

APPENDICES INDEX

RECEIVED: 18/08/2025

CHAPTER 7

LAND, SOILS AND GEOLOGY

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Uploaded in 3 Files <20MB

> Appendix Part 1 = Appendix 7-1; 7-2 & 7-3.

> Appendix Part 2 = Geophysical Reports - Greenfield Area 2025 (Apex 2018a, 2018b).

> Appendix Part 3 = Apex (2025); Appendix 7-5 & 7-6.

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Appendix 7-1 GSI & TII Scoping responses with Hydro-G technical responses

1. GSI Response to Scoping: Hydro-G hereby states that, as advised by the GSI, all available GSI data have been employed in the EIA and are detailed in the EIAR, where appropriate. In the EIAR Hydro-G provided specific references to the maps and databases listed by the GSI text.

2. TII raised points regarding geotechnics, noise, road guidance and water. The two specific water related issues are addressed after the full text of appendix 8.8 of the Water Chapter. The Geotechnical aspects of the TII are addressed in a site-specific Geotechnical Assessment (AMS, 2025), which is presented as Appendix 7-4 of this chapter. The Tables of the LSG Chapter address TII's concerns in terms of Potential, Mitigation and Residual Impact Tables and associated Text.



RECEIVED: 18/08/2025

Rory Brickenden
Quarry Consulting
Unit 3, Cedar Crescent,
Cedar Park
Westport
Co. Mayo, F28 PN47

25 February 2025

Re: Proposed extension of limestone quarry, Kilree, Sheastown, Bennettsbridge, Co Kilkenny

Your Ref: 63.01

Our Ref: 25/32

Dear Rory,

Geological Survey Ireland is the national earth science agency and is a division of the Department of the Environment, Climate and Communications. We provide independent geological information and interpretation and gather various data for that purpose. Please see our [website](#) for data availability.

With reference to your email received on the 20 February 2025, concerning the proposed extension of limestone quarry, Kilree, Sheastown, Bennettsbridge, Co Kilkenny, we recommend using our various data sets when conducting the EIAR, SEA, planning and scoping processes for developments, plans and policies. For more detailed information on how to access this data please access 'Data and Maps' [Data & Maps \(gsi.ie\)](#) on our 'Geoscience for planning' webpage. Use of our data or maps should be attributed correctly (please refer to each individual dataset's metadata for correct attribution).

For specific data available for Environmental Assessment and Planning topics please follow this link [\[Data by Environmental Assessment and Planning Topic \(gsi.ie\)\]](#), where you will find our data arranged by environmental assessment topic as illustrated below:

Land and soils <i>Soil</i> • Subsoils (Quaternary Geology) • Tellus Geochemistry • Geotechnical <i>Geology</i> • Bedrock • Geophysics • Bedrock & Quaternary 3D	Water <i>Groundwater</i> • Aquifers GW vulnerability, GWPSs (GWPPs) <i>Surface water</i> • Tellus Geochemistry <i>Estuarine & marine waters</i> • Marine and coastal <i>Flooding</i> • GWClimate • Karst	Climate Change <i>Carbon accounting / Carbon balance</i> • Geothermal • Carbon capture and storage <i>Climate change trends</i> • National coastal change assessment
Cultural Heritage <i>Archaeology</i> • Cherish <i>Underwater Archaeology</i> • Shipwrecks	Material Assets <i>Built Services</i> • Natural resources (Minerals & Aggregates) • Active quarries	The Landscape <i>Landscape Appearance & Character</i> • Physiographic units <i>Historical landscapes</i> • Historic mines
Other Relevant Data		
<i>Natural (Geo) hazards</i> • Landslide Susceptibility Mapping • Groundwater flooding • Coastal vulnerability • Subsidence • Radon	<i>Natural heritage</i> • Geoheritage (County Geological Sites) • Dimension Stone/Stone Built Ireland	



RECEIVED 10/03/2025

Other Comments

Should development go ahead, all other factors considered, Geological Survey Ireland would much appreciate a copy of reports detailing any site investigations carried out. The data would be redacted for confidentiality and added to Geological Survey Ireland's national database of site investigation boreholes, implemented to provide a better service to the civil engineering sector. Data can be sent to the Geological Mapping Unit, at <mailto:GeologicalMappingInfo@gsi.ie>.

Geological Survey Ireland would request that the operator might assist our geological heritage goals with the following (and ideally this would be written into the restoration / closure plan) 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.

The Geoheritage Programme tries to promote a partnership between geological heritage and active quarrying, with such measures as those outlined in the 'Geological Heritage Guidelines for the Extractive Industry', which can be downloaded [here](#). This document, written in association with Irish Concrete Federation, acts as a comprehensive guide in the sustainable extraction of natural resources while preserving the geological heritage of Ireland.

If we can be of any further help, please do not hesitate to contact me Clare Glanville, or my colleague Trish Smullen at GSIPlanning@gsi.ie.

Yours sincerely,

Dr. Clare Glanville
Senior Geologist
Geoheritage and Planning Programme
Geological Survey Ireland

Trish Smullen
Geologist
Geoheritage and Planning Programme
Geological Survey Ireland

The publicly available data referenced/presented here, should in no way be construed as Geological Survey Ireland support for or objection to the proposed development or plan. The data are made freely available to all and can be used as independent scientific data in assessments, plans or policies. It should be noted that in many cases these data are a baseline or starting point for further site specific assessments.

From: [Rory Brickenden](#)
To: [Pamela Bartley](#)
Cc: [markg](#)
Subject: FW: TII Ref: TII25-130488 - Lateral Extension of an Existing Permitted Limestone Quarry Kilree, Bennettsbridge, Co. Kilkenny
Date: Monday 10 March 2025 15:41:11
Attachments: [image001.png](#)

Hi Pamala,

Please see email below which shows TII's preplanning consultation response for Bennettsbridge. They mention flooding on the M9 and not impacting the M9 independent drainage scheme.

Regards,

Rory Brickenden
B.A. MEngSc



Unit 3, Cedar Crescent, Cedar Park, Westport, Co. Mayo, F28 PN47.

Email: rbrickenden@quarryconsulting.ie
Tel: + 353 87 607 5989

From: INFO <Information@tii.ie>
Sent: 10 March 2025 15:22
To: Rory Brickenden <rbrickenden@quarryconsulting.ie>
Subject: TII Ref: TII25-130488 - Lateral Extension of an Existing Permitted Limestone Quarry Kilree, Bennettsbridge, Co. Kilkenny

Dear Mr. Brickenden,

Thank you for your correspondence of 20 February 2025 regarding the above. Transport Infrastructure Ireland's (TII's) position in relation to your enquiry is as follows.

TII will endeavour to consider and respond to planning applications referred to it, given its status and duties as a statutory consultee under the Planning Acts. The approach to be adopted by TII in making such submissions or comments will seek to uphold official policy and guidelines, as outlined in the Section 28 Ministerial Guidelines 'Spatial Planning and National Roads Guidelines for Planning Authorities' (DoECLG, 2012). Regard should also be had to other relevant guidance available at www.TII.ie.

The issuing of this correspondence is provided as best practice guidance only and does not prejudice TII's statutory right to make any observations, requests for further information, objections or appeals, following the examination of any valid planning application referred.

National Strategic Outcome 2 of the National Planning Framework includes the objective to maintain the strategic capacity and safety of the national road network. In addition, Chapter 7 'Enhanced Regional Accessibility' of the National Development Plan, 2021 – 2030, sets out the key sectoral priority of maintaining Ireland's existing national road network to a robust and safe standard for users. This requirement is further reflected in the publication of the National Investment Framework for Transport in Ireland and also the existing Statutory Section 28 'Spatial Planning and National Roads Guidelines for Planning Authorities'.

With respect to EIAR Scoping issues, the recommendations indicated below provide only general guidance for the preparation of an EIAR, which may affect the national road network.

The developer should have regard, inter alia, to the following:

The development site is located immediately north of the M9 motorway and the area that the proposed quarry extends into also adjoins the M9 motorway with the EIAR Scoping Report confirming that the M9 motorway forms the southernmost boundary of the site.

As set down in the 'DoECLG Spatial Planning and National Roads Guidelines', (2012), it is in the public interest that the national road network continues to serve its intended strategic purpose. The EIAR should identify the methods/techniques proposed for any works traversing/in proximity to the national road network in order to demonstrate that the development can proceed complementary to safeguarding the capacity, safety and operational efficiency of that network.

While it is acknowledged that Section 6.9 of the EIAR Scoping Report addresses 'Transportation', the assessment outlined appears to concentrate primarily on traffic impact and does not also consider impacts of quarrying activity generally on the adjoining M9, motorway. This should be addressed in the EIAR.

TII is of the opinion that geotechnical assessment of quarrying impacts on the adjoining M9 Motorway should be considered in any subsequent EIAR and shall include for an appropriate setback from the M9 motorway and demonstrate no impacts on the motorway reservation including subsurface, alignment, pavement and screening bunds.

In addition, the EUIAR should consider and assess:

1. Mitigation of potential dust and debris impacts on the adjoining M9.
 2. Geotechnical assessment and monitoring to maintain the physical integrity of, and mitigate potential impact on, the M9 and the motorway reservation and all related motorway infrastructure.
 3. Appropriate control of discharge from any holding ponds/lagoons such that flooding of the adjoining M9 does not occur.
 4. The M9 drainage regime is an independent drainage regime and shall not be impacted nor affected by the proposed development.
- Consultations should be had with the relevant Local Authority/National Roads Design

Office, with regard to the locations of existing and future national road schemes in the area.

- TII would be specifically concerned as to potential significant impacts the development would have on the national road network (and junctions with national roads) in the proximity of the proposed development, including the potential haul route.
- The developer should assess visual impacts from existing national roads.
- The developer should have regard to any EIAR/EIS and all conditions and/or modifications imposed by An Bord Pleanála regarding road schemes in the area. The developer should, in particular, have regard to any potential cumulative impacts.
- The developer, in preparing EIAR, should have regard to TII Publications (formerly DMRB and the Manual of Contract Documents for Road Works).
- The EIAR should have regard to TII's Environmental Assessment and Construction Guidelines, including the Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (National Road Authority (NRA), 2014).
- The EIAR should consider the 'European Communities (Environmental Noise) Regulations, 2018, (S.I. no. 549 of 2018)', and, in particular, how the development will affect future action plans by the relevant competent authority. The developer may need to consider the incorporation of noise barriers to reduce noise impacts (see 'Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014)').
- It would be important that, where appropriate, subject to meeting the appropriate thresholds and criteria and having regard to best practice, a Traffic and Transport Assessment (TTA) be carried out in accordance with relevant guidelines, noting traffic volumes attending the site and traffic routes to/from the site, with reference to impacts on the national road network and junctions of lower category roads with national roads.

In relation to national roads, TII's 'Traffic and Transport Assessment Guidelines' (2014) should be referred to in relation to proposed development with potential impacts on the national road network. The scheme promoter is also advised to have regard to Section 2.2 of TII's TTA Guidelines, which addresses requirements for sub-threshold TTA.

Any improvements required to facilitate development should be identified. It will be the responsibility of the developer to pay for the costs of any improvements to national roads to facilitate the private development proposed, as TII will not be responsible for such costs.

- The designers are asked to consult TII Publications to determine whether a Road Safety Audit is required.
- In the interests of maintaining the safety and standard of the national road network, the EIAR should identify the methods/techniques proposed for any works traversing/in proximity to the national road network.

- TII recommends that the applicant/developer should clearly identify haul routes proposed and fully assess the network to be traversed. Where abnormal 'weight' loads are a feature of the development, e.g., turbine or substation components, separate structure approvals/permits and other licences may be required in connection with the proposed haul route. All national road structures on the haul route through all the relevant County Council administrative areas should be checked by the applicant/developer to confirm their capacity to accommodate any abnormal 'weight' load proposed. Any requirements for 'Exceptional Abnormal Loads' should also be addressed in accordance with TII Publications.

In addition, the haul route should be assessed to confirm capacity to accommodate abnormal 'length' loads and any temporary works required are identified.

The national road network is managed by a combination of PPP Concessions, Motorway Maintenance and Renewal Contractors (MMaRC) and local road authorities, in association with TII.

The applicant/developer should also consult with all PPP Companies, MMarC Contractors and road authorities over which the haul route traverses, to ascertain any operational requirements, including delivery timetabling, etc., to ensure that the strategic function of the national road network is safeguarded.

Where temporary works within any MMarC Boundary are required to facilitate the transport of turbine components to site, the applicant/developer shall contact thirdpartyworks@tii.ie in advance, as a works specific Deed of Indemnity will be needed by TII before the works can take place.

Additionally, any damage caused to the pavement on the existing national road arising from any temporary works due to the turning movement of abnormal loads (e.g., tearing of the surface course, etc.) shall be rectified in accordance with TII Pavement Standards and details in this regard shall be agreed with the road authority prior to the commencement of any development on site.

Any Road Safety Audit requirements should be addressed.

Notwithstanding any of the above, the developer should be aware that this list is non-exhaustive, thus site and development specific issues should be addressed in accordance with best practice.

I hope that this information is of assistance to you.

Yours sincerely,

Suzanne Cahill
Regulatory & Administration Executive

From: Rory Brickenden
Sent: Thursday 20 February 2025 11:58

To: Rory Brickenden
Subject: Preplanning Consultation

You don't often get email from rbrickenden@quarryconsulting.ie. [Learn why this is important](#)

CAUTION: This email originated from outside of TII. Do not click links or open attachments unless you recognise the sender and are sure that the content is safe.

Dear Sir / Madam,

Please find attached a Preplanning Consultation document in relation to the following development:

- Local Authority: Kilkenny Co Co;
- Applicant: Bennettsbridge Limestone;
- Proposed Development: Lateral Extension of an Existing Permitted Limestone Quarry
- Address: Kilree, Bennettsbridge, Co. Kilkenny

We look forward to your response.

Regards,

Rory Brickenden
B.A. MEngSc



Unit 3, Cedar Crescent, Cedar Park, Westport, Co. Mayo, F28 PN47.

Email: rbrickenden@quarryconsulting.ie
Tel: + 353 87 607 5989

In accordance with TII's Right to Disconnect policy, if you are receiving this email outside of normal working hours, I do not expect a response or action outside of your own working hours unless it is clearly noted as requiring urgent attention.

Appendix 7-2 NRA rating criteria Tables
of Appendix C of IGI (2013) Guidance

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Table 7-1 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	- 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	- 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	- 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	- 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 7-2.

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

Magnitude	Criterion	Description & Example
Large Adverse	Results in loss of attribute	- 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	- 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	- 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 7-3 determines the significance of the impacts based on the site importance and magnitude of the impacts as determined by and Table 7-2.

Table 7-3 Criteria for Rating of Significant Environmental Impacts (NRA, 2009; IGI, 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

Environmental Impact Assessment Report

Client: Bennettsbridge Limestone

Proposed Lateral Extension to a Limestone Quarry at Kilree, Bennettsbridge, Co. Kilkenny.

Ref. No.: 63.01

Appendix 7-3 Geotechnical Report (AMS, 2022; 2024; 2025).

RECEIVED: 18/08/2025

Geotechnical Assessment of Bennettsbridge Limestone Quarry

RECEIVED: 18/08/2025



ADVANCED
MINING SOLUTIONS LTD.

Jonathan Talbot Geotechnical Engineer Advanced Mining Solutions Ltd.

July 2022

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1. Introduction

Advanced Mining Solutions Ltd (AMS) has been employed by Bennettsbridge Limestone Ltd (BBL) to conduct a geotechnical assessment as per the 2008 Quarry Regulations. This assessment follows on from the ones conducted in 2016, 2018 and 2020. The quarry is located just off the R700 just north of the town of Bennettsbridge, Co. Kilkenny in the townland of Sheastown. The quarry office is located at the co-ordinates N52.60125 E-7.19620



Figure 1 Site Location

The site is bounded to the South by the M9 Motorway, to the East by the R700 regional road and to the North and West by farmland. The River Nore is located approximately 1km to the East of the main quarry buildings.

2. Geological Setting

The quarry is located within the Ballyadams Formation which is a thickly bedded fossiliferous limestone dating from the Carboniferous period. In general, the Ballyadams Formation has a very high intact rock strength due to its thickly bedded nature and structural uniformity however the presence of major fault structures and complex joint sets can affect its stability on a local level.

To the South East the Ballyadams formation starts to give way to a more dolomitised reef limestone which also has a high intact rock strength but a greater degree of weathering.

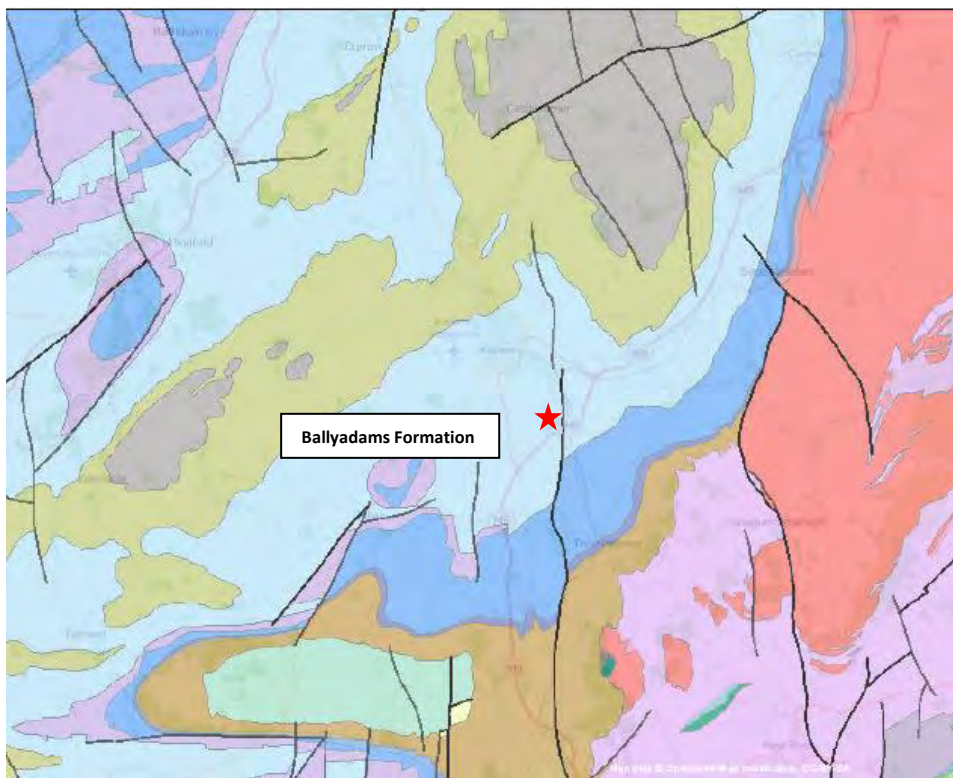
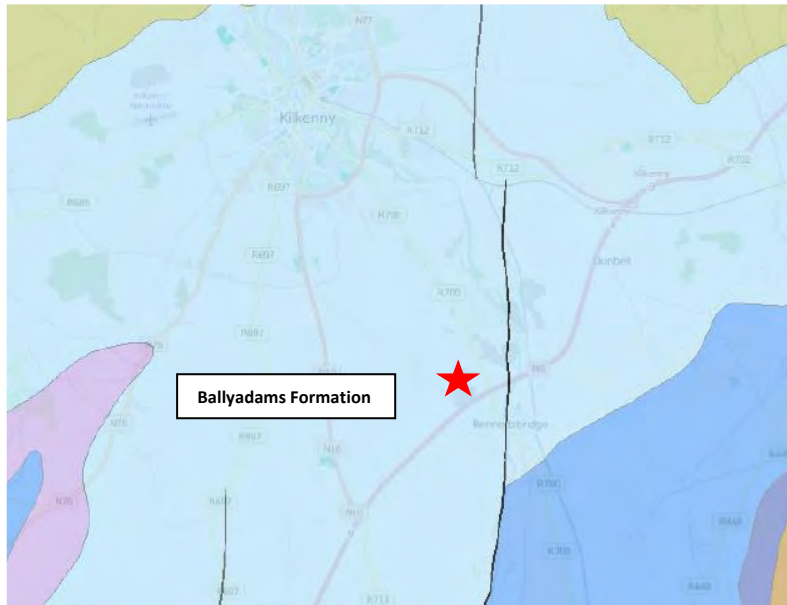


Figure 2 Large Scale Geological Map



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Figure 3 Small Scale Geological Map

From visual observations the intact rock strength of the rock in the quarry is good. There are local areas of weathering to the East and South East of the quarry primarily in the upper benches. Structurally there is a large fault running close to West East through the middle of the quarry. This fault has a large persistence, an aperture of c.0.5m with a weathered clay/rock infill. The fault has a measured strike of 080° and a Dip of 80° South.



