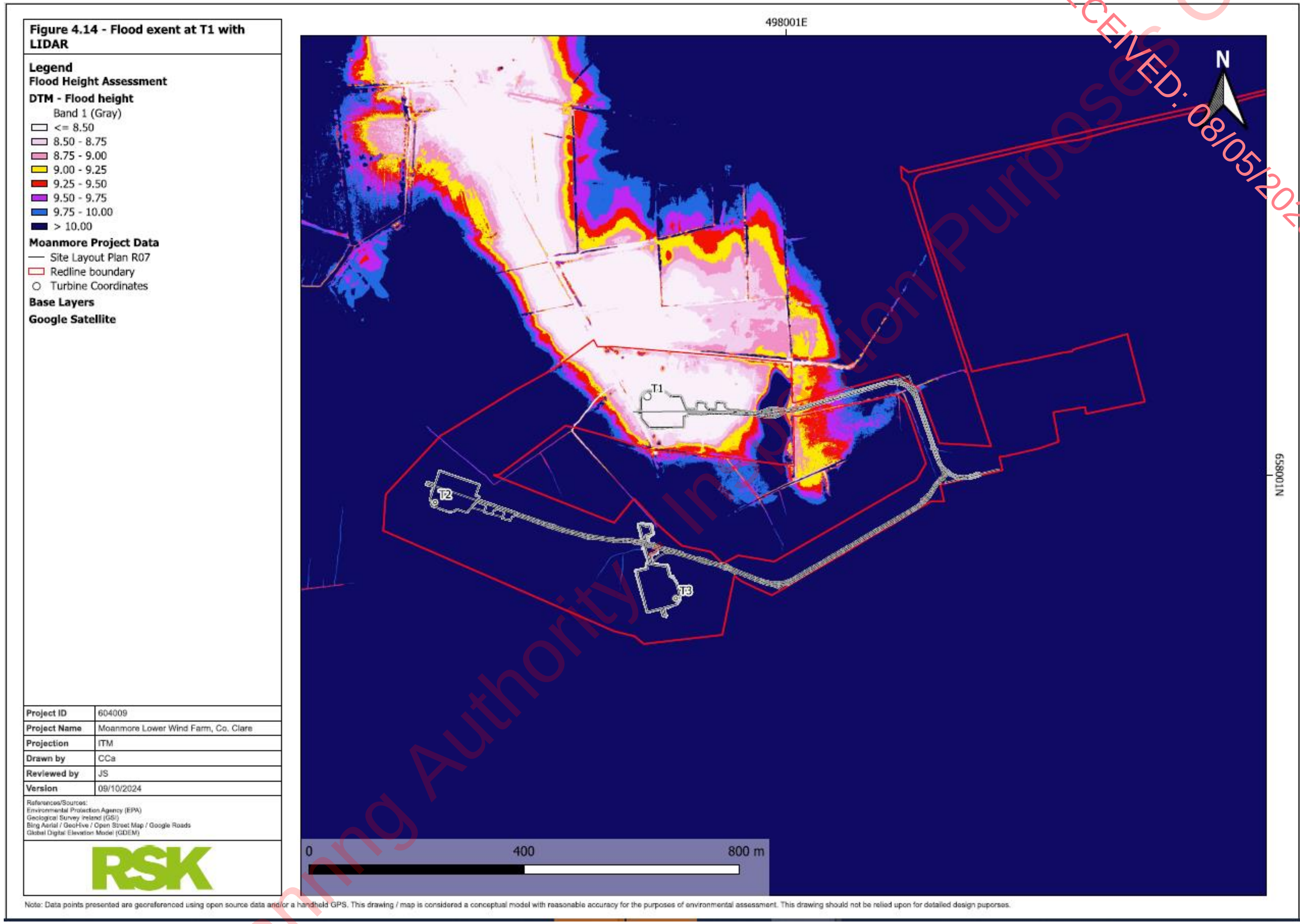


Figure 4.14 Flood extent at T1 with LIDAR

4.3.3.3 Assessment of Sensitive Receptors

Receptors within or in close proximity to the mapped flood extent are agricultural in nature, with associated non-essential infrastructure. A review of topography and dwellings detected by review of aerial imagery concluded that receptors in the proximity of the site are >2.5 m above conservative flood height of 9.6 maOD.

