Appendix F

Lackagh Tunnel Report

F

Galway County Council

N6 Galway City Ring Road

Lackagh Tunnel: Geotechnical and Hydrogeological Appraisal

GCOB-4.03-4.16

Issue 3 | 26 July 2018

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Job number 233985-00

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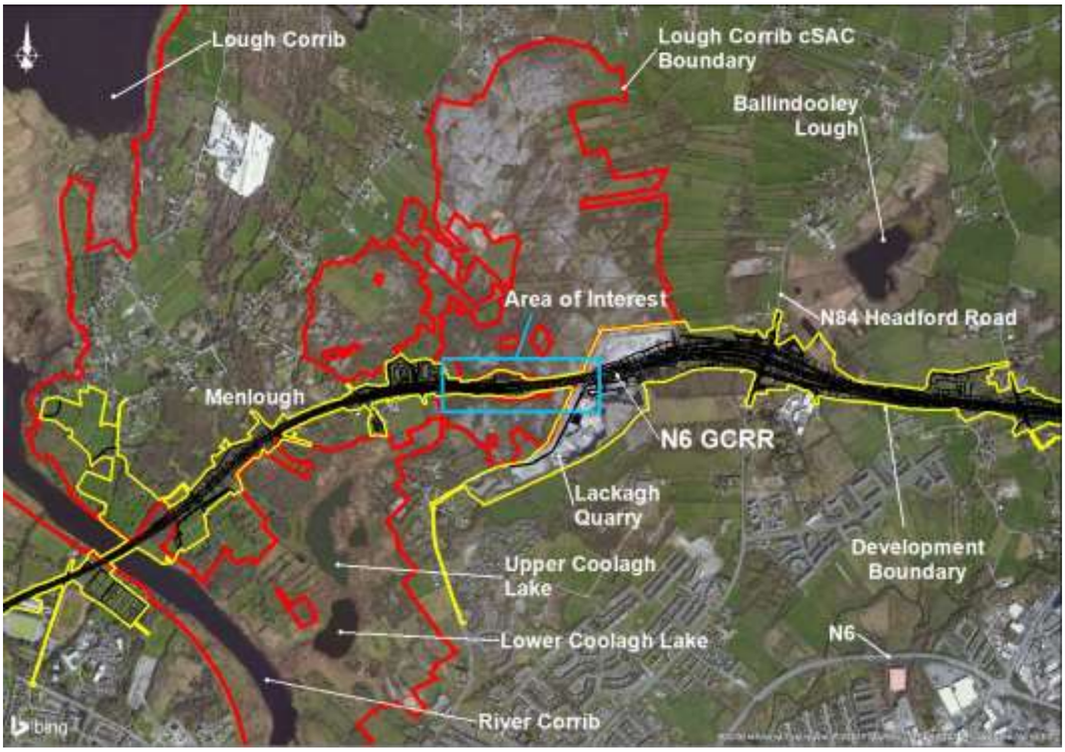
1 Introduction

As part of the N6 Galway City Ring Road, hereafter referred to as the proposed road development, a mined twin tunnel is proposed east of Menlough and west of Lackagh Quarry, Lackagh Tunnel. The western approach to the tunnel lies partly within Lough Corrib candidate Special Area of Conservation (cSAC), with the tunnel itself passing beneath this cSAC. The tunnel exits through the western boundary of Lackagh Quarry (which has been inactive since 2010) at its eastern portal. Refer to **Figure 1.1**.

Figure 1.1: Overview of the Area of Interest



There are a number of Qualifying Interest (QI) Annex I habitats within Lough Corrib cSAC which are located above, immediately adjacent to, or in close proximity to the proposed road development, some of which are groundwater dependent. The proposed road development tunnels beneath the Lough Corrib cSAC from the western face of Lackagh Quarry in a westerly direction and then enters a cutting which runs adjacent to the Lough Corrib cSAC boundary.

Construction and operation of Lackagh Tunnel and the Western Approach has the potential to directly and indirectly impact these sensitive ecological habitats. The purpose of this report is to appraise the hydrogeological and geotechnical aspects of the design, construction and operation of Lackagh Tunnel and its approaches.

The report describes the hydrogeological and geotechnical existing environmental features (constraints[1]) and potential direct and indirect impacts[2] on these features. These include the Annex I habitats located at the surface above the proposed tunnel, namely priority Annex I Limestone pavement [*8240] habitat and Annex I Calcareous grassland [*6210/6210] and the groundwater catchments within this area which support groundwater dependant terrestrial ecosystems (GWDTE); including Coolagh Lakes and Ballindooley Lough. Ballindooley Lough includes supporting habitat for birds listed as Special Conservation Interests (SCIs) of Lough Corrib Special Protection Area (SPA) and Inner Galway Bay SPA. This report also outlines the design measures incorporated into the proposed road development to avoid potential direct and indirect impacts and mitigation measures for the construction and operation of the proposed tunnel.

The focus of this report is an assessment of the hydrogeological and geotechnical aspects of the design, construction and operation of Lackagh Tunnel. Potential environmental direct and indirect impacts not effecting the hydrogeological or geotechnical environment are assessed in the relevant sections of the NIS and EIA Report.

Chapter 2 of this report describes the proposed works at Lackagh Tunnel. **Chapter 3** describes the receiving hydrogeological and geological environment and identifies the hydrogeological and geotechnical constraints and also includes the ground investigation (GI) data. **Chapter 4** identifies the potential direct and indirect impacts to the hydrogeological and geotechnical constraints as a result of the proposed road development at Lackagh Tunnel and the immediate approaches. **Chapter 5** presents the design avoidance and mitigation measures required during construction and operation to prevent or address potential direct or indirect impacts to the hydrogeological and geotechnical constraints based on scientific data. Finally, **Chapter 6** summarises the report findings, with a conclusion in **Chapter 7**.

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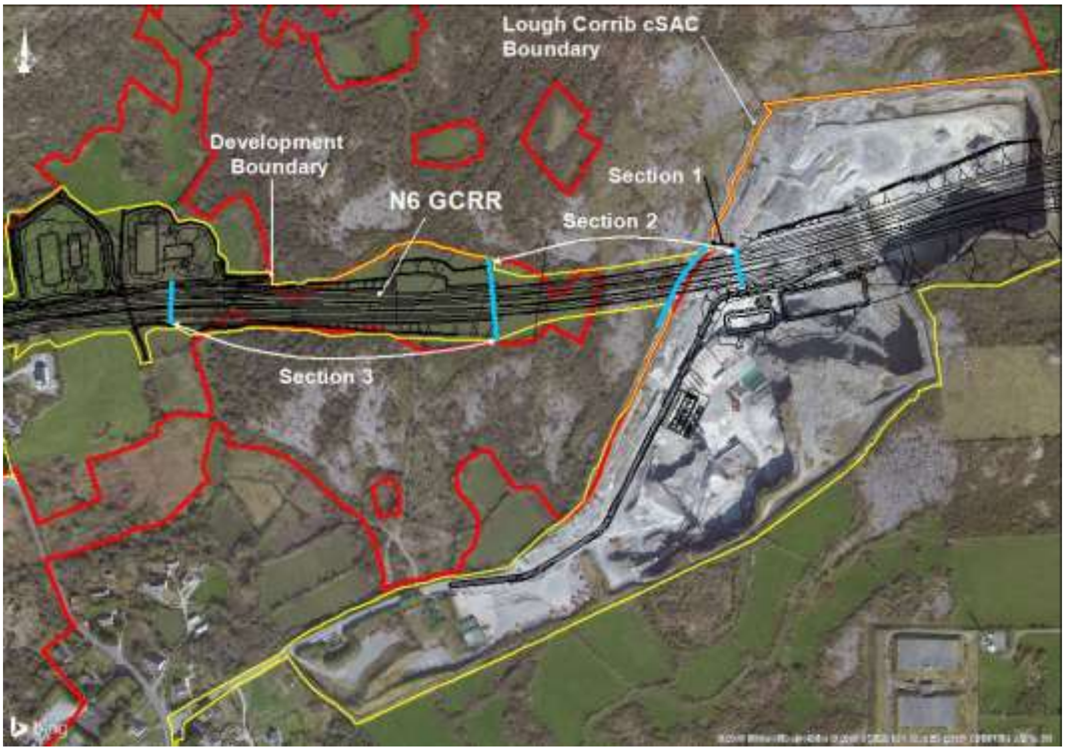
[1] Constraints are hydrogeological and geotechnical environmental features

[2] Potential direct and indirect impacts are the potential impacts that the proposed road development could have on a particular feature/constraint

2 Lackagh Tunnel Description

For the purpose of this report the assessment of the design, construction and operation of Lackagh Tunnel is split into three areas, namely Section 1 (Lackagh Quarry Face), Section 2 (Lackagh Tunnel) and Section 3 (Western Approach), hereafter referred to as Sections 1, 2 and 3 and are shown in **Figure 2.1** below. A combined assessment of the potential hydrogeological and geotechnical direct and indirect impacts for Sections 1, 2 and 3 are presented in **Sections 4.4** and **5.4** of the report.

Figure 2.1: Aerial view of the three Sections 1, 2 and 3



Section 1, Lackagh Quarry Face, includes the stabilisation of the western quarry face and the construction of the eastern tunnel portal. Section 2, Lackagh Tunnel, includes a mined twin bore tunnel in rock constructed using a drill and blast methodology. There is a cross over between Sections 1 and 2 as the tunnel extends into Lackagh Quarry. The eastbound tunnel is approximately 20m longer than the westbound tunnel as a result of the existing topography on entering Lackagh Quarry. Section 3, the Western Approach, includes the construction of the western tunnel portal (where the underlying ground conditions change from rock to overburden) and retaining systems to support the cut face between the existing ground level and proposed road level. In Section 3 the proposed road development lies partially within the Lough Corrib cSAC and in close proximity to Qualifying Interest (QI) Annex I habitat. Refer below to **Table 2.1** and **2.2** for Section and tunnel details.

The tunnel entry portals extend from existing bedrock and are located between chainages:

- Eastbound tunnel:
  - Eastern entry portal Ch. 11+150 to 11+180
  - Western entry portal Ch. 11+390 to 11+420
- Westbound tunnel:
  - Eastern entry portal Ch. 11+150 to 11+180
  - Western entry portal Ch. 11+375 to 11+400

Lough Corrib cSAC is located immediately west of Section 1. Section 2 tunnels beneath Lough Corrib cSAC, including the Annex I habitat, between approximately Ch. 11+240 and 11+350. Section 3 lies partially within the Lough Corrib cSAC and traverses between Annex I habitat which is located north and south of the proposed road development. In this section the proposed development overlaps with the Lough Corrib cSAC boundary, but does not impact directly on any QI or Annex I habitat, between approximately Ch. 10+830 and Ch. 11+020 to the south and Ch. 10+880 and 10+950 to the north, refer to **Figure 2.2** and **Appendix B**.

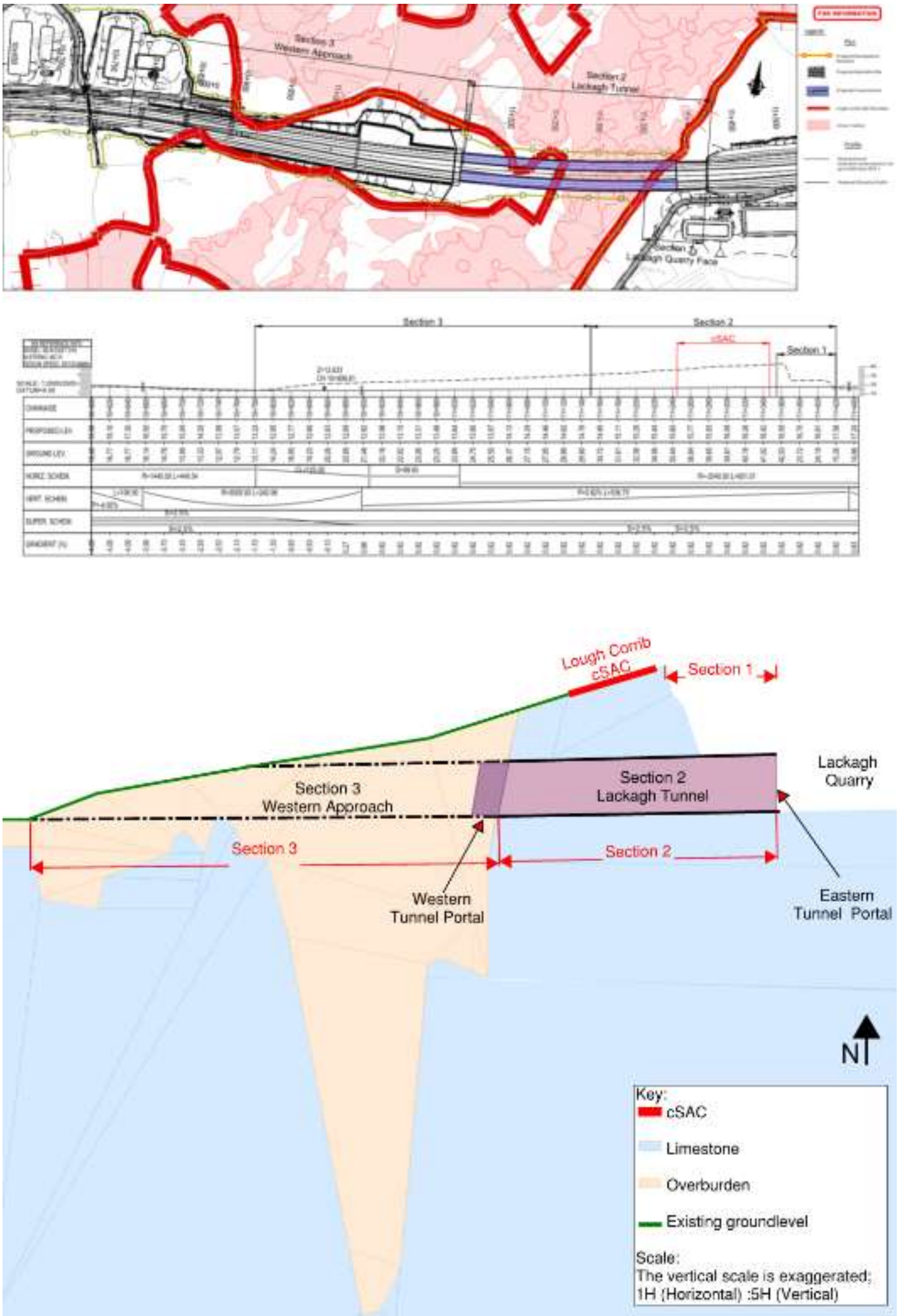
Table 2.1: Summary of the Section details

Section	Chainage		Approximate Section Length	Proposed finished road level (range in mOD)	
	From	To		Minimum	Maximum
1	11+390	11+420	30	+16.5	+17.0
2	11+180	11+420	240	+14.8	+17.0
3	10+775	11+180	405	+12.7	+14.8

Table 2.2: Summary of Tunnel Details

Tunnel bore	Approximate Chainage		Approx. Tunnel Length	Approximate chainage of mined and blast tunnel in rock		Approx. length of tunnel in rock
	From	To		From	To	
Eastbound (North)	11+150	11+420	270	11+180	11+390	21
Westbound (South)	11+150	11+400	250	11+180	11+375	195

Figure 2.2: Plan, profile and schematic cross section of Section 1-3



3 Receiving Environment

3.1 Introduction

This chapter of the report identifies the receiving hydrogeological and geotechnical environment (constraints) which is of relevance to the design, construction and operation of Lackagh Tunnel and its approaches, i.e. Sections 1, 2 and 3. The potential direct and indirect impacts to the hydrogeological and geotechnical constraints are presented in **Chapter 4**.

3.2 Background

The proposed road development lies within the regional vicinity of four European sites. These European sites are listed as follows:

- Lough Corrib cSAC
- Lough Corrib SPA
- Galway Bay Complex cSAC
- Inner Galway Bay SPA

Of these four European sites, the proposed road development traverses the Lough Corrib cSAC, refer to **Figure 3.1**.

Based on the hydrogeological assessment, there are two groundwater bodies (GWB) that are directly traversed by the proposed road development at Lackagh Tunnel namely the Lough Corrib Fen 1 GWB and the Clare-Corrib GWB (refer to **Figure 3.11** and **Appendix A Hydrogeology Figure 5.02**). Lough Corrib Fen 2 GWB lies adjacent to Lackagh Tunnel. These two groundwater bodies contribute directly to Lough Corrib cSAC. Lough Corrib Fen 2 GWB also contributes to Lough Corrib SPA. As the River Corrib flows into Galway Bay these three GWBs also contribute indirectly to Galway Bay Complex cSAC and Inner Galway Bay SPA.

As discussed in **Chapter 1** and **2**, the Western Approach to the Lackagh Tunnel lies partly within Lough Corrib cSAC, with the tunnel itself passing beneath the cSAC. The Coolagh Lakes, located to the south west of Lackagh Quarry, which also form part of the Lough Corrib cSAC, are groundwater dependant terrestrial ecosystems (GWDTE). There are groundwater flow paths between the Coolagh Lakes and the groundwater bodies (GWB) in the vicinity of the proposed Lackagh Tunnel. Furthermore, Ballindooley Lough, located 1.1 km to the north east of the proposed Lackagh Tunnel is used by bird species listed as Special Conservation Interests (SCIs) of Lough Corrib SPA (which is located 1.8km North West of Lackagh Tunnel) and of Inner Galway Bay SPA.

Galway Bay Complex cSAC and Inner Galway Bay SPA lie 2.5km south of Lackagh Tunnel. The regional groundwater regime in the area discharges to the Coolagh Lakes, the River Corrib, and Galway Bay. Therefore groundwater contributes indirectly to Galway Bay Complex cSAC and Inner Galway Bay SPA.

The ecology in the area of the proposed tunnel sensitive to potential hydrogeological and geological direct and indirect impacts include Limestone pavement, Calcareous grassland and GWDTE (including Turloughs and Coolagh Lakes) - refer to **Figure 3.1**. Groundwater contributes to Coolagh Lakes, Lough Corrib, River Corrib and Galway Bay. GWDTE and Limestone pavement are sensitive to changes in hydrogeology but are dependent on different aspects of the water environment. Whilst, GWDTE is dependent on the groundwater table and its interaction with surface water, Limestone pavement habitat is dependent on exposed, free draining and unsaturated limestone with clints and grykes.

Figure 3.1: Limestone pavement and GWDTE adjacent to Lackagh Tunnel

An overview of the topography is given in **Section 3.3**, the existing hydrogeological and geotechnical environment in **Section 3.4** and **3.5** respectively and a description of the ground model in **Section 3.6** of the report.

3.3 Topography

3.3.1 Section 1: Lackagh Quarry Face

The proposed eastern tunnel entry portal is located within the now inactive Lackagh Quarry, on the western quarry wall. The western quarry wall comprises of a lower and upper bench. The lower bench floor level is at +15mOD which rises steeply to +24mOD at the upper bench with a slope angle ranging from 75 degrees to sub-vertical in places with an uneven surface, (**Figure 3.2**). The distance between the top of the lower bench to the base of the upper bench ranges in width from 28m to 40m around the proposed tunnel portal area, (**Figure 3.3**). The upper bench ranges in height from 18m to 20m with a slope angle ranging from 70 degrees to sub-vertical. The maximum elevation of the quarry wall in this location is +44mOD.

Figure 3.2: Section 1 – Aerial view of Lackagh Quarry and the eastern tunnel portal

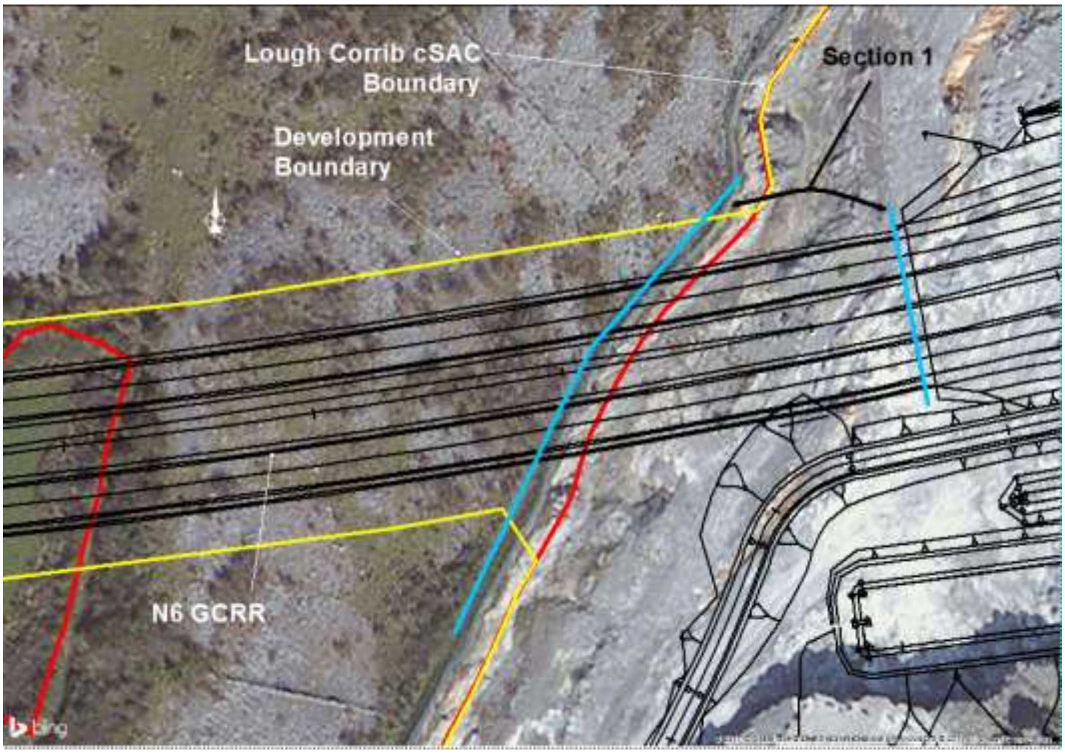


Figure 3.3: Photograph of Lackagh Quarry in the vicinity of the tunnel portal

The quarry boundary is defined by a steel fence on a concrete plinth, which borders the Limestone pavement within the Lough Corrib cSAC. There is an average distance of approximately 1m between the edge of the fenceline plinth and the top of the upper quarry bench. **Figure 3.4** below shows a view of the western quarry wall from a distance, outlining the lower and upper bench and boundary fence.

Figure 3.4: Features of the eastern tunnel portal area, with extent of tunnel portal marked within red rectangle

Some instability in the rock face is evident predominantly from blast damage during the operation of the quarry, with open discontinuities (joints and fractures), loose rock and the accumulation of debris resulting from spalling and failures present at the base of the lower and upper benches, see **Figure 3.5** below.

Figure 3.5: Face instability on the lower and upper bench

3.3.2 Section 2: Lackagh Tunnel

Section 2 focuses on Lackagh Tunnel which overlaps with Sections 1 as the tunnel extends into Lackagh Quarry, **Figure 3.6**. The proposed tunnel lies beneath Limestone pavement within the Lough Corrib cSAC and beneath agricultural fields. The existing ground levels of the Limestone pavement, **Figure 3.7**, range from 36.4 to +40.5mOD along the alignment of the proposed road development, falling from east to west. The tunnel extends west beyond the Limestone pavement extents, in an area overlain by agricultural land where the ground level reduces to +30.7mOD in the west from +36.4mOD in the east.

Figure 3.6: Section 2 – Lackagh Tunnel Footprint

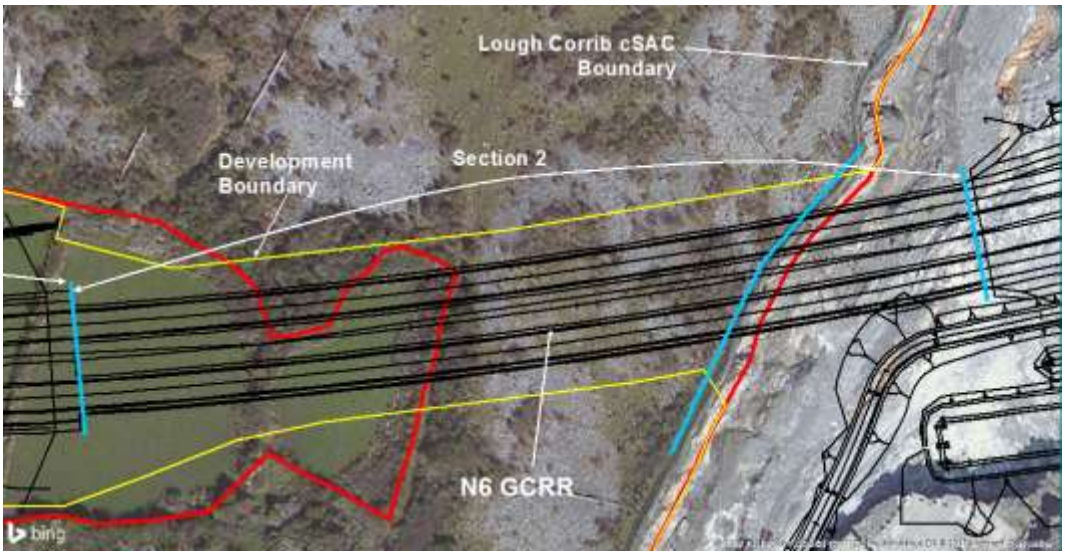


Figure 3.7: Photographs of Limestone pavement located in Section 2

3.3.3 Section 3: Western Approach

Section 3 is bounded on the north and south by Lough Corrib cSAC and is located in an area made up of agricultural fields and stone boundary walls, **Figure 3.8**. The existing ground levels fall from east to west from +30.7 to +13.41mOD.

Figure 3.8: Section 3 – Western Approach

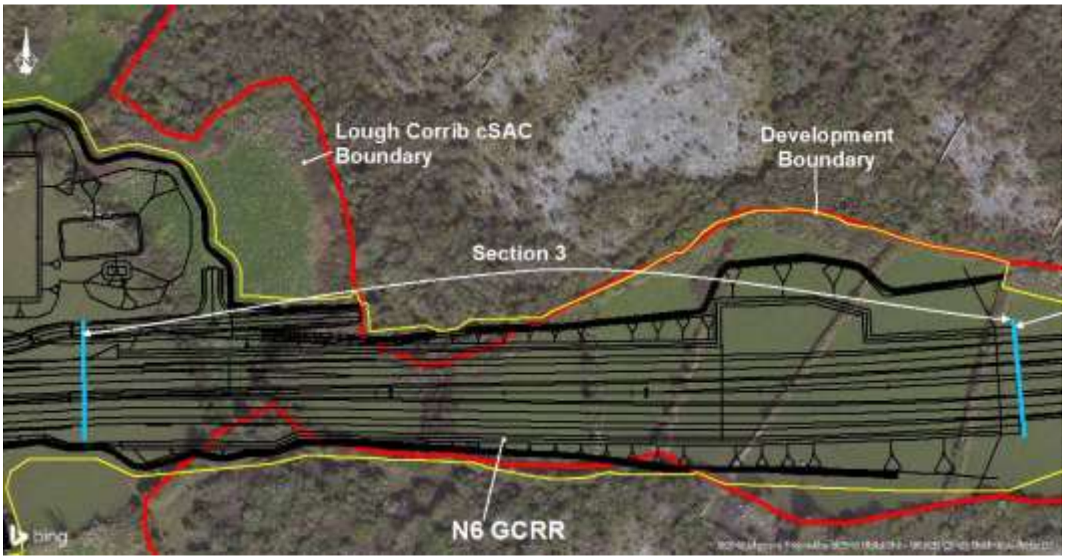


Figure 3.9: Photographs of the agricultural fields located in Section 3

3.4 Existing Hydrogeological Environment

3.4.1 Introduction

This section of the report presents an overview of the existing hydrogeological environment including groundwater dependant terrestrial ecosystems (GWDTE) and Limestone pavement, groundwater data collection and an interpretation of the groundwater data in the areas of Coolough, Menlough and Lackagh Quarry.

3.4.2 Overview

To understand the existing hydrogeological environment investigations including a desk study, walkovers, site surveys and ground investigations were undertaken.

The karst survey undertaken for the constraints study for the proposed road development included a site walkover. The survey identified several karst features in the area including the Western Coolagh Springs, which discharges to Upper Coolagh Lake, as well as three Turloughs in the Menlough/Coolough area (Refer to **Figure 3.1**).

From site walkovers the ground surface in this area is found to almost entirely comprise of limestone, whilst in a number of areas there is no rock outcrop and clayey subsoils dominate, such as beneath the agricultural fields in Sections 2 and 3. This includes areas at Terryland, where the Terryland River flows along a wide flat valley floor of clayey subsoils and at Coolough where the lakes lie on a wide flat low lying area with clayey soils and subsoils.

As part of the ground investigation (GI), undertaken for the proposed road development, areas with clay subsoils were examined by geophysics (resistivity) surveying and borehole drilling. In a number of locations, such as the Western Approach to Lackagh Tunnel, Section 3, these clayey areas were proven to be deep buried karst features that have been in filled by sediment deposition. These features are particularly deep, with the feature at the western approach to Lackagh Tunnel having a depth of 104.95m (to -78.69mOD). Adjacent features at Lackagh Quarry were proven by geophysics to be greater than 30m deep (to > -20mOD) and are also considered to be buried karst features.

These buried karst features with clay dominated fill separate the hydrogeology of the area into a number of limestone blocks that form distinct groundwater bodies (GWB), refer to **Section 3.4.3** of the report, **Figure 3.11**. The full extents of the groundwater bodies are presented in **Appendix A**, **Figure 5.02**. These buried karst features also generate surface runoff unlike the limestone areas where all rainfall recharges to ground.

Lackagh Quarry remains dry most of the year apart from during peak rainfall events groundwater ponds on the lowest bench of the quarry. Groundwater level data has been recorded in the area between June 2015 and January 2017, with the highest recorded level of groundwater flooding in Lackagh Quarry being +15.7mOD, which was recorded in January 2016. Following rainfall there are a number of small seepages on the quarry faces, the majority of which are located along a clay wayboard [3](bedding plane) that separates the upper and lower quarry benches (**Figure 3.4**).

3.4.2.1 Groundwater Dependant Terrestrial Ecosystems (GWDTE)

Groundwater contributes to Coolagh Lakes, Lough Corrib, River Corrib and Galway Bay. The ecological surveys identified a number of GWDTE where the habitat is dependent on the groundwater in the groundwater bodies traversed by Lackagh Tunnel and its approaches. These include Coolagh Lakes, Ballindooley Lough and three Turloughs.

Coolagh Lakes

Coolagh Lakes comprise of an upper and lower lake that are perennial with a c.70cm seasonal fluctuation in water level. The combined area of the Coolagh Lakes ranges from 0.08km^2 (2.2km perimeter) in the summer to 0.22km^2 (3.5km perimeter) in the winter. Whilst, Upper Coolagh Lake is entirely groundwater fed, Lower Coolagh Lake is in continuity with the River Corrib.

Surface water level instrumentation was installed and monitored at Coolagh Lakes from July 2015 to January 2017 to record the seasonal water levels between the upper and lower lake as well as springs. The surface water monitoring data was supplemented with the groundwater level monitoring data from local boreholes so the interaction between surface and groundwater could be assessed. These data sources indicate that the groundwater contribution to the lake water is mainly during the autumn, winter and spring and that the groundwater input to the lakes ceases during the summer months. During the summer, the water level in the lakes lowers to the level in the River Corrib. During the winter months the lake levels rise and remains slightly higher than the River Corrib.

The upper lake receives flow from the Western Coolagh Spring and Eastern Coolagh Spring (Refer **Figure 3.1** for location of springs). It is noted that the Western Coolagh Spring is a karst spring whilst Eastern Coolagh Spring is not a karst spring because it sits on thick clay subsoil as evidenced by ground investigations (GI). There is a potential for seepage from the limestone aquifer through the clayey subsoil to the Eastern Coolagh Spring but due to the low permeability and thickness of the clayey subsoil, these potential seepages are of a very low flow rate. If present, seepages from the subsoil to the Eastern Coolagh Spring would represent a very small fraction of the groundwater contribution to Coolagh Lakes compared to the karst inflow at Western Coolagh Spring which provides the main groundwater contribution flow to Coolagh Lakes. The flow rate from the Western Coolagh Spring has been estimated to range from 0 to 100 l/s

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[3] Clay wayboard’s are described as fossil soils (palaeosols) that developed on paleokarst surfaces during periods in which the underlying limestones were above sea level (Pracht and Sommerville, 2015).
Clay wayboard’s are present in the west of Ireland, shown most famously in the Burren Co. Clare. The Geological Survey of Ireland suggests that these thin clay layers are usually rich in volcanic ash. (gsi.ie)[4] Structural Integrity of the mosaic of Limestone pavement and Calcareous grassland is the physical and mechanical geotechnical properties that control the behaviour of the geotechnical Limestone pavement environment

with the flow being greatest in the winter and flow ceasing during the summer. Flow from the Eastern Coolagh Spring remains low throughout the year and with an estimated flow of <1l/s is not considered to provide a significant groundwater contribution.

Ballindooley Lough

Ballindooley Lough is a permanent lake that is located approximately 1km northeast of Lackagh Quarry and is a supporting habitat for birds listed as Special Conservation Interests (SCIs) of Lough Corrib Special Protection Area (SPA). During the summer period the water level in Ballindooley Lough is perched above the regional groundwater table. During the winter period the lake receives groundwater causing the lake to rise in continuity with the regional groundwater level.

Turloughs

Three Turloughs were identified in the Menlough area, with all three located outside the Lough Corrib cSAC (Refer to **Figure 3.1**). Turlough K31 lies immediately to the south of the proposed road development, Turlough K20 is located just to the north of Menlough Village and K72 is located north of Lackagh Quarry. The winter flooding of the turloughs is due to the seasonal groundwater rise. Although outside of the Lough Corrib cSAC, these turloughs are assessed in this report as there is the potential for indirect hydrogeological impacts on these features due to Lackagh Tunnel.

3.4.2.2 Limestone pavement

Limestone pavement comprises of flat bare rock surfaces with limestone blocks (clints) separated by fissures (grykes). Clints and grykes are characteristic features of Limestone pavement and these features form by a combination of chemical and physical weathering from rainfall. As rainfall is mildly corrosive to limestone, chemical weathering is enhanced over other non-calcareous rock types and where soil or vegetation is present then rainfall can become more aggressive to limestone.

Limestone pavement forms because of incident rainfall on the exposed limestone surfaces, as such Limestone pavement is dependent on rainfall. Limestone pavement characteristically forms in the unsaturated zone above the groundwater table~~.~~ Being dependant on rainfall and having a free draining unsaturated zone, Limestone pavement is not a groundwater dependent habitat.

The pathway of rainfall through the unsaturated zone to the groundwater table, follows fractures and bedding planes through the limestone bedrock. On the surface, the grykes in the Limestone pavement are fractures in the limestone that has been solutionally enlarged and they provide a rapid free draining vertical flow path that allows rainfall to drain through the bedrock and down to the groundwater table.

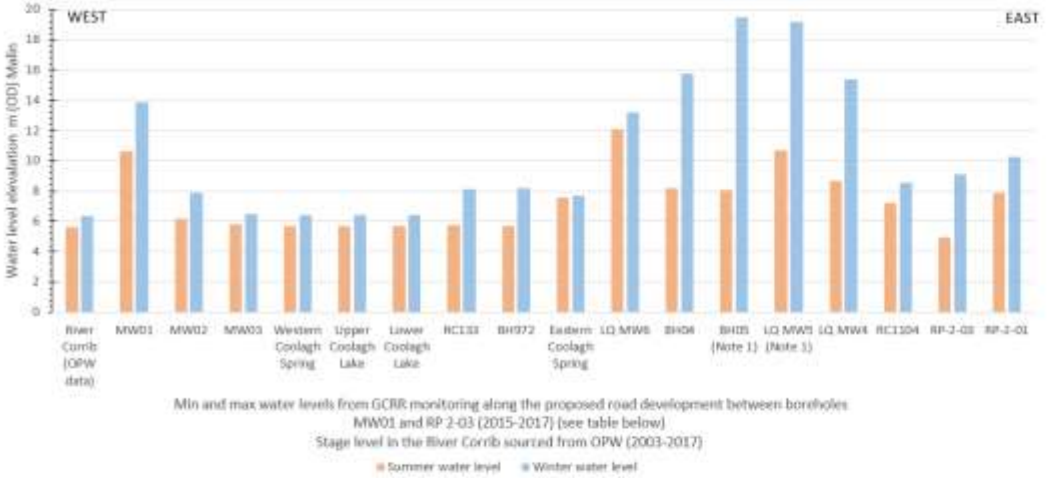
There are multiple areas of Limestone pavement in the region, including areas within or immediately adjacent to the proposed development boundary. As Limestone pavement occurs in the unsaturated zone, above the groundwater table and is not groundwater dependent there is no groundwater interconnectivity or dependency between the Limestone pavement within the Lough Corrib cSAC beneath which Lackagh Tunnel traverses and the other areas of Limestone pavement shown on **Figure 3.1**.

3.4.2.3 Groundwater data collection

Groundwater level data has been gathered between June 2015 and January 2017 from a number of monitoring boreholes in the area between Menlough, Lackagh Quarry and Ballindooley Lough. These include monitoring boreholes as shown in **Figure 3.10** and **Table 3.1**. Based on this data the regional groundwater levels have been compiled and this allows the extents of groundwater bodies to be delineated as shown in **Figure 3.11**. The groundwater bodies are named based upon the original delineation of groundwater bodies by the GSI.

Figure 3.10: Groundwater and surface water monitoring locations along the proposed road development

Table 3.1: Surface water and Groundwater data recorded in the GWDTE Lough Corrib Fen 1 and Clare-Corrib Groundwater Bodies (2015-2017)

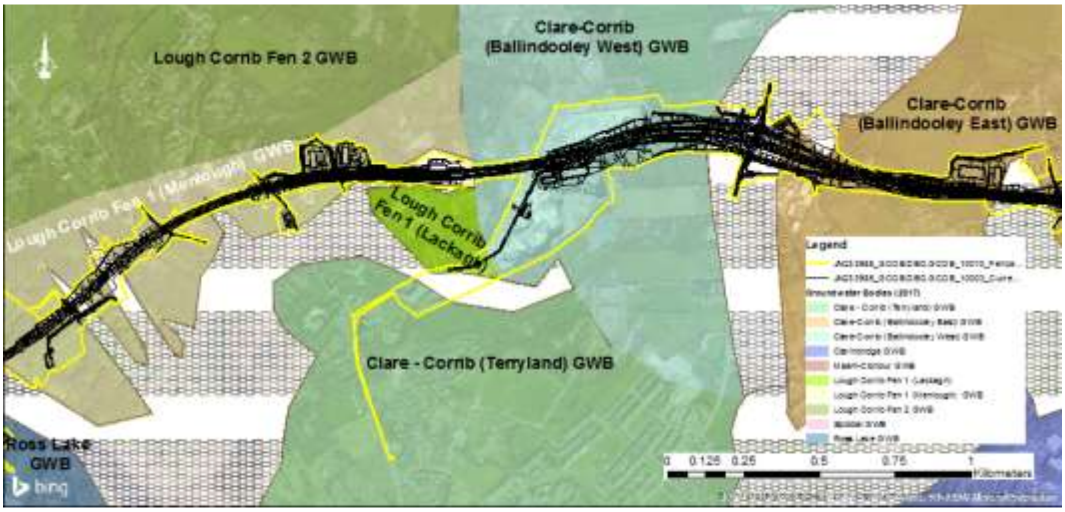


Min and max water levels from GCRR monitoring along the proposed road development between boreholes MW01 and RP 2-03 (2015-2017) (see table below)
Stage level in the River Corrib sourced from OPW (2003-2017)

Monitoring Location	Ground Elevation (mOD)	Summer GW low (mOD)	Winter GW high (mOD)	Seasonal change (m)
River Corrib (OPW data)	-	5.6	6.4	1.0
GWDTE Lough Corrib Fen 1 Groundwater Body (GWB)				
MW01	16.1	10.6	13.9	3.3
MW02	13.4	6.2	7.9	1.7
MW03	6.7	5.8	6.5	0.7
Western Coolagh Spring (SW-2-	5.4	5.7	6.4	0.7
Upper Coolagh Lake (SW-2-3)	-	5.7	6.4	0.7
Lower Coolagh Lake (SW-2-2)	-	5.7	6.4	0.7
RC133	11.7	5.7	8.2	2.5
BH972	12.3	5.7	8.2	2.5
Eastern Coolagh Spring (SW-2-5)	7.4	7.6	7.7	0.1
Clare-Corrib Groundwater Body (GWB)				
BH04	32.2	8.2	15.7	7.5
BH05 (Note 1)	34.1	8.1	19.5	11.4
LQ MW6	15.4	12.1	13.2	1.1
LQ MW5 (Note 1)	25.4	10.7	19.2	8.5
LQ MW4	16.8	8.7	15.4	6.7
RC1104	9.4	7.2	8.6	1.4
RP-2-03	22.4	4.9	9.1	4.2
RP-2-01	21.4	7.9	10.3	2.4

[Note 1]: Monitoring wells LQ MW5 and BH05 both straddle a thin black argillaceous limestone that overlies a clay wayboard in the geology sequence, which perches recharge above the main groundwater body. The groundwater levels recorded in BH05 and LQMW5 represent interaction between the main groundwater body and recharge. The water level data in BH05 and LQMW5 are not representative of the groundwater levels in the main groundwater body.

Figure 3.11: Groundwater bodies in the area of Lackagh Tunnel (based on 2017 data)



3.4.3 Interpretation of groundwater data

The groundwater levels shown in **Table 3.1** indicate a groundwater body divide between Lackagh Quarry and Coolagh Lakes with the watershed located near monitoring well BH04 and BH05. The divide between the Clare-Corrib GWB and the Lough Corrib Fen 1 GWB lies approximately at the boundary of Section 2 and Section 3. The tunnel sections within each GWB are as follows:

- Lackagh Tunnel Section 1 lies entirely within the Clare-Corrib GWB
- Lackagh Tunnel Section 2 lies entirely within the Clare-Corrib GWB
- Lackagh Tunnel Section 3 lies within the Lough Corrib Fen 1 GWB

The maximum peak groundwater level recorded was +15.7mOD in BH04 during the winter of 2015/2016. Water levels in BH04 and BH05 show slightly different responses to storm events with BH05 showing short term peaks during rainfall that are higher than BH04. These short term peaks (up to +19.46mOD) are considered to be a feature of the borehole rather than the aquifer and +15.7mOD is considered to be the peak recorded groundwater level of the water table.

Peak groundwater levels in BH972 (300m west of the Section 3) were recorded in December 2015with a winter high of +8.2mOD. This data indicates a significantly lower groundwater level to the west of Section 3 at BH972 and supports the conceptual model of a groundwater divide between Clare-Corrib GWB and the Lough Corrib Fen 1 (Menlough) GWB.

On the basis of this divide, groundwater at Lackagh Quarry will drain south-eastwards towards Terryland, and not south-westwards towards Coolagh Lakes. (**Figure 3.11**) and Lackagh Quarry is in a separate groundwater catchment to Coolagh Lakes.

The limestone bedrock is classified as being a regionally important karst aquifer by the GSI based upon the high number of high yielding wells in the formation but also due to the low density of ditches and streams locally. The higher conductivities represent where test boreholes have intersected fractures and the lower conductivities represent where test boreholes encountered few or narrow discontinuities.

Based on the groundwater level data, the regional groundwater regime discharges to the Coolagh Lakes, the River Corrib, and Galway Bay. There are divides that split the groundwater into a number of bodies. In the area of Lackagh Quarry the aquifer is divided into the Lough Corrib Fen 1 (Menlough) GWB, which drains to Coolagh Lakes and the Clare-Corrib (Ballindooley West) GWB, which drains south-eastwards. Groundwater in the Clare-Corrib (Ballindooley West) GWB and Clare-Corrib (Ballindooley East) GWB likely drains through the aquifer southwards at depth towards the Terryland River sinks and from there to Galway Bay.

3.5 Existing Geological Environment

3.5.1 General

Lackagh Tunnel is located within an area of Lower Carboniferous Limestone. Rockhead level of the limestone generally exists quite close to ground level with large areas of limestone bedrock outcrops. The ground investigation demonstrated that the depth to bedrock varies from surface outcrop to 104.95m below ground level (mbgl) within the study area. Where bedrock is not exposed at ground level it is generally overlain with topsoil, glacial till (sandy gravelly CLAY) and silt deposits where rock is at depth.

3.5.2 Site Specific Ground Investigation

A site specific ground investigation (GI) was undertaken in 2015 and 2016 to understand the ground conditions at Lackagh Tunnel comprising:

- Desk study and site walkover
- One horizontal borehole in Section 1 and Section 2
- Four vertical boreholes in Sections 2 and 3
- Geophysical Survey (surface and downhole)

A plan layout of the ground investigation is presented in **Figure 3.12**, outlining each survey location with the exception of the microgravity geophysical survey stations (118 stations across Sections 1, 2 and 3). During the ground investigation factual data was recorded and is included in **Appendix A**.

Figure 3.12: Ground investigation plan layout

In total five boreholes (BH1, 3, 4, 5 and 6), were drilled both in Lackagh Quarry and in the adjacent fields west of the quarry (Refer to **Table 3.2** and **Figure 3.12**). One horizontal rotary core borehole (BH1) (**Figure 3.13**), was drilled at an inclination of ~12° off horizontal, through the western quarry face, at the location of the proposed eastern tunnel portal and four vertical rotary core boreholes were drilled in the fields adjacent to the quarry on the west, above the proposed tunnel alignment.

Figure 3.13: BH01 Horizontal borehole at the eastern tunnel portal

Table 3.2: Summary of Lackagh Tunnel borehole data

Name	Type	End Depth / Horizontal Length	Limestone Rockhead Depth
BH01 (Sections 1 and 2)	Horizontal rotary corehole (61mm triple barrel HQ [3HQ]) along the length of the alignment for a length of 300m with an incline of 12° to the horizontal, includes rock core recovery and discontinuity logs	278m from quarry face	Immediately
BH03 (Section 3)	Vertical rotary corehole (82mm 3PQ), tricone open hole drilling from 85m	109.9mbgl (-83.6mOD)	104.95.5mbgl (-78.692mOD)
BH04 (Section 2)	Vertical rotary corehole (82mm 3PQ)	35mbgl (-2.8mOD)	4mbgl (+28.2mOD)
BH05 (Section 2)	Vertical rotary corehole (82mm 3PQ)	50mbgl (-15.9mOD)	0.4mbgl (+33.7mOD)
BH06 (Section 3)	Vertical rotary corehole (82mm 3PQ)	45mbgl (-14.2mOD)	Not encountered

Lab testing of the recovered soil samples and rock core was completed in order to attain parameters to aid in tunnel design. In-situ hydrogeological testing was also carried out in two of the four vertical boreholes.

Geophysics in the form of microgravity was carried out at Lackagh Quarry. Electrical resistivity tomography (ERT) and seismic refraction was carried out in the agricultural fields adjacent to the quarry. Details of geophysics survey are presented below in **Table 3.3** below.

Table 3.3: Summary of the Geophysical survey data

Location	Type of GI	Details	Date
Section 1, 2 and 3, along the upper bench of Lackagh Quarry and within the 3 fields immediately to the west of the quarry	Microgravity Survey	118 stations along the centre line and 15m either side of the proposed alignment and on the upper bench	27 Oct – 3 Nov 2015
ERT 1-5 located in Sections 2 and 3 in fields to west of quarry	Electrical Resistivity Tomography (ERT)	682m's of line, depth range 25-30m	27 Oct – 3 Nov 2015
ERT 6, Section 3, perpendicular to the proposed alignment (North to South)	Electrical Resistivity Tomography (ERT)	381m's of line, depth range 50-60m	25 Nov 2015
ERT 7-10, Sections 2 and 3, along and perpendicular the proposed alignment	Electrical Resistivity Tomography (ERT)	834m's of line, depth range of 25-50m	13 – 15 Jan 2015
G.P. 3/23 – G.P. 3/25, Section 3	Electrical Resistivity Tomography (ERT) and Seismic Refraction	540m's of line, depth range 25-30m	Mar – Apr 2016
G.P. 3/19, 3/20 and 3/21. East of Lackagh Quarry and west of the study area (completed as part of the hydrogeology survey)	Electrical Resistivity Tomography (ERT) and Seismic Refraction	1365m's of line, depth range 15 - 30m	Mar – Apr 2016

Downhole geophysics was also carried out in BH04 and BH05 to understand the rock mass. Geophysical logging methods undertaken comprise:

- Acoustic/Optical Televiewer surveys to identify the nature and orientation of discontinuities in the bedrock
- Fluid Temperature and Conductivity, Natural Gamma, Calliper logging in order to determine any flow pattern within the borehole and identify flow zones; identify different zones of water quality; detect the clays that contain potassium K40, and to measure the mean diameter of the borehole
- Impeller Flow meter to determine flow patterns and identify flow zones
- Focused Resistivity to aid in the identification of strata and quality of the pore water
- Full Wave Sonic, again to aid in the identification of strata

3.6 Ground Model

As discussed in **Section 3.5.2** of the report, a site specific ground investigation was undertaken which is the basis of this ground model. Several stratigraphy were encountered varying in depth along the proposed tunnel alignment.

Surface geophysics highlighted a large karst feature, possibly a doline beneath the agricultural fields adjacent to Lackagh Quarry. Overburden from this feature was recovered in BH03 and BH06. The stratigraphy encountered within Sections 1, 2 and 3 include topsoil, glacial till, silt, clay/organic clay, cobbles and boulders, weathered rock and limestone bedrock. A plan and profile of the proposed alignment and a schematic profile of Sections 1, 2 and 3 is presented in **Figure 2.1** and a geotechnical cross section is included in **Appendix B**.

Section 1 and Section 2 are appraised in a combined section as they examine the same limestone lithology and lab testing confirmed that the limestone from these sections have similar geotechnical properties. Section 3 is discussed independently as the overburden thickens and the ground conditions vary.

3.6.1 Section 1 and Section 2

Ground conditions at the western face of Lackagh Quarry comprise a cyclical sequence of carboniferous limestones (see **Figure 3.14**). Each cycle is between 10m and 15m thick and is characterised by thinly bedded, dark mud-rich (argillaceous) limestones which pass upward into thicker bedded, paler non-argillaceous limestones. The darker limestone marks the beginning of the upper bench at the western face, and is generally considered to be stronger than the paler limestones.

Figure 3.14: Cyclical sequence of Limestones at Lackagh Quarry

The stratigraphy of Section 1 and 2 was investigated by a 280m horizontal borehole (BH01) drilled sub-horizontally along at a 12° off horizontal incline along the alignment of the proposed road development, beginning at the eastern tunnel portal location. The ground conditions in Section 2 were also determined using vertical boreholes BH04 and BH05 which reached depths of 35m and 40m, respectively.

The bedrock is described as strong to very strong, thickly bedded, pale grey, fine to medium grained slightly fossiliferous limestone. Argillaceous limestones found in the quarry face were not found during investigation of Section 2, suggesting that these beds are not present moving west.

A clay wayboard of varying thicknesses from ~30cm to absent is evident on all faces of Lackagh Quarry, refer to **Figure 3.15**. A thin 20cm band of laminated mudstone, which compares favourably with the material observed on the quarry face, was encountered in BH04, however it is unknown whether this is a continuous layer or a cavity infill. BH04 and BH05 encountered several cavities, some not filled, and some infilled with clay.

Figure 3.15: Clay wayboard on the quarry face at Lackagh Quarry

Geophysical surveying included, electrical resistivity tomography (ERT) and microgravity surveying. These survey lines highlighted high resistivity limestones in the east (in Section 2) which give way to a lower resistivity zone to the west. BH06 and BH03 located within Section 3 respectively, penetrated this low resistivity zone proving thick overburden consisting of glacial tills and silts.

Both the geophysics and horizontal borehole showed the presence of karst features within the limestone rock mass in Section 2, with several cavities discovered at depth, below the proposed road alignment, as well as a large buried karst feature which underlies the agricultural fields adjacent to the quarry on the west. The boreholes cored along the proposed line of the tunnel encountered a number of cavities in the bedrock that were generally less than 0.5m in size, with some infilled cohesive material. The microgravity survey data showed a similar finding to the ERT, dense limestones in the east giving way to a less dense zone in the west. Low density readings were found at the edges of the quarry face in Section 1, resulting from historic blast damage which extends 2 to 3m into the quarry face and is further discussed below.

Rock core recovered from BH01 indicates that:

- The Limestone is laterally and stratigraphically homogenous, it is described as pale grey to grey, fine to medium grained, strong to very strong fossiliferous (slightly) weathered (slightly) to fresh massive limestone
- Historic quarry blasting has affected a zone of the quarry face extending on average 1.5 to 3.0m into the rock mass. Beyond the blast affected zone, the discontinuities become more widely spaced, and show less alteration, indicating a more stable rock mass

It is important to know the rock mass discontinuities, orientation and state as they can act as failure planes, impacting the Limestone pavement in Sections 1 and 2. A discontinuity is a plane of weakness in the rock mass which has a lower tensile weakness than that of the surrounding rock. It also marks a change in physical or chemical characteristics of the rock mass. Examples include bedding and jointing, both of which are evident in Lackagh Quarry. Through visual inspection, borehole logging and downhole geophysics, four discontinuity sets have been highlighted in the rock mass (**Table 3.4** and **Figure 3.16**). From these parameters an analysis of kinematic stability can be conducted.

Table 3.4: Discontinuity summary

Discontinuity Set	Dip/Dip Direction	Nature of Discontinuity
1	02/288	Bedding
2	68/047	Joint
3	54/008	Joint
4	53/204	Joint

The rock mass discontinuities provide the main flow path for groundwater. In this case the main pathway is flow along joints and bedding planes. Groundwater flow is generally from the north-west and accordingly the north-western faces of the quarry have most groundwater inflows. The main seepage zones occur where prominent bedding planes and joints intersect.

Figure 3.16: Exposed discontinuities on the upper bench

The vertical and horizontal discontinuities are visible on the exposed quarry face and are more evident in the upper bench wall, as the lower bench wall has been heavily affected by blast induced fractures.

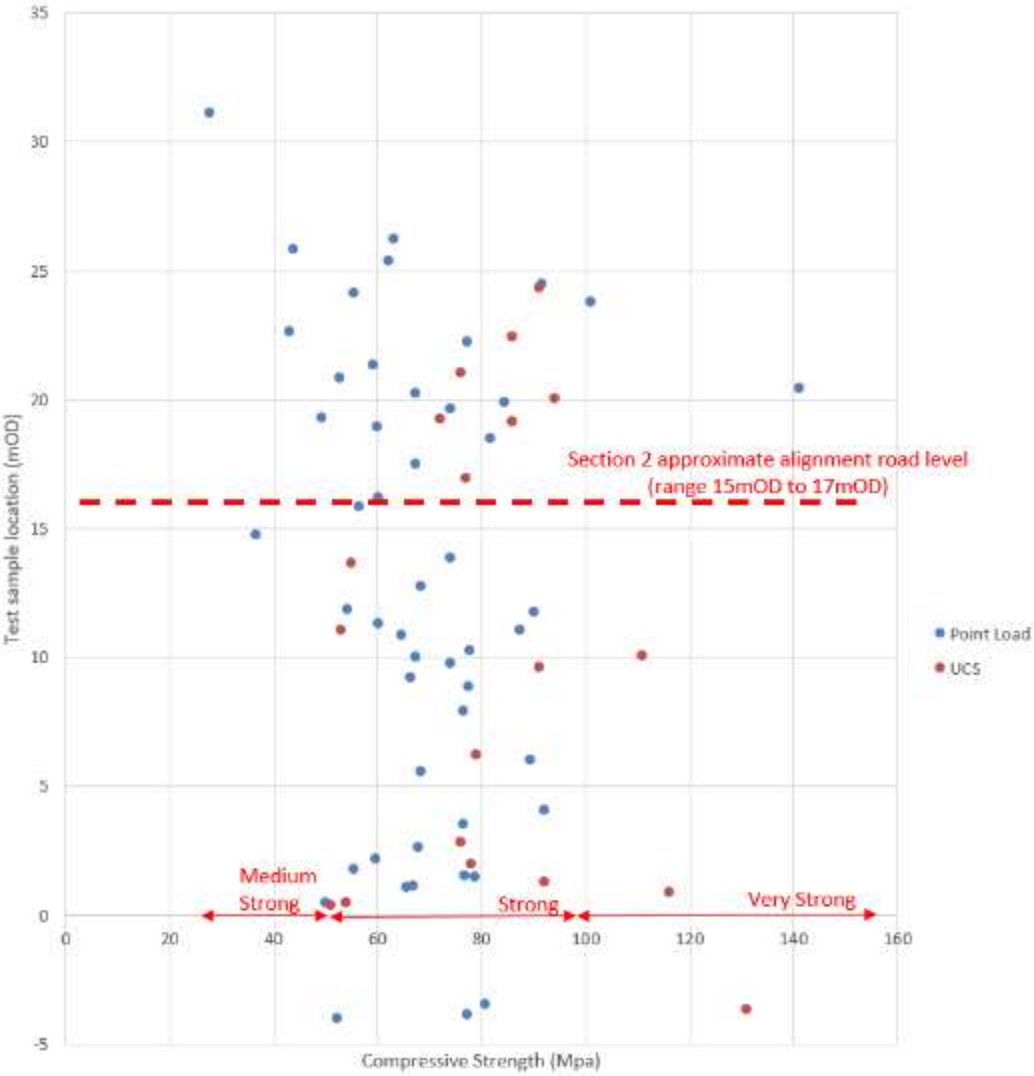
The western face has been left unprotected since the closure of the quarry in 2010 and has gradually deteriorated over time. Previous quarry workings have resulted in a heavily fractured rock face, both natural and blast induced (**Figure 3.17**), and unsafe overhangs and loose rock are present in the area of the proposed tunnel portal.

Figure 3.17: Blast damage on quarry face

Given the nature of the fracturing and the evidence of failures, the angle at which the current rock face stands is too steep in parts, suggesting that this unprotected face, if left in its present state will continue to erode and may potentially impact the overlying Limestone pavement if a deep seated slope failure was to occur.

The geotechnical laboratory test results, which consisted of Point Load testing and Uniaxial Compressive Strength (UCS) tests, from rock core samples from BH01, BH04 and BH05, confirmed that the limestone is in the strength range of strong to very strong, **Figure 3.18**.

Figure 3.18: Compressive Strength of Limestone vs Depth (mOD)



Groundwater levels in Section 1 (Lackagh Quarry Face), and Section 2 (Lackagh Tunnel) have been recorded from summer 2015 to summer of 2016. This data is presented in **Table 3.1** and shows that groundwater levels in Section 2 were recorded between 8.7m and 16.7mOD. Water filled conduits were encountered during the drilling of inclined borehole BH01. Although no conduits have been observed in Lackagh Quarry they are present within the aquifer locally.

3.6.2 Section 3

Surface geophysics and boreholes BH03 and BH06 are used to establish the ground conditions in the agricultural fields in Section 3.

The geophysical survey picked up a zone of low density, low resistivity material beneath the agricultural fields in Section 3. A large buried karst feature underlies the agricultural fields, with a stepped bedrock profile and deep overburden deposits. BH03 and BH06 confirmed the geophysics findings, bedrock was encountered in BH03 at 101.5mbgl, -75.2mOD and was not confirmed in BH06 as drilling terminated prior to hitting rock. BH03 and BH06 terminated 109.9 and 45m below ground level (-83.6 and -14.2mOD) respectively.

Overburden comprises topsoil, glacial till (boulder clay), silt, organic clay, and a transition zone consisting of cobbles and boulders which is likely to be weathered bedrock. In summary the overburden in Section 3 comprises:

- Topsoil is present throughout Section 3, although it was not recovered from the boreholes
- Glacial Till was present in vertical boreholes BH03 and BH06 with the top surface occurring at 1.2m -1.05mbgl. Glacial Till found is described as firm to very stiff brown and grey (slightly) sandy gravelly (slightly) CLAY with occasional to some cobbles and boulders. Cobbles and Boulders are generally described as sub-rounded to sub-angular and of limestone, and occasional granites
- Silt was found in just one borehole, BH03, which is located west of BH06. It is described as very soft to firm greenish (slightly) grey SILT. Locally its shows faint laminae. In BH03 it occurs below Glacial Till with a top surface at 13.65mbgl and a thickness of 23m
- Clay/Organic Clay was found in both BH03 and BH06. It is generally described as soft to stiff greyish (slightly) brown to dark brown CLAY. In BH03 it is found beneath the silt stratum with a top surface at 38.38m below ground level (bgl) and a thickness of 12m. It is described as very stiff dark brown grey (slightly) organic clay towards the end of the strata with some small fibres, possible lignite. It was found again with a top surface of 61mbgl and a thickness of 10m beneath gravelly CLAY with occasional cobbles and boulders, but is described as firm to stiff locally laminated fine sandy CLAY
- A transitional layer of gravels, cobbles and boulders, which represents the weathered rock horizon, was encountered, above slightly weathered to fresh limestone. This transition zone was encountered in both boreholes ranged in thickness from 20 to 25m. Where present it is generally described as GRAVELS, COBBLES and BOULDERS with sandy gravelly CLAY or loose, coarse gravelly COBBLES and BOULDERS with some clay. In BH03 the top surface of the cobbles and boulders was found at 80.10m BGL, with bedrock eventually being encountered at a depth of 101.5m. The stratigraphy of the weathered bedrock unit is unclear as the drilling was undertaken with a tricone bit with no recovery. In BH06 the cobbles and boulders were encountered at

22m, and have a thickness at least 20m. Its stratigraphy varies greatly over the course of the unit, as can be seen from the following generalised descriptions

- It is described as soft to firm grey sandy clay with coarse grained angular GRAVELS and COBBLES, angular to sub-angular with occasional boulders. The clay content decreases with depth and is almost completely absent close to fresh bedrock

In BH06, it is likely that drilling was close to the margin of a deeply buried karst rock topography and that the significant thickness of transition zone before bedrock which was encountered may represent a wall or side to the feature

Table 3.5 below summarises the findings of BH03 and BH06 completed in Section 3 (Western Approach).

Table 3.5 : Section 3 stratigraphy summary

Stratum	**Depth to top of stratum**			
	BH03		**BH06**	
	(mbgl)	**(mOD)**	**(mbgl)**	**(mOD)**
Glacial Till	1.5	+24.8	1.5	+29.3
Silt	13.7	+12.7	Not present	
Clay	38.4	-12.1	15.9	+14.9
Cobbles/Boulders (Transition)	80.1	-53.8	26.6	+4.2
Limestone bedrock	101.5	-75.2	Not reached	

Section 3 traverses the deep buried karst feature filled by fine grained sediment. The fine grained nature of the sediment indicates low hydraulic conductivity and storage and as such it is unlikely to be significantly water bearing. The bedrock surrounding the palaeokarst is water bearing and will have a water table that reduces from the groundwater high at BH04 westwards to BH972 and RC133 (refer to **Figure 3.10** for location) to the west of Section 3. On the basis of the data presented in **Table 3.1**, the groundwater level in Section 3 is estimated to range between 8.5-15.7m OD at the western tunnel portal (eastern extent of Section 3) to an estimated 6.5-10m OD at the western extent of Section 3.

4 Potential Direct and Indirect Impacts

This chapter identifies the potential direct and indirect impacts to the hydrogeological and geotechnical constraints within the zone of influence of Lackagh Tunnel and its immediate approaches. The hydrogeological assessment outlines the potential risks to groundwater bodies and flow paths for groundwater dependant terrestrial ecosystems (GWDTE) and the geotechnical assessment assesses the potential risks to Annex I habitats, Limestone pavement and Calcareous grassland within the Lough Corrib cSAC above Lackagh Tunnel during construction and operation.

For the purpose of this assessment each area is split into three areas, Section 1, 2 and 3 with a combined assessment presented in **Section 4.4** of the report.

4.1 Section 1: Lackagh Quarry Face

Section 1 is located in the now inactive Lackagh Quarry. Construction of the proposed eastern tunnel entry portal for Lackagh Tunnel will commence from the quarry. The potential construction and operation indirect and direct impacts are:

Hydrogeological:

- Changes to the groundwater recharge pattern
- Intercepting and modifying flow paths to GWDTE
- Contamination of groundwater by pollutants during construction and operation

Geotechnical:

- Rock mass instability causing destabilisation and subsequent slope failure of the quarry face and encroachment into the overlying Annex I habitats
- Rock mass instability during the construction works of Lackagh Tunnel causing destabilisation and subsequent slope failure of the quarry face and encroachment into the overlying Annex I habitats

4.2 Section 2: Lackagh Tunnel

The proposed road development tunnels beneath the Lough Corrib cSAC immediately west of Lackagh Quarry to avoid direct and indirect impacts on Limestone pavement and Calcareous grassland, both QI of the Lough Corrib cSAC at the surface. The potential construction and operation hydrogeological and geotechnical direct and indirect impacts are:

Hydrogeological:

- Modifying the groundwater divide between Lough Corrib Fen 1 (Menlough) GWB and the Clare-Corrib GWB
- Intercepting and modifying flow paths to GWDTE
- Changes to the groundwater recharge pattern
- Intercepting the groundwater table

- Contamination of groundwater by pollutants during construction and operation

Geotechnical:

- Impact the mosaic of Limestone pavement and Calcareous grassland due to collapse of the tunnel
- Impact the mosaic of Limestone pavement and Calcareous grassland due to ground settlement from the tunnel bore
- Impact to the structural integrity[4] of the Limestone pavement due to the blasting activities required for the construction of the tunnel

4.3 Section 3: Western Approach

The Western Approach traverses between the northern and southern boundary of the Lough Corrib cSAC immediately west of Lackagh Tunnel. The Western Approach cutting ranges from being predominately in rock to entirely in overburden where Section 3 encounters a buried karst feature. The potential construction and operation hydrogeological and geotechnical direct and indirect impacts are:

Hydrogeological:

- Modifying the divide between Lough Corrib Fen 1 (Menlough) GWB and Clare-Corrib GWB
- Intercepting and modifying flow paths to GWDTE
- Changes to the groundwater recharge pattern
- Intercepting the groundwater table
- Contamination of groundwater by pollutants during construction and operation

Geotechnical:

- Impact to the mosaic of Limestone pavement and Calcareous grassland due its close proximity to the proposed road development caused by significant ground settlement, rock mass and slope instability where excavated slopes are steeper than a 2 (horizontal) in 1 (vertical) to prevent encroachment on the adjacent Annex I habitats
- Impact to the structural integrity of the Limestone pavement due to the blasting activities during the excavation of bedrock

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[4] Structural Integrity of the mosaic of Limestone pavement and Calcareous grassland is the physical and mechanical geotechnical properties that control the behaviour of the geotechnical Limestone pavement environment

4.4 Combined Assessment

The potential hydrogeological and geotechnical direct and indirect impacts for each section have been presented independently above. These impacts are identified with respect to the constraints presented in **Chapter 3**. The combined principal potential direct and indirect impacts of Lackagh Tunnel and its immediate approaches include:

- Modifying the divide between Lough Corrib Fen 1 (Menlough) GWB and Clare-Corrib GWB
- Changes to the groundwater recharge pattern
- Intercepting the and modifying flow paths to GWDTE
- Contamination of groundwater by pollutants during construction and operation
- Encroachment onto the mosaic of Limestone pavement and Calcareous grassland due to its proximity to the proposed road development caused by rock mass instability and slope instability in Sections 1 and 3
- Impact to the structural integrity of the Limestone pavement due to the blasting activities required for the construction of Sections 2 and 3
- Impact the mosaic of Limestone pavement and Calcareous grassland due to collapse of the tunnel, ground settlement from the tunnel bore

5 Design, Avoidance and Mitigation

This chapter presents the design, avoidance and mitigation measures required to prevent potential direct or indirect impact to the hydrogeological and geotechnical constraints of the proposed Lackagh Tunnel based on scientific data. The design strategy, which includes the construction methodology, and mitigation measures were developed to avoid potential impacts to the hydrogeological and geotechnical constraints during construction and operation.

To ensure that the environmental management criteria outlined in this report is adopted and implemented as part of the proposed road development the environmental construction and operation requirements are included in the Schedule of Commitments.

5.1 Section 1: Lackagh Quarry Face

5.1.1 Hydrogeology Design and Avoidance

The following measures have been incorporated into the design to address the potential direct and indirect impacts to the hydrogeological constraints:

- Each drainage catchment is designed to avoid groundwater divides in order to manage road runoff and maintain recharge to the catchments of individual groundwater bodies
- To ensure that the proposed road development is not impacted by the seasonal groundwater flooding that occurs in Lackagh Quarry, and prevent interception of the groundwater table, Section 1 invert level of Lackagh Tunnel is designed to be a minimum of 1.2m higher than the groundwater flooding recorded during the extreme winter of 2015/16
- The design of the proposed road development at the eastern portal of Lackagh Tunnel has determined the invert level of the infiltration basin. During the normal seasonal groundwater fluctuation the infiltration basin in Lackagh quarry will operate normally. However, during extreme winter events, the peak groundwater level will rise into the base of the infiltration basin. The infiltration basin is designed to function during these peak groundwater events and is designed to accommodate road runoff with a standing level of groundwater in the base of the basin
- Discharge from the infiltration basin in Lackagh quarry retains the natural recharge pattern by maintaining recharge to the Clare-Corrib GWB
- To ensure there is no risk of groundwater pollution during operation the drainage design for the proposed road development within Lackagh Quarry collects all surface water from the road carriageway in a sealed system which passes through hydrocarbon interceptor for pollution control before entering a treatment wetland. From the treatment wetland, the runoff is then discharged to ground via an infiltration basin. The infiltration basin will include a subsoil bed to allow the treated water to recharge to ground. The pond is designed to

accommodate a 100-year storm event, with 50% of volume to infiltrate to ground within 24 hours

5.1.2 Hydrogeology Mitigation

A hydrogeologist will be appointed, as per the Schedule of Commitments, for the construction phase by the contractor and will be present to monitor at all times when the construction activities have the potential to impact on groundwater. If karst is encountered during any excavation, e.g. excavation for an infiltration basin, it will be examined by the hydrogeologist so that the extent and pathway can be classified. The feature will then be backfilled with granular material so as to maintain the hydraulic connectivity of the pathway and it will be sealed from the excavation to avoid potential impact to the groundwater recharge pattern and flow paths to GWDTE.

Temporary bund walls are included in the design at the eastern tunnel portal as a measure to be implemented if extreme high groundwater conditions occur (>15m OD). This measure will prevent water with potentially high suspended solids that is ponded in the quarry from entering the tunnel during construction.

During the construction phase groundwater may be at risk from pollution during site storm water runoff or infiltration. To ensure this does not occur, the following construction methodology measures detailed in the Construction Environmental Management Plan (CEMP) will be implemented:

- All runoff or discharges will be treated for suspended solids before discharged
- All liquid fuel or chemicals stored on site will be bunded within an area of sufficient capacity in order to contain 110% capacity

There are no potential direct or indirect hydrogeological impacts during the operation of Lackagh Tunnel with the implementation of the design avoidance and mitigation measures.

5.1.3 Hydrogeology Conclusion

Implementing the design, construction methodology control measures and mitigation measures will avoid potential direct and indirect impact on the existing hydrogeological environment during construction works and operation of Lackagh Tunnel.

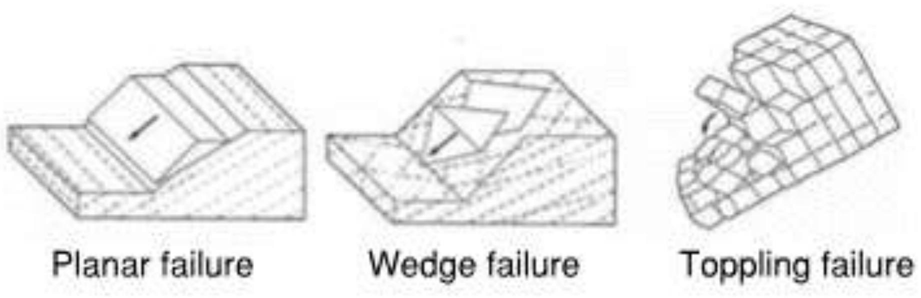
5.1.4 Geotechnical Design and Avoidance

In Lackagh Quarry there is potential to impact the mosaic of Limestone pavement and Calcareous grasslands due to rock mass instability of the quarry face and during the tunnel construction works. This is assessed by determining the principal failure mechanism in Lackagh Quarry.

The three principal failure mechanisms which occur in a rock mass are discussed below and illustrated as schematics in **Figure 5.1**. The principal rock mass failure mechanisms are:

- Planar Failure
  - In order for a rock mass to undergo planar failure, the dip of the rock face must exceed the dip of the potential slip plane
  - The potential slip plane must be visible on the rock face
- Wedge Failure
  - Occurs when the dip of the rock face exceeds the dip of the line of intersection between two discontinuity planes
  - The line of intersection of the two discontinuity planes must daylight on the rock face
- Toppling Failure (Direct toppling)
  - Two sets of discontinuity planes whose intersections must dip into the rock face
  - Another set of discontinuity planes which daylight on the rock face and dip at a shallow angle

Figure 5.1: Schematic of potential failure mechanisms, Planar, Wedge and Toppling[5]



Following analysis of the site specific ground information and the discontinuity data, presented in **Table 3.4** in **Chapter 3**, it was determined that the failure most likely to occur within the rock mass and impact upon the structural integrity of the Limestone pavement is wedge failure and toppling. Wedge failures are seen in the upper section of the upper bench illustrated in **Figure 5.2** below.

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[5] G. D. Matheson, 1983, Rock Stability Assessment in Preliminary Site Investigations – Graphical Methods, TRRL Laborartory Report 1039, Transport and Road Research Laboratory, Department of the Environment Department of Transport.

Figure 5.2: Wedge failure in the upper bench

Design Support measures

In order to protect and avoid potential direct and indirect impacts to the overlying Limestone pavement/Calcareous grassland during the construction and operation works, a series of quarry face support works will be undertaken to ensure stability at the quarry face rock mass. These stability measures are required prior to and during tunnel excavation to prevent encroachment into the overlying Limestone pavement. The rock stability concern at the portal is avoided through the design of a permanent composite rock support system designed to the relevant design standards (Eurocode 7, BS8081) and best practice guidance documents. This solution will be installed prior to any excavation for the tunnel portal and remain in-situ for the design life of the tunnel. The design requires a combination of the following:

i. Rock bolts

ii. Rock dowels

iii. Steel mesh

iv. Sprayed concrete

Each of these methods are described below including the construction methodology.

Rock Bolts

There are several types of rock bolts, which generally consist of plain steel rods with a mechanical or chemical anchor at one end and a face plate and nut at the other. During the installation the rock bolt anchor (steel rod) will be inserted into a borehole that has been drilled through the rock face. The anchor is tensioned after installation and grouted. They work by 'knitting' the rock mass together sufficiently prohibiting movement to loosen and fail the rock slope. Rock bolts are effective as they are anchored into the stronger rock mass, i.e. beyond the blast affected zone, therefore >2m in length for Lackagh Quarry. Rock bolts are generally installed in patterns. The exact length, spacing and tension strength depend on the rock mass characteristics, bolt structural capacity, design standard requirements and best practice guidance documents. The rock bolts may extend in length up to 10m.

Rock Dowels

Rock dowels generally comprise deformed steel bars which are grouted into the rock. Unlike rock bolts, tensioning is not possible and the load in the dowels is generated by movements in the rock mass. In order to be effective, dowels have to be installed before significant movement in the rock mass has taken place. In the case of Lackagh Quarry Face most of the support will result from rock bolting, however the rock dowels are an added safety measure.

Like rock bolts, rock dowels are inserted into a borehole drilled into the quarry face, however they are inserted after grouting of the hole, and will be up to 3m in length. The exact length and positioning of the rock dowels depend on the rock bolt design, rock mass characteristics, dowel structural capacity, design standard requirements and best practice.

Steel Mesh

Following the installation of the rock bolts and dowels, an added safety measure of a steel mesh is proposed on the Lackagh Quarry face. This steel mesh will be put in place to cover the quarry face above the tunnel portals and 30m either side. The steel mesh will be held in place by the rock bolts. This will act as a cover on the rock face, protecting against the movement of any failures.

Sprayed concrete

An additional safety measure is using a sprayed concrete, shotcrete, coating which covers the rock bolts, dowels and steel mesh to further stabilise the quarry face. Shotcrete is usually used in conjunction with a steel reinforcement, and in this instance the steel mesh will provide sufficient support. Shotcrete is sprayed onto the rock face surface pneumatically via a shotcrete machine. Where shotcrete is utilised weep holes will be installed to allow the groundwater drain.

Design Support Solution

It is proposed that works on the upper bench wall will consist of rock bolts and rock dowels with steel mesh and shotcrete. Works on the lower bench wall will consist of rock dowels and steel mesh with shotcrete. A composite support system of rock bolts, steel mesh and sprayed concrete will be used, **Figure 5.3**. These stability measures will be installed prior to excavation works on Section 2 commencing as per the Schedule of Commitments to ensure rock mass stability and no impact to the overlying Annex I habitats.

Figure 5.3: Extent of proposed works at tunnel eastern portal

Proposed works:
Rock bolts, dowels, steel mesh and shotcrete on upper and lower bench around portal area and 30m either side.

Exact spacing of rock bolts and dowels to be decided and are only indicative, shown here to be 2.5 -3m.

Preparatory Works:

Scaling of western rockface 30m either side of the portal and upper bench above portal and 30m either side.

5.1.5 Geotechnical Mitigation

The potential direct and indirect impacts to the geotechnical constraints during the construction and operation of Lackagh Tunnel are predominately addressed by the design. The mitigation measures outlined below provide an added factor of safety to ensure that there is no encroachment into the overlying Annex I habitat.

During the construction of Section 1 the supported rock face and retaining walls will be monitored for movement. A geotechnical expert[6] will be appointed, as per the Schedule of Commitments, by the contractor and will be present to monitor the rock mass stability during the construction period of Section 1.

In the unlikely event that instability within the rock mass is observed additional support measures will be installed to ensure that there is no impact to the structural integrity of the surface above. The additional rock support measures comprise rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards (Eurocode 7, BS8081) and best practice guidance documents. However, based on the conservative design approach and all of the support measures set out in **Section 5.1.4** it is considered that the risk of instability will be avoided and additional support measures will not be required.

During the operational phase, monitoring of the rock mass stability will continue, the exposed rock slopes in Section 1 will continue to be monitored as part of the TII (Transport Infrastructure Ireland) maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed additional support measures (e.g. rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures) will be installed to enas an adsure that there is no impact to the structural integrity of the surface above. However, based on the conservative design approach, the installed composite rock support system and monitoring during

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[6] Geotechnical engineer or engineering geologist

construction it is considered that the risk of instability will be avoided and additional support measures will not be required.

5.1.6 Geotechnical Conclusion

Implementing all of the above measures will avoid potential direct and indirect impact on the structural integrity of the Annex I habitats during construction works and operation of Lackagh Tunnel.

5.2 Section 2: Lackagh Tunnel

5.2.1 Hydrogeology Design and Avoidance

The following measures are incorporated into the design to prevent potential impacts to the hydrogeological constraints:

- The hydrogeological study of the Lackagh Quarry area has identified a local perched water table and flow path along a clay wayboard in the limestone sequence. The clay wayboard will be intersected by the proposed tunnel which may generate localised inflows. These inflows are managed during construction by designing them to infiltrate to the floor of the tunnel during excavation until their inflow to the tunnel is sealed off.
- Dewatering has the potential to impact the Lough Corrib cSAC. To ensure impact does not occur the following measures detailed in the CEMP will be implemented:
    - Dewatering of the bedrock aquifer will not be permitted during construction and operation phases so there is no reduction in groundwater flow transmitted by these pathways through the aquifer to the GWDTE. This will also maintain the boundary between Clare-Corrib GWB and Lough Corrib Fen 1 (Menlough).
- All construction works will remain above the groundwater table for the duration of the works to ensure the groundwater table is not intercepted and dewatering is not required. The construction schedule will be tailored so that the excavation of the lower section will occur only during the groundwater low when the water table is below the construction level. In order to maintain the recharge pattern the tunnel will be fully lined with concrete. During operation all inflows will be transferred laterally around the tunnel via the aquifer and not be impeded from draining to the groundwater table below.

5.2.2 Hydrogeology Mitigation

A hydrogeologist will be appointed for the construction phase by the contractor and will be present to monitor at all times when the construction activities have the potential to impact on groundwater. If karst is encountered during any excavation of the proposed road development, including Lackagh Tunnel, as per the CEMP the feature will be examined by the hydrogeologist so that the extent and pathway can be assessed to advise on the granular material required to fill the feature and seal it from the excavation. By appointing a hydrogeologist and following the karst mitigation measures in the CEMP the karst feature will be sealed out from the excavation and will not be impacted by the construction.

To ensure that groundwater is not impacted by pollution during the construction phase, the following construction control measures will be implemented as detailed in the CEMP:

- A temporary barrier will be installed at the eastern portal when groundwater flooding occurs in the quarry to prevent runoff entering the tunnel from the quarry

- All runoff or discharges will be managed as detailed in the CEMP so as to not discharge without being first treated
- All liquid fuel or chemicals stored on site will be bunded within an area of sufficient capacity in order to contain 110% capacity

There are no potential direct and indirect impacts during the operation of Lackagh Tunnel with the implementation of the design avoidance and mitigation measures.

5.2.3 Hydrogeology Conclusion

Implementing the design, construction methodology control measures and mitigation measures will avoid potential direct and indirect impact on the existing hydrogeological environment during construction works and operation of Lackagh Tunnel.

5.2.4 Geotechnical Design and Avoidance

Lackagh Tunnel has the potential to impact the mosaic of Limestone pavement and Calcareous grassland and the structural integrity of the Limestone pavement during tunnel construction. To prevent potential impact the size, minimum rock cover and separation of the tunnel bores are designed based upon the available geological information and the sensitivity of the habitats present above in Lough Corrib cSAC. The tunnel cross section is included in **Appendix B**.

The design requires for each individual tunnel bore to maintain at least 8m of clear rock above the crown to the top of rock/ground level. This 8m allows a stable rock arch to develop around the tunnel which will ensure the stability of the tunnel in the temporary case. The calculation showing the required depth of clear rock above the tunnel crown and the effect of the rock arch is presented in **Appendix C**. The proposed alignment for Lackagh Tunnel provides bedrock cover ranging from approximately 10m to 14.5m above the tunnel crown below the Lough Corrib cSAC which is greater than the minimum requirement of 8m.

Lackagh Tunnel comprises of two tunnel bores in close proximity to each other. The rock that separates and remains between the two tunnel bores is described as a rock pillar. If this pillar is too thin or too weak it could lead to a collapse or partial collapse of both tunnels. This pillar will see a notable stress increase as it acts as the support for the arch around both tunnels. The design demonstrates that the minimum clear distance between the tunnels should be 7m, which can be found in **Appendix D**. This was determined by analysing the quality and unconfined compressive strength of the rock encountered during the site investigation. The tunnel design allows for a rock pillar of 7.3m which is greater than the minimum requirement and will avoid potential impact to the overlying Annex I habitat.

Permanent tunnel stability will be provided by a cast in-situ reinforced concrete lining and permanent waterproofing of the tunnel will be provided by the application of a water proof membrane or equivalent.

A preliminary baseline vibration assessment was carried out with a conservative design approach vibration limit of 25mm/sec at the Limestone pavement surface and maximum instantaneous charge weights are shown in **Appendix E** to determine the structural integrity limitations of the Limestone pavement. Vibrations at this limit will not impact the structural integrity of the Limestone pavement environment. To ensure that this Limestone pavement vibration limit is not exceeded a reduced blast target limit of 20mm/sec will be implemented for Lackagh Tunnel, this target vibration limit provides a factor of safety to the construction works and is required as per the Schedule of Commitments.

Where karst features are present in the tunnel zone there is potential to impact the stability of the tunnel. If encountered these karst features will be investigated by a geotechnical expert, mapped and backfilled or bridged to ensure stability of the overlying mosaic of Limestone pavement and Calcareous grassland due to collapse of the tunnel or ground settlement from the tunnel bore.

Construction methodology

The construction methodology of the tunnel is pivotal to the design and avoidance of potential impacts to the overlying Annex I habitat. This section of the report outlines the construction methodology requirements including the construction sequence.

