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QUARRYING ACTIVITIES AT REDROCK QUARRY, CLOGRENNANE, CO. CARLOW

STAGE II - FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:
MILFORD QUARRIES LTD

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

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SIGNED:	Michael Gill ______________________________ **Michael Gill B.A., B.A.I., M.Sc., MIEI** **Managing Director – Hydro-Environmental Services**

Disclaimer:
This report has been prepared by HES with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our terms and conditions and taking account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client, and others in respect of any matters outside the scope of the above. The flood risk assessment undertaken as part of this study is site-specific, and the report findings cannot be applied to other sites outside of the survey area which is defined by the site boundary. This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

TABLE OF CONTENTS

FIGURES IN TEXT

TABLES IN TEXT

1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) was engaged by Tom Philip's and Associates (TPA), on behalf of Milford Quarries Ltd, to undertake a Stage II Flood Risk Assessment (FRA) for the historic quarrying activities at Redrock Quarry, Clogrennane, Co. Carlow.

The FRA has been completed with respect to the following conditions:

- The current hydrology of the Development Site; and,
- The implementation of the proposed restoration plan for Redrock Quarry.

This FRA is intended to support the remedial Environmental Imapct Aassessment Report (rEIAR) submitted as part of the substitute consent application. The Development is described in full in Chapter 3 of the rEIAR. For the purposes of the FRA, and consistent with Chapter 8 of the rEIAR, the various components are described and assessed using the following references: the 'Development', the 'Development Site', the 1995 Baseline, the 'Extraction Phase' (1995 Baseline to 2023) and the 'Current Phase' (2023-Present).

The following FRA is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). This FRA is also completed in accordance with the Surfaace Water Drainage / SuDS policies (SWP1 to SWP6) and the Flood Risk Management policies (FRP1-FRP6) as detailed in the Carlow County Council Development Plan (2022-2028).

1.2 STATEMENT OF EXPERIENCE

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

Our core area of expertise and experience is hydrology and hydrogeology, including flooding assessment and surface water modelling. We routinely work on surface water monitoring and modelling and prepare flood risk assessment reports.

This report was prepared by Michael Gill, Conor McGettigan and Nitesh Dalal.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Civil/Environmental Engineer, Hydrologist and Hydrogeologist with 22 years' environmental consultancy experience in Ireland. Michael has a degree in Civil and Environmental Engineering, a MSc in Engineering hydrology from TCD and a MSc in Applied Hydrogeology from Newcastle University. Michael has completed numerous (60+) hydrological and hydrogeological assessments relating to bedrock quarries and sand and gravel pits. Recent examples include Ardfert quarry in County Kerry, Middleton Quarry in County Cork, and Rathcore and Clonard Quarries in County Meath.

Conor McGettigan (BSc, MSc) is an Environmental Scientist, with over 5 years' experience in the environmental sector in Ireland. Conor holds an MSc in Applied Environmental Science and a BSc in Geology from University College Dublin. Conor routinely completes hydrological and hydrogeological assessments for a wide range of developments including sand and gravel pits and bedrock quarries.

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

1.3 REPORT LAYOUT & METHODOLOGY

This FRA report has the following format:

- Section 2 describes the setting and details of the Development Site;
- Section 3 outlines the hydrological and geological characteristics of the local hydrological regime and existing drainage at the Development Site;
- Section 4 presents the current site-specific flood risk conditions at the Development Site in accordance with the above-mentioned guidelines;
- Section 5 presents an assessment of the potential change in flood risk conditions (from the baseline) at the Development Site, and downstream, as a result of the previous quarrying activities, and the proposed restoration plans; and,
- Section 6 presents the FRA report conclusions.

As stated above, this FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009). The assessment methodology involves researching and collating flood related information from the following data sources:

- Geological Survey of Ireland (GSI) geological databases and Teagasc soils map (www.gsi.ie);
- EPA Hydrological Databases (www.epa.ie);
- OPW National Flood Mapping Databases (www.flood.info); and,
- Carlow County Development Plan 2021 – 2027.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Development Site.

2.2 SITE LOCATION AND TOPOGRAPHY

The Development Site is located in the townland of Clongrenan, Co. Carlow, and lies immediately to the south of the Laois – Carlow county border. The Development Site is located ~1.5km east of the small village of Bilboa, Co. Laois which was historically a coal-mining settlement. The Development Site also lies ~5km southwest of Carlow town and ~7.5km northwest of the town of Leighlinbridge, Co. Carlow. The Development Site has a total area of 41.86 hectares (ha), and a surrounding landholding of 45.68 ha. A site location map is included as **Figure A**.

The Development Site can be accessed via the L3896/L7134 which is located ~300m to the east. An existing access road branches off this local road to the east and runs along the northern boundary of the quarry, providing access to the quarry void.

The Development Site currently comprises of an existing quarry void which is surrounded by agricultural lands. The Development Site was previously used to extract sandstone bedrock, with extraction ceasing in 2014. The floor of the existing quarry void stands at ~304mOD (metres above Ordnance Datum).

The Development Site is located on the eastern edge of the Castlecomer Plateau, an upland area in north Co. Kilkenny which also extends into Co. Laois and Co. Carlow at its northern edge. Locally, natural ground elevations within the Development Site range from ~319mOD in the west to ~310mOD in the east. Natural ground elevations had been altered in the quarry void due to the previous removal of overburden, extraction of bedrock and stockpiling of spoil material. The existing topography to the east of the quarry void slopes steeply to the east. Meanwhile, the rough agricultural pastures to the southwest of the quarry void are relatively flat.

2.3 SITE HISTORY AND SITE DRAINAGE

A full description of the Development and all works completed at the Development Site post-dating the 1995 baseline are described in full in Chapter 3 of the rEIAR.

No large scale quarrying operations were occurring at the Development Site in 1995. A small historic and abandoned borrow pit was present at the Development Site at this time.

The primary hydrological changes occurred during the Extraction Phase (1995 baseline to 2014). During this time period sandstone bedrock was removed by rock breacking, with all rock being crushed and processed on-site. Spoil was stored in large spoil heaps within and surrounding the quarry void.

