

R54/25

PROFESSIONAL GEOLOGIST'S REPORT AS REQUIRED BY S.R.21:2014 ANNEX E & A1:2016



Commissioned by

John Nulty Ltd. Ardkill Mor Quarry.

Report Delivered: 18th October, 2025

Effective Date: 18th October, 2025

Report Prepared By: EurGeol Dave Blaney PGeo

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Statement of Qualification for Technical Reports

This declaration is to be completed by the author of the report(s) or by the individual responsible for endorsing and signing off technical reports and should be attached to the front of the report.

Declaration

The attached report has been approved by the undersigned; a Qualified Person as recognised by the Institute of Geologists of Ireland.

Name (Capitals) **DAVE BLANEY**

Professional Association (current membership number) **INSTITUTE OF GEOLOGISTS OF IRELAND
No. 087**

Relevant area(s) of expertise as recognised by the Professional Association. **MINING GEOLOGY & EXPLORATION, EXPLORATION GEOLOGICAL MAPPING, PROJECT MANAGEMENT and GEOLOGY**

Registered by the Institute of Geologists of Ireland as a Qualified Geoscientist / Qualified Person with respect to **PYRITE**.



Signature...

Date.....**18th October, 2025**

EurGeol Dave Blaney P. Geo, M.Sc., B.Sc.

BRG Ltd.

Unit 8B

Athy Business Campus

Athy

Co. Kildare

059 8647221 / 087 2796487

blaneyd@brg.ie



Introduction

Following laboratory testing and a site visit on the 10th of October 2025 a report has been compiled to meet a requirement of Standard Recommendation SR.21:2014 & A1:2016. This Standard Recommendation deals with Guidance on the use of I.S.13242:2002+A1:2007 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. Section E.2.4 of S.R.21 requires a geological, chemical and petrographic assessment of the quarry and the end products.

This report also meets a requirement of I.S.EN 932-3:1997 – Tests for General Properties of Aggregates-Part3: Procedure and Terminology for Simplified Petrographic Description.

This report has been compiled by EurGeol. Dave Blaney P.Geo, BSc, MSc, who is a qualified Professional Geologist, a member of the Institute of Geologists of Ireland and a registered Competent Person (in respect of pyrite).

Quarry Planning, Extraction Methods, and Ground Stability Issues are not part of the remit of this report. This report applies only to aggregates quarried and processed on the site as described, located at Ardkill Mor Quarry, County Cavan.



Location / Quarry History

Ardkill Mor Quarry is located in County Cavan, to the south-southeast of Cavan Town, on the western flank of Ardkill Mor hill. Ardkill Mor hill is a prominent topographic feature, rising to an elevation of 268m. (Figures 1 & 2). John Nulty Ltd. has been in operation for over 20 years, producing high quality aggregates for use in civil engineering, road construction and road maintenance. John Nulty Ltd. are currently quarrying between 60,000 – 70,000t of crushed rock aggregate per year from the Ardkill Mor quarry site.

BRG were contracted by to carry out an assessment of the aggregate being produced at the John Nulty Ltd. Ardkill Mor Quarry, Co. Cavan with particular reference to compliance with the terms and conditions of "S.R.21:2014, 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 quarry site was visited by Competent Person (professional geologist), Mr Dave Blaney on the 10th of October 2025, the source of aggregate and the production process was assessed. Samples of material were collected from the production line, as per QA/QC specifications, evaluated and subsequently examined under hand lens and a binocular microscope for a hand specimen, simplified petrographic description.

