# 8 HYDROLOGY & HYDROGEOLOGY

## 8.1 Introduction

### 8.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by Tom Phillip's and Associates (TPA) to carry out an assessment of the potential likely and significant effects of the proposed lateral expansion of Red Rock Quarry (i.e. the' Proposed Development') at Clogrennane, Co. Carlow on the hydrological and hydrogeological environments (water environment).

This chapter provides a baseline assessment of the environmental setting of the Proposed Development, in terms of hydrological and hydrogeological environment and discusses the potential likely significant effects that the operation and restoration phases of the Proposed Development will have. Where required, appropriate mitigation measures to avoid any identified likely significant effects to the hydrological and hydrogeological environment are recommended and the residual effects of the Proposed Development post-mitigation are assessed. Potential cumulative effects on the hydrological and hydrogeological environment are also assessed in this chapter.

Please note that the purposes of this chapter, where:

- The 'Proposed Development' is referred to, this related to all the project components described in Chapter 4; and,
- The 'Proposed Development Site' is referred to, this relates to the primary study area for the EIAR, as delineated by the EIAR Site Boundary.

### 8.1.2 Quality Assurance and Competence

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 chapter of EIAR was prepared by Michael Gill, Adam Keegan, Conor McGettigan and Nitesh Dalal.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is a 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.

Adam Keegan PGeo (B.Sc., M.Sc.) is a hydrogeologist with 7 years environmental consultancy experience in Ireland. Adam has worked on numerous Environmental Impact Assessments for infrastructure projects, such as wind farms, strategic housing developments and quarries. Adam has experience in intrusive site investigation works within sand and gravel environments, primarily relating to quarry developments. Adam has worked on numerous quarry EIAR projects including Mallow quarry, Barrigone quarry, Kilmeague quarry, and Killarney East quarry.

Conor McGettigan (BSc, MSc) is an Environmental Scientist, with over 4 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. Conor has worked on numerous quarry EIAR project including Rathcore quarry, Old Leighlin quarry and Kilchreest quarry.

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).

### 8.1.3 Scoping and Consultation

As detailed in Section 1.5 of the EIAR a non-statutory scoping exercise was completed by TPA for the EIAR.

A scoping request was also submitted to Carlow County Council but no response has been received.

HES submitted an information request to Uisce Éireann on 13th October 2025 to identify any UÉ public water supplies within 5km of the site. A response was received on 15th October 2025 and the information is presented in Section 8.3.4.10.

### 8.1.4 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

The requirements of the following legislation are complied with:

- Planning and Development Acts, 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No. 477/2011: European Communities (Birds and Natural Habitats) Regulations, implementing EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and Directive 2009/147/EC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("WFD").
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722/2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for the implementation of 'daughter' Groundwater Directive (2006/118/EC);
- S.I. No. 122/2014: European Union (Drinking Water) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations;

- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended;
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended; and,
- S.I. No. 99/2023: European Union (Drinking Water) Regulations.

### 8.1.5 Relevant Guidance

The hydrology and hydrogeology chapter of this EIAR was carried out in accordance with the guidance contained in the following:

- Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Department of the Environment, Heritage and Local Government (2004) 'Quarries and Ancillary Activities, Guidelines for Planning Authorities';
- European Commission (2017): Environmental impact assessment of projects – Guidance on the preparation of the environmental impact assessment report (Directive 2011/90/EU as amended by 2014/52/EU);
- Environmental Protection Agency (2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Environmental Protection Agency (2006): Environmental Management in the Extractive Industry;
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001;
- OPW (2009): The Planning System and Flood Risk Management;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Carlow County Council (2022): Carlow County Development Plan (2022-2028).

## 8.2 Study Methodology

### 8.2.1 Desk Study

A desk study of the Proposed Development Site and surrounding area was carried out in November 2024 to collect all relevant geological data. The initial desk study was completed to supplement site walkover surveys and site investigations. The desk study information has been checked and updated, where necessary, in December 2025.

The desk study involved consultation with the following sources:

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland - groundwater databases (www.gsi.ie);
- Met Éireann Meteorological Databases (www.met.ie);

- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive "catchments.ie" Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 19; Geology of Carlow-Wexford;
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- Cycle 3 (HA 14) Barrow Catchment Report (EPA, 2024);
- Cycle 3 (HA 15) Nore Catchment Report (EPA, 2024);
- OPWs National Flood Information Portal (www.floodinfo.ie);
- EPA Hydrotool Databases (www.catchment.ie); and,
- Aerial Photography, 1:5,000 and 6" base mapping.

### 8.2.2 Baseline Monitoring and Site Investigations

Michael Gill of HES completed an initial visit and walkover survey of the Proposed Development Site on 09th May 2024. Site investigations comprising of borehole drilling were completed by Peterson Drilling Ltd, under the supervision of Adam Keegan of HES, on 26th, 27th and 28th June 2024. Additional walkover surveys and geological mapping were completed by Michael Gill and Conor McGettigan on 13th December 2024, 18th February, 25th March, 29th April, 29th May, 25th June, 23rd July, 14th August, 25th September and 13th November 2025.

A comprehensive geological, hydrological and hydrogeological dataset has been collected as part of this EIAR study.

In summary, the site investigations to address the hydrology and hydrogeology chapter of the EIAR included the following:

- HES completed walkover surveys of the Proposed Development Site 26th, 27th, 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 water flow directions and drainage patterns were recorded and ground conditions assessed;
- HES completed detailed logging of exposed subsoil profiles and existing bedrock quarry side walls;
- Mineral soils, subsoils and bedrock were logged according to BS: 5930:2015 Code of Practice for Ground Investigations;
- Apex Geophysics completed geophysical surveys at the Proposed Development Site between 11th and 15th March 2024;
- HES supervised the drilling of 5 no. boreholes at the Proposed Development Site by Peterson Drilling Ltd on 26th, 27th and 28th June 2024. These boreholes extended to a maximum depth of 40mbgl (metres below ground level);
- Groundwater levels in the 5 no. onsite boreholes were manually recorded on a monthly basis from January 2025 to November 2025;
- In addition to the manual water level monitoring, continuous water level monitoring was completed in the 5 no. onsite boreholes over a period of 15 no. months from August 2024 to November 2025. This monitoring was completed through the installation of 5 no. water level monitoring devices and 1 no. barometric monitoring device;
- Groundwater sampling was completed at 2 no. locations on 23rd July and 14th August 2025; and,
- A total of 4 no. rounds of surface water sampling, field hydrochemistry and flow monitoring were completed on the discharges from the Development Site between 3rd April and 25th June 2025.

### 8.2.3 Impact Assessment Methodology

The importance / sensitivity of the hydrogeological and hydrological receptors was assessed on completion of the desk study and baseline assessment. Using the NRA Guidance (NRA, 2008), an estimation of the importance / sensitivity of the hydrogeological and hydrological environments within the study area, as set out in **Table 8-1** for hydrology and **Table 8-2** for hydrogeology, are used to assess the potential effect that the Proposed Development may have on them.

*Table 8-1: Estimation of Importance of Hydrology Criteria (NRA, 2008)*

| Importance | Criteria | Typical Example |
|---|---|---|
| **Extremely High** | Attribute has a high quality or value on an international scale | River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988. |
| **Very High** | Attribute has a high quality or value on a regional or national scale | River, wetland or surface water body ecosystem protected by national legislation – NHA status.<br>Regionally important potable water source supplying >2500 homes.<br>Quality Class A (Biotic Index Q4, Q5).<br>Flood plain protecting more than 50 residential or commercial properties from flooding.<br>Nationally important amenity site for a wide range of leisure activities. |
| **High** | Attribute has a high quality or value on a local scale | Salmon fishery locally important potable water source supplying >1000 homes.<br>Quality Class B (Biotic Index Q3-4).<br>Flood plain protecting between 5 and 50 residential or commercial properties from flooding. |
| **Medium** | Attribute has a medium quality or value on a local scale | Coarse fishery.<br>Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3).<br>Flood plain protecting between 1 and 5 residential or commercial properties from flooding. |
| **Low** | Attribute has a low quality or value on a local scale | Locally important amenity site for small range of leisure activities.<br>Local potable water source supplying <50 homes.<br>Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding. |

| Importance | Criteria | Typical Example |
|---|---|---|
| | | Amenity site used by small numbers of local people. |

*Table 8-2: Estimation of Importance of Hydrogeology Criteria (NRA, 2008)*

| Importance | Criteria | Typical Example |
|---|---|---|
| **Extremely High** | Attribute has a high quality or value on an international scale | Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status. |
| **Very High** | Attribute has a high quality or value on a regional or national scale | Regionally Important Aquifer with multiple wellfields.<br>Groundwater supports river, wetland or surface water body ecosystem protected by national legislation - NHA status.<br>Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source. |
| **High** | Attribute has a high quality or value on a local scale | Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers.<br>Locally important potable water source supplying >1000 homes.<br>Outer source protection area for regionally important water source.<br>Inner source protection area for locally important water source. |
| **Medium** | Attribute has a medium quality or value on a local scale | Locally Important Aquifer.<br>Potable water source supplying >50 homes.<br>Outer source protection area for locally important water source. |
| **Low** | Attribute has a low quality or value on a local scale | Poor Bedrock Aquifer Potable water source supplying <50 homes. |

Once the importance and sensitivity of the geological, hydrological and hydrogeological attribute is established, the conventional source-pathway-receptor model for groundwater / surface water protection was applied to assess impacts on geology, groundwater and surface water specifically on downstream sensitive ecological receptors and local groundwater supplies.

Where potential impacts are identified, the classification of impacts in the assessment follows the descriptors provided in the Glossary of Impacts contained in EPA (2022) guidance. The description process clearly and consistently identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

In order to provide an understanding of the stepwise impact assessment process applied below, we have firstly presented below a summary guide that defines the steps (1 to 7) taken in each element of the impact assessment process in below. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to continued activities which have the potential to generate a source of significant adverse impact on the hydrological/hydrogeological (including wells, streams and water quality) environments.

*Table 8-3: Impact Assessment Process Steps*

| Attribute | Status / Occurrence | Importance |
|---|---|---|
| **Step 1** | Identification and Description of Potential Impact Source<br><br>This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described. | |
| **Step 2** | Pathway / Mechanism: | The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of sand and gravel extraction, surface water and groundwater flows are the primary pathways. |
| **Step 3** | Receptor: | A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present. |
| **Step 4** | Pre-mitigation Impact: | Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place. |
| **Step 5** | Proposed<br>Mitigation Measures: | Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. These measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by best practice engineering design. |
| **Step 6** | Post Mitigation Residual Impact: | Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place. |
| **Step 7** | Significance of Effects: | Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment. |

### 8.2.4 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of Chapter 8 of this EIAR: Hydrology and Hydrogeology.

### 8.2.5 Study Area

The Water Study Area for the hydrological and hydrogeological impact assessment is defined by the regional surface water catchments and groundwater body within which the Proposed Development Site is located.

A regional hydrology map showing the Water Framework Directive (WFD) surface water catchments and sub-catchments is included as **Figure 8-1**. Details regarding the regional hydrological setting of the Proposed Development Site are provided in Section 8.3.3.1. In addition, the bedrock aquifer and groundwater body (GWB) which underlie the Proposed Development Site are detailed in Section 8.3.4.1. The bedrock aquifers in the local area are shown in **Figure 8-8**.

## 8.3 Receiving Environment

### 8.3.1 Site Description and Topography

The Proposed Development Site is located in the townland of Clongrenan, Co. Carlow, and lies immediately to the south of the Laois – Carlow county border. The Proposed Development Site is located ~1.5km east of the small village of Bilboa, Co. Laois which was historically a coal-mining settlement. The Proposed Development Site also lies ~5km southwest of Carlow town and ~7.5km northwest of the town of Leighlinbridge, Co. Carlow. The Proposed Development Site has a total area of 27.5hectares (ha).

The Proposed 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 existing quarry void.

The Proposed Development Site currently comprises of an existing quarry void which is surrounded by agricultural lands. Red Rock Quarry was previously used to extract sandstone bedrock, with extraction ceasing in 2014. The floor of the existing quarry stands at ~304mOD (metres above Ordnance Datum). The existing quarry contains several large stockpiles of spoil which have vegetated in places. An access track passes through the centre of the existing void. Some old plant, machinery and workshops are located to the east of the Proposed Development Site, adjacent to the L3896/L7134. Meanwhile, the lateral expansion lands are located predominantly to the south and southwest of the existing void. These lands comprise of rough agricultural pastures. Meanwhile, the lands to the east of the Proposed Development Site comprise of good agricultural pastures.

The Proposed 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 Proposed Development Site range from ~319mOD in the west to ~310mOD in the east. Natural ground elevations have been altered in the existing quarry void due to the previous removal of overburden, extraction of bedrock and stockpiling of spoil material. The existing topography in the east of the lateral extension lands slopes steeply to the east. Meanwhile, the rough agricultural pastures to the southwest of the existing quarry void are relatively flat.

### 8.3.2 Water Balance

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 Proposed 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 Proposed Development Site due to the significant topographic differences which exist between the Proposed Development Site and Coon rainfall station. Ground elevations at Coon rainfall station stand at ~176mOD (metres above Ordnance Datum) while at the Proposed 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 Proposed Development Site, assigned to location E267000, N173000 are presented in **Table 8-4**. The AAR at the Proposed Development Site is modelled to be 1,118mm/yr. This is considered to be the most accurate estimate of AAR from the available sources.

*Table 8-4: Modelled Monthly Rainfall Averages (mm) 1991 - 2020*

| Location: Proposed Development Site | | | | | | X-Coord: 267000 | | | | Y-Coord: 173000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 109 | 87 | 81 | 74 | 73 | 80 | 76 | 88 | 90 | 121 | 119 | 121 | 1,118 |

The closest synoptic[1] station where the average Potential Evapotranspiration (PE) is recorded is at Kilkenny, ~22km southwest of the Proposed 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 Proposed 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 Proposed Development Site is calculated as follows:

Effective Rainfall (ER) = Average Annual Rainfall (AAR) – Actual Evaporation (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 Proposed 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 Proposed Development Site is mapped as having a recharge coefficient of 85%. Therefore, based on this recharge coefficient, annual recharge and runoff rates for the Proposed 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 8-5** below presents return period rainfall depths for the area of the Proposed 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).

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

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

*Table 8-5: Red Rock Quarry- 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 |

### 8.3.3 Surface Water - Hydrology

#### *8.3.3.1 Regional and Local Hydrology*

Regionally, the majority of the Proposed Development Site is located within the River Barrow surface water catchment and Hydrometric Area 14 of the Southeastern River Basin District. Meanwhile, the southwest of the Proposed Development Site is located within the River Nore surface water catchment and Hydrometric Area 15 of the Southeastern River Basin District.

The Barrow Catchment includes the area drained by the River Barrow upstream of the River Nore confluence and all streams entering tidal water between the Barrow railway bridge at Great Island and Ringwood, Co. Kilkenny, draining a total area of 3,025km$^2$. The largest urban centre in the catchment is Carlow town (EPA, 2024).

More locally within the River Barrow surface water catchment, the Proposed Development Site is mapped within the Barrow_SC_110 sub-catchment and Barrow_170 WFD river sub-basin. Within the Barrow_170 WFD river sub-basin, the EPA map a small 1$^{st}$ order stream, referred to by the EPA as the Raheendoran Stream (EPA Code: 14R41) to flow through the centre of the Proposed Development Site. The stream is mapped to flow from northwest to southeast across the existing 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 has been altered by the previous quarrying activities. No watercourse crosses the existing quarry void. Water gathers in the floor of the existing quarry and drains out from an existing pond in the north of the quarry. From here the stream/quarry discharge flows to the southeast along the existing 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.

Meanwhile, the River Nore Catchment includes the area drained by the River Nore and all streams entering tidal water between its confluence with the River Barrow at Ringwood, and the Barrow railway bridge at Drumdowney, Co. Kilkenny, draining a total area of 2,595km². The largest urban centre in the catchment is Kilkenny (EPA, 2024).

More locally within the River Nore surface water catchment, the Proposed Development Site is mapped within Dinin[South]_SC_010 sub-catchment and Dinin (South)_010 WFD river sub-basin. Within the Dinin (South)_010 river sub-basin the closest EPA mapped stream is an unnamed stream located ~1.3km west of the Proposed 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 Proposed 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 Proposed Development Site may currently flow to the west towards the Dinin River.

A regional hydrology map is attached as **Figure 8-1** below.

A local hydrology map is shown as **Figure 8-2**.

#### *8.3.3.2 Site Drainage*

The course of the Raheendoran Stream has been altered by the historic quarrying activities. 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 as discussed below.

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.

The Development has therefore altered the hydrology at the Development Site by removing the upper reaches of the Raheendoran Stream and redirecting water which used to flow in the Raheendoran Stream to the Mortarstown Stream.