It should be noted that critical sensitive infrastructure such as the proposed Development without mitigation would fall below the conservative flood height of 9.6 maOD. It is proposed that the top of the plinth of the foundation for Turbine T1 will be 9.6mOD.

4.3.4 Increased Hydraulic Loading / Runoff

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:

- Turbine hardstands = c 14,721m².
- New access track / floated access track / turning points = 8,915m^2
- Electrical Substation = c. 1,650m^2 x 1 no.
- Site Compound = 1,165m^2 x 1 no.
- 1 in 100 year rainfall event = c. 29.6mm 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)). Surface water networks draining the site are mapped.

Table 4.2 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1 in 100 year storm event.

Table 4.3 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 4.2: Micro-catchment Area 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 (m2)	Quantity	Approx Area (m2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity % of Effective Rainfall*	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 . % of Effective Rainfall**	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.		3	14721	0.0213	20.00%	0.01704	250.85	0.07		0.00%	0.0213	313.56	0.09		
SW1	Substation	No.		1	1,649.5	0.0213	20.00%	0.01704	28.11	0.01		0.00%	0.0213	35.13	0.01		
SW1	Site Compound	No.		1	1,161.5	0.0213	20.00%	0.01704	19.80	0.01		0.00%	0.0213	24.75	0.01		
SW1	New Access Track & floating / hardstand/ turning points	m		1	8915	0.0213	20.00%	0.01704	151.91	0.04		0.00%	0.0213	189.89	0.04		
SW1	**Subtotal**										0.13					0.16	**0.031**
													Total	**563.32**	**0.16**	**0.16**	**0.031**

* Conservative Value for Water Balance Calc's
**(Hardstand Areas assumed impermeable)

Table 4.3: 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)

Proposed Development Baseline Run off Volumes (1 in 100 Year Hour Storm Event)										
Proposed Project	**Approximate Area (m2)**	**1 in 100 Year Rainfall Event (m/hour Rain)**	**Capped Recharge Capacity. Percentage of Effective Rainfall** (Conservative Value for Water Balance 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)**	**Net increase of run off from site in percentage**
Total Redline Boundary for Moanmore Lower WF	367,663.00	0.0213	20.00%	0.01704	6,264.98	1.74	0.033	1.88%	3.00	1.09%
				Total	**6264.97752**	**1.74**	**0.033**	1.88%	**3.00**	1.09%

Water balance calculations allow for the addition of hardstand infrastructure area (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. 0.033m^3/second, (or 1.09% relative to the associated catchment), which is lower in comparison to the Q95th percentile using the EPA Hydrotool for the subcatchment (ID: 27_952) is 0.044m^3/s. This net increase, relative to the scale of the Site or the scale of the associated catchment is considered an adverse, moderate effect of the development. With suitable mitigation measures, the pressure to the surface water bodies and sites downgradient can be reduced to a neutral effect.

4.3.4.1 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).

Data from the meteorological stations listed in **Table 4.4: Meteorological Stations** are used in this assessment[7]. Using data presented in **Table 4.6: Met Eireann Return Period Rainfall Depths (Irish Grid; 97831, 157904)**, storm event of 25 days duration with a 1 in 100 year return period is inferred to be 286.9mm. For the purpose of this flood risk assessment, predicted extreme or worst-case values are used, as presented in **Table 4.5: EIA Specific Assessment Data**.

[7] Met Eireann, Historical Data, Available at; www.met.ie, Accessed; 03rd March 2025

Table 4.4: Meteorological Stations (Met Eireann, 2024)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	SHYAN 1984 - 2024	12.2
Rainfall (2020/21 Monthly/Daily)	SHYAN 1984 - 2024	12.2
Evapotranspiration	Shannon Airport – 2019-2024 Minimum	40.5

Table 4.5: EIA Specific Assessment Data (Met Eireann, 2024)

Category	Value
Average Annual Effective Rainfall (Long term) (mm/year)	1,483.1
Max monthly effective rainfall (mm/month)	156.5
1 in 100 Year Rainfall Event (30 day duration) (mm/month)	465.1
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	29.6
Minimum monthly evapotranspiration (mm/month)	13.5