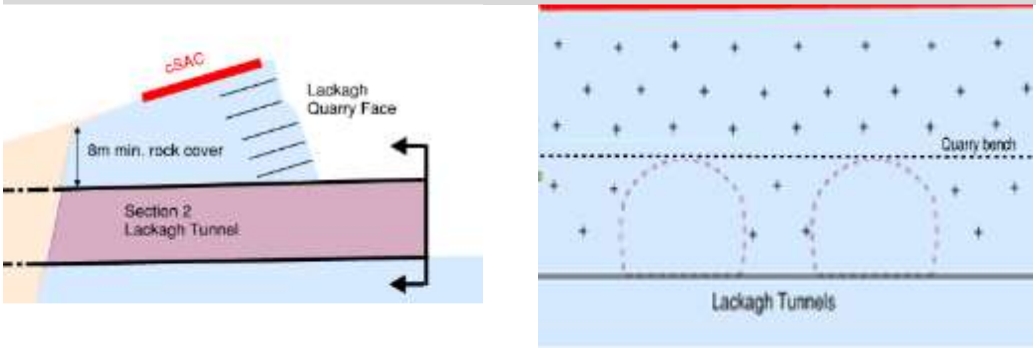
The tunnel excavation will be carried out by mined tunnel methods (drill and blast), which are commonly used for tunnels through hard rock. Prior to tunnel excavation works the following steps will be undertaken:

- A trial blast is required as per the Schedule of Commitments and will be carried out for Lackagh tunnel as part of a blast assessment. The monitored trial blast will be undertaken in the same bedrock formation by the blasting contractor in a controlled location that will pose no risk to sensitive receptors including Annex I habitat in Lough Corrib cSAC, namely Limestone pavement and Calcareous grasslands. The trial blast must not exceed the vibration limitations of the local sensitive receptors and therefore pose no impact. The trial blast will calibrate the blast design to a site specific design. The Limestone pavement vibration limitations and these site specific parameters will refine and validate the blast design properties ensuring that there will be no impact to the structural integrity of the Limestone pavement.
- The quarry face is stabilised as discussed for Section 1 (**Figure 5.4** Stage 1), then in the vicinity of the tunnel portals the lower bench will be cut back in line with the upper quarry bench (**Figure 5.4** Stage 2).

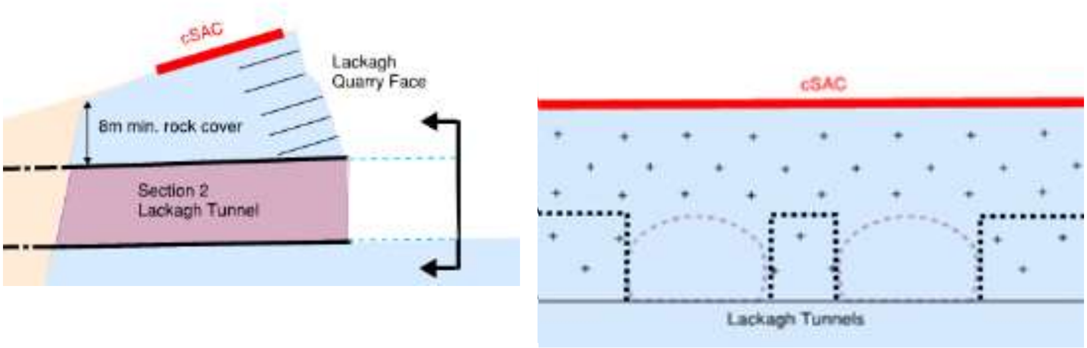
Works will be completed using drill and blast methods where rock thickness above the crown of the tunnel excavation is greater than 8m at the minimum location.

Figure 5.4: Tunnel construction sequence stage 1 and 2

Stage 1:
Stabilise quarry face prior to tunnel excavation works using rock bolts, steel mesh and sprayed concrete



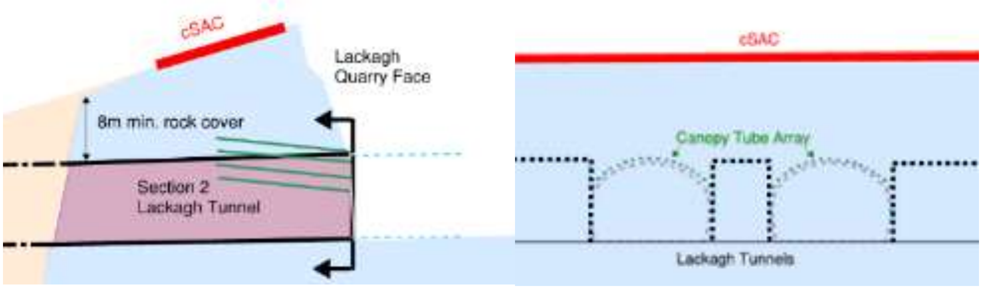
Stage 2:
Removal of quarry bench



Temporary support measures (**Figure 5.5** Stage 3) for the eastern tunnel portal will be installed around the arch of the tunnel through the quarry rock face in the form of 10-12m length sub-horizontal canopy tubes**.** Canopy tubes are steel tubes that are drilled into the ground around the tunnel arch. These tubes extend a maximum of 2m above the tunnel crown. These pre-support measures form a canopy of support and allow the portal to be excavated without causing risk of collapse to the quarry face.

Figure 5.5: Tunnel construction sequence Stage 3

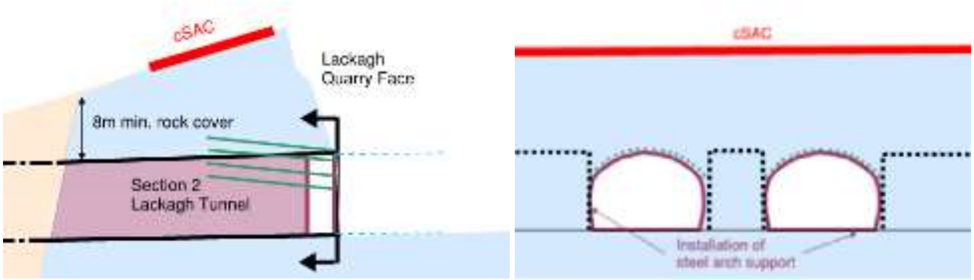
Stage 3:
Installation of tunnel pre-support (canopy tubes)



Once the temporary support measures are installed the first two metres of tunnel is excavated (Stage 4, **Figure 5.6**). A portal support structure in the form of a steel arch will then be installed to provide support to the pre-support and the ground above.

Figure 5.6: Tunnel construction sequence Stage 4

Stage 4
First advance of tunnel



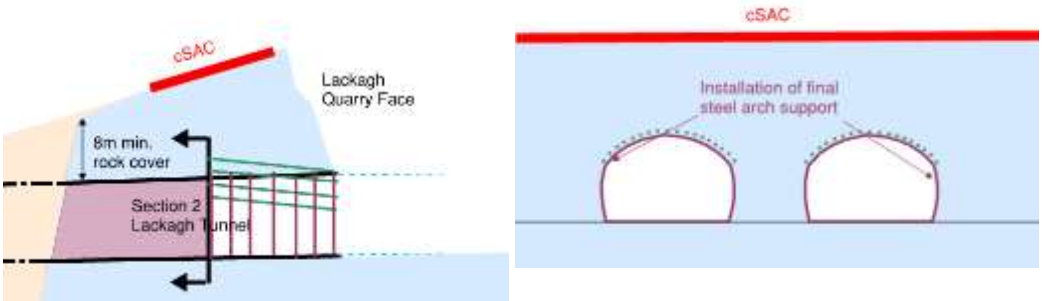
Excavation will be then progressed for the tunnel in a cyclic manner with drilling, blasting, rock face mapping by a geotechnical expert, mucking out, probing for karst features, installation of support measures and then preparing for the next advance of the tunnel (Stages 5 and 6 **Figure 5.7**). The excavation will be in short advances with steel arches and sprayed concrete implemented until the end of the pre-support zone.

Following each blast and as the tunnel advances the rock face will be mapped for discontinuities by a geotechnical expert, so that any potential instabilities are identified. Once this mapping is complete, the loose rock will be removed and any rock that was not successfully blasted will be manually broken out and temporary support measures where required will be installed. These support measures are based on the results of the mapped rock face and the presence of karst features. The most common support system is the use of radial rock bolts (discussed for Section 1) with sprayed concrete (shotcrete) which are used to develop a reinforced rock arch. These work by 'knitting' the rock mass together prohibiting movement and potential impact to the mosaic of Limestone pavement and Calcareous grassland. The maximum length of rock bolt will be 5m from the excavated tunnel face.

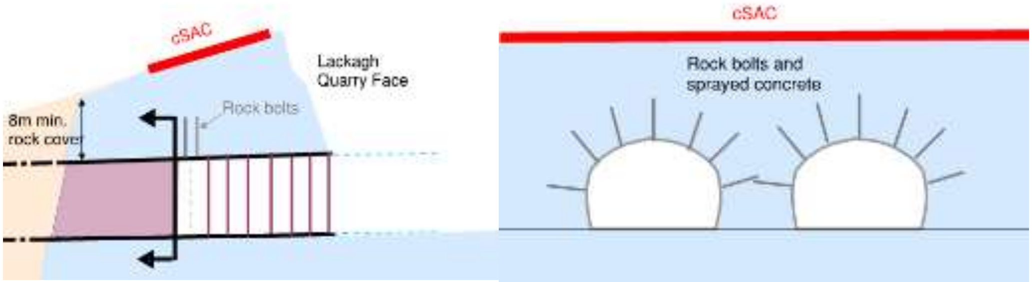
Where karst features are encountered they will be investigated, mapped and backfilled or bridged to ensure stability of the overlying mosaic of Limestone pavement and Calcareous grassland due to collapse of the tunnel or ground settlement from the tunnel bore.

Figure 5.7: Tunnel construction sequence Stage 5 and 6.

Stage 5:
Excavation until end of pre-support zone



Stage 6:
Switch to conventional drill and blast tunnelling



The blast pattern will drill, using a rock hammer, through the tunnel excavation face, the blast holes will then be loaded with detonators and explosives as per the blast design. These will be set to explode at set time intervals so that the instantaneous intensity of the blast is reduced and vibration levels are kept to below the specified vibration threshold. The blast is designed to only break out the required rock to form the tunnel.

This standard rock tunnelling methodology will cease once the rock cover is 8m based on the available ground investigation (GI) data and preliminary modelling of the tunnel. Tunnelling with less rock cover is possible and in the event that there is less than 8m cover pre-support measures in the form of sub-horizontal spiles, similar to canopy tubes, will be implemented which provide a stiffer support. Spiles will be used in addition to the rock bolts and sprayed concrete. These additional measures provide an extra level of safety to the temporary works ensuring tunnel stability during construction and no impact to the mosaic of Limestone pavement and Calcareous grassland.

To facilitate groundwater flow around the concrete lining, a drainage blanket in the form of a drainage layer or drainage pipes or similar placed outside the waterproof membrane or equivalent is installed.

Permanent tunnel support will then be installed in the form of a cast in-situ reinforced concrete lining.

5.2.5 Geotechnical Mitigation

The potential direct and indirect impacts to the geotechnical constraints during the construction and operation of Lackagh Tunnel are predominately addressed by design and avoidance. The mitigation measures outlined below provide an added factor of safety to ensure that there is no impact to the overlying mosaic of Limestone pavement and Calcareous grassland.

As set out in the Schedule of Commitments, a geotechnical expert will be appointed by the contractor and will be present to monitor the rock mass stability and blast vibrations during the Section 2 construction works.

As set out in the Schedule of Commitments, the blast target vibration limit is defined as 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the Limestone pavement surface which provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement environment. In addition as construction mitigation the Limestone pavement blast vibrations will be monitored during the tunnelling works. In the unlikely event that the blast target vibration limit at the surface is exceeded blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

Minimal settlement or deformation, less than 10mm, of the tunnel lining, is expected directly above the tunnel crown and less than 3mm settlement occurring at the surface based on the conservative design approach, refer to **Appendix C**. Any slight movement that does occur will not impact to the mosaic of Limestone pavement and Calcareous grassland.

5.2.6 Geotechnical Conclusion

The tunnel enabling works and the control measures incorporated during construction of Section 2 including stabilization of the quarry rock face, blast assessment including a trial blast, blast vibration limits, installation of the pre-tunnelling support measures, rock face mapping by a geotechnical expert following blasting and probing for karst features will ensure there will be no impact to the structural integrity of the surface above.

Implementing the design, construction methodology control measures and mitigation will avoid potential direct and indirect impact on the structural integrity of the surface above and in turn on the Annex I habitats namely Limestone pavement and Calcareous grasslands during construction works and operation of Lackagh Tunnel.

5.3 Section 3: Western Approach

5.3.1 Hydrogeology Design and Avoidance

The following measures are incorporated into the design to prevent potential impact to the hydrogeological constraints:

- Each drainage catchment is designed to avoid groundwater divides in order to manage road runoff and maintain recharge to the catchments of individual groundwater bodies.so as to not discharge without being first treated
- Dewatering has the potential to impact the Lough Corrib cSAC. To ensure this does not occur the following construction methodology measures detailed in the CEMP will be implemented:
    - Dewatering of the bedrock aquifer will not be permitted during construction and operation phases so there is no reduction in groundwater flow transmitted by these pathways through the aquifer to the GWDTE. This will also maintain the boundary between Clare-Corrib GWB and Lough Corrib Fen 1 (Menlough)
    - All construction works will remain above the groundwater table for the duration of the works to ensure the groundwater table is not intercepted and dewatering is not required. The construction schedule will be tailored so that the excavation of the lower section will occur only during the groundwater low when the water table is below the construction level
- A watertight seal will be installed on the underside of the road base and the cutting sides to protect against groundwater inflow and prevent contamination of groundwater
- The retaining walls will be watertight to a level of +17.7mOD, which is derived from the groundwater high (+15.7mOD) plus 2m free board. This will seal out any groundwater in the subsoil or bedrock and will prevent contamination of groundwater

5.3.2 Hydrogeology Mitigation

- A hydrogeologist will be appointed for the construction phase by the contractor and will be present to monitor at all timesso as to not discharge without being first treated
- All liquid fuel or chemicals stored on site will be bunded within in an area of sufficient capacity in order to contain 110% capacity

There are no potential direct and indirect impacts during the operation of Lackagh Tunnel with the implementation of the design avoidance and mitigation measures

5.3.3 Hydrogeology Conclusion

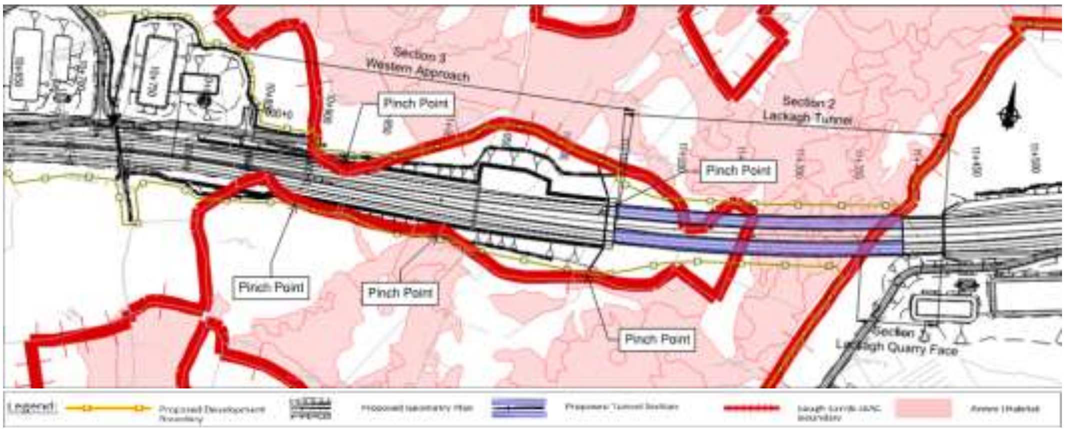
Implementing the design, construction methodology control measures and mitigation measures will avoid potential direct and indirect impact on the existing hydrogeological environment during construction works and operation of Lackagh Tunnel.

5.3.4 Geotechnical Design and Avoidance

Section 3 comprises of the Western Approach open cutting and the western tunnel entry portal. The overburden ground conditions encountered in Section 3, between existing and proposed alignment levels, would allow an unsupported 2 horizontal in 1 vertical slope. However, within Section 3 there are pinch point locations where the use of these slopes would encroach on areas of Annex I habitats. For the construction and operation of Section 3 retaining systems are designed to prevent the encroachment of the proposed road development on these areas, **Figure 5.8** and prevent potential impact to the Annex I habitat, a mosaic of Limestone pavement and Calcareous grasslands

The retaining system solution is governed by the ground conditions encountered at a particular location. As discussed in **Chapter 3** the rock head level changes significantly in Section 3. From the ground investigation data, the ground conditions at the pinch point locations where retaining systems are required vary from overburden only, rock only and a combination of overburden and rock ground conditions.

Figure 5.8: Plan Section outlining slope pinch points



Slope retaining systems

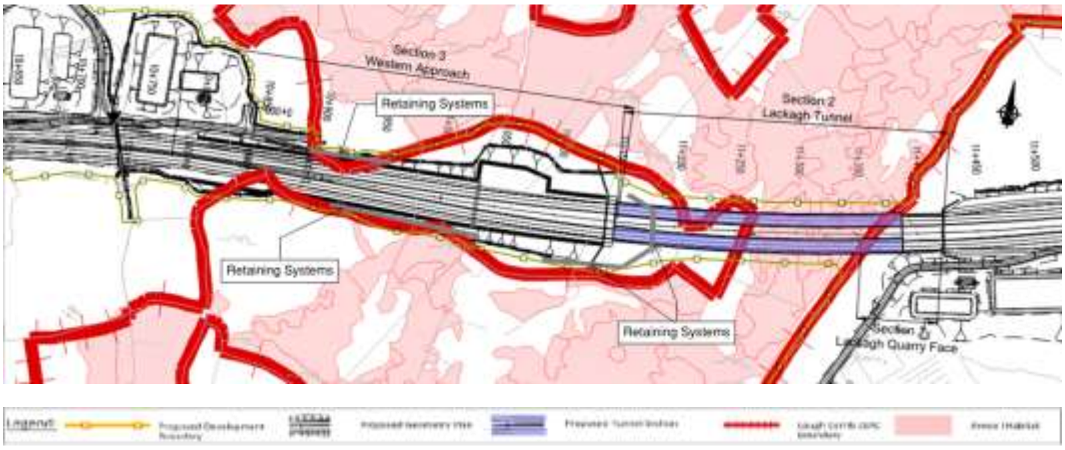
Retaining systems are required and will be installed in Section 3 at the locations shown in **Figure 5.9** to prevent instability and potential impact on the Annex I habitat. These systems include:

1. Rock bolts, rock dowels, steel mesh, and sprayed concrete (described in **Section 5.1.4** of the report) in areas of rock only
2. Piled retaining walls, supported with ground anchors in areas of overburden only and in areas with a combination of overburden and rock

Other support options include reinforced concrete retaining walls or gabion baskets filled with stone. It is also possible for a combination solution to be employed where one method is used to support the overburden such as gabion baskets and rock bolts/

rock dowels/ steel mesh / sprayed concrete are employed to support the exposed rock face. A combination solution will be implemented where shallow overburden is present which is located on the western extent of Section 3. The permanent stability solution for rock only or overburden and rock ground conditions designed to the relevant design standards (Eurocode 7) and best practice guidance documents avoid potential impact to the mosaic of Limestone pavement and Calcareous grassland that is in close proximity to the proposed road development.

Figure 5.9: Plan Section illustrating the retained locations

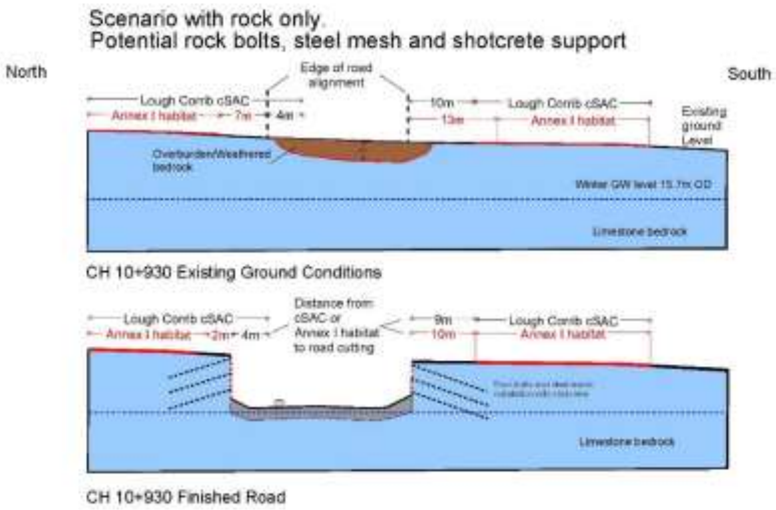


Rock retained slopes

Where rock only is present for the depth of the excavation, rock face stability composite control systems will be implemented where required to prevent potential impact to Annex I habitat. This will include rock bolts, rock dowels, steel mesh and sprayed concrete as discussed in **Section 5.1** of the report.

Rock will be excavated predominately using drill and blasting methods during construction. Rock excavation will be progressed in levels in a cyclic manner including drilling, blasting, rock mapping by a geotechnical expert and mucking out. A composite rock stability support system in the form of rock bolts, steel mesh and sprayed concrete will be implemented where required on the rock face prior to excavation to the next excavation level based on the rock mapping results. **Figure 5.10** presents a schematic of a retained design solution at a rock only pinch point in Section 3.

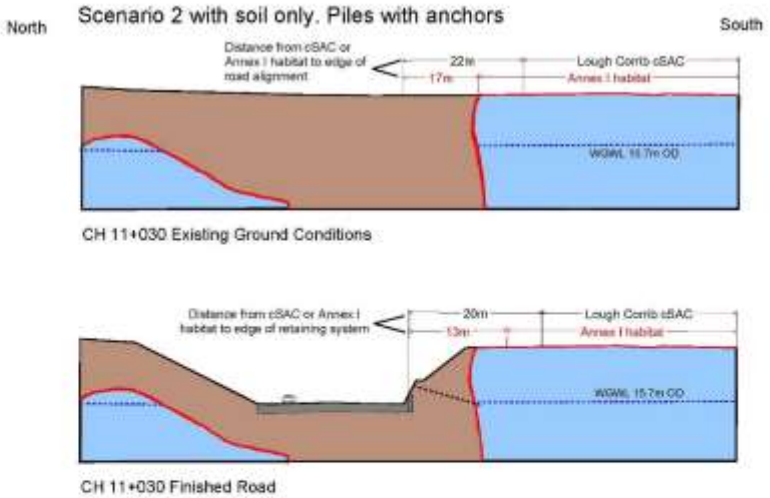
Figure 5.10: Schematic cSAC Pinch Point at Ch. 10+930



Piled retained slopes

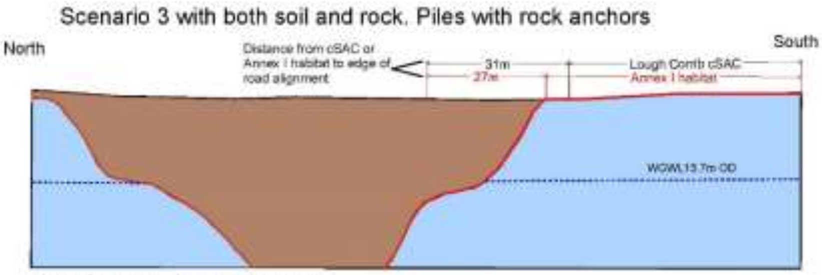
In the central area of Section 3 (Western Approach) the ground investigation indicates that overburden only is present for the depth of the road excavation. In these locations a piled retaining wall solution will be installed, **Figure 5.11**. This retaining system is installed from the existing ground level prior to excavation. The retaining structure may require permanent and/or temporary support in the form of ground anchors which are installed in the same way as rock bolts, through the retaining wall under the Limestone pavement. The installation and use of these rock bolts will not impact the structural integrity of Limestone pavement. Ground anchors limit the temporary and long term deflection of the retaining wall and control the risk of settlement of the Limestone pavement avoiding potential impact.

Figure 5.11: Schematic Lough Corrib cSAC Pinch Point at Ch. 11+030

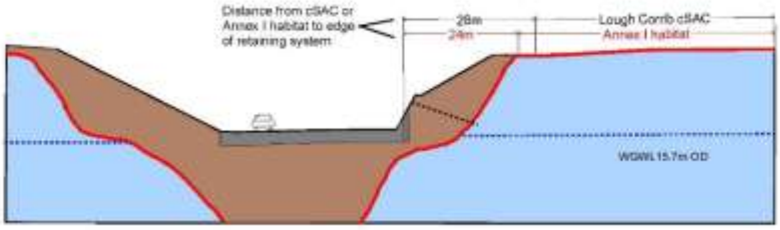


Where a combination of overburden and rock is present for the depth of the road excavation, a piled retaining wall solution will be installed, **Figure 5.12**.

Figure 5.12: Schematic Lough Corrib cSAC Pinch Point at Ch. 11+140



CH 11+140 Existing Ground Conditions



CH 11+140 Finished Road

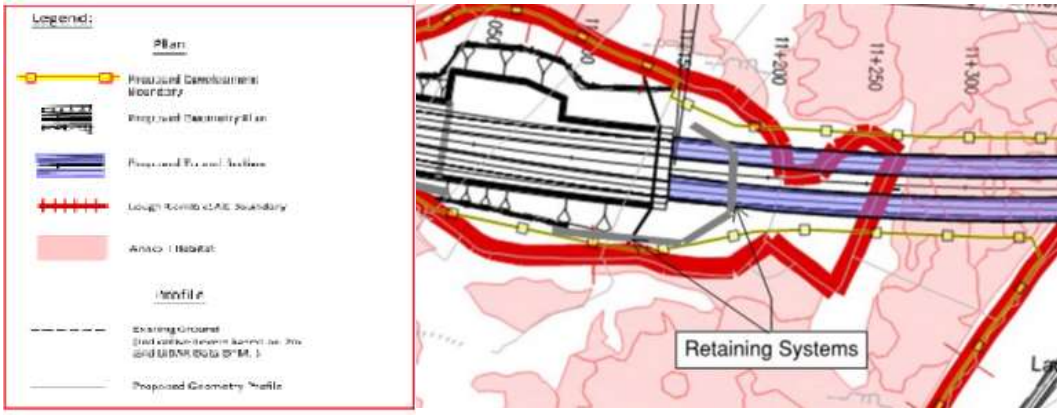
Western tunnel portal and tunnel entry structure

Lackagh Tunnel extends approximately 30m westwards, across the buried karst feature. Control measures have been designed to enable the construction and operation of the western entry portal and prevent encroaching on the Annex I habitats within Lough Corrib cSAC which are located to north, south and east of the portal. The western portal will be constructed following the excavation of the Western Approach. During the excavation slope retaining systems will be installed where an unsupported 2 horizontal in 1 vertical slope is not possible. As described for the Western Approach the retaining system solution is governed by the ground conditions encountered at a particular location. These stability systems include the following:

- In areas of overburden, retaining walls will be implemented
- In areas of rock, rock stability measures will be implemented including rock bolts, rock dowels, steel mesh and sprayed concrete

These controls are outlined in the Schedule of Commitments and will be implemented as part of the construction methodology to enable the construction and operation of the western entry portal. These measures will prevent encroaching on the Annex I habitats within Lough Corrib cSAC

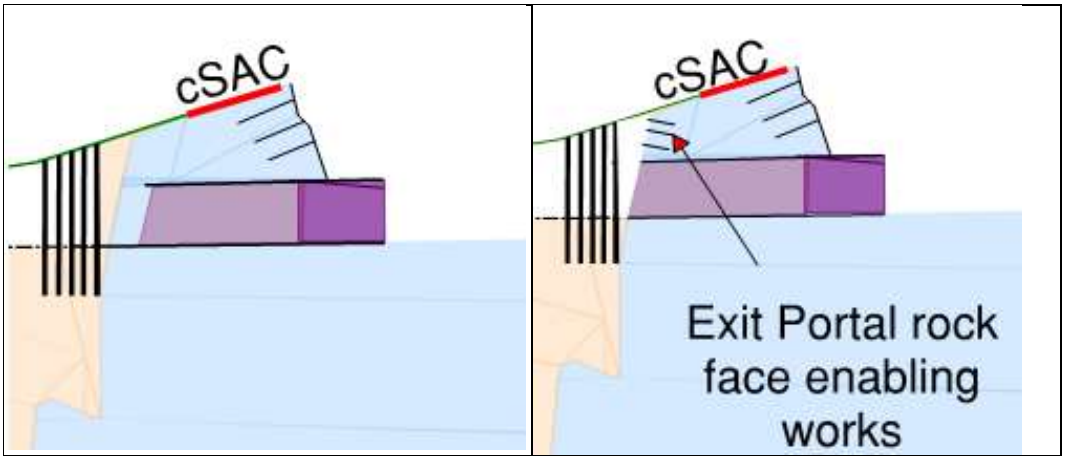
Figure 5.13: Lough Corrib cSAC Pinch Point between Ch. 11+150 and Ch. 11+180



During the excavation of Section 3 the overburden and rock face above the western tunnel entry portal will be exposed. Retaining systems will be installed during construction to prevent slope instability and encroachment on the Annex I habitats within Lough Corrib cSAC during construction and operation above the tunnel portal, refer to **Figure 5.13**.

During excavation in areas of rock, the rock face will be mapped by a geotechnical expert so that any potential instabilities are identified. A rock stability system similar to Section 1 including a combination of rock bolts, rock dowels, steel mesh and sprayed concrete will be installed where required. Stability works including sub horizontal canopy tubes for the eastern tunnel entry portal and tunnelling works as described for Section 2 (**Section 5.2.4** of the report) shall be utilised if required.

Figure 5.14: Schematic of the exit portal rock face enabling works



The construction methodology requirements for Section 3 are listed below:

- As outlined for Section 2 a blast assessment including a trial blast will be carried out as per the Schedule of Commitments prior to blasting works in Section 2 or 3. The monitored trial blast will calibrate the blast design to a site specific design and ensure that there will be no impact to the structural integrity of the Limestone pavement. In the unlikely event that blasting is not viable the rock will be excavated slowly using hydraulic hammers

- Rock mapping assessments will be completed by a geotechnical expert during excavation and in stages on exposing rock following the excavation 2-4m overburden to determine the rock stability solution that will be employed avoiding impact to mosaic of Limestone pavement and Calcareous grassland that is in close proximity to the proposed road development
- Horizontal deflections of the retaining walls will be monitored during construction and compared with the design to ensure there is no impact to mosaic of Limestone pavement and Calcareous grassland that is in close proximity to the proposed road development

5.3.5 Geotechnical Mitigation

The potential direct and indirect impacts to the geotechnical constraints during the construction and operation of Lackagh Tunnel are predominately addressed by design and avoidance. The mitigation measures outlined below provide an added factor of safety to ensure that there is no impact to the mosaic of Limestone pavement and Calcareous grassland that is in close proximity to the proposed road development.

As set out in the Schedule of Commitments, a geotechnical expert will be appointed by the contractor and will be present to monitor the rock mass stability and blast vibrations during the Section 3 construction works.

During the construction phase, during the installation of the support measures, including rock and overburden retaining systems, Section 3 will be monitored for instability although it is considered that based on the design support measures set out above, this risk will be avoided.

In the unlikely event that instability is observed additional support measures will be installed to ensure that there is no impact to the mosaic of Limestone pavement and Calcareous grassland that is in close proximity to the proposed road development. The additional support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards (Eurocode 7, BS8081) and best practice guidance documents.

During the operational phase, monitoring of the rock mass stability will continue, the rock and overburden retaining systems in Section 3 will continue to be monitored as part of the TII maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed additional support measures outlined above for the construction phase will be installed to ensure that there is no impact to the mosaic of Limestone pavement and Calcareous grassland. However, based on the conservative design approach, the installed composite support system and monitoring during construction it is considered that the risk of instability will be avoided and additional support measures will not be required.

Where blasting is required the blast target vibration limit is 20% more conservative than the conservative design approach vibration limit of 25mm/sec at the Limestone pavement surface providing an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement environment. In the unlikely event that the blast target vibration limit, set out in the Schedule of Commitments, is exceeded at the Limestone pavement surface that is in close proximity to Section 3, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

5.3.6 Geotechnical Conclusion

Implementing the design, construction methodology control measures and mitigation measures will avoid potential direct and indirect impacts on the structural integrity of the surface above which supports a mosaic of Limestone pavement and Calcareous grassland during construction and operation.

5.4 Combined Assessment

The implementation of the hydrogeological and geotechnical design, avoidance and mitigation measures for Sections 1, 2 and 3 will prevent potential hydrogeological and geotechnical direct and indirect impacts during the construction works and operation of Lackagh Tunnel and its approaches.

The hydrogeological design, avoidance and mitigation measures presented in **Sections 5.1**, **5.2** and **5.3** prevent the potential direct and indirect impact to divide between Lough Corrib Fen 1 (Menlough) GWB and Clare-Corrib GWB, groundwater recharge pattern, groundwater flow paths to GWDTE and contamination of groundwater by pollutants during construction and operation.

The geotechnical design, avoidance and mitigation measures presented in **Sections 5.1**, **5.2** and **5.3** prevent the potential direct and indirect impact to the mosaic of Limestone pavement and Calcareous grassland due its proximity to the proposed road development and to the structural integrity of the Limestone pavement.

As a result it can be concluded that when all sections are combined there are no direct or indirect hydrogeological and geotechnical impacts as a result of Lackagh Tunnel and its immediate approaches.

6 Summary

There are a number of QI Annex I habitats some of which are groundwater dependent within Lough Corrib cSAC which are located above or immediately adjacent to the proposed road development in the area around Lackagh Quarry in Menlough which is the subject of this report.

The proposed road development tunnels beneath the Lough Corrib cSAC from the western face of Lackagh Quarry in a westerly direction and then enters a cutting which overlaps and runs adjacent to the Lough Corrib cSAC boundary.

Construction and operation of Lackagh Tunnel and the Western Approach, as a result of the proposed road development has the potential to directly and indirectly impact these sensitive ecological habitats. This report provides a geotechnical and hydrogeological assessment based on scientific data of the potential direct and indirect impacts on the existing hydrogeological regime and the structural integrity of the surrounding rock mass which supports a mosaic of Limestone pavement and Calcareous grasslands, as a result of Lackagh Tunnel.

From the geological and hydrogeological desk study, walkovers, site surveys and investigations in the area of interest it is understood that the modern undulating landscape masks an ancient landscape of deep karst landforms and valleys up to 100m in depth but now buried by thick subsoils. The rock topography and sediment fill is an integral part of the hydrogeology of the region, which along with the Lough Corrib, River Corrib, Coolagh Lakes, Ballindooley Lough and Galway Bay allows the groundwater bodies and catchments to be delineated and flow paths identified.

The design of the proposed road development in this area has considered the hydrogeological and geological environmental constraints, identified the potential direct and indirect impacts and developed a design to prevent such impacts where possible. Where potential impacts could not be prevented or avoided mitigation measures have been included.

From the assessment, the main areas of geological and hydrogeological risks to the QI Annex I habitats have been identified and are summarised below:

- Impact on groundwater recharge from runoff on sealed drainage over the operation of the lifetime of the proposed road development
- The potential impact from operation of the proposed road development on groundwater dependent terrestrial ecosystems (GWDTE) at Coolagh Lakes, Ballindooley Lough and turloughs by interception of the groundwater table and modification of the extents of the groundwater catchment
- Modification of the groundwater divide between GWDTE Lough Corrib Fen 1 GWB and Clare-Corrib GWB
- Potential pollution of groundwater from construction and operation
- Encroachment onto the mosaic of Limestone pavement and Calcareous grassland due its proximity to the proposed road development caused by rock mass instability of Lackagh Quarry Face in Section 1

- Impact to the structural integrity of the Limestone pavement due to the blasting activities required for the construction of Sections 2 and 3
- Impact the mosaic of Limestone pavement and Calcareous grassland due to collapse of the tunnel, ground settlement from the tunnel bore
- Instability where the road excavation requires an excavation slope steeper than a 2 (horizontal) in 1 (vertical) in Section 3 due to the proximity of the mosaic of Limestone pavement and Calcareous grassland during construction and operation

Measures have been incorporated into the design to facilitate the operation of Sections 1, 2 and 3 for Lackagh Tunnel. The design also includes the construction design methodology for each section taking cognisance of the potential direct and indirect impacts to the existing hydrogeological and geotechnical environment.

Any impact on recharge could potentially impact the groundwater level. A reduction in recharge caused by the proposed road development would lead to a reduction in groundwater levels which may reduce flow to GWDTE. To ensure this does not occur the design of the proposed road development captures, treats and infiltrates all runoff to the ground and there will be no net loss in recharge to the groundwater catchments and potential direct and indirect impacts from reduction in groundwater quantity are avoided. This will ensure that there is no impact on recharge to groundwater.

Interception of groundwater and the modification of groundwater bodies or catchments has the potential to reduce flow to GWDTE. The hydrogeological assessment undertaken for the proposed road development has delineated groundwater bodies and identified their divides and considered seasonal fluctuation. In doing so particular attention has been applied to the area of the catchment boundaries so that the proposed road development will not modify the extent of the groundwater body. As such, particular attention has been applied to the groundwater catchment divide to ensure that these are not modified by the proposed road development. This includes replacement of natural barriers where required so as to maintain the groundwater regime of the existing environment. This is particularly the case in the Lackagh Tunnel were the tunnel and Western Approach are sealed to prevent groundwater ingress.

To avoid potential direct and indirect impacts from pollutants the design of the proposed road development incorporates control measures including no dewatering in groundwater bodies that support GWDTE along with the implementation of the control measures detailed in the CEMP. The operational phase of the proposed road development includes treatment of road runoff with infiltration to ground via an infiltration pond or for those adjacent to the River Corrib, discharge to surface water after treatment.

The potential construction and operational direct or indirect geotechnical impacts in Section 1 (Lackagh Quarry Face), Section 2 (Lackagh Tunnel) and Section 3 (Western Approach) are prevented by design, avoidance and mitigation measures. Section 1 will be supported where required by an engineered composite support system of rock bolts, steel mesh and sprayed concrete. Tunnel excavation and construction will be supported by canopy tubes, sub horizontal spiles, a portal steel structure and rock bolts. Bridging and backfilling of karstic features identified by probing will resolve the risk due to karst. The blast charge will be designed considering the sensitive receptor limits. In the permanent and operating condition the tunnel will be supported by a cast in-situ reinforced lining. Where steepened embankments are required due to the proximity to the QI Annex I habitat a suitable retaining system will be installed depending on the ground conditions. Retaining systems in rock will include rock bolts, rock dowels, steel mesh, and sprayed concrete. In areas of overburden only and a combination of overburden and rock piled retaining walls with ground anchors are recommended.

In addition to the design, including the construction methodology, mitigation measures for construction and operation are required and have been outlined in this report and are included in the Schedule of Commitments to ensure their implementation and that there is no impact to the hydrogeological and geotechnical constraints in respect to Lackagh Tunnel and its immediate approaches. At construction stage, works will be completed as per the Schedule of Commitments and the CEMP. A hydrogeology and geotechnical expert will be appointed by the contractor and will be present to monitor at all times when the construction activities have the potential to impact on groundwater or the mosaic of Limestone pavement and Calcareous grassland. Monitoring of the exposed rock slopes and retaining walls will be carried out during construction and operation to ensure there is no impact to the mosaic of Limestone pavement and Calcareous grassland, in the extremely unlikely event that instability is observed additional support measures will be installed to ensure that there is no impact to the mosaic of Limestone pavement and Calcareous grassland. The additional support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards (Eurocode 7, BS8081) and best practice guidance documents.

Implementation of the design, avoidance and mitigation measures ensure there is no impact to the hydrogeological and geotechnical constraints in respect of the Lackagh Tunnel and its immediate approaches.

7 Conclusion

The potential hydrogeological direct and indirect impacts to the groundwater dependant terrestrial Ecosystems, GWDTE, and the Annex I habitat including Limestone pavement and Calcareous grasslands from the proposed Lackagh Tunnel during construction and operation have been identified and assessed.

The specific design avoidance and mitigation measures that will be carried out during construction and operation to prevent potential direct or indirect impact to the hydrogeological and geotechnical constraints of the proposed Lackagh Tunnel are delineated and based on scientific data.

Based on all of the measures outlined in this report, it is concluded that there will be no direct or indirect impact to the groundwater bodies which support GWDTE or the structural integrity of rock mass which supports the complex of Limestone pavement and Calcareous grasslands during the construction and operation of Lackagh Tunnel and its immediate approaches.

Appendix A

Ground Investigations - Factual Report

R15-16

N6 Galway City Transport Project

Phase 3 Ground Investigation

Contract No. 2 - Factual Report

Galway County Council

Prepared by BRG Ltd. on behalf of Priority Drilling Ltd.

Dave Blaney

Project Number:	**R15/16**
Author(s):	Dave Blaney P. Geo
BRG Ltd.	Galway County Council
Date of Report:	May 2016

R15/16
N6 Galway City Transport Project - Phase 3 Ground Investigation Contract No. 2 - Factual Report
Dave Blaney P.Geo
May 2016

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1. Purpose and Scope of Works

Galway County Council, on its own behalf and on behalf of Galway City Council, are committed to developing a solution to the existing transportation issues in Galway City and its environs, which are having a negative impact upon the local, regional and national road network. As part of this work it is necessary to undertake ground investigation works prior to the commencement of detailed design work.

The Menlough region, within and to the immediate west of Lackagh Quarry, has been selected as a possible route for the N6 road development (Figure 1).

Figure 1: Lackagh Quarry Ground Investigation Site - Yellow Polygon (Google 2015)

The site consists of a non-active quarry with associated derelict, buildings, plant, structures and poor quality agricultural land used for the grazing of cattle (Figure 2).

Figure 2: Site Area - Dashed Red Line (Bing 2015)

This area is in an environmentally sensitive region, with the Lough Corrib, SAC No. 000297 (Special Area of Conservation), located immediately west and north of the Lackagh Quarry site (Figure 3).

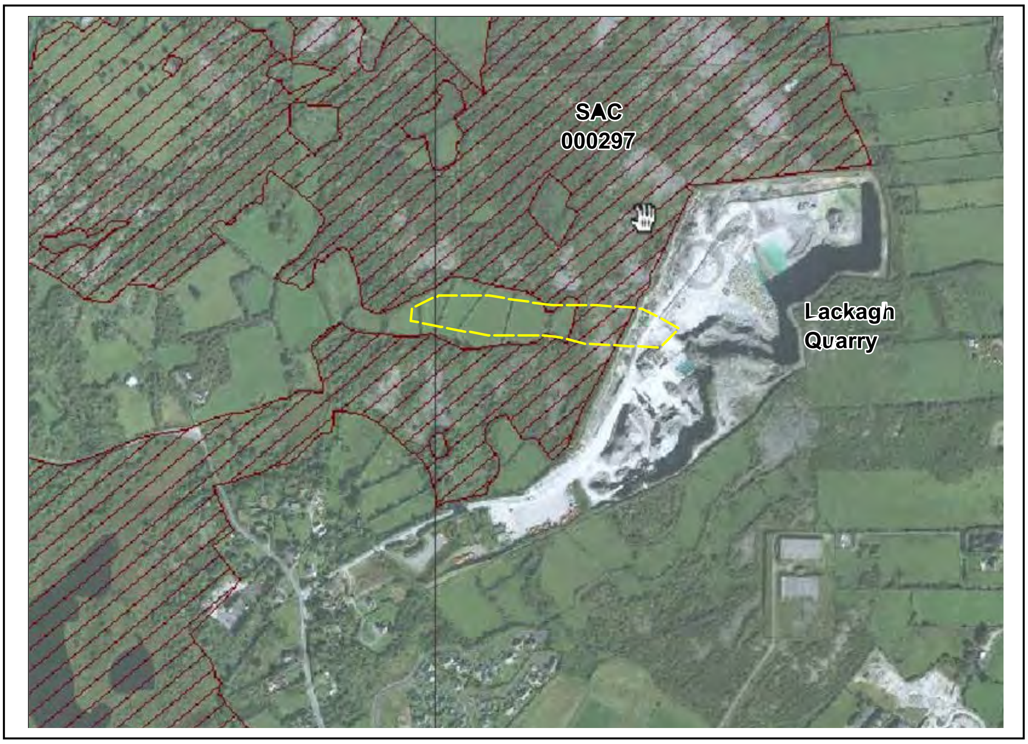

Figure 3: SAC Location (Red Hashed Area) (NPWS 2015)

The objective of the ground investigation is as follows:

- Characterise the nature of the rockmass for tunnel design;
- Characterise the hydrogeology for tunnel design and the existing groundwater conditions;
- Indentify any existing karst features and potential for karstic conditions with the rockmass
- Carryout in-situ and laboratory testing to provide geotechnical and hydrological parameters for tunnel design

In order to accomplish the stated objectives the following ground investigation was proposed:

- 1 No. Sub-horizontal rotary cored drillhole along the proposed tunnel alignment for a length of approximately 300m
- 3 No. Vertical Rotary cored drillholes to depths of 32.5m, 35.0m and 40.0m
- 3 No. Monitoring Installations (piezometers) with raised steel covers
- Geotechnical Laboratory Testing

- Downhole Geophysics
- Surface Geophysics
- Factual Reporting

2. Geological Setting and Ground Conditions

The site is underlain by Lower Carboniferous (Visean) Limestone located approximately 2km to the northeast of the contact with the Galway granitic intrusive complex (Figure 4). There is little published data for this region and Geological Survey of Ireland (GSI) 1:100,000 scale Bedrock Map series record this area as Undifferentiated Visean Shelf Limestones.

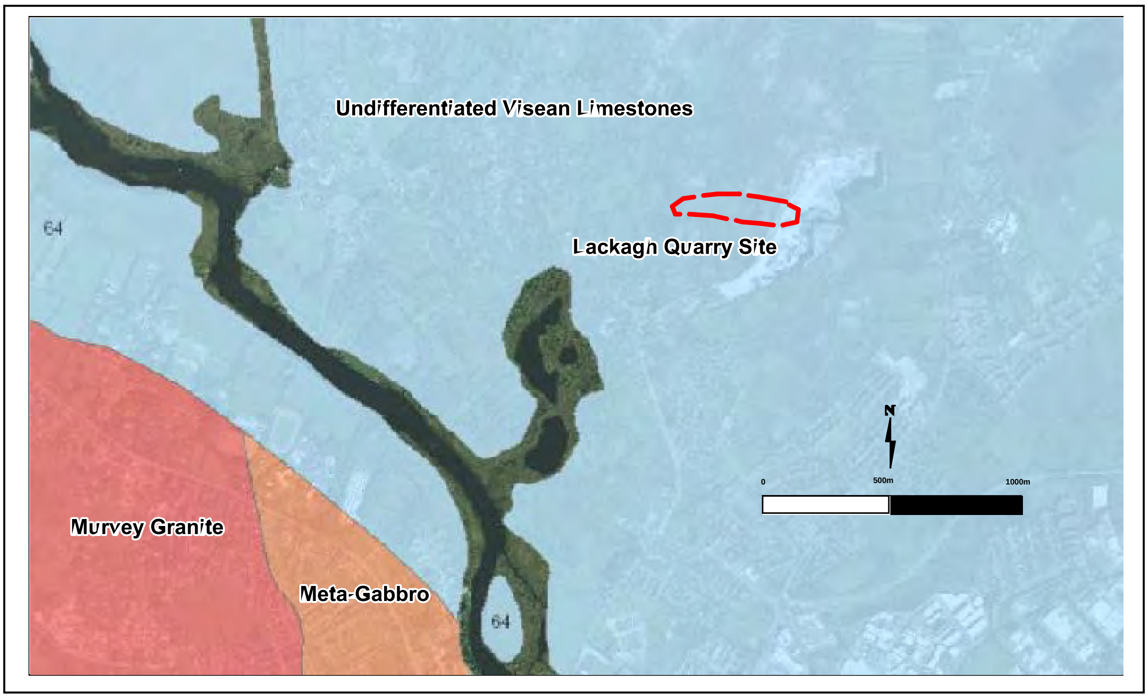

Figure 4: Simplified Geology Map of the Memlo Region (GSI 1:100,000 series)

The bedrock geology is dominated by light grey / grey, massively bedded, fine to medium grained pellety to weakly oolitic grainstones. Discrete, metric scale, beds of dark grey / black limestones are developed within the sequence. The black limestone beds are dominated by synsedimentary breccias with intraclastic clasts of grainstone supported in a black fine grained micritic matrix. There is evidence of burrowing and the brecciation may have been caused by bioturbation. Minor bioclastic debris is disseminated throughout, dominated by unrecognisable small shell fragments. Locally occurring coarse bioclastic fragments consist of thick shelled brachiopods and solitary corals. The fauna and well sorted nature of the rock are indicative of a shallow water, relatively high energy depositional environment. Thin (centimetric scale), horizons of grey / green to black mudstone form semi-continuous marker horizons within the geological sequence. The mudstone horizons (often known as clay wayboards) can be weakly tuffaceous, often containing a significant proportion of finely disseminated pyrite. The pyrite in these thin bands oxidises strongly and is responsible for the surficial iron staining present on parts of the lower benches at Lackagh Quarry.

The unconsolidated Quaternary geology of this region has been proven by the recent drilling to be much more complex than originally anticipated. A deep buried channel /

trough is located to the west orientated along an east-west axis. Unconsolidated material deposited within this feature ranges from lacustrine, laminated (possibly varved) dark brown, organic clays to sands / gravels of a possibly fluviatile origin, all overlain by very stiff, glacial boulder clays.

Extensive areas of limestone pavement are developed to the north and west of the quarry site and there are numerous glacial erratics scattered throughout, many of which are granitic.

3. Ground Investigations

3.1 Setting Out / Surveying

Drawings and coordinates were provided by ARUP and were used to locate and position each borehole and geophysical station. The drillhole collar locations were positioned using a Trimble GeoExplorer 6000 RTK GPS system corrected to a differential base station through a phone modem link. Locations were measured relative to Irish Transverse Mercator.

The low angle borehole, BH01, was set out using the Trimble GeoExplorer 6000 RTK GPS system. The hole / working platform was orientated using a prismatic compass, accurate to +/- 0.5^o. The rig was then set up using a Reflex TN14 Gyrocompass to measure the exact dip and azimuth of the hole before coring commenced.

Downhole surveying of drillhole BH01 was carried out at 3m intervals using a Reflex EZ-TRAC digital downhole survey instrument. Owing to ground conditions (cavities and localised broken ground from 186m) the hole could only be surveyed from 175m back to surface. A core orientation tool had been used throughout the drilling that provided information about the dip of the hole, the driller noted no significant variation in dip from 175m. Refer to Appendix I for all surveying data.

3.2 Rotary Borehole Investigation

Five rotary boreholes were drilled during this phase of the investigation. Four vertical and one low angle borehole drilled from the quarry floor (Figures 5 & 6).

DHID	East	North	Elevation	Dip	Azimuth	Length (m)
BH01	530370.592	728426.557	16.712	-11.5^o	268.3^o	276.7
BH03	530023.824	728382.566	26.256	-90^o	360^o	109.9
BH04	530150.783	728400.125	32.167	-90^o	360^o	35
BH05	530186.649	728378.105	34.138	-90^o	360^o	40.3
BH06	530125.143	728383.081	30.799	-90^o	360^o	45

Table 1: Borehole Collar Locations

The low angle borehole, BH01, was drilled using a Dura Lite rig producing HQ diameter core (63.5mm). This borehole was drilled using a 3m hexagonal core barrel in order to minimise droop and deflection away from the planned section. The borehole was collared at an azimuth of 268.3^o N_{mag} and a dip of -11.5^o to the horizontal. BH01 was located within the boundary of the quarry and was designed to drill into the quarry face. The hole was located at the base of the second bench and rig was stepped back approximately 6m from the quarry face. The face was scaled back before the rig was moved onto site using an excavator to remove loose, unstable rock material that was at risk of collapse. A concrete plinth was constructed between the borehole collar and the quarry face to support the rods whilst drilling and accordingly the first 6m cored from BH01 consists of concrete.

BH01 was drilled to a final depth of 276.7m. It was scheduled to drill to approximately 300m. However, poor quality and unconsolidated / cavernous ground intersected from 272.4m to the end of hole at 276.7m meant that the hole could not be continued.

After drilling was completed borehole BH01 was sealed at a depth of 175m using a Vann Ruth plug and was then backfilled with a cement / bentonite grout from 175m back to surface. The cavities in the lower part of the hole (175.0 - 276.7m) contributed to localised unstable ground conditions and it was considered a significant possibility that they may act as conduits to draw the cement / bentonite grout away from the hole, therefore, a plug was installed at 175m to seal the lower part of the hole.

The vertical boreholes (BH03, BH04, BH05 & BH06) were all drilled using a top drive Hang Seng drilling rig producing PQ diameter drill core (85mm). The holes were collared along the line of the proposed tunnel route to the west of the quarry. BH03 was scheduled to drill to a depth of 32.5m, however, it drilled through a deep overburden feature with very challenging, poorly consolidated ground, intersecting rock at a depth of 104.95m and stopping at a depth of 109.9m. The hole was cored to 85.55m in PQ and subsequently cased to 85m with PW casing. It was then open hole drilled using a HQ tricone until competent ground was intersected at 104.95m and continued to the end of hole with HQ core. Due to the instability of hole BH03 the planned piezometer could not be installed or the downhole geophysical survey carried out. It was backfilled with a cement / bentonite grout upon completion.

BH04 and BH05 were drilled to scheduled depths and intersected the expected geological succession of shallow overburden overlying competent, massively bedded limestones. Piezometers were installed in both of these holes. BH06 was an additional hole added to the ground investigation to test a zone of transition from competent to poorly consolidated rock / overburden that had been detected by the ground geophysical survey. This hole was drilled to a final depth of 45m in unconsolidated clay, sand and gravel it was backfilled with a cement grout from the end of hole back to a depth of 11.0m. A stand pipe was installed in the top of the hole.

The core from the rotary drilling was logged in accordance with the BS5930:1999 specification. A detailed geological description of the rock was generated and a quantitative description of the fracture state of the rock core was provided for each borehole, including:

- Total Core Recovery (TCR)
- Solid Core Recovery (SCR)
- Fracture Index (FI)
- Fracture Number (FNo.)

- Rock Quality Designation (RQD)

The logs were generated using HoleBase AGS software (Hard copies - Appendix II).

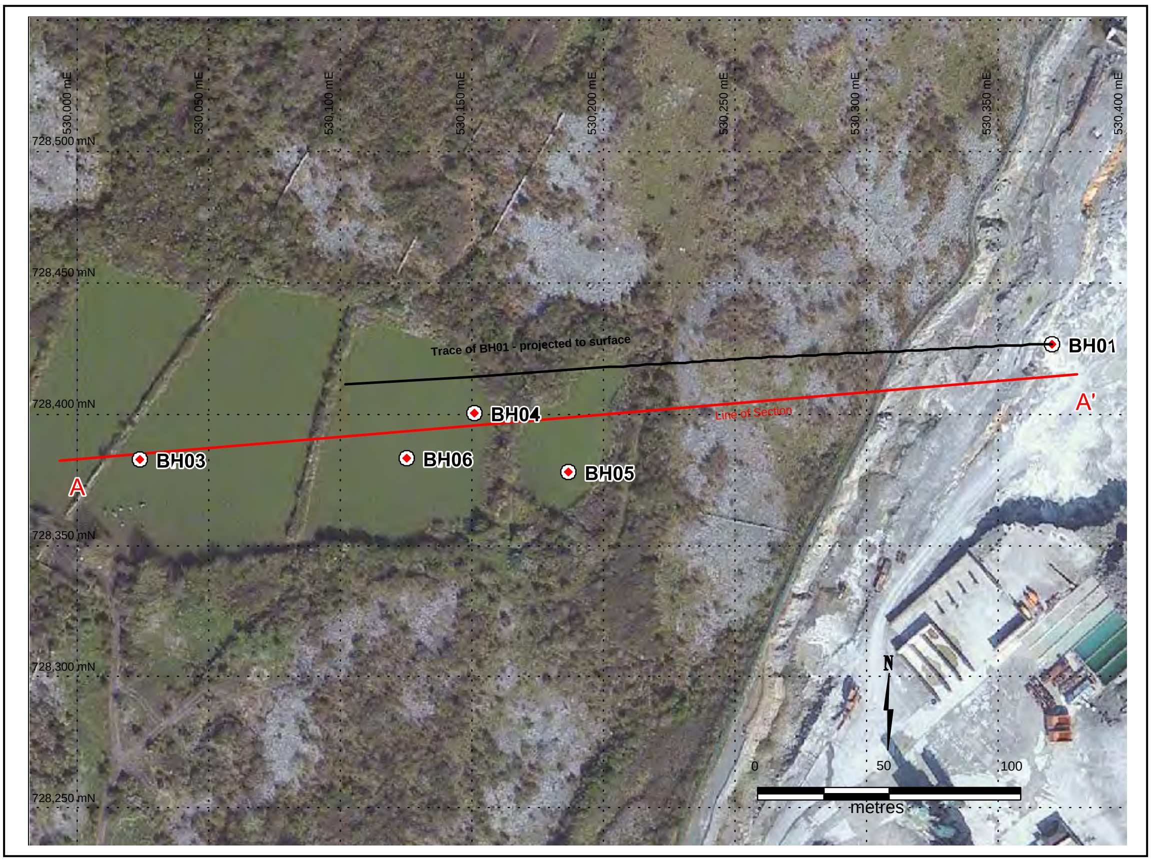

Figure 5: Borehole Collar Locations, Traces and Line of Section

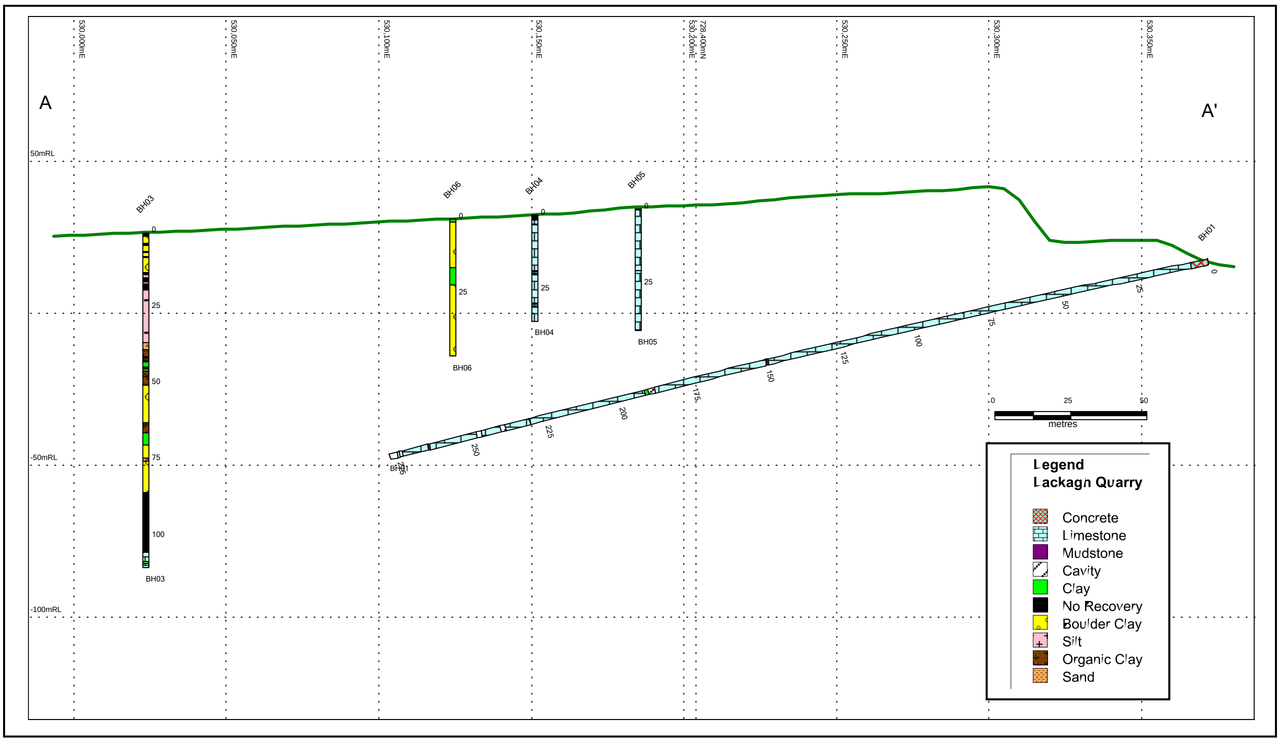

Figure 6: A - A' Drill Section (looking North) through the Lackagh Quarry GI Site

3.3 Discontinuity Logging

Discontinuity logging of rock cores was carried out using the ARUP "Rock Core Discontinuity Log" template for holes BH01, BH04 and BH05. The following headings were used:

- Orientation
- Spacing
- Roughness
- Weathering
- Infilling
- Number of Discontinuity Sets

The core from BH01 was orientated using a core orientation system mounted on the core barrel. and the discontinuities were measured relative to the invert of the core.

See Appendix III for the discontinuity logs.

3.4 Piezometer Installations

Three piezometers were installed in the vertical boreholes located to the west of the quarry. They were installed in boreholes BH04, BH05 and BH06. A summary of the installation design can be seen in Tables 2 - 4.

From (m)	To (m)	Installation
0.00	28.00	Blank 19mm PVC Pipe
28.00	34.00	Slotted 19mm PVC Pipe
34.00		End Cap
0.00	21.00	Cement Grout
21.00	23.00	Bentonite Pellets
23.00	24.00	Sand
24.00	34.00	Pea Gravel
34.00	35.00	Gravel Base

Table 2: BH04 Piezometer Installation Details

From (m)	To (m)	Installation
0.00	33.00	Blank 19mm PVC Pipe
33.00	39.00	Slotted 19mm PVC Pipe
39.00		End Cap
0.00	19.00	Cement Grout
19.00	23.00	Bentonite Pellets
23.00	24.00	Sand
24.00	39.00	Pea Gravel
39.00	40.30	Gravel Base

Table 3: BH05 Piezometer Installation Details

From (m)	To (m)	Installation
0.00	4.00	Blank 19mm PVC Pipe
4.00	10.00	Slotted 19mm PVC Pipe
10.00		End Cap
0.00	1.00	Cement Grout
1.00	2.00	Bentonite Pellets
2.00	3.00	Sand
3.00	11.00	Pea Gravel
11.00	45.00	Cement Grout

Table 4: BH05 Piezometer Installation Details

3.5 Ground Geophysical Surveying

Ground geophysical surveying was specified for the Lackagh Quarry Ground Investigation. BRG Ltd were sub-contracted by Priority Drilling Ltd. to carry out the surveying. The geophysical surveys consisted of 2D Electrical Resistivity Tomography (ERT) and Microgravity across an initial area of roughly 300x30m, this area was subsequently extended to define the lateral and depth extent of a zone of deep overburden. The surveys were designed to test for subsurface heterogeneity and bedrock depths in advance of follow up rotary core drilling. Information on potential karst features were of particular interest to the client.

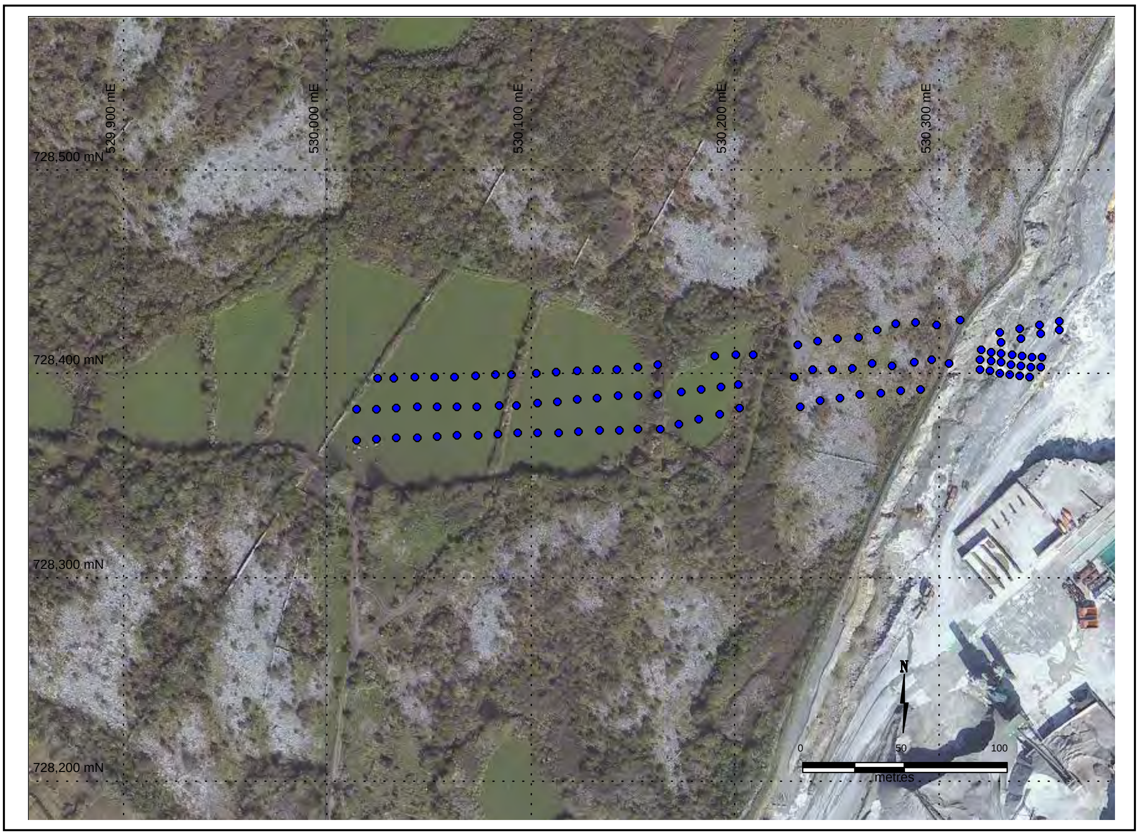

Figure 7: Microgravity Station Locations

Microgravity data was acquired with measured sites along the centre line and 15m either side of the proposed tunnel section. These lines were measured with nominal station spacing of 10m, with gaps where scrub hawthorn was too thick. Extra stations were measured within the quarry on the first bench at 5-10m intervals. Measurements were taken using a Lacoste & Romberg model G gravity meter. Instrument drift was monitored by returning to a locally established base station at hourly intervals.

Stations were topographically surveyed using a Trimble GeoExplorer 6000 RTK GPS system corrected through phone modem link for both the ERT and the gravity surveys. The drift corrected gravity data was corrected for elevation, latitude, and reduced to Bouguer 2.67g/cm^3 to allow for local average rock densities. It was then gridded and exported for display and interpretation in the MapInfo GIS system (Figure 7).

Figure 8: 2D Electrical Resistivity Tomography (ERT) Line / Station Locations

The depth mapping potential with the ERT is limited by the length of each spread. The variability of line lengths meant that the ERT surveying was capable of surveying to a minimum depth of 22m bgl on Line 5 to a maximum depth of 60m bgl on Line 6. Equipment used was an Allied Associates Tigre system which has the potential for up to 128 electrode takeouts. 2m station spacing was initially used to get the required detail along the chosen lines, with 3m intervals on the long lines (6, 7 & 8). Data was measured using a Wenner array, controlled by an Imager2006 programme with a laptop computer. Saved data was inverted using the Geotomo Res2Dinv programme and exported as an image file displaying a cross section of the inverted Resistivities with elevation data. The resultant resistivity sections were subsequently interpreted and an interpreted geological model developed.

Resistivity sections from the 2D ERT and the microgravity data show a marked contrast from high resistivity bedrock in the east with a sharp contact into very low resistivity zones to the west. The western region has a low gravity response coincident with the low resistivity. The base of the initial ERT lines did not penetrate below 30m, however, the low resistivity zone developed to the west suggests that this area was dominated by a significant deep overburden feature. Subsequent 2D ERT surveying, particularly line 6 defined a channel / basin shaped feature developed along a roughly east - west axis with sharp contacts to the north and south. The northern side of the feature seems to be step down into the core of the channel, which is roughly coincident with BH03.

The surface geophysical report is appended as Appendix V.

3.6 Borehole Geophysical Surveying

Ground geophysical surveying was specified for the Lackagh Quarry Ground Investigation. European Geophysical Services Ltd were sub-contracted by Priority Drilling Ltd. to carry out this surveying. It was originally intended to survey three boreholes, however, the poor ground conditions encountered in BH03 meant that only BH04 and BH05 were surveyed.

The geophysical surveys consisted of:

- Optical Televiewer
- Acoustic Televiewer
- Fluid Temperature and Conductivity, Natural Gamma Calliper
- Impeller Flowmeter
- Focused Resistivity
- Full Wave Sonic Velocity
- Pumped Temperature and Conductivity

Report attached as Appendix VI

3.7 Rock / Soil / Water - Laboratory Testing

Core samples were taken from the rock / soil recovered during the drilling operations and forwarded to two accredited laboratories for a testing. The Celtest Laboratory near Bangor in North Wales was selected to carry out the rock testing. The Priority Geotechnical Soil testing Laboratory was selected to carry out the soil testing.

Test	BH01 (No.)	BH04 (No.)	BH05 (No.)	Total Number of Tests
Deformability in Uniaxial Compression	10	5	5	20
Indirect Tensile Strength by Brazilian Test	3	1	1	5
Natural Water Content	40	10	9	59
Oxidisable Sulphate	5	1	1	7
pH Value	5	1	1	7
Point Load	58	25	25	108
Porosity / Density using Saturation & Buoyancy	15	2	3	20
Porosity / Density using Saturation & Calliper	15	2	3	20
Thin Section Petrography	2	1	1	4
Total Sulphur	6	1	1	8
Uniaxial Compressive Strength	36	10	10	56
Total	**195**	**59**	**60**	**314**

Table 5: Scheduled Rock Tests

Test	BH03 (No.)	BH06 (No.)	Total Number of Tests
Atterberg Limits	9	3	12
Moisture Content	19	3	22
Oedometer	4	3	7
Organic Matter Content	9	3	12
Particle Size Distribution	9	0	9
pH Value	5	0	5
Triaxial Test (Unconsolidated / Undrained)	5	3	8
Total	**60**	**15**	**75**

Table 6: Scheduled Soil Tests

A suite of aggregate tests had been scheduled in the Bill of Quantities, including:

- Slake Durability Index
- Los Angeles Coefficient
- Aggregate Crushing Value
- Ten Percent Fines
- Aggregate Impact Value
- Aggregate Abrasion Value
- Polished Stone Value
- Aggregate Frost Heave

The volume of material required to carry out these tests was excessive (e.g. the Aggregate Frost Heave test needs a minimum of 75kg of rock) and would have taken the bulk of the available drill core. Given the relatively homogenous nature of the limestone intersected it was agreed that a representative bulk sample would be acquired from the quarry and sent for the specified aggregate testing. Accordingly, a composite, 275kg, representative sample was obtained from the quarry and sent to Celtest.

Water samples were obtained from the piezometers in boreholes BH04, BH05 and BH06 and sent to the IAS Laboratory in Bagenalstown, Co Carlow for testing for major cations and anions.

Test results are summarised in Tables 7 - 10 certificates are attached as Appendix VII

Location ID	Sample ID	Depth Top	Depth Base	Test	Result
BH01	**48861**	6.70	6.80	Moisture Content	**1.20%**
BH01	**48862**	10.36	10.46	Point Load	**79.3MPa**
BH01	**48863**	10.46	10.69	Uniaxial Compressive Strength	**97MPa**
BH01	**48864**	10.69	10.76	Point Load	**78MPa**
BH01	**48865**	10.89	10.97	Porosity / Density using Saturation and Buoyancy	**0.5 / 2.63**
BH01	**48866**	10.97	11.07	Porosity / Density using Saturation and Calliper	**0.47/2.69**
BH01	**48867**	11.57	11.94	Deformability in Uniaxial Compression	**99.8MPa**
BH01	**48868**	13.26	13.35	Moisture Content	**1.60%**
BH01	**48869**	13.35	13.45	Point Load	**82.9MPa**
BH01	**48870**	13.45	13.70	Uniaxial Compressive Strength	**59MPa**
BH01	**48871**	13.70	13.80	Point Load	**71.9MPa**
BH01	**48872**	16.30	16.40	Point Load	**67.7MPa**
BH01	**48873**	16.40	16.66	Uniaxial Compressive Strength	**73MPa**
BH01	**48874**	16.66	16.80	Point Load	**76.5MPa**
BH01	**48875**	22.40	22.50	Porosity / Density using Saturation and Calliper	**0.58/2.65**
BH01	**48876**	22.50	22.60	Porosity / Density using Saturation and Buoyancy	**1.2 / 2.70**
BH01	**48877**	26.20	26.36	Point Load	**47.1MPa**
BH01	**48878**	26.36	26.61	Uniaxial Compressive Strength	**100MPa**
BH01	**48879**	26.61	26.70	Point Load	**60.5MPa**
BH01	**48880**	27.85	28.15	Deformability in Uniaxial Compression	**112.4MPa**
BH01	**48881**	32.65	32.72	Moisture Content	**1.40%**
BH01	**48882**	34.44	34.48	Point Load	**88.8MPa**
BH01	**48883**	34.48	34.73	Uniaxial Compressive Strength	**69MPa**
BH01	**48884**	34.73	34.83	Point Load	**62.2MPa**

BH01	**48885**	44.35	44.40	Porosity / Density using Saturation and Calliper	**0.54/2.70**
BH01	**48886**	44.45	44.54	Point Load	**84.8MPa**
BH01	**48887**	44.54	44.79	Uniaxial Compressive Strength	**83MPa**
BH01	**48888**	44.79	44.90	Point Load	**53.0MPa**
BH01	**48889**	45.65	45.74	Porosity / Density using Saturation and Buoyancy	**0.5/2.68**
BH01	**48890**	48.90	49.16	Deformability in Uniaxial Compression	**187.5MPa**
BH01	**48891**	53.80	53.93	Total Sulphur	**<0.1%**
BH01	**48892**	55.30	55.40	Oxidisable Sulphate	**<0.01%**
BH01	**48893**	55.84	55.92	pH Value	**9.1**
BH01	**48894**	56.50	56.60	Point Load	**64.4MPa**
BH01	**48895**	56.60	56.85	Uniaxial Compressive Strength	**138MPa**
BH01	**48896**	56.85	56.93	Point Load	**63.9MPa**
BH01	**48897**	57.30	57.40	Moisture Content	**1.10%**
BH01	**48898**	61.65	61.75	Moisture Content	**1.20%**
BH01	**48899**	62.76	62.86	Point Load	**83.4MPa**
BH01	**48900**	62.86	63.05	Uniaxial Compressive Strength	**65MPa**
BH01	**50857**	63.05	63.16	Point Load	**49.6MPa**
BH01	**50858**	64.20	64.50	Indirect Tensile Strength by Brazilian Test	**7.8MPa**
BH01	**50859**	65.40	65.50	Total Sulphur	**<0.1%**
BH01	**50860**	65.66	65.75	Porosity / Density using Saturation and Buoyancy	**0.2/2.72**
BH01	**50861**	65.75	65.92	Porosity / Density using Saturation and Calliper	**0.64/2.69**
BH01	**50862**	66.00	66.10	Point Load	**69.6MPa**
BH01	**50863**	66.10	66.34	Uniaxial Compressive Strength	**104MPa**
BH01	**50864**	66.34	66.45	Point Load	**62.6MPa**
BH01	**50865**	67.07	67.20	Moisture Content	**1.10%**
BH01	**50866**	67.20	67.28	Porosity / Density using Saturation and Calliper	**0.57/2.71**
BH01	**50867**	68.50	68.59	Porosity / Density using Saturation and Buoyancy	**0.2/2.63**
BH01	**50868**	70.10	70.20	Moisture Content	**1.30%**
BH01	**50869**	72.10	72.30	Deformability in Uniaxial Compression	**136.3MPa**
BH01	**50870**	73.03	73.10	Moisture Content	**1.60%**
BH01	**50871**	76.00	76.09	Moisture Content	**1.20%**
BH01	**50872**	79.10	79.18	Point Load	**51.8MPa**
BH01	**50873**	79.18	79.40	Uniaxial Compressive Strength	**62MPa**
BH01	**50874**	79.40	79.52	Point Load	**48.0MPa**
BH01	**50875**	80.04	80.12	Moisture Content	**1.20%**
BH01	**50876**	81.70	81.78	Moisture Content	**1.60%**
BH01	**50877**	87.50	87.57	Moisture Content	**1.80%**
BH01	**50878**	39.70	39.80	Moisture Content	**1.30%**
BH01	**50879**	91.10	91.20	Total Sulphur	**<0.1%**
BH01	**50880**	91.34	91.42	Porosity / Density using Saturation and Calliper	**0.49/2.71**

BH01	**50881**	91.42	91.51	Porosity / Density using Saturation and Buoyancy	**1.0/2.70**
BH01	**50882**	91.63	91.71	Moisture Content	**1.80%**
BH01	**50883**	92.35	92.47	Point Load	**73.3MPa**
BH01	**50884**	92.47	92.70	Uniaxial Compressive Strength	**76MPa**
BH01	**50885**	92.70	92.79	Point Load	**71.1**
BH01	**50886**	93.00	93.10	Moisture Content	**1.50%**
BH01	**50887**	94.90	94.96	Oxidisable Sulphate	**<0.01%**
BH01	**50888**	94.96	95.05	pH Value	**9.2**
BH01	**50889**	97.34	97.43	Moisture Content	**1.30%**
BH01	**50890**	97.95	98.23	Deformability in Uniaxial Compression	**110.0MPa**
BH01	**50891**	101.36	101.45	Moisture Content	**1.60%**
BH01	**50892**	102.90	103.20	Indirect Tensile Strength by Brazilian Test	**12.6MPa**
BH01	**50893**	108.15	108.22	Point Load	**61.2MPa**
BH01	**50894**	108.22	108.51	Uniaxial Compressive Strength	**107MPa**
BH01	**50895**	108.51	108.62	Point Load	**70.2MPa**
BH01	**50896**	108.62	108.70	Moisture Content	**1.20%**
BH01	**50897**	110.27	110.37	Porosity / Density using Saturation and Calliper	**0.57/2.69**
BH01	**50898**	110.37	110.45	Porosity / Density using Saturation and Buoyancy	**0.7/2.59**
BH01	**50899**	113.00	113.08	Thin Section - Petrology	
BH01	**50900**	113.12	113.19	Moisture Content	**1.50%**
BH01	**50901**	115.89	116.05	Point Load	**52.5MPa**
BH01	**50902**	116.05	116.29	Uniaxial Compressive Strength	**104MPa**
BH01	**50903**	116.29	116.39	Point Load	**62.2MPa**
BH01	**50904**	118.82	118.88	Moisture Content	**1.90%**
BH01	**50905**	123.44	123.55	Moisture Content	**2.20%**
BH01	**50906**	125.90	126.00	Moisture Content	**1.30%**
BH01	**50907**	126.80	126.90	Moisture Content	**2.50%**
BH01	**50908**	128.80	128.89	Point Load	**80.8MPa**
BH01	**50909**	128.89	129.14	Uniaxial Compressive Strength	**79MPa**
BH01	**50910**	129.14	129.21	Point Load	**84.0MPa**
BH01	**50911**	131.12	131.17	Moisture Content	**2.60%**
BH01	**50912**	131.60	131.70	Moisture Content	**1.20%**
BH01	**50913**	132.65	132.62	Moisture Content	**1.80%**
BH01	**50914**	133.21	133.32	Point Load	**69.2MPa**
BH01	**50915**	133.32	133.54	Uniaxial Compressive Strength	**110MPa**
BH01	**50916**	133.54	133.63	Point Load	**61.8MPa**
BH01	**50917**	134.35	134.44	Moisture Content	**1.10%**
BH01	**50918**	137.06	137.20	Porosity / Density using Saturation and Calliper	**0.76/2.81**
BH01	**50919**	37.20	137.30	Porosity / Density using Saturation and Buoyancy	**0.3/2.63**
BH01	**50920**	138.60	138.72	pH Value	**9.2**
BH01	**50921**	140.00	140.20	Deformability in Uniaxial Compression	**58.7MPa**
BH01	**50922**	142.81	142.91	Moisture Content	**1.30%**

BH01	**50923**	146.20	146.30	Point Load	**55.0MPa**
BH01	**50924**	146.30	146.52	Uniaxial Compressive Strength	**100MPa**
BH01	**50925**	146.52	146.61	Point Load	**62.6MPa**
BH01	**50926**	148.97	149.05	Thin Section - Petrology	
BH01	**50927**	150.29	150.37	Porosity / Density using Saturation and Calliper	**0.61/2.75**
BH01	**50928**	151.67	151.75	Porosity / Density using Saturation and Buoyancy	**0.7/2.67**
BH01	**50929**	152.97	153.04	Total Sulphur	**<0.1%**
BH01	**50930**	153.20	153.30	Oxidisable Sulphate	**<0.01%**
BH01	**50931**	154.60	154.68	Moisture Content	**1.40%**
BH01	**50932**	155.20	155.28	Moisture Content	**1.70%**
BH01	**50933**	156.33	156.44	Point Load	**42.0MPa**
BH01	**50934**	156.44	156.68	Uniaxial Compressive Strength	**86MPa**
BH01	**50935**	156.68	156.76	Point Load	**47.3MPa**
BH01	**50936**	163.49	163.56	Moisture Content	**2.50%**
BH01	**50937**	165.17	165.25	Point Load	**77.7MPa**
BH01	**50938**	165.25	165.49	Uniaxial Compressive Strength	**83MPa**
BH01	**50939**	165.49	165.58	Point Load	**64.6MPa**
BH01	**50940**	166.00	166.10	Moisture Content	**1.30%**
BH01	**50941**	172.96	173.07	Porosity / Density using Saturation and Calliper	**0.49/2.68**
BH01	**50942**	173.07	173.20	Porosity / Density using Saturation and Buoyancy	**0.4/2.72**
BH01	**50943**	174.47	174.69	Uniaxial Compressive Strength	**76MPa**
BH01	**50944**	175.18	175.26	Point Load	**58.6MPa**
BH01	**50945**	175.26	175.50	Uniaxial Compressive Strength	**86MPa**
BH01	**50946**	175.50	175.59	Point Load	**58.6MPa**
BH01	**50947**	176.00	176.10	Moisture Content	**1.20%**
BH01	**50948**	180.24	180.50	Indirect Tensile Strength by Brazilian Test	**14.6MPa**
BH01	**50949**	182.12	182.20	pH Value	**9.3**
BH01	**50950**	183.17	183.40	Deformability in Uniaxial Compression	**118.6MPa**
BH01	**50951**	183.90	184.02	Point Load	**48.8MPa**
BH01	**50952**	184.02	184.25	Uniaxial Compressive Strength	**97MPa**
BH01	**50953**	184.25	184.34	Point Load	**70.1MPa**
BH01	**50954**	196.19	186.25	Moisture Content	**1.80%**
BH01	**50955**	193.60	193.68	Total Sulphur	**<0.1%**
BH01	**50956**	194.13	194.20	Porosity / Density using Saturation and Calliper	**0.54/2.69**
BH01	**50957**	194.60	194.67	Point Load	**48.0MPa**
BH01	**50958**	194.67	194.90	Uniaxial Compressive Strength	**114MPa**
BH01	**50959**	194.90	194.99	Point Load	**57.6MPa**
BH01	**50960**	195.77	195.86	Porosity / Density using Saturation and Buoyancy	**0.5/2.71**
BH01	**50961**	201.47	201.55	Oxidisable Sulphate	**<0.01%**
BH01	**50962**	204.62	204.70	Point Load	**83.6MPa**
BH01	**50963**	204.70	204.95	Uniaxial Compressive Strength	**132MPa**

BH01	**50964**	204.95	205.02	Point Load	**60.5**
BH01	**50965**	209.65	209.72	Moisture Content	**1.70%**
BH01	**50966**	210.18	210.30	Porosity / Density using Saturation and Calliper	**0.65/2.69**
BH01	**50967**	210.30	210.40	Porosity / Density using Saturation and Buoyancy	**0.3/2.85**
BH01	**50968**	210.57	210.82	Uniaxial Compressive Strength	**111MPa**
BH01	**50969**	211.10	211.20	Moisture Content	**1.40%**
BH01	**50970**	211.77	211.85	Point Load	**56.2MPa**
BH01	**50971**	211.85	212.10	Uniaxial Compressive Strength	**52MPa**
BH01	**50972**	212.10	212.20	Point Load	**68.7MPa**
BH01	**50973**	212.33	212.58	Deformability in Uniaxial Compression	**104.7MPa**
BH01	**50974**	213.80	213.90	pH Value	**9.1**
BH01	**50975**	218.20	218.28	Moisture Content	**1.50%**
BH01	**50976**	222.52	222.62	Moisture Content	**1.00%**
BH01	**50977**	223.70	223.80	Porosity / Density using Saturation and Calliper	**0.56/2.75**
BH01	**50978**	224.08	224.20	Porosity / Density using Saturation and Buoyancy	**0.3/2.63**
BH01	**50979**	225.65	225.74	Point Load	**80.3MPa**
BH01	**50980**	225.74	225.95	Uniaxial Compressive Strength	**77MPa**
BH01	**50981**	225.95	226.03	Point Load	**72.3MPa**
BH01	**50982**	228.16	228.24	Porosity / Density using Saturation and Calliper	**0.64/2.70**
BH01	**50983**	228.24	228.32	Porosity / Density using Saturation and Buoyancy	**0.4/2.65**
BH01	**50984**	230.13	230.20	Moisture Content	**2.00%**
BH01	**50985**	231.65	231.78	Point Load	**53.0MPa**
BH01	**50986**	231.78	232.00	Uniaxial Compressive Strength	**111MPa**
BH01	**50987**	232.00	232.10	Point Load	**74.6MPa**
BH01	**50988**	232.46	232.60	Deformability in Uniaxial Compression	**69.6MPa**
BH01	**50989**	235.04	235.10	Moisture Content	**1.30%**
BH01	**50990**	235.64	235.73	Total Sulphur	**<0.1%**
BH01	**50991**	236.73	237.03	Uniaxial Compressive Strength	**80MPa**
BH01	**50992**	237.17	237.43	Uniaxial Compressive Strength	**76MPa**
BH01	**50993**	242.82	242.92	Point Load	**53.8MPa**
BH01	**50994**	242.92	243.14	Uniaxial Compressive Strength	**118MPa**
BH01	**50995**	243.14	243.23	Point Load	**64.6MPa**
BH01	**50996**	250.30	250.56	Deformability in Uniaxial Compression	**56.4MPa**
BH01	**50997**	251.81	251.95	Point Load	**52.5MPa**
BH01	**50998**	251.95	252.22	Uniaxial Compressive Strength	**121MPa**
BH01	**50999**	252.22	252.32	Point Load	**61.4MPa**
BH01	**51000**	253.30	253.38	Oxidisable Sulphate	**<0.01%**
BH01	**51001**	259.72	259.82	Point Load	**64.1MPa**
BH01	**51002**	259.82	260.06	Uniaxial Compressive Strength	**143MPa**
BH01	**51003**	260.06	260.18	Point Load	**44.9MPa**
BH01	**51004**	262.43	262.63	Uniaxial Compressive Strength	**66MPa**
BH01	**51005**	262.63	262.73	Point Load	**67.7MPa**

BH01	**51006**	264.80	164.93	Point Load	**48.5MPa**
BH01	**51007**	264.93	264.15	Uniaxial Compressive Strength	**83MPa**
BH01	**51008**	265.15	265.25	Porosity / Density using Saturation and Calliper	**0.63/2.65**
BH01	**51009**	265.25	265.38	Porosity / Density using Saturation and Buoyancy	**0.5/2.64**
BH01	**51010**	268.30	268.40	Uniaxial Compressive Strength	**90MPa**
BH01	**51011**	271.70	271.90	Uniaxial Compressive Strength	**91MPa**

Table 7: Summary of Rock Test Results in BH01.