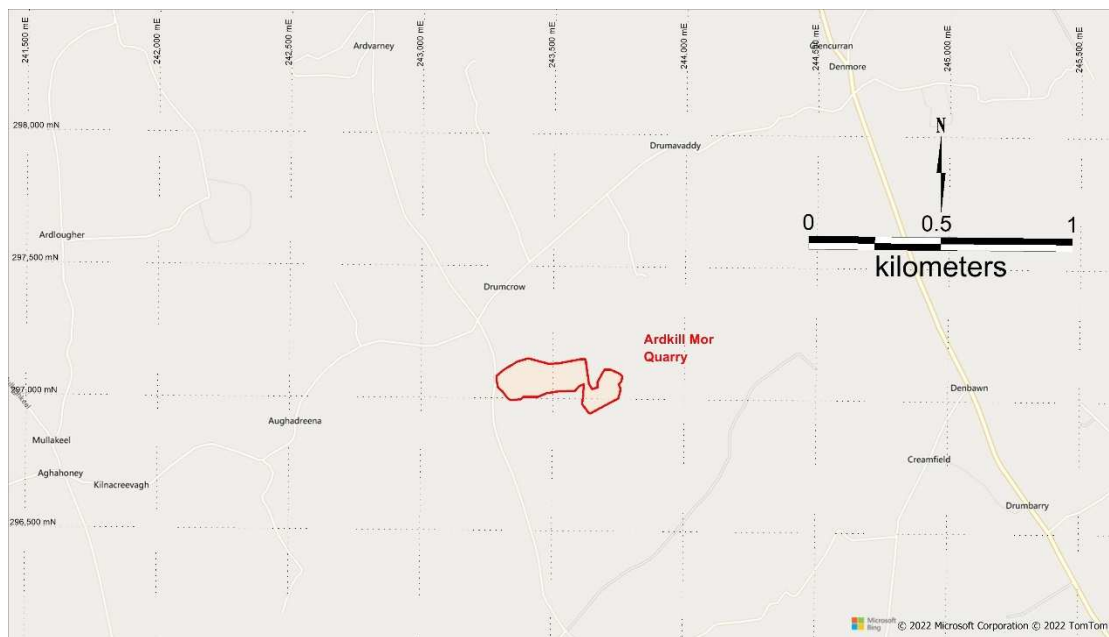


FIGURE 1: REGIONAL LOCATION MAP





FIGURE 2: LOCATION MAP ON BING AERIAL PHOTOGRAPH



Regional Geology of Carrickgorman Quarry

John Nulty Ltd. Ardkill Mor Quarry is located in a region underlain by northeast-southwest striking, southerly dipping, Silurian and Ordovician aged metasediments, dominated by greywackes, sandstones, siltstones and shales within the Southern Uplands – Longford / Down Terrane. The Geological Survey of Ireland (GSI) 1:100,000 scale map shows the quarry located at the faulted contact between the Ordovician, Caradoc aged, Red Island Formation consisting of green to greenish grey greywackes with subordinate grey to black shales, and the Silurian, Llandovery aged, Slieve Glah Formation, consisting of blueish grey, siltstone turbidites, intercalated meta-mudstones, subordinate conglomerates and green greywackes. The Ardkill Quarry lies at the faulted contact between the Ordovician and Silurian. The contact is a major, regional scale, fault zone known as the Orlock Bridge Fault, or Slieve Glah Shear Zone, which is a major sinistral, northeast – southwest striking shear zone which can be traced as far as the Southern Uplands in Scotland. Further structural complexity is caused by a series of conjugate, northwest – southeast striking cross faults. The Orlock Bridge Fault Zone is described “as marked by abundant folded and disrupted, phyllonite parallel quartz segregations and protomylonitic to mylonitic textures. The phyllonitic fault zone fabric overprints the earlier, regional S1 cleavage, but pre-dates c.400Ma Caledonian dykes” (Geology of Longford and Roscommon, Sheet 12, Geological Survey of Ireland).



FIGURE 3: GEOLOGY MAP

The quarry is divided in two, with an upper and lower pit straddling the trace of the Orlock Bridge Fault zone. The Upper Pit is currently not in production and does not form part of the short to medium term development plans for this site. The Lower Pit (Figure 4) is currently in production and the development is extending to the east. The current and planned production is located at the eastern end of the Lower Pit where the upper bench is being lowered to the level of the quarry floor. Development planned for the medium term is to extend the lower bench to the north.





FIGURE 4: CURRENT DEVELOPMENT (LOWER BENCH, LOOKING EAST)



FIGURE 5: PLANNED DEVELOPMENT – NORTHERN FACE OF LOWER BENCH (LOOKING NORTH)



Within the region currently being worked in the Lower Pit the strata are highly foliated with numerous bedding parallel, discontinuous, stringer-like, white quartz veins. These veins appear to have been crenulated and re-folded (figure 6).