Table 4.6: Met Eireann Return Period Rainfall Depths (Irish Grid; 97831, 157904)[8]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 97831, Northing: 157904,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.8,	3.8,	4.3,	5.0,	5.5,	5.9,	7.1,	8.5,	9.4,	10.6,	11.6,	12.4,	13.6,	14.6,	15.4,	N/A ,
10 mins	3.9,	5.3,	6.0,	7.0,	7.7,	8.2,	9.9,	11.8,	13.0,	14.7,	16.2,	17.3,	19.0,	20.3,	21.4,	N/A ,
15 mins	4.6,	6.2,	7.0,	8.3,	9.1,	9.7,	11.7,	13.9,	15.3,	17.3,	19.0,	20.4,	22.4,	23.9,	25.2,	N/A ,
30 mins	6.2,	8.1,	9.1,	10.6,	11.6,	12.3,	14.6,	17.2,	18.8,	21.1,	23.0,	24.5,	26.8,	28.5,	29.9,	N/A ,
1 hours	8.2,	10.6,	11.8,	13.6,	14.7,	15.6,	18.3,	21.3,	23.2,	25.7,	27.9,	29.6,	32.1,	34.0,	35.5,	N/A ,
2 hours	11.0,	13.9,	15.4,	17.4,	18.8,	19.8,	23.0,	26.3,	28.5,	31.3,	33.8,	35.6,	38.4,	40.5,	42.2,	N/A ,
3 hours	13.0,	16.3,	17.9,	20.2,	21.6,	22.8,	26.2,	29.8,	32.1,	35.2,	37.8,	39.8,	42.7,	44.9,	46.7,	N/A ,
4 hours	14.7,	18.2,	19.9,	22.4,	23.9,	25.1,	28.8,	32.6,	35.0,	38.2,	40.9,	43.0,	46.0,	48.3,	50.1,	N/A ,
6 hours	17.4,	21.3,	23.2,	25.9,	27.6,	28.9,	32.8,	36.9,	39.5,	42.9,	45.8,	47.9,	51.1,	53.5,	55.4,	N/A ,
9 hours	20.6,	24.9,	27.0,	29.9,	31.8,	33.2,	37.4,	41.8,	44.5,	48.1,	51.2,	53.4,	56.8,	59.3,	61.3,	N/A ,
12 hours	23.2,	27.8,	30.1,	33.2,	35.1,	36.6,	41.1,	45.7,	48.5,	52.3,	55.4,	57.7,	61.2,	63.8,	65.8,	N/A ,
18 hours	27.5,	32.6,	35.0,	38.4,	40.5,	42.1,	46.9,	51.7,	54.7,	58.7,	62.0,	64.4,	68.0,	70.7,	72.8,	N/A ,
24 hours	31.0,	36.4,	39.0,	42.6,	44.8,	46.4,	51.4,	56.5,	59.6,	63.7,	67.1,	69.6,	73.3,	76.0,	78.2,	85.3,
2 days	39.2,	45.7,	48.7,	52.9,	55.6,	57.5,	63.3,	69.2,	72.8,	77.5,	81.4,	84.3,	88.5,	91.6,	94.0,	102.2,
3 days	46.3,	53.7,	57.2,	61.9,	64.9,	67.1,	73.6,	80.2,	84.2,	89.5,	93.8,	97.0,	101.7,	105.1,	107.8,	116.8,
4 days	52.8,	61.0,	64.9,	70.1,	73.4,	75.8,	83.0,	90.2,	94.6,	100.3,	105.1,	108.6,	113.7,	117.4,	120.4,	130.2,
6 days	64.7,	74.4,	78.9,	85.0,	88.9,	91.7,	100.1,	108.5,	113.5,	120.2,	125.6,	129.7,	135.5,	139.8,	143.2,	154.4,
8 days	75.8,	86.8,	91.9,	98.8,	103.1,	106.3,	115.8,	125.2,	130.9,	138.3,	144.5,	149.0,	155.5,	160.3,	164.1,	176.6,
10 days	86.2,	98.5,	104.1,	111.8,	116.6,	120.1,	130.6,	141.0,	147.3,	155.4,	162.2,	167.1,	174.3,	179.6,	183.8,	197.4,
12 days	96.3,	109.7,	115.9,	124.3,	129.5,	133.4,	144.8,	156.1,	162.9,	171.8,	179.1,	184.5,	192.3,	198.0,	202.5,	217.2,
16 days	115.7,	131.3,	138.5,	148.3,	154.3,	158.7,	171.9,	184.9,	192.8,	203.0,	211.4,	217.5,	226.4,	232.9,	238.1,	254.9,
20 days	134.3,	152.0,	160.2,	171.2,	178.0,	183.0,	197.8,	212.5,	221.3,	232.7,	242.1,	249.0,	258.9,	266.2,	272.0,	290.8,
25 days	157.0,	177.2,	186.5,	199.0,	206.7,	212.3,	229.1,	245.7,	255.7,	268.6,	279.1,	286.9,	298.1,	306.3,	312.8,	333.8,