Location ID	Sample ID	Depth Top	Depth Base	Test	Certificate
BH03	**48801**	4.15	4.42	Triaxial - Unconsolidated / Undrained	x
BH03	**48802**	13.65	13.73	Moisture Content	x
BH03	**48803**	13.73	13.85	Atterberg Limits	x
BH03	**48804**	14.90	15.00	Particle Size Distribution	x
BH03	**48805**	19.00	19.10	Particle Size Distribution	x
BH03	**48806**	19.10	19.20	Atterberg Limits	x
BH03	**48807**	19.25	19.30	Moisture Content	x
BH03	**48808**	19.90	20.00	Moisture Content	x
BH03	**48809**	20.95	21.05	pH	x
BH03	**48810**	21.30	21.40	Moisture Content	x
BH03	**48811**	25.50	25.60	Particle Size Distribution	x
BH03	**48812**	25.80	25.90	Particle Size Distribution	x
BH03	**48813**	26.50	26.60	Particle Size Distribution	x
BH03	**48814**	26.70	26.80	Particle Size Distribution	x
BH03	**48815**	27.20	27.25	pH	x
BH03	**48816**	27.45	27.55	Atterberg Limits	x
BH03	**48817**	27.55	27.65	Particle Size Distribution	x
BH03	**48818**	30.25	30.33	Particle Size Distribution	x
BH03	**48819**	31.20	31.30	Moisture Content	x
BH03	**48822**	33.95	34.03	Moisture Content	x
BH03	**48824**	36.70	36.80	Particle Size Distribution	x
BH03	**48825**	38.60	38.70	Moisture Content	x
BH03	**48826**	38.95	39.05	Organic Matter Content	x
BH03	**48827**	39.25	39.30	Atterberg Limits	x
BH03	**48828**	39.45	39.55	Organic Matter Content	x
BH03	**48829**	39.80	39.83	Moisture Content	x
BH03	**48830**	40.65	40.77	Atterberg Limits	x
BH03	**48831**	41.20	41.25	pH	x
BH03	**48832**	41.30	41.50	Oedometer	x
BH03	**48833**	41.85	42.08	Triaxial - Unconsolidated / Undrained	x
BH03	**48834**	42.30	42.35	Moisture Content	x
BH03	**48835**	42.35	42.40	Organic Matter Content	x
BH03	**48836**	42.65	42.97	Triaxial - Unconsolidated / Undrained	x
BH03	**48837**	42.97	43.30	Oedometer	x

BH03	**48838**	44.05	44.20	Oedometer	x
BH03	**48839**	46.20	46.27	Organic Matter Content	x
BH03	**48840**	46.27	46.59	Triaxial - Unconsolidated / Undrained	x
BH03	**48841**	47.00	47.10	pH	x
BH03	**48842**	47.20	47.27	Moisture Content	x
BH03	**48843**	47.45	47.55	Organic Matter Content	x
BH03	**48844**	47.85	48.02	Oedometer	x
BH03	**48845**	48.20	48.30	Atterberg Limits	x
BH03	**48846**	48.45	48.70	Triaxial - Unconsolidated / Undrained	x
BH03	**48847**	49.00	49.10	Organic Matter Content	x
BH03	**48848**	49.30	49.40	Moisture Content	x
BH03	**48849**	63.15	63.22	Organic Matter Content	x
BH03	**48850**	63.38	63.43	pH	x
BH03	**48851**	63.50	63.55	Moisture Content	x
BH03	**48852**	63.90	63.95	Organic Matter Content	x
BH03	**48853**	64.30	64.35	Moisture Content	x
BH03	**48854**	64.90	64.95	Organic Matter Content	x
BH03	**48855**	65.50	65.60	Moisture Content	x
BH03	**48856**	66.95	67.05	Moisture Content	x
BH03	**48857**	68.40	68.45	Moisture Content	x
BH03	**48858**	70.40	70.50	Moisture Content	x
BH03	**48859**	70.75	70.85	Moisture Content	x
BH03	**48860**	71.60	71.70	Moisture Content	x
BH06	**50742**	5.25	5.50	Triaxial - Unconsolidated / Undrained	x
BH06	**50744**	16.20	16.50	Oedometer	x
BH06	**50745**	16.60	16.70	Moisture Content	x
BH06	**50746**	16.70	16.80	Atterberg Limits	x
BH06	**50747**	17.13	17.20	Organic Matter Content	x
BH06	**50748**	18.00	18.25	Triaxial - Unconsolidated / Undrained	x
BH06	**50749**	18.25	18.35	Moisture Content	x
BH06	**50750**	18.65	18.75	Atterberg Limits	x
BH06	**50851**	18.95	19.05	Organic Matter Content	x
BH06	**50852**	19.70	19.95	Oedometer	x
BH06	**50853**	20.00	20.25	Oedometer	x
BH06	**50854**	21.45	21.52	Moisture Content	x
BH06	**50855**	21.52	21.60	Atterberg Limits	x
BH06	**50856**	21.75	21.80	Organic Matter Content	x

Table 8: Summary of Soil Test Results in BH03 & BH06.

Location ID	Sample ID	Depth Top	Depth Base	Test	Result
BH04	**48901**	3.5	3.55	Moisture Content	**0.20%**
BH04	**48902**	5.4	5.48	Moisture Content	**0.60%**
BH04	**48903**	8.06	8.36	Deformability in Uniaxial Compression	**119.9MPa**
BH04	**48904**	9.3	9.36	Moisture Content	**0.30%**

BH04	**48905**	10.63	10.88	Deformability in Uniaxial Compression	**41.6MPa**
BH04	**48906**	11.77	11.83	Moisture Content	**0.20%**
BH04	**48907**	12.62	12.75	Point Load	**59.2MPa**
BH04	**48908**	12.85	13.1	Uniaxial Compressive Strength	**76MPa**
BH04	**48909**	13.1	13.25	Point Load	**52.7MPa**
BH04	**48910**	14.4	14.63	Deformability in Uniaxial Compression	**62.0MPa**
BH04	**48911**	14.63	14.74	Point Load	**49.2MPa**
BH04	**48912**	14.74	14.97	Uniaxial Compressive Strength	**86MPa**
BH04	**48913**	14.97	15.13	Point Load	**60.1MPa**
BH04	**48914**	11.77	11.83	Porosity / Density using Saturation and Calliper & Porosity / Density using Saturation and Buoyancy	**0.2/2.72**
BH04	**48915**	17.74	17.86	Point Load	**60.2MPa**
BH04	**48917**	18.12	18.2	Point Load	**56.5MPa**
BH04	**48918**	19.2	19.32	Point Load	**36.5MPa**
BH04	**48919**	20.05	20.12	Thin Section / Petrography	
BH04	**48920**	20.12	20.22	Point Load	**73.9MPa**
BH04	**48921**	20.22	20.5	Uniaxial Compressive Strength	**55MPa**
BH04	**48922**	20.8	20.85	Moisture Content	**0.40%**
BH04	**48923**	21.2	21.3	Point Load	**68.4MPa**
BH04	**48924**	21.8	21.9	Moisture Content	**1%**
BH04	**48925**	22.2	22.31	Point Load	**90.2MPa**
BH04	**48926**	22.6	22.78	Point Load	**60.1MPa**
BH04	**48927**	22.78	23.06	Uniaxial Compressive Strength	**53MPa**
BH04	**48928**	23.1	23.2	Point Load	**64.6MPa**
BH04	**48929**	21.8	21.9	Porosity / Density using Saturation and Calliper & Porosity / Density using Saturation and Buoyancy	**0.4/2.69**
BH04	**48930**	23.7	23.8	Point Load	**77.7MPa**
BH04	**48931**	23.8	24.1	Uniaxial Compressive Strength	**111MPa**
BH04	**48932**	24.17	24.28	Point Load	**74MPa**
BH04	**48933**	24.28	24.52	Uniaxial Compressive Strength	**91MPa**
BH04	**48934**	25.08	25.19	Point Load	**77.5MPa**
BH04	**48935**	25.19	25.41	Deformability in Uniaxial Compression	**64.1MPa**
BH04	**48936**	28.27	28.4	Porosity / Density using Saturation and Calliper	**0.5/2.65**
BH04	**48937**	27.91	28	Point Load	**89.4MPa**
BH04	**48938**	28.27	28.4	Moisture Content	**0.10%**
BH04	**48939**	28.4	28.44	Point Load	**68.3MPa**
BH04	**48941**	29.38	29.54	Indirect Tensile Strength by Brazilian Test	**5.97MPa**
BH04	**48943**	29.86	29.94	Point Load	**92MPa**
BH04	**48949**	30.93	30.03	Point Load	**76.6MPa**
BH04	**48950**	31.03	31.3	Uniaxial Compressive Strength	**76MPa**
BH04	**48951**	31.3	31.4	Point Load	**67.8MPa**
BH04	**48954**	31.66	31.7	Total Sulphur	**<0.1%**
BH04	**48955**	31.76	31.84	Point Load	**59.6MPa**
BH04	**48956**	31.84	31.93	Oxidisable Sulphur	**0.04**
BH04	**48957**	31.93	32.15	Uniaxial Compressive Strength	**78MPa**

BH04	**48958**	32.15	32.26	Point Load	**55.4MPa**
BH04	**48959**	32.26	32.35	pH	**9.3**
BH04	**48962**	32.5	32.57	Point Load	**78.8MPa**
BH04	**48963**	32.57	32.85	Uniaxial Compressive Strength	**92MPa**
BH04	**48964**	32.85	32.96	Point Load	**65.5MPa**
BH04	**48965**	33.12	33.16	Moisture Content	**0.10%**
BH04	**48966**	33.2	33.48	Deformability in Uniaxial Compression	**66.5MPa**
BH04	**48967**	33.48	33.6	Point Load	**49.9MPa**
BH04	**48968**	32.35	32.43	Porosity / Density using Saturation and Buoyancy	**0.4/2.69**
BH04	**48969**	34.56	34.59	Moisture Content	**0.30%**
BH04	**48970**	34.96	35	Moisture Content	**0.20%**
BH05	**48971**	0.65	0.73	Moisture Content	**0.30%**
BH05	**48972**	0.98	1.04	Moisture Content	**0.10%**
BH05	**48973**	1.41	1.5	Moisture Content	**0.10%**
BH05	**48974**	2.62	2.67	Porosity / Density using Saturation and Calliper	**0.4/2.68**
BH05	**48975**	2.8	2.96	Point Load	**27.8Mpa**
BH05	**48976**	1.41	1.5	Porosity / Density using Saturation and Buoyancy	**0.3/2.65**
BH05	**48977**	7.73	7.84	Point Load	**63MPa**
BH05	**48978**	8.1	8.25	Point Load	**43.8MPa**
BH05	**48979**	8.54	8.66	Point Load	**62MPa**
BH05	**48980**	8.9	8.96	Moisture Content	**0.10%**
BH05	**48981**	9.46	9.57	Point Load	**91.5MPa**
BH05	**48982**	9.57	9.77	Uniaxial Compressive Strength	**91MPa**
BH05	**48983**	9.77	9.92	Point Load	**55.4MPa**
BH05	**48984**	10.2	10.26	Point Load	**101.0MPa**
BH05	**48985**	11.3	11.45	Point Load	**43.1MPa**
BH05	**48986**	11.45	11.72	Uniaxial Compressive Strength	**86MPa**
BH05	**48987**	11.72	11.83	Point Load	**77.2MPa**
BH05	**48988**	12.92	13.07	Moisture Content	**0.30%**
BH05	**48989**	13.5	13.6	Point Load	**141.1MPa**
BH05	**48990**	13.7	13.81	Point Load	**67.3MPa**
BH05	**48991**	13.81	14.07	Uniaxial Compressive Strength	**94MPa**
BH05	**48992**	14.07	14.15	Point Load	**84.4MPa**
BH05	**48993**	14.27	14.4	Point Load	**74.0MPa**
BH05	**48994**	14.65	14.89	Uniaxial Compressive Strength	**72MPa**
BH05	**48995**	15.43	15.55	Point Load	**81.8MPa**
BH05	**48996**	15.95	16.22	Deformability in Uniaxial Compression	**57.0MPa**
BH05	**48997**	16.45	16.55	Point Load	**67.3MPa**
BH05	**48998**	16.87	17.19	Uniaxial Compressive Strength	**77MPa**
BH05	**48999**	17.97	18.06	Porosity / Density using Saturation and Buoyancy	**0.3/2.69**
BH05	**50701**	19.7	19.92	Indirect Tensile Strength by Brazilian Test	**3.39MPa**
BH05	**50702**	28.85	28.95	Porosity / Density using Saturation and Calliper	**0.4/2.69**
BH05	**50703**	22.07	22.21	Point Load	**54.3MPa**

BH05	**50704**	22.9	23	Point Load	**87.3MPa**
BH05	**50705**	23.94	24.05	Point Load	**67.2MPa**
BH05	**50706**	24.05	24.3	Deformability in Uniaxial Compression	**44.9MPa**
BH05	**50707**	24.73	24.85	Point Load	**66.4MPa**
BH05	**50708**	25.2	25.4	Deformability in Uniaxial Compression	**22.6MPa**
BH05	**50709**	26	26.12	Point Load	**76.4MPa**
BH05	**50710**	26.12	26.35	Deformability in Uniaxial Compression	**66.3MPa**
BH05	**50711**	27.68	27.88	Uniaxial Compressive Strength	**79MPa**
BH05	**50712**	28.75	28.85	Moisture Content	**0.10%**
BH05	**50715**	29.09	29.18	Total Sulphur	**<0.1**
BH05	**50716**	29.18	29.3	Oxidisable Sulphur	**<0.01**
BH05	**50717**	29.3	29.4	pH	**9.2**
BH05	**50718**	30.3	30.4	Moisture Content	**0.40%**
BH05	**50721**	30.88	30.92	Moisture Content	**0.30%**
BH05	**50725**	32.44	32.54	Point Load	**76.8MPa**
BH05	**50726**	32.54	32.6	Moisture Content	**0.20%**
BH05	**50727**	32.83	32.92	Point Load	**66.7MPa**
BH05	**50728**	32.92	33	Thin Section / Petrography	
BH05	**50729**	33	33.26	Uniaxial Compressive Strength	**116MPa**
BH05	**50730**	33.22	33.26	Porosity / Density using Saturation and Calliper	**0.6/2.69**
BH05	**50731**	33.5	33.7	Uniaxial Compressive Strength	**51MPa**
BH05	**50733**	33.92	33.16	Uniaxial Compressive Strength	**54MPa**
BH05	**50735**	34.5	34.7	Porosity / Density using Saturation and Buoyancy	**0.4/2.68**
BH05	**50736**	37.4	37.5	Point Load	**80.7MPa**
BH05	**50737**	37.5	37.82	Uniaxial Compressive Strength	**131MPa**
BH05	**50738**	37.82	37.92	Point Load	**77.2MPa**
BH05	**50740**	37.92	38.08	Point Load	**52.3MPa**

Table 9: Summary of Rock Test Results in BH04 & BH05

Sample	Test	Result
Bulk Sample	Aggregate Crushing Value	**23%**
Bulk Sample	Aggregate Impact Value	**17%**
Bulk Sample	Aggregate Abrasion Value	**12**
Bulk Sample	Polished Stone Value	**38**
Bulk Sample	Slake Durability	**99.40%**
Bulk Sample	Los Angeles Coefficient	**28**
Bulk Sample	Soundness by Magnesium Sulphate	**1**
Bulk Sample	10% Fines	**150kN**
Bulk Sample	Frost Heave	**3.3mm**

Table 10: Summary of Rock Test Results in Bulk Sample

3.8 In Situ Water Testing

Water samples were obtained from boreholes BH04, BH05 and BH06 and tested for pH, Temperature, Conductivity and Dissolved O_2. Three water samples were obtained and the pH, Temperature, Conductivity and dissolved O_2 data was acquired using a Watterra Pump with each borehole purged for at least 30 minutes. This work was carried out by Ronan Doyle of Ronan Doyle Monitoring Solutions, Ballinrobe County Mayo.

Borehole	pH	Temperature (°C)	Conductivity (µS)	Dissolved O_2 (mg/l)
BH04	7.47	10.5	295	0.21
BH05	7.77	10.5	420	0.8
BH06	12.53	9.8	6187	0.8

Table 11: In Situ Water Testing Results

3.9 Permeability Testing

Falling Head and Packer Testing was carried out on boreholes BH04 and BH05. The ground conditions intersected in boreholes BH03 and BH06 was considered too unstable for permeability testing.

A falling head test was carried out in BH04 on the 5th of January 2016. The rods were removed from the hole and the water level in the borehole was recorded at 17.88m bgl before the test commenced. Initially a volume of 130 litres was pumped into the hole, upon cessation of pumping the water level recovered almost immediately (i.e. faster than the dip meter could be lowered into the hole). A second test was subsequently carried out and 500 litres were pumped into the hole and same rapid recovery to 17.88m bgl was observed.

Falling head tests were carried out in BH05 on the 7th of January 2016. The rods were removed from the hole and the water level in this borehole was recorded at 19.45m bgl before commencement of the test. Initially a volume of 215 litres was pumped into the hole and the hole recovered back to 19.42m bgl and had stabilised after 40 minutes. A second test using a greater volume of water was carried out and 1000 litres of water was pumped into the hole. This test had proceeded almost to conclusion when the water level rose slightly (c.1.0cm) and a obstruction could be felt in the hole. The driller ran the rods back into the hole to assist with the piezometer installation and found that there was clay in the hole from 19.3 to 20.8m. The Falling Head test data is presented in Appendix XI.

Packer testing was carried out in boreholes BH04 and BH05 on the 18th of December 2015 and the 6th of January 2016 respectively. Set up details are presented in Table 12 and the results in Appendix X.

Borehole	Top (m)	Bottom (m)	Midpoint (m)
BH04	18	20	19
BH04	21	23	22
BH04	24	26	25
BH04	28	30	29
BH05	36	38	37
BH05	30	32	31
BH05	24	27	25.5
BH05	20	23	21.5

Table 12: Packer Test Installation Details

The Packer Tests carried out at 28-30m and 21-23m in BH04 suffered from loss of water pressure due to cavities / fractures. For both of these tests only one stage could be measured. All of the scheduled packer tests were carried out in BH05.

It was noted that the water pressure recovery once pumping had ceased was instantaneous in all of the test intervals.

APPENDIX I

Hole	**East**	**North**	**Elevation**
BH1	530370.592	728426.557	16.712
BH3	530023.824	728382.566	26.256
BH4	530150.783	728400.125	32.167
BH5	530186.649	728378.105	34.138
BH6	530125.143	728383.081	30.799

Survey name	Station	East	North	Elevation	Dip	Azimuth	Tool–	Gravity	Mag.Str.	Mag.Dip	Mag.X	Mag.Y	Mag.Z	Roll Angle	Mag.T/face	DLS
*	Metres	Metres	Metres	Metres	Degrees	Degrees	Centigrade	G	nT	Degrees	nT	nT	nT	Degrees	Degrees	deg./30m
BH-1	1	0	0	0	-11.5	268.3	11	1.000147	48955	67.9	18396	0	45367	90	292.4	0
BH-1	4	-2.94	-0.09	-0.6	-11.5	268.1	11	1.00047	48954	67.9	18424	0	45355	90	292.4	1.9
BH-1	7	-5.88	-0.18	-1.2	-11.5	268.4	11	1.000677	48946	67.9	18415	0	45350	89.7	292.1	2.3
BH-1	10	-8.81	-0.28	-1.8	-11.7	267.9	11	1.00063	49023	67.9	18436	0	45424	89	291.5	5.4
BH-1	13	-11.75	-0.39	-2.41	-11.7	267.9	11	1.001172	49022	67.9	18468	0	45410	88.4	290.9	0.4
BH-1	16	-14.68	-0.5	-3.02	-11.8	267.6	11	1.000628	49027	67.9	18422	0	45434	88.4	290.8	3
BH-1	19	-17.62	-0.62	-3.63	-11.9	267.5	11	1.00041	49014	67.9	18451	0	45408	88.2	290.7	0.9
BH-1	22	-20.54	-0.81	-4.27	-12.6	265.4	11	1.002129	49028	68.5	17966	0	45618	89.2	291	22.5
BH-1	25	-23.47	-0.99	-4.91	-12.1	267.2	11	1.000351	49037	67.9	18457	0	45431	88.7	291.1	19
BH-1	28	-26.4	-1.13	-5.54	-12.2	267.3	11	1.000495	49044	67.9	18458	0	45438	88.4	290.8	1.2
BH-1	31	-29.33	-1.28	-6.18	-12.4	267.1	11	1.000687	49069	67.9	18452	0	45467	88.5	290.9	3.2
BH-1	34	-32.25	-1.43	-6.83	-12.6	266.9	11	1.000132	49044	67.9	18419	0	45454	88.4	290.8	2.8
BH-1	37	-35.18	-1.58	-7.48	-12.6	267.1	11	1.000742	49065	67.9	18458	0	45460	88.3	290.7	2.2
BH-1	40	-38.1	-1.73	-8.13	-12.6	267.1	11	1.000358	49075	67.9	18479	0	45463	88.3	290.8	0.4
BH-1	43	-41.02	-1.88	-8.79	-12.6	267.1	11	1.000171	49057	67.9	18429	0	45464	88.5	290.9	0.6
BH-1	46	-43.95	-2.02	-9.44	-12.5	267.3	11	1.000035	49054	67.9	18466	0	45446	88.8	291.3	2
BH-1	49	-46.87	-2.17	-10.09	-12.7	267	11	1.000317	49034	67.9	18438	0	45435	89.4	291.8	2.7
BH-1	52	-49.8	-2.32	-10.75	-12.7	267.1	11	1.000291	49062	68	18415	0	45475	89.7	292.1	0.4
BH-1	55	-52.72	-2.47	-11.41	-12.7	266.9	11	1.000127	49043	67.9	18450	0	45440	90.4	292.9	2
BH-1	58	-55.64	-2.61	-12.06	-12.5	267.8	11	0.99969	49044	67.6	18658	0	45356	90.8	293.6	9.5
BH-1	61	-58.57	-2.74	-12.72	-12.8	267.1	11	1.000477	49098	67.9	18474	0	45490	92.3	294.8	8
BH-1	64	-61.49	-2.89	-13.38	-12.8	267	11	1.00001	49037	67.9	18460	0	45430	93.1	295.6	0.4
BH-1	67	-64.41	-3.04	-14.05	-12.9	266.9	11	1.000212	49044	67.9	18458	0	45438	93.5	296	1.5
BH-1	70	-67.33	-3.2	-14.72	-12.9	267	11	1.0002	49029	67.9	18458	0	45422	94.5	297	1.4
BH-1	73	-70.25	-3.35	-15.39	-12.9	266.9	11	1.000355	49071	67.9	18437	0	45476	94.9	297.4	1.7
BH-1	76	-73.17	-3.51	-16.06	-12.9	267	11	1.000287	49068	67.8	18512	0	45442	95.4	297.9	1.8
BH-1	79	-76.11	-3.53	-16.68	-10.9	272	11	0.992033	49037	67.9	18432	0	45441	95.8	298.3	52.4

Survey name	Station	East	North	Elevation	Dip	Azimuth	Tool–	Gravity	Mag.Str.	Mag.Dip	Mag.X	Mag.Y	Mag.Z	Roll Angle	Mag.T/face	DLS
*	Metres	Metres	Metres	Metres	Degrees	Degrees	Centigrade	G	nT	Degrees	nT	nT	nT	Degrees	Degrees	deg./30m
BH-1	82	-79.04	-3.56	-17.3	-13	266.9	11	1.000459	49018	67.9	18469	0	45406	96.3	298.8	53.7
BH-1	85	-81.96	-3.72	-17.98	-13.2	266.6	11	1.000487	49052	67.9	18490	0	45434	96.5	299.1	3.2
BH-1	88	-84.87	-3.89	-18.66	-13.1	266.8	11	1.000296	49038	67.9	18437	0	45440	96.8	299.2	1.2
BH-1	91	-87.79	-4.06	-19.34	-13.1	266.8	11	1.000282	49031	67.9	18455	0	45426	96.8	299.3	0.7
BH-1	94	-90.71	-4.22	-20.03	-13.1	266.7	11	1.000122	49080	67.9	18447	0	45482	97.2	299.7	1
BH-1	97	-93.62	-4.39	-20.71	-13.2	266.7	11	1.000303	49066	67.9	18470	0	45457	97.6	300.1	0.6
BH-1	100	-96.54	-4.55	-21.4	-13.2	266.7	11	1.000268	49068	67.8	18503	0	45445	97.5	300.1	0.5
BH-1	103	-99.47	-4.63	-22.05	-11.8	270.2	11	0.995246	49056	68.6	17887	0	45678	98.2	300	37
BH-1	106	-102.39	-4.71	-22.7	-13.3	266.7	11	1.00031	49060	67.9	18480	0	45446	97.7	300.2	37.4
BH-1	109	-105.31	-4.88	-23.39	-13.3	266.6	11	1.000017	49021	67.9	18429	0	45425	97.8	300.3	0.7
BH-1	112	-108.22	-5.05	-24.08	-13.4	266.5	11	1.000223	49056	67.9	18482	0	45442	98	300.5	1.5
BH-1	115	-111.13	-5.22	-24.78	-13.4	266.7	11	1.000889	49063	67.9	18460	0	45457	98	300.5	1.4
BH-1	118	-114.05	-5.4	-25.48	-13.5	266.5	11	1.000317	49027	67.9	18468	0	45416	98.3	300.8	2.1
BH-1	121	-116.96	-5.58	-26.18	-13.4	266.6	11	1.000141	49042	67.9	18448	0	45440	98.3	300.8	1.2
BH-1	124	-119.87	-5.75	-26.88	-13.5	266.5	11	1.000272	49046	67.9	18477	0	45433	98.3	300.9	0.9
BH-1	127	-122.78	-5.93	-27.58	-13.5	266.5	11	0.99995	49034	67.9	18473	0	45422	98.3	300.8	0.6
BH-1	130	-125.69	-6.11	-28.28	-13.6	266.4	11	1.000699	49079	67.9	18430	0	45487	98.2	300.7	0.8
BH-1	133	-128.6	-6.29	-28.99	-13.6	266.6	11	1.00039	49055	67.9	18443	0	45456	98.2	300.8	1.6
BH-1	136	-131.51	-6.47	-29.7	-13.7	266.3	11	0.999701	49064	67.9	18444	0	45466	98	300.5	2.8
BH-1	139	-134.42	-6.65	-30.41	-13.7	266.4	11	1.000129	49052	67.9	18462	0	45445	98.2	300.7	0.9
BH-1	142	-137.33	-6.83	-31.12	-13.8	266.4	11	1.000614	49054	67.9	18477	0	45441	98.7	301.3	0.9
BH-1	145	-140.24	-7.02	-31.83	-13.8	266.3	11	1.000523	49075	67.9	18474	0	45465	98.7	301.2	0.7
BH-1	148	-143.14	-7.21	-32.55	-13.8	266.3	11	1.000394	49034	67.9	18471	0	45422	98.9	301.5	0.6

Survey name	Station	East	North	Elevation	Dip	Azimuth	Tool–	Gravity	Mag.Str.	Mag.Dip	Mag.X	Mag.Y	Mag.Z	Roll Angle	Mag.T/face	DLS
*	Metres	Metres	Metres	Metres	Degrees	Degrees	Centigrade	G	nT	Degrees	nT	nT	nT	Degrees	Degrees	deg./30m
BH-1	151	-146.05	-7.39	-33.26	-13.8	266.4	11	1.000164	49043	67.9	18474	0	45430	98.9	301.5	1.5
BH-1	154	-148.96	-7.57	-33.98	-13.9	266.4	11	1.000365	49066	67.9	18451	0	45464	99.1	301.6	1
BH-1	157	-151.87	-7.76	-34.7	-13.9	266.3	11	1.000252	49055	67.8	18506	0	45430	99.2	301.8	1
BH-1	160	-154.77	-7.95	-35.43	-14	266.2	11	0.999691	49068	67.9	18477	0	45456	99.2	301.7	0.6
BH-1	163	-157.68	-8.14	-36.15	-14	266.3	11	1.001008	49040	67.9	18411	0	45453	99.3	301.8	0.5
BH-1	166	-160.58	-8.33	-36.88	-14	266.2	11	0.999912	49061	67.9	18462	0	45455	100.3	302.8	0.6
BH-1	169	-163.48	-8.52	-37.6	-14	266.3	11	1.00026	49044	67.9	18480	0	45430	100.3	302.9	1.2
BH-1	172	-166.39	-8.71	-38.33	-14.1	266.4	11	1.000443	49080	67.9	18462	0	45476	100.3	302.8	0.4
BH-1	175	-169.29	-8.89	-39.06	-14.1	266.2	11	0.999983	49089	67.9	18458	0	45487	100.3	302.8	1.5

APPENDIX II

Rotary Core Log

Borehole No.
BH01
Sheet 1 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level: 16.71	Scale 1:50
Client:	Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		0.00 - 5.60								Concrete Plinth
		5.60 - 6.30	14	100	60	41	5.60	11.11		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. (Core invert not marked)
		6.30 - 7.52	3	100	100	100	6.30	10.41		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Sub-vertical stylolites, occasional coarse shelled bioclast (Brachiopod)
		7.52 - 10.15	6	100	89	81	7.52	9.19		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Occasional fine grained scattered bioclasts, minor stylolites

Continued on next sheet

Remarks

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Borehole No. **BH01** Sheet 2 of 28
				Hole Type RC
Location:	Galway		Level: 16.71	Scale 1:50
Client:	Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.15 - 11.10	2	88	88	88	10.15	6.56		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Very occasional fine grained bioclast
		11.10 - 12.66	5	100	44	38	11.10	5.61		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. pellety / slightly oolitic texture
		12.66 - 14.20	2	100	100	96	12.66	4.05		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. pellety / slightly oolitic intervals with small rounded bioclasts
		14.20 - 14.58	18	100	29	29	14.20	2.51		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Intersecting conjugate joints
		14.58 - 15.46	2	100	100	100	14.58	2.13		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Minor white calcite fill along joint
		15.46 - 15.86	15	100	25	0	15.46	1.25		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. White calcite fill and weak oxidation along steeply dipping joint surface
		15.86 - 17.04	2	100	100	100	15.86	0.85		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. pellety / slightly oolitic texture, minor thick shelled brachiopods
		17.04 - 21.07	3	97	87	86	17.04	-0.33		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Slightly pellety scattered fine bioclastic debris with occasional coarse shelled brachiopod fragment

Continued on next sheet

Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 3 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56
Location:	Galway		Level: 16.71
Client:	Galway County Council		Dates: 13/11/2015 - 21/12/2015

Hole Type: RC
Scale: 1:50
Logged By: Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		21.07 - 21.60	23	100	53	40	21.07	-4.36		Strong. fresh, grey / pale grey, fine to medium grained, massive LIMESTONE. minor bioclastic debris and white calcite veinlets, basal 10cm is rubble
		21.60 - 22.75	3	100	100	100	21.60	-4.89		Strong. fresh, grey / pale grey, fine to medium grained, massive LIMESTONE. Occasional coarse shelled brachiopod fragments
		22.75 - 24.34	4	100	78	65	22.75	-6.04		Strong. fresh, grey / pale grey, fine to medium grained, massive LIMESTONE. Thin, discontinuous white/pink dolomite veinlets dipping at 45'. Minor scattered fine grained bioclasts and very fine stylolites
		24.34 - 24.73	15	92	0	0	24.34	-7.63		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Cavity developed with weak oxidation and pitting / dissolution on contacts
		24.73 - 31.68	2	100	100	100	24.73	-8.02		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. with hairline white calcite veinlets dipping at 50 - 70'. Minor scattered poorly sorted bioclastic debris. Fine sub-vertical stylolites

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Remarks

Rotary Core Log

			Borehole No. **BH01** Sheet 4 of 28
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56
Hole Type	RC		
Location:	Galway	Level:	16.71
Scale	1:50		
Client:	Galway County Council	Dates:	13/11/2015 - 21/12/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
											31
		31.68 - 33.22	7	100	77	55	31.68	-14.97		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. fine sub-vertical stylolites. 31.78m calcite filled vugs locally developed	32 33
		33.22 - 37.10	2	100	97	95	33.22	-16.51		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Small scattered bioclasts, very rare coarse shell and coral fragment. Minor fine stylolites	34 35 36 37
		37.10 - 38.70	6	100	59	51	37.10	-20.39		Strong. fresh, brownish pale grey, fine to medium grained, massive LIMESTONE. Fine grained scattered bioclastic debris, minor very fine stylolites	38
		38.70 - 40.45	2	100	100	100	38.70	-21.99		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Very minor scattered bioclastic debris, minor orange limonitic staining along a joint surface at 39.35m	39 40

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 5 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		40.45 - 43.30	3	100	90	88	40.45	-23.74		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Minor bioclastic debris, and fine stylolites
		43.30 - 44.30	6	90	9	0	43.30	-26.59		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Fine vuggy texture and faint stylolites
		44.30 - 52.98	6	100	96	91	44.30	-27.59		Strong. fresh, light grey, fine to medium grained, massive LIMESTONE. Scattered bioclastic debris, fragments of coarse shelled brachiopods or solitary corals. locally developed fine vuggy texture (49.1 - 49.55m). White calcite veinlets dip 90', azimuth 020' to core invert

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 6 of 28

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Hole Type RC
Location: Galway		Level: 16.71	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		52.98 - 53.74	9	97	37	13	52.98	-36.27		Strong. fresh, light grey, fine to medium grained, massive LIMESTONE. Minor fine stylolites
		53.74 - 56.10	3	94	94	90	53.74	-37.03		Strong. fresh, light grey, fine to medium grained, massive LIMESTONE. Very rare small bioclastic fragments, fine stylolites
		56.10 - 58.60	3	100	96	92	56.10	-39.39		Strong. fresh, grey, medium grained, massive LIMESTONE. Pellety texture with scattered small bioclastic fragments and faint stylolites.
							58.60	-41.89		Strong. fresh, light grey, fine to medium grained, massive LIMESTONE. Minor bioclastic debris, and fine stylolites

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 7 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56
Hole Type	RC		
Location:	Galway	Level:	16.71
Scale	1:50		
Client:	Galway County Council	Dates:	13/11/2015 - 21/12/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		58.60 - 61.47	3	100	99	99				
		61.47 - 62.25	10	100	55	47	61.47	-44.76		Strong. fresh, light grey, fine to medium grained, massive LIMESTONE. Fine vuggy texture, 61.94m a 1cm thick white calcite vein dipping at 80' azimuth 185' to core invert
		62.25 - 63.73	1	100	100	100	62.25	-45.54		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Occasional fine stylolite
		63.73 - 64.22	10	94	69	61	63.73	-47.02		Strong. fresh, grey/light grey, fine to medium grained, massive LIMESTONE. Minor bioclastic debris, and fine stylolites. Some coarse vugs (6mm wide) irregular shaped with orange/brown limonitic infill
		64.22 - 67.85	3	100	100	100	64.22	-47.51		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Incipient pellety texture , scattered bioclastic debris, and faint stylolites
		67.85 - 68.78	9	92	77	60	67.88	-51.17		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Minor bioclastic debris, and fine stylolites

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 8 of 28

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Hole Type RC
Location: Galway		Level: 16.71	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		68.78 - 72.31	3	98	96	96				
		72.31 - 73.39	6	100	30	19	72.31	-55.60		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Minor bioclastic debris, and fine stylolites. Axial parallel jointing
		73.39 - 75.70	3	100	94	94	73.39	-56.68		Strong. fresh, pale grey, fine grained, massive LIMESTONE. Minor fine stylolites
		75.70 - 76.37	12	96	67	16	75.70	-58.99		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE.
		76.37 - 77.60	2	100	100	95	76.37	-59.66		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Fine stylolites
		77.60 - 78.20	20	100	12	0	77.60	-60.89		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. 77.85m 1cm thick white calcite vein, 78.16m 1cm thick white orange calcite vein (Fe stains)
							78.20	-61.49		Strong. fresh, pale grey, fine grained, massive LIMESTONE. Numerous stylolites

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 9 of 28

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Hole Type RC
Location: Galway		Level: 16.71	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		78.20 - 86.15	3	99	99	98					81 82 83 84 85 86
		86.15 - 88.77	2	100	96	96	86.15	-69.44		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Occasional stylolites and fine grained bioclastic debris. 87.06m - 1cm thick white calcite vein	87 88
		88.77 - 90.30	7	100	49	23	88.77	-72.06		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. 90.09m - 2cm thick white calcite vein. Locally developed fine vuggy texture	89 90

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Remarks

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH01** Sheet 10 of 28
Co-ords:	530370.59 - 728426.56		Hole Type RC
Location:	Galway		
Level:	16.71		Scale 1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015		Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		90.30 - 95.95	2	100	99	98	90.30	-73.59		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Minor faint stylolites
		95.95 - 100.33	3	99	94	89	95.95	-79.24		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. small scattered bioclasts with some large (7cm dia.) coarse shelled brachiopods

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Remarks

Rotary Core Log

Borehole No.

BH01

Sheet 11 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		100.33 - 102.74	6	97	85	71	100.33	-83.62		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Scattered small partially oxidised vugs. 101.4 & 101.43m 1cm thick white calcite veins dip 90' Azimuth 360'
		102.74 - 105.90	3	100	99	99	102.74	-86.03		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Fine bioclastic debris scattered throughout
		105.90 - 108.60	2	100	100	99	105.90	-89.19		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Thin (c.1mm), randomly orientated white / brown calcite veinlets over top 40cm. scattered fine bioclastic debris and fine stylolites
							108.60	-91.89		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Occasional scattered fine bioclastic debris and fine stylolites . Minor white calcite veining dipping at 85' to 180'

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 12 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		108.60 - 111.55	5	100	98	86				
		111.55 - 113.73	1	100	100	100	111.55	-94.84		Strong. fresh, grey, fine grained, massive LIMESTONE. Fine black stylolites
		113.73 - 114.33	3	100	0	0	113.73	-97.02		Strong. fresh, grey, fine grained, massive LIMESTONE. Fine grained bioclastic debris. Axial parallel jointing
		114.33 - 119.52	1	100	100	98	114.33	-97.62		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Disseminated very fine grained bioclastic debris
							119.52	-102.81		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Faint pellety texture, etched stylolites and scattered small vugs, often

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Remarks

Rotary Core Log

Borehole No.	**BH01**	Sheet 13 of 28	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530370.59 - 728426.56	Hole Type	RC
Location:	Galway		
Level:	16.71	Scale	1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	**Coring** TCR	SCR	RQD	Depth (m)	Level (m)	Legend	Stratum Description	
										weakly oxidised. Disseminated fine grained bioclastic debris	121 122 123
		119.52 - 127.29	4	100	95	87					124 125 126 127
		127.29 - 128.75	6	99	97	82	127.29	-110.58		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Incipient mottled texture and scattered fine bioclastic debris.	128
							128.75	-112.04		Strong. fresh, dark grey, fine to medium grained, massive LIMESTONE. Wispy black argillaceous partings. Scattered fine bioclastic debris with some coarse shelled brachiopods / gastropods. thick black stylolites with argillic infill. Occasional white calcite veinlet	129 130

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Remarks

Rotary Core Log

					Borehole No. **BH01** Sheet 14 of 28
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		128.75 - 134.90	1	100	97	97				
		134.90 - 136.05	4	84	84	84	134.90	-118.19		Strong. fresh, dark grey, fine to medium grained, massive LIMESTONE. Wispy black argillaceous partings. Scattered fine bioclastic debris with some coarse shelled brachiopods.
		136.05 - 137.52	3	100	100	95	136.05	-119.34		Strong. fresh, dark grey, fine to medium grained, massive LIMESTONE. Weak intraclastic breccia texture minor stylolites and black argillic partings
		137.52 - 141.84	2	100	100	100	137.52	-120.81		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Small scattered bioclasts, incipient intraclastic breccia texture locally developed minor discontinuous white calcite veinlets

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Remarks

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Borehole No. **BH01** Sheet 15 of 28
Location: Galway		Level: 16.71	Hole Type RC
Client: Galway County Council		Dates: 13/11/2015 - 21/12/2015	Scale 1:50
			Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
											141
		141.84 - 142.93	3	100	100	100	141.84	-125.13		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Small scattered bioclasts, incipient bioturbated / burrowed texture	142
		142.93 - 143.70	0	100	100	100	142.93	-126.22		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE.. Pellety / almost oolitic texture	143
		143.70 - 148.30	1	100	100	100	143.70	-126.99		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Intraclastic breccia texture sub-rounded clasts 0.5 - 2.0cm dia. possibly related to bioturbation / burrowing. Minor stylolites and a very rare bioclast	144 145 146 147 148
		148.30 - 148.90	10	100	0	0	148.30	-131.59		Core is crosscut by a 2cm thick band of weak / very weak, fresh, fine grained Black MUDSTONE. Soft / Friable texture, locally altered to clay dip 32' to 060'	
							148.90	-132.19		Strong. fresh, dark grey / black, fine to medium grained, massive LIMESTONE. Intraclastic breccia texture poorly sorted, very irregular / angular clasts of fine grained limestone (micrite) in a black / dark grey locally argillaceous matrix. Intensity of brecciation decreasing with depth	149 150

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 16 of 28

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Hole Type RC
Location: Galway		Level: 16.71	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		148.90 - 154.60	2	100	99	97				
							154.60	-137.89		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Stylolites locally up to 3mm thick. Minor bioclastic debris. Locally developed incipient intraclastic breccia / bioturbation textures
		154.60 - 161.75	1	100	100	71				

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Remarks

Rotary Core Log

Borehole No.

BH01

Sheet 17 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
									▦	
		161.75 - 166.30	1	100	100	98	161.75	-145.04	▦	Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Locally developed pellety / oolitic texture. Scattered bioclastic debris
		166.30 - 168.90	1	100	100	99	166.30	-149.59	▦	Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Numerous coarse bioclasts and white calcite infilling small voids
							168.90	-152.19	▦	Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Slight pellety texture. Scattered fine to medium grained bioclasts

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 18 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530370.59 - 728426.56	Hole Type	RC
Location:	Galway		
Level:	16.71	Scale	1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		168.90 - 172.00	1	100	100	100				
key key incorrect incorrect inc key key incorrect incorrect inc key key		172.00 - 175.65	2	100	100	99	172.00	-155.29		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE.
		175.65 - 177.00	1	100	100	100	175.65	-158.94		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Scattered coarse shelled brachiopods
		177.00 - 182.50	1	100	100	100	177.00	-160.29		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Minor stylolites, some up to 2mm thick. Scattered fine bioclastic debris

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Remarks

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH01** Sheet 19 of 28
Co-ords:	530370.59 - 728426.56		Hole Type RC
Location:	Galway		
Level:	16.71		Scale 1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015		Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
											181 182
		182.50 - 186.80	1	100	100	99	182.50	-165.79		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Locally developed incipient intraclastic breccia texture. Fine stylolites and minor bioclasts	183 184 185 186
		186.80 - 189.00	0	0	0	0	186.80	-170.09		Cavity - No recovery. Pitting / dissolution textures and slight brown oxidation on contacts	187 188
		189.00 - 190.30		100	0	0	189.00	-172.29		Soft to firm, light brown, fine grained sandy CLAY. Some tabular / angular clasts of light brown oxidised mudstone within the clay	189 190

Continued on next sheet

Remarks

Rotary Core Log

Borehole No.	**BH01**	Sheet 20 of 28	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530370.59 - 728426.56	Hole Type	RC
Location:	Galway		
Level:	16.71	Scale	1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
			0							
		190.30 - 191.20	0	100	100	100	190.30	-173.59		Strong. fresh, grey, fine to medium grained, massive LIMESTONE.
		191.20 - 192.85	8	100	64	41	191.20	-174.49		Strong. fresh, grey / dark grey, fine to medium grained, massive LIMESTONE.
		192.85 - 195.70	1	100	100	100	192.85	-176.14		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Light brown sandy clay coating joint surfaces
		195.70 - 198.70	1	100	100	100	195.70	-178.99		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Scattered coarse shelled brachiopods
							198.70	-181.99		Strong. fresh, light grey / grey, fine to medium grained, massive LIMESTONE. Occasional coarse shelled brachiopod, locally developed incipient intraclastic breccia texture

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 21 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
		198.70 - 203.00	2	91	91	91					201 202
		203.00 - 203.90	9	94	94	56	203.00	-186.29		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Minor coarse shelled brachiopods. Joints coated with light brown fine sandy clay	203
		203.90 - 207.50	1	100	98	98	203.90	-187.19		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Scattered coarse shelled brachiopods	204 205 206 207
							207.50	-190.79		Strong. fresh, grey, fine to medium grained, massive LIMESTONE.	208 209 210

Continued on next sheet

Remarks

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530370.59 - 728426.56	Borehole No. **BH01** Sheet 22 of 28
					Hole Type RC
Location:	Galway		Level:	16.71	Scale 1:50
Client:	Galway County Council		Dates:	13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		207.50 - 214.50	1	100	100	99			▦		211 212 213 214
		214.50 - 216.90	2	100	90	90	214.50	-197.79	▦	Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. disseminated bioclastic debris	215 216
		216.90 - 217.60	3	100	100	100	216.90	-200.19	▦	Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Slightly vuggy with minor oxidation focused upon vugs	217
		217.60 - 221.55	4	97	87	78	217.60	-200.89	▦	Strong. fresh, light grey / grey, fine to medium grained, massive LIMESTONE.	218 219 220

Continued on next sheet

Remarks

Rotary Core Log

Borehole No.	**BH01**
Sheet 23 of 28	
Project Name:	Lackagh Quarry Preliminary Ground Investigation
Project No.	Lackagh Quarry
Co-ords:	530370.59 - 728426.56
Hole Type	RC
Location:	Galway
Level:	16.71
Scale	1:50
Client:	Galway County Council
Dates:	13/11/2015 - 21/12/2015
Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		221.55 - 223.55	5	100	98	96	221.55	-204.84		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Minor oxidation and light brown clay localised along joints and along some stylolites
		223.55 - 226.55	3	97	84	81	223.55	-206.84		Strong. fresh, pale grey/ grey, medium grained, massive LIMESTONE. Distinct pellety texture, fine grained bioclastic debris. 226.4 - 226.5 evidence of oxidation, dissolution (pitting) along a shallowly dipping joint plane
		226.55 - 229.10	3	100	97	95	226.55	-209.84		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. slight dissolution and oxidation focused on some joint surfaces
		229.10 - 229.20	0	0	0	0	229.10	-212.39		Cavity infilled with light brown soft / firm sticky clay
							229.20	-212.49		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Slight discolouration and oxidation along some joint surfaces

Continued on next sheet

Remarks

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH01** Sheet 24 of 28
Co-ords:	530370.59 - 728426.56		Hole Type RC
Location:	Galway		
Level:	16.71		Scale 1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015		Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		229.20 - 231.10	4	95	91	86				
		231.10 - 233.20	1	100	98	95	231.10	-214.39		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE.
		233.20 - 234.15	11	91	79	45	233.20	-216.49		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Joints and fractures infilled with light brown fine / medium grained sand. 232.78 2cm white calcite vein
		234.15 - 237.55	6	99	80	70	234.15	-217.44		Strong. fresh, grey, fine to medium grained, massive LIMESTONE. Locally developed fine vuggy texture. 236.6m joint with intense bright orange Fe Staining.
		237.55 - 239.20	0	0	0	0	237.55	-220.84		CAVITY - coarse grained yellow sand and angular gravel with some light brown silt. Recover 30 - 35%
							239.20	-222.49		Strong. fresh, light grey / grey, fine to medium grained, massive LIMESTONE. Locally developed coarse vuggy texture - vugs up to 5mm dia.

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Remarks

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH01** Sheet 25 of 28
Co-ords:	530370.59 - 728426.56		Hole Type RC
Location:	Galway		
Level:	16.71		Scale 1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 21/12/2015		Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		239.20 - 241.40	6	50	19	13	241.40	-224.69		
		241.40 - 243.90	4	100	97	95	243.90	-227.19		Strong. fresh, pale grey, fine to medium grained, massive LIMESTONE. Scattered poorly sorted bioclastic debris. Fine grained orange brown sand coating joint surfaces
		243.90 - 245.58	7	85	36	29	245.58	-228.87		Strong. slightly weathered, pale grey, fine to medium grained, massive LIMESTONE. 243.9-244.35m axial parallel discontinuity with black argillaceous lamina. Orange brown clayey sand coating joint surfaces
		245.58 - 247.25	0	0	0	0	247.25	-230.54		CAVITY - 5% recovery of yellow brown fine to medium grained sand
		247.25 - 248.37	4	100	61	38	248.37	-231.66		Strong. fresh, pale grey / grey, mottled, fine to medium grained, massive LIMESTONE. Fine vuggy texture with minor oxidation / Fe staining localised within the vugs. Some axial parallel jointing
		248.37 - 250.20	3	100	97	93				Strong. fresh, dark grey, medium grained, massive LIMESTONE. Poorly sorted bioclastic debris

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Remarks

Rotary Core Log

Borehole No.
BH01
Sheet 26 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56
Hole Type	RC		
Location:	Galway	Level:	16.71
Scale	1:50		
Client:	Galway County Council	Dates:	13/11/2015 - 21/12/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		250.20 - 253.00	2	100	98	98	250.20	-233.49		Strong. fresh, dark grey, medium grained, massive LIMESTONE. Poorly sorted bioclastic debris. Discontinuous randomly orientated white calcite veinlets
		253.00 - 255.50	2	100	92	92	253.00	-236.29		Strong. fresh, grey, medium grained, massive LIMESTONE. Scattered poorly sorted bioclastic debris. Incipient intraclastic breccia texture
		255.50 - 255.90	7	100	0	0	255.50	-238.79		Strong. grey LIMESTONE cross cut by cavity / dissolution zone bright orange staining and dissolution textures on cavity contact
		255.90 - 256.90	4	100	60	60	255.90	-239.19		Strong. fresh, grey, medium grained, massive LIMESTONE. Scattered bioclastic debris
		256.90 - 257.35	22	78	0	0	256.90	-240.19		Moderately strong, black, fine to medium grained LIMESTONE - black argillite rich zones - Rubble poorly sorted fragments with some polished surfaces.
		257.35 - 259.40	3	100	68	68	257.35	-240.64		Moderately strong. black / dark grey, fine to medium grained, massive LIMESTONE. Intraclastic breccia, irregular poorly sorted limestone clasts in a black argillite rich matrix
		259.40 - 259.50	0	100	0	0	259.40	-242.69		Strong. fresh, dark grey, medium grained, massive LIMESTONE.

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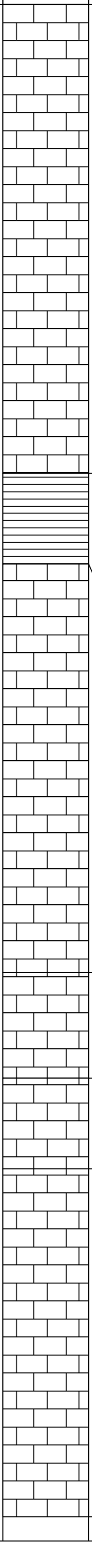
Remarks

Rotary Core Log

Borehole No.	**BH01**	Sheet 27 of 28

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Hole Type RC
Location:	Galway		Level: 16.71	Scale 1:50
Client:	Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		259.50 - 263.10	3	100	90	87				
		263.10 - 263.70	3	58	0	0	263.10	-246.39		Weak, black / grey MUDSTONE, running sub-parallel to core axis band is 2 - 3cm thick and partially altered to clay. The contact with the limestone shows evidence of oxidation / Fe staining
		263.70 - 266.40	2	100	100	100	263.70	-246.99		Strong. fresh, grey / pale grey, medium grained, massive LIMESTONE. Mottled and evidence of bioturbation / burrowing. 265.4 - 265.46 fracture zone with rubble and coarse brown sand
		266.40 - 267.10	17	100	40	40	266.40	-249.69		Strong. fresh, grey / pale grey, medium grained, massive LIMESTONE. Mottled and evidence of bioturbation / burrowing. Core is coated with coarse brown sand
		267.10 - 267.70	2	100	100	100	267.10	-250.39		Strong. fresh, grey / pale grey, medium grained, massive LIMESTONE. Mottled and evidence of bioturbation / burrowing.
		267.70 - 270.30	6	100	55	52	267.70	-250.99		Strong. fresh, grey / dark grey, medium grained, massive LIMESTONE. Occasional stylolitic and axial parallel joint



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Remarks

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Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530370.59 - 728426.56	Borehole No. **BH01** Sheet 28 of 28
				Hole Type RC
Location:	Galway		Level: 16.71	Scale 1:50
Client:	Galway County Council		Dates: 13/11/2015 - 21/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
									▦	
		270.30 - 272.40	1	100	100	100	270.30	-253.59	▦	Strong. fresh, grey / dark grey, medium grained, massive LIMESTONE.
		272.40 - 273.40	0	0	0	0	272.40	-255.69		CAVITY no recovery
		273.40 - 274.16	5	79	39	20	273.40	-256.69	▦	Strong. fresh, very pale grey, medium grained, massive LIMESTONE. Probably a boulder within cavity / unconsolidated sediments
		274.16 - 276.70	0	8	0	0	274.16	-257.45		CAVITY - unconsolidated ground only 10% medium to coarse limestone cobbles and some gravel recovered
							276.70	-259.99		End of borehole at 276.70 m

Remarks

AGS

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH03** Sheet 1 of 11
Co-ords:	530023.82 - 728382.57		Hole Type RC
Location:	Galway	Level: 26.26	Scale 1:50
Client:	Galway County Council	Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
									▨	No Recovery
							1.20	25.06	▨	Very soft, light brown, sandy CLAY with minor angular gravel
							1.45	24.81	▨	Rubble of sub-angular to sub-rounded grey Limestone fragments and minor creamy coloured calcite. Lumps of soft light grey/brown clay. (Recovery 0.35m)
							2.70	23.56	▨	Stiff, grey brown, sandy CLAY, occasional sub angular gravel and cobbles of dark grey limestone
							3.00	23.26	▨	Coarse cobbles of dark grey limestone with firm / stiff grey brown sandy clay
							3.20	23.06	▨	Coarse COBBLES with gravel. Sub-angular to sub-rounded grey / dark grey limestone with minor pink (tonalitic) granite
							3.55	22.71	▨	Core loss
		4.15 - 4.42	C				4.00	22.26	▨	Stiff / very stiff, light grey/brown sandy CLAY with minor (10 - 15%) scattered angular limestone gravel
							4.85	21.41	▨	Stiff / very stiff, light grey/brown sandy CLAY with angular limestone gravel & cobbles
							6.00	20.26	▨	Core loss
							6.55	19.71	▨	Stiff / very stiff, light grey/brown sandy CLAY with angular limestone gravel, cobbles and occasional boulders
							6.85	19.41	▨	Stiff / very stiff, grey / brown sandy CLAY with (12 - 20%) angular limestone gravel and occasional sub-rounded cobbles
							7.65	18.61	▨	Core loss
							8.05	18.21	▨	Loose angular GRAVEL with cobbles. Coated with stiff sandy clay
							8.25	18.01	▨	Stiff / very stiff, light grey / brown, sandy CLAY, 205 sub-angular / sub-rounded gravel and occasional sub-rounded cobble and small boulder

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Remarks
All angles measured relative to core normal

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530023.82 - 728382.57	Borehole No. **BH03** Sheet 2 of 11
			Hole Type RC
Location: Galway		Level: 26.26	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							11.55	14.71		Stiff / very stiff, light grey / brown, sandy CLAY, 205 sub-angular / sub-rounded gravel and occasional sub-angular cobbles and small boulder
							12.94	13.32		Soft, dark chocolate brown CLAY
							12.98	13.28		Core Loss
		13.65 - 13.73 13.73 - 13.85	D D				13.65	12.61		Soft / very soft, greenish grey, fine sandy SILT (recovery 0.5m)
		14.90 - 15.00	D				14.75	11.51		Core Loss
							16.15	10.11		Soft / firm, grey / green SILT
							16.45	9.81		Soft / very soft, grey brown SILT with very thin clay laminae (Mobilised and coating surface by drilling additive)
							16.85	9.41		Core loss
		19.00 - 19.10 19.10 - 19.20	D D				18.60	7.66		Soft / very soft, grey SILT
		19.25 - 19.30 19.90 - 20.00	D D				19.25	7.01		Soft / firm, grey SILT, locally developed faint brown laminae (smearing of clay surface)

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Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Borehole No.
BH03
Sheet 3 of 11

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530023.82 - 728382.57	Hole Type RC
Location:	Galway		Level: 26.26	Scale 1:50
Client:	Galway County Council		Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.95 - 21.05	D						× × ×	
		21.30 - 21.40	D						× × ×	
							21.70	4.56	× × ×	Very soft / soft, grey SILT (Recovery 50%)
							23.00	3.26	× × ×	Soft / firm, grey SILT (Recovery 60%)
							25.20	1.06	× × ×	Soft / very soft, grey SILT (Recovery 90%)
		25.50 - 25.60	D							
		25.80 - 25.90	D							
		26.50 - 26.60	D							
		26.70 - 26.80	D							
		27.20 - 27.25	D							
		27.45 - 27.55	D				27.50	-1.24	× × ×	Firm grey SILT with centimetric scale horizontal banding
		27.55 - 27.65	D							
							28.45	-2.19	× × ×	Soft, grey SILT (recovery 60%)
							30.00	-3.74		

Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Borehole No.
BH03
Sheet 4 of 11

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530023.82 - 728382.57	Hole Type RC
Location: Galway		Level: 26.26	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
		30.25 - 30.33	D							Soft / firm grey SILT	
											31
		31.20 - 31.30	D								
		31.35 - 31.45	D								
							31.73	-5.47		Firm, grey / brown SILT	
											32
							32.40	-6.14		Soft, grey SILT	
											33
		33.70 - 33.80	D								
		33.95 - 34.03	D								34
							34.60	-8.34		Soft / Firm, light grey SILT. Minor fine grained sand	
											35
		36.05 - 36.15	D				36.05	-9.79		Loose / medium dense, light grey / brown, silty SAND (recovery 30%)	36
		36.70 - 36.80	D								
											37
											38
							38.38	-12.12		Firm, dark chocolate brown organic CLAY, Small fibres bottom 0.5m of core coated with fine grained grey sand	
		38.60 - 38.70	D								
		38.95 - 39.05	D								39
		39.25 - 39.30	D								
		39.45 - 39.55	D								
		39.80 - 39.83	D								
											40

Continued on next sheet

Remarks
All angles measured relative to core normal

AGS

Rotary Core Log

Borehole No.
BH03
Sheet 5 of 11

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530023.82 - 728382.57	Hole Type RC
Location: Galway		Level: 26.26	Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	SCR	RQD	Depth (m)	Level (m)	Legend	Stratum Description
		40.65 - 40.77	D				40.65	-14.39		Loose / medium dense, grey, fine to medium grained SAND (recovery 60%)
							41.00	-14.74		Firm grey / brown, organic CLAY, minor dark brown banding 0.5 - 1cm thick
		41.20 - 41.25	D							
		41.30 - 41.50	C							
							41.80	-15.54		Stiff / very stiff, dark brown, organic CLAY. Basal 4cm laminated - light / dark brown millimetric scale laminae
		41.85 - 42.08	C							
		42.30 - 42.35	D							
		42.35 - 42.40	D				42.40	-16.14		Firm / stiff, dark brown grey, CLAY
		42.65 - 42.97	C							
		42.97 - 43.30	C							
							43.25	-16.99		Soft to firm light grey CLAY
		44.05 - 44.20	C							
							44.20	-17.94		Core Loss
							44.85	-18.59		Firm, dark grey brown CLAY
							45.24	-18.98		Soft, grey SILT
							45.30	-19.04		Very Stiff, Dark brown / grey, organic CLAY
		46.20 - 46.27	D							
		46.27 - 46.59	C							
		47.00 - 47.10	D							
		47.20 - 47.27	D							
		47.45 - 47.55	D							
		47.85 - 48.02	C							
		48.20 - 48.30	D							
		48.45 - 48.70	C							
		49.00 - 49.10	D							
		49.30 - 49.40	D							
							50.00	-23.74		

Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Borehole No.	**BH03**
Sheet 6 of 11	
Project Name:	Lackagh Quarry Preliminary Ground Investigation
Project No.	Lackagh Quarry
Co-ords:	530023.82 - 728382.57
Hole Type	RC
Location:	Galway
Level:	26.26
Scale	1:50
Client:	Galway County Council
Dates:	13/11/2015 - 09/12/2015
Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
							50.35	-24.09		Firm grey CLAY, with cobbles of strong pale grey limestone rounded to sub-angular
							51.30	-25.04		Soft, light greyish brown, cobbly CLAY, cobbles of pale grey limestone, comprise 50% of material
							52.56	-26.30		Boulder of pale grey massive limestone, stylolitic with stylolites rotated to sub-vertical orientation
							56.40	-30.14		Soft / firm, brownish grey gravelly CLAY, angular gravel (10 - 20%), sub-rounded coarse cobbles / small boulders (30 - 40%) of light grey massive limestone. (recovery 80%)
							57.15	-30.89		Sub-rounded COBBLES with coarse gravel - coated by soft light grey clay
							57.85	-31.59		Soft / firm Pale grey CLAY with angular cobbles of grey limestone (recovery 40%)
										Soft grey brown CLAY with angular gravel and cobbles (Recovery 40%)

Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Borehole No.
BH03
Sheet 7 of 11

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530023.82 - 728382.57
Hole Type	RC		
Location:	Galway	Level:	26.26
Scale	1:50		
Client:	Galway County Council	Dates:	13/11/2015 - 09/12/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
							60.55	-34.29		BOULDER of strong, pale grey, fine to medium grained Limestone
							62.20	-35.94		Soft to firm grey brown cobbly CLAY - cobbles of angular limestone
							62.52	-36.26		Stiff brown, organic CLAY
		63.15 - 63.22	D							
		63.38 - 63.43	D							
		63.50 - 63.55	D							
		63.90 - 63.95	D							
							64.05	-37.79		Loose / medium dense, brown / grey, medium grained SAND
							64.11	-37.85		Firm / stiff, brown / dark brown, organic CLAY, Finely laminated (0.5 - 1.5mm laminae) light / dark brown. Occasional small white clay flecks / blebs. Millimetric to centimetric scale bands of fine to medium grained sand, locally developed grading - coarsening down
		64.30 - 64.35	D							
		64.90 - 64.95	D							
		65.50 - 65.60	D							
							65.78	-39.52		Stiff pale grey CLAY
							65.85	-39.59		Firm / stiff, brownish grey, finely laminated CLAY with sub-rounded cobbles of grey limestone, locally friable and broken up in situ
							66.48	-40.22		Firm grey, fine sandy CLAY, with 10% angular gravel
							66.85	-40.59		Firm, pale creamy grey, fine grained sandy CLAY (recovery 80%)
		66.95 - 67.05	D							
							67.65	-41.39		Firm, grey / creamy grey fine sandy CLAY laminated and banded texture with small clasts of creamy white, soft weather limestone
		68.40 - 68.45	D							
							69.15	-42.89		BOULDER of strong, fresh pale grey, fine grained Limestone
							69.89	-43.63		

Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530023.82 - 728382.57	Borehole No. **BH03** Sheet 8 of 11
Location: Galway		Level: 26.26	Hole Type RC
			Scale 1:50
Client: Galway County Council		Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Firm, dark brown / grey, laminated CLAY, with boulders of light grey limestone
		70.40 - 70.50	D							
		70.75 - 70.85	D							
							72.98	-46.72		Soft / firm, grey / brown fine sandy CLAY with angular fine to medium grained limestone gravel and cobbles
							73.95	-47.69		Loose. light grey / brown medium grained SAND, with bands of soft brown clay (Recovery 50%)
							75.00	-48.74		BOULDER of strong, fresh, pale grey Limestone
							76.14	-49.88		Firm dark brown organic CLAY, minor coarse grained gravel
							76.35	-50.09		Soft dark brown organic CLAY - very light / low density
							76.42	-50.16		Soft light brown / grey, gravelly CLAY, 50 -60% coarse angular gravel and occasional cobbles, poor recovery of clay but all cobbles / gravel have a clay coating
							79.10	-52.84		BOULDER of strong light grey limestone
							79.54	-53.28		Soft / firm grey brown sandy CLAY, with sub-angular limestone gravel / cobbles

Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Borehole No.	**BH03**	Sheet 9 of 11	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No.	Lackagh Quarry
Co-ords:	530023.82 - 728382.57	Hole Type	RC
Location:	Galway	Level:	26.26
Scale	1:50		
Client:	Galway County Council	Dates:	13/11/2015 - 09/12/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							80.10	-53.84		Loose coarse gravelly COBBLES of light grey limestone. evidence of reworking by the bit
							85.55	-59.29		Tricone drilling - Open hole drilling - no recovery

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Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH03** Sheet 10 of 11
Co-ords:	530023.82 - 728382.57		Hole Type RC
Location:	Galway	Level: 26.26	Scale 1:50
Client:	Galway County Council	Dates: 13/11/2015 - 09/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
									incorrect key		91 92 93 94 95 96 97 98 99 100

Continued on next sheet

Remarks
All angles measured relative to core normal

Rotary Core Log

Borehole No.	**BH03**	Sheet 11 of 11	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530023.82 - 728382.57	Hole Type	RC
Location:	Galway		
Level:	26.26	Scale	1:50
Client:	Galway County Council		
Dates:	13/11/2015 - 09/12/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	**Coring**			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
							104.95	-78.69		Strong, grey, fine to medium grained, massive LIMESTONE. Discontinuous white calcite veining dipping at 55 - 65' and up to 1cm thick., scatter bioclast debris.
							107.10	-80.84		Rubble of gravel sized pale grey Limestone fragments
		107.50 - 108.16	7	90	52	52	107.50	-81.24		Strong, fresh pale grey, fine grained, massive LIMESTONE. Scattered bioclastic debris, stylolitic thin argillite partings
							108.16	-81.90		Soft, dark brown CLAY, with cobbles of angular / sub-angular limestone
		108.60 - 109.90		100	100	100	108.60	-82.34		Strong, fresh, grey medium grained, massive LIMESTONE. Scattered fine bioclastic debris. 109.4m small calcite filled void with cubic crystals of purple fluorite
							109.90	-83.64		End of borehole at 109.90 m

Remarks

All angles measured relative to core normal

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530150.78 - 728400.13	Borehole No. **BH04** Sheet 1 of 7
					Hole Type RC
Location:	Galway		Level:	32.17	Scale 1:25
Client:	Galway County Council		Dates:	11/11/2015 - 12/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.20		0	0	0	1.20	30.97		No Recovery sandy gravelly soil
		1.20 - 1.35		100	0	0	1.35	30.82		Mid brown, soft CLAY, with fine to medium grained, angular, limestone gravel
		1.35 - 1.50		100	0	0	1.50	30.67		Light grey to pale brown soft CLAY
		1.50 - 2.84		37	0	0	2.84	29.33		Rubble comprising - Strong, Slightly weathered pale grey fine to medium grained LIMESTONE
		2.84 - 3.36		87	13	0	3.36	28.81		Strong, fresh, pale grey to brownish grey, fine to medium grained LIMESTONE
		3.36 - 4.00		100	0	0	4.00	28.17		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Broken in chaotic angular fragments clasts ranging in size from 0.5cm to 10cm across in a matrix of firm to stiff brown / grey clay between fragments and in bands up to 10cm thick.
		4.00 - 4.20	25	100	0	0	4.20	27.97		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. two fracture sets, 1. dipping at 25' Planar / Rough, 2. Dipping at 85', Planar / Rough coated with grey / brown clay.
		4.20 - 4.45		100	0	0	4.45	27.72		A rubble of Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE.
		4.45 - 4.90	9	100	24	24	4.90	27.27		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Two fracture sets, 1. dipping at 15 -30' Planar to slightly undulating / Rough, infilled with grey /brown grey stiff clay with fine grained sand, 2. Dipping at 65', Planar / Rough

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.	**BH04**
	Sheet 2 of 7
Project Name:	Lackagh Quarry Preliminary Ground Investigation
Project No.	Lackagh Quarry
Co-ords:	530150.78 - 728400.13
Hole Type	RC
Location:	Galway
Level:	32.17
Scale	1:25
Client:	Galway County Council
Dates:	11/11/2015 - 12/11/2015
Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	**Coring**			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		4.90 - 5.95	10	100	10	10				Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Etched, sub-horizontal stylolites. Two fracture sets, 1. Closely spaced, dipping at 15-25' Planar to slightly undulating / Rough, coated with light brown / grey clay and fine sand, 2. Dipping at 70 - 90', Planar -undulating/ Rough coated with grey / brown clay and fine grained sand.	
		5.95 - 6.20		88	0	0	5.95	26.22		Rubble of Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Fragments angular and 1 - 7cm across.	6
		6.20 - 7.30	8	100	0	0	6.20	25.97		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE.. Slightly etched stylolites. two fracture sets, 1. dipping at 5 - 20' Planar / Rough,, grey clay infill 2. Dipping at 70 - 90', Planar - undulating / Rough coated with grey / brown clay.	7
		7.30 - 7.53	2	100	100	70	7.30	24.87		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. One fracture set, dipping at 10' Planar / Rough,	
		7.53 - 7.80	7	100	0	0	7.53	24.64		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Sub-horizontal stylolites. 3 - 10cm apart. One fracture set dipping at 70 - 90' Undulating / Rough, brown clay fill - aperture width up to 2mm..	
		7.80 - 8.60	3	100	93	93	7.80	24.37		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Sub horizontal, well developed stylolites two fracture sets, 1. dipping at 5 - 10' Planar / Rough, 2. Dipping at 45', Planar / Rough no infill	8
		8.60 - 11.36	5	100	13	13	8.60	23.57		Strong, fresh, pale grey / brown, fine to medium grained massive LIMESTONE. Sub horizontal stylolites 10-20cm apart. Locally developed, sub -vertical white calcite veinlets at 9.7m. Three fracture sets, 1. dipping at 10 - 25' Undulating to Planar / Rough, locally developed light brown clay and fine grained sand, 2. Dipping at 70 - 90, Planar / Rough coated / infilled with with grey / brown clay. 3. Locally developed (between 9.4 - 97m), dipping at 85' Planar / Rough controlled by hairline white calcite veinlets	9 10

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530150.78 - 728400.13	Borehole No. **BH04** Sheet 3 of 7 Hole Type RC
Location: Galway		Level: 32.17	Scale 1:25
Client: Galway County Council		Dates: 11/11/2015 - 12/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
							11.36	20.81			11
		11.36 - 12.50	8	100	72	66	12.50	19.67		Strong, fresh, grey, fine to medium grained massive LIMESTONE. two fracture sets, 1. dipping at 5-15' Planar / Rough, locally developed thin clay light brown coating, 2. Dipping at 55', Planar / Rough coated with white grey calcite.	12
		12.50 - 15.86	1	100	100	100				Strong, fresh, grey / pale grey, fine to medium grained massive LIMESTONE. Sub horizontal stylolites., minor fine bioclastic debris. One fracture set dipping at 10' Planar / Rough.	13 14 15

Continued on next sheet

Remarks
All angles measured relative to short core axis

Keynetix

Rotary Core Log

Borehole No.	**BH04**	Sheet 4 of 7	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530150.78 - 728400.13	Hole Type	RC
Location:	Galway		
Level:	32.17	Scale	1:25
Client:	Galway County Council		
Dates:	11/11/2015 - 12/11/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
		15.86 - 17.74	6	100	41	41	15.86	16.31		Strong, fresh, grey, slightly mottled, fine to medium grained, massive LIMESTONE. Two fracture sets, 1. dipping at 10-25' undulating / Rough, Grey/brown to orange-brown clay coating fracture surfaces. and locally infilling fractures - aperture up to 2mm thick. 2. Dipping at 60 - 70', Planar / Rough very minor clay coating.	16 17
		17.74 - 18.40	0	100	100	100	17.74	14.43		Strong, fresh, pale grey / grey, slightly mottled, fine to medium grained, massive LIMESTONE. 5mm wide calcite vein dipping at 85'.	18
		18.40 - 18.50		100	0	0	18.40	13.77		Very soft, dark bluish grey CLAY	
		18.50 - 18.60		100	0	0	18.50	13.67		Medium strength, fresh, faintly laminated, black MUDSTONE. Disseminated, sub mm to mm scale blebs of crystalline pyrite. Basal contact has a wavy / undulating nature.	
		18.60 - 19.36	1	100	100	100	18.60	13.57		Strong, fresh, grey / dark grey, fine to medium grained, massive LIMESTONE. Faint brecciated intraclastic texture. - very irregular shaped angular, centimetric scale clasts in a dark grey fine grained matrix. Chaotic network of shaley stylolitic partings - incipient randomly orientated fracturing. One fracture set. dipping at 5' Planar / Rough, no infill	19
		19.36 - 19.55		79	0	0	19.36	12.81		Dark grey, soft CLAY with friable angular / tabular grey limestone fragments 2 - 5mm across	
		19.55 - 19.95	18	100	58	40	19.55	12.62		Strong, fresh, grey / dark grey, slightly mottled, fine to medium grained, massive LIMESTONE. Brecciated texture, angular / irregularly shaped intraclasts 0.5 - 3cm across, in a dark grey fine grained matrix (micrite), clasts are matrix	
							19.95	12.22			20

Continued on next sheet

Remarks
All angles measured relative to short core axis

AGS

Rotary Core Log

Borehole No.
BH04
Sheet 5 of 7

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530150.78 - 728400.13	Hole Type RC
Location: Galway		Level: 32.17	Scale 1:25
Client: Galway County Council		Dates: 11/11/2015 - 12/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.95 - 20.78	0	100	100	100	20.78	11.39		supported. One fracture set, dipping at 40-45' Planar / Rough, minor grey/brown clay. Strong, fresh, grey, slightly mottled, fine to medium grained, massive LIMESTONE. Brecciated texture, sub-angular, irregular shaped, intraclasts in a dark grey fine grained matrix. Minor bioclastic debris.
		20.78 - 21.64	2	100	100	100	21.64	10.53		Strong, fresh, grey, fine to medium grained, massive LIMESTONE. Incipient breccia texture. Sub-horizontal stylolites 10 - 15cm apart, minor scattered bioclasts. One fracture set dipping at 25' Planar / Rough, no infill (rubbly)
		21.64 - 22.60	9	96	57	57	22.60	9.57		Strong, fresh, grey / pale grey, slightly mottled, fine to medium grained, massive LIMESTONE. Sub-horizontal stylolites and very small discontinuous white calcite veins. Three fracture sets, 1. dipping at 5-10' Planar to slightly stepped / Rough,. 2. Dipping at 30 - 40', Planar / Rough, 3. Dipping at 70 - 75' Planar / Rough minor orange brown clay particulary over top 20cm. .
		22.60 - 26.50	2	100	100	99				Strong, fresh, pale grey / brownish grey, fine to medium grained, massive LIMESTONE. Scattered small bioclasts and an occasional larger (2- 3cm) coral fragment. Sub-horizontal stylolites 20 - 30cm apart. One fracture set dipping at 5-10' Planar / Rough, minor pale brown sandy clay coating.