**Figure 8-3** below presents a map of the existing site drainage.

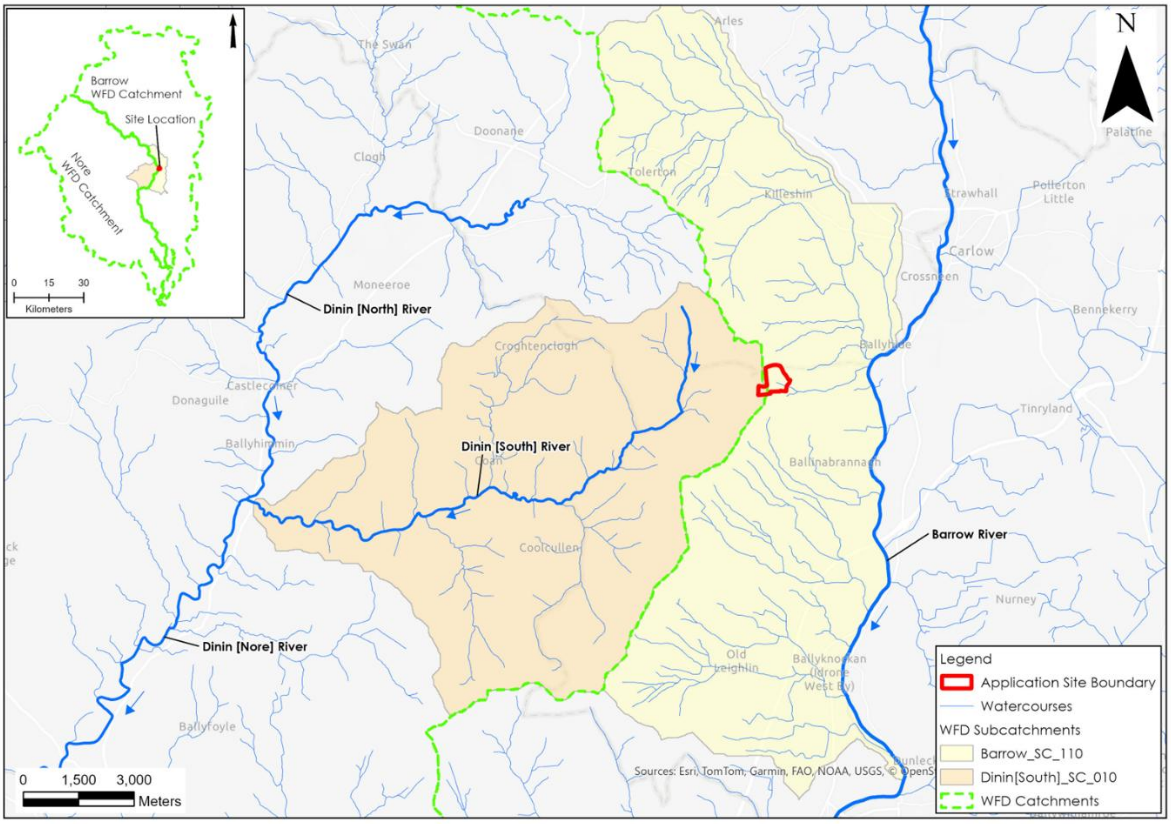


*Figure 8-1: Regional Hydrology Map*

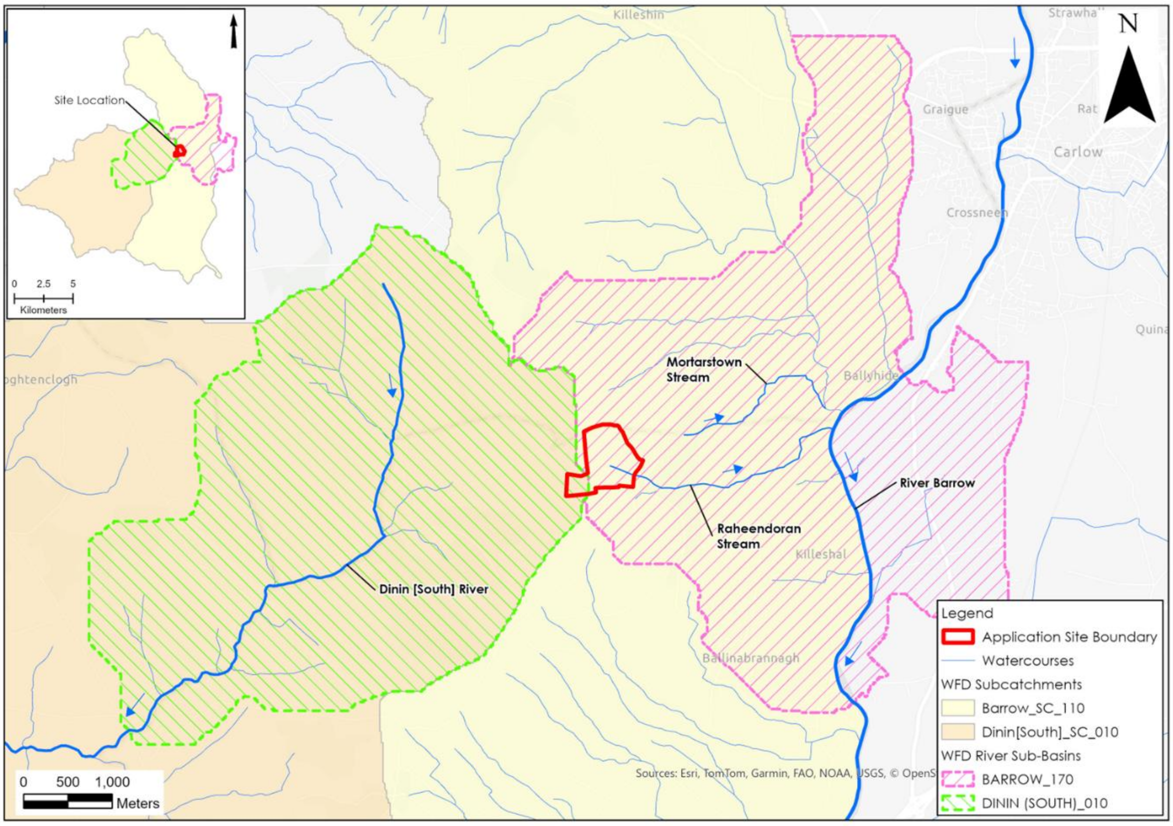


*Figure 8-2: Local Hydrology Map*

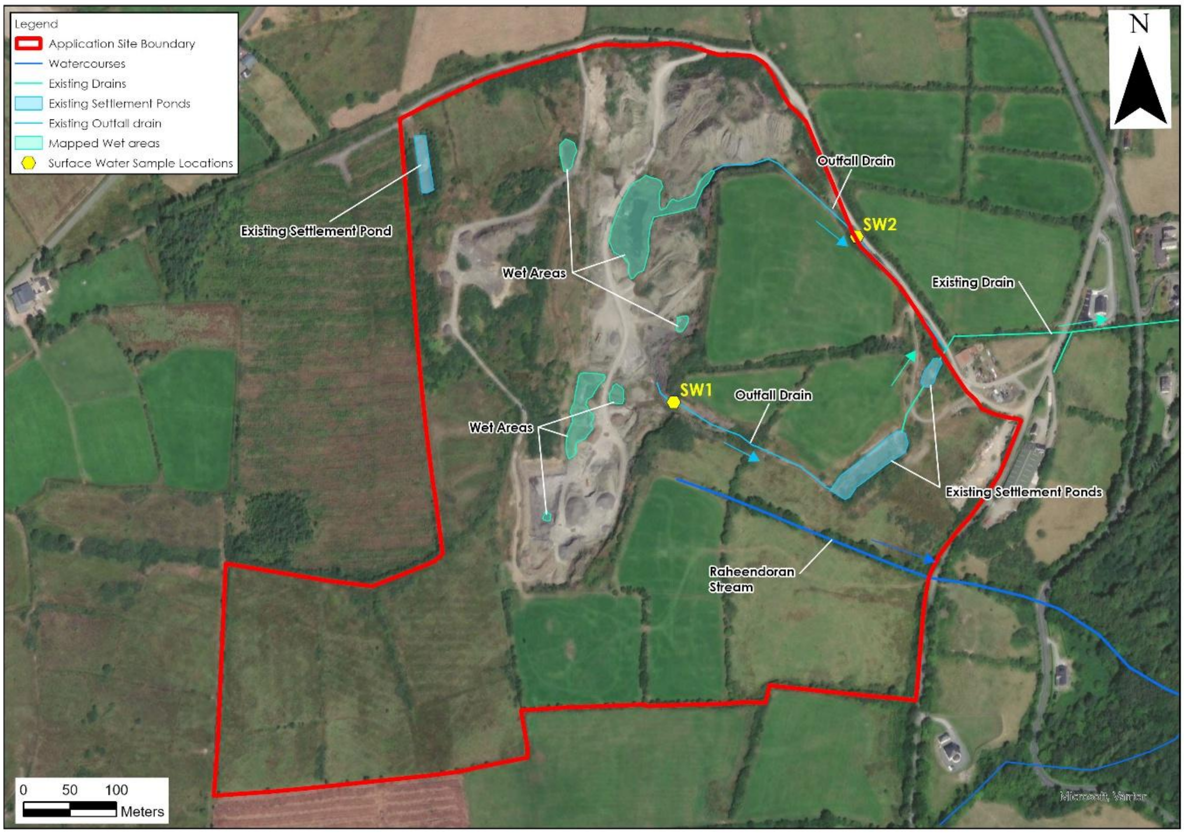


*Figure 8-3: Site Drainage Map*

### *8.3.3.3 Surface Water Flows*

Existing Quarry Discharge

HES completed flow monitoring of the existing surface water discharges from the quarry void (both the discharge to the roadside drain and the discharge to the large settlement pond) on 4 no. occasions between 3rd April and 25th June 2025. The current discharge volumes for both are small, ranging from ~0.3l/s to ~1.2l/s. The combined discharge volume is ~2l/s.

Downstream Flow Volumes

There are no OPW gauging stations located in the immediate vicinity of the Proposed Development Site. The closest OPW gauging station downstream of the Proposed Development Site within River Barrow catchment is located on the River Barrow at Royal Oak (Station Code: 14018). Here the 95%tile flow is estimated to be 3.21$m^3$/s. This means that 95% of the time the flow in the River Barrow at this location will equal or exceed 3.21$m^3$/s (3,210l/s). Meanwhile, within the River Nore catchment, the nearest OPW gauging station is located on the Dinin River at Dinin Bridge (Station Code: 15003). Here the 95%tile flow is estimated to be 0.284$m^3$/s. This means that 95% of the time the flow in the Dinin River at this location will equal or exceed 0.284$m^3$/s (284l/s).

The EPA's Hydrotool, available on www.catchments.ie, was consulted in order to estimate baseline flow volumes in the local area of the Proposed Development Site. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several nodes were consulted in the vicinity and downstream of the Proposed Development Site.

**Figure 8-4** below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Proposed Development Site in the River Barrow catchment. Note that no Hydrotool nodes are available for the EPA named Raheendoran or the Mortarstown streams.

The 95%tile flow at Node 14_190 on the River Barrow, downstream of the Proposed Development Site and the EPA named Raheendoran Stream, is estimated to be 6.061m$^3$/s (6,061l/s). Meanwhile, the 95%tile flow on the Fushoge River downstream of the Mortarstown Stream, and upstream of its confluence with the River Barrow is 0.042m$^3$/s (42l/s). Due to the increasing catchment size, the 95%tile flow at nodes along the River Barrow further downstream get progressively larger. For example, at Node 14_217 on the River Barrow upstream of Goresbridge, the 95%tile flow is estimated to be 6.521m$^3$/s (6,521l/s). Further downstream, the 95%tile flow in the River Barrow, upstream of the Upper Barrow Estuary transitional waterbody at Node 14_1909, is estimated to be 10.859m$^3$/s (10,859l/s). The progressively increasing flow volumes downstream of the Proposed Development Site are associated with the increased upstream catchment of the respective waterbodies.

Note that the recorded (OPW gauging station) and modelled flow volumes (Hydrotool) in the River Barrow are significant and several orders of magnitude greater than the existing discharge volumes from the Proposed Development Site. Therefore, the potential for effects is limited. Nevertheless, the Proposed Development does not in any way rely upon the dilution or assimilative capacity of any downstream watercourse. The mitigation measures prescribed in Section 8.6 will ensure the protection of the receiving watercourses, including those in close proximity to the Proposed Development Site.

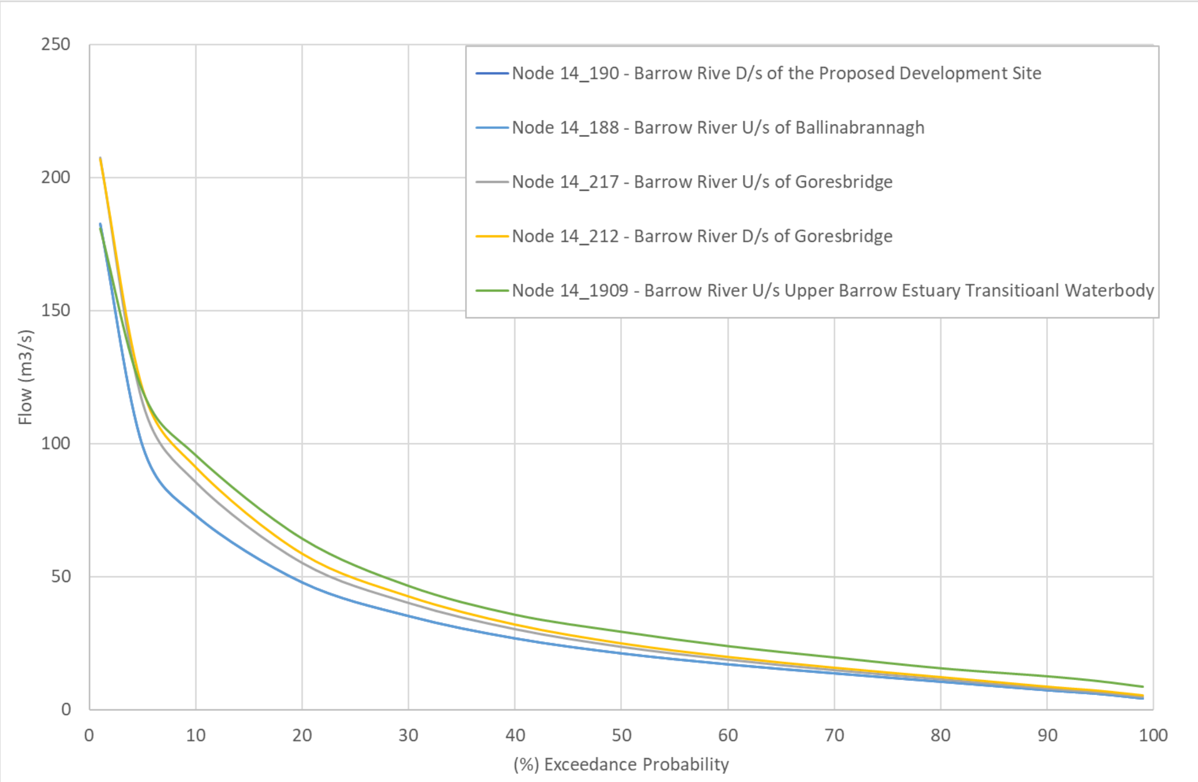


*Figure 8-4: EPA Hydrotool Node Flow Duration Curve (Barrow WFD Catchment)*

**Figure 8-5** below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Proposed Development Site in the River Nore surface water catchment.

The 95%tile flow at Node 15_1 on the Dinin (South) River, downstream of the southwest of the Proposed Development Site, is estimated to be 0.01m$^3$/s (10l/s). Due to the increasing catchment size, the 95%tile flow at the nodes along the Dinin (Main Channel) and Nore rivers are progressively larger. For example, at Node 15_1955 on the Dinin (Main Channel) River upstream of its confluence with the River Nore, the 95%tile flow is estimated to be 0.374m$^3$/s (374l/s). Further downstream, the 95%tile flow in the River Nore, upstream of the Nore Estuary transitional waterbody at Node 15_1994, is estimated to be 7.56m$^3$/s (7,560l/s). The progressively increasing flow volumes downstream of the

Proposed Development Site are associated with the increased upstream catchment of the respective waterbodies.