During the Extraction Phase the quarry expanded to the south, towards the Raheendoran Stream and resulted in the alteration of the previous baseline drainage patterns. . Within the extraction area the headwaters of this stream (~120m in length) have been removed and are no longer present. Water which used to make its way into the stream now gathers on the floor of the quarry and outfalls from the existing quarry void via 2 no. separate outfall locations. Today a large, flooded area is present in the northeast of the existing quarry void. This flooded area outfalls to a small drain which is located along an access track in the northeast of the Development Site. Meanwhile, some settlement ponds and flooded areas located towards the centre of the existing quarry void and outfall to the southeast. This outfall flows through a narrow, deeply incised gully before it discharges into a larger settlement pond in the east of the overall landholding. This settlement pond, and the wet flooded areas in the quarry void, provide treatment in the form of attenuation and settlement of suspended solids. The treated water flows from the settlement pond to the northeast and joins with the discharge from the northern outfall which flows along the existing access track. The combined discharge then flows to the east for ~630m before it discharges into the EPA mapped Mortarstown Stream (EPA Code: 14M40). This stream is a tributary of the Fushoge River (EPA Code: 14F03), discharging into the Fushoge River just upstream of its confluence with the River Barrow.

Bedrock extraction largely ceased by the end of 2014, with some minor site consolidation works being completed up until 2023. The Applicant took ownership of the Development Site in 2023 and the quarry has remained inactive throughout this period.

The Development includes for a proposed restoration plan. The extraction area will be restored to agricultural grassland using material from an existing infill area in the west of the site. Revegetation will be allowed to occur naturally. The restoration plan also includes the planting of existing soil storage areas with woodland mosaic. During the site restoration water will also be redirected from the existing settlement pond back into the Raheendoran Stream.

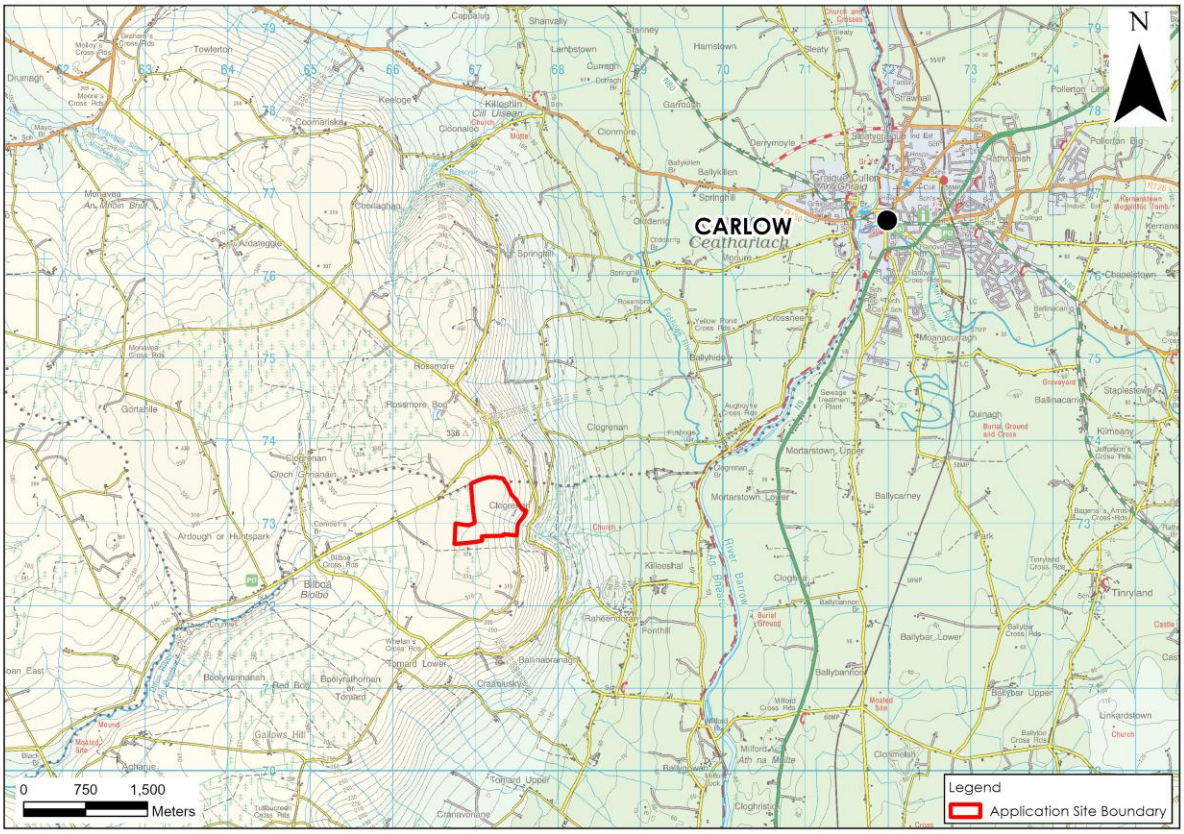

Figure A: Site Location Map

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics in the area of the Development Site.

3.2 BASELINE HYDROLOGY

3.2.1 Regional and Local Hydrology

Regionally, the majority of the Development Site is located within the River Barrow surface water catchment and Hydrometric Area 14 of the Southeastern River Basin District. Meanwhile, a small portion in the west of the Development Site is located within the Nore River surface water catchment and Hydrometric Area 15 of the Southeastern River Basin District.

More locally, within the River Barrow surface water catchment, the Development Site is mapped within the Barrow_SC_110 sub-catchment and Barrow_170 WFD river sub-basin. Within this WFD river sub-basin, the EPA map a small 1st order stream, referred to by the EPA as the Raheendoran Stream (EPA Code: 14R41) to flow through the centre of the Development Site. The stream is mapped to flow from northwest to southeast across the quarry void before continuing to the south, crossing the L7134, flowing to the east through Clogrennane Woods for ~3km, before discharging into the River Barrow. However, based on site walkover surveys and drainage mapping, the course of this stream had been altered by the quarrying activities. No watercourse crosses the quarry void. Water gathers in the floor of the quarry and drains out from a pond in the north of the quarry. From here the stream/quarry discharge flows to the southeast along the quarry access road. The drain is culverted under the access road and flows to the east where it joins the EPA named Mortarstown Stream (EPA Code: 14M40) ~670 to the east. This stream flows to the east and discharges into the Fushoge River (EPA Code: 14F03) just upstream of its confluence with the River Barrow.