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Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530150.78 - 728400.13	Borehole No. **BH04** Sheet 6 of 7 Hole Type RC
Location: Galway		Level: 32.17	Scale 1:25
Client: Galway County Council		Dates: 11/11/2015 - 12/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	**Coring**			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
											26
		26.50 - 27.20	9	100	46	20	26.50	5.67		Strong, fresh, pale grey / brownish grey, fine to medium grained, massive LIMESTONE. Two fracture sets, 1. dipping at 5-10 Planar / Rough, no infill. 2. Dipping at 55-60', Planar / Rough, very minor yellowish brown clay coating.	27
		27.20 - 28.95	4	100	87	78	27.20	4.97		Strong, fresh, pale grey, fine to medium grained, massive LIMESTONE. Two fracture sets, 1. closely / medium spaced, dipping at 5-10' Planar / Rough, Grey/brown to orange-brown clay coating fracture surfaces. and locally infilling fractures - aperture up to 2mm thick. 2. Dipping at 45'', Planar / Rough	28
		28.95 - 29.32		0	0	0	28.95	3.22		CAVITY. Contacts display evidence of dissolution, pitting etc... thin coatings of yellowish brown clay	29
		29.32 - 30.20	3	100	100	100	29.32	2.85		Strong, fresh, pale grey, fine to medium grained, massive LIMESTONE. Sub-horizontal stylolites 10 - 20cm apart. One fracture set, 1. Closely spaced, dipping at 0-5' Planar / Rough,	30

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.
BH04
Sheet 7 of 7

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530150.78 - 728400.13
Hole Type	RC		
Location:	Galway	Level:	32.17
Scale	1:25		
Client:	Galway County Council	Dates:	11/11/2015 - 12/11/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		30.20 - 30.40		100	0	0	30.20	1.97		Very soft light brown / grey CLAY with a band of pale brown sand 5cm thick at top. Cavity Fill?
		30.40 - 33.72	2	100	100	98	30.40	1.77		Strong, fresh, pale grey, fine to medium grained, massive LIMESTONE. Sub-horizontal stylolites. One fracture sets dipping at 5-20' Planar / Rough, Medium spaced.
		33.72 - 34.30	7	100	0	0	33.72	-1.55		Strong, fresh, pale grey, fine to medium grained, massive LIMESTONE. Sub-horizontal stylolites. Two fracture sets 1. dipping at 5-10' Planar / Rough, no infill. 2. dipping at 75-85', Planar / Rough.
							34.20	-2.03		Strong, fresh, pale grey, fine to medium grained, massive LIMESTONE. Minor sub-horizontal stylolites. One fracture sets dipping at 250' Planar to undulating / Rough, no infill.
		34.30 - 35.00	1	100	100	100				
							35.00	-2.83		End of borehole at 35.00 m

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Remarks
All angles measured relative to short core axis

Keynetix

Rotary Core Log

Borehole No.
BH05
Sheet 1 of 9

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530186.65 - 728378.11	Hole Type RC
Location:	Galway		Level:	34.14	Scale 1:25
Client:	Galway County Council		Dates:	06/11/2015 - 10/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
							0.40	33.74	░	Overburden minor cobbles recovered	
		0.40 - 0.95	13	100	0	0	0.95	33.19	▦	Strong, pale grey, medium grained, massive LIMESTONE. Joint set dipping at 5 - 10' Planar / Rough, no infill. Joint set dipping at 85 - 90' Planar / Rough, grey calcite coating joint surface	
		0.95 - 1.17	0	100	100	100	1.17	32.97	▦	Strong, pale grey, medium grained, massive pellety LIMESTONE	1
		1.17 - 1.50	12	100	0	0	1.50	32.64	▦	Strong, pale grey, medium grained, massive LIMESTONE. Joints dipping at 5 - 10' Planar - slightly undulating / Rough,, very close to closely spaced,	
		1.50 - 2.30	11	100	0	0	2.30	31.84	▦	Strong pale grey / grey, medium grained, massive LIMESTONE. Joints dipping at 5 - 10' Planar / Rough. Set of two conjugate joints dipping at 85 - 90' with strike angle between sets of 110 / 70' Planar to Slightly undulating / Rough	2
		2.30 - 3.27	11	100	32	32	3.27	30.87	▦	Strong, pale grey, fine to medium grained, slightly bioclastic, massive LIMESTONE. Minor stylolites, Very closely to closely spaced fractures dipping at 5 - 15', Planar to slightly undulating / Rough.	3
		3.27 - 5.80	8	99	0	0			▦	Strong, grey / pale grey, medium grained, pellety, massive LIMESTONE. closely spaced fracture dipping at 5 - 15', Planar to slightly undulating / Rough. Fracture set dipping at 85' planar / rough	4 5

Continued on next sheet

Remarks
All angles measured relative to short core axis

AGS

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530186.65 - 728378.11	Borehole No. **BH05** Sheet 2 of 9
Location: Galway		Level: 34.14	Hole Type RC
			Scale 1:25
Client: Galway County Council		Dates: 06/11/2015 - 10/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	**Coring**			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		5.80 - 8.00	6	100	0	0	5.80	28.34		Strong, pale grey, medium grained, pellety, massive LIMESTONE. fine grained scattered bioclastic debris, Sub horizontal stylolites. Very closely to closely spaced fractures dipping at 5 - 20', Planar to slightly undulating / Rough, minor fine grained grey sand infill. Axial parallel conjugate jointing dipping at 85 - 90' striking 120 / 60 relative to each other. minor clay coating	6 7
		8.00 - 8.68	1	91	91	91	8.00	26.14		Strong, pale grey, medium grained, massive LIMESTONE. fine grained scattered bioclastic debris, Sub horizontal stylolites.	8
		8.68 - 9.50	11	100	88	37	8.68	25.46		Strong, pale grey, fine grained, massive LIMESTONE. Sub horizontal stylolites. Fractures dipping at 5 - 10', Planar / Rough, Fractures dipping at 45' Planar - slightly undulating / Rough	9
		9.50 - 10.25	0	100	100	100	9.50	24.64		Strong, pale grey, fine grained, massive LIMESTONE. fine, sub horizontal stylolites, spaced 5 - 10cm.	10

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530186.65 - 728378.11	Borehole No. **BH05** Sheet 3 of 9
Location:	Galway		Level: 34.14	Hole Type RC
Client:	Galway County Council		Dates: 06/11/2015 - 10/11/2015	Scale 1:25
				Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	**Coring** TCR	SCR	RQD	Depth (m)	Level (m)	Legend	Stratum Description	
		10.25 - 11.34	13	100	0	0	10.25	23.89		Strong, pale grey, fine grained, massive LIMESTONE. Sub horizontal stylolites. Three fractures sets 1. dipping at 5 - 10', Planar / Rough, no infill; 2. dipping at 45 - 50' planar to slightly undulating / Rough, fine sand coating fracture surfaces. 3. dipping at 85 - 90', Planar to slightly undulating / Rough cross-cutting the other fracture sets.	11
		11.34 - 12.62	3	100	100	78	11.34	22.80		Strong, pale grey, fine to medium grained, massive LIMESTONE. Sub horizontal stylolites. Two fracture sets 1. dipping at 5 - 10', Planar to slightly undulating / Rough, 2. dipping at 85 - 90', Planar / Rough very minor iron staining.	12
		12.62 - 13.27	15	100	0	0	12.62	21.52		Strong, pale grey / grey, fine / medium grained, massive LIMESTONE. Two fractures sets 1. Close to very closely spaced dipping at 5 - 20', Planar / Rough; 2. dipping at 70 - 80', Planar / Rough	13
		13.27 - 15.04	4	100	100	96	13.27	20.87		Strong, grey, fine / medium grained, massive LIMESTONE. Very small scattered bioclasts, Occasional sub-horizontal stylolites. Small elongate calcite filled "Birdseyes", elongate sub vertical long axis 5 - 10mm long and 0.5mm wide. Two fracture sets 1. Medium spaced dipping at 5 - 15', Planar / Rough; 2. Widely spaced, dipping at 55', Planar / Rough	14 15

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.	**BH05**	Sheet 4 of 9	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530186.65 - 728378.11	Hole Type	RC
Location:	Galway		
Level:	34.14	Scale	1:25
Client:	Galway County Council		
Dates:	06/11/2015 - 10/11/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description
				TCR	SCR	RQD				
		15.04 - 15.44	18	100	100	0	15.04	19.10		Strong, grey, fine / medium grained, massive LIMESTONE. Very small scattered bioclasts and a large 1cm dia. gastropod , Occasional sub-horizontal stylolites. Two fracture sets 1. Closely to very closely spaced dipping at 5 - 15', Planar / Rough; 2. Dipping at 85', Planar to slightly undulating / Rough
		15.44 - 16.82	2		100	100	15.44	18.70		Strong, grey, fine / medium grained, massive LIMESTONE. Occasional sub-horizontal stylolites. Faint intraclasts centimetric scale. One fracture set dipping at 10', Planar / Rough;
		16.82 - 18.40	8	100	100	63	16.82	17.32		Strong, grey, fine / medium grained, massive LIMESTONE. Fine grained scattered bioclastic debris. Locally developed intraclasts, clasts are rounded to sub-rounded 1 - 2cm in dia. Two fracture sets 1. Medium spaced dipping at 10 - 15', Planar / Rough, minor associated rubble; 2. Sub-vertical - undulating dipping at 80 - 90', Planar / Rough
		18.40 - 19.26	7	100	95	60	18.40	15.74		Strong, grey, fine grained, massive LIMESTONE. Thin band of coarse brachiopod shells at 18.82m. Two fracture sets 1. Medium spaced, dipping at 10', Planar / Rough, minor light brown clay coating the fracture surfaces; 2. Dipping at 80-85', Planar / Rough associated with thin white calcite veinlets
		19.26 - 19.95	3	100	100	100	19.26	14.88		Strong, pale grey, fine / medium grained, massive, pellety LIMESTONE. Fine scattered bioclasts, Occasional sub-horizontal stylolites. Fracture set dipping at 5 - 10', Planar / Rough, no infill.
							19.95	14.19		

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Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530186.65 - 728378.11	Borehole No. **BH05** Sheet 5 of 9
Location:	Galway		Level: 34.14	Hole Type RC
Client:	Galway County Council		Dates: 06/11/2015 - 10/11/2015	Scale 1:25
				Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD
		19.95 - 20.20	24	100	60	0
		20.20 - 20.30	0	0	0	0
		20.30 - 20.45	0	100	100	100
		20.45 - 20.75	20	100	0	0
		20.75 - 21.50	9	100	35	24
		21.50 - 22.40	4	100	94	94
		22.40 - 23.73	5	100	16	16
		23.73 - 25.55	2	100	93	93

Depth (m)	Level (m)	Legend	Stratum Description
20.20	13.94		Strong, grey, fine / medium grained, massive LIMESTONE. Two fracture sets 1. Closely spaced dipping at 5 - 10', Planar / Rough; 2. Dipping at 45', Planar / Rough light brown clay infill, up to 2mm thick.
20.30	13.84	incorrect incorrect incorrec key key key	Core loss
20.45	13.69		Very stiff, light brown / orange brown CLAY. Finely laminated.
20.75	13.39		Strong, grey, fine / medium grained, massive LIMESTONE. Small black millimetric scale blebs- burrowing? Three fracture sets 1. Very closely spaced, dipping at 5', Planar / Rough; 2. Dipping at 80', Planar / Rough with white calcite coating fracture surfaces. 3. dipping at 70', undulating / rough crosscut by set 2.
21.50	12.64		Strong, grey pale grey mottled, fine / medium grained, massive, pellety LIMESTONE. Intraclastic texture sub-angular to sub-rounded clasts 1 - 2cm dia. in a darker grey fine grained matrix. Two fracture sets 1. Dipping at 10 - 15', Planar / Rough; 2. Dipping at 60', Planar to undulating / Rough, fracture surfaces coated with light brown clay
22.40	11.74		Strong, grey, medium grained, massive LIMESTONE. Very small scattered bioclasts with occasional coarse brachiopods. Minor sub-horizontal stylolites. Two fracture sets 1. Medium spaced dipping at 10', Planar / Rough; 2. Medium spaced, dipping at 35', Planar / Rough
23.73	10.41		Strong, pale grey, fine / medium grained, massive LIMESTONE. Occasional sub-horizontal stylolites with minor oxidation. Thin hairline, steeply dipping white calcite veinlets. Two fracture sets 1. Medium spaced dipping at 5 - 10', Planar / Rough; 2. Dipping at 80-85', Planar / Rough, light brown clay coating fracture surfaces, locally developed fracture infill up to 1mm thick
			Strong, grey / grey brown, fine / medium grained, massive LIMESTONE. Occasional faint, sub-horizontal stylolites. Minor scatter fine bioclastic debris. Two fracture sets 1. Medium spaced dipping at 5 - 10', Planar / Rough; 2. Dipping at 60', Planar / Rough

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Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.
BH05
Sheet 6 of 9

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530186.65 - 728378.11	Hole Type RC
Location:	Galway		Level:	34.14	Scale 1:25
Client:	Galway County Council		Dates:	06/11/2015 - 10/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		25.55 - 25.85	13	100	80	80	25.55	8.59		Strong, grey / brownish grey, fine / medium grained, massive LIMESTONE. Very small scattered bioclasts, Two fracture sets 1. dipping at 10 - 20', Planar / Rough; 2. Dipping at 50', Planar / Rough no infill	
		25.85 - 26.60	3	100	91	91	25.85	8.29		Strong, grey, fine / medium grained, massive LIMESTONE. Slightly oxidised sub-horizontal stylolites. Fracture set dipping at 5 - 10', Planar / Rough; no infill	26
		26.60 - 27.65	9	100	37	37	26.60	7.54		Strong, pale grey / brownish grey, fine / medium grained, massive LIMESTONE. Occasional thick shelled bioclasts - brachiopod, Three fracture sets 1. Dipping at 10 - 20', Planar / Rough; 2. Close spaced, dipping at 55 - 60', Planar / Rough; 3. Dipping at 85', Planar / Rough minor white calcite coating fracture surfaces	27
		27.65 - 28.03	3	100	100	100	27.65	6.49		Strong, pale grey / brownish grey, fine / medium grained, massive LIMESTONE. Occasional sub-horizontal stylolites. Fracture set dipping at 5 ', Planar / Rough, no infill	28
							28.03	6.11		Strong, pale grey / brownish grey, fine / medium grained, massive LIMESTONE. Three fracture sets 1. Close spaced dipping at 5 - 20', Planar / Rough; 2. Widely spaced, dipping at 40-50', Planar / Rough, at 31.7m light brown clay infill 1mm thick; 3. Axial parallel - 90', crosscuts all the other fracture sets. Planar / rough with a thin coating of white calcite.	29 30

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Borehole No. **BH05** Sheet 7 of 9
Co-ords: 530186.65 - 728378.11		Hole Type RC
Location: Galway	Level: 34.14	Scale 1:25
Client: Galway County Council	Dates: 06/11/2015 - 10/11/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	SCR	RQD	Depth (m)	Level (m)	Legend	Stratum Description	
		28.03 - 32.03	3	100	0	0					31
		32.03 - 34.72	4	100	100	97	32.03	2.11		Strong, pale grey / brownish grey, fine / medium grained, massive LIMESTONE. Occasional sub-horizontal stylolites. One fracture set, close to Medium spaced, dipping at 5 - 20', Planar / Rough, no infill.	32 33 34
							34.72	-0.58		Strong, grey . brownish grey, fine / medium grained, massive LIMESTONE. Very small scattered bioclasts, and a rare thick shelled	35

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.	**BH05**	Sheet 8 of 9		
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords:	530186.65 - 728378.11
Hole Type	RC			
Location:	Galway		Level:	34.14
Scale	1:25			
Client:	Galway County Council		Dates:	06/11/2015 - 10/11/2015
Logged By	Dave Blaney			

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		34.72 - 37.20	6	100	4	4				brachiopod . Occasional sub-horizontal stylolites. Three fracture sets 1. Close spaced dipping at 10 - 20', Planar / Rough; 2. Very widely spaced, dipping at 35-40', Planar / Rough; 3. 75 - 85' Undulating / rough, fracture surface coated with light brown clay. Crosscuts other fracture sets	36 37
		37.20 - 38.00	0	100	100	100	37.20	-3.06		Strong, grey / pale grey, fine / medium grained, massive LIMESTONE.	
		38.00 - 40.00		100	0	0	38.00	-3.86		Strong, pale grey, fine to medium grained, massive LIMESTONE. Occasional stylolites, two fracture sets. 1. dipping at 5', planar / rough , 2. dipping at 85-90' Planar / rough coated and partially infilled by light brown clay	38 39 40

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.	**BH05**	Sheet 9 of 9	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530186.65 - 728378.11	Hole Type	RC
Location:	Galway		
Level:	34.14	Scale	1:25
Client:	Galway County Council		
Dates:	06/11/2015 - 10/11/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
							40.30	-6.16		End of borehole at 40.30 m	
											41
											42
											43
											44
											45

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.	**BH06**	Sheet 1 of 5	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530125.14 - 728383.08	Hole Type	RC
Location:	Galway	Level:	30.80
Scale	1:50		
Client:	Galway County Council	Dates:	10/12/2015 - 18/12/2015
Logged By	Dave Blaney		

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10	30.70		TOPSOIL
							1.05	29.75		Soft, pale grey, sandy CLAY (Recovery 35%)
							1.50	29.30		Loose grey to dark grey cobbly BOULDERS of bioclastic limestone, minor pale grey sandy clay
							3.10	27.70		Firm, light yellowish brown, sandy CLAY, coarse grained sub-angular cobbles of dark grey limestone and occasional granite cobble (recovery 45%)
		5.25 - 5.50	C							
							7.91	22.89		Very stiff , light yellowish brown sandy CLAY with coarse gravel / cobbles and occasional boulders of sub-rounded to sub-angular limestone with minor granite
							7.96	22.84		Firm / stiff light grey CLAY
										Very stiff, light brown sandy CLAY with minor light orange oxidation spots / patches. Coarse gravel / cobbles and occasional boulders of sub-rounded to sub-angular limestone with minor granite
		9.95 - 10.20	C							

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.
BH06
Sheet 2 of 5

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530125.14 - 728383.08	Hole Type RC
Location: Galway		Level: 30.80	Scale 1:50
Client: Galway County Council		Dates: 10/12/2015 - 18/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description	
											11
											12
											13
											14
											15
							15.20	15.60		Loose, medium grained angular clayey GRAVEL with small cobbles all coarse fragments coated with sticky, soft, dark grey clay	
							15.93	14.87		Very Stiff dark grey / brown CLAY	16
		16.20 - 16.50	C								
		16.60 - 16.70	D								
		16.70 - 16.80	D								
											17
		17.13 - 17.20	D								
		18.00 - 18.25	C				18.00	12.80		Very Stiff grey CLAY	18
		18.25 - 18.35	D								
		18.65 - 18.75	D								
		18.95 - 19.05	D								19
		19.70 - 19.95	C								
		20.00 - 20.25	C								20

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.
BH06
Sheet 3 of 5

Project Name: Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530125.14 - 728383.08	Hole Type RC
Location: Galway		Level: 30.80	Scale 1:50
Client: Galway County Council		Dates: 10/12/2015 - 18/12/2015	Logged By Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	SCR	RQD	Depth (m)	Level (m)	Legend	Stratum Description
							21.20	9.60		Firm grey CLAY
		21.45 - 21.52 21.52 - 21.60	D D				21.48	9.32		Firm / Stiff finely laminated dark brown / brown CLAY
							21.82	8.98		Firm, dark brown CLAY with 60% tabular angular gravel
							21.92	8.88		Firm grey fine sandy CLAY with angular limestone gravel and some coarse cobbles and small boulders
							22.60	8.20		Very soft, light grey sandy CLAY with rounded gravel
							22.84	7.96		Soft, grey sandy CLAY angular gravel / cobbles
							23.30	7.50		Firm / Stiff grey sandy CLAY with sub-angular / angular matrix supported coarse gravel and cobbles
							23.60	7.20		Soft, grey, sandy CLAY with medium / coarse grained, angular gravel and an occasional boulder (25cm dia.
							25.50	5.30		Soft / firm grey / green sandy CLAY with sub angular cobbles and boulders. Some of the clay is washed out and is just coated the cobbles and boulders
							26.65	4.15		Stiff / very stiff, light grey CLAY occasional boulder of pale grey limestone
							27.30	3.50		Loose, grey / dark grey cobbly GRAVEL with occasional boulders of limestone coated with very soft brownish grey clay

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Borehole No.	**BH06**	Sheet 4 of 5	
Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	
Co-ords:	530125.14 - 728383.08	Hole Type	RC
Location:	Galway		
Level:	30.80	Scale	1:50
Client:	Galway County Council		
Dates:	10/12/2015 - 18/12/2015	Logged By	Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
							30.85	-0.05		Soft / very soft, pale grey / greenish grey bouldery CLAY, cobbles and coarse gravel, clay washed out and just left coating fragments in some areas.	31 32 33
							33.20	-2.40		Firm greenish grey (Khaki) CLAY with angular coarse cobbles of pale grey limestone	
							33.50	-2.70		Firm, greenish grey gravelly CLAY, gavel composed of dark grey limestone	
							33.70	-2.90		Pale grey, medium grained, fresh, massively bedded limestone BOULDER Broken up along a series of fractures - undulating rough dipping at 70-80' and planar rough dipping at 50-60'. Minor grey clay coating joint surfaces.	34
							34.70	-3.90		Loose sub-angular COBBLES coated with soft pale grey clay	35
							35.10	-4.30		Soft greenish grey sandy, gravelly CLAY with angular cobbles and small boulders of pale grey / occasionally black limestone	36 37 38 39
							39.10	-8.30		Loose sub-angular COBBLES of very dark grey limestone (Recovery 30%)	40

Continued on next sheet

Remarks
All angles measured relative to short core axis

Rotary Core Log

Project Name:	Lackagh Quarry Preliminary Ground Investigation	Project No. Lackagh Quarry	Co-ords: 530125.14 - 728383.08
Location:	Galway		Level: 30.80
Client:	Galway County Council		Dates: 10/12/2015 - 18/12/2015

Borehole No.
BH06
Sheet 5 of 5

Hole Type
RC

Scale
1:50

Logged By
Dave Blaney

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							40.60	-9.80		Loose, coarse gravelly COBBLES, angular to sub-angular with some coated by greenish grey clay occasional small boulder
							44.40	-13.60		BOULDER of strong, fresh, fine / medium grained, massively bedded Limestone. 44.8m a joint filled with soft, dark grey clay, 2cm thick (Possibly bedrock)
							45.00	-14.20		End of borehole at 45.00 m

Remarks
All angles measured relative to short core axis

APPENDIX III

PROJECT NAM **Lackagh Quarry**
CLIENT: **Galway County Council**
ENGINEER: ARUP

REPORT NO:
HOLE NO: **BH-01**
LOGGED BY: **Dave Blaney**

Depth of Discontinuity (m BGL)	Azimuth	Dip	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering						Hole Azimuth	Hole Dip	True Azimuth	True Dip
				Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	No	Sl	Mod	High	Comp					
				R	Sm	St	R	Sm	St	R	Sm	St		>10 mm	2.5-10	0.5-2.5	0.1-0.5	<0.1															
5.80		45					X									X			X					X					No Invert marked	268	-11.5		
5.95		10								X						X			X					X					No Invert marked	268	-11.5		
6.10		20								X						X			X					X					No Invert marked	268	-11.5		
6.18		25	X							X						X			X					X					No Invert marked	268	-11.5		
6.30		65	X							X						X			X					X					No Invert marked	268	-11.5		
6.90	180	85								X						X			X					X						268	-11.5		
7.08	190	60								X						X			X					X						268	-11.5		
7.52	165	65								X						X			X					X						268	-11.5		
7.58	165	65								X						X			X					X						268	-11.5		
7.66	230	70								X						X			X					X						268	-11.5		
7.90	180	55					X									X			X					X						268	-11.5		
8.35	285	90								X						X			X					X						268	-11.5		
8.55	210	75								X						X			X					X						268	-11.5		
8.72	135	72								X						X			X					X						268	-11.5		
8.83	60	82								X						X			X					X						268	-11.5		
8.85	150	90					X									X			X					X						268	-11.5		
9.35	195	78								X						X			X					X						268	-11.5		
9.67	215	90								X						X			X					X						268	-11.5		
9.81	130	62								X						X			X					X						268	-11.5		
9.90	335	82								X						X			X					X						268	-11.5		
10.17	330	90								X						X			X					X						268	-11.7		
10.20	180	90					X									X			X					X						268	-11.7		
10.71	10	90								X						X			X					X						268	-11.7		
10.90	5	82								X						X			X					X						268	-11.7		
11.42	0	75								X						X			X					X						268	-11.7		
11.44	115	74								X						X			X						X				Slight Fe Staining	268	-11.7		
11.54	200	40	X							X						X			X					X						268	-11.7		
11.92	145	45								X						X			X					X						268	-11.7		
11.97	180	85								X						X			X					X						268	-11.7		
12.20	285	45					X									X			X					X						268	-11.7		
12.35	350	50	X							X						X			X					X						268	-11.7		
12.47	100	65								X						X			X					X						268	-11.7		
13.02	150	60								X						X			X					X						268	-11.7		
13.33	220	60								X						X						x		X					Partial coating of white calcite	268	-11.7		
13.43	350	75								X						X			X					X						268	-11.7		
14.32	25	72								X						X			X					X						268	-11.7		
14.36	120	85								X						X			X					X						268	-11.7		
14.39	185	62								X						X			X					X						268	-11.7		
14.42	30	80								X						X			X					X						268	-11.7		
14.45	120	80								X						X			X					X						268	-11.7		
14.52	140	65								X						X						X	X	X					Minor white calcite and smears of pale brown clay	268	-11.7		
14.56	50	80								X						X			X					X						268	-11.7		
14.70	170	80								X						X						X			X				White clacite and small patches of Fe Staining	268	-11.7		
15.27	165	80								X						X						X		X					Very Minor white calcite	268	-11.7		
15.47	170	80								X						X						X		X						268	-11.7		
15.58	130	72								X						X						X	X	X					White clacite and minor clay smears	268	-11.7		
15.63	355	50								X						X			X					X						268	-11.7		
15.68	75	90								X						X			X					X						268	-11.7		
15.76	135	85								X						X			X					X						268	-11.7		
15.83	195	60								X						X							X	X					Minor light brown clay	268	-11.7		
16.33	170	85								X						X			X					X						268	-11.8		
17.05	180	85								X						X			X					X						268	-11.8		

17.64	25	84	X							X						X			X					X						268	-11.8		
17.76	30	80								X						X							X	X					Minor smear of light brown clay	268	-11.8		
18.06	270	20								X						X			X					X						268	-11.8		
18.12	185	85	X							X						X			X					X						268	-11.8		
18.59	35	75								X						X						X		X					Minor light grey calcite	268	-11.8		
19.48	145	80								X						X			X					X						268	-11.9		
20.07	40	70								X						X			X					X						268	-11.9		
20.26	135	90								X						X			X					X						268	-11.9		
20.57	225	65								X						X			X					X						268	-11.9		
21.10	120	90	X							X						X			X					X						268	-11.9		
21.14	220	60								X						X			X					X						268	-11.9		
21.20	170	90								X						X							X	X					Minor smear of light brown clay	268	-11.9		
21.33	310	70								X						X			X					X						268	-11.9		
21.38	315	70								X						X			X					X						268	-11.9		
21.41	230	75	X							X						X			X					X						268	-11.9		
21.58	230	70								X						X			X					X						268	-11.9		
22.34	5	90								X						X			X					X						268	-11.9		
22.48	30	60								X						X			X					X						268	-11.9		
22.73	170	48								X						X			X					X						268	-11.9		
22.96	290	52		X												X			X					X						268	-11.9		
23.03	20	60								X						X						X		X					Creamy white calcite coating	268	-11.9		
23.56	220	65								X						X			X					X						268	-11.9		
23.86	320	65					X									X						X			X				Pale grey calcite / minor grey clay and very slight Fe staining	268	-11.9		
24.26	20	80								X						X			X					X						268	-11.9		
24.35	140	70								X						X							X		X				Minor clay / localised dark brown Fe staining	268	-11.9		
24.73	125	90								X						X								X						268	-11.9		
24.94	130	90								X						X			X					X						268	-11.9		
26.18	185	85								X						X			X					X						267	-12.1		
27.35	0	85								X						X			X					X						267	-12.1		
27.48	30	80								X						X			X					X						267	-12.1		
27.84	195	80								X						X			X					X						267	-12.1		
28.16	175	85								X						X			X					X						267	-12.2		
28.74	5	80		X												X			X					X						267	-12.2		
31.02	15	90								X						X						X		X					White / Grey calcite deposited on fracture surface	267	-12.4		
31.25	320	85		X												X			X					X						267	-12.4		
31.34	0	50								X						X			X					X						267	-12.4		
31.66	195	75								X						X			X					X						267	-12.4		
31.73	10	60	X							X						X			X					X						267	-12.4		
31.76	10	85										X			X							X		X					Creamy white calcite vein, 4mm thick weak striae	267	-12.4		
31.82	20	70		X											X				X					X						267	-12.4		
32.01	50	90								X						X			X					X						267	-12.4		
32.08	330	50								X						X			X					X						267	-12.4		
32.64	145	65								X						X			X					X						267	-12.4		
32.90	20	90								X						X			X					X						267	-12.4		
32.97	315	62								X						X			X					X						267	-12.4		
33.11	30	35								X						X			X					X						267	-12.4		
33.20	310	80								X						X			X					X						267	-12.4		
33.70	310	70	X							X						X			X					X						267	-12.4		
34.05	60	75								X						X			X			X		X					Minor white calcite coating fracture surface	267	-12.6		
35.04	0	90								X						X			X					X						267	-12.6		
35.35	10	72		X												X			X					X						267	-12.6		
35.48	335	78								X						X			X					X						267	-12.6		
36.43	175	85								X						X			X					X						267	-12.6		
36.88	235	90								X						X			X					X						267	-12.6		
36.95	235	90								X						X			X					X						267	-12.6		
37.23	195	15					X									X			X					X						267	-12.6		
37.31	225	65								X						X			X					X						267	-12.6		
37.51	215	70								X						X			X					X						267	-12.6		
38.13	175	88								X						X			X					X						267	-12.6		
38.20	230	22		X												X			X					X						267	-12.6		
38.30	305	75								X						X			X					X						267	-12.6		
38.50	5	15								X						X			X					X						267	-12.6		

39.35	180	45								X						X				X					X				Minor orange Fe staining	267	-12.6		
40.53	160	40								X						X			X					X						267	-12.6		
40.80	0	90								X						X			X					X						267	-12.6		
41.03	50	88								X						X			X					X						267	-12.6		
41.20	315	90								X						X								X						267	-12.6		
41.67	180	10					X									X			X			X		X					Traces of white calcite	267	-12.6		
41.97	30	30								X						X			X					X						267	-12.6		
42.52	0	90								X						X			X					X						267	-12.6		
43.28	225	62								X						X			X					X						267	-12.5		
43.40	170	10								X						X			X					X						267	-12.5		
43.70	75	60								X						X			X					X						267	-12.5		
43.90	285	80								X						X			X					X						267	-12.5		
44.02	15	48								X						X			X					X						267	-12.5		
44.22	170	40								X						X			X					X						267	-12.5		
44.47	30	50								X						X			X					X						267	-12.5		
44.52	30	50								X						X			X					X						267	-12.5		
45.16	15	50								X						X			X					X						267	-12.5		
45.30	180	75								X					X					X		X			X				White calcite, minor Fe staining	267	-12.5		
45.47	30	55								X						X			X					X						267	-12.5		
45.62	30	70								X						X			X					X						267	-12.5		
45.70	25	55								X						X				X					X				Slight Fe staining	267	-12.5		
45.88	175	42								X						X						X		X					Discontinuous coating of white calcite	267	-12.5		
46.06	0	75								X						X			X					X						267	-12.7		
46.88	310	75								X						X			X					X						267	-12.7		
47.20	120	80								X						X							X	X					Minor brown clay	267	-12.7		
47.50	15	80								X						X			X					X						267	-12.7		
47.75	320	80					X									X						X		X					Partial coating of white calcite	267	-12.7		
47.88	310	75								X						X						X		X					Partial coating of white calcite	267	-12.7		
48.34	240	80								X						X			X					X						267	-12.7		
49.08	175	75								X						X			X					X						267	-12.7		
49.54	45	84								X						X			X					X						267	-12.7		
49.70	225	58								X						X			X					X						267	-12.7		
50.28	0	90								X						X			X					X						267	-12.7		
50.77	160	45								X						X			X					X						267	-12.7		
51.04	175	90								X						X			X					X						267	-12.7		
51.52	140	50								X						X			X					X						267	-12.7		
51.60	120	65								X						X			X					X						267	-12.7		
51.65	120	70								X						X			X					X						267	-12.7		
51.75	125	65								X						X			X					X						267	-12.7		
51.84	145	80								X						X			X					X						267	-12.7		
52.14	140	62								X						X			X					X						267	-12.7		
25.23	140	60								X						X			X					X						267	-12.7		
52.70	45	85								X						X			X					X						267	-12.7		
53.07	310	65	X							X						X			X					X						267	-12.7		
53.27	345	30								X						X			X					X						267	-12.7		
53.35	0	90								X						X			X					X						267	-12.7		
53.43	0	90								X						X			X					X						267	-12.7		
53.48	80	85	X				X									X			X					X						267	-12.7		
52.52	355	85								X						X			X					X						267	-12.7		
53.56	285	75	X				X									X			X					X						267	-12.7		
53.80	5	90								X						X			X					X						267	-12.7		
53.94	0	90								X						X			X					X						267	-12.7		
54.70	170	85								X						X			X					X						267	-12.7		
55.34	20	85								X						X			X					X						267	-12.7		
55.44	20	85								X						X			X					X						267	-12.7		
55.73	355	90								X						X			X					X						267	-12.7		
56.14	30	44					X									X			X					X						267	-12.7		
56.61	320	85								X						X			X					X						267	-12.7		
57.28	320	85								X						X			X					X						267	-12.7		
57.75	55	80	X							X						X			X					X						267	-12.7		
58.20	175	50					X									X			X					X					Curved / Arcuate joint surface	267	-12.7		
58.31	345	50								X						X			X					X						267	-12.7		

58.48	0	80								X						X			X					X					Possible drillers break	267	-12.7		
58.80	5	90										X				X			X					X					Triae due to intersecting stylolite	267	-12.7		
59.47	355	90								X						X			X					X						267	-12.7		
59.63	160	85								X						X			X					X						267	-12.7		
59.83	170	80					X									X			X					X					Curved / Arcuate joint surface	267	-12.7		
60.00	5	90								X						X			X					X						267	-12.7		
61.02	180	80								X						X			X					X						267	-12.8		
61.47	140	70								X						X						X		X					Trace grey calcite	267	-12.8		
61.80	90	85	X				X									X			X					X						267	-12.8		
61.85	200	65					X									X				X					X				Partial orange / brown Fe staining	267	-12.8		
62.02	20	80					X									X			X					X					Very Rough joint surface	267	-12.8		
62.17	50	60								X						X			X					X						267	-12.8		
62.58	145	60								X						X						X		X					Light grey calcite coating	267	-12.8		
63.77	40	50								X						X			X					X						267	-12.8		
63.97	200	42								X						X			X					X						267	-12.8		
64.06	30	65								X						X			X					X						267	-12.8		
64.20	210	50								X						X			X					X						267	-12.8		
64.50	345	50								X						X			X					X						267	-12.8		
64.98	180	85								X						X			X					X						267	-12.8		
65.72	130	75								X						X			X					X						267	-12.8		
65.88	130	80								X						X			X					X						267	-12.8		
66.97	50	80								X						X			X					X						267	-12.8		
66.99	50	78								X						X			X					X						267	-12.8		
67.20	175	78								X						X			X					X						267	-12.9		
67.60	220	80								X						X			X					X						267	-12.9		
67.70	45	90								X						X			X					X						267	-12.9		
67.90	60	72	X							X						X			X					X						267	-12.9		
68.38	350	90								X						X			X					X						267	-12.9		
68.60	355	90								X						X			X					X						267	-12.9		
68.66	350	90								X						X			X					X						267	-12.9		
68.73	0	90								X						X						X		X					Calcite vein 1mm thick	267	-12.9		
68.78	0	80								X						X						X		X					Calcite vein	267	-12.9		
68.90	170	75								X						X			X					X					Very irregular	267	-12.9		
69.25	355	90								X						X			X					X						267	-12.9		
69.66	20	75								X						X			X					X						267	-12.9		
69.93	325	85	X							X						X			X					X						267	-12.9		
69.98	140	75								X						X			X					X						267	-12.9		
70.13	10	80								X						X			X					X						267	-12.9		
70.27	15	80								X						X			X					X						267	-12.9		
70.60	5	80										X				X			X					X					Slickensides, plunging at 25' to 270'	267	-12.9		
71.43	355	80					X									X			X					X					Curved Arcuate Joint	267	-12.9		
71.90	50	82								X						X			X					X						267	-12.9		
72.34	310	80								X						X			X					X						267	-12.9		
72.45	50	30								X						X				X					X				Slight pale orange Fe staining	267	-12.9		
72.50	135	45	X							X						X			X					X						267	-12.9		
72.80	0	90								X						X			X					X						267	-12.9		
73.20	295	30								X						X			X					X						267	-12.9		
73.74	35	72								X						X			X					X						267	-12.9		
73.98	75	65		X												X			X					X					very small mm scale steps	267	-12.9		
74.50	350	78										X				X						X		X					White grey calcite vein, sub-horizontal striae	267	-12.9		
74.60	80	75					X											X	X					X						267	-12.9		
74.73	195	72								X						X			X					X					Very rough texture - almost stepped	267	-12.9		
75.14	5	80								X						X			X					X						267	-12.9		
75.27	150	55								X						X			X					X						267	-12.9		
75.50	170	85										X				X			X					X					Faint stating	267	-12.9		
75.80	20	75	X							X						X			X					X						267	-12.9		
75.92	30	65								X						X			X					X						267	-12.9		
76.09	25	70								X						X			X					X						267	-12.9		
76.19	165	60								X						X			X					X						267	-12.9		
76.39	50	50	X				X									X			X					X						267	-12.9		
76.72	200	70								X						X			X					X						267	-12.9		
77.10	325	70								X						X			X					X						267	-12.9		

77.17	205	85								X						X			X					X						267	-12.9		
77.63	305	55	X							X						X			X					X						267	-12.9		
77.67	65	80	X							X						X			X					X						267	-12.9		
77.80	110	85	X							X						X			X					X						267	-12.9		
77.86	20	75								X						X			X					X						267	-12.9		
77.93	335	90					X									X				X					X				urved / Arcuate fracture, Minor Fe staining	267	-12.9		
78.02	50	90								X						X			X					X						267	-12.9		
78.06	155	90	X							X						X			X					X						267	-12.9		
78.13	180	90	X							X						X			X					X						267	-12.9		
78.18	160	85	X							X						X			X					X						267	-12.9		
78.37	180	90	X							X						X			X					X						267	-12.9		
79.93	140	90	X				X									X			X					X						267	-12.9		
80.07	140	70		X												X			X					X						267	-12.9		
80.16	180	90								X						X			X					X						267	-12.9		
80.65	45	65								X						X							X		X				Thin coating of grey calcite	267	-12.9		
80.94	310	85								X						X			X					X						267	-12.9		
81.15	40	74								X						X			X					X						267	-12.9		
81.20	300	90								X						X			X					X						267	-12.9		
81.66	5	78										X				X				X					X				weak, sub-horizontal striae - Minor Fe staining	267	-12.9		
81.85	340	38								X						X			X					X						267	-12.9		
82.26	320	60					X									X			X					X						267	-13.1		
82.36	145	72										X				X			X					X					Striae formed by intersection offracture with stylolite	267	-13.1		
82.59	220	68										X				X			X					X						267	-13.1		
82.80	220	64					X									X			X					X					Curved / arcuate	267	-13.1		
83.12	320	58								X						X			X					X						267	-13.1		
83.40	355	44								X						X			X					X						267	-13.1		
83.53	335	84					X									X			X					X						267	-13.1		
84.00	0	90								X						X			X					X						267	-13.1		
84.25	10	88										X				X			X					X					Striae from intersection of stylolites	267	-13.1		
85.05	170	80								X						X			X					X					Curved / Arcuate joint surface	267	-13.1		
85.32	170	82								X						X				X		X			X				White / orange Fe stained clacite	267	-13.1		
86.10	310	54								X						X			X					X						267	-13.1		
86.38	220	50								X						X			X					X						267	-13.1		
86.62	350	38								X						X			X					X						267	-13.1		
86.96	350	52								X						X			X					X						267	-13.1		
87.47	205	58								X						X			X					X						267	-13.1		
87.53	285	70	X							X						X			X					X						267	-13.1		
88.14	10	88								X						X			X					X						267	-13.1		
88.77	0	90								X						X			X					X						267	-13.1		
88.82	90	78					X									X			X					X					Curved / Arcuate	267	-13.1		
88.99	0	42				X										X			X					X					Partially striated	267	-13.1		
89.13	340	42								X						X			X					X						267	-13.1		
89.35	210	52								X						X			X					X						267	-13.1		
89.44	70	82					X									X			X					X					Curved / Arcuate	267	-13.1		
89.64	10	78								X						X			X					X						267	-13.1		
89.75	100	86	X				X									X			X					X					Curved / Arcuate	267	-13.1		
90.00	80	84					X									X			X					X						267	-13.1		
90.30	100	84					X											X					X		X				Grey calcite	267	-13.1		
90.85	330	82									X					X			X					X					smooth	267	-13.1		
91.18	350	90								X						X			X					X						267	-13.1		
91.48	220	82								X						X			X					X						267	-13.1		
91.58	0	90								X						X			X					X						267	-13.1		
91.83	355	90								X						X			X					X						267	-13.1		
91.96	160	84								X						X			X					X						267	-13.1		
92.71	345	78								X						X			X					X						267	-13.1		
93.14	165	88								X						X							X		X				Partially coated with white calcite	267	-13.1		
93.97	320	82								X						X			X					X						267	-13.1		
94.75	350	70								X						X			X					X						267	-13.2		
95.00	10	78								X						X							X		X				Partially coated with white calcite	267	-13.2		
95.32	355	80								X						X			X					X						267	-13.2		
95.98	340	76	X	X												X			X					X						267	-13.2		
96.02	350	78								X						X			X					X						267	-13.2		

96.13	15	90		X												X			X					X						267	-13.2		
96.84	5	90					X									X			X					X					Curved / Arcuate	267	-13.2		
97.44	180	48								X						X			X					X						267	-13.2		
97.53	195	86								X					X							X			X				Joint infilled with 5mm white calcite veinlet minor Fe stain	267	-13.2		
98.92	225	74								X						X			X					X						267	-13.2		
98.37	320	48								X						X			X					X						267	-13.2		
98.92	5	90								X						X			X					X						267	-13.2		
99.35	225	58								X						X						X		X					Partially coated with grey calcite	267	-13.2		
99.40	185	80								X						X			X					X						267	-13.2		
99.70	185	36								X						X				X					X				Trace Fe staining	267	-13.2		
100.08	355	40								X						X			X					X						267	-13.2		
100.45	340	46								X						X			X					X						267	-13.2		
100.60	320	70		X												X			X					X					Very rough / irregular - pitted surface	267	-13.2		
100.65	195	56								X						X			X					X						267	-13.2		
100.74	215	62								X						X			X					X						267	-13.2		
100.85	140	62		X												X				X				X					Minor Fe Staining	267	-13.2		
100.91	210	70								X						X			X					X						267	-13.2		
101.16	345	36								X						X						X		X					Trace grey calcite	267	-13.2		
101.70	310	42								X						X			X					X					Very rough - almost stepped	267	-13.2		
101.43	350	90								X				X								X			X				Coarsely crystalline white calcite vein - Fe staining	267	-13.2		
101.65	170	72								X						X			X						X				Minor Fe staining	267	-13.2		
102.27	0	38								X						X			X					X						267	-13.2		
102.50	0	90	X						X							X				X					X				Stiae with locallised Fe Staining	267	-13.2		
102.55	180	18	X							X						X			X					X						267	-13.2		
103.48	340	80	X							X						X			X					X						267	-13.2		
103.87	355	86								X						X			X					X						267	-13.2		
103.92	330	76	X							X						X			X					X						267	-13.2		
103.95	210	62	X							X						X			X					X						267	-13.2		
104.15	150	38								X						X			X					X						267	-13.2		
104.78	350	74								X						X			X					X						267	-13.2		
105.42	350	88								X						X			X					X						267	-13.2		
105.54	345	85								X						X			X					X						267	-13.2		
105.70	0	90								X						X			X					X						267	-13.2		
106.13	185	50								X						X			X					X						267	-13.3		
106.30	150	62								X						X			X					X						267	-13.3		
107.10	5	50								X						X			X					X						267	-13.3		
107.35	10	48								X						X							X	X					Trace Fe staining -minor light brown clay	267	-13.3		
107.84	180	88								X						X			X					X						267	-13.3		
108.61	180	44								X						X			X					X						267	-13.3		
108.80	40	70								X						X								X						267	-13.3		
108.92	305	84								X						X						X		X					Slightly oxidised calcite	267	-13.3		
108.98	320	90								X						X			X					X						267	-13.3		
109.40	320	90								X						X			X					X						267	-13.3		
109.17	140	84								X						X			X					X						267	-13.3		
108.36	150	70								X						X			X					X						267	-13.3		
109.42	140	88								X						X			X					X						267	-13.3		
109.54	115	86	X	X												X			X					X						267	-13.3		
109.60	320	78								X						X			X					X						267	-13.3		
109.91	310	90								X						X						X		X						267	-13.3		
110.25	300	74								X						X			X					X						267	-13.3		
110.95	315	52								X						X						X		X						267	-13.3		
111.09	325	78								X						X			X					X						267	-13.3		
111.30	60	86								X						X						X		X						267	-13.3		
112.40	325	82		X												X			X					X						267	-13.4		
113.52	30	54		X												X						X		X						267	-13.4		
114.00	0	8	X				X									X			X					X						267	-13.4		
115.30	335	84								X						X			X					X						267	-13.4		
117.92	215	88								X						X			X					X						267	-13.4		
118.32	330	82								X						X			X					X						267	-13.5		
118.74	330	80								X						X			X					X						267	-13.5		
119.15	20	55	X				X									X			X					X						267	-13.5		
119.38	5	90								X						X			X					X						267	-13.5		

119.52	230	56								X						X			X					X						267	-13.5		
119.66	235	70								X						X								X						267	-13.5		
120.15	50	24					X									X			X			X		X						267	-13.5		
120.68	10	90					X									X			X					X						267	-13.5		
120.95	5	84								X						X			X					X						267	-13.5		
121.40	135	90								X						X			X					X						267	-13.5		
121.58	140	62	X							X						X				X					X					267	-13.5		
122.10	135	70		X												X				X					X					267	-13.5		
122.40	340	84								X					X							X			X					267	-13.5		
122.58	150	70					X									X			X					X						267	-13.5		
122.64	140	70		X												X			X					X						267	-13.5		
122.80	50	70					X									X						X		X						267	-13.5		
123.00	115	78					X									X			X					X						267	-13.5		
123.05	115	74					X									X			x						X					267	-13.5		
123.28	140	74					X									X			X					X					Very rough joint surface	267	-13.5		
123.38	20	68								X						X						X		X					Minor white grey calcite	267	-13.5		
123.44	320	80					X									X			X					X					Crystalline white calcite vein	267	-13.5		
123.52	160	60		X												X			X						X				Pitted surface - Dissolution	267	-13.5		
123.60	325	40								X						X			X					X						267	-13.5		
124.12	15	76								X						X						X		X					Minor light grey calcite	267	-13.5		
124.42	130	78								X						X						X		X					Minor white calcite	267	-13.5		
125.05	50	90					X									X			X					X					Curved / arcuate	267	-13.5		
125.28	25	64					X									X			X					X						267	-13.5		
125.62	320	90								X						X			X					X						267	-13.5		
126.10	240	80	X							X						X			X						X				Very weak Fe staining	267	-13.5		
126.25	150	58					X									X			X					X						267	-13.5		
126.72	235	72								X						X			X					X						267	-13.5		
126.83	325	64								X						X			X					X					Very irreglaur jointing	267	-13.5		
126.87	325	64								X						X			X					X						267	-13.5		
126.93	325	76								X								X	X					X						267	-13.5		
127.05	200	80					X									X			X					X						267	-13.5		
127.54	150	68					X									X			X					X					Slight undulation	267	-13.5		
127.61	320	70					X									X			X					X						267	-13.5		
127.67	315	82					X									X			X					X						267	-13.5		
127.80	220	74								X						X			X					X					Sub-parallel white calcite veinlets	267	-13.5		
127.91			X							X						X			X					X					Non Intact / broken core - pocssibly drilling related	267	-13.5		
128.36	195	52								X						X			X					X						267	-13.5		
128.41	165	62								X						X			X					X						267	-13.5		
128.48	150	62								X						X			X					X						267	-13.5		
129.60	195	62					X									X			X					X						267	-13.5		
129.83	20	60		X												X			X					X						267	-13.5		
130.25	205	42									X					X						X		X					Slightly polished - black argillite coating surface	266	-13.6		
130.30	80	80						X								X						X		X					Slightly polished - black argillite coating surface	266	-13.6		
130.62	170	84								X						X			X					X						266	-13.6		
131.47	160	48								X						X			X					X						266	-13.6		
131.60	80	80	X				X									X						X		X					Black argilite - stylolitic contact	266	-13.6		
131.71	350	70								X						X			X					X						266	-13.6		
132.14	340	86								X							X					X		X					White calcite vein	266	-13.6		
133.45	210	48								X						X			X					X						266	-13.6		
134.73	160	62					X									X			X					X						266	-13.6		
134.90	340	80								X				X								X		X					Infilled with 20mm thick white calcite vein	266	-13.6		
135.38	185	40								X						X			X					X						266	-13.6		
135.57	180	90					X									X			X					X					Strongly undulating	266	-13.6		
136.47	180	32								X						X			X					X						266	-13.7		
136.72	175	32								X						X			X					X						266	-13.7		
137.10	340	86								X						X			X					X						266	-13.7		
137.70	10	82								X						X			X					X						266	-13.7		
138.39	320	90								X						X			X					X						266	-13.7		
139.60	25	86								X						X			X					X						266	-13.7		
140.65	150	62					X									X			X					X						266	-13.7		
140.90	190	54								X						X			X					X						266	-13.7		
141.02	190	68								X						X			X					X						266	-13.7		

141.40	5	86								X					X			X					X							266	-13.7		
142.05	10	90								X					X			X					X							266	-13.7		
142.60	40	46		X											X			X					X							266	-13.8		
142.79	150	72								X						X		X					X							266	-13.8		
142.86	130	80								X					X			X					X							266	-13.8		
144.36	150	68								X					X			X					X							266	-13.8		
145.45	155	62								X					X			X					X							266	-13.8		
145.57	140	58								X					X			X					X							266	-13.8		
145.80	130	66								X					X			X					X							266	-13.8		
148.30			X																										148.3 148.5m NI / Broken & Friable core	266	-13.8		
149.10	350	86								X					X			X					X							266	-13.8		
149.77	155	70	X	X											X			X					X							266	-13.8		
150.44	160	76								X					X			X					X							266	-13.8		
150.84	30	70		X											X			X					X							266	-13.8		
150.88	140	90								X					X			X					X							266	-13.8		
150.93	320	80		X											X			X					X							266	-13.8		
151.20	310	72		X											X			X					X							266	-13.8		
151.60	150	82								X					X			X					X							266	-13.8		
152.09	10	90								X					X			X					X							266	-13.8		
152.56	165	60		X											X							X	X						Very rough / pitted / evidence of dissolution, Black argillite	266	-13.8		
152.94	20	84		X											X			X					X						Very rough / pitted / evidence of dissolution, Black argillite	266	-13.8		
153.35	15	90								X					X			X					X							266	-13.8		
153.70	140	74		X											X			X					X						Very rough / pitted / evidence of dissolution, Black argillite	266	-13.8		
154.30	350	90								X					X			X					X							266	-13.9		
154.80	355	60								X					X			X					X							266	-13.9		
154.90	355	60								X					X			X					X							266	-13.9		
155.12	340	60								X					X			X					X							266	-13.9		
155.90	340	82		X											X			X					X						Very Rough	266	-13.9		
156.30	350	90								X					X			X					X							266	-13.9		
157.15	5	86								X					X			X					X							266	-13.9		
159.45	5	90								X					X			X					X							266	-13.9		
159.60	120	86								X					X			X					X							266	-13.9		
162.05	5	82								X					X			X					X							266	-14		
163.48	325	88								X					X			X					X							266	-14		
163.57	330	86								X					X			X					X							266	-14		
163.97	15	90					X								X			X					X							266	-14		
164.08	5	90					X								X			X					X							266	-14		
164.55	180	44								X					X			X					X							266	-14		
165.00	325	86								X					X			X					X							266	-14		
167.00	60	74								X					X			X					X							266	-14		
167.68	135	90								X					X			X					X							266	-14		
168.64	140	80								X					X			X					X							266	-14		
168.69	140	82								X					X			X					X							266	-14		
171.07	60	78								X					X						X		X						Minor grey calcite	266	-14		
171.30	310	80								X					X			X					X							266	-14		
171.66	315	80								X					X			X					X							266	-14		
172.15	60	90								X					X						X		X						Minor grey calcite	266	-14.1		
172.56	315	90								X					X			X					X							266	-14.1		
173.00	320	74								X					X			X					X							266	-14.1		
173.40	325	76		X											X			X					X							266	-14.1		
173.44	330	76								X					X			X					X							266	-14.1		
174.05	320	76								X					X			X					X							266	-14.1		
174.86	330	82								X					X			X					X							266	-14.1		
176.52	310	70								X					X			X					X							266	-14.1		
177.10	180	18					X								X			X					X							266	-14.1		
179.77	0	90								X					X			X					X							266	-14.1		
180.17	350	84								X					X			X					X							266	-14.1		
180.75	330	86								X					X			X					X							266	-14.1		
182.53	45	86								X					X			X					X							266	-14.1		
182.97	115	76								X					X			X					X							266	-14.1		
183.95	230	76								X					X			X					X							266	-14.1		
185.83	50	68								X					X			X					X							266	-14.1		

186.17	180	88								X						X			X					X						266	-14.1		
186.24	180	85								X						X			X					X						266	-14.1		
186.53	40	80								X						X			X					X						266	-14.1		
191.20	335	90	X							X						X							X	X					Light brown sandy clay coating joints	266	-14.1		
191.64	40	72	X							X						X							X	X					Light brown sandy clay coating joints	266	-14.1		
191.72	40	72	X							X						X							X	X					Light brown sandy clay coating joints	266	-14.1		
191.90	340	52								X						X							X	X					Light brown sandy clay coating joints	266	-14.1		
192.21	350	38	X							X						X							X	X					Light brown sandy clay coating joints	266	-14.1		
192.50	140	48								X						X			X					X						266	-14.1		
192.70	330	80	X							X						X						X	X	X					White calcite & Light brown sandy clay	266	-14.1		
192.82	5	78								X						X			X					X						266	-14.1		
193.50	5	78								X						X			X					X						266	-14.1		
194.80	20	70								X						X			X					X						266	-14.1		
196.30	5	78								X						X			X					X						266	-14.1		
196.74	340	70								X						X			X					X						266	-14.1		
199.10	180	90								X						X			X					X						266	-14.1		
199.45	20	50								X						X						X		X					Wjite grey calcite	266	-14.1		
199.52	140	68								X						X			X					X						266	-14.1		
199.97	5	90								X						X			X					X						266	-14.1		
200.95	250	42	X						X							X				X					X				Slight Fe staining	266	-14.1		
203.00	345	38								X						X							X	X					Light brown, fine grained sand infill	266	-14.1		
203.21	340	54								X						X			X					X						266	-14.1		
203.24	340	56								X						X			X					X						266	-14.1		
203.32	345	50								X						X			X					X						266	-14.1		
203.64	340	70								X						X			X					X						266	-14.1		
203.69	345	62								X						X						X	X	X						266	-14.1		
203.87	145	54								X						X							X		X				Light brown grey clay coating, minor Fe staining	266	-14.1		
205.40	5	90								X						X			X					X						266	-14.1		
205.68	140	42								X						X			X					X						266	-14.1		
205.93	130	68								X						X			X					X						266	-14.1		
206.68	195	62		X												X				X					X				Slight Fe Staining	266	-14.1		
207.02	10	90								X						X			X					X						266	-14.1		
207.25	345	40		X												X			X					X						266	-14.1		
207.60	350	90								X						X			X					X						266	-14.1		
209.30	0	90								X						X			X					X						266	-14.1		
210.15	170	76								X						X			X					X						266	-14.1		
210.94	0	90								X						X			X					X						266	-14.1		
212.94	20	78								X						X			X					X						266	-14.1		
213.00	145	90								X						X							X		X				Brown grey clay coating, minor Fe staining	266	-14.1		
213.80	20	72								X						X			X					X						266	-14.1		
214.65	215	38								X						X			X					X						266	-14.1		
215.00	210	36								X						X			X					X						266	-14.1		
216.05	15	62		X												X						X		X					White calcite	266	-14.1		
216.80	30	70								X						X						X		X					Minor white calcite	266	-14.1		
216.90	135	74								X						X			X					X						266	-14.1		
217.10	340	88		X												X			X					X						266	-14.1		
217.33	330	90		X												X			X					X						266	-14.1		
217.92	330	82	X							X						X			X					X						266	-14.1		
217.94	40	78	X							X						X			X					X						266	-14.1		
218.04	330	82		X												X				X					X				slight oxidation	266	-14.1		
218.36	310	78								X						X				X					X				slight oxidation	266	-14.1		
218.37	310	76								X						X			X						X				slight oxidation	266	-14.1		
218.56	210	82								X						X			X					X						266	-14.1		
218.92	310	90								X						X			X						X				slight oxidation	266	-14.1		
219.70	320	86								X						X			X						X				slight oxidation	266	-14.1		
219.74	330	90								X						X			X						X				slight oxidation	266	-14.1		
219.77	330	90	X							X						X			X					X						266	-14.1		
220.44	240	42					X									X			X					X						266	-14.1		
220.58	310	90								X						X			X					X						266	-14.1		
220.74	45	78	X							X						X						X		X					Trace white calcite	266	-14.1		
221.61	120	46		X												X				X					X				Leached / pitted - slight Fe staining	266	-14.1		
221.90	20	60								X						X				X				X					Very light Fe staining	266	-14.1		

222.05	25	52								X					X							X		X					White calcite veining	266	-14.1		
223.34	15	58								X						X			X					X						266	-14.1		
222.55	160	70								X						X							X	X					Trace light brown clay smearing	266	-14.1		
222.65	20	58								X						X						X		X					White calcite	266	-14.1		
223.00	135	76								X						X							X	X					Minor yellow brown clay coating	266	-14.1		
223.05	140	78								X						X							X	X					Minor yellow brown clay coating	266	-14.1		
223.65	120	42								X						X			X					X						266	-14.1		
224.00	30	82								X						X						X		X					Coarse crystalline calcite	266	-14.1		
224.50	60	52								X						X			X					X						266	-14.1		
224.71	145	62								X						X			X					X						266	-14.1		
225.00	120	58								X						X							X	X					Trace light brown clay	266	-14.1		
225.45	170	36								X						X			X					X						266	-14.1		
226.35	220	40					X									X							X			X			Intensely oxidised, pitted - dissolution	266	-14.1		
226.62	140	62								X				X					X						X				Fe staining / minor clay	266	-14.1		
226.74	150	70								X						X				X					X				Slightly leached / dissolution	266	-14.1		
227.84	150	72								X						X				X					X				Slightly leached / dissolution	266	-14.1		
227.92	140	80								X						X				X					X				Slightly leached / dissolution	266	-14.1		
227.95	210	60	X	X												X			X					X						266	-14.1		
228.55	45	86								X						X			X					X						266	-14.1		
228.75	30	90								X						X			X					X						266	-14.1		
229.00	50	80								X				X									X		X				Clay filled cavity 10cm wide	266	-14.1		
229.10	50	80								X				X									X		X				Clay filled cavity 10cm wide	266	-14.1		
229.90	145	42								X						X							X	X					Minor grey brown clay	266	-14.1		
230.20	310	82								X						X							X		X				Slightly leached with grey / brown clay	266	-14.1		
230.36	310	90								X						X							X		X				Slightly leached with grey / brown clay	266	-14.1		
230.60	230	76	X													X									X				Axial parallel / broken int angular elongate fragments	266	-14.1		
230.93	310	90								X						X							X		X				Slightly leached grey sandy clay coating	266	-14.1		
231.10	35	72								X						X							X		X				Slightly leached grey clay coating	266	-14.1		
232.10	160	82								X						X			X					X						266	-14.1		
232.17	145	66								X						X			X					X						266	-14.1		
232.22	170	53								X						X			X					X						266	-14.1		
232.80	345	88									X					X						X		X					White calcite vein, vertical striae	266	-14.1		
233.20	55	68	X							X						X							X	X					Coarse brown grey sand	266	-14.1		
233.34	210	70								X						X			X					X						266	-14.1		
233.40	340	58	X							X					X								X	X					fine grained briwn / grey sand	266	-14.1		
233.56	50	82								X						X							X	X					Minor sand coating	266	-14.1		
233.70	310	82					X									X							X	X					Minor sand coating	266	-14.1		
233.90	180	88	X				X									X							X	X					Minor sand coating	266	-14.1		
134.10	180	86	X				X									X							X	X					Minor sand coating	266	-14.1		
234.36	160	70								X						X							X	X					Minor clayey sand	266	-14.1		
234.48	345	42					X									X			X					X					Curved / arcuate joint plane	266	-14.1		
234.96	160	64	X				X									X							X	X					Trace clay	266	-14.1		
235.03	350	78	X							X						X			X					X						266	-14.1		
235.08	0	60	X							X						X			X					X						266	-14.1		
235.19	150	72	X							X						X			X					X						266	-14.1		
235.26	180	50	X	X												X			X					X						266	-14.1		
235.31	155	48		X												X							X	X					Light brown clay coating	266	-14.1		
235.65	230	32								X						X			X					X						266	-14.1		
235.80	175	64								X						X							X	X					Soft grey brown clay	266	-14.1		
235.87	140	75					X									X							X	X					Soft grey brown clay	266	-14.1		
236.20	70	64	X							X						X							X	X					Minor grey clay	266	-14.1		
236.30	50	78	X							X						X							X	X					Minor grey clay	266	-14.1		
236.37	320	54	X							X						X							X	X					Minor grey clay	266	-14.1		
236.48	60	78		X												X			X					X						266	-14.1		
236.60	20	38								X					X								X				X		Fine sand infill & bright orange Fe staining	266	-14.1		
237.18	20	36								X						X			X					X						266	-14.1		
237.55	110	64								X						X								X					Upper contact of a cavity	266	-14.1		
239.25		45	X							X						X						X	X	X					No Invert marked	266	-14.1		
239.86		90		X												X			X					X					No Invert marked	266	-14.1		
240.00			X																					X					240.0 - 240.2m Rubble recovered	266	-14.1		
241.20		15								X						X				X					X				No Invert marked - Slight oxidation	266	-14.1		
241.55	220	42								X						X				X					X				Slight Oxidation	266	-14.1		

242.15	150	90								X						X				X					X				Slight Oxidation, fine sand	266	-14.1		
242.45	35	52								X						X				X					X				Slight Oxidation	266	-14.1		
242.70	320	88								X						X							X	X					Yellow brown clay coating joint surface	266	-14.1		
242.80	330	90								X						X							X	X					Yellow brown clay coating joint surface	266	-14.1		
243.50	20	90								X						X			X					X						266	-14.1		
243.53	20	84								X						X							X		X				Slightly oxidised with brown clay coating	266	-14.1		
243.55	20	86								X						X							X		X				Slightly oxidised with brown clay coating	266	-14.1		
243.74	175	44								X						X							X		X				Slightly oxidised with brown clay and fine sand coating	266	-14.1		
244.30	0	10					X									X						X			X				Black argillite caoting , undulating and axial paraleel	266	-14.1		
244.76	50	66								X						X				X						X			Bright orange oxidation	266	-14.1		
245.35	10	10								X						X							X		X				Orange brown sand coating surface, leached contact	266	-14.1		
247.70	0	28								X						X			X					X						266	-14.1		
247.90	95	78					X									X				X					X				Slight oxidation	266	-14.1		
248.05	310	30								X						X				X					X				Slight oxidation	266	-14.1		
249.00	315	90								X						X							X		X				Orange brown sandy clay coating	266	-14.1		
249.05	320	90	X							X						X			X					X						266	-14.1		
249.54	355	70								X						X							X	X						266	-14.1		
250.90	25	78					X									X							X	X					Orange brown fine grained sand	266	-14.1		
252.60	345	52	X							X						X							X	X					coarse yellow brown sand infill	266	-14.1		
253.15	145	82								X						X			X					X						266	-14.1		
254.11	0	90								X						X			X					X						266	-14.1		
254.70	140	48								X						X			X					X						266	-14.1		
254.94	160	78								X						X				X					X				Weak Fe staining	266	-14.1		
255.30	40	72	X	X												X				X					X				Weak Fe staining	266	-14.1		
255.33	230	80								X						X							X	X					Minor Orange brown clay	266	-14.1		
255.93		60	X							X						X			X						X				No Invert Marked	266	-14.1		
256.10		75					X									X							X	X					No Invert Marked - Curved / Arcuate	266	-14.1		
256.57		45								X						X			X					X					No Invert Marked	266	-14.1		
256.60		45								X						X			X					X					No Invert Marked	266	-14.1		
256.70		45								X						X			X					X					No Invert Marked	266	-14.1		
257.00		20	X					X								X			X					X					No Invert Marked - Polished	266	-14.1		
257.60		90	X					X								X			X					X					No Invert Marked - Polished and undulating	266	-14.1		
257.90		90	X					X								X			X					X					No Invert Marked	266	-14.1		
258.50		45								X						X			X					X					No Invert Marked	266	-14.1		
258.70		30								X						X							X	X					No Invert Marked - minor sand	266	-14.1		
259.05		85						X								X			X					X					No Invert Marked - slightly polished	266	-14.1		
260.23	155	78								X						X			X					X						266	-14.1		
260.51	150	70								X						X			X					X						266	-14.1		
260.70	40	90								X						X							X	X					Minor clay	266	-14.1		
260.80	280	38	X				X									X			X					X						266	-14.1		
260.84	150	78								X						X			X					X						266	-14.1		
261.30	170	62								X						X					X			X					Coarse sand	266	-14.1		
261.42	170	56								X						X			X					X						266	-14.1		
262.94	340	86								X						X			X					X						266	-14.1		
263.15	195	80								X						X			X					X						266	-14.1		
263.45	165	18					X									X				X						X				266	-14.1		
263.95	340	84								X						X			X					X						266	-14.1		
264.20	340	74								X						X			X					X						266	-14.1		
265.07	310	84	X							X						X				X					X				Slightly oxidsed	266	-14.1		
265.48	210	66								X				X							X				X				Coarse sand infill / ribble	266	-14.1		
266.09	210	70								X						X			X					X						266	-14.1		
266.35	305	72								X						X			X					X						266	-14.1		
266.44		55								X						X					X			X					No Invert Marked - Coarse sand	266	-14.1		
266.62		75								X						X					X			X					No Invert Marked - Coarse brown sand	266	-14.1		
267.05	50	72								X						X			X					X						266	-14.1		
267.15	40	662								X						X					X	X		X					Grey calcite & coarse brown sand	266	-14.1		
267.75	250	18								X						X					X			X					Minor Sand	266	-14.1		
267.96		60								X						X			X					X					No Invert Marked	266	-14.1		
268.04		65								X						X			X					X					No Invert Marked	266	-14.1		
268.50			X													X								X					268.5 - 268.65m Coarse Rubble	266	-14.1		
268.65		45								X						X			X					X					No Invert Marked	266	-14.1		
268.79		45								X						X			X					X					No Invert Marked	266	-14.1		

269.00		85	X							X						X			X					X					No Invert Marked - Conjugate Jointing	266	-14.1		
269.00		75					X									X			X					X					No Invert Marked - Conjugate Jointing	266	-14.1		
269.52	140	76								X						X			X					X						266	-14.1		
269.75	90	48								X						X			X					X						266	-14.1		
270.15	310	30								X						X			X					X						266	-14.1		
271.54	180	82								X						X			X					X						266	-14.1		

PROJECT NAME Lackagh Quarry

CLIENT: Glaway County Council

ENGINEER: ARUP

REPORT NO:

HOLE NO: BH-04

LOGGED BY: Dave Blaney

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	No	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
5.30	20								x						x							x	x					Grey brown soft clay
5.40	20								x						x							x	x					Grey brown soft clay
5.60	50								x						x							x	x					Grey brown soft clay
5.70	80					x									x							x	x					Grey brown soft clay
6.35	10					x									x							x	x					Grey brown soft clay
6.40	90								x							x						x	x					Minor clay smeared on fracture surface
6.70	90								x							x						x	x					Minor clay smeared on fracture surface
6.50	15					x									x			x					x					
6.68	35					x									x			x					x					
6.95	85								x						x							x	x					Minor br/gy clay smeared on fracture surface
7.02	5								x						x			x					x					
7.37	15								x						x			x					x					
7.54	15								x						x			x					x					
7.73	75					x									x			x					x					
7.75	80					x									x							x	x					Stiff / Firm br/gy clay 1mm aperture
7.86	10								x						x			x					x					
8.20	10					x									x			x					x					
8.70	70					x									x			x					x					
8.90	80					x									x							x	x					Firm gy/br clay 2mm aperture
8.95	5					x									x							x	x					Minor gy/br clay smearing fract. Surface
9.05	80					x									x							x	x					Firm gy/br clay 1mm aperture
9.10	10					x									x							x	x					
9.16	80					x									x							x	x					
9.24	55					x									x			x					x					
9.72	85					x									x							x	x					
9.33	85					x									x							x	x					
9.40	50					x									x			x					x					
9.50	85								x						x							x	x					Minor light grey clay smearing
10.00	80					x									x							x	x					Minor light grey clay smearing
10.50	80					x									x							x	x					Localised small smears of light grey clay
10.87	5								x						x			x					x					
11.06	80					x									x			x					x					
11.30	60					x									x			x					x					
11.60	45								x						x			x					x					

PROJECT NAME Lackagh Quarry
CLIENT: Glaway County Council
ENGINEER: ARUP

REPORT NO:
HOLE NO: BH-04
LOGGED BY: Dave Blaney

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	No	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
11.63	5	x							x						x			x					x					
11.79	45								x						x			x					x					
11.80	5	x							x						x			x					x					
11.97	15					x									x			x					x					
12.50	60								x						x						x		x					White / grey calcite coating
12.51	15								x						x			x					x					
12.92	15					x									x			x					x					
14.40	10					x									x			x					x					
15.14	10					x									x			x					x					
15.90	70								x						x							x	x					Minor light grey clay smearing fract. Surface
16.38	10					x								x				x						x				Minor etching / pitting on fract. Surface
16.55	70					x									x			x					x					
16.77	5					x									x			x					x					
17.05	10					x									x			x					x					Strongly undulating - 30mm amplitude
17.40	10					x								x								x	x					Orange / brown clay infill
17.50	80					x									x							x		x				Minor clay and locallised Fe. staining
17.60	45	x							x						x			x					x					
17.65	70	x							x						x			x					x					
18.77	10								x						x			x					x					
19.93	25					x							x					x					x					
20.98	10								x						x			x					x					
21.85	60					x									x			x					x					
22.05	20					x								x				x					x					
22.15	40								x						x			x					x					
22.35	10								x						x			x					x					
23.10	10								x						x			x						x				Slight Fe Staining
23.13	0								x						x			x					x					
23.62	5								x						x			x					x					
24.17	20								x						x			x					x					
24.98	5					x									x			x					x					
25.16	10					x								x				x						x				Slight Fe Staining
25.58	10								x						x			x					x					
25.80	10								x						x			x					x					

PROJECT NAME **Lackagh Quarry**

CLIENT: **Glaway County Council**

ENGINEER: ARUP

REPORT NO:

HOLE NO: **BH-04**

LOGGED BY: **Dave Blaney**

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	No	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
26.52	5					x									x			x					x					
26.70	75								x						x							x	x					Fine smear of light brown clay
26.72	20	x							x						x			x					x					
26.96	5					x									x			x					x					
27.06	60	x							x						x			x					x					
27.09	15	x							x						x			x					x					
27.13	10	x							x						x			x					x					
27.18	60	x							x						x			x					x					
27.53	5								x						x			x					x					
27.84	5					x									x			x					x					
27.87	5								x						x			x					x					
27.98	5								x						x			x					x					
28.25	5								x						x							x	x					Trace light grey clay coating
28.55	50								x						x			x					x					
28.90						x							x									x		x				37cm wide void - minor clay / slight oxidat.
29.77	5								x						x			x					x					
29.94	5								x						x			x					x					
30.10	5								x						x			x					x					
30.63	15					x									x							x	x					Minor light brown clay smearing
30.69	5								x						x							x	x					Minor light brown clay smearing
30.92	10					x									x			x					x					
31.43	10					x									x							x	x					Minor light brown clay smearing
31.60	5					x									x							x	x					Minor light brown clay smearing
32.47	20								x						x			x					x					
32.90	5								x						x			x					x					
33.94	10	x							x						x			x					x					
34.00	85								x						x			x					x					
34.04	10	x							x						x			x					x					
34.30	10	x							x						x			x					x					
34.52	75								x						x			x					x					
34.57	15	x							x						x			x					x					
34.96	15								x						x			x					x					

PROJECT NAME Lackagh Quarry

CLIENT: Galway County Council

ENGINEER: ARUP

REPORT NO:

HOLE NO: BH-05

LOGGED BY: Dave Blaney

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness									Other	Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar				V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	X	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
0.52	5	X				X									X			X					X					
0.60	5					X									X			X					X					
0.63	85								X						X						X		X					White / brown crystalline calcite
0.63	85								X						X			X					X					
0.68	5					X									X			X					X					
0.75	5	X							X						X			X					X					
0.84	5	X							X						X			X					X					
0.90	5								X						X			X					X					
1.31	15								X						X							X	X					Pale brown clay smearing fract. Surface
1.37	10	X				X									X							X	X					Pale brown clay smearing fract. Surface
1.40	10	X				X									X							X	X					Pale brown clay smearing fract. Surface
1.50	85	X							X						X							X	X					Pale brown clay smearing fract. Surface
1.66	5					X									X							X	X					Pale brown clay smearing fract. Surface
1.83	85	X							X						X			X					X					
2.13	10								X						X			X					X					
2.22	20		X												X			X					X					
2.42	5								X						X			X					X					
2.47	10								X						X			X					X					
2.57	10								X						X			X					X					
2.64	5								X						X			X					X					
2.70	10								X						X			X					X					
2.77	20					X									X			X					X					
2.82	5								X						X			X					X					
2.99	15								X						X			X					X					
3.07	10					X									X			X					X					
3.20	10								X						X			X					X					
3.27	20								X						X			X					X					
3.50	85					X									X			X					X					Minor fine gr. Sand coating fract. Surface
3.45	15	X				X									X			X					X					
3.62	20	X				X			X						X			X					X					
4.02	15								X						X			X					X					
4.10	85								X						X							X			X			Fine sandy clay coating & weak Fe staining
4.10	85								X						X							X			X			Joints are sub-parallel c.2-3cm apart
4.16	5								X						X			X					X					

PROJECT NAME Lackagh Quarry | **REPORT NO:**
CLIENT: Galway County Council | **HOLE NO:** BH-05
ENGINEER: ARUP | **LOGGED BY:** Dave Blaney

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	X	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
4.25	5	X							X						X			X					X					
4.50	5	X							X						X			X					X					
4.73	5	X							X						X			X					X					
4.60	85								X						X							X			X			Fine sandy clay coating & weak Fe staining
4.60	85								X						X							X			X			Fine sandy clay coating & weak Fe staining. Joints are parallel and 2cm apart
4.74	5	X							X						X			X					X					
4.83	5	X							X						X			X					X					
3.85-8.0	85-90								X						X						X	X			X			Fine sandy clay coating & Fe staining. Fracture is are axial parallel and continue for 4.15m. From 6.5m white calcite deposited on fracture surface. 7.0-7.65m firm brown/grey clay infill - aparture up to 4mm wide
4.97	5	X							X						X			X					X					
5.07	10	X							X						X							X	X					Minor clay coating fracture surface
5.13	20	X							X						X							X	X					Minor clay coating fracture surface
5.20	75	X							X						X			X					X					Conjugate with vertical joint
5.16	10	X							X						X			X					X					
5.61	20	X				X									X			X					X					
5.73	10	X							X						X			X					X					
5.80	5	X							X						X			X					X					
5.97	5	X							X						X			X					X					
6.10	85	X	X												X							X	X					Conjugate with vertical fracture strike 120 / 60'
6.26	5	X							X						X			X					X					
6.38	10	X							X						X							X	X					Light brown clay
6.48	5	X							X						X			X					X					
6.60	5	X							X						X			X					X					
6.74	5	X							X						X			X					X					
6.78	5	X							X						X			X					X					
6.88	15	X				X									X			X					X					
6.91	10	X				X									X			X					X					
7.13	5	X							X						X			X					X					
7.37	5	X							X						X			X					X					
7.57	10	X							X						X			X					X					
7.74	15								X						X			X					X					
8.64	0								X						X				X					X				Orange brown Fe staining
8.68	50								X						X				X					X				Orange brown Fe staining
8.73	50								X						X				X					X				Orange brown Fe staining

PROJECT NAME **Lackagh Quarry**	**REPORT NO:**
CLIENT: **Galway County Council**	**HOLE NO:** **BH-05**
ENGINEER: ARUP	**LOGGED BY:** **Dave Blaney**

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	X	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
8.92	45		X												X				X					X				Orange brown Fe staining
9.20	45								X						X							X		X				Orange brown Fe staining
9.35	60		X												X				X					X				Orange brown Fe staining, light brown clay smearing
10.25	5								X						X			X					X					
10.4 - 11.3	85								X						X						X	X		X				Axial parallel fracture, minor calcite and orange brown clay coating fracture surface
10.50	5								X						X			X					X					
11.20	50					X									X						X	X	X					Light grey calcite and minor brown clay coating fracture surface
11.30	5								X						X			X					X					
11.90	5		X												X						X		X					Fracture devoped along stylolite, black argillite lining
11.95	80	X							X						X			X						X				Minor Fe staining
12.05	15					X									X			X					X					
12.42	10		X												X						X		X					Fracture devoped along stylolite, black argillite lining
12.60	55								X						X			X					X					
12.6 - 13.4	85								X						X				X					X				Minor Fe staining
12.78	0	X							X						X							X	X					Minor light brown clay
12.84	5	X							X						X							X	X					Minor light brown clay
13.02	5	X							X						X			X					X					
13.26	5	X							X						X			X					X					
13.52	20								X						X			X					X					
13.82	5								X						X			X					X					
14.39	30								X						X							X	X					Sand/clay coating, minor Fe staining
14.72	55								X						X			X					X					
15.00	30								X						X			X					X					
15.15	15		X												X						X		X					Fracture devoped along stylolite, black argillite lining
15.20	85	X				X									X			X					X					
15.33	85	X				X									X			X					X					
15.40	20					X									X							X	X					Minor brown clay
15.55	10		X												X						X		X					Fracture devoped along stylolite, black argillite lining
16.59	10					X									X			X					X					
16.86	10								X						X							X		X				Minor light brown clay, some pitting & weak oxidation of fracture surface
16.90	30								X						X							X		X				Minor light brown clay, some pitting & weak oxidation of fracture surface

PROJECT NAME **Lackagh Quarry**
CLIENT: **Galway County Council**
ENGINEER: ARUP

REPORT NO:
HOLE NO: **BH-05**
LOGGED BY: **Dave Blaney**

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	X	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
17.20	10								X						X							X	X					Grey/brown clay coating fract. Surface
17.25	85	X				X									X							X	X					Minor grey / brown clay
17.40	45					X									X							X	X					Minor grey/brown clay coating fract. Surface
17.78	5					X									X							X	X					Undulating - amplitude 2cm, brown clay infill
18.03	15		X												X							X	X					Minor clay
18.30	15					X									X			X					X					
18.50	85	X							X						X						X		X					Minor white calcite
18.60	20								X						X							X	X					Orange/brown clay smeared on fract surface
18.80	10								X						X							X	X					Orange/brown clay smeared on fract surface
18.90	85								X						X						X		X					Minor white calcite
18.97	10					X									X			X					X					
19.20	20					X									X							X	X					Orange/brown clay infill
19.60	5								X						X			X					X					
19.98	45	X							X						X							X	X					Orange/brown clay infill, aperture up to 2mm thick
20.00	45	X							X						X							X	X					Orange/brown clay infill, aperture up to 2mm thick
20.04	45								X						X			X					X					
20.12	10								X						X			X					X					
20.60	85								X						X			X					X					
20.60	75					X									X							X	X					Orange/brown clay coating fract. Surface
20.52	10								X						X			X					X					
20.73	20	X	X												X							X	X					Very rough - Orange/brown clay coating fract. Surface
20.87	35	X	X												X							X	X					Very rough - Orange/brown clay coating fract. Surface
20.97	50					X									X							X	X					Orange/brown clay coating fract. Surface
21.23	55					X									X							X	X					Brown sandy clay coating
21.35	55					X									X							X	X					Brown sandy clay coating
21.42	55					X							X									X	X					Joint aperture is >10mm infilled with orange brown clay
21.86	30	X							X						X			X					X					
21.90	20								X						X			X					X					
22.05	45								X						X			X					X					

PROJECT NAME Lackagh Quarry

CLIENT: Galway County Council

ENGINEER: ARUP

REPORT NO:

HOLE NO: BH-05

LOGGED BY: Dave Blaney

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	X	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
22.10	5								X						X			X					X					
22.45	85	X							X						X							X		X				Clay coating fract surface minor Fe staining
22.92	10	X							X						X							X	X					Clay coating fract surface
23.40	70								X						X							X	X					Light brown clay over basal 30cm
23.60	5	X							X						X			X					X					
23.72	10								X						X						X		X					Minor light grey calcite
24.40	60								X						X			X					X					
24.50	0								X						X			X					X					
25.04	0								X						X			X					X					
25.52	45								X						X						X		X					Minor light grey calcite
25.82	25					X									X			X					X					
26.37	5								X						X			X					X					
26.61	5								X						X			X					X					
26.70	80	X							X						X				X				X					Minor Fe staining
27.10	85								X						X						X		X					Minor white calcite
27.14	20	X	X												X			X					X					
27.27	55								X						X			X					X					
27.62	55		X												X			X					X					
27.88	0								X						X			X					X					
28.05	5	X							X						X			X					X					
28.12	60	X							X						X			X					X					
28.16	5	X				X									X			X					X					
28.25	90								X						X						X		X					Minor white calcite veining
28.40	55	X							X						X			X					X					
28.1 - 32.35	85-90								X						X						X		X					Axial parallel fracture, surfaces partially coated with white calcite
28.81	15	X							X						X			X					X					
28.90	20	X							X						X			X					X					
29.05	30	X							X						X			X					X					
29.35	10	X							X						X			X					X					
29.40	60	X							X						X			X					X					
30.00	5	X							X						X			X					X					
30.30	40	X							X						X			X					X					
30.38	10	X				X									X			X					X					
30.50	10	X							X						X			X					X					

PROJECT NAME **Lackagh Quarry**

CLIENT: **Galway County Council**

ENGINEER: ARUP

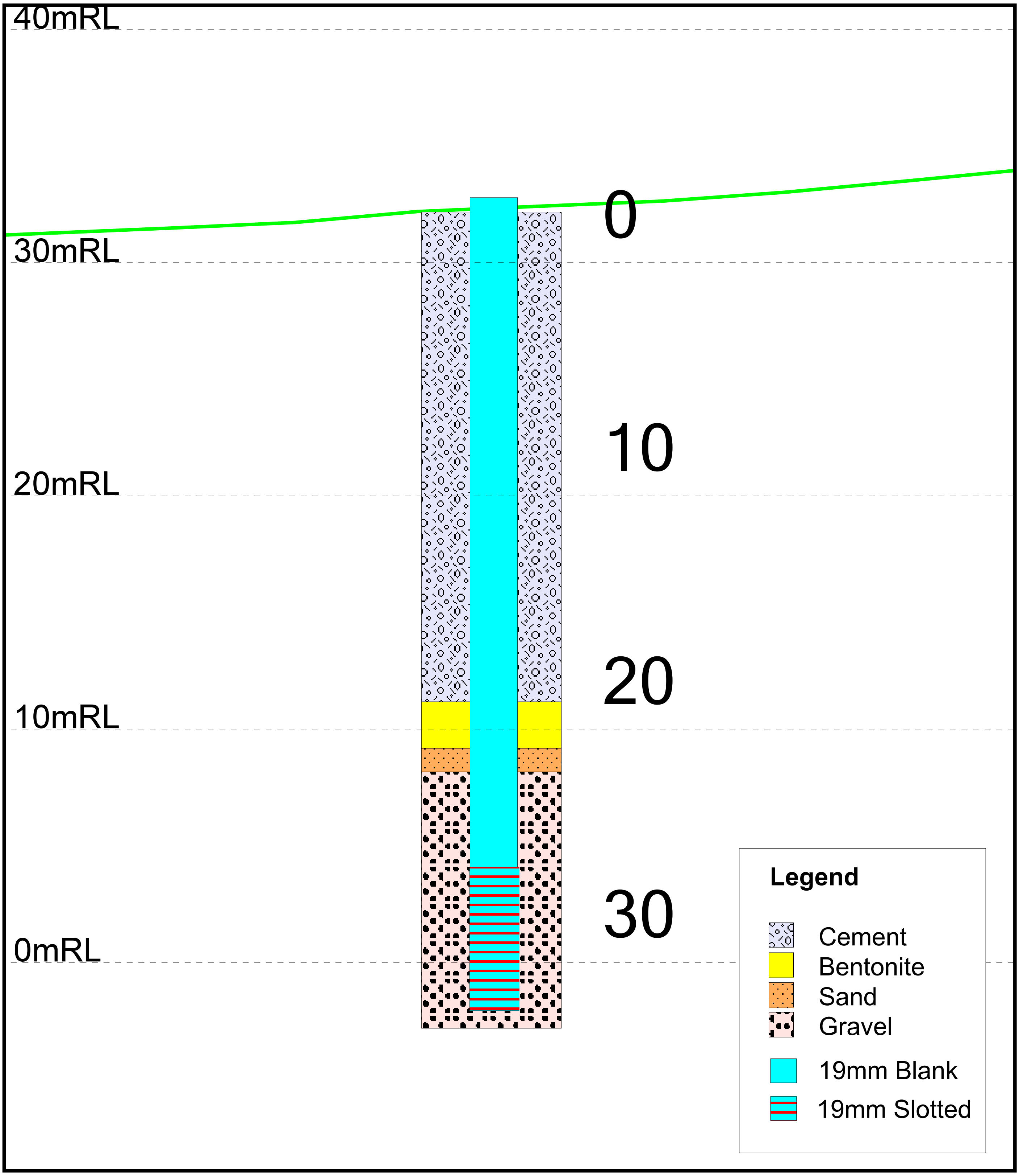
REPORT NO:

HOLE NO: **BH-05**

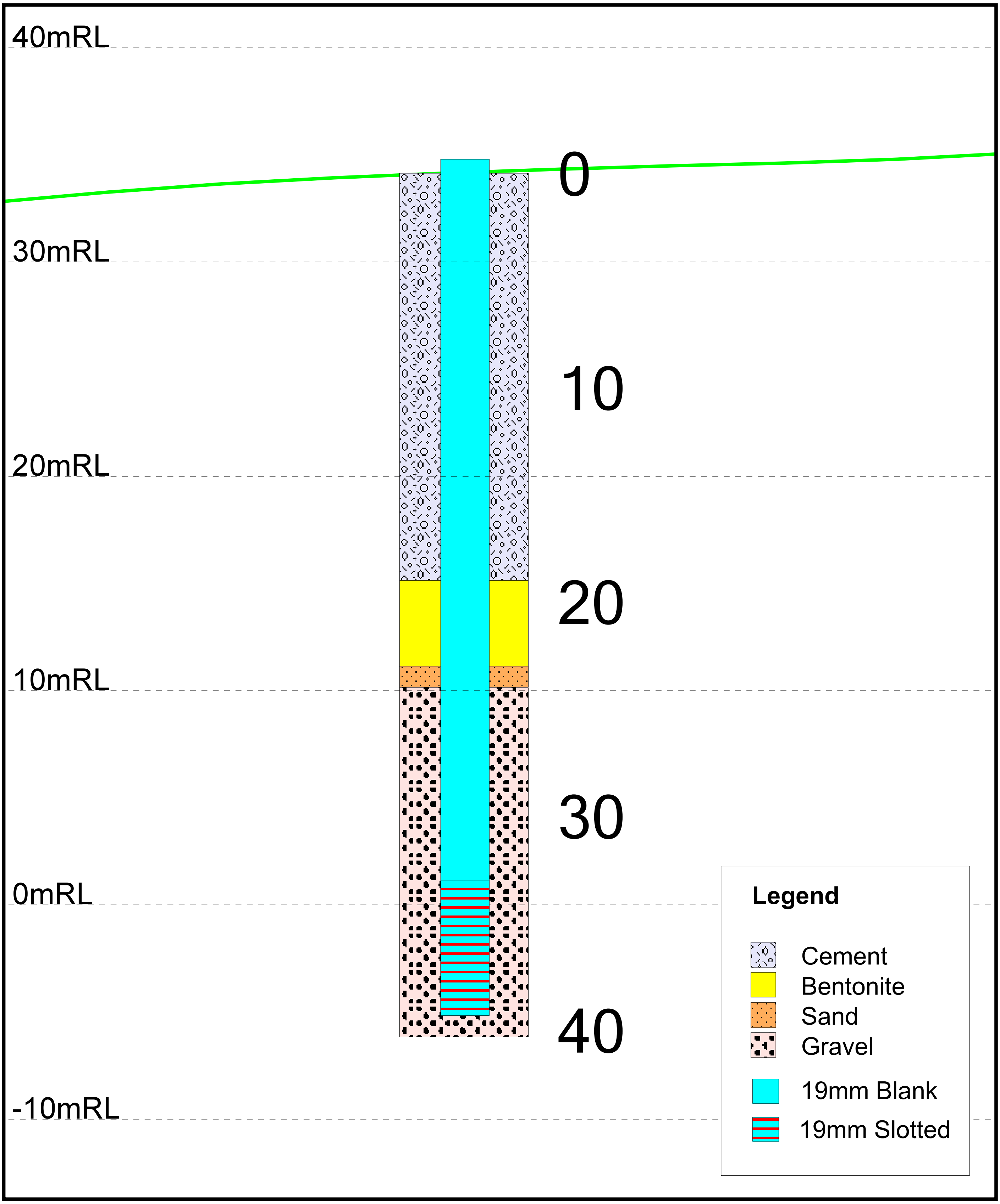
LOGGED BY: **Dave Blaney**

Depth of Discontinuity (m BGL)	Orient.to Short Core Axis	Non Intact? (NI)	Roughness										Aperture					Filling					Weathering					Comments
			Stepped			Undulating			Planar			Other	V Open	Open	Mod Open	Tight	V Tight	Clean	Staining	% Soil	% Mineral	Clay	X	Sl	Mod	High	Comp	
			R	Sm	St	R	Sm	St	R	Sm	St		>10mm	2.5-10	0.5-2.5	0.1-0.5	<0.1											
30.78	10	X							X						X			X					X					
30.90	35	X							X						X			X					X					
31.30	50	X							X						X				X					X				
31.60	70	X							X						X				X					X				
31.90	45	X							X						X			X					X					
32.07	35								X						X			X					X					
32.24	5								X						X			X					X					
32.85	15								X						X			X					X					
32.91	20								X						X			X					X					
33.30	5								X						X			X					X					
33.55	5								X						X			X					X					
33.80	5								X						X			X					X					
33.94	10					X									X			X					X					
34.55	10								X						X			X					X					
34.73	45								X						X			X					X					
34.9 - 37.2	85					X									X				X			X		X				Locally stepped aspect, trace clay coating surfaces, slight Fe staining over top 1.5m
34.90	20								X						X			X					X					
35.00	45	X							X						X			X					X					
35.23	20	X		X											X			X					X					
35.37	10	X							X						X			X					X					
35.54	15	X							X						X			X					X					
35.63	10								X						X			X					X					
35.73	10								X						X			X					X					
36.10	5	X							X						X							X		X				Minor clay, slight Fe Staining
36.40	20	X							X						X			X					X					
36.47	10								X						X			X					X					
36.88	45	X							X						X			X					X					
37.20	30					X									X							X	X					Traces of orange brown clay
38.05	10								X						X			X					X					
37.95 - 40.0	85					X									X							X		X				Minor clay smearing surfaces and locallised Fe staining
38.64	10	X							X						X			X					X					
39.64	10	X							X						X			X					X					
39.75	55	X							X						X			X					X					
39.90	65	X							X						X			X					X					

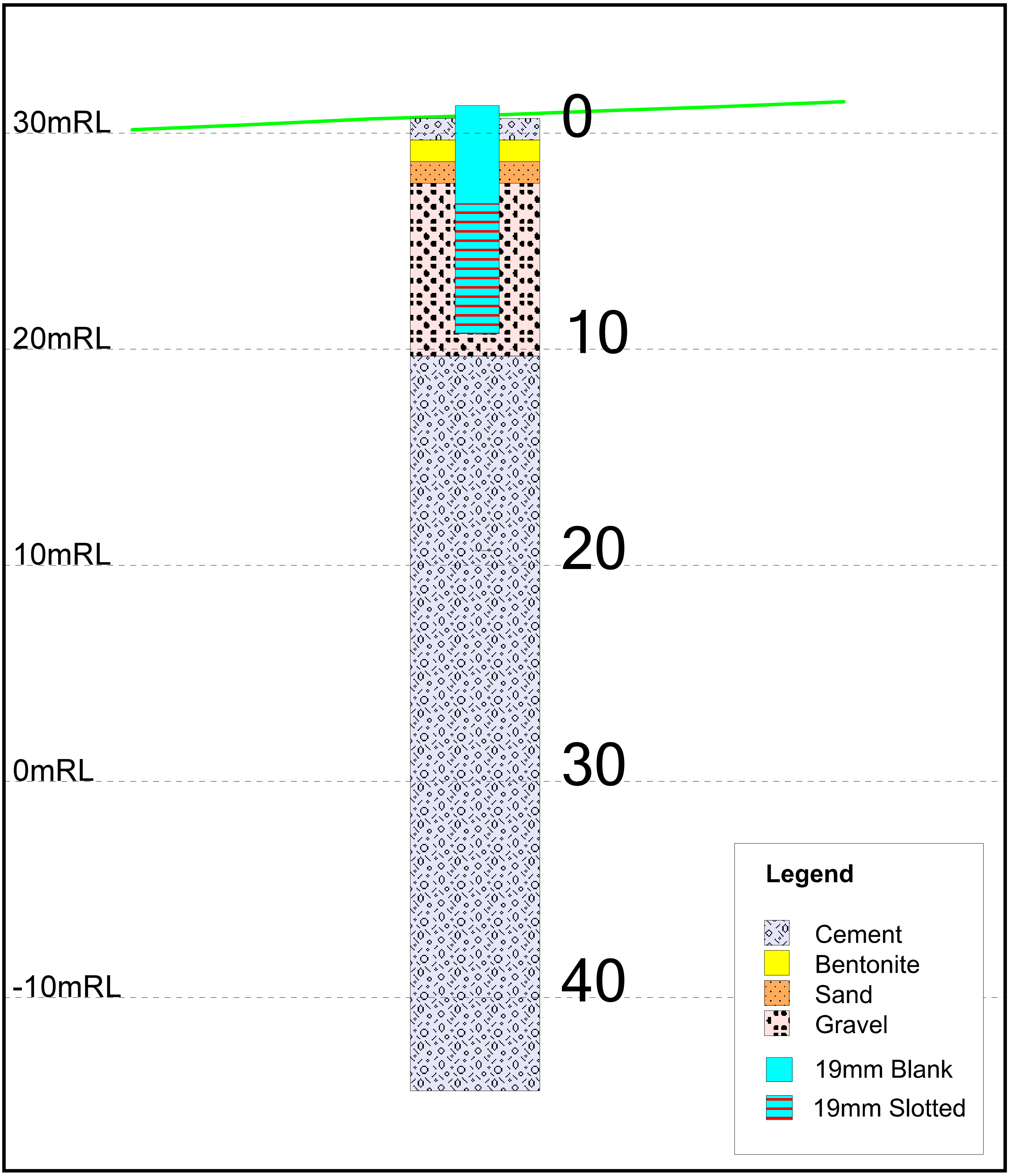
APPENDIX IV



Piezometer Installation BH04



Piezometer Installation BH05



Piezometer Installation BH06

APPENDIX V

R13/16

Report on Geophysical Surveys completed at Lackagh Quarry Co. Galway for Arup

Graham Reid P.Geo.