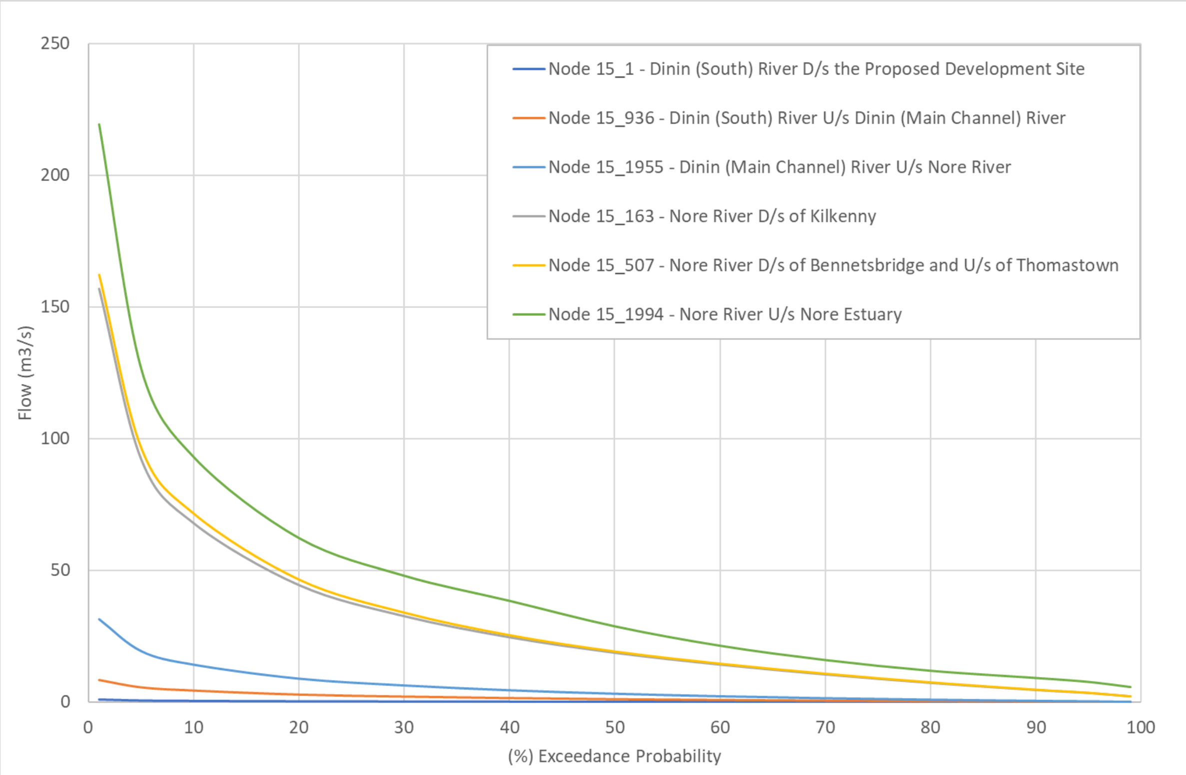


*Figure 8-5: EPA Hydrotool Node Flow Duration Curve (Nore WFD Catchment)*

#### *8.3.3.4 Surface Water Quality*

EPA Biological Monitoring

Biological Q-rating data for EPA monitoring points on the River Barrow, Dinin (South), Dinin (Main Channel) and River Nore downstream of the Proposed Development Site are shown in **Table 8-6** below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from 0-1 (Poor) to 4-5 (Good/High).

Within the River Barrow catchment, no recent biological monitoring has been completed on the Mortarstown stream or the Fushoge River downstream of the Proposed Development Site. Meanwhile, the River Barrow downstream of the Proposed Development Site achieved a Q3-4 rating ('Moderate' Q-status) at Milford Bridge (Station Code: RS14B012600), Cardinal Moran Bridge (Station Code: RS14B012680) and Royal Oak Bridge (Station Code: RS14B012900) in 2023.

Within the Nore WFD catchment, the Dinin(South) River at Black Bridge (Station Code: RS15D080450) and at Dysart Bridge (Station Code: RS15D080600) achieved a Q4 rating ('Good' Q-status) in 2022. Further downstream the Dinin (Main Channel) also achieved a Q4 rating at Lisnafunshion (Station Code: RS15D020700) in 2022.

A map of EPA monitoring stations is included as **Figure 8-6**.

*Table 8-6: Latest EPA Water Quality Monitoring Q-Rating Values*

| River Name | Station Name and ID | Year | Easting | Northing | EPA Q-Rating (Status) |
|---|---|---|---|---|---|
| **Barrow River Surface Water Catchment** | | | | | |
| Barrow River | Milford Bridge (RS14B012600) | 2023 | 269975 | 170430 | Q3-4 (Moderate) |
| Barrow River | Cardinal Moran Bridge (RS14B012680) | 2023 | 269489.39 | 166360.77 | Q3-4 (Moderate) |
| Barrow River | Royal Oak Bridge (LHS) (RS14B012900) | 2023 | 268957 | 161462 | Q3-4 (Moderate) |
| **Nore River Surface Water Catchment** | | | | | |
| Dinin (South) River | Black Bridge (RS15D080450) | 2022 | 261802.93 | 170092.56 | Q4 (Good) |
| Dinin (South) River | Dysart Bridge (RS15D080600) | 2022 | 253090.78 | 169833.52 | Q4 (Good) |
| Dinin (Main Channel) River | Lisnafunshion (RS15D020700) | 2022 | 252180 | 168082 | Q4 (Good) |

HES Water Quality Monitoring

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) were taken at the existing outfall location on 5 no. occasions from the quarry between 3rd April and 23rd July 2025. SW1 is located at the main outfall location which flows from the existing quarry void through the deeply incised gully before entering a large settlement pond. Meanwhile, SW2 is located along the access track in the northeast of the Development Site (refer to **Figure 8-3**).The results of the field hydrochemistry are listed in **Table 8-7**.

The surface water samples indicate a neutral to very slightly basic type surface water, with pH ranging from 7.47 to 8.27. Dissolved oxygen ranged from 8.1 to 10.61mg/l, specific electrical conductivity ranged from 251 to 678µS/cm. Turbidity ranged from 0.82 to 15.4NTU while temperate ranged from 10.5 to 18°C.

*Table 8-7: Field Hydrochemistry Measurements in Discharge (03/04/2025 and 23/07/2025)*

| Parameters | SW1 | SW2 |
|---|---|---|
| **Temperature (°C)** | 10.5 - 18 | 16.7 – 17.1 |
| **pH** | 7.47 – 8.07 | 7.99 – 8.2 |
| **DO (mg/l)** | 8.1 – 10.61 | 9.18 – 9.47 |
| **Specific Conductivity (µS/cm)** | 251 - 678 | 580 – 643 |

| Parameters | SW1 | SW2 |
|---|---|---|
| **Turbidity** | 0.82 - 4.04 | 1.07 – 15.4 |
| **Flow (l/s)** | 0.3 – 1.0 | 0.5 – 1.2 |

Surface water grab samples were also taken for laboratory analysis on 5 no. occasions between 3rd April and 23rd July 2025. SW1 was sampled during all 4 no. monitoring rounds (3rd April, 29th April, 29th May, 25th June and 23rd July 2025) whilst SW2 was sampled on 3 no. occasions (29th May, 25th June and 23rd July). Results of the laboratory analysis are shown alongside relevant water quality regulations in **Table 8-8** below. The laboratory reports are attached as **Appendix 8-1**.

Suspended solid concentrations ranged from <5 to 10mg/l. Suspended solid concentrations were below the S.I 293/1988 threshold limit of 25mg/l in all samples.

BOD concentrations were of 'High' status in all samples with respect to S.I. 272/2009 (≤1.3mg/l) except for the 2 samples obtained on 23rd July. The BOD in both of these samples (2mg/l) exceeded the 'Good' status threshold of <1.3mg/l. Ammonia concentrations were below the limit of detection of the laboratory in all samples (i.e. <0.02mg/l). These samples therefore achieved 'High' status with respect to ammonia and S.I. 272/2009 (≤0.04mg/l). Meanwhile, the orthophosphate concentrations were generally of 'High' status (≤0.02mg/l). However, the concentration of orthophosphate at SW1 exceeded the 'Good' status threshold of ≤0.035mg/l on 29th April 2025. Nitrate concentrations were below the limit of detection of the laboratory in all samples. Chloride concentrations ranged from 5.6 to 7.7mg/l.

*Table 8-8: Summary Laboratory Data (03/04/2025 and 23/07/2025)*

| Parameters | EQS | SW1 | SW2 |
|---|---|---|---|
| **Suspended Solids (mg/l)** | ≤25(-) | <5 - 10 | <5 |
| **Ammonia (mg/l)** | Good Status: ≤0.065, High Status ≤ 0.04(*) | <0.02 | <0.02 |
| **Ortho-Phosphate – P (mg/l)** | Good Status ≤ 0.035 to High Status: ≤0.025(*) | <0.02 – 0.53 | <0.02 |
| **Nitrate - $NO^3$ (mg/l)** | - | <5 | <5 |
| **Chloride (mg/l)** | - | 5.6 - 7.7 | 4.1 – 5.6 |
| **BOD (mg/l)** | Good Status: ≤ 1.5, High Status: ≤ 1.3(*) | <1 | <1 |

(-)S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations, 1988.

(*) S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended).

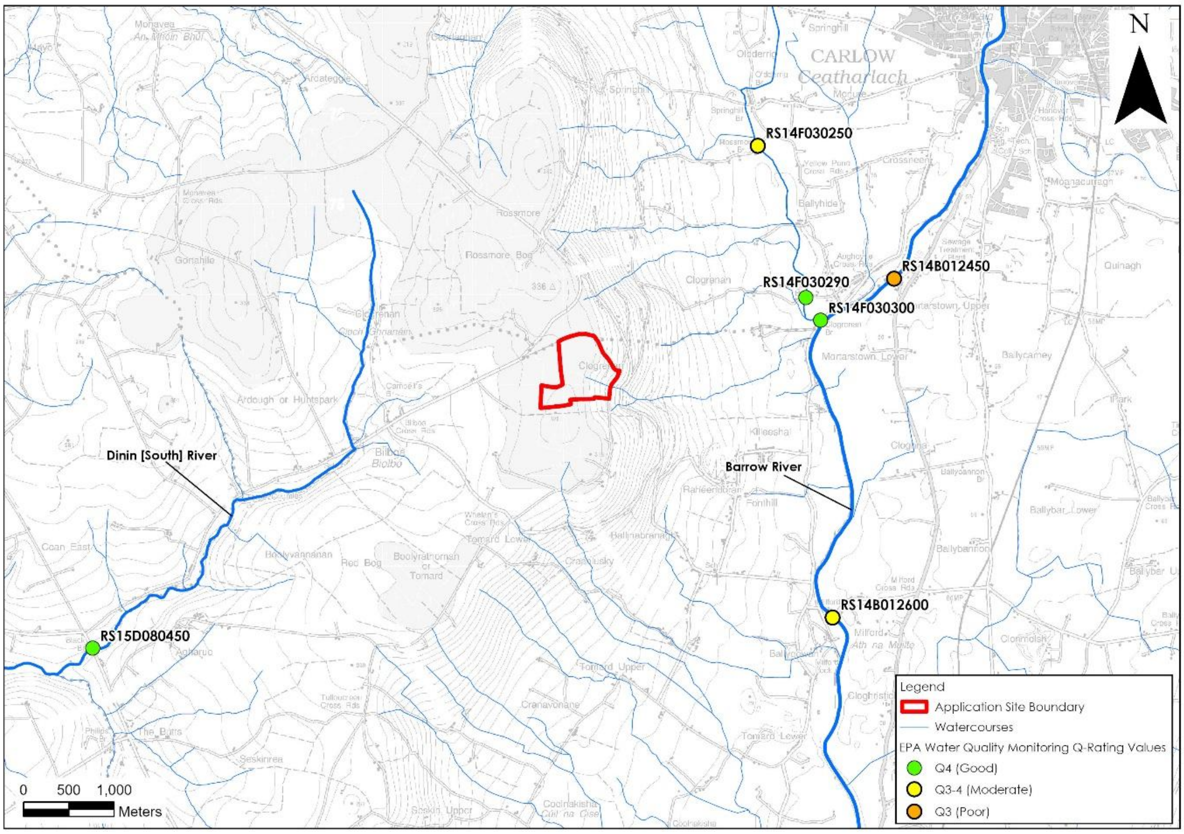


*Figure 8-6: EPA Monitoring Stations*

### *8.3.3.5 Flood Risk Assessment*

A Flood Risk Assessment has been completed for the Proposed Development and is included as **Appendix 8-2**.

OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/) and historical mapping (i.e. 6" & 25" base maps) were consulted.

There is no text on local available historical 6" or 25" mapping for the local areas that identifies areas that are "prone to flooding" within the Proposed Development Site, or in the surrounding lands.

Based on the EPA/GSI soil map for the area no regions of alluvium are mapped within the Proposed Development Site boundaries. The closest downstream alluvium deposits are located ~2km to the east of the Proposed Development Site along the River Barrow. Within the River Nore Catchment, alluvium deposits are mapped ~2.2km to the west along the Dinin River.

OPW's Past Flood Event Mapping was consulted to identify those areas as being at risk of flooding. No historic or recurring flooding incidents are mapped within the Proposed Development Site or in the surrounding lands. The nearest OPW mapped past flood event (Flood ID:12779) is located at Fonthill, ~1.45km southeast of the Proposed Development Site (www.floodinfo.ie). This flood event is undated and no detailed are provided. Another past flood event (Flood ID: 11338) dated from 15th November 2009 is located at Fonthill, Raheendoran, Co Carlow, ~2.6km southeast of the Proposed Development Site. A recurring flood event (Flood ID: 2742) is mapped on the Fushoge River upstream of its confluence with the Mortarstown Stream. Meanwhile, further to the southeast and downstream of the Proposed Development Site, several recurring flood incidents are mapped along the Barrow River. A map of OPW Past Flood Events is included as **Figure 8-7**.

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

The National Indicative Flood Mapping (NIFM) shows modelled flood zones for catchments greater than 5km$^2$ for which flood maps were not produced under the National CFRAM Programme. For the Present-Day Scenario, no medium (1 in 100) or low probability (1 in 1,000) fluvial flood zones are mapped to encroach upon the Proposed Development Site. No NIFM flood zones are mapped along the Raheendoran or Mortarstown streams. The Proposed Development Site is mapped entirely within Fluvial Flood Zone C and is considered to be at low risk of fluvial flooding.

The GSI Winter (2015/2016) Surface Water Flooding Map shows flood zones for the winter 2015/2016 flood event which was considered to be the largest recorded flood event in many areas. This flood map does not record any flood zones within the Proposed Development Site. The closest GSI Winter Surface Water Flooding is recorded ~900m northwest of the Proposed Development Site and is associated with a lake feature in Rossmore Bog.

In terms of the potential effects of climate change on fluvial flooding in the local area, the NIFM Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the NIFM 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. Therefore, flood zones at the Proposed Development Site are unlikely to be significantly impacted by future climate change.

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

Based on the information gained through the flood identification process, no parts of the Proposed Development Site are mapped within any fluvial flood zones (Flood Zones A or B). The Proposed Development Site is located above the mapped 1,000-year flood level and is therefore located in Flood Zone C (Low Risk).

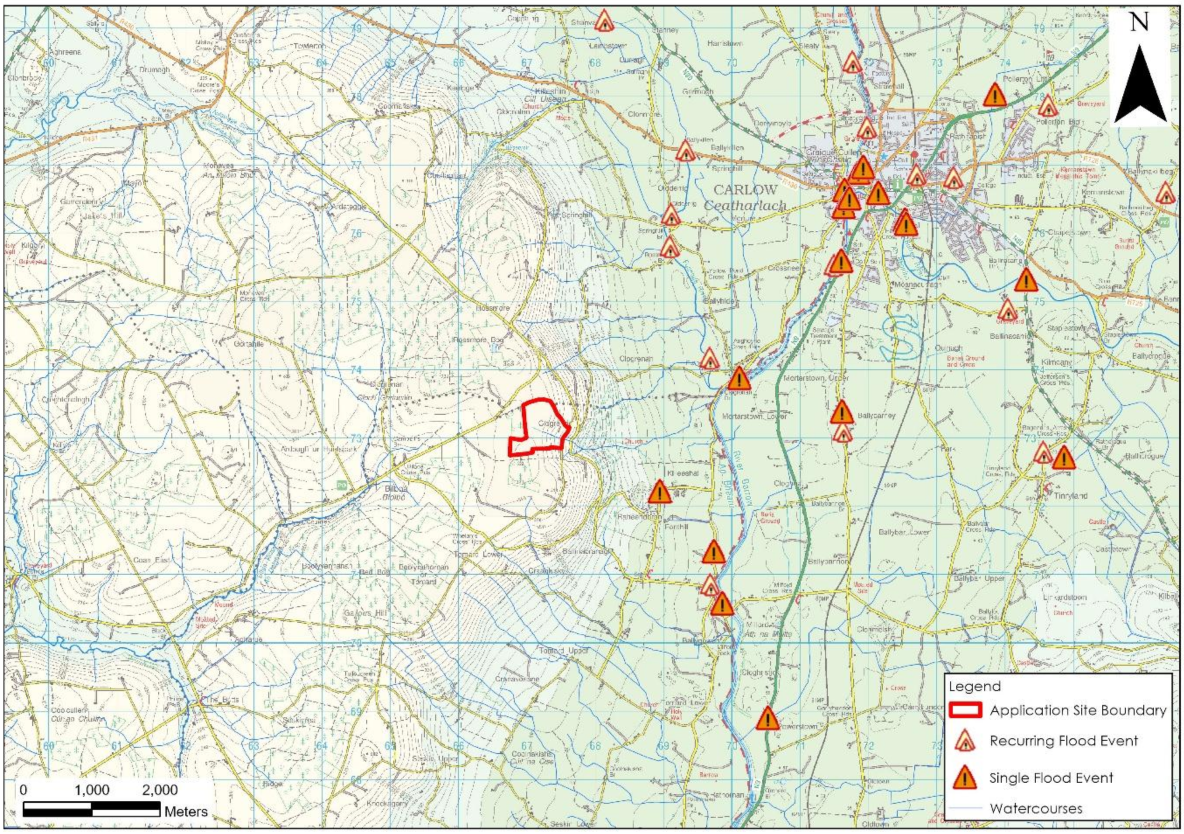


*Figure 8-7: OPW Past Flood Events ([www.floodinfo.ie](http://www.floodinfo.ie))*

#### *8.3.3.6 Water Framework Directive*

The Water Action Plan 2024 was published in September 2023 and is Ireland's 3rd River Basin Management Plan. It's objectives have been integrated into the design of the Proposed Development and include the following:

- Ensure full compliance with relevant EU legislation;
- Build on the achievements of the 2nd Cycle;
- Prevent deterioration and maintain a 'high' status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least good status by 2027;
- Ensure waters in protected areas meet requirements; and,
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at restoring impacted waters and protecting waters from deterioration.