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

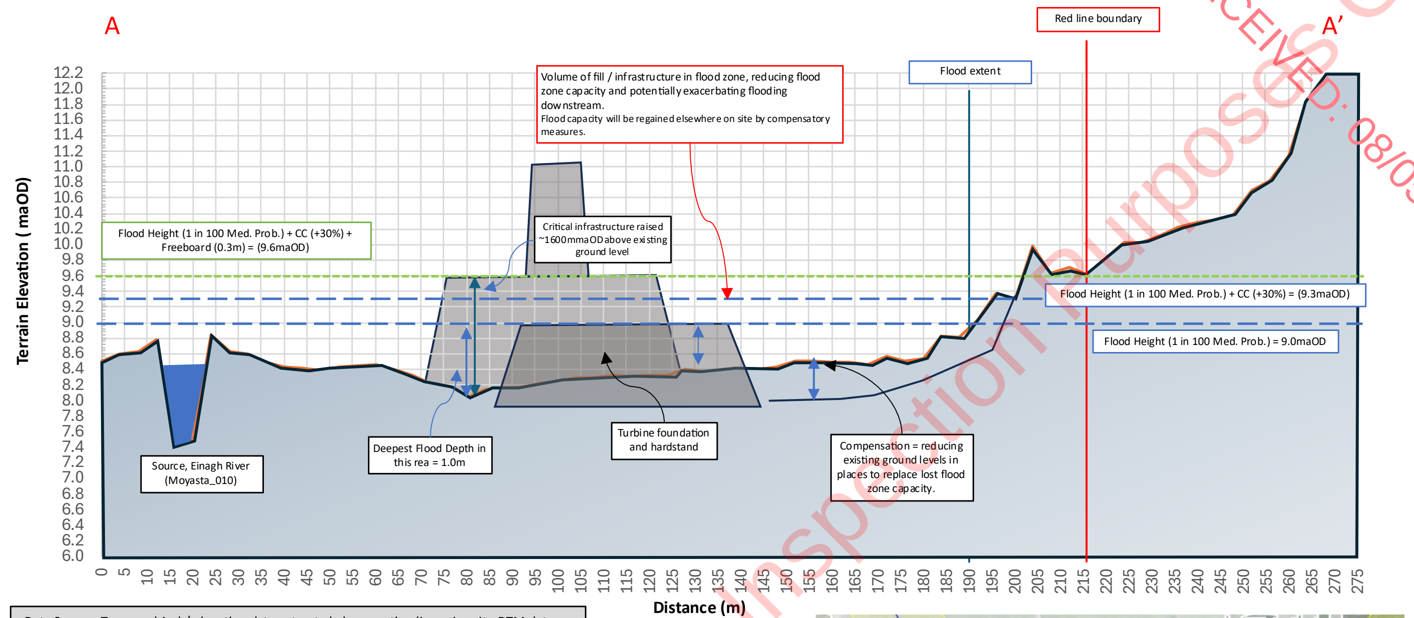
[8] Met Eireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods , Accessed; 2nd April 2024

4.3.4.2 Developments in Flood Plains

Developments constructed in floodplains will likely displace a corresponding volume of flood waters during flood events, in turn potentially exacerbating flood risk downstream or upstream of the site. Similarly, the obstruction of overland flow of flood waters in flood plains will potentially lead to an exacerbated flood risk on site, while also impacting upstream / downstream receptors.