Figure 4 The main West East trending fault

The primary joint set has an average orientation of 350° Strike and 85° Dip with a secondary joint set with an average orientation of 064° Strike and 82° Dip. The bedding within the rock is close to horizontal with a slight tendency in dipping to the East.



Figure 5 The primary joint set (highlighted in red)



Figure 6 The secondary joint set (highlighted in red)

These orientations give a slight proclivity towards potential toppling failure in the western faces with more likely block failure in the northern, southern and eastern

faces however from visual observations there are few naturally formed stability hazards within the current quarry layout and most of the stability hazards currently are minor and related to active working faces.

Since the last assessment the quarry has opened up an extension in the south west of the quarry. The rock in this section is of extremely good quality. There is little or no weathering and minimal structure despite some potential faults being identified in the geophysical investigation.



Figure 7 South west extension upper face.

3. Current Quarry Layout

As mentioned previously the quarry is currently being developed to the south west. The upper bench in this corner has been pushed back to its extent to the northern side of the farmhouse while the remainder of the faces in this area will be under development for some time. The crushing and screening plant located in the northern lower section of the quarry with some additional mobile crushing and screening in the lower eastern portion and the stockpiles located in the remaining lower sections of the quarry. Lagan Cement Plc operate a tarmac facility on the upper Northeast bench of the quarry. Vehicles are currently driving in and out of the stockpile area and the tarmac facility for loading. There is a disused covered gantry crane building which was part of a pre-cast production facility now closed in the northernmost section of the quarry. The quarry faces surrounding the pre-cast and tarmac facilities are old faces that have not been active in many years.

Access to the lower portion of the quarry is through the main access ramp starting after the main office buildings running south down into the base of the quarry. There is another access ramp which runs up to the middle bench in the western side of the quarry. This bench also provides access to the dump hopper for the crushing facility and the western upper benches. There is also a small ramp back down to the western side of the pre-cast facility in this area also.

Geotechnical Assessment of Bennettsbridge Limestone Quarry



Figure 8 Ortho image showing quarry layout (not to scale)

More detailed scaled plans and cross sections of the quarry are contained in the back of this document.

4. Geotechnical Appraisal

The 2008 Quarry regulations specify that a geotechnical appraisal must be carried out regularly by a competent person. Where a significant hazard is found, a geotechnical assessment must be carried out by a geotechnical specialist. In order to determine first where the significant hazards lie, AMS carried out a geotechnical appraisal so that the hazards could be identified and then analysed further as part of the geotechnical assessment.

Faces

The 2008 quarry regulations state that a face/ excavation may be considered to be a significant hazard:

- Where in the case of moderately weak or stronger rock which is normally excavated using explosives or saws
 - The vertical height of any individual face is greater than 20 metres.
 - Where multiple benches are present and bench widths or the overall face angle may be inadequate to ensure quarry stability; or
- In the case of weak rock or very weak rocks and engineering soils, (for example clay or sand and gravel deposits), where the vertical height of any excavation exceeds 7.5m and the overall face angle is steeper than a suitable angle to ensure safety; or
- Irrespective of any excavation face height, depth or angle, other factors, for example, the geology, location or proximity of a tip, location or proximity or infrastructure or private lands means that there is a significant hazard.

The quarry has been designed and operated to take cognisance of good practice and the 2008 regulations. As a result, a conscious effort has been made to keep individual bench heights below 20m and stand-off zones are present beneath all the currently active and old faces. The quarry operator has also instigated procedures

where no unauthorised personnel are allowed anywhere near faces keeping most quarry activity far away from active faces.

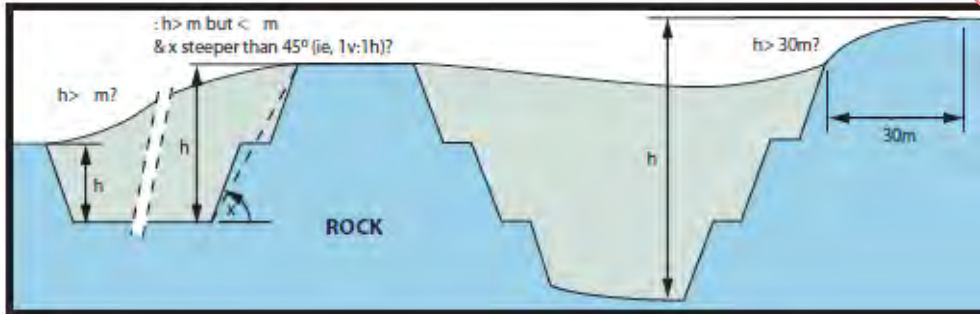


Figure 9 Criteria for significant hazard in rock faces according to 2008 regulations

Although these is no deliberate contravention of the best practice for face stability in terms of face height a section of the East face has left an overall face height in excess of 20m and therefore this can be considered to be a significant hazard.

In general the stability of the quarry has improved since the last visit and there are no new additional significant hazards as per the regulations. There are a few areas that warrant additional scrutiny in the assessment section of this report.



Figure 10 The new south western side of quarry all benches under 20m in height

Stockpiles

The quarry operates a system whereby most of the drilling, blasting and material crushing is conducted in or around the summer months and the material moved during this period is stockpiled for sale during the winter months. This system makes the quarry heavily reliant on good stockpile management and monitoring stockpile stability.

At the time of AMS's visit to the quarry the stockpiles were moderately sized and may not be reflective of how large the stockpiles may be during the winter but by following best practice in terms of stockpile stability and management, the operator can ensure that the control of stockpiles at any time of the year can be safe and efficient for workers and visitors to site.

According to the 2008 Quarry Regulations stockpiles can be considered to be a significant hazard when:

- The stockpile is not in a wholly, or mainly, solid state and not in solution or suspension. (i.e. well drained and not likely to flow)
- The area of land covered by an individual stockpile exceeds $10,000\text{m}^2$
- The height of the stockpile exceeds 20 metres.
- The average gradient of the land covered by the stockpile exceeds 1 in 12.

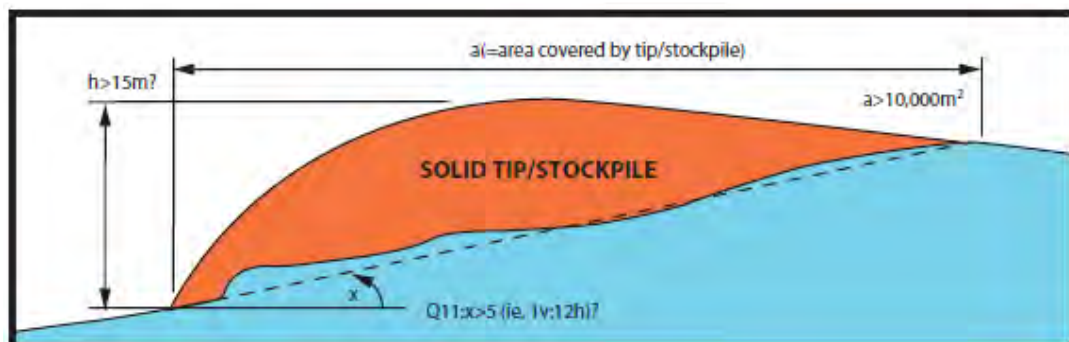


Figure 11 Criteria for significant hazard in stockpiles according to 2008 regulations

The stockpiles at the time of writing in Bennettsbridge Limestone quarry do not exceed any of the above specifications and can be considered stable. The individual stockpiles are below 20m in height, situated on level ground and well drained to the point where all stockpiles are located on dry ground with the quarry drainage system situated between the individual tips.

None of the stockpiles in Bennettsbridge Limestone quarry can be considered a significant hazard as part of the geotechnical appraisal.



Figure 12 Showing the stockpiles in BBL Quarry

A notable new feature in the quarry is the stripped material from the south west extension that was placed and shaped into a bund running along the periphery of the quarry site to the south near the boundary with the M9 motorway. The stability of this was assessed in previous appraisal reports but will also be added to in this report now that the bund is complete.



Figure 13 Bund running along southern boundary of the quarry

Lagoon

The 2008 quarry regulations state that a lagoon may be considered to be a significant hazard where:

- The contents of the lagoon are more than 4 metres above the level of the land which is within 50m of its perimeter, or;
- The contents of the lagoon exceed 10,000m³.

The BBL quarry lagoon is located to the east of the excavation. It features a primary pond for initial settlement followed by a larger pond for longer term settlement and an outflow weir where the treated water flows down towards the River Nore.

There is also a small water sump within the quarry which is located in the East corner of the quarry.

The size, location and orientation of the land around the lagoon are all within the accepted guidelines of the regulation and can be considered not to contain any significant hazards as per the geotechnical appraisal.

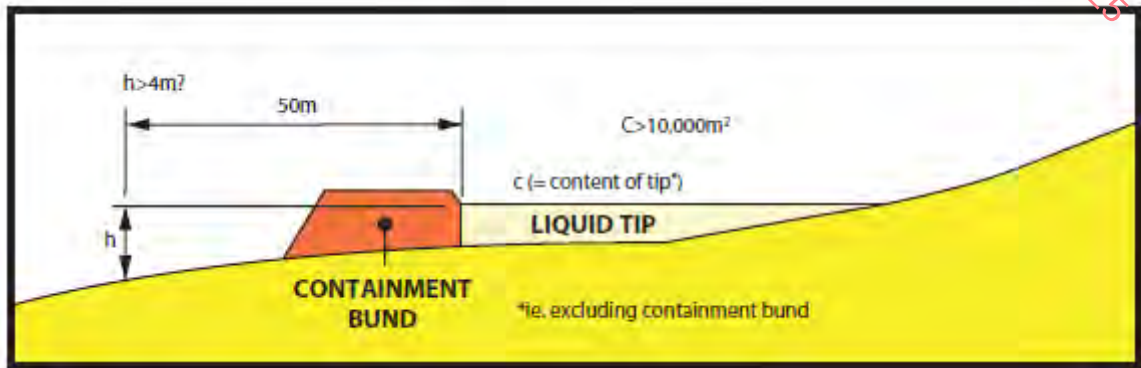


Figure 14 Criteria for significant hazard in lagoons according to 2008 regulations



Figure 15 Showing larger settlement lagoon

5. Geotechnical Assessment

When conducting the geotechnical assessment of Bennettsbridge Limestone it should be noted that overall the quarry is well designed, in generally stable condition and the procedures and controls put in place by the management of the quarry relating to access to active faces and control of loose face material are of a good standard. This standard has been maintained and indeed improved since the last geotechnical assessment in 2020.

The only area that can be considered as a significant hazard according to the regulations is a small section of the East face where the lack of an adequately sized middle bench has created an overall face height in excess of 20m. This hazard was first identified in 2016 and has been rectified according to the recommendations in that assessment. Since then the hazard has not worsened in any way. Some other faces also have localised loose rocks.

In order to conduct a stability assessment of the faces in BBL quarry it was necessary to classify the faces in terms of their rock mass condition using a qualitative assessment of the rock condition combined with a quantitative evaluation by means of RQD measurements.

RQD (Rock-quality designation) is a measure of the degree of jointing or fracture in a rock mass, measured as a percentage of the measured run of rock or drill core in lengths of 10 cm or more. The higher the percentage the less fractured the rock is as a mass. In the case of the AMS site investigation of the quarry, a number of 2 metre runs were randomly chosen on each face and assessed for RQD.

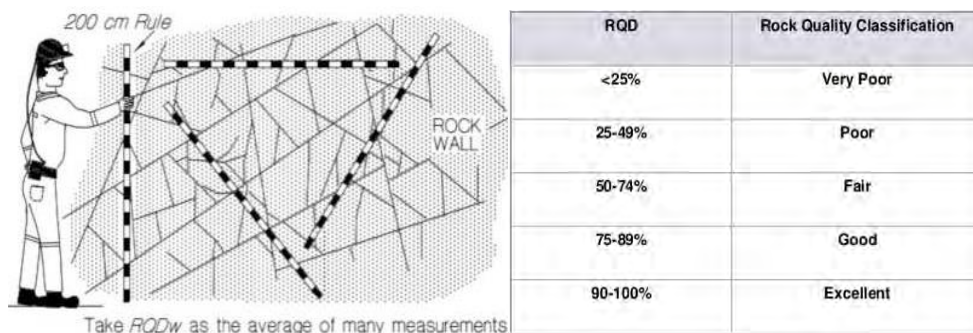


Figure 16 RQD Method of measurement and table showing classification of result

By combining the assessment of the intact rock strength with the measured RQD an assessment of the Rock Mass Strength and stability of each face can be made.

What follows is an overall stability assessment of the entire quarry and recommendations will follow from this analysis.

Faces

As mentioned previously the Ballyadams formation in the area the quarry is situated in has a high intact rock strength. In order to conduct a stability assessment of the faces in Bennettsbridge limestone quarry it was necessary to classify the faces in terms of their rock mass condition using a qualitative assessment of the rock condition combined with a quantitative evaluation by means of RQD measurements. The majority of this data was collected during previous assessments and this was added to in the 2022 assessment.

Southern Upper Face



Figure 17 Southern Upper Face

Although there is very little exposure of quarry personnel to the southern upper face there appears to be loose present particularly on the corner to the left of the interim ramp access and in some other weathered portions of the face. There is also signs of previous small failures from the southern upper face and although small could be a sign that a larger instability is developing or that the face stability overall is deteriorating.



Figure 18 Southern Upper Face weathered section and evidence of small loose rock

It is recommended that the rockfall bund and exclusion zone be increase in size or that the area be shut off completely and access be granted on an individual risk assessed basis when needed. The bund and exclusion zone need particular attention around the two corners identified on the image below:



Figure 19 Areas where bund height should be increased

Aside from the visible loose on this face the rock is generally in good condition. There is some localised weathering around the primary joints set but the measured RQD at two locations is 75. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.



Figure 20 RQD of Southern Upper face

Southern Lower Face

The lower southern face has not been significantly developed since the last AMS visit. It appears intact, unweathered and has a good face profile.



Figure 21 Southern Lower face

There is a large ramp obscuring a portion of the southern face but from what is visible there is no major geotechnical hazards observed.

Eastern Upper Face

The Eastern upper face is essentially split into two distinct sections from a geotechnical perspective. The southern section highlighted in red in Figure 18 below is composed of a much more weathered rock as illustrated by the orange discoloration in the rock. The rock in this section of the quarry also has an increased dolomite content as it progresses towards neighbouring rock units. This face has remained entirely unchanged since the last assessment.



Figure 22 Eastern Upper faces

As has been highlighted in previous assessments there is a high degree of weathering in the southern upper east face but as access to this area has been limited the risk is low. Much like other faces there is a moderate amount of loose material in the upper sections of the face and some tension cracks at the top of the bench.



Figure 23 Loose Material in Eastern upper face as evidenced from previous assessment

The measured RQD at two locations is 49. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture. This rock is much more subject to degradation over time and as such should be subject to more regular face inspections.



Figure 24 RQD of weathered section of eastern upper face.

The northern section of the east upper face which runs from the far eastern corner of the quarry around to the lookout point is in a better condition than the weathered southern section. However, there is a greater degree of loose material particularly at the top of the face and there is also a short section where the middle bench reduces to a width that is too small to be considered as two separate faces making it a singular face that is 32m in height. By the 2008 regulation this is considered to be a

significant hazard. The 2016 assessment identified this hazard and recommended the quarry place an exclusion zone beneath this face. This exclusion zone remains in place to this day and access is restricted. There is evidence of loose rock that has fallen and been retained by this exclusion zone so this is working.

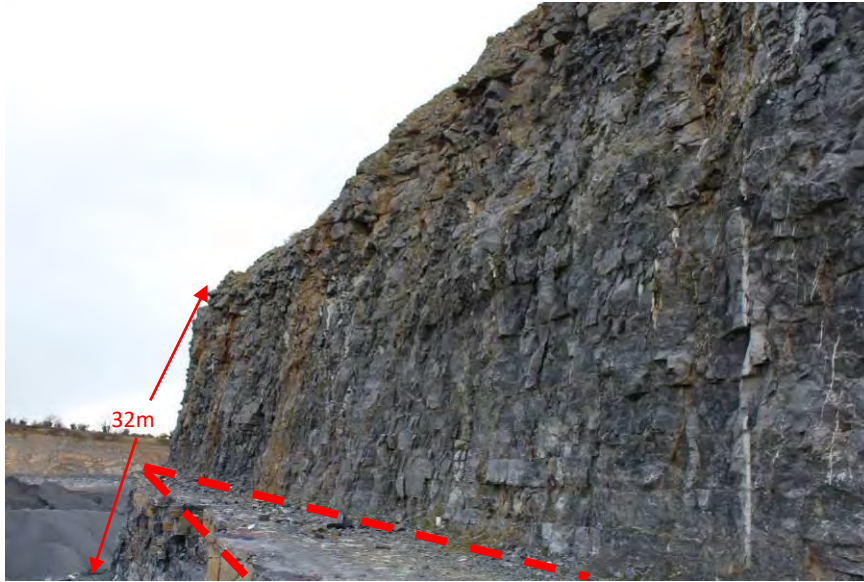


Figure 25 Eastern Upper face showing decreasing middle bench width



Figure 26 Beneath high face showing rockfalls.

The measured RQD at two locations is 90 making it a competent rock however the development of large loose blocks is clear in the upper sections of the face. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.



Figure 26 RQD of eastern upper face norther section

Eastern Lower Face

The lower eastern face has not been worked since the last assessment. This face is noticeably the wettest face in the quarry and also is visibly more weathered than most lower faces. The rock in this section also appears to be more dolomitic in composition than the rest of the quarry. Despite the weathered nature of the rock and the presence of water which always adds to stability concerns this face appears to have less loose material than others. This could be down to the fact that additional face dressing/ scaling has been conducted or due to the fact that the face has a noticeably shallower angle than most of the other faces which are vertical.



Figure 27 Eastern Lower Face



Figure 28 Eastern Lower Face water infiltration

There is little or no work going on in this area and AMS has no further stability recommendations for this face.

Western Faces



Figure 29 The western face (northern portion)

The northern portion of the western faces in Bennettsbridge Limestone Quarry shown above have been in place and stable for quite some time. They are not considered active faces and have not been for a number of years. The majority of the activity is now in the southern western face. Some hazards have been identified in this area in previous geotechnical assessments specifically relating to a large overhang in the upper benches and the main fault system but these hazards have been recognised and control measures in the form of catch trenches and bunds have been put in place.



Figure 30 Potential Wedge failure related to main fault

Other than monitoring the faces underneath which the rock is being hauled from the south western portion of the quarry AMS has no further recommendations for the northern portion of the west face

The southern portion of the western face is the most recently active in the quarry and is where the majority of the development has been conducted for a number of years. More recently the quarry has stripped off overburden heading westwards either side of a farm building and quarried the upper bench westwards. A visual assessment of this area shows it to be stable and the individual face heights are within acceptable parameters.



