

RECEIVED: 27/08/2025

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CHAPTER 7: Land, Soils and Geology

Introduction

- 7.1 This 'Land, Soils and Geology' (LSG) chapter of the Environmental Impact Assessment Report (EIAR) has been prepared for a lateral extension of the eastern boundary of an existing working quarry at Ardgaheen, Claregalway, Co. Galway .
- 7.2 A detailed description of the Proposed Development is provided in Chapter 3.
- 7.3 As described in detail in chapter 3, the proposed development site comprises a 6.1 Ha lateral extension to an existing limestone quarry. The majority of the application area is greenfield and lies immediately to the northeast of the existing operating quarry – refer to the introductory Chapters of this EIAR for Site Layout. Part of the application area is within the working zone of the active quarry. Refer to Quarry Consulting's Site Layout presented at the beginning of the EIAR.
- 7.4 Adjacent to the application area proposed for development in this evaluation is a worked limestone quarry, in the ownership of the applicant, in which the limestone has been extracted from natural ground level.
- 7.5 The proposed development area concerns lateral extension into greenfield agricultural lands that form the eastern boundary of the current working floor of the quarry. That proposed greenfield extension area will be deepened to the same elevation as the floor of the operational quarry. It is therefore possible to examine the wall of rock exposed along the greenfield application's boundary with the working floor of the operational quarry.
- 7.6 This chapter of the EIAR presents the baseline land, soils and geological environment and then assesses potential impacts, assigns mitigation measures and then reassesses the potential residual impacts. Potential cumulative impacts are also addressed.
- 7.7 As stated throughout this EIAR, the assessments have been completed in accordance with the EU EIA Directive 2011/92/EU, as amended by EIA Directive 2014/52/EU and the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018, in order to inform the consideration of the Application and provide the planning authority with the environmental Information that must be considered when determining the Application.
- 7.8 Chapter 1 of the EIAR has confirmed that the Proposed Development is entirely within the administrative boundary of Galway County Council (GCC) and the EIAR is being provided to GCC as part of a planning application seeking full planning permission.
- 7.9 The applicant, Harrington Concrete and Quarries, the application site, contributors to this EIAR and other pertinent details were previously presented in Chapter 1 and Chapter 3 of this chapter.
- 7.10 This Lands, Soils & Geology (LSG) assessment and chapter of the EIAR has been completed by Dr. Pamela Bartley (Hydro-G) who also completed the field works and assessment for the Water assessment. The potential risk of groundwater interception in the areas of land surrounding the application site led to a strong hydrogeological, Water Chapter, focus for the Environmental Impact Assessment for the proposal under consideration.

- 7.11 This current assessment of the LSG environment has added to the historical geophysics information with more recent drilling. Readers are advised to consider the Water Chapter detail in combination with the detail of this LSG Chapter.
- 7.12 This LSG Impact Assessment has applied the most recent guidance from the EPA (2022) in the presentation of information in an EIAR and application of Impact Assessment.

Study Methodology

- 7.13 The objectives of this assessment are, as per the EIA Directive (2014/52/EU) and EPA Guidance (2022), include as follows:
- (i) Use publicly available resources and historical site-specific literature to characterise the baseline land, soils and geological conditions for the site.
 - (ii) Update this information using additional site investigation work (*e.g.*, drilling) and analysis.
 - (iii) Assess the potential impact of the proposed development on the LSG environment.
 - (iv) Specify appropriate mitigation measures for any identified potential impacts, as deemed necessary. The proposed development works, impacts and mitigation measures will then be reassessed, and residual impacts defined.

Statement of Expertise

- 7.14 The Water Chapter and the Lands, Soils & Geology (LSG) Chapter of this EIAR have been prepared by Dr. Pamela Bartley (Hydro-G).
- 7.15 Dr. Pamela Bartley (Hydro-G) is a water focused civil engineer with 24 years' field-based practice in subsurface site investigations. 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 focused Ph.D at TCD. Pamela has completed impact assessments for many regionally important quarries in SAC settings.
- 7.16 Hydro-G completed assessments for McGrath's Quarry, Cong, Mortimers Quarries, Co Galway and collaborated in the compilation of EIAR: Water and LSG chapters for MC Group, Castleisland, Breedon quarries at Spink, Castlepollard, Kinnegad and Lobinstown, Claremorris (McGrath's), Borrisoleigh (Kelly's of Fantane) and Churchill stone, Letterkenny.
- 7.17 Hydro-G was the sole hydrogeologist contributor to the assessments that resulted in the successful grant of permissions, and Section 4 Licensing, at Mc Grath's Limestone, Cong, Co. Mayo, Churchill Stone, Letterkenny, Co. Donegal, Harrington Concrete and Quarries, Ardgaheen, Co. Galway and Bennettsbridge Limestone, Kilkenny.
- 7.18 Hydro-G holds the required Professional Indemnity Insurances, Employers and Public Liability Insurances.

Legislative Instruments & Planning Guidance

- 7.19 This Lands, Soils and Geology assessment was prepared with consideration of European legislation, Irish Regulations and Guidance, listed as follows:
- (i) Mines and Quarries Act (S.I. No. 7 of 1965).
 - (ii) S.I. No. 349 of 1989, European Communities (Environmental Impact Assessment) Regulations, and subsequent amendments (S.I. No. 84 of 1994, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001).
 - (iii) The Planning and Development Acts, 2000, as amended.
 - (iv) The Planning and Development (Amendment) Act 2010, S.I. 600 of 2001 Planning and Development Regulations and subsequent amendments, including S.I. No. 364 of 2005 and S.I. No. 685 of 2006.
 - (v) EIA 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.
 - (vi) S.I. No. 473 of 2011, European Union (Environmental Impact Assessment and Habitats) Regulations 2011 and S.I. No. 584 of 2011, European Union (Environmental Impact Assessment and Habitats) (No. 2) Regulations 2011.
 - (vii) Geology in Environmental Impact Statements. Institute of Geologists of Ireland (2002) & Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements. Institute of Geologists of Ireland (2013).
 - (viii) Quarries and Ancillary Activities: Guidelines for Planning Authorities. Department of Environment, Heritage and Local Government (2004) & Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals). Environmental Protection Agency (2006).
 - (ix) Reclamation Planning in Hard Rock Quarries. Department of Civil & Structural Engineering, University of Sheffield and Edge Consultants, Mineral Industry Research Organisation (2004) & A Quarry Design Handbook. GWP Consultants and David Jarvis Associates Limited, UK (2014).
 - (x) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes. Transport Infrastructure Ireland (undated, c. 2009). <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>
 - (xi) Environmental Impact Assessment of Projects. Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU, as amended by 2014/52/EU. European Union (2017).
 - (xii) Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment. Department of Housing, Planning and Local Government (2018).
 - (xiii) Guidelines on the Information to be contained in Environmental Impact Assessment Reports. Environmental Protection Agency (2022).

- (xiv) Galway County Development Plan 2022-2028.

Consultations

- 7.20 Quarry Consulting managed the Consultation process of this development proposal.
- 7.21 With respect to National Agency responses to consultation communication, the response from the GSI is of primary importance to the LSG assessment. The Geological Survey of Ireland (GSI). The authors of this chapter hereby confirm that this EIAR chapter and Impact Assessment have utilised all relevant and publicly available datasets available from the GSI and all requests of the GSI.
- 7.22 The GSI requested that the operator might assist the GSI's geological heritage goals with the following and be included as a condition of planning as deemed appropriate by the planning authority:
- (1) Allowing access to quarry faces by appropriate scientists (upon request and with due regards to Health and Safety requirements) during quarrying to check for interesting new stratigraphies / relationships as they might become exposed and to establish if the quarry site is worthy of recognition post extraction and through aftercare/restoration planning.
 - (2) If deemed appropriate in (1) above, leaving a representative section of the quarry face at the end of the quarry life or inclusion of information panels to promote the geology to the public or develop tourism or educational resources if appropriate depending on the future use of the site. Natural exposures are few, or deeply weathered, this measure would permit on-going improvement of geological knowledge of the subsurface.
- 7.23 Throughout previous assessments, Pamela Bartley consulted with the Environment Section of Galway County Council (GCC) and the National Federation of Group Water Schemes. The Water Chapter of this EIAR presents more detail on this matter.
- 7.24 Scoping response from Uisce Eireann is discussed in the Water Chapter.
- 7.25 During the assessment period, the site held on site meetings with the Planning Section of Galway County Council and the Environment Section completed operational and compliance site visits.

Impact Assessment Methodology

- 7.26 In addition to adhering to "Guidelines on the Information to be contained in Environmental Impact Statement Reports" (EPA, 2022), the Lands, Soils and Geology assessment was completed in accordance with "Geology in Environmental Impact Statements, a Guide" (IGI, 2002), and "Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements" (IGI, 2013). In addition, "Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes" (NRA, 2009) is referenced where the methodology for assessment of impact is appropriate.
- 7.27 The procedure for determination of potential impacts on the receiving land, soil and geological environment is to identify potential receptors within the site boundary and

surrounding environment and use the information gathered during the desk study and field work to assess the degree to which these receptors will be impacted upon.

- 7.28 Criteria for assessing importance of site attributes and their magnitude of importance were taken from the NRA Guidelines (NRA, 2009) (as included in 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI, 2013)).
- 7.29 The rating of potential environmental impacts on the land, soils and geology environment is based on the quality, significance, duration and type of impact characteristic identified. Consideration is given to both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed activities on that cited attribute.

Assessment of Magnitude and Significance of Impact on Land, Soils and Geology

- 7.30 An impact rating has been developed for each of the phases of the proposed development based on the Institute for Geologists Ireland Guidance for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (IGI, 2013).
- 7.31 In line with the IGI Guidance the receiving environment (Geological Features) was first identified.
- 7.32 The NRA rating criteria Tables of Appendix C of the IGI Guidance are presented as Appendix 7-1 to this assessment. The significance of the impact prior to application of mitigation measures is set out in 7-4. Refer to Appendix 7-1 accompanying this assessment.
- 7.33 The assessments completed in this Section of the EIAR considered phases as follows:
- (i) Construction Phase.
 - (ii) Operational Phase.
 - (iii) Landscaping, Restoration, Decommissioning & Aftercare.

Existing Environment

- 7.34 Desktop mapping and published information were employed to describe the land, soils, underlying quaternary and bedrock geology, areas of geological heritage, areas of economic interest with respect to geological resources and potential for soil contamination.
- 7.35 Desk study site information resources employed include, as follows:
- SLR (2023) Geological Quality Report Ardgaheen, presented as Appendix 7-2. The assessment of the quality of the aggregates is completed by a chartered geologist each year. Hydro-G has reviewed the reports for the purposes of background information and completion of this Environmental Impact and interaction with the receiving environment.
 - Apex (2005) Draft Report on The Geophysical Survey at Ardgaheen Quarry, Claregalway, Co. Galway for John Barnett And Associates Ltd. NOVEMBER 2005. O Connor & O Connell.

- Apex (2021) Report on The Geophysical Survey at the Ardgaheen Quarry, Claregalway, Co. Galway for Harrington Concrete. AGP21055. July 2021.
- EPA mapping for land and geology <https://gis.epa.ie/EPAMaps/>.
- GSI On-line Groundwater database. Teagasc Soil, GSI Subsoils, Bedrock Classifications and Geoheritage Reporting <https://dcenr.maps.arcgis.com/apps/MapSeries/>.
- GSI (2003, 2005) Bedrock Geology Sheets 11, 14 & 15, 1:100,000 Map Series. Geological Survey of Ireland.
- Ordnance Survey of Ireland, 1:50,000 Discovery Map Series.
- Google Earth Pro Historic Photography series.
- EIA portal (<https://housinggovie.maps.arcgis.com/>).
- An Bord Pleanála files.
- Previous EIARs created for applications for the site. Previous Permissions associated with the site are listed in the introductory sections of this EIAR.
- Hydro-G (2022) Discharge to Groundwater Licence Application Hydrogeological Report Harrington's Harrington Concrete & Quarries, Ardgaheen, Claregalway, Co. Galway (Hydro-G, January 2022). Lodged with Galway County Council January 2022. Reference No. W/502/22.
- Irish Drilling (2021) Site Investigation Report for Quarry at Ardgaheen, Claregalway, Co. Galway.
- Meehan, et al., (2019) Geoheritage Reports for Knockmaa, Pollnahallia, Knockmaa Quarries, Ballybanagher M17 Road Cut, Ballyglunin Cave and Lough Corrib.

7.36 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 2019, 2020 and 2021, to support the development of the baseline environment.

7.37 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.

7.38 There are NO geological heritage sites located within a 5 km radius of the proposed development. In the wider landscape, Geoheritage sites mapped by the GSI as follows:

- (i) Knockmaa (GY082) is located c.7km to the north – north west of the quarry and application area. It is mapped under IGI Themes 1, 3, 7. Described as “A large area of landscape with glacial deposits which have slightly modified a much older landscape”. Recommended for Geological NHA. ITM co-ordinates 534800E 748000N (centre of area). Described in detail by Meehan *et al.* (2019) as “The bedrock in the area is Carboniferous Limestone but the primary interest are the karstic features within it that are proven or indicative of a late Pliocene age (the youngest part of the old

terminology 'Tertiary' – from about 5.3 to 2.6 million years ago).

- (ii) Within the Knockmaa landscape is another Geoheritage site named Pollnahallia (GY116), which is mapped under IGI Themes 7 & 12. It is described as a deep, abandoned sand pit, on the southern footslopes of the hills west of Knockmaa Hill. ITM Co-ordinates 533670E 746830N (centre of pit). Again, reported upon by Meehan *et al.* (2019) as "The distinctive white sands and associated lignite exposed at Pollnahallia and in the area of Knockmaa have gained a wider reputation as a mineral resource and as a rare fragment of Ireland's landscape history".
- (iii) The final Geoheritage site within the Knockmaa complex is named "Knockmaa Quarries" (GY083), which are described as Two large working quarries, side-by-side, on the southeastern slopes of Knockmaa Hill. ITM Co-ordinates 536955E 748500N (centre of boundary between both quarries) The quarries are, again, reported upon by Meehan *et al.* (2019) as of geological interest because they provide "a good representative site displaying the Carboniferous limestone bedrock geology of mid-Galway".
- (iv) At c. 6km to the north east of the application area is the 'Ballybanagher M17 Road Cut' (GY010), which is mapped as a Geoheritage site under IGH Theme IGH8. ITM Co-ordinates 543584E 744620N (centre of section). This is a 400 m long road cutting along the M17 motorway is reported by Meehan *et al.* (2019) as "A scientifically useful, well exposed representative section of Carboniferous limestone".
- (v) At c. 8km to the east, north-east, is the Geoheritage site mapped as 'Ballyglunin Cave' (GY013) under IGH Theme IGH1. It is described as a cave consisting of a complex network of passages that is geologically significant because, as again described by Meehan *et al.* (2019), "This is an unusual example of a cave directly under a river bed, with limited connection". 545900E 742050N (cave entrance) ITM Coordinates.
- (vi) At c. 7km due west, Lough Corrib is also mapped as a Geoheritage site (GY093) under IGI Theme 14, 2 and 7. IT is described as "A large lake situated between County Galway's western acidic uplands and the limestone lowlands and is of international conservation importance, for its lakeshore karst assemblages". Co-ordinates (ITM) 517968.525, 744210.183 or 523565E 741910N (Knockferry Pier).

7.39 Each of the GSI's Geoheritage Reports is presented for review in Appendix 7-3. This assessment considered the proposed development's potential to interact with the geoheritage sites and determined that there are no land, soils or geology connections between the quarry and any of the Geoheritage sites except Lough Corrib, which is a water

site. For that reason, Lough Corrib is discussed in detail at the end of Chapter 8 Water, in a Section entitled Lough Corrib SAC Protection Measures.

Site Location & Topography

- 7.40 As described in more detail in Chapter 3 of this EIAR, the site is located within the townland of Ardgaheen, Claregalway, Co. Galway.
- 7.41 The application site and regional topography are presented as Figure 7-1. The application site is situated in a geographical area which is characterised as being a gently undulating low-lying limestone plateau without surface drainage ranging in height from 30-80m above sea level. Refer to Figure 8.3 for regional topography. To the east, immediately bordering the working quarry, the greenfield component of the application lands are 40m OD, approximately. Lands to the west of the overall landholding are 30m OD, approximately. Lough Corrib Lower has a perimeter elevation of 10m OD, approximately, at a distance of c.7 km due west of the site.
- 7.42 Elevations at the site of the active quarry have varied over time. Topography at the working site varies from a natural ground level high point of 35m OD at the weighbridge on the south side of the site to a low zone of -15m OD, approximately, which is the Pre-63 base of the sump in the void of the working quarry. The greenfield application area is proposed for extraction of rock to an elevation of 4m OD and the walls of the quarry bordering the application area allow evaluation of the limestone from the greenfield's ground level to the greenfield's proposed 4m OD floor.

Land Use

- 7.43 As previously stated, according to the County Development Plan (refer to separate Planning Report submitted with the application) the site lies in an area which is zoned as a Rural General area and is not apparent within any designated scenic Views or Prospects. There are no Prime Special Amenity or Secondary Special Amenity areas designated at the site. Agriculture and forestry are the land uses. There is ribbon rural development along the roads leading to the site locally.
- 7.44 Land use in the vicinity of the site predominantly involves agriculture with interspersed forestry and one-off houses – refer to EIAR Chapter on Population and Human Health.
- 7.45 Agricultural land occurs all around the site, apart from along the roads in which there is ribbon rural one-off dwellings.
- 7.46 A recent history of activities on, and in the vicinity of, the application area was gained from aerial photography and historical mapping and is summarised in Table 7-1.

Table 7-1 Historical Land-Use at the Site and its Surroundings

Ordinance Survey Map Reference & / or dates	Existing Quarry Site	Adjacent Greenfield Proposed Development Site to the East	Immediate Surroundings
OS 6" colour (1837-1842)	The site consists of unimproved agricultural land.	Same as the quarry site	There are a number of dwellings south of the site along the road. St Cathaldus's church (mapped as in ruins) is to the east of the site.
OS 6" Cassini (1845)	The site has been split up by boundaries similar to those in place today.	Same as the quarry site	There are a number of dwellings south of the site along the road. There are a number of dwellings, a children's burial ground and St Cathaldus's church (mapped as in ruins) in the vicinity of Corrandrum school, to the east of the site.
OS 25 inch (1888-1913)	No change relative to descriptions above		
Aerial Photography 1995	There is a quarry established on the site.	Greenfield agricultural grazing	New dwellings have been established South and North of the site.
GSI Aerial Maps 2005 - 2010	Significant expansion of the quarry to the southwest of the site	Greenfield lands are scrubby.	Density of Development does not seem to change much.
Google Earth pro Aerial Photography 2014 To 2023	Working quarry footprint remains the same.	Greenfield lands are scrubby.	
		Greenfield lands are brown earth, presumably reseeded grassland.	
		Greenfield lands are good green pasture grasslands.	In 2021 there is a lot of reseeded of grassland locally to the N, W, E of the site. Evidence of ploughing and bare soils.

Soils, Subsoils, Geological Mapping

7.47 Teagasc soil mapping is presented as Figure 7-2, which shows that the soil type over the entire application area used to be 'Predominantly shallow soils derived from calcareous rock or gravels with/without peaty surface horizon' and are described as 'Shallow well drained mineral (Mainly basic)'. The soils in the surrounding farmlands would be described by the GSI as 'Till derived chiefly from limestone' in the 'Grey Brown Podzolics, Brown Earths (medium-high base status)' soils group and also being described as 'Shallow well drained mineral (Mainly basic)'. This information suggests that rainfall can readily travel through the topsoils and recharge subsoils below.

- 7.48 The GSI subsoils map (www.gsi.ie) for the area also shows that the majority of the application site is within the subsoil (Quaternary Sediments) classification of 'Karstified Limestone Bedrock at surface (KaRck)' while the northern and eastern sections of the site are mapped as Carboniferous Limestone Till (TLs), as is much of the wider geographical region. The Subsoils Map is shown as Figure 7-3.
- 7.49 GSI mapping for bedrock is shown as Figure 7-4. The Geological Survey of Ireland (GSI) 1:100000 geology sheet 14 (Galway Bay) shows the entire regional area to be underlain by the Hydrostratigraphic Rock Unit named Dinantian Pure Bedded Limestones. There are no mapped faults in the area. The GSI mapped bedrock Map is shown as Figure 7.9. The GSI (2004) presents that the Dinantian Pure Bedded Limestones are generally over 100 m thick. Most groundwater flows in an epikarstic layer a couple of metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits that extends approximately 30 m below this. Deeper inflows can occur in areas associated with faults or dolomitisation.
- 7.50 Further detail is provided by GSI Data and Maps web mapping in describing the limestone under the site as the 'Burren Formation', which is a pale grey clean skeletal limestone that is typified by pale-grey packstones and wackestones, but also contains intervals of dark cherty limestones, often associated with oolitic grainstones. The formation has been divided into 10 members in the type area of the Burren. The name was first used by MacDermot (unpublished) in Gallagher 1992, 1996, brief description in Sleeman And Pracht (1999) where the unit was formalised, also Pracht et al 2004, and a detailed description in Gallagher et al 2006. Type Sections are at Black Head (base - M 1532 1214) Ballard Bridge (base - R3291 9177) and NE of Ailwee (base - M2481 0658), Co. Clare.
- 7.51 SLR (2023)'s chartered geologist's assessment reports specific bedrock mapping information, as follows:
- "Ardgaheen Quarry extracts limestones from the Two Mile Ditch Member of the Knockmaa Limestone Formation, composed of well bedded, clean, medium to coarse-grained, homogeneous bioclastic grainstones and packstones (limestones). There is no mudrock in the sequence.*
- Quarry site visits and inspection of quarry faces, and stockpile material indicates that the working area of the quarry producing quality aggregates is developed in the Two Mile Ditch Member of the Knockmaa Limestone Formation. Potentially deleterious lithologies and minerals are not present in excessive quantities."*
- 7.52 The Mineral Section of the GSI provides a dataset of Aggregate Potential Mapping (APM) showing areas geologically suitable for quarry development. The quarry is considered to have 'Very High potential' for quarrying of 'crushed rock aggregate'.
- 7.53 SLR (2023, Appendix 7-2 of this Chapter) concludes for Aggregate testing at the site, as follows:
- Current aggregate production at Ardgaheen Quarry is primarily derived from strong, fresh durable limestones.
 - The produced aggregates are strong to very strong, durable, and resistant to fragmentation, have low water absorption characteristics and are compliant with the limits for these properties outlined in the relevant standards for concrete materials.

- Values for Total Sulfur and Acid Soluble Sulfate test results are very low and are well within the limits outlined in all relevant standards.
- The Calculated Equivalent Pyrite (CEP) value determined from this quantitative testing has been calculated at 0.2%. BRE522-1 and Canadian Standard CTQ-M200 indicate that the swelling risk of an aggregate is negligible to very low if the pyrite content is <0.5%.
- The expansion risk of fill materials produced at Ardgaheen is assessed as being negligible on a scale of negligible to very high.
- Aggregates produced at Ardgaheen Quarry are compliant with the relevant standards:
 - TII Series 500, 600, and 800
 - S.R.21:2014+A1:2016 Guidance on the use of IS EN 13242:2002+A1:2007 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
 - SR16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - aggregates for concrete.