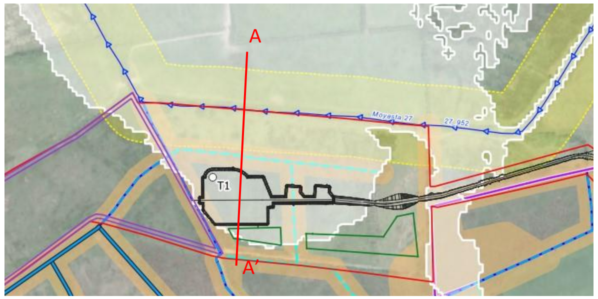
The volume (land take) of the Project or equivalent flood capacity volume has been calculated as part of this assessment. A cross section of the flood extents and compensation areas in relation to T1 is presented in **Figure 4.15.**

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. 0.033m³/sec or 5511m³/hour (or 1.09% increase). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse moderate effect of the development. With suitable mitigation measures, the pressure to the surface water bodies and sites downgradient can be reduced to a neutral impact.



Data Source: Topographical / elevation data extracted along section line using site DTM data.

	DEM (mAOD)	DTM (mAOD)	DSM (mAOD)
Mean	8.70483	9.03666	9.19531
Median	8.66014	8.981	9.059
Standard Deviation	0.647588	0.494957	0.693561
Range	2.49789	3.14	7.836
Minimum	8	7.495	7.647
Maximum	10.4979	10.635	15.483



Site Name: **Moanmore Lower Wind Farm**	**Project No.**	604009	**Drawn By:**	CC, JS, CC Environmental Consultant	RSK
	Client:	Jennings O'Donovan			
Figure Name: **Flood Risk Assessment, Height Assessment Section, Cross -section A**	**Date:**	24/05/24	**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 4.15 Flood Risk Assessment, height assessment section, cross section A

4.3.4.3 Building of Hardstands and tracks within a Flood Plain

In line with Section 50 of the Arterial Drainage Act 1945, if building, reconstructing or restoring any new or existing bridge over any water course (drain) consent must be sought from the Office of Public Works (OPW).

The construction of a hardstand and access track has the potential to change the hydrological characteristics of a river which include (OPW, 2019):

- Flood levels upstream of the hardstand being increased due to the creation of a restricted water course.
- Flood levels downstream of the hardstand being increased due to the removal of a beneficial restriction from the watercourse.
- Erosion of the watercourse and / or floodplain being initiated or accelerated due to the restriction to flood areas, increasing the flow velocity and turbulence.
- Deposition of material in the watercourse or on the floodplain due to a change in flow velocities and turbulence.
- Overland flow paths on the adjacent floodplain being blocked or diverted due to the construction of bridge approaches.

4.4 Mitigation Measures Associated with the Development

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 third River Basin Management Plan (RBMP) (EPA Catchment Unit, 2022).

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.

Flood Relief Schemes, outlined by the OPW, are in place for Kilrush town south of the 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 4.16**. If SUDS measures are not in place following an increase in sealed land, rainfall and surface waters would follow the blue peak. In developments where SUDS measures are implemented, the rainfall and surface water levels will follow the red profile as water is retained and released at 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 (such as restoration of wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