Our understanding of these objectives is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all. Furthermore, any development must not in any way prevent a waterbody from achieving at least good status by 2027.

##### **8.3.3.6.1** Surface Water Body Status

A summary of the WFD status and risk result for Surface Water Bodies (SWBs) immediately downstream of the Proposed Development Site is shown in **Table 8-9**.

As stated above in Section 8.3.3.1, the vast majority of the Proposed Development Site is located within the River Barrow catchment. **Table 8-9** presents a summary of the available WFD information for all SWBs between the Proposed Development Site (Barow_170 SWB) and the River Barrow at Bagenalstown (Barrow_200 SWB). The River Barrow in the vicinity and downstream of the Proposed

Development Site (Barrow_170 to Barrow_200 SWBs) achieved 'Moderate' status in the latest WFD cycle (2019-2024). The Barrow_170 and Barrow_180 SWBs achieved 'Moderate' status in the 3 no. recent WFD cycles. The Barrow River between the Proposed Development Site and Bagenalstown is generally 'at risk' of failing to meet their WFD objectives except for Barrow_190 SWB whose risk status is "under review".

Agriculture is listed as a significant pressure on 3 no. sections of the Barrow River between the Proposed Development Site and Bagenalstown (Barrow_170, 180 and 200 SWBs). Urban run-off is also a significant pressure on 2 of these SWBs (Barrow_180 and 200 SWBs). Hydromorphology is also identified as a significant pressure on the Barrow_170 SWB. Urban wastewater is listed as a significant pressure on the Barrow_200 SWB.

A small area of the Proposed Development Site is located within the River Nore catchment. **Table 8-9** presents a summary of the available WFD information for all SWBs between the Proposed Development Site, which is mapped in the Dinin (South)_010 WFD river sub-basin, and the Dinin River upstream of its confluence with the River Nore (Dinin (Main Channel)_010 SWB). The Dinin (South)_010 and Dinin (South)_020 SWBs have achieved 'Good' status in the latest WFD cycle. The Dinin(South)_010 experienced an improvement in WFD status from the 'Moderate' status it achieved in the 2nd Cycle. Further downstream the Dinin (Main Channel)_010 and Dinin (Main Channel)_020 SWBs achieved "Good" and "Moderate" status respectively in the latest WFD cycle. In terms of risk status, the Dinin (South)_010 and Dinin (South)_020 SWBs are 'not at risk' whilst the Dinin (Main Channel)_010 and Dinin (Main Channel)_020 SWBs are 'at risk' of failing to meet their respective WFD objectives.

Within the Nore River WFD catchment, agriculture is the significant pressure identified on the Dinin (Main Channel)_010 and 020 SWBs. Meanwhile, abstractions and mines and quarries are also listed as significant pressures on the Dinin (Main Channel)_020 SWB.

*Table 8-9: Summary WFD Information for SWBs*

| SWB | Overall Status (2013-2018) | Overall Status (2016-2021) | Overall Status (2019-2024) | Risk Status (3rd Cycle) | Pressures |
|---|---|---|---|---|---|
| **River Barrow Surface Water Catchment** | | | | | |
| Barrow_170 | Moderate | Moderate | Moderate | At risk | Hydromorphology and agriculture |
| Barrow_180 | Moderate | Moderate | Moderate | At risk | Urban run-off and agriculture |
| Barrow_190 | Unassigned | Moderate | Moderate | Under review | None |
| Barrow_200 | Good | Moderate | Moderate | At risk | Urban run-off, agriculture and urban wastewater |
| **River Nore Surface Water Catchment** | | | | | |
| Dinin (South)_010 | Moderate | Good | Good | Not at risk | None |
| Dinin (South)_020 | Good | Good | Good | Not at risk | None |

| | | | | | |
|---|---|---|---|---|---|
| Dinin (Main Channel)_010 | Moderate | Moderate | Good | At risk | Agriculture |
| Dinin (Main Channel)_020 | Moderate | Moderate | Moderate | At risk | Agriculture, abstractions and mines and quarries |

#### *8.3.3.7 Surface Water Abstractions for Drinking Water*

No sections of the Barrow River downstream of the Proposed Development Site are identified as Drinking Water Protected Areas (DWPAs) (www.catchments.ie).

Meanwhile, within the River Nore catchment, the DWPA downstream of the Proposed Development Site is located on the Dinin (Main Channel)_020 SWB. This surface water abstraction is associated with the Public Water Scheme Supply for Kilkenny City. This DWPA is distant from the Proposed Development Site. As stated above, there is extremely limited potential for effects in the River Nore Catchment as all discharge during the operational phase will be within the River Barrow catchment.

#### *8.3.3.8 Surface Water Discharges*

A discharge licence was granted by Carlow County Council in November 2011 (DL/S4/2011/2) for the Development. However, Annual Environmental Reports associated with the Licence are not available.

The EPA do not map the presence of any Section 4 discharges to surface waters within the Barrow_170 WFD river sub-basin. The closest mapped Section 4 discharge is associated with Clonmelsh Quarry which is located ~5.5km to the southeast of the Proposed Development Site. Clonmelsh Quarry is located to the east of the Barrow River.

There is no Urban Waste Water Treatment Plant (UWWTP) in the vicinity of the Proposed Development Site. The closest UWWTP (Licence No.: D0028-01) is located in Carlow town, ~3.7km to the east-northeast.

### 8.3.4 Groundwater – Hydrogeology

#### *8.3.4.1 Regional Bedrock Aquifer*

The GSI's bedrock geology map for the local area (www.gsi.ie) shows that the majority of the Proposed Development Site is underlain by the Moyadd Coal Formation described as shale, siltstone and minor sandstone. Meanwhile, the southwest of the Proposed 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 Bregaun Flagstone Formation is classified by the GSI as a Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones (PI). Meanwhile, the Moyadd Coal Formation is described as a Poor Aquifer - Bedrock which is Generally Unproductive (Pu).

A local bedrock aquifer map is shown as **Figure 8-8**.

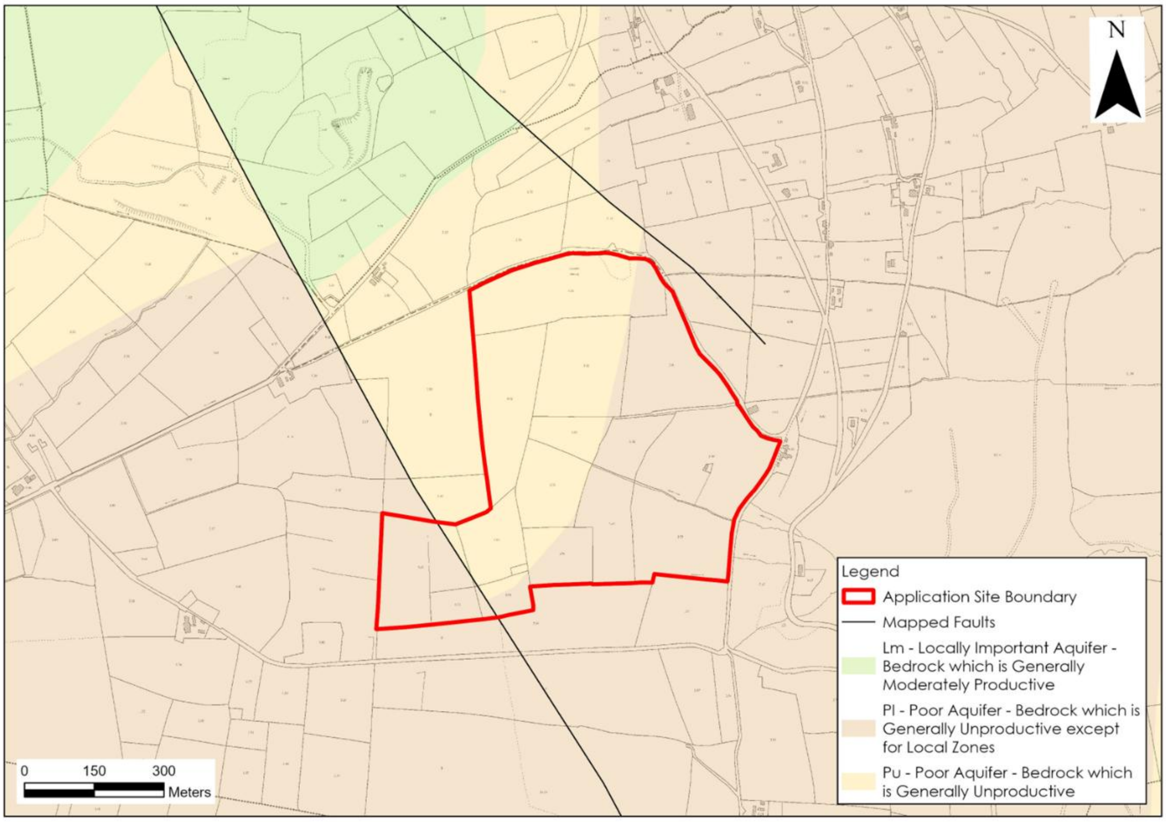


*Figure 8-8: Local Bedrock Aquifer Map*

#### *8.3.4.2 Groundwater Body*

In terms of Groundwater Bodies (GWBs), the Proposed Development Site is underlain by the Shanragh GWB (IE_SE_G_124). According to the GSI's Shanragh GWB Characterisation Report (GSI, 2004), this GWB consists of the Westphalian Shales of the Castlecomer Plateau that lie within the River Barrow catchment. This GWB is not considered to be an important aquifer. Recharge will occur at the elevated eastern peaks of the Castlecomer Plateau. Groundwater will flow be concentrated in the shallow weathered bedrock, and will flow downhill, following the surface topography and it will discharge, sometimes via springs at the base of the hills, into the Barrow Valley.

Groundwater flowpaths in this area are considered to be short, because the bedrock is not considered to constitute a major aquifer. Therefore, it is likely that the majority of groundwater flow circulated in the upper tens of metres, recharging and discharging in local zones.

#### *8.3.4.3 Groundwater Vulnerability*

The GSI describe groundwater vulnerability as a term used to represent the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities. Groundwater vulnerability embodies the characteristics of the intrinsic geological and hydrogeological features at a site that determine the ease of groundwater contamination. Groundwater vulnerability is related to recharge acceptance, whereby in areas where recharge occurs more readily, a higher quantity of contaminants will have access to groundwater.

Based on the groundwater vulnerability maps published on the GSI website (www.gsi.ie), the majority of the Proposed Development Site is mapped within the 'X' groundwater vulnerability with some small areas in the northwest mapped as having 'Extreme' groundwater vulnerability.

Based on the site investigation data (5 no. boreholes and walkover surveys of the existing quarry) the depth to the bedrock is shallow across the majority of the Proposed Development Site i.e. 0-

1.2mbgl. The groundwater vulnerability in these areas will be 'Extreme' (refer to Table 8-10)[3]. Meanwhile, MW2 in the west of the quarry encountered thicker sub-soils, comprising of made ground (associated with spoil heaps associated with the historic extraction activities) and clay with depth to rock in this area recorded as 9.7mbgl. The groundwater vulnerability in this area will be 'Moderate'.

**Table 8-10: Groundwater Vulnerability and Subsoil Permeability and Thickness**

| Vulnerability Rating | Hydrogeological Conditions | | | | |
|---|---|---|---|---|---|
| | Subsoil Permeability (Type) and Thickness | | | Unsaturated Zone | Karst Features |
| | High permeability (sand/gravel) | Moderate permeability (e.g. Sandy subsoil) | Low permeability (e.g. Clayey subsoil, clay, peat) | (Sand/gravel aquifers only) | (<30 m radius) |
| Extreme (E) | 0 - 3.0m | 0 - 3.0m | 0 - 3.0m | 0 - 3.0m | - |
| High (H) | >3.0m | 3.0 - 10.0m | 3.0 - 5.0m | >3.0m | N/A |
| Moderate (M) | N/A | >10.0m | 5.0 - 10.0m | N/A | N/A |
| Low (L) | N/A | N/A | >10.0m | N/A | N/A |

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

### *8.3.4.4 Groundwater Recharge*

Based on GSI mapping (www.gsi.ie), the groundwater recharge coefficient at the Proposed Development Site ranges from 22 to 85% with average recharge ranging from 51-100mm/year. The recharge capacity of the bedrock in this area is 100mm/yr and therefore a high proportion of potential recharge will be rejected by the bedrock.

### *8.3.4.5 Site Specific Geology*

A detailed description of the geology of the Proposed Development Site is provided in Chapter 7. The following is a brief summary of the relevant geological information that has a bearing on the hydrogeology of the Proposed Development Site.

- 5 no. monitoring wells were drilled at the Proposed Development Site in June 2024. The bedrock encountered during these investigations was described mostly as shale, siltstone and sandstone.
- HES examined the existing quarry faces at Red Rock Quarry and found that the bedrock comprises of sandstone and shale.
- The monitoring well logs show water inflows at depths ranging from 2.5m to 23.5m. The flows strikes encountered during the drilling were described as seepages or very slow to minor water strikes.

### *8.3.4.6 Local Groundwater Levels*

Groundwater monitoring has been completed in the 5 no. groundwater monitoring wells drilled by Petersen Drilling Services Ltd. in June 2024. The location of the groundwater monitoring wells are shown in **Figure 8-9**.

Water level monitoring devices were installed in 4 no. onsite boreholes (MW02, MW03S, MW03D and MW04) on 1st August 2024. A datalogger was subsequently installed at MW01 on 4th March 2025.

[3] Environmental Protection Agency (EPA) (2008) Strive Report Series No. 6, Water Framework Directive – Recharge and Groundwater Vulnerability [Accessed: 25/07/2024]

MW1 is located in the floor of the existing quarry void. MW2 is located immediately to the west of the quarry void, along an agricultural track. MW3s and MW3d are located in rough agricultural pasture in the southwest of the Proposed Development Site, and MW4 is located in agricultural land to the southeast of the quarry void.

In addition to the continuous monitoring, the boreholes have been manually dipped on a monthly basis between February and November 2025. This monthly monitoring was preceded by manual dip measurements completed on 13th December 2024. The minimum, maximum and average recorded water levels are presented in **Table 8-11**. The continuous water level data is presented graphically in **Figure 8-10.**

During the monitoring period groundwater elevations ranged from a maximum of 317.65mOD at MW03S to a minimum of ~291.06mOD at MW04. The recorded groundwater levels at each monitoring location do not exhibit a significant range and remain relatively constant throughout the year. The water level range varied between 0.64m at MW01 to 1.68m at MW03S. The variation of the elevation of the local groundwater table is a function of surface topography with the highest groundwater elevations recorded in the southwest of the Proposed Development Site (MW03s and MW03d) where the greatest ground elevations are recorded. Groundwater flow will follow surface topography and flow to the east.

The groundwater levels in the proposed extraction area are greater than the proposed final floor level of the quarry void (~300mOD) except for MW4 which is located on lower ground to the southeast of the quarry. Therefore, an assessment of potential groundwater inflows is required and this is addressed in Section 8.5.2.5.