7.54 A Geotechnical Assessment is completed for the stability of the rock faces at the quarry at an interval of every two years. The latest report is AMS (2024). These geotechnical assessments demonstrate compliance with the Quarry Regulations (2008).

Site Investigations

7.55 Environmental Impact Assessments have been carried out in connection with various planning applications at or near the site over the past 20 years. Substantive historical site investigation works have been carried out to support these assessments. In this LSG Chapter, results of Site Investigations relating to the water environment are presented, as follows:

- Geophysical information for the application area and the site's associated Nature Based System for water management and discharge zone.
- Information for the Bored Holes in the Greenfield Application Area.
- Hydraulic Conductivity for the bedrock across the site.

7.56 Historical geophysical surveying was carried out and reported for the greenfield application area by Apex (2005) and additional geophysical surveying was completed in the site's discharge zone by Apex (2021).

7.57 Site Investigation Drilling was completed by Priority Drilling in 2020 under field supervision by Hydro-G. In addition, shot blast probe holes were used to explore the greenfield application area in the search for karst conduits. Nothing of particular significance to the

development proposal was found.

- 7.58 All Site Investigation (SI) locations are shown in **Figure 7-5** and all **Site Investigation reports are presented in Appendix 7-4.**
- 7.59 Mineral soils in the area are of limestone origin and described as 'till'. Apex (2005, Appendix 7-4) reported a geophysical survey for the part of the application area that is greenfield and, with respect to soils and subsoils, report that "Overburden appears relatively thin (1 – 3m) across most of the site apart from localised pockets of thicker material (up to 10 m)".
- 7.60 With respect to the non-greenfield component of the application area, it has already been stripped of overburden, hence there will be no impact to soils and subsoils.
- 7.61 Apex (2021, Appendix 7-4) have also assessed the site's discharge area, as subsequently granted by Galway County Council in the W/502/22 Section 4 Discharge Licence issued in 2023. Apex (2021) reported for the discharge area that "Soil cover is generally thin (between 1 and 3 m) with the thickest sequence found along the west and south of the low-lying vegetated area. Soil resistivities are indicative of sandy gravelly CLAY. Seismic velocities of the soil are in the range 400 – 500 m/s indicating a soft-firm material".
- 7.62 Irish Drilling (2021, Appendix 7-4) investigated the overall site's discharge area by multiple Trial Pitting, percolation testing and laboratory analyses of Particle Size Distribution. The Irish Drilling Site Investigation suggests relatively shallow soil in most Trial Pits with depths <1.0 m and measured, fully saturated, hydraulic conductivity of 10^{-5} m/s at the top of bedrock in the percolation test holes.
- 7.63 Hydro-G (2022, Appendix 8.1, Water Chapter report submitted with application for the subsequently granted Section 4 Licence W/502/22) used all Site Investigation results for the discharge area and more details are contained within.
- 7.64 As presented in Plate 7-5, Hydro-G has supervised bedrock drilling within the working floor of the quarry and the adjacent greenfield lands to the east of the site, as follows:
- 2017 = 11 boreholes on the floor of the quarry.
 - 2019 = 26 Site Investigation holes in the greenfields to the north and east of the quarry floor.
 - 2020 = Supervised drilling and installation of 4 long term piezometers in the greenfield lands.
- 7.65 Therefore, bedrock drilling has been completed at 41 locations over the application site and on its peripheries i.e. the working floor outside the current application area. Borehole Logs and Hydraulic Response Test details are contained within the Site Investigation Appendices. Drilling results are discussed hereafter.
- 7.66 **Floor BHs 2017:**

In December 2017, eleven boreholes were drilled into the quarry floor using a 4" blast hole rig. The drill locations were shown on Plate 7-5 and are denoted by a bright red circle with an encircling yellow ring.

Each borehole returned the exact same lithology. There were no changes and no features of note. Therefore, a generalised table of details is presented rather than eleven BH logs with nothing different to show in each. BH details are presented in Table 7-2 and the numbering of that Table should be referenced using Figure 7-6.

With respect to drilling results, returns presented a grey and black, solid, limestone, very hard, no conduits, no water strikes in the zone of the 10m OD floor elevation to base of hole depth drilled elevation of -8.6m OD.

The limestone was pale grey in northern part of proposed vertical extension area and dark cherty limestones in the southern zone. This is not uncommon in the Burren Formation.

Subsequent to drilling, the bedrock was tested for its hydraulic conductivity using falling head response tests in each of the boreholes, except BH6 & BH7, which had gotten covered by a spoil heap. With respect to hydraulic conductivity results, the saturated hydraulic conductivity results average at 10^{-8} m/s K_{sat} and this means that the limestone has the ability to conduct of water similar to a heavy clay. This is classic limestone matrix porosity with no ability to transmit water in the limestone itself. Hence, the karst CONDUIT Aquifer classification. Hydraulic response test results are also presented in Table 7-2.

Those 2017 BHs, on the main floor of the working quarry, are upgradient of the site's discharge zone in terms of regional groundwater elevation flow towards Lough Corrib. Given that the discharge zone's ground elevation is 32m OD, approximately (refer to Trial Pit Logs, Irish Drilling SI Report 2021, Appendix VI), the 2017 BHs represent deep limestone at a depth of 22m to 42m below ground elevation of the discharge zone. Results of the 2017 drilling therefore suggest a competent tight limestone bedrock matrix at significant depth below the discharge elevation and very low hydraulic conductivities.

Table 7-2 2017 Floor BHs Summary Results

		Borehole Drilling Information				Falling Head Response Tests: Hydraulic Conductivity Result					Hydraulic Conductivity Comment/ Primary or Secondary Porosity?
	NGR	Ground Level Elevation (m OD)	Depth Drilled (m)	Base of Borehole Elevation (m OD)	Drilling Notes/ Limestone encountered/Karst Conduits?	BH Water Level (m bgl) February 2018	BH Water Level (m OD) February 2018	Ksat (m/s)	Ksat (m/d)	Ksat (m/d)	
BH 1	38327, 40418	11	21.6	-10.6	4" diameter holes, drilled with blast rig, returned gray and black, solid, limestone, very hard, no conduits, no water strikes in the zone of 10m OD to lowest depth drilled elevation of minus 8.6m OD. Pale grey in northern part of proposed vertical extension area and dark cherty limestones in the southern zone.	2.1	8.9	4E-07	0.03	3.E-02	Hence, the karst CONDUIT Aquifer classification. These Ksat (m/d) results present a limestone matrix that has a slower conductance of water than a heavy clay. This is classic limestone matrix porosity of no ability to transmit water.
BH 2	38315, 40400	10.5	22	-11.5		14.8	-4.3	8E-10	0.00007	7.E-05	
BH 3	38319, 40366	11	22	-11		2	9	4E-08	0.004	4.E-03	
BH 4	38266, 40377	11	21.5	-10.5		10.55	0.45	5E-09	0.0004	4.E-04	
BH 5	38257, 40370	10	21.5	-11.5		3.55	6.45	2E-09	0.0002	2.E-04	
BH 6	38265, 40349	11	21	-10		lost in spoil heaps					
BH 7	38266, 40349	10	21.6	-11.6		0.5	11.5	3E-08	0.0025	3.E-03	
BH 8	38328, 40464	12	22	-10		4	9	8E-10	0.0001	1.E-04	
BH 9	38320, 40489	13	22	-9		1.2	11.8	1E-08	0.0008	8.E-04	
BH 10	38304, 40505	13	21.6	-8.6		0.95	12.05	2E-07	0.02	2.E-02	
								7E-08	6E-03	6E-03	
							8E-10	7E-05	7E-05	Min	
							4E-07	3E-02	3E-02	Max	

7.67 Greenfield BHs 2019:

In February 2019, twenty-six investigation holes were drilled to ground truth the Apex (2005) geophysical survey. The drill locations are shown on Plate 7-5 and are denoted by a brown circle with an encircling blue ring. These holes were drilled with the blast hole to test clay infills identified in the Apex (2005) work. Refer to Appendix 7-4 for the reports.

The 2019 SI BHs revealed limestone rock at surface in most BHs and dry limestone drilling to 30m bgl.

Those Clay Infills identified in the Apex (2005) report did ground truth correctly in 2 BHs only (BH1 and BH6) when drilling did reveal dry gravelly Clay infills from ground level to 14m bgl, when the rig could not progress further. The blast holes were not retained because the drilling was used to test the geophysical results and inform the locations of four permanent monitoring BHs to house 50mm piezometers for long term groundwater monitoring and water quality sampling and analysis.

7.68 Greenfield Monitoring Well Installations 2020:

In October 2020, four Monitoring Wells, 45m deep each, were drilled and completed with 50mm diameter piezometer installations, which were sealed with bentonite grout seals above screens set to target the groundwater strike zones. The drill locations are shown on Plate 7.7 and are denoted by a green circle with an encircling red ring. These Monitoring Wells are also shown overlaid with the APEX (2005) geophysical mapping in Plate 7-7.

The four Monitoring Wells were completed at Ground Level with above ground steel casing and protective fences. Two of the four Monitoring Well locations were chosen to target solid limestone and two locations were selected to target the weathered zones indicated in the Apex 2004 geophysical survey. For each Monitoring Well, both the drillers notes and Borehole Logs are presented in the Site Investigation Appendix VI. The conditions encountered at each MW were related to ground level elevations and drilling details of note are summarised in Table 7-3.

Table 7-3 Greenfield Monitoring Well details of note

	MW 01	MW 02	MW 03	MW 04
MW Co-ordinates	538442E, 740406N	538468E, 740555N	538445E, 740668N	538077E, 740609N
Total Drilled Depth (m)	45	45	45	45
Drilling Details				
Ground Level (m OD)	41.37	40.86	37.38	33.11
Depth of Overburden (m)	0.4	3.7	7	0.3
Top epikarst (m OD)	40.97	37.16	30.38	32.81
Top solid rock (m OD)	39.87	36.36	29.88	31.91
Karst features encountered & depths	NONE	11.9 to 13.8m bgl = dry weathered zone & 28m to 38.4m bgl dry weathered zone.	Deep overburden but no features in bedrock, no voids, dry drilling.	NONE
Water Strike (m bgl)	> 43m bgl	42.5m bgl	38m bgl	40m bgl
Water Strike (m OD)	-1.63	-1.64	-0.62	-6.89
END of MW Drilled Depth (m OD)	-3.63	-4.14	-7.62	-11.89
Calculated Unsaturated depth (m) [i.e. relative to Discharge Zone's Ground Elevation 32m OD]	34	34	33	39

The drilling experiences are described fully in the text that follows.

The details presented in Table 7-3 were determined from the drilling experiences, as follows:

- **MW 01 = Targeting Solid Limestone (Apex, 2005, Appendix VI):**
 - Ground Level Elevation = 41.37m OD
 - Topsoil to 0.4m bgl, broken rock @ 0.4m bgl and solid limestone @ 1.5m bgl.
 - This suggests a 1.1m deep Epikarst at the top of the rock from 0.4m bgl to 1.5m bgl.
 - Well drilled to a total depth of 45m (i.e. base elevation = -3.63m OD).
 - Solid limestone rock from 1.5m to 45m bgl, with no voids, no clay bands and no heavily weathered zones. Mostly a black soft rock, with strong odour that can normally occur when a historic organic matter layer in the sedimentary limestone bedrock is encountered. Some layers of slightly harder grey to dark grey rock.

- No real water strike, small amount of water seeping in from 43m bgl and below (Elevation = -1.63m OD).
- Completed with a 45m long 50mm piezometer with a geotextile sock over a factory slotted screen from 39m to 45m bgl.
- Clean washed pea gravel from 45m to 38m and bentonite seal from 38m to Ground Level.
- **CONCLUSION MW 01: Apex 2004 Geophysics is correct & Solid Limestone is found here.**

- **MW 02 = Targeting Geophysical Anomaly zone (Apex, 2005, Appendix VI):**
 - Ground Level Elevation = 40.86m OD.
 - Topsoil to 0.3m bgl, Gravelly Cobbly Clayey Sands and some rock from 0.3m until 3.7m bgl = Glacial fill above rock with epikarst broken limestone at 3.7m to 4.5m bgl.
 - Solid dark grey limestone bedrock @ 4.5m bgl.
 - Black to grey/dark grey solid limestone. Easy solid drilling from 4.5m to 11.9m bgl.
 - Very weathered rock with clay bands and loose material from 11.9 to 12.2m bgl and then a 0.3m DRY void with CLAY and loose rock again from 12.5m to 13.8m bgl = DRY Karst Feature.
 - Solid from 13.8m bgl to 28.4m bgl but dry weathered zone again from 28.4m to 33m bgl.
 - Solid Limestone again from 33m to end of bored hole to 45m (*i.e.* base elevation = -4.14m OD).
 - Water strike @ 42.5m bgl (Water Strike Elevation = -1.64m OD).
 - Completed with a 45m long 50mm piezometer with a geotextile sock over a factory slotted screen from 39m to 45m bgl.
 - Clean washed pea gravel from 45m to 38m and bentonite seal from 38m to Ground Level.
 - **CONCLUSION MW 02: Apex 2004 Geophysics is correct & there are weathered zones and dry voids here.**

- **MW 03 = Targeting Geophysical Anomaly zone (Apex, 2005, Appendix VI):**
 - Ground Level Elevation = 37.38m OD
 - Topsoil to 0.4m bgl.
 - Clayey sandy Gravel or very weathered rock from 0.4m until 7m bgl = Glacial fill above solid bedrock.
 - 7m to 7.5 m is broken rock = epikarst.

- 7.5m = Solid Limestone rock with no voids, no clay bands. Mostly black, soft and easy to drill rock. Small band of mudstone (0.25m) as is common in sedimentary rock. Hard, grey to dark grey, Limestone to drilled depth of 45m (*i.e.* base elevation = -7.62m OD).
 - Water strike @ 38m bgl (Water Strike Elevation = -0.62m OD).
 - Completed with a 45m long 50mm piezometer with a geotextile sock over a factory slotted screen from 36m to 45m bgl.
 - Clean washed pea gravel from 45m to 35m and bentonite seal from 35m to Ground Level.
 - **CONCLUSION MW 03: Apex 2004 Geophysics is correct in that there is epikarst glacial fill but is deeper than they have mapped. However, there are no anomalies in the limestone bedrock to 45m here.**
- **MW 04 = Evaluating outside the Apex 2005 survey area**
 - Ground Level Elevation = 33.11m OD
 - Topsoil to 0.3m bgl followed by gravelly subsoil to 1.2m bgl.
 - Broken rock from 1.2m bgl to 1.5m bgl.
 - Well drilled to a total depth of 45m (*i.e.* base elevation = -11.89m OD).
 - Solid limestone rock from 1.5m to 45m bgl, with no voids, no clay bands and no heavily weathered zones that present the same black soft rock odorous weathered zones. Some layers of slightly harder grey to dark grey rock.
 - Water @ 40m bgl (Elevation = -6.89m OD).
 - Completed with a 45m long 50mm piezometer with a geotextile sock over a factory slotted screen from 36m to 45m bgl.
 - Clean washed pea gravel from 45m to 35m bgl and bentonite seal from 35m to Ground Level.
 - **CONCLUSION MW 04: Solid Limestone was found here.**

The overall conclusion of the Monitoring Well drilling (2020) is that groundwater strikes are between 38m and 44m bgl and given the slight differences in ground level at each of the drilling sites the water strike elevations range from approximately sea level: *i.e.* groundwater strike elevation @ -0.62m OD @ MW 03 location and significantly below sea level @ -6.89m OD @ MW04.

Considering that the ground elevation at the discharge zone is 32m OD, approximately, there is at least 33m of unsaturated bedrock between the discharge and the groundwater table. However, the Irish Drilling (2021) subsoil investigation revealed very thin soil cover and the Apex 2021 geophysical survey revealed that there are POTENTIALLY vertical shafts in the discharge area, with infill mechanisms for movement towards the walls and so it would be

better to conceptualise and model the discharge as a 'direct discharge', which is permitted in the Groundwater Regulations (2010) and is referred to in Appendix D of the WTSG (2011) Guidance Manual for the Authorisation of Discharges to Groundwater.

7.68 With respect to hydraulic conductivities completed for various parts of the site, the following can be summarised and noted:

- Greenfield area MWs with piezometer screened interval from 5m OD to -5m OD $K_{sat} = 10^{-6}$ m/s.
- Quarry Floor deep limestone bedrock @ 10m OD to -20m OD $K_{sat} = 10^{-8}$ m/s (Hydro-G, 2017) & Table 7-2.
- Discharge Area top of rock @ 31m OD, approximately = epikarst $K_{sat} = 10^{-5}$ m/s (Irish Drilling, 2021, Appendix 7-4).

Results at different depths suggest that there is an order of magnitude reduction in hydraulic conductivity between the epikarst limestone, the bedrock at 25m bgl and again another 'order of magnitude' reduction in hydraulic conductivity in the bedrock at 50m bgl.

7.69 Photographs of the bedrock walls of the quarry were presented in Chapter 8. The quarry face bedrock exposures on the perimeter of the quarry with the greenfield application area shows competent bedrock. The walls of the quarry with the application area to the north and west were dry on every single visit of many completed by Hydro-G between 2017 to 2024.

7.70 In overall summary, site investigations have found no potential for interaction between the proposed bedrock extraction zone and any landscape features outside the site.

Impact Assessment

7.71 Over the part of the application area that is already worked bedrock, the impact to the geological (soils/subsoils) attribute is deemed to be 'Negligible' because of the absence of soils/subsoils.

7.72 Over the part of the application area that is greenfield, there is thin soil cover and the impact is also 'Negligible'. The area is not known for subsoil value.

7.73 Bedrock at the site is considered to be a geological attribute of High importance and the proposed excavation works would have a potential adverse impact of Moderate magnitude (Loss of a moderate proportion of future quarry or pit reserves). The impact to the geological (bedrock) attribute is deemed to be 'Significant/Moderate'.

- 7.74 The application of the framework and methodologies provides a general screening of the likely impact to the land, soils and geology environment.
- 7.75 The procedure for determination of more specific potential impacts to the receiving land, soils and geology environment is to use the information gathered, by desk study and field work, within the site boundary and surrounding landscapes and the assessment of potential impacts to these receptors are then described in terms of quality, significance, duration and type. This methodology adheres to the terminology provided by (EPA, 2022)'s Table 3.4 'Description of Effects', as provided in 'Guidelines on the information to be contained in Environmental Impact Assessment Reports'.

Potential Impacts - Direct

- 7.76 Potential Impacts can arise from three project phases:
- (i) Construction (enabling) phase.
 - (ii) Operational phase, and
 - (iii) Landscaping, restoration, decommissioning and aftercare phase.
- 7.77 Historical, permitted, development across the working floor component of the application area involved the stripping of soils and overburden followed by the extraction and breaking of rock. This has already taken place within part of the footprint of the application area. The Construction Phase is already past. No enabling works are necessary for some of the site and for that area, there are no Potential Impacts for the Construction (enabling) Phase.
- 7.78 For the greenfield area of the application area there will be stripping of thin soils and there could be Potential Impacts for the Construction (enabling) Phase.
- 7.79 With respect to the Operational Phase, further extraction of bedrock within the application site and associated activities, such as blasting and mechanical removal of rock, has the potential for direct impact on the geology of the limestone within the bedrock extraction area. This is therefore considered to be a direct and permanent impact to bedrock. This impact has occurred historically within the active quarry and it is considered appropriate in order to continue extraction of bedrock at this site. Operational Phase impacts require assessment.
- 7.80 The significance of the continued extraction of bedrock from this geological unit is considered to be significant/moderate, again as a function of the proposed scale of excavation being sought as part of this application. A quarry of this size would be considered to be at lower end of medium scale for quarry development.
- 7.81 It is proposed to develop two extractive benches of limestone below the greenfield application area. The lateral expansion development of the quarry will result in the exact

same rainfall runoff amount at the quarry and the drilling experience suggests potential for a small additional volume of water that will require management.

Water Management Systems are already in place to manage the waters that will arise on the floor during the excavation and breaking of bedrock proposed. In order to maintain a dry working environment on the floor of the quarry the floor sumps will evolve with progression into the bench being excavated. Following attenuation and treatment, the waters arising from operation of the site will be discharged to surface water, under the Section 4 Discharge Licence for the site (W/502/22). Review of the information presented in the Water Chapter suggests that there is adequate capacity in the existing discharge licence and it will not need review or amendment in order to treat the proposed development's waters.

- 7.82 By its nature, quarrying of the underlying rock will involve removal of an identified geological resource and therefore impact upon land, soils and geology must be expected. There will be impact arising from removal of rock. There need not be negative impacts, by virtue of correct design and mitigation measures.
- 7.83 There is potential for contamination of exposed overburden and bedrock as a result of spillages and leakages. Providing adequate mitigation control measures are in place, the risk of such is deemed to be negligible.
- 7.84 Quarrying presents a risk of potential impact on the stability of the bedrock environment. Subsidence, slope stability, compaction and slope failure are fully considered in the design of all extraction phases at this site, which ensures that these impacts will be prevented.
- 7.85 The decommissioning phase will provide a safer environment than is currently the case, with the removal of all plant and infrastructure, and creation of stable slopes in the interest of health & safety and long-term sustainability.
- 7.86 The restoration stage of the project describes the aftercare phase that follows the cessation of extractive activities. The restoration plan will involve allowing water to accumulate in the quarry void. This confirms that the long-term land use will have changed from quarrying to biodiversity/amenity.
- 7.87 The site will be reinstated in accordance with the approved quarry restoration scheme, and thus integrated back into the surrounding landscape with the attendant improvement to the visual amenity of the area. This benefit is acknowledged in the Galway County Development Plan (2022-2028).
- 7.88 With respect to geological features there are no Designated Sites with Conservation Objectives (SACs or SPAs) relating to geology within the application area or within radius of influence of the proposed development.
- 7.89 On the basis of the foregoing, the Summary Table for Potential Impacts on Land, Soils and Geology is presented as Table 7-4.

