8.0 WATER

8.1 Introduction

This 'Water' chapter of the Environmental Impact Assessment Report (EIAR) has been prepared for the proposed development area within an existing, operational, limestone quarry at Killaskillen, Kinnegad, Co. Meath. The purpose of this section of the EIAR is to present the baseline hydrological and hydrogeological environment and to then assesses the potential impacts, assign mitigation measures and then reassess the potential resultant residual Impacts. Potential cumulative impacts are also addressed.

The study area, as proposed for development in this evaluation, is already a worked limestone zone in which the limestone has been extracted from ground level to an elevation of c. 70m OD. Previous Permissions associated with the site are presented in Table format in Appendix 8.A. The application site is already part of an overall site whose operations are overseen by the EPA and whose activities are controlled in an Industrial Emissions Licence [EPA Ref. P0487-07 for Breedon Cement Ireland Ltd. (referred to in the report as Breedon)], which replaces the former IPPC Licence. The Licence is presented as Appendix 8.B. Therefore, all site operations, emissions and discharges are regulated.

The Road Map for the EIAR was presented in Chapter 1.0 of this EIAR. Chapter 2.0 provided information on the Site location and Context, Chapter 3.0 provided the Description of the Proposed Development and Section 16.0 addresses the Interactions and Cumulative Impacts. This Water Chapter and the Lands, Soils & Geology Chapter were created by the same team of geologists, hydrologists and hydrogeologists.

Hydrologically and hydrogeologically, the site is mapped as sitting within the Boyne Catchment (Hydrometric Area 07) and the Kinnegad River catchment. The Kinnegad River flows in an easterly direction along the northern boundary of the applicant's overall landholding. More details for regional river systems, WFD Subcatchments & Sub Basins are provided later in this chapter. Characterisations, Pressures and other significant information relating to the rivers, lakes and groundwater connected to the site have been presented by the catchment and WFD teams of the EPA and reported in EPA (2018) and EPA (2021). All published data have been employed for the characterisation of the Baseline and the Assessment of Impacts, Required Mitigations and Residual Impacts.

With respect to designations, none of the watercourses in the vicinity of the site are designated areas. However, the Kinnegad and Castlejordan Rivers flow to the north and south of the site, respectively, and both contribute to the River Boyne river system, which is mapped as the 'River Boyne and River Blackwater' Special Area of Conservation (SAC Site Code: 002299) and Special Protection Area (SPA Site Code: 004232). Those SAC and SPA sites are also connected to other SAC and SPA sites. The information presented in this chapter has been used by the ecologists in their evaluations as presented in Chapter 6 Biodiversity.

All waters arising at the site proposed for development in this application are already integrated into the Water Management Systems for the overall landholding and are regulated by the EPA in the Integrated Pollution Control (IPC) License Ref. P0487-07 for Breedon Cement Ireland Ltd.

8.1.1 Statement of Authority

The evaluation of the hydrological and hydrogeological environment and the assessment of impacts was completed collaboratively by Dr. Colin O'Reilly, Dr. Pamela Bartley and P.Geol Pat Breheny.

Dr. Colin O'Reilly has a doctorate degree in soil's systems and hydrology. He has over 20 years of professional and field-based experience as a hydrogeologist coupled with a doctorate degree in hydrology, awarded by the Centre for Water Resources Research, School of Architecture, Landscape and Civil Engineering, UCD, while a recipient of a Teagasc Walsh Fellowship. Colin's company is Envirologic, which has key competencies in hydrogeology and hydrology with expertise in flood assessments in addition to assessment of quarries across a range of diverse hydrogeological conditions across Ireland. Colin is a current and active member of Engineers Ireland and International Association of Hydrogeologists (Irish Group).

Dr. Pamela Bartley (Hydro-G) is a water focussed civil engineer with 24 year's field-based practice in groundwater, surface water and wastewater. Pamela completed her primary degree in Civil Engineering at Queen's University, Belfast and postgraduate education at the School of Civil Engineering at Trinity College, Dublin. She completed an MSc. in Environmental Engineering, at the School of Civil Engineering at TCD, with geotechnical, hydrogeological and legislation specialities and later a hydrogeologically focussed Ph.D at TCD. Pamela has become a specialist in quarry and discharge evaluations in the context of enacted Irish Regulation and EU Directives. She has completed impact assessments for many regionally important quarries in SAC settings. Pamela's quarry assessments include Bennettsbridge Limestone, Co. Kilkenny, McGrath's Limestone of Cong, Cos. Galway and Mayo, Cassidy's of Buncrana, Co. Donegal, Harrington's of Turlough, Co. Mayo, Ardgaineen, Co. Galway and Mortimer's of Belclare, Co. Galway. Each of these quarries operate within SAC catchments and have successfully managed their discharge, under licence, for many years.

Pat Breheny MSc (Hydrogeology) PGeo. EurGeol. works with Colin O'Reilly in Envirologic. Pat completed much of the supervision, monitoring, sampling, hydrogeological response investigation works and analysis and interpretation of field data at Breedon's Kinnegad Quarry. Patrick Breheny has 12 years of post-graduate experience in environmental consultancy having worked extensively in Ireland and the UK, with a background specialising in hydrogeology, hydrology and contaminated land. Patrick holds a Master of Science Degree (MSc) in Hydrogeology which he attained at the University of Leeds, UK. He is a member of the International Association of Hydrogeologists (IAH) and is a Chartered Geologist, as awarded by the Institute of Geologist Ireland (IGI). Working as a senior hydrogeologist, Patrick's key skills and experience include site investigation, groundwater resources, risk assessment, groundwater remediation, environmental permitting and management and liability assessment for soil and groundwater remediation projects.

Examples of recent relevant projects completed by Envirologic include:

(i) Hydraulic capacity assessment and flood risk assessment relating to six crossings on R181 prior to road upgrade works, Shantonagh, Co. Monaghan (client: Monaghan County Council).

(ii) Hydrological assessment relating to proposed drainage channel upgrade and maintenance works on a 5.3 km stretch of a river and its tributaries, Oranmore, Co. Galway (client: Galway County Council).

(iii) Design and specification of a flood alleviation scheme to include a new quarry discharge route from an active limestone quarry, Co. Galway.

Both Hydro-G and Envirologic hold the required Professional Indemnity Insurances, Employers and Public Liability Insurances.

8.1.2 Site Location

As described in more detail in Chapter 2 of this EIAR, the subject site is located in the townland of Killaskillen, Kinnegad, Co. Meath. The application site and the entire landholding of the applicant are presented as Figure 8.1 with this Water Chapter. Breedon Cement Ireland Ltd. (Breedon) is the owner and operator of the site at Kinnegad. The overall landholding extends to c. 286ha and sits in the townlands of Killaskillen, Cappaboggan and Toor. The site is located directly south of the M6 Dublin-Galway motorway and 700m southwest of Junction 2, which serves the nearby town of Kinnegad at a distance of 1.5km to the northeast. The eastern boundary of the site is defined by a local road (L8021) which provides access to the small settlement of Ballinabracken, positioned 400m beyond the southern site boundary.

8.1.3 Project Description

As described in more detail in Chapter 3, the proposed development involves the deepening of c. 4.13ha of an area on the northwestern boundary of the main working floor of the existing limestone quarry. The area proposed for development is already a worked limestone zone in which the limestone has been extracted from ground level to an elevation of c. 70m OD (TA/900603). The proposal under consideration here is to deepen an area of 4.13ha from an elevation of 70m OD to 10m OD, which equates to 4 no. 15m extractive benches. This proposal is deemed necessary for the efficient functioning of the main quarry floor area, which is already permitted under Planning Ref. 98/2026 (An Bord Pleanála Ref. PL17.111198) to a depth of 10m OD.

8.1.4 Consultations

Breedon Cement Ireland Ltd. retained Tom Phillips + Associates (Town Planning Consultants), to prepare a planning application for proposed development at their existing quarry at Kinnegad, Co. Meath.

Tom Phillips + Associates (Town Planning Consultants) managed all pre-planning discussions with Meath County Council, as per the provisions of Section 247 of the Planning and Development Acts 2000, as amended, and all stakeholders. A meeting with Meath County Council took place on the 20th of May 2022.

Hydro-G and Envirologic requested that Tom Phillips + Associates (Town Planning Consultants) issue the project description and preliminary findings to the Geological Survey of Ireland (GSI), NPWS and Irish Water.

The GSI responded on 30th May 2022. Key points from the consultation are reproduced, as follows:

- The GSI encourages use of and reference to their publicly available datasets
- The quarry at Killaskillen is not a geological heritage site and there are no County Geological Sites (CGS's) in the vicinity of the proposed development.
- The groundwater data viewer indicates that the area is underlain by an aquifer classed as a 'Locally Important Aquifer – bedrock which is generally moderately productive only in local zones'. The GSI recommend that the groundwater viewer is used to identify areas of High to Extreme vulnerability and 'rock at or close to surface' in the assessment, as any groundwater-surface water interactions that might occur would be greatest in these areas.

The authors of this chapter hereby confirm that this EIAR chapter and Impact Assessment has utilised all relevant and publicly available datasets available from the GSI.

This assessment has also been completed cognisant of historical consultation output from the DAFM (2016) requesting that "hydrological characteristics should be taken into account to ensure no adverse impacts on groundwater quality which may impact on local supplies or on the ecology of neighbouring bogs (both designated and undesignated).

8.2 Assessment Methodology

8.2.1 Assessment Objectives

The objectives of this assessment are, as per the EIA Directive (2014/52/EU) and EPA Guidance (2022), to:

- Provide baseline hydrogeological and hydrological conditions for the site & update previous assessments based on additional drilling, monitoring information and assessments.
- Assess the potential impact of the proposed development on the underlying groundwater body, associated surface water bodies and ecosystems.

Upon identification of potential impacts, provide appropriate mitigation measures for any identified potential impacts, as deemed necessary. The proposal impacts and proposed mitigations will then be reassessed, and residual impacts defined.

The methodology adopted for this assessment is as follows:

- Review of appropriate guidance and legislation
- Characterisation of the Receiving Environment (hydrology and hydrogeology)
- Review of the 'Subject' development
- Site Investigations to explore the potential of the 'Subject' development to result in Environmental Impact
- Assessment of Potential Effects
- Identification of Mitigation Measures and
- Assessment of Residual Impacts

8.2.2 Guidance Documents & Legislative Instruments

Overall, the assessment was prepared with consideration of enacted Irish Regulations, EU Directives and Guidance Documents listed as follows:

This report was prepared with consideration of the following Irish Regulations and Guidance, listed as follows:

- EIA Directive (2014/52/EU) DIRECTIVE 2014/52/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment
- Groundwater Regulations: European Communities Environmental Objectives (Groundwater) Regulations, S.I. No. 9 of 2010, as amended 2019 as S.I. No. 366 of 2019
- European Communities (Birds and Natural Habitats) Regulations, 2011. S.I. No. 477 of 2011, as amended 2021 as S.I. No. 293 of 2021
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 Statutory Instruments S.I. No. 272 of 2009, as amended 2012 (S.I. No. 327 of 2012), 2015 (S.I. No. 386 of 2015) and 2019 (S.I. No. 77 of 2019)
- European Communities (Conservation of Wild Birds (River Boyne and River Blackwater Special Protection Area 004232)) Regulations 2012. S.I. No. 462 Of 2012.
- European Union Habitats (Boyne Coast and Estuary Special Area of Conservation 001957) Regulations 2021. S.I. No. 433 of 2021.
- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2022)
- Geology in Environmental Impact Statements: A Guide (IGI, 2002)
- Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements, Institute of Geologists of Ireland (IGI, 2013)
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment. Department of Housing, Planning and Local Government (2018)
- The Planning System and Flood Risk Management: Guidelines for Planning Authorities. Office of Public Works and Department of Environment, Heritage and Local Government (2009)
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA @ https://www.tii.ie/technical-services/environment/planning/Guidelines-on-Procedures-for-Assessment-and-Treatment-of-Geology-Hydrology-and-Hydrogeology-for-National-Road-Schemes.pdf
- Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals) (EPA 2006)
- Quarries and Ancillary Activities – Guidelines for Planning Authorities, Dept. of Environment, Heritage and Local Government (2004)
- Guidance Document no. GW5: Guidance on the Assessment of the Impact of Groundwater Abstractions. WFD Working Group (2004)

- Using Science to Create a Better Place: Hydrogeological Impact Appraisal for Dewatering Abstractions. Environment Agency, Science Report – SC40020/SR1. Bristol, UK. Boak, et al. (2007)
- Reclamation Planning in Hard Rock Quarries. Department of Civil & Structural Engineering, University of Sheffield, Edge Consultants & Mineral Industry Research Organisation (2004); and
- A Quarry Design Handbook. 2014 Edition. GWP Consultants and David Jarvis Associates Limited, UK (2014).

8.2.3 Characterisation Information & Study Methodology

Overall, the study components comprised as follows:

A. Desktop study review of all published national data from the DHLG&H, OPW, EPA, GSI and NPWS. Mapped information and databases for the site and wider region.

B. Review of historical planning documentation and assessments for the site and wider area to include, but not limited to, the following:
   a) Drilling logs from previous well installations
   b) Analysis of historical pumping rates from the existing quarry sump and other flow monitoring points within the site
   c) Review of details relating to, and visual assessment of, all on-site water management infrastructure
   d) Groundwater level data that is routinely collected by the applicant's employees from on-site and off-site wells
   e) Discharge water quality and discharge volume records as per IE Licence Annual Reports to the EPA. Receiving surface water quality and flow records (Kinnegad River)
   f) Review historical licensing documentation to include, but not limited to, the files listed under IPC Licenses 90487-01 to 90487-07

C. Site walkovers, local area visual surveys and discussions with site personnel, including as follows:
   a) A walkover survey of the application site and surrounding area was undertaken by Hydro-G and Envirologic on multiple occasions between Summer 2021 and Summer 2022.
   b) Assessment of the landscape position, surrounding lands and dwellings was undertaken to better understand topography and geological patterns. Features of hydrological and hydrogeological significance were identified and used as a basis for discussing sources, pathways and receptors that the study should focus on.
   c) Locations of water schemes in the wider regional context was evaluated. There are no public drinking water sources at risk of impact from the proposed development.
   d) Breedon routinely survey third party wells. Envirologic completed a survey of properties within 1 km of the site to identify any potential groundwater

receptors at risk of impact due to proposed development works. Approximately 17 domestic water supply boreholes were identified in the survey.

D. With respect to site-specific characterisations and assessments having a hydrological and hydrogeological focus, Hydro-G and Envirologic completed a field programme which involved surveying and description of groundwater and surface water systems at and in the vicinity of the site. Field gathered information was combined with available hydrometric and hydrochemical data. Intrusive site investigations were undertaken between August 2021 and April 2022. The study period forms part of a longer and continuing record of investigation and monitoring at the site. The 2021 to 2022 investigation involved the following key components:

a) Surveying in, to Malin Datum, wellhead elevations of all existing on-site boreholes were to Malin Head datum. This was done in conjunction with a preliminary groundwater level survey.
b) Surveying in, to Malin Datum, all off-site boreholes that form the network of community wells that are monitored by Breedon as part of routine operations on a monthly basis.
c) Site Investigation monitoring wells (MW's) were drilled by Petersen Drilling Ltd. between October and November 2021. Seven MWs were drilled, one in the application area and 6 in the surrounding lands. MWs were installed on the working areas of the shale quarry and main limestone quarry. More details are provided later and the Monitoring Well Logs are included in the Site Investigation Appendix 7.A. Pat Breheny P.Geol was in attendance to supervise drilling and log bedrock lithology. Results from the monitoring well drilling programme corresponded with findings from historical site investigation works in these areas. The monitoring wells will facilitate long-term monitoring of groundwater level and groundwater quality. Groundwater level dataloggers were installed at selected monitoring well locations.
d) Hydraulic response slug testing was performed on the MWs to estimate bedrock permeability. The results of these permeability tests were consistent with previous site investigation and shows bedrock in this part of the site to have low permeability and to be reasonably homogenous.
e) MW drilling and permeability testing suggested a localised anomalous zone of high permeability close to the surface on quarry floor of the application area. To further evaluate this anomaly, a geophysical survey was commissioned.
f) APEX Geophysics Ltd. completed a geophysical survey in January 2022. Results of the geophysical survey and the interpretative report will be discussed in more detail later in this chapter. However, in summary nothing of note was identified beneath the application area but two drill targets were proposed to provide confidence in the integration of the MW SI BH

experience and the overall understanding of geology and hydrogeology at the application site.

g) In order to complete the recommendations of the Geophysical Report, three larger diameter (8”) ‘production’ wells were drilled in the application area in February 2022. Briody Well Drilling Ltd. completed the works with Dr. Pamela Bartley in attendance to supervise drilling and log lithology. More details are provided later but the full extent of the application depth was explored.

h) Full scale pumping tests were completed on the PWs during April and May 2022. This work provided the information on likely future dewatering needs and aided quantification of likely impact on local and regional groundwater and surface water receptors.

i) Sequential water quality sampling and analysis was performed throughout the study period to inform baseline condition and assimilative capacity of receiving waters. Water sampling commenced in December 2021 and continued into Spring 2022.

E. A quantitative review of the established and IE Licenced Surface Water Management Plan was undertaken. This included review and analysis of dewatering rates, settlement lagoons, treatment of discharge waters and process water management. In addition to the established flow meters, Capital Water Systems Ltd. were commissioned to install another rainfall gauge and flow gauges on selected points in the water management system’s infrastructure.

F. The hydrological regime and flow capacity of the Kinnegad River was established by Envirologic’s surveying of channel cross sections and streamflow gauging. Field work enabled the development of a hydrological model. Simulations were then performed to quantify the hydraulic capacity of the receiving waters and ability to safely transmit discharge from the application site without increasing flood risk to downstream receptors.

G. Integration of investigation and monitoring findings informed the update to the site’s established CSM (Conceptual Site Model) for the hydrogeological system at the site and the local surrounding area’s hydrology and hydrogeology.

H. All works were employed in the population of a Hydrogeological Risk Assessment Framework (UK EA).

I. The EIA procedure was followed through the assessment, identification of impacts, mitigation proposals and evaluation of residuals’ process.

8.2.4 EPA (2022) Assessment Methodology

Unless otherwise stated, the EPA's method (2022) of determining the significance of impacts has been applied. There are seven generalised degrees of impact significance that are commonly used in EIA, which are provided in EPA (2022) as Table 3.4 as follows:

1) **Imperceptible:** An impact capable of measurement but without noticeable consequences.
2) **Not Significant:** An effect which causes noticeable changes in the character of the environment but without significant consequences.
3) **Slight:** An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
4) **Moderate:** An impact that alters the character of the environment in a manner consistent with existing and emerging trends.
5) **Significant:** An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
6) **Very Significant:** An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment.
7) **Profound:** An impact which obliterates sensitive characteristics.

The EPA's Table 3.4 (2022) is presented here as Table 8.1.

Table 8.1 Criteria and Terminology to be Used in Description of Effects (EPA, 2022, Table 3.4)

8.1 (a) Quality, Significance, Extent and Context of Effects

Quality of Effects It is important to inform the non-specialist reader whether an effect is positive, negative or neutral	**Positive Effects** A change which improves the quality of the environment (for example, by increasing species diversity; or the improving reproductive capacity of an ecosystem, or by removing nuisances or improving amenities).
	Neutral Effects No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
	Negative/adverse Effects A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem; or damaging health or property or by causing nuisance).
Describing the Significance of Effects ''Significance' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful (also see *Determining Significance* below.).	**Imperceptible** An effect capable of measurement but without significant consequences.
	Not significant An effect which causes noticeable[2] changes in the character of the environment but without significant consequences.
	Slight Effects An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
	Moderate Effects An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
	Significant Effects An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
	Very Significant An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
	Profound Effects An effect which obliterates sensitive characteristics
Describing the Extent and Context of Effects Context can affect the perception of significance. It is important to establish if the effect is unique or, perhaps, commonly or increasingly experienced.	**Extent** Describe the size of the area, the number of sites, and the proportion of a population affected by an effect.
	Context Describe whether the extent, duration, or frequency will conform or contrast with established (baseline) conditions (is it the biggest, longest effect ever?)

Cont'd Table 8.1 Criteria and Terminology to be Used in Description of Effects (EPA, 2022, Table 3.4)

8.1 (b) Probability & Duration of Effects (Table 3.4 EPA 2022 continued)

Describing the Probability of Effects Descriptions of effects should establish how likely it is that the predicted effects will occur so that the CA can take a view of the balance of risk over advantage when making a decision.	**Likely Effects** The effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented.
	Unlikely Effects The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.
Describing the Duration and Frequency of Effects 'Duration' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful.	**Momentary Effects** Effects lasting from seconds to minutes.
	Brief Effects Effects lasting less than a day.
	Temporary Effects Effects lasting less than a year.
	Short-term Effects Effects lasting one to seven years.
	Medium-term Effects Effects lasting seven to fifteen years.
	Long-term Effects Effects lasting fifteen to sixty years.
	Permanent Effects Effects lasting over sixty years.
	Reversible Effects Effects that can be undone, for example through remediation or restoration.
	Frequency of Effects Describe how often the effect will occur (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually).

Cont'd Table 8.1 Criteria and Terminology to be Used in Description of Effects (EPA, 2022, Table 3.4)

8.1 (c) Types of Effects (Table 3.4 EPA 2022 continued)

Describing the Types of Effects	**Indirect Effects (a.k.a. Secondary or Off-site Effects)** Effects on the environment, which are not a direct result of the project, often produced away from the project site or because of a complex pathway.
	Cumulative Effects The addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects.
	'Do-nothing Effects' The environment as it would be in the future should the subject project not be carried out.
	'Worst-case' Effects The effects arising from a project in the case where mitigation measures substantially fail.
	Indeterminable Effects When the full consequences of a change in the environment cannot be described.
	Irreversible Effects When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost.
	Residual Effects The degree of environmental change that will occur after the proposed mitigation measures have taken effect.
	Synergistic Effects Where the resultant effect is of greater significance than the sum of its constituents (e.g. combination of SOx and NOx to produce smog).

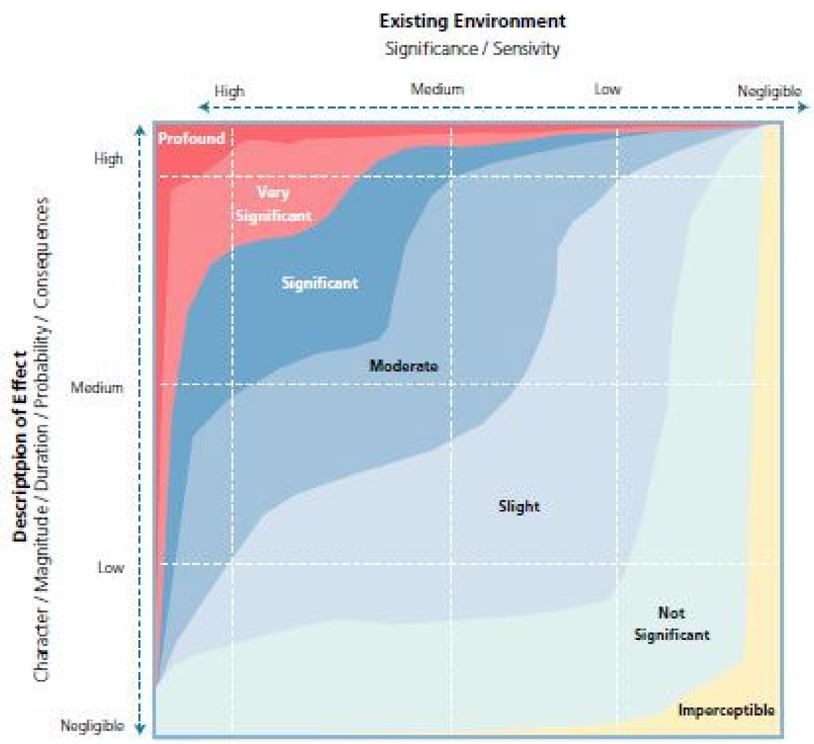
The assessments completed in this Water Section of the EIAR considered phases as follows:

(i) Construction Phase (no construction associated with proposed development)
(ii) Operational Phase
(iii) Landscaping, Restoration, Decommissioning & Aftercare

Detail for all phases was presented in Chapter 3.0 of this EIAR.

Using the definitions for the degree of impact significance outlined above, the methodology for combining project information was presented in EPA (2022) as Figure 3.5 and is reproduced here as Plate 8.1.

Plate 8.1 EPA's Chart Showing 'Indicative' Typical Classifications of the Significance of Effects (2022) as adapted from SNH (2018).



There are seven generalised degrees of effect significance that are commonly used in EIA. Imperceptible, Not Significant, Slight, Moderate, Significant, Very Significant and Profound. Generalised definitions of each of these are provided in Table 3.4. When more specific definitions exist within a specialised factor or topic, e.g. biodiversity, these should be used in preference to these generalised definitions. (ref. Advice Notes[68].)

The assessment of impacts within this chapter is carried out with respect to the hydrogeological and hydrological environment. Within this chapter, potential impacts are considered to be effects of the proposed development's resultant changes to the environment.