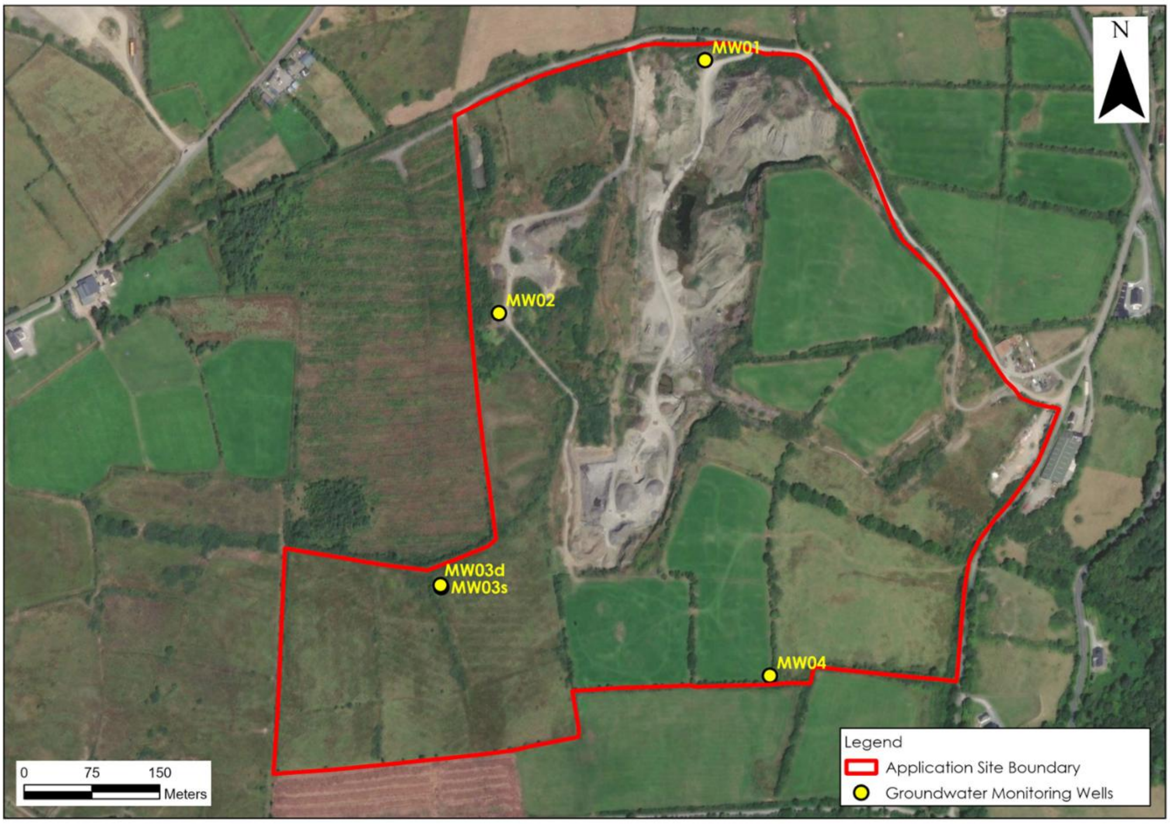


*Figure 8-9: Groundwater Monitoring Wells*

*Table 8-11: Manually Dipped Groundwater Levels*

| Monitoring Well | Ground Elevation (mOD) | Water Level (mOD) | | |
|---|---|---|---|---|
| | | Minimum | Maximum | Range |
| **MW1** | 304.719 | 300.62 | 301.27 | 0.64 |
| **MW2** | 325.171 | 311.9 | 313.23 | 1.33 |
| **MW3s** | 318.116 | 315.97 | 317.65 | 1.68 |
| **MW3d** | 318.108 | 315.68 | 317.15 | 1.47 |
| **MW4** | 296.342 | 291.06 | 299.92 | 0.86 |

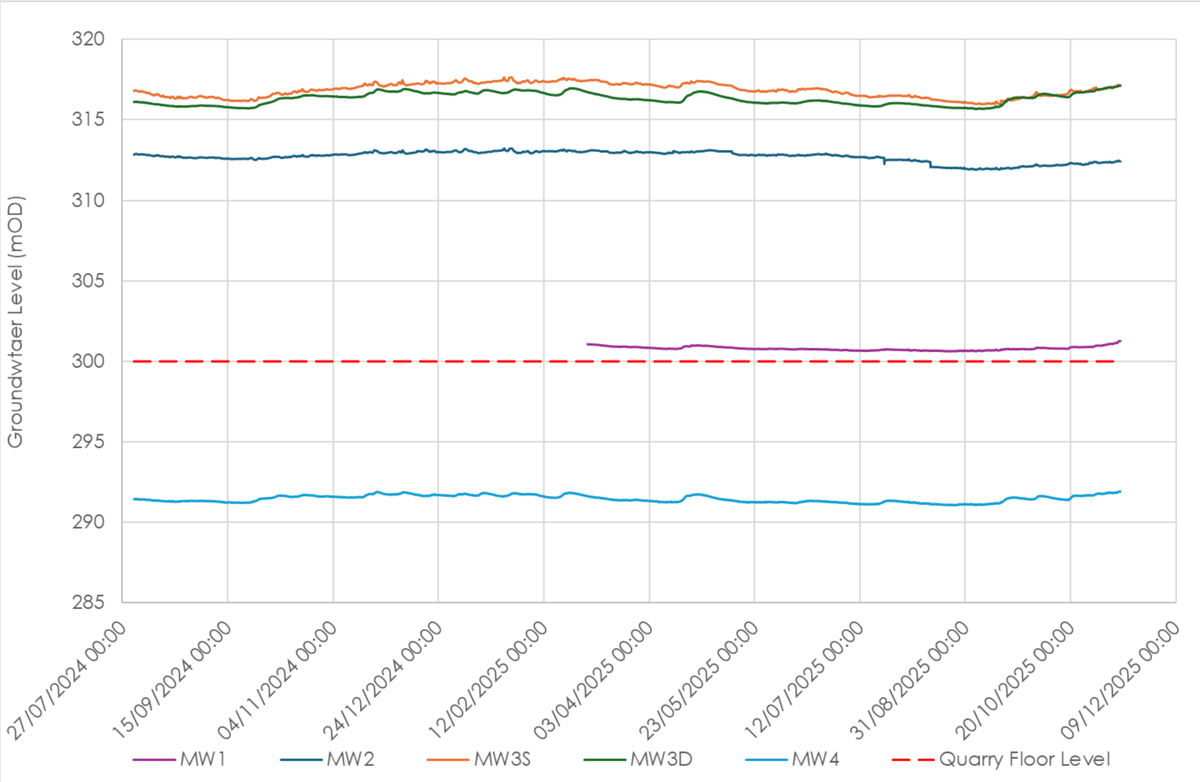


*Figure 8-10: Continuous Groundwater Levels*

#### *8.3.4.7 Groundwater Hydrochemistry*

Recent groundwater sampling was completed at 2 no. locations (MW1 and MW2) on 23rd July and 14th August 2025. During the sampling, hydrochemical parameters were recorded using a calibrated YSI multimeter probe. Electrical conductivity ranged from 424 to 473µS/cm and dissolved oxygen ranged from 3.55 to 4.45mg/L. pH was neutral to slightly basic, ranging from 7.18 to 7.4.

The laboratory data of the samples recorded from MW1 and MW2 indicates that the water is typically of an acceptable chemical quality relative to the Groundwater Regulation (S.I. 9/2010). Ammonia ($NH_3$-N) ranged between 0.054 and 0.068mg/L at MW1 and 1.54 and 3.23mg/L at MW2. Nitrate ($NO_3$) was below the laboratory limit of detection in all samples (<4.4mg/L) and is well below the drinking water threshold value for groundwaters of 37.5mg/L. Chloride ranged between 8.69 and 13.8mg/L, well below the EQS threshold of 24mg/L (S.I. 9/2010). The concentrations of Total Petroleum Hydrocarbons (TPH) were below the laboratory limit of detection in all samples.

Iron and manganese concentrations were elevated at both MW1 and MW2 on 23rd July 2025. The concentrations of these parameters were lower, and well below the guideline values on 14th August 2025. It is noted that Namurian rocks can have high concentrations of iron and manganese due to the dissolution of iron and manganese rich minerals.

Summary results are provided in **Table 8-12** whilst the full laboratory reports are included in **Appendix 8-3**.

*Table 8-12: Groundwater Sampling Laboratory Results (23/07/2025 and 14/08/2025)*

| Parameter | EQS | Sample ID | | | |
|---|---|---|---|---|---|
| | | MW1 | | MW2 | |
| | | 23/07/2025 | 14/08/2025 | 23/07/2025 | 14/08/2025 |
| Ammonia-N (mg/l) | | 0.054 | 0.068 | 3.23 | 1.54 |
| Nitrite – N (mg/l) | 0.5*/0.1⁺ | <0.01 | <0.01 | <0.01 | <0.01 |
| Ortho-phosphate (mg/l) | 0.035* | 0.01 | 0.01 | 0.06 | 0.034 |
| Nitrate – $NO_3$ (mg/l) | 37.5⁺ | <4.4 | <4.4 | <4.4 | <4.4 |
| Chloride (mg/l) | 24*/250⁺ | 8.69 | 8.86 | 13.8 | 12.9 |
| BOD (mg/l) | | 1.2 | <1 | 5.7 | <1 |
| TPH Total (µg/l) | | <0.1 | <0.1 | <0.1 | <0.1 |
| Iron (µg/L) | 200*⁺ | 1,650 | <0.005 | 135 | 0.054 |
| Magnesium (mg/L) | 50* | 29.2 | 26.4 | 7.53 | 10.7 |
| Manganese (µg/L) | 50*⁺ | 545 | 0.342 | 1,630 | 2.2 |
| TDS (mg/L) | - | 311 | 17 | 305 | 299 |
| TSS (mg/L) | - | 5 | 307 | 4,790 | 1,500 |
| Sulphate (mg/L) | 187.5*/250⁺ | 5.58 | 3.97 | 18.7 | 9.62 |

*(*) S.I. No. 9/2010 – Groundwater Regulations*

*(⁺) S.I. 99/2023 – Drinking Water Regulations*

#### 8.3.4.8 Karst Features

Karst features are mapped by the GSI and are available to view through the GSI online viewer (www.gsi.ie).

The GSI do not map the presence of any karst features within or in the vicinity of the Proposed Development Site.

The closest mapped karst feature is an enclosed depression (GSI Karst Feature ID: 2617NWK001) which is mapped ~7.5km northeast of the Proposed Development Site in the townland of Cappanaboe, Co. Laois. Another karst feature recorded in a borehole is located ~8.7km north-northeast of the Proposed Development Site in the townland of Hollymount, Co. Laois.

Based on the site walkover and site investigation report, the bedrock at the Proposed Development Site consists of shale, siltstone and sandstone which are not susceptible to karstification. Due to the siliclastic nature of the mapped bedrock, karst features would not be anticipated in this area as they are associated with the dissolution of limestone. No limestone bedrock is mapped in the local area.

#### 8.3.4.9 Groundwater Body Status

A summary of the WFD status and risk result for the Ground Water Body (GWB) in the vicinity of the Proposed Development Site is shown in **Table 8-13**.

The Proposed Development Site is underlain by the Shanragh GWB. This GWB achieved 'Good' status in all 3 no. recent WFD cycles (2010-2015, 2013-2018 and 2016-2021). This GWB is currently deemed to be 'not at risk' of failing to meet its WFD objectives. No significant pressures have been identified to be impacting this GWB.

*Table 8-13: Summary WFD Information for GWBs*

| GWB | Overall Status (2013-2018) | Overall Status (2016-2021) | Overall Status (2019-2024) | Risk Status (3rd Cycle) | Pressures |
|---|---|---|---|---|---|
| **Shanragh** | Good | Good | Good | Not at risk | None |

#### 8.3.4.10 Groundwater Resources

According to GSI Online Mapping (wwwgsi.ie), there are no Group Water Schemes (GWS) or Public Water Supply Schemes (PWS) located within the Proposed Development Site.

The closest GSI mapped GWS is the Ballinabranna GWS. The Source Protection Area associated with this GWS is located ~600m south of the Proposed Development Site. Meanwhile, the boreholes associated with this GWS are located ~2.4km to the east/southeast. Ballinabranns Water Cooperative Society supplies water to about 400 members. The scheme uses about 170m$^3$ of water every day (http://ballinabrannawater.ie/).

Meanwhile, the closest GSI mapped PWS is the Paulstown PWS. The Source Protection Area associated with this PWS is located ~8.7km southwest of the Proposed Development Site.

A search of private well locations (wells with location accuracy of 1–100m were only sought) was undertaken using the GSI well database (www.gsi.ie). The GSI national well database (www.gsi.ie) records two dug wells (GSI Name: 2617SWW409 and 2617SWW410) ~2.30 and ~370m to the east of the Proposed Development Site. These wells have a locational accuracy of 10m and are listed as having agricultural and domestic uses. A spring (GSI Name: 2617SWW064) is also mapped ~350m northeast of the Proposed Development Site while a dug well (GSI Name: 2617SWW078) is mapped ~140m to the northwest.

We accept that the GSI well database does not include all potential water wells. As such, and in order to be conservative, for the purposes of assessment (as completed in Section 8.5.2.9) we assume that there is a groundwater well source at each local house/dwelling location in the vicinity of the Proposed Development Site. These are several dwellings located along the L3896/L7134 to the east of the Proposed Development Site. The closest dwelling along these local roads are ~184m to the northeast of the quarry void. Several dwellings are also located to the west of the Proposed Development Site. The closest dwellings to the proposed quarry extension area are located ~400m to the southwest and ~320m to the northwest.

In addition, all Water Framework Directive (WFD) GWBs have been identified as Drinking Water Protected Areas (DWPA) due to the potential for qualifying abstractions of water for human consumption as defined under Article 7 of the WFD. The DWPA designation applies to all groundwater bodies nationally, regardless of the productivity status of the underlying aquifer.

An information request was also submitted to Uisce Éireann for the location of all Uisce Éireann groundwater abstraction locations within 5km of the Proposed Development Site was submitted. No groundwater abstractions other than those listed above were identified.

A map of local groundwater resources is included as **Figure 8-11**.

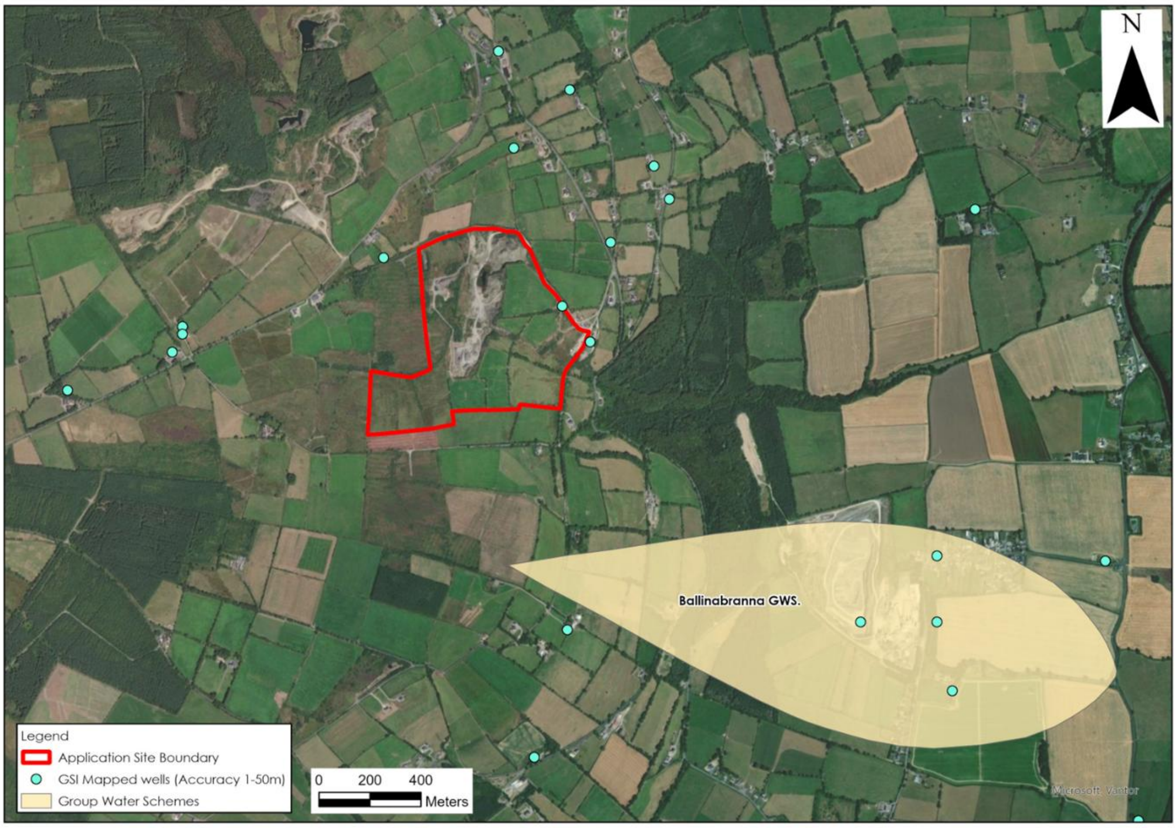


*Figure 8-11: Local Groundwater Resources*

### 8.3.5 Designated Sites

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

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

The Proposed 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).