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Table 7-4 Summary of Potential Impacts on Land, Soils & Geology Environment

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
Enabling Phase	Not Applicable – Site is already enabled with its existing road entrance and part of the application area is a hard rock floor of quarry. With respect to stripping of the thin soils of the greenfield application area, management controls are in place (as per W/502/22).									
Operational Phase	Extraction of bedrock	Bedrock	High	Loss of bedrock	Moderate / Adverse	Significant / Moderate	Removal many MT over 25 years.	Likely	Permanent	Direct
	Extraction of bedrock	Bedrock	High	Raw material for use in construction industry	Positive	Significant/ Moderate	Local & Regional resource generation	Likely	Long-term	Direct
	Use and storage of fuel & hydrocarbon	Bedrock	High	Potential for contamination of underlying bedrock during refuelling or due to leakage	Adverse	Significant/ High	Within application boundary	Unlikely	Medium	Direct

Environmental Impact Assessment Report

Client: Harringtons Concrete and Quarries

Ref. No.: 03.23

Project: Proposed Lateral Extension to a Limestone Quarry at Ardgaheen, Claregalway, Co. Galway

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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
Restoration Phase	Landscaping, movement of soils and stockpiles necessary to facilitate site restoration	Soil & Bedrock	High	Restoration of land to water-filled void	Positive	Significant/ Moderate	Application Area	Likely	Permanent	Direct
Unplanned Events	Fuel tank failure or large scale spillage	Exposed Bedrock	High	Hydrocarbon contamination	Negative	Significant/ High	Within application site boundary	Unlikely	Medium	Direct

Potential Impacts - Indirect

- 7.90 Indirect impacts (or secondary impacts) are those which are not a direct result of the proposed activity, often produced away from the project site or because of a complex pathway. The extraction of bedrock across the floor has already removed the capacity of these lands to provide agricultural production. The indirect impact on the soils may be considered to be of a medium to long-term nature because the soils have been reused elsewhere.
- 7.91 Activity at the proposed development site has the potential for the generation of dust, which could have an indirect, brief, imperceptible impact beyond the application boundary, without mitigation and monitoring methods already associated with the site.

Impacts – Transboundary

- 7.92 The 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 (c. 120 km from the border with N. Ireland), the nature, size and scale of the proposed development, it is expected that the impacts of the development would not have any significant transboundary effects with respect to land, soils and geology.

Impacts – Cumulative

- 7.93 The aim of the cumulative impact assessment 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.
- 7.94 The cumulative impact assessment considered relevant activities within a 10 km radius. The cumulative impact Section of the Water Chapter has considered all potential for cumulative impact on the hydrogeological environment and the same targets are relevant for the geological environment. Given that the Water Chapter could conclude no potential for cumulative impact with other developments with respect to hydro and geology, the same conclusion is possible here in the LSG conclusions: No Potential for Cumulative Impact.

'Worst Case' Impacts

- 7.95 The 'worst case' impacts would involve a substantial fuel or other hydrocarbon spill on-site, resulting in localised contamination of the working bedrock environment, given that there are no soils or subsoils on the quarry floor. However, the floor sump, hydrocarbon interceptor and Water management system associated with the Section 4 Discharge Licence (W/5-2/22) will ensure that there is no migration of contamination off site.
- 7.96 Additionally, lowering the quarry floor could increase the groundwater component in the sump, which will need to be dewatered. This could lead to increased discharge to external surface watercourses and to lowering of the water table outside the quarry, with a possible

attendant impact on nearby domestic wells. The quarry floor and its sump settlement system are to be adequately sized to handle the water volumes they will receive.

Mitigation Measures

- 7.97 Mitigation measures are set out in Table 7-5 and these will be adopted for the proposed extraction activities to reduce the potential impacts to the receiving land, soils and geology environment as identified in Table-7-4.
- 7.98 As a result of the mitigation measures implemented at the site, it is considered that any impacts associated with the quarrying related activities undertaken at the site will not contribute to cumulative impacts in combination with any developments in the surrounding area.

Residual Impacts

- 7.99 Residual impacts refer to the degree of environmental change that will occur after the proposed mitigation measures have taken effect. Residual Impacts are also shown with Mitigation Measures in Table 7-5.
- 7.100 As a result of the proposed mitigation and enhancement measures incorporated in the design, no significant, long-term, adverse residual impacts are predicted in terms of Land, Soils and Geology during the operational phase, other than the inevitable loss of mineral resources (i.e., limestone) due to quarrying.
- 7.101 It is considered that following full restoration and closure of the site that there will be no significant, long-term, adverse impacts in terms of Land, Soils and Geology, again other than the permanent, significant negative impact due to extraction of the mineral resources. The restored quarry will provide a more manageable environment, than is currently the case, but with a change in land-use from Mineral extraction to the future beneficial future land-use as wildlife amenity.
- 7.102 The primary mitigating factor is that the overall regional and national scale of this type of bedrock is large. The impact of the extraction of the proposed footprint of limestone bedrock is small relative to the volume of this type of this rock in the region. A large area of Galway and Clare is underlain by this type of Limestone.

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Table 7-5 Mitigation Measures and Residual Impacts

POTENTIAL IMPACT				MITIGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
Phase where impacts may arise	Activity	Attribute	Character of Potential Impact	Description of Mitigation	Significance or quality of Effect	Probability
Construction	Not applicable as explained in Table 7-5.					
Operational	Extraction of bedrock	Bedrock	Local & Regional Resource Generation	No mitigation required for the supply of materials because it is the planned, positive activity for the development.	Positive, Significant	Likely
	Extraction of bedrock	Bedrock	Long-term stability	A detailed working scheme/ restoration plan has been prepared. In preparing the design, standard criteria were adopted with regard to face slopes, standoffs to site boundaries, etc. The final quarry face angles have been assessed by a geotechnical engineer to ensure long-term stability after completion of extraction operations. The stability of restored faces observed in the existing quarry indicates that the long-term stability of the final quarry faces will be satisfactory in this geological environment.	Negative, Not significant	Likely
	Extraction of bedrock	Bedrock	Geological Heritage	Allowing access to quarry faces by appropriate scientists (upon request and with due regards to Health and Safety requirements) during quarrying to check for interesting new stratigraphies / relationships as they might become	Positive, Significant	Likely

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Ref. No.: 03.24

Project: Proposed Lateral Extension to a Limestone Quarry at Ardgaheen, Claregalway, Co. Galway

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POTENTIAL IMPACT				MITIGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
Phase where impacts may arise	Activity	Attribute	Character of Potential Impact	Description of Mitigation	Significance or quality of Effect	Probability
				<p>exposed and to establish if the quarry site is worthy of recognition post extraction and through aftercare/restoration planning.</p> <p>Leaving a representative section of the quarry face at the end of the quarry's life or inclusion of information panels to promote the geology to the public or develop tourism or educational resources if appropriate depending on the future use of the site.</p> <p>Should any significant bedrock exposures of importance be identified, Breedon will work with the GSI to find a mutually beneficial arrangement on how best they can be designed to remain visible as rock exposure rather than covered with soil and vegetated, in accordance with safety guidelines and engineering constraints. This measure would permit on-going improvement of geological knowledge of the subsurface and could be included as additional sites of the Geoheritage dataset, if appropriate.</p> <p>The final land restoration scheme will ultimately allow the site to be returned to a condition whereby there will be negligible residual impact on the geological heritage of the site and surrounding environment due to the excavation and removal of bedrock underlying the site. It is planned to minimise, eliminate or decrease long-term ecological and visual impacts on the environment through the implementation of the final restoration scheme.</p>		
	Landscaping. Restoration of Residual faces, movement of berms	Soils, subsoils & Bedrock	Restoration of land to water filled void	No mitigation is required for restoration as it is a planned part of the development.	Positive, Moderate	Likely

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POTENTIAL IMPACT				MITIGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
Phase where impacts may arise	Activity	Attribute	Character of Potential Impact	Description of Mitigation	Significance or quality of Effect	Probability
	and stockpiles necessary to facilitate site restoration			<p>It is anticipated that final restoration will be achieved within 2 years of completion of extraction operations. Final restoration will be to a beneficial after-use as a secure wildlife refuge/ amenity with water feature. The intention is to create a habitat suitable for aquatic life and birds, such that the disused workings will eventually become of considerable amenity value. A detailed Restoration and landscaping plan has been prepared as part of the application.</p> <p>A well-coordinated restoration process will ensure that representative areas of quarry faces are left unvegetated. Parts of the upper benches will also be seeded with suitable species of shrubs and climbers to create vegetated ledges. Vegetation and natural colonisation on these benches will encourage growth on the faces and will subsequently break up the natural harshness of the exposed rock face. This will occur in a progressive manner as quarrying progresses.</p>		
Restoration Phase	Fuel tank failure or large-scale spillage	Exposed Bedrock	Potential for contamination of exposed bedrock as a result of spillages/leakages.	<p>Fuels are stored with bunds.</p> <p>Refueling and lubrication of semi-mobile plant and haulage vehicles is carried out by a trained and dedicated operative.</p> <p>Control measures exist as standard operating procedures in the overall quarry.</p>	Neutral	Unlikely

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Phase where impacts may arise	POTENTIAL IMPACT			MITIGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
	Activity	Attribute	Character of Potential Impact		Description of Mitigation	Significance or quality of Effect
Unplanned Events	As above.					

Interaction with other Impacts

- 7.103 The EIA guidelines (EPA, 2022) highlight that the interaction of impacts to the land, soils and geological environment, arising from proposed activities, must be given due consideration alongside potential receptors identified in other EIA sections. The likely interactions have been identified as follows:
- (i) The movement of bedrock by blasting and mechanical means can give rise to increased dust emissions.
 - (ii) The operation of plant associated with extraction and haulage can give rise to increased traffic movements.
 - (iii) The operation of plant associated with extraction and haulage can give rise to increased noise emissions.
 - (iv) The extraction of bedrock can impact upon surface and groundwater quality and flow patterns.
 - (v) The extraction of bedrock can impact upon biodiversity and cause disturbance to habitats in the area.
- 7.104 Each of these issues and the mitigation measures proposed are addressed in detail in the relevant sections of this EIA & the 'Interactions of the Foregoing'. These impacts are considered to be negative but with suitable measures in place, their significance can be mitigated, with the exception of the extraction of bedrock, the removal of which is permanent. However, this is an inevitable consequence of quarrying and extractive activities that is deemed essential to development of society.

Do-Nothing Scenario

- 7.105 The 'Do Nothing Scenario' evaluation requires consideration of the effect on the environment as it would be in the future should the proposed works not be carried out.
- 7.106 If the development did not proceed, the aggregate resource would remain unused in situ, and the local supply of quality aggregates would be more restricted. The existing permitted quarry comprises a moderate-sized quarry. The quarry floor area represents a disturbed and degraded landscape with infrastructure and stockpiles on the quarry floor. The greenfield component of the application area is currently pasture.
- 7.107 Under the 'Do Nothing' scenario, all quarrying activities would cease. The site would be restored to beneficial after-use as per the requirements of the existing planning permission. However, the potential future resources of the quarry would remain in situ, unutilised, and would possibly result in the requirement to develop a more remote greenfield site in a different part of the landscape.
- 7.108 As the proposed activities are a continuation and extension of activities at an established extraction site, it is envisaged that no new or different potential impacts shall be introduced when compared to the current operational phase.

- 7.109 It is considered more appropriate to continue activities at an existing active quarry as opposed to opening a new quarry on a greenfield site. The extractive industry is necessary in order to meet the needs of society for homes, transport networks, places of work and recreational areas. Quarrying is an established land use at this site and it has been integrated into the local environment. As it is a continuation of existing activities, there will be effectively no construction or enabling phase with respect to access to the extraction area.
- 7.110 The extraction is sought to provide the applicant with the ability to respond to demand for aggregates in the region. Permission is sought for a period of 25 years.
- 7.111 Whilst machinery will be replaced as necessary, there will be no increase in site infrastructure associated with ongoing extraction, internal haulage and processing of raw material.
- 7.112 Sourcing of bedrock at a greenfield site at a further remove would significantly increase impacts linked to traffic such as increased combustion of fossil fuels.

Monitoring

- 7.113 As no significant impacts are expected other than the loss of the mineral resource, no specific monitoring with respect to the land, soil or geological environment is likely envisaged.
- 7.114 The detailed procedures to be followed, in respect of monitoring for the purpose of demonstrating compliance with Permissions and Licences etc., are understood by site workers, operators and management. Operation of the quarry already includes monitoring activities (e.g., Water, Blasting, Noise and Dust) to demonstrate that the development is not having an adverse impact on the surrounding environment.
- 7.115 Future environmental monitoring reports for the site will continue to be submitted to Galway County Council for their approval prior to the commencement of quarry activities.
- 7.116 New monitoring programs will be compiled to comply with any new Conditions attached to any decision to grant planning permission, and also to ensure that the development is not having an adverse impact on the surrounding environment.

Close

- 7.117 The Galway County Development Plan (2022 – 2028.) acknowledges that the continual supply of aggregates, including recycled construction and demolition material, is necessary for the implementation of the National Development Plan. The field works and application of EPA (2022), NRA (2009) and IGI (2013) Guidelines for assessment enable a conclusion that the crushed stone can continue to supply rock, with the application of mitigation measures, and that there will be no residual effects. It is respectively requested that the site has been assessed in accordance with the EU EIA Directive 2011/92/EU, as amended by EIA Directive 2014/52/EU and the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018.

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Figures



Figure 7-1 Application Site and Regional Topography

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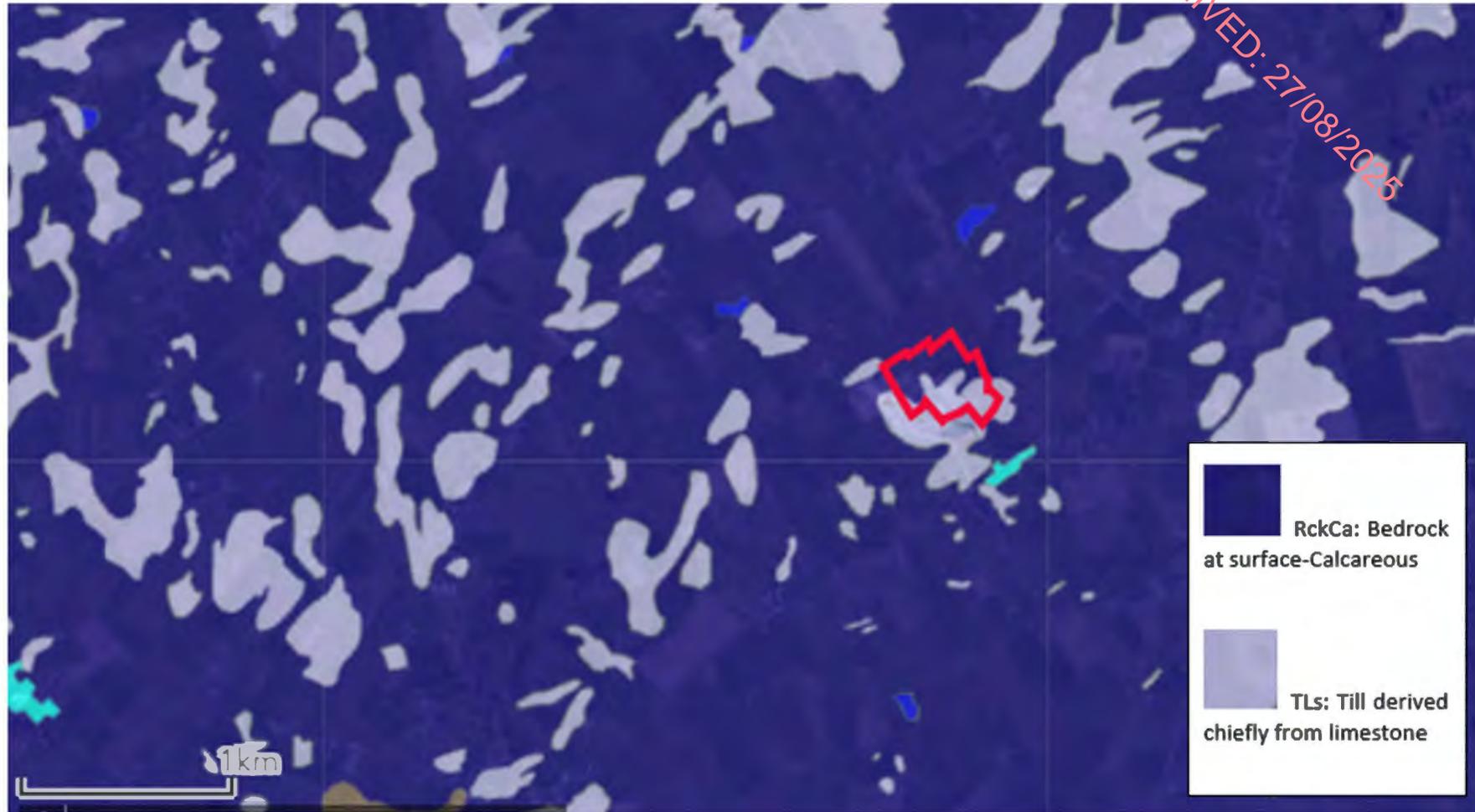


Figure 7-2 Teagasc Soils Mapping & Harringtons Quarry Application Area

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Figure 7-3 GSI Subsoil Mapping & Harringtons Quarry Application Area

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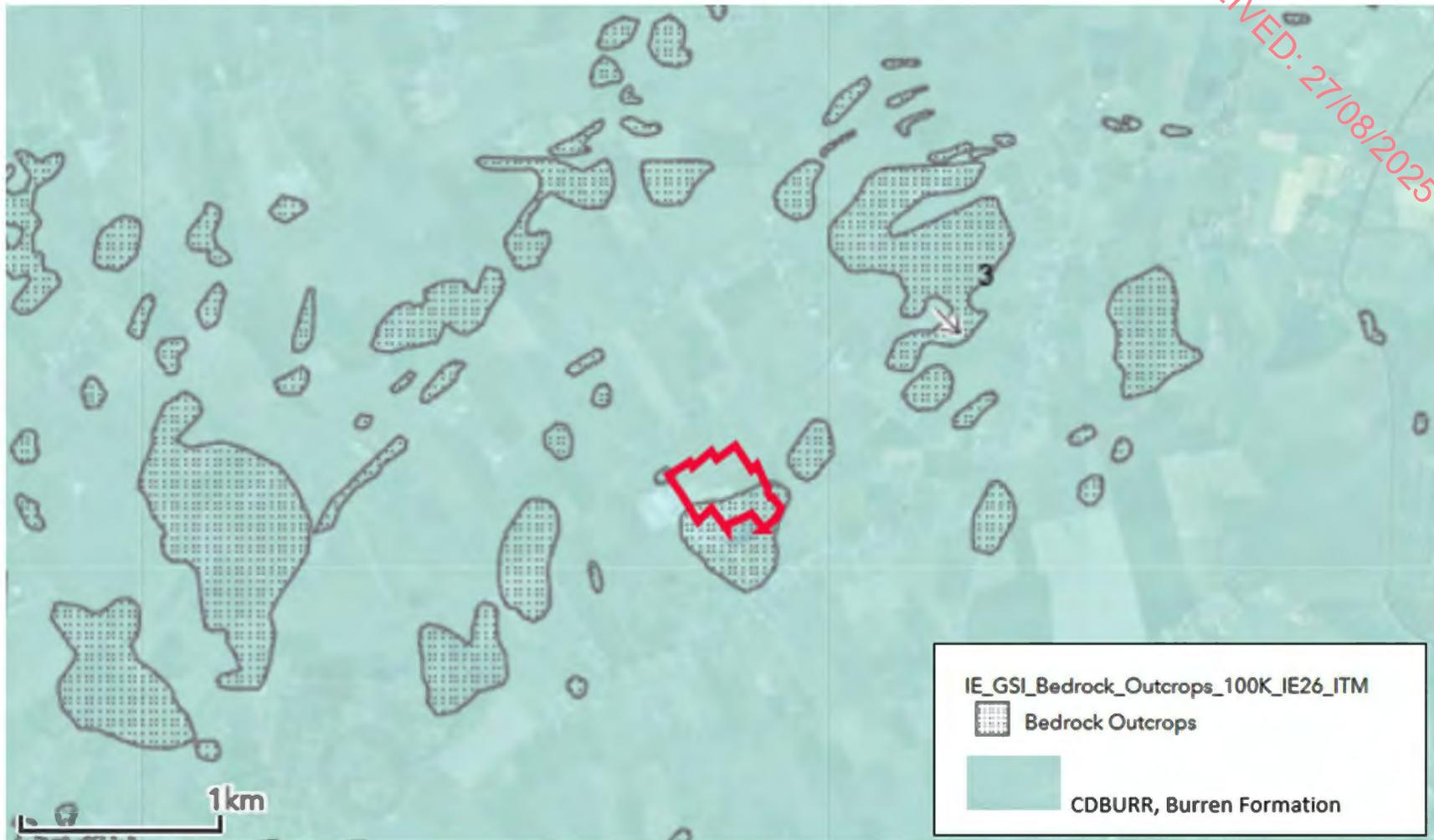


Figure 7-4 GSI Bedrock Mapping 100K

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Legend				
■ Percolation tests	■ Trial Pits	● Floor BHs (2017)	● Greenfield BHs (2019)	● Piezometer BHs (2020)
— 2D Resistivity	○ ? Sinkhole/Shaft	— Seismic Refraction profile	F1 Weathered Fractured Rock	◀ Flow into Quarry ??
- - - 2004 Geophysical Survey area		- - - 2021 Geophysical Survey area		

Figure 7-5 Site Investigation Mapping



Figure 7-6 Floor BH IDs (2017) with reference to Table 7-2 data for Ksat.

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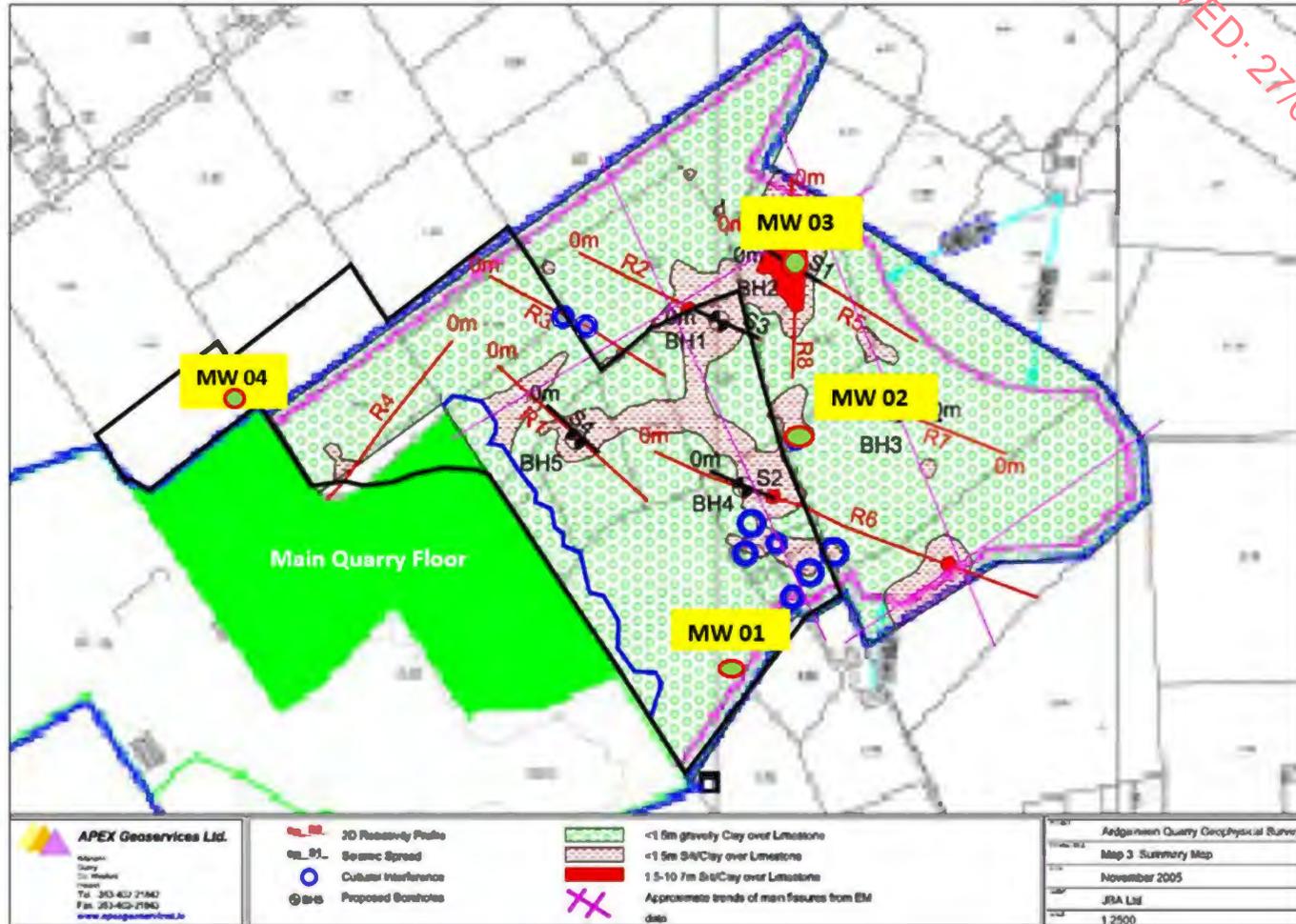


Figure 7-7 Greenfield MW Installation Locations 2020 (●), overlaid with Apex (2005) Geophysical Results.