Criteria for assessing importance of site attributes and their magnitude of importance were evaluated using NRA Guidelines (NRA, 2008) [as prescribed in 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI, 2013)]. NRA rating criteria uses the same significance terminology as the EPA. However, the NRA & IGI Guidance suggest intermediate steps to justify using that terminology, as follows:

- **Step 1:** Quantify the Importance of a feature for geology (Table C2) and hydrogeology (Table C3);
- **Step 2:** Estimate the Magnitude of the impact on the feature from the proposed development (Table C4: Geology, Table C5: Hydrogeology);
- **Step 3:** Determine the Significance of the impact on the feature from the matrix (Table C6) based on the Importance of the feature and the Magnitude of the impact.

IGI (2013) and NRA (2008) Tables of significance to this study are presented here as Tables 8.2, 8.3, 8.4 and 8.5: These frameworks for assessment have been applied in this work.

Table 8.2: Criteria for Rating Site Importance of Hydrological Features (NRA, 2008)

Importance of Attribute	Criteria	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
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 Regionally important potable water source supplying > 2,500 homes Quality Class A (Biotic Index Q4, Q5) Floodplain protecting more than 50 residential or commercial properties from flooding Nationally important amenity site for 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 Quality Class B (Biotic Index Q3-Q4) Floodplain protecting between 5 and 50 residential or commercial properties from flooding Locally important amenity site for wide range of leisure activities
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3) Floodplain 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 Local potable water source supplying <50 homes Quality Class D (Biotic Index Q2, Q1) Floodplain protecting 1 residential or commercial property from flooding Amenity site used by small numbers of local people

Table 8.3: Criteria for Rating Site Importance: Hydrogeological Features (IGI, 2013, Table C3)

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. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – e.g. NHA status. 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. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes. 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.

Table 8.4: Criteria for Estimating Magnitude of Impact: Hydrogeology Attribute (IGI, 2013, Table C5)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off[1]. Calculated risk of serious pollution incident >2% annually[2].
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off[1]. Calculated risk of serious pollution incident >1% annually[2].
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off[1]. Calculated risk of serious pollution incident >0.5% annually[2].
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually[2].

Table 8.5: Criteria for Rating of Significant Environmental Impacts (IGI, 2013, Table C6)

Importance of Attribute	Magnitude of Impact			
	Negligible	**Small Adverse**	**Moderate Adverse**	**Large Adverse**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/ Moderate

The application of criteria, as outlined in Tables 8.1 to 8.5 above, to the specifics of the study area provides a general screening of the likely impact to the hydrological and hydrogeological environment. The methodology involves the identification all of the potential receptors within the site boundary and surrounding environment. This information was gathered during the desk study, site walkover, site investigation and monitoring phases of the study.

8.2.5 Dewatering Impact Appraisal

In addition to the application of Irish Guidelines as outlined in EPA (2022) and NRA (2008), and in the absence of Irish Guidance specifically focussed on quarries and hydrogeology, the work presented in this EIAR Section has also applied UK practical guidance as published by the **UK Environment Agency** (the public body equivalent of the Irish EPA). The UK Guidance provides a **'Hydrogeological impact appraisal for dewatering abstractions'** (Boak, R. et. al. (2007) and the approach is succinctly outlined by the EA as follows:

> *"The methodology for hydrogeological impact appraisal (HIA) is designed to fit into the Environment Agency's abstraction licensing process. It is also designed to operate within the Environment Agency's approach to environmental risk assessment, so that the effort involved in undertaking HIA in a given situation can be matched to the risk of environmental impact associated with the dewatering. The HIA methodology can be summarised in terms of the following 14 steps:*

- ***Step 1:*** Establish the regional water resource status.
- ***Step 2:*** Develop a conceptual model for the abstraction and the surrounding area.
- ***Step 3:*** Identify all potential water features that are susceptible to flow impacts.
- ***Step 4:*** Apportion the likely flow impacts to the water features.
- ***Step 5:*** Allow for the mitigating effects of any discharges, to arrive at net flow impacts.
- ***Step 6:*** Assess the significance of the net flow impacts.
- ***Step 7:*** Define the search area for drawdown impacts.
- ***Step 8:*** Identify all features in the search area that could be impacted by drawdown.
- ***Step 9:*** For all these features, predict the likely drawdown impacts.
- ***Step 10:*** Allow for the effects of measures taken to mitigate the drawdown impacts.
- ***Step 11:*** Assess the significance of the net drawdown impacts.
- ***Step 12:*** Assess the water quality impacts.
- ***Step 13:*** If necessary, redesign the mitigation measures to minimise the impacts.

- ***Step 14:*** Develop a monitoring strategy.

  The steps are not intended to be prescriptive, and the level of effort expended on each step can be matched to the situation. Some steps will be a formality for many applications, but it is important that the same thought-process occurs every time, to ensure consistency. The methodology depends heavily on the development of a good conceptual model of the dewatering operation and the surrounding aquifer. The steps of the methodology are followed iteratively, within a structure with three tiers, and the procedure continues until the required level of confidence is achieved. Advice is also given on how to undertake HIA in karstic aquifers and fractured crystalline rocks." Boak, R. et. al. (2007).

Hydro-G has applied the **UK Environment Agency**'s step wise process in order to apply a quarry development process to the EPA (2022) and NRA (2008) Guidance and present a reasoned assessment of the potential for impact that might arise in response to the proposed development and its interaction with the activities at the site and in the region.

Now, the existing environment will be described.

8.3 Existing Environment

The receiving environment is described here. Desktop mapping and published information is presented to describe the land, soils, surface water systems, underlying quaternary and bedrock geology, mapped aquifer and groundwater vulnerability classifications and other information relevant to the Water environment.

Mapped information and databases for the site and wider region employed included as follows:

- EPA mapping and surface water and groundwater quality data https://gis.epa.ie/EPAMaps/.
- EPA (2018) 2nd Cycle WFD Sub Basin Report.
- EPA (2021) 3rd Cycle WFD Draft Catchment Assessment Boyne Catchment Report (HA 07).
- OPW hydrometric flow and level data from EPA/OPW hydrometric stations.
- GSI (2004) Meath Groundwater Protection Scheme.
- GSI (2004) Athboy Groundwater Body Report 1st Draft.
- GSI On-line Groundwater database. Aquifer Classification, Aquifer Vulnerability, Teagasc Soil Classification. https://dcenr.maps.arcgis.com/apps/MapSeries/.
- McConnell, B., Philcox, M.E., Geraghty, M. 2001. Sheet 13: Geology of Meath. 1: 100,000 Bedrock Geology Map Series, Geological Survey of Ireland.
- Information relating to Irish Water and National Federation Group Water Schemes.
- Evaluation of groundwater usage and water supplies in the area using Meath County Council's ePlanning system which provides comprehensive information of local houses and their water supply.
- NPWS River Boyne & River Blackwater SAC 002299 Site Synopsis (2014) and Conservation Objectives Series (2021).
- NPWS River Boyne & River Blackwater SPA 004232 Site Synopsis (2010) and Conservation Objectives Series (2022).

- European Communities (Conservation of Wild Birds (River Boyne and River Blackwater Special Protection Area 004232)) Regulations 2012. S.I. No. 462 Of 2012.
- NPWS Boyne Coast and Estuary SAC 001957 Site Synopsis (2016) and Conservation Objectives (2012)
- NPWS Boyne Coast and Estuary SPA 004080 Site Synopsis (2015) and Conservation Objectives (2013)
- European Union Habitats (Boyne Coast and Estuary Special Area of Conservation 001957) Regulations 2021. S.I. No. 433 of 2021.
- NPWS Mount Hevey Bog SAC 002342 Site Synopsis (2014) and Conservation Objectives Series (2016).
- Ordnance Survey of Ireland, 1:50,000 Discovery Map Series.
- Google Earth Pro Historic Photography series.
- EIA portal (https://housinggovie.maps.arcgis.com/).

In addition to national datasets and desktop available published information, this section also presents an overview of the significant body of historic site investigations at the site and the results of the current site investigation works, completed in 2021 and 2022, to support the development of the baseline environment.

Desk study, historic and current site investigation results were then used to complete an Impact Assessment, identification of required mitigation measures and presentation of residual effects, if found.

8.3.1 Land, Land Use & Topography

Chapter 7, Section 7.3.1 and the associated Table 7.4 presented the required information for the lands, topography and historic changes in land use. As previously stated, the team responsible for the Water Chapter also completed Chapter 7. Therefore, the information has been already presented and considered also in this assessment and reporting of the Water Chapter.

The Meath Groundwater Protection Scheme report (GSI, 1996) suggests that *"The topography is generally flat to undulating with elevation generally around 60 to 100 metres above sea level, but ranging from 15 metres along the Boyne valley to around 200-300 metres along the tops of ridges (Slieve na Calliagh, north of Slane and north of Moynalty). The surface water drainage of County Meath is dominated by the River Boyne, which drains more than half the county. The Boyne's most important tributaries are (downstream of Navan) the Kells Blackwater, Moynalty, Mattock and Devlin rivers, and (upstream of Navan) the Enfield Blackwater, Athboy, Boycetown, Castlejordan, Clady, Deel, Kinnegad, Knightsbrook, Riverstown, Skane, Stonyford, and Yellow rivers. Other significant rivers in Meath are the Dee, Nanny, Inny, Glyde, Liffey, Tolka, Broad Meadow, and Delvin. …..Several of the rivers also drain adjoining counties.* ***Agriculture is the dominant land use activity in Meath, particularly livestock farming and tillage".***

8.3.2 Designated Sites

None of the watercourses in the **immediate** vicinity of the site are designated sites with Conservation Objectives.

The application area, and the overall working quarries and factories adjacent to the application area, sit in catchments of sites that are designated and have Conservation Objectives. Designated sites in the region, distances from the application area and means of hydraulic connectivity are presented in Table 8.6.

Table 8.6: Regional Designated Sites Information

Site Name	Designation	Site Code	Distance from the Application Area	Means of Connectivity to Applciation Area	Qualifying Interests	Conservation Objectives
River Boyne and River Blackwater	SAC	_002299	c. 12km as the crow flies, NE.	Breedon site is licensed to discharge 6,150m3/d max to the Kinnegad River. This river joins the Boyne_030 at a distance of c. 13.6km in river flow path length to the point at which the River Boyne is designated @ Longwood, Co. Meath.	1099 River Lamprey Lampetra fluviatilis. 1106 Salmon Salmo salar. 1355 Otter Lutra lutra. 7230 Alkaline fens. 91E0 Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)*.	To maintain the favourable conservation condition Alkaline Fens and to Restore other habitats.
River Boyne and River Blackwater	SPA	_004232			The site is a Special Protection Area (SPA) under the E.U. Birds Directive of special conservation interest for the following species: Kingfisher, a species that is listed on Annex I of the E.U. Birds Directive.	To maintain or restore the favourable conservation condition of the Kingfisher bird species.
River Boyne and River Blackwater SAC overlaps with Boyne Estuary SPA (004080) and River Boyne and River Blackwater SPA (004232). The SAC is also adjacent to Boyne Coast and Estuary SAC (001957).						
Boyne Estuary	SPA	_004080	c. 67km as the crow flies	Boyne River discharges to this estuary. Kinnegad River contributes to the Boyne. The hydro catchment is enormous. There are Lakes in Cavan connected to the Boyne Estuary SAC and SPA.	Lots of Birds and Wetland Habitat	To maintain the favourable conservation condition of many Birds and the Wetland habitat that supports the birds.
Boyne Coast and Estuary	SAC	_001957			Estuaries, Mudflats, Sandflats, Muds, Sands, Dunes, Vegetation,	Two of the Habitats are to be Maintained, most need to be Restored.
Mount Hevey Bog	SAC	_002342	6.5km	Not hydraulically connected to the application site. An outflow overflow from Mount Hevey Bog joins the Kinnegad_030 River, at a distance of 5km downstream of the licensed discharge from Breedon Operations.	7110 Active raised bogs. 7120 Degraded raised bogs still capable of natural regeneration. 7150 Depressions on peat substrates of the Rhynchosporion.	Restore & Maintain

With reference to mapped sites and the information presented in Table 8.6, rainfall runoff from the application site has always flowed naturally towards the sump of the main limestone quarry at the site. That sump, on the limestone floor, has pumped water forward to multiple parts of the site including another sump (Terrace), a balancing pond and 2 large settlement lagoons from which there is a licensed discharge to the Kinnegad River, under IE Licence. The point of licensed discharge from the Breedon site is >13km stream flow length from the point at which the Boyne_030 is mapped as a designated site, which is at Longwood, Co. Meath. Review of EPA HydroTOOL catchments reveals that the overall catchment area is 436km2 to that point of the commencement of Conservation Objective designation on the Boyne river system. Information for catchments, HydroTOOL maps and flows is presented in Appendix 8.C. HydroTOOL information for Model Node 07_951 suggests a 50%tile flow rate of 3.85 m3/s, which is equivalent to 332,726 m3/d. This suggests that at times of approximate equivalent mean flow at the point of confluence between the Kinnegad River and the point of commencement of the Designated Boyne, a maximum permitted discharge of 6,150 m3/d from the Breedon site combined, including all quarries and lands associated with the Breedon operation, represents <2% of the flow in the Designated River at that start point of its Designation. That <2% of hydraulic relativity would place the contributions from the Breedon site in the 'little potential for impact' using WFD GW5 (WFD Ireland, 2004). Moving along the river the proportion of the River Boyne's flow that could be influenced by the site, will diminish further as the larger catchment area brings more water to the river system.

8.3.3 Meteorology

Preliminary, general, and unrefined surface water runoff calculations for the application site (4.13 ha), the limestone quarry (77.25 ha) and the shale quarry (24.9 ha) can be calculated using Met Eireann rainfall and evapotranspiration values with GSI recharge coefficients.

Monthly gridded rainfall data was sourced from Met Éireann (Walsh 2012) and is presented in Table 8.7.

Table 8.7: Mullingar Long term mean monthly rainfall data (mm) (Met Éireann)

J	F	M	A	M	J	J	A	S	O	N	D	Annual
85	61	70	61	59	68	72	82	71	96	83	87	896

Average Annual Rainfall (AAR) over a 30-year period is reported by Met Eireann as 896mm/yr for the nearest Synoptic Station, which is Mullingar.

Average annual potential evapotranspiration rate for Mullingar is provided by Met Eireann as 491mm/yr across the period 2018–2021.

Actual evapotranspiration (AE) is estimated by multiplying PE by 0.95, to allow for the reduction in evapotranspiration during periods when a soil moisture deficit is present (Water Framework Directive 2004). Actual evapotranspiration is therefore 466 mm/yr (0.95 PE).

The Effective Rainfall (ER) for the site, using Met Eireann AAR data, is determined as follows:

- ER = AAR – AE = 896mm/yr – 466mm/yr = 430mm/yr = 0.43m/yr

For comparative purposes, the GSI maps Effective Rainfall to be 498.7mm/yr (https://dcenr.maps.arcgis.com/). The GSI assigns Groundwater Recharge as only 200mm of that 498.7mm/yr ER. This is because the GSI apply a Groundwater Recharge 'cap' to the rock of the site. This is because the GSI has assigned a rating of poor recharge water acceptance in the limestone bedrock at the site. This has implications (positive) for assessment of potential impact of the proposed development on groundwater resources.

8.3.4 Hydrology

The hydrological component of the assessment requires understanding of natural surface water drainage patterns in the area and delineation of the surface water catchments contributing flow to the various watercourses in the area.

8.3.4.1 Regional Hydrology

As introduced in Section 8.1, the application site is mapped as within the catchment of the Kinnegad River, which in turn sits in the Boyne Catchment (Hydrometric Area 07). The Boyne catchment is reported to have a catchment area of 2,694km2. This large value for the contributing land mass suggests a very large number of connected rivers. The Kinnegad River flows in an easterly direction along the northern boundary of the applicant's overall landholding. As previously stated, IE Licence P0487-07 for the overall Breedon operation, in which the application site is located, permits discharge to the Kinnegad_020 River.

The two primary, regional scale, watercourses to the north and south of the applicant's lands are the Kinnegad River and the Castlejordan River. Summary data for these two regional scale rivers are shown in Table 8.8. EPA's HydroTOOL model are provided in Table 8.8 for Model Nodes on the Kinnegad River and the Castlejordan River. Some information for local streams is also presented in Table 8.8 and is discussed in the following section under the heading of Local Hydrology.

Given the relatively flat topography in the area it is difficult to delineate the surface water catchment divide precisely but the boundary appears to lie just south of the application site, running southwest-northeast across the centre of the limestone quarry. Refer to Figure 8.6 for mapped catchment delineations. The application site is in the catchment of the Kinnegad River. This has implications (positive) in that the hydromorphological characteristics of the receiving water system are maintained at the pre-development natural condition.

The Kinnegad River rises 12km west of the site near Gaybrook and flows in an easterly direction running parallel, and adjacent to, the northern boundary of Breedon's overall landholding. The upgradient catchment of the watercourse as it passes, adjacent to, the Breedon site is approximately 32.5km^2. The lands that it drains upgradient are predominantly low-lying farmland and forested areas. Downstream of the site, the Kinnegad River is culverted below the M4/M6 before proceeding northeast through Kinnegad town. The Kinnegad River outfalls to the River Boyne at a distance of c. 12km downstream of the site. There are no hydrometric stations on the Kinnegad River.

Table 8.8: Summary characteristics of Regional and Local watercourses

					~ Mean Flow = relates to quarry's discharges	
Watercourse	Description	Catchment Area (km^2)	95%ile flow (m^3/s) [EPA Hydrotool]	95%ile flow (m^3/d) EQUIVALENT calculation	50%ile flow (m^3/s) [EPA Hydrotool]	50%ile flow (m^3/d) EQUIVALENT calculation
Kinnegad River	North of site, flows east	32.5 km^2 to discharge (SW1)	0.075	**6,480**	0.297	**25,661**
Castlejordan River	South of site, flows east	101.4 km^2 where passes south of site	0.196	**16,934**	0.953	**82,339**
Baltigeer Stream	West of site, flows north	2.43 km^2 to outfall	no information available at Desk Study			
Killaskillen Stream	East of site, flows north	1.75 km^2 to outfall				
Lewellansland Stream	Southeast of site, flows south	3.75 km^2 to outfall				

The Castlejordan River rises at a distance of 15km to the west, of the Breedon landholding, near Rochfortbridge and flows south-southeast at a distance of c. 3km from the application site. The Castlejordan River has a catchment of c. 100km^2 as it passes the general area of the Breedon landholding. The Castlejordan River outfalls to the Yellow River at a distance of c. 3km downstream of the site, which subsequently flows into the River Boyne a further 2km downstream of that confluence. The general flow direction of the River Boyne in the area is from south to north, such that the Yellow River outfall is upstream of the Kinnegad River outfall.

8.3.4.2 Local Hydrology

There are several minor tributaries that drain to the two primary rivers. They tend to rise in low-lying areas and are fed by a network of open field boundary drains which were installed to improve agricultural drainage. Location information is also provided for those three streams in the vicinity: namely the Baltigeer Stream, Killaskillen Stream and Lewellansland Stream. Whilst information, for flow rates, is available for the Kinnegad and Castlejordan River, no such data exists for the streams in the vicinity of the site. This lack of HydroTOOL model data tells its own story because it means that the streams are too small for the application of the HydroTOOL flow model. It is therefore reasonable to assume that these are essentially field drains that transmit rainfall runoff and shallow subsurface flow from soils and subsoils in the fields that the streams bound. It is reasonable then to assume that those field drains do not act as a baseflow sink for groundwater in the bedrock aquifer.

The two streams that flank the western and eastern boundaries both flow northwards and are referred to on the EPA database as the Baltigeer Stream and the Killaskillen Stream, respectively. Their catchment areas are quite small and estimated to be 2.4 and 1.8 km^2, respectively. Given the relatively high density of field boundary drains and first order streams in the area and the professional understanding of land and hydrology, it is reasonably assumed that quarry dewatering, and associated drawdown, will not affect the hydrological characteristics of local streams and that productivity of agricultural lands will remain unaffected in terms of drainage. This information forms part of the development of a Conceptual Site Model.

8.3.4.3 WFD Surface Water Status

The Kinnegad River, Baltigeer Stream and Killaskillen Stream are part of the Kinnegad_020 catchment. The Kinnegad_020 (IE_EA_07K010100) is mapped by the EPA, as follows:

- **Risk =** 'Under Review' & **Status =** Moderate Status (2013 to 2018).

The EPA characterisation (2018) Report entitled WFD Cycle 2 Catchment Boyne Subcatchment Boyne_SC_030 cites as follows:

> *"All four river water bodies in this subcatchment are AT RISK: Kinnegad_010 due to Moderate biological status; Kinnegad_020, Kinnegad_030 and Boyne_040 due to Moderate biological status and elevated phosphate and ammonia. Biological status was driven by invertebrate status for all water bodies.*
>
> *Peat harvesting and agriculture on peaty soils is present throughout the subcatchment and are likely to be the significant pressures in all water bodies particularly with regard to elevated ammonia concentrations (and in addition, siltation issues within Kinnegad_010). Urban waste water treatment may also be impacting Kinnegad_030 whereas quarry activities and channelisation are likely to be additional pressures within Boyne_040."*

In this assessment it is reasonable to conclude that the quarry presents no source of phosphate and that all discharges are controlled and regulated by the IE Licence for the site. Therefore, it is more likely that domestic houses and agriculture are the pressures to the river systems, rather than quarrying. Whilst the 'Extractive Industry' is mentioned as a significant Pressure on the Kinnegad_020 in EPA (2018), the sub category published is Peat Harvesting rather than hard rock quarrying.

The Castlejordan River and Lewellandsland Stream are part of the Castlejordan_030 catchment. The Castlejordan_020 has a risk status of 'Not at Risk' and WFD Status 2013-2018 of 'Good'.

All of these rivers are mapped as part of the Boyne Catchment (Hydrometric Area 07). The Boyne Hydrometric Area 07 (EPA, 2021) 3rd Cycle Catchment Assessment report mentions the Kinnegad_020 river only once and it provides the reason for the 'Under Review' Risk Classification as 'Peat Harvesting'. Section 5.1.1.5 of the Boyne catchment's (EPA, 2021) provides information on pressures caused by the 'Extractive industry' but no quarry is mentioned: *"Peat drainage and extraction remains a significant pressure in 13 river water* *bodies, a reduction from 16 waterbodies in Cycle 2. The peat pressures have resulted in increased sediment loads in these rivers, which alters habitats, morphology and hydrology. There have also been fluctuations in ammonia concentrations."* Also mentioned, in EPA (2021) for the Boyne catchment's pressures, are those Pressures caused by 'Mines & Quarries', 'Industry' (2 IPPC Licences for other industrial sites are listed as Pressures) and 'Other Significant Pressures'. At no point is the Breedon site mentioned. It is concluded that the extraction of rock at the application site, or operations in the adjacent quarries and factories, has not impacted the Status or Risk categories of the associated rivers.

8.3.4.4 Biological Data

EPA biological monitoring stations are located on both the Kinnegad River and the Castlejordan River upstream and downstream of the application site. Summary details are presented in Table 8.9. The next nearest downgradient biological quality monitoring station on the Kinnegad River is downstream of Kinnegad town which in itself is a point pressure. The 2020 sampling event shows that there is no detectable difference in biological quality upstream and downstream of the primary quarry discharge point (SW1) from the Breedon site, which includes surface water runoff from the application area.

In terms of biological status, the Castlejordan has superior quality when compared to the Kinnegad River. This is to be expected because there is no major town or urban runoff pressure to the Castlejordan.

Table 8.9: Historical EPA biological water quality monitoring data

Watercourse	Kinnegad River	Kinnegad River	Castlejordan River	Castlejordan River
Location	1,800 m u/s of primary discharge SW1	800 m d/s of primary discharge SW1	2,000 m u/s Breedon Site	2,000 m d/s Breedon Site
Station	Br SE of Cloonfad House	Br on L8021 (u/s Kinnegad)	Baltinoran Br	Castlejordan Br
2020	3	3	4	4
2018	3-4		4	4
2015	3-4		3-4	4
2012	3-4		3-4	4
2009	4		3-4	4
2006	3-4		3-4	4
2003	3-4		3	3
2000	3-4		4	4
1997	3		3-4	3-4
1994	2-3		3-4	3-4
1990	3-4		4	4

8.3.4.5 Abstractions & Discharges

There are no known surface water public water supply schemes or group water schemes that source water from the Kinnegad River or Castlejordan River within 5 km downstream distance from the site.

Kinnegad WWTP discharges treated effluent downstream of Kinnegad town centre.

Any Section 4 Discharge Licences mapped by the EPA are discharges to ground and are remote from the application site (https://gis.epa.ie/EPAMaps/). There are a couple of Section 4 discharges to the headwaters of the Castlejordan in Co. Westmeath at c. 7km due west from the application site [Refs ENV/W10/2013 and ENV W10/2012). This assessment concludes that they are to a different river system than the Breedon Site discharges to and are sufficiently remote to present no potential for cumulative impact by the time the Kinnegad and Castlejordan rivers meet the Boyne.