Figure 31 South Western face

The measured RQD at two locations in the south western faces is 92 making it a very competent rock. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.



Figure 32 Western Face RQD

The only observable way in which that stability of the faces in the south west corner could be improved is the presence of overhangs at the very top of some of the faces.



Figure 33 Overhang in south west corner

Over time the sugar cube like jointing in the overhang can deteriorate creating a loose rock hazard. This can be avoided by reducing the stemming in blast holes or by dumping the blast holes forward more than 10 degrees. This ensures a stable face profile and is also more efficient for blast fragmentation by directing more blast energy upwards.

Other than dumping future blast holes forwards AMS has no further recommendations for this face.

Northern Upper Face

The upper section of the Northern face is located parallel to the pre-cast building in the north of the quarry. For the most part this face has been there for a long time and been stable for most of that period. There is a chained, signed and bunded exclusion zone at the base of this face



Figure 34 Northern Upper face

The measured RQD at two locations in the Northern faces is 92 making it a competent rock. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.



Figure 35 Northern Upper face RQD

In addition to the northern face next to the precast plant there are some smaller faces in and around ramps, quarry infrastructure and the tarmacadam plant. Inspections of these faces did not highlight any significant hazards.

Stockpiles

From the site investigation/ geotechnical appraisal it was noted that all stockpiles appear to conform to the guidelines set out in the 2008 regulations. All stockpiles are below 20m in height, do not cover an area greater than 10,000m² and are sufficiently drained so as not to cause liquefaction.

All stockpiles are bring loaded and unloaded correctly and there appears to be good awareness of stockpile management amongst management and staff at BBL.



Figure 36 Showing stockpiles at BBL

Since the last assessment a significant bund has been placed to the south of the quarry site along the boundary with the M9 motorway. During construction material was excavated from the south western extension of the quarry. The material was found to be a medium brown, sandy, gravelly CLAY with intermittent grey to blue limestone cobbles.



Figure 37 Excavated material used in bund construction

During construction the material was transported across the site and dumped before being placed using a 360 excavator and compacted.



Figure 38 Bund Construction

After construction the berm height was measure as being between 4.5m and 6.6m high with a slope angle of between 20.4° and 27° which complies with the design

submitted in the planning application and is shallow enough to be stable for this material type.

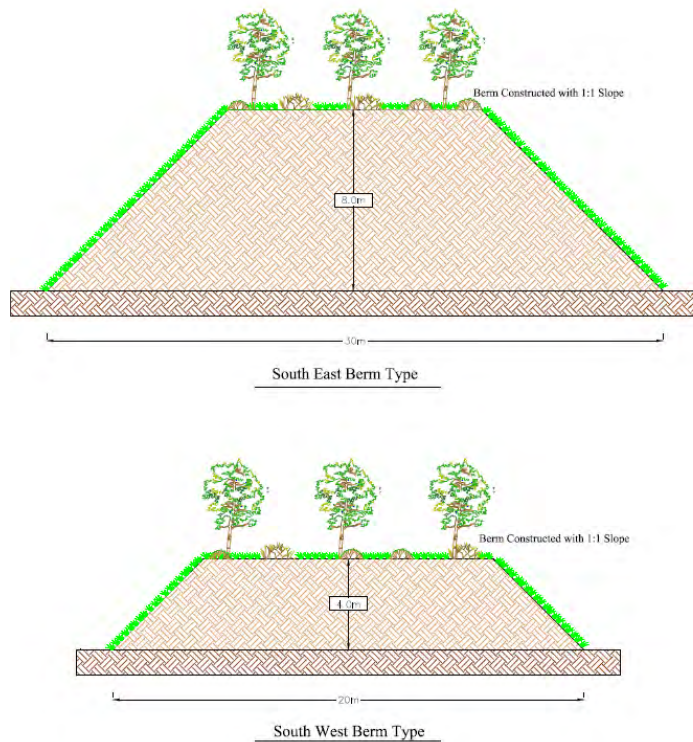


Figure 39 Bund Design



Figure 40 Bund on completion

Since the last AMS visit vegetation has started to take hold which will further aid stability. AMS has no further recommendation relating to the bund and it will be re-assessed during the next geotechnical assessment.



Figure 41 Showing Bund at BBL



Figure 42 Showing Bund at BBL

Lagoon

As part of the geotechnical assessment the geotechnical specialist must ensure that the lagoon is in a stable state and that the land down dip of the lagoon is less than 4 metres lower than the level of the water within the lagoon. This is the case with the lagoon in BBL and there is nothing present which can be considered a significant hazard.

Quantitative Analysis

The figure below shows the tool used to analyse the favourability or unfavourability of the various discontinuities in the quarry relative to the orientation of each face. The faces are highlighted by the planes of various colours while the red poles highlight each discontinuity measurement taken at the quarry during the site investigations.

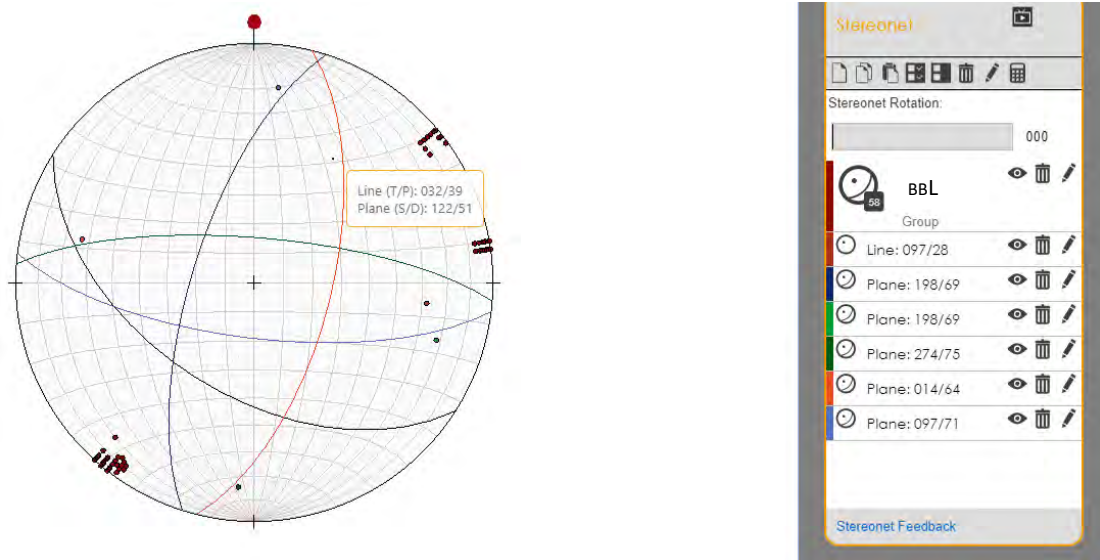


Figure 43 Discontinuity pole analysis

Analysis of the poles shows a propensity for toppling failure in the Eastern face. The northern and southern face is more likely to form larger wedge or planar failures however there is a clear potential larger failure directly observed in the Eastern face also.

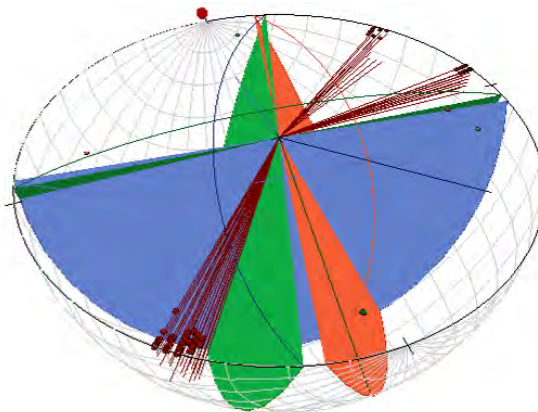


Figure 44 Discontinuity pole analysis

The figures below show analysis conducted on the nature of rockfalls that could occur. The program used allows the user to alter the face heights, angles and orientations, the rock conditions, rock shapes, rock size, failure position, velocity, weather conditions and also allows for the placement of bunds.

The analysis for Bennetsbridge quarry shows the following:

For the eastern face which was simulated as greater than 20m high with and without a rockfall bund 2m high for a number falls of various sizes (0.1T, 1 T and 10T). All rockfall simulations were arrested by the Rockfall bund meaning that this is an appropriate measure for mitigating against rockfalls in Bennetsbridge.

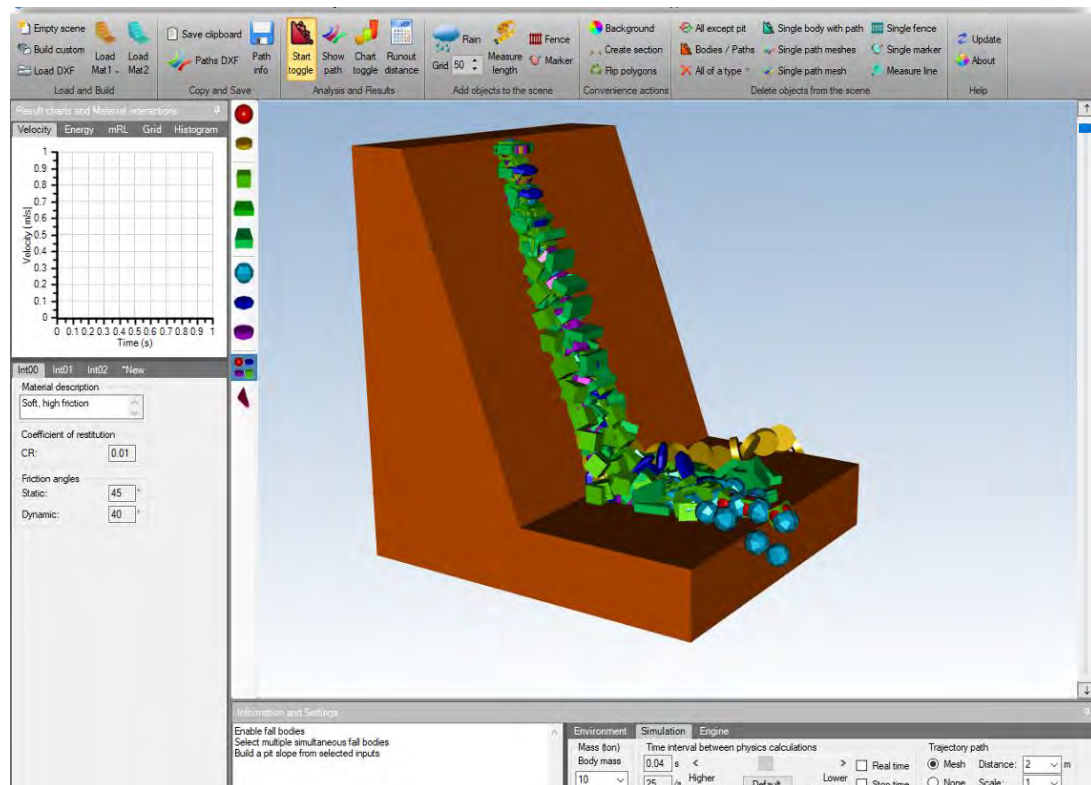


Figure 45 East face rockfall simulation without bund

Geotechnical Assessment of Bennettsbridge Limestone Quarry

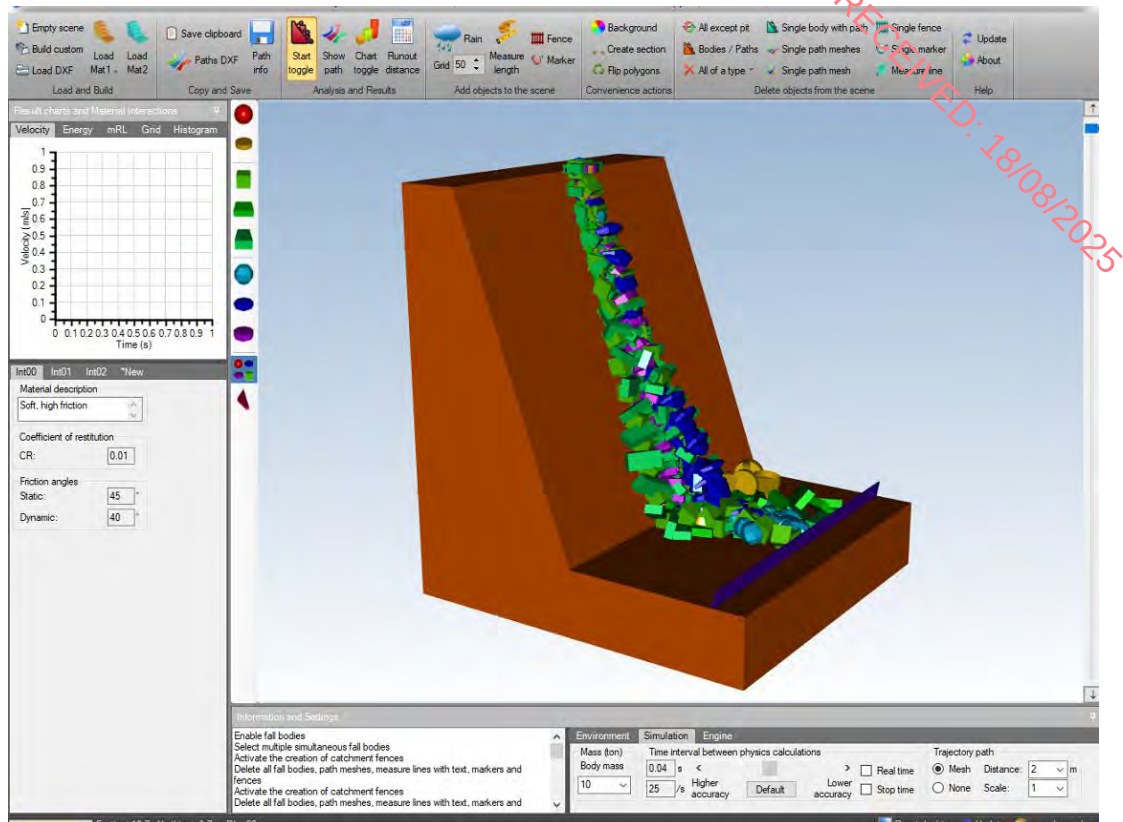


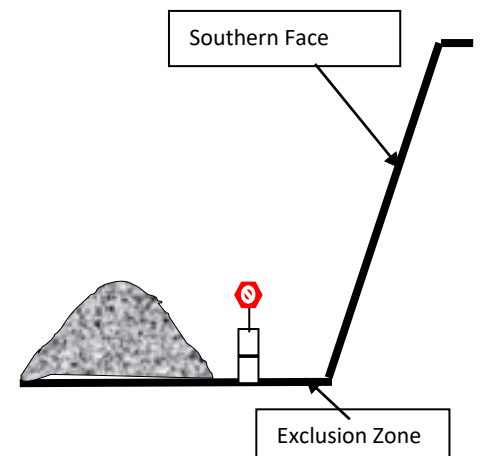
Figure 46 East face rockfall simulation with 1.5m bund

If the placement of the bund is an appropriate measure for the highest face in the quarry then it can be applied to the other faces with the same effectiveness. Given that all faces developed since 2016 have remained well below this height it is shown to be an effective means of protection in other areas of the quarry also.

6. Recommendations

Based on the geotechnical assessment the following is a summary of the recommendations that need to be implemented at BBL:

1. Increase and extend bund beneath the southern portion of the Eastern face particularly on the two corners identified in the assessment.



2. When blasting the quarry periphery blasts on any level reduce final face angle to 80° as part of the blast design as this will decrease the chances of developing overhangs and loose material and will also reduce the risk of developing tension cracks. This will allow safe development of lower benches without having to deal with hazards on old legacy faces.
3. Further geotechnical assessments must be carried out every 12 months by a geotechnical specialist to monitor the significant hazards in the quarry and track implementation of past recommendations.

4. Assumptions made before analysis

- The operation of the quarry on the day of the site visit is the good representation of the average annual day in the quarry i.e. water infiltration, face conditions, blasting sequence, stockpile size and condition will vary depending on what time of the year it is.
- Outside of the observed structure in the quarry there is no major karstic feature potential in any of the faces.
- The RQD measurements conducted as part of the site investigation are reflective of the site in general and there is not a significant enough variation in RQD to affect this analysis.
- The discontinuity orientation measurements are reflective of the overall discontinuity system.
- The future plans outlined by the quarry manager are reflective of how the future development will be conducted.

5. Declaration

The recommendations contained within this report are based on the experience and qualifications of Advanced Mining Solutions Ltd. (AMS) staff combined with the visual observations recorded on the site visit by AMS to Bennettsbridge Limestone Quarry (BBL) July 2022.

AMS or any of its staff are not responsible for any accidents, injuries, fatalities, loss of production or loss of income that may arise out of the implementation or failure of implementation of the recommendations contained within this report or any unforeseen circumstances which may arise out of the geotechnical assessment conducted at Bennettsbridge Limestone in July 2022.

Signed

Director and Lead Consultant AMS

Mark Galvin Quarry Manager BBL

Sections

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A

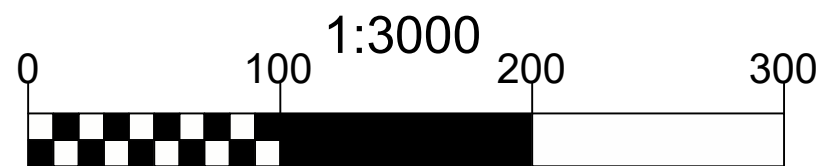
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Geotechnical Assessment of Bennettsbridge Limestone Quarry

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ADVANCED
MINING SOLUTIONS LTD.

Jonathan Talbot Geotechnical Engineer Advanced Mining Solutions Ltd.

May 2024

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1. Introduction

Advanced Mining Solutions Ltd (AMS) has been employed by Bennettsbridge Limestone Ltd (BBL) to conduct a geotechnical assessment as per the 2008 Quarry Regulations. The assessment follows on from the ones conducted in 2016, 2018, 2020 and 2022. The quarry is located just off the R700 just north of the town of Bennettsbridge, Co. Kilkenny in the townland of Sheastown. The quarry office is located at the co-ordinates N52.60125 E-7.19620

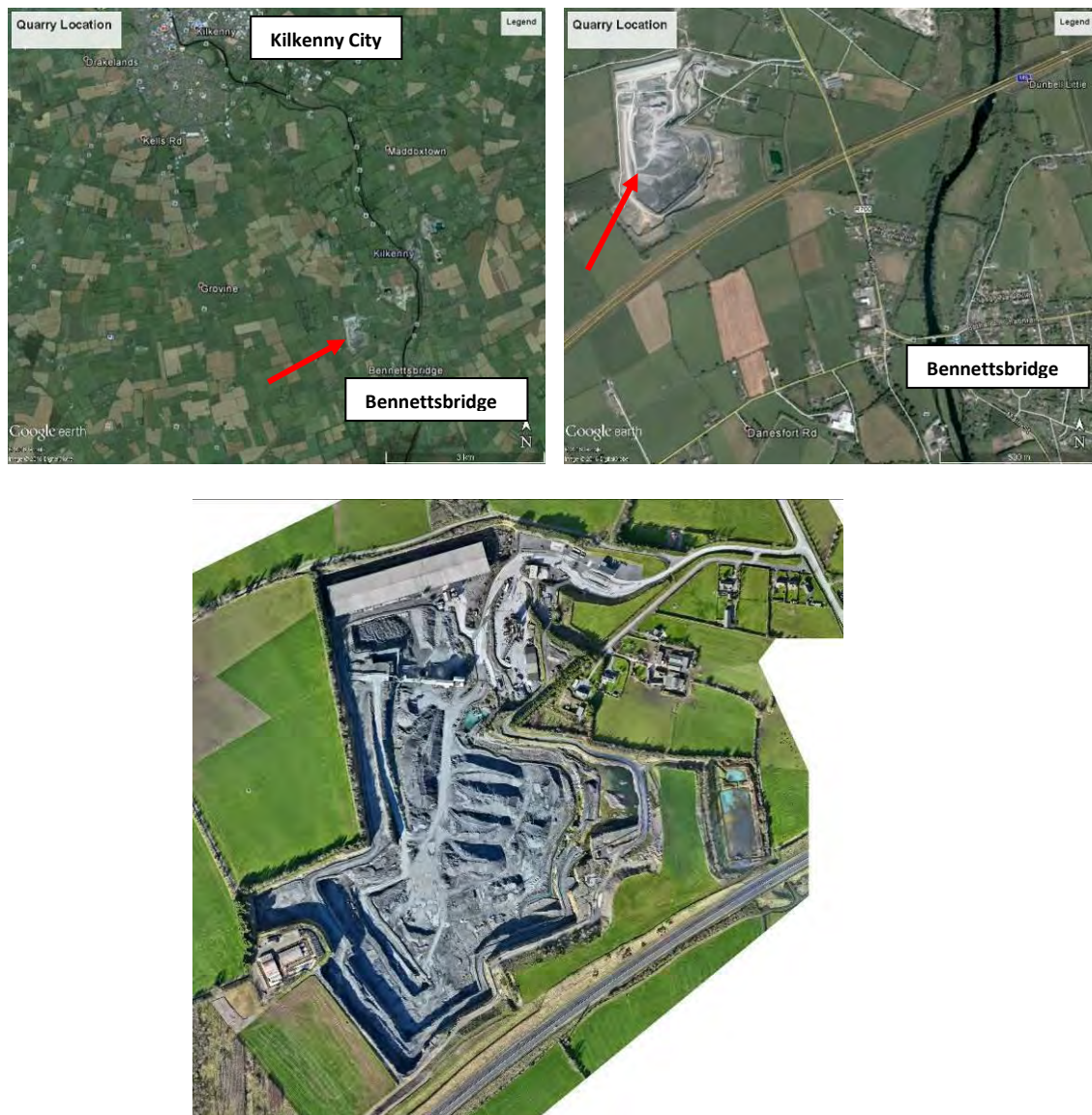


Figure 1 Site Location

The site is bounded to the South by the M9 Motorway, to the East by the R700 regional road and to the North and West by farmland. The River Nore is located approximately 1km to the East of the main quarry buildings.