FIGURE 6: PARTIALLY SILICIFIED, DARK BLUE / GREY META-MUDSTONE WITH UNDULATING, BEDDING PARALLEL, DISCONTINUOUS WHITE QUARTZ VEINS / VEINLETS.



FIGURE 7: DARK BLUE / GREY META-MUDSTONE WITH POLISHED BEDDING / CLEAVAGE PLANES



The rock currently being worked in the Lower Pit can be described as proto-mylonitic to mylonitic, green-blue-black, fine grained meta-mudstones, meta-siltstone and minor meta-sandstone with a high proportion of thin, white, discontinuous, contorted, quartz veins. The country rock is dominated by recrystallised cleaved, dark blue / black meta-mudstone with a well-developed polished texture (Figure 7). There is some evidence of partial silicification, but most of the rock examined during this visit was not silicified.



FIGURE 8: META-MUDSTONE WITH DISCONTINUOUS CONTORTED AND FOLDED WHITE QUARTZ VEINING.

There is faulting and jointing developed across the current working face. A major fault zone, that is water bearing, is located on the southern side of the current working face (Figure 9), striking north-south and dipping at 80 – 85° to the west.



FIGURE 9: MAJOR FAULT ZONE SOUTH-EAST CORNER OF WORKING FACE





FIGURE 10: FAULT PLANE WITH COARSELY CRYSTALLINE CREAMY / YELLOW QUARTZ DEVELOPED AS SLICKENSIDES

There are localised small scale fault planes developed across the working face with local evidence of minor slickenside development (Figure 10).

There is evidence of iron staining developed along joint surfaces. The iron staining tends to be related to limonite deposition, possibly due to the circulation of groundwater through fractures. It forms very thin coatings / staining confined to the immediate surface of the joint plane (Figure 11).



FIGURE 11: BRIGHT ORANGE LIMONITIC STAINING ON JOINT SURFACE



Examination of the working face and the blast spoil during this site visit presented no evidence of pyrite. A small boulder with quartz veining and patterned limonitic staining was noted, but an examination on site could see no evidence of fresh, relic or oxidised sulphides (Figure 12).



FIGURE 12: QUARTZ VEIN WITH ROUNDED LIMONITIC STAINING



Sampling / Hand Specimen Description

The quarry was visited on the 10th of October 2025 to assess the raw material, the crushing / screening processes, the protocols currently in operation, and to take a representative sample of the aggregate being produced. A general site overview was carried out and discussions held with the operator to assess the nature and the history of the operation.

The SR21-Annex E class aggregate product is being produced using raw material actively worked on site. During processing the material is crushed and sorted by screening.

A sample was obtained from a finished aggregate stockpile (figure 13). Sample (# AMQ025-001), it was a representative 25kg sample of material taken from the margin of stockpile, away from ground level and after the surficial layer had been scrapped off, to minimise the potential for contamination and oxidation or sorting by rain.



FIGURE 13: SR21 AGGREGATE STOCKPILE

The aggregate sample was separated, washed and visually inspected under a hand lens and binocular microscope. The hand specimen sample (Figures 14 & 15) consists of five different facies types:

1. Angular / tabulate clasts of strong to very strong, dark blue grey, fine to medium grained, foliated, recrystallised, meta-mudstone / meta-siltstone, with white, light grey quartz veinlets. Trace amounts of very finely crystalline, small cubic grains of fresh, unoxidised, brassy pyrite is hosted within a few of the white quartz veins / veinlets. Trace, small, silver, acicular, needle like crystals of arsenopyrite also occur within the quartz veins / veinlets. This facies makes up approximately 80 - 90% of the coarser grained material.
2. Angular / tabulate clasts of strong to very strong, orange-brown / dark blue grey, fine to medium grained, foliated, recrystallised, meta-mudstone / meta-siltstone, with white, light grey



quartz veinlets. Partial to intense limonitic staining forming a coating on the surfaces of the clasts. This facies makes up approximately 10 - 20% of the coarser grained material.

The fine-grained fraction of the aggregate was examined under a binocular microscope and no potential issues were noted within this sample.