8.3.4.6 Hydrometrics

EPA Hydronet shows that a hydrometric station existed previously in Kinnegad. Downloaded data shows intermittent spot gauging between 1976 and 1999. There is no evidence of a functioning hydrometric gauge currently in Kinnegad.

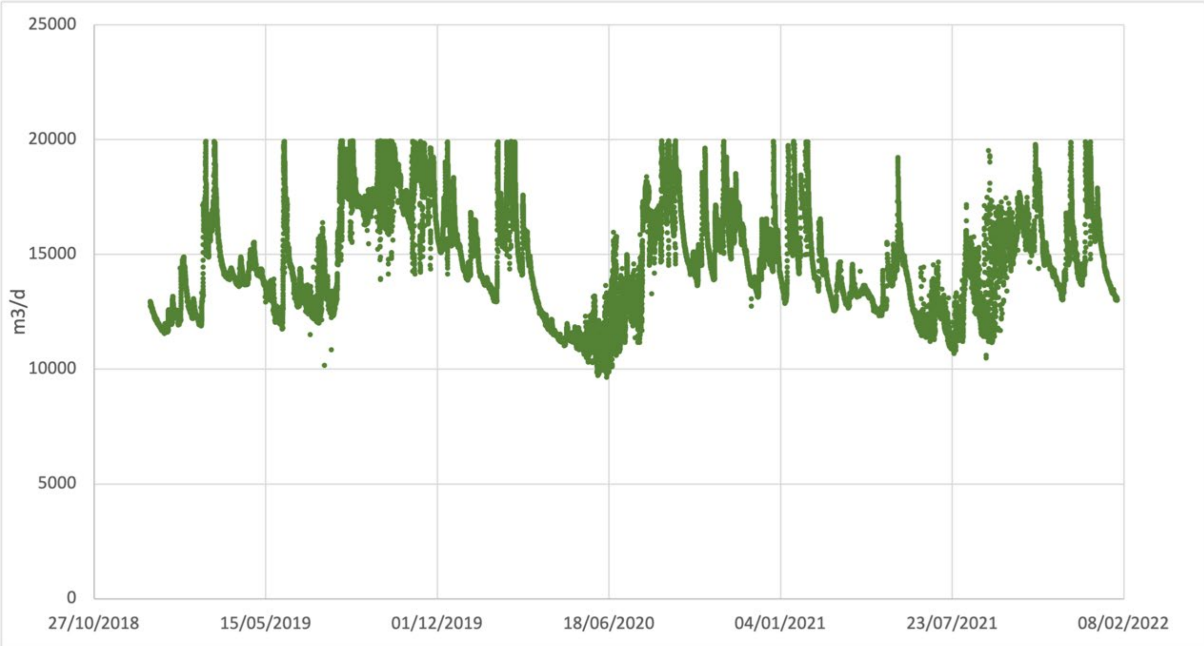
The nearest hydrometric station is on the River Boyne at the Boyne Aqueduct. The mapped surface water catchment to this gauge is 441 km^2. The application site and the overall Breedon operation's site lies in this catchment. Maps and HydroTOOL flow characteristics are presented in Appendix 8.C. HydroTOOL flow characteristics for low and mean flows were also provided in Table 8.8 and are summarised as follows:

- Kinnegad River, North of site, flows east:
    - 95%tile Flow = 0.075m3/s (~6,480 m3/d)
    - 50%tile Flow = 0.297m3/s (~25,661m3/d)

- Castlejordan River, South of site, flows east:
    - 95%tile Flow = 0.196 m3/s (~16,934 m3/d)
    - 50%tile Flow = 0.953 m3/s (~82,339 m3/d)

The 1999 permission An Bord Pleanála conditioned a flow recording station to be installed in the Kinnegad River, upstream of the primary discharge point. The dataset for the measured flow data for the period 2019-2021 is presented in Graph 8.1.

Graph 8.1: Breedon Flow Stn, Kinnegad River Daily Flow Data 2019 – 2021



With reference to the information recorded, as presented in Graph 8.1, the stage meter at the gauging station is flooded at times of higher flows. However, the data is accurate for the low flow scenario because the minimum flows recorded are in the order of 9,000m^3/d (0.1m^3/s), which is in general agreement with the EPA HydroTOOL MODEL value for 95%ile, which is 0.075m^3/s (https://gis.epa.ie/EPAMaps/Water). The significance of the data for the site's record for flow data at the point of discharge is that the river, the time of maximum discharge from the quarry, has a flow rate at least three times greater than the discharge rate.

8.3.4.7 Mapped Flood Risk

Desktop mapping sources suggest no apparent flood risk to the application site. CFRAM maps show the application site is **not at risk of flooding**.

8.3.5 Hydrogeology

In these assessments hydrogeology is considered to include all aspects from the topsoil, subsoil, bedrock, aquifer classification and GSI mapped groundwater flow regime. There is a certain overlap with the information presented in the Lands, Soils & Geology Chapter of this EIAR (Chapter 7). In this Water Chapter, the characteristics of the subsurface components are described in terms of their significance in how rainfall travels through and recharges groundwater flows.

8.3.5.1 Soils & Quaternary Geology

Soil types in the application and wider area were presented as Figure 7.2 and subsoils were presented as Figure 7.3. As previously presented in Chapter 7, deep, well-drained grey-brown podzolics of calcareous origin lie on local ground which is slightly raised or sloping. These mineral soils were originally in-situ across much of the limestone quarry area, extending across the shale quarry and through the central part of the overall site. Grey-brown podzolics belonging to the Patrickswell Series are mapped on the application area and these have been stripped already as part of quarry preparation.

In the southern lands of the applicant's overall landholding, *i.e.,* south of the main working limestone quarry, the soils are mapped as peat. Outside the applicant's landholding, large tracts of peat to the east and west have been processed for milled peat by Bord na Mona.

8.3.5.2 Bedrock

The application site is underlain by Waulsortian Limestone. To the north of the limestone quarry, the Waulsortian limestones give way to the overlying Tober Colleen Formation which consists of both the Colleen Shale and Shaley Limestone seen in the Lucan Formation. The Tober Colleen is a weak, silty shale more prone to weathering than limestone and as a result is often a repository for significant amounts of organic carbon. The southern part of the applicant's landholding is underlain by the by the Ballysteen Formation, a limestone/shale formation which contains mudstone impurities. The mapped delineations for geology and likely transitions in formations were presented in Figure 7.5. The site and its bedrock are described in the GSI's 1:100,000 Sheet 13 Geology of Meath.

The Waulsortian Limestones are muddy, reef limestone. They are typically pale grey and formed from mounds of calcareous mud in deep to moderate depths of water. These limestones can have steep depositional dips reflecting their original mound-form topography on the scale of a few meters to over 100 m. The mounds can be continuous or discontinuous and are referred to as 'reefs' or 'mud-mounds'. The limestone is many hundreds of meters thick in this part of County Meath (GSI, 2001).

8.3.5.3 Aquifer Classification

Regionally, the aquifer classification is almost entirely 'LI' = Locally important aquifer which is moderately productive only in local zones. The application area is underlain by this same LI aquifer classification. The aquifer is mapped by the GSI as covering an area of 17,808km2. Refer to Figure 8.4 for mapped aquifer classifications. The GSI suggests that the LI classification means that the aquifer is capable of supplying locally important abstractions (e.g. smaller public water supplies, group schemes), or 'good' yields limited to $400m^3/d$. Groundwater flow within the Ll category occurs predominantly within a limited and relatively poorly connected network of fractures, fissures and joints, giving a low fissure permeability which tends to decrease with depth. A shallow zone of higher permeability may exist within the top few metres of more fractured/weathered rock and higher permeability may occur along fault zones. In general, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only a few hundred metres. Due to the low permeability and poor storage capacity the aquifer has a low recharge acceptance. Some recharge in the upper, more fractures/weathered zone is likely to flow along the relatively short flow paths and rapidly discharge to streams, small springs and seeps.

The narrow band of Tober Colleen Shales, which outcrops at surface north of the limestone quarry, is regarded as a poor aquifer, with bedrock being generally unproductive except for local zones (Pl). Poor bedrock aquifers are only capable of supplying small abstraction (*e.g.*, domestic supplies) or 'moderate' to 'low' yields (i.e. < 100 m^3/d). Groundwater in this type of aquifer flows through a poorly connected network of fractures, fissures and joints.

Given their massive structure, Waulsortian limestones are understood by hydrogeologists as presenting hit and miss water strikes, are generally low-yielding and have limited and poorly connected fractures. However, their high purity can make them susceptible to dissolution and karstification which involves the enlargement of the primary openings. In Waulsortian limestones this dissolution is limited to small stomatactis, otherwise known as vugs. These cavities may or may not have been later infilled with calcite.

8.3.5.4 Mapped Karst

Neither the application site nor any of the Breedon overall landholding is mapped as Karst. That is the information available at the description of the Desk Top available information. However, there are CLAY infills at the site and this will be discussed later when the site-specific Site Investigation information and walkover observations are presented. The nearest mapped karst features on the GSI database are shown at a distance of 7 km to the north (St. Brigid's Well, Killucan) and 7 km to the southeast (Toberhale Spring, Edenderry). Review of topographical contours, subsoil mapping and bedrock feature mapping suggests that these mapped springs can be related to wither boundaries with gravel or peat, topographic low elevations (depressed landscapes) or mapped fault lines. There are no topographical or geological features at the application site to suggest that karst features may be present, even if they are not presented on the national scale mapping.

8.3.5.5 Groundwater Body & Type

The GSI maps the site as being underlain by the Athboy Groundwater Body (GWB) (GSI, 2004). This groundwater body is very large (964 km2) and *"extends from Navan in the northeast to Tyrrellspass and Rochfortbridge in Westmeath. The area is typical of the midlands of Ireland with little relief. There are some isolated hills which rarely rise above 150 m OD. In general, the elevation falls from northwest to southeast, reflected in the overall drainage pattern. The region shows a distinctive topography, a typical product of the last glaciation. The land surface is undulating, with large hummocks of glacial drift, deposited under the ice as moraines."* (GSI, 2004).

Reference was made to the County Meath Groundwater Protection Scheme report (GSI, 1996), which presents that *"There is very limited evidence of dolomitisation and karstification within the Waulsortian of Co. Meath, other than the warm springs. Two warm springs in particular are located in the south near Longwood: St Gorman's Spring and Ardanew Spring."* The county report does not contain hydrogeological information specific to the Waulsortian limestones in the Kinnegad area.

The Athboy Groundwater Body [European Code IE_EA_G_001] is mapped by the GSI as having a Flow *Regime* of a Poorly Productive bedrock and a Groundwater Type = PP = Poorly Productive.

8.3.5.6 Groundwater Vulnerability

Groundwater vulnerability for the application site is mapped by the GSI as High (H). This was likely mapped prior to commencement of any quarrying activities at the site as a vulnerability classification of Extreme (E) is applied where rock is at or near surface. Due to the nature of quarrying, which requires removal of overburden, the groundwater vulnerability rating at all quarry sites will be Extreme. Groundwater vulnerability is presented in Figure 8.5.

8.3.5.7 Groundwater Flow Direction

Regionally, groundwater flow direction is likely to be from the south to the Kinnegad River.

8.3.5.8 Groundwater Status & Risk

The site lies within the Athboy GWB. Information presented by the EPA confirms that for the reporting period 2013 – 2018 the Athboy GWB (European_Code IE_EA_G_001) is mapped as 'Good Status' and 'At Risk'.

8.3.5.9 Mapped Wells & Groundwater Users

Historical 6" and 25" maps compiled by the Ordnance Survey of Ireland (OSI) were consulted as a reference point for identifying domestic wells, springs and other hydrological features of interest in the area. With the exception of the Kinnegad River neither the 6 inch Cassini maps (1830's – 1930's) or 6-inch OSI maps (1837-1842) show any hydrogeological or hydrological features of interest in the locality. The area to the south of the ownership boundary that is shown as being waterlogged or prone to seasonal inundation coincides with the cutover peat bog described in the Land, Soils and Geology chapter. The 25-inch Cassini maps (1888 – 1913) show a far greater level of detail in the area. Much of this additional detail covers mapping of open drainage channels along field boundaries. Lansdowne Lodge sat in the centre of the northern section of the limestone quarry (*i.e.*, the application area) and is noted as having a 'pump' in the centre of a courtyard. Similarly, Killaskillen House 220 m east of the application area is noted as having a 'pump'. The gatelodge to Lansdowne Lodge is marked at Killaskillen Cross Roads, 140 m east of the balancing pond and remains an inhabited dwelling (current well reference: W02). No hydrogeological feature is shown at this dwelling on historical maps. Only two 'springs' are marked, with one corresponding to the current cement plant facility, the other being north of Killaskillen House. The 25" maps displayed a much lower housing density in the area than is present today.

The GSI well database records only contain a small number of wells in the locality (see Figure 8.4), these being:

- A 28m deep local authority borehole, 2.5 km northeast of site (accuracy 100 m);
- A 7.6m deep, shallow dug well, 2.5 km northeast (accuracy 1 km);
- An 18.3m deep borehole, 2.3 km southwest (accuracy 1 km), yield 21.8 m3/d;
- A 6.7m deep, shallow dug well, 1.7 km west (accuracy 1 km);
- A 4.6m deep, shallow dug well, 1.4 km southwest (accuracy 1 km);
- A 3.7m deep, shallow dug well, 1.1 km south (accuracy 50 m).

Where yield information is available it is never greater than 21.8 m^3/d. The majority of wells on the GSI database are shallow hand-dug wells. These presumably abstract water from the weathered bedrock in the transition zone between bedrock and overburden.

In addition to the historical maps and the GSI well database, there is information on the network of wells that surround the overall landholding. Those wells are discussed in more detail in the following Section in which a 'Review of the Subject Development' has been documented, which includes all licence and monitoring data.

8.3.5.10 Groundwater Source protection Zones

The nearest source protection area serving a National Federation of Group Water Schemes (NFGWS) groundwater abstraction is 7.7 km to the southeast, serving Ballindoolin GWS. The nearest source protection area serving a public Irish Water groundwater abstraction is 9.6 km to the southwest, serving Toberdaly PWS. The proposed development is significantly remote from all mapped Source Protection Areas. Therefore, no potential for impact exists with respect to Public or Group Water Scheme supplies.

Potable water supply to local residents is sourced from private wells. The network of local wells is included in the routine Standard Operation Procedure for the overall operation in the vicinity of the application site. The monitoring record is presented with the following Section in which a 'Review of the Subject Development' has been documented, which includes all licence and monitoring data. Mitigation Measures for the limestone quarry area currently being worked, with permission, made provisions in case of impact on local wells.

8.4 Review of the Subject Development

The site proposed for development, and considered here, is part of a larger operation, which has permission to excavate to 10m OD. The proposed development is to continue to quarry an area that has already been worked from natural ground level to one bench of excavation into bedrock. Therefore, the historic workings were enabled by the services of the overall site, such as access roads, water supply, wastewater services, water management systems and discharge licensing. The services for the entire site remain sufficient to service the proposed development because they have served the area in the past.

8.4.1 Licensing

The site operates under the conditions of an Industrial Emissions (IE) Licence as issued by the

EPA in 2001 (P0487-01) and now in its seventh iteration, P0487-07 (22/02/18). The License P0487-06 granted on 12th March 2012 included for the extension of the existing quarry over lands to the north, east and south. The extension was to a depth of 1 bench at approximately 70 mOD, increasing the quarry footprint by approximately 52.5 ha over three phases. The proposed development resulted in an overall limestone quarry extraction area of 77 ha.

IE Licence P0487-07 has 44 pages of control specifications and Conditions for the site's operation. Condition C.2 concerns water emissions. Condition C.2.1 related to the "Discharge to Kinnegad River from settlement lagoons, comprising stormwater, pumped water from quarry and treated sewage effluent" and specifies a discharge volume limit of 6,150m3/d for the Maximum Total in each day and at a maximum rate of 260m3/hr. Emission Limit Values are also specified. The site reports that it is in full compliance with the Conditions of the Licence.

8.4.2 Site Layout

The proposed development is a part of an existing, operational, permitted limestone quarry at Killaskillen. In addition to the limestone quarry, there are ancillary operations including the permitted and operational shale quarry, cement manufacturing plant, asphalt plant, settlement ponds, administration building and storage buildings (Figure 8.3). These activities are all complimentary to one another with operation and management the responsibility of Breedon Cement Ireland Ltd. (Breedon), the applicant for the current development.

The application site occupies a total area of approximately 4.13 hectares (see Figure 8.2) within an overall landholding of c. 286 hectares. The application site is located almost in the centre of the overall landholding of Breedon. The overall landholding shares its northern boundary with the southern bank of the Kinnegad River. A local road (L8021) is also part of the overall landholding's boundary, and a connecting underpass has been constructed under the L8021. The application site and the main limestone quarry lie to the south of this local road. The applicant's shale quarry is located to the north of the limestone quarry. The applicant's cement manufacturing plant is located to the southwest of the application site. The applicant's asphalt plant is located to the southeast of the application site and towards the southern end of the main limestone quarry.

The main limestone quarry has a length of c. 1,500m along a northwest-southeast axis and a width of c. 400m through the middle, narrowing to around c. 250m at either end. The central portion of the existing limestone quarry occupies an area of 24.8ha and has been worked to a depth of 30m below ground level, from a pre-development level of 80-87m OD. The current floor elevation of the operational limestone quarry is c. 53m OD. That main central zone has permission, under Planning Ref. 98/2026, to continue to 10 mOD, this being equivalent to three more benches of excavation. Three peripheral areas connected to the north, south and east of this central area have an additional combined footprint of 52.5 ha and have permission to excavate one bench down to 70m OD under Planning Ref. TA/900603.

In the 1998 application the applicant highlighted that potential long-term extension areas lie to the north in the land around Lansdown Lodge and that extension in depth may also be feasible. Breedon are now seeking to further develop this relatively small northern portion of the limestone quarry in order to safeguard the strategic limestone reserves on the subject lands and thereby secure the long-term viability of cement production and the significant capital investment already on the site.

The application site is the northern part of the existing limestone quarry. The application area has already been stripped of overburden and bedrock has been quarried down one bench, from the pre-development ground elevations of 80-87m OD down to the permitted 70m OD. The proposed works will involve lowering this northern end down to 10m OD, consistent with the central area. The purpose of the current development proposal is to provide space on the periphery of the main quarry so as to enable efficient working on the main floor and enable boundary perimeter access routes to the permitted main quarry.

Activities in the application area will be a continuance of those that have already taken place within the application area and those currently being carried out at the main limestone quarry, as follows:

1. Blasting of rock faces to reduce the rock to manageable size
2. Transport to a crusher using large (60 tonne) haulage vehicles
3. Crushing on quarry floor
4. Stockpiling of crushed limestone
5. Transfer by conveyor belt to blending house to produce cement, in a blend with shale

Plant and machinery which operate at the limestone quarry area consist of tracked excavators, wheeled loaders, dump trucks and mobile processing plant. Ancillary plant such as a drilling rig and a water bowser are deployed on an intermittent basis.

The activities and facilities within the Breedon site linked to extraction at the limestone quarry, of significance to this assessment of the hydrological and hydrogeological regime, are listed as follows:

a) The shale quarry, c. 350m north of the limestone quarry. This quarry has progressed, with permission, below groundwater. Waters arising are pumped from the shale quarry's floor sump to permitted settlement lagoons.
b) The asphalt plant adjoins the southern part of the limestone quarry.
c) The cement manufacturing unit west of the limestone quarry contains blending and milling units, clinker formation, cooling and grinding, silos and cement storage warehousing. Breedon Cement manufactures 700,000 tonnes of cement each year at the site. Crushed bedrock sourced from the limestone quarry and the shale quarry is blended and then milled before being thermally treated in a kiln to produce clinker. Gypsum is added to the clinker and these combined products are then milled to produce the final cement product which is stored and dispatched in bulk or bag form.
d) An area dedicated to workers and administration buildings, staff welfare facilities and car parking is located north of cement plant.

e) Associated internal infrastructure such as haulage routes, weighbridge, wheelwash, bunded refuelling area, floor sumps, pumps, pipelines, settlement ponds and monitoring equipment.
f) Agricultural lands which are still farmed and agricultural lands which are no longer farmed.

8.4.3 Water Management at the Site

The management of rainfall, groundwater and process waters, within the existing permitted limestone quarry, is in accordance with the Conditions of the IE licence (Appendix 8.B). The proposed development is already part of the catchment to the water management system of the main limestone quarry. The surface water management regime will continue to operate as it does now.

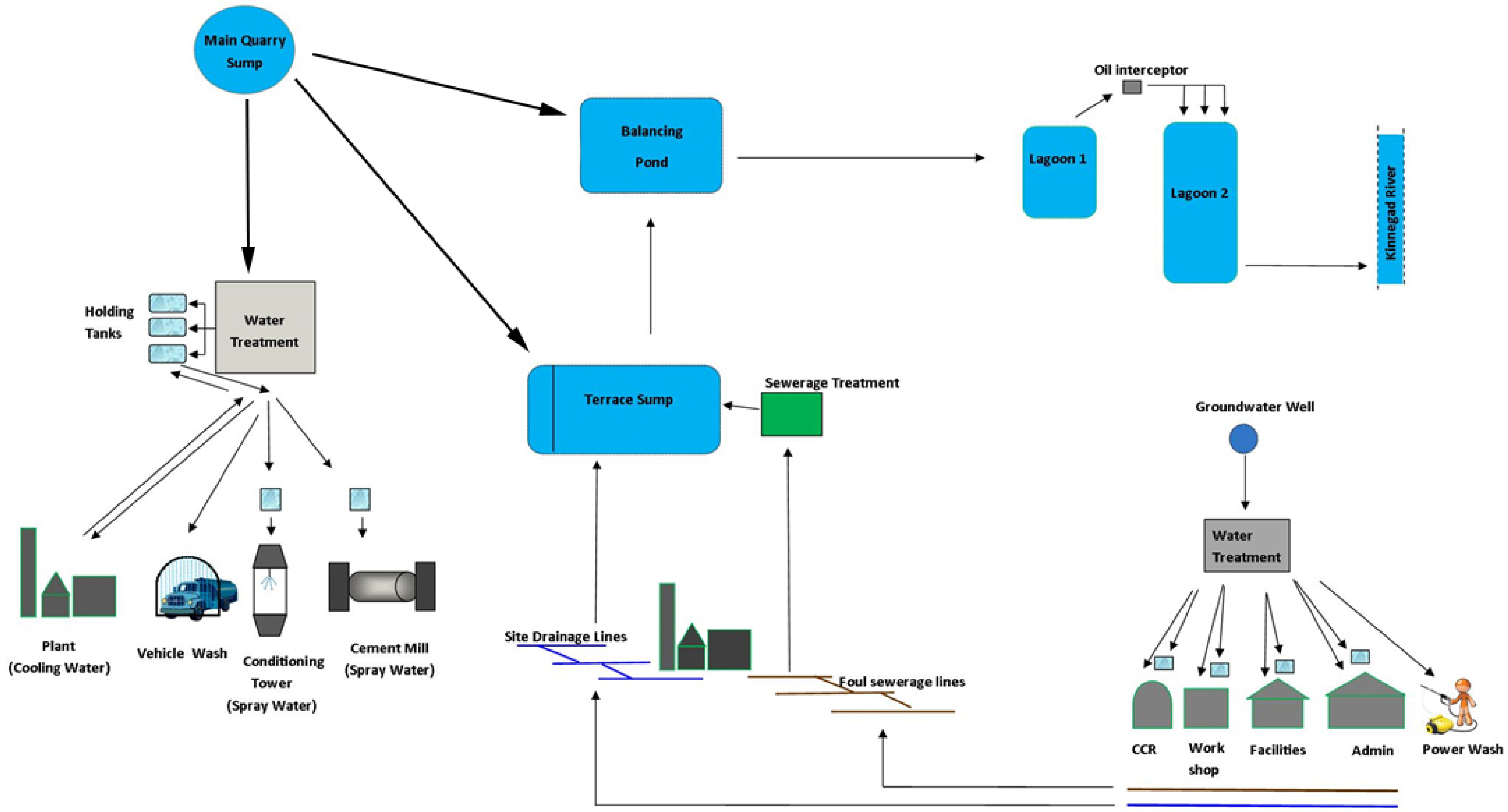
The primary features of the surface water management system are illustrated in Figure 8.3 and listed as follows:

1. Limestone quarry sump
2. Cement Manufacturing Plant
3. Terrace sump
4. Balancing pond
5. Shale quarry sump
6. Settlement lagoons
7. Hydrocarbon Interceptor
8. Discharge point SW1
9. Domestic Wastewater
10. Abstraction Well ONGW6

A conceptual schematic representation of how water interacts with these features and is diverted within the overall site are shown in Plate 8.1.

There is a minor discharge along the western boundary (SW2). However, this captures runoff from agricultural lands within the site and this flow path is not part of site activities.

Plate 8.1: Schematic representation of Breedon site water management system



The main features of the quarry water management system at the site are shown in plan and relative site location in Figure 8.3. Whilst some components of the water management regime do not interact directly with quarry waters, all excess waters from the site are discharged under IE Licence to the Kinnegad River and therefore require consideration for potential for cumulative impacts.