Within the Nore River surface water catchment, the Development Site is mapped within Dinin[South]_SC_010 sub-catchment and Dinin (South)_010 WFD river sub-basin. Within this WFD river sub-basin the closest EPA mapped stream is an unnamed stream located ~1.3km west of the Development Site. This stream flows for ~1km before discharging into Dinin (South) River (EPA Code: 15D08). Inspection of local 6" and 25" basemaps for the local area shows that this watercourse, referred to on these maps as the Dinin River, rises ~500m west of the Development Site. There is no existing (and/or proposed) discharge from the quarry within the River Nore catchment. However, runoff from some areas in the west of the Development Site may currently flow to the west towards the Dinin River.

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

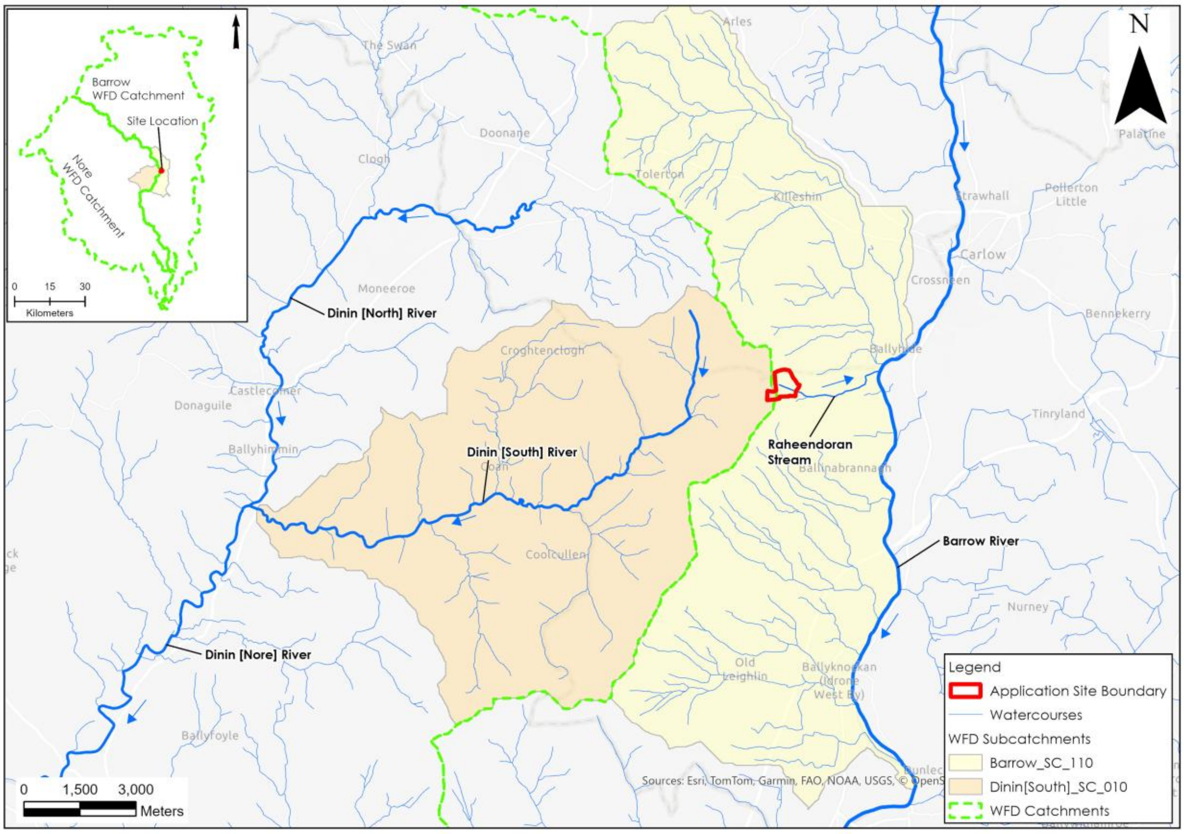

Figure B: Local Hydrology Map

3.2.2 Rainfall and Evaporation

Long term rainfall and evaporation data were sourced Met Éireann (www.met.ie).

The nearest rainfall station is at Coon, located ~7.5km west-southwest of the Development Site and has an Average Annual Rainfall (AAR) of 1,056.2mm. However, the AAR at Coon may underestimate the actual AAR at the Development Site due to the significant topographic differences which exist between the Development Site and Coon rainfall station. Ground elevations at Coon rainfall station stand at ~176mOD (metres above Ordnance Datum) while at the Development Site, the local ground elevations vary from ~310mOD to ~319mOD.

Met Éireann also provide a grid of modelled AAR for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the 30-year AAR (1991-2020) at the Development Site, assigned to location E267000, N173000, is modelled to be 1,118mm/yr. This is considered to be the most accurate estimate of AAR from the available sources.

The closest synoptic[1] station where the average Potential Evapotranspiration (PE) is recorded is at Kilkenny, ~22km southwest of the Development Site. The long-term average PE for this station is 458.8mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Development site is estimated as 435.9mm/year (which is 0.95 × PE).

The Effective Rainfall (ER)[2] represents the water available for runoff and groundwater recharge. The ER for the Development Site is calculated as follows:

[1] Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.

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

Effective Rainfall (ER) = Average Annual Rainfall (AAR) – Actual Evapotranspiration (AE)

= 1,118mm/year – 435.9mm/year

ER = 682.1mm/year

Based on recharge coefficient estimates from the GSI (www.gsi.ie), groundwater recharge coefficients at the Development Site range from 22 to 85%. The estimates are based on the presence of poorly drained mineral soils (22% groundwater recharge), with higher recharge rates in the areas where bedrock is close to the ground surface (85% groundwater recharge). The vast majority of the Development Site is mapped as having a recharge coefficient of 85%. Therefore, based on this recharge coefficient, annual recharge and runoff rates for the Development Site are estimated to be 579.8mm/year and 102.3mm/year respectively. However, the GSI state that the bedrock in this area is noted to be of low permeability and has a maximum recharge capacity of 100mm/yr. Therefore, a high proportion of this potential recharge is rejected by the underlying bedrock and will discharge into local streams and watercourses. This is supported by observations made during site walkover surveys.