The designated sites hydrologically connected with the Proposed Development Site, or within 10km of the Proposed Development Site, are listed in **Table 8-14**. A map of designated sites is shown as **Figure 8-12** below.

*Table 8-14: Designated Sites*

| Site Name | Site Code | Distance from Site | Hydrological / Hydrogeological Connection |
|---|---|---|---|
| **River Barrow and River Nore SAC** | 002162 | ~1.8km east and ~5.6km southwest | The Proposed Development Site is hydrologically (~2.7km) connected with this SAC via the Mortarstown Stream which received the discharge from the Proposed Development Site. The lower reaches of this stream and the Fushoge River form part of the SAC.<br><br>There is no direct hydrogeological connection between the Proposed Development Site and the SAC due to the poor permeability of the underlying bedrock aquifer. Groundwater flowpaths will be short (0-300m) and groundwater will discharge into nearby streams such as the Raheendoran and Mortarstown Stream or at springs at the base of the hills. Therefore, in terms of groundwater flow and indirect connection exists, initially via groundwater flowpaths and then via surface water streams. |
| **Cloghristick Wood pNHA** | 000806 | ~3.48km southeast | The Cloghristick Wood pNHA is located on the eastern banks of the River Barrow downstream of the Proposed Development Site. The length of the hydrological flowpath between the Proposed Development Site and this pNHA is~6.3km. The pNHA includes some wet woodland adjacent to the river.<br><br>No direct hydrogeological connection exists between the Proposed Development Site and the pNHA due to the short groundwater flowpaths in the underlying aquifer. |
| **River Nore SPA** | 004233 | ~22km southwest | Within the River Nore catchment, the River Nore SPA is located downgradient of the Proposed Development Site via the Dinin River. only a very small area of the Proposed Development Site is located in this catchment. The length of any potential hydrological flowpath would be in excess of 30km. Furthermore, there is no surface water discharge from the site to any tributary of the Dinin River.<br><br>The Proposed Development Site is not connected hydrogeologically with this SPA as the ground water is expected to flow to the east of the Proposed Development Site. |

| Site Name | Site Code | Distance from Site | Hydrological / Hydrogeological Connection |
|---|---|---|---|
| **Coan Bogs NHA** | 002382 | ~5km west | There is no hydrological or hydrogeological connection between the Proposed Development Site and this NHA. |

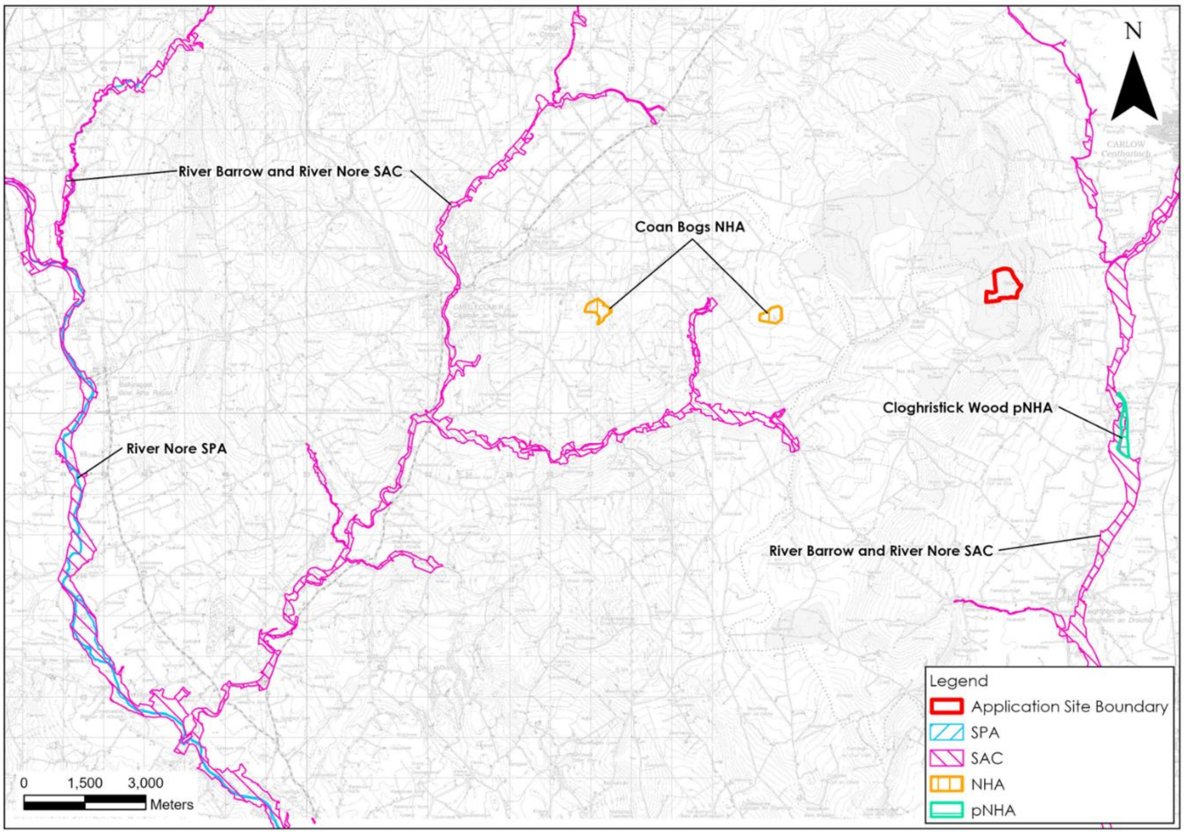


*Figure 8-12: Designated Sites*

### 8.3.6 Receptor Sensitivity

This section discusses the sensitivity of the receiving hydrological and hydrogeological environment in terms of the Proposed Development and identifies those receptors which will be included in the impact assessment.

Due to the nature of the Proposed Development (*i.e.* a lateral extension to a previous bedrock quarry which is located on a topographic high), and the local hydrogeological regime (Poor Bedrock Aquifer), surface water is considered to be the main receptor. Water falling within the existing quarry void currently gathers in ponds on the quarry floor and there is an existing surface water outfall which connect to the Mortarstown Stream. The low permeability of the underlying bedrock rejects a significant proportion of the potential groundwater recharge. Therefore, surface waters are considered to be the main sensitive receptor in terms of the Proposed Development.

The following surface water receptors are identified for inclusion in the impact assessment:

- Water quality and flow volumes in the Mortarstown Stream as the quarry outfall is hydrologically connected to this watercourse;
- Water quality and flow volumes in the Fushoge River and River Barrow which are located downstream of the Mortarstown Stream;
- Water quality in the Dinin River; and,
- The WFD status of all downstream SWBs.

As stated in Section 8.3.3.1 a section of the Proposed Development site is located in the Nore surface water catchment. However, within this catchment there are no watercourses mapped in the immediate vicinity of the Proposed Development Site. The nearest watercourse to the Proposed Development Site is the Dinin River located ~500m to the west. The only potential for effects on this watercourse will occur during the initial site preparation works (soil/subsoil stripping and berm creation) in the western section of the proposed quarry extension area. Once quarrying commences, all water will be directed to the quarry void and there will be no potential outfall or discharge within the Nore Catchment. For this reason, no significant effects are likely within the Nore Catchment.

Note that the Dinin (Main Channel)_020 DWPA will not be included in the impact assessment. This DWPA is distant from the Proposed Development Site (hydrological flowpath length in excess of 19km) and based on the above, (no outfall from the Proposed Development Site in the River Nore catchment) there will be no potential for significant effects on this DWPA.

Based on the criteria set out in

**Table** 8-2 above, the Poor Bedrock Aquifer which underlies the Proposed Development Site can be classed as being of Low Importance. The primary risks to groundwater would be from hydrocarbon spillage and leakages from plant serving and facilitating the construction and operational activities as well as the potential reduction in local groundwater levels as extraction progresses.

The following groundwater receptors are identified for inclusion in the impact assessment:

- The Poor Bedrock Aquifer underlying the Proposed Development Site;
- The WFD status of the underlying Shanragh GWB;
- The Ballinabranna GWS; and,
- Local private groundwater wells.

The Paulstown PWS has been screened out of the impact assessment. There is no hydrogeological connection between the Proposed Development Site and this PWS. There is no potential for effects on the Paulstown PWS.

Local downstream surface waters including the lower reached of the Mortarstown Stream, the Fushoge River and River Barrow can be considered as being of Extremely High Importance due to their designation as part of the River Barrow and River Nore SAC (refer to Table 8-1). The primary potential for surface water contamination is via elevated concentrations of suspended solids and potential oil/fuel leaks and spills from plant and machinery making their way into local surface watercourses.

The following designated sites are included in the impact assessment:

- River Barrow and River Nore SAC; and,
- Cloghristick Wood pNHA.

The River Nore SPA has been screened out of the impact assessment due to the lack of watercourses mapped in the vicinity of the Proposed Development Site in the River Nore Catchment. During the operational phase the quarry will not discharge to any watercourse within the River Nore Catchment. Furthermore, the SPA is distant from the Proposed Development Site (~hydrological flowpath length in excess of 30km). There is no potential for effects on this SPA.

With regards to the Coan Bogs NHA which is located ~5km to the west of the Proposed Development Site. This NHA has been screened out of the impact assessment due to the lack of any hydrological or hydrogeological connection with the Proposed Development Site. The Dinin River and several of its tributaries act as hydrological barriers between the Proposed Development Site and this NHA. There is no potential for effects on this NHA.

The River Nore is also listed as a salmonid river (S.I. 293). However, as stated previously, the Proposed Development has no potential to impact the River Nore, and this watercourse is screened out of the impact assessment.

All potential contamination sources are to be carefully managed at the Proposed Development Site during the extraction phase of the development and mitigation measures are proposed to deal with these potential impacts.

## 8.4 Characteristics of the Proposed Development

The Proposed Development is described in full in Chapter 3 of this EIAR.

The development site consists of an area of 41.86 ha within a total landholding of 45.68 ha, of which c. 18.3 ha is currently subject to an application for substitute consent under Section 177E of the Planning and Development Act 2000 (As amended) to regularise previous unauthorised development. The proposed development will consist of further quarry extraction over a total area of 16.17 ha to include the pre-existing quarry and additional agricultural lands with a projected lifespan of c. 20 years.

The proposed development will involve blasting, extraction and processing of rock using mobile primary crushing / screening and associated plant on the proposed quarry floor. The proposed quarry void will be extracted over 4 no. phases to a depth of 2 no. benches of c. 10m each to a quarry depth of c. 300m AOD with a proposed rate of extraction of c. 200K tonnes per annum. The proposed development will include for construction of earthen screening berms, soil storage areas and will utilise existing quarry entrance from the northern boundary linking to the L7130 local road to the east. Existing and proposed access tracks and existing settlement ponds will be utilised as part of the proposed development. The proposed development will be accompanied by a phased restoration plan.

## 8.5 Potential Likely Significant Effects of the Proposed Development

### 8.5.1 Do Nothing Scenario

If the Proposed Development is not permitted, the Proposed Development Site will remain as a disused quarry with agricultural land in the proposed extraction area. The Proposed Development Site would remain largely unaltered as a result of the Do-Nothing Scenario. There would be no alteration of the existing groundwater vulnerability rating at the Proposed Development Site. The existing quarry void would continue to discharge surface water as per the baseline conditions.

### 8.5.2 Operational Phase

In the context of the Proposed Development Site the operational phase is taken to be the extraction of bedrock to a final proposed depth of ~300mOD. This phase of the Proposed Development involves the extraction of 2no. benches of 10m each in the lateral expansion areas to the southwest of the existing quarry and the deepening of some areas of the existing quarry floor. The extracted bedrock will be crushed and processed on-site and all spoil material will be used to create perimeter berming or stored in the proposed spoil storage area.

The operation phase of the Proposed Development requires the management of both groundwater inflows and surface water discharge. With the extraction extending to a final depth of ~300mOD, which is below the local groundwater table, some groundwater inflows may occur. However, the inflows will be small and will only be from local short groundwater flowpaths. This excess water on the quarry floor will continue to be discharged to surface waters.

#### *8.5.2.1 Potential Effects on Local Groundwater Vulnerability Rating*

The construction phase will involve the phased removal of soil, overburden and rock from proposed extension areas. The removal of the ~145,000m$^3$ overburden and the ~3.9 million tonne of rock will increase the groundwater vulnerability rating of the underlying bedrock aquifer within the proposed extension area.

However, based on site investigation data, the groundwater vulnerability rating across the Proposed Development Site currently ranges from 'High' to 'Extreme' due to the presence of shallow soils/subsoils and bedrock being located near the surface. The Proposed Development Site already has a very high level of groundwater vulnerability. There may be a slight increase in groundwater vulnerability (from 'High' to 'Extreme') in some of the proposed quarry extension area, associated with the stripping and removal of soils and subsoils. Meanwhile, there will be no change in the groundwater vulnerability rating within the existing quarry void as bedrock is already exposed at the surface and the groundwater vulnerability rating is currently 'Extreme'.

Therefore, based on the existing geological and hydrogeological characteristics at the Proposed Development Site, any change in the groundwater vulnerability rating will be minor and will not represent a significant increase in the groundwater vulnerability rating.

**Pathways:** Soil and subsoil removal and rock extraction.

**Receptors:** Groundwater vulnerability rating of the underlying bedrock aquifers and the Shanragh GWB.

**Pre-Mitigation Potential Effect:** Negative, irreversible, slight, direct, permanent, likely effect on the local groundwater vulnerability rating.

#### *8.5.2.2 Potential Effects on Downstream Surface Water Flow Volumes*

The Proposed Development has the potential to increase the volumes of water being discharged from the site as surface waters which enter the Raheendoran Stream and the Barrow River downstream of the Proposed Development Site. The increase in surface water discharge will be as a consequence of the increased volumes of surface and shallow groundwater being generated within the proposed expanded quarry void. Any unmitigated or uncontrolled increase in discharge volumes has the potential to adversely impact downstream hydromorphology, water quality and increase the downstream flood risk.

However, any potential increase is likely to be small as the Proposed Development will not drastically change the local hydrological and/or hydrogeological regime. Currently the vast majority of water within the Proposed Development Site ponds in the existing quarry void and is subsequently discharged to as surface water. Meanwhile, groundwater flow is limited and shallow with short groundwater flowpaths. Groundwater at the Proposed Development Site discharges to nearby surface water features.

Furthermore, the site investigations (5 no. boreholes) at the Proposed Development Site did not encounter any significant groundwater strikes. The bedrock encountered is of low permeability and all groundwater strikes were described as minor water strikes or slow/very slow water inflow. The floor of the existing quarry is currently well below the recorded groundwater level, but no significant groundwater inflows were recorded. This is a function of the low permeability of the bedrock aquifer.

Therefore, there will be little groundwater ingress into the quarry void. As a consequence, the surface water being discharged from the Proposed Development Site will consist largely of rainfall falling within the quarry void. The discharge rate from the quarry is proposed to be the same as the existing discharge rates. This is a very small discharge volume, and therefore, there will be no significant increase in flow volumes in the Mortarstown Stream, the Fushoge River or in the River Barrow as a result of the Proposed Development.

There is no potential to alter flow volumes in the River Nore catchment as there is no existing and/or proposed discharge to surface waters within this catchment.

**Pathways:** Surface water discharge.

**Receptors:** Surface water flows and water quality in downstream watercourses (Mortarstown Stream, Fushoge River and the River Barrow).

**Pre-Mitigation Potential Effect:** Negative, imperceptible, direct, long-term, likely effect on downstream watercourses.

#### *8.5.2.3 Potential Effects from the Entrainment of Suspended Solids in Surface Waters*

Surface water is the main sensitive receptor associated with the Proposed Development due to the local hydrogeological regime, the low permeability of the underlying bedrock and the surface water outfall.

There will be a requirement to strip and store overburden from the proposed extension area. Earthworks, the stripping of soil/subsoil, the creation of boundary berms, will be a potential source of sediment laden water. This will have the potential to impact water quality in the Mortarstown Stream. Due to the large flow volumes in the Fushoge River and the River Barrow there will be limited potential for effects on these watercourses (even in the absence of mitigation measures). Note that the Proposed Development does not in any way rely upon the dilution/assimilative capacity of any watercourse. The mitigation measures prescribed in Section 8.6.1.3 will ensure the protection of all watercourses in close proximity and further downstream of the Proposed Development Site.

There will also be a very limited potential to impact water quality in the Dinin River in the River Nore Catchment. Once the boundary berms are in place and bedrock extraction has commenced, the bowl-shaped nature of the quarry will remove the potential for any effects in the River Nore Catchment. Therefore, there is only the potential for short-term effects on the Dinin River.