Water is removed from the lowest part of the operational limestone quarry (referred to as the sump) via three pumping lines, the destination of these being as follows:

1) Cement manufacturing plant. There are no discharges of water associated with the cement manufacturing plant. Excess water from the cement plant is evaporated as steam or recycled internally.
2) Terrace Sump. Located adjacent to the cement manufacturing plant, this receives hardstanding runoff and water from the limestone quarry sump.
3) Balancing Pond. The balancing pond receives inflows from the limestone quarry sump and the terrace sump.
    - Settlement Pond 1 receives inflows from the Balancing Pond and the shale quarry sump. Outflow by gravity passes through a hydrocarbon interceptor before entering Settlement Pond 2.
    - The outfall from Settlement Pond 2 forms the primary site discharge (SW1) which enters the Kinnegad River. This discharge is regulated under IE License P0487-07 (Appendix 8.B).

Each component is explained in more detail in the following sub sections.

8.4.3.1 Limestone quarry sump

In order to maintain a dry working environment on the floor of the limestone quarry, rainfall-runoff and groundwater ingress that collects in the lowest part of the void, *i.e.,* the sump, must be removed by pumping. Waters pumped from the limestone quarry sump are directed via three rising main pipes, the destination of these being: (i) cement manufacturing plant, (ii) terrace sump, and (iii) balancing pond.

8.4.3.2 Cement Manufacturing Plant

Waters pumped from the limestone sump to the cement manufacturing plant initially pass through a water treatment plant to remove suspended solids. This water is then used for cooling purposes in the plant and as spray water in the mill. There are no discharges of water associated with the cement manufacturing plant. Excess water from the cement plant is evaporated as steam or recycled.

8.4.3.3 Terrace sump

The terrace sump is located at the northern end of the raw materials reception and handling compound and has an approximate footprint of 880 m^2 (44 m x 20 m) and a depth of 7 m. It is constructed from concrete.

Stormwater runoff generated on hardstanding areas in and around the cement manufacturing plant is captured in the terrace sump. The terrace sump also receives a portion of waters pumped from the limestone quarry sump, in addition to treated effluent from the wastewater treatment plant.

The terrace sump waters are pumped to the balancing pond, controlled by means of a float switch. Waters are pumped from the terrace sump to the balancing pond via three 160 mm pipes.

The terrace sump has buffering capacity to provide additional storage when the balancing pond is operating at capacity. Water used by the road sweeper and for dust suppression is sourced from the terrace sump.

8.4.3.4 Balancing pond

The balancing pond is located adjacent to the north eastern corner of the limestone quarry. The minimum design specifications were for a footprint of 170 m x 100 m and a depth of 4 m. The volume of the balancing pond is approximately 35,000m^3. The maximum water level is 85.5m OD and the invert of the discharge pipe is 82.25m OD.

The balancing pond receives inflows from the limestone quarry sump and the terrace sump via a single 360 mm diameter HDPE pipe, with the separate inflow pipes having merged elsewhere. Primary outflow from the balancing pond is culverted by gravity through a 450 mm pipe beneath the internal access road and directed towards Settlement Pond 1 by gravity.

The discharge from the balancing pond is regulated by a 52 mm diameter throttle plate attached to the outflow pipe which can also act as a shutoff valve. This makes the balancing pond capable of temporarily storing pumped waters from both the limestone and shale quarry to facilitate cleaning of the settlement ponds and maintenance of the connecting infrastructure and interceptors. The pond was designed to accept excess run-off from storm conditions.

8.4.3.5 Shale Quarry Sump

The shale quarry is permitted on a footprint of up to 13.9 ha, to a depth of 25m OD. In order to maintain a dry working environment on the floor of the shale quarry, rainfall-runoff and groundwater ingress that collects in the lowest part of the void, *i.e.,* the sump, is be removed by pumping. Waters are pumped from the shale quarry sump into a purpose-built drain which transmits water by gravity to Settlement Pond 1. The shale quarry sump will also remain unaffected by the development proposal. The shale quarry sump is controlled by means of a float switch.

8.4.3.6 Settlement Ponds

Settlement Pond 1 receives inflows from the Balancing Pond and the shale quarry sump. The lagoon bases and perimeter embankments were constructed from overburden stripped from the quarry surfaces. It has an estimated volumetric capacity of 35,000m^3. It has a gravity outflow and waters pass through a hydrocarbon interceptor before entering Settlement Pond 2 via 3 parallel pipes. Settlement Pond 1 is fitted with an overflow mechanism.

Settlement Pond 2 is larger and is setback 180 m from the Kinnegad River. It has an estimated volumetric capacity of 70,000m^3. This larger lagoon was designed to have a minimum footprint of 120m x 60m. The actual footprint is closer to 190m x 110m and depth is estimated to be 3.3m. The inlet and outlet are positioned at the southwestern and north eastern corners, respectively.

The design residence time in the settlement lagoons is 28 hrs. The final discharge to SW1 is *via* a pipe from the overflow weir. Flows from the settlement lagoons to the Kinnegad River are continuously monitored and when they exceed the IE P0487-07 Licence limit of 256m^3/hr, a number of automated site controls automatically enable. The site is enabled to ensure full control over compliance with the emission limit value of the licence by virtue of hydraulic, mechanic and electrical controls. There is an automatic shut-off valve immediately before the final discharge point (SW1). If the discharge volume is approaching the hourly maximum permitted ELV, the valve is programmed to close and discharge ceases until the following hour. The attenuation available in the flood freeboard, above the top level of the discharge pipe at SW1, along the perimeter embankments of the settlement ponds enables retention of storm waters until the discharge mechanism again enables itself automatically. There are so many other elements to the water management system that precede the final settlement lagoons that also can provide attenuation when needed: working back from the final settlement lagoons there are the balancing pond, the floor and sump of the shale quarry, the terrace sump and the sump and floor of the limestone quarry.water from the shale quarry is diverted to the balancing pond, the outlet of which is automatically closed to withhold excess water. When the balancing pond approaches a pre-set level limit quarry sump pumps are temporarily switched off to withhold water.

8.4.3.7 Hydrocarbon Interceptor

An oil interceptor is installed to remove oils and hydrocarbons from all waters prior to leaving the site.

8.4.3.8 Discharge point SW1

The outfall from Settlement Pond 2 forms the site discharge which enters the Kinnegad River. This discharge is regulated under IE Licence P0487-07, Condition C2 Emissions to Water: C.2.1 SW1 discharge specifies Maximum in any one day: 6,150 m^3. Maximum rate per hour: 260 m^3 . Emission Limit Values are also specified in the IE Licence P0487-07, Condition C2 Emissions to Water: C.2.1 SW1 (Appendix 8.B). The site reports that it is fully compliant with the Conditions specified in the Licence.

8.4.3.9 Discharge point SW2

With respect to discharge of water, a second discharge point (SW2) is regulated under IE Licence P0487-07, Condition C2 Emissions to Water: C.2.2 SW2. However, SW2 has a 'Not Limited' discharge volume because it relates to "Discharge to tributary of Kinnegad River of overland flow from lands around the cement factory". As previously stated, SW2 is a minor discharge that captures runoff from agricultural lands within the site and this flow path is not integral to site activities.

8.4.4 Site Services in Water & Wastewater

With respect to water supply, the site has its own well and water consumption is recorded.

With respect wastewater, the application area's staff are part of the overall operations staff contingent and the entire facility is served by a package waste water treatment system located to the south west of the existing bagging plant. The treatment system serves areas of the Lagan Cement Ltd. site, as follows:

1) The administration building
2) Staff facilities building
3) The weighbridge
4) The workshop and heavy stores building
5) The control room and laboratory

The treatment system is a Hydrefficiency HiPAF system which combines a fixed film and suspended biomass reactions. The HiPAF treatment plant is installed entirely below ground and has large covers which provide full access to all parts of the unit for de-sludging and routine maintenance. The system incorporates primary settlement, biological treatment and humus settlement chambers in a single structure. Once the foul water on site has passed through the Hydrefficiency HiPAF system, the treated water then flows to the terrace sump where it is treated with the storm water run-off from the site. Discharge from the site is licensed in the IE Licences P0487-01 to P0487-07. Figure 8.3 of the EIAR presented the overall Site Layout and the location of the wastewater treatment system.

8.4.5 Quantification of Waters Requiring Management & Discharge

Using Met Eireann Annual Average Rainfall rates and GSI Effective Rainfall rates rainfall-runoff calculations landing directly on the application site is estimated as follows:

Application site area runoff-recharge = area x ER
= 41,300 m^2 x 0.494 m/yr = 20,402 m^3/yr
= 55.9 m^3/d

The volume of water generated directly from rainfall runoff on the application site is therefore 56 m^3/d, on average.

Repeating the calculation for the active limestone quarry area yields as follows:

Limestone quarry area runoff-recharge = area x ER
= 772,500 m^2 x 0.494 m/y = 381,615 m^3/yr
= 1,046 m^3/d

A water balance derived from rainfall landing on the application area of the site, and the limestone quarry area, is presented as Table 8.10. As the application area has already been stripped it is included within the limestone quarry area's calculations.

Table 8.10 Rainfall Derived Water Balance

Parameter	Unit	Application Area	Limestone Quarry	Shale Quarry		
Area	m^2	41,300	772,500	249,000		
Effective rainfall	m/yr	0.494	0.494	0.494		
Rainfall volume	m^3/yr	20,402	381,615	123,006		
Rainfall volume	m^3/d	55.9	1,046	337		
Recharge coefficient	%	85	85	85		
Recharge cap (GSI)	m/yr	0.2	0.2	0.2		
Recharge to aquifer	m^3/yr	8,260	154,500	49,800		
Recharge rejected by bedrock	m^3/yr	12,142	227,115	73,206		
	m^3/d	33.26	622.23	200.6	856.09	m3/d Total
	l/s	0.385	7.2	2.32		

With reference to the calculations presented in Table 8.10, the combined total rainfall derived water generated at the application site will be 12,142m^3/yr, equivalent to 33m^3/d (0.4 l/s). To put this in context it represents approximately 5% of overall rainfall and recharge within the limestone quarry. It is reiterated that the IE Licence permits 6,150 m3/d discharge at SW1 (Appendix 8.B, Condition C.2.1, page 37). Again, with reference to the calculations presented in Table 8.10, the amount of rainfall runoff rejected by bedrock will be c. 856m3/d. The Licence makes provision for the additional runoff from roads, buildings and some groundwater.

This preliminary water balance is a 'first run', desk-based exercise and it is acknowledged that a more robust water balance will be obtained using site-specific information for the hydraulic properties of the bedrock. That is the purpose of the Site Investigations completed, which will be presented in Section 8.5. However, to complete this Section's Consideration of the Subject Development, historic Site Investigation Results are briefly presented.

8.4.6 Historic Site Investigation Information for the Site

Several Environmental Impact Assessments have been carried out in connection with various planning applications at the site over the past 20 years. Substantive historical site investigation works have been carried out to support these assessments. It is not intended to present a comprehensive summary of all previous works herein but rather aspects deemed relevant to the current application. Focus was given to historical investigations in the northern part of the limestone quarry to assist with the assessment of the development works currently proposed.

The locations of selected boreholes, installed in 1998 to support planning application 98/2026 in 1999 and in 2007/2008 to support planning application TA/900603 in 2009, were shown on Figure 7.6 accompanying the Lands, Soils & Geology Chapter. Of the wells drilled in 1998, LANS4 and LANS5 fell within the current application site. Of the wells drilled in 2008, PW01 and MW05A fell within the current application site. The majority of boreholes drilled in 1998 and 2008 have since been decommissioned because they were drilled in lands that have now been quarried, with valid permissions.

8.4.6.1 Historic Site Investigations: Soils & Subsoils

Prior to the permitted development of the site, mineral soils at the site could be described as peaty sandy CLAY of c. 0.5 – 0.75m thickness, overlying a sticky boulder clay.

Superficial deposits of boulder clay across the main limestone quarry area were continuous and noted as being between 1.5 to 7.5m thick, being deepest at the southern end of the overall site. Overburden depth was logged as being only 1.71 m thick at LANS4. Subsoil depths in the shale quarry area were logged as being 10.6 m thick. Peats are present at depths of up to 4 m at the southern end of the overall landholding. Some sand and gravel deposits are present towards the northern end of the overall landholding. These have been partially worked out, with valid permission, with material mainly used in the construction of internal roads.

With respect to the current application the area where deepening is proposed has already been stripped of overburden, hence there will be no impact to soils and subsoils.

8.4.6.2 Historic Site Investigations: Bedrock

The results of previous investigations into bedrock have confirmed the three primary bedrock formations across the site:

- Very high-quality Reef Limestone (Waulsortian Limestones) to the south of the landholding's internal access road.
- Silty Shale (Tober Colleen Formation) to the north of the landholding's internal access road.
- Shaley Limestones (Lucan Formation) to the north of the landholding's internal access road.

The thirteen boreholes drilled in 1998 across the current limestone quarry area encountered Waulsortian Limestone only. Refer to Chapter 7's Figure 7.6. No clay bands or silts were identified in the Waulsortian Limestones during geological coring. The limestones are therefore considered to be homogenous.

Within the current application area LANS4 was drilled to a depth of 79.40 m, equivalent to 6.48 mOD. This is below the proposed floor in the application area. No water strikes were reported. Of these, MW05A, MW05B and BH01 were drilled within the current application. Logs for these boreholes were included with Chapter 7's Appendix 7.A. Summary details were presented in Chapter 7's Table 7.5. A column in Table 7.5 provided the elevation of the base of the drilled holes and the information suggests that MW05B and BH01 were drilled to beneath the target depth of this application's area. Lithological profiles of other wells drilled across the entire landholding in 2008 were evaluated, integrated into this assessment, and were also summarised in Table 7.5. Information suggests that all but BH01 provide bedrock information to elevations significantly deeper than the 10m OD proposed elevation of the application area. It is therefore concluded that there are sufficient data for the area surrounding the application area.

The log for MW05 (Appendix 7.A) shows that the upper 3 m of limestone bedrock was broken. Beneath this, competent limestone to a depth of 84m was present. The historic SI information for the BHs relates to drilling in virgin land for permission to extract the bedrock that is now gone and the land elevation for the well head was 85m OD, approximately. For example, the 84m drilled depth for MW05B would describe the proposed application area from the BH log depths of 14m bgl, approximately, to 74m bgl. The Log for MW05B describes the rock to below the proposed final elevation of the floor in this application area (Appendix 7A). No water strikes are reported. Solid limestone is reported.

8.4.6.3 Historic Site Investigations: Aquifer Testing

Slug tests and pumping tests carried out on other selected wells indicated that the hydraulic response of the Waulsortian limestones appeared to be uniform across the test area, suggesting that the limestone aquifer has uniform properties. This provides confidence that the predicted dewatering requirements for the limestone area can be reasonably well defined.

Approximately 44 m^3/d was encountered in BH01, drilled in the current application area in 2008. The water strike was limited to between 3 and 6 m below ground. The driller sealed the shallow groundwater off in BH01 by casing to 6 m and seemed to have dry drilling thereafter. Only 10 m^3/d was encountered in MW05, drilled in the current application area in 2008.

Overall, historic results for the application area suggest that groundwater strike was shallow and encountered in depths that have already been worked. Water strike has always been associated with broken rock close to surface. It is therefore envisaged that the proposal to go deeper presents less chance of encountering groundwater.

8.4.6.4 Historic Groundwater Levels

As part of the 1999 permission An Bord Pleanála stipulated that a groundwater level monitoring programme be implemented to track the change in groundwater levels due to pumping. Though there have been some minor alterations to the list of wells included in the monitoring programme it remains largely the same as when it was conceived. The groundwater level dataset is of a very high standard in terms of areal distribution, duration, and monitoring frequency. It is extremely rare to have such a long-term and comprehensive dataset. The monthly monitoring results are submitted to the EPA on a regular basis as part of IE Licensing requirements.

Groundwater levels at the site prior to its development were noted as being high and commonly located at or near the base of the superficial deposits. Pre-development groundwater levels in the centre of the limestone quarry area were 85.65 mOD (LANS2). As the working floor levels of the shale and limestone quarries have been reduced over time rainfall-runoff and groundwater ingress have been removed by pumping from a sump.

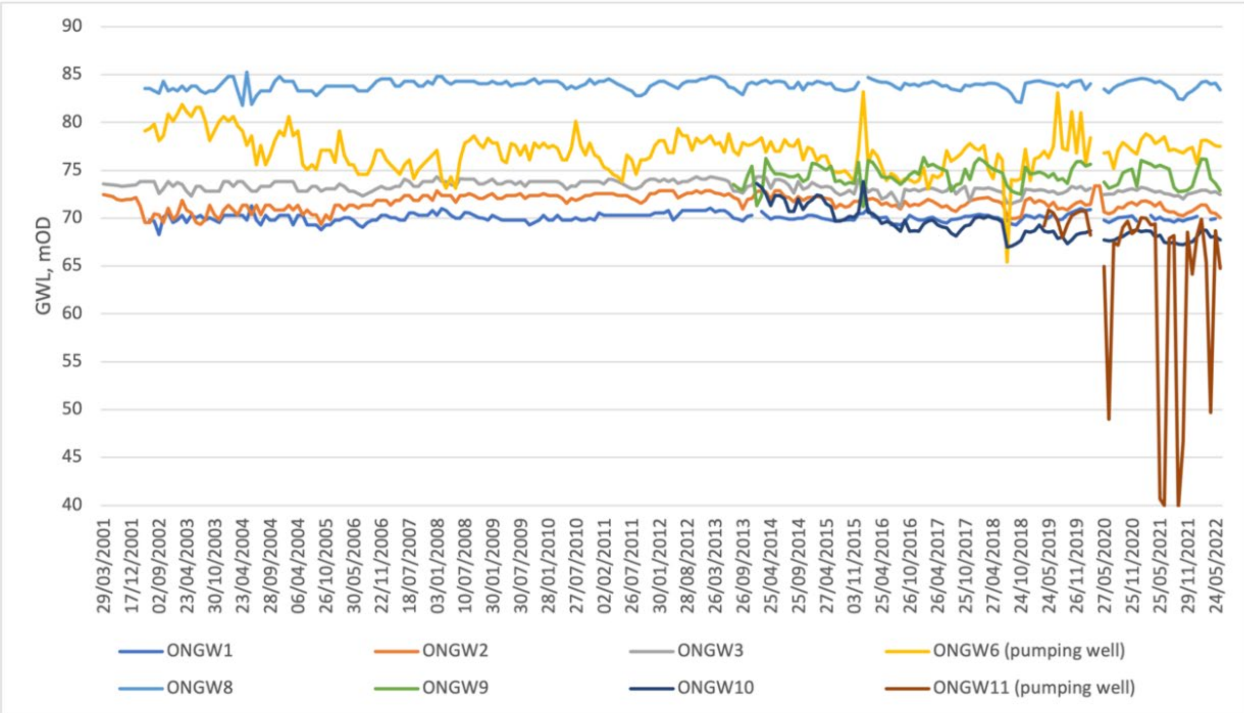
Eleven on-site wells are currently monitored (ONGW1 – ONGW11) and these are listed in Table 8.11. Given the progressive nature of quarrying there is no permanent groundwater level monitoring point within the active excavation area itself. Long term groundwater monitoring results are presented in Graph 8.2.

Table 8.11: Summary of on-site monitoring wells

Well Ref.	Old Ref.	Easting	Northing	Depth, m	Ground Level, mOD	Top of Casing, mOD
ONGW1	2001/21	657,322	744,512	7	70.94	71.29
ONGW2	Lans129	657,387	743,735	10		73.36
ONGW3	Lans111	657,608	743,825	24	73.94	94.83
ONGW4	n/a	657,115	743,263			

ONGW5	LC001	657,151	743,149			
ONGW6	Facilities Well	656,897	742,942	110	84.66	84.60
ONGW7		658,023	742,414			
ONGW8	Lans33	656,390	742,562	5	85.26	85.29
ONGW9	MW02	657,427	743,571	110	77.11	77.82
ONGW10	LC002	657,344	743,920	30	73.20	74.41
ONGW11		657,520	742,552	40	85.60	84.67

Graph 8.2: Monthly groundwater levels (mOD) recorded on-site between 2002 - 2021



It is clear, from 28.6, that groundwater levels at ONGW1, ONGW3, ONGW8 and ONGW9 have remained stable since quarrying commenced. There are two wells that suggest long-term declines of 6m and 2m, respectively, over a 20-year timescale. These wells are ONGW10 and ONGW11, which are located within the overall landholding of the applicant but they are outside the application area. The wells presenting decline in the 20-year record are closest to the limestone and shale quarries. Decline in water level close to any operational quarry is part of the design for extractions. The extraction is permitted and therefore the decline must be inferred as determined to be acceptable in the previous planning determinations.

The dataset also presents short-term fluctuations at ONGW6 and ONGW11, which are a natural and common response to intermittent pumping for water supply. This response is also by design, by virtue of the fact that water is intermittently required from the BHs. The magnitude of the drawdown, again, supports the understanding that the rock is not capable of providing large volumes of water. ONGW6 is the on-site abstraction well used for potable water while ONGW11 is used to supply water to the asphalt plant.

Overall, it can be concluded that most on site wells present a stable water level response over the 20-year monitoring period. For any wells presenting a decline, the responses are expected, concur with the original model for the site and do not contravene what was expected at the granting of permissions.

As there is no mains water supply in the area most of the local houses obtain potable water from individual private wells. The water source is generally groundwater pumped from the bedrock aquifer or weathered bedrock at the top of the formation. A total of 42 wells were visited as part of the initial groundwater level survey in 1998. This list of wells has been maintained and is updated on an ongoing basis. Seventeen off-site wells are included in the monthly monitoring round (see Table 8.12 for the details of the Monitoring Points and Appendix D for graphs of the long-term record).

Table 8.12: Details for off-site monitoring wells routinely monitored as SOP

Well Ref.	Old Ref.	Other Ref.	Easting	Northing	Depth, m	Top of Casing, mOD
OFGW1	W21	John Judge	658,028	744,144		75.12
OFGW2	W36	James Fox	656,838	744,136		79.72
OFGW3	W20	Rose Judge	656,754	743,701		80.53
OFGW4	W18	Murphy	656,846	743,693	4.9	80.93
OFGW5	W25	Nancy Bracken	656,284	743,268		82.11
OFGW6	W24	Andy Bracken	656,332	743,115		91.08
OFGW7	W16	Noel Loran	656,191	742,559	91.4*	83.95
OFGW8	W09	J McCormack	658,454	742,028		85.70
OFGW9	W38	Mrs Daly	656,790	741,550	33.5	84.24
OFGW10	W39	Noel Daly	657,641	740,918		81.32
W02	W02	Goonery/Vatter odt	657,362	743,394	91.4*	81.22
W03	W03	Josh Cahill	657,972	742,506	73	84.01
Bent		Bent	656,924	743,607	54.9	83.14
Dockery		Dockery	658,121	742,418	97.5*	84.47
Monaghan		Monaghan**	658,144	742,612	100*	78.08
Dunning		Dunning***	658,412	742,395		
Fox(2)	J Fox (2)	J Fox (2)	656,938	744,170		82.43

* Log available
** Monaghan well was replaced by a 100 m borehole in 2018
*** Dunning well has not been accessible since 2018

As part of this assessment, the long-term dataset for local area well's groundwater monitoring, as supplied by the applicant were analysed and graphed. Trends and commentary are provided in Appendix 8.D. These data are of relevance to the quarry area permitted and currently being worked. These data are included here for the purposes of the development of a conceptual understanding of the site's overall landscape setting. In overall conclusion, long term monitoring of local wells suggests no potential for interaction with the bedrock in the application area.

8.4.6.5 Historic & Ongoing Groundwater Quality

As part of the IE Licence requirements there is an existing groundwater monitoring programme for the site. This includes monitoring of a number of selected wells, which are listed in Table 8.13. These on-site wells which are sampled biannually for the stated parameters as stipulated under Schedule C.5.1 in Appendix F2 of the existing IE Licence (P048-07).

Table 8.13: Ongoing IE Licence Groundwater Quality Monitoring Programme

Sampling Frequency	On-Site Well Ref.	Parameter
Biannual	ONGW1	pH COD Nitrate Total Ammonia Total Nitrogen Conductivity Hydrocarbons
	ONGW2	
	ONGW3	
	ONGW6	
	ONGW7	
	ONGW8	
	ONGW9	
	ONGW10	
	ONGW11	

Schedule C.5.1 of the current license requires monitoring at 13 off-site wells. Quality monitoring involves pH testing. The EPA license technical committee stated that given the uncontaminated condition of groundwater at present, and the level of risk of future contamination, the frequency of monitoring for these was amended to 'as required by the Agency'. This would enable the Agency to require monitoring in the event of an incident at the Breedon site which could impact groundwater.

No evidence of contamination arising from site activities has been detected in groundwater during operations at the site to date. This would infer that there is no adverse impact on groundwater as a result of the existing site activities. The existing mitigation measures are clearly effective in preventing any contaminants from entering the groundwater at or near the site.