Appendix 7-1

NRA rating criteria Tables of Appendix C of IGI (2013) Guidance

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Table 7-1-1 Criteria for Rating Site Importance of Geological Features (NRA, 2009)

Magnitude	Criterion	Description & Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale	<ul style="list-style-type: none"> Geological feature on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying the site is significant on a local scale	<ul style="list-style-type: none"> Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site) Well drained and/or high fertility soils Moderately sized existing quarry or pit Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying the site is moderate on a local scale	<ul style="list-style-type: none"> Contaminated soil on site with previous light industrial usage Small recent landfill site for mixed wastes Moderately drained and/or moderate fertility soils Small existing quarry or pit Sub- economic extractable mineral resource
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying the site is small on a local scale	<ul style="list-style-type: none"> Large historical and/or recent site for construction and demolition wastes Small historical and/or recent landfill site for construction and demolition wastes Poorly drained and/or low fertility soils Uneconomic extractable mineral resource

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the impact. The magnitude criteria for geological impacts are defined in Table 7-1-2.

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Table 7-1-2 Criteria for Estimating Magnitude of Impact on Geology Attribute (NRA, 2009)

Magnitude	Criterion	Description & Example
Large Adverse	Results in loss of attribute	<ul style="list-style-type: none"> Loss of high proportion of future quarry or pit reserves Irreversible loss of high proportion of local high fertility soils Removal of entirety of geological heritage feature Requirement to excavate / remediate entire waste site Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	<ul style="list-style-type: none"> Loss of moderate proportion of future quarry or pit reserves Removal of part of geological heritage feature Irreversible loss of moderate proportion of local high fertility soils Requirement to excavate / remediate significant proportion of waste site Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	<ul style="list-style-type: none"> Loss of small proportion of future quarry or pit reserves Removal of small part of geological heritage feature Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils Requirement to excavate / remediate small proportion of waste site Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

The matrix in Table 7-1-3 determines the significance of the impacts based on the site importance and magnitude of the impacts as determined by Table 7-1-3 and Table 7-1-2.

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Table 7-1-3 Criteria for Rating of Significant Environmental Impacts (NRA, 2009; JGI, 2013)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small	Moderate	Large
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/moderate	Profound/significant	Profound
High	Imperceptible	Moderate/slight	Significant/moderate	Severe/significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/moderate

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Appendix 7-2

SLR (2023) Geological Resource Report



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Ardgaineen Quarry

Aggregate Compliance Assessment Report

Harrington Concrete & Quarries

Ardgaineen, Co. Galway

Prepared by:

SLR Environmental Consulting (Ireland) Ltd

7 Dundrum Business Park, Windy Arbour, Dublin, D14 N2Y7

SLR Project No.: 501.065235.00001

13 December 2023

Revision: 00

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
00	13 December 2023	Tom Moore	Tom Moore	Tom Moore

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Basis of Report

This document has been prepared by SLR Environmental Consulting (Ireland) Ltd (SLR) with reasonable skill, care and diligence, and taking account of the timescales and resources devoted to it by agreement with Harrington Concrete & Quarries (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

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Executive Summary

SLR Environmental Consulting Ireland were requested by Harrington Concrete & Quarries to assess the geology of Ardgaineen Quarry – Ardgaineen, Co. Galway, review a range of geological investigations and test results conducted on the aggregates produced at the site and to assess the geology of the site, the quality of aggregates produced at Ardgaineen Quarry and their compliance with a range of aggregate standards.

This assessment has been undertaken by Professional Geologist – EurGeol Tom Moore PGeo.

Geology of Ardgaineen Quarry

Ardgaineen Quarry extracts limestones from the Two Mile Ditch Member of the Knockmaa Limestone Formation, composed of well bedded, clean, medium to coarse-grained, homogeneous bioclastic grainstones and packstones (limestones). There is no mudrock in the sequence.

Quarry site visits and inspection of quarry faces and stockpile material indicates that the working area of the quarry producing quality aggregates is developed in the Two Mile Ditch Member of the Knockmaa Limestone Formation.

Potentially deleterious lithologies and minerals are not present in excessive quantities.

Statement of Compliance of Aggregates

Aggregates produced at Ardgaineen Quarry by Harrington Concrete & Quarries Ltd have been geologically assessed and relevant aggregate tests have been completed by accredited testing laboratories and professionals.

The results of the above assessments and testing have been reviewed by a Professional Geologist qualifying as a Competent Person with the production faces in the quarry inspected. Bulk samples of the production material were taken in accordance with I.S. EN932-1.

The aggregates have been determined to be in compliance with the test requirements of the following relevant standards and are suitable for use in the following aggregate products which are produced at Ardgaineen.

- S.R.21:2014+A1:2016 Guidance on the use of IS EN 13242:2002+A1:2007 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction.
- SR16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - aggregates for concrete.



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Appendices

Appendix A	Aggregate Test Results
Appendix B	Petrographic Reports



1.0 Introduction

SLR Environmental Consulting Ireland were requested by Harrington Concrete & Quarries to assess the geology of Ardgaineen Quarry, Co. Galway, review a range of geological investigations and test results conducted on the aggregates produced at the site and to assess the geology of the site, the quality of aggregates produced at Ardgaineen Quarry and their compliance with the relevant aggregate standards.

This assessment has been undertaken by Professional Geologist – EurGeol Tom Moore PGeo.

2.0 Location Details and Production History

Ardgaineen Quarry is located in Co. Galway.

Ardgaineen Quarry produces a wide range of quarry products including aggregates suitable for the following end use:

- TII Series 500, 600, and 800
- S.R.21:2014+A1:2016 Guidance on the use of IS EN 13242:2002+A1:2007 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
- SR16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - aggregates for concrete.

3.0 Geology of Ardgaineen Quarry

3.1 Bedrock Geology

Ardgaineen Quarry extracts limestones from the Two Mile Ditch Member of the Knockmaa Limestone Formation, composed of well bedded, clean, medium to coarse-grained, homogeneous bioclastic grainstones and packstones (limestones). There is no mudrock in the sequence.

Quarry site visits and inspection of quarry faces, and stockpile material indicates that the working area of the quarry producing quality aggregates is developed in the Two Mile Ditch Member of the Knockmaa Limestone Formation.

Potentially deleterious lithologies and minerals are not present in excessive quantities.



4.0 Aggregate Testing

4.1 Aggregate Test Results and Compliance

A range of aggregate tests have been undertaken by accredited laboratories on aggregates produced from the bedrock materials at Ardgaineen Quarry. A geological assessment of the quarry has been undertaken by a Competent Person (Professional Geologist).

Geological assessment of quarry faces, and stockpiles indicates that production is being derived entirely from strong, fresh and durable limestones which contain no sedimentary mudrock content or other potentially deleterious lithologies. The lithologies used for aggregate production are relatively uniform and homogenous and no significant geological variation is observed.

Physical and chemical testing indicates that the grading, physical and chemical tests are compliant with the requirements of SR16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - aggregates for concrete and SR21: 2014 + A1: 2016 Annex E Guidance on the use of I.S. EN 13242 unbound fill materials.

Total Sulfur has been determined to be 0.1% and Acid Soluble Sulfate has been determined to be <0.1%. The Calculated Equivalent Pyrite (CEP) value determined from this quantitative testing has been calculated at 0.2%.

The CEP calculation assumes that all non-sulfate sulfur in the sample is in the form of pyrite. This calculation is therefore typically an overestimate of pyrite content and is considered conservative.

Pyrite content in the tested aggregate is negligible.

- BRE 522-1 states "No significant sulfate attack and expansion problems for hardcore materials containing less than 0.5% mass of pyrite (FeS₂) and this is mass equivalent of 0.8% SO₄. In practice, this limit could be raised further for particular materials if it can be established (e.g. by petrographic study) that pyrite is predominantly present in the non-reactive form."
- Canadian Standard (CTQ-M200) has been used to assess the potential reactivity of aggregate based upon the calculated pyrite content. CTQ-M200 states that pyrite contents of <0.5% are deemed as having a negligible to low risk of swelling.

The 2003 publication "Alkali-Silica Reaction in Concrete – General Recommendations and Guidance in the Specification of Building and Civil Engineering Works" prepared by an expert group from The Institution of Engineers Ireland and the Irish Concrete Society states that there have been no reported instances of alkali silica reactivity (ASR) in concrete in Ireland. Previous history of use of an aggregate in concrete is a prime indicator in relation to incidence of ASR.



**Table 1. Comparison of aggregate test results from Ardgaineen Quarry with S.R.21
Guidance on the use of EN13242:2002+ A1:2007 Compliance Limits.**

Property	Test	Limit	Ardgaineen Value	Compliance with S.R.21
Physical	Grading	Grading must be compliant with the standard specifications	<i>Grading is compliant with the standard specifications</i>	Compliant
Durability	Water Absorption	WA (2)	T1 - 1.8%	Compliant
	Magnesium Sulfate Soundness	MS(25)	MS 5	Compliant
	Los Angeles Value	LA (30)	LA 26	Compliant
Chemical	Total Sulfur	TS (1.0%)	TS 0.1%	Compliant
	Acid Soluble Sulfate	AS(0.2%)	AS <0.1%	Compliant
Geological Classification	Geological Examination	The mudrock content of the aggregate should not exceed 10%	<i>Mudrock content is <10%</i>	Compliant
	Petrographic assessment (thin section +/- XRD) Only if TS > 0.1%	Determine if mudrock content of the aggregate does not exceed 10% and any pyrite present is primarily non-reactive if TS >0.1%	<i>Total sulfur ≤0.1%</i> <i>Mudrock content is <10%</i> <i>Rare to trace pyrite content is present</i>	Not required



**Table 2. Comparison of aggregate test results from Ardgaineen Quarry with S.R.16
Guidance on the use of I.S. EN 12620:2002 Aggregates for concrete products
Compliance Limits.**

Property	Test	Limit	Ardgaineen Value	Compliance with S.R.16
Physical	Particle Density	PD (Declared)	T1 – 2.68% 10mm – 2.67% 20mm – 2.69%	Compliant
	Drying Shrinkage	DS (D<0.075)	DS 0.021%	Compliant
	Flakiness Index	FI (35)	10mm – 20 20mm – 10	Compliant
	Methylene Blue	MB (Declared)	MB TBC	Declared
Durability	Water Absorption	WA (Declared)	T1 – 1.8% 10mm – 0.9% 20mm – 0.5%	Declared
	Magnesium Sulfate Soundness	MS(25)	T1 – 5 UGM A – 5 14mm – 9	Compliant
	Los Angeles Value	LA (40)	T1 – 2.68 20mm – 2.69 10mm – 2.67	Compliant
Chemical	Total Sulfur	TS (1.0%)	TS 0.1%	Compliant
	Acid Soluble Sulfate	AS (0.2%)	AS <0.1%	Compliant
	Water Soluble Chloride	WSC (Declared)	WSC 0.001	Compliant
Geological Classification	Geological Examination	Determine if potentially deleterious lithologies and minerals are present in excessive quantities	Potentially deleterious lithologies and minerals are not present in excessive quantities	Compliant
		Potential for Alkali Silica Reactivity	Non-reactive	Compliant



5.0 Aggregate Quality Assessment

- Current aggregate production at Ardgaineen Quarry is primarily derived from strong, fresh durable limestones.
- The produced aggregates are strong to very strong, durable, and resistant to fragmentation, have low water absorption characteristics and are compliant with the limits for these properties outlined in the relevant standards for concrete materials.
- Values for Total Sulfur and Acid Soluble Sulfate test results are very low and are well within the limits outlined in all relevant standards.
- Total Sulfur has been determined to be <0.1% and Acid Soluble Sulfate has been determined to be <0.1%. The Calculated Equivalent Pyrite (CEP) value determined from this quantitative testing has been calculated at 0.2%.
 - BRE522-1 and Canadian Standard CTQ-M200 indicate that the swelling risk of an aggregate is negligible to very low if the pyrite content is <0.5%.
- The expansion risk of fill materials produced at Ardgaineen is assessed as being negligible on a scale of negligible to very high.
- The results of the above assessments and testing have been reviewed by a Professional Geologist qualifying as a Competent Person.
- Aggregates produced at Ardgaineen Quarry are compliant with the relevant standards:
 - TII Series 500, 600, and 800
 - S.R.21:2014+A1:2016 Guidance on the use of IS EN 13242:2002+A1:2007 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
 - SR16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - aggregates for concrete.



6.0 Future Testing Regime

S.R.16: Guidance on the use of I.S. EN 12620:2002 Aggregates for concrete products and SR21: 2014 + A1: 2016 Annex E Guidance on the use of I.S. EN 13242 unbound fill materials, require that aggregates being used as concrete be tested on an ongoing basis.

Aggregate test results should be forwarded to SLR for review to ensure that the material continues to comply with the parameters outlined in S.R.16: Guidance on the use of I.S. EN 12620:2002 Aggregates for concrete products and SR21: 2014 + A1: 2016 Annex E Guidance on the use of I.S. EN 13242 unbound fill materials.

In the case of Ardgaineen Quarry, the following testing protocol is advised:

Table 3. Recommended testing schedule for Ardgaineen Quarry aggregates.

Properties	Test Description	Test Method	Category/Size	S.R.16 Test Frequency	S.R.21 Test Frequency	Recommended Test Frequency
Geometrical	Grading (crushed rock)	I.S. EN 933-1	See Required Table (T0, T1, T2 and T3)	1 per week	1 per week	1 per week
	Fines content	I.S. EN 933-1	F ₇	1 per week	1 per week	1 per week
	Shape of coarse aggregate	I.S EN 933-3	FI	1 per month		1 per month
Physical	Los Angeles coefficient	I.S. EN 1097-2	LA ₃₀	2 per year	2 per year	Annually
Durability	Water Absorption	I.S. EN 1097-6 Clause 8	WA ₂₄₂	1 per year	2 per year	Annually
	Magnesium Sulfate Soundness	I.S. EN 1367-2	MS ₂₅	1 per 2 years	1 per year	Annually
	Aggregate Abrasion Value	I.S EN 1097-8	PSV	1 per 2 years		1 per 2 years Dependent on end use
	Polished Stone Value	I.S EN 1097-8	AAV	1 per 2 years		1 per 2 years Dependent on end use
Chemical	Acid Soluble Sulfate	I.S. EN 1744-1	AS _{0.2}	Quarterly	Quarterly	Annually
	Total Sulfur	I.S. EN 1744-1	See E.2.4.4	Quarterly	Quarterly	Annually



Properties	Test Description	Test Method	Category/Size	S.R.16 Test Frequency	S.R.21 Test Frequency	Recommended Test Frequency
	Water Soluble Chloride	I.S EN 1744-1	-	1 per 2 years		1 per 2 years
	Calcium Carbonate	I.S EN 1744-1	-	1 per 2 years		1 per 2 years Dependent on end use
	Organic Content	I.S EN 1744-1	Humus Content	1 per year		Annually
	Drying Shrinkage	I.S. EN 1367-4	DS	1 per 5 years		1 per 5 years
Geological Classification	Geological examination	I.S. EN 932-3 and E.2.4.3	See E.2.4.3	1 per 3 years	Quarterly	Annually
	Petrographic assessment (thin section)	See E.2.4.5	See E.2.4.5	1 per 3 years	Only if TS >0.1%	Only if TS >0.1%

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Appendix A Aggregate Test Results

Ardgaineen Quarry

Aggregate Compliance Assessment Report

Harrington Concrete & Quarries

SLR Project No.: 501.065235.00001

13 December 2023

RECEIVED: 27/08/2025

Appendix B Petrographic Reports

Ardgaineen Quarry

Aggregate Compliance Assessment Report

Harrington Concrete & Quarries

SLR Project No.: 501.065235.00001

13 December 2023

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LABORATORY TEST REPORT

**To determine the Total Sulfur Content of an Aggregate Sample
 in accordance with BS EN 1744-1 : 2009 + A1 : 2012 : Clause 11**

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24448
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	Mixed Aggs
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	Client

Sample Details Mixed Aggs

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT	95% Confidence limit
Total Sulfur Content as S (%)	<0.1	0.06%-0.14%
Total Sulfur Content as SO4 (%)	<0.3	N/A

Comments:

* 95% Confidence Limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2
 Departure from specified procedure: Additional reporting as SO4 (S x 3)

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
 Subcontracted to a laboratory accredited for this testing**

Approved Signature
James Ward, Operations Manager
 CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To determine the Acid Soluble Sulfate of an Aggregate Sample
in accordance with BS EN 1744-1 : 2009 + A1 : 2012 Clause 12

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24448
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	Mixed Aggs
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	Client Info

Sample Details

Mixed Aggs

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT
Acid Soluble Sulfate Content (SO₃) (%)	<0.1 (nearest 0.1%)
<i>95% Confidence limit*</i>	<i>0.09% - 0.11%</i>
Acid Soluble Sulfate Content (SO₄) (%)	<0.1 (nearest 0.1%)
<i>95% Confidence limit*</i>	<i>0.09% - 0.11%</i>

Comments:

*95% confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2.

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
Subcontracted to a laboratory accredited for this testing**



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

**To determine the Total Sulfur Content of an Aggregate Sample
 in accordance with BS EN 1744-1 : 2009 + A1 : 2012 : Clause 11**

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24421
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	T1
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	SR21

Sample Details

T1

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT	95% Confidence limit
Total Sulfur Content as S (%)	0.1	0.06%-0.14%
Total Sulfur Content as SO4 (%)	0.3	N/A

Comments:

* 95% Confidence Limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Departure from specified procedure: Additional reporting as SO4 (S x 3)

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
 Subcontracted to a laboratory accredited for this testing**



Approved Signature
James Ward, Operations Manager
 CMTL Ireland Limited

LABORATORY TEST REPORT

To determine the Oxidisable Sulfides (OS) Content of a Sample
by calculation from BS EN 1744-1:2009 +A1 2012 Cl.11 & 12

RECEIVED: 27/08/2025

Project:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24421
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	T1
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	SR21

Sample Details

T1

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT
Oxidisable Sulfides (OS) (%)	0.2

Comments:

None

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.
Tested in accordance with the above specifications
Subcontracted to a laboratory competent in this testing



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To determine the Acid Soluble Sulfate of an Aggregate Sample
in accordance with BS EN 1744-1 : 2009 + A1 : 2012 Clause 12

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24421
Order No.:	55944	Date Received:	20/06/2023
Originator:	Fintan Keane	Date Reported:	17/07/2023
		Material:	T1
		Date Tested:	12/07/2023
		Specification:	SR21

Sample Details

T1

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT
Acid Soluble Sulfate Content (SO₃) (%)	<0.1 (nearest 0.1%)
<i>95% Confidence limit*</i>	<i>0.09% - 0.11%</i>
Acid Soluble Sulfate Content (SO₄) (%)	<0.1 (nearest 0.1%)
<i>95% Confidence limit*</i>	<i>0.09% - 0.11%</i>

Comments:

*95% confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2.

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

Tested in accordance with the above specifications
Subcontracted to a laboratory accredited for this testing



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

**To determine the Total Sulfur Content of an Aggregate Sample
 in accordance with BS EN 1744-1 : 2009 + A1 : 2012 : Clause 11**

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24421
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	UGM A
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	Series 800

Sample Details

UGM A

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT	95% Confidence limit
Total Sulfur Content as S (%)	0.1	0.06%-0.14%
Total Sulfur Content as SO4 (%)	0.3	N/A

Comments:

* 95% Confidence Limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Departure from specified procedure: Additional reporting as SO4 (S x 3)

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
 Subcontracted to a laboratory accredited for this testing**



Approved Signature
James Ward, Operations Manager
 CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

**To determine the Oxidisable Sulfides (OS) Content of a Sample
 by calculation from BS EN 1744-1:2009 +A1 2012 Cl.11 & 12**

Project:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24421
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	UGM A
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	Series 800

Sample Details

UGM A

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT
Oxidisable Sulfides (OS) (%)	0.2

Comments:

None

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.
 Tested in accordance with the above specifications
 Subcontracted to a laboratory competent in this testing



Approved Signature
 James Ward, Operations Manager
 CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To determine the Acid Soluble Sulfate of an Aggregate Sample
in accordance with BS EN 1744-1 : 2009 + A1 : 2012 Clause 12

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24421
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	UGM A
Order No.:	55944	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	Series 800

Sample Details

UGM A

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT
Acid Soluble Sulfate Content (SO₃) (%)	<0.1 (nearest 0.1%)
<i>95% Confidence limit*</i>	<i>0.09% - 0.11%</i>
Acid Soluble Sulfate Content (SO₄) (%)	<0.1 (nearest 0.1%)
<i>95% Confidence limit*</i>	<i>0.09% - 0.11%</i>

Comments:

**95% confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2.*

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
Subcontracted to a laboratory accredited for this testing**



**Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited**

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To determine the Total Sulfur Content of an Aggregate Sample
in accordance with BS EN 1744-1 : 2009 + A1 : 2012 : Clause 11

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24408
		Date Received:	20/06/2023
		Date Reported:	17/07/2023
		Material:	Series 600
Order No.:	Not Supplied	Date Tested:	12/07/2023
Originator:	Fintan Keane	Specification:	Series 600

Sample Details

Series 600

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT	95% Confidence limit
Total Sulfur Content as S (%)	<0.1	0.06%-0.14%
Total Sulfur Content as SO4 (%)	<0.3	N/A

Comments:

* 95% Confidence Limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Departure from specified procedure: Additional reporting as SO4 (S x 3)

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

Tested in accordance with the above specifications
Subcontracted to a laboratory accredited for this testing



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To determine the Water Soluble Chloride salt content of an aggregate sample
 in accordance with BS EN 1744-1:2009+A1:2012:Clause 7(Volhard method)

Project:	Ardgaineen	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co. Mayo	Lab Ref. No.:	ST 24448
		Date Received:	20/06/2023
		Date Reported:	11/07/2023
		Material:	Mixed Aggs
Order No.:	55944	Date Tested:	06/07/2023
Originator:	Fintan Keane	Specification:	Client

Sample Details

Mixed Aggs

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06
Source:	Ardgaineen	Sampled By:	EK
Sample Location:	Stockpile	Sampling Reason:	Request

Results:

Chloride Content of Aggregate (C) (%)	0.001 (nearest 0.001)
95% Confidence Limit	<0.0008%-<0.0012%

Comments:

*95% confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2.