2. Geological Setting

The quarry is located within the Ballyadams Formation which is a thickly bedded fossiliferous limestone dating from the Carboniferous period. In general, the Ballyadams Formation has a very high intact rock strength due to its thickly bedded nature and structural uniformity however the presence of major fault structures and complex joint sets can affect its stability on a local level.

To the Southeast the Ballyadams formation starts to give way to a more dolomitised reef limestone which also has a high intact rock strength but a greater degree of weathering.

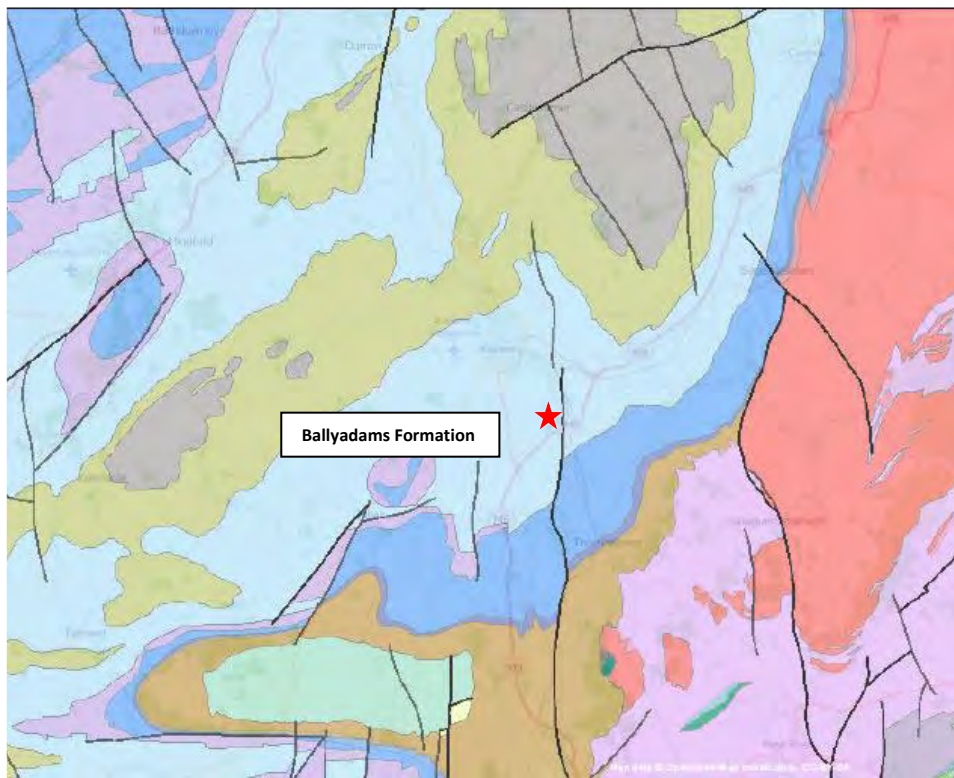
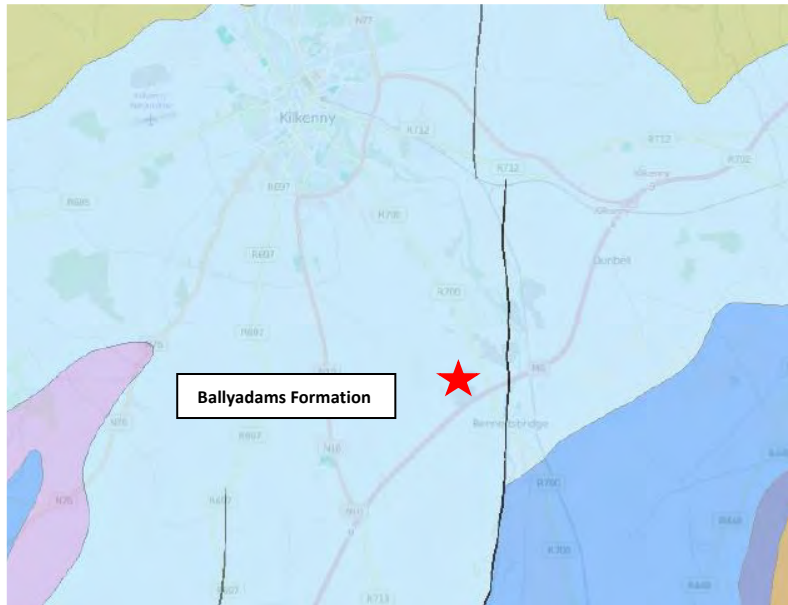


Figure 2 Large Scale Geological Map



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Figure 3 Small Scale Geological Map

From visual observations the intact rock strength of the rock in the quarry is good. There are local areas of weathering to the East and Southeast of the quarry primarily in the upper benches. Structurally there is a large fault running close to West East through the middle of the quarry. This fault has a large persistence, an aperture of between 0.5m and 2m depending on location with a weathered clay/rock infill. The fault has a measured strike of 080° and a Dip of 80° South.



Figure 4 The main West East trending fault (2024)

The primary joint set has an average orientation of 350° Strike and 85° Dip with a secondary joint set with an average orientation of 064° Strike and 82° Dip. The bedding within the rock is close to horizontal with a slight tendency in dipping to the East.



Figure 5 The primary joint set (highlighted in red taken in 2020)



Figure 6 The secondary joint set (highlighted in red taken in 2020)

These orientations give a slight proclivity towards potential toppling failure in the western faces with more likely block failure in the northern, southern and eastern faces. There is no obvious kinematically controlled hazards that are currently near any active portions of the quarry, but this will be discussed further in the geotechnical assessment section of this report.

3. Current Quarry Layout

The quarry is being developed currently in the lower bench near the southwest corner of the quarry. On the day of AMS visit there was a blast being cleared in this area. There was also a blast being prepared on the upper western face. The crushing and screening plant located in the northern lower section of the quarry and the stockpiles located in the remaining lower sections of the quarry. Lagan Cement Plc operate a tarmac facility on the upper Northeast bench of the quarry. Vehicles are currently driving in and out of the stockpile area and the tarmac facility for loading. There is a disused covered gantry crane building which was part of a pre-cast production facility now closed in the northernmost section of the quarry. The quarry faces surrounding the pre-cast and tarmac facilities are old faces that have not been active in many years.

The main active faces are the southern lower benches and the Western lower and upper benches.

Access to the lower portion of the quarry is through the main access ramp starting after the main office buildings running south down into the base of the quarry. There is another access ramp which runs up to the middle bench in the western side of the quarry. This bench also provides access to the dump hopper for the crushing facility and the western upper benches. There is also a small ramp back down to the western side of the pre-cast facility in this area also. Future development will continue to the south and the west of the quarry in the upper and lower benches.

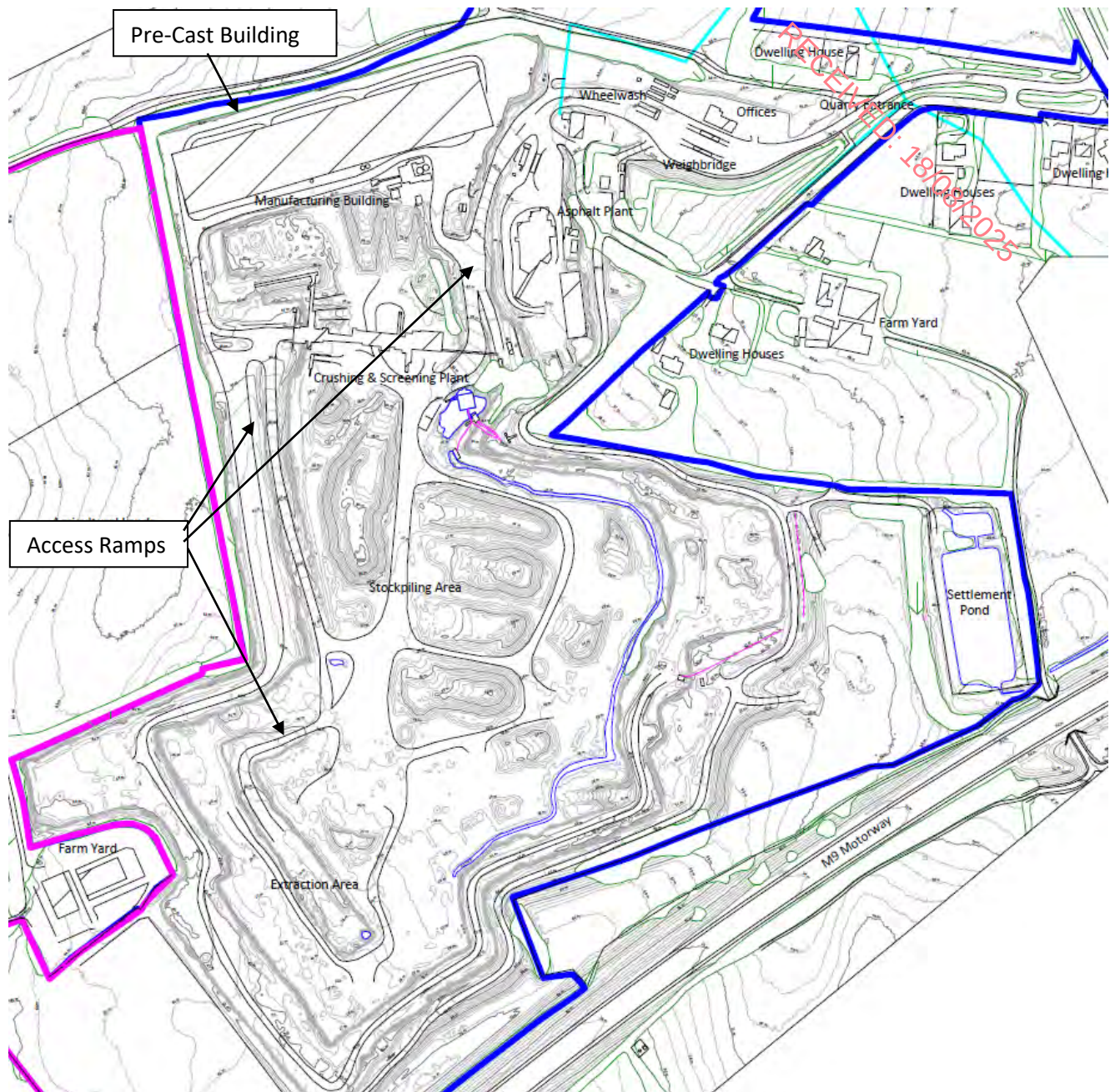


Figure 7 Sketch plan showing quarry layout (not to scale)

More detailed scaled plans and cross sections of the quarry are contained in the back of this document.

4. Geotechnical Appraisal

The 2008 Quarry regulations specify that a geotechnical appraisal must be carried out regularly by a competent person. Where a significant hazard is found, a geotechnical assessment must be carried out by a geotechnical specialist. In order to determine first where the significant hazards lie, AMS carried out a geotechnical appraisal so that the hazards could be identified and then analysed further as part of the geotechnical assessment.

Faces

The 2008 quarry regulations state that a face/ excavation may be considered to be a significant hazard:

- Where in the case of moderately weak or stronger rock which is normally excavated using explosives or saws
 - o The vertical height of any individual face is greater than 20 metres.
 - o Where multiple benches are present and bench widths, or the overall face angle may be inadequate to ensure quarry stability; or
- In the case of weak rock or very weak rocks and engineering soils, (for example clay or sand and gravel deposits), where the vertical height of any excavation exceeds 7.5m and the overall face angle is steeper than a suitable angle to ensure safety; or
- Irrespective of any excavation face height, depth or angle, other factors, for example, the geology, location or proximity of a tip, location or proximity or infrastructure or private lands means that there is a significant hazard.

The quarry has been designed and operated to take cognisance of good practice and the 2008 regulations. As a result, a conscious effort has been made to keep individual bench heights below 20m and stand-off zones are present beneath all the currently active and old faces. The quarry operator has also instigated procedures where no unauthorised personnel are allowed anywhere near faces keeping most quarry activity far away from active faces.

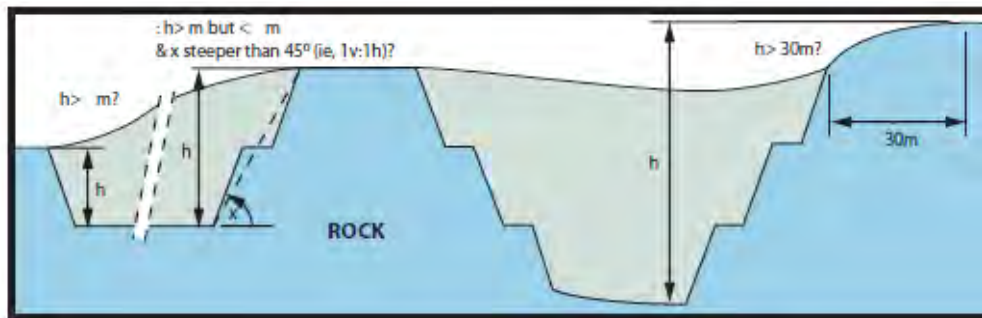


Figure 8 Criteria for significant hazard in rock faces according to 2008 regulations

There is a section of the East face that has left an overall face height in excess of 20m and therefore this can be considered to be a significant hazard.

There are also a number of areas that need to be considered for further stability analysis based on remnant loose rock from blasting and weaker or weathered rock. These areas will be covered in the geotechnical assessment in the next section and will form the basis for the recommendations in section 6.



Figure 9 Individual benches in the southern side of quarry all under 20m in height

Stockpiles

The quarry operates a system whereby most of the drilling, blasting and material crushing is conducted in or around the summer months and the material moved during this period is stockpiled for sale during the winter months. This system makes the quarry heavily reliant on good stockpile management and monitoring stockpile stability.

At the time of AMS's visit to the quarry the stockpiles were moderately sized and may not be reflective of how large the stockpiles may be during the winter but by following best practice in terms of stockpile stability and management, the operator can ensure that the control of stockpiles at any time of the year can be safe and efficient for workers and visitors to site.

According to the 2008 Quarry Regulations stockpiles can be considered to be a significant hazard when:

- The stockpile is not in a wholly, or mainly, solid state and not in solution or suspension. (i.e. well drained and not likely to flow)
- The area of land covered by an individual stockpile exceeds $10,000\text{m}^2$
- The height of the stockpile exceeds 20 metres.
- The average gradient of the land covered by the stockpile exceeds 1 in 12.

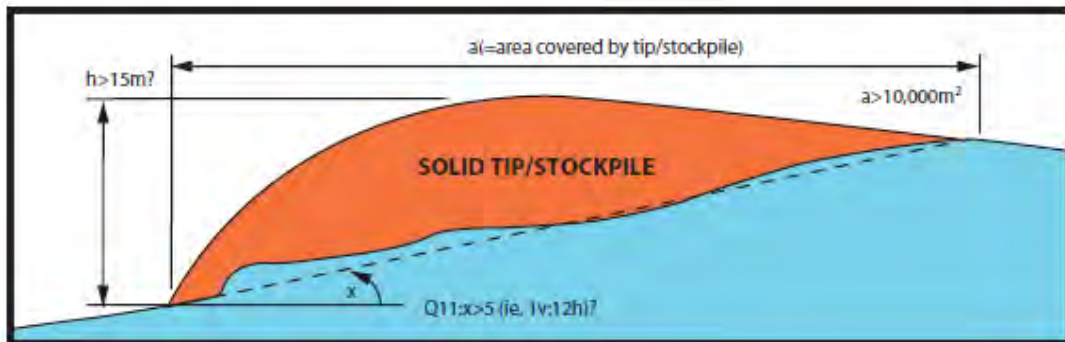


Figure 10 Criteria for significant hazard in stockpiles according to 2008 regulations

The stockpiles at the time of writing in Bennettsbridge Limestone quarry do not exceed any of the above specifications and can be considered stable. The individual stockpiles are below 20m in height, situated on level ground and well drained to the point where all stockpiles are located on dry ground with the quarry drainage system situated between the individual tips.

None of the stockpiles in Bennettsbridge Limestone quarry can be considered a significant hazard as part of the geotechnical appraisal.



Figure 11 Showing the stockpiles in BBL Quarry

In addition to the stockpiles there has been a significant amount of stripper material placed as a bund to the West of the quarry along the M9 motorway since 2020. The stability of this material was observed closely during construction and its current stability will be examined further in the assessment section of this report.



Figure 12 Bund on southern side of quarry.

Lagoon

The 2008 quarry regulations state that a lagoon may be considered to be a significant hazard where:

- The contents of the lagoon are more than 4 metres above the level of the land, which is within 50m of its perimeter, or.
- The contents of the lagoon exceed 10,000m³.

The BBL quarry lagoon is located to the east of the excavation. It features a primary pond for initial settlement followed by a larger pond for longer term settlement and an outflow weir where the treated water flows down towards the River Nore.

There is also a small water sump within the quarry which is located in the East corner of the quarry.

The size, location and orientation of the land around the lagoon are all within the accepted guidelines of the regulation and can be considered not to contain any significant hazards as per the geotechnical appraisal.