During rock extraction and the subsequent processing of materials, there is the potential for the generation of suspended sediment in surface water runoff. Suspended sediment may become entrained in surface waters on the floor of the quarry. The surface waters will be directed to settlement ponds which will facilitate the settlement of solids out of solution. Note that the existing discharge from Red Rock Quarry is treated for suspended solids and attenuated prior to release via settlement ponds. Surface water sampling results from the existing discharge do not record elevated concentrations of suspended solids (refer to Section 8.3.3.3).

**Pathways:** Surface water runoff, surface water discharge and lateral short groundwater flowpaths.

**Receptors:** Downstream surface water quality (Mortarstown Stream, Fushoge River, River Barrow and the Dinin River).

**Pre-Mitigation Potential Effect:**

Negative, direct, moderate, long-term, likely effect on downstream surface water quality in the Mortarstown Stream.

Negative, direct, imperceptible, long-term, likely effect on downstream surface water quality in the Fushoge and Barrow rivers.

Negative, indirect, slight, short-term, unlikely effect on downstream surface water quality in the Dinin River.

#### *8.5.2.4 Potential Effects on Groundwater and Surface Water Quality Due to Blasting*

Baseline nitrate recorded in groundwater is low (<4.4mg/l in all samples). Nitrate can occur in groundwater from various sources including landspreading (organic N) and use of fertilizers (inorganic N).

The extraction of bedrock will be achieved through blasting in order to break the rock into pieces suitable for crushing. Blasting activities typically involve the drilling of holes behind the existing rock face and the placement of explosives within these holes. The explosives are then detonated to dislodge the bedrock. The use of explosives has the potential to effect local groundwater quality at the Proposed Development Site.

Common explosives used at quarry sites, such as Ammonium Nitrate, often contain large percentages of nitrogen compounds. It has been found that small percentages of nitrogen compounds remain as residual coating on the rock following blasting. This coating has the potential to be dissolved when it comes into contact with water. The study that is most referenced was completed by Environment Canada in 1988 (Ferguson and Leak, 1988). This study outlines a procedure for determining the residual nitrogen compounds for carious mine site types. The stepwise procedure in the 1988 study for predicting aqueous concentrations of nitrogen, as outlined by Morin and Hutt (2009) is:

- Calculate the annual leached nitrogen loading (kg/year) for the entire site based upon annual explosives mass usage and residual nitrogen fraction associated with the explosive type;
- Separate the leached nitrogen loading among quarry components (e.g. entering water and remaining on the extracted rock);
- Separate into loadings of nitrogen compounds (nitrate, nitrite and ammonia) and,
- Calculate the flow concentration.

The concentration of nitrogen species in groundwater at the Proposed Development Site are calculated using this procedure. The highest residual is for nitrate (99%), and upper limit of the range is used in all cases to determine the concentration of nitrogen species in the water. The calculation also assumes that 100% of the residual nitrogen is dissolved in water and subsequently enters the underlying regional groundwater system.

Having used conservative values in the approach the resulting nitrogen species concentration are small and below all relevant EQS values. The calculations below are very conservative and assume that there is no surface water runoff and that all water in the void will recharge to ground (this is not the case of the site).

Blasting has been completed at Red Rock Quarry as part of the previous historic extraction of bedrock at the established quarry. No significant effects associated with the historic blasting were recorded to date. The future blasting practices will not differ from those previously completed at the site and at similar sits across the country.

*Table 8-15: Potential Nitrogen Compound Concentrations from Quarry Explosives*

| **Explosive Mass Balance** | |
|---|---|
| **Quarry Area (ha)** | 16.17 |
| **Extraction Volumes ($m^3$)** | 6,400,000 (~200,000 tonnes/yr over 20-year period) |
| **Explosive Mass required for $m^3$ ($kg/m^3$)** | 0.4 |

| Explosive Mass Balance | | |
|---|---|---|
| **Explosive Mass (kg)** | 16,000,000 | |
| **Quarry Life (years)** | 20 | |
| **Explosive Mass per year (kg/year)** | 800,000 | |
| **Nitrogen Mass Balance** | | |
| **% Explosive mass as Ammonium Nitrate** | 94% | |
| **% Ammonium Nitrate as N** | 35% | |
| **Mass of N (kg)** | 263,200 | |
| **Residual Fraction (1-6%)** | 0.06 | |
| **Residual N (kg)** | 15,792 | |
| **N Compound** | | |
| **Residual $NO_3$ (75-99%)** | 0.99 (conservative) | 15,634 |
| **Residual $NH_4$ (0.5-24%)** | 0.24 (conservative) | 3,790 |
| **Residual $NO_2$ (0-6%)** | 0.06 (conservative) | 947 |
| **Water Balance** | | |
| **Average Annual Rainfall (mm/yr)** | 1,118 | |
| **Recharge Coefficient** | 1.0 (conservative calc assumes no runoff in quarry void) | |
| **Quarry Area (ha)** | 16.17 | |
| **Average Annual Recharge ($m^3$/year)** | 180,781 | |
| **Average Daily Recharge ($m^3$/day)** | 495.3 | |
| **Nitrogen Compound Concentrations** | | |
| **Residual $NO_3$ (mg/L)** | 0.086 | |
| **Residual $NH_4$ (mg/L)** | 0.021 | |
| **Residual $NO_2$ (mg/L)** | 0.0052 | |

**Pathway:** Detonation of explosives, short groundwater flowpaths and surface water discharge.

**Receptors:** Local groundwater quality and downstream surface water quality (Mortarstown Stream, Fushoge River and the Barrow River).

**Pre-Mitigation Potential Effect:** Negative, indirect, slight, long-term, unlikely effect on groundwater quality. Negative, direct, moderate, long-term, likely effect on downstream surface water quality.

#### *8.5.2.5 Potential Effects on Groundwater Levels*

Quarrying activities below the groundwater table have the potential to impact local groundwater levels in the vicinity of the Proposed Development. Once the quarrying operations extend below the groundwater table, groundwater levels in the surrounding area will be lowered as the groundwater flows towards the newly created void. Drawdown may have a negative impact on local private groundwater wells.

Groundwater monitoring has revealed the presence of a shallow groundwater system which lies above the proposed final floor level of the quarry (300mOD). During the site investigations (borehole drilling) all water strikes were minor and described typically as seepages. Furthermore, inspections of the current quarry void faces and footprint does not suggest any significant inflows of groundwater. No significant groundwater inflows would be expected at elevations of 300mOD. The groundwater present at the Proposed Development Site is hosted in bedrock that has a low permeability and groundwater flowpaths will be short.

Therefore, based on the hydrogeological and topographic setting of the Proposed Development Site there will be no significant effects on groundwater levels. Due to the low permeability of the bedrock aquifer any minor effects will be localised.

**Pathways:** Groundwater flow and groundwater levels (infiltration rates i.e. groundwater recharge).

**Receptors:** Groundwater levels in the underlying Shanragh GWB.

**Pre-Mitigation Potential Effect:** Negative, slight, direct, long-term, likely effect on local groundwater levels.

#### *8.5.2.6 Potential Effects Due to Oil and Fuel Spillages*

The removal of vegetation, stripping of soil/subsoil, and the extraction and processing of the rock will be completed using machinery. Such machinery are powered by diesel engines and operate using hydraulics. Unless carefully managed such plant and machinery have the potential to leak hydraulic oils or cause fuel leaks. The accidental release of these compounds into the environment have the potential to negatively impact the groundwater quality in the underlying bedrock aquifer and surface water quality in downstream receptors.

Due to the local hydrogeological regime, characterised by high rates of surface water runoff and low rates of groundwater recharge, there is very limited potential for effects on groundwater quality. A high proportion of potential groundwater recharge will be rejected due to the low permeability of the underlying bedrock aquifer. Any groundwater will discharge locally to nearby streams.

Surface water is the main sensitive receptor due to the existing surface water discharge and the ponding of water in the floor of the existing void. The existing discharge provides a direct hydrological connection between the quarry and downstream watercourses including the Mortarstown Stream, the Fushoge River and the River Barrow. However, due to the large flow volumes in the Fushoge and Barrow rivers there will be limited potential for effects on these watercourses (even in the absence of mitigation measures). Note that the Proposed Development does not in any way rely upon the dilution/assimilative capacity of any watercourse. The mitigation measures prescribed in Section 8.6.1.6 will ensure the protection of all watercourses in close proximity and further downstream of the Proposed Development Site.

The only potential for effects on the Dinin River will occur during the initial stripping of soil and subsoils. Once bedrock extraction has commenced, the bowl-shaped nature of the quarry will remove the potential for any effects in the Nore Catchment. Therefore, there is only the potential for short-term effects on the Dinin River.

**Pathway:** Surface water runoff, short groundwater flowpaths and surface water discharge from the quarry.

**Receptor:** Local groundwater quality and downstream surface water quality (Mortarstown Stream, Fushoge River, River Barrow and the Dinin River).

**Pre-Mitigation Potential Effect:**

Negative, indirect, slight, long-term, unlikely effect on groundwater quality.

Negative, direct, moderate, long-term, likely effect on downstream surface water quality in the Mortarstown Stream.

Negative, direct, imperceptible, long-term, likely effect on downstream surface water quality in the Fushoge and Barrow river.

Negative, indirect, slight, short-term, unlikely effect on downstream surface water quality in the Dinin River.

#### *8.5.2.7 Potential Effects from Wastewater Disposal*

The potential release of untreated wastewater during the operational phase has the potential to effect local groundwater quality underlying the Proposed Development Site and downstream surface water quality. As stated in the preceding sections surface water is the main potential receptor due to the local hydrogeological regime. There is no potential for wastewater to reach the Dinin River in the River Nore Catchment.

**Pathway:** Short groundwater flowpaths and surface water discharge from the quarry.

**Receptor:** Local groundwater quality and downstream surface water quality (Mortarstown Stream, Fushoge River and the River Barrow).

**Pre-Mitigation Potential Effect:**

Negative, indirect, slight, long-term, unlikely effect on groundwater quality.

Negative, direct, moderate, long-term, likely effect on downstream surface water quality in the Mortarstown Stream.

Negative, direct, imperceptible, long-term, likely effect on downstream surface water quality in the Fushoge and Barrow rivers.

#### *8.5.2.8 Potential Effects on Group Water Schemes*

The Ballinabranna GWS source supply is located ~2.4km to the east/southeast of the Proposed Development Site. The Proposed Development Site is not located within the delineated Source Protection Area associated with this GWS. The Source Protection Area is situated ~600m to the south.

Given the nature of the local hydrogeological regime, the low permeability of the underlying aquifer and the separation distance between the Proposed Development Site and the Ballinabranna GWS there is limited potential for effects. Due to the low permeability of the bedrock aquifer, groundwater flowpaths will be short and groundwater at the Proposed Development Site will discharge to surface waters prior to reaching the delineated Source Protection Area.

**Receptor:** Ballinabranna GWS.

**Pathway:** Groundwater flowpaths.

**Pre-Mitigation Potential Effects:**

No significant effects will occur on the Ballinabranna GWS as the Proposed Development Site is not mapped within the delineated Source Protection Area.

The pre-mitigation effect is considered to be an indirect, negative, imperceptible, short-term, very unlikely effect on the Ballinabranna GWS.

#### *8.5.2.9 Potential Effects on Local Private Groundwater Well Supplies*

The GSI map several private groundwater wells supplies in the local area. In addition, to the GSI mapped wells, the assessment presented in this chapter is conservative and assumes that all dwellings in the local area are served by a private groundwater supply.

The closest dwellings to the Proposed Development Site are located are along local roads: ~184m to the northeast of the existing quarry void, ~250m to the southeast, ~400m to the southwest and ~320m to the northwest of the proposed quarry extension area.

However, there is no potential for significant effects on local private groundwater well supplies due to the hydrogeological and topographic settings of the Proposed Development Site. The Proposed Development Site is underlain by rocks of low permeability which will reject the majority of potential groundwater recharge. Water that does recharge to ground will flow for short distances (300m maximum) and will discharge to nearby watercourses and as springs in the Barrow valley. Therefore, there is limited potential for qualitative effects on local private groundwater well supplies.

In terms of potential quantitative effects on local wells. The topographic setting of the Proposed Development, at a significant elevation at the eastern edge of the Castlecomer Plateau, ensures that no significant dewatering will be required. Furthermore, the low permeability of the underlying bedrock aquifer will inhibit the inflow of significant volumes of water into the quarry void (there are no significant groundwater inflow into the existing quarry void which stands well below the recorded local groundwater table).

**Receptor:** Local groundwater well supplies.

**Pathway:** Groundwater flowpaths.

**Pre-Mitigation Potential Effects:** Indirect, negative, imperceptible, long-term, very unlikely effect on local private groundwater well supplies.

#### *8.5.2.10 Potential Effects on Downstream Designated Sites*

The River Barrow and River Nore SAC is located ~1.8km to the east of the Proposed Development Site. The SAC is hydrologically connected to the Proposed Development Site via the existing quarry discharge which connects to the Mortarstown Stream. The lower reaches of this stream form part of the SAC. Other designated sites located downstream and hydrologically connected to the Proposed Development Site in the River Barrow Catchment include the Cloghristick Wood pNHA. Any potential deterioration in local surface water quality could impact these downstream designated sites.

All other downstream designated sites in the River Barrow Catchment have been screened out of the impact assessment due to their distant locations from the Proposed Development Site.

**Pathway:** Surface water flowpaths.

**Receptors:** River Barrow and River Nore SAC and Cloghristick pNHA.

**Pre-Mitigation Potential Effect:** Indirect, negative, imperceptible, long-term, very unlikely effects on River Barrow and River Nore SAC and Cloghristick pNHA.

#### *8.5.2.11 Potential Effects on WFD Status*

The EU Water Framework Directive (2000/60/EC) requires that all member states protect and improve water quality in all waters, with the aim of achieving good status by 2027 at the latest. Any new development must ensure that this fundamental requirement of the Directive is not compromised.

The status of the GWBs and SWBs in the vicinity and downstream of the Proposed Development Site are described in Section 8.3.3.6.1 and Section 8.3.4.9 respectively.

Potential effects on groundwater and surface water quality and quantity as a result of the Proposed Development has the potential to negatively affect the WFD status of the underlying GWB and downstream SWBs.

In terms of GWBs, due to the scale of the Proposed Development with respect to the overall size of the underlying Shanragh GWB (148km$^2$) there is limited potential for effects on the WFD status of this GWB. The main potential for effects will be on the WFD status of the Barrow_170 SWB. This SWB includes the Mortarstown Stream which received the existing quarry discharges. However, significant volumes of water exist within the River Barrow and will limit the potential for effects on the status of this entire SWB. Note that the Proposed Development does not in any way rely upon the dilution or assimilative capacity provided by any downstream watercourse. The mitigation measures detailed in Section 8.6 ensure the protection of all downstream watercourses.

The Dinin (South)_010 SWB is also included in the assessment, as the Proposed Development Site extends into this WFD river sub-basin. However, the potential for effects is limited as there will be no discharge of surface waters within the Nore Catchment. The only potential for effects occurs during the initial stripping of soil/subsoil and the creation of boundary berms. Once bedrock extraction commences, all discharge from the quarry void will be within the Barrow_170 WFD river sub-basin.

A full WFD Compliance Assessment is included as **Appendix 8-4**.

**Pathways**: Surface water and groundwater flowpaths.

**Receptors:** The WFD status of the Shanragh GWB and downstream SWBs (via lateral groundwater flow and discharge to surface waters).

**Pre-mitigation Potential Effects:**

No potential for effects on the WFD status of the Shanragh GWB.

Negative, imperceptible, indirect, long-term, likely effect on WFD status of downstream SWBs.

### 8.5.3 Restoration Phase

Once extraction of bedrock has ceased within each of the proposed extraction areas, the topsoil used to create the screening berms will be spread over the floor of the quarry. The void will be surrounded by a secure post and wire fence. The soil storage areas will be allowed to revert to scrubland. Meanwhile, the set down area and shed will be cleared and restored to scrubland. The remainder of the Proposed Development Site will be allowed to naturally revegetate.

Potential effects associated with the restoration phase are the same as during the construction phase with the potential for elevated concentrations of suspended sediment and leaked fuels and oils from plant and site vehicles to impact downstream surface water quality. Groundwater quality may also be negatively impacted due to accidental spills and leaks of fuels and oils.

However, the restoration and post-restoration phase will have a largely positive effect in terms of hydrology and hydrogeology, by returning much of the Proposed Development Site back to natural scrubland habitats and redirecting water back into the Raheendoran Stream via a diversion channel.

## 8.6 Avoidance, Remedial & Mitigation Measures

### 8.6.1 Operational Phase

#### *8.6.1.1 Potential Effects on Local Groundwater Vulnerability Rating*

The removal of soil and subsoil from the proposed extension areas will increase the vulnerability rating of the underlying bedrock aquifer. This will result in a likely and permanent effect on the local groundwater vulnerability rating. However, such a change would be in line with existing trends (i.e. the vulnerability rating of the existing quarry void) and therefore, its effect is not considered to be significant.