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
 Subcontracted to a laboratory accredited for this testing**



Approved Signature
 James Ward, Operations Manager
 CMTL Ireland Limited

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To determine the Water Soluble Chloride salt content of an aggregate sample
in accordance with BS EN 1744-1:2009+A1:2012:Clause 7(Volhard method)

Project:	Ardgaineen	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co. Mayo	Lab Ref. No.:	ST 24408
Order No.:	55944	Date Received:	20/06/2023
Originator:	Fintan Keane	Date Reported:	11/07/2023
		Material:	Series 600
		Date Tested:	06/07/2023
		Specification:	Client

Sample Details

Series 600

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06
Source:	Ardgaineen	Sampled By:	EK
Sample Location:	Stockpile	Sampling Reason:	Request

Results:

Chloride Content of Aggregate (C) (%)	0.001 (nearest 0.001)
95% Confidence Limit	<0.0008%-<0.0012%

Comments:

*95% confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2.

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

**Tested in accordance with the above specifications
Subcontracted to a laboratory accredited for this testing**



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited

Laboratory Test Report
Physical Properties Testing
To determine the Magnesium Sulfate Value of aggregate
sample within the size range in accordance with BS EN 1367-2:2009

Site:	Ardgaineen Quarry	Job No.:	N/A
Client :	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24442
		Date Received:	20/06/2023
		Date Reported:	19/07/2023
		Material:	14mm
		Aggregate Size:	10mm
Originator	Fintan Keane	Specification:	Client

Sample Details

14mm

Certificate of sampling:	No	Sampling Reason:	Request
Sample Cert. Attached:	No	Date of Sampling:	20/06/2023
Sample Supplier:	Harrington Concrete & Quarries	Sampled By:	EK
Sample Source:	Ardgaineen Quarry	Sample Type:	Bulk
Sample Location:	Quarry		

Results

Size Fraction Tested:	10mm		
Proportion by mass of laboratory sample used for the test portion:		20%	(nearest 5%)
Magnesium Sulfate Value Portion 1 (MS₁) :	8.8		
Magnesium Sulfate Value Portion 2 (MS₂) :	8.7		
Mean Magnesium Sulfate value (MS) =	9		(nearest whole number)

Comments/Departure from specified procedure:

None

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited



Laboratory Test Report
Physical Properties Testing
To determine the Magnesium Sulfate Value of aggregate
sample within the size range in accordance with BS EN 1367-2:2009

Site:	Ardgaineen Quarry	Job No.:	N/A
Client :	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24419
		Date Received:	20/06/2023
		Date Reported:	18/07/2023
		Material:	UGM A
		Aggregate Size:	10mm
Originator	Fintan Keane	Specification:	Series 800

Sample Details

UGM A

Certificate of sampling:	No	Sampling Reason:	Request
Sample Cert. Attached:	No	Date of Sampling:	20/06/2023
Sample Supplier:	Harrington Concrete & Quarries	Sampled By:	EK
Sample Source:	Ardgaineen Quarry	Sample Type:	Bulk
Sample Location:	Quarry		

RESULTS

Size Fraction Tested:	10mm		
Proportion by mass of laboratory sample used for the test portion:		20%	(nearest 5%)
Magnesium Sulfate Value Portion 1 (MS₁) :	4.6		
Magnesium Sulfate Value Portion 2 (MS₂) :	4.9		
Mean Magnesium Sulfate value (MS) =	5		(nearest whole number)

Comments/Departure from specified procedure:

None

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited



Laboratory Test Report
Physical Properties Testing
To determine the Magnesium Sulfate Value of aggregate
sample within the size range in accordance with BS EN 1367-2:2009

Site:	Ardgaineen Quarry	Job No.:	N/A
Client :	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24419
		Date Received:	20/06/2023
		Date Reported:	18/07/2023
		Material:	T1
		Aggregate Size:	10mm
Originator	Fintan Keane	Specification:	SR21

Sample Details

T1

Certificate of sampling:	No	Sampling Reason:	Request
Sample Cert. Attached:	No	Date of Sampling:	20/06/2023
Sample Supplier:	Harrington Concrete & Quarries	Sampled By:	EK
Sample Source:	Ardgaineen Quarry	Sample Type:	Bulk
Sample Location:	Quarry		

Results

Size Fraction Tested:	10mm		
Proportion by mass of laboratory sample used for the test portion:		20%	(nearest 5%)
Magnesium Sulfate Value Portion 1 (MS₁) :	4.6		
Magnesium Sulfate Value Portion 2 (MS₂) :	4.9		
Mean Magnesium Sulfate value (MS) =	5		(nearest whole number)

Comments/Departure from specified procedure:

None

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited



RECEIVED: 27/08/2025

LABORATORY TEST REPORT

**To determine the Water Soluble Sulfate of Natural and Manufactured Aggregate
 in accordance with BS EN 1744-1 : 2009 + A1 : 2012 : Clause 10.1**

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24408
		Date Received:	20/06/2023
		Date Reported:	13/07/2023
		Material:	Series 600
Order No.:	55944	Date Tested:	10/07/2023
Originator:	Fintan Keane	Specification:	Series 600

Sample Details

Series 600

Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Source:	Ardgaineen Quarry	Sampled By:	EK
Sample Location:	Quarry	Sampling Reason:	Request

Results

Parameter	RESULT	95% Confidence limit
Water Soluble Sulfate Content (SO ₃) (%)	<0.01	<0.007%-<0.013%
Water Soluble Sulfate Content (SO ₄) (%)	<0.01	<0.007%-<0.013%
Water Soluble Sulfate Content (SO ₄) (mg/l)	<50	<34.7mg/l-<65.3mg/l

Comments:

* 95% Confidence Limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2
 Departure from specified Procedure - Additional reporting of mg/l and g/l included.

**Tested in accordance with the above specifications
 Subcontracted to a laboratory accredited for this testing**

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.



**Approved Signature
 James Ward, Operations Manager
 CMTL Ireland Limited**

RECEIVED: 27/08/2025

LABORATORY TEST REPORT

To Determine the Drying Shrinkage of an aggregate sample in accordance
with BS EN 1367-4 : 2008

Project:	Ardgaineen Quarry	Job No.:	PL
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24448
		Date Received:	20/06/2023
		Date Tested:	10/07/2023
		Date Reported:	31/07/2023
Order No.:	55944	Material:	Mixed Aggs
Originator:	Fintan Keane	Specification:	Client

Sample Details

Mixed Aggs

Certificate of sampling:	Yes	Sample Type:	Bulk
Sample Supplier:	Harrington Concrete & Quarries	Date of Sampling:	20/06/2023
Sample Source:	Ardgaineen Quarry	Ticket No.	N/A
Sample Location:	Quarry	Sampled By:	EK
		Sampling Reason:	Routine

Results

Drying Shrinkage %		0.021%
95% confidence limits	+/-	0.0033%

COMMENTS/DEPARTURE FROM SPECIFIED PROCEDURE

None

The stated result only relates to the item/location tested, this report shall not be reproduced except in full.

Tested in accordance with the above specifications
Subcontracted to a laboratory accredited for this testing



Approved Signature
James Ward, Operations Manager
CMTL Ireland Limited

LABORATORY TEST REPORT
DETERMINATION OF PARTICLE DENSITY AND WATER ABSORPTION - BS EN 1097-6: 2013 Clause 8

Project:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24435
		Date Received:	20/06/2023
		Date Reported:	23/06/2023
		Material:	20mm
Originator:	Fintan Keane	Specification:	Client

Sample Details

Certificate of sampling:	Yes	Client Ref.	20mm
Supplier:	Harrington Concrete & Quarries	Date Tested:	21/06/2023
Source:	Ardgaineen Quarry	Date of Sampling:	20/06/2023
Sample Location:	Quarry	Ticket No.	N/A
Sampling Method:	Bulk	Sampled By:	EK
Size Fraction Tested:	31.5-4mm		

Results

Test	Result
Mass of dry sample tested (g)	2275.0
Particle density on an oven-dried basis (Mg/m ³)	2.65
Particle density on a saturated & surface-dried basis (Mg/m ³)	2.66
Apparent Particle density (Mg/m ³)	2.69
Water absorption (% of dry mass)	0.5

Tested in accordance with the above specifications

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James Ward, Operations Manager



LABORATORY TEST REPORT
DETERMINATION OF PARTICLE DENSITY AND WATER ABSORPTION - BS EN 1097-6: 2013 Clause 8

Project:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24433
Originator:	Fintan Keane	Date Received:	20/06/2023
		Date Reported:	23/06/2023
		Material:	10mm
		Specification:	Client

Sample Details

Certificate of sampling:	Yes	Client Ref.	10mm
Supplier:	Harrington Concrete & Quarries	Date Tested:	21/06/2023
Source:	Ardgaineen Quarry	Date of Sampling:	20/06/2023
Sample Location:	Quarry	Ticket No.	N/A
Sampling Method:	Bulk	Sampled By:	EK
Size Fraction Tested:	31.5-4mm		

Results

Test	Result
Mass of dry sample tested (g)	1805.0
Particle density on an oven-dried basis (Mg/m ³)	2.61
Particle density on a saturated & surface-dried basis (Mg/m ³)	2.63
Apparent Particle density (Mg/m ³)	2.67
Water absorption (% of dry mass)	0.9

Tested in accordance with the above specifications

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LABORATORY TEST REPORT
PARTICLE SIZE DISTRIBUTION - BS EN 933-1:2012
FLAKINESS INDEX - BS EN 933-3: 2012
WATER CONTENT - BS EN 1097-5: 2008

RECEIVED 27/08/2025

Project:	Ardgaineen Quarry	Lab Ref No.:	ST 24426
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Date Received:	20/06/2023
		Date Tested:	21/06/2023
		Date Reported:	28/06/2023
		Material:	20mm
Originator:	Fintan Keane	Specification:	ISEN 12620 Gc 80/20 10/20mm

Client Sample Ref : 20mm

Supplier: Harrington Concrete & Quarries
Location : Quarry
Ticket No.: N/A
Date Sampled : 20/06/2023
Sample Type: Bulk
Sampled by: EK
Sampling Cert.: Yes
Sample Preparation Method: Oven dried

SIEVE ANALYSIS				
Sieve size	% Passing	Specification	Size Fraction (mm)	Flakiness Index
200.0mm	100			
125.0mm	100			
100.0mm	100			
90.0mm	100			
80.0mm	100			
63.0mm	100		80-63	0.0
50.0mm	100		63-50	0.0
40.0mm	100	100-100	50-40	0.0
31.5mm	100	98-100	40-31.5	0.0
25.0mm	100		31.5-25	0.0
20.0mm	98	80-99	25-20	16.2
16.0mm	68		20-16	9.4
14.0mm	42			
12.5mm	23		16-12.5	10.3
10.0mm	7	0-20	12.5-10	9.1
8.0mm	3		10-8.0	17.5
6.3mm	2		8.0-6.3	9.4
5.0mm	2		6.3-5.0	8.8
4.0mm	2	0-5	5.0-4.0	7.1
2.8mm	2			
2.0mm	2			
1.0mm	2			
500µm	1			
250µm	1			
125µm	1			
63µm	0.5			

Additional Testing

Fines Content:	F _{0.5}	1.0mm	2
Water Content: (%)	0.6	500µm	1
Overall Flakiness Index:	10	250µm	1
Flakiness Index Test Portion	4323.9	125µm	1
Mass (g):		63µm	0.5

Tested in accordance with BS EN 933-1:2012 - WET SIEVING
 Tested in accordance with BS EN 1097-5:2008 - WATER CONTENT
 Tested in accordance with BS EN 933-3: 2012 - FLAKINESS INDEX
 The sample, as supplied **does** comply with the specification above



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 James Ward, Operations Manager
 CMTL Ireland Limited



LABORATORY TEST REPORT
PARTICLE SIZE DISTRIBUTION - BS EN 933-1:2012
FLAKINESS INDEX - BS EN 933-3: 2012
WATER CONTENT - BS EN 1097-5: 2008

RECEIVED 27/08/2025

Project:	Ardgaineen Quarry	Lab Ref No.:	ST 24424
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Date Received:	20/06/2023
		Date Tested:	21/06/2023
		Date Reported:	28/06/2023
		Material:	10mm
Originator:	Fintan Keane	Specification:	ISEN 12620 Gc80/20 4/10mm

Client Sample Ref : 10mm

Supplier: Harrington Concrete & Quarries
Location : Quarry
Ticket No.: N/A
Date Sampled : 20/06/2023
Sample Type: Bulk
Sampled by: EK
Sampling Cert.: Yes
Sample Preparation Method: Oven dried

SIEVE ANALYSIS				
Sieve size	% Passing	Specification	Size Fraction (mm)	Flakiness Index
200.0mm	100			
125.0mm	100			
100.0mm	100			
90.0mm	100			
80.0mm	100			
63.0mm	100		80-63	0.0
50.0mm	100		63-50	0.0
40.0mm	100		50-40	0.0
31.5mm	100		40-31.5	0.0
25.0mm	100		31.5-25	0.0
20.0mm	100	100-100	25-20	0.0
16.0mm	100		20-16	0.0
14.0mm	100	98-100		
12.5mm	100		16-12.5	0.0
10.0mm	93	80-99	12.5-10	12.0
8.0mm	63		10-8.0	20.6
6.3mm	26		8.0-6.3	20.8
5.0mm	10		6.3-5.0	19.8
4.0mm	5	0-20	5.0-4.0	22.8
2.8mm	3			
2.0mm	2	0-5		
1.0mm	2			
500µm	1			
250µm	1			
125µm	1			
63µm	0.6			

Additional Testing

Fines Content:	F ₁	1.0mm	2		
Water Content: (%)	1.0	500µm	1		
Overall Flakiness Index:	20	250µm	1		
Flakiness Index Test Portion	1215	125µm	1		
Mass (g):		63µm	0.6		

Tested in accordance with BS EN 933-1:2012 - WET SIEVING
 Tested in accordance with BS EN 1097-5:2008 - WATER CONTENT
 Tested in accordance with BS EN 933-3: 2012 - FLAKINESS INDEX
 The sample, as supplied **does** comply with the specification above



Approved Signature
 James Ward, Operations Manager
 CMTL Ireland Limited



LABORATORY TEST REPORT
DETERMINATION OF PARTICLE DENSITY AND WATER ABSORPTION - BS EN 1097-6: 2013 Clause 8

Project:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref. No.:	ST 24417
Originator:	Fintan Keane	Date Received:	20/06/2023
		Date Reported:	30/06/2023
		Material:	SR21 T1
		Specification:	SR21

Sample Details

Certificate of sampling:	Yes	Client Ref.	SR21 T1
Supplier:	Harrington Concrete & Quarries	Date Tested:	28/06/2023
Source:	Ardgaineen Quarry	Date of Sampling:	20/06/2023
Sample Location:	Quarry	Ticket No.	N/A
Sampling Method:	Bulk	Sampled By:	EK
Size Fraction Tested:	31.5-4mm		

Results

Test	Result
Mass of dry sample tested (g)	1470.0
Particle density on an oven-dried basis (Mg/m ³)	2.56
Particle density on a saturated & surface-dried basis (Mg/m ³)	2.60
Apparent Particle density (Mg/m ³)	2.68
Water absorption (% of dry mass)	1.8

Tested in accordance with the above specifications

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James Ward, Operations Manager



**LABORATORY TEST REPORT
DETERMINATION OF RESISTANCE TO FRAGMENTATION**

RECEIVED: 27/08/2025

Site:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref No.:	ST 24420
		Date Received:	20/06/2023
		Date Tested:	04/07/2023
		Date Reported:	04/07/2023
Originator:	Fintan Keane	Material:	UGM A

Sample Ref:	UGM A	Sampled By:	EK
Size fraction:	14-10mm	Location:	Quarry
Date Sampled:	20/06/2023	Sample certificate/Plan:	Yes
Sampling Method:	Bulk		

Los Angeles Coefficient (LA) = 23

Los Angeles Coefficient carried out in accordance with BS EN 1097-2:2020

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LABORATORY TEST REPORT
DETERMINATION OF RESISTANCE TO FRAGMENTATION

RECEIVED 27/08/2025

Site:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref No.:	ST 24420
		Date Received:	20/06/2023
		Date Tested:	04/07/2023
		Date Reported:	04/07/2023
Originator:	Fintan Keane	Material:	T1

Sample Ref:	T1	Sampled By:	EK
Size fraction:	14-10mm	Location:	Quarry
Date Sampled:	20/06/2023	Sample certificate/Plan:	Yes
Sampling Method:	Bulk		

Los Angeles Coefficient (LA) = 23

Los Angeles Coefficient carried out in accordance with BS EN 1097-2:2020

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LABORATORY TEST REPORT
DETERMINATION OF RESISTANCE TO FRAGMENTATION

RECEIVED: 27/08/2025

Site:	Ardgaineen Quarry	Job No.:	N/A
Client:	Harrington Concrete & Quarries Kilkelly Co Mayo	Lab Ref No.:	ST 24400
		Date Received:	20/06/2023
		Date Tested:	21/06/2023
		Date Reported:	23/06/2023
Originator:	Fintan Keane	Material:	Series 600

Sample Ref:	Series 600	Sampled By:	EK
Size fraction:	14-10mm	Location:	Quarry
Date Sampled:	20/06/2023	Sample certificate/Plan:	Yes
Sampling Method:	Bulk		

Los Angeles Coefficient (LA) = 29

Los Angeles Coefficient carried out in accordance with BS EN 1097-2:2020

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DETAILED PETROGRAPHIC REPORT

**for SR16: 2016 Compliance
on Sample No.
41351
CRF**

Ardgaineen, Claregalway, Co. Galway

Prepared for: Harrington Concrete & Quarries

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BASIS OF REPORT

This document has been prepared by SLR Consulting Limited with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with Harrington Concrete & Quarries (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

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1.0 Introduction

An 8kg bag of crushed rock fines (CRF) was provided by Harrington Concrete & Quarries on 08/07/2022 to SLR, for detailed petrographic analysis in accordance with *SR16 IS EN 12620-2002 + A1-2008: Aggregates for Concrete*.

The material was analysed, and a representative sample was sent to be mounted in glue for polished thin sectioning, with staining for carbonates of half the slide. The thin section was examined using a SP-1500-P Polarising Microscope; volumes / percentages given for hand specimen and thin section analysis are visual estimates only. The petrographic study is reported below.

Please refer to Table 1 for mineral component level definitions as used in SLR reports.

SLR Reports component level definitions		SLR 
Major	>10%	
Minor	2-10%	
Trace	1-2%	
Rare	<1%	
Very rare	<0.1%	
Negligible	barely present	

Table 1 SLR Mineral Component Level Definitions

1.1 Summary Results

The sample is identified as:

Ardgaineen, Claregalway, Co. Galway

41351 BIOCLASTIC LIMESTONE CRF

This sample is compliant with SR16: 2016.

1.1.1 Comment

This sample consists of fresh, sub-angular to sub-rounded CRF; these particles consist of approximately 92% bioclastic limestone / calcite spar, 5% fine-grained limestone, 1% dolomite, <1% quartz, <1% calcareous mudstone, <0.1% chert, and <0.1% limonite. No free mica is observed. There is very rare pyrite observed overall. The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability and soundness criteria.

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Lithology	Percentage	Classification
Bioclastic Limestone / Calcite Spar	92%	Major
Fine-grained Limestone	5%	Minor
Dolomite	1%	Trace
Quartz	<1%	Rare
Calcareous Mudstone	<1%	Rare
Chert	<0.1%	Very Rare
Limonite	<0.1%	Very Rare

Table 2 Percentages of Lithologies Present

1.2 SR16 Requirements

In Annex F of *IS EN 12620: 2002 + A1: 2008: Aggregates for concrete*, petrography is used to identify the presence of weak and/or highly absorptive particles that can be susceptible to damage from freeze-thaw action such as “schist, mica schist, phyllite, chalk, marl, shale, porous flint, altered porous basalt or particles loosely cemented by clay minerals”.

The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability and soundness criteria.

1.3 SR16 Requirements

There are a number of aspects that are specified for assessment in the SR16. These aspects are discussed below:

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Criteria for Assessment	Comment	Pass / Fail
Potentially reactive minerals or rocks	No potentially reactive minerals or rocks are observed.	PASS
Pyrite and Pyrrhotite Occurrence	Very rare pyrite is observed overall. No pyrrhotite is observed.	PASS
Evidence of Oxidised Pyrite	Negligible pyrite with red-stained rims associated with limonite is observed overall.	PASS
Presence of Sedimentary Mudrock or other Potentially Deleterious Minerals or Lithologies	Rare calcareous mudstone is observed.	PASS
Presence of carbonate	Carbonate is the dominant component in the bioclastic limestone / calcite spar, and a major component in the fine-grained limestone, calcareous mudstone and chert.	PASS
Gypsum occurrence	No visible gypsum.	PASS
Structure including foliation and apparent permeability (water absorption)	Massive chert, massive to faintly laminated bioclastic limestone / calcite spar, faintly laminated fine-grained limestone, and laminated calcareous mudstone. Individual grains of dolomite, quartz and limonite also occur. Particles are too fine to determine the apparent permeability.	PASS
Presence of layered silicates including type and form (free / bound)	No layered silicates (free/bound) are observed.	PASS
Potential alkali silica reactivity	Based on the sample location and age, the very rare chert observed it is not considered to be problematic.	PASS

Table 3 Aspects Specified for Assessment in SR16

The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability and soundness criteria.

In the opinion of SLR's geologist, the very rare pyrite observed in these lithologies is unlikely to affect the suitability of the aggregate for use as unbound granular fill (hardcore) under concrete floors and footpaths. The lithologies of the aggregate are bioclastic limestone / calcite spar, fine-grained limestone, trace dolomite, rare quartz, calcareous mudstone, very rare chert, and limonite.