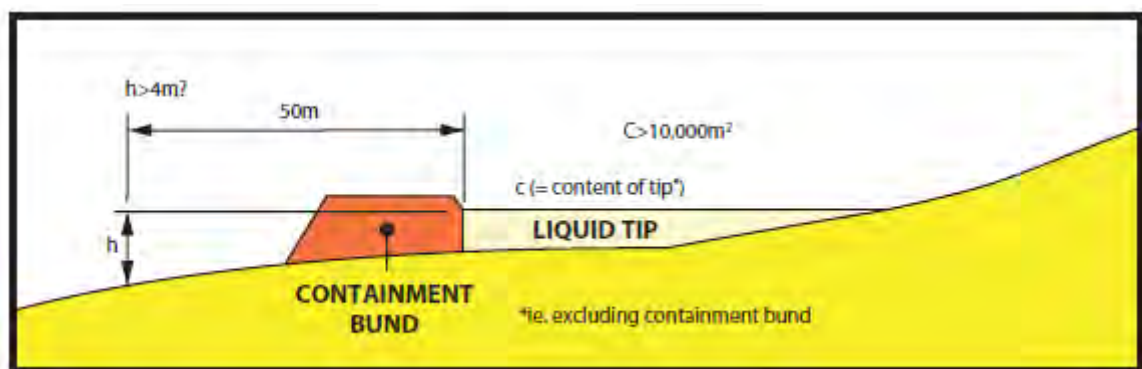


Figure 13 Criteria for significant hazard in lagoons according to 2008 regulations

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Figure 14 Showing larger settlement lagoon

5. Geotechnical Assessment

When conducting the geotechnical assessment of Bennettsbridge Limestone it should be noted that overall, the quarry is well designed, in generally stable condition and the procedures and controls put in place by the management of the quarry relating to access to active faces and control of loose face material are of a good standard. This standard has been maintained since the last geotechnical assessments in 2022.

The only area that can be considered as a significant hazard according to the regulations is a small section of the East face where the lack of an adequately sized middle bench has created an overall face height in excess of 20m. This hazard was identified in 2016 and has been rectified according to the recommendations in previous assessments. This hazard has not degraded further since then. Some other faces also have localised loose rocks.

In order to conduct a stability assessment of the faces in BBL quarry it was necessary to classify the faces in terms of their rock mass condition using a qualitative assessment of the rock condition combined with a quantitative evaluation by means of RQD measurements.

RQD (Rock-quality designation) is a measure of the degree of jointing or fracture in a rock mass, measured as a percentage of the measured run of rock or drill core in lengths of 10 cm or more. The higher the percentage the less fractured the rock is as a mass. In the case of the AMS site investigation of the quarry, a number of 2 metre runs were randomly chosen on each face and assessed for RQD.

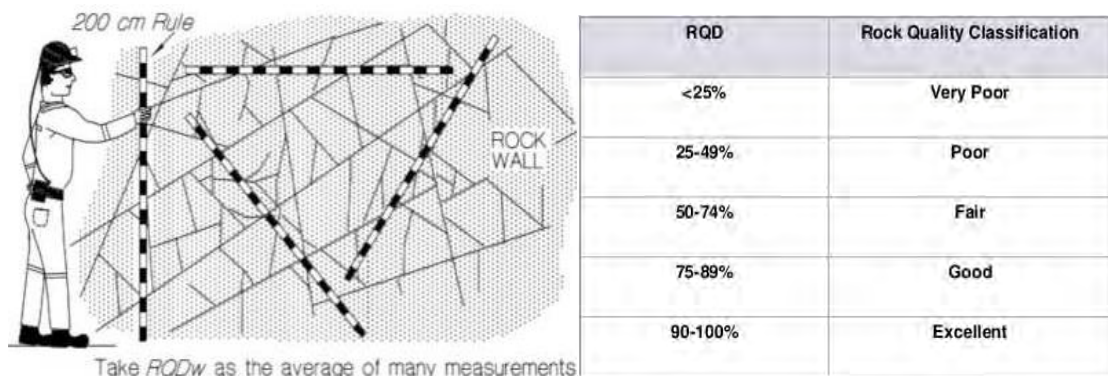


Figure 15 RQD Method of measurement and table showing classification of result

By combining the assessment of the intact rock strength with the measured RQD an assessment of the Rock Mass Strength and stability of each face can be made.

What follows is an overall stability assessment of the entire quarry and recommendations will follow from this analysis.

Faces

As mentioned previously the Ballyadams formation in the area the quarry is situated in has a high intact rock strength. In order to conduct a stability assessment of the faces in Bennettsbridge limestone quarry it was necessary to classify the faces in terms of their rock mass condition using a qualitative assessment of the rock condition combined with a quantitative evaluation by means of RQD measurements. The majority of this data was collected during the 2016 assessment, and this was added to in subsequent assessments.

Southern Upper Face



Figure 16 Southern Upper Face

An examination of the southern upper face shows a number of examples of loose rock at the top of the face. There is evidence of failure although mostly small in size. It is necessary to monitor the loose rock on this face and although there is little or no

exposure of quarry personnel to these hazards in some cases the loose rock should be removed by using a rockbreaker sitting on top of a temporary ramp. In the interim it is necessary to limit access to this area except when absolutely necessary.

Aside from the visible loose on this face the rock is generally in good condition. There is some localised weathering around the primary joints set but the measured RQD is 79%. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.

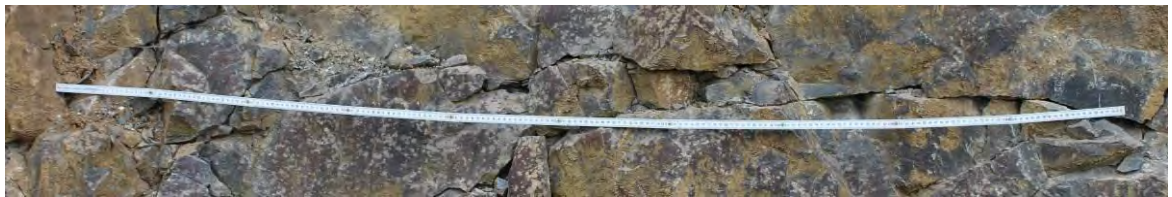


Figure 17 RQD of Southern Upper face

It was highlighted in the last assessment that the corners on the access road to the upper southern face had significant loose rock and that the bund in this area should be raised and extended. This work was completed.



Figure 18 Southern Upper Face Corner

Southern Middle Face

The southern middle face previously the lower face has not been developed since AMS last visit and remain intact, unweathered and has a good face profile.



Figure 19 Southern Lower face

AMS has no recommendations regarding the southern middle face.

The southern lower face will be examined later as part of the analysis of the overall lower faces.

Eastern Upper Face

The Eastern upper face is essentially split into two distinct sections from a geotechnical perspective. The southern section highlighted in red in Figure 20 below is composed of a much more weathered rock as illustrated by the orange discoloration in the rock. The rock in this section of the quarry also has an increased dolomite content as it progresses towards neighbouring rock units. In general, this face remains unchanged since the 2016 assessment.



Figure 20 Eastern Upper faces

From previous assessments it was noted that the eastern upper face despite the noticeably increased degree of weathering is stable. Much like other faces there is a moderate amount of loose material in the upper sections of the face and some tension cracks at the top of the bench. Access near the face must be restricted in order to lower the risk of exposure.



Figure 21 Loose Material in Eastern upper face

The measured RQD at two locations is 49. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture. This rock is much more subject to degradation over time and as such assessment should be conducted of this face on an annual basis to monitor this deterioration.



Figure 22 RQD of weathered section of eastern upper face.

The northern section of the east upper face which runs from the far eastern corner of the quarry around to the lookout point is in a better condition than the weathered southern section. However, there is a greater degree of loose material particularly at

the top of the face and there is also a short section where the middle bench reduces to a width that is too small to be considered as two separate faces making it a singular face that is 32m in height. By the 2008 regulation this is considered to be a significant hazard. The 2016 assessment identified this hazard and recommended the quarry place an exclusion zone beneath this face. This exclusion zone is in place and access beneath this face remains heavily restricted. This face has been observed by AMS for many years now and has not shown any further signs of instability in this time. The control measures in place are effective for this hazard.



Figure 23 Eastern Upper face showing decreasing middle bench width

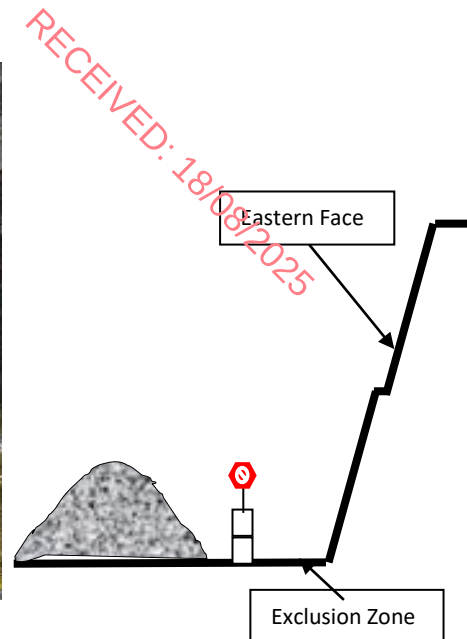
The measured RQD at two locations is 90 making it a competent rock however the development of large loose blocks is clear in the upper sections of the face. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.



Figure 24 RQD of eastern upper face norther section



Figure 25 Exclusion zone beneath overheight face.



Eastern Lower Face

The lower eastern face has not been worked since the 2016 assessment. This face is noticeably the wettest face in the quarry and also is visibly more weathered than most faces. The rock in this section also appears to be more dolomitic in composition than the rest of the quarry. Despite the weathered nature of the rock and the presence of water which always adds to stability concerns this face appears to have less loose material than others. This could be down to the fact that the face has a noticeably shallower angle than most of the other faces which are vertical.



Figure 26 Eastern Lower Face

Western Faces



Figure 27 The western face (northern portion)

The northern portion of the western faces in Bennettsbridge Limestone shown above have not been active for many years. Some hazards have been identified in this area in previous geotechnical assessments specifically relating to a large overhang in the upper benches and the main fault system, but these hazards have been recognised and control measures in the form of catch trenches and bunds have been put in place and maintained.



Figure 28 Potential Wedge failure related to main fault

The southern western corner has been developed extensively in recent years. The quality of the rock is excellent. The upper southern face was being prepared for a blast on the day of AMS visit and this face will continue to be developed westwards in the coming years.



Figure 29 Western Face Southern portion

The measured RQD at two locations in the western faces is 80 making it a competent rock. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture. AMS has no recommendations regarding the Western faces other than continued observation.



Figure 30 Western Face RQD

Northern Upper Face

The upper section of the Northern face is located parallel to the pre-cast building in the north of the quarry. For the most part this face has been there for a long time and been stable for most of that period. There is a chained, signed and banded exclusion zone at the base of this face



Figure 31 Northern Upper face

The measured RQD at two locations in the Northern faces is 88 making it a competent rock. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.

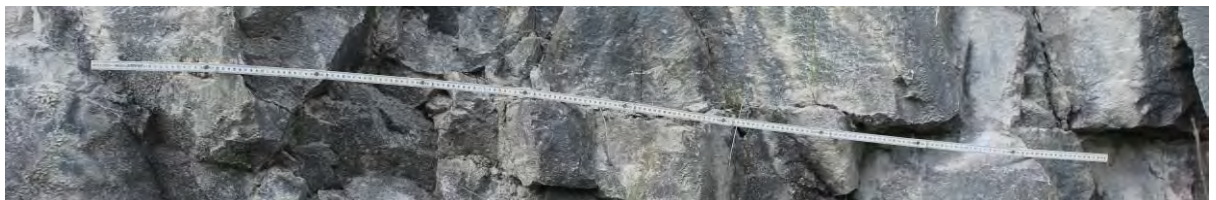


Figure 32 Northern Upper face RQD

Lower face extension

Since the last AMS assessment in 2022 the quarry has started a lower bench in the central portion of the southwest floor. The face will be expanded in the coming years. It is currently 15m high and consists of extremely competent rock.

The measured RQD of the lower face extension is 92 making it a competent rock. All discontinuities were dry on the day of the site visit and have a medium to high persistence, high roughness coefficient and low aperture.



Figure 33 Lower Face Extension

In addition to the faces identified there are some smaller faces in and around ramps, quarry infrastructure and the tarmacadam plant. Inspections of these faces did not highlight any significant hazards.

Stockpiles

From the site investigation/ geotechnical appraisal it was noted that all stockpiles appear to conform to the guidelines set out in the 2008 regulations. All stockpiles are below 20m in height, do not cover an area greater than 10,000m² and are sufficiently drained so as not to cause liquefaction.



Figure 34 Showing stockpiles at BBL

In 2020 a significant bund was placed to the south of the quarry site along the boundary with the M9 motorway. During construction material was excavated from the southwestern extension of the quarry. The material was found to be a medium brown, sandy, gravelly CLAY with intermittent grey to blue limestone cobbles.



Figure 35 Excavated material used in bund construction

During construction the material was transported across the site and dumped before being placed using a 360 excavator and compacted.



Figure 36 Bund Construction

After construction the berm height was measure as being between 4.5m and 6.6m high with a slope angle of between 20.4° and 27° which complies with the design submitted in the planning application and is shallow enough to be stable for this material type.

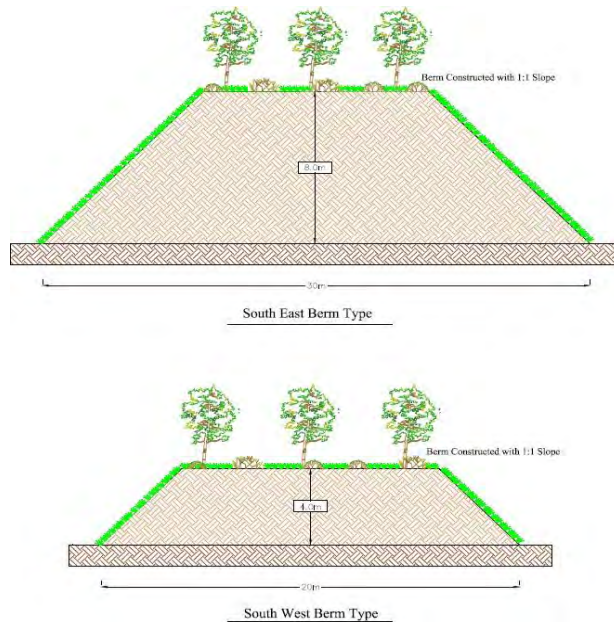


Figure 37 Bund Design



Figure 38 Bund on completion and bund in 2024

Since AMS last visit the bund there has been no further change to the bund and it remains stable. AMS has no further recommendation relating to the bund and it will be re- assessed during the next geotechnical assessment.

Lagoon

As part of the geotechnical assessment the geotechnical specialist must ensure that the lagoon is in a stable state and that the land down dip of the lagoon is less than 4 metres lower than the level of the water within the lagoon. This is the case with the lagoon in BBL and therefore there is nothing present which can be considered a significant hazard.

Quantitative Analysis

The figure below shows the tool used to analyse the favourability or un-favourability of the various discontinuities in the quarry relative to the orientation of each face. The faces are highlighted by the planes of various colours while the red poles highlight each discontinuity measurement taken at the quarry during the site investigations.

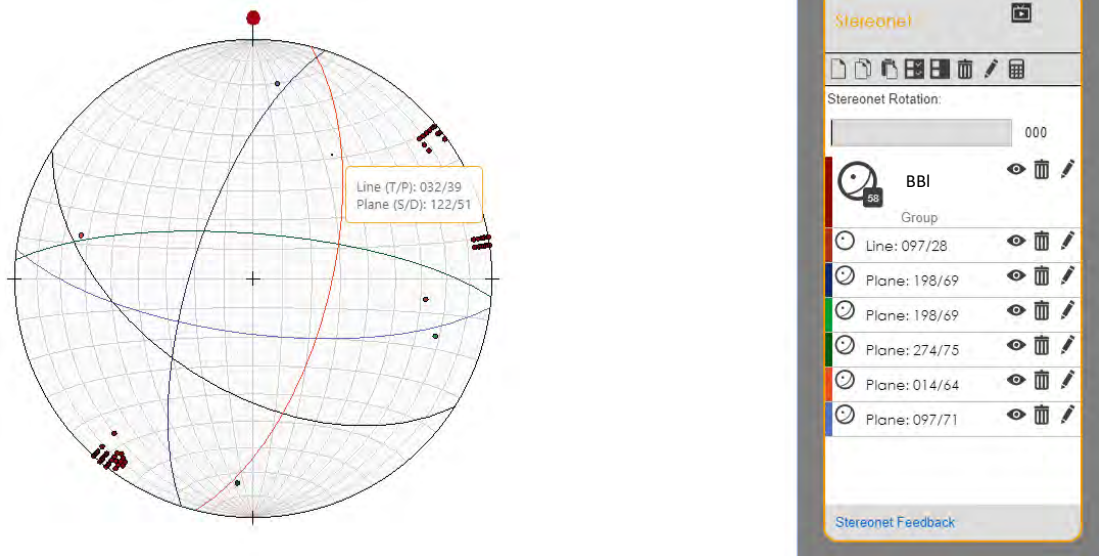


Figure 39 Discontinuity pole analysis

Analysis of the poles shows a propensity for toppling failure in the Eastern face. The northern and southern face is more likely to form larger wedge or planar failures however there is a clear potential larger failure directly observed in the Eastern face also.

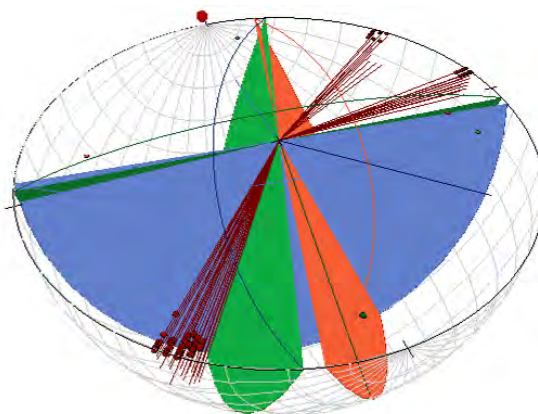


Figure 40 Discontinuity pole analysis

The figures below show analysis conducted on the nature of rockfalls that could occur. The program used allows the user to alter the face heights, angles and orientations, the rock conditions, rock shapes, rock size, failure position, velocity, weather conditions and also allows for the placement of bunds.

The analysis for Bennettsbridge quarry shows the following:

For the eastern face which was simulated as greater than 20m high with and without a rockfall bund 2m high for a number of falls of various sizes (0.1T, 1 T and 10T). All rockfall simulations were arrested by the Rockfall bund meaning that this is an appropriate measure for mitigating against rockfalls in Bennettsbridge.