Met Éireann's Translate Project (https://www.met.ie/science/translate) provides projections for a range of future climate change scenarios, as Ireland's future climate will depend on global greenhouse gas emissions reductions. The severity of any future climate change will depend on the degree of future warming. In a 1.5°C world, average winter and summer precipitation rates are projected to be 3.39mm/day and 2.07mm/day respectively in Co. Carlow. Meanwhile, in a 4°C world, the average winter and summer precipitation rates in Co. Carlow are projected to be 3.70mm/day and 1.85mm/day respectively.

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

Table A: Development Site - Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	3.4	5.5	9.0	12.1
15 mins	5.6	9.0	14.7	19.8
30 mins	7.3	11.5	18.2	24.3
1 hours	9.6	14.7	22.7	29.7
6 hours	19.1	27.5	39.8	50.1
12 hours	25.0	35.0	49.5	61.3
24 hours	32.6	44.6	61.5	75.0
2 days	40.1	53.6	72.1	86.6

3.3 GEOLOGY

The published Teagasc soil maps (www.gsi.ie) for the local area shows that the majority of the Development Site is overlain by shallow, rocky, peaty/non-peaty mineral complexes (mainly acidic) (AminSRPT) and shallow, peaty, poorly drained mineral soils (mainly acidic) (AminSPPT). A small portion in the northwest of the Development Site is overlain by blanket peat (BktPt). To the east of the Development Site Teagasc map the presence of shallow, well drained mineral soils (mainly acidic) (AminSW), with smaller areas mapped to be overlain by poorly drained mineral soils (mainly acidic) (AminPD) and shallow poorly drained mineral soils (mainly acidic) (AminSP).

The published GSI subsoil maps (www.gsi.ie) for the local area shows that the majority of the Development Site is underlain by bedrock outcrop or subcrop (Rck) with small pockets of till derived from Namurian sandstones and shales (TNSSs) and blanket peat (BktPt) to the west.

The GSI's bedrock geology map for the local area (www.gsi.ie) shows that the majority of the Development Site is underlain by the Moyadd Coal Formation described as shale, siltstone and minor sandstone. Meanwhile, the southwest of the Development Site, and some small areas in the east, are mapped to be underlain by the Bregaun Flagstone Formation. The Bregaun Flagstone Formation is described by the GSI as being comprised of thick flaggy sandstone and siltstone. The GSI map 1 no. northwest to southeast orientated fault to dissect the southwest of the Development Site. Another fault of similar orientation is mapped ~40m to the north of the Development Site.

3.4 DESIGNATED SITES & HABITATS

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

The Development Site is not located within a Ramsar site or a designated site of national (Natural Heritage Area (NHA) / Proposed Natural Heritage Area (pNHA)) or European importance (Special Area of Conservation (SAC) / Special Protection Area (SPA).

However, there are downstream hydrological connections with some Natura 2000 sites within the River Barrow surface water catchment. Designated sites that lie downstream of the site include:

- River Barrow and River Nore SAC (Site Code: 002162), is hydrologically linked within the Development Site. This SAC is located ~1.8km east and ~5.6km southwest of the Development Site. The length of the hydrological connection between the Development Site and the SAC is ~2.7km via the Mortarstown Stream. This stream receives discharge from the Development Site. The lower reaches of this stream and the Fushoge River form part of the SAC.
- Cloghristick Wood pNHA (Site Code: 000806) located ~3.48km southeast of the Development Site and on the eastern banks of the River Barrow. The length of the hydrological flowpath between the Development Site and this pNHA is ~6.3km.
- River Nore SPA (Site Code: 004233) is located downstream and ~22km southwest of the Development Site in the River Nore catchment. Any potential hydrological pathway would be in excess of 30km in length. There is no surface water discharge from the Development Site to any tributary of the Dinin River.

Other protected sites located within 10km of the Development Site but are not directly linked via surface water pathways are considered below:

- Coan Bogs NHA (Site Code: 002382) located ~5km west of the Development Site.

4. BASELINE FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). The basic objectives of these guidelines are to:

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

A stage 1 assessment of flood risk requires an understanding of where the water 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). It is necessary to identify whether there may be any flooding or surface water management issues related to the proposed site that may warrant further detailed investigation.

As per the guidance (DOEHLG, 2009), the stage 1 of a flood risk assessment comprises:

- *Flood risk identification* – identify whether there are surface water flooding issues at a site; and,
- *Initial flood risk assessment* - confirm sources of flooding that may affect a proposed development.

4.1 FLOOD ZONE MAPPING

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

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

As per the Guidelines, there are essentially two major causes of flooding:

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

- High tide level;

- Storm surges caused by low barometric pressure exacerbated by high winds (the highest surges can develop from hurricanes); and,
- Wave action, which is dependent on wind speed and direction, local topography and exposure.

Coastal Flooding is not applicable to the Development Site.

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

- Overland flow occurs when the amount of rainfall exceeds the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural hollows and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall and eventually enters a piped or natural drainage system.
- River flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying areas (the floodplain). This can occur rapidly in short steep rivers or after some time and some distance from where the rain fell in rivers with a gentler gradient.
- Flooding from artificial drainage systems results when flow entering a system, such as an urban stormwater drainage system, exceeds its discharge capacity and the system becomes blocked, and/or cannot discharge due to a high-water level in the receiving watercourse. This mostly occurs as a rapid response to intense rainfall. Together with overland flow, it is often known as pluvial flooding. Flooding arising from a lack of capacity in the urban drainage network has become an important source of flood risk, as evidenced during recent summers.
- Groundwater flooding occurs when the level of water stored in the ground rises as a result of prolonged rainfall to meet the ground surface and flows out over it, i.e. when the capacity of this underground reservoir is exceeded. Groundwater flooding tends to be very local and results from interactions of site-specific factors such as tidal variations. While water levels may rise slowly, they may be in place for extended periods. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life.
- Estuarial flooding may occur due to a combination of tidal and fluvial flows, i.e., the interaction between rivers and the sea, with tidal levels being dominant in most cases. A combination of high flow in rivers and a high tide will prevent water flowing out to sea, tending to increase water levels inland, which may flood over riverbanks.