2.0 Detailed Petrography

Based on ISRM suggested methods, BS EN 932-3:1997, IS EN 12620-2002 + A1-2008: Aggregates for Concrete.

2.1 Sample Description

Sample Number	41351	
Source	Harrington Concrete & Quarries	
Condition	CRF	Weight 8kg
Appearance	Damp, sub-angular to sub-rounded, fresh, CRF with <12mm chips.	

2.2 Hand Specimen

Appearance	Dark grey, limestone CRF with <12mm chips. The particles are sub-angular to sub-rounded, fresh, stable, and highly calcareous.
Effervescence with HCl	Strong.
Joints / fractures	None visible.
Veins	None visible.
Texture	Particles are too fine to determine.
Apparent permeability (water absorption)	Particles are too fine to determine.
Strength	Particles are too fine to determine.

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Hand specimen (unwashed)
cm scale

Damp, sub-angular to sub-rounded, dark grey, limestone CRF.

Figure 1 Photographic Record of 41351 (unwashed)

2.3 Thin Section

Half of the thin section was stained using alizarin red S and potassium ferricyanide to identify calcite, dolomite, and ferroan variations (Evamy, 1969).

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41351	Thin Section
--------------	---------------------

COMPONENT	PETROGRAPHY
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Structure	<p>The CRF is comprised of bioclastic limestone / calcite spar with minor fine-grained limestone, trace dolomite, rare quartz, calcareous mudstone, very rare chert and limonite, as categorised under the Carbonate Rock Texture Classification of Dunham (1962). No free mica is observed. There is approximately 92% bioclastic limestone / calcite spar, 5% fine-grained limestone, 1% dolomite, <1% quartz, <1% calcareous mudstone, <0.1% chert, and <0.1% limonite.</p>
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The bioclastic limestone (bioclastic grainstone and packstone) is fine to coarse-grained, massive to faintly laminated, and composed of micrite, micro-spar and sparite forming bioclasts and matrix, with minor dolomitization, rare fine-grained / stylolitic material, and quartz as anhedral to subhedral authigenic grains and silicification. The calcite spar is massive and medium to coarse-grained. Very rare fine-grained pyrite occurs as approximately 95% cubic and 5% framboidal grains. Negligible pyrite with red-stained rims associated with limonite are observed.

The fine-grained limestone is faintly laminated and composed of micrite, micro-spar and sparite forming bioclastic hash and matrix, with major fine-grained / stylolitic material. Rare fine-grained pyrite occurs as approximately 85% cubic and 15% framboidal grains. Very rare pyrite with red-stained rims associated with limonite are observed.

The calcareous mudstone / mudstone is fine-grained, laminated, and predominantly composed of fine-grained / stylolitic material with major calcite as micrite and micro-spar forming bioclastic hash, and minor dolomite. Trace (2%) fine-grained pyrite occurs as approximately 25% cubic and 75% framboidal grains. Rare pyrite with red-stained rims associated with limonite are observed.

The chert is massive and predominantly composed of microcrystalline quartz with major dolomite. No pyrite or oxidised pyrite are observed.

Individual grains of dolomite, quartz and limonite are fine to medium and probably have originated from the bioclastic limestone / calcite spar.

Components present are calcite, dolomite, fine-grained material, quartz, rare limonite, and trace (1%) pyrite.

BIOCLASTIC LIMESTONE CRF

Calcite	Major occurrence as micrite, micro-spar, and sparite forming bioclasts and matrix of the bioclastic limestone / calcite spar, as micrite and micro-spar forming bioclastic hash and matrix of the fine-grained limestone and calcareous mudstone.
---------	---

Dolomite	Minor occurrence as fine to medium grains in the bioclastic limestone / calcite spar, calcareous mudstone and chert, and as trace individual grains.
----------	--

Fine-grained / stylolitic material	Trace occurrence as very dark laminations in the bioclastic limestone / calcite spar and fine-grained limestone. Fine-grained / stylolitic material forms most of the calcareous mudstone.
------------------------------------	--

- Quartz Trace occurrence as fine to medium, anhedral to subhedral authigenic grains and silicification in the bioclastic limestone / calcite spar, and as rare individual grains.
- Limonite Trace occurrence as fine grains in all lithologies.
- Pyrite Very rare occurrence overall as fine grains replacing bioclasts and the matrix in the bioclastic limestone / calcite spar, fine-grained limestone and calcareous mudstone; there are approximately 90% cubic and 10% framboidal grains. Negligible pyrite with red-stained rims is observed overall in the bioclastic limestone / calcite spar, fine-grained limestone and calcareous mudstone.

COMPONENTS	Volume %	Crystal / Grain size	Origin
Calcite	91%	<1.1mm	Primary and Secondary
Dolomite	5%	<0.4mm	Secondary
Fine-grained / stylolitic material	2%	<0.1mm	Secondary
Quartz	1%	<0.3mm	Primary and Secondary
Limonite	1%	<0.3mm	Secondary
Pyrite	<0.1%	<0.1mm	Secondary

Diagnosis:

BIOCLASTIC LIMESTONE CRF

There is very rare pyrite observed overall.

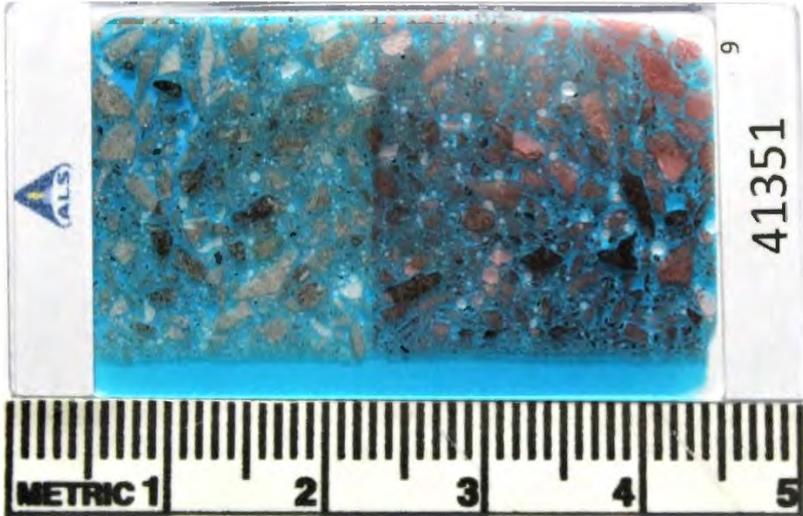
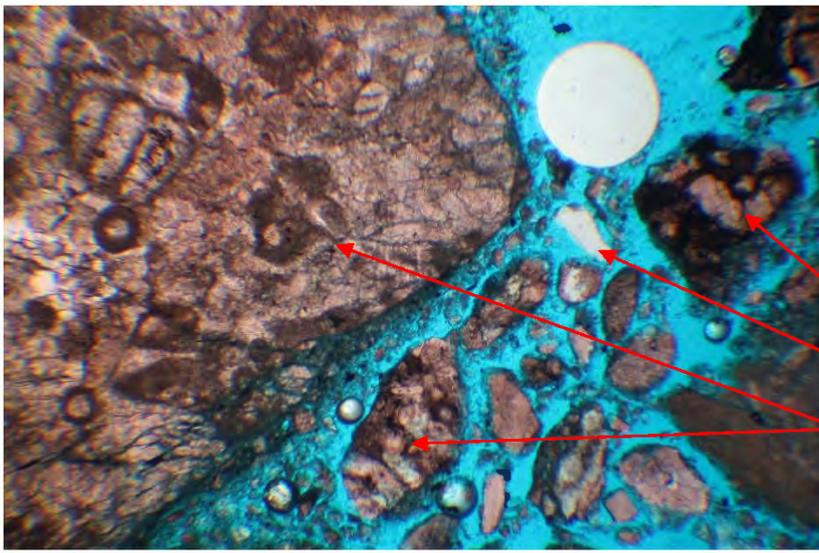
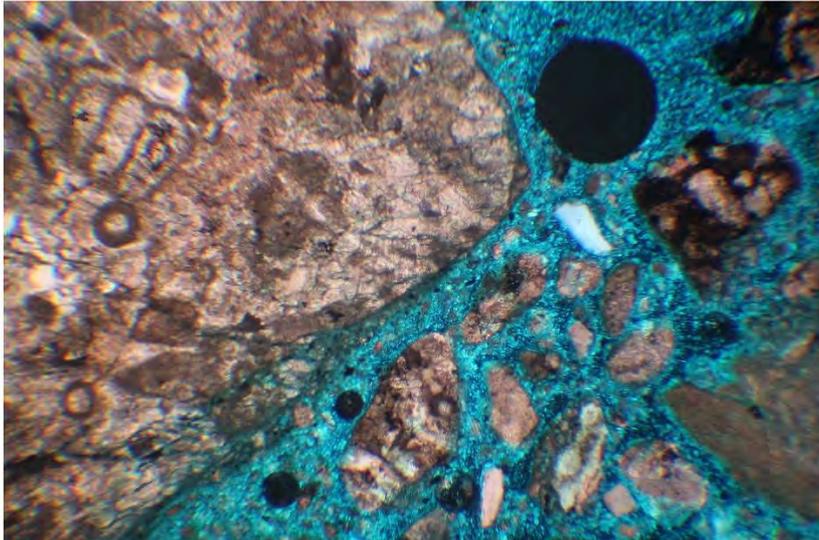
	<p>41351</p> <p>CRF</p> <p><i>Hand specimen</i></p> <p>cm scale</p> <p>Mounted in blue glue, polished thin section of CRF, half stained for carbonates (right).</p>
	<p><i>Plane Polarised Light</i></p> <p>Field of view: 4mm</p> <p>Stained area of thin section: pink indicates calcite, black indicates fine-grained material, colourless indicates quartz and dolomite.</p> <ul style="list-style-type: none"> Fine-grained limestone Quartz Bioclastic limestone
	<p><i>Cross Polarised Light</i></p> <p>Field of view: 4mm</p>

Figure 2 Photographic Record of 41351, CRF (hand specimen and under microscope)

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PETROGRAPHIC REPORT

for SR16: 2016 and SR21: 2014 + A1: 2016 Compliance

on Sample No.

41354

804

Ardgaineen, Claregalway, Co. Galway

Prepared for: Harrington Concrete & Quarries

RECEIVED: 27/08/2025

BASIS OF REPORT

This document has been prepared by SLR Consulting Limited with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with Harrington Concrete & Quarries (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

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Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

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This document may contain information of a specialised and/or highly technical nature and the Client is advised to seek clarification on any elements which may be unclear to it.

Information, advice, recommendations and opinions in this document should only be relied upon in the context of the whole document and any documents referenced explicitly herein and should then only be used within the context of the appointment.

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1.0 Introduction

A 8.5kg bag of aggregate was provided by Harrington Concrete & Quarries on 08/07/2022 to SLR, for petrographic analysis in accordance with *SR16 IS EN 12620-2002 + A1-2008: Aggregates for Concrete* and *SR21: 2014 + A1: 2016 Guidance on the use of I.S.EN 13242: 2002 +A1:2007 Aggregates for Unbound and Hydraulically Bound Materials for use in Civil Engineering Work and Road Construction*.

The material was washed and analysed. Volumes / percentages given for hand specimen analysis are visual estimates only. The petrographic study is reported below.

Please refer to Table 1 for mineral component level definitions as used in SLR reports.

SLR Reports component level definitions		SLR 
Major	>10%	
Minor	2-10%	
Trace	1-2%	
Rare	<1%	
Very rare	<0.1%	
Negligible	barely present	

Table 1 SLR Mineral Component Level Definitions

1.1 Summary Results

The sample is identified as:

Ardgaineen, Claregalway, Co. Galway

41354 BIOCLASTIC LIMESTONE

There are no potentially deleterious minerals or lithologies observed.

There is no pyrite observed in hand specimen.

The sample is compliant with SR16: 2016 and SR21: 2014 + A1: 2016, 2.4.3, 2.4.5.

1.1.1 Comment

This <25mm sample consists of fresh, angular to rounded, medium strong particles of 97% bioclastic limestone and 3% dolomite. No free mica is observed in hand specimen. The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability and soundness criteria. No pyrite is observed in hand specimen. There are no potentially deleterious lithologies present and, given the nature of the lithologies present, the sample is not considered a swelling risk.

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Lithology	Percentage	Classification
Bioclastic Limestone	97%	Major
Dolomite	3%	Minor

Table 2 Percentages of Lithologies Present

1.2 SR16 Requirements

In Annex F of *IS EN 12620: 2002 + A1: 2008: Aggregates for concrete*, petrography is used to identify the presence of weak and/or highly absorptive particles that can be susceptible to damage from freeze-thaw action such as “schist, mica schist, phyllite, chalk, marl, shale, porous flint, altered porous basalt or particles loosely cemented by clay minerals”.

The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability and soundness criteria.

1.3 SR21: 2014 + A1: 2016 E2.4.3 Requirements

In SR21: 2014 + A1: 2016 Annex E 2.4.3, it is stated that “The mudrock content of the aggregate should not exceed 10%”. Mudrock is defined in SR21: 2014 + A1: 2016 Annex E as “lithified argillaceous sediments comprised significantly of clay minerals”.

There are no potentially deleterious lithologies present and, given the nature of the lithology present, it is not considered a swelling risk. This sample is compliant with SR21: 2014 + A1: 2016 Annex E 2.4.3.

1.4 SR16 and SR21: 2014 + A1: 2016 E2.4.5 Requirements

There are a number of aspects that are specified for assessment in the SR16 and SR21: 2014 + A1: 2016 Annex E2.4.5. These aspects are discussed below:

Criteria for Assessment	Comment	Pass / Fail
Potentially reactive minerals or rocks	No potentially reactive minerals or rocks are observed.	PASS
Pyrite and Pyrrhotite Occurrence	No pyrite is observed in hand specimen. No pyrrhotite is observed in hand specimen.	PASS
Evidence of Oxidised Pyrite	No oxidised pyrite is observed.	PASS
Presence of Sedimentary Mudrock or other Potentially Deleterious Minerals or Lithologies	No Sedimentary Mudrock or other Potentially Deleterious Minerals or Lithologies are observed.	PASS
Presence of carbonate	Carbonate is the dominant component.	PASS
Gypsum occurrence	No visible gypsum.	PASS
Structure including foliation and apparent permeability (water absorption)	Massive to faintly laminated bioclastic limestone and massive dolomite, both with low apparent permeability.	PASS
Presence of layered silicates including type and form (free / bound)	No layered silicates are observed.	PASS
Potential alkali silica reactivity	No potentially reactive silica minerals are observed.	PASS

Table 3 Aspects Specified for Assessment in SR16 and SR21: 2014 + A1: 2016 Annex E2.4.5

The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability and soundness criteria.

In the opinion of SLR's geologist, since there is no pyrite observed in these lithologies in hand specimen, the aggregate is suitable for use as unbound granular fill (hardcore) under concrete floors and footpaths. The lithologies of the overall aggregate are a medium strong, competent bioclastic limestone and minor dolomite, both with low apparent permeability.

Based on the conclusions above under SR21: 2014 + A1: 2016 E2.4.5 guidance, in the opinion of the geologist, this material is suitable (with respect to its petrography) for use as unbound granular fill (hardcore) under concrete floors and footpaths, assuming the aggregate meets all the other requirements (geometrical, physical, durability and chemical) of SR21: 2014 + A1: 2016 Annex E.

2.0 Detailed Petrography

Based on ISRM suggested methods, BS EN 932-3:1997, IS EN 12620-2002 + A1-2008: Aggregates for Concrete, and SR21: 2014 + A1: 2016 Annex E.

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2.1 Sample Description

Sample Number	41354	
Source	Harrington Concrete & Quarries	
Condition	Damp aggregate	Weight 8.5kg
Appearance	Damp, angular to rounded, fresh aggregate ranging in size from fines to <25mm.	

2.2 Hand Specimen

Appearance	Dark grey, fine to coarse-grained bioclastic limestone with very rare weak weathering. A single greyish brown, medium-grained dolomite chip. The particles consist of 97% bioclastic limestone and 3% dolomite. The rock particles are angular to rounded, fresh, stable and highly calcareous.
Effervescence with HCl	Strong on bioclastic limestone, moderate on dolomite.
Joints / fractures	None visible.
Veins	None visible.
Texture	Sedimentary: massive to faintly laminated bioclastic limestone, massive dolomite.
Apparent permeability (water absorption)	Low in both lithologies.
Strength	Medium strong in both lithologies.

DIAGNOSIS

BIOCLASTIC LIMESTONE

No potentially deleterious minerals or lithologies are observed.

No pyrite is observed in hand specimen.

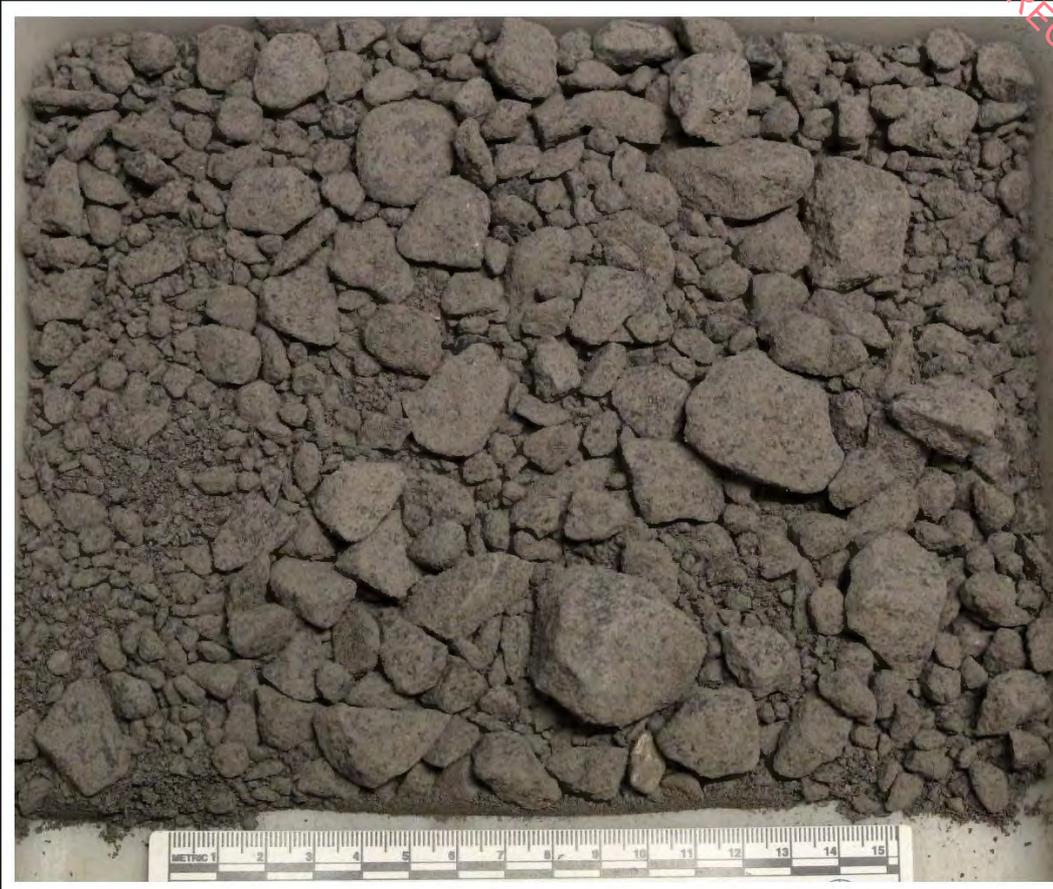
	<p>RECEIVED: 27/08/2023</p> <p>Hand specimen (unwashed) cm scale</p> <p>Damp, angular to rounded, fresh limestone aggregate.</p>
	<p>Hand specimen (washed) cm scale</p> <p>Clean, angular to rounded, fresh, bioclastic limestone (left) and dolomite (right) aggregate.</p>

Figure 1 Photographic Record of 41354 (unwashed and washed)

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PETROGRAPHIC REPORT

for SR16: 2016 and SR21: 2014 + A1: 2016 Compliance
on Sample No.

42856

804

Ardgaineen Quarry, Claregalway, County Galway

Harrington Concrete & Quarries

Prepared by:

SLR Environmental Consulting (Ireland) Ltd

7 Dundrum Business Park, Windy Arbour, Dublin, D14
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SLR Project No.: 501.065235.00001

Client Reference No: IR.001020

27 October 2023

Revision: 0

RECEIVED: 27/10/2023

Basis of Report

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1.0 Introduction

A 5kg bag of aggregate was provided by Harrington Concrete & Quarries on 23/08/2023 to SLR, for petrographic analysis in accordance with *SR16 IS EN 12620-2002 + A1-2008: Aggregates for Concrete* and *SR21: 2014 + A1: 2016 Guidance on the use of I.S. EN 12620: 2002 + A1:2007 Aggregates for Unbound and Hydraulically Bound Materials for use in Civil Engineering Work and Road Construction*. The material was washed and analysed; volumes / percentages given for hand specimen analysis are visual estimates only. The petrographic study is reported below.

Please refer to Table 1 for mineral component level definitions as used in SLR reports.

SLR Reports component level definitions	
Major	>10%
Minor	2-10%
Trace	1-2%
Rare	<1%
Very rare	<0.1%
Negligible	barely present



Table 1 - SLR Mineral Component Level Definitions

1.1 Summary Results

This sample is identified as:

Ardgaineen Quarry, Claregalway, County Galway

42856 **BIOCLASTIC LIMESTONE**

No potentially deleterious minerals or lithologies are observed.

There is no pyrite observed.

The sample is compliant with SR16 and SR21.



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1.1.1 Comment

This <35mm sized granular fill sample consists of fresh, angular, medium strong rock particles of 100% bioclastic limestone. No free mica is observed. There is no pyrite observed; there are no potentially deleterious lithologies present and, given the nature of the lithologies present, it is not considered a swelling risk. The sample is compliant with SR16: 2016 provided the aggregate meets all the strength, durability, grading and soundness criteria.

Lithology	Percentage	Classification
Bioclastic Limestone	100%	Major

Table 2 - Percentages of Lithologies Present

1.2 SR16: 2016 Requirements

In Annex F of *IS EN 12620: 2002 + A1: 2008: Aggregates for concrete*, petrography is used to identify the presence of weak and/or highly absorptive particles that can be susceptible to damage from freeze-thaw action such as “schist, mica schist, phyllite, chalk, marl, shale, porous flint, altered porous basalt or particles loosely cemented by clay minerals”.

The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability, grading and soundness criteria.

1.3 SR21: 2014 + A1: 2016 E2.4.3 Requirements

In SR21: 2014 + A1: 2016 Annex E 2.4.3, it is stated that “The mudrock content of the aggregate should not exceed 10%”. Mudrock is defined in SR21: 2014 + A1: 2016 Annex E as “lithified argillaceous sediments comprised significantly of clay minerals”.