FIGURE 14: UNWASHED COARSE AGGREGATE SAMPLE (PEN FOR SCALE 14CM LONG)



FIGURE 15: WASHED COARSE AGGREGATE SAMPLE (PEN FOR SCALE 14CM LONG)



Trace amounts of fresh, crystalline, unoxidised pyrite and arsenopyrite were noted during the hand specimen assessment. However, no visual evidence of pyrrhotite, deleterious clay minerals, free mica, gypsum, secondary minerals, surface coatings, significant Fe staining, chert, chalcedony or visible secondary crystal growth were observed during the sample inspection or site visit.



Testing and Analysis

Durability tests, chemical analysis and geological assessment were carried out on representative samples of aggregate product (Table 1).

Test	Testing company	Material Tested	Date	Result	SR21 Compliance
Water Absorption	Testall	SR21-T1	24/09/2025	0.90%	≤2%
Particle Density	Testall	SR21-T1	24/09/2025	2.73t.m3	Not Specified
Particle Size Distribution	Testall	SR21-T0	11/03/2025	1.70%	<7%
Particle Size Distribution	Testall	SR21-T0	19/09/2025	1.90%	<7%
Particle Size Distribution	Testall	SR21-T1	16/09/2025	3.00%	<7%
Particle Size Distribution	Testall	SR21-T1	07/03/2025	2.10%	<7%
Particle Size Distribution	Testall	SR21-T2	07/03/2025	0.40%	<7%
Particle Size Distribution	Testall	SR21-T2	12/09/2025	0.70%	<7%
Magnesium Sulphate Soundness	Testall	SR21-T1	02/10/2025	18	≤25
Los Angeles Coefficient	Testall	SR21-T1	26/09/2025	20	≤30
Total Sulphur Content	Testall	SR21-T1	18/09/2025	0.10%	>0.1 - ≤1% Petrography
Total Sulphur Content	Testall	SR21-T1	18/09/2025	0.10%	>0.1 - ≤1% Petrography
Total Sulphur Content	Testall	SR21-T2	18/09/2025	0.10%	>0.1 - ≤1% Petrography
Total Sulphur Content	Testall	SR21-T0	18/09/2025	<0.1%	>0.1 - ≤1% Petrography
Acid Soluble Sulphate	Testall	SR21-T	18/09/2025	0.10%	≤0.2%
Acid Soluble Sulphate	Testall	SR21-T1	18/09/2025	0.10%	≤0.2%
Acid Soluble Sulphate	Testall	SR21-T1	18/09/2025	0.14%	≤0.2%
Acid Soluble Sulphate	Testall	SR21-T2	18/09/2025	<0.1%	≤0.2%
Water Soluble Sulphate	Testall	SR21-T1	26/09/2025	<0.01%	Not Specified
Flakiness Index	Testall	SR21-T1	16/09/2025	22	Not Specified
Geological Examination	BRG	Pit and Products	10/10/2025	Satisfactory	To Be declared



Alkali Silica Reactivity	BRG	Pit and Products	10/10/2025	Non Reactive	Not Specified
Liquid Limit	Testall	804 Aggregate	04/10/2025	23	Not Specified
Methylene Blue	Testall	SR21-T1	28/07/2025	1.4g/kg	Not Specified

Table 1: Durability / Physical and Chemical Test Results

Durability / physical tests and chemical analysis have been carried out by a certified laboratory, namely, Testall Ltd., Co. Fermanagh. Certificates are available on request.

Ardkill Mor Quarries Ltd. are using crushed, foliated, metamorphosed, meta-mudstone, meta-siltstone, meta-sandstone bedrock to produce S.R.21, Annex E material.

S.R 21:2014+A1:2016 requires suitable material to contain less than 10% sedimentary mudrock. Based on the Professional Geologist's examination of the quarry there is no sedimentary mudrock present in the crushed rock aggregate or in the source material, all of the material examined is low grade, metamorphic rock.

Section E.2.5 outlines testing requirements where a number of different graded products are being produced and the Professional Geologist can select a single product suitable for testing for Los Angeles Value, Water Absorption, Particle Density and Magnesium Sulphate Soundness. Ardkill Mor Quarries Ltd. have tested SR21 (T0 - T2) material and the Professional Geologist is satisfied that the testing regime is appropriate.

The Los Angeles Coefficient value was obtained using the I.S.EN 1097-2:2010 method and returned a Los Angeles Coefficient value of 20, this value is compliant and within the parameters specified in I.S. EN13242:2002, Annex E. N.B. It is suitable for high strength concrete.