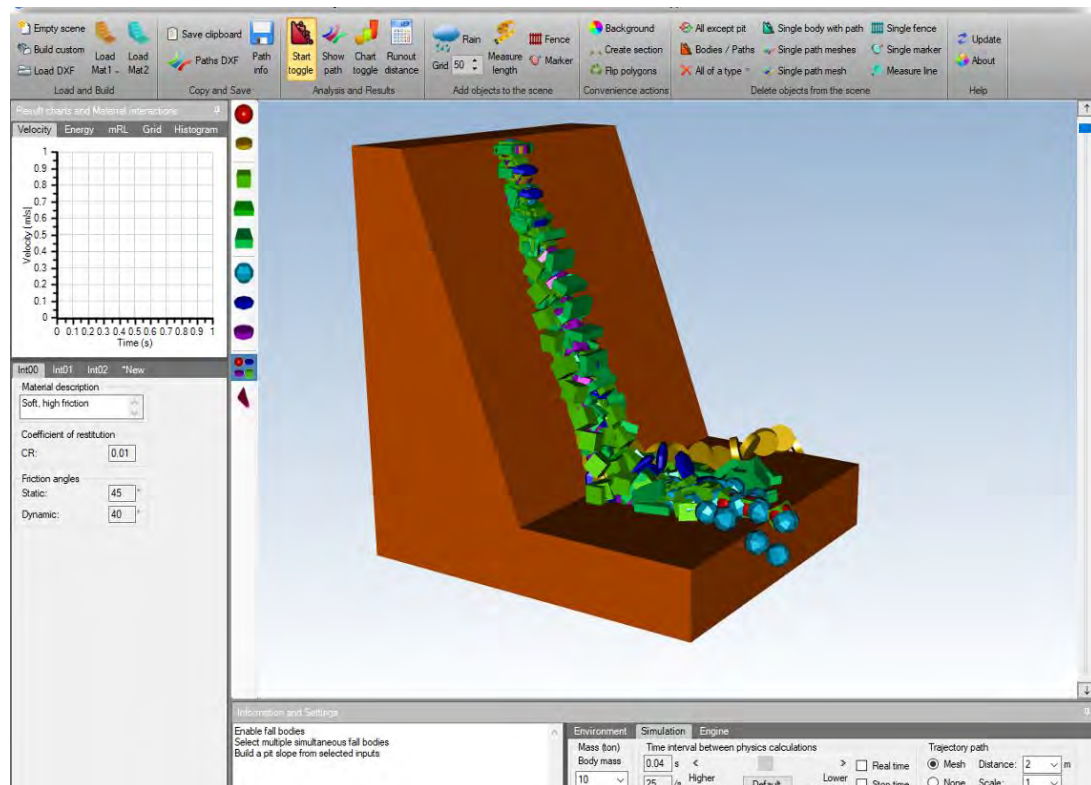


Figure 41 East face rockfall simulation without bund

Geotechnical Assessment of Bennettsbridge Limestone Quarry

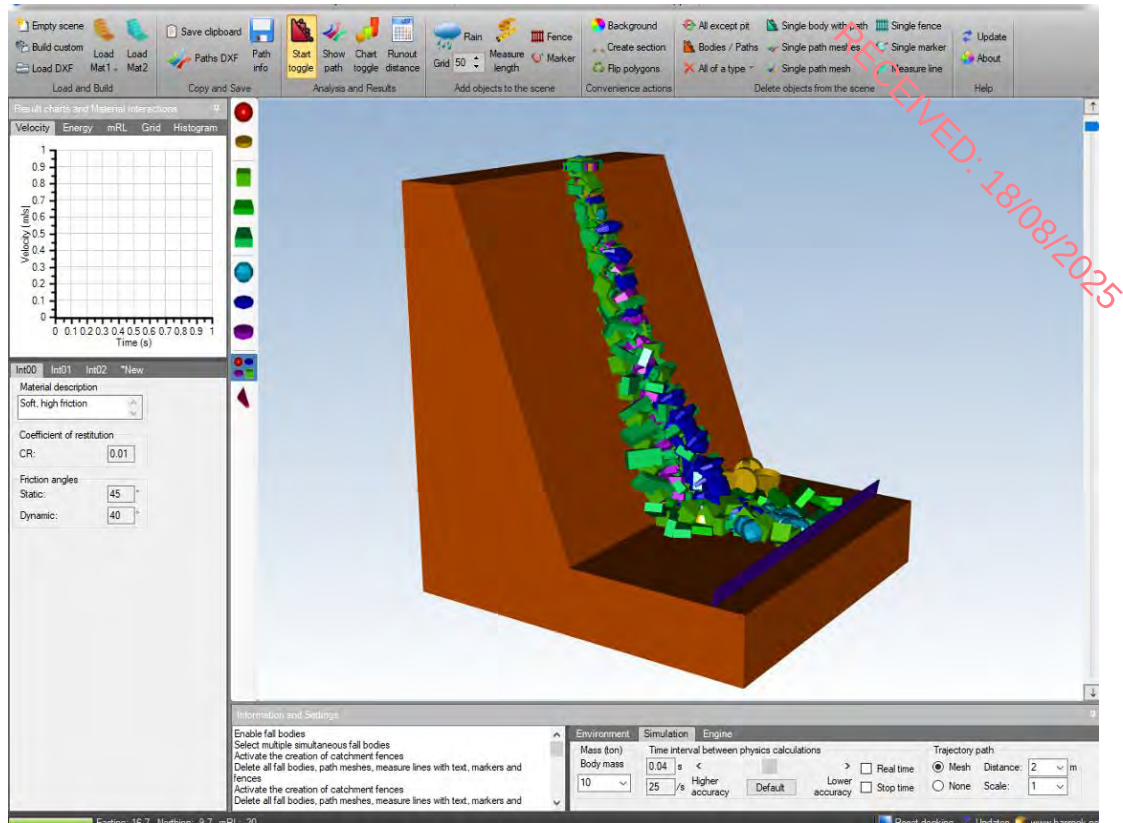


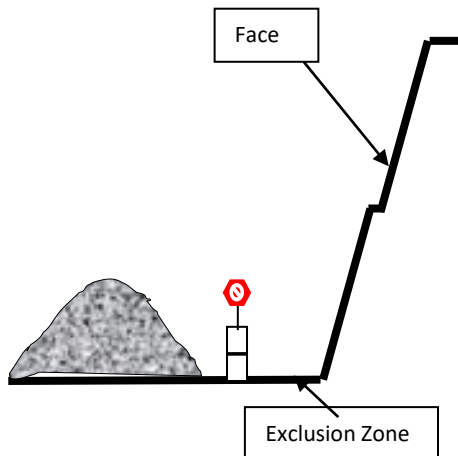
Figure 42 East face rockfall simulation with 1.5m bund

If the placement of the bund is an appropriate measure for the highest face in the quarry, then it can be applied to the other faces with the same effectiveness. Given that all new faces since 2016 have been quarried below 20m in height then it is an effective means of protection in the new areas of the quarry also.

6. Recommendations

Based on the geotechnical assessment the following is a summary of the recommendations that need to be implemented at BBL:

1. Maintain and extend exclusion zones at the base faces identified in previous assessments or where significant loose rock is found.



2. Ensure all new faces particularly those in the new lower level of the quarry continue to be less than 20m in height.
3. Dump blast holes to 80° as part of the blast design as this will decrease the chances of developing overhangs and loose material and will also reduce the risk of developing tension cracks. This will allow safe development of lower benches without having to deal with hazards on old legacy faces.
4. Further geotechnical assessments must be carried out every 12 months by a geotechnical specialist to monitor the significant hazards in the quarry and track implementation of past recommendations.

5. Assumptions made before analysis

- The operation of the quarry on the day of the site visit is the good representation of the average annual day in the quarry i.e. water infiltration, face conditions, blasting sequence, stockpile size and condition will vary depending on what time of the year it is.
- Outside of the observed structure in the quarry there is no major karstic feature potential in any of the faces.
- The RQD measurements conducted as part of the site investigation are reflective of the site in general and there is not a significant enough variation in RQD to affect this analysis.
- The discontinuity orientation measurements are reflective of the overall discontinuity system.
- The future plans outlined by the quarry manager are reflective of how the future development will be conducted.

6. Declaration

The recommendations contained within this report are based on the experience and qualifications of Advanced Mining Solutions Ltd. (AMS) staff combined with the visual observations recorded on the site visit by AMS to Bennettsbridge Limestone Quarry (BBL) in May 2024.

AMS or any of its staff are not responsible for any accidents, injuries, fatalities, loss of production or loss of income that may arise out of the implementation or failure of implementation of the recommendations contained within this report or any unforeseen circumstances which may arise out of the geotechnical assessment conducted at Bennettsbridge Limestone in May 2018.

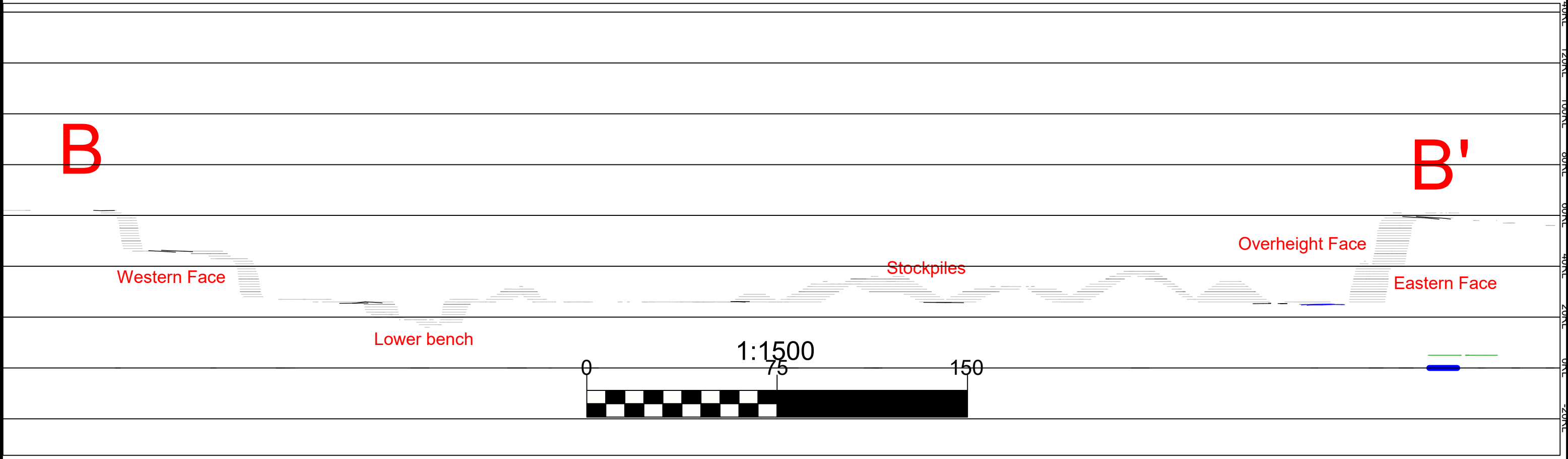
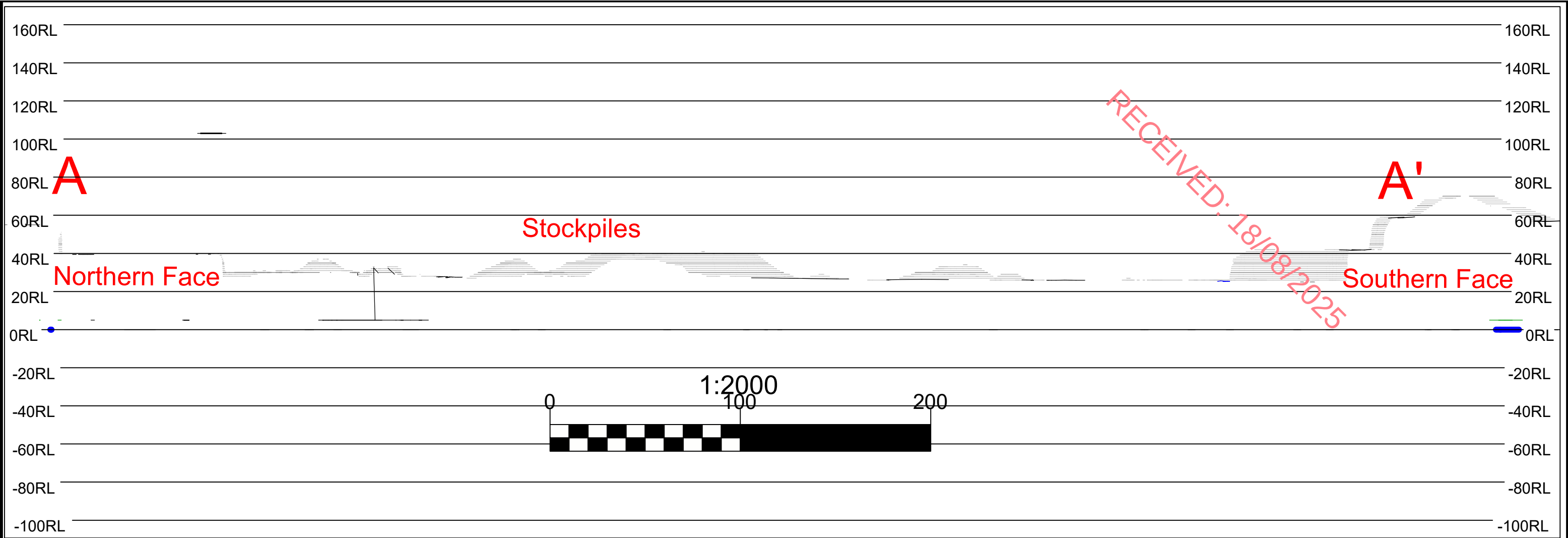
Signed

Director and Lead Consultant AMS

Mark Galvin Quarry Manager BBL

Sections

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Geotechnical Appraisal of proposed extension to Bennettsbridge Limestone April 2025



Jonathan Talbot Geotechnical Engineer Advanced Mining Solutions Ltd.

April 2025

1. Introduction

This report is a geotechnical competent person's appraisal of the proposed extension to Bennettsbridge Limestone Quarry, Kilkenny, prepared in response to a recommendation from Transport Infrastructure Ireland (TII) during pre-application consultation on the EIAR. TII requested that the EIAR should include:

A geotechnical assessment and monitoring strategy to maintain the physical integrity of, and mitigate any potential impact on, the M9 motorway, its reservation, and associated infrastructure.

This report specifically addresses this recommendation and assesses the geotechnical stability of the proposed extension to the quarry in accordance with the 2008 Quarry Regulations. It evaluates the rock mass strength based on extensive field investigation, including RQD surveys, geophysical analysis, and rotary percussive boreholes, to confirm that the proposed development will not pose a risk to the structural integrity of the M9 motorway corridor.

The quarry is located just off the R700, just north of Bennettsbridge, Co. Kilkenny, in the townland of Sheastown. The quarry office is located at coordinates N52.60125, E-7.19620.



Figure 1 Site Location

The site is bounded to the South by the M9 Motorway, to the East by the R700 regional road and to the North and West by farmland. The River Nore is located approximately 1km to the East of the main quarry buildings.



Figure 2 Proposed Extension outline area outlined in purple

An extension was granted to the south west of the site based on a 2018 application and the quarry is now applying for further extension in the south west and west of the site. Figure 2 above shows the design for the proposed extension to the quarry.

The extension runs from the south west corner of the current excavation into what is currently a neighbouring field and will be bounded to the south by the M9 motorway. It continues Northwards around a wooded area turning north east before running north along an access road to the west of the site in a field adjacent to the old precast warehouse.

2. Geological Setting

The quarry is located within the Ballyadams Formation which is a thickly bedded fossiliferous limestone dating from the Carboniferous period. In general, the Ballyadams Formation has a very high intact rock strength due to its thickly bedded nature and structural uniformity however the presence of major fault structures and complex joint sets can affect its stability on a local level. The entire quarry and the proposed extension are located in the Ballyadams formation.

To the South East the Ballyadams formation starts to give way to a more dolomitised reef limestone which also has a high intact rock strength but a greater degree of weathering.

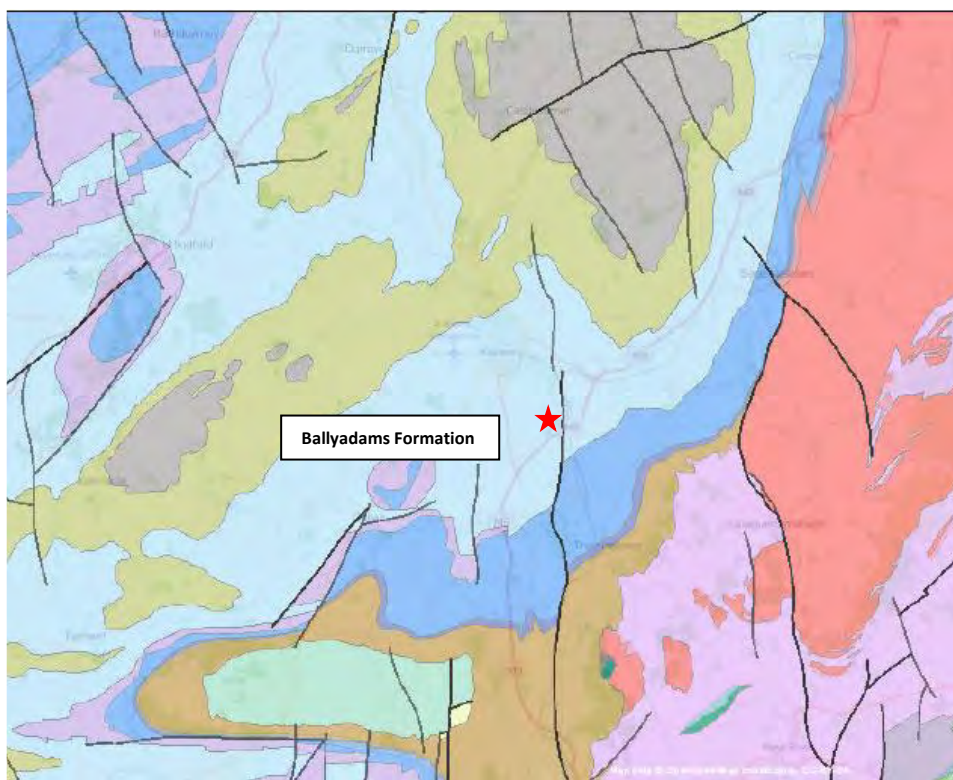
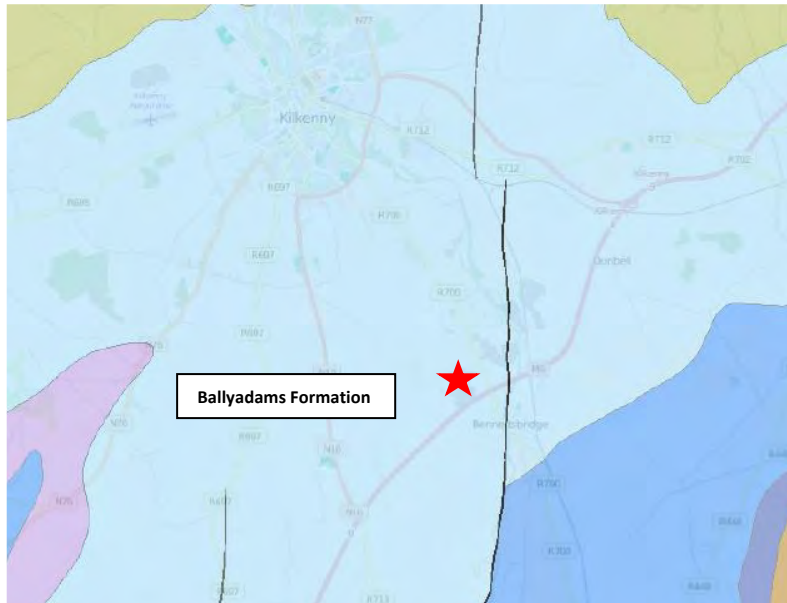


Figure 3 Large Scale Geological Map



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Figure 4 Small Scale Geological Map

From visual observations the intact rock strength of the rock in the quarry is good. There are local areas of weathering to the East and South East of the quarry primarily in the upper benches. Structurally there is a large fault running close to West East through the middle of the quarry. This fault has a large persistence, an aperture of c.0.5m with a weathered clay/rock infill. The fault has a measured strike of 080° and a Dip of 80° South. It is likely that this fault will continue westwards into the new proposed extension. The likely condition of this fault in the extension can be inferred from the geophysical data later in this report.



Figure 5 The main West East trending fault in the northern portion of the west face

The primary joint set has an average orientation of 350° Strike and 85° Dip with a secondary joint set with an average orientation of 064° Strike and 82° Dip. The bedding within the rock is close to horizontal with a slight tendency in dipping to the East.



Figure 6 The Primary joint set (highlighted in red)



Figure 7 The primary joint set (highlighted in red)

These orientations give a slight proclivity towards potential toppling failure or minor planar failure in the western faces with more likely planar or wedge failure in the northern, southern and eastern faces. Overall the quarry is very stable and the quarry operators and manager have excellent knowledge of the rock conditions and quarry safety.

3. Current quarry stability

Advanced Mining Solutions Ltd has conducted multiple full geotechnical assessments of the quarry dating back as far as April 2016. All assessments featured a detailed look at the stability of the current quarry faces, tips, stockpiles and lagoons. By combining a measurement of the Rock Quality Design (RQD) of the rock with a qualitative assessment of the intact rock strength and general quarry operation AMS was able to make determinations with regards to the stability of the quarry as a whole as well as a comparison of the stability of individual faces.