8.4.6.6 IE Licence Monitoring Data

As part of the IE Licence requirements there is an existing discharge water monitoring programme for the site. As previously stated, the existing IE Licence (P048-07) specifies discharge emission points SW1 and SW2.

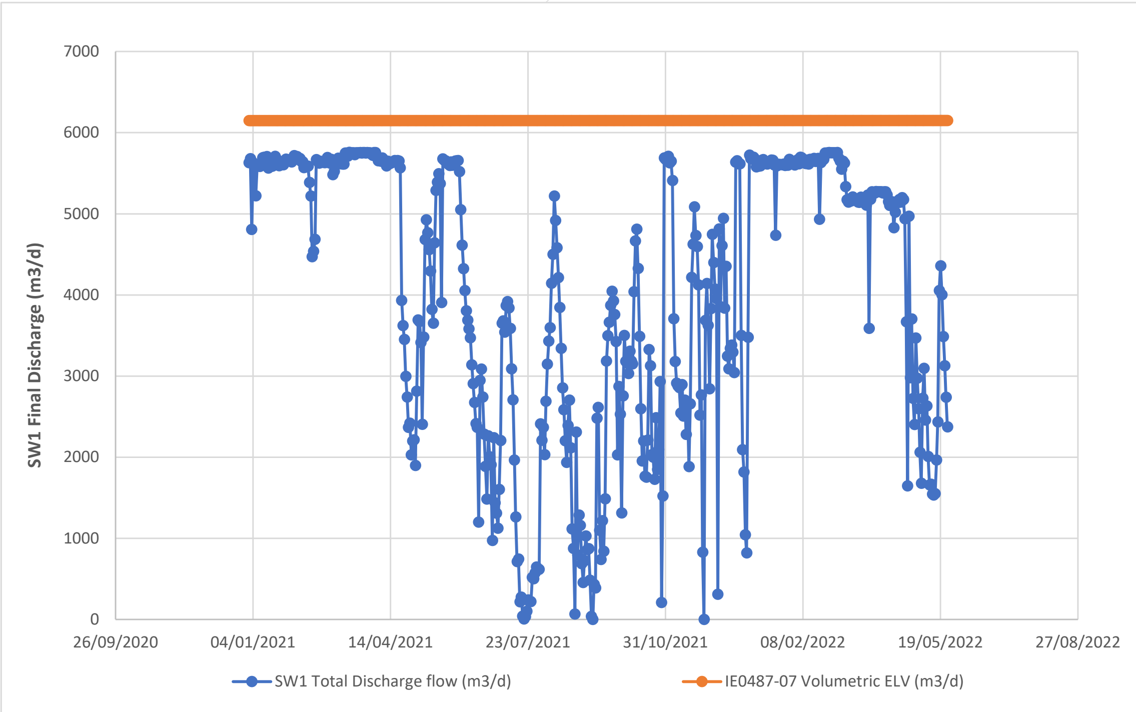
SW1 is considered to be the primary discharge from the site which is released to the Kinnegad River on the northern site boundary and is comprised of waters arising at the site, as follows:

- Pumped groundwater and rainfall-runoff from the limestone quarry
- Pumped groundwater and rainfall-runoff from the shale quarry
- Treated effluent
- Runoff landing on impermeable areas (hardstanding, roofs) which is captured by the site stormwater network

As previously stated, SW2 represents rainfall-runoff generated from an agricultural greenfield area. Condition C.2.2 states that the volume to be emitted from SW2 is 'Not Limited'. The reason for this is because it is natural land drainage that is unaffected by the quarry.

Discharge flow monitoring at SW1 is specified in Condition C.2.1 to a maximum of 6,150m3/d maximum. A daily record exists but the dataset is big. For the purposes of ease of reference, the last 18month's discharge record is presented as Graph 8.3. The data presented here, which is a subset of the entire dataset, spans from January 2021 to mid-May 2022.

Graph 8.1: Daily discharges at SW1 (18 month data snip)



With reference to Graph 8.3, the maximum daily discharge recorded at SW1 was 5,759m3/d. Interrogation of the entire dataset reveals that the maximum hourly discharge recorded at SW1 was 257.90m3/hr. These discharge volumes and hourly rates are in full compliance with the Conditions of the IE Licence. As previously outlined, the site is enabled to ensure full control over compliance with the emission limit value of the licence with the automatic shut-off valve immediately before the final discharge point (SW1) and other site controls, which were previously explained.

The seasonal variation is clearly demonstrated by the discharge monitoring data. Discharge rates decrease in the summer months and increase in response to rainfall during the autumn and winter periods. At all times, the emission limit value is complied with.

Other site controls include hydrocarbon and silt interceptors. Waters leaving at SW1. All waters leaving the site at SW1 pass through the hydrocarbon interceptor. All waters leaving at SW2 pass through a silt interceptor.

With respect to hydrochemical monitoring, IE P0487-07 licence specifies Conditioned parameters and the frequency of analysis. These are presented as Table 8.14.

Table 8.14: IE Licence Discharge Water Quality Monitoring Programme

Sample Ref.	Location	Sampling Frequency	Parameter	Limit
SW1	Northern Boundary	Continuous	Temperature	22 °C
			Suspended Solids	35 mg/l
			pH	6-9
		Daily	Suspended Solids	35 mg/l
		Weekly	BOD	5 mg/l
			COD	n/a
			Mineral Oil	1 mg/l
		Monthly	BOD	5 mg/l
			COD	n/a
			Ammonia	1 mg/l
			Nitrate	30 mg/l
		Annual	Organic compounds and heavy metals	n/a
SW2	Western Boundary	Quarterly	Suspended Solids	15 mg/l
			BOD	3 mg/l

Review of historical AER water quality data for SW1 between 2016 – 2020 suggests full compliance with the requirements of the IE Licence.

The IE Licence also Conditions, in C.2.3 for SE1, the quality of the discharge of Treated effluent and specifies biannual sampling by way of a grab sample. The Licence Conditions for the parameters BOD, Suspended Solids and Ammonia. The ELVs of the Licence are shown in Table 8-15.

Table 8.15: Ongoing IE Licence Discharge Water Quality Monitoring Programme

Sample Ref.	Location	Sampling Frequency	Parameter	Limit
SE1	Outlet of WWTP	Biannual	BOD	30 mg/l
			Suspended Solids	20 mg/l
			Ammonia	5mg/l

The site reports full compliance for the SE1 Monitoring Point.

8.5 Site Investigations

Site Investigation Results for the site, specific to the current application, are now presented. Intrusive site investigations completed specifically for the purposes of this assessment of the c. 4.13ha proposed development area included as follows:

- Observation of quarry rock face exposures on the perimeter of the application area and beneath it.
- Bedrock drilling comprising Monitoring Wells and Production Wells. The difference being the diameter of the borehole and the scale of hydraulic testing that can be conducted. Both scales of hydraulic response testing were completed at the application area: both the Site Investigation piezometer response scale and longer duration yield testing similar to the methods adopted in Public Water Supply BH's yield testing.
- Geophysical Survey
- Hydraulic response tests in the floor of the application area and bedrock around the site and Pump Tests on Production Wells in the application area
- Water level recording using dataloggers.
- Sampling and laboratory analysis of groundwater, quarry floor sump and discharge water samples
- Discharge Flow Monitoring and Rain Gauge Recording

Site Investigation details for the Water Chapter should be considered with the Site Investigations detail presented in Chapter 7 (Land, Soils & Geology).

8.5.1 Quarry Bedrock Exposures

With reference to Chapter 7's Section 7.3.11.1 and Plates 7.1 and 7.2, the following has already been presented:

> *Exposed faces revealed relatively clean, competent limestone, generally massive in structure. Bedrock just below undisturbed ground level displays slightly more weathering but no epikarst was observed. No regular bedding or jointing is present. Some deformation is shown in the centre of Plate 7.1. Apex geologists refer to the structure of this wall as evidence of faulting in this area.*

The floor of the application area was always dry, which is expected because it sits elevated and adjacent to the main working area of the limestone quarry. Direct observation shows that the floor of the application area is loose and broken rock to a depth of approximately 3 metres, which understood to be a result of traffic and material's stockpiling at the site.

The area to the southeast of the application area is the main operational working quarry and therefore, it is possible to observe the bedrock in an additional bench below the application area and the wall of rock, that separates the application area from the main quarry, is completely dry, massive limestone with no clay bands and no evidence of water bearing zones.

8.5.2 Monitoring Well Drilling

As presented in Chapter 7,

Seven small diameter monitoring wells were drilled across the entire landholding between 21st October – 8th November 2021 for the purposes of geological confirmation and hydrogeological testing and monitoring.

Borehole locations are shown in Figure 7.8. Lithology and construction logs from monitoring well drilling are included as Appendix 7B. Construction details and summary findings are also provided in a Table in Appendix 7B.

The Monitoring Well labelled 'ONGW14' was drilled in the centre of the application area. The drilling purpose was to clarify bedrock homogeneity and facilitate a bedrock permeability test. A significant water strike was experienced at 1.2m below ground level (mbgl), which corresponds to the broken rock zone on the floor of the application area (Plate 7.2). A zone of weathered limestone containing clay infill was logged from 4.8m – 7.5m. No water ingress was reported in the clay stratum. Competent strong to very strong limestone bedrock was reported from 7.5m to the base of hole, equivalent to the target depth of 10m OD, approximately. Groundwater ingress was estimated at ~84m3/d, airlifting at 4m. The actual magnitude and sustainability of the water strike in the 3m bgl zone was tested with specifically targeted Production Wells that were subsequently installed. Detailed information is presented in the Water Chapter and a summary overview is given at the end of the SI detail of this Section. In summary, the water strike was not sustained in Pumping Tests and it was concluded that the water had accumulated in the broken quarry floor.

The Monitoring Well labelled 'ONGW12' was drilled in the Gravel & Sand Pit area, located to the north of the shale quarry. It will serve as a long-term groundwater level monitoring point outside the application area.

The Monitoring Well labelled 'ONGW13' was drilled to the south of the application area, on the western side of the existing limestone quarry. This borehole was drilled as close as was feasible to the current sump with the objective of long-term level and quality monitoring. It also clarified bedrock homogeneity and will facilitate a bedrock permeability test.

The Monitoring Wells labelled ONGW15(S&D), ONGW16 and ONGW17 were drilled to chase the contact between the Waulsortian Limestones and Tober Colleen Formation. ONGW16 will also serve as a long-term groundwater level monitoring point to supplement monitoring at nearby third-party dwellings.

Results of monitoring well drilling revealed the following key findings:

- *ONGW16 is drilled within the shales & ONGW12 is drilled in the Gravel & Sand Pit.*
- *Overburden on ground that has not been quarried (ONGW17) show 0.3 m of soft, brown topsoil underlain by a firm to stiff limestone till to 3.5 m.*
- *Drilling at the Monitoring Well location ONGW14 revealed a layer of brown weathered limestone between 4.8 – 7.5 m. The driller notes repeated borehole collapse around 7 m below ground. Significant water was encountered during the monitoring well drilling in the application area's ONGW14. This is in the application area.*
- *Aside from the broken rock encountered close to surface, the application site was proven by drilling to be underlain by very strong, massive limestone to below the target depth of 10m OD.*

The logs obtained from monitoring well drilling show that the desk study's GSI bedrock geology map presented as Figure 7.5 is not entirely accurate. For example, ONGW17 is drilled entirely within limestone but is mapped on the Tober Colleen shales when superimposed onto the GSI bedrock map. A bedrock geology map generated in the 1998 application (named then as Figure 2.2.1) proves to be more accurate and has been included herein as Figure 7.9.

With respect to the significance of the Monitoring Well drilling programme to this Water Assessment, "*significant water was encountered during the monitoring well drilling in the application area's ONGW14".* The highly weathered rock, with a water-bearing zone close to the worked floor's surface in the application area, was not in accordance with the understanding of the character of Waulsortian Limestones, which are typically unbedded and massive in structure, resulting in very low hydraulic conductivity. There was also uncertainty surrounding the presence of a possible structural fault traversing the application site, purely based on visual observations on exposed faces.

Two options were discussed with a view to completing more Site Investigations to better understand the nature and areal extent of this water-bearing zone, as follows:

1. Drilling a high density of narrow diameter holes across the northern section using a blast rig.
2. Geophysical surveying.

It was agreed the optimal approach would be a geophysical survey and that more drilling could then be completed, if necessary.

8.5.3 Geophysics

As outlined in Chapter 7,

Apex Geophysics were commissioned to carry out a preliminary geophysical survey in October 2021, which was followed up with supplementary fieldwork in February 2022. The final interpretive report was issued on 7th February and is included as Appendix 7C. Overall, the survey comprised 13 ERT profiles, 8 seismic refraction totals and EM conductivity data, though some of these were to cover other parts of the limestone quarry outside the application area. The 2D resistivity lines penetrate to a maximum depth of 30m at the centre.

The plan view of the geophysics interpretation (Apex, 2022) shows that there is negligible variation in electrical resistivity through bedrock across the application area. This suggests that bedrock in this area is indeed competent, massive in structure and homogenous. Closer inspection of the interpreted geophysical survey results, and the cross sections created, suggests that competent bedrock only reaches surface at a couple of isolated locations (*e.g.*, c. 20m at the SE end of R1, 10m just SW of centre point of R2 and 40m just NE of centre point of R3). The remainder of each section shows very weak material in the upper 5 m. This material is likely the remnants of historic blasting, heavy machinery, working and stockpiling the floor.

The ERT profiles confirmed 1-4m thickness of weathered or fractured limestone over slightly weathered to fresh limestone on top of a massive/thickly bedded, very strong rock. Resistivities are typical of Waulsortian Limestone. Weak indications of localised weathering or a change in lithology were detected at 30m below ground. There is no suggestion that this is a transition to Tober Colleen or Lucan Formation.

Apex Geophysics (2022) cite the NE-SW trending fault through the application area. However, there was no geophysical evidence and the orientation of the fault was confirmed by the exposures in the walls of the application area.

Karst infill zones were identified in the geophysics results, but these features are all outside the application area. The clay infill feature closest to the area where deepening is proposed has subsequently been worked and partially excavated in mid-2022 and there was no water in the feature. It is a sticky CLAY infill.

No evidence of structural faulting was detected. The Apex (2022) geophysics report recommended drilling confirmatory boreholes at locations within the application area. The report references Proposed BHs referenced as PBH8 and PBH9. This Production Well drilling was subsequently completed and the system was then tested using conventional Production Well Testing methods.

8.5.4 Production Well Drilling

As outlined in Chapter 7,

The aims of the production well drilling programme were:

(1) To explore and validate the findings of the geophysical survey, as per the recommendations outlined by Apex (2022).

(2) To investigate possible structural faulting based on visually observed features on the western and eastern exposed faces of the walls of the application area.

(3) To facilitate pumping test(s) to better understand the hydrogeology in the application area, namely the amount of water perched on the competent bedrock.

Briody Well Drilling Ltd. drilled 3 wells, in the application area's floor, to Production Well specification in February 2022. Dr. Pamela Bartley of Hydro-G was in attendance for the full duration of drilling and cement grouting. Summary details were included in Chapter 7's Table 7.3. The Production Wells are named ONGW18S, ONGW18D and ONGW19. Production Well drill Logs are presented as Appendix 8.E.

A. ONGW18S

Production Well ID '**ONGW18S**' was the first target suggested by Apex Geophysics (2022) and they label the Proposed BH as PBH9. It is in the same place as the MW labelled ONGW14, which was drilled by Petersen Drilling and at that location a water-bearing zone had been encountered very close to surface.

Drilling commenced using a Symmetric shoe on 8" diameter mild steel casing. Very loose rock was encountered to a depth of 3 m below ground. Competent limestone bedrock between 3 to 7m bgl and underlain by a pocket of gravels with some clay between 7 to 8.5m bgl. Drilling was terminated at 9m bgl, upon reaching competent bedrock beneath the clayey gravel. The steel casing was retracted to sit with its base in the clayey gravel. The purpose of this hole was to provide a Production Well that could be pump tested to evaluate the long-term sustainable yield of water close to the floor of the application area. Therefore, the steel was pulled back and manually slotted with an angle grinder from 1m to 4m bgl, approximately.

B. ONGW18D

A second Production Well diameter borehole was drilled at 6m distance from ONGW14 and 4m distance from ONGW18S. The purpose of this hole was to create a BH that cement grouted off the upper water bearing shallow floor zone and obtain knowledge of hydraulic properties of the competent bedrock beneath the application area.

Drilling was opened at 10" diameter and 10" ID steel casing was inserted to 3 m below ground level (mbgl). Similar to the drilling experience at the adjacent ONGW14 and ONGW18S, a very broken rock was encountered from 0 to 2 m. The dry clay infill zone observed at 4.8 – 7.5 m in ONGW14 and from 7 – 8.5 m in ONGW18S was not detected in this borehole. This would suggest the previous detection was an isolated pocket.

Drilling was continued at 10" to 12 m whereupon 6" diameter steel casing was installed. A tremie pipe was used to pump cement into the annulus between the inner and outer steel. An accelerator was added to the cement grout and samples were collected during the grouting process. The cement was left to cure for 18 hrs and samples confirmed the grout had set. Drilling was continued inside the 6" casing to a depth of 63 m below ground, equivalent to c.7m OD.

On the whole, dry drilling was encountered in the limestone bedrock beneath the shallow cement grouted zone. This confirmed the achievement of a competent seal between the upper broken rock and the underlying competent limestone bedrock. Small clay bands between 0.5 – 1.0 m thick were logged at 19 m, 31 m and 48 mbgl. Very small ingresses of water were associated with each clay band.

C. ONGW19

The third large diameter well, ONGW19, was installed at a location corresponding with PBH8 in the Apex Geophysics report (2022). This borehole was drilled under the structural feature observed in the eastern face of the application area and along the orientation towards the structural feature on the southwestern face. This borehole, ONGW19, penetrated through competent limestone bedrock to the final drilled depth of 64m, equivalent to 6m OD, which is beneath the proposed 10m OD elevation of the application area's quarry floor level.

8.5.4.1 Synopsis of Well Drilling

Results from drilling in 2021 and 2022 are consistent with the drilling conducted in 1998 and 2008. The application area is underlain entirely by Waulsortian Limestones which appear to be homogenous to the target floor elevation of 10m OD. The competent bedrock is covered in a layer of infill material composed of quarry screenings and stone. The quarry manager confirmed this material was left over from when this area was used for crushing and screening activities.

Following review of historical site investigation, monitoring well drilling, intensive geophysical surveying and production well drilling there is no evidence that the NE-SW structural fault visible in the exposed perimeter walls and faces of the application area acts as a preferential flowpath transmitting groundwater.

8.5.5 Hydraulic Response Tests & Bedrock Hydraulic Conductivity

Slug testing using the displacement rod method (3m HDPE) was performed across the overall landholding on five of the monitoring wells installed in 2021. The purpose was to evaluate and compare hydraulic conductivity of the geological formation(s).

An example of the analysis is shown below for ONGW15D and involved plotting drawdown against time since insertion of slug (Graph 8.4) and repeating with drawdown plotted against time on a log scale (Graph 8.5). The Bouwer and Rice approach (1976) was then applied for the solution.

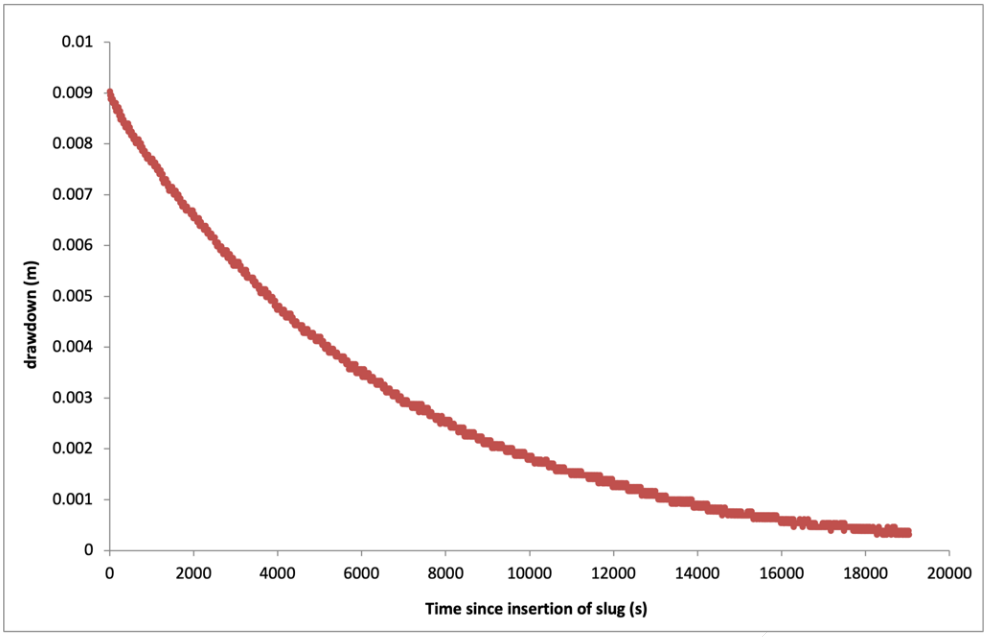
Permeability of the tested limestone bedrock was calculated to be between 10^{-8} and 10^{-10} m/s. Given that these boreholes had substantial screen lengths that enabled a deep vertical length of bedrock testing, it is reasonable to evaluate the results as suggesting that there is little or no fracture flow in the limestone aquifer. However, the slug test performed in the MW in the application area, ONGW14, suggested that no distinction could be made between the permeability of the broken material close to surface and the competent bedrock beneath. For this, the Production wells were tested and those results are evaluated in a Section of this Chapter dedicated to the results of Pump Testing.

By contrast, the permeability value in the Tober Colleen shales (ONGW16) is a couple of orders of magnitude higher at 10^{-6} m/s which infers flow along bedding planes and joints.

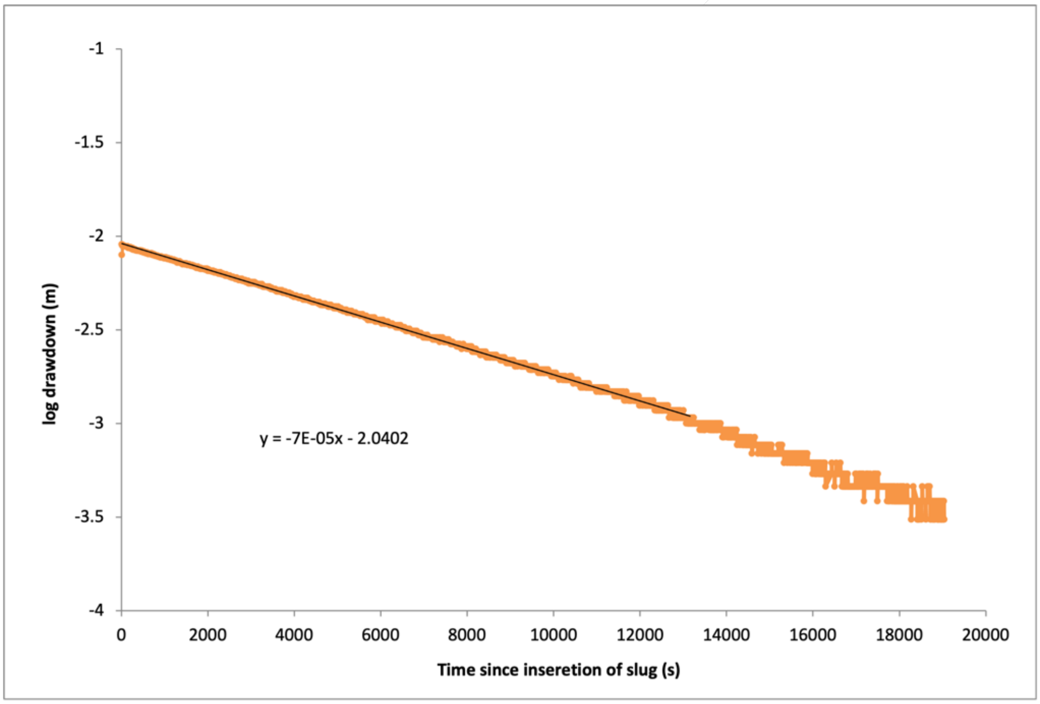
Results at ONGW17 are at the higher end of the range which could represent inflow from the fractured zone noted by the driller at 19.5 – 20.0 m. Although logged as limestone this zone is likely to be very close to the contact with the Tober Colleen. A cored borehole might provide more clarity here, though it is not necessary for the purposes of this study because the application area and the study area is entirely in limestone and there are no potential points of contact within a distance that could affect the hydraulics of the application area. The purpose of testing outside the limestone formations was to demonstrate that differences are measurable across the different bedrock formations. In this way, confidence is carried forward in the assessment of little or no groundwater in the competent rock beneath the application area proposed for development.

In overall conclusion, the Slug Tests determined that the limestone has a relatively low hydraulic conductivity and this is to be expected because the rock is competent and there is no evidence of the secondary permeability that would be required to transmit groundwater.