The Water absorption testing was carried in compliance with I.S. EN 1097-6-2000 and returned a Water Absorption value of 0.9%, this value is within the range specified in I.S. EN13242:2002, SR21:2014 Annex E.

Magnesium Sulphate Soundness testing was carried out by Testall, in accordance with BS EN 1367-2-2009, and the sample has returned a magnesium sulphate value of 18, within the threshold limit of 25 as specified by I.S. EN13242:2002, SR21 Annex.

Particle Size Distribution / Grading testing has been carried out by Testall Ltd. Curves were examined and all test results are within the guidance limits. A Methylene Blue Test was carried out in 2025, and the result confirmed the potential for swelling was minimal.

The Flakiness Index is not required for SR21 however a test was carried out, and a value was obtained using the I.S.EN 933-3 method and returned a FI value for 22.

Chemical analysis was carried out, with samples analysed for Total Sulphur in accordance with EN 13242 specification. SR21 states that material with a total sulphur value of <0.1% is always acceptable and material with a value of >1% is unacceptable. Material which falls between these two values may be acceptable but additional work, including petrography must be completed to determine the nature of the sulphur bearing mineral. Four total sulphur tests were carried out by Testall on the SR21 material, and all returned values of ≤0.10%. The rock type is a metamorphic rock



with no sedimentary mudstone and little potential for swelling, and the simplified petrographic carried out by the author found nothing of concern. The Acid Soluble Sulphate testing is also compliant and consistently below the guidance threshold of 0.2%.

The testing has been carried out within an acceptable timeframe on samples of aggregate that have been selected and submitted by the operator.

Test	Table E1	Recommendation of Professional Geologist
Magnesium Sulphate Soundness	1 per year	1 per year
Water Absorption	2 per year	1 per year
Los Angeles Coefficient	2 per year	1 per year
Acid Soluble Sulphate	Quarterly	Quarterly
Total Sulphur	Quarterly	Quarterly
Geological Examination	Quarterly	1 per year
Thin and polished sections	As required depending on Sulphur values	Only required when Total Sulphur values are > 0.1%

Table 2: Test frequencies (these may be revised based on the advice of the Competent Person (Professional Geologist), see NOTE 1, Table E.1)

The table E.1 calls for a geological examination of the finished aggregate on a quarterly basis. The Professional Geologist may revise the frequency of the geological examination. In the case of Ardkill Mor Quarry, an annual examination of the quarry and the aggregates, followed by a Professional Geologists report will be adequate, but if there are any significant changes in the geology, the test results, or in the operating methods the geologist should be contacted immediately.

Clause 601.5 of Series 600 of the TII Specification for Roadworks

Clause 601.5 of Series 600 of the TII Specification for Roadworks requires the geological assessment to state whether the raw material should be classified as argillaceous or non-argillaceous. The Professional Geologist is satisfied that the aggregates produced from Ardkill Mor Quarry are non-argillaceous.

Alkali Silica Reaction

Some Irish aggregates, including Carboniferous limestones, and gravels derived from Carboniferous limestone contain chert (SiO₂). Chert content is variable and may be as much as 10% in limestone aggregate and can be considerably higher in some gravels.

In some parts of the world silica rich aggregates, for example flint in the UK, are responsible for a reaction known as Alkali-Silica Reaction. The silica in the flint reacts with alkalis (Na₂O and K₂O) in



the cement to produce a silica gel which in humid environments or in prolonged wet conditions, absorbs water and causes the concrete product to swell and crack. Opaline silica, tridymite and cristobalite are the forms of quartz most likely to react in this way.

In 1993 Dr P Strogen produced a report on the potential for Irish aggregates to be affected by Alkali-Silica reaction. He collected and examined chert from 74 locations, both bedrock quarries and gravel pits, across Ireland. He found that most Irish gravels can contain significant amounts of chert, but he concluded that Irish chert was totally different from flint, and he found no evidence of alkali-silica reaction associated with Irish chert. Neither did he find any evidence for alkali silica reaction associated with Irish greywackes. He attributed the lack of any reaction to the fact that most Irish rocks have reached temperatures well in excess of 200°C and this has stabilised the chert. Greywacke have reached even higher temperatures. The porosity of Irish cherts is also far lower than the porosity of reactive flint, and the lower the porosity of the material the lower the potential of the silica to react.