There are no potentially deleterious lithologies present and, given the nature of the lithology present, it is not considered a swelling risk. This sample is compliant with SR21: 2014 + A1: 2016 Annex E 2.4.3.



1.4 SR16: 2016 and SR21: 2014 + A1: 2016 E2.4.5 Requirements

There are a number of aspects that are specified for assessment in the SR16. These aspects are discussed below:

Criteria for Assessment	Comment	Pass / Fail
Potentially Reactive Minerals or Rocks	No Potentially Reactive Minerals or Rocks are observed.	PASS
Pyrite and Pyrrhotite Occurrence	No pyrite or pyrrhotite are observed.	PASS
Evidence of Oxidised Pyrite	No oxidised pyrite is observed.	PASS
Presence of Sedimentary Mudrock or other Potentially Deleterious Lithologies	No Sedimentary Mudrock or other Potentially Deleterious Lithologies are observed.	PASS
Presence of Carbonate	Carbonate is the dominant component.	PASS
Gypsum Occurrence	No visible gypsum.	PASS
Structure including Foliation and Apparent Permeability (Water Absorption)	Sedimentary: massive bioclastic limestone with low apparent permeability.	PASS
Presence of layered silicates including type and form (free / bound)	No layered silicates (free/bound) are observed.	PASS
Potential alkali silica reactivity	No potentially reactive silicates are observed.	PASS

Table 3 - Aspects Specified for Assessment in SR16 and SR21

The sample is compliant with SR16: 2016, provided the aggregate meets all the strength, durability, grading and soundness criteria.

In the opinion of SLR's geologist, since there is no pyrite observed in this lithology in hand specimen, the aggregate is suitable for use as unbound granular fill (hardcore) under concrete floors and footpaths. The lithology of the overall aggregate is a medium strong, competent, bioclastic limestone with low apparent permeability.



Based on the conclusions above under SR21: 2014 + A1: 2016 E2.4.5 guidance, in the opinion of the geologist, this material is suitable (with respect to its petrography) for use as unbound granular fill (hardcore) under concrete floors and footpaths, assuming the aggregate meets all the other requirements (geometrical, physical, durability and chemical) of SR21: 2014 + A1: 2016 Annex E.

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2.0 Detailed Petrography

Based on ISRM suggested methods, BS EN 932-3:1997, and IS EN 12620-2002 + A1-2008: Aggregates for Concrete, and SR21: 2014 + A1: 2016 Annex E.

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2.1 Sample Description

Sample Number 42856

Source Harrington Concrete & Quarries

Condition Dry aggregate Weight 5kg

Appearance Dry, grey, angular, fresh aggregate ranging in size from fines to 35mm.

2.2 Hand Specimen

Appearance	Dark grey and greyish brown, fine to coarse-grained bioclastic limestone with very rare calcite veins (<1mm wide). Major silicification is observed in a single chip. Rare darker fine-grained material is observed at a particle margin. The rock particles are angular, fresh, stable, and highly calcareous. The particles consist of 100% bioclastic limestone.
Effervescence with HCl	Strong, weak on silicification and fine-grained material.
Joints / fractures	None visible.
Veins	Very rare calcite veins (<1mm wide) occur.
Texture	Sedimentary: massive.
Apparent permeability (water absorption)	Low.
Strength	Medium strong.





Figure 1 - Photographic Record of 42856 (unwashed and washed)



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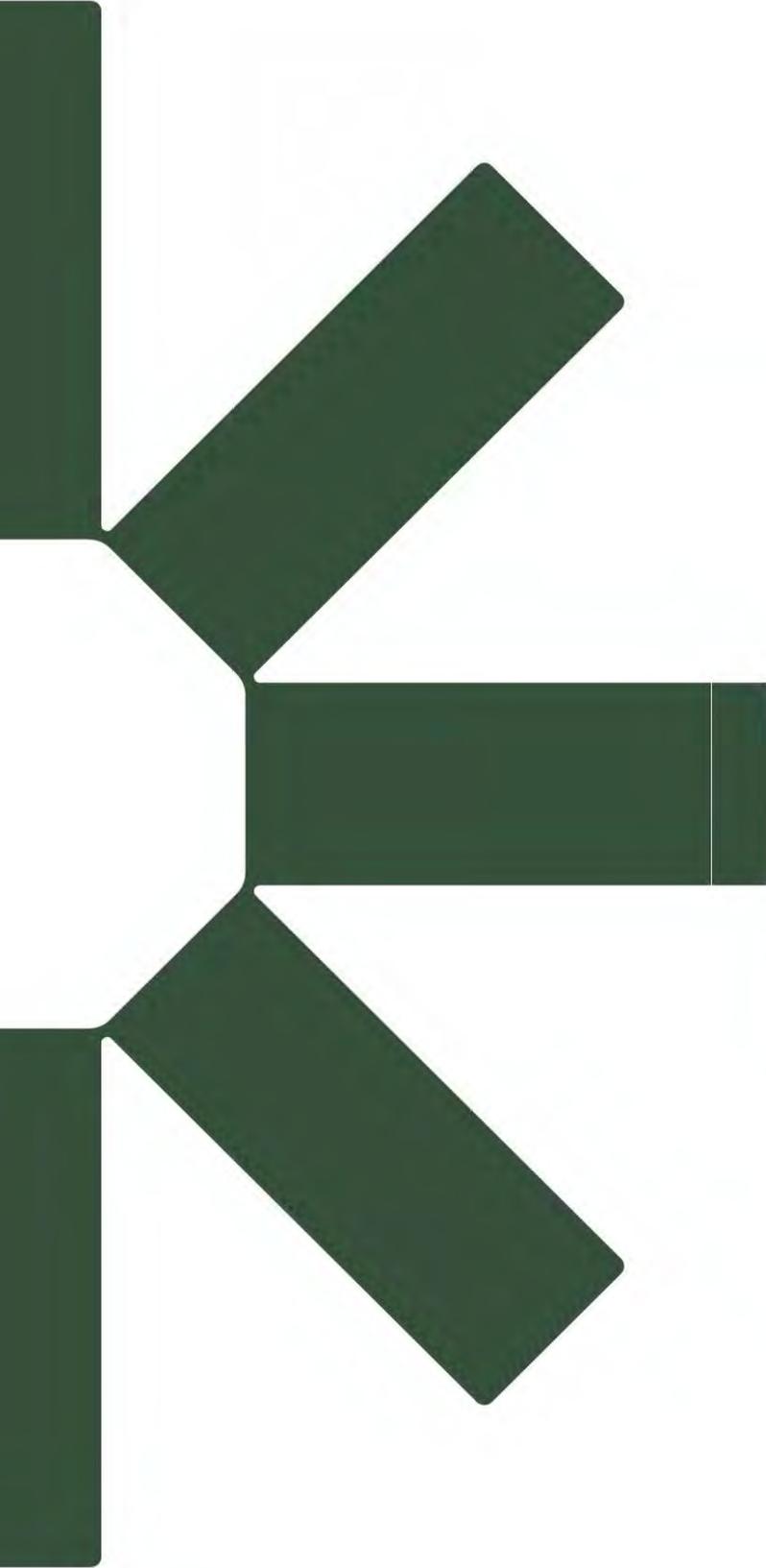
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Appendix 7-3

Geoheritage Reports

Appendix 7-3

GSI Geoheritage Reports for the Wider Area

(Meehan et al., 2019)

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- (i)** Knockmaa (GY082) located c.7m to the north – north west.
- (ii)** Pollnahallia (GY116) within Knockmaa.
- (iii)** Knockmaa Quarries (GY083) within Knockmaa.
- (iv)** Ballybanagher M17 Road Cut (GY010) at c. 6km to the north east.
- (v)** Ballyglunin Cave (GY013) at c. 8km to the east, north-east.
- (vi)** Lough Corrib (GY093) at c. 7km due west.

GALWAY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Knockmaa
Other names used for site	Killwullaun, Pollnahallia
IGH THEME	IGH1 Karst, IGH3 Carboniferous to Pliocene Palaeontology, IGH7 Quaternary, IGH12 Mesozoic and Cenozoic
TOWNLAND(S)	Pollnahallia, Killwullaun, Kildrum, Stonepark or Bawnmore, Carrowconlaun, Bohercuill, Cave, Caltragh, Tobermina, Carheens, Fearagha, Biggera Beg, Castlehackett, Carrowbeg South, Cartron, Carrowntemple, Knockacarrigan, Ballaghbaun
NEAREST TOWN/VILLAGE	Headford, Tuam
SIX INCH MAP NUMBER	42, 43, 56
ITM CO-ORDINATES	534800E 748000N (centre of area)
1:50,000 O.S. SHEET No. 46	GS1 BEDROCK 1:100,000 SHEET NO. 11

Outline Site Description

A large area of landscape between Headford and Tuam with thin glacial deposits which have only slightly modified a pre-Pleistocene karst landscape, developed on Carboniferous limestones, which contains late Pliocene sediments.

Geological System/Age and Primary Rock Type

The bedrock in the area is Carboniferous Limestone but the primary interest are the karstic features within it that are proven or indicative of a late Pliocene age (the youngest part of the old terminology 'Tertiary' – from about 5.3 to 2.6 million years ago).

Main Geological or Geomorphological Interest

The distinctive white sands and associated lignite exposed at Pollnahallia and in the area of Knockmaa have gained a wider reputation as a mineral resource and as a rare fragment of Ireland's landscape history. The Pollnahallia deposits are well described and are the subject of a separate site report within the much larger landscape site of Knockmaa. However, there are many other features focused on Knockmaa, that represent a glimpse of Ireland's pre-Pleistocene landscape, since biostratigraphical dating of the pollen assemblages within gorge and cave sediments, indicates a late Pliocene or early Pleistocene age. Pollnahallia is a sediment-filled gorge. The Knockmaa site also includes large shallow depressions, deep depressions, sand filled caverns, turloughs, isolated hills and other karstic features which must have developed in the late Tertiary. The age of this landscape is an important element of the debate as to the age and origin of turloughs within the Irish landscape. It also has implications for understanding the variation in local effect on the landscape of Pleistocene glaciation, since here there is little modification yet the glaciation is widely held to be a major influence.

Site Importance – County Geological Site; recommended for Geological NHA

The site is of international importance, and is recommended to NPWS for Geological NHA status.

Management/promotion issues

Management of a large landscape site such as this is difficult to prescribe for. It is a living, working landscape of quarries [see Knockmaa Hill Quarries site], farms and dwellings, but public spaces like Knockmaa Hill are ideally placed to be able to tell a landscape story that most people will not have heard before. Distilling it into simple concepts and visualisations should be attempted, but with strong geological input from appropriately qualified geological landscape interpreters. If any developments are permitted which involve significant ground excavation or engineering, then there should be some geological monitoring for new features and sediments which can be sampled for dating and other environmental evidence.



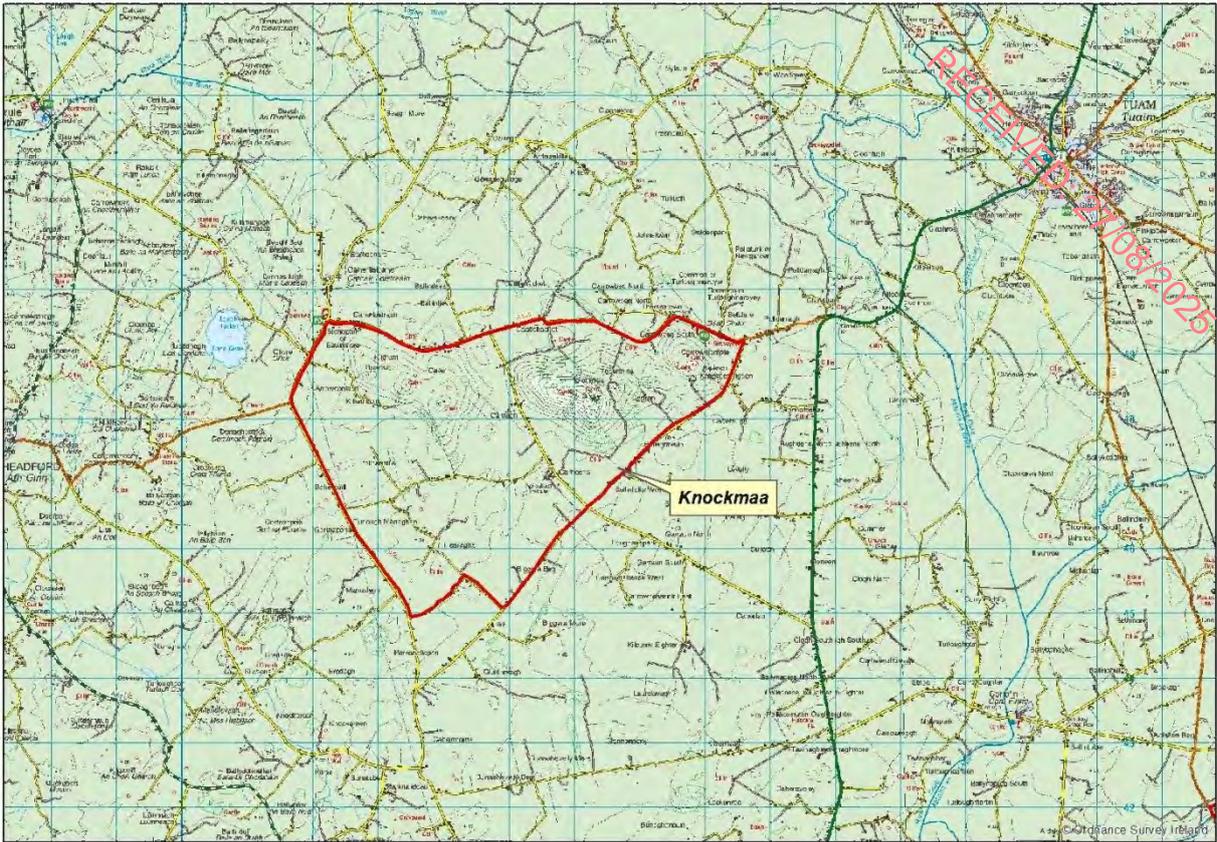
A panoramic view southward from Knockmaa Hill over the landscape area.

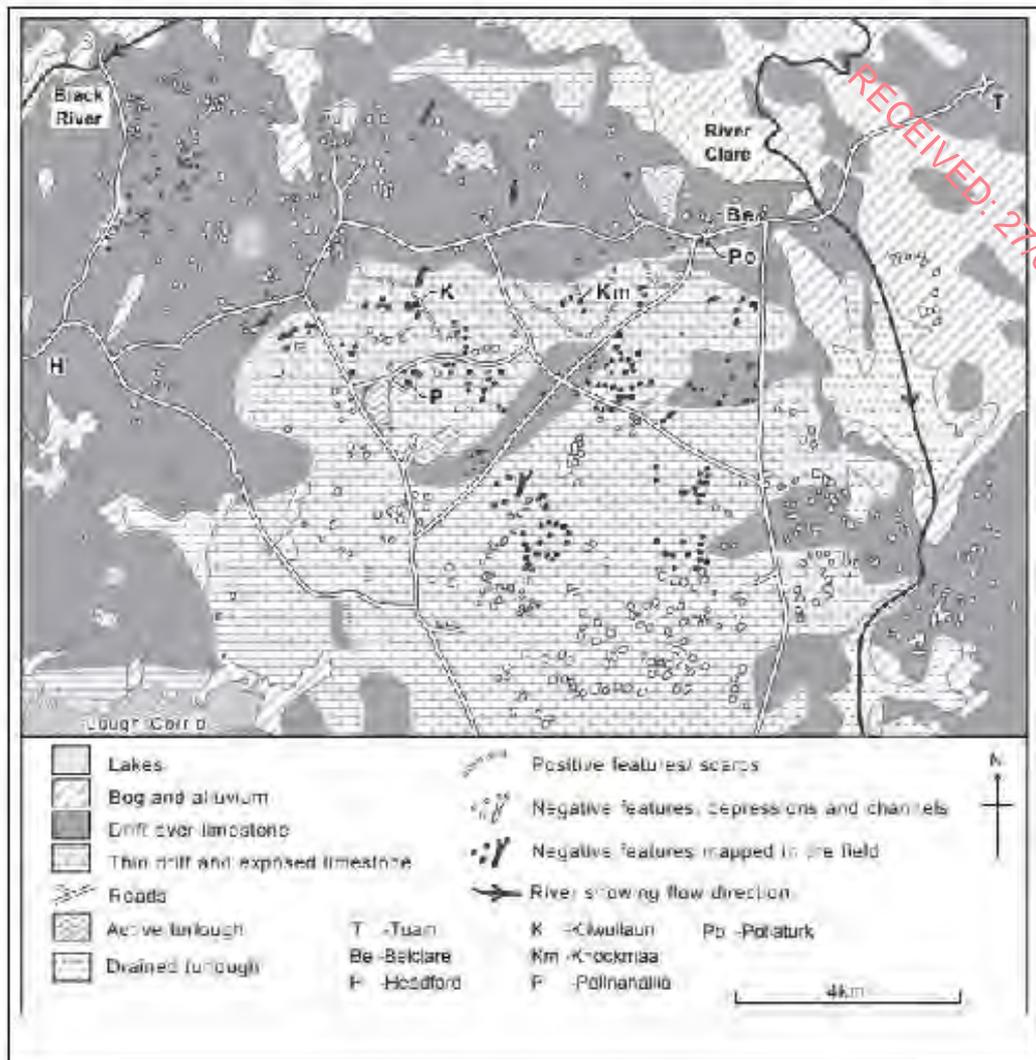


View east across a number of shallow depressions, with Knockmaa Hill in the distance.



A deep enclosed depression in Carheens Townland.





Detailed map from Pete Coxon's 2005 paper on the Knockmaa area.

GALWAY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Pollnahallia
Other names used for site	
IGH THEME	IGH7 Quaternary, IGH12 Mesozoic and Cenozoic
TOWNLAND(S)	Pollnahallia
NEAREST TOWN/VILLAGE	Headford
SIX INCH MAP NUMBER	42
ITM CO-ORDINATES	533670E 746830N (centre of pit)
1:50,000 O.S. SHEET No. 46	GS1 BEDROCK 1:100,000 SHEET NO. 11

Outline Site Description

This site comprises a deep, abandoned sand pit, on the southern footslopes of the hills west of Knockmaa Hill, about 6 kilometres east of Headford.

Geological System/Age and Primary Rock Type

The pit is set within an area of thick-bedded, pure Lower Carboniferous limestones of the Knockmaa Formation, but the sand within the feature which has been quarried out, was Pliocene in age (2.5-5.3 million years ago), from within the Cenozoic.

Main Geological or Geomorphological Interest

Pollnahallia is a townland east of Headford in County Galway, within an area of c. 200 km² of surface depressions, small scarps, bare limestone and superficial deposits, as well as many known turloughs. Many of the irregularities in the land surface are of karstic origin. This ancient karstic landscape is described in Knockmaa Hill and Knockmaa Quarries sites.

Extensive drilling and field investigations in the 1980's and 1990's in and around a sand pit in Pollnahallia revealed a network of gorges and caves in the limestone, over which are draped wind-blown sands, and later glacial sediments including till. Palynological results suggest that the organics (including lignites) infilling the base of the limestone gorge are probably Pliocene in age. An organic bed lying on the surface of the limestone shows alternation of organic-rich sediment and clays and silts with sand horizons at the base of the gorge. This suggests deposition in water of varying energy regimes. At least 9 m of windblown sands overlie these materials, with some partial glaciofluvial reworking. All of these materials were capped by a glacial lodgement till, which contained huge ice rafted blocks of limestone.

One striking element of the pollen recovered from sediments at Pollnahallia is the exotic nature of some of the flora. Many of the taxa recorded are no longer native to Europe, with many only occurring in North America and Asia today. The important biostratigraphical elements of the pollen diagram include the presence of typical late Cenozoic taxa: *e.g.* Sequoia, Swamp Cypress, Sourgum, Sweetgum, Sweet chestnut, Hop-hornbeam, Walnut, Japanese umbrella, Hickory and Wingnut. Such taxa are frequently found in Pliocene deposits in the Netherlands, and this correlation with the Netherlands taxa, the absence of pre-Pliocene marker taxa and the apparent climatic deterioration recorded in the upper part of the sequence, allows a probable correlation to be made to the Reuverian of the Netherlands, possibly Reuverian C (late Pliocene, 2.5-5.3 million years ago).

Site Importance – County Geological Site; recommended for Geological NHA

The Late Pliocene date of the organic-rich, lignite silt/clay means that the limestone surface underlying the deposits is at least of this age. Thus, karstification of the limestone of the area must have taken place before the late Tertiary. This site gives us an unprecedented view into an era of Ireland's past, known only from here and its deposits are unique and of international importance. Although within the area of the Knockmaa site, the level of investigation and information about Pollnahallia justifies it being documented as a single site.

Management/promotion issues

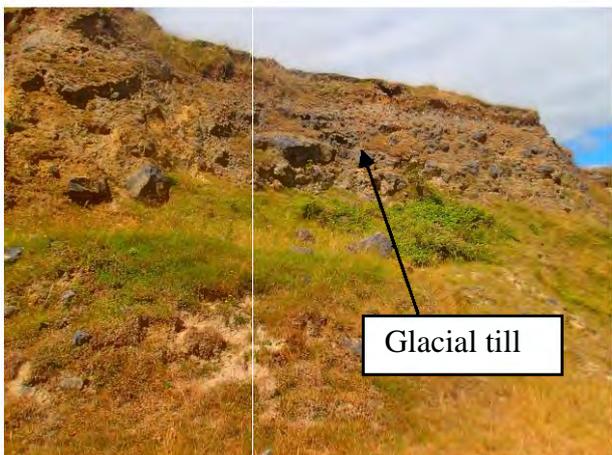
The pit is in private ownership and permission should be sought before entering. Any infilling or dumping within the pit, as well as, potentially further excavation, will seriously alter the site.



Overview of the sand pit at Pollnahallia, November 2000.



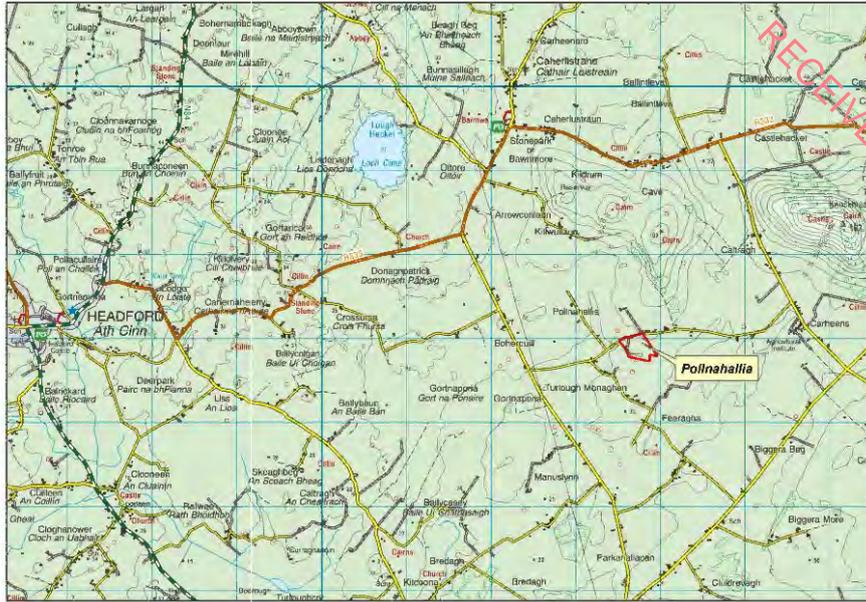
An overview of the pit from the east, July 2018.