Project Number:	**R13/16**
Author(s):	Graham Reid P.Geo,
BRG Ltd.	Arup
Date of Report:	January 2016

Private & Confidential

THE DATA PRESENTED IN THIS REPORT WAS ACQUIRED FROM GEOPHYSICAL NON-INVASIVE TECHNIQUES CARRIED OUT AT SURFACE. INTERPRETATIONS ARE DERIVED FROM A COMBINATION OF GROUND CONDITIONS, TYPICAL GEOPHYSICAL RESPONSES AND THE KNOWLEDGE/EXPERIENCE OF THE AUTHOR. BRG LTD HAS COMPILED AND INTERPRETED THE DATA TO BEST INDUSTRY STANDARDS AND WITH ALL REASONABLE SKILL AND DILIGENCE IN RELATION TO THE TECHNIQUES AND RESOURCES APPLIED IN AGREEMENT WITH THE CLIENT. ANY FUTURE USE OF THIS REPORT SHOULD TAKE ITS INTERPRETIVE NATURE INTO CONSIDERATION.

Report Number	**Author**	**Checked By**	**Version**	**Date**
R13/16	Graham Reid P. Geo	Dave Blaney P. Geo	V1	18/01/2016
Signed				

R13/16

Report on Geophysical Surveys at Lackagh, Co. Galway

Graham Reid, January 2016

Contents

List of Figures

1. Executive Summary

BRG Ltd completed geophysical surveys in an area to the west of the abandoned Lackagh Quarry, Menlo, Co. Galway as part of the Priority Drilling Ltd preliminary site investigation for the proposed new road alignment through this area. The geophysical surveys consisted of 2D Electrical Resistivity Tomography (ERT) and Microgravity across an initial area of roughly 300*30m, subsequently extended to better define the extent of a deep weathering/karst zone.

The surveys were designed to test for subsurface details and bedrock depths in advance of follow up rotary core drilling. Information on potential karst features were of particular interest to the client. The bedrock exposed in the quarry and outcropping to the west consists of strong, thickly bedded Visean limestones dipping gently to the south-west. A thin Tuff band is reputed to control a local aquifer, with more thinly bedded limestones and thin shaley bands developed beneath.

Outcrop to the west of the quarry consists of well-developed limestone pavement extending c,80-100m to the west, which gives way to grass fields across the remainder of the survey area.

Resistivity sections from the 2D ERT and gravity data show a marked contrast from high resistivity bedrock in the east with a sharp contact into very low resistivity zones to the west. The western region has a low gravity response coincident with the low resistivity. The base of the initial ERT lines did not penetrate below 30m in the west suggesting that this area could be a deep overburden/weathered zone, possibly a karst filled sinkhole or more shaley unit.

The work was completed over three separate periods:

- 6 day period from 27th October to 3rd November 2015.
- 1 day, 25th November
- 3 days, 13-15th January

2. Introduction

BRG was hired by Priority drilling Ltd. to acquire 2D ERT and microgravity data along a planned potential route for the new Galway ring road located to the west of Lackagh Quarry.

The Quarry is located to the north of Galway city with easy access off the Coolagh Road. The quarry is abandoned and fenced off and site access was organised through Sean Ross of Arup. The work was completed mainly across fields and limestone pavement to the west of the quarry and outside the quarry footprint. A rough track running from inside the quarry bounds allowing access into the fields. Loose cattle including a bull were running free within the fields and surrounding scrub, however these were fenced out of the fields when ERT lines were being acquired. A minor microgravity grid was also added on the first bench within the quarry over the area where the proposed horizontal borehole was drilled.

Figure 1: Aerial Photograph Site Location Map

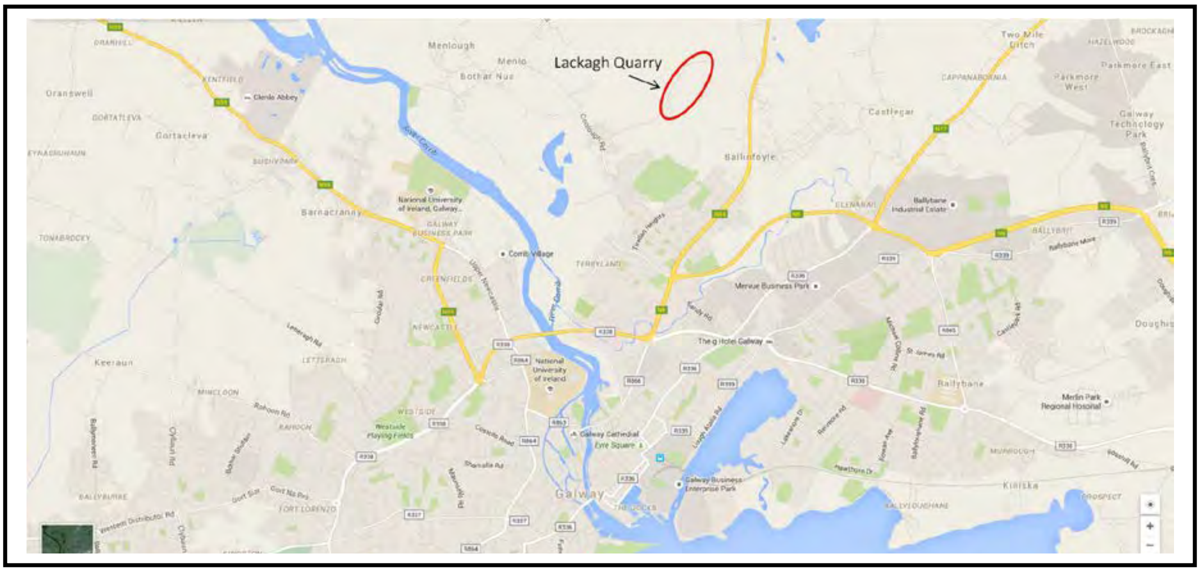


Figure 2: Location Map

2.1 Survey Objectives

1) Acquire 2D Resistivity and Microgravity data across the specified region within and proximal to the Lackagh Quarry site.

2) Generate Maps and sections showing the geophysical characteristics of the site and generate interpretative maps and sections of the overburden/bedrock model over the chosen areas.

3) Outline potential areas for future intrusive investigations (in particular to assist with locating follow up rotary drilling)

3. Geological setting

The mapped geology from the Geological Survey of Ireland (1:100,000) shows the site to be underlain by undifferentiated Visean limestones / shaley limestones. The rocks are well exposed within the quarry and to the west as outcropping weathered limestone pavement. These limestones are massive, thickly bedded micritic / grainstone units, generally strong and dipping to the southwest. Overburden appears to be mostly clay and gravels and most likely glacially derived soils (the site walk over noted rounded granite boulders scattered across the limestone pavement, these are probably glacial erratics). A pronounced Tuff band clearly exposed in the quarry underlies the massive limestones and is thought to control a local aquifer. It also appears to host minor sulphides (pyrite) with iron staining developed on the surface of the underlying, slightly argillaceous, limestones.

4. Survey Equipment and methodology

The geophysical surveys were chosen to provide detailed overburden/bedrock profiles along the chosen lines (ERT) and to identify any significant anomalous zones that could be a result of faults/fractures or karst development (ERT and Microgravity).

The depth mapping potential with the ERT is limited by the length of each spread so that individual spreads were capable of surveying to from 22m b.g.l. in Line 5 to a maximum of 60m b.g.l. with Line 6. Equipment consisted of an Allied Associates Tigre system which has the potential for up to 128 electrode takeouts. 2m station spacing was initially used to get the required detail along the chosen lines, with 3m intervals on the long lines (6, 7 & 8). Data was measured using a Wenner array, controlled by an Imager2006 programme with a laptop computer. Saved data was inverted using the Geotomo Res2Dinv programme and exported as an image file displaying a cross section of the inverted Resistivities with elevation data. The resultant resistivity sections were subsequently interpreted and an interpreted geological model developed.

Microgravity data was acquired with measured sites along the centre line and 15m either side of the proposed tunnel section. These lines were measured with nominal station spacing of 10m, with gaps where scrub hawthorn was too thick. Extra stations were measured within the quarry on the first bench at 5-10m intervals. Measurement was taken using a Lacoste & Romberg model G gravity meter. Instrument drift was monitored by returning to a locally established base station at hourly intervals.

Stations were topographically surveyed using a Trimble GeoExplorer 6000 RTK GPS system corrected through phone modem link for both the ERT and the gravity surveys. The drift corrected gravity data was corrected for elevation, latitude, and reduced to Bouguer 2.67g/cm^3 to allow for local average rock densities. It was then gridded and exported for display and interpretation in the MapInfo GIS system.

All points were surveyed in Irish Transverse Mercator (ITM) projection.

5. Discussion of Results (Figures 3-16)

The 2D ERT data defines a marked contrast between the resistive massive limestones to the east and exposed within the quarry and a narrow, deep, conductive response that was detected to the west. This contact is clearly seen on lines 1 (at station 114) & 2 (station 134) where it is shown as steep westerly dipping feature. Lines 3 & 4 are almost entirely mapping the lower resistivity unit which is greater than 14m deep. This conductive zone could represent a combination of thicker overburden and underlying weathered bedrock. Line 5 was surveyed entirely on the edge of the outcropping limestone pavement and displays a thin conductive overburden layer over resistive bedrock.

Line 6 was extended N-S perpendicular to the long axis of the fields with the aim of mapping the edges of the deep overburden feature – this line was surveyed while BH3 was still in progress, with the inversion model shows the hole located within a significant deep overburden (low resistivity) feature. The southern contact of the deep overburden feature is mapped as being sub-vertical with the overburden depth increasing from <1.0m to >55.0m within a few meters. The northern side of the deep overburden feature exhibits a steeped nature with a rapid shallowing at station 210 to a depth of c.35m bgl, and the northern edge seen at station 275 where the overburden depth shallows rapidly.

Lines 7 & 8 were surveyed along similar locations to 2 & 1 respectively; however they were surveyed at 3m electrode spacing and extended to the west. Line 7 exhibits a strange higher resistivity shallow zone to the west of station 96 with lower resistivity below – this most likely reflects the line location proximal to the southern contact of the deep overburden feature resulting in the inversion model displaying some “edge” effects.

Lines 9 & 10 were also designed to map the edges of the deep overburden feature, and this has been successfully achieved along the southern contact and only partially successful in the north (where thick hawthorn bush in an environmentally sensitive area restricted access to extend the lines). These lines were surveyed using a 2m electrode spacing.

The microgravity data shows the same general scenario as the resistivity data. Higher density and more coherent limestones in the east give way to a lower density zone to the west with an irregular sinuous contact between the two. Measurements on the bench within the quarry give the same relatively high density limestone situation as seen at the area underlain by limestone pavement. However, the lower gravity readings located in zones along the edges of the quarry faces are interpreted as the effect of terrain factors

The geophysical interpretation (Figure 16) is derived from a combination of both the Microgravity and 2D ERT methods. This outlines the contact zone at about 530,130E between shallow limestones to the east and deeper overburden/weathered zone to the west. The original ERT lines and microgravity provided limited definition of the contact zones and these have been refined by the extended 3m interval lines. The rotary drilling has shown that the ERT models correlate well with the underlying geology. The mapped low resistivity zone closely follows the field outline. Completed drillholes have been located on the model sections, with those annotated as “offset” projected from up to 10m away onto the sections (N.B. there is some slight discrepancy between the plotted holes and the modelled section inversion as the holes have been extrapolated from up to 10m off line)

The unusual nature of these grass fields and where they sit within the surrounding limestone pavement would also support the possibility that they reflect the surface expression of an infilled topographic feature such as a slot canyon.

ERT Line Locations

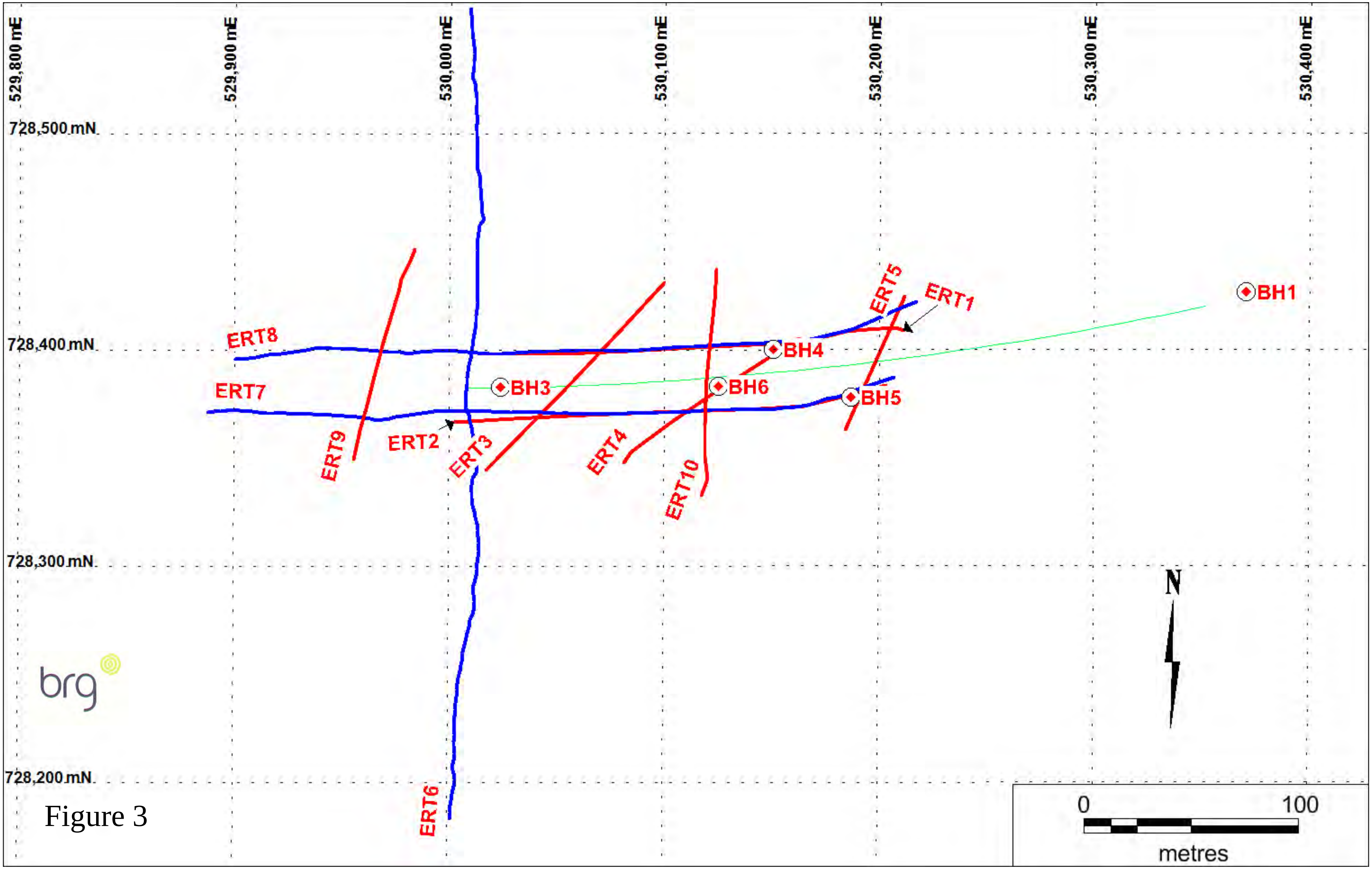


Figure 3

Resistivity – ERT Line 1

2m Electrode Takeouts

West

East

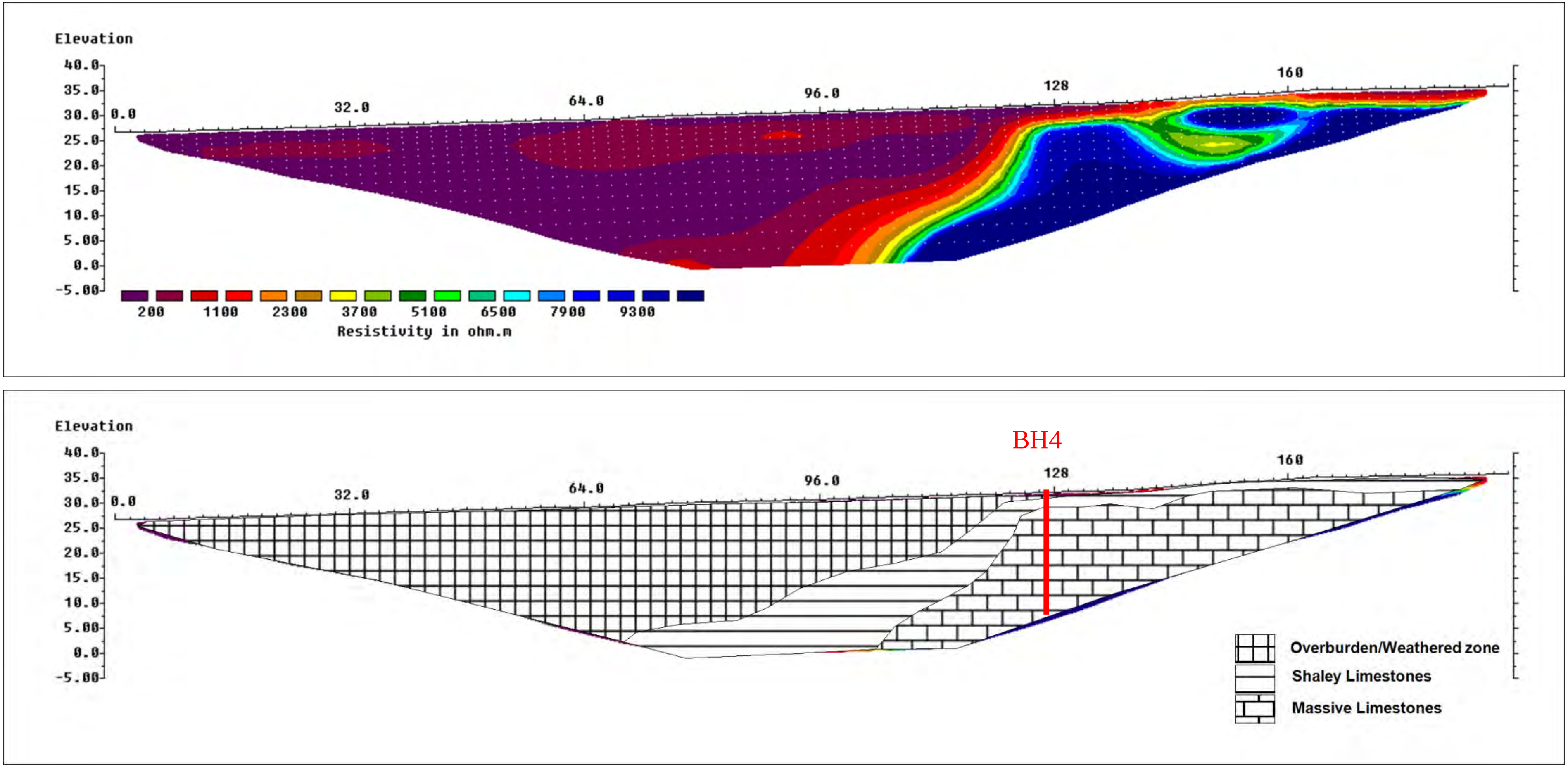


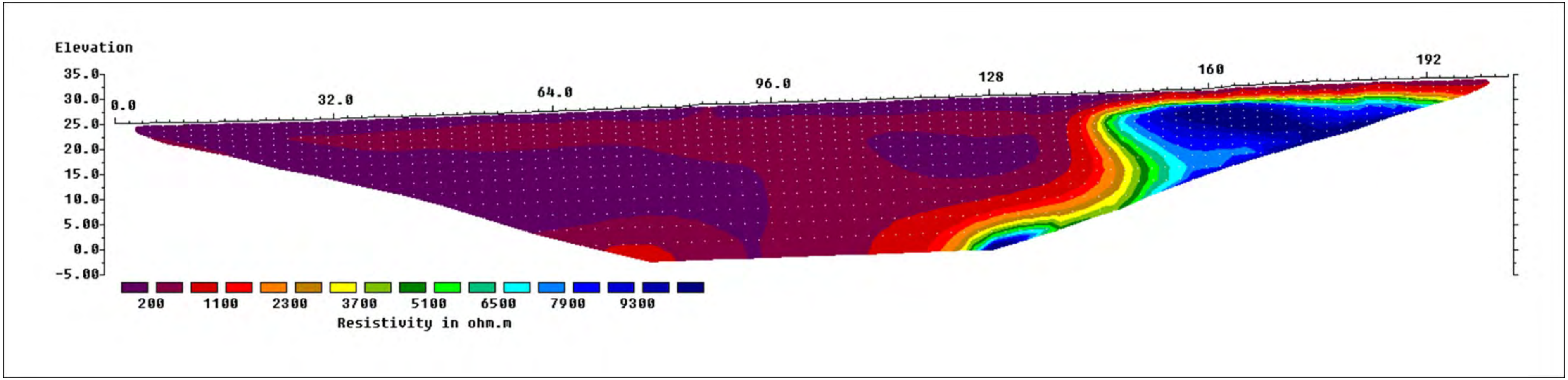
Figure 4

Resistivity – ERT Line 2

West

2m Electrode Takeouts

East



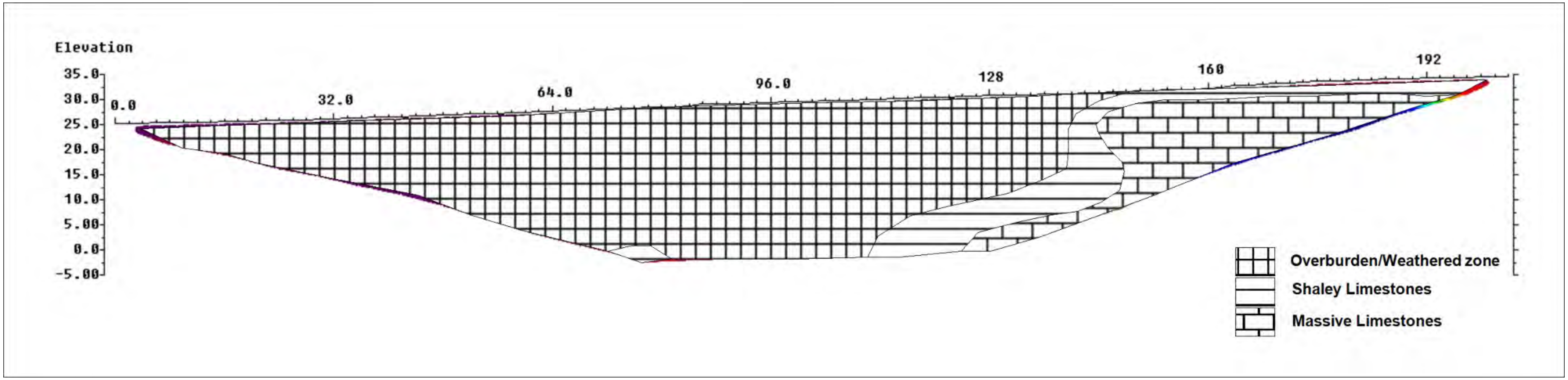


Figure 5

brg

Resistivity – ERT Line 3

2m Electrode Takeouts

SW

NE

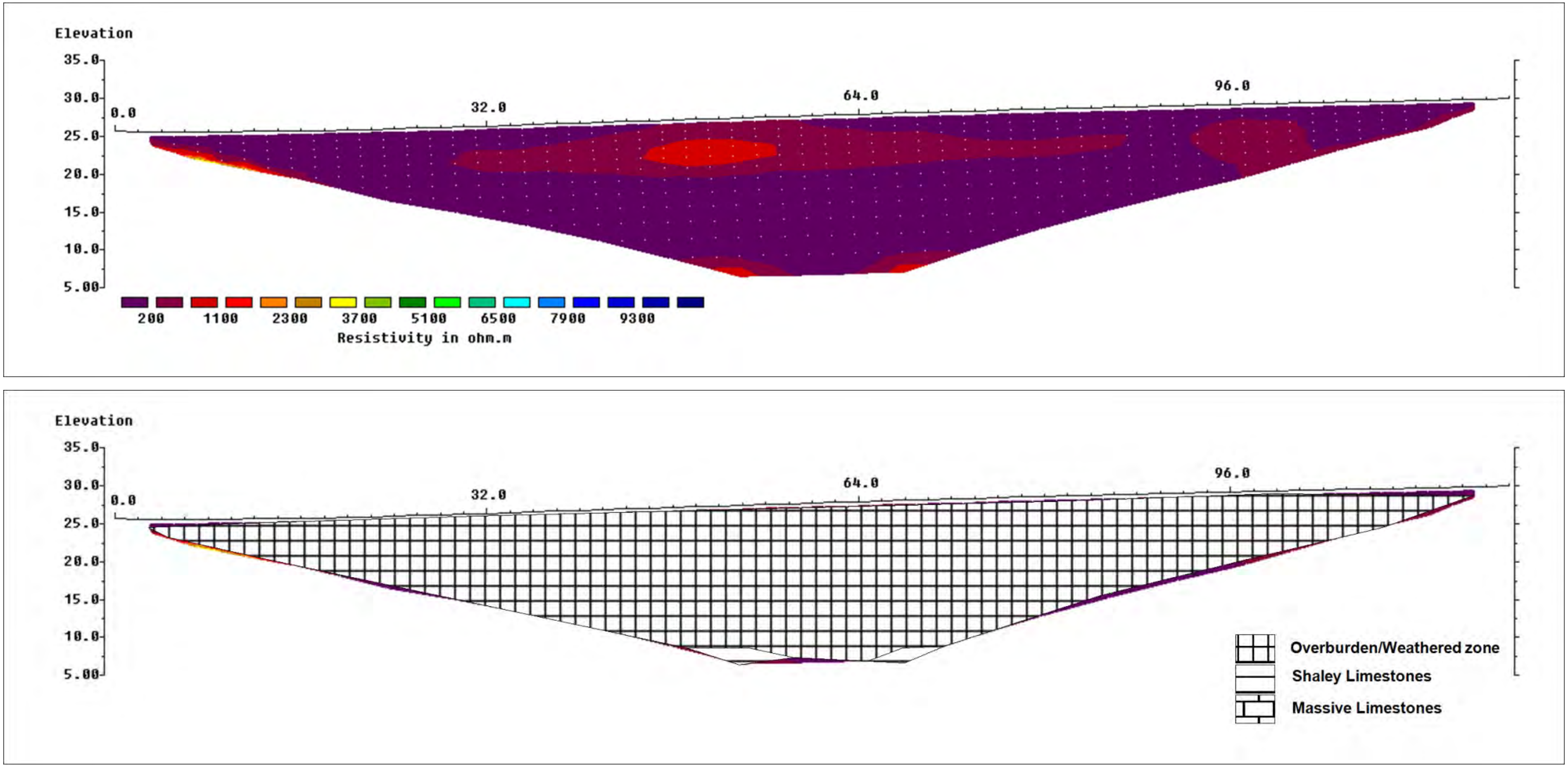


Figure 6

Resistivity – ERT Line 4

2m Electrode Takeouts

SW

NE

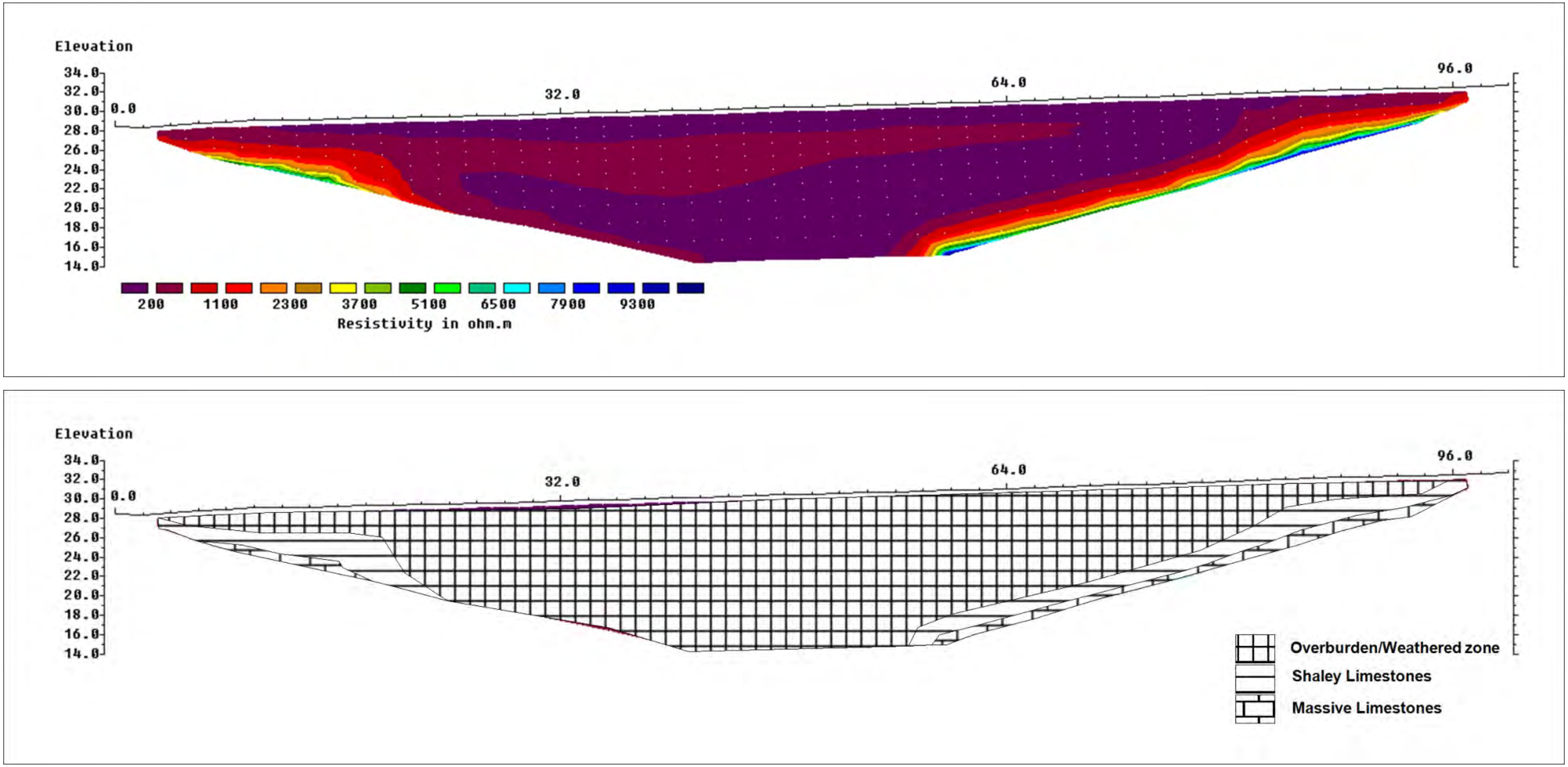


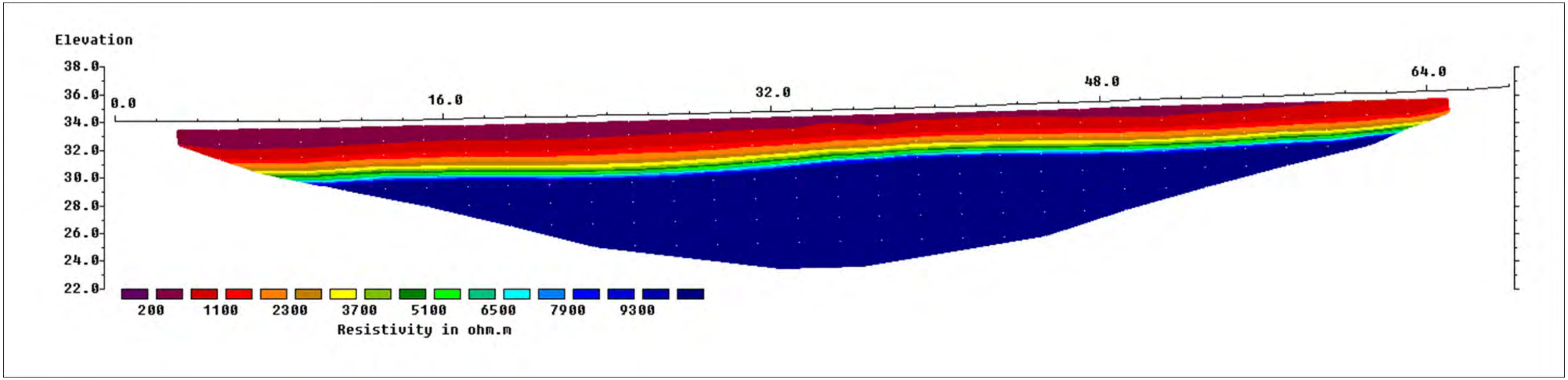
Figure 7

Resistivity – ERT Line 5

2m Electrode Takeouts

SW

NE



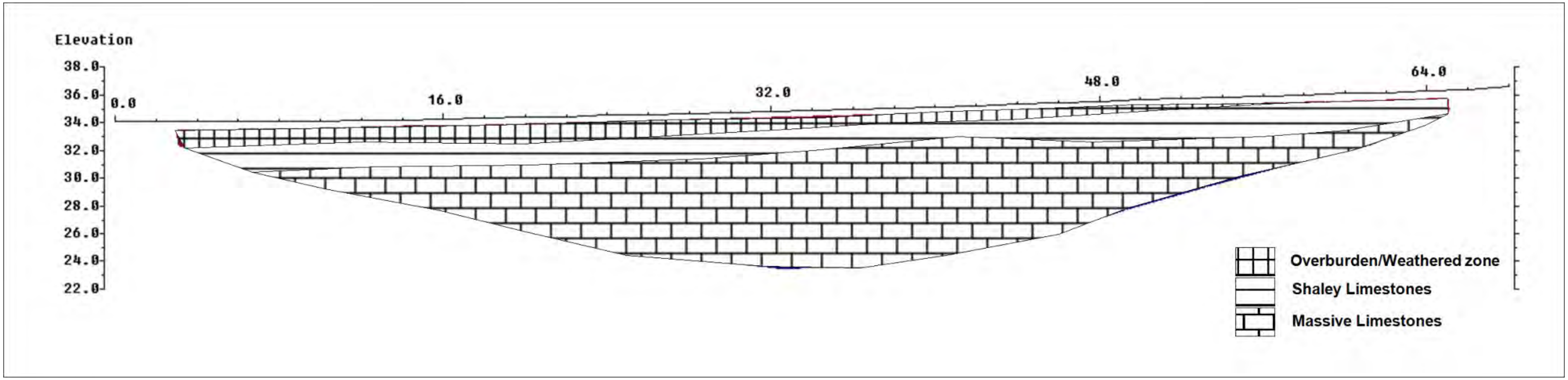


Figure 8

Resistivity – ERT Line 6

3m Electrode Takeouts

S

N

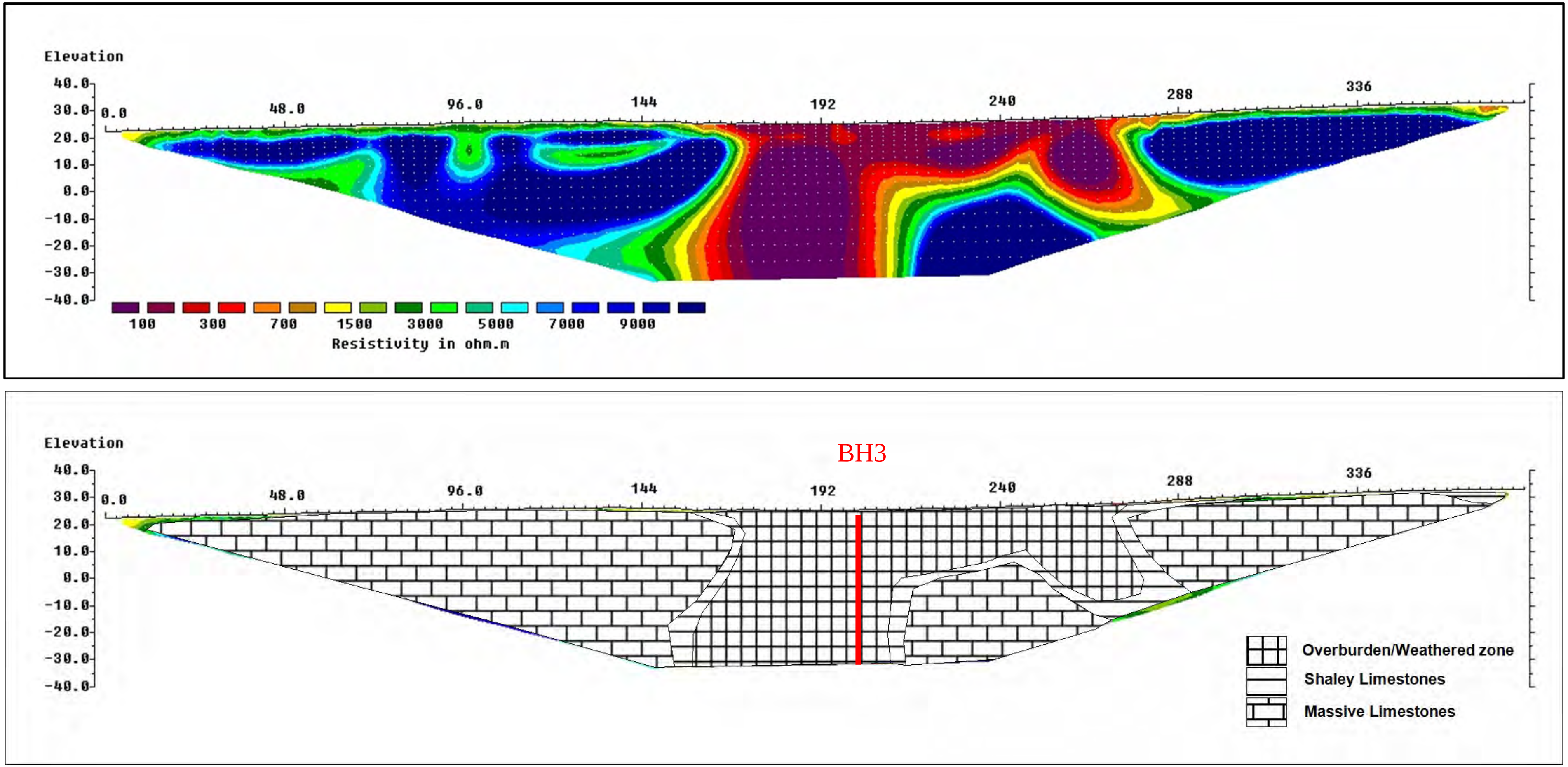
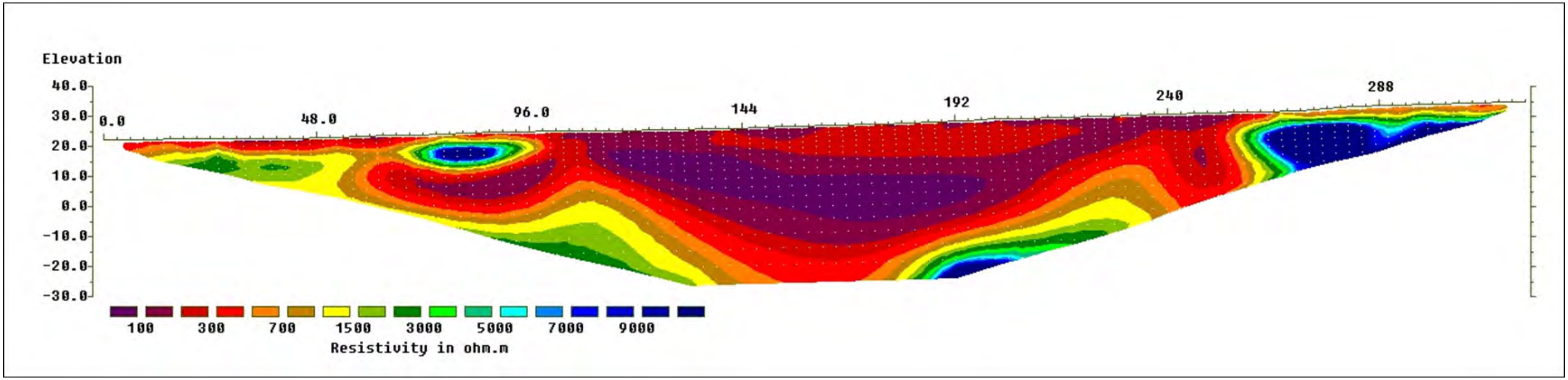


Figure 9

Resistivity – ERT Line 7

3m Electrode Takeouts

W E



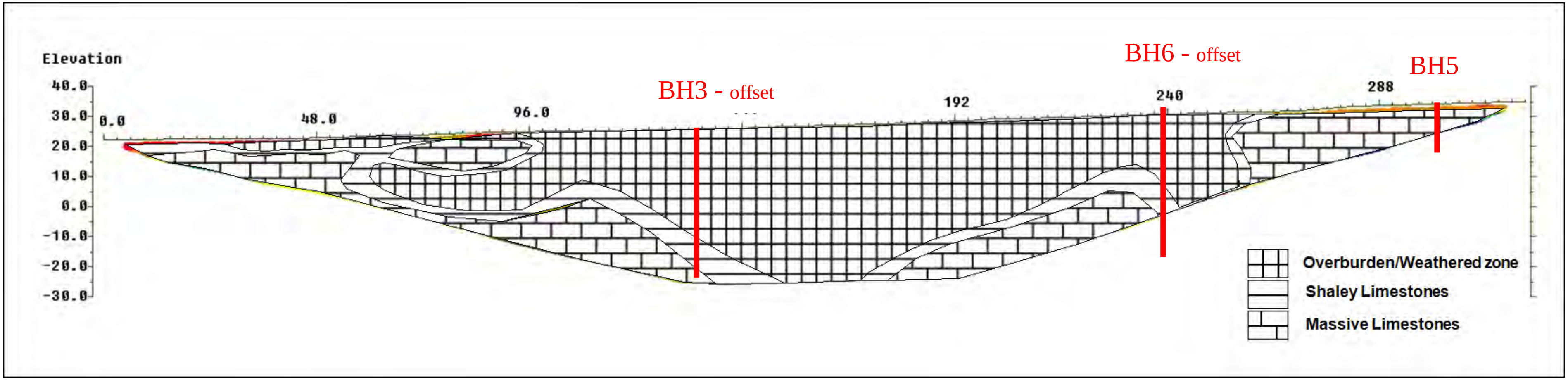


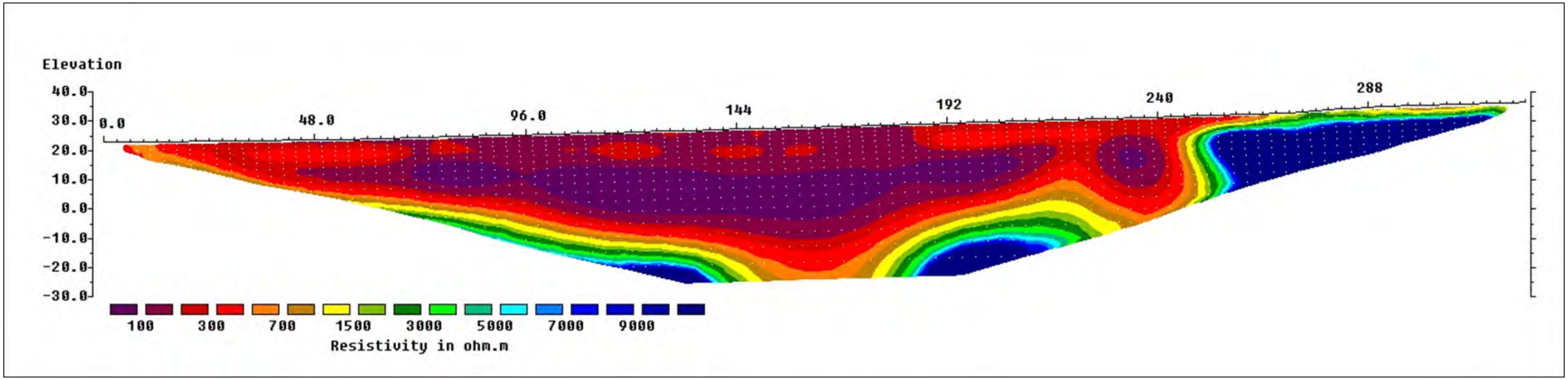
Figure 10

brg

Resistivity – ERT Line 8

3m Electrode Takeouts

W E



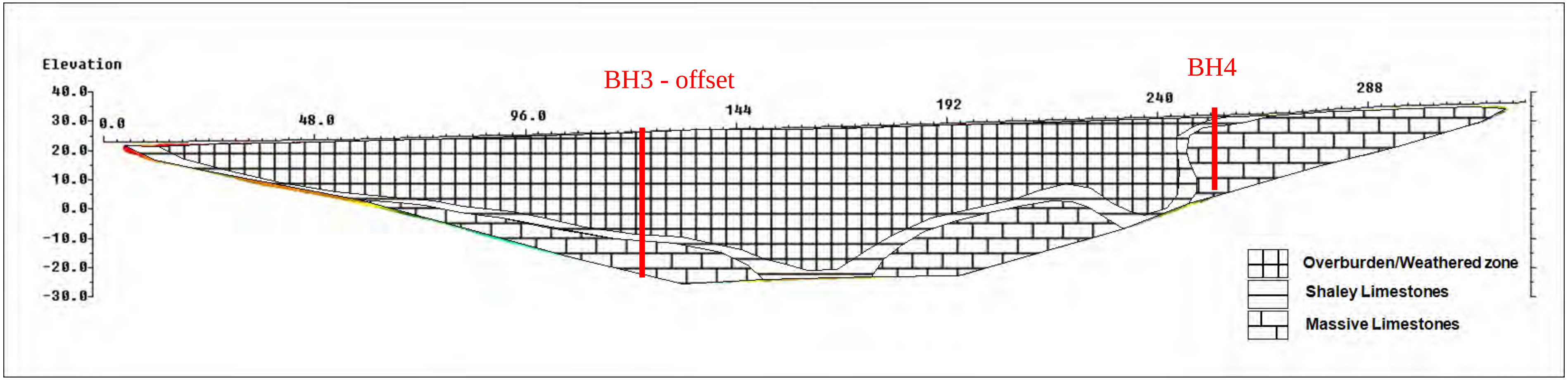


Figure 11

Resistivity – ERT Line 9

2m Electrode Takeouts

S

N

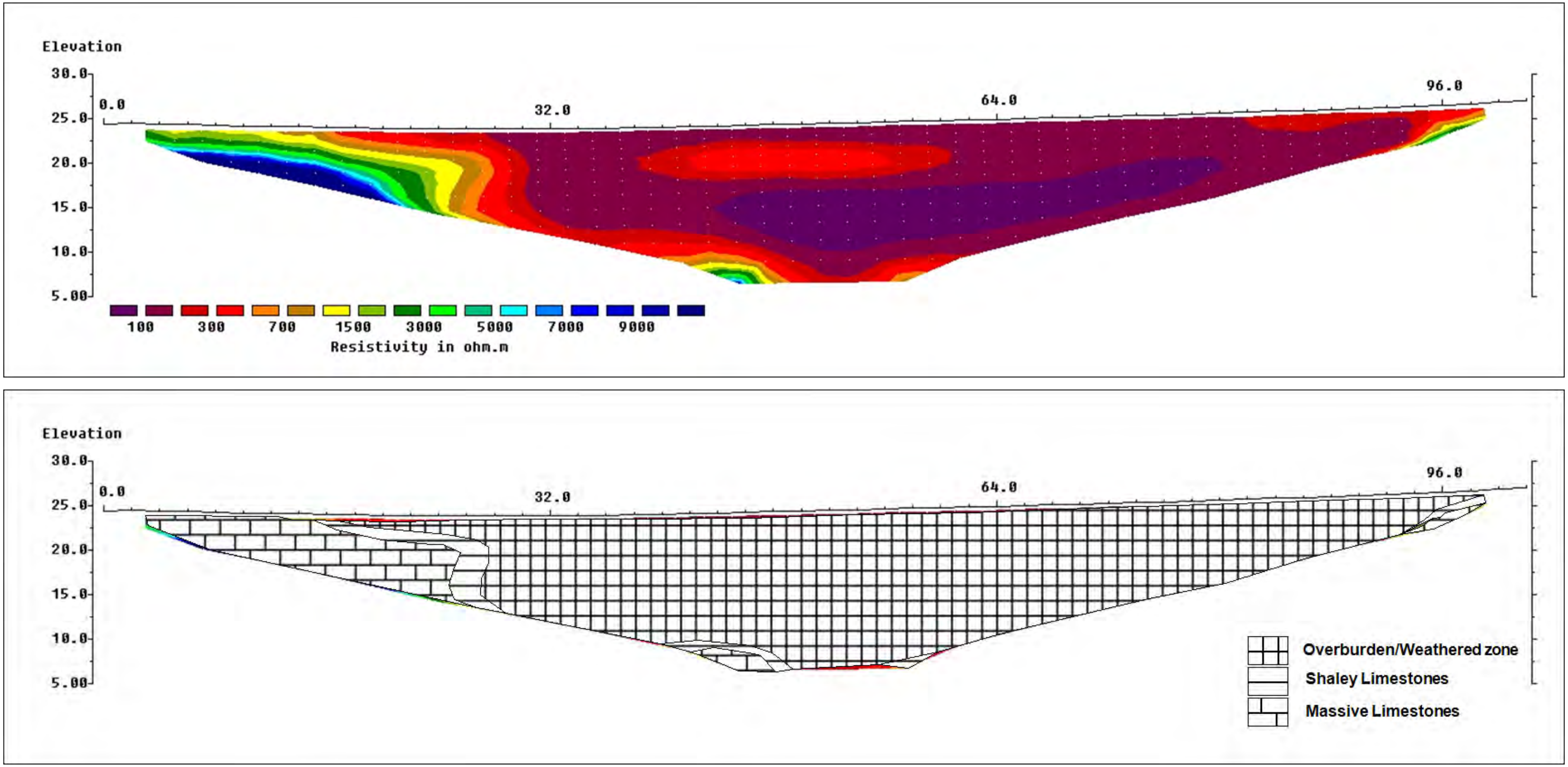
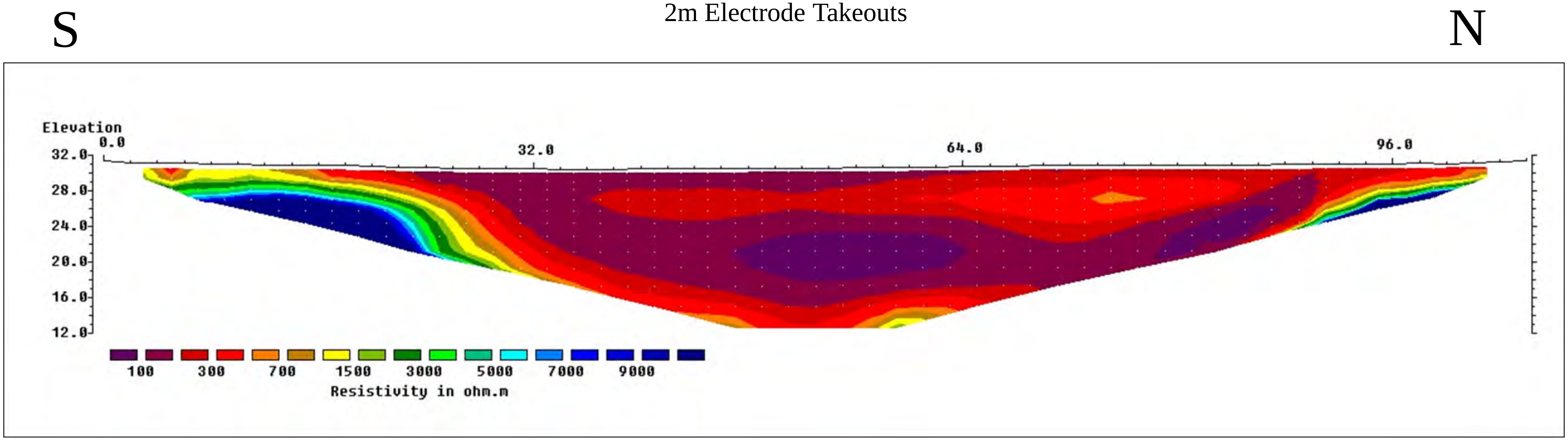


Figure 12

Resistivity – ERT Line 10

2m Electrode Takeouts



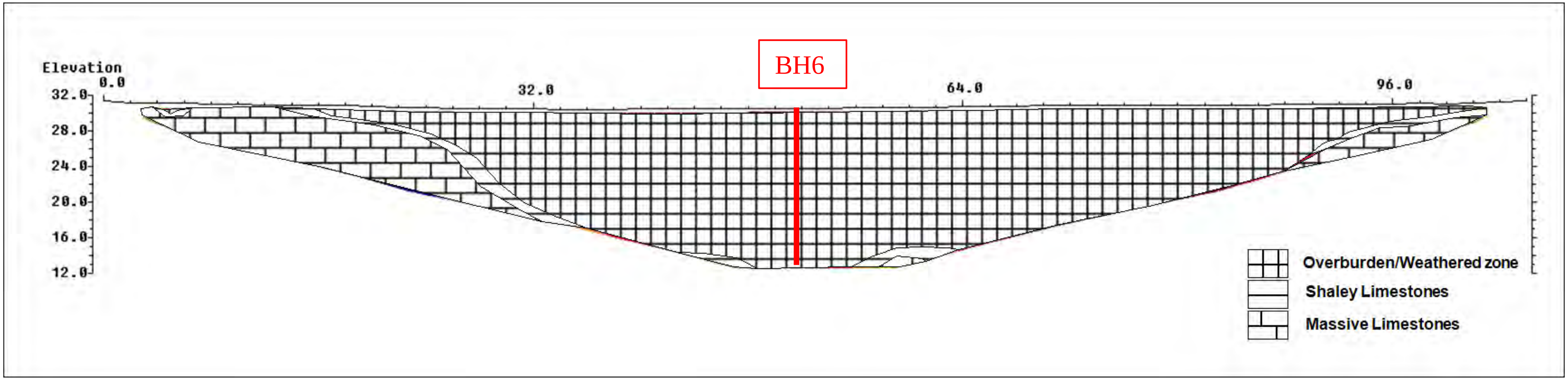


Figure 13

Microgravity Station Location Map

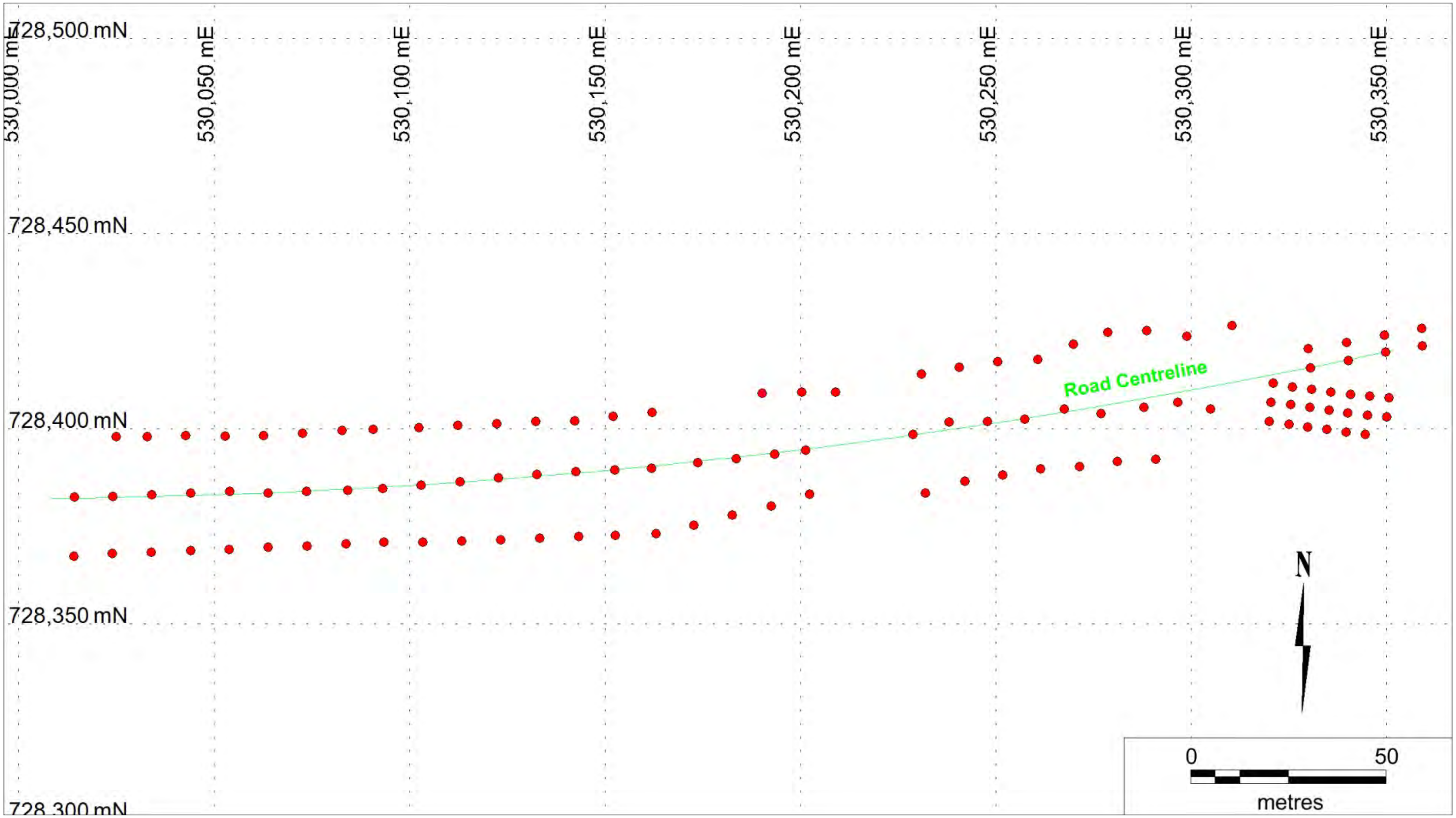


Figure 14

Microgravity Bouguer Gravity Map

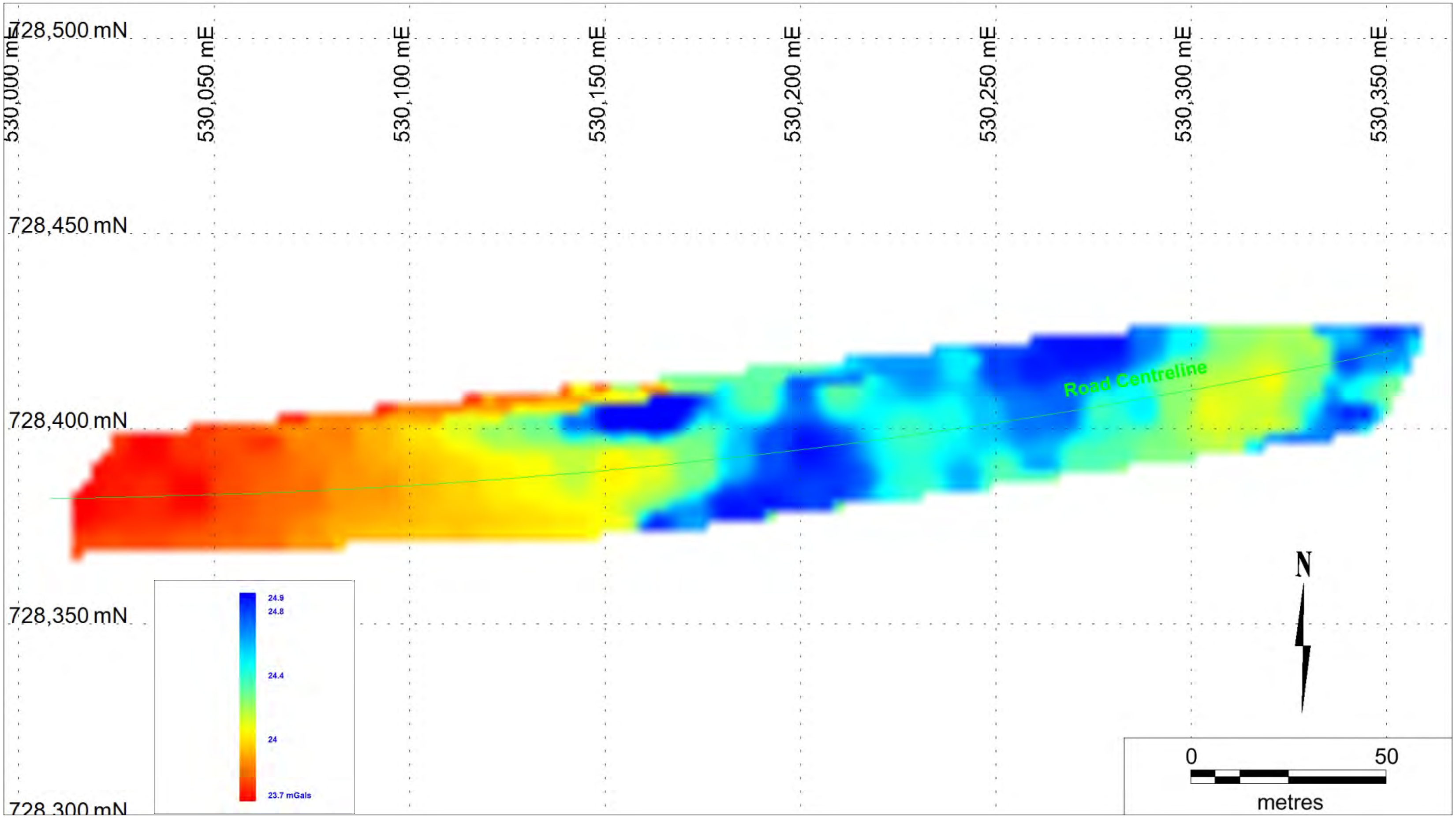


Figure 15

Geophysical Interpretation Map

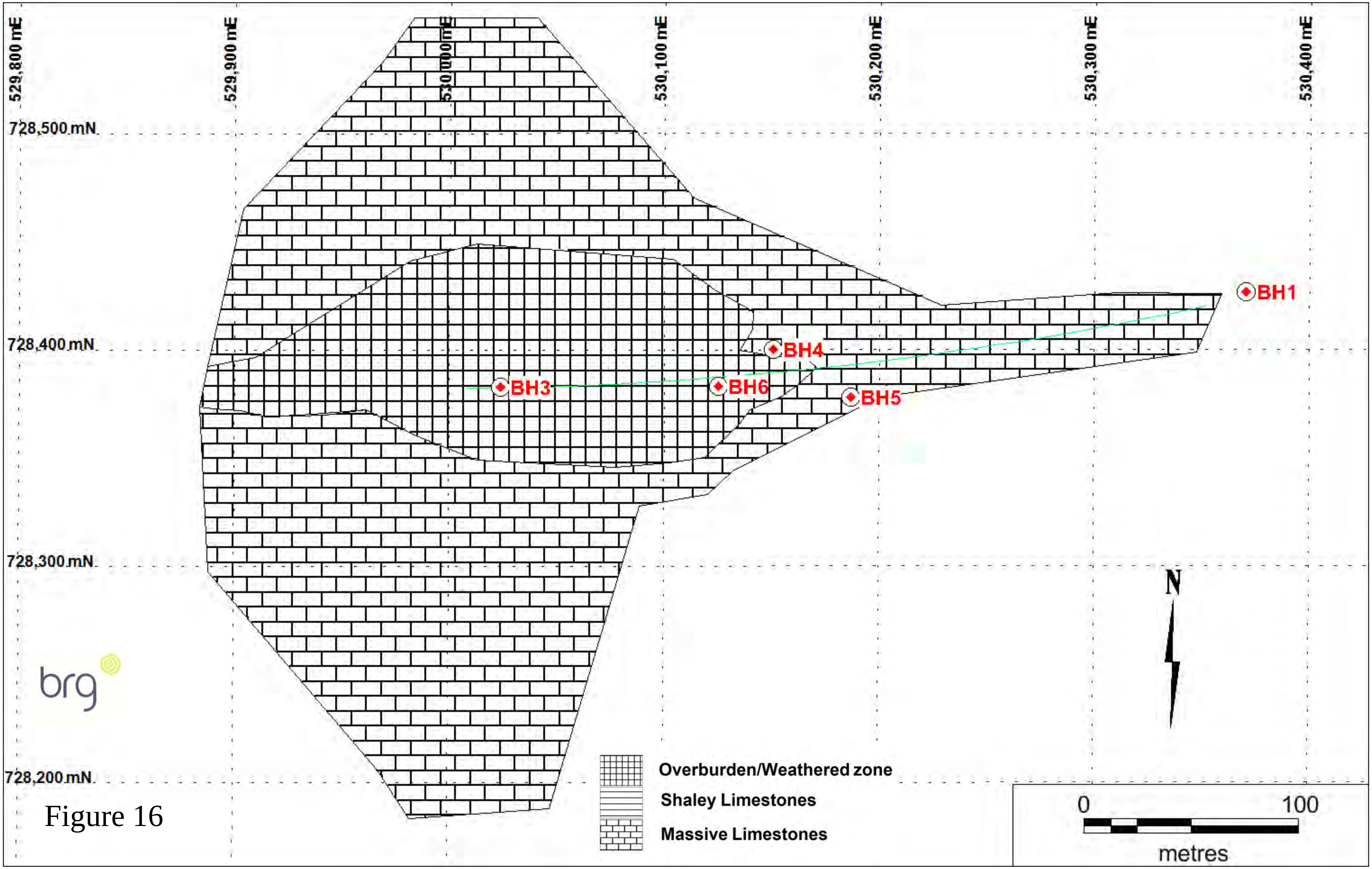


Figure 16

APPENDIX VI

EUROPEAN GEOPHYSICAL SERVICES

REPORT ON THE

GEOPHYSICAL LOGGING

OF TWO BOREHOLES

AT

LACKAGH QUARRY

Prepared For:

Priority Drilling Ltd.
Killimor, Ballinasloe,
Co. Galway, Ireland

JAN 2016/PRIO1502_ rpt/IRL

	Name	Date
Logged by:	Rhys Powell	8/9.12.15
Report by:	Rhys Powell	4.1.16
Checked by:	James Whitford	6.1.15

European Geophysical Services Ltd
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www.europeangeophysical.com

Registered in England and Wales No. 2962962 | VAT No. GB 648 4148 18

CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

At the request of Priority Drilling Ltd., borehole imaging and geophysical logging was carried out in two boreholes at Lackagh Quarry, Co. Galway, Ireland.

The work was carried out by European Geophysical Services on the 8th and 9th of December 2015.

The following logs were run:-

BH	Logs	From (m)	To (m)
4	Optical Imager, Acoustic Imager	3.1	34.0
4	Fluid Temperature and Conductivity, Natural Gamma, Caliper	3.1	34.2
4	Impeller Flowmeter	16.0	33.7
4	Focused Resistivity	15.5	34.0
4	Full Wave Sonic	15.5	34.0
4	Pumped Temperature and Conductivity	18.8	34.2

BH	Logs	From (m)	To (m)
5	Optical Imager, Acoustic Imager	1.0	39.9
5	Fluid Temperature and Conductivity, Natural Gamma, Caliper	1.0	40.0
5	Impeller Flowmeter	17.6	40.0
5	Focused Resistivity	17.6	40.0
5	Full Wave Sonic	17.6	40.0
5	Pumped Temperature and Conductivity	24.1	40.0

2.0 THE GEOPHYSICAL LOGGING METHODS

The Equipment and Field Procedure

A fully digital logging system with a 600m capacity motorised winch mounted in a Land Rover was used.

All logging data was recorded digitally for reprocessing and archiving purposes.

With the exception of the fluid logs, all logs were run from the bottom of the boreholes upward.

The optical imager survey was carried out first to avoid the disturbance of the fluid by the geophysical logs which may affect water clarity.

Fluid Temperature (T)

There is a natural geothermal gradient of increasing temperature with depth. This gradient varies with the thermal conductivity of the geological formation and is modified by water flowing in, out or vertically though the borehole.

This log is used to determine any flow pattern within the borehole and to identify flow zones.

Differential logs are produced over a one metre spacing, these are an interpretative aid to detect gradient changes.

Fluid Conductivity (EC or EC25)

The electrical conductivity (EC) of the water is related to its salinity and dissolved solids and is therefore a measure of the quality of the borehole water. The shape of the log trace can indicate zones of inflow.

Using data from the temperature log the electrical conductivity is corrected to 25°C (EC25).

This log is used to identify different zones of water quality.

Differential logs are produced over a one metre spacing, these are an interpretative aid to detect gradient changes.

2.0 THE GEOPHYSICAL LOGGING METHODS

Optical Borehole Imager (Optical)

A precision-machined prism and CCD camera assembly permits a high definition video image of the borehole wall to be captured in a variety of horizontal and vertical resolutions. The resulting image is digitised in the sonde for transmission to the surface acquisition system.

The image is then orientated to Magnetic North and displayed as an unwrapped image log. This enables a detailed structural interpretation to be made if required.

For the best results the optical imager should be run above the water level or in clean, clear fluid. The logging tool is centralised during data acquisition by two sets of bow springs. The bow springs are adjusted to a variety of borehole diameters prior to acquisition. The image is recorded on the way down the borehole to limit disturbance to the clarity of the water in the borehole by the logging tool.

Images and associated data are viewed in real time during the data acquisition.

The orientation system employs a flux gate magnetometer and therefore the recorded data within approximately one metre of magnetic steel casing is un-orientated. This is corrected manually during the post-processing stage

Acoustic Borehole Imager (Amplitude and Travel Time)

This tool scans the borehole wall through 360 degrees and records the acoustic reflection of the resulting signal in terms of amplitude and transit time (the travel time from the tool to the borehole wall). This technique requires a fluid filled borehole with a minimum of suspended solids, polymers or muds within the fluid column.

This sensitive technique responds to small diameter changes, rugosity and the acoustic nature of the borehole wall. It is primarily used for detecting fractures and other discontinuities. The resultant images are orientated (to magnetic North) 0° through 90°, 180° and 270° back to 0°.
The logging tool is centralised during data acquisition by two sets of bow springs. The bow springs are adjusted to a variety of borehole diameters prior to acquisition. The image is viewed on the way down the borehole to allow fine tuning of the acquisition parameters. The settings are then adjusted and the image recorded on the way up the borehole which ensures a constant line speed during acquisition.

Images and associated data are viewed in real time during the data acquisition.

The orientation system employs a flux gate magnetometer and therefore the recorded data within approximately one metre of magnetic steel casing is un-orientated. This is corrected manually during the post-processing stage

2.0 THE GEOPHYSICAL LOGGING METHODS

Impeller Flowmeter (FV)

This log is used to determine any flow pattern within the borehole and identify flow zones. The tool uses an impeller and is normally run at a constant logging speed against the anticipated flow for the best response. The data is corrected for logging speed and a fluid velocity (FV) log is produced.

Caliper (Cal)

This tool measures the mean diameter of the borehole. It is used to check the integrity of the borehole lining, and where the borehole is unlined to identify zones of washout, breakout or fissures.

Natural Gamma (Gam)

The tool measures the naturally occurring gamma radiation found in rocks and sediments. It is mainly used to detect the clays that contain potassium K^{40}, though the U^{238} series of elements and the Th^{232} series of elements also emit gamma radiation.

The higher the concentration of these clay minerals the greater the responses on the natural gamma log.

Focused Resistivity Log (Res Deep and Res Shallow)

The Focused Resistivity tool uses Guard Electrodes to focus the current into the formation. This gives excellent vertical resolution and good penetration, especially in highly conductive borehole fluids where a Normal Resistivity Sonde would not be as effective.

The tool has two electrode spacing’s to allow a deep and shallow depth of investigation.

The response of this log is a function of porosity, type of formation / mineralogy and its pore water quality. These logs aid in the identification of strata and quality of the pore water.

2.0 THE GEOPHYSICAL LOGGING METHODS

Full Wave Sonic (VDL)

This tool has been specially designed to provide a full wave form recording of sonic signals and uses fixed spaced transmitter – receivers.
The received signals are digitised at a fast sampling rate with high resolution. Data may be sampled at typically 5cm or 10cm intervals dependant upon resolution required.

The data is processed for P wave velocity (or transit time) and amplitude.

This tool can only be used in fluid filled unlined boreholes.

3.0 SITE DETAILS

Site:
Lackagh Quarry

Irish Grid Ref: M 30240 28372

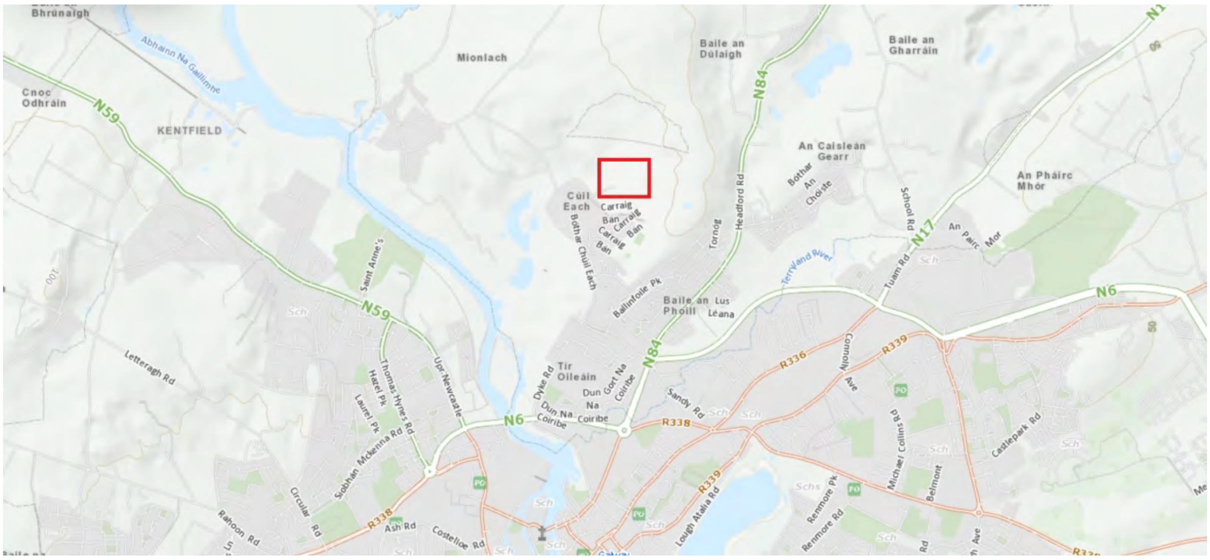


Figure 3.1 Location map showing location highlighted by red circle.
© 2014 Ordnance Survey Ireland.

Figure 3.2 Aerial image showing approximate borehole locations. © Google 2016.

4.0 PROCESSING AND PRESENTATION OF RESULTS

Detailed logs of the imager data have been produced at a vertical scale of 1:10. Composite geophysical logs have been produced at 1:50. Full Wave Sonic results are presented separately at 1:50 with Imager, Natural Gamma and Caliper data to aid interpretation.

Constructional details and information on each borehole are given in the headers of each log.

All images have been referenced to Magnetic North.

The borehole's azimuth and tilt are plotted alongside the images.

The image of the borehole wall is presented in an unwrapped form with a horizontal scale marked 0° - North, through 90° - East, 180° - South, 270° - West, back to North.

Structural features and discontinuities have been picked from the images in the form of colour coded sinusoidal projections - see Appendix 1 for details. This 'Discontinuities' log is also presented with a horizontal scale marked 0° - North, through 90° - East, 180° - South, 270° - West, back to North.

Structure picking is not a definitive analysis of all the features within a borehole. Only the discontinuities that have a linear dip and direction are 'picked' and used in the analysis of the discontinuities. Features that do not have a regular sinusoidal shape do not have a linear dip and direction, 'best fit' picking of these features is done if approximately 80% coverage of the sinusoid can be achieved. Below this percentage the inaccuracy of the picking is too great and if included in any structural analysis may adversely skew the results. Vughs, solution holes, and angular break outs are examples of features not picked.

The apparent azimuth and apparent dip (i.e. relative to the borehole's azimuth and tilt) of the discontinuities are calculated using the diameter of the borehole and the geometric parameters of the sinusoids overlaid on the discontinuities. The final processing stage is to correct these apparent values to true azimuth (in relation to Magnetic North) and true dip (from horizontal) by correcting for the borehole's azimuth and tilt.

The final results are presented as a 'tadpole' plot (Discontinuities - True°). The horizontal position of the tadpole's head gives the defect's true dip angle and its tail points in the direction of the defect's azimuth. These logs are presented with a horizontal scale in degrees. By convention the top of the page is North (Magnetic) and the right hand edge of the paper is East.

The true structural data has been presented in digital format as an excel file (xls).

5.0 BOREHOLE LOGGING CONSTRAINTS

- **Vehicle access restrictions**
  Poor ground conditions, soft ground access to borehole locations

- **Tool access restrictions**
  None

- **Borehole conditions / risk to equipment**
  Drill rods left in boreholes prior to logging to prevent collapse. Highly fractured rock below casing in BH4.

- **Lack of fluid filled column / cloudy fluid**
  Optical and Acoustic run in both boreholes due to cloudy water. Boreholes pumped dry during pumped TC logging, not possible to run pumped flowmeter.

- **Time constraint**
  None

- **Borehole construction / casing**
  BH4 not cased deep enough – loose rock below casing. No casing in BH5.

Appendix 1

Discontinuity Classification.

Discontinuity	**Colour**	**Classification Parameters**
Major Fracture or Fissure	Blue	An open break in the formation, that is **continuous** across the entire image.
Minor Fracture or Fissure	Turquoise	A thin or closed break in the formation, that is **continuous or discontinuous** across the image.
Vein	Green	That may be **continuous or discontinuous** across the entire image.
Fabric	Red	Defines a feature generally metamorphic, igneous or sedimentary in origin that may be **continuous or discontinuous** across the image, such as bedding and cross-bedding, schistosity or gneissosity.
Intrusions	Purple	Intrusive features such as dykes and sills, generally **continuous** across the image
Unknown	Black	Faint features which **can not** be classified.