Graph 8.4: ONGW15D drawdown in response to slug insertion



Graph 8.5: ONGW15D drawdown plotted on a log scale in response to slug insertion



8.5.6 Pump Tests

The three large diameter wells (Production Wells) were constructed at the site because they are capable of accommodating larger capacity pumps for the purpose of conducting pumping tests. The pumping tests were performed to determine the hydraulic characteristics (transmissivity, specific capacity, hydraulic conductivity) of the high-yielding zone close to surface and the underlying composite bedrock and the water bearing potential of the solid mass of limestone underneath the broken floor.

The Industry Standard methodology applied to determine the yield of a well is to undertake a series of tests on the well as follows:

1. Step test - involves pumping the well for three to five discrete pumping rates for periods of equal duration. The duration of each step is typically between 60 and 180 minutes (with the intention of achieving steady-state drawdown conditions), depending on the drawdown/discharge characteristics of the well. By plotting the Abstraction Rate of each 'Step' against the 'Cumulative Drawdown', an indication of the likely yield is provided for longer term testing for sustainable yield.

2. Constant discharge test - used to determine hydraulic properties of the well, and to provide information on the likely drawdown in nearby wells. The analysis of results of the constant rate test can provide a value for the hydraulic property named 'Transmissivity': this being the rate water is transmitted through an aquifer in terms of a unit width and a unit hydraulic gradient. Transmissivity is the aquifer's hydraulic conductivity (permeability) times the aquifer thickness. The higher the transmissivity, the more prolific the aquifer is considered. Transmissivity is a concept that hydrogeologists use to compare different sites.

3. Recovery test – involves monitoring and analysis of groundwater levels following cessation of test pumping. This is an important part of the testing programme.

Bedrock was exposed at surface in all boreholes and groundwater levels were within 1.5m of ground level. With this in mind the aquifer was initially treated as being unconfined with respect to analysis.

The methodology applied, observations and hydraulic analyses are presented in Appendix 8.F.

8.5.7 Likely Water that would be encountered in the Application Area

The application area quarry floor is covered with a layer of saturated broken stone. This is understandable considering the area has been used to stockpile materials extracted from excavations in the permitted working area. The pumping test results confirmed that the water was not connected to a bedrock aquifer. Rather, the layer of broken stone below the quarry floor in the application area acts as a storage reservoir. The perched groundwater above competent bedrock appears to be finite and before each pumping test this reservoir needed to be dewatered before any reliable aquifer data could be gathered.

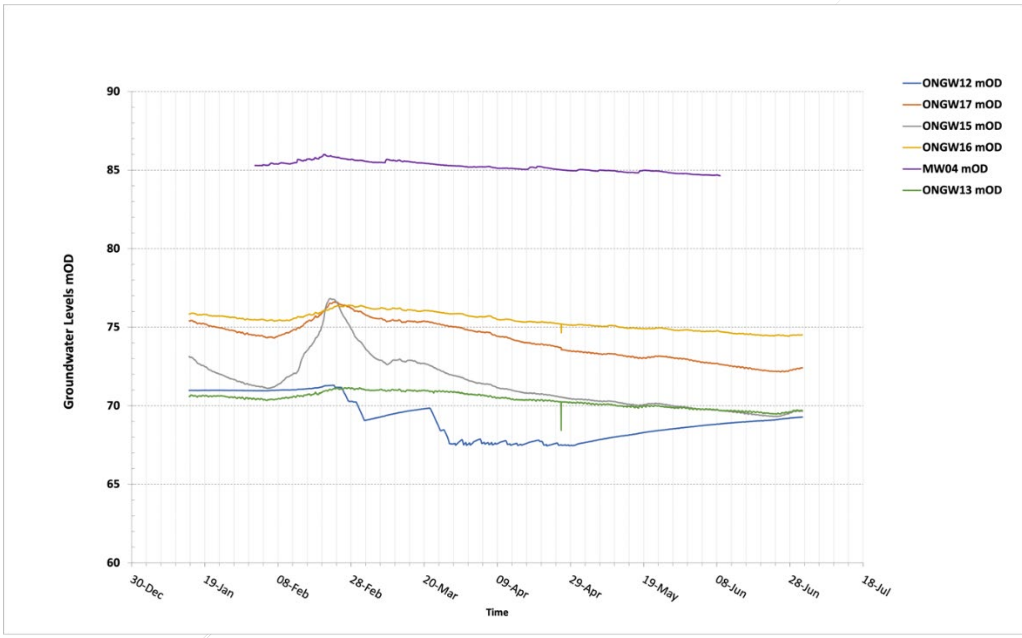
Aquifer testing confirmed that the application site is underlain by massive structured Waulsortian limestones with low permeability, in the range 10^{-10} to 10^{-8} m/s. This means that little future groundwater will be encountered in the long term. In overall conclusion, the water found directly under the floor of the application area could not be sustained. The response to pumping was linear drawdown no matter what the abstraction rate was. This is because it was only an accumulation of water in the broken rock of the floor.

The results on the competent limestone Production Well (ONGW19) in the application area concurs with the mathematical values applied by the GSI's for their category for a 'Poorly Productive Aquifer', which is what underlies the application area.

8.5.8 Groundwater Levels 2022

In January 2022 groundwater dataloggers were installed throughout the site. The purpose was to collect information for the landscape and surrounding lands. Dataloggers were installed in MW04, ONGW12, ONGW13, ONGW15D, ONGW16 and ONGW17. The data is shown in Graph 8.6.

Graph 8.6: Datalogger **groundwater levels from on-site monitoring wells**



The results for water level response show responses to rainfall and recessions after. The responses are expected and natural. Depressed spikes are associated with the occasional, temporary, removal of instruments. In June 2022 groundwater level in the limestone quarry sump was recorded as 53.11 mOD. Results presented in Graph 8.6 demonstrate that the water levels in the wider area wells of the landholding remain substantially above the controlled water level of the floor's sump. This is more information to support the ongoing development of the Conceptual Model for the site, which is that there is little groundwater in the competent Waulsortian Limestone.

8.5.9 Groundwater Flow Direction

Groundwater levels for all monitoring points were calculated and plotted in contours for winter and summer levels, *i.e.,* November 2021 and June 2022. Data are presented in Figures 8.9 and 8.10, respectively. Interrogation and comparison of the groundwater contour maps suggest that the pre-development groundwater gradient (south to north) is maintained between the limestone quarry sump and the shale quarry sump. There is a divide that corresponds with the contact between the Waulsortian limestones and the Tober Colleen shales.

There is local drawdown towards the shale quarry sump.

Groundwater levels in the limestone quarry sump (53 mOD) are approximately 20 to 30m lower than groundwater levels outside the site boundary. As such groundwater flow direction within the central part of the ownership boundary tends to be drawn towards the sump.

The groundwater contours presented in Figures 8.9 and 8.10 demonstrate that there is no significant difference between the winter and summer groundwater flow regimes at the Breedon site. The well survey levels suggest that some wells were pumping at the time of the survey. This is clearly evident at J Fox (2), Dockery and OFGW3 which would suggest that these domestic wells penetrate low permeability bedrock that has a low specific capacity.

Data for both the winter and summer confirm that the general groundwater flow direction through the Breedon site is from south to north. This suggests that the application site is within the Kinnegad River catchment. Both contour maps infer that the peat bog to the south acts as the catchment divide between the Kinnegad River to the north and the Castlejordan River to the south.

The groundwater contours suggest that the IE licensed management and dewatering has resulted in the envisaged local impact that is required for the extraction of rock.

8.5.10 Groundwater Quality

There was no groundwater sampling completed within the application area because the water encountered during drilling seemed to be shallow floor water rather than bedrock aquifer water. This was subsequently confirmed by Production Well drilling and hydraulic response testing.

As previously stated, groundwater flow direction was from south to north. Therefore, groundwater was sampled to the south and the north of the application area.

Groundwater sampling was undertaken by Envirologic in December 2021 and April 2022. Samples were retrieved from the limestone quarry sump as a grab sample and from Monitoring Wells using low flow sampling technique. Groundwater sampling locations were as follows:

- ONGW6, which is to the south west of the application area.
- ONGW13, which is to the south of the main limestone's sump

- ONGW16 and ONGW17, which are to the north of the application area and in the direction of groundwater flow from the application area to the Kinnegad River

Physiochemical parameters were measured in the field using an Aquatroll 600 sonde, as follows: temperature, dissolved oxygen, pH, conductivity and oxidation-reduction potential (ORP). These parameters had stabilised at the time of water sampling using the low-flow technique.

Samples were delivered to ALS on the day of sampling for analysis of microbiological parameters and biochemical oxygen demand (BOD). Remaining samples were collected in the appropriate sample containers that contained the appropriate fixation substance per parameter, stored in cooler boxes and dispatched by courier on the sampling day for analysis of remaining hydrochemical parameters to Element Laboratories, Deeside, UK. Groundwater quality Certificates of Analysis are presented in Appendix 8G. Results can be summarised as follows:

- No hydrocarbons were detected in any of the samples.
- MTBE concentrations were below the detection limits of the laboratory.
- The groundwater contains no traces of either Aliphatic or Aromatic compounds.
- Overall, nutrient concentrations in the groundwater were low. Nitrate, Nitrite and ortho-phosphate were below the limit of concentration for most groundwater samples. With respect to those sampling points that returned elevated ammonia concentrations, elevated suspended solids and often presented elevated Total Organic Carbon concentration. It is therefore concluded that the groundwater itself, when not compromised by the monitoring point's construction or the sampling methodology, is low in nutrient concentration.

8.5.11 Surface Water Quality

Surface water quality sampling was undertaken in December 2021 and April 2022, in order to represent autumn/winter and spring/summer conditions. Samples were retrieved from the Kinnegad River, upstream of the discharge point SW1.

Surface water quality results are presented in Appendix 8G. Certificates of Analysis are presented in Appendix 8G.

Almost all parameters satisfied the Surface Water Regulations (2009, as amended 2019). The upstream surface water quality results showed that nutrient levels in terms of nitrates, nitrites, orthophosphate were relatively low. Ammonia concentration in the winter sample was 0.15 mg/l, which satisfies the Surface Water Regulations under mean flow conditions.

No hydrocarbons were detected and suspended solids were below the laboratory limit of detection in all samples.

8.5.12 Discharge Water Quality

Discharge water quality sampling was undertaken in December 2021 and April 2022. Samples were retrieved at SW1. Discharge water quality results are presented in Appendix 8G. Certificates of Analysis are presented in Appendix 8G.

Parameters satisfied the Groundwater Regulations (2010, as amended 2016) and the Surface Water Regulations (2009, as amended 2019). Nitrate, nitrite and orthophosphate concentrations were all low indicating low nutrient status. Ammonia values on both occasions were 0.10 mg/l.

No hydrocarbons were detected, and suspended solids were below the 10 mg/l laboratory limit of detection.

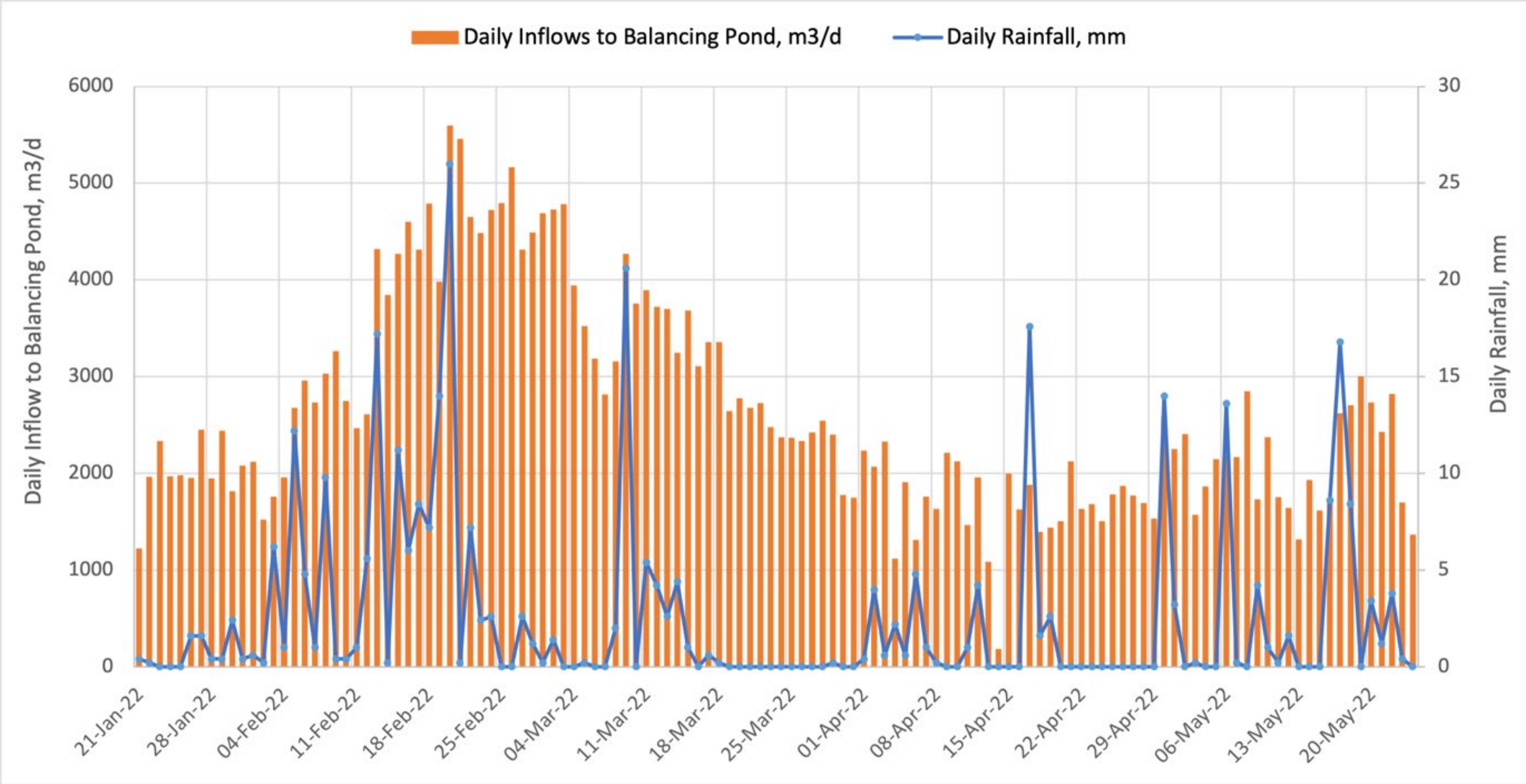
8.5.13 Additional Flow and Rainfall Recording at the Site

CWSL were commissioned to install additional monitoring infrastructure with a view to improving the Water Team's understanding of flow paths around the site. The CWSL installations comprised a Flow Meter at the inlet to the Balancing Pond and a tipping-bucket rain gauge. A selection of the Monthly Reports is presented in Appendix 8.H. All reports are on file but to include them all would result in an unnecessary bulk in the EIAR Appendices. The installations took place on the 21st January 2022. The reason for the mid-project installation date is that as the evaluation of the site progressed, the Water team requested more focussed data. CWSL were commissioned to install an in-line ultrasonic flowmeter on the 360 mm inlet pipe to the balancing pond (see Plate 8.2). As previously presented, the site has a flow meter on the Licenced point of discharge (SW1). However, the Water team wanted to separate the limestone flow data from the shale quarry data. The final discharge flow meter at SW1 is a sum of all waters generated at the site. The Water Team required detail for the limestone quarry component.

Plate 8.2: CWSL Installation Ultrasonic flowmeter fitted to balancing pond inlet

The CWSL monitoring data for daily rainfall and balancing pond inflows are presented in Graph 8.7. With respect to the rainfall data collected, two major storm events (one of which was storm Eunice) occurred in February 2022 of the monitoring period. Hence February 2022 is considered to be a worst-case scenario for volumes of water to be managed within the site in its current condition, which includes rainfall runoff from the application area. Monthly rainfall recorded at the site's rainfall gauge during February 2022 was 150mm, giving an average daily rainfall of 5.33 mm. For comparison purposes the long-term 30-year average total amount for monthly rainfall for February is 61mm. This suggests that the rainfall recorded in February 2022 was more than twice the norm. On the 13th February 2022 daily rainfall total was 17.2 mm; this was considered to be a storm event. A week later on 20th February 2022 Storm Eunice occurred, with a total of 26 mm rainfall at the site on this day. For comparison, monthly rainfall in March 2022 was 43 mm, with an average daily rainfall rate of 1.4 mm.

Graph 8.7: Daily Inflows to Balancing Pond in (January to May 2022)



The recorded daily flows (orange lines), along with daily rainfall rates (blue lines) were presented in Graph 8.7. The chart shows that there is no constant, average, steady daily flow into the balancing pond. The maximum value recorded was 5,600 m^3/d, which was in February 2022 in response to an extreme storm event, named storm Eunice, which was preceded by another extreme storm. What flows into the balancing pond is part of what will eventually flow out of the final settlement lagoons at the point of discharge. However, the balancing pond and the settlement lagoons have significant available volumetric attenuation (retention) capacity. That is the reason that the site persistently achieves their Suspended Solids Emission Limit Value of the overall site's IE Licence (P0487-07), which already includes the application area.

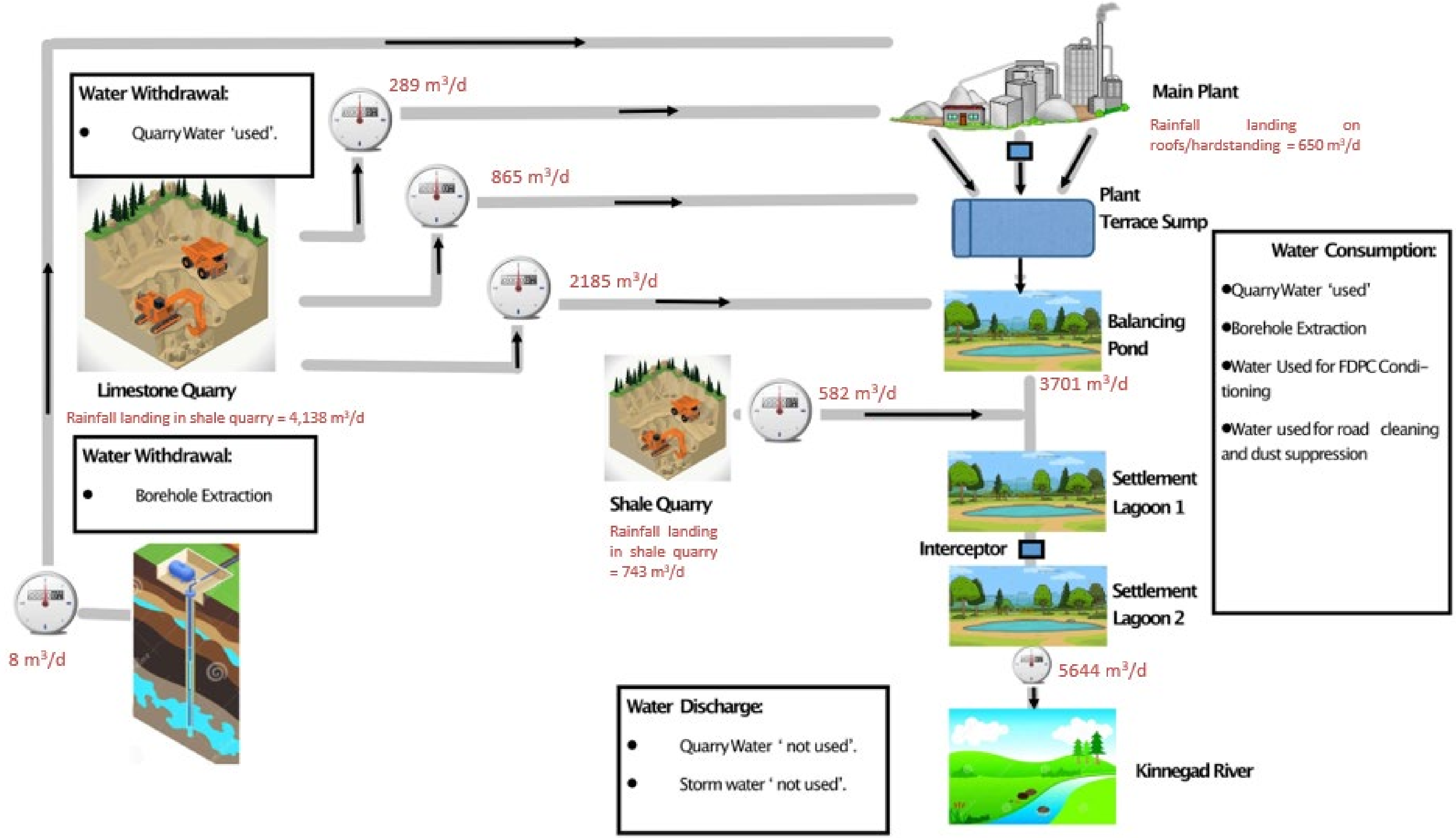
8.5.14 Water Balance

Site specific rainfall data for the site was interrogated and the worst month was selected for the purposes of presenting the magnitude of the overall site's flow component.

A schematic flow component diagram, with measured values, for the rainfall and storm conditions of February 2022 is presented as Plate 8.3. The data sources include mixture of site-specific rainfall data, ultrasonic flowmeters and magmeters. Where there are data gaps, estimates are based on differences between measured flows. The schematic is useful for demonstrating what proportion of the final discharge comes from what components of the on-site water management scheme. The maximum recorded daily discharge flow at the point of discharge was 5,644m3/d.

Given that the maximum permitted discharge volume of the IE Licence (P0487-07) is 6,150m3/d, flow data suggests the minimum amount available to any new groundwater that could be encountered in the application area is (6,150 – 5,644 = 506m3/d) under the worst storm rainfall events i.e., 2 notified extreme weather events in 1 week in February 2022. The TOTAL inflow to the balancing pond, recorded by the CWSL flow meter during the selected 'worst case' month of February 2022, was 103,641 m^3, giving a daily average of 3,701 m^3/d. Therefore, on an average basis in a winter/early spring storm month, considering the available attenuation on the floor of the main quarry and its associated balancing pond and settlement lagoons, the amount of freeboard in the volume of the IE Licence (P0487-07) can be calculated to be (6,150 – 3,701) = ~2,450m3/d. Given that the flow volumes measured already take rainfall runoff from the application area and that little additional groundwater is envisaged for the proposed deepening in the 4.13ha, the available minimum freeboard of ~506m3/d and average freeboard of ~2,450m3/d available in the current licence, a review of the licence is deemed unnecessary.

Plate 8.3: Schematic of Water Flow Pathways and associated daily flows during February 2022 within the Breedon Kinnegad site



With respect to all data collected, flow component quantification and water balance calculations, using the worst-case February 2022 data suggest that the licensed discharge volume for the site was not exceeded and that there is sufficient attenuation storage available within the site to hold back excess waters. An increase in the IE Licence volume is not necessary. This conclusion is supported by comparing water balance data for rainfall with site monitoring data for flow, as follows:

- The footprint area of the limestone quarry is 77ha (770,000m^2).
- The total volume of rain measured at the site's rain gauge during February 2022 was 150mm (i.e., 0.15m).
- The amount of water arising on the limestone quarry's floor is therefore calculated as (770,000m^2 x 0.15m = 115,875m^3), which is broadly equivalent to an average daily volume of 4,138 m^3/d.
- Each of the three rising mains carrying water from the limestone quarry sump are fitted with a magmeter. Flow data suggests flows through each of these lines during February 2022 was as follows:
  - Limestone quarry to cement manufacturing plant = 8,091 m^3
  - Limestone quarry to balancing pond = 61,176m^3
  - Limestone quarry to terrace sump = 24,208m^3
  - Therefore, the **Total** amount of water measured by magmeter as it was pumped from the limestone quarry sump was equal to 93,475m^3, which is equivalent to an average of 3,339 m^3/d.
- The difference between the calculated average water balance amount of 4,138m^3/d, attributed to direct rainfall input to the limestone quarry, and the average measured outflow of 3,339m^3/d is rationally and reasonably attributed to some losses of direct rainfall by absorption into broken rock on the floor, interception between broken rock crevices at the surface, infiltration, groundwater recharge, accumulation and storage on the floor and in the limestone quarry sump.
- The sum of waters pumped to the terrace sump and the balancing pond, ultimately enter the settlement lagoons, this being equal to ~3,050m^3/d, *i.e.,* ((61,176m3+24,208m^3)/28days = ~3,050m3/d). This is part of the licensed maximum daily discharge volume of 6,150m3/d (IE Licence P0487-07).
- However, the final discharge also comprises flow from the shale quarry. Rainfall data suggests that the volume of precipitation landing in the shale quarry footprint (139,000m^2) during February 2022, suggests an average daily volume of 743m^3/d. During February 2022 the average daily water volume pumped from the shale quarry sump to settlement pond 1 was measured using a flowmeter as approximately 587m^3/d. This difference in values can be explained by some storage on the floor of the shale quarry and the capacity of its sump.

- The combination of the shale quarry and limestone quarry's flow meters data, for the storm conditions and the month of February 2022 = 3,339m3/d + 587m3/d = 3,926 m3/d.