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

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

There are three types or levels of flood zones defined within the guidelines:

Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% (AEP)[3] or 1 in 100 for river flooding or 0.5% (AEP) or 1 in 200 for coastal flooding);

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

Once a flood zone has been identified for a site, the guidelines set out the different types of development appropriate to each identified zone (pg. 25, Table 3.1 of the Guidelines). Exceptions to the restriction of development due to potential flood risks are provided for through the application of a Justification Test (JT), where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

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

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

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

4.2 BASELINE FLOOD RISK IDENTIFICATION

4.2.1 Historical Mapping

To identify those areas as being at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) was consulted. There was no identifiable map text on local available historical 6" or 25" mapping that would identify lands that are "liable to flood" within or in the vicinity of the Development Site.

4.2.2 Soils Maps – Fluvial Maps

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

[3] AEP – Annual Exceedance Probability

Based on the EPA/Teagasc soil maps (www.epa.ie/www.gsi.ie) for the area it appears that there are no areas of mineral alluvium located within the Development Site or in the surrounding lands. The closest mapped area of mineral alluvium soils (fluvial deposits) is mapped along the River Barrow ~1.5km east of the Development Site.

4.2.3 OPW Past Flood Events Mapping

The OPW's Past Flood Events Map does not record any recurring or historic flood incidents within the Development Site (refer to **Figure C** below).

The nearest mapped historic flood event (Flood ID:12779) is located at Fonthill, ~1.45km southeast of the Development Site. This flood event is undated and no details are available on www.floodinfo.ie.

Another past flood event (Flood ID: 11338), dating from 15th Novemebr 2009, is located at Fonthill, Raheendoran, Co Carlow, ~2.6km southeast of the Development Site. A recurring flood event (Flood ID: 2742) is also mapped on the Fushoge River upstream of its confluence with the Mortarstown Stream. Meanwhile, further to the southeast and downstream of the Development Site, several recurring flood incidients are mapped along the River Barrow.

No areas within the Development Site are mapped as an OPW Drainage District (*i.e.* an area where drainage schemes to improve land for agricultural purpose) or as Benefiting Lands (*i.e.* land identified by the OPW as potentially benefitting from the implementation of Arterial (Major) Drainage Schemes and an indicator of land subject to flooding and poor drainage).

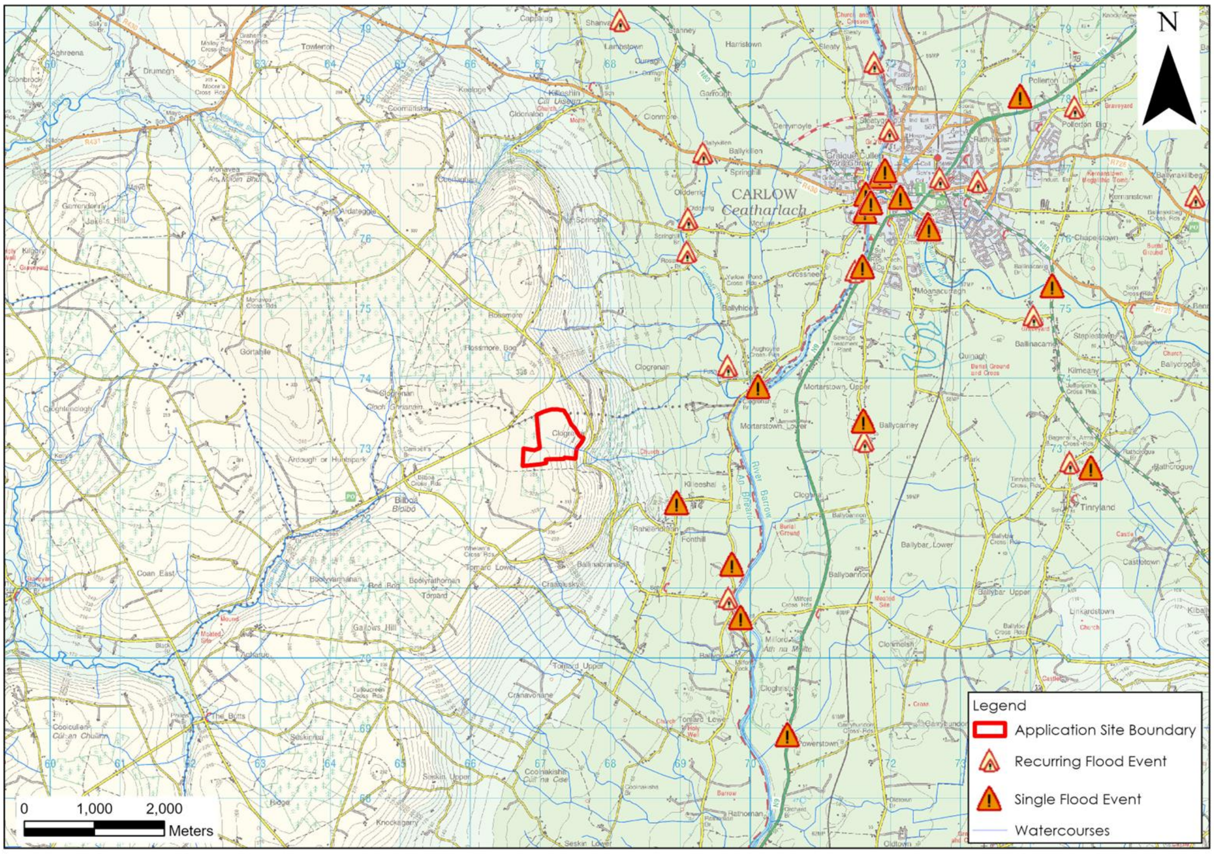

Figure C: OPW Past Flood Event Map

4.2.4 GSI Winter (2015/2016) Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding Map[4] shows areas of fluvial and pluvial flood extents during the Winter 2015/2016 flood event, which was the largest recorded flood event in many areas.