Appendix 2

Geophysical Logs

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Priority Drilling**	Log Type: **_Composite_**
Borehole:	**BH4**	

Location: **Lackagh Quarry** Area: **Co. Galway** Grid Ref: Elevation:

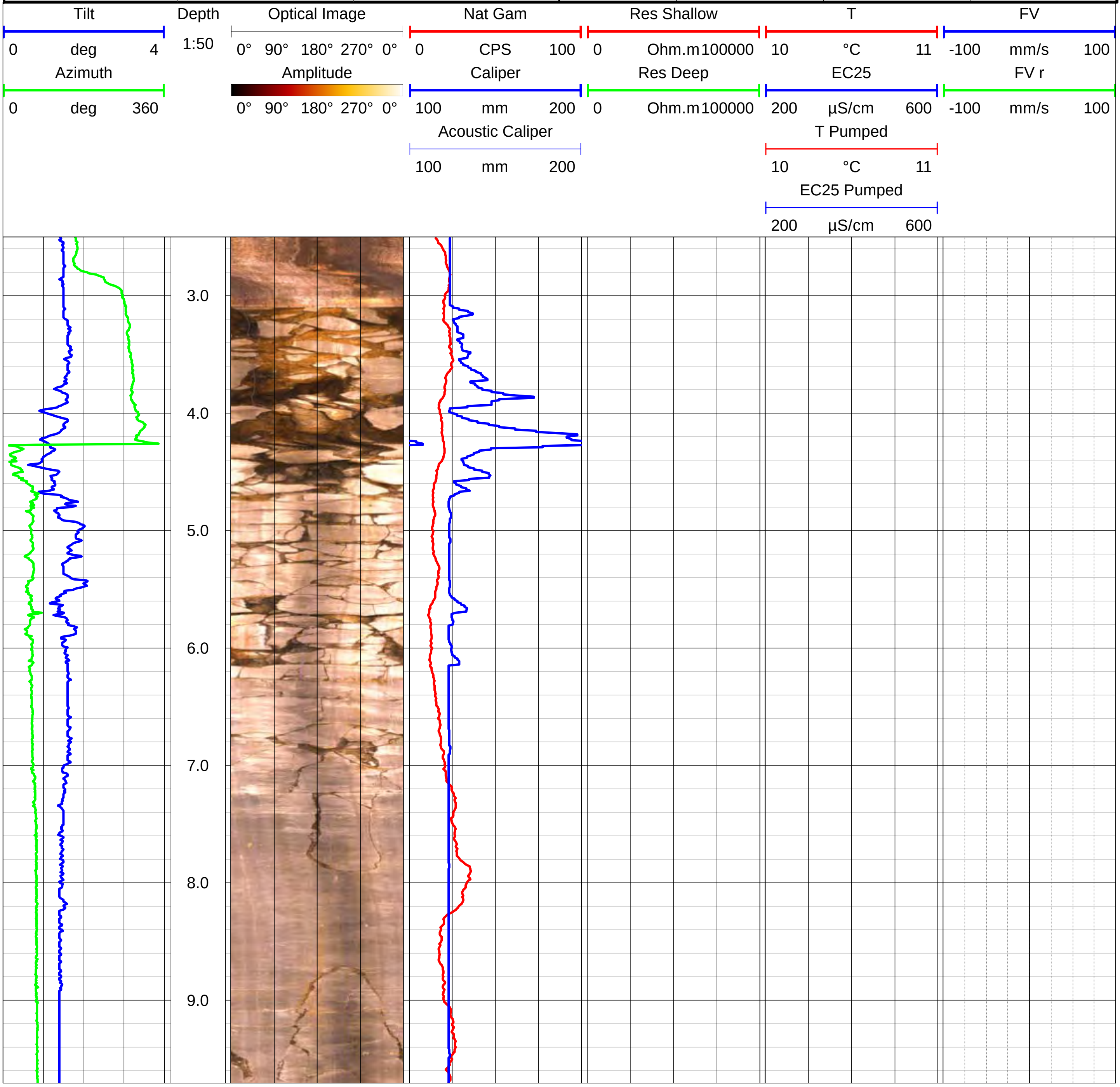
Drilled Depth: (m)	**35**	Date:	**8.12.15 / 9.12.15**
Logged Depth: (m)	**34.1**	Recorded By:	**Rhys Powell**
Logging Datum:	**Ground Level**	Remarks:	Rods pulled immediately before logging.
Logged Interval: (m)	**3.1 - 34.1**		
Fluid Level: (m)	**14.6 / 15.5**	Ref:	

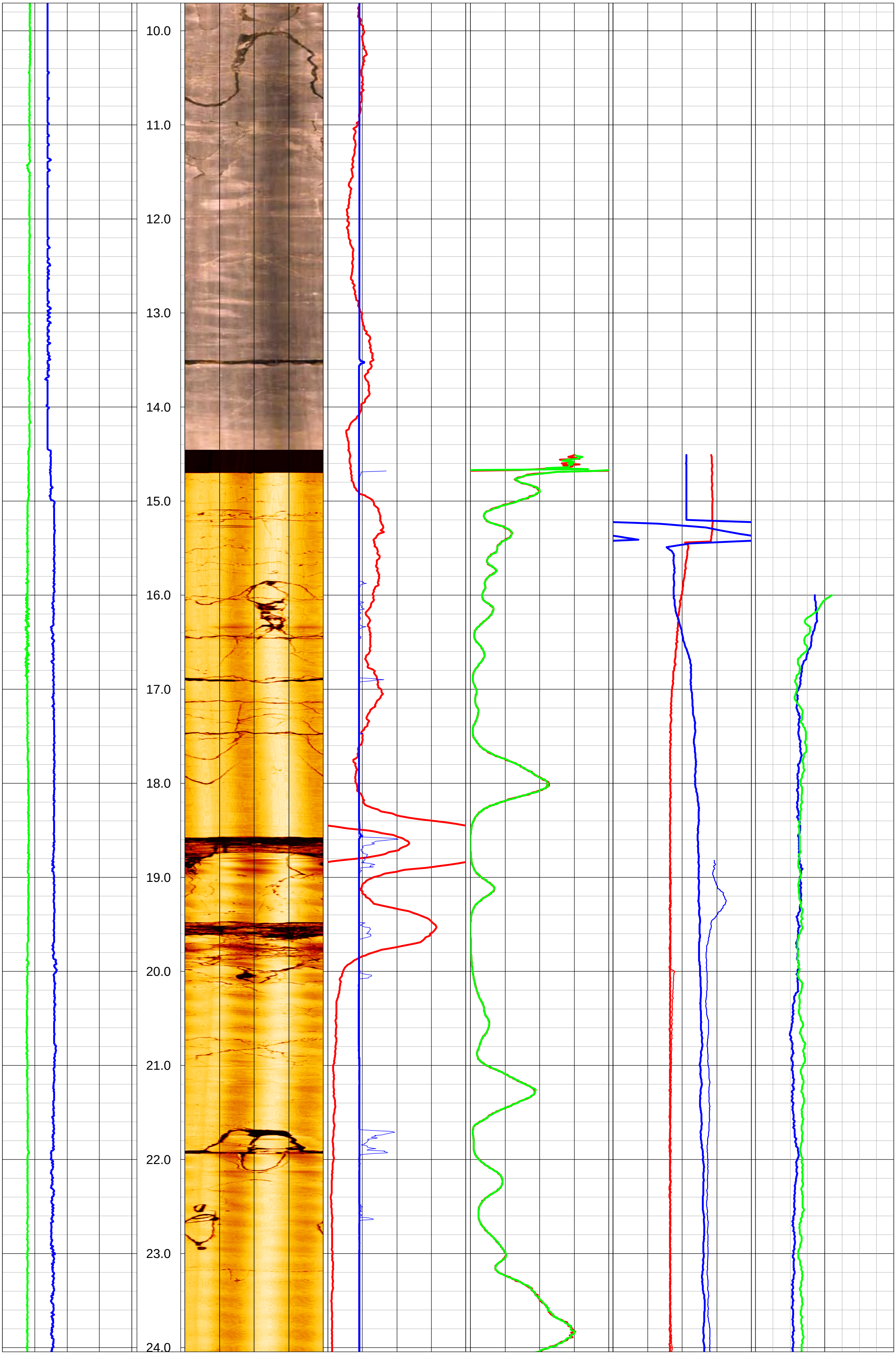
BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
122	**0.1**	**35**

CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
Steel	**130**	**0.0**	**3.1**





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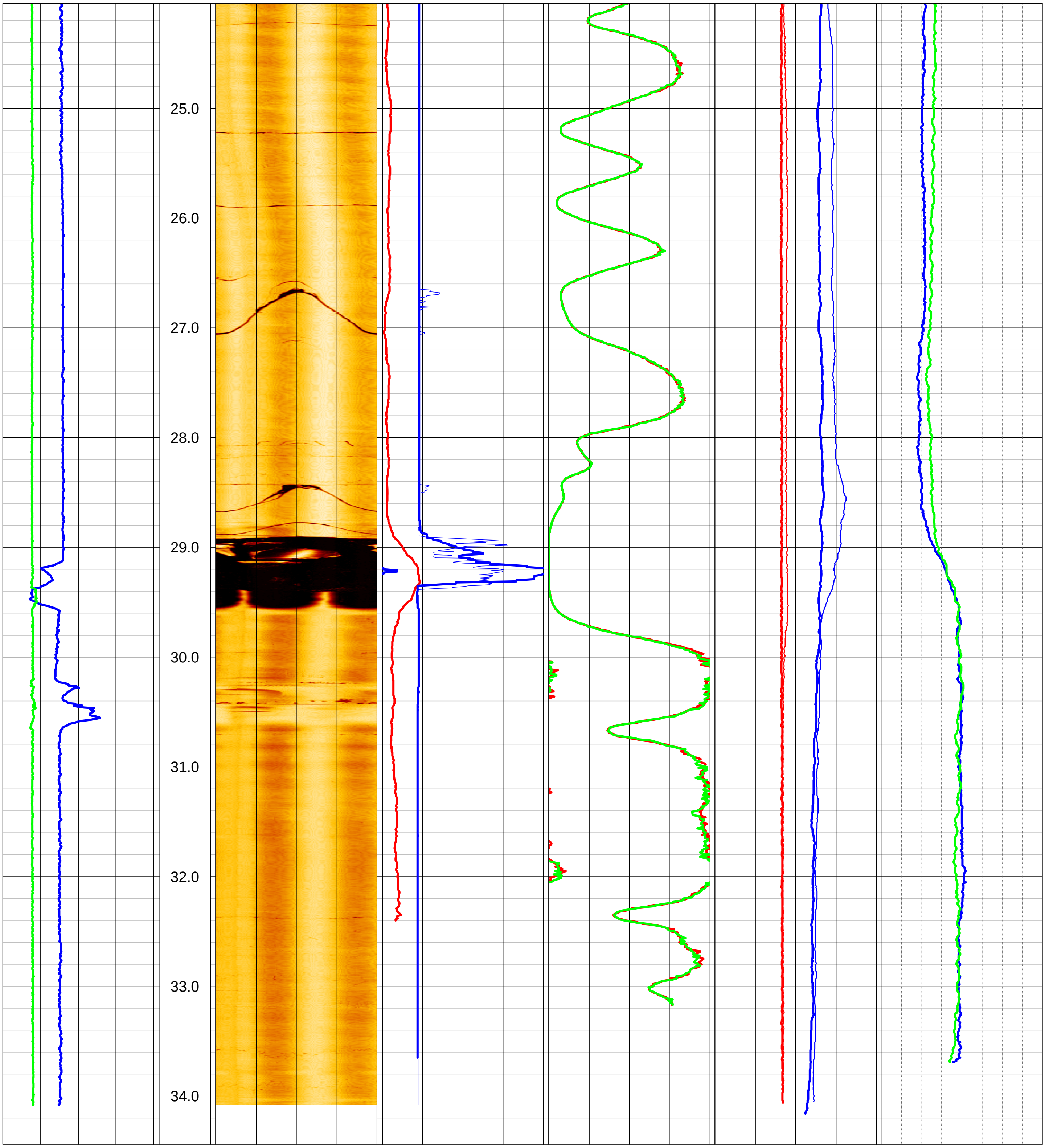
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34.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Priority Drilling**	Log Type: ***Image***
Borehole:	**BH4**	

Location: **Lackagh Quarry** Area: **Co. Galway** Grid Ref: Elevation:

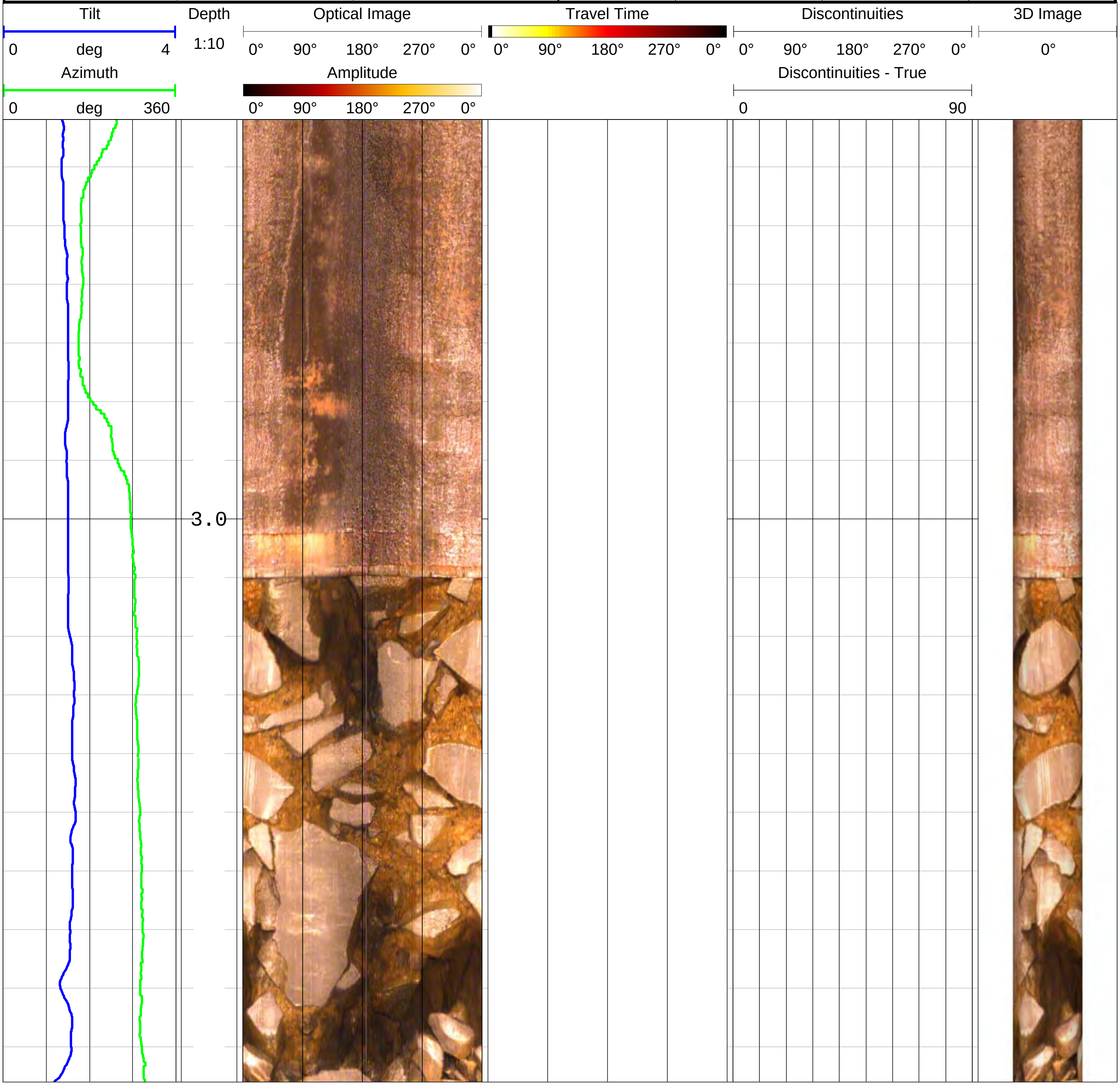
Drilled Depth: (m)	**35**	Date:	**8.12.15**
Logged Depth: (m)	**34.0**	Recorded By:	**Rhys Powell**
Logging Datum:	**Ground Level**	Remarks: Rods pulled immediately before logging.	
Logged Interval: (m)	**3.1 - 34.0**		
Fluid Level: (m)	**14.6**	**Ref:**	

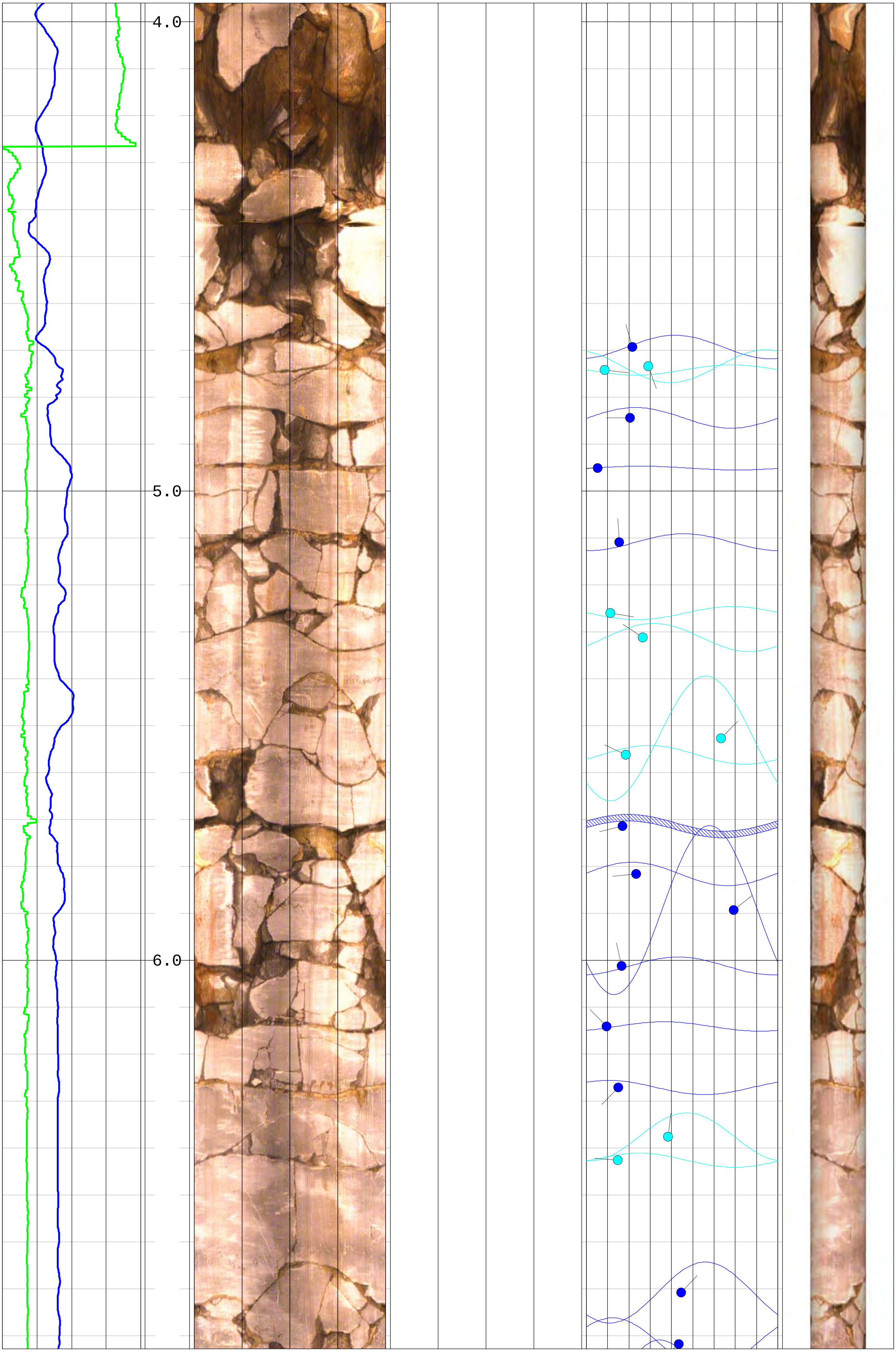
BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
PQ	**0.1**	**35**

CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
Steel	**130**	**0.0**	**3.1**

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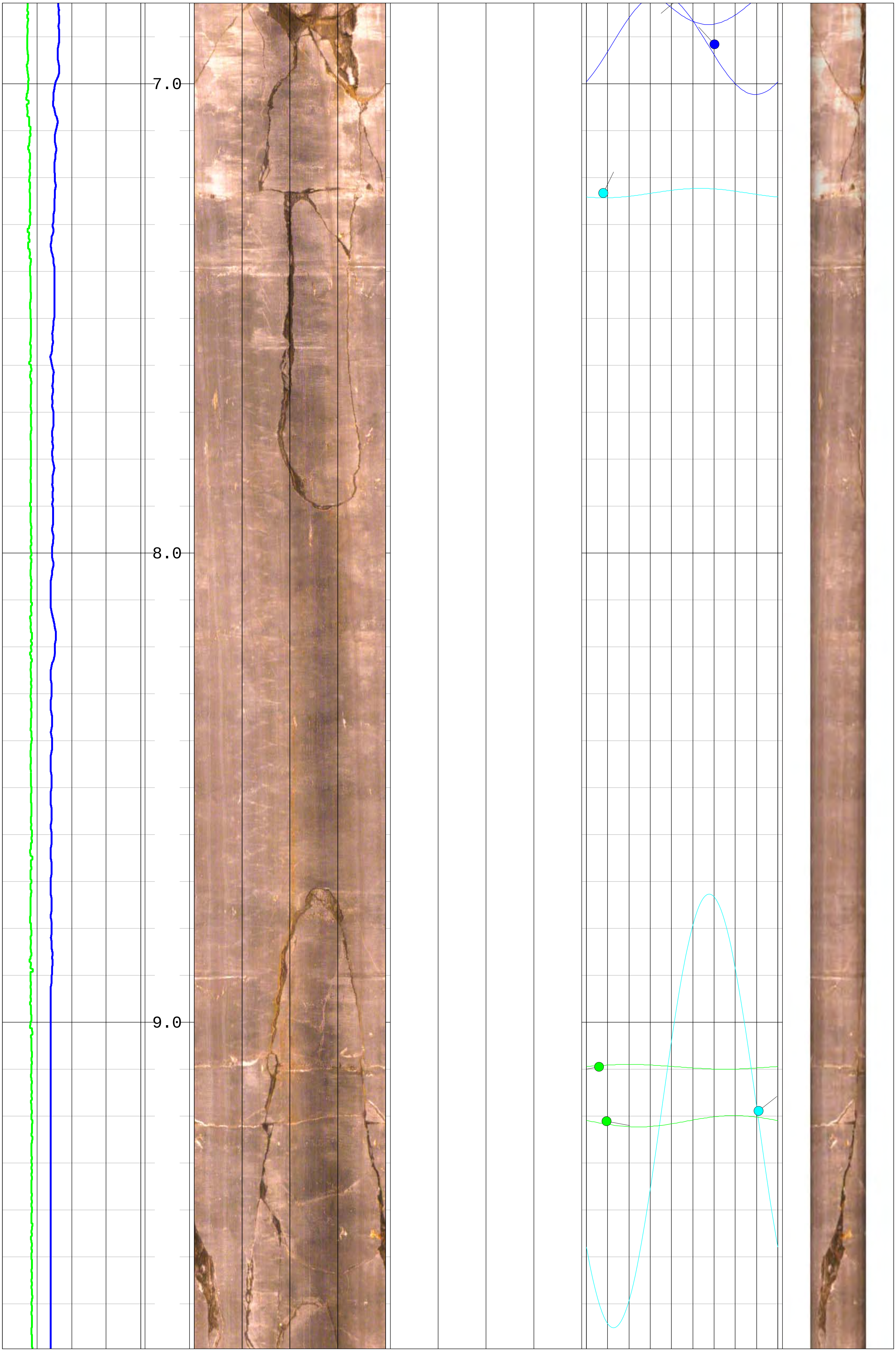
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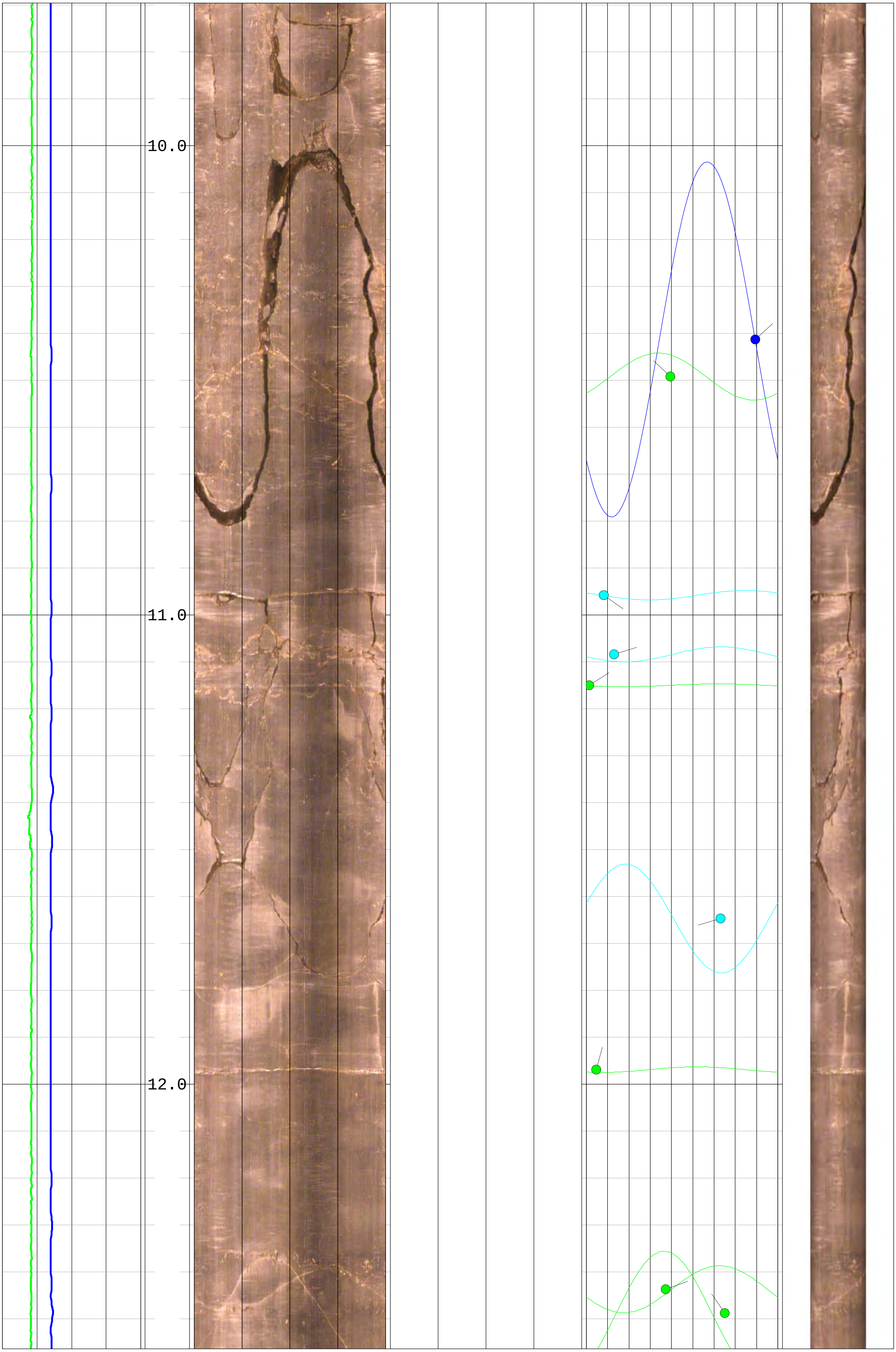
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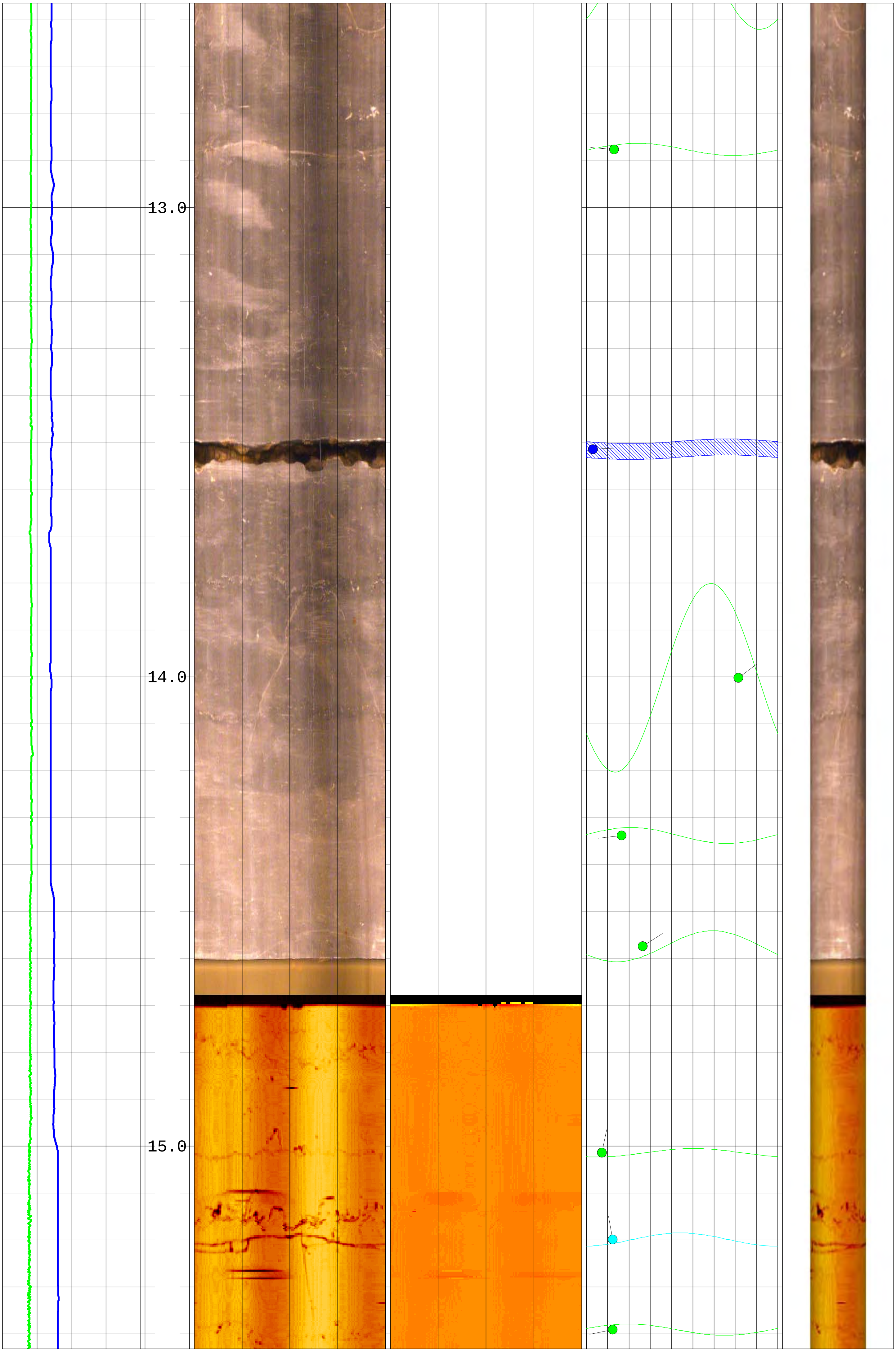
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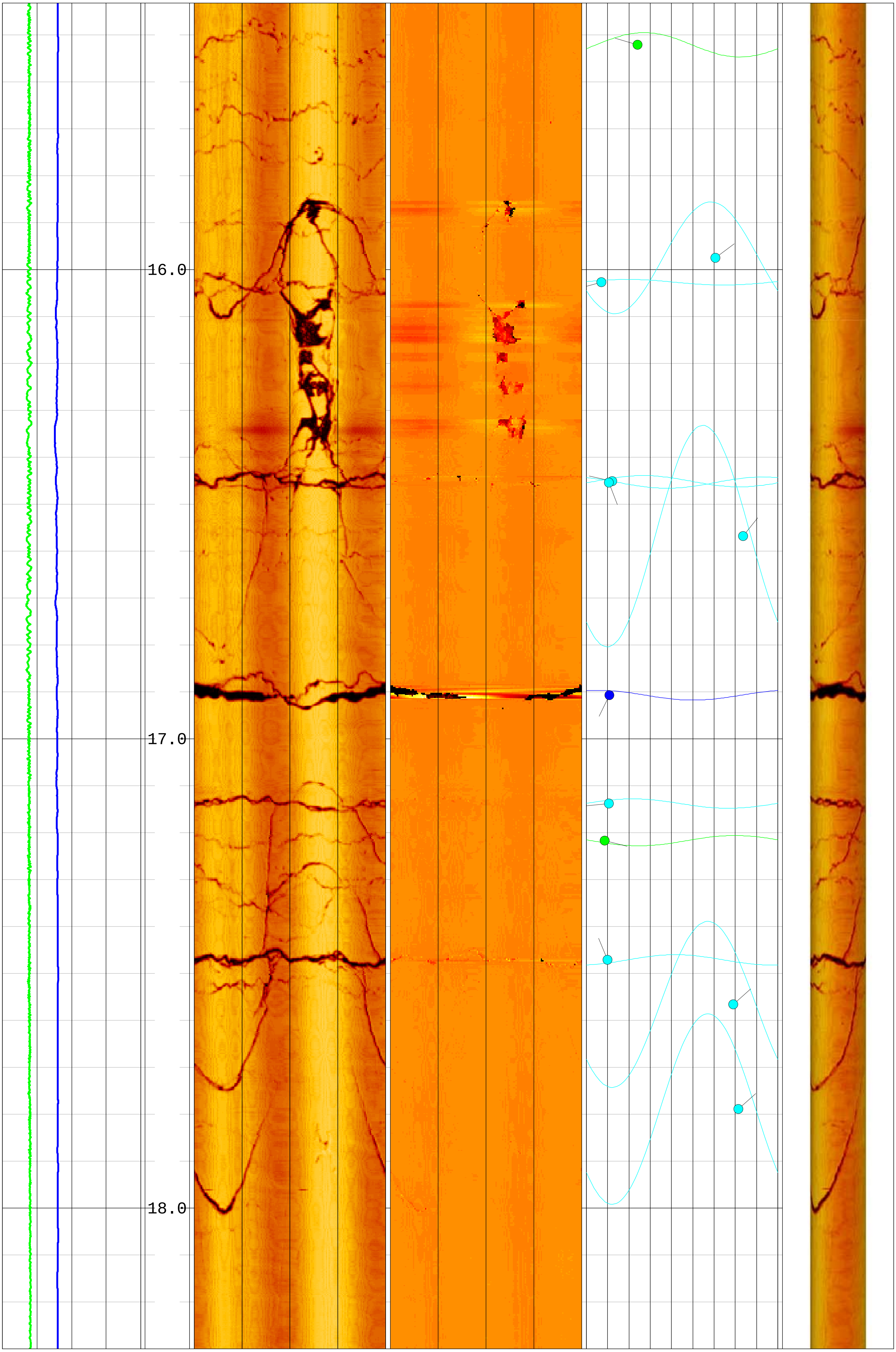
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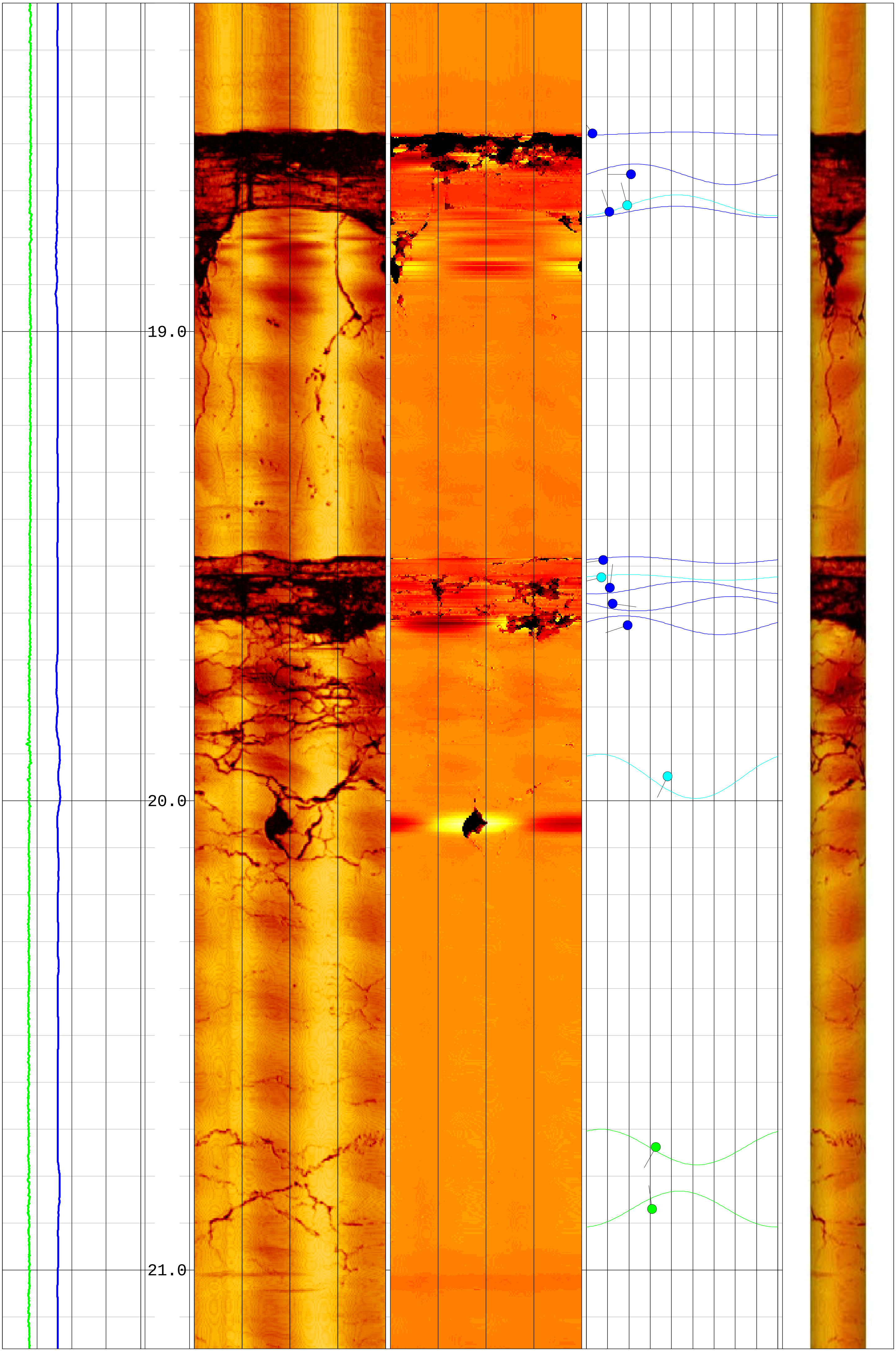
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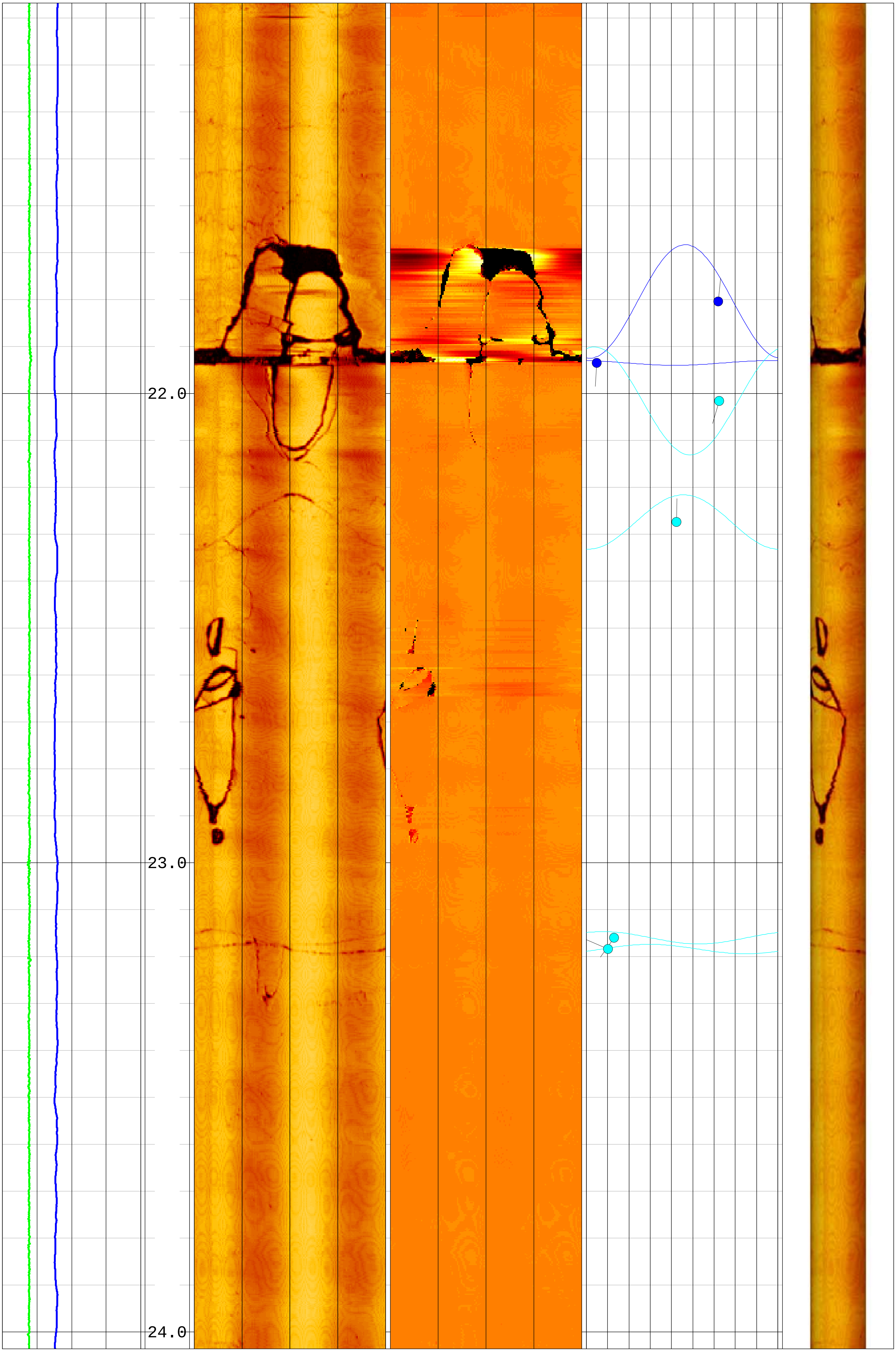
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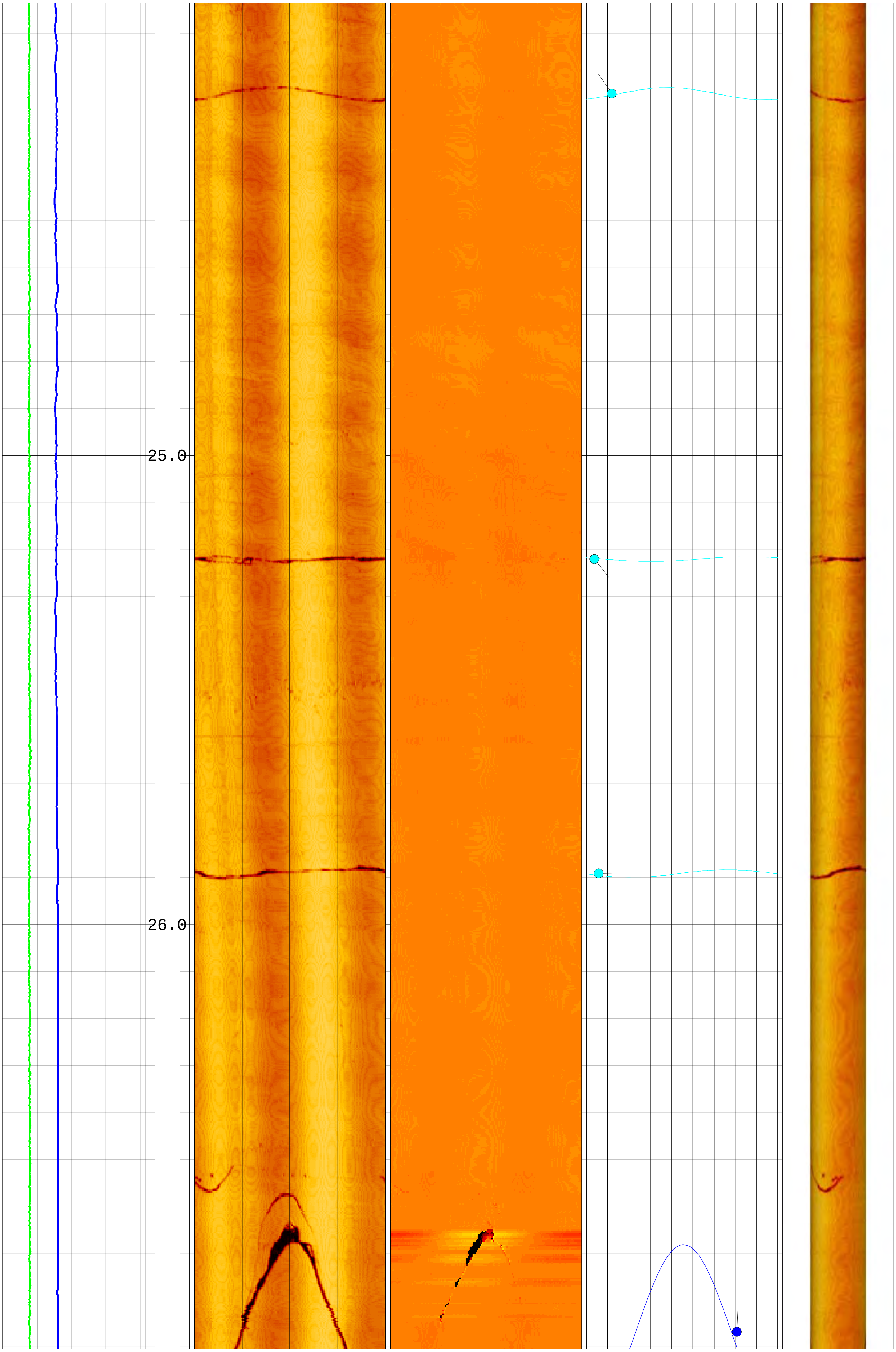
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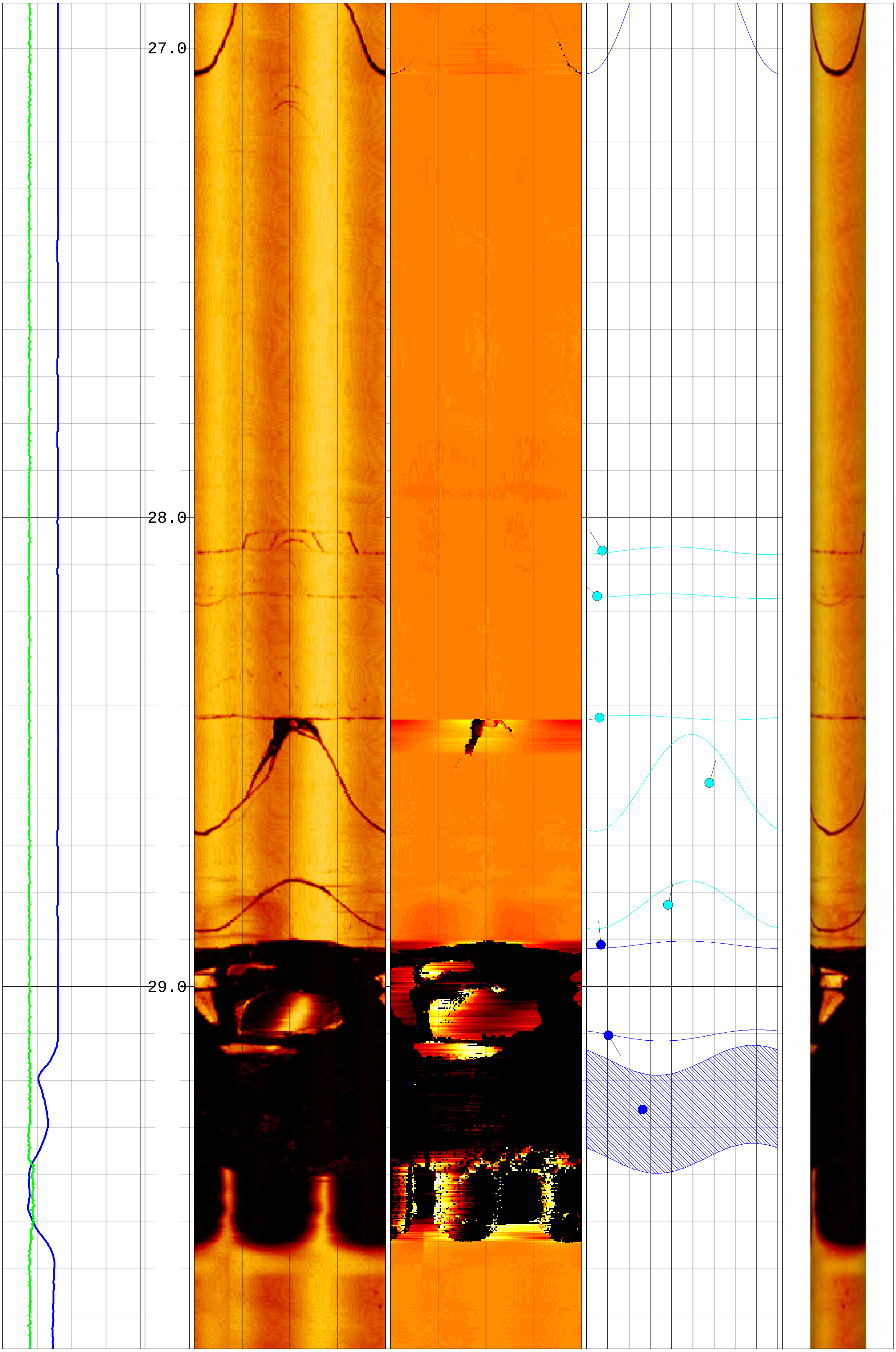
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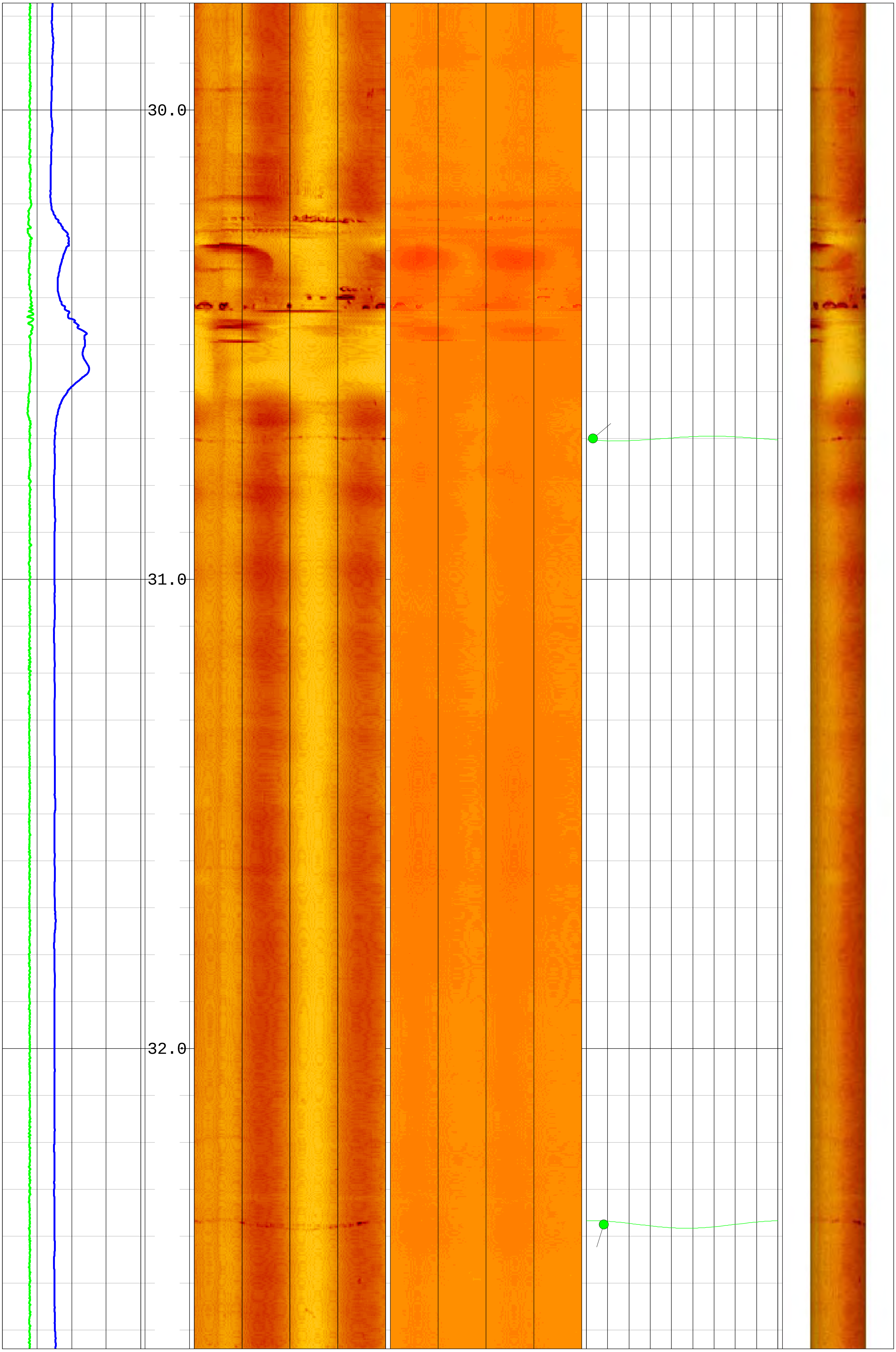
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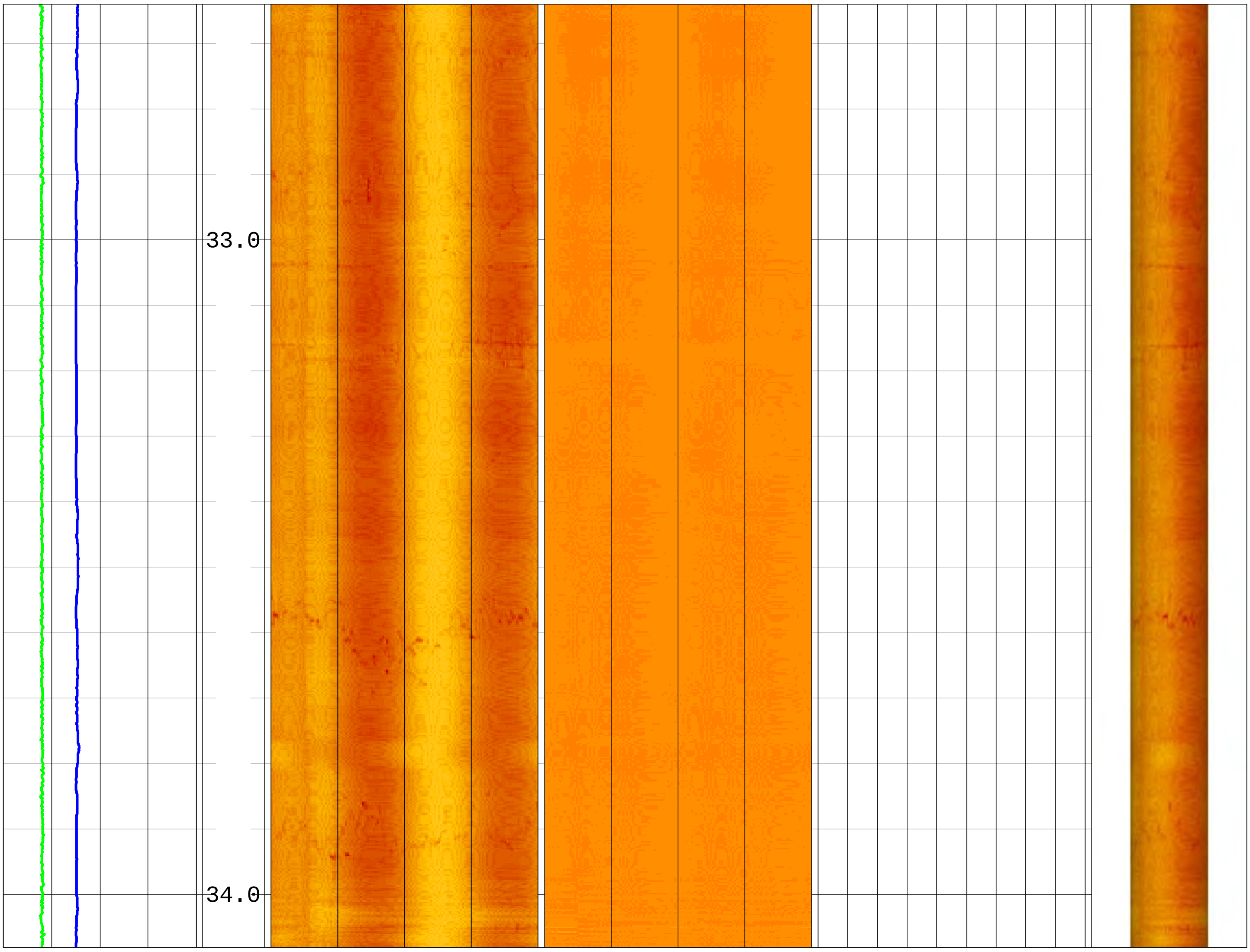
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EUROPEAN GEOPHYSICAL SERVICES LTD

Client: **Priority Drilling**

Borehole: **BH4**

Log Type:

Full Wave Sonic

Location: **Lackagh Quarry** Area: **Co. Galway** Grid Ref: Elevation:

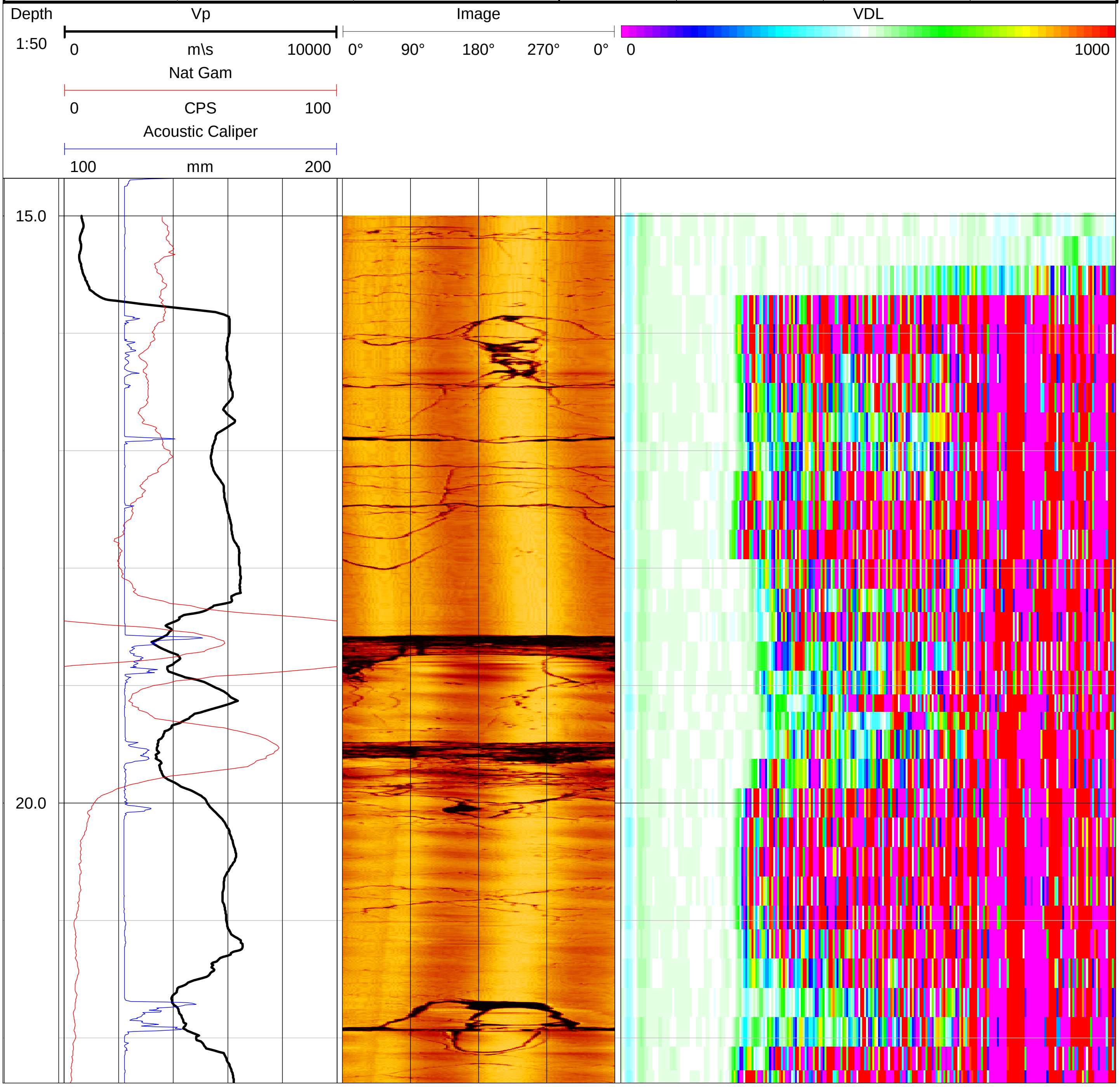
Drilled Depth: (m)	**35**	Date:	**9.12.15**
Logged Depth: (m)	**33.5**	Recorded By:	**Rhys Powell**
Logging Datum:	**Ground Level**	Remarks:	
Logged Interval: (m)	**16.0 - 33.5**		
Fluid Level: (m)	**16.0**	**Ref:**	

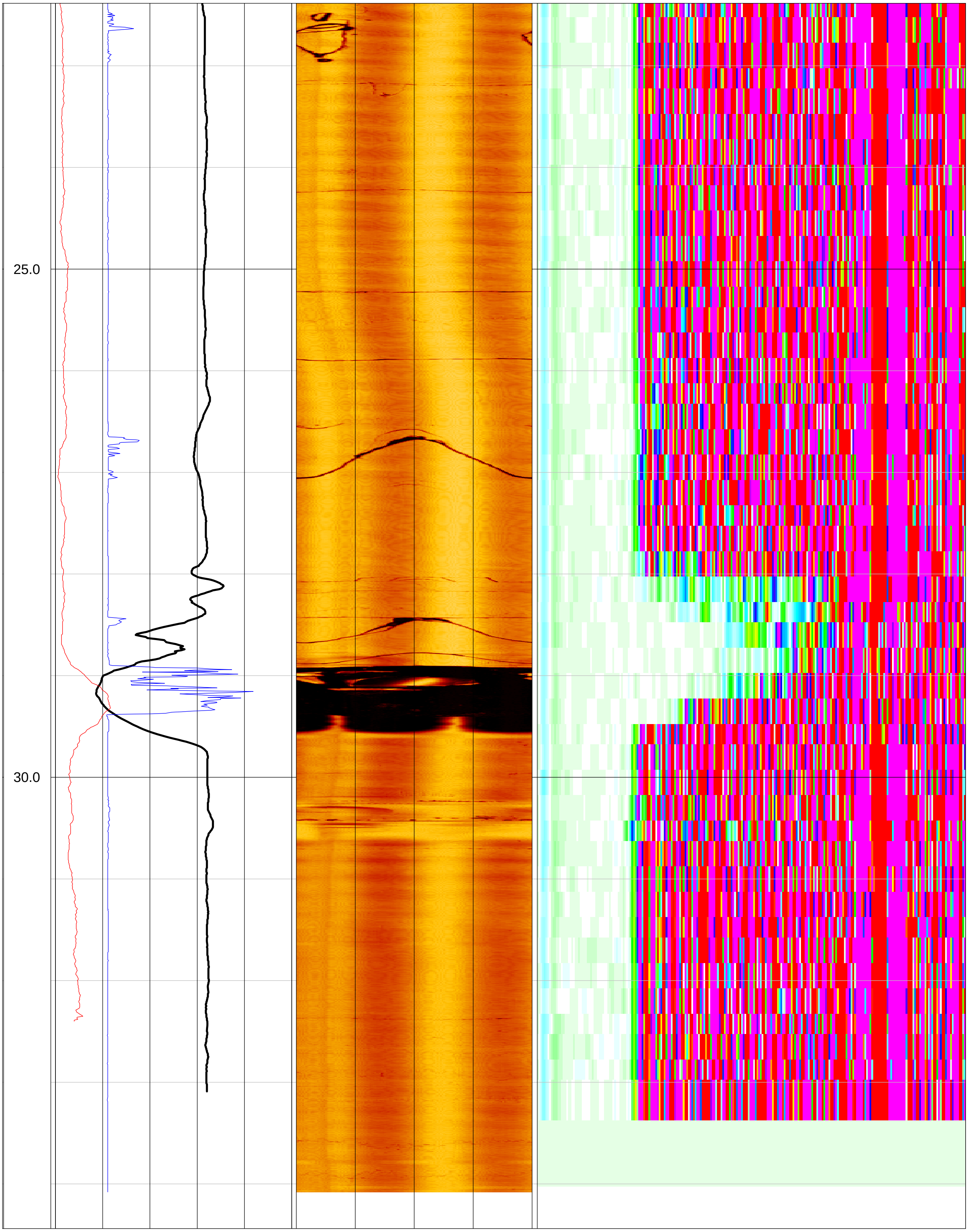
BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
122	**0.0**	**35**

CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
Steel	**130**	**0.0**	**3.1**

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30.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Priority Drilling**	Log Type: ***Composite***
Borehole:	**BH5**	

Location: **Lackagh Quarry** Area: **Co. Galway** Grid Ref: Elevation:

Drilled Depth: (m)	**40.3**	Date:	**8.12.15**
Logged Depth: (m)	**40.1**	Recorded By:	**Rhys Powell**
Logging Datum:	**Ground Level**	Remarks:	
Logged Interval: (m)	**1.0 - 40.1**		
Fluid Level: (m)	**17.6**	**Ref:**	

BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
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CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
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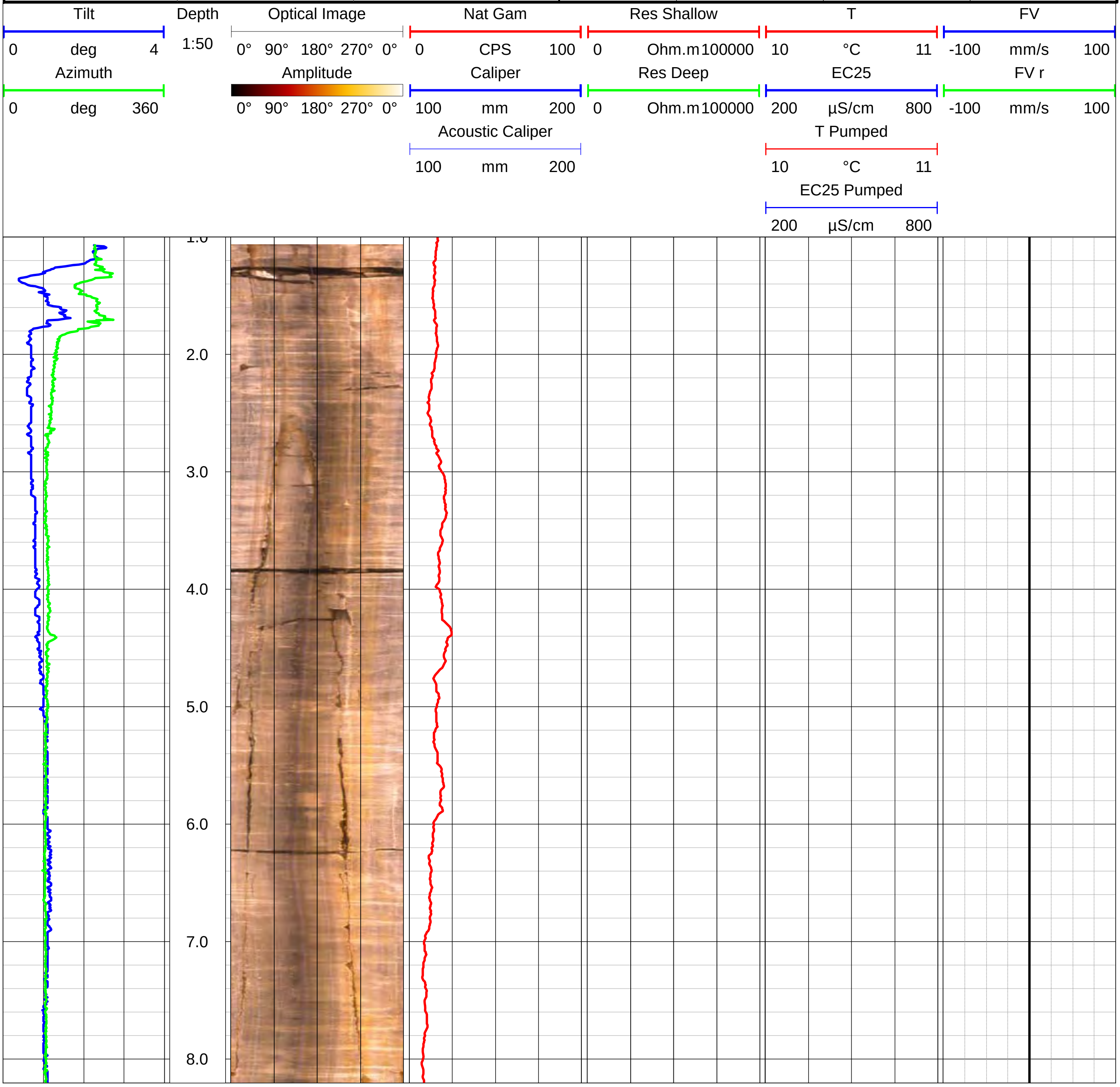

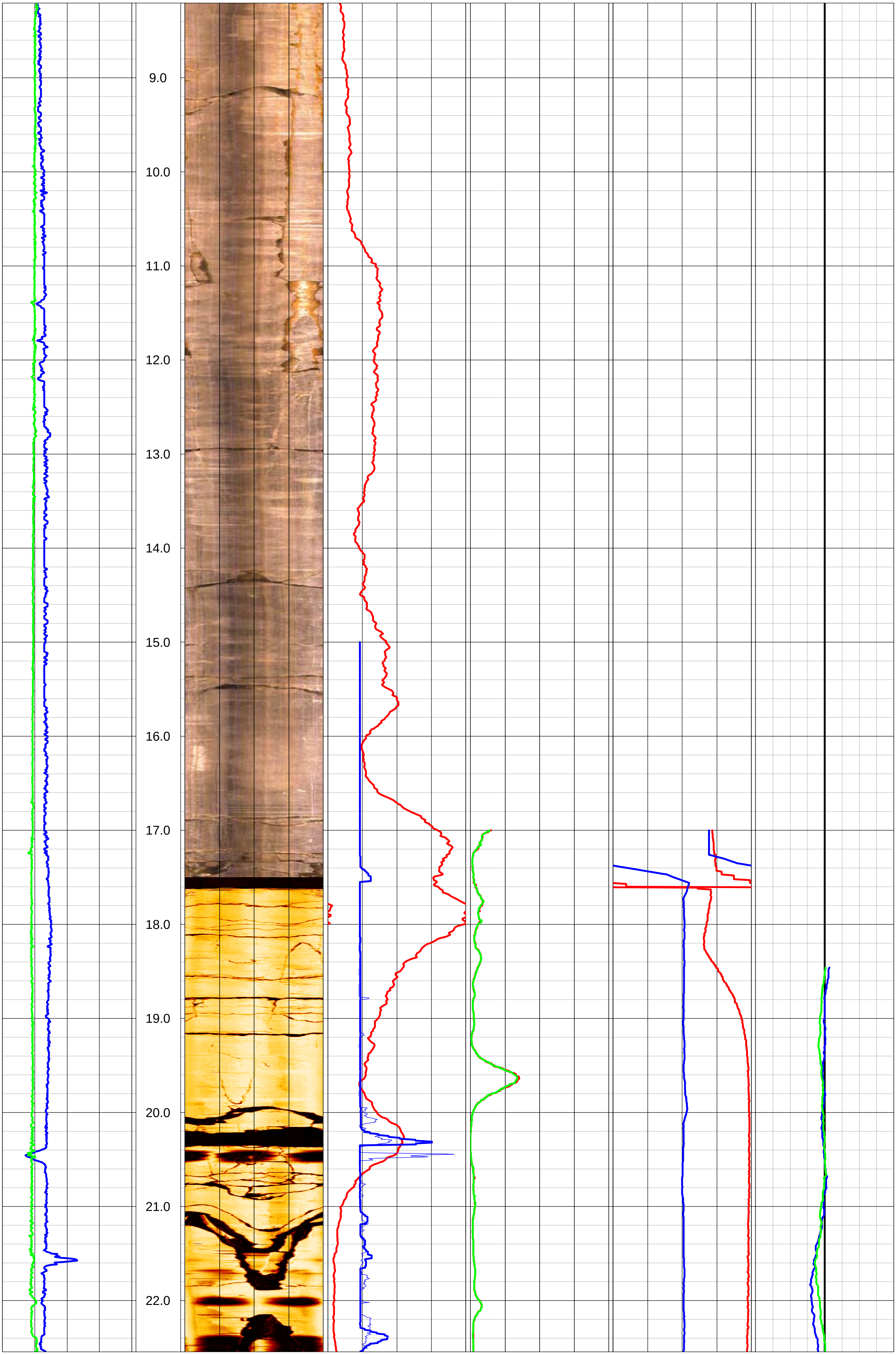
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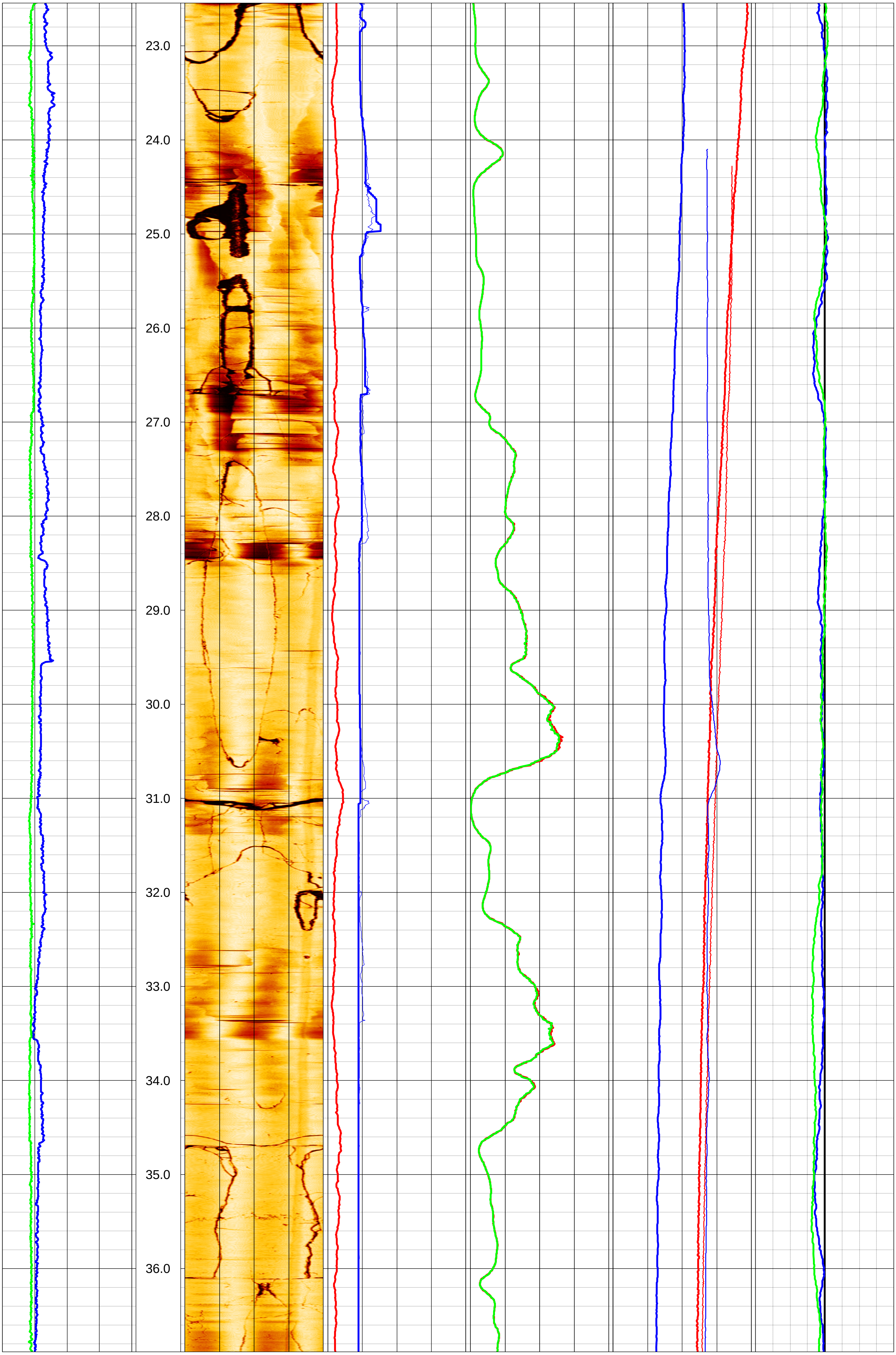

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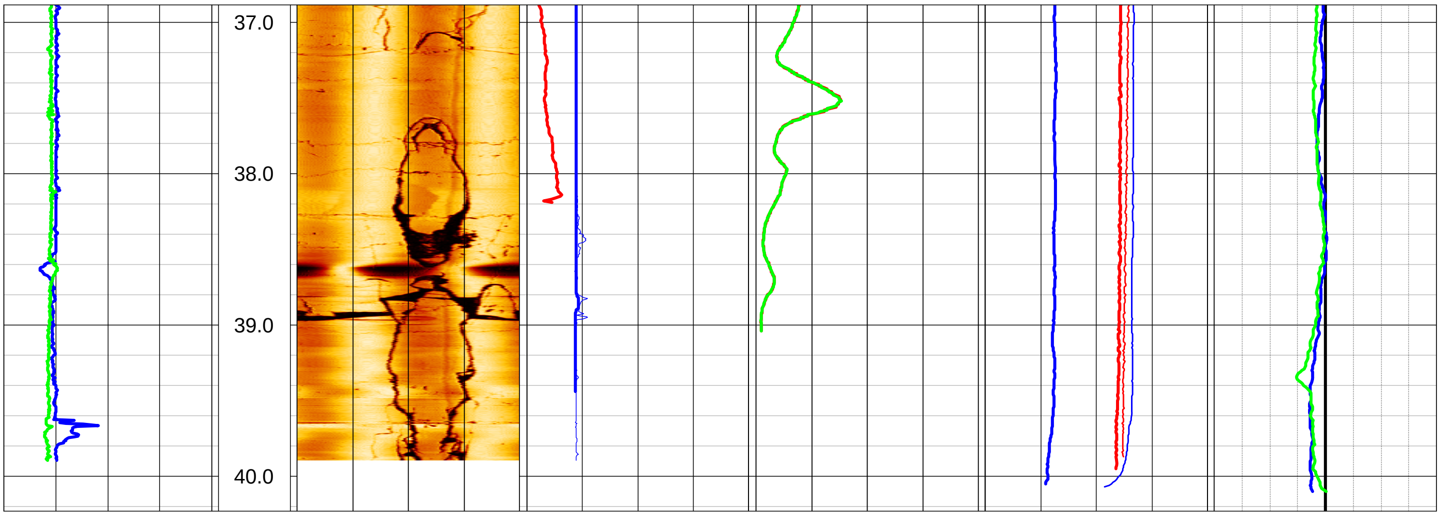
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40.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Priority Drilling**	Log Type: ***Image***
Borehole:	**BH5**	

Location: **Lackagh Quarry** Area: **Co. Galway** Grid Ref: Elevation:

Drilled Depth: (m)	**40.3**	Date:	**8.12.15**
Logged Depth: (m)	**39.9**	Recorded By:	**Rhys Powell**
Logging Datum:	**Ground Level**	Remarks: Rods pulled immediately before logging.	
Logged Interval: (m)	**1.0 - 39.9**		
Fluid Level: (m)	**17.9**	**Ref:**	

BOREHOLE RECORD		
Bit: (mm)	From: (m)	To: (m)
122	**0.1**	**40.3**

CASING RECORD			
Type	Size: (mm)	From: (m)	To: (m)
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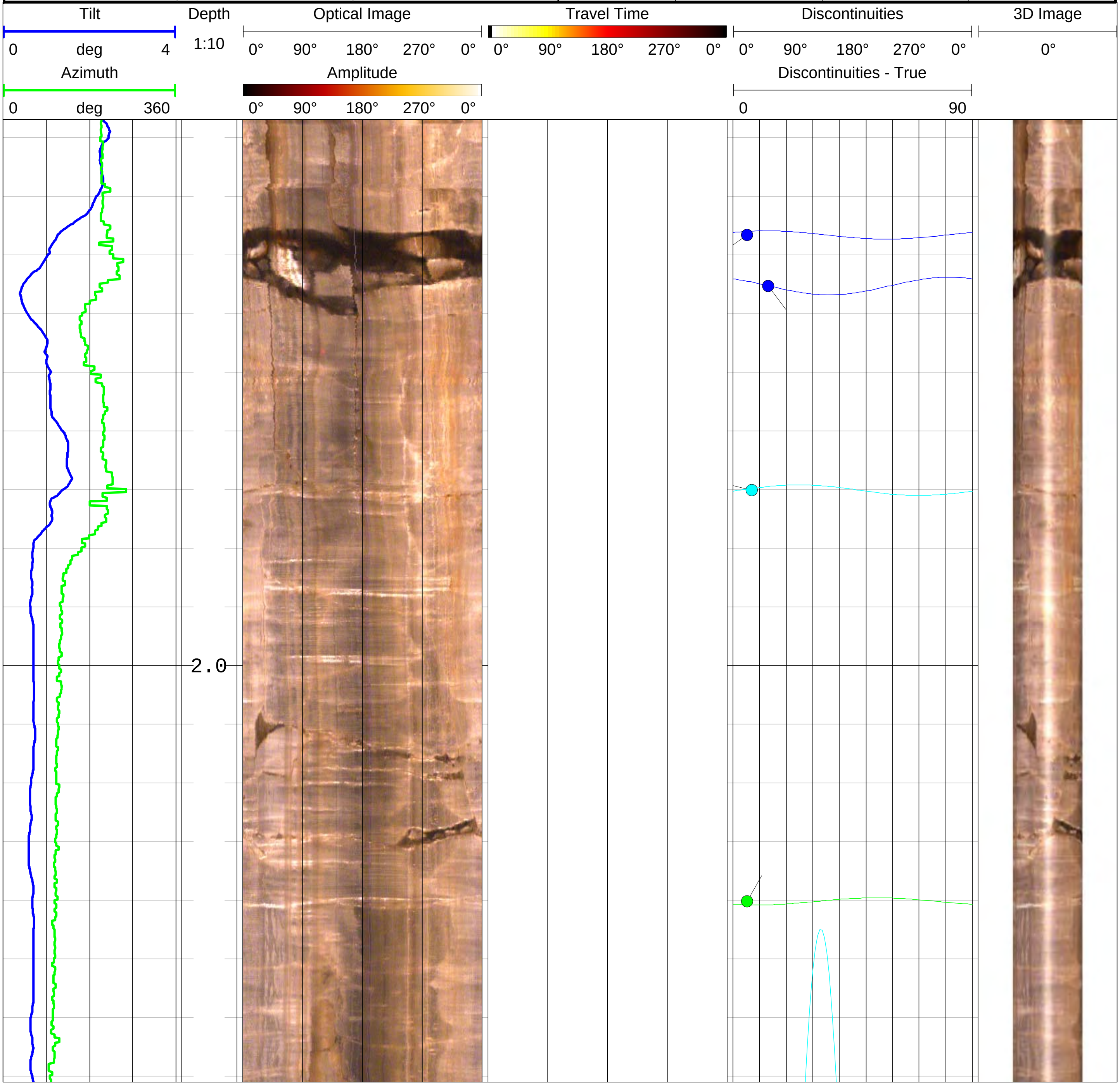