Further interrogation of site monitoring data suggests as follows:

- All flows at the site, and discharge from the site, are seasonal and directly responsive to rainfall. However, data for discharge volume cannot always be directly related to rainfall and this is because of the size of the main limestone's floor. The discharge measurement point only shows a direct response after an extreme daily rainfall rate above 15mm/d. This is because there is a large amount of attenuation on the floor and in the sump of the main limestone quarry, which also accommodates the runoff from the application area. There is also attenuation capacity in the Terrance Sump and this holds back some of the limestone quarry's sump waters before sending them to the settlement ponds and final lagoons. That action also provides more space in the main limestone quarry's floor sump.
- Discharge volume is greatest at the end of the winter period when cumulative rainfall is highest. Discharge volume is lowest in periods of low rainfall.
- From early spring, a there is an observable recession in discharge volume, with flows consistently declining, relative to the storm flow peaks that happen in early spring.

8.5.15 Site Specific Flood Risk

A site-specific flood risk assessment was completed for the Kinnegad River. Envirologic surveyed the river channel, completed cross sections for the river bed and banks, surveyed the slope on adjacent lands, completed flow gauging and modelled the impact of the licensed discharge. The acceptance capacity of the receiving water was assessed. The Flood Risk Assessment is included as Appendix 8.I. In conclusion the river can accept the maximum permitted and proposed discharge from the entire landholding, including the application site, and will not cause a perceptible increase in flood risk to identified downstream receptors when the river is under flood flow conditions.

8.6 Conceptual Groundwater Model

Baseline and Site Investigation information were applied to develop a conceptual model for surface water and groundwater flow in and around the application area and the overall site, with reference to downstream receptors. With respect to groundwater flow, it is from the south to the north. The peatlands to the south of the overall main quarry, and south of the application area, are the surface water divide between the Kinnegad River and the Castlejordan River. There is an IE Licence controlling all site emissions and a discharge volume of 6,150m3/ is permitted to the Kinnegad River. The application site sits in the catchment of the Kinnegad River. The natural hydrological regime is thereby retained. Groundwater quality at the site is good and discharge quality is good. Data are returned to the EPA each year in the AER for the IE Licence.

The site's long-term record for total discharge meter confirms a rainfall dominated discharge that peaks in response to storm events and regresses after. This study benefitted from data response collection for two storm events that occurred almost within the same week. The rainfall amount of February 2022 was more than double the amount of the 30-year average. Evaluation of the response of the site's water management systems in the extreme storm events enabled a conclusion that the hydrogeological model, associated with previous planning applications for the site, remains valid. The maximum discharge from the site remains below the IE Licenced maximum daily ELV for volume of 6,150m3/d. There is freeboard capacity for any additional waters that might arise from the proposed development. However, site investigation results for the application area did not show any evidence that additional or 'new' groundwater will be introduced via preferential flowpaths such as fractures, bedding, joints, or structural joints. Neither is there any evidence that any of the water directly beneath the floor of the application area is connected to any location outside the application area.

The hydrogeological environment is limestone bedrock that is classified by the GSI as a 'LI' classification, which means that the aquifer is capable of supplying locally important abstractions. The Groundwater Flow Regime is mapped by the GSI as 'Poorly Productive'. Drilling encountered no water bearing zones in the competent bedrock beneath the application area. There is water in some zones of the western part of the the floor of the application area but it does not sustain abstraction. The response is akin to dewatering a reservoir rather than pulling water from a continuous source of an aquifer. The 2021 geophysical survey confirmed competent limestone bedrock beneath the application area. The bedrock type is Waulsortian Limestone. There are other types of rock in the lands surrounding the application area. All relevant information is presented in the Site Conceptual Model presented as

Four boreholes were drilled on the application area's quarry floor in December 2021 and 2022. No sustained water strikes were encountered in the competent limestone beneath the application area. Hydraulic conductivity testing of the rock matrix in the on-site boreholes reveals a solid limestone with little primary (matrix) porosity and no secondary permeability in the bedrock. There is shallow water in the broken floor of the quarry but it is limited and unconnected to the areas outside the application area. Hydraulic Conductivity determinations, based on hydraulic response tests completed, confirm the GSI's classification of a LI Aquifer and Poorly Productive Groundwater Regime.

The application area is already a worked quarry zone, with permission, so the proposed development works will not introduce any additional rainfall to the site or to the water management scheme.

The proposed development will enlarge the footprint of limestone quarry void that is already permitted.

The highest groundwater flow rates will occur when head difference is greatest (*i.e.* Local land surface elevation of 80mOD – proposed future floor elevation of 10 mOD = 70m head differential).

Applying Darcy's Law because the rock is competent solid bedrock:

Groundwater flow, Q = KiA

Where Q = groundwater flow rate in aquifer, m^3/d

[Note, site investigations suggest that the bedrock is homogenous through its depth to the proposed 10m OD excavation elevation. Therefore, the application of Darcy's Law is considered acceptable]

And the input values are

K = hydraulic conductivity = 1×10^{-9} m/s = 8.64×10^{-5} m/d
i = hydraulic gradient = 70m/m
A = cross sectional area of part of the aquifer, m^2 = 1m width by 70m depth = $70m^2$

A resultant Groundwater Flow rate of Q = $0.42m^3/d$ is thereby calculated.

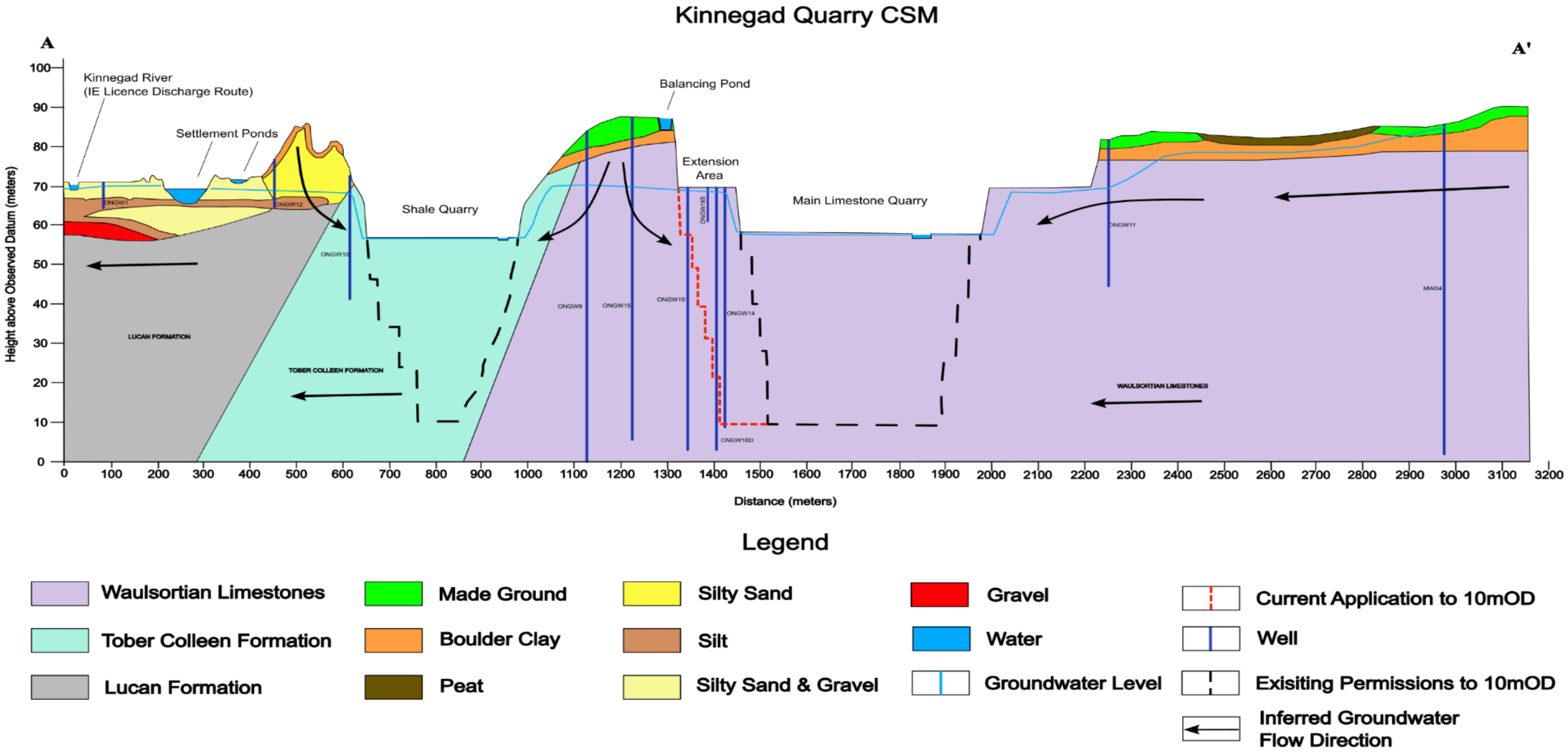
It is therefore determined that the application of the Site Investigation information suggests that $0.42m^3/d$ of groundwater will enter through every 1 m wide, 70m deep section of exposed bedrock. The perimeter length of exposed bedrock quarry face around the proposed application area will be c.600m. Therefore, (0.43m3/d x 600m perimeter) **= $300m^3/d$ groundwater ingress will enter the void through the exposed faces in the application area and bedrock beneath.**

Given that the proposed development is an extension to an area that is already worked, these exposed faces already exist in the permitted area and beneath it (i.e., the boundary of the application area and the current working floor of the main limestone quarry). Regardless of whether the proposed application is approved or not, the same groundwater flow regime will occur. Therefore, the Conceptual Site Model remains as it was in the previous applications. The proposed application is unlikely to introduce significant additional groundwater above that which will enter when the permitted development is approaching its target depth of 10m OD. Rainfall runoff and groundwaters arising at the application area will continue to flow to the sump on the floor of the main limestone quarry and continue to be discharged to the Kinnegad River. Regionally, groundwater will continue to flow south to north and the peatlands in the southern part of the overall landholding will remain the marker for the surface water catchment divide.

Given that the Conceptual Site Model suggests retention of the pre development and current water flow regimes, no potential exists for impact to designated sites with water species or water habitat related Conservation Objectives.

A schematic of the updated Conceptual Site Model is presented in Plate 8.4 as a cross section through the site. The cross section is presented showing Site Investigation locations and likely groundwater flow. The location, in plan view, of that A-A' Section Line is presented on Figure 8.10.

Plate 8.4: Schematic Conceptual Site Model (updated 2022)



8.7 Impact Assessment

8.7.1 Methodology for Determination of Impacts

The methodology for determination of impacts was outlined in Chapter 1 of the EIAR and presented more specifically for Hydrology and Hydrogeology in Section 8.2.3 of this Chapter.

As previously presented,

a. The applied Impact Assessment Methodology adheres to EPA (2022) Guidelines and it is therefore taken that the assessment adheres to the requirements of the EIA Directive.

b. Criteria for assessing importance of site attributes and their magnitude of importance were evaluated using NRA Guidelines (NRA, 2008) [as prescribed in 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI, 2013)]. NRA rating criteria uses the same significance terminology as the EPA.

8.7.2 Potential Impacts

This assessment will evaluate potential impacts from proposed works to the local and regional hydrological and hydrogeological environment. Only likely or significant impacts are included in the analysis. The assessment of potential impacts is divided into the three primary project phases:

(i) Enabling (or construction) phase,

(ii) Operational phase and

(iii) Landscaping, Restoration, Decommissioning & Aftercare

A Summary Table for Potential Impacts associated with each phase is presented as Table 8.16.

The procedure for determination of potential impacts on the receiving hydrogeological environment was to identify potential receptors within the site boundary and surrounding environment and use the information gathered during the field work and desk study to assess the degree to which these receptors will be impacted upon.

The application site lies within and adjacent to the existing quarry void, and when considered as a cumulative site, will be of moderate to large size. The site is therefore considered to be an attribute of high importance. In line with best practice, the individual impacts will be considered with respect to the application site, plus the cumulative impacts with respect to the existing and application site.

Generally, at all quarry sites the primary activity with **potential** to impact the local and regional hydrological and hydrogeological environment is the removal of rainfall-runoff and groundwater from the local hydromorphological regime. Stripping soils from the land to create access to rock can have impacts. However, at this site the soil has already been removed and the discharge of waters arising at the proposed development is regulated under IE licence P0487-07.

In terms of local hydrology, the Water Framework Directive (WFD) sub catchments delineate a surface water divide running broadly northwest-southeast through the centre of the overall landholding. Lands north of this divide drain naturally to the Boyne_SC_030, whereas lands to the south drain to the Yellow (Castlepollard)_SC_010. Another catchment boundary including the eastern half of the site drains to the Boyne_SC_010.

Waters leaving the application site enter the Kinnegad River which outfalls to the River Boyne and River Blackwater Special Protection Area (SPA Site Code 004232) and Special Area of Conservation (SAC Site Code 002299). The significance of the hydrological and hydrogeological setting is therefore acknowledged.

A surface water management system has been designed with cognisance of the relevant national assessment guidelines (DoEHLG 2011, EPA 2011) and Regulations, namely the Groundwater Regulations (2010, as amended 2011, 2012, 2016), Surface Water Regulations (2009, as amended 2019) and Birds and Natural Habitats Regulations (2011).

The proposed development site and surrounding working areas are within the Athboy Groundwater Body (GWB). The Athboy GWB report (GSI, 2004) suggests that the hydrogeological regime of the area is influenced by a low-lying and gently undulating land surface covered in a blanket of glacial drift that is underlain by heterogenous limestone bedrock.

Table 8.16: Summary of Potential Impacts

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
Construction Phase	None required	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Operational Phase	Blasting of bedrock	Surface waters; groundwater	Surface waters: Medium Aquifer: Medium	Deterioration in groundwater and surface water quality	Negative	Moderate	Kinnegad River, River Boyne, Athboy GWB, Bedrock aquifer	Likely	Temporary Long-term	Direct
	Extraction of bedrock	Bedrock aquifer	Aquifer: Medium	Change in unsaturated thickness resulting in change in groundwater vulnerability classification. Deterioration in groundwater quality. Site is already Extreme (X) vulnerability	Negative	Neutral	Bedrock aquifer within site boundary	Unlikely	Permanent	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
	Movement of aggregate stockpiles	Surface waters	Surface waters: Medium	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Negative	Slight	Kinnegad River	Likely	Occasionally Temporary	Direct
	Use of quarrying machinery and equipment – spillages during refuelling, use and storage of lubricants	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Contamination of surface waters and groundwaters with hydrocarbons	Negative	Moderate	River Boyne, Athboy GWB, Bedrock aquifer	Unlikely	Rarely Momentary	Direct
	Quarry dewatering – lowering of groundwater levels in	Bedrock aquifer	Aquifer: Medium	Reduction in third party well yields Reduction in baseflow to surface waters	Negative	Moderate	Third party wells within 1 km	Likely	Long-term Constant Reversible	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
	surrounding area									
	Use of settlement ponds	Surface waters	Surface waters: Medium	Removal and entrapment of particulate matter entrained in waters leaving site	Positive	Moderate	Kinnegad River, River Boyne	Likely	Long-term Constant	Direct
	Cleaning of settlement ponds	Surface waters	Surface waters: Medium	Improves efficiency of settlement ponds; attenuation Mobilisation and migration of suspended solids	Neutral	Not Significant	Kinnegad River, River Boyne	Likely	Annual Long-term	Direct
	Use of wheelwash	Surface waters	Surface waters: Moderate	Removal and entrapment of particulate matter attached to vehicles	Positive	Slight	Kinnegad River, River Boyne	Likely	Long-term Constant	Direct
	Wheelwash maintenance	Surface waters	Surface waters: Moderate	Improves wheelwash and reduces mobilisation and migration of suspended solids	Neutral	Not Significant	Kinnegad River, River Boyne	Unlikely	Annual Long-term	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
	Use of hydrocarbon interceptors	Surface waters; groundwater	Surface waters: Moderate	Entrapment of hydrocarbons lost during discharge	Positive	Slight	Kinnegad River, River Boyne	Likely	Long-term Constant	Direct
	Pumped discharge of quarry waters	Surface waters	Surface waters: Moderate	Increase flood risk to downgradient receptors	Negative	Imperceptible	Kinnegad River, River Boyne	Unlikely	Long-term Constant	Direct
	Pumped discharge of quarry waters	Surface waters	Surface waters: Moderate	Deterioration in surface water quality	Negative	Slight	Kinnegad River, River Boyne	Unlikely	Long-term Constant	Direct
	Pumped discharge of quarry waters	Peat Bog	Peat Bog: Low	Degradation of hydrogeological flow regime to peat bog	Negative	Imperceptible	Peat bog to south	Unlikely	Long-term	Indirect
	Use of cement manufacturing plant	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	Contamination of surface waters and groundwaters with cementitious material. Cement is highly alkaline and can have a significant negative	Negative	Slight & Not Significant	Kinnegad River; Bedrock aquifer	Unlikely	Long-term Constant	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
				impact on water quality.						
	Monitoring	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	Monitoring of discharge rates, suspended solids, discharge water quality, receiving surface water quality, groundwater quality	Positive	Not Significant to Imperceptible	On- and off-site	Unlikely	Continuous, hourly, quarterly, annually	n/a
Restoration Phase	Removal of semi-mobile and mobile plant (pumps, generators, etc.)	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	Elimination of hydrocarbon sources	Positive	Slight	Within site boundary	Likely	Permanent	Direct
	Dismantling and removal of fixed plant & machinery (cement manufacturing plant,	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	Elimination of hydrocarbon and cementitious sources	Positive	Slight	Within site boundary	Likely	Permanent	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
	wheelwash, etc.)									
	Landscaping and movement of infrastructure and overburden stockpiles necessary to facilitate site restoration	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Negative	Moderate	Kinnegad River, River Boyne	Likely	Once-off Temporary	Direct & Indirect
	Cessation of pumping & discharge	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	Recovery of groundwater levels Reduction of flood risk Reduction in risk of contamination to surface waters	Positive	Significant	Within site boundary and 1 km radius	Likely	Permanent	Direct
Unplanned Events	Major Spillage	Surface waters; groundwater	Surface waters: Moderate	Hydrocarbon contamination	Negative	Significant	Within site boundary and 1 km radius	Likely	Momentary	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect *	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
			Aquifer: Medium							
	Intense Rainfall Events	Surface waters; groundwater	Surface waters: Moderate Aquifer: Medium	On-site & off-site flooding	Negative	Moderate	Within site boundary and 1 km radius	Likely	Brief	Direct

* Importance of Attribute in Column 4 was determined on basis of criteria from NRA (2008) and IGI (2013), and informed determination of Significance/ Magnitude of Effects in Column 7, which is principally based on criteria of EPA (2017 & 2022).

8.7.3 Potential Impacts of Blasting at the Site

Mass balance calculations are presented to demonstrate potential for effects of blasting to present nitrogen residues in the discharge waters, which has potential to impact groundwater quality. The risk to groundwater and surface water is assessed by quantifying the resultant concentrations for the potential residual nitrogen compounds Nitrate (NO3), Ammonia (NH4) and Nitrite (NO2).

Peak activity rates of the extraction activities, blasting frequency and the type of explosives used were supplied to Hydro-G by the quarry manager. The explosives used in quarry are Kemex 70. Kemex 70 is a site mixed bulk emulsion explosives produced from emulsion matrix. Emulsion matrix is essentially an aqueous solution of ammonium nitrate emulsified in oil. Kemex products may also contain ammonium nitrate prills, fuel oil, aluminium and/or gassing agents. The Technical Data Sheets (TDS's) and MATERIAL SAFETY DATA SHEET (MSDS's) for explosives, primers and detonators used at the site are held at the site and in the offices of the hydrogeologists.

Literature suggests that small percentages of N compounds can remain as residual coating on bedrock following blasting. This has the potential to be dissolved when it comes into contact with water, albeit potential concentrations are low. The study that is most referenced was completed by Environment Canada in 1988 (Ferguson & Leask, 1988). This study outlines a procedure for determining the residual N compounds for various mine site types. The stepwise procedure used in the 1988 study for predicting aqueous concentrations of N species, is as follows:

a) Calculate the annual leached nitrogen loading (kg/year) for the entire site based upon annual explosive mass usage and residual N fraction associated with explosive type.
b) Separate the leached nitrogen loading among quarry components (e.g. entering surface water, remaining on extracted rock etc.)
c) Separate into loadings of N compounds (Nitrate, Nitrite and Ammonia), and
d) Calculate the flow concentration.

The concentrations of N species in discharge water from the proposed extension at the application site quarry are calculated using this procedure. This is presented in Table 8.17, below. The total area of the limestone quarry in which blasting could occur is 77ha. The current application is for a total area of 4.13ha in the existing quarry. For the purposes of impact assessment, the entire quarry area will be considered. The highest residual upper limit of the range has been adopted in all simulations. In this way, the highest concentrations of N species concentrations have been calculated. These are very conservative assumptions. The calculation also assumes that 100% of residual N is dissolved in drainage waters and is subsequently pumped from the quarry by dewatering. The results of calculations presented in Table 7.17 clearly show that the residual N compounds would have concentrations each of less than 0.00043mg/l N. Specifically, resultant increases in concentrations in waters within the quarry, if impacted by explosives within the entire quarry site area, would be: **0.006mg/l NO3, 0.002mg/l NH4 and 0.0004 mg/l NO2.**

Table 8.17: N compound concentrations from explosives in dewatering discharge

EXPLOSIVE MASS BALANCE		
77	Total Site Area	ha
770,000	Total Area	m2
31,678,000	Approximate Volume of rock to be extracted	m3
26,926,300	USUAL for 15% losses to be applied	m3
0.2	Explosive Mass Required	kg/m3
5,385,260	Explosives Mass Required	kg
20	Planned Duration of extraction	years
269,263	Explosives Mass Required per year	kg/yr
NITROGEN MASS BALANCE Facts		
94%	% Explosive mass as Ammonium Nitrate	%
35%	% Ammonium Nitrate as N	%
88,588	Mass of N	kg/yr
0.06	Residual Fraction	
5,315	Residual N left behind	kg/yr
Total N Species Generated by explosive's residues (areal annual loading rate)*	***69.03***	***Kg/ha/yr***
*facilitates comparison with agricultural inputs [total quarry area used]. Compare to 170 kg N/ha/yr Total Nitrogen loadings permitted in the Good Agricultural Practice Regulations (SI 605 of 2017)		
Residual N COMPOUNDS**		
5,262	Residual NO_3 *(75-99% of Residual N value)*	**kg/yr**
1,276	Residual NH_4 *(0.5 - 24% of Residual N value)*	**kg/yr**
319	Residual NO_2 *(0-6% of Residual N value)*	**kg/yr**
****Highest possible % Residuals Adopted from the available ranges, as conservative measure.**		
WATER BALANCE		
6,150	Envisaged MAX Daily Quarry Discharge (max)	m^3/day
2,244,750,000	Quarry Discharge	litres/yr
INCREASE IN NITROGEN COMPOUND CONCENTRATIONS***		
Additional Residual NO_3	***0.006***	***mg/l/d***
Additional Residual NH_4	***0.002***	***mg/l/d***
Additional Residual NO2	***0.0004***	***mg/l/d***
*** Calculation of Residual Concentrations = (kg/yr*10^6 = mg/yr)/(litres/yr)		
MASS OF NITROGEN COMPOUNDS GENERATED Over the Whole SITE Area (kg/ha/yr)***		
Total N	**69.03**	***Kg/ha/yr***
Residual NO_3	***68.34***	*Kg/ha/yr*
Residual NH_4	***85.04***	*Kg/ha/yr*
Residual NO2	***0.00041***	*Kg/ha/yr*

With respect to the calculated resultant concentrations determined for the site following blasting, as presented in Table 8.17, context is offered as follows:

- The limit for nitrate in waters affected by agriculture is 50 mg/l NO3 (Nitrate & Good Agricultural Practice Regulations) and it is also 50 mg/l NO3 for the Freshwater Fish Directive (2006/44/EC). Baseline water quality in the quarry's sump is 15mg/l NO3, on average, and therefore, the simulated resultant increase in concentration of 0.006mg/l NO3 poses no threat to breach of Environmental Quality Objectives or the Threshold Value of 37.5mg/l NO3 as specified in the Groundwater Regulations.

- The limit for Ammonia in High Status Waters EQS (Surface Water Regulations 2009) is 0.04 mg/l NH4 and the resultant increase in concentration calculated for the waters is 0.002 mg/l NH4. Given that the baseline groundwater concentration in the quarry sump is <0.03, on average, environmental impact is not envisaged because the resultant concentrations calculated will still meet the High Status EQSs of the Surface Water Regulations.

- Overall, the residual concentrations are so low that the site will continue to comply with the requirements of the Threshold Values of the Groundwater Regulations (2010) & the targets set out in both the Freshwater Fish Directive and Salmonid Waters Regulations.

In summary, having used conservative values in this approach the resulting N species concentrations are small, and below all relevant Regulatory EQS values. The risk of impact to local water quality arising from the use of explosives at the site is therefore negligible. These calculations are based on PEAK abstraction rates.

8.7.4 Potential Impact of the Discharge Volume

A Groundwater Body and Aquifer scale hydrogeological impact assessment is presented as Table 8.18.