The GSI Winter (2015/2016) Surface Water Flooding Map does not record any flood zones within the Development Site. The closest GSI Winter Surface Water Flooding is recorded ~900m northwest of the Development Site and is associated with a lake feature in Rossmore Bog (refer **Figure D** below).

Flood zones were also recorded downstream of the Development Site on the River Barrow.

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

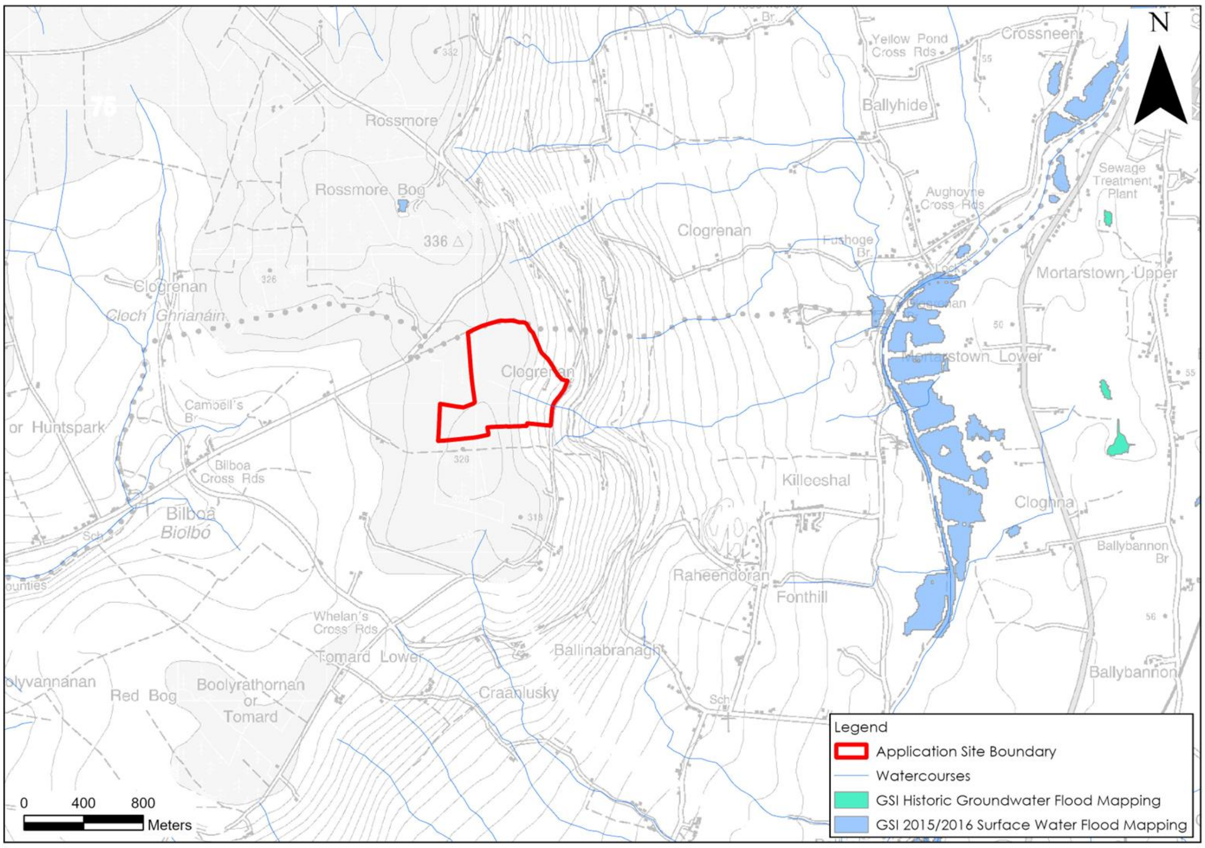

Figure D: GSI Winter 2015/2016 Surface Water Flood and Ground Water Flood Mapping

4.2.5 CFRAM Maps – Fluvial and Pluvial Flooding

Catchment Flood Risk Assessment and Management (CFRAM)[5] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA[6] maps. CFRAM mapping of river flood extents are available at www.floodinfo.ie.

CFRAM mapping has not been completed for the area of the Development Site. There is no CFRAM Fluvial Flood Zones mapped within the Development Site. The nearest downstream CFRAM fluvial flood zones are mapped along the River Barrow, ~1.75km to the east of the Development Site.

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

4.2.6 National Indicative Fluvial Flood Mapping

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

The Present-Day Scenario has been generated using methodologies based on historic flood data and does not consider the potential changes due to climate change. The potential effects of climate change on flooding have been separately modelled (see **Section 4.2.9** below.)

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

For the Present-Day Scenario, no medium (1 in 100) or low probability (1 in 1,000) fluvial flood zones have been mapped to encroach upon the Development Site. The Development Site is mapped entirely within Fluvial Flood Zone C.

A map showing the National Indicative Fluvial Mapping for the present-day scenario is included as **Figure E** below. The nearest fluvial flood zones are mapped alonf the river Barrow and the Fushoge river to the east of the Development Site.

Based on the combined CFRAM and NIFM fluvial flood zones, the Development Site is located in Fluvial Flood Zone C, where the probability of fluvial flooding is low (less than 0.1%).