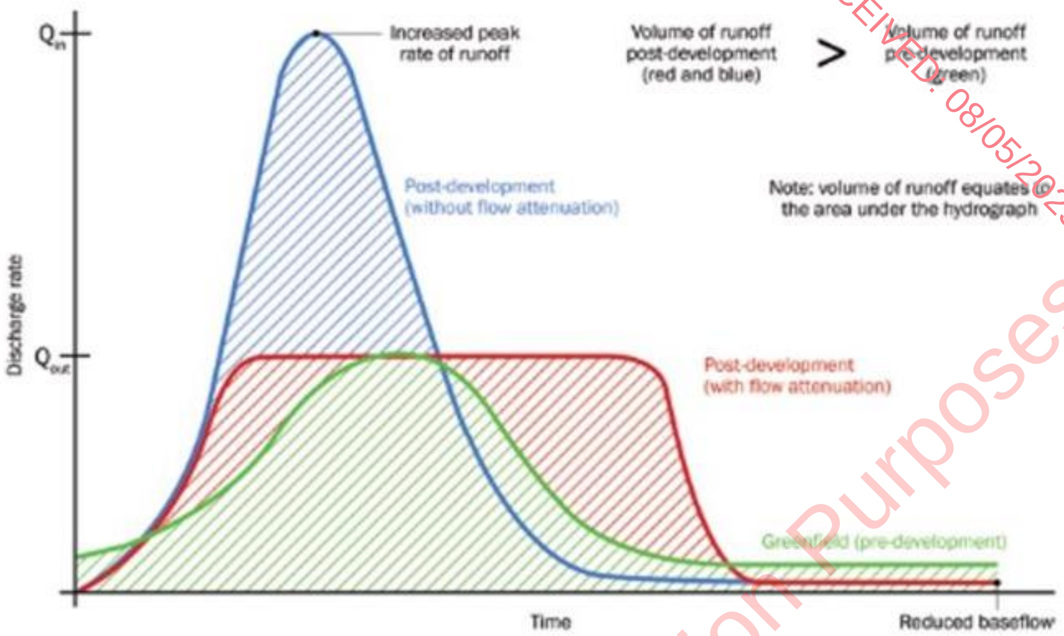


Figure 4.16: Example of a hydrograph (CIRIA, 2015)

4.4.1 Mitigation for on Site Runoff/ Hydraulic Loading and downstream Flood Risk

To mitigate any net change in hydraulic loading to surface waters during the construction and operational phase of the Development , the following mitigation measures 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/compensation areas and riparian woodland
- Riverbank restoration
- River morphology and floodplain restoration – removal of embankments, re-meandered river reach

- In stream structure – large woody debris
- Land and soil management practices – cover crops, cross contour hedgerows.

These mitigation measures will reduce the risk of downstream flooding by attenuation on site runoff and potential flood water when it occurs. The compensation areas will allow the release of this flood water at a reduce flow rate which will benefit downstream areas at risk for further flooding.

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)

4.4.2 Flood Risk Management on Site in Design

The Development has the potential to result in an increase of volume of runoff during the operational phases of the Development relative to baseline conditions. However, with the appropriate environmental engineering controls these potential effects 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 of flooding of the drainage network or downstream of the development.

Alterations to ground levels, reducing floodplain attenuation, impeding flood flow routes or raising flood embankments must be accompanied by compensatory provision of flood storage (OPW, 2009 Appendix B[9]).

The design has incorporated a number of culverts along the access track within the flood zone. This will ensure that when the flood occurs, and the land is inundated with flood water, overland flow will not be completely impeded, and will flow through the culverts and therefore through the area of raised ground.

Compensation works refers to the reorientation of land to mitigate changes to flood extents caused by construction. Compensation works are divided into direct and indirect methods (CIRIA[10]). Direct compensation (level for level) methods re-grade land and provide a direct replacement for the lost storage volume. Indirect compensation relies on water entering a defined storage area and releasing water at a slower rate, similar to a surface water attenuation scheme. The storage area can be remote from the floodplain and can contribute to an enhancement of the floodplain. Note that these areas have been named as 'flood compensatory areas' to align with the terminology used in the 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009).

Indirect schemes are complicated to design and construct and may require a more intensive maintenance regime, which must be continued indefinitely. Therefore, level for level compensation should be considered, and where a Strategic Flood Risk Assessment suggests that a relaxation is possible, compensation can be provided by these indirect methods. For this development direct compensation areas are implemented in the design.

Level for level compensation only applies in areas where flood water is stored. Floodwater is stored in natural and defended floodplains which are inundated in the 1% AEP event. Flood flow routes must be protected, whatever the cause of flooding. In some circumstances, this is more critical than providing level for level compensation. There may sometimes be benefits in altering routes or increasing

[9] OPW (2009) The Planning System and Flood Risk Management Guidelines for Planning Authorities, Technical Appendices

[10] UK Construction Industry Research and Information Association (CIRIA) report C624 (2004) Development and flood risk – guidance for the construction industry

flood flow capacity. However, it should only be carried out after careful assessment of the downstream impacts.