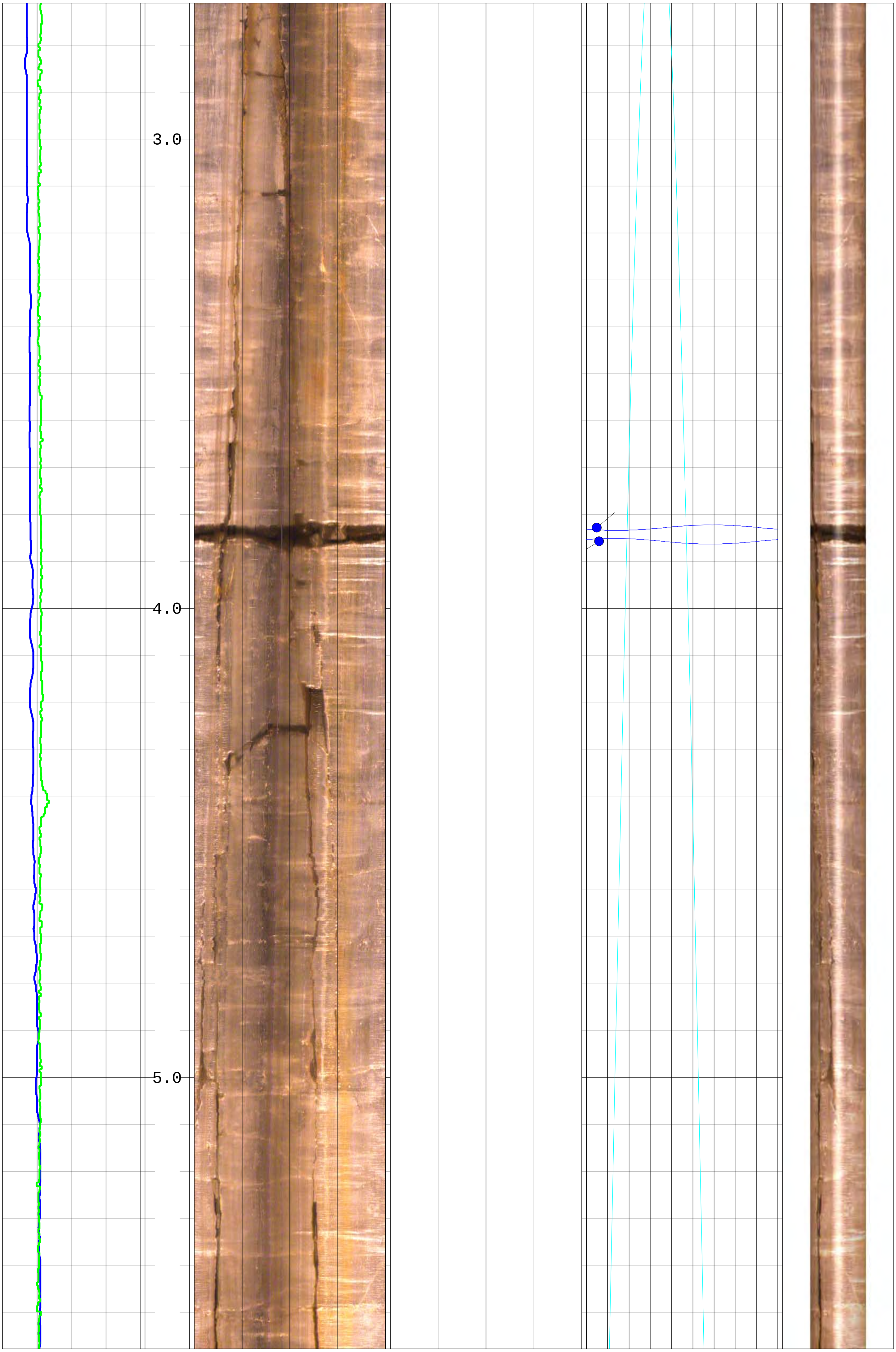
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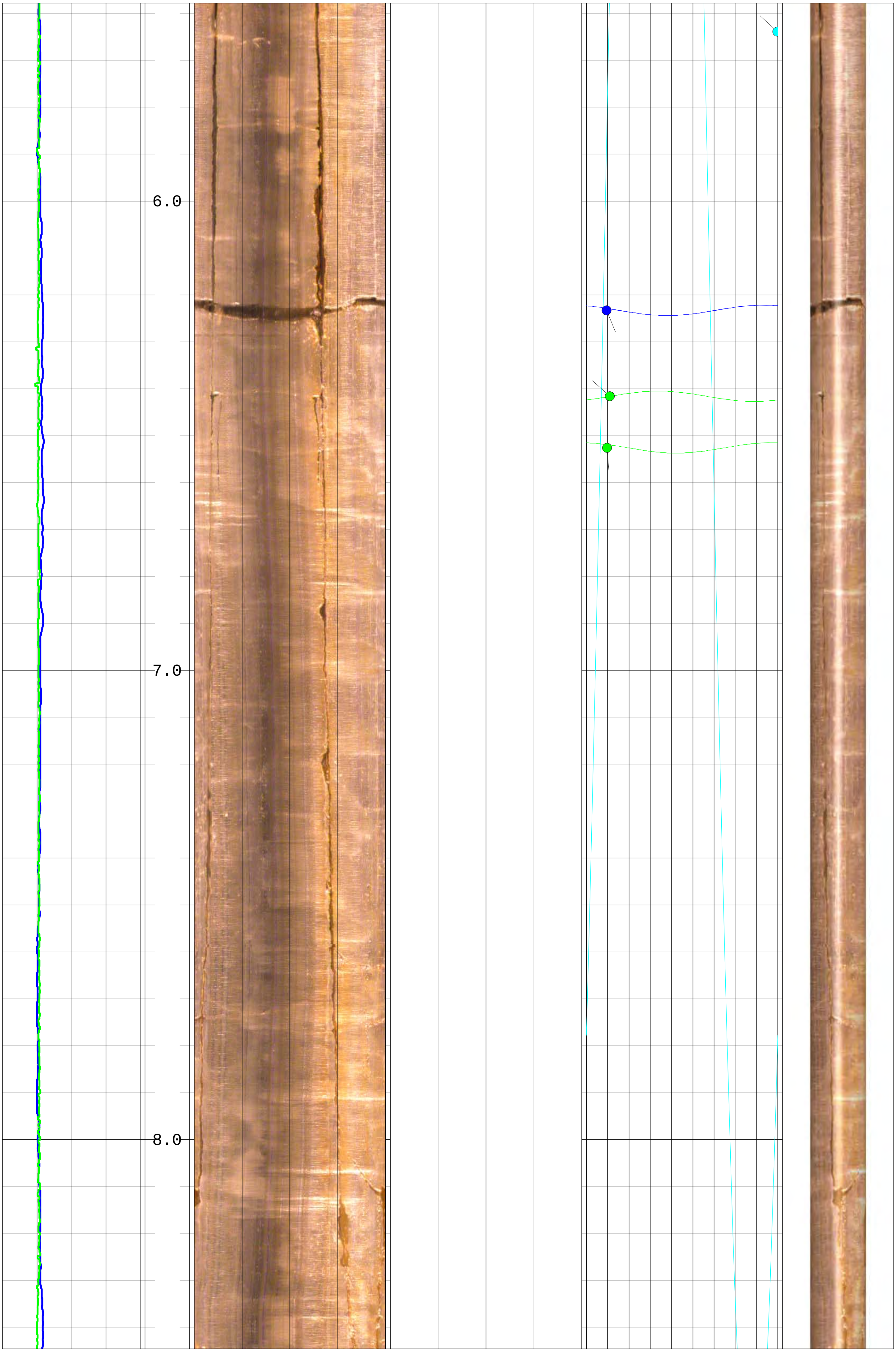
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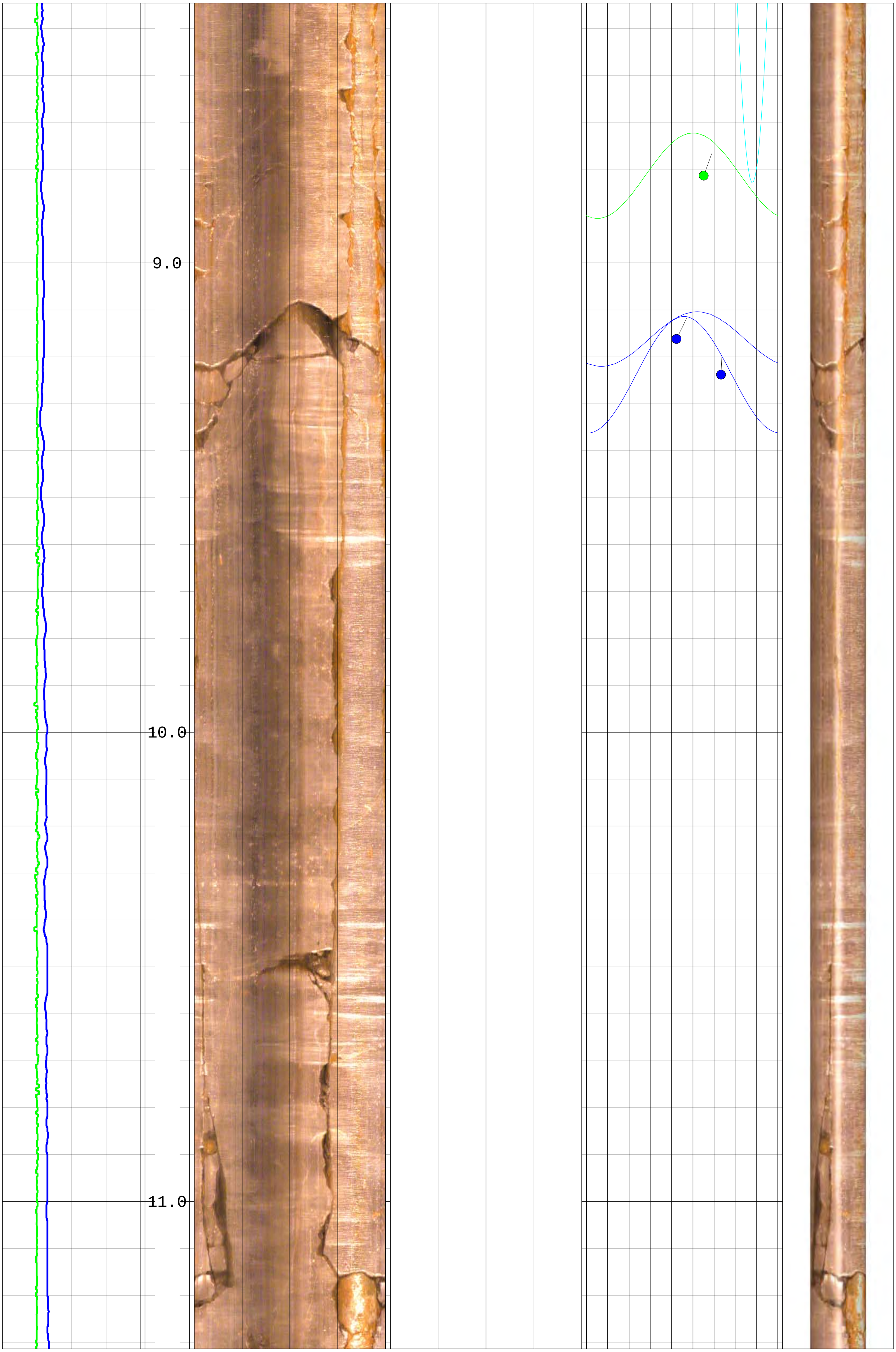
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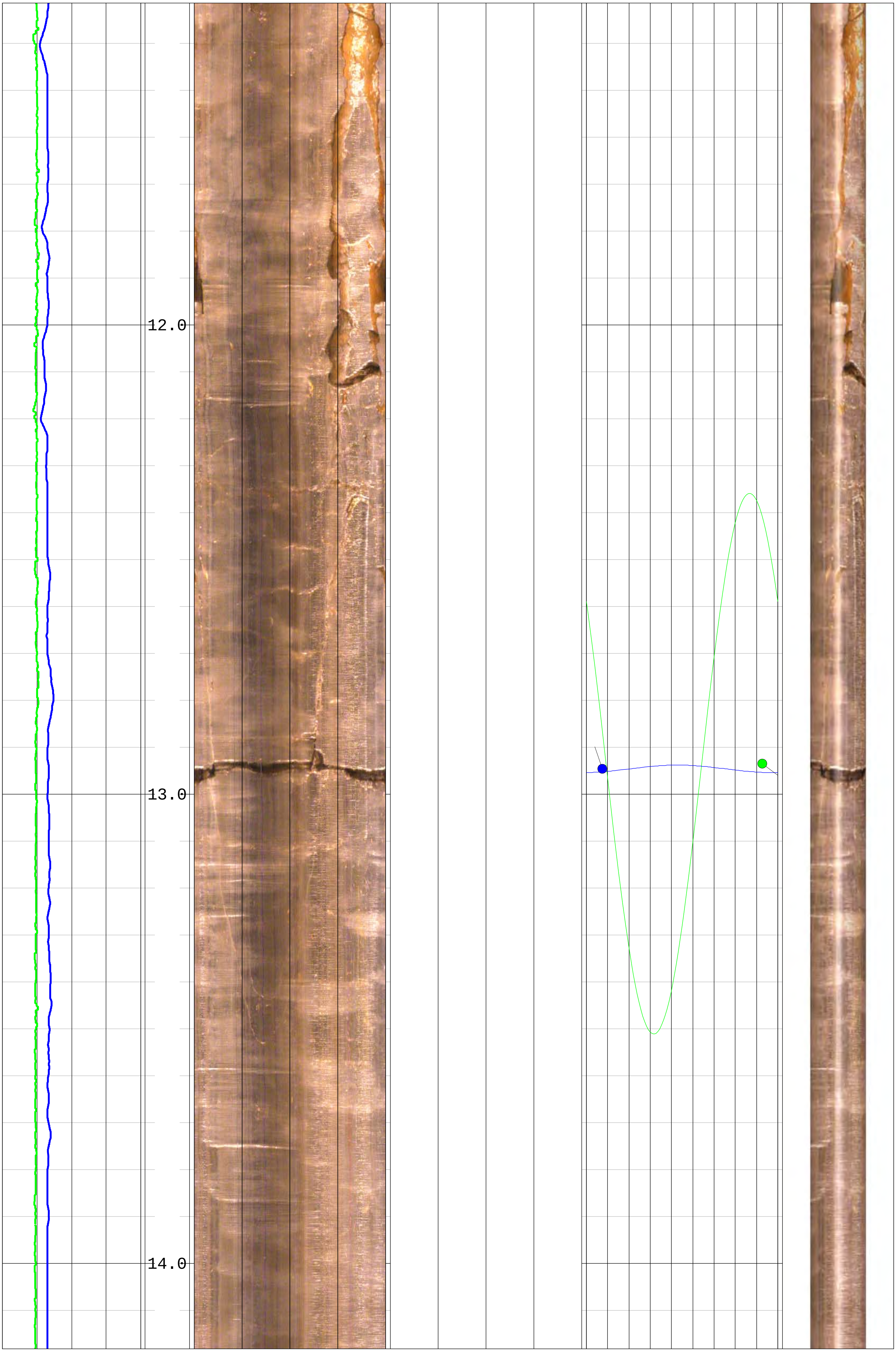
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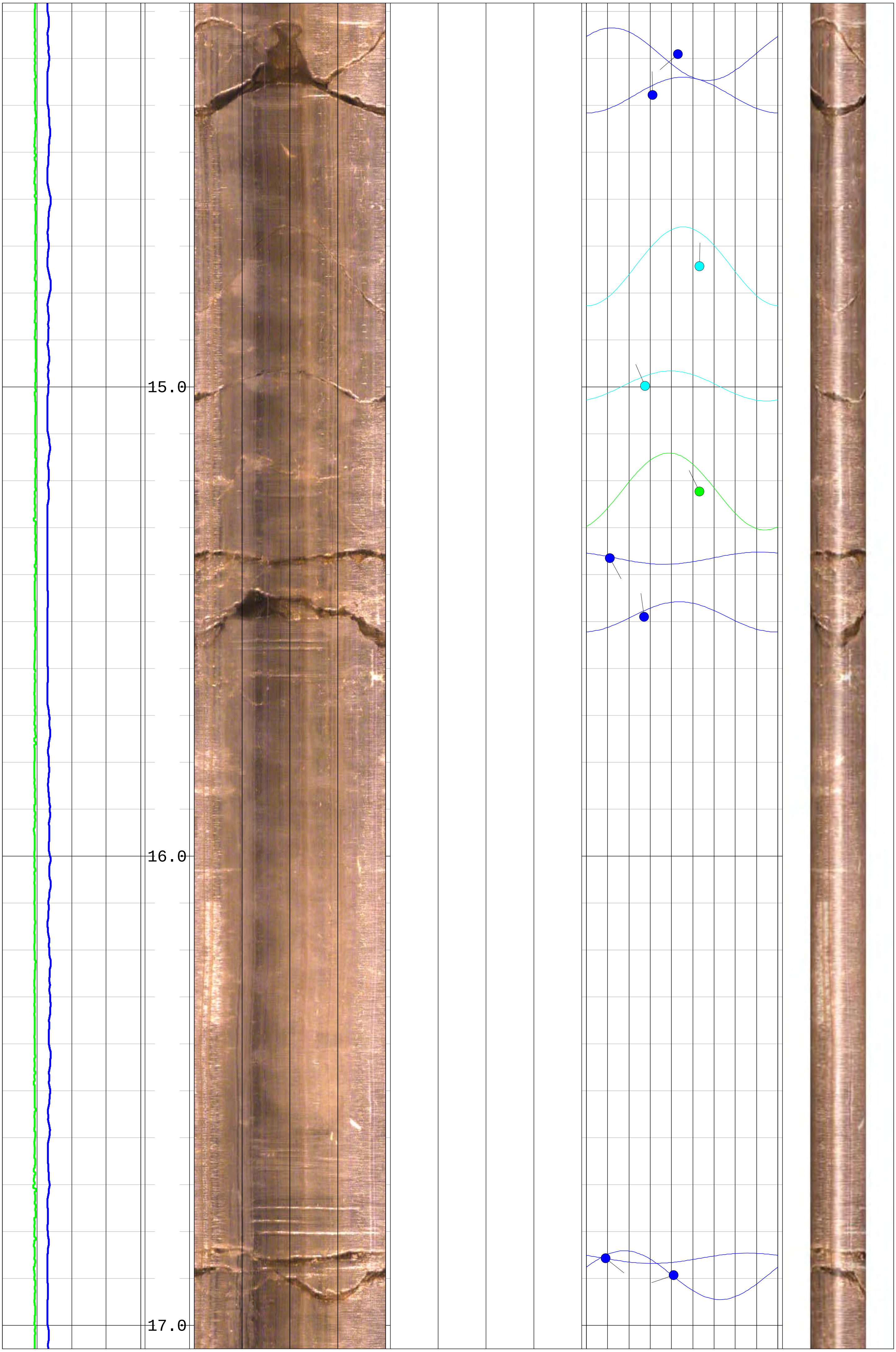
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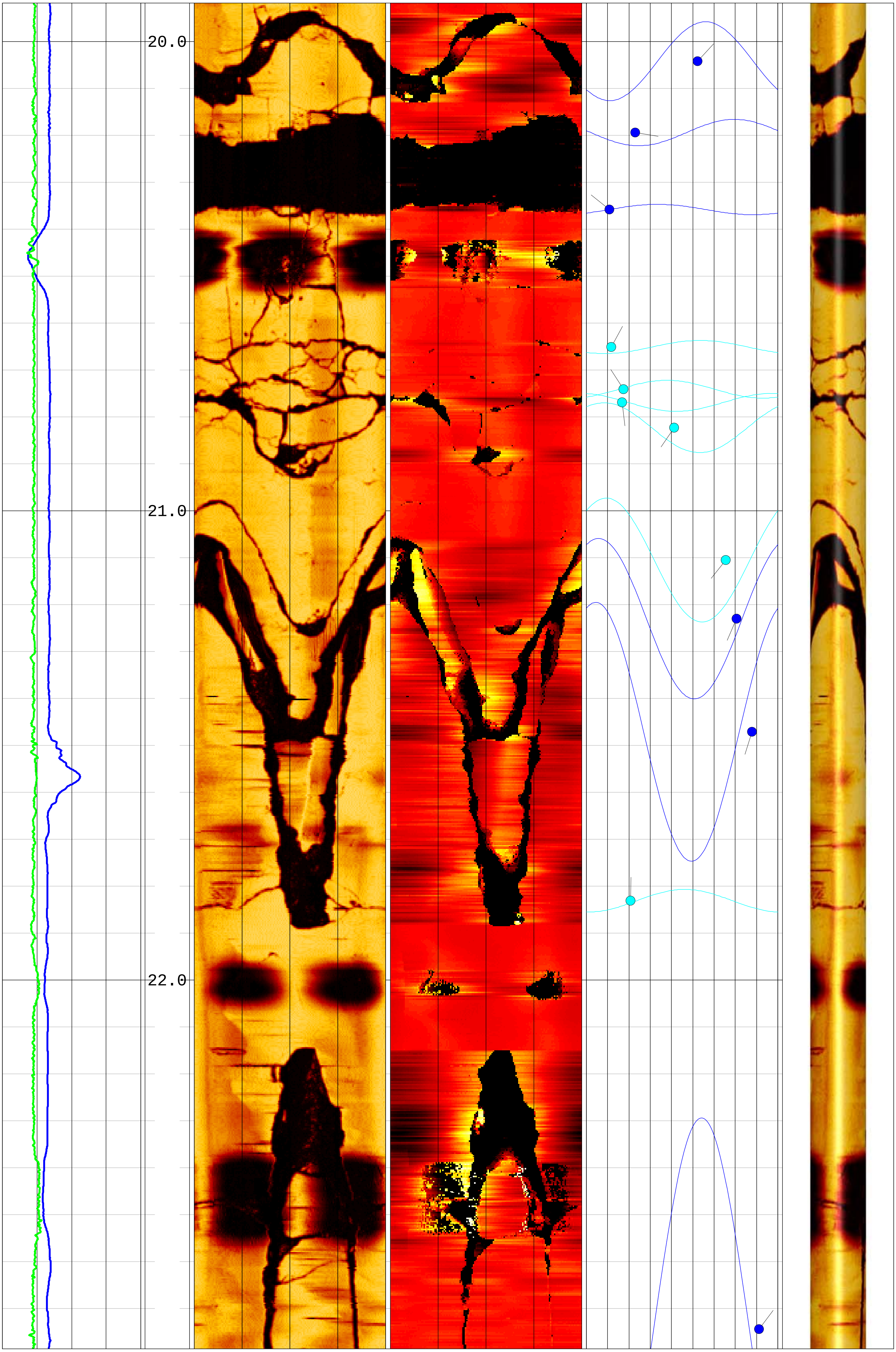
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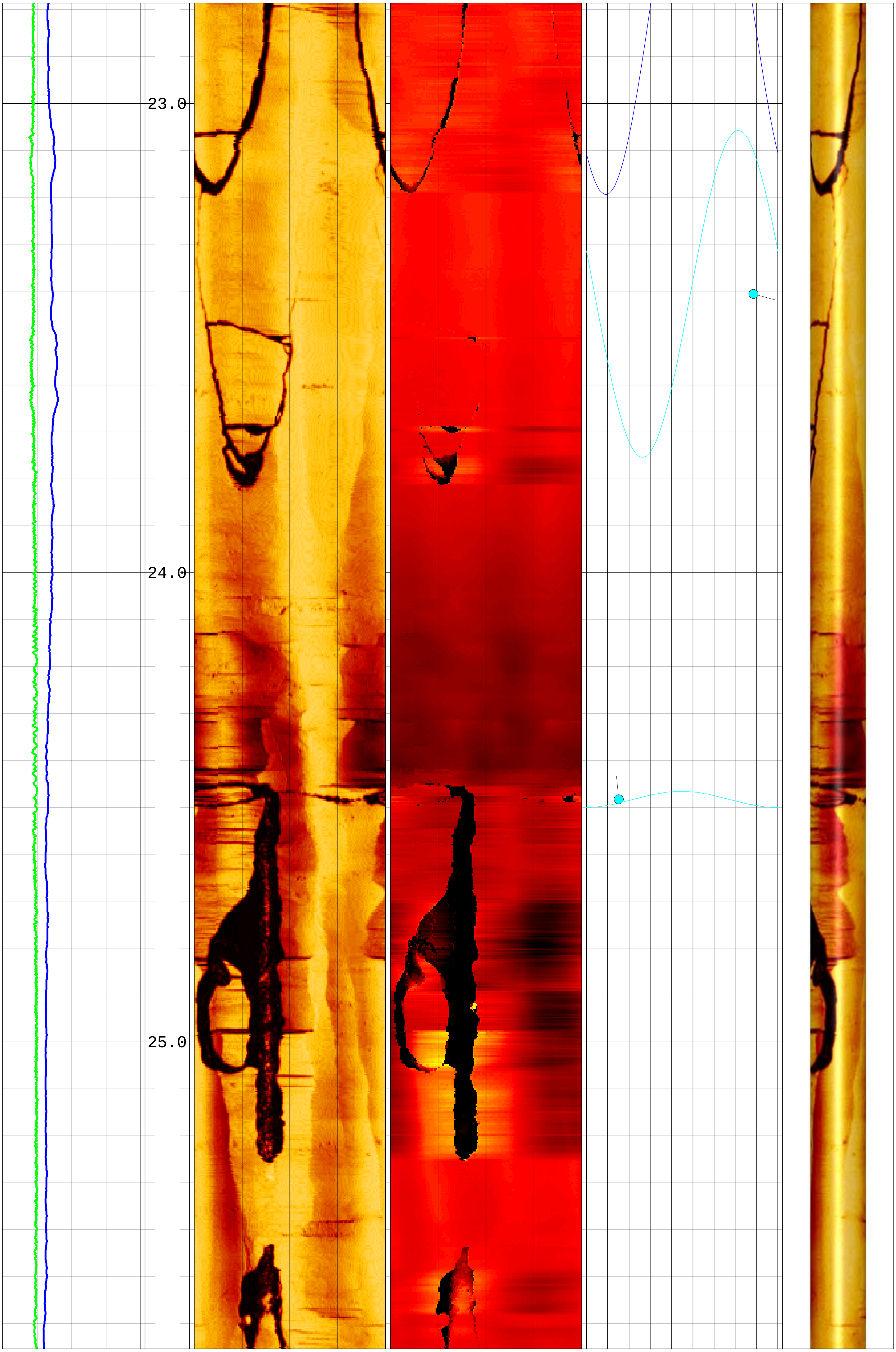
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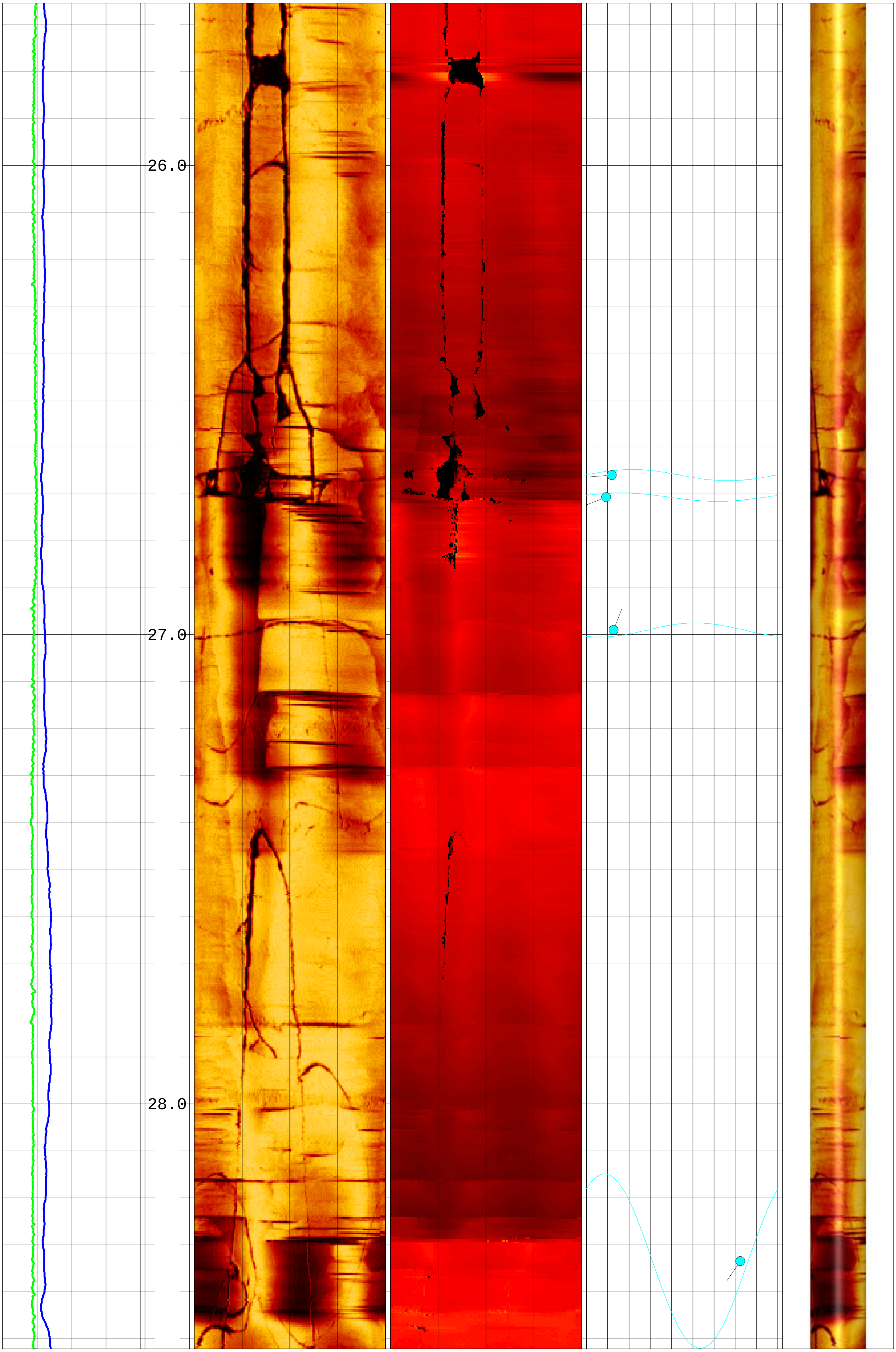
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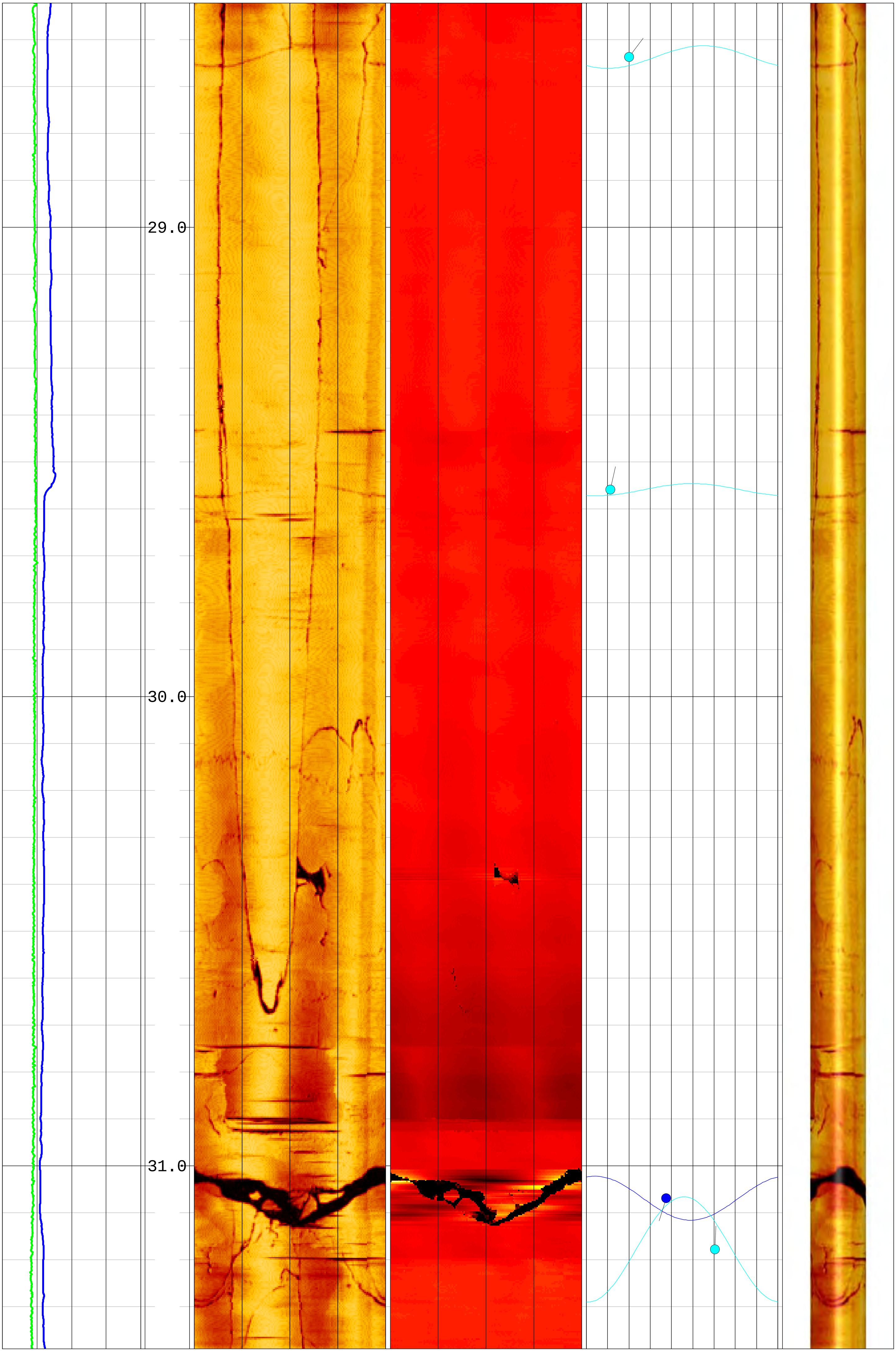
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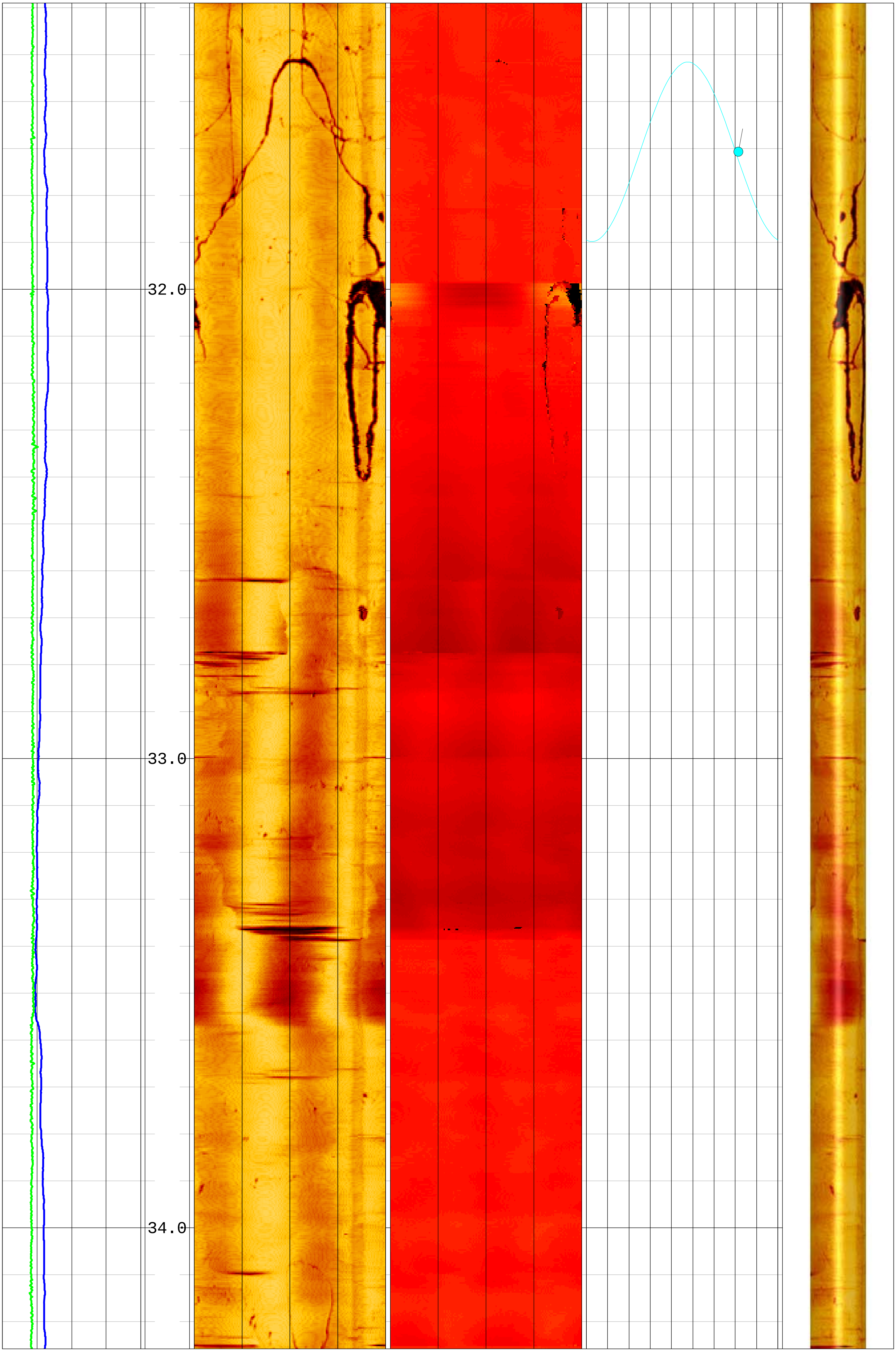
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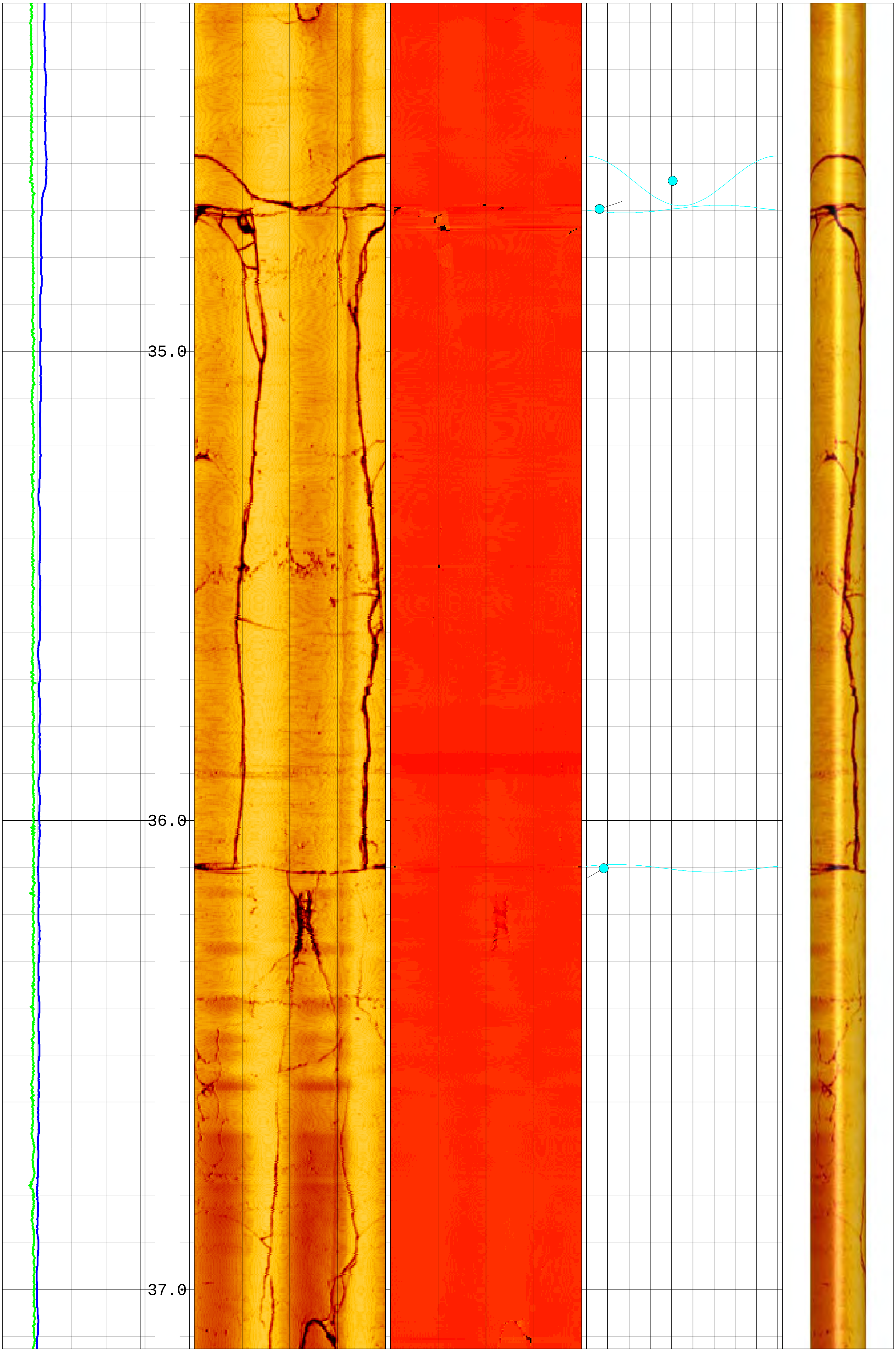
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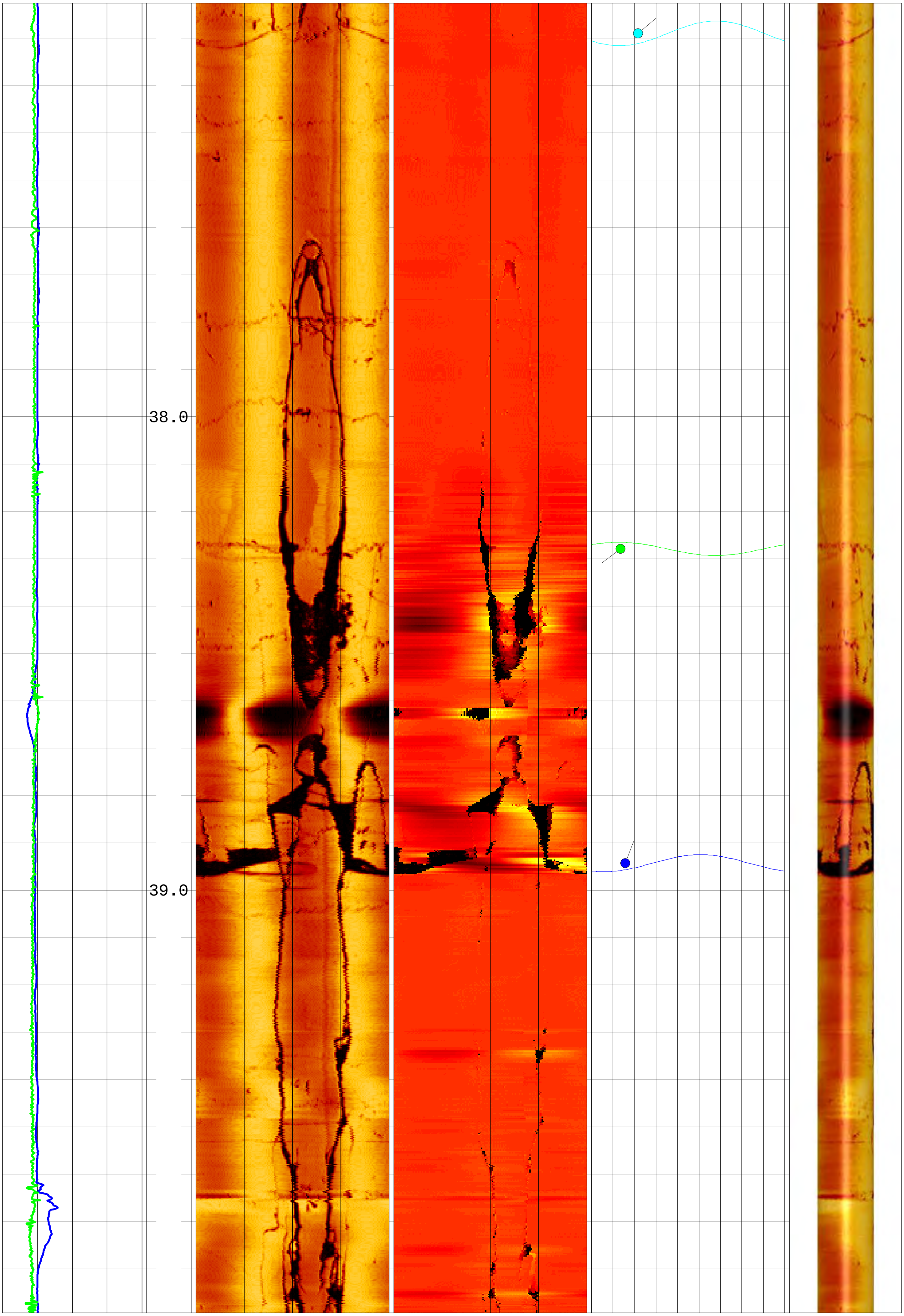

38.0
39.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Priority Drilling**	Log Type:
Borehole:	**BH5**	***Full Wave Sonic***

Location: **Lackagh Quarry** Area: **Co. Galway** Grid Ref: Elevation:

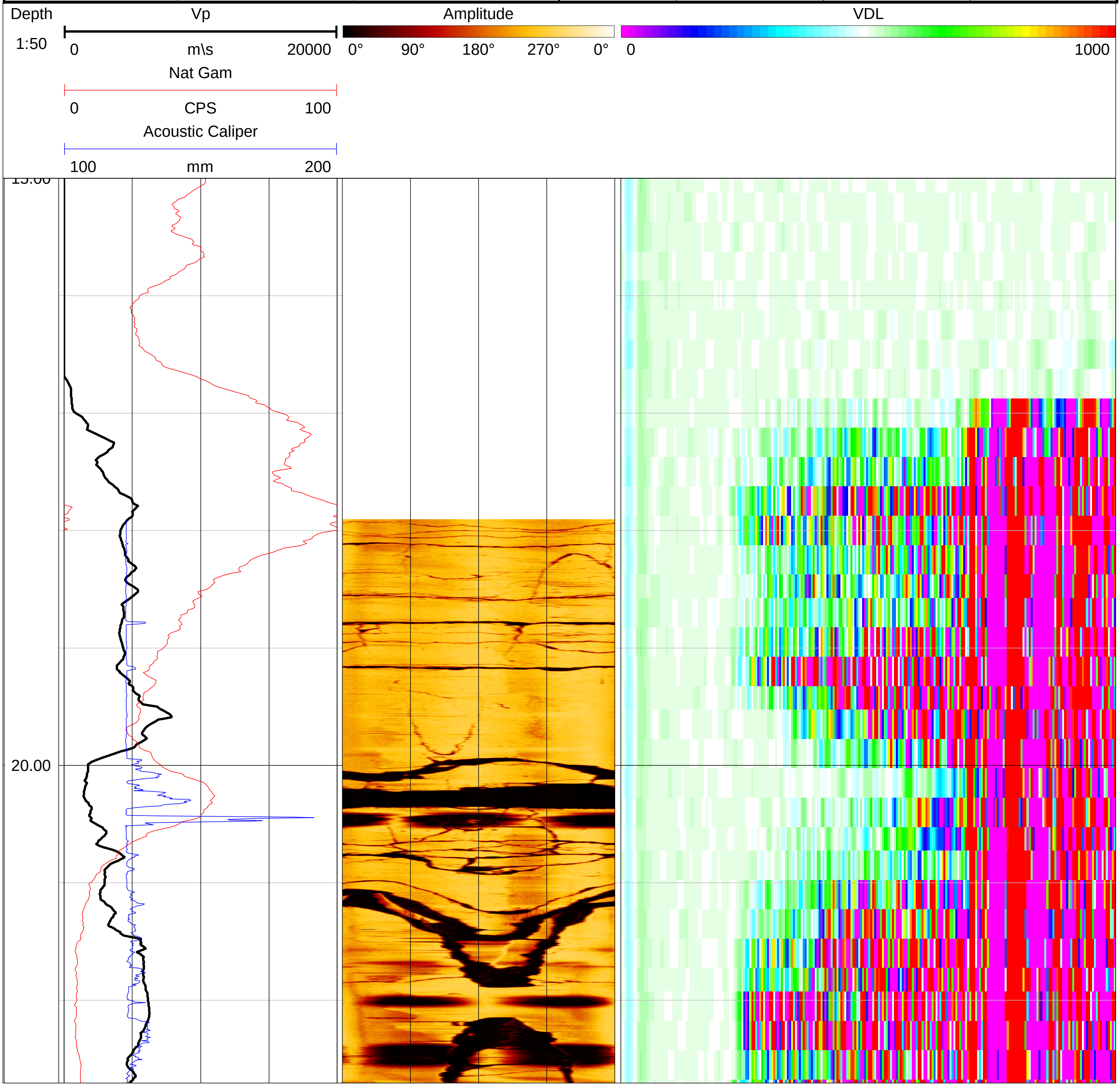
Drilled Depth: (m)	**40.3**	Date:	**8.12.15**
Logged Depth: (m)	**39.2**	Recorded By:	**Rhys Powell**
Logging Datum:	**Ground Level**	Remarks:	
Logged Interval: (m)	**16.9 - 39.2**		
Fluid Level: (m)	**16.9**	**Ref:**	

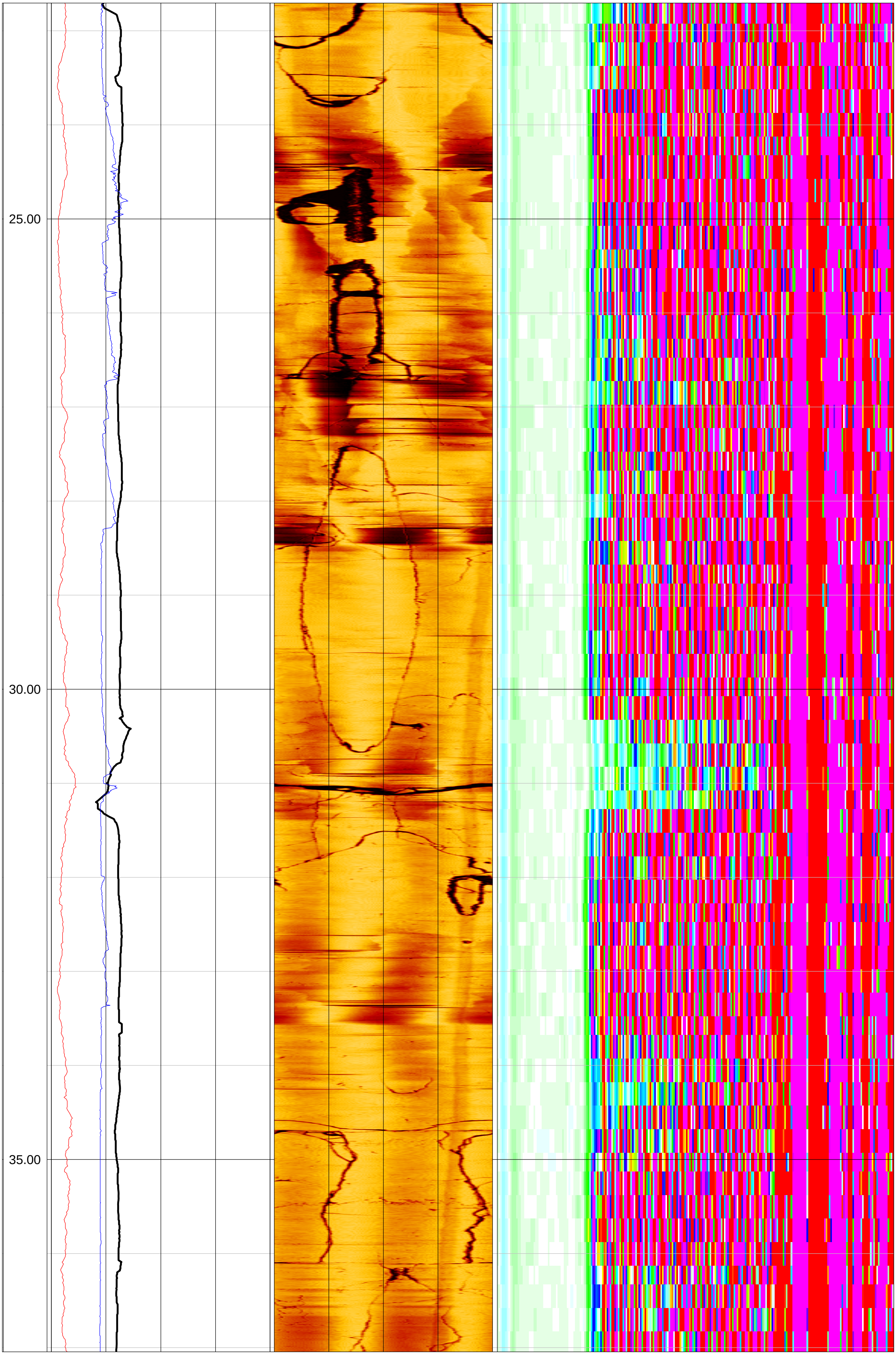
BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
122	**0.0**	**40.3**

CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
None			

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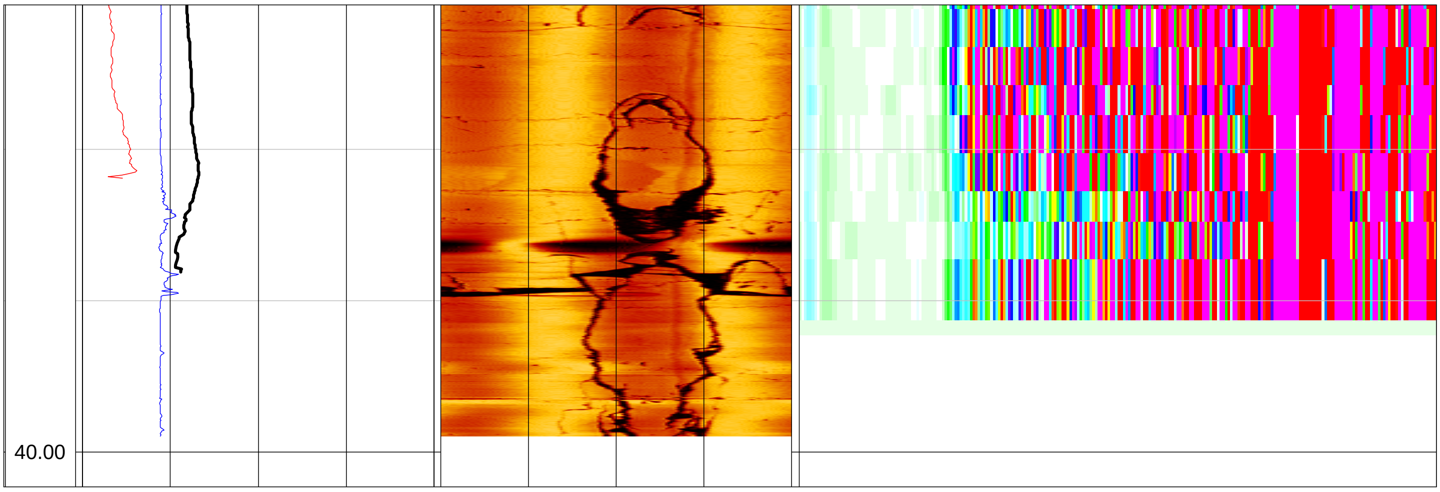
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APPENDIX VII

10% Fines

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448031

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Ten Per Cent Fines Value (TFV) of aggregate sample 10mm and greater in accordance with **BS 812: Part 111: 1990.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Bulk Sample**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**21/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification	**N/A**

RESULTS:

Ten per cent fines value (DRY) = 150 kN

Comments

Has the “as received material” been altered by crushing in the laboratory: **Yes**

Report to nearest 10kN for forces of 100kN or more report to nearest 5kN for forces less than 100kN.

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

UKAS TESTING 0494

Aggregate Abrasion Value

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448026

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Aggregate Abrasion Value (AAV) of aggregate sample, in accordance with **BS EN 1097-8 : 2009 Annex A**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Bulk Sample**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**23/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification:	**N/A**

RESULTS:

Aggregate Abrasion Value (Test 1) = 12.1 (three significant figures)
Aggregate Abrasion Value (Test 2) = 12.4 (three significant figures)

Mean Aggregate Abrasion Value = 12 (two significant figures)

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Aggregate Crushing Value

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448024

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Aggregate Crushing Value (ACV) of aggregate sample, in accordance with **BS 812: Part 110: 1990.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Bulk Sample**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**20/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification:	**N/A**

RESULTS:

Aggregate Crushing Value (%) = **23 (nearest whole number)**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Aggregate Impact Value

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448025

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Aggregate Impact Value (AIV) of aggregate sample – DRY, in accordance with **BS 812: Part 112: 1990.**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **Bulk Sample**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **21/02/2016**
Sampling Location: **Unknown**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Aggregate**
Target Specification: **N/A**

RESULTS:

Aggregate Impact Value (DRY) (%) = 17 (nearest whole number)

Comments

If the AIV is greater than 30 then, the results should be treated with caution.
No departure from specified procedure.

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Deformability in Uniaxial Compression and Brazil Tests

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
REP. Of Ireland.
VAT No: 9D53971I

Date: 15th February 2016
Test Report Ref. STR: 443020

LABORATORY TEST REPORT

TEST REQUIREMENTS: Unconfined compressive strength, elastic moduli & indiect tensile strength by Brazil.

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**8/12/2016**
Date of Start of Test.:	**15/12/2015**
Sampling Location:	**Various**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Aggregate Type and Nominal Size:	**Core**
Target Specification:	**N/A**

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our competent, sub contracted laboratory.

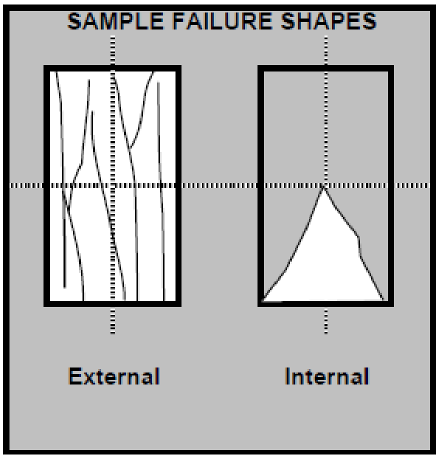
RESULTS

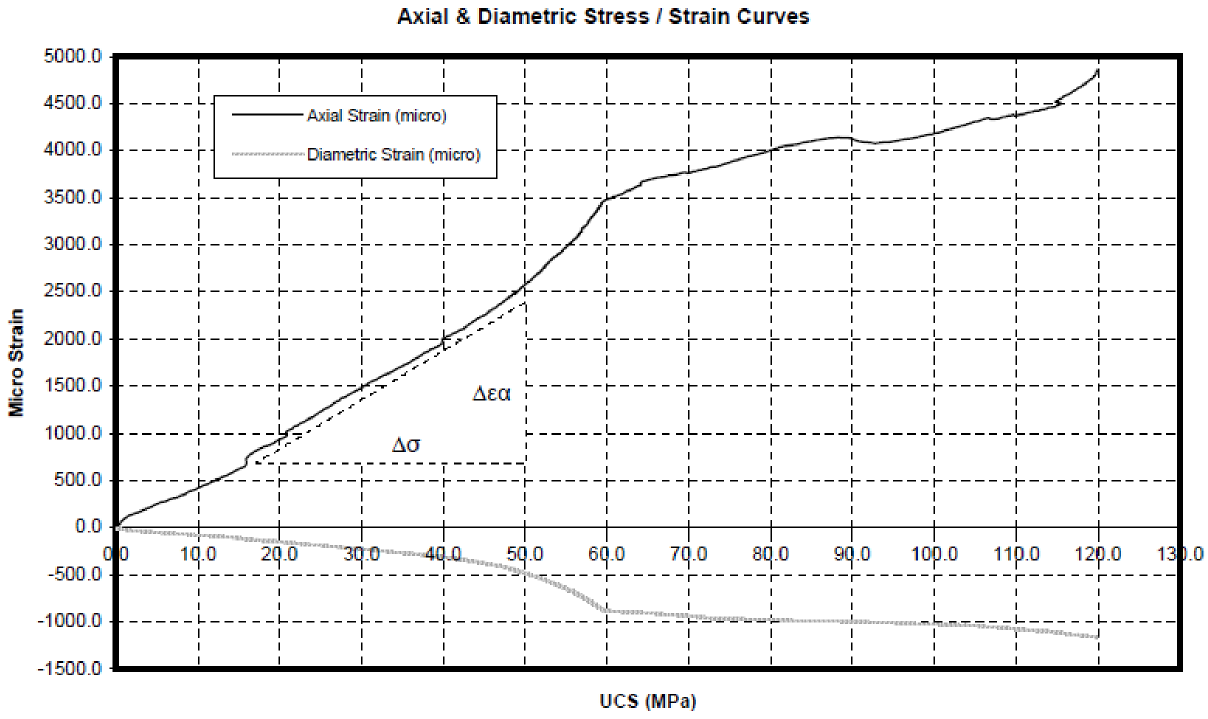
( ) E. R. Goulden
Technical Manager
Approved Signatories

( ) E. N. Jones
Soils Laboratory Manager

(✓) N Dumbarton
Assistant Laboratory Manager

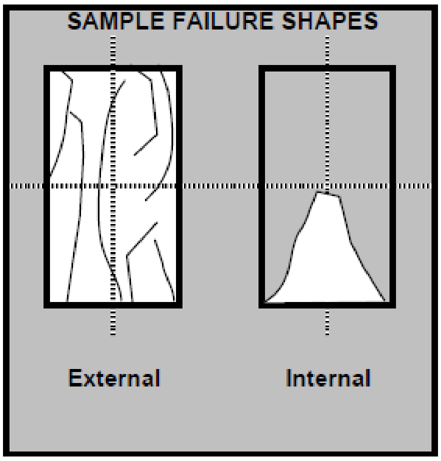
BOREHOLE		BH04
CORE RUN		48903
DEPTH		8.06-8.36
SAMPLE DIAMETER	mm	82.22
SAMPLE HEIGHT	mm	186.15
WATER CONTENT	%	0.0
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	14.21
DATE OF TESTING		24/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	18.60
POISSON'S RATIO *v*		0.20
UNCONFINED COMPRESSIVE STRENGTH	MPa	119.9



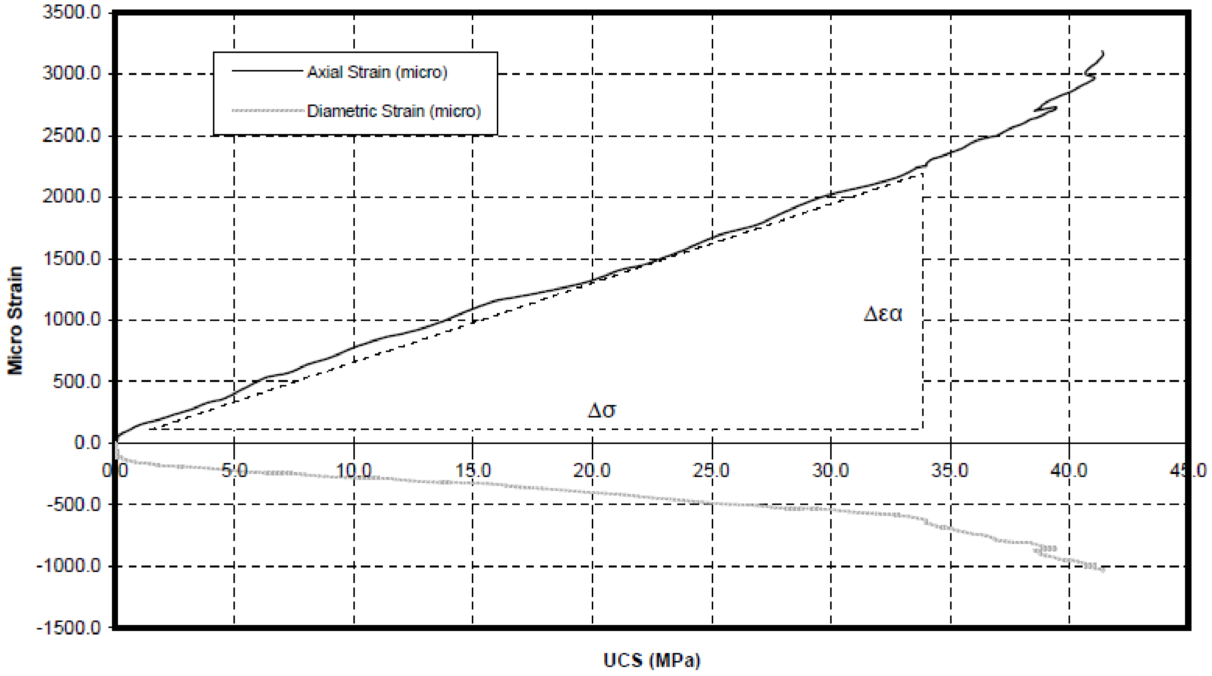


Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 16.6MPa and 50.1MPa

BOREHOLE		BH04
CORE RUN		48905
DEPTH		10.63-10.88
SAMPLE DIAMETER	mm	82.11
SAMPLE HEIGHT	mm	197.38
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.6
TEST DURATION	mm.sec	6.4
DATE OF TESTING		25/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	15.57
POISSON'S RATIO *v*		0.22
UNCONFINED COMPRESSIVE STRENGTH	MPa	41.6



Axial & Diametric Stress / Strain Curves

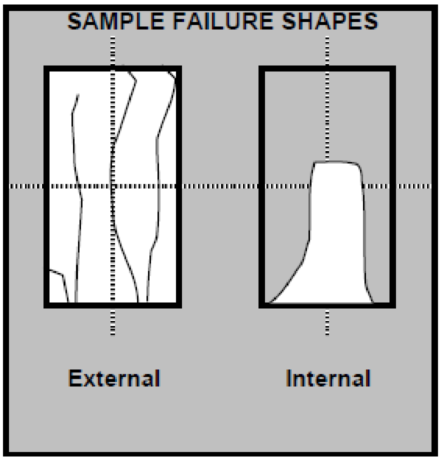


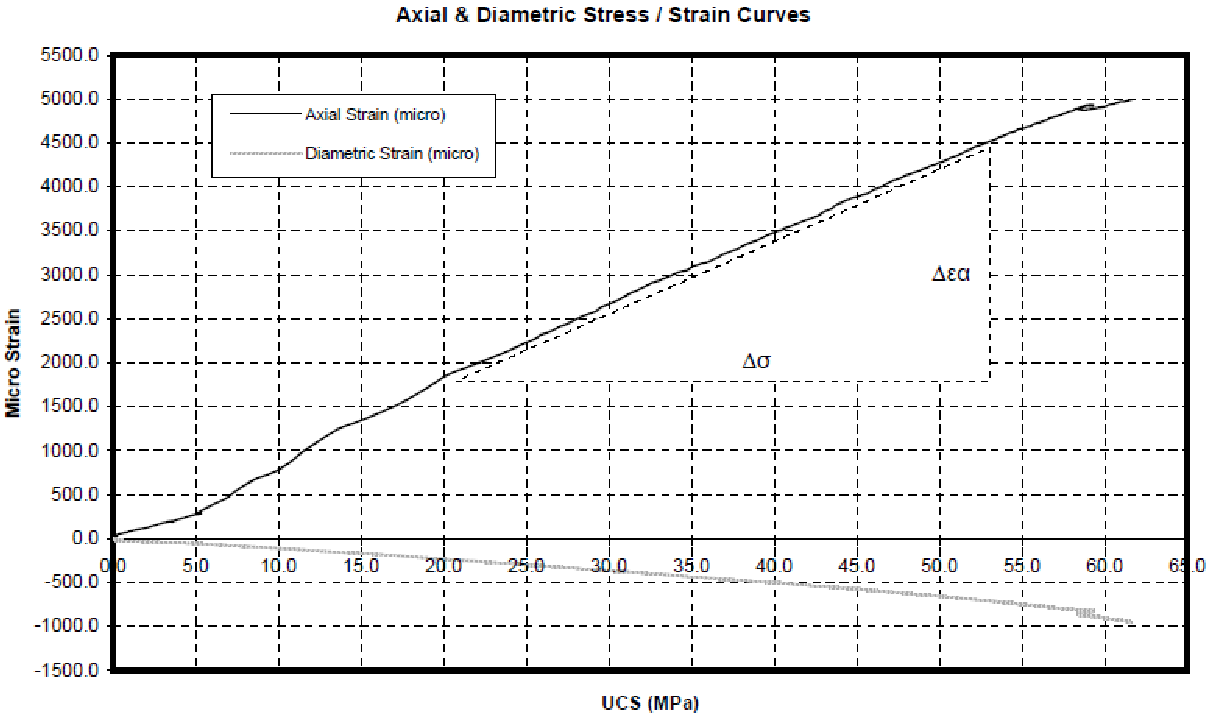
Test Notes:

Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 1MPa and 34MPa

Test Report Ref. STR: 443020 Page 4 of 12

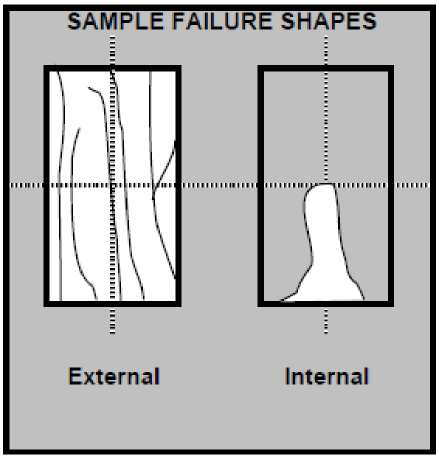
BOREHOLE		BH04
CORE RUN		48910
DEPTH		14.40-14.63
SAMPLE DIAMETER	mm	82.43
SAMPLE HEIGHT	mm	186.76
WATER CONTENT	%	0.2
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.8
TEST DURATION	mm.sec	6.52
DATE OF TESTING		25/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	12.33
POISSON'S RATIO *v*		0.18
UNCONFINED COMPRESSIVE STRENGTH	MPa	62.0

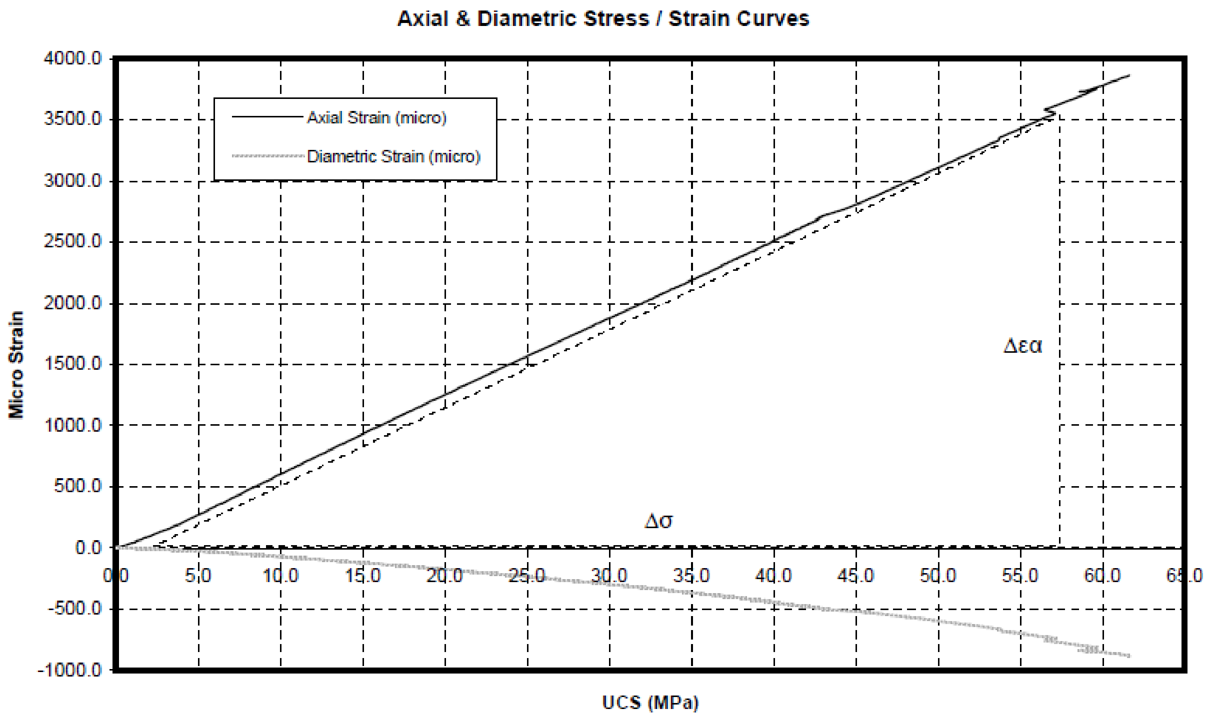




Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 20.2MPa and 52.9MPa

BOREHOLE		BH04
CORE RUN		48935
DEPTH		25.19-25.41
SAMPLE DIAMETER	mm	81.94
SAMPLE HEIGHT	mm	186.81
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	8.34
DATE OF TESTING		25/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	15.68
POISSON'S RATIO *v*		0.20
UNCONFINED COMPRESSIVE STRENGTH	MPa	64.1

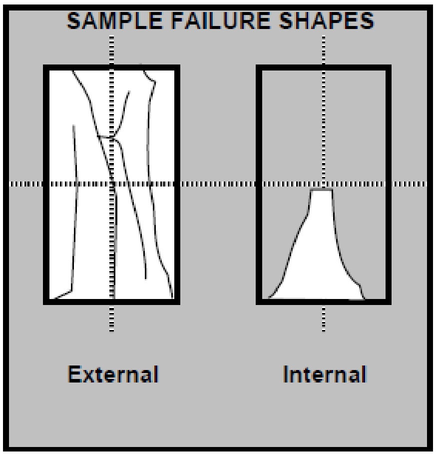




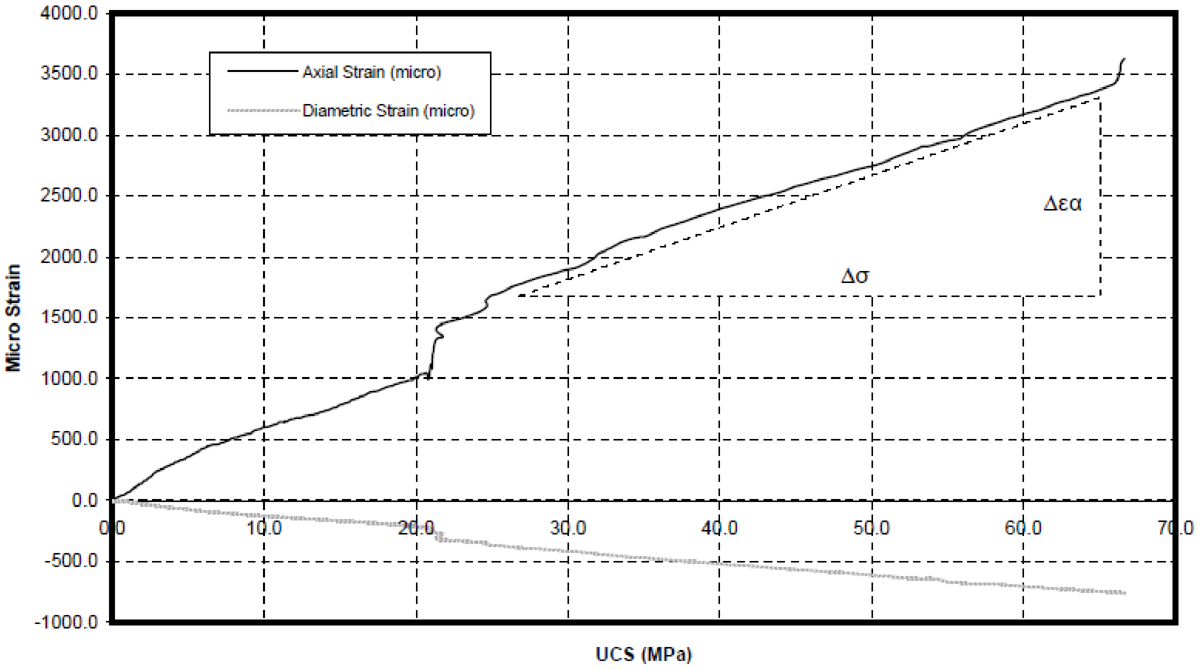
Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 2MPa and 57.5MPa

BOREHOLE		BH04
CORE RUN		48966
DEPTH		33.20-33.48
SAMPLE DIAMETER	mm	82.14
SAMPLE HEIGHT	mm	184.83
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	1.1
TEST DURATION	mm.sec	5.11
DATE OF TESTING		25/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	23.77
POISSON'S RATIO *v*		0.23
UNCONFINED COMPRESSIVE STRENGTH	MPa	66.5

SAMPLE FAILURE SHAPES

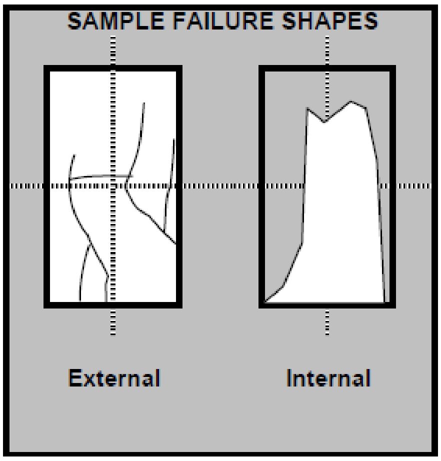


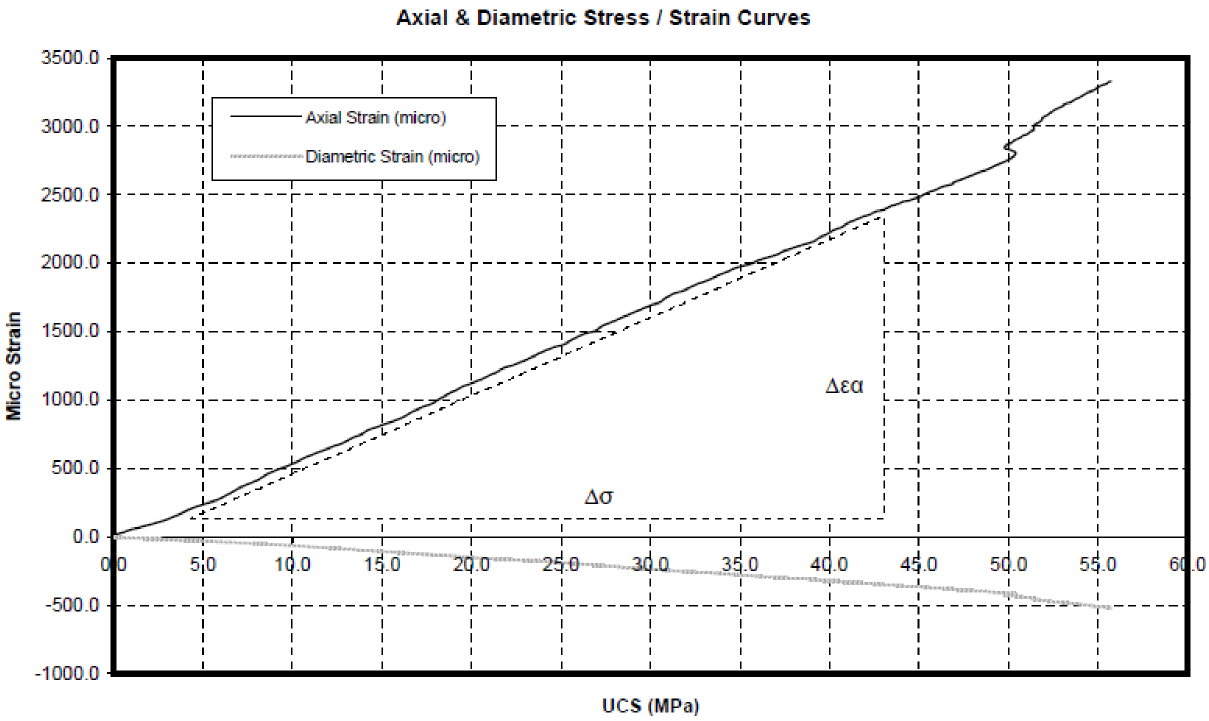
Axial & Diametric Stress / Strain Curves



Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 25.9MPa and 65.1MPa

BOREHOLE		BH05
CORE RUN		48996
DEPTH		15.95-16.22
SAMPLE DIAMETER	mm	82.33
SAMPLE HEIGHT	mm	187.90
WATER CONTENT	%	0.2
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.5
TEST DURATION	mm.sec	9.58
DATE OF TESTING		21/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	17.68
POISSON'S RATIO *v*		0.15
UNCONFINED COMPRESSIVE STRENGTH	MPa	57.0

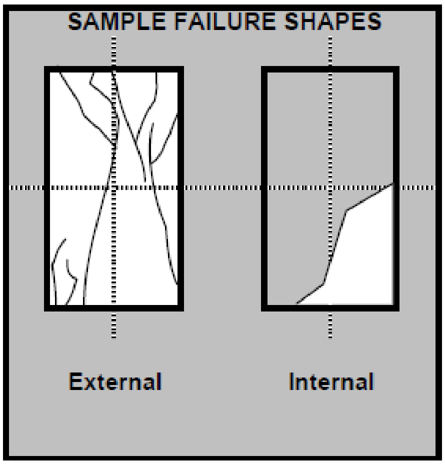




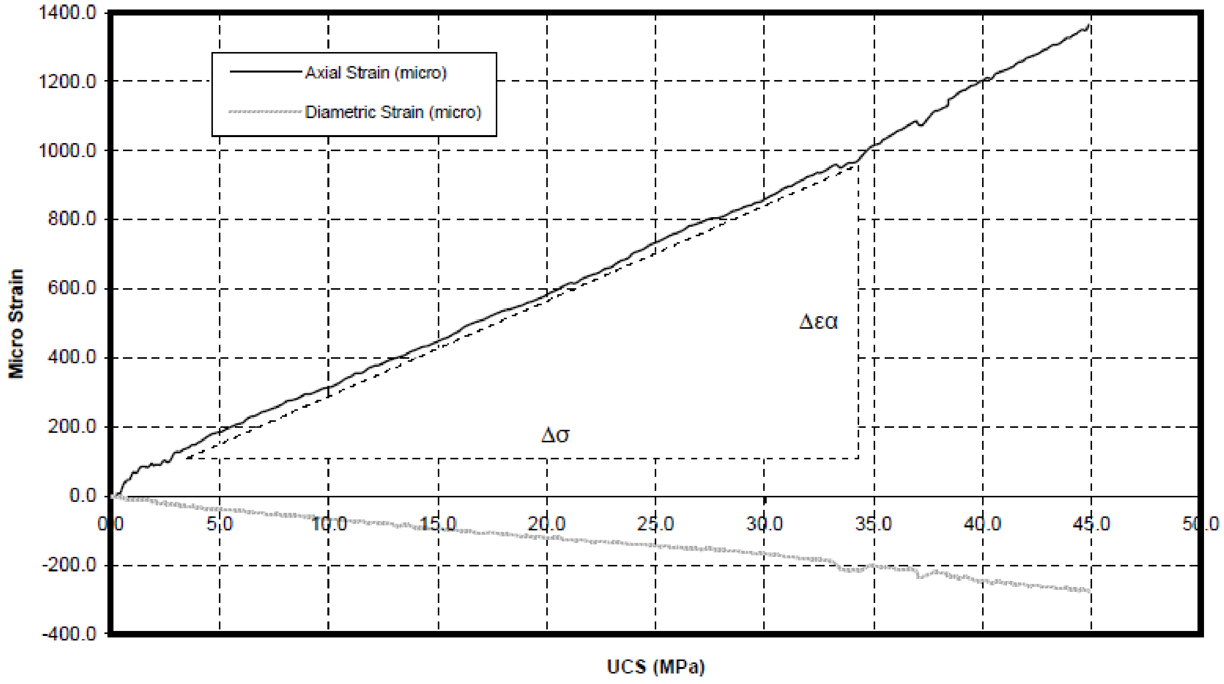
Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 3.6MPa and 43MPa

BOREHOLE		BH05
CORE RUN		50706
DEPTH		24.05-24.30
SAMPLE DIAMETER	mm	81.06
SAMPLE HEIGHT	mm	187.95
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	5.38
DATE OF TESTING		24/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	36.97
POISSON'S RATIO *v*		0.20
UNCONFINED COMPRESSIVE STRENGTH	MPa	44.9

SAMPLE FAILURE SHAPES



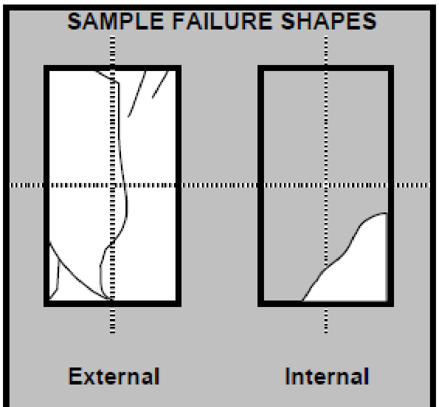
Axial & Diametric Stress / Strain Curves



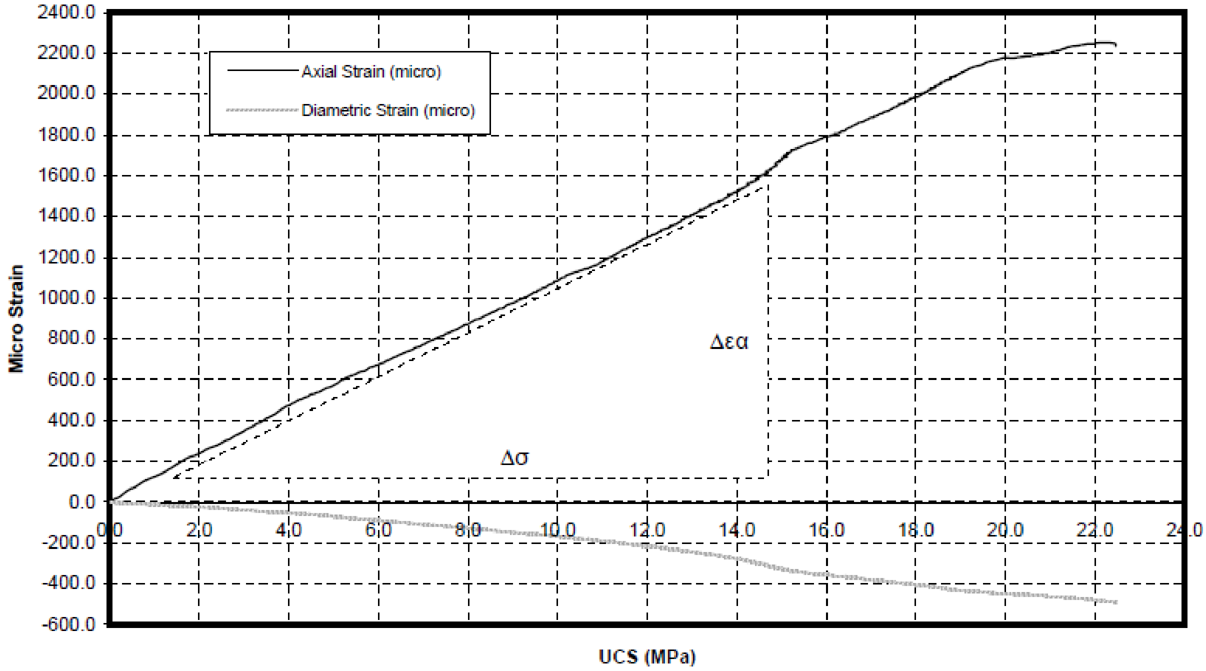
Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 3.1MPa and 34.3MPa

BOREHOLE		**BH05**
CORE RUN		**50708**
DEPTH		**25.20-25.40**
SAMPLE DIAMETER	**mm**	**82.08**
SAMPLE HEIGHT	**mm**	**190.12**
WATER CONTENT	**%**	**0.1**
TEST CONDITION		**As Received**
RATE OF LOADING	**kN/s**	**0.6**
TEST DURATION	**mm.sec**	**3.21**
DATE OF TESTING		**25/01/2016**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Perpendicular**
YOUNG'S MODULUS *E* (AVERAGE)	**GPa**	**9.10**
POISSON'S RATIO *v*		**0.21**
UNCONFINED COMPRESSIVE STRENGTH	**MPa**	**22.6**

SAMPLE FAILURE SHAPES

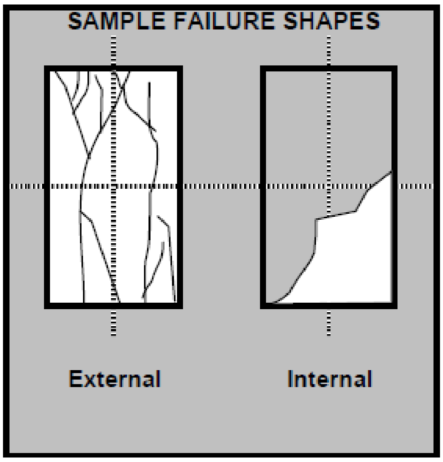


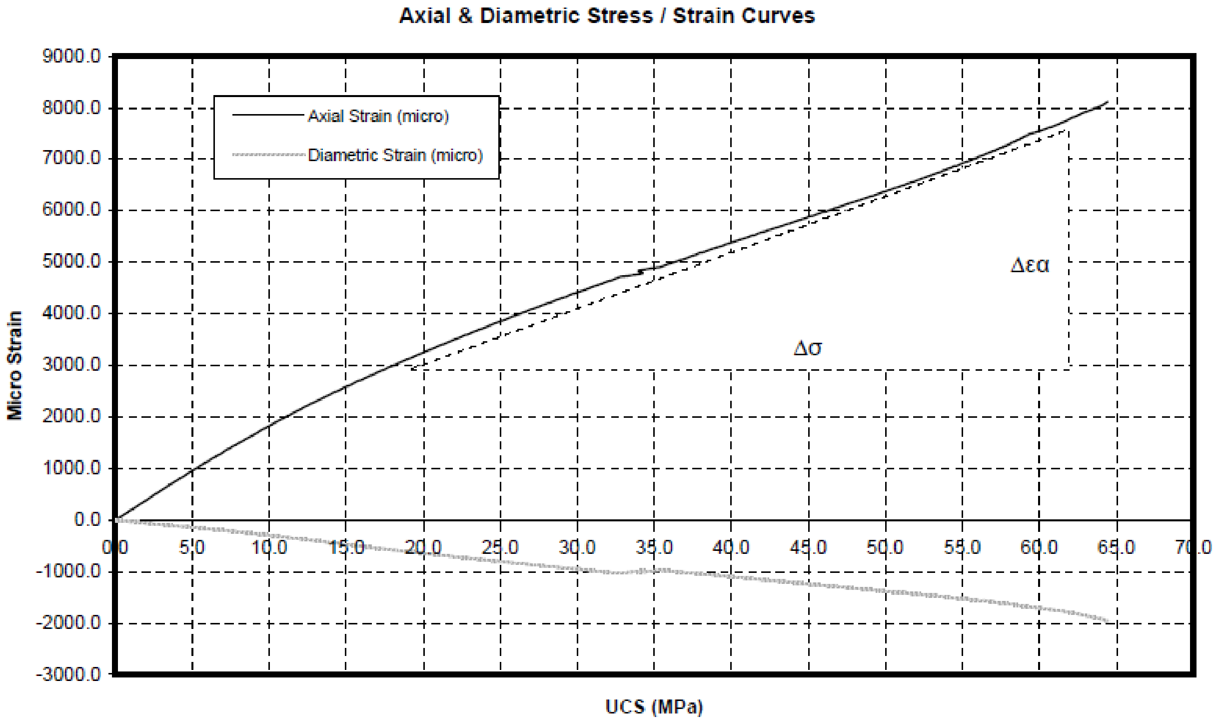
Axial & Diametric Stress / Strain Curves



Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 1.2MPa and 14.8MPa

BOREHOLE		BH05
CORE RUN		50710
DEPTH		26.12-26.35
SAMPLE DIAMETER	mm	79.70
SAMPLE HEIGHT	mm	181.09
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.8
TEST DURATION	mm.sec	7.14
DATE OF TESTING		24/01/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	9.18
POISSON'S RATIO *v*		0.24
UNCONFINED COMPRESSIVE STRENGTH	MPa	66.3

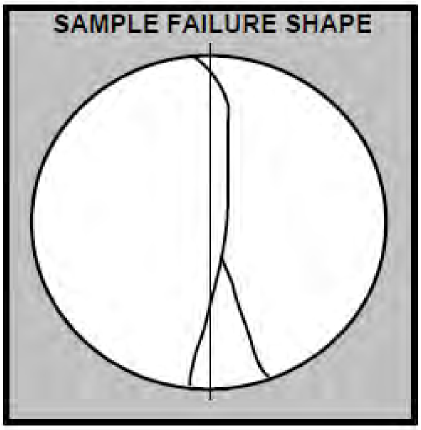




Test Notes:

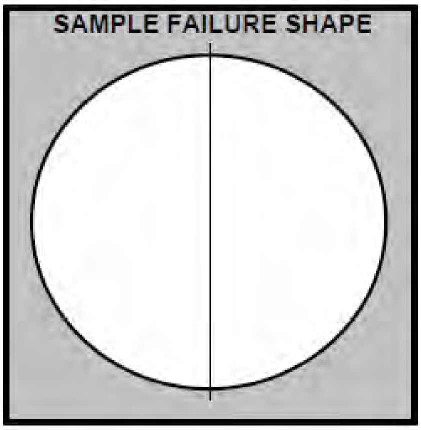
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 18.8MPa and 62.4MPa

BOREHOLE		BH04
CORE RUN		48941
DEPTH		29.38-29.54
SAMPLE DIAMETER	mm	82.10
SAMPLE THICKNESS	mm	38.53
WATER CONTENT	%	0.1
DEGREE OF SATURATION	%	N/A
STRESS RATE	kN/s	1.90
TEST DURATION	secs	16
DATE OF TESTING		21-Jan-16
LOAD FRAME USED		Impact
ORIENTATION OF LOADING		Diam
TENSILE STRENGTH	MPa	5.97



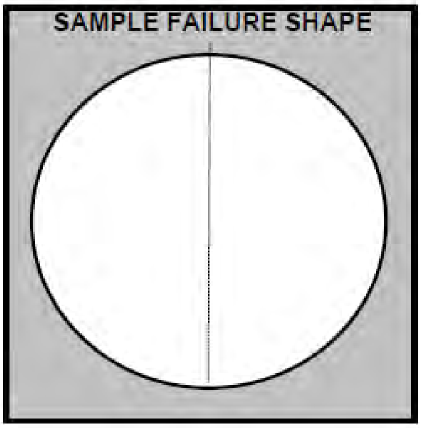
SAMPLE FAILURE SHAPE

BOREHOLE		
CORE RUN		
DEPTH		
SAMPLE DIAMETER	mm	
SAMPLE THICKNESS	mm	
WATER CONTENT	%	
DEGREE OF SATURATION	%	
STRESS RATE	kN/s	
TEST DURATION	secs	
DATE OF TESTING		
LOAD FRAME USED		
ORIENTATION OF LOADING		
TENSILE STRENGTH	MPa	



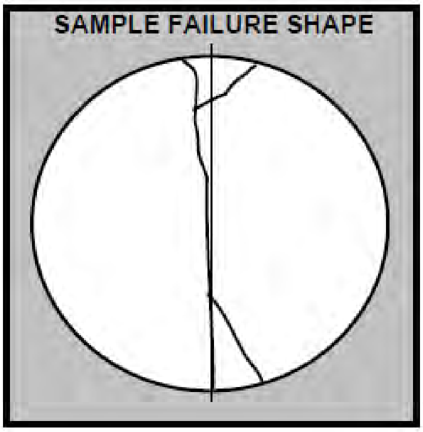
SAMPLE FAILURE SHAPE

BOREHOLE		
CORE RUN		
DEPTH		
SAMPLE DIAMETER	mm	
SAMPLE THICKNESS	mm	
WATER CONTENT	%	
DEGREE OF SATURATION	%	
STRESS RATE	kN/s	
TEST DURATION	secs	
DATE OF TESTING		
LOAD FRAME USED		
ORIENTATION OF LOADING		
TENSILE STRENGTH	MPa	

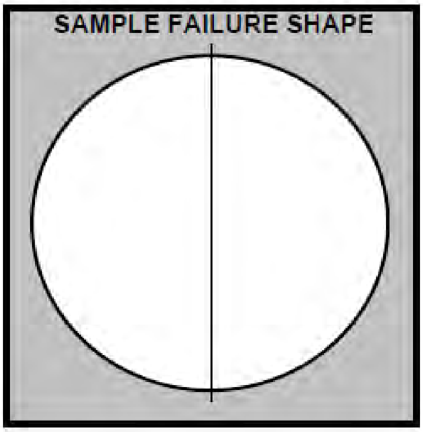


SAMPLE FAILURE SHAPE

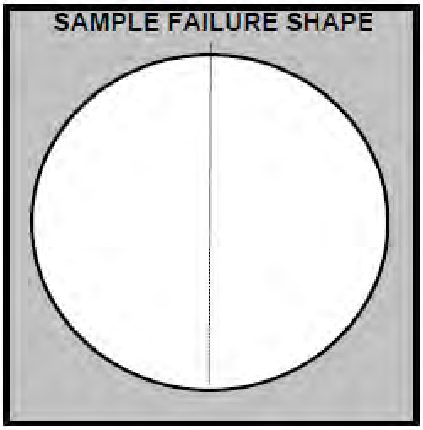
BOREHOLE		BH05
CORE RUN		50701
DEPTH		19.70-19.92
SAMPLE DIAMETER	mm	82.24
SAMPLE THICKNESS	mm	41.12
WATER CONTENT	%	0.2
DEGREE OF SATURATION	%	N/A
STRESS RATE	kN/s	0.80
TEST DURATION	secs	22
DATE OF TESTING		21-Jan-16
LOAD FRAME USED		Impact
ORIENTATION OF LOADING		Diam
TENSILE STRENGTH	MPa	3.39



BOREHOLE		
CORE RUN		
DEPTH		
SAMPLE DIAMETER	mm	
SAMPLE THICKNESS	mm	
WATER CONTENT	%	
DEGREE OF SATURATION	%	
STRESS RATE	kN/s	
TEST DURATION	secs	
DATE OF TESTING		
LOAD FRAME USED		
ORIENTATION OF LOADING		
TENSILE STRENGTH	MPa	



BOREHOLE		
CORE RUN		
DEPTH		
SAMPLE DIAMETER	mm	
SAMPLE THICKNESS	mm	
WATER CONTENT	%	
DEGREE OF SATURATION	%	
STRESS RATE	kN/s	
TEST DURATION	secs	
DATE OF TESTING		
LOAD FRAME USED		
ORIENTATION OF LOADING		
TENSILE STRENGTH	MPa	



Priority Drilling Ltd.
Killimor
Ballinasloe
Co Galway
Ireland
8D23036i

Date: 29th March 2016
Test Report Ref. STR: 447866

LABORATORY TEST REPORT

TEST REQUIREMENTS: Unconfined compressive strength, elastic moduli & indirect tensile strength by Brazil.