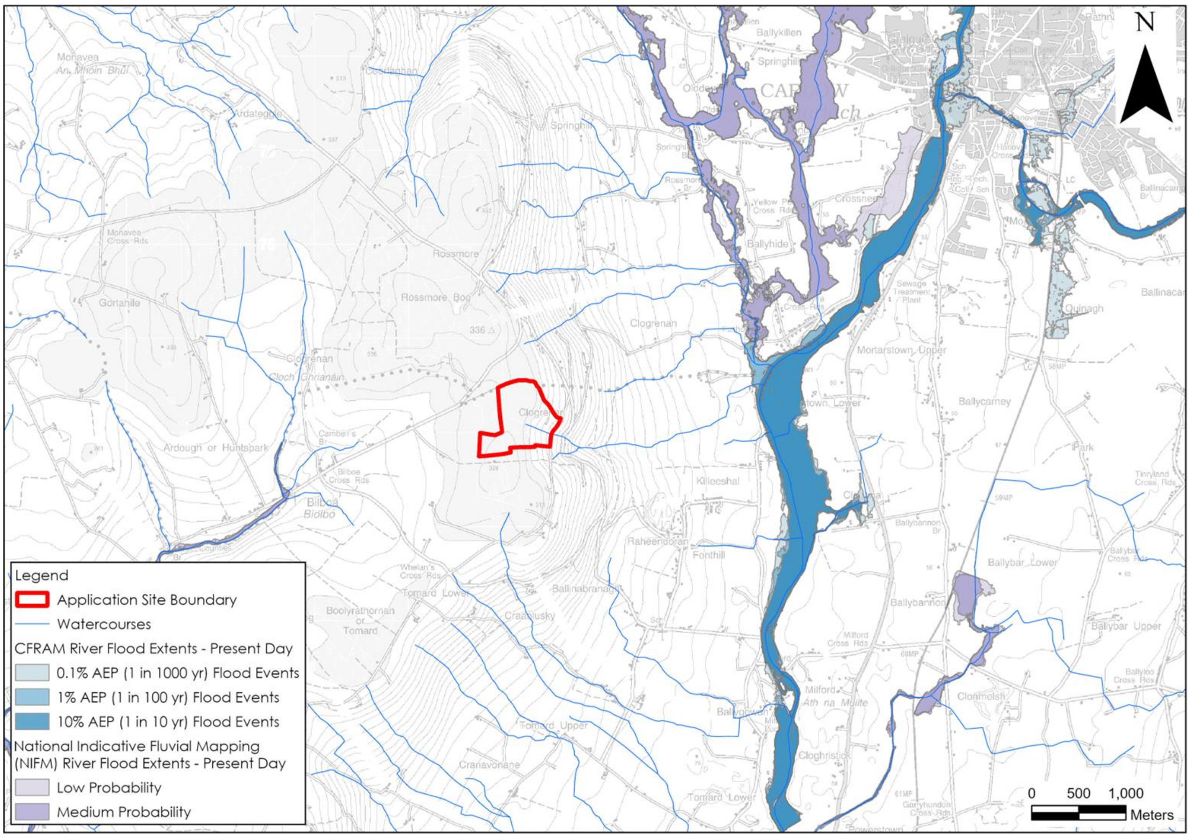

Figure E: CFRAM and National Indicative Fluvial Mapping (www.floodinfo.ie)

4.2.7 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the Development Site or in the surrounding lands.

In terms of historic groundwater flooding, the GSI's Maximum Historic Groundwater Flood Map (www.gsi.ie) does not show any groundwater flooding within the Development Site. The closest historic groundwater flooding is located ~3.36km east of the Development Site.

4.2.8 Coastal Flooding

The Development Site is located ~58km inland and at a significant elevation. Therefore, the Development Site is not at risk of coastal / tidal flooding.

4.2.9 Climate Change

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

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood extends based on a 30% increase in rainfall. Both of these modelled flood extents show similar flood zones to the Present Day Scenario discussed above in **Section 4.2.6.** Therefore, flood zones at the Development Site are unlikely to be significantly impacted by future climate change.

The CFRAM flood mapping has also been completed for the Mid-Range and High-End Future Scenarios. Both of these modelled flood extents show similar flood zones to the Present Day Scenario discussed above in **Section 4.2.5**. Therefore, flood zones at the Development Site are unlikely to be significantly impacted by future climate change.

4.2.10 Site Walkover Survey

Detailed walkover surveys of the Developemnt Site and the surrounding areas were undertaken by HES on 26th, 27th and 28th June 2024, 13th December 2024, 18th February, 25th March, 29th April, 29th May, 25th June, 23rd July, 14th August, 25th September and 13th November 2025.

During these walkover surveys the landcover at the Development Site was verified and noted to comprise of a bedrock quarry surrounded by agricultural pastures.

Contrary to EPA mapping, no watercourse crosses the quarry void. Currently water gathers in the floor of the quarry and drains out from 2 no. ponds. The quarry void has 2 no. separate outfall locations however these merge downgradient of the quarry. HES completed flow monitoring on the quarry outfalls and the flows are small, recorded as <2l/s.

The combined quarry discharge then flows to the southeast along the quarry access road. The drain is culverted under the access road and flows to the east where it joins the EPA named Mortarstown Stream (EPA Code: 14M40) ~670 to the east. This stream flows to the east and discharges into the Fushoge River (EPA Code: 14F03) just upstream of its confluence with the River Barrow.

No evidence of flooding was recorded on the outfall stream or in the lands surrounding the quarry.

4.2.11 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Development Site can be described using the Source – Pathway – Receptor Model (S-P-R). The primary potential source of flooding in this area, and the one with the most consequence for the Development Site, is pluvial flooding.

The quarry void holds/retains rainwater following heavy or prolonged rain. Several large flooded areas are present on the floor of the quarry and provide for the attenuation of surface water runoff from the site. The depth of the flooded areas is relatively shallow. The retention and attenuation of water within the quarry void during rainfall events reduces the downstream flooding risk. Potential receptors in the area are infrastructure, people, land and other private property.

4.2.12 Summary – Initial Flood Risk Assessment

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

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

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the streams that are close to Development Site	Land & infrastructure	The Development Site is located in Fluvial Flood Zone C. The Development Site is not at risk of fluvial flooding.
Pluvial	Ponding of rainwater on Development Site	Land & infrastructure	Rainwater gathers on the floor of the quarry and is attenuated prior to release to the downstream surface water network. .
Surface water	Surface ponding/ Overflow	Land & infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land & infrastructure	Based on local hydrogeological regime and GSI mapping, there is no risk of groundwater flooding at the Development Site.
Coastal/tidal	Overbank flooding	Land, People, property	The Development Site is located ~58km inland from the sea. So no coastal flooding will be possible.