The basic requirements for compensatory flood plain storage area as follows:

- A volume of flood plain equal to that lost, if the proposed Development should be created. Normally this is calculated by comparing volumes taken by the development and the volume offered by the compensatory storage for a number of horizontal slices through the range defined above. This is currently achieved by two areas within the redline boundary (0.1037ha and 0.3658ha).
- The equal volume should apply at all levels between the lowest point on the site and the design flood level. This is usually calculated by comparing volumes taken by the development and the volume offered by the compensatory storage for a number of horizontal slices.
- Level for level compensation provides the same surface area at the same elevation before and after development. This should be assessed using increments of approximately 0.1m. Level for level compensation in a fluvial flooding area to ensure incremental loss of floodplain is managed throughout the catchment. In the case of large flat sites or very steep sites, this may be varied to 0.2 or even 0.05 metres in order to have about 10 slices to compare.
- **Table 4.7** presents preliminary calculations to achieve the points above. Excavation depth is taken at 0.65m below existing ground where the ground is below the 9.6m contour and 0.65m below the 9.6m contour where the land is higher than the 9.6m flood level.
  - Area 01 = 1037m3
  - Area 02 = 3,658m3

Table 4.7: Compensation capacity calculations

	Elevation Interval		Volume of infrastructure	Volume of infrastructure	Volume of Compensation Storage Achieved.
	Base	Top	TEMPORARY	PERMANENT	PERMANENT
	mAOD	*mAOD*	*m3*	*m3*	*m3*
Flood Height 9.3maOD	9.20	9.40	500	250	250
	9.00	9.20	500	250	250
	8.80	9.00	1000	300	300
	8.60	8.80	1100	450	450
	8.40	8.60	1150	550	550
	8.20	8.40	1250	650	650
Lowest GL	8.00	8.20	1500	700	700
	TOTAL		7000	3150	3150

4.4.3 Data Gaps & Limitations

This Flood Risk Assessment (FRA) Stage 2 assessment has been conducted using indicative flood extents, available lidar data, and preliminary engineered designs.

This assessment uses available lidar data to assess elevation and potential flood levels and depths. The elevation data used is obtained via airborne vehicles and includes anomalies such forestry cover. Advanced assessment and detailed design will include obtaining elevation data with on-site data validation to ensure forest cover etc. does not lower accuracy of the assessment or design.

4.5 FRA Stage 2 – Conclusions

The Site lies within probable flood zones and on-site risks. A portion of the Development lies within a low and medium probability flood plain, classified as Flood Zone A & B. Turbine T1 and associated hardstand and approach access track are positioned in these flood zones. The infrastructure in these areas can be defined as critical, and therefore passes the justification test.

A 1 in 100 year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be 0.031m^3/second, (or 1.09% relative to the associated catchment). The magnitude of potential net increase in runoff as a function of the Development at the Site is considered an adverse moderate effect**.** 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.

The design of the proposed hardstand and the associated portion of site access track will be done in line with the requirements of appropriate guidelines, as presented in this report. The proposed hardstand and access tracks within the flood zone is shown on Planning Drawing No. 6778-JOD-MM-XX-DR-C-0101 and 6778-JOD-MM-XX-DR-C-0102 which accompany the application. As a result, portions of the hardstand and access tracks will be raised above the level of 8.8mAOD, to facilitate a 1 in 20 year flood event. Both the hardstand and access tracks will also allow adequate sizing and freeboard to facilitate peak flows and flood heights and maintain overland flow in the flood plain reaching a flood height of 9.6mAOD, this is a 1 in 100year event. It is assumed that the turbine (T1) finished base level will be located at a height of 9.6mOD. A number of culverts along the access track within the flood zone will be installed to ensure that flood water flow routes will not be completely impeded. Loss in flood zone capacity will be regained through appropriate measures, previously the two flood compensation areas.

The CEMP includes a Surface Water Management Plan (SWMP) (which will be updated further prior to the construction phase commencing) with a view to ensuring surface water runoff at the site is managed effectively and does not exacerbate flood risk to the surrounding areas upstream and downstream. As the associated drainage - some of which is permanent 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.

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