AMS found that the quarry has been designed and operated to take cognisance of good practice in stability and the 2008 quarry regulations. As a result, a conscious effort has been made to keep individual bench heights below 20m and stand-off zones are present beneath all the currently active and old faces. The quarry operator has also instigated procedures where no unauthorised personnel are allowed anywhere near faces keeping most quarry activity far away from active faces.

Over the course of the last 9 years AMS found the rock to be of exceptionally high quality with a high intact rock strength. The rock is normally oriented with horizontal bedding, and clean tight moderately spaced jointing. AMS conducted a number of RQD scanlines in the southern and western faces for the purposes of this assessment AMS also reviewed the site investigation report for the extension area which featured geophysics by way of 2d resistivity sections and boreholes. The following section is a summary of that analysis.

4. Stability of proposed extension

Following a walkover of the proposed extension area it was noted that it comprises entirely of a green agricultural field to the north and a lightly forested area to the west.



Figure 8 Wooded are in southern extension area.

To the south of this field is the boundary fence with an embankment on the other side. There is a rock outcrop at the base of this embankment along which runs the M9 motorway. Upon completion, the base of the lowest face in the quarry that is closest to the motorway will be between 80m and 130m from the edge of the road whilst the crest of that face will be between 55m and 86m away. The crest of the top face will be 30m in from the boundary of the boundary fence at the top of the road embankment. (Refer to Drawing title M9 Cross sections in Appendix)

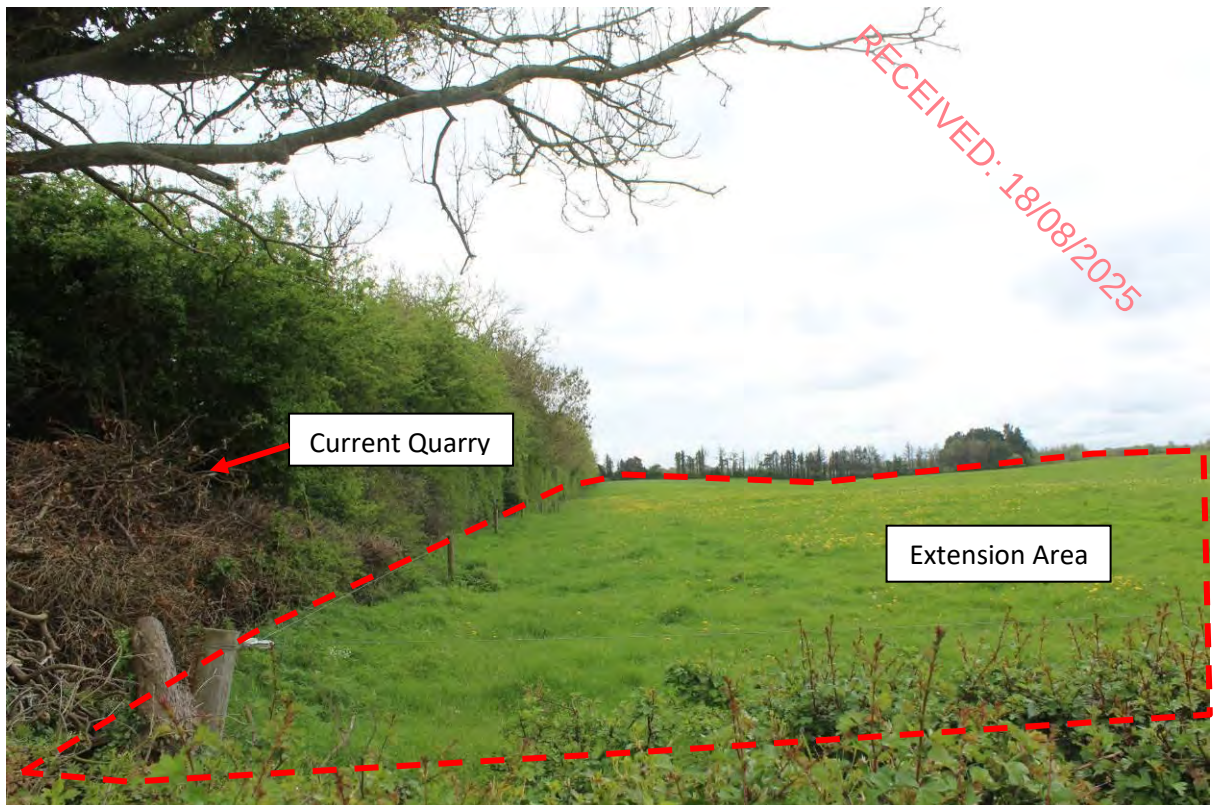


Figure 9 Greenfield site in proposed northern section of extension area. Looking South

In order to assess the rock mass strength of the proposed extension AMS:

- Recorded a number of RQD scanline surveys along the upper and lower western faces which will be the starting point for the extension.
- Reviewed the 2d resistivity survey data looking for any signs of potential zones of weakness or karst features within the extension area.
- Reviewed the rotary percussive borehole logs for the proposed extension.

Scanline surveys

The scanline surveys were conducted over a 2m horizontal interval at a number of locations and the RQD values averaged for the South Western face and the old western face adjacent to the haul ramp. (The north Western face)

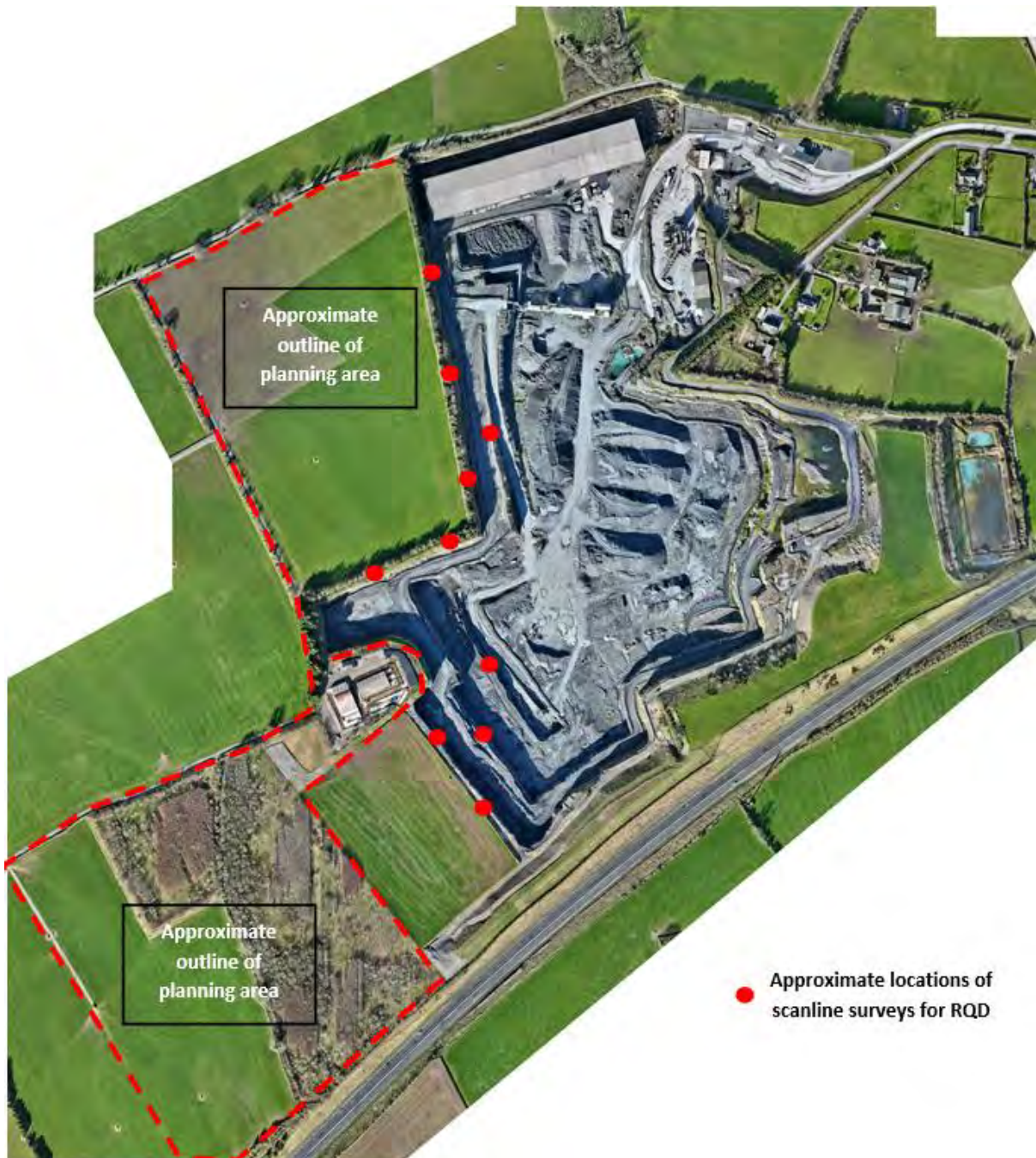
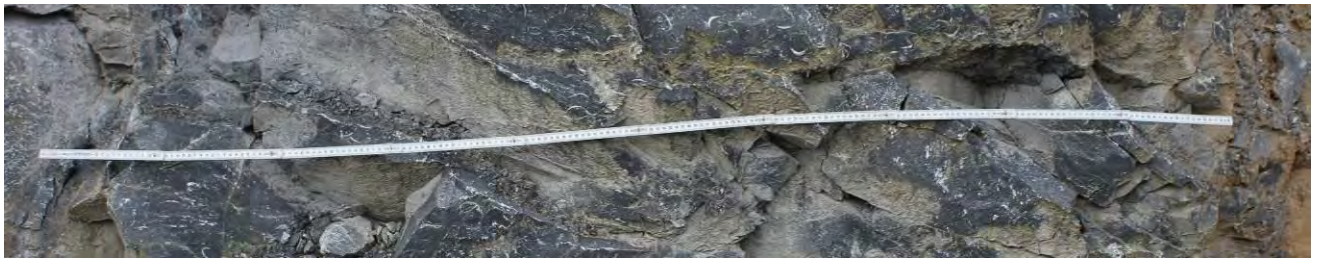


Figure 10 RQD Scanline survey locations



Upper South Western face: Unweathered, medium thick bedded limestone. Large joint spacing. Low joint aperture with clean joint surface. RQD-92.



Upper South Western face: Minor Weathering. medium thick bedded limestone. Medium to large joint spacing. Low joint aperture with some light brown staining. RQD-78.



Middle South Western face: Unweathered, medium thick bedded limestone. Medium joint spacing. Low joint aperture with clean joint surface. RQD-82.



Lower South Western face: Unweathered, medium thick bedded limestone. Medium joint spacing. Low joint aperture with some light calcite infill. RQD-80.



Upper North Western Face: Minor Weathering, medium thick bedded limestone. Medium to large joint spacing. Low joint aperture with some light brown staining. RQD-84.



Upper North Western Face: Unweathered, medium thick bedded limestone. Medium joint spacing. Low joint aperture with some light brown staining. RQD-88.



Upper North Western Face: Unweathered, medium thick bedded limestone. Medium joint spacing. Low joint aperture with some light brown staining. RQD-78.



Upper North Western Face: Unweathered, medium thick bedded limestone. Medium joint spacing. Low joint aperture with clean joint surface. RQD-76.



Upper North Western Face: Unweathered, medium thick bedded limestone. Small to Medium joint spacing. Low joint aperture with clean joint surface. RQD-64.



Middle North Western Face: Minor Weathering, medium thick bedded limestone. Medium to large joint spacing. Low joint aperture with orange staining. RQD-86.

The scanline survey shows an average RQD for the southern face of 80.8% which indicates good rock quality.

RQD	Rock Quality Classification
<25%	Very Poor
25-49%	Poor
50-74%	Fair
75-89%	Good
90-100%	Excellent

Geophysical Data

Apex Geoservices conducted a comprehensive geophysical survey of the proposed extension in September 2024. The Figures below shows the locations of the 2d resistivity surveys (R&RK), the seismic line surveys (S) and the most recent Rotary percussive drill holes (SP) also drilled in 2024. This follows on from similar investigations conducted by Apex in 2006 and 2018 for previous planning applications.

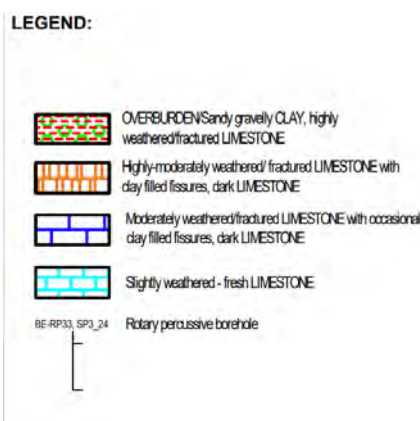


Figure 11 Geophysical investigation and RP drill hole locations R1-R4

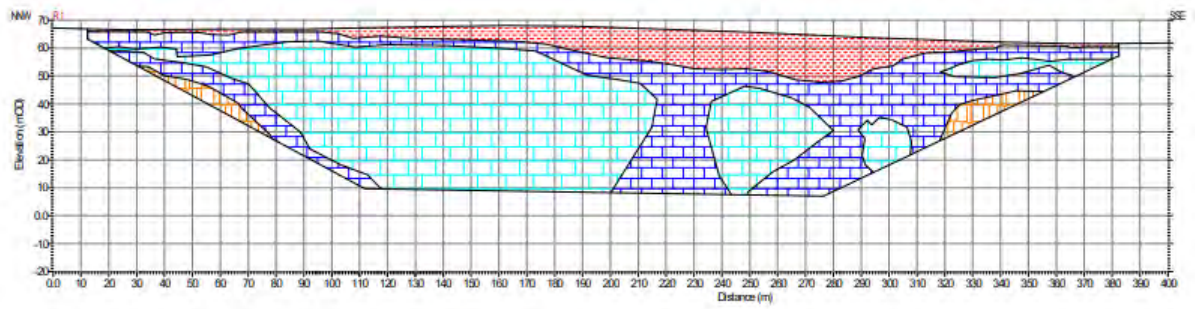
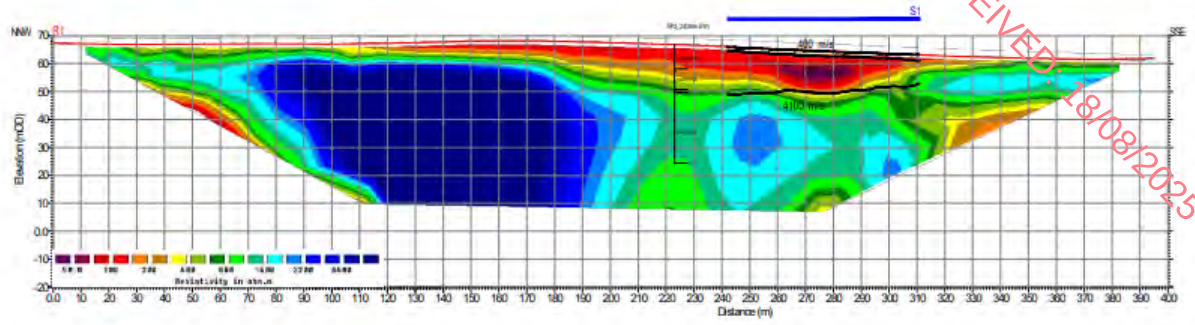


Figure 12 Geophysical investigation and RP drill hole locations R5 to R10

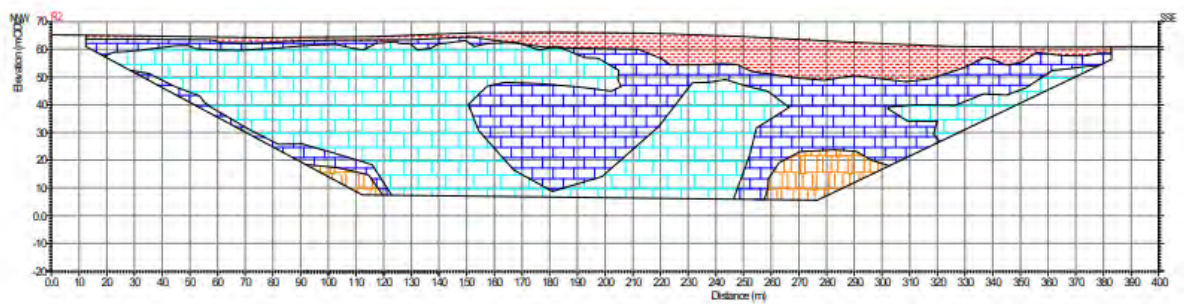
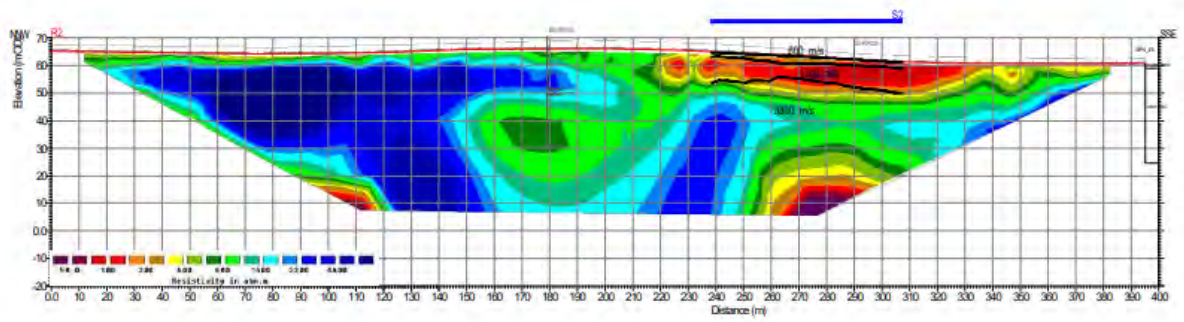
The following is the 2d resistivity sections with the interpreted rock conditions. Sections R1 to R4 run roughly north-south across the north west portion of the extension shown in Figure 9. R7 to R10 run roughly north south across the south west portion of the extension. The associated online seismic survey interpretation is included with the resistivity lines. The legend below is the interpreted rock conditions from the survey data:



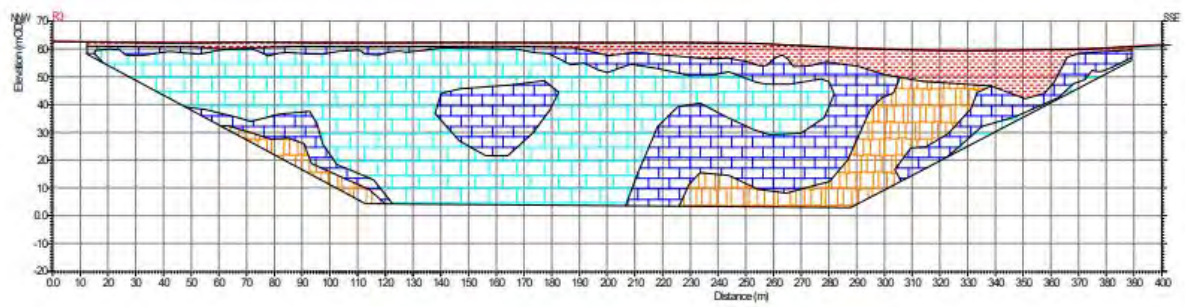
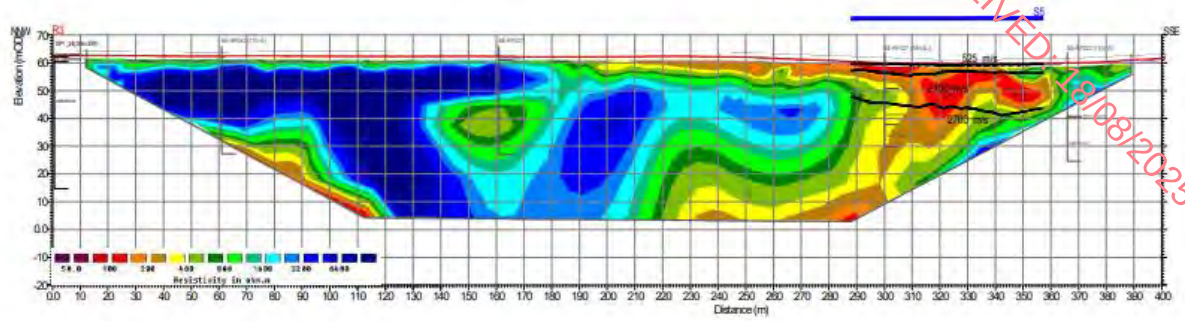
R1