The main mitigation with respect groundwater quality protection during this phase will be employment of best practice measures with respect to oil usage and refuelling of plant and machinery which are dealt with in Section 8.6.1.6 below.

Furthermore, the operational phase will comprise of phased extraction and the subsoil/overburden material removed from each phase will be spread over the previous phased extraction area, thus reducing the area of bedrock exposed at any given time. The mitigation for the protection of groundwater vulnerability is therefore, through the implementation of the phased restoration.

#### *8.6.1.2 Potential Effects on Downstream Surface Water Flow Volumes*

The Proposed Development includes the provision of a water management system which will include the installation of surface water attenuation and settlement ponds on the quarry floor to cater for water generate within both the existing void and the quarry extension areas.

The proposed water management system will direct surface water and any minor groundwater inflows in the site towards suitably designed settlement lagoons on the quarry floor. These lagoons will serve to attenuate discharge from the site and will ensure that discharge rates do not exceed the greenfield runoff rates or the maximum permitted daily discharge volume as per the discharge licence.

The proposed infrastructure will attenuate storm water so that any increase in discharge volumes during storm events are gradual and controlled, preventing an increase in the flood risk downstream of the Proposed Development Site.

#### *8.6.1.3 Potential Effects from the Entrainment of Suspended Solids in Surface Waters*

The Proposed Development will utilise a water management system designed to prevent contamination of local surface waters with elevated concentrations of suspended solids. All water within the quarry void will be directed to suitably sized ponds in the floor of the quarry which will allow for the settlement of suspended solids. All discharge will be in accordance with the discharge licence requirements.

<u>Management of Drainage from Spoil Storage Areas:</u> Excavated soil/subsoil material from the extension area will be used for landscaping throughout the Proposed Development Site and in the construction of boundary berms. Berms will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in drainage water. Once re-vegetated and stabilised berms will no longer be a potential source of silt laden drainage water.

The topsoil/overburden removed from one phased extraction area will be spread over the void created in the previous phased extraction area. These reinstated areas will be within the quarry void, which will have a bowl-shaped topography and all runoff will be directed to the water management system.

Timing of Site Preparation Works: The removal of soil/subsoil form the other proposed extension areas will only be carried out during periods of low rainfall. This will minimise the risk of entrainment of suspended sediment in drainage water.

No other mitigation measures are required.

#### *8.6.1.4 Potential Effects on Groundwater and Surface Water Quality Due to Blasting*

Red Rock Quarry will operate a site-specific protocol for blasting which will follow the current international best practice. This protocol will be employed to mitigate the potential effects of explosives on groundwater and surface water quality during blasting operations.

#### *8.6.1.5 Potential Effects on Groundwater Levels*

The proposed extraction will only extend to 300mOD, thereby significantly limiting the potential for effects on groundwater levels.

Site investigations and groundwater monitoring has revealed that the rock underlying the Proposed Development Site is of low permeability. No significant groundwater inflow occurs into the existing quarry void with the current discharge rate from the quarry estimated to be 172.8$m^3$/day (2l/s). Groundwater inflow will therefore be minimal, and the Proposed Development will not have the potential to significantly impact local groundwater levels.

Furthermore, there will be no significant alteration of local groundwater recharge or surface water runoff rates as a result of the Proposed Development.

No specific mitigation measures are required.

#### *8.6.1.6 Potential Effects Due to Oil and Fuel Spillages*

The Proposed Development will utilise a water management system designed to prevent contamination of local surface waters with hydrocarbons.

Water from the wheel wash will be recycled and will not enter the settlement ponds or be discharge to surface waters.

In addition the following measures will be implemented to ensure that surface waters are not contaminated with hydrocarbons:

- Hydrocarbons at the Proposed Development site will be delivered via fuel truck;
- There will be no storage of hydrocarbons on site;
- Major repairs will be completed off site. Emergency mechanical repairs will use spill kits kept on-site;
- All water from the site will be passed through a hydrocarbon interceptor prior to discharge; and,
- All activities on site will be completed in accordance with the EMP.

Highest standards of site management will be maintained and utmost care and vigilance followed to prevent accidental contamination or unnecessary disturbance to the site and surrounding environment during the operation of the quarry.

#### *8.6.1.7 Potential Effects from Wastewater Disposal*

The Proposed Development will utilise an established wastewater treatment system.

The Proposed Development does not include any discharge of untreated wastewater to ground or surface waters.

#### *8.6.1.8 Potential Effects on Group Water Supplies*

There will be no effects on the Ballinabranna GWS for the following reasons:

- The separation distance (~2.4km) between the Proposed Development Site and the boreholes which supply the Ballinabranna GWS;
- No area of the Proposed Development Site is located within the delineated Source Protection Area associated with this GWS. The Source Protection Area is located ~600m to the south;
- The low permeability of the bedrock underlying the Proposed Development Site means that the majority of potential groundwater recharge is rejected;
- Groundwater flowpaths will be short with groundwater discharging into nearby surface watercourses;
- Therefore, there is no potential for groundwater at the Proposed Development Site to reach the Ballinabranna GWS boreholes;
- Furthermore, there will be no significant inflow of groundwater into the quarry void and the Proposed Development has very limited potential to alter groundwater recharge rates;
- Detailed, tried and tested, best practice mitigation measures for the protection of groundwater quality are prescribed in Section 8.7.1.6 (hydrocarbons), Section 8.7.1.3 (suspended solids), Section 8.7.1.4 (blasting) and Section 8.6.1.7 (wastewater); and,
- These mitigation measures are used at similar bedrock quarries across the county and are proven to protect the hydrogeological environment.

#### *8.6.1.9 Potential Effects on Local Groundwater Well Supplies*

There will be no effects on the local groundwater well supplies for the following reasons:

- The separation distance between the Proposed Development Site and local well supplies;
- The low permeability of the bedrock underlying the Proposed Development Site means that the majority of potential groundwater recharge is rejected;
- No conduits for groundwater flow are present at the Proposed Development Site that could act as a pathway for potential contaminants;
- Groundwater flowpaths will be short with groundwater discharging into nearby surface watercourses;
- There will be no significant inflows of groundwater into the quarry void and the Proposed Development has very limited potential to alter groundwater recharge rates;
- Therefore, there will be no potential for the Proposed Development to impact groundwater levels or groundwater quantity in local well supplies;
- Nevertheless, detailed, tried and tested, best practice mitigation measures for the protection of groundwater quality are prescribed in Section 8.7.1.6 (hydrocarbons), Section 8.7.1.3 (suspended solids), Section 8.7.1.4 (blasting) and Section 8.6.1.7 (wastewater); and,
- These mitigation measures are used at similar bedrock quarries across the county and are proven to protect the hydrogeological environment.

#### *8.6.1.10 Potential Effects on Downstream Designated Sites*

There is no potential for effects on the River Barrow and River Nore SAC or Cloghristick Wood pNHA for the following reasons:

- Whilst the Proposed Development is hydrologically connected to the Barrow River and these designated sites, the Proposed Development is in excess of 2km from the Barrow;
- The length of the hydrological flowpath between the Proposed Development Site and the SAC is >2.5km whilst the flowpath to the pNHA is ~6km;

- There is limited potential for effects due to the volume of water within the Barroe River in comparison to the proposed discharge volumes;
- However, the Proposed Development does not rely on the dilution or assimilative capacity of any downstream watercourse;
- Nevertheless, the Proposed Development will utilise a water management system designed to prevent contamination of local surface waters with hydrocarbons or suspended solids;
- The detailed, tried and tested, best practice mitigation measures presented in Section 8.6.1.2 (surface water flows), Section 8.6.1.3 (suspended solids), Section 8.6.1.4 (blasting), Section 8.6.1.6 (hydrocarbons) and Section 8.6.1.7 (wastewater), will ensure the protection of all watercourses in the immediate vicinity of the Proposed Development Site;
- By ensuring the protection of watercourses proximal to the site, the status of all downstream designated sites is also protected.

##### *8.6.1.11 Potential Effects on WFD Status*

Strict mitigation measures in relation to the protection of surface waters and groundwaters have been described in the preceding sections. The implementation of these mitigation measures will ensure the quantitative and qualitative status of the receiving SWB and the underlying GWB will not be altered.

There will be no change in the WFD status of the underlying GWB or downstream SWBs resulting from the Proposed Development. As such, the Proposed Development is compliant with the requirements of the Water Framework Directive (2000/60/EC).

### 8.6.2 Restoration Phase

Similar mitigation measures prescribed above for the construction phase will be implemented during the restoration phase.

## 8.7 Residual Effects of the Proposed Development

### 8.7.1 Operational Phase

#### *8.7.1.1 Potential Effects on Local Groundwater Vulnerability Rating*

**Post Mitigation Residual Effects:** The application of best practice methods with regard oils and fuels and the proposed restoration plan means effect on groundwater vulnerability will be negative, irreversible, slight, direct, permanent, likely effect on the local groundwater vulnerability.

**Significance of Effects:** For the reasons outlined above, no significant effects on groundwater vulnerability will occur.

#### *8.7.1.2 Potential Effects on Downstream Surface Water Flow Volumes*

**Post Mitigation Residual Effect:** All drainage and runoff water will be managed and attenuated prior to release. Due to the topographical setting and hydrogeological characteristics of the Proposed Development Site the discharge volumes will be small. The residual effect is considered to be a negative, direct, imperceptible, long-term, likely effect on downstream surface water flow volumes.

**Significance of Effects:** For the reasons outlined above, no effects on surface water flow volumes will occur.

#### *8.7.1.3 Potential Effects from the Entrainment of Suspended Solids in Surface Waters*

**Post Mitigation Residual Effect:** All drainage and runoff water will be managed, attenuated and treated prior to discharge. The residual effect is considered to be a negative, indirect, imperceptible, temporary, unlikely effect on surface water quality.

**Significance of Effects:** For the reasons outlined above, no effects on surface water or groundwater quality will occur.

#### *8.7.1.4 Potential Effects on Groundwater and Surface Water Quality Due to Blasting*

**Post-Mitigation Residual Effects:** The use and storage of explosives is a standard risk associated with most bedrock quarries. Proven and effective measures to mitigate the risk of groundwater contamination have been proposed above and will break the pathway between the potential source and the receptor. The residual effects is considered to be a negative, indirect, imperceptible, long-term, likely effect on groundwater and surface water quality.

**Significance of Effects:** For the reasons outlined above, no significant effects on groundwater and surface water quality will occur.

#### *8.7.1.5 Potential Effects on Groundwater Levels*

**Post-Mitigation Residual Effect:** No residual effects on local groundwater levels will occur due to the topographical setting and hydrogeological characteristics of the area.

**Significance of Effects:** For the reasons outlined above, no significant effects on groundwater levels will occur.

#### *8.7.1.6 Potential Effects Due to Oil and Fuel Spillages*

**Post Mitigation Residual Effects:** The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all quarry sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. These same measures have proven effective at numerous other quarry sites. The residual effects is considered to be a negative, indirect, imperceptible, long-term, likely effect on groundwater quality and surface water quality.

**Significance of Effects:** For the reasons outlined above, no significant effects on groundwater or surface water will occur.

#### *8.7.1.7 Potential Effects from Wastewater Disposal*

**Post-Mitigation Residual Effects:** It is propped to use an established wastewater treatment system at the Proposed Development Site. There will be no untreated discharge to ground. The residual effect is considered to be a negative, indirect, imperceptible, long term, unlikely effect on groundwater quality.

**Significance of Effects:** For the reasons outlined above, no significant effects on groundwater quality will occur.

#### *8.7.1.8 Potential Effects on Group Water Supplies*

**Post-Mitigation Residual Effect:** Based on the separation distance and the location of the Proposed Development Site outside of the delineated Source Protection Area to the Ballinabranna GWS, combined with the implementation of the prescribed mitigation measures the residual effect is considered to be an indirect, negative, imperceptible, short-term, unlikely effect.

**Significance of Effects:** For the reasons outlined above, and with the implementation of the listed mitigations measures, no significant effects will occur.

#### *8.7.1.9 Potential Effects on Local Groundwater Well Supplies*

**Post-Mitigation Residual Effect:** Based on the topographical setting of the Proposed Development Site, the local hydrogeological regime (bedrock of low permeability) along with the implementation of the prescribed mitigation measures, the residual effect on local groundwater wells is considered to be an indirect, negative, imperceptible, short-term, unlikely effect.

**Significance of Effects:** For the reasons outlined above, and with the implementation of the listed mitigations measures, no significant effects will occur.

#### *8.7.1.10 Potential Effects on Downstream Designated Sites*

**Post Mitigation Residual Effect:** Due to the separation distances and with the implementation of the prescribed mitigation measures for the protection for downstream surface water quality, there will be no residual effects on downstream designated sites.

**Significance of Effects:** For the reasons outlined above, there will be no significant effects on downstream designated sites.

#### *8.7.1.11 Potential Effects on WFD Status*

**Post-Mitigation Residual Effect:** With the implementation of the prescribed mitigation measures for the protection of surface and groundwater quality we consider that there will be no residual effect on the WFD status of the underlying groundwater body. We also consider that the residual effect on the WFD status of surface waterbodies downstream of the Proposed Development Site will be a negative, indirect, imperceptible, temporary, unlikely effect.

**Significance of the Effect:** With the implementation of the mitigation measures outlined above there will be no change in the GWB or SWB status in the underlying GWBs or downstream SWBs resulting from the Proposed Development. The Proposed Development will not result in the deterioration in the WFD status of any surface or groundwater body nor will it jeopardise the attainment of good status in the future.

### 8.7.2 Restoration Phase

The potential impacts associated with the restoration phase are similar to those outlined during the operational phase. The mitigation measures outlined for the operational phase in order to protect against contamination of surface and groundwaters will be implemented throughout the restoration phase.

With the implementation of the mitigation measures no negative impacts on the hydrological and hydrogeological environments are expected during the restoration or post restoration phase. The restoration will have a positive effect in terms of returning the site back to scrubland and redirecting water back into the Raheendoran Stream.

## 8.8 Potential Cumulative Effects

Other land use activities in the surrounding area comprise mainly of agricultural land and coniferous forestry plantations. Several other quarries are also located in the local area.

Due to the local hydrogeological regime, the greatest potential for cumulative or in-combination effects with other developments or land use practices will be in terms of surface water quantity and surface water quality. However, the Proposed Development and other quarries in the local area will operate under strict conditions set out in their respective Environmental Management Plans and IPC Licences designed for the protection of surface water quality and quantity. Due to the lack of any significant residual impacts from the Proposed Development that would affect the wider hydrological environment, there will be no significant cumulative impacts to downstream surface watercourses.

Similarly, in terms of groundwater, the Proposed Development will not have a significant impact on groundwater quantity (groundwater levels) or groundwater quality due to the nature of the local hydrogeological regime with short groundwater flowpaths and bedrock of low permeability.

Therefore, no significant hydrological and/or hydrogeological cumulative effects will occur.

## 8.9 "Worst Case" Scenario

The Risk of Major Accidents and Disasters (MADS) associated with quarrying operations relates to the potential for significant pollution events. Best-practice, tried and tested, mitigation measures have been prescribed in this EIAR chapter in relation to hydrocarbons (Section 8.6.1.6), blasting (Section 8.6.1.4), wastewater (Section 8.6.1.7) and suspended solids (Section 8.6.1.3). These mitigation measures will ensure that there are no significant effects on the local water environment.

## 8.10 Potential Health Effects

Potential health effects arise mainly through the potential for surface and groundwater contamination from the accidental spillage of hydrocarbons or wastewater.

In relation to oils and fuels, best practice controls in place to ensure any potential sources of contamination on the site will be managed appropriately and the volumes present will be small in the context of the scale of the project. Furthermore, the established wastewater treatment systems at the Proposed Development Site will be used and there will be no discharge of wastewater at the site.

With the implementation of the prescribed mitigation measures, the potential residual effects associated with groundwater contamination and subsequent health effects are negligible.

## 8.11 Monitoring

### 8.11.1 Operational Phase

Groundwater level monitoring will continue at the existing monitoring wells and data loggers have been installed in these wells for continuous groundwater level monitoring.

Surface water monitoring will be completed through the operational phase of the proposed development, with monitoring of the discharge water quality and flow volumes.

Groundwater quality should also be completed on a bi-annual basis and shall include testing for the following parameters:

- pH
- BOD

- Ammonia (as N)
- Nitrate
- Total Nitrogen (as N)
- Orthophosphate (as P)
- Total Dissolved Solids
- Dissolved Metals ((Cd, Cu, Fe, Pb, Mg, Mn, Ni & Zn)
- Total Petroleum Hydrocarbons
- Diesel Range Organics
- Petrol Range Organics
- Total Coliforms
- Faecal Coliforms

### 8.11.2 Restoration Phase

No monitoring required.

## 8.12 Interactions

The potential effects on surface water quality due to the proposed development has the potential to impact downstream designated sites. This has been assessed in terms of water quality effects in this chapter and is assessed in terms of biodiversity on Chapter 6: Biodiversity.

## 8.13 References

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