5. DOWNSTREAM FLOOD RISK ASSESSMENT

5.1 EXTRACTION PHASE (1995 BASELINE TO 2014)

The greatest flood risk associated with the development of a bedrock quarry is the potential for an increased downstream flood risk associated with surface water discharges.

However, the Development had no potential to increase the downstream flood risk due to the very small volumes of water being discharged from the quarry. The small volumes of water requiring discharge is a function of the topographical and hydrogeological setting of the Development Site. There is no singifcant ingress of groundwater into the quarry void due to the low permeability of the bedrock aquifer and the location of the site on a topographic high at the edge of the Castlecomer Plateau. The vast majority of water which gathered in the quarry void and required discharge comprised of rainfall and local surface water runoff from the lands situated immediately upgradient of the quarry. This resulted in small volumes of water requiring discharge. Furthermore, the Development did not discharge any unattenuated water. Large areas of the quarry floor have been allowed to flood with surface water, and settlement ponds have been constructed. This allowed for the attenuation of surface water runoff and ensured that water was released from the site at a slow and controlled rate. During walkover surveys the volumes of water being discharged from the site were small and typically less than 2l/s. Note that the volumes of water currently being discharged are likely to represent the greatest discharge volumes. The volumes of water being discharged would have gradually increased as the quarry void expanded throughout the Extraction Phase.

With regards to the increase in downstream flood risk associated with the alteration of the local drainage patterns and the discharge of runoff towards the Morstarstown Stream, there would have been very little potential for any increase in the downstream flood risk due to the following reasons:

- Little ingress of groundwater occurred into the quarry void due to the topographic (on a topographic high at the edge of the Castlecomer Plateau) and hydrogeological setting (Poor Bedrock Aquifers) of the Development Site;
- The Raheendoran Stream in the vicinity of the Development Site, prior to the quarrying activities had a very small upstream catchment area (~0.28km^2) and only ~150m of the stream was lost; and,
- There was no discharge of untreated or unattenuated waters.

For the above reasons (topographic and hydrogeological setting of the Development Site), the historic quarrying activities would not have resulted in any significant increase in the downstream flood risk.

5.2 CURRENT PHASE (2023 TO PRESENT)

The hydrological regime described above for the Extraction Phase has remained in place since the extraction ceased. There was no discharge of untreated or unattenuated waters during the Current Phase.

5.3 RESTORATION PHASE

Regarding the proposed restoration of the Development Site, the Development will not have any potential to increase the downstream flood risk. The use of infill material to restore the quarry void to agricultural pastures will slow local surface water runoff rates, with the inflill material providing great infiltration capacity. The site restoration also includes the diversion of water from the site back into the Raheendoran Stream. This will be achieved by constructing a diversion channel from the existing settlement pond to the stream. The restoration plan also includes a wildlife pond which will provide additional attenuation of water. There will be no increase in the downstream flood risk given the attenuation of water provided by the existing settlement pond and by the proposed wildlife pond.

5.3.1 Requirement for a Justification Test – Proposed Restoration

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

It may be considered that the proposed restoration plan can be categorised as a "Water Compatible development". The restoration plan includes infilling of the quarry void with suitable material and the diversion of flows back into the Raheendoran Stream downstream of the Development Site. The infill material will have suitable infiltration capacity and will slow rates of surface water runoff from the Development Site. Water will also be attenuated in the existing settlement pond and in the proposed wildlife pond. Therefore, there will be no increase in the downstream flood risk associated with the Development. Consequently, the Restoration Phase is not at risk of flooding and would not require further justification from a planning perspective.

Table C: Matrix of Vulnerability versus Flood Zone

	Flood Zone A	Flood Zone B	Flood Zone C
Highly Vulnerable Development (including essential infrastructure)	Justification test	Justification test	Appropriate
Less Vulnerable Development	Justification test	Appropriate	Appropriate
Water Compatible Development	Appropriate	Appropriate	**<u>Appropriate</u>**

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

5.3.2 Flood Risk Implications Associated with the Lateral Expansion of Redrock Quarry

Milford Quarries Ltd propose to laterally expand the existing quarry void at Redrock Quarry. It is proposed to expans the quarry to the west and southwest into existing greenfield areas. Extraction will be in 2 no. benches of 10m each. Th total volume of overburden to be removed is estimated to be ~145,000m^2 and it is proposed to extract ~3.9million tonnes of rock over a 20-year period, followed by 2 years of restoration.

However, the proposed quarry expansion will not result in the release of any untreated or unattenuated discharge. The quarry will operate in accordance with a discharge licence with respect to water quality and discharge flow volumes. Discharge from the expanded quarry will be directed to the Raheendoran Stream. Discharge volumes will be small due to the topographic and hydrogeological setting of the site.

There will be no signficant hydrological and/or hydrogeological cumulative effects between the restoration phase and the proposed lateral extension of the quarry.

6. CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Red Rock Quarry, Clogrennane, Co. Carlow. From this study:
  - No instances of historical flooding were identified in historic OS maps for the Development Site;
  - No instances of recurring or historic flooding were identified on OPW maps within the Development Site;
  - The GSI Winter 2015/2016 Surface Water Flood Map does not record any historic flood zones within the Development Site;
  - The GSI Groundwater flood map does not record any groundwater flood zones within the Development Site;
  - No CFRAM fluvial flood zones are mapped within the Development Site;
  - No NIFM fluvial flood zones are mapped within the Development Site.
- The entire Development Site is mapped as being located in Fluvial Flood Zone C and the Development is considered to be appropriate from a flood risk perspective;
- The Development did not contribute to any downstream flooding due to the small volumes of water requiring discharge and the attenuation of all water within the quarry void through the use of settlement ponds and flooded areas on the quarry floor; and,
- The proposed restoration plan for the Development Site is categorised as being a "Water Compatible Development" and a justification test is therefore not required. The proposed restoration plan is designed to improve the hydrological regime at the site, through the use of permeable fill material which will lower surface water runoff rates, and this will reduce the downstream flood risk.

* *

7. REFERENCES

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Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.
Carlow County Council	2022	Carlow County Development Plan 2022-2028

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