Glacial till above sand in the northern face of the Pollnahallia pit.



White, windblown sand from Pollnahallia.



GALWAY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Knockmaa Quarries
Other names used for site	Cartron Quarries, Belclare Quarries (collectively); Mortimer Quarries, McTigue Quarry (individually)
IGH THEME	IGH1 Karst, IGH8 Lower Carboniferous, IGH12 Mesozoic and Cenozoic
TOWNLAND(S)	Cartron
NEAREST TOWN/VILLAGE	Tuam
SIX INCH MAP NUMBER	42, 43
ITM CO-ORDINATES	536955E 748500N (centre of boundary between both quarries)
1:50,000 O.S. SHEET No. 46	GS1 BEDROCK 1:100,000 SHEET NO. 11

Outline Site Description

This site includes two large working quarries, side-by-side, on the southeastern slopes of Knockmaa Hill, about 7 km southwest of Tuam.

Geological System/Age and Primary Rock Type

The quarries are excavated in thick-bedded, pure Lower Carboniferous limestones of the Knockmaa Formation.

Main Geological or Geomorphological Interest

Some horizontal limestone beds, as well as blocks of massive limestones, are seen throughout the quarries set into Knockmaa Hill, which provide a deep window into the limestone bedrock which is normally only exposed at the surface in a few localities in mid- to east County Galway.

Thick and massive beds are visible across the quarries. Some of the northern faces in particular, but also faces elsewhere in the quarries, display some karstic solution, with pipes and clay filled cavities, as well as brown calcite stained walls of narrow fissures. Many of these features are similar to those seen around the (adjacent) site at Pollnahallia, and this ancient karstic landscape dates to the Pliocene Period (2.5-5.3 million years ago) within the Cenozoic. Extensive drilling and field investigations in and around this area in the 1990s revealed a network of gorges and caves in the limestone, over which are draped windblown sands, and later glacial sediments including till.

The hill was overtopped by ice sheets during the Ice Age, since there are glacial erratics of limestone on top of Knockmaa Hill at the northwest of the quarry, and deposits of glacial till in portions of the northern faces within McTigue Quarry.

Site Importance – County Geological Site

These quarries provide a good representative site displaying the Carboniferous limestone bedrock geology of mid-Galway, with additional features of pre-glacial and karstic interest.

Management/promotion issues

The quarries are run by two private businesses producing certified stone, building stone, fill, tarmac and asphalt products, as well as agricultural lime. The site is not suited to general promotion of geology.



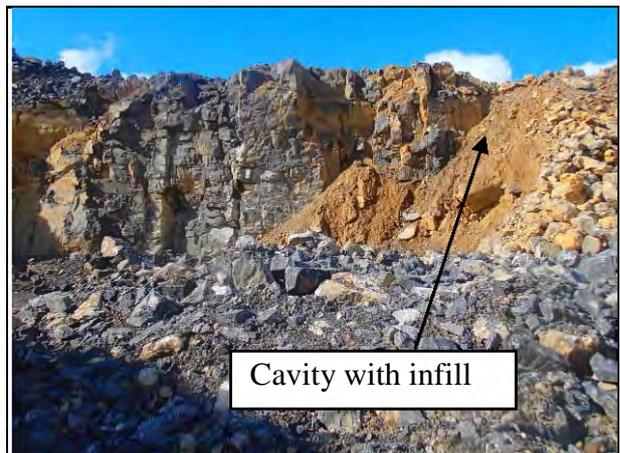
The main face in McTigue Quarry, showing bedded limestones overlying massive rock.



An overview of the workings and the surrounding faces in Mortimer Quarry.

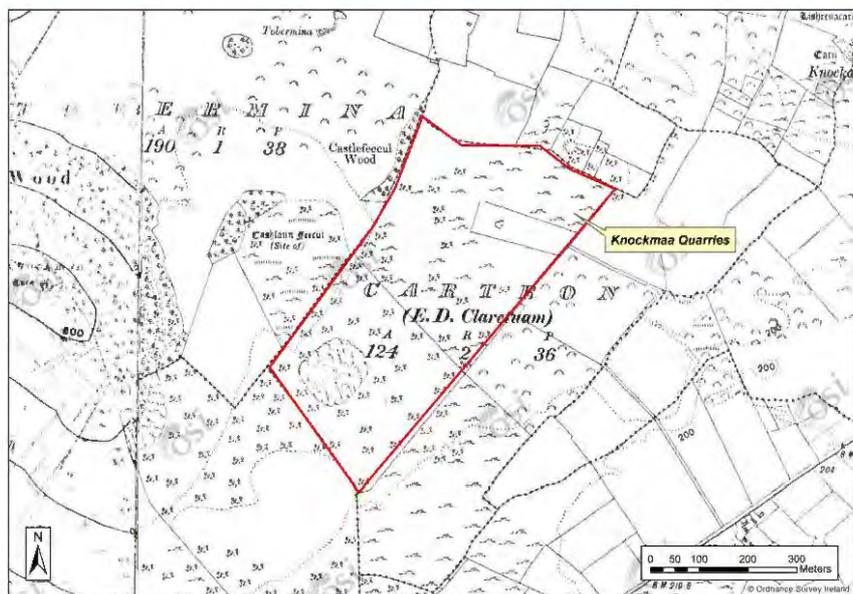
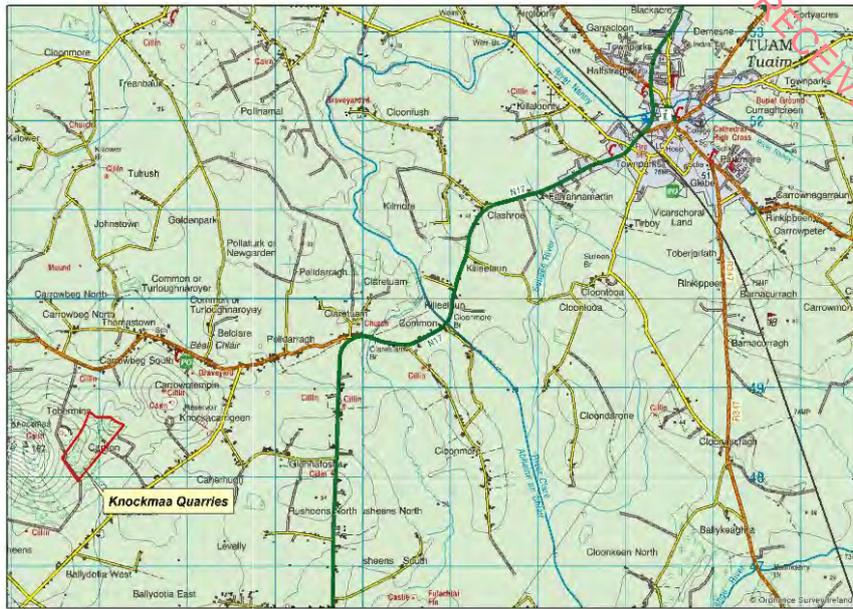


Glacial till above bedrock in the northern face of McTigue Quarry.



Clay-filled cavity in the northern face of Mortimer Quarry.

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GALWAY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Ballybanagher M17 Road Cut
Other names used for site	
IGH THEME	IGH8 Lower Carboniferous
TOWNLAND(S)	Ballybanagher, Ballinphuill
NEAREST TOWN/VILLAGE	Corrofin
SIX INCH MAP NUMBER	57
ITM CO-ORDINATES	543584E 744620N (centre of section)
1:50,000 O.S. SHEET No. 46	GSI BEDROCK 1:100,000 SHEET NO. 11

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Outline Site Description

This site comprises a 400 m long road cutting along the M17 motorway, with both high and low cliffs of rock overlain by a veneer of glacial till.

Geological System/Age and Primary Rock Type

The rocks are limestones of Carboniferous age (approximately 330 million years). They are part of the Knockmaa Formation.

Main Geological or Geomorphological Interest

The rocks are limestones of Viséan age, from the Lower Carboniferous Period, and part of the Knockmaa Formation. The sections have been cut through a high hill, therefore forming some very high cliffs with spectacular bedrock exposure. The limestone beds generally dip gently to the south, but the beds in much of the cutting are essentially flat lying.

A number of distinct clay wayboards can be seen between beds of limestone on both sides of the cuttings. These wayboards are probably products of contemporaneous volcanic ashfalls. There are also occasional, well-distributed blobs of the white mineral calcite. These may have been developed during the conversion of lime sediment into hard rock (a process called diagenesis). However, they may have replaced the mineral anhydrite which was formed earlier in the process.

A well developed epikarst layer can be seen along portions of the motorway cutting, particularly along the eastern section. Groundwater seeps out from beneath this layer in several places. There also seem to be some small cavities in the bedrock outcrop associated with dissolution and karstification.

The bedrock is overlain by approximately 2 m depth of till (glacial sediment), which was deposited by the last ice sheet to cover the area, and the bedrock has been planed off along a clear erosive boundary while this material was being deposited.

Site Importance – County Geological Site

The site is of County Geological Site importance as a scientifically useful, well exposed representative section of Carboniferous limestone in north central Galway, where it is otherwise poorly exposed. Further comparisons by experts in Carboniferous limestone geology may indicate the bedrock at the site is of national importance, as representative of otherwise relatively poorly exposed Carboniferous stratigraphy in the area around central Galway.

Management/promotion issues

This road cutting is completely unsuitable for any general public visits as it is on a motorway. The GSI will liaise with TII, the County Council and appropriate authorities to discuss appropriate options for dissemination of information about the geological interest of the site.



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View north along the Ballybanagher road cut along the M17.



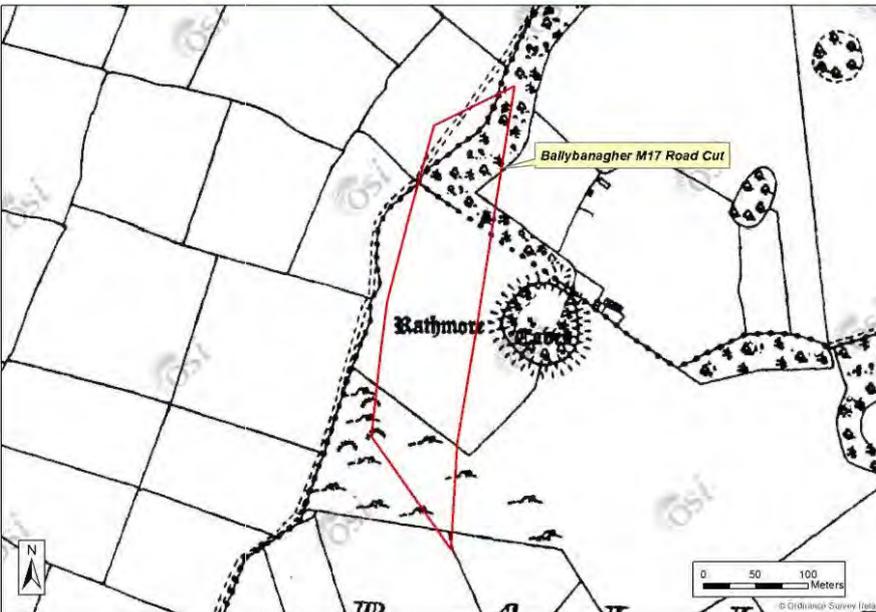
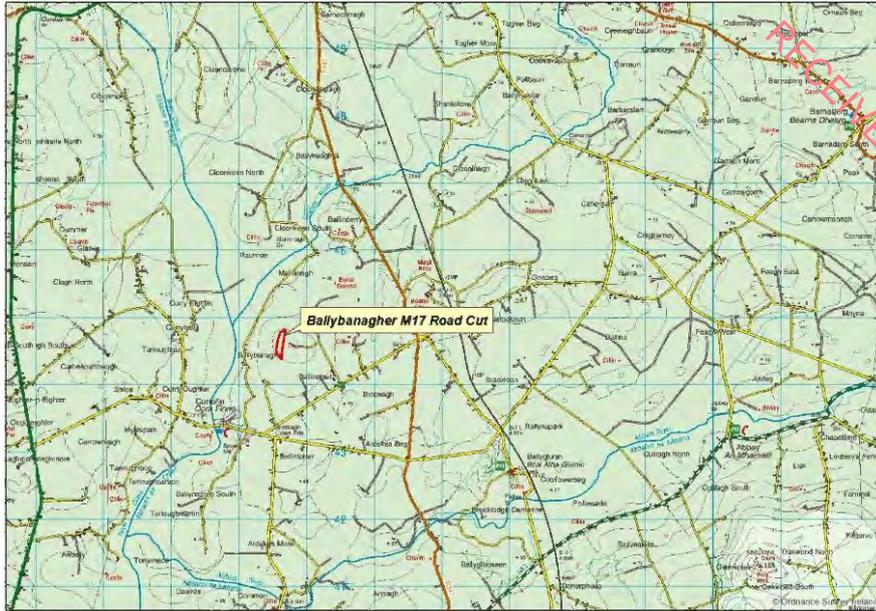
Gently dipping beds of limestone, along the western section of the outcrop. The clay wayboards are clearly seen as black lines through the section.



Groundwater seepage beneath epikarst layer, and potential karstified bedrock cavities.



Nodules of calcite seen as white blobs in the left hand side of this, the eastern section.



GALWAY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Ballyglunin Cave
Other names used for site	
IGH THEME	IGH1 Karst
TOWNLAND(S)	Ballyglunin
NEAREST TOWN/VILLAGE	Corrofin, Abbey, Monivea
SIX INCH MAP NUMBER	58
ITM CO-ORDINATES	545900E 742050N (cave entrance)
1:50,000 O.S. SHEET No. 46	GSI BEDROCK 1:100,000 SHEET NO. 11, 14

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Outline Site Description

A cave consisting of a complex network of passages.

Geological System/Age and Primary Rock Type

The cave is formed in Carboniferous Limestone, and is post glacial (Holocene) in age, but may have an inherited component of pre-glacial development.

Main Geological or Geomorphological Interest

The cave consists of a complex network of passages carrying a water flow which was diverted off the Abbert River. There are the remains of a water powered turbine structure which had been installed in the entrance depression which was probably a natural collapse into the cave. The passages are a complex mix of different heights and widths, some dry and some carrying water.

Although all the cave water is probably ultimately derived from the Abbert River, the river bed losing flow from upstream of the cave, the cave is located at a very shallow depth under the bed of the river and there is very little leakage from the upper into the lower system. There was a reported sinking of the entire river into the cave downstream of the present limits in 1955, leaving a dry river bed from thereon. However, the hydrogeology of this site is complex and deserves further study.

Site Importance – County Geological Site

As an unusual example of a cave directly under a river bed with limited connection, the site deserves recognition as a County Geological Site.

Management/promotion issues

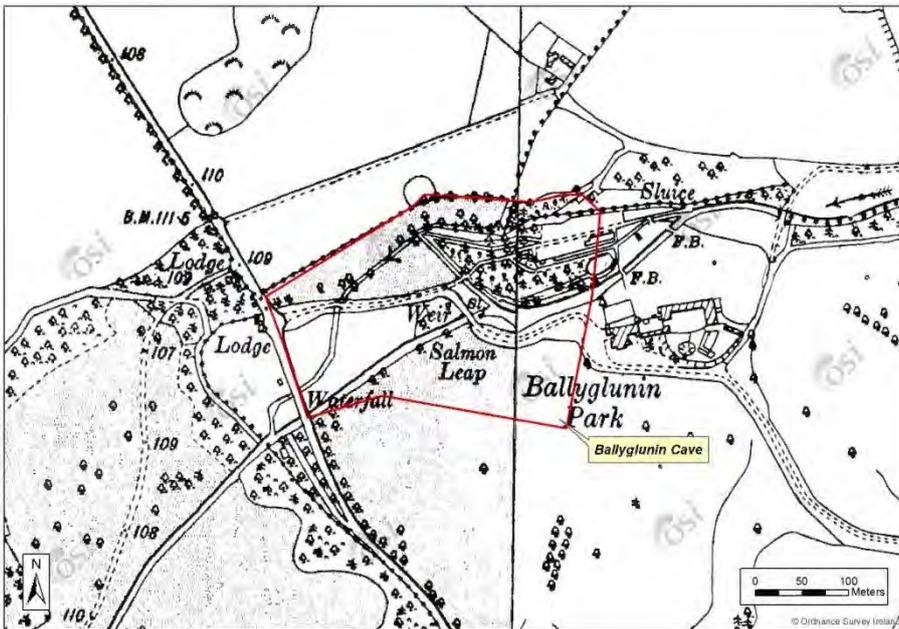
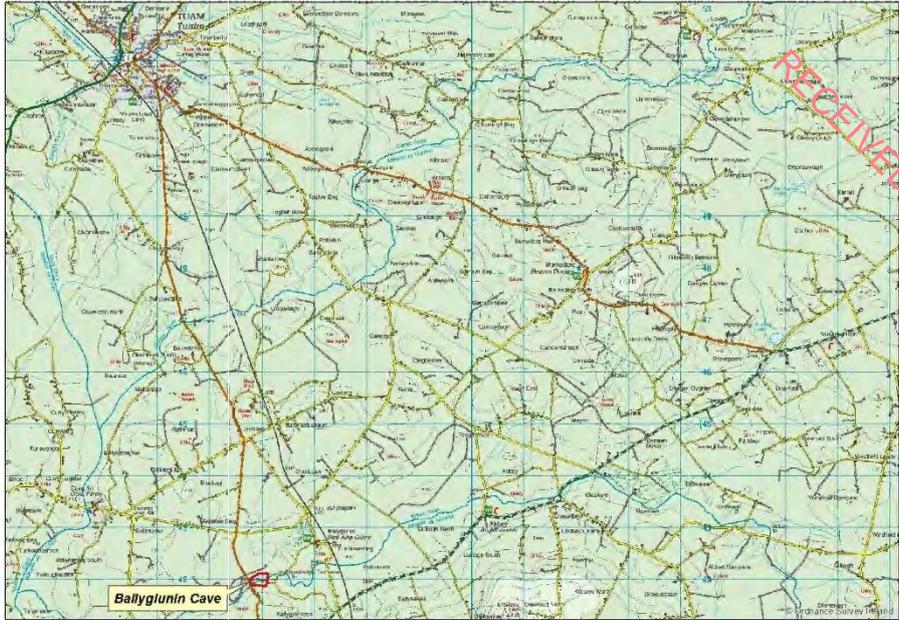
The site is on very private land and there is no access without landowner permission. It is not a site that is suitable for any general promotion for its karstic geology. In addition, caves are potentially dangerous and fragile environments, and no visit should be considered except in the company of experienced cavers, even if allowed by the owners.



The sinking stream in the entrance collapse of Ballyglunin Cave.



The remains of a turbine structure above the sinking stream entrance to Ballyglunin Cave.



GALWAY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	Lough Corrib
Other names used for site	<i>Loch Coirib</i>
IGH THEME	IGH14 Fluvial and Lacustrine Geomorphology, IGH1 Karst, IGH7 Quaternary
TOWNLAND(S)	Numerous
NEAREST TOWN/VILLAGE	Moycullen, Oughterard, Corr na Móna, Conga, Headford
SIX INCH MAP NUMBER	26, 27, 39, 40, 41, 54, 55, 56, 68, 69, 81, 82
ITM CO-ORDINATES	523565E 741910N (Knockferry Pier)
1:50,000 O.S. SHEET Nos. 38,39,45,46	GSI Bedrock 1:100,000 SHEET NOs. 11, 14

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Outline Site Description

A large lake situated between County Galway's western acidic uplands and the limestone lowlands to the east.

Geological System/Age and Primary Rock Type

Lough Corrib in its current shape formed in the Holocene (<11,650 years). The lakeshore karst assemblages formed after deglaciation and the retreat of the last ice sheets around 14,000 years ago. The southern half of the lake occupies a shallow basin (mean depth <4 m) overlying Carboniferous limestone. The northwestern part of the lake occupies a deeper basin floored by Neoproterozoic Dalradian metasediments, Ordovician Oughterard Granite, and Silurian South Mayo Trough sedimentary rocks.

Main Geological or Geomorphological Interest

Lough Corrib is the second largest lake on the island of Ireland, and has a maximum depth of 42 m. The lake covers an area of c. 18,200 ha, and is approximately 16 km from north to south, and 6 km at its widest point. Limestone pavement and karst features (springs, tube karren, egg-box pitting, kamenitza) are present around the lake's limestone shore. The lake water has a high alkalinity (>100 mg/CaCO₃). The Lough Corrib basin formed as a result of contributory factors including acidic waters draining from the quartzite, schists, granite and sandstone uplands in Connemara and Joyce Country (which contributed to the dissolution of lowland limestone), and glacial erosion which furthered the development of the depression. The entire region was covered by thick ice during the last ice age. Numerous drumlin islands (NE-SW orientation) occupy the northern part of the lake. The main rivers feeding into the lake include the Clare, Black, Cregg rivers on the east shore, the Owenriff and Drimneen rivers on the west, and the Failmore/Bealnabrack, Dooghta and Cong rivers in the north. The Cong Canal (seasonally dry) links Lough Mask (via the Cong River) to Lough Corrib. However, most of the water flowing from Lough Mask to Lough Corrib does so via subterranean channels. Lough Corrib drains to Galway Bay via the River Corrib, exiting the lake via two channels: the 'Friar's Cut' and the 'Old River'. These two channels merge near Menlo and continue south to the city.

Site Importance – County Geological Site; recommended for Geological NHA

Lough Corrib is of international conservation importance, particularly for its lakeshore karst assemblages and its hard-water lake habitat. A significantly important County Geological Site, the site is also a designated SAC (Lough Corrib SAC site code 000297) and SPA (Lough SPA site code 004042).

Management/promotion issues

Lough Corrib is an important public water source for the population of the region and of Galway City. The removal of lakeshore karst ('water-worn' or 'holey') limestone for any reason (ornamental or otherwise) should be prohibited. Limestone pavement is a priority habitat (EU Habitats Directive, 8240), and it is protected under EU law. The inclusion of visitor information panels at strategic lakeshore sites and piers could help communicate aspects of the hydrogeological and geological heritage of the feature, as well as share the importance of protecting and conserving water quality and the Corrib's unique lacustrine karst assemblages.



Lough Corrib outflow to the Friar's Cut channel. View northeast. Knockmaa Hill (Tuam) visible in background.



View across Lough Corrib towards Lackavrea Mountain, at dusk.



Karstified bedrock at Kilbeg Quay, Lough Corrib.