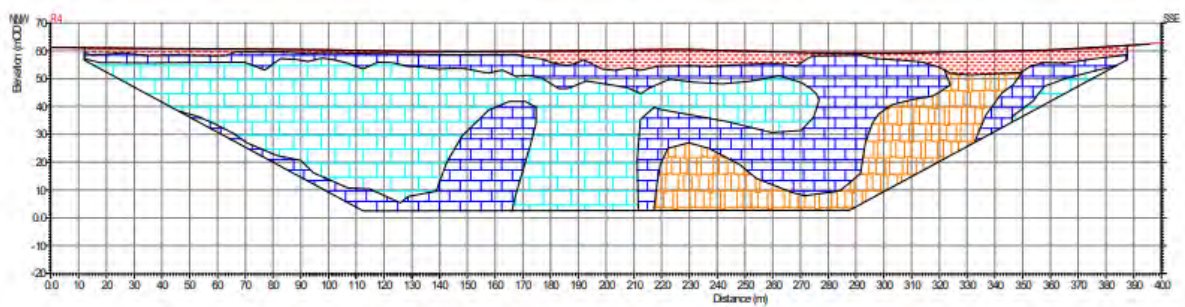
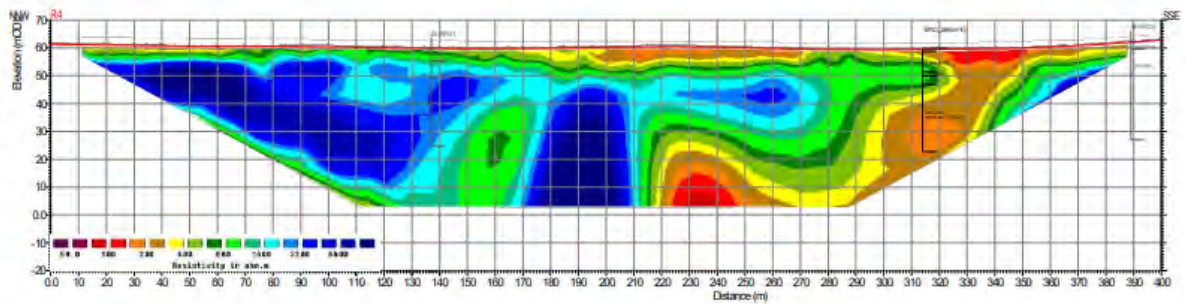
R2



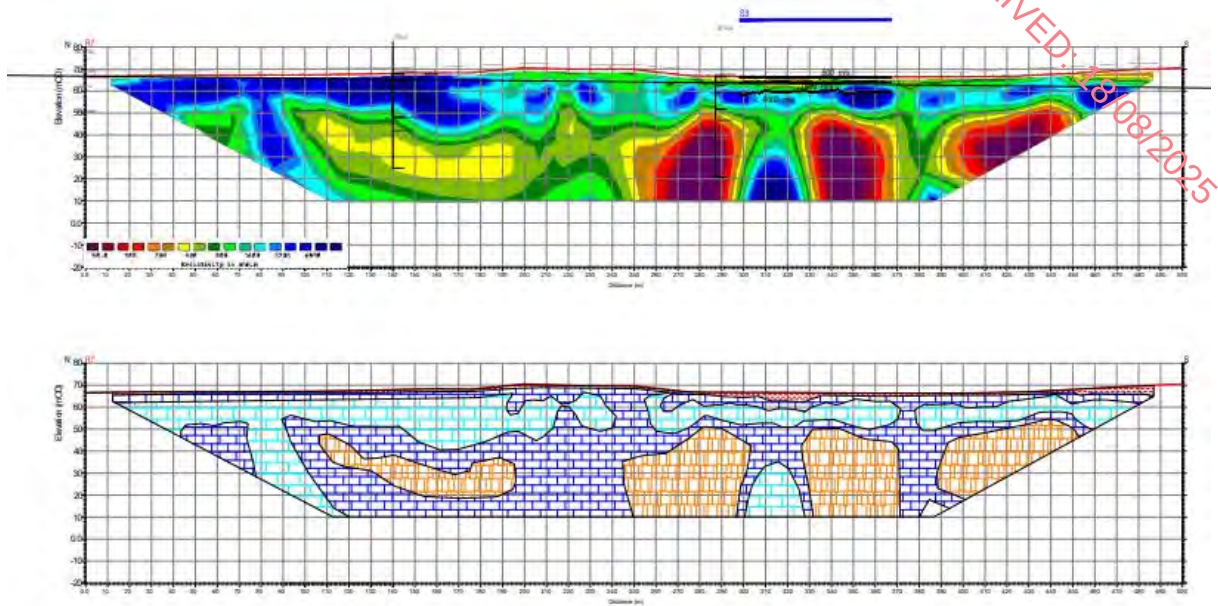
R3



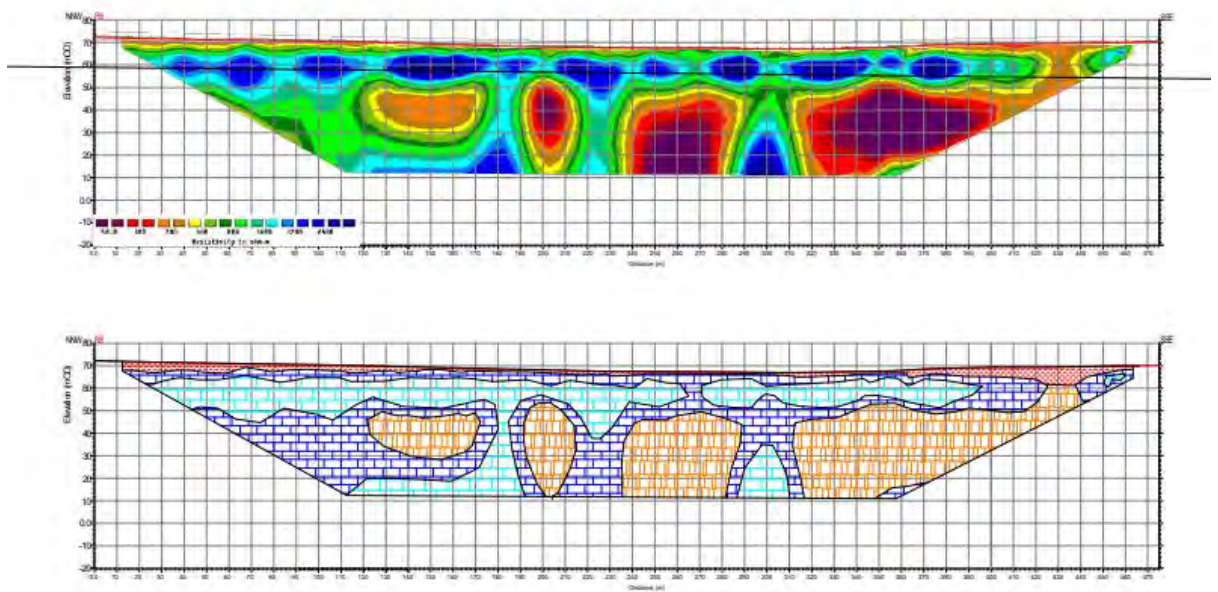
R4



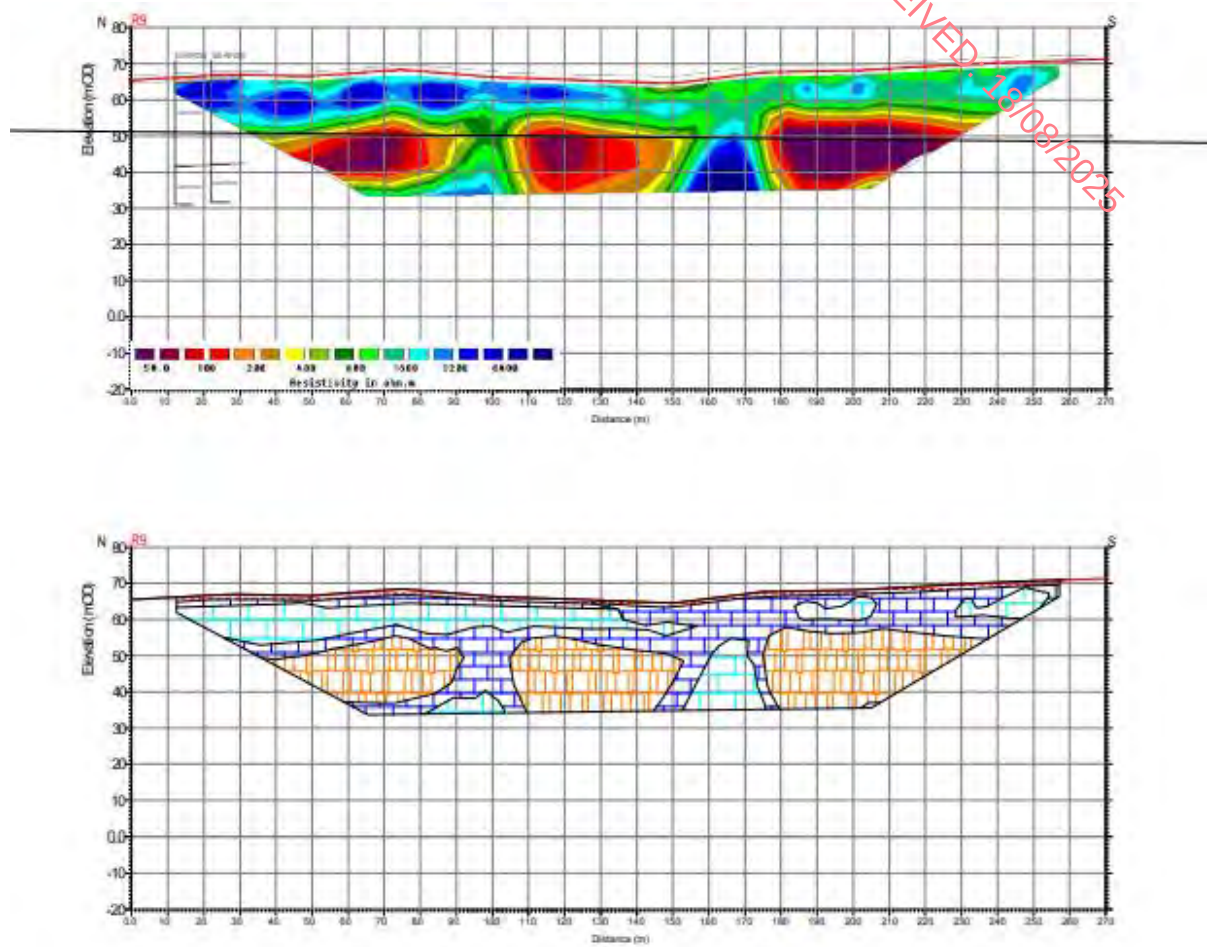
R7

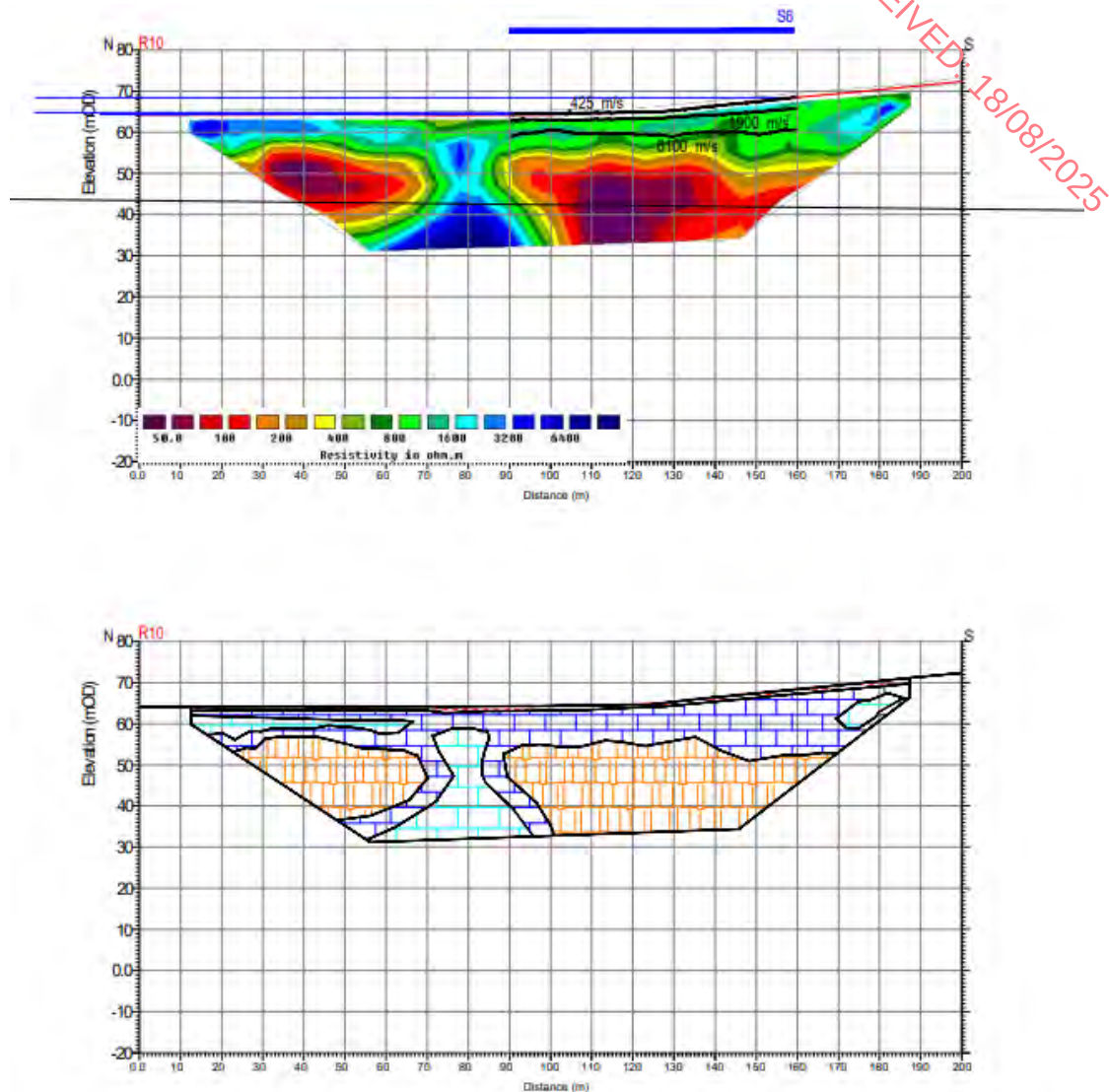


R8



R9



R10

The interpreted inverse resistivity profiles show large areas of clean limestone throughout. In the north west area of the extension there is an area of highly weathered limestone towards the south which correlates with the orientation of the existing known structure highlighted in Figure 5. Although this structure has some aperture and clay infill the weathering surrounding this structure is highly localised and it will pose little stability issues to blasting operations if handled in a similar manner to how it has been managed to date.

There are some similar high conductivity zones highlighted in the south west area of the extension. There are 3 to 4 separate areas interpreted as highly weathered limestone areas at depth. These could be interpreted as similar structures to the one found in the north west face. There is little evidence currently in the south west face to support this hypothesis

but structures could come across this face starting in the south making their way into the face as it progresses westwards. Great care should be taken when quarrying this face as it could lead to large scale wedge or planar failures.

Overall, however the resistivity appears to show a good quality rock mass over the whole survey area with a low likelihood of large weathered features. Some areas interpreted as highly weathered limestone in the 2018 geophysical survey were quarried easily in the current south west extension with little or no weathering present.

Rotary percussive borehole logs

The rotary percussive holes drilled in 2024 were drilled by Peterson drilling ltd. The holes displayed in figures 11 and 12 above were drilled to a maximum depth of 48m and the cuttings logged by the drillers All holes drilled showed Medium strong to strong dark grey to black LIMESTONE with occasional thin calcite veins throughout with steady drill penetration throughout with the exception of SP2_24 and SP3_24 that lie in the northern section of the proposed extension area:

SP2_24- 9.4-12.4m Soft to firm orange to brown CLAY

SP3_24- 16.1-17.2 Firm orange to brown CLAY

These almost certainly relate to the West East trending structure that is known and observed in the quarry and has been highlighted above in the geophysics.

The proposed quarry extension has designed face heights of 16m to 20m with intermediate shelf widths of 6m.

The proposed berm to the south of the quarry will follow the same design as the berm currently in place and will be approximately 10m in height over a width of approximately 30m founded on level ground with proposed side slopes of 1:1.5 and will consist of stripped overburden material which is comprised of Grey to brown sandy cobbly clay. External faces will be vegetated. Given the proposed location of this berm and the observed stability of the existing berm it is deemed as being stable in AMS's opinion.

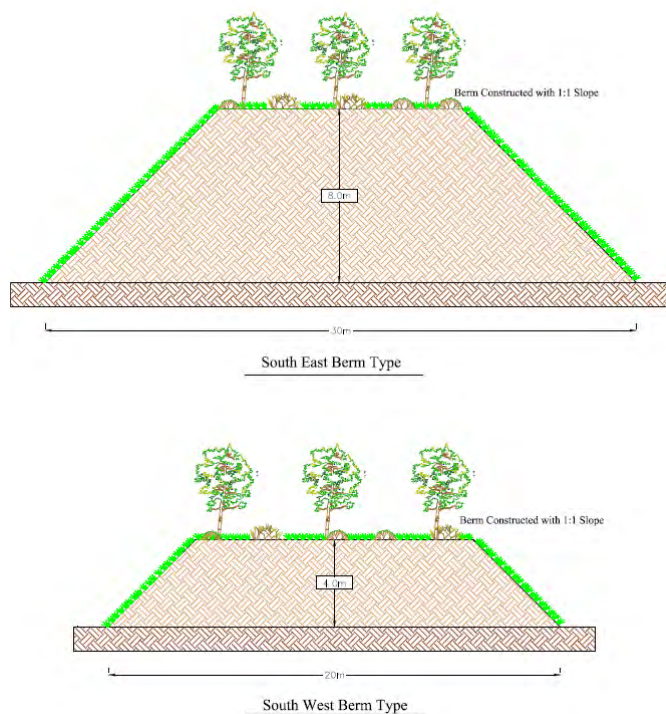


Figure 9 Berm design

Given the good rock mass strength of the proposed extension and the designed overall standoff distance of both the crest and the base of the final quarry face it is AMS's professional opinion that there is no threat to the M9 motorway from a rock stability perspective as a result of quarrying the proposed extension. When quarrying in this area however the operator should be cognisant that there was some high conductivity areas detected which could mean weathered structures may make their way into the face from the south as it progresses westwards.

Provided the extension is conducted according to the plan and follows the 2008 quarry regulation guidelines regarding face heights and angles the stability within the quarry extension itself will also be good. It is recommended however that during development the quarry operator conduct regular geotechnical appraisals and geotechnical assessments to track progress of the extension and the effect it is having on quarry stability.