The Institution of Engineers of Ireland and The Irish Concrete Society jointly produced a report on Alkali-Silica Reaction in Concrete in 2003, referenced as Item 36 in the Bibliography attached to SR16:2016. They reviewed Strogen's work and a report prepared by IEI in 1991. The 2003 report states that the degree of crystallinity in the chert is important. This is affected by the degree of low-grade metamorphism and deformation to which the rock has been subjected. Temperatures in excess of 200°

The IEI/ICS report also confirms that there were no recorded issues of ASR in Irish aggregates when they carried out surveys in 1989 or in 2003. The IEI/ICS report states in Table 1 that if the chert, chalcedony, flint content is $\leq 5\%$ the aggregate may be classified as unlikely to be deleteriously alkali reactive.

The risk of Alkali-Silica reaction is very low in Ireland but may be somewhat higher with some Northern Irish aggregates which contain flint or silica derived from Tertiary volcanic rocks/aggregates.

An accelerated mortar bar expansion test can be used to test for alkali-silica reaction; an expansion of $\leq 0.10\%$ is indicative that the aggregate is suitable for all purposes. Further investigation may be required if $\geq 0.10\%$

After taking of the above into account and based upon examination of the hand specimens, the Professional Geologist is satisfied that Ardkill Mor aggregate can be considered non deleterious with respect to Alkali Silica reactivity.

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Conclusions / Recommendations

John Nulty Ltd. Ardkill Mor Quarry has been visited and assessed, and representative samples of aggregate material have been examined, analysed, and tested as per the guidelines in SR21:2014 Annex E.

The results of this work confirm that the aggregate being produced from the quarry, that was examined during October 2025, is compliant within the guideline requirements of SR21:2014, Annex E the relevant standards for:

- SR21:2014 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.

It should be noted that aggregates produced as unbound and hydraulically bound materials for use in civil engineering work and road construction have been reclassified as "2+" under the systems of Assessment and Verification of Constancy of Performance (AVCP) in accordance with the EU Construction Products Regulation. As such, the producer is required to determine the product type, instigate production control, and devise a plan for ongoing testing of samples.

The minimum testing schedule recommended by BRG is presented in Table 2. As there was trace pyrite / arsenopyrite noted in the hand sample assessment it is recommended to carry out Total Sulphur and Acid Soluble Sulphate tests on a quarterly basis to confirm ongoing compliance with SR21:2014.

It is of the utmost importance that the operator consults with a Competent Person (professional geologist) if any of the following are noted:

1. If there is a marked change in the lithology type
2. If there is a significant change in the proportion of lithologies in the raw material.
3. If there is evidence of significant pyrite content in the observed rocks.
4. If there is evidence of more intense iron staining in the exposed faces.
5. If there is evidence of secondary mineral growths or surface coatings.
6. If there is evidence of swelling and disintegration of facies on the exposed faces or in the aggregates
7. Any significant changes in the test results

If any changes in the raw material are noted it is important that this should be documented, and records maintained (the inclusion of a date stamped photographic record is recommended).



Statement of Compliance

The Professional Geologist is satisfied that, providing grading specifications continue to be met, based on his examination of the quarry, together with the chemical and physical test results supplied by the operator, material from Ardkill Mor Quarry is suitable for use as unbound granular fill (hardcore) for use under concrete floors and footpaths and that it meets with S.R.21:2014 & A1:2016 guidelines.

These statements of compliance do not imply Certification to I.S. EN 13242:2002+A1:2007 and I.S. EN 12620:2002 + A1:2008.

Certification to relevant harmonised standards is subject to an Inspection/Certification by an independent Notification Body within the European Union.

The Statement of Compliance has been approved by the undersigned; a Qualified Person as recognised by the Institute of Geologists of Ireland.

Name (Capitals) **DAVE BLANEY**

Registered by the Institute of Geologists of Ireland as a Qualified Geoscientist / Qualified Person with respect to PYRITE.



Signature

Date: 18th October 2025

EurGeol Dave Blaney P. Geo, M.Sc., B.Sc.

BRG Ltd.

059 8647221 / 087 2796487

blaneyd@brg.ie



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