The application of Site Investigation results and site monitoring data led to a conclusion, earlier in this Chapter, that the floors of the quarries, the site's water management infrastructure and the IE Licence have capacity to be fit for purpose for the additional discharge from the application area under consideration. The calculated additional groundwater that might arise, during the course of the excavations proposed, is likely to be ~300m3/d. Rainfall runoff from the proposed application area is already collected, attenuated, balanced, settled and discharged as part of the permitted 6,150m3/d of the IE Licence. Monitoring and controls already in place for the IE Licence will always permit compliance with that maximum volume Conditioned. Therefore, using the 6,150m3/d as the maximum future volume that will leave the site, with reference to the calculations presented as Table 8.18, it is calculated that the percentage of waters that will be pumped from the overall site is less than the 5% threshold value of the Water Framework Directive Working Group (GW5) and is therefore **deemed 'Low Potential Impact' and 'Not at Significant Risk'** by WFD characterisation methods (GW5, 2005). This water balance data provides the confidence to assert that there will be no adverse impact on the local or regional groundwater regime.

Table 8.18 : Groundwater Body and Aquifer scale hydrogeological impact assessment

Regional hydrogeology & Breedon's Killaskillen Water Management	
GSI assigned area for 'Athboy Groundwater Body' (km2)	964
Athboy Groundwater Body (m2)	964,000,000
GSI Stated Total Regional LI Aquifer Area (km2)	17,808
Total Aquifer Area (m2)	17,808,000,000
AVERAGE Across Region GSI Effective Rainfall (mm/yr)	470
AVERAGE Across Region GSI Groundwater Recharge (mm/yr)	100
GSI Groundwater Recharge (m/yr)	0.1
Groundwater Recharge to Athboy GWB = [0.1m recharge x m2 area] (m3/yr)	96,400,000
AVERAGE Groundwater Recharge to Athboy GWB = [0.1m recharge xm2 area]/365 days] (m3/d)	264,110
Rainfall Recharge to Total Aquifer area = [AVERAGE 0.1m groundwater rainfall recharge x 17,808,000,000m2 area] (m3/yr)	1,780,800,000
Future Anticipated maximum daily discharge volume from the quarry (m3/d)	6,150
Annual Discharge based on MAX daily discharge from the quarry (m3/yr)	2,244,750
Hydro-G Calculation	
Proportion of Quarry's discharge volume as a % of Athboy GWB's annual rechange amount to groundwater from rain falling on its catchment (%)	**2.33**
Rainfall Recharge to Total Aquifer area = [0.1m rainfall recharge x 17,808,000,000m2 area] (m3/yr)	1,780,800,000
Proportion of Quarry's Discharge as a % of the total AQUIFER area's annual recharge to groundwater from rainfall (%)	**0.13**

8.7.5 Mitigation Measures

The significant potential impacts identified in Table 8.16 are resolved under the mitigation measures set out under Table 8.19. The key principles of avoidance, prevention, reduction and remedy/off-set have been adhered to in this regard.

8.7.6 Residual Impacts

Residual impacts refer to the degree of environmental change that will occur after the proposed mitigation measures have taken effect. Assuming implementation of the mitigation measures, the majority of residual impacts on the hydrological and hydrogeological environment during all phases are assessed to be **unlikely** and **imperceptible**. Residual Impacts are presented in the Mitigation Measures Table 8.19. There are no anticipated residual impacts on the hydrological or hydrogeological environment. A potential residual impact at any quarry site is reduction of groundwater level in local third-party wells. Hydraulic response testing in the 4.13ha application area suggests that the proposed development cannot impact local wells. Mitigation measures for local wells are already in place for the permitted deepening to 10m OD in the adjacent main limestone quarry.

Table 8.19: Summary of Mitigation Measures & Residual Impact Assessment

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
Construction phase	None	n/a	n/a	n/a	n/a	n/a
Operational Phase	Blasting of bedrock	Surface waters; groundwater	Deterioration in groundwater and surface water quality	The blasting protocol to be employed are regulated and controlled by industry standards. Breedon uses Kemex emulsion explosives across all sites. In the EIAR Hydro-G presented a sequence of calculations to estimate N-residue in discharge waters due to blasting. The results of the calculations show that the simulated resultant concentrations for Nitrogen species' residues are very low and satisfy the relevant Environmental Quality Standards by at least an order of magnitude. The risk of impact to local water quality is imperceptible.	Imperceptible	Unlikely
	Extraction of bedrock	Bedrock aquifer	Change in unsaturated thickness resulting in change in groundwater vulnerability classification. Deterioration in groundwater quality	Vulnerability classification in the area shall be maintained at the current classification: Extreme.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Movement of aggregate stockpiles	Surface waters	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	All rainfall-runoff generated on the application site will drain towards the existing limestone sump. These waters are pumped via the balancing pond to the settlement lagoons prior to being discharged to the Kinnegad River. Discharge quality is monitored under an existing EPA IE Licence P0487-07. An extensive network of water management systems are already in place and already serve the proposed application area.	Imperceptible	Unlikely
	Use of earthworks machinery and equipment – spillages during refuelling, use and storage of lubricants	Surface waters; groundwater	Contamination of surface waters and groundwaters with hydrocarbons	Breedon's SOPs have been designed to ensure responsible activity on their sites. There will be no bulk fuels stored on the application site itself. Refuelling of fixed and semi-mobile plant (e.g. crusher) is by dedicated and trained personnel using a mobile bunded (double-skinned) bowser. Procedures are in place to ensure refuelling is carried out above drip trays. Potentially contaminating substances (e.g. lubricants) and hazardous wastes such as waste oil are stored in designated, lockable containers. All waste containers (including all ancillary equipment such as vent pipes and refuelling hoses) are stored within a secondary containment system (e.g. a bund for static tanks or a drip tray for mobile stores and drums). Bunds are in place and are capable of storing 110% of tank capacity, plus a minimum 30 mm rainwater allowance where the bund is	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
				uncovered. Bunds and drip trays to be visually monitored on a regular basis. The designated lubrication storage areas will be in a designated area, not within 30 m of drainage ditches or surface waters.		
	Quarry dewatering – lowering of groundwater levels in surrounding area	Bedrock aquifer	Reduction in third party well yields Reduction in baseflow to surface waters	Runoff generated from rainfall landing on the application area already drains to the limestone quarry sump. The most permeable zone in the Waulsortian Limestones is the weathered zone close to surface, typically in the upper 3 m. This layer has already been removed during previous activities. Hence proposed development works will not introduce any additional shallow subsurface flow from this layer, above that which already occurs. Beneath the application area, almost the entire depth to the proposed floor level of 10 mOD is homogenous limestone of very low permeability. Hence proposed works are unlikely to introduce notable volumes of additional bedrock groundwater. There is some water close to the floor of the application area but this does not persist in depth or sustained pumping. The proposed works have potential to push some small drawdown effects further northwest. However, the point of contact between the Waulsortian Limestones and the Tober Colleen Shales, in that north-westerly direction, appears to form a partial groundwater flow barrier. Hence this is not likely to be a significant impact.	Slight	Likely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
				There will be no net loss or gain in the GWB system because volume intercepted and managed at the site represents, by calculated water balance, 2.3% of the regional groundwater volume. In any case, any waters intercepted at the site are returned to the place they were originally going, which is the Kinnegad River. This maintains the hydromorphological and hydrogeological regime. The site's IE licence contains the discharge licence for water and this is the Mitigation Measure.		
	Use of settlement ponds	Surface waters	Removal and entrapment of particulate matter entrained in waters leaving site	Discharge waters pass through a sequence of existing settlement ponds which are in good condition. These serve to clarify pumped quarry waters prior to them leaving site.The quarry sump and settlement lagoon system have sufficient volumetric capacity to accommodate all waters for the required residence time. Discharge will be of a quality that will not have a detrimental impact on surface water quality in terms of suspended solids.	Imperceptible	Unlikely
	Cleaning of settlement ponds	Surface waters	Improves efficiency of settlement ponds; attenuation Mobilisation and migration of suspended solids	Particulate matter captured in settlement ponds to be transferred to bunds.	Imperceptible	Unlikely
	Use of wheelwash	Surface waters	Removal and entrapment of	A wheel wash facility exists near the site offices and the roads have a dedicated trailed water tanker.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
			particulate matter attached to vehicles			
	Wheelwash maintenance	Surface waters	Improves of wheelwash Mobilisation and migration of suspended solids	The wheelwash is to be maintained in accordance with manufacturer's specifications.	Imperceptible	Unlikely
	Use & maintenance of hydrocarbon interceptors	Surface waters	Entrapment of hydrocarbons lost during discharge	All discharges arising indirectly from the application site shall pass through the existing, appropriately sized hydrocarbon interceptors. Oil that accumulates within hydrocarbon interceptors shall be regularly removed by an appropriately licensed contractor. The hydrocarbon interceptors shall be appropriately maintained in accordance with the manufacturer's specifications.	Imperceptible	Unlikely
	Pumped discharge of quarry waters	Surface waters	Increase flood risk to downgradient receptors	The existing quarry sump is adequately sized to accommodate an extreme rainfall event. The hydrological impact assessment (flood risk assessment) determined that there is sufficient capacity for the Kinnegad River to accommodate discharge waters from the quarry without any increase in flood risk. A flowmeter is fitted on the discharge line to measure and log discharge rates.	Imperceptible	Unlikely
	Pumped discharge of quarry waters	Surface waters	Deterioration in surface water quality	All discharges shall be as per the current IE licence in terms of flowrate and quality.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Pumped discharge of quarry waters	Peat Bog	Degradation of hydrogeological flow regime to peat bog	Groundwater levels are monitored. The potential impact to the area of peat bog to the south of the site was assessed as part of the 1998 and 2009 applications. Site investigation works in 1998 revealed the peat substrate to be underlain by 4 – 7m of low boulder clay. This subsoil remains in situ beneath the peat. Its low permeability means that it acts as a confining layer, resulting in a perched water table within the peats. This perched groundwater within the peats is not in hydraulic connectivity with groundwater stored in the limestone bedrock aquifer. Thus, drainage of water stored in the peats will not be accelerated by reduction of groundwater levels in the quarry sump, and the resultant increase in drawdown extents. Pre-development groundwater conditions in the limestone aquifer were considered to be confined due to the cover of low permeability boulder clay. As a result of interim works the limestone aquifer is now unconfined at the quarry, with current groundwater levels in the sump being ~53mOD, which is approximately 27m below original land's surface. With respect to the peat bog to the south the only source of water is direct rainfall (acidic). The low permeability of the peat means that large amounts of rainfall water are stored within the organic substrate, which provides the supporting conditions for growth. The peat bog is not supplied with groundwater from the underlying limestone bedrock aquifer (alkaline).	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Use of cement manufacturing plant	Surface waters; groundwater	Contamination of surface waters and groundwaters with cementitious material	Cement is manufactured in a dedicated building. There is no storage of use outdoors and no release of waters from the plant that have potential to contain cement.	Imperceptible	Unlikely
	Monitoring	Surface waters; groundwater	Monitoring of discharge rates, suspended solids, discharge water quality, receiving surface water quality, groundwater quality	Regular visual monitoring of the terrace sump, balancing pond and settlement lagoons will continue as per requirements of IE licence to ensure no visual oil or fuel contamination is present. Hydrocarbon is monitored regularly in discharge. Biannual monitoring of on-site wells will continue as per requirements of IE licence.	Imperceptible	Unlikely
Restoration phase	Removal of semi-mobile and mobile plant (pumps, generators, etc.)	Surface waters; groundwater	Elimination of hydrocarbon sources	Positive impact; no mitigation required.	None	None

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Dismantling and removal of fixed plant & machinery (batching plant, wheelwash, etc.)	Surface waters; groundwater	Elimination of hydrocarbon sources	Positive impact; no mitigation required. Materials such as concrete can be crushed and recycled for use as an aggregate in the construction industry.	None	None
	Landscaping and movement of overburden stockpiles necessary to facilitate site restoration	Surface waters; groundwater	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Site restoration will take place on a phased basis as extraction is completed in defined areas of the site. In the final restoration of boundaries with adjoining lands levels will be graded to harmonise with the surrounding landscape. Perimeter silt fence to be installed at the toe of any overburden stockpiles. Interceptor drains 500 mm wide and 500 mm deep will be excavated around the toe slope of any soil. Silt fences to be installed within the interceptor drains. Interceptor drains will divert captured runoff back in towards the site where runoff will enter the settlement lagoons. These will clarify any runoff waters prior to them leaving the site. Restored areas to be vegetated to enhance stability.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Cessation of pumping & discharge	Surface waters; groundwater	Recovery of groundwater levels Reduction of flood risk Reduction in risk of contamination to surface waters	Post-completion groundwater levels will return to pre-development levels (c. 80 mO), thereby partially filling any voids. These voids may be left as open waterbodies for recreational or ecological benefits.	None	None
Unplanned events	Major Spillage	Surface waters; groundwater	Hydrocarbon contamination	All runoff generated on potentially at-risk areas pass through hydrocarbon interceptors prior to leaving the site. The outlet of each interceptor is be fitted with a shutoff valve to facilitate manual containment of a significant spill. A contained spillage will be disposed of appropriately by a licensed contractor. Potentially harmful chemicals stored on site (e.g. lubricants) to be stored under cover on bund trays.	Imperceptible	Unlikely
	Intense Rainfall Events	Surface waters; groundwater	On-site & off-site flooding	Site monitoring data confirms that the site has the ability to retain extreme storm events.	Imperceptible	Unlikely

8.7.7 Cumulative Impact Assessment

A cumulative impact assessment is presented in Table 8.20. The aim of this exercise is to examine whether any other proposed developments have the potential to act in-combination with the proposed application, subsequently giving rise to effects that would not otherwise be significant. The assessment considers the phasing of the proposed project.

The cumulative impact assessment considered activities within a 5km radius and all activities within the Kinnegad River catchment. The Kinnegad River has a large catchment to its outfall (c. 75 km^2) so discretion has been used to select those activities most likely to have an in-combination effect with the application site. The activities included in the cumulative impact assessment include:

- the current operations within the Breedon site, i.e., existing limestone quarry, existing shale quarry, existing cement manufacturing facility;
- future operations within the limestone quarry that have planning permission, i.e., deepening central area to 10 mOD;
- off-site planning activities, e.g. a solar farm submitted under Planning Ref. 22/958.

The application site itself is not self-contained but rather a minor addition to the existing limestone quarry. The purpose of the proposal is to enable better perimeter road access to the permitted main limestone quarry area and to enable efficient extraction of the bedrock resource. Alterations to the IE Licence are not necessary because both flow measurements in the storm scenario and water balance calculations demonstrate that there is adequate capacity in the current IE Licence. The monitoring programme currently in place will be retained.

Whilst some components of the water management regime do not interact directly with quarry waters, all excess waters from the site are discharged to surface waters at a single point and therefore require due consideration given potential for cumulative impacts.

There are some minor developments in the area such as dwellings, residential extensions, agricultural buildings, etc. are listed in Table 8.20. These small developments are necessary to support local communities are not considered likely to significant in-combination effects along with the proposed application.

Table 8.20: Cumulative Impact Evaluation

Type	Operator	Location	Distance	Pl. Ref. / IPC No.	Potential cumulative impacts identified	Likelihood of cumulative impacts	Justification for Decision
Cement Manufacturing Plant	Breedon	Killaskillen	240 m SW of application site	98/2026 & TA/40228 IE Licence P0487-07	Runoff from around the cement plant drains to the Terrace Sump and is pumped forward to the Balancing Pond. Potential impact to Kinnegad River due to migration of suspended solids and cementitious material.	Negligible	All runoff generated from hardstanding around the cement plant is treated and discharged under IE Licence P0487-07. There have been no incidences to date and it is unlikely that there will be incidences in the future.
Limestone Quarry	Breedon	Killaskillen	Adjoins southern boundary of application site. The application site currently part of	98/2026 24.8 ha to 10 mOD; TA/800654 52.5 ha to 70 mOD	Groundwater and rainfall-runoff generated on the application site drains to the limestone sump and is ultimately discharged to the Kinnegad River. Potential impact to Kinnegad River due	Slight	The application site is already part of the limestone quarry and has been deepened by 10 m already. All rainfall-runoff generated on the application site already drains to the quarry sump. It is predicted that groundwater ingress resulting from deepening from 70 mOD to 10 mOD will be <300m3/d and the sump and floor of the quarry

			the limestone quarry		to migration of suspended solids.		have capacity to accommodate that small increase. The envisaged 'new' groundwater is very small and cumulative impact to third party wells is therefore deemed to be slight. The application site is also distant from wells in the Waulsortian Limestones.
Shale Quarry	Breedon	Killaskillen	450 m NE of applicatio n site	98/2026 Gave permissi on to 25 mOD; TA/2019 6 gave permissi on to extend by 1.7 ha.	Groundwater and rainfall-runoff generated on the shale quarry is ultimately discharged to the Kinnegad River. Potential impact to Kinnegad River due to migration of suspended solids.	Negligible	Groundwater level contour map appears to show clear structural separation between the limestone quarry and shale quarry in terms of groundwater flow regime. The cumulative impact to third party wells and discharges to the Kinnegad River is deemed to be negligible.
Solar Farm	Breedon	Killaskillen	165 m NE of applicatio n site	22/958	FRA confirmed no flood risk associated with solar farm. No alteration to hydrological or hydrological regime.	Negligible	No predicted impact to surface waters or groundwater.

Agricultural Buildings	Private	Killaskillen	760 m	TA190618	No alteration to hydrological or hydrological regime. Potential for groundwater contamination	Negligible	No impacts to surface waters or groundwater providing all slurry storage facilities, soiled water tanks and milking parlour constructed in accordance with planning drawings.
Dwelling	Private	Cappaboggan	930 m	TA200091	No alteration to hydrological or hydrological regime.	Negligible	No impacts to surface waters or groundwater providing new septic tank and percolation installed in accordance with planning drawings.
Dwelling	Private	Rattin	1.4 km	21/654	No alteration to hydrological or hydrological regime.	Negligible	No impacts to surface waters or groundwater providing new septic tank and percolation installed in accordance with planning drawings.
Dwelling	Private	Gortnahorna	1.7 km	TA191415	No alteration to hydrological or hydrological regime.	Negligible	No impacts to surface waters or groundwater providing new septic tank and percolation installed in accordance with planning drawings.

8.7.8 Worst Case Impact

Under the worst case of what might happen, a major groundwater strike could be intercepted and the quarry void would fill with groundwater. A lake would be created, the quarry would cease to operate. Water Level in the lake would be close to the elevation of the perimeter of the quarry working area.

This 'worst case' scenario is highly unlikely to occur because the published desktop information suggests a Poorly Productive groundwater flow regime. Site Investigations completed support the published information. In the areas outside the application area, but within the overall landholding, there was evidence of a karst type feature but has now been explored by excavation and it is a sticky CLAY infill that is not capable of bearing water.

8.7.9 Do Nothing' Scenario

If the development did not proceed, the ground of the proposed development would remain similar to the current site status and would be affected. Thus, it would be expected that the application site footprint would not undergo any changes in a 'do-nothing' scenario. Hydro-G has assessed that the groundwater component of the depth proposed for excavation at the site is small, therefore, to extend and excavate is unlikely to change the 'do-nothing' scenario.

8.7.10 Transboundary Impacts

EIA Directive 2014-52-EU invokes the Espoo Convention on Environmental Impact Assessment in a Transboundary Context, 1991, and applies its definition of transboundary impacts. Given the location of the site at >75km, approximately, at its closest position to the border with Northern Ireland, the nature, size and scale of the proposed development, and the fact that water from the catchment in which the site sits does not flow north, it is expected that the development will not have any significant transboundary effects with respect to water bodies.

8.7.11 Application of EA Hydrogeological Risk Assessment Methodology

In addition to the usual impact assessment, description of likely impacts and mitigation measures presented above, a 'best practice' approach to a hydrogeologically focussed assessment of quarrying and dewatering was also applied (Boak, R. et. al., 2007). As previously outlined in the Methodology Section of this Water Section, the UK EA's approach suggests a stepwise thought-process. Following on from the completed desk and field studies, Hydro-G answers to each of the steps can be summarised as follows:

- ***Step 1:*** Establish the regional water resource status:

Answer **=** The application site and surrounding lands overlie an aquifer that is mapped as a Locally Important Aquifer, named the Athboy groundwater body, assigned Good Status (EPA 2010-2015, https://gis.epa.ie/EPAMaps/).

- ***Step 2:*** Develop a conceptual model for the abstraction and the surrounding area:
  Answer **=** The site's discharge (abstraction) is a mixture of rainfall runoff and groundwater inflow. The conceptual model, based on drilling and hydraulic response testing, is that there will be little new groundwater encountered. The porosity of the bedrock is very low. The catchment's hydromorphological regime continues as usual because all waters are discharged, under IE Licence, to the river that they would have originally contributed to. The site's water balance accounts for 2.33% of the Athboy's groundwater body's water balance. That % is assigned a **'Low Potential Impact' and 'Not at Significant Risk'** by WFD characterisation methods (GW5, 2005).

- ***Step 3:*** Identify all potential water features that are susceptible to flow impacts:
  - *Kinnegad River*
  - *River Boyne and Blackwater SAC & SPA*
  - Boyne Estuary SPA
  - Boyne Estuary and Coast SAC
  - Athboy Groundwater Body

- ***Step 4:*** Apportion the likely flow impacts to the water features.
  Answer **=**
  1. *With respect to Surface Waters, no impacts are envisaged because there is no nett loss of water. Any waters arising at the site are discharged back into the same water system under EPA controlled IE Licence. No change is needed in the Licence Conditions. The site is always compliant with the Licence Conditions.*
  2. *Overriding value of significance is that the interception amount at the quarry represents 2.33% of the Athboy groundwater body's water balance.* That % is assigned a **'Low Potential Impact' and 'Not at Significant Risk'** by WFD characterisation methods (GW5, 2005).

- ***Step 5:*** Allow for the mitigating effects of any discharges, to arrive at net flow impacts:
  Answer = Discharge *of waters that are surplus to dust suppression and product generation requirements is to a network of water management systems. No net flow impacts are envisaged.*

- ***Step 6:*** Assess the ***significance*** of the net flow impacts.
  - *Negligible significance*

- ***Step 7:*** Define the search area for drawdown impacts.
  Answer = Area of 1km radius assessed, no targets for impact identified. In any case, the groundwater flow mechanism is mapped, and confirmed, as 'Poorly Productive' flow with extremely low measured hydraulic conductivity in the bedrock boreholes.

- ***Step 8: Identify*** all features in the search area that could be impacted by drawdown.
  Refer to comment ***at Step 7, above.***

- ***Step 9:*** For all these features, predict the likely drawdown impacts.
  - ***None predicted.***

- ***Step 10:*** Allow for the effects of measures taken to mitigate the drawdown impacts.
  - ***Not relevant.***

- ***Step 11:*** Assess the significance of the net drawdown impacts.
  - ***Not applicable***

- ***Step 12:*** Assess the water quality impacts.
  Answer = none *are predicted. The IE Licence P0487-07 is designed to avoid impacts on water quality.*

- ***Step 13:*** If necessary, *redesign* the mitigation measures to minimise the impacts.
  - ***Not necessary.***

- ***Step 14:*** *Develop* a monitoring strategy.
  Answer: The *site* ***monitors their discharge waters in compliance with the Conditions of the IE Licence and this is to continue***. The waters discharged represent an integrated picture of groundwater and surface waters at the site and therefore discharge monitoring is enough.

8.7.12 SAC Protection Measures

The main risk associated with the proposed depth extension to this quarry is the initially perceived potential adverse impact it could have on the River Boyne and Blackwater SAC. However, the proposed future water discharge volume is possible within the existing permitted 6,150 m3/d because the area proposed for development is already within the land mass that collects rainfall and groundwater at the site. The activities are governed and regulated by the EPA under IE Licence. No additional SAC protection measures are required.

8.8 Conclusions

EPA (2022) suggests that the impact assessment should be concise and that conclusions regarding the environment are unnecessary. Instead, conclusions on the Impact Assessment are required and it is hereby concluded that with the application of the Specified Mitigation Measures there will be no residual impact on the water environment.

Similarly, it has been determined that there is no potential for Cumulative Impact.

Given that Guidance on Impact Assessment has been applied as per EPA (2022), it is respectfully proposed that the assessment presented also complies with the EIA Directive.

8.9 Bibliography & References

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Appendices

Appendix 8.A	Previous Planning Determinations
Appendix 8.B	IE Licence P0487-07
Appendix 8.C	Desktop Hydrology & Hydrogeology Reports
Appendix 8.D	Long Term Local Area Groundwater Levels
Appendix 8.E	Site Investigation Results: Production Well Logs
Appendix 8.F	Mathematical Analysis of Site Investigation Tests
Appendix 8.G	Water Quality Analysis Result Tables & Certificates of Analysis
Appendix 8.H	CWSL Reports for Rain and Flow Monitoring
Appendix 8.I	Site Specific Flood Risk Assessment (Envirologic, 2022)

A Figure Series, labelled Figures 8.1 to 8.10, accompanies this Chapter.