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test.:	**18/03/2016**
Sampling Location:	**Various**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Aggregate Type and Nominal Size:	**Rock Testing**
Target Specification:	**N/A**

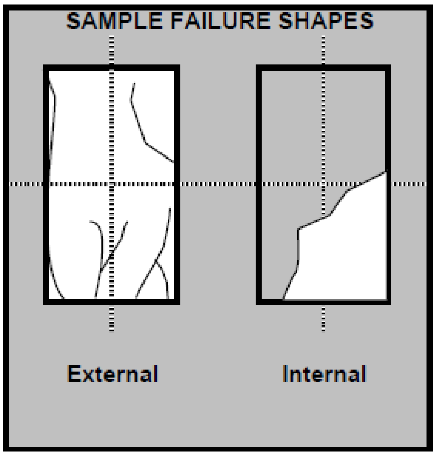
COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

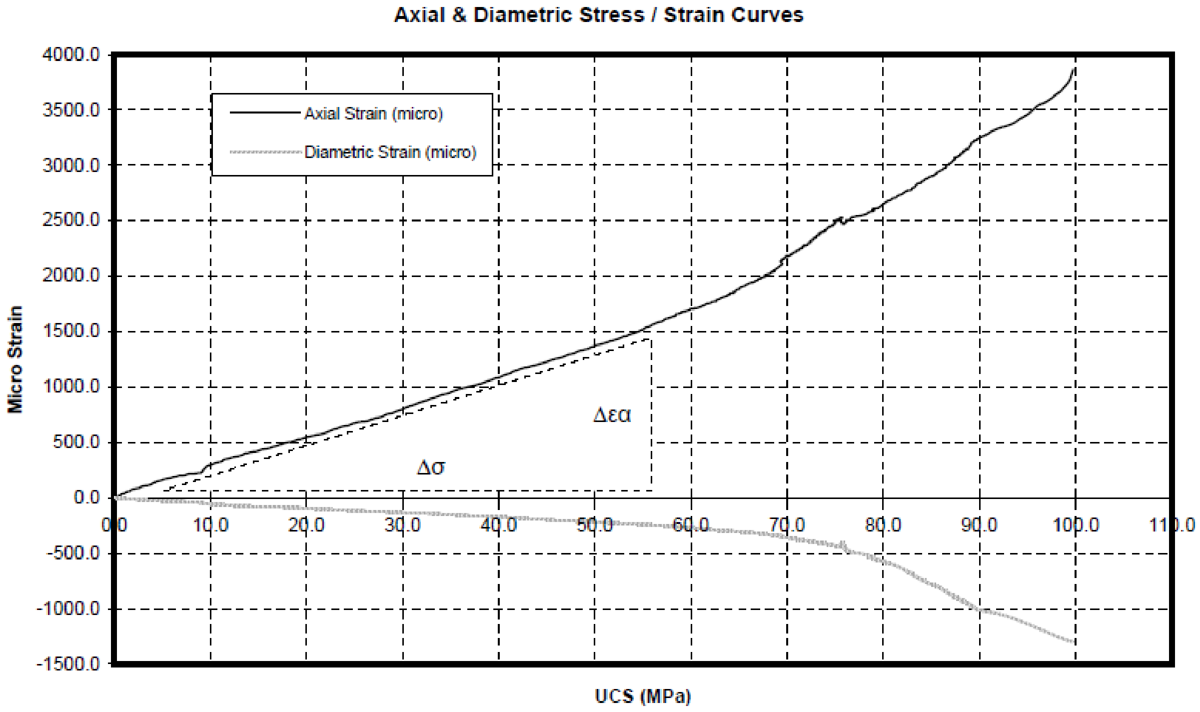
The work was carried out by our competent, sub contracted laboratory.

RESULTS

( ) E. R. Goulden Technical Manager Approved Signatories	( ) E. N. Jones Soils Laboratory Manager	(✓) N Dumbarton Assistant Laboratory Manager

BOREHOLE		BH01
CORE RUN		48867
DEPTH		11.57-11.94
SAMPLE DIAMETER	mm	61.08
SAMPLE HEIGHT	mm	137.42
WATER CONTENT	%	0.2
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.6
TEST DURATION	mm.sec	8.18
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	36.46
POISSON'S RATIO *v*		0.15
UNCONFINED COMPRESSIVE STRENGTH	MPa	99.8





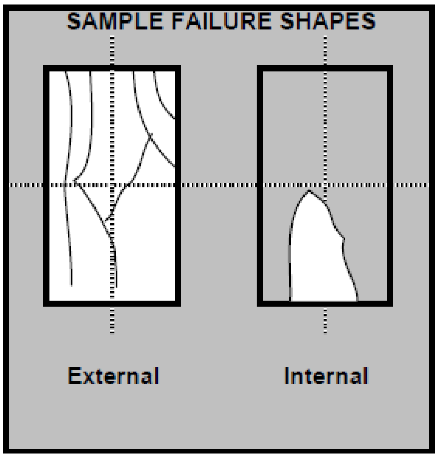
Test Notes:

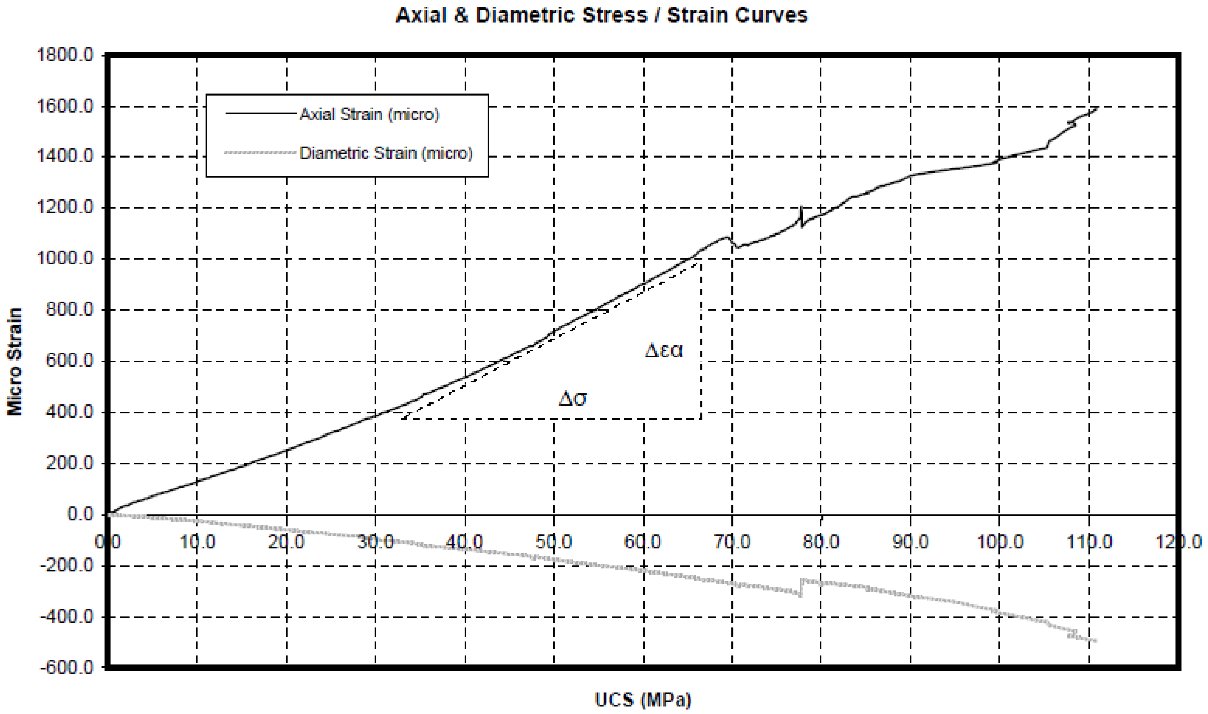
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve

Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve

Young's modulus and poisson's ratio calculated between stress levels of 4.4MPa and 56MPa

BOREHOLE		**BH01**
CORE RUN		**48880**
DEPTH		**27.85-28.15**
SAMPLE DIAMETER	**mm**	**61.32**
SAMPLE HEIGHT	**mm**	**135.90**
WATER CONTENT	**%**	**0.1**
TEST CONDITION		**As Received**
RATE OF LOADING	**kN/s**	**0.7**
TEST DURATION	**mm.sec**	**8.18**
DATE OF TESTING		**22/03/2016**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Perpendicular**
YOUNG'S MODULUS *E* (AVERAGE)	**GPa**	**55.37**
POISSON'S RATIO *v*		**0.23**
UNCONFINED COMPRESSIVE STRENGTH	**MPa**	**112.4**

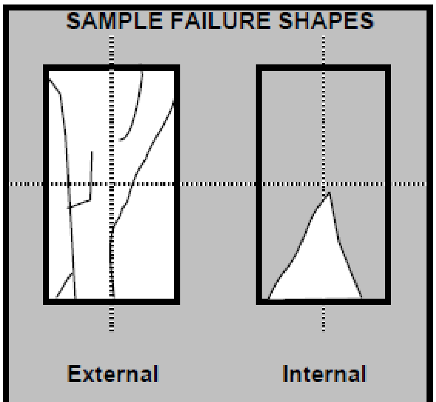




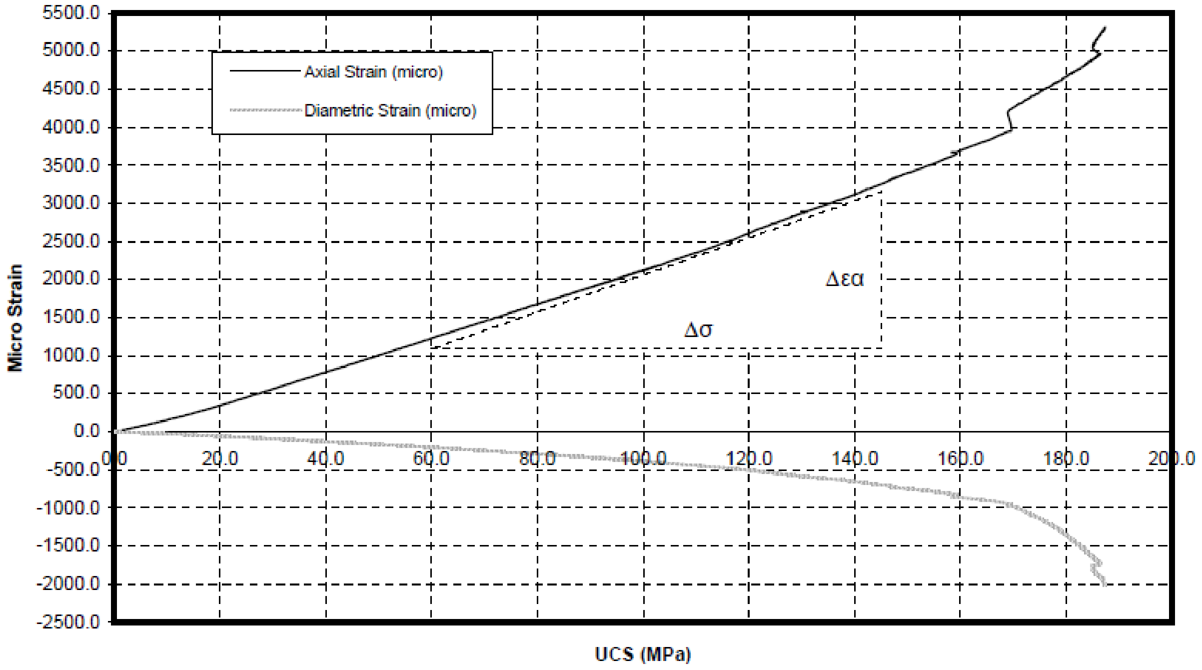
Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 32MPa and 66.7MPa

BOREHOLE		BH01
CORE RUN		48890
DEPTH		48.90-49.16
SAMPLE DIAMETER	mm	61.11
SAMPLE HEIGHT	mm	136.32
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	12.58
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	42.01
POISSON'S RATIO *v*		0.24
UNCONFINED COMPRESSIVE STRENGTH	MPa	187.5

SAMPLE FAILURE SHAPES



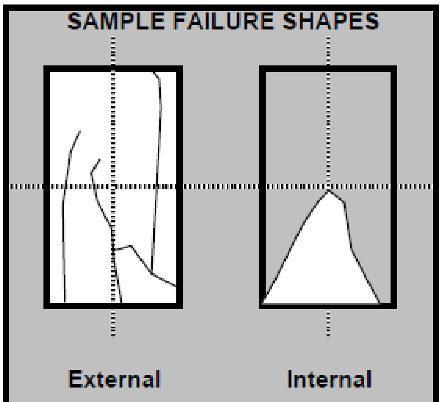
Axial & Diametric Stress / Strain Curves



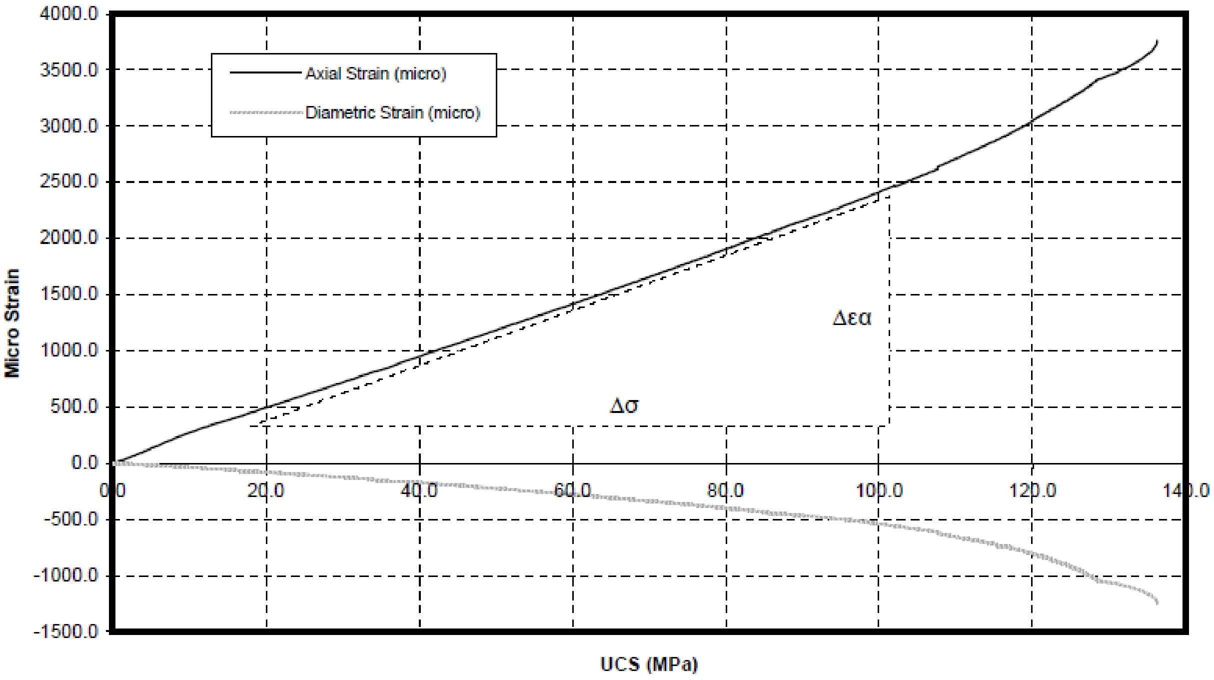
Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 58.6MPa and 145.9MPa

BOREHOLE		BH01
CORE RUN		50869
DEPTH		72.10-72.30
SAMPLE DIAMETER	mm	60.91
SAMPLE HEIGHT	mm	134.09
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.6
TEST DURATION	mm.sec	10.36
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	41.60
POISSON'S RATIO *v*		0.24
UNCONFINED COMPRESSIVE STRENGTH	MPa	136.3

SAMPLE FAILURE SHAPES

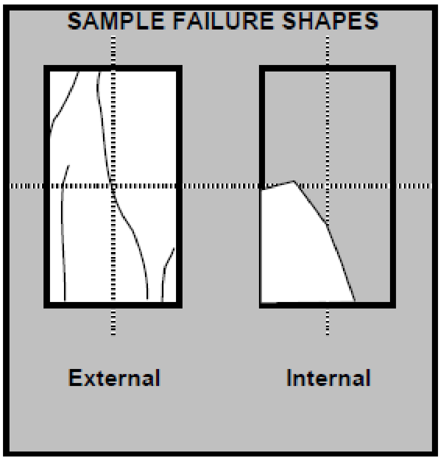


Axial & Diametric Stress / Strain Curves

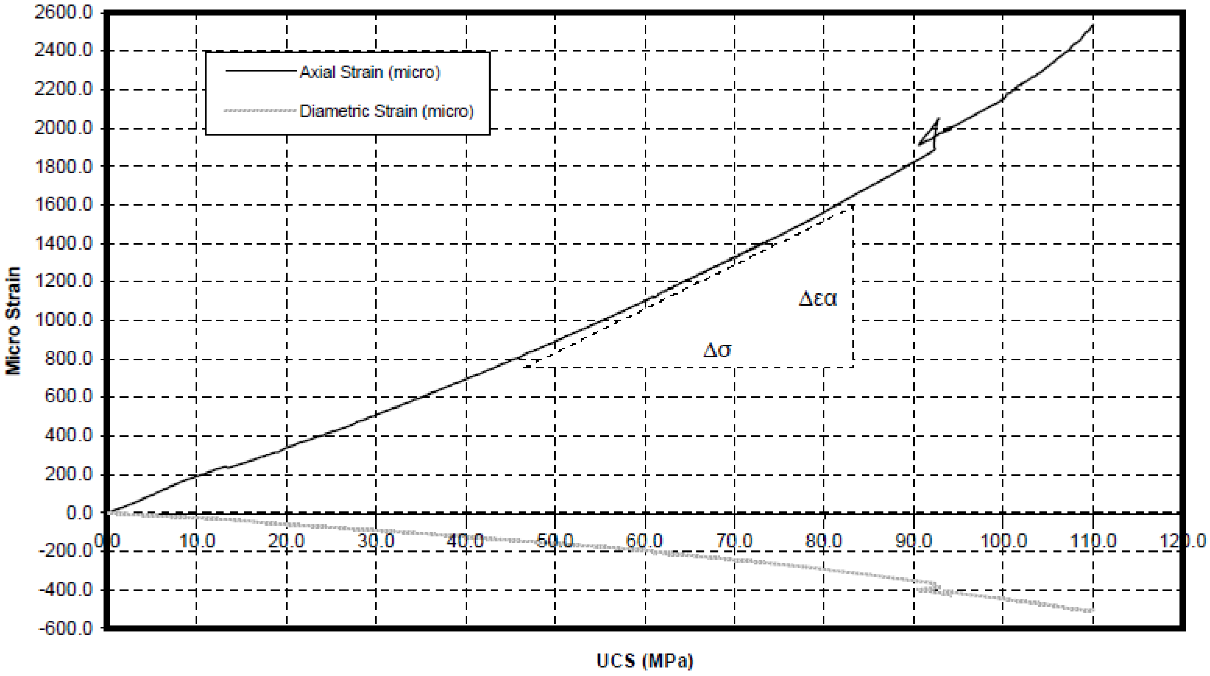


Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 16.8MPa and 102.1MPa

BOREHOLE		BH01
CORE RUN		50890
DEPTH		97.95-98.23
SAMPLE DIAMETER	mm	61.07
SAMPLE HEIGHT	mm	135.52
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	7.5
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	44.43
POISSON'S RATIO *v*		0.20
UNCONFINED COMPRESSIVE STRENGTH	MPa	110.0

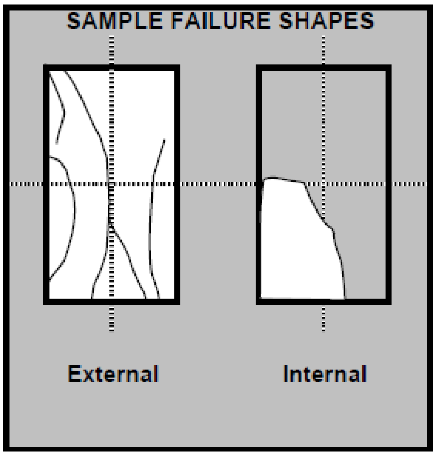


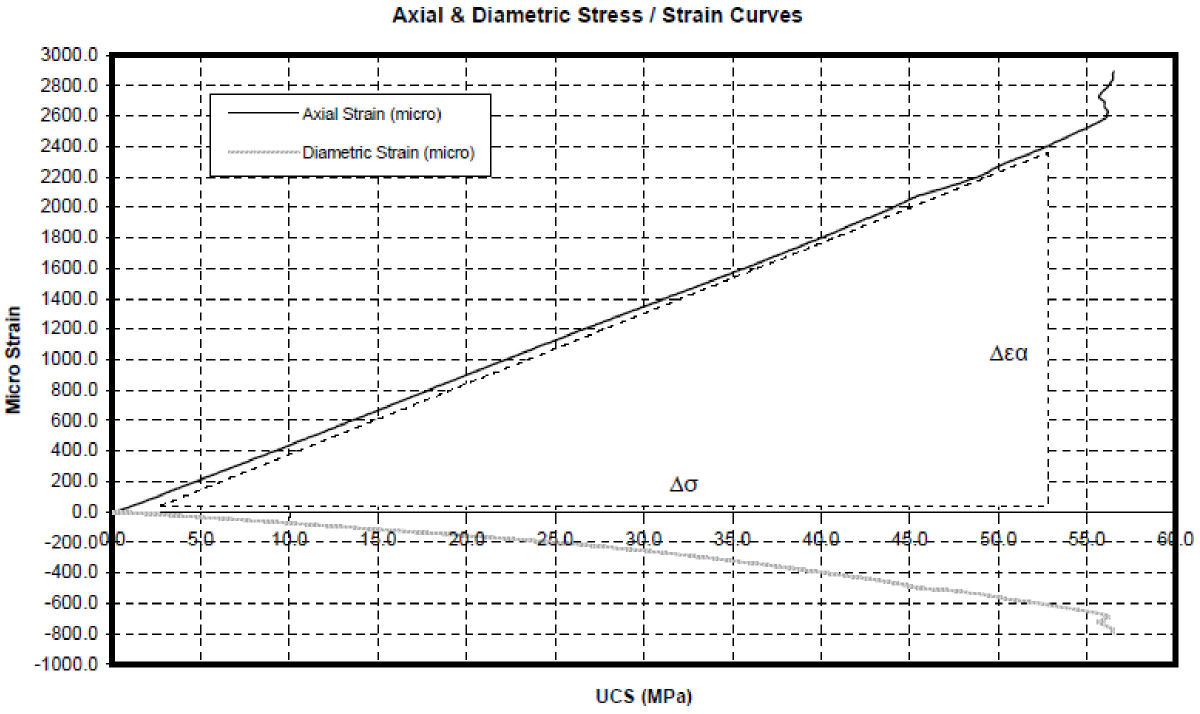
Axial & Diametric Stress / Strain Curves



Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 45.6MPa and 83.4MPa

BOREHOLE		BH01
CORE RUN		50921
DEPTH		140.00-140.20
SAMPLE DIAMETER	mm	61.10
SAMPLE HEIGHT	mm	135.31
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	4.05
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	21.81
POISSON'S RATIO *v*		0.25
UNCONFINED COMPRESSIVE STRENGTH	MPa	58.7

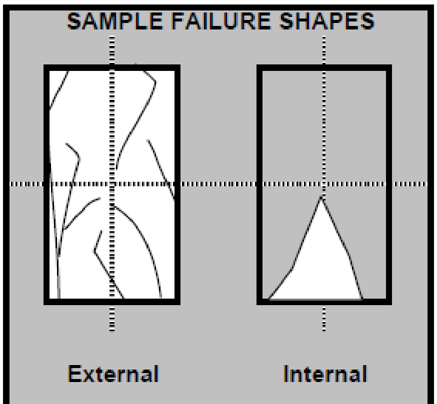




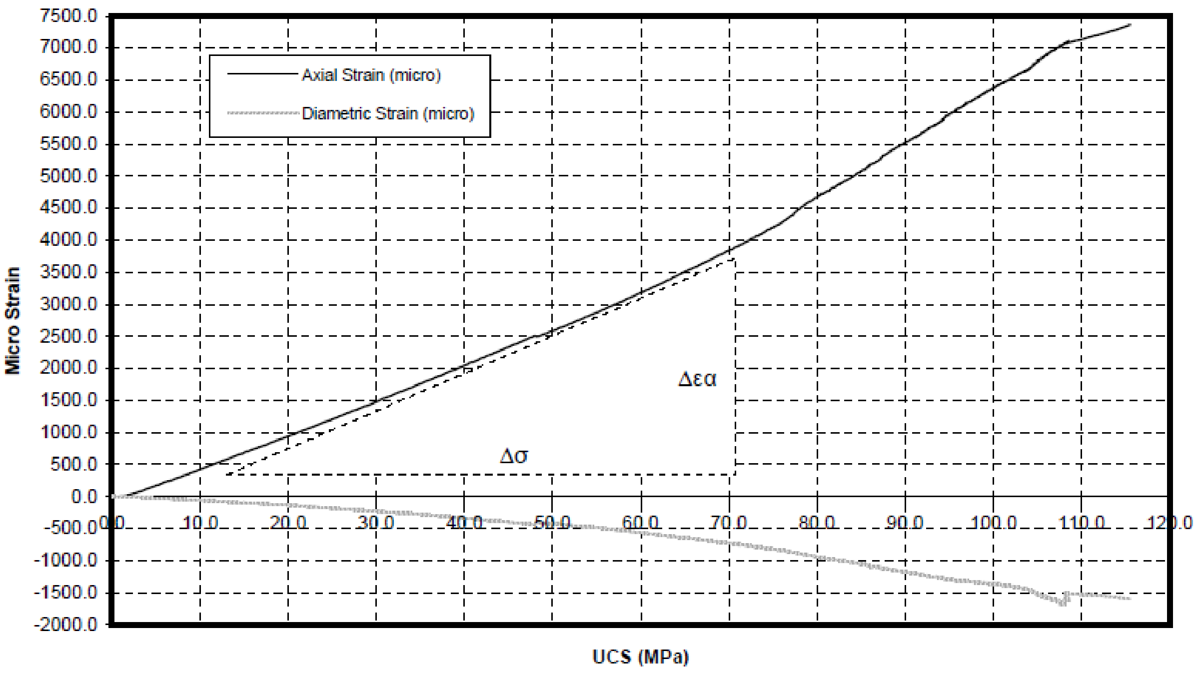
Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 2.3MPa and 53MPa

BOREHOLE		BH01
CORE RUN		50950
DEPTH		183.17-183.40
SAMPLE DIAMETER	mm	61.20
SAMPLE HEIGHT	mm	136.93
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.9
TEST DURATION	mm.sec	6.55
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	17.44
POISSON'S RATIO *v*		0.20
UNCONFINED COMPRESSIVE STRENGTH	MPa	118.6

SAMPLE FAILURE SHAPES



Axial & Diametric Stress / Strain Curves

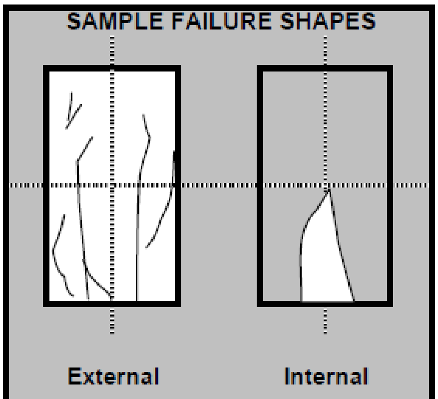


Test Notes:

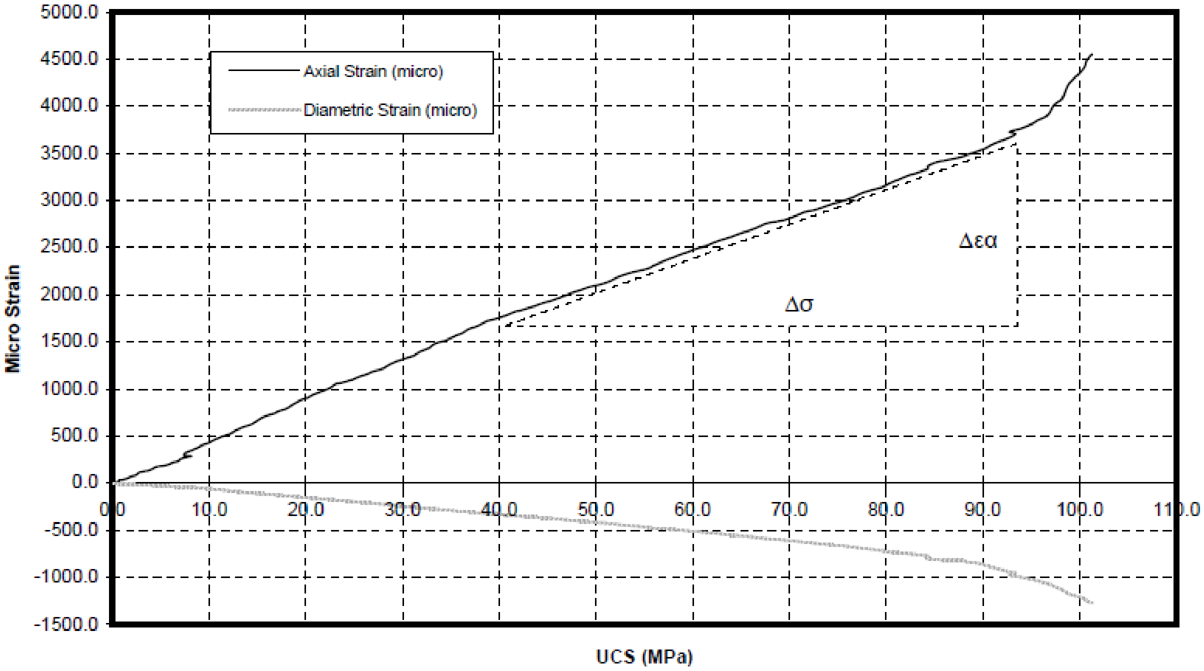
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 12.4MPa and 70.7MPa

BOREHOLE		BH01
CORE RUN		50973
DEPTH		212.33-212.58
SAMPLE DIAMETER	mm	61.08
SAMPLE HEIGHT	mm	136.48
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	7.33
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	26.89
POISSON'S RATIO *v*		0.31
UNCONFINED COMPRESSIVE STRENGTH	MPa	104.7

SAMPLE FAILURE SHAPES



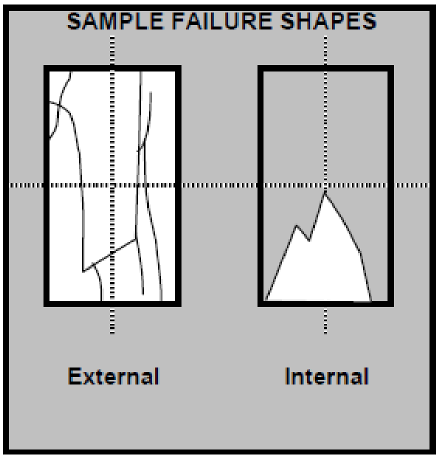
Axial & Diametric Stress / Strain Curves

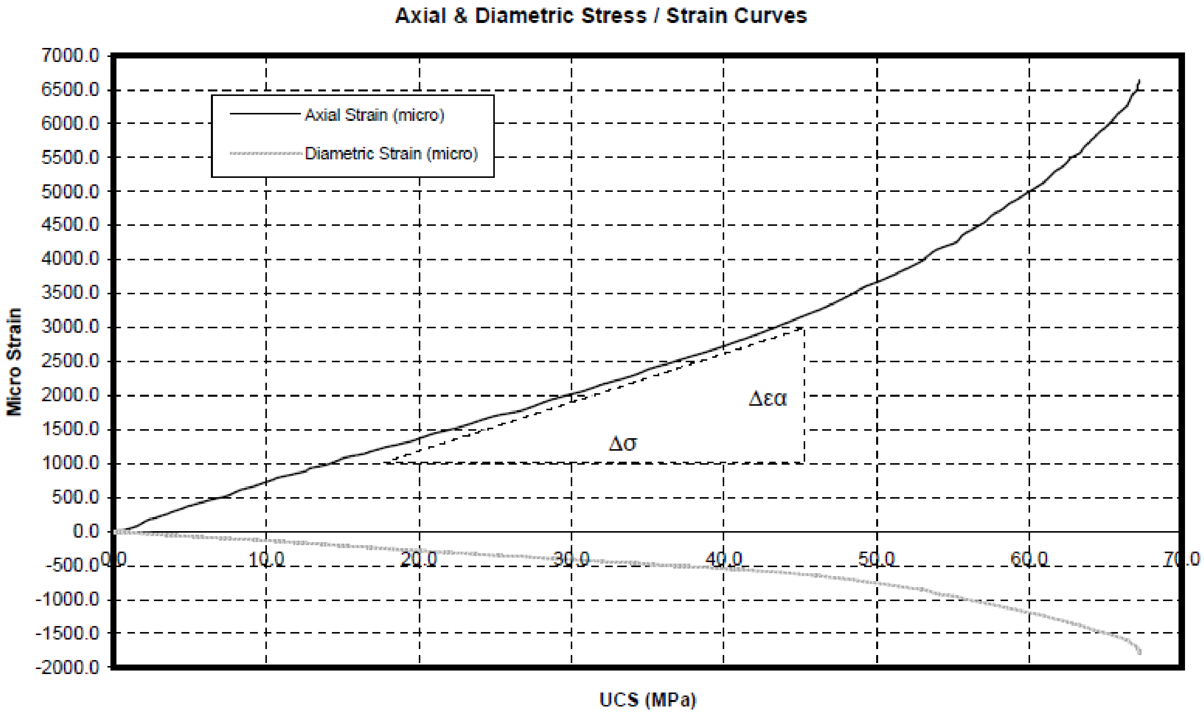


Test Notes:

Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 39.7MPa and 93.4MPa

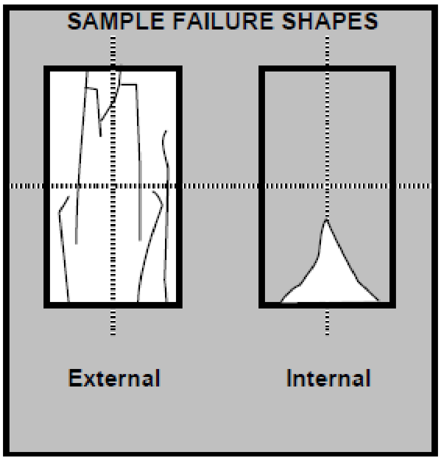
BOREHOLE		BH01
CORE RUN		50988
DEPTH		232.46-232.60
SAMPLE DIAMETER	mm	60.90
SAMPLE HEIGHT	mm	125.20
WATER CONTENT	%	0.2
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.4
TEST DURATION	mm.sec	8.19
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	14.17
POISSON'S RATIO *v*		0.19
UNCONFINED COMPRESSIVE STRENGTH	MPa	69.6

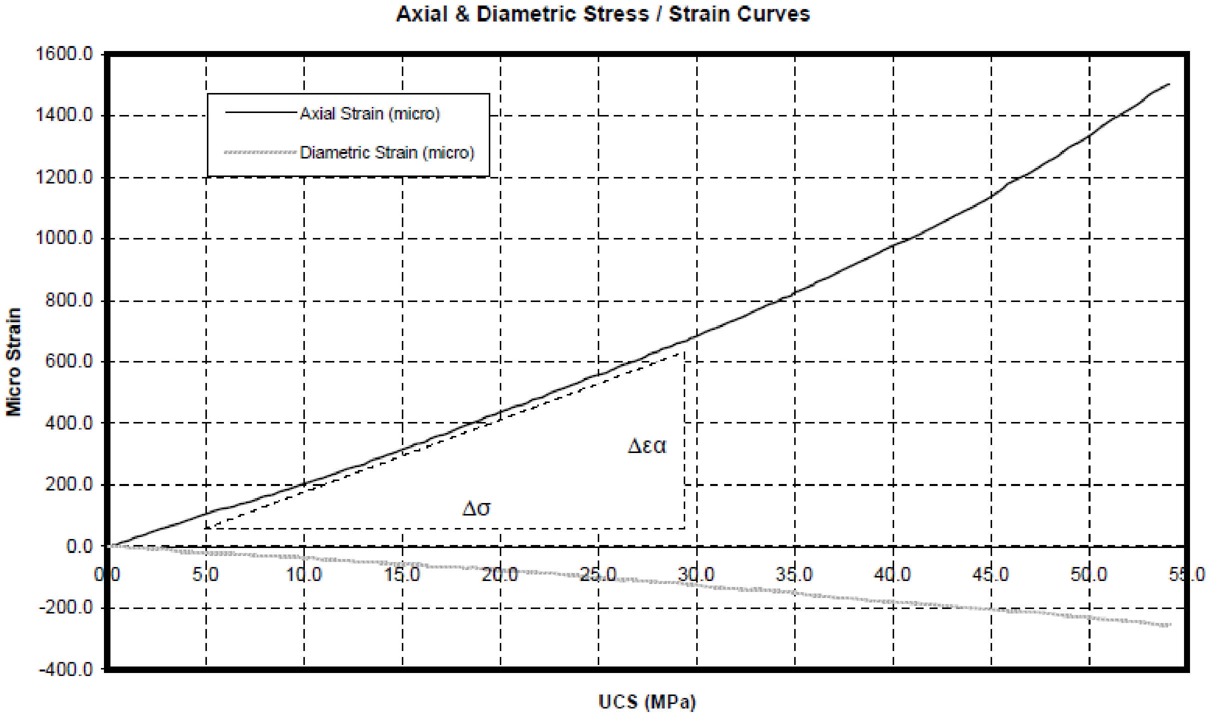




Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 16.8MPa and 45.4MPa

BOREHOLE		BH01
CORE RUN		50996
DEPTH		250.30-250.56
SAMPLE DIAMETER	mm	60.88
SAMPLE HEIGHT	mm	126.80
WATER CONTENT	%	0.1
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.7
TEST DURATION	mm.sec	4.17
DATE OF TESTING		22/03/2016
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
YOUNG'S MODULUS *E* (AVERAGE)	GPa	43.34
POISSON'S RATIO *v*		0.18
UNCONFINED COMPRESSIVE STRENGTH	MPa	56.4

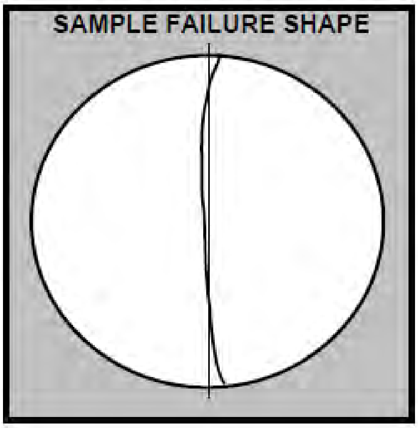




Test Notes:
Method of Young's modulus determination - Average Modulus of Linear Portion of Axial Stress-Strain Curve
Method of Poisson's ratio determination - slope of axial curve / slope of lateral curve
Young's modulus and poisson's ratio calculated between stress levels of 5MPa and 29MPa

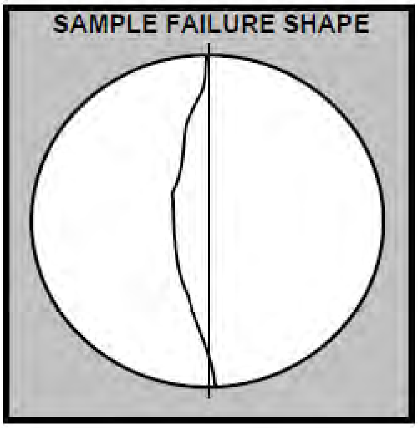
BOREHOLE		BH01
CORE RUN		50858
DEPTH		64.20-64.50
SAMPLE DIAMETER	mm	60.97
SAMPLE THICKNESS	mm	30.76
WATER CONTENT	%	0.3
DEGREE OF SATURATION	%	N/A
STRESS RATE	kN/s	1.10
TEST DURATION	secs	20
DATE OF TESTING		21-Mar-16
LOAD FRAME USED		2000kN
ORIENTATION OF LOADING		Diam
TENSILE STRENGTH	MPa	7.80

SAMPLE FAILURE SHAPE



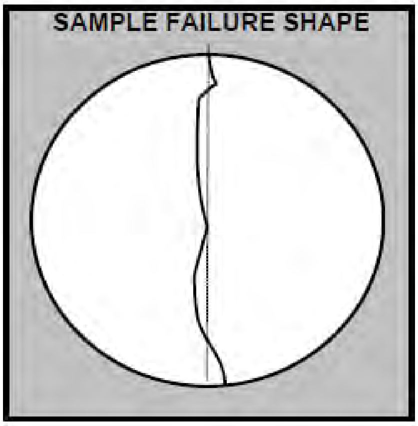
BOREHOLE		BH01
CORE RUN		50892
DEPTH		102.90-103.20
SAMPLE DIAMETER	mm	61.19
SAMPLE THICKNESS	mm	30.52
WATER CONTENT	%	0.1
DEGREE OF SATURATION	%	N/A
STRESS RATE	kN/s	1.50
TEST DURATION	secs	24
DATE OF TESTING		21-Mar-16
LOAD FRAME USED		2000kN
ORIENTATION OF LOADING		Diam
TENSILE STRENGTH	MPa	12.60

SAMPLE FAILURE SHAPE



BOREHOLE		BH01
CORE RUN		50948
DEPTH		180.24-180.50
SAMPLE DIAMETER	mm	61.51
SAMPLE THICKNESS	mm	30.46
WATER CONTENT	%	3.9
DEGREE OF SATURATION	%	N/A
STRESS RATE	kN/s	1.7
TEST DURATION	secs	26
DATE OF TESTING		21-Mar-16
LOAD FRAME USED		2000kN
ORIENTATION OF LOADING		Diam
TENSILE STRENGTH	MPa	14.60

SAMPLE FAILURE SHAPE



Frost Heave

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 448032

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Frost Heave of Unbound Aggregate in accordance with **BS 812: Part 124: 2009 - Annex B (Use of Comparator Specimens)**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Bulk Samples**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**24/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification	**SHW Series 800: clause 801.8**

RESULTS:

Were any unrepresentative lumps present? No

Frost Heave Test Result:

Maximum Heave Observed in 96 hours (mm)		
Comparator Specimen 1	11.5	(nearest 0.5mm)
Comparator Specimen 2	12.0	(nearest 0.5mm)
Comparator Specimen 3	12.0	(nearest 0.5mm)
Mean	**11.8**	(nearest 0.1mm)
Test Specimen 1	3.5	(nearest 0.5mm)
Test Specimen 2	2.0	(nearest 0.5mm)
Test Specimen 3	4.5	(nearest 0.5mm)
Mean Frost Heave	**3.3**	**(nearest 0.1mm)**

In accordance with SHW Series 800: clause 801.8 the sample is classified as being
Non Frost Susceptible (mean frost heave ≤ 15mm)

UKAS TESTING 0494

Test Report Ref: STR 448032 Page 2 of 2

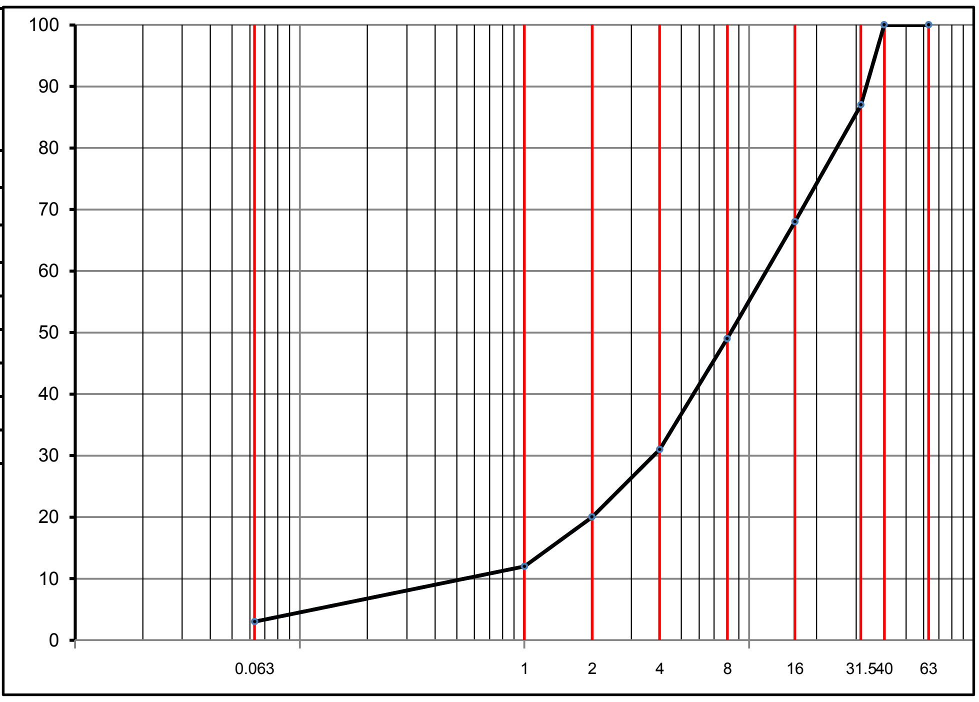
RESULTS CONTINUED:

Laboratory Dry Density & Water Content Test Result

Maximum Dry Density	**2.18 Mg/m3**
Optimum Water Content	**6.5 %**
Actual Dry Density	**2.18 Mg/m3**
Actual Water Content	**6.5 %**

Particle Size Distribution Test Result

BS Test Sieve Nominal Apperature	As Received Test Portion % Passing	Stable Test Portion % Passing
63.0 mm	100	100
40.0 mm	100	100
31.5 mm	87	87
16.0 mm	68	68
8.0 mm	49	49
4.0 mm	31	31
2.0 mm	20	20
1.0 mm	12	12
0.063 mm	3	3



Comments

None

Certificate
Prepared by:-

Mathew Sayer
Assistant Laboratory Manager

Approved by: -

Eric Goulden
Technical Manager

Los Angeles Coefficient

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448029

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Fragmentation of Aggregate - Los Angeles Test Method in accordance with **BS EN 1097-2: 2010**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Bulk Sample**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**21/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification:	**N/A**

RESULTS:

Size fraction from which the test portion was obtained: **14mm to 12.5mm**
12.5mm to 10.0mm

Los Angeles Coefficient (LA) = 28

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Magnesium Sulphate Soundness

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448030

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Magnesium Sulfate Value of aggregate sample within the size range 10mm to 14mm in accordance with **BS EN 1367-2 : 2009**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**Bulk Sample**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**26/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification:	**N/A**

RESULTS:

Magnesium Sulfate Value Portion 1 (MS_1) =	**0.6**
Magnesium Sulfate Value Portion 2 (MS_2) =	**0.3**
Mean Magnesium Sulfate Value (MS) =	**1**

Comments

Proportion by mass of laboratory sample used for the test portion = 5% (nearest 5%)

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Moisture Content

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447817

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48861**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:6.70 Depth Base:6.80**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.2**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
EGoulden
Eric Goulden
Technical Manager

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Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447830

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48868**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:13.26 Depth Base:13.35**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = 1.6

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447843

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48881**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:32.65 Depth Base:32.72**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.4**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

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Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447861

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48897**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:57.30 Depth Base:57.40**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.1**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447862

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48898**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:61.65 Depth Base:61.75**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.2**

Comments

None

Certificate Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447873

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50865**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **17/02/2016**
Sampling Location: **Depth Top:67.07 Depth Base:67.20**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **1.1**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

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Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447876

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50868**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:70.10 Depth Base:70.20**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447878

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50870**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:73.03 Depth Base:73.10**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.6**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447879

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50871**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:76.00 Depth Base:76.09**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.2**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Priority Construction Ltd	Date: 24 February 2016
162 Clontarf Road	Test Report Ref: STR 447883

Dublin 3
Ireland
VAT No: 9D53971I

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50875**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:80.04 Depth Base:80.12**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.2**

Comments

None

Certificate Prepared by:-	Approved by: - EGoulden
Mathew Sayer	Eric Goulden
Assistant Laboratory Manager	Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447884

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50876**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:81.70 Depth Base:81.78**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.6**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447885

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50877**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:87.50 Depth Base:87.57**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = 1.8

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447886

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50878**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:39.70 Depth Base:39.80**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

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Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447890

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50882**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:91.63 Depth Base:91.71**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.8**

Comments

None

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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Priority Construction Ltd
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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447894

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50886**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **17/02/2016**
Sampling Location: **Depth Top:93.00 Depth Base:93.10**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **1.5**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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Priority Construction Ltd
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Date: 24 February 2016
Test Report Ref: STR 447897

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50889**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:94.96 Depth Base:95.05**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments
None

Certificate
Prepared by:-
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Approved by: - EGoulden
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Date: 24 February 2016
Test Report Ref: STR 447899

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50891**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:101.36 Depth Base:101.45**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.6**

Comments

None

Certificate
Prepared by:-
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Approved by: -
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Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447904

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50896**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:108.62 Depth Base:108.70**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.2**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447908

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50900**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:113.12 Depth Base:113.19**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = 1.5

Comments

None

Certificate
Prepared by:-
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Approved by: -
Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447912

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50904**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:118.82 Depth Base:118.88**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.9**

Comments

None

Certificate
Prepared by:-
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Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447908

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50900**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:113.12 Depth Base:113.19**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**1.5**

Comments

None

Certificate
Prepared by:-
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Approved by: -
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Date: 24 February 2016
Test Report Ref: STR 447912

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50904**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:118.82 Depth Base:118.88**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**1.9**

Comments

None

Certificate
Prepared by:-
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Approved by: -
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Technical Manager

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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447913

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50905**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:123.44 Depth Base:123.55**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **2.2**

Comments

None

Certificate
Prepared by:-
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Approved by: -
Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447914

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50906**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:125.90 Depth Base:126.00**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447915

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50907**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:126.80 Depth Base:126.90**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**2.5**

Comments

None

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: - EGoulden
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Priority Construction Ltd
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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447919

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50911**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:131.12 Depth Base:131.17**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **2.6**

Comments

None

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447920

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50912**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:131.60 Depth Base:131.70**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.2**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
Eric Goulden
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Priority Construction Ltd
162 Clontarf Road

Dublin 3
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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447921

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50913**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:132.65 Depth Base:132.62**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.8**

Comments

None

Certificate
Prepared by:-
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Approved by: -
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Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447925

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50917**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:134.35 Depth Base:134.44**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.1**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447930

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50922**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:142.81 Depth Base:142.91**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447940

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50931**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:154.60 Depth Base:154.68**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.4**

Comments

None

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: -
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Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447941

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50932**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:155.20 Depth Base:155.28**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = 1.7

Comments
None

Certificate
Prepared by:-
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Approved by: - EGoulden
Eric Goulden
Technical Manager

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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447945

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50936**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:163.49 Depth Base:163.56**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **2.5**

Comments

None

Certificate Prepared by:-
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Approved by: - EGoulden
Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447949

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50940**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:172.96 Depth Base:173.07**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: -
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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447949

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50940**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:172.96 Depth Base:173.07**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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Date: 24 February 2016
Test Report Ref: STR 447957

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50947**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:176.00 Depth Base:176.10**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**1.2**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
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Technical Manager

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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447964

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50954**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **17/02/2016**
Sampling Location: **Depth Top:196.19 Depth Base:186.25**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **1.8**

Comments

None

Certificate Prepared by:-
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Approved by: -
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Date: 24 February 2016
Test Report Ref: STR 447975

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50965**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:209.65 Depth Base:209.72**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.7**

Comments

None

Certificate
Prepared by:-
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Approved by: -
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Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447979

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50969**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:211.10 Depth Base:211.20**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**1.4**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447985

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50975**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **17/02/2016**
Sampling Location: **Depth Top:218.20 Depth Base:218.28**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = 1.5

Comments

None

Certificate
Prepared by:-
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VAT No: 9D53971I

Date: 24 February 2016
Test Report Ref: STR 447986

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50976**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:222.52 Depth Base:222.62**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.0**

Comments

None

Certificate
Prepared by:-
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Approved by: -
Eric Goulden
Technical Manager

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Date: 24 February 2016
Test Report Ref: STR 447994

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50984**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:230.13 Depth Base:230.20**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **2.0**

Comments

None

Certificate
Prepared by:-
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Date: 24 February 2016
Test Report Ref: STR 447999

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50989**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **17/02/2016**
Sampling Location: **Depth Top:235.04 Depth Base:235.10**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **1.3**

Comments

None

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Date: 16 February 2016
Test Report Ref: STR 443012

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48901**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 3.5 Depth Base: 3.55**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.2**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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Date: 15 February 2016
Test Report Ref: STR 443013

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48902**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 5.4 Depth Base: 5.48**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.6**

Comments

None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443016

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48904**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 9.3 Depth Base: 9.36**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.3**

Comments
None

Certificate
Prepared by:-
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Approved by: -
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Technical Manager

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Date: 15 February 2016
Test Report Ref: STR 443018

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48906**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 11.77 Depth Base: 11.83**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**0.2**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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VAT No: 9D53971I

Date: 21 December 2015
Test Report Ref: STR 443020

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Uniaxial Compressive Strength in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. :	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**08/12/2015**
Sampling Location:	**Various**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See attached

Certificate
Prepared by:-
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Approved by: - EGoulden
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Technical Manager

BH	Core Diameter (mm)	Height/ Diameter Ratio	Uniaxial compressive strength (MPa)	Mode of Failure	EN ISO 14689-1 Term	Water content (%)
BH04 48908	82	2.6:1	**76**	N	Strong	0.1
BH04 48912	82.3	1.9:1	**86**	N	Strong	0.3
BH04 48921	82.3	1.5:1	**55**	N	Strong	0.1
BH04 48927	82.1	1.6:1	**53**	N	Strong	0.2
BH04 48931	82.2	2.6:1	**111**	N	Very Strong	0.1
BH04 48933	82	2.1:1	**91**	N	Strong	0.2
BH04 48950	82	2.5:1	**76**	N	Strong	0.2
BH04 48957	82	2:1	**78**	N	Strong	0.3
BH04 48963	82.2	2.4:1	**92**	N	Strong	0.1
BH05 48982	82	1.8:1	**91**	N	Strong	0.2
BH05 48986	81.5	2.6:1	**86**	N	Strong	0.4
BH05 48991	81.4	2.5:1	**94**	N	Strong	0.1
BH05 48994	82	1.9:1	**72**	N	Strong	0.2
BH05 48998	82.2	2.6:1	**77**	N	Strong	0.2
BH05 50711	78.5	1.8:1	**79**	N	Strong	0.2
BH05 50729	79	2.5:1	**116**	N	Very Strong	0.3
BH05 50731	81.4	2.6:1	**51**	N	Strong	0.1
BH05 50733	81.6	2.1:1	**54**	N	Strong	0.2
BH05 50737	82	1.5:1	**131**	N	Very Strong	0.2

Comments

1) The uniaxial compressive strength was carried out in accordance with ISRM guidelines.
2) Stress Rate: 0.7Mpa/s.

3)

EN ISO 14689-1 : 2003 Rock Strength Terms	
Compressive Strength mpa	Term
<1.0	Extremely Weak
1 to 5	Very Weak
5 to 25	Weak
25 to 50	Meduim Strong
50 to 100	Strong
100 to 250	Very Strong
> 250	Extremely Strong

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Date: 15 February 2016
Test Report Ref: STR 443034

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56158**
Client Ref. No: **BH04 - 48922**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **08/12/2015**
Date of Start of Test: **15/12/2015**
Sampling Location: **Depth Top: 20.8 Depth Base: 20.85**
Name of Source: **Lackagh Quarry SI**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **0.4**

Comments

None

Certificate
Prepared by:-
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Approved by: - EGoulden
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Date: 15 February 2016
Test Report Ref: STR 443036

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48924**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 21.8 Depth Base: 21.9**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **1.0**

Comments

None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443050

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48938**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 28.27 Depth Base: 38.4**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.1**

Comments

None

Certificate
Prepared by:-
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Date: 15 February 2016
Test Report Ref: STR 443067

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48954**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**21/12/2015**
Sampling Location:	**Depth Top: 31.66 Depth Base: 31.7**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

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Date: 15 February 2016
Test Report Ref: STR 443069

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. :	**BH04 - 48956**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**24/12/2015**
Sampling Location:	**Depth Top: 31.84 Depth Base: 31.93**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = 0.04 SO_4

Comments

The work was carried out by our accredited, competent, sub contracted laboratory.

Certificate Prepared by:-
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Approved by: - EGoulden
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Technical Manager

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Date: 15 February 2016
Test Report Ref: STR 443072

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48959**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**22/12/2015**
Sampling Location:	**Depth Top: 32.26 Depth Base: 32.35**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.3**
*95% Confidence limit**	*9.06% - 9.54%*

Comments

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

Certificate
Prepared by:-

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Date: 15 February 2016
Test Report Ref: STR 443081

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48965**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 33.12 Depth Base: 33.16**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**0.1**

Comments

None

Certificate
Prepared by:-
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Date: 15 February 2016
Test Report Ref: STR 443085

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48969**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 34.56 Depth Base: 34.59**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.3**

Comments

None

Certificate
Prepared by:-
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Date: 15 February 2016
Test Report Ref: STR 443086

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48970**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 34.96 Depth Base: 35**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.2**

Comments

None

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: -
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Technical Manager

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VAT No: 9D53971I

Date: 15 February 2016
Test Report Ref: STR 443087

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 48971**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 0.65 Depth Base: 0.73**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.3**

Comments

None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443088

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56158**
Client Ref. No: **BH05 - 48972**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **08/12/2015**
Date of Start of Test: **15/12/2015**
Sampling Location: **Depth Top: 0.98 Depth Base: 1.04**
Name of Source: **Lackagh Quarry SI**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = 0.1

Comments

None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443089

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56158**
Client Ref. No: **BH05 - 48973**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **08/12/2015**
Date of Start of Test: **15/12/2015**
Sampling Location: **Depth Top: 1.41 Depth Base: 1.5**
Name of Source: **Lackagh Quarry SI**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **0.1**

Comments

None

Certificate
Prepared by:-
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Approved by: -
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Date: 15 February 2016
Test Report Ref: STR 443096

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 48980**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 8.9 Depth Base: 8.96**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**0.1**

Comments

None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443104

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56158**
Client Ref. No: **BH05 - 48988**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **08/12/2015**
Date of Start of Test: **15/12/2015**
Sampling Location: **Depth Top: 12.92 Depth Base: 13.07**
Name of Source: **Lackagh Quarry SI**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Core**
Target Specification: **N/A**

RESULTS:

Water Content (%) = **0.3**

Comments

None

Certificate
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Approved by: -
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Date: 15 February 2016
Test Report Ref: STR 443128

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50712**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 28.75 Depth Base: 28.85**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**0.1**

Comments

None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443132

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. :	**BH05 - 50716**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**24/12/2015**
Sampling Location:	**Depth Top: 29.18 Depth Base: 29.3**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = <0.01 SO_4

Comments

The work was carried out by our accredited, competent, sub contracted laboratory.

Certificate
Prepared by:-
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Approved by: -
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Date: 15 February 2016
Test Report Ref: STR 443133

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50717**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**22/12/2015**
Sampling Location:	**Depth Top: 29.3 Depth Base: 29.4**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.2**
*95% Confidence limit**	*8.96% - 9.44%*

Comments

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

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Date: 15 February 2016
Test Report Ref: STR 443134

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50718**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 30.3 Depth Base: 30.4**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.4**

Comments

None

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Date: 15 February 2016
Test Report Ref: STR 443137

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50721**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 30.88 Depth Base: 30.92**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) =	**0.3**

Comments
None

Certificate
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Date: 15 February 2016
Test Report Ref: STR 443142

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS To determine the Water Content of aggregates by – drying in a ventilated oven according to **BS EN 1097-5: 2008**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50726**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**15/12/2015**
Sampling Location:	**Depth Top: 32.54 Depth Base: 32.6**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Water Content (%) = **0.2**

Comments

None

Certificate
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Oxidisable Sulphur

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VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447856

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**BH01 - 48892**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:55.30 Depth Base:55.40**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = <0.01 SO_4

Comments

The work was carried out by our accredited, competent, sub contracted laboratory.

Certificate
Prepared by:-
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Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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Date: 16 March 2016
Test Report Ref: STR 447895

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**BH01 - 50887**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:94.90 Depth Base:94.96**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = **<0.01 SO_4**

Comments

The work was carried out by our accredited, competent, sub contracted laboratory.

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Date: 16 March 2016
Test Report Ref: STR 447938

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**BH01 - 50930**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:153.20 Depth Base:153.30**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = <0.01 SO_4

Comments

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Date: 16 March 2016
Test Report Ref: STR 447971

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**BH01 - 50961**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:201.47 Depth Base:201.55**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = <0.01 SO_4

Comments

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Date: 16 March 2016
Test Report Ref: STR 448010

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**BH01 - 51000**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:253.30 Depth Base:253.38**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = <0.01 SO_4

Comments

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Date: 15 February 2016
Test Report Ref: STR 443069

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. :	**BH04 - 48956**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**24/12/2015**
Sampling Location:	**Depth Top: 31.84 Depth Base: 31.93**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = **0.04 SO_4**

Comments

The work was carried out by our accredited, competent, sub contracted laboratory.

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Approved by: - EGoulden
Eric Goulden
Technical Manager

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VAT No: 9D53971I

Date: 15 February 2016
Test Report Ref: STR 443132

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Oxidisable sulphides (OS) content of an Sample by calculation of **TRL Report 447 Test No. 2 and Test No. 4**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. :	**BH05 - 50716**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**24/12/2015**
Sampling Location:	**Depth Top: 29.18 Depth Base: 29.3**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**<0.5 % SO_4 - If deposited within 500mm of Cementitious Materials** **<0.06 % SO_4 - If deposited within 500mm of Metallic Structural Elements**

RESULTS:

Oxidisable Sulphides (OS) (%) = <0.01 SO_4

Comments

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Certificate
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Approved by: -
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Technical Manager

pH Value

Priority Construction Ltd	Date: 16 March 2016
162 Clontarf Road	Test Report Ref: STR 447857

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Ireland
VAT No: 9D53971I

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48893**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**09/02/2016**
Sampling Location:	**Depth Top:55.84 Depth Base:55.92**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.1**
*95% Confidence limit**	*8.86% - 9.34%*

Comments

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

Certificate Prepared by:-
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VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447896

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Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50888**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **09/02/2016**
Sampling Location: **Depth Top:94.96 Depth Base:95.05**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Testing**
Target Specification: **N/A**

RESULTS:

pH Value = **9.2**
*95% Confidence limit** *8.96% - 9.44%*

Comments

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

Certificate
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Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447928

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50920**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**09/02/2016**
Sampling Location:	**Depth Top:138.60 Depth Base:138.72**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.2**
*95% Confidence limit**	*8.96% - 9.44%*

Comments

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447959

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50949**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**09/02/2016**
Sampling Location:	**Depth Top:182.12 Depth Base:182.20**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.3**
*95% Confidence limit**	*9.06% - 9.54%*

Comments

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447984

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50974**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**09/02/2016**
Sampling Location:	**Depth Top:213.80 Depth Base:213.90**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.1**
*95% Confidence limit**	*8.86% - 9.34%*

Comments

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

Certificate Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 15 February 2016
Test Report Ref: STR 443072

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48959**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**22/12/2015**
Sampling Location:	**Depth Top: 32.26 Depth Base: 32.35**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.3**
*95% Confidence limit**	*9.06% - 9.54%*

Comments

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 15 February 2016
Test Report Ref: STR 443133

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the pH Value of Soils in accordance with **BS 1377:Part 3:1990 - Clause 9, Electrometric Method.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50717**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**22/12/2015**
Sampling Location:	**Depth Top: 29.3 Depth Base: 29.4**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

pH Value =	**9.2**
*95% Confidence limit**	*8.96% - 9.44%*

Comments

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

Certificate Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Point Load Testing

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443019

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48907**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 12.62 Depth Base: 12.75**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443019 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48907

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	112	20.0	8960	11408	1.75	1.41	2.47	59.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**59.2**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443021

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48909**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 13.1 Depth Base: 13.25**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443021 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH04 48909

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	130	20.0	10400	13242	1.51	1.46	2.20	52.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**52.7**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443023

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48911**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 14.63 Depth Base: 14.74**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443023 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48911

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	105	15.8	8400	10695	1.48	1.39	2.05	49.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**49.2**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443025

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48913**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 14.97 Depth Base: 15.13**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443025 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48913

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	125	22.1	10000	12732	1.74	1.44	2.50	60.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**60.1**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443027

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48915**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 17.74 Depth Base: 17.86**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443027 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48915

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	135	23.5	10800	13751	1.71	1.47	2.51	60.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**60.2**

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Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443029

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No.: **S56158**
Client Ref. No.: **BH04 - 48917**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab.: **08/12/2015**
Date of Start of Test.: **8/12/2015**
Sampling Location: **Depth Top: 18.12 Depth Base: 18.2**
Name of Source: **Lackagh Quarry SI**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Core**
Target Specification: **N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443029 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48917

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	85	15.4	6800	8658	1.78	1.32	2.35	56.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**56.5**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443030

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48918**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 19.2 Depth Base: 19.32**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443030 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48918

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	120	13.0	9600	12223	1.06	1.43	1.52	36.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**36.5**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443032

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48920**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 20.12 Depth Base: 20.22**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443032 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48920

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	98	22.5	7840	9982	2.25	1.37	3.08	73.9
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**73.9**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443035

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48923**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 21.2 Depth Base: 21.3**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443035 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH04 48923

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	87	19.0	6960	8862	2.14	1.33	2.85	68.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**68.4**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443037

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48925**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 22.2 Depth Base: 22.31**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443037 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48925

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	27.9	8000	10186	2.74	1.37	3.76	90.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**90.2**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443038

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48926**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 22.6 Depth Base: 22.78**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443038 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48926

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	142	24.4	11360	14464	1.69	1.48	2.50	60.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**60.1**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443040

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48928**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 23.1 Depth Base: 23.2**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443040 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48928

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	20.0	8000	10186	1.96	1.37	2.69	64.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**64.6**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443042

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48930**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 23.7 Depth Base: 23.8**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443042 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48930

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	95	23.1	7600	9677	2.39	1.36	3.24	77.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**77.7**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443044

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48932**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 24.17 Depth Base: 24.28**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443044 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48932

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	22.9	8000	10186	2.25	1.37	3.08	74.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**74.0**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443047

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48934**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 25.08 Depth Base: 25.19**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443047 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48934

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	111	26.0	8880	11306	2.30	1.40	3.23	77.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**77.5**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443049

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48937**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 27.91 Depth Base: 28**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443049 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48937

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	86	24.6	6880	8760	2.81	1.33	3.72	89.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**89.4**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443051

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48939**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 28.4 Depth Base: 28.44**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443051 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH04 48939

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	104	21.8	8320	10593	2.06	1.38	2.85	68.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**68.3**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443051

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48939**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 28.4 Depth Base: 28.44**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443051 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH04 48939

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	104	21.8	8320	10593	2.06	1.38	2.85	68.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**68.3**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443054

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48943**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 29.86 Depth Base: 29.94**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443054 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH04 48943

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		80	40	14.0	3200	4074	3.44	1.12	3.84	92.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**92.0**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443062

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48949**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 30.93 Depth Base: 30.03**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443062 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48949

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	85	20.9	6800	8658	2.41	1.32	3.19	76.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**76.6**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443064

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48951**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 31.3 Depth Base: 31.4**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443064 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48951

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	112	22.9	8960	11408	2.01	1.41	2.82	67.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**67.8**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443068

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48955**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 31.76 Depth Base: 31.84**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443068 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48955

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	90	17.0	7200	9167	1.85	1.34	2.48	59.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**59.6**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443071

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48958**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 32.15 Depth Base: 32.26**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443071 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48958

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		59	125	16.1	7375	9390	1.71	1.35	2.31	55.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**55.4**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443075

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48962**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 32.5 Depth Base: 32.57**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443075 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48962

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		68	75	17.2	5100	6494	2.65	1.24	3.28	78.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**78.8**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443077

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48964**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 32.85 Depth Base: 32.96**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443077 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48964

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		65	90	15.9	5850	7448	2.13	1.28	2.73	65.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**65.5**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443083

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH04 - 48967**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 33.48 Depth Base: 33.6**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443083 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH04 48967

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	115	17.2	9200	11714	1.47	1.42	2.08	49.9
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**49.9**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443091

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48975**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 2.8 Depth Base: 2.96**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443091 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48975

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	170	13.0	13600	17316	0.75	1.55	1.16	27.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**27.8**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443093

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48977**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 7.73 Depth Base: 7.84**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443093 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48977

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	110	21.0	8800	11205	1.87	1.40	2.63	63.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**63.0**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443094

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48978**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 8.1 Depth Base: 8.25**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443094 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48978

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	160	19.5	12800	16297	1.20	1.52	1.82	43.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**43.8**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443095

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48979**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 8.54 Depth Base: 8.66**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443095 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48979

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	120	22.1	9600	12223	1.81	1.43	2.58	62.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**62.0**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443097

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48981**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 9.46 Depth Base: 9.57**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443097 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48981

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	28.3	8000	10186	2.78	1.37	3.81	91.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**91.5**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443099

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48983**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 9.77 Depth Base: 9.92**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443099 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48983

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	126	20.5	10080	12834	1.60	1.44	2.31	55.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**55.4**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443100

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48984**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 10.2 Depth Base: 10.26**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443100 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48984

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		80	48	17.7	3840	4889	3.62	1.16	4.21	101.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**101.0**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443101

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48985**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 11.3 Depth Base: 11.45**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443101 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48985

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	146	17.9	11680	14871	1.20	1.49	1.80	43.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**43.1**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443103

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48987**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 11.72 Depth Base: 11.83**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443103 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48987

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	23.9	8000	10186	2.35	1.37	3.22	77.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**77.2**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443105

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48989**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 13.5 Depth Base: 13.6**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443105 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48989

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		80	43	22.7	3440	4380	5.18	1.13	5.88	141.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**141.1**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443106

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48990**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 13.7 Depth Base: 13.81**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443106 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48990

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	108	22.1	8640	11001	2.01	1.40	2.80	67.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**67.3**

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443108

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48992**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 14.07 Depth Base: 14.15**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443108 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH05 48992

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		80	70	19.8	5600	7130	2.78	1.27	3.52	84.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**84.4**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443109

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48993**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 14.27 Depth Base: 14.4**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443109 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48993

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	95	22.0	7600	9677	2.27	1.36	3.08	74.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**74.0**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443111

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48995**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 15.43 Depth Base: 15.55**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443111 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH05 48995

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	80	21.3	6400	8149	2.61	1.30	3.41	81.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**81.8**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443113

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 48997**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 16.45 Depth Base: 16.55**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443113 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 48997

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	95	20.0	7600	9677	2.07	1.36	2.80	67.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**67.3**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443119

Page 1 of 2

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50703**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 22.07 Depth Base: 22.21**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443119 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 50703

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	150	23.0	12000	15279	1.51	1.50	2.26	54.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**54.3**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443120

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50704**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 22.9 Depth Base: 23**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443120 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 50704

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		80	55	17.0	4400	5602	3.03	1.20	3.64	87.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**87.3**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443121

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50705**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 23.94 Depth Base: 24.05**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443121 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH05 50705

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	20.8	8000	10186	2.04	1.37	2.80	67.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**67.2**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443123

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50707**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 24.73 Depth Base: 24.85**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443123 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH05 50707

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		75	90	18.0	6750	8594	2.09	1.32	2.77	66.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**66.4**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443125

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50709**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 26 Depth Base: 26.12**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443125 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 50709

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		75	103	23.0	7725	9836	2.34	1.36	3.18	76.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**76.4**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443141

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50725**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 32.44 Depth Base: 32.54**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443141 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH05 50725

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	80	20.0	6400	8149	2.45	1.30	3.20	76.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**76.8**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443143

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50727**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 32.83 Depth Base: 32.92**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 443143 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 50727

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Lump	b		80	72	16.0	5760	7334	2.18	1.27	2.78	66.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**66.7**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443154

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50736**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 37.4 Depth Base: 37.5**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443154 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56158
Date Recived 8.12.15
Sample Ref BH05 50736

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	95	24.0	7600	9677	2.48	1.36	3.36	80.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**80.7**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 21st December 2015
Test Report Ref:. STR: 443156

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50738**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**8/12/2015**
Sampling Location:	**Depth Top: 37.82 Depth Base: 37.92**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 443156 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56158
Date Recived	8.12.15
Sample Ref	BH05 50738

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	100	23.9	8000	10186	2.35	1.37	3.22	77.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**77.2**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447819

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48862**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:10.36 Depth Base:10.46**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447819 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48862

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	70	14.9	4200	5348	2.79	1.19	3.31	79.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**79.3**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447825

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48864**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:10.69 Depth Base:10.76**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447825 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48864

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	60	13.0	3600	4584	2.84	1.15	3.25	78.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**78.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447831

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48869**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:13.35 Depth Base:13.45**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447831 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 48869

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	18.1	5100	6494	2.79	1.24	3.46	82.9
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**82.9**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447833

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48871**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:13.70 Depth Base:13.80**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447833 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48871

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	90	16.4	5400	6875	2.39	1.26	3.00	71.9
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**71.9**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447834

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48872**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:16.30 Depth Base:16.40**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447834 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 48872

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	16.1	5700	7257	2.22	1.27	2.82	67.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**67.7**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447836

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48874**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:16.66 Depth Base:16.80**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447836- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48874

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	115	21.1	6900	8785	2.40	1.33	3.19	76.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**76.5**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447839

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48877**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:26.20 Depth Base:26.36**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447839 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 48877

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	165	17.2	9900	12605	1.36	1.44	1.96	47.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**47.1**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447841

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48879**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:26.61 Depth Base:26.70**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447841 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 48879

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	13.2	5100	6494	2.03	1.24	2.52	60.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**60.5**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447844

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48882**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:34.44 Depth Base:34.48**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447844 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48882

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		39	60	10.6	2340	2979	3.56	1.04	3.70	88.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**88.8**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447846

Order No:

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48884**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:34.73 Depth Base: 34.83**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447846 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 48884

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	14.8	5700	7257	2.04	1.27	2.59	62.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**62.2**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447848

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48886**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:44.45 Depth Base:44.54**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447848 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48886

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	75	16.8	4500	5730	2.93	1.21	3.53	84.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**84.8**

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447851

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48888**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:44.79 Depth Base:44.90**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447851- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48888

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	90	12.1	5400	6875	1.76	1.26	2.21	53.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**53.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447858

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48894**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:56.50 Depth Base:56.60**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447858 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48894

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	70	12.1	4200	5348	2.26	1.19	2.68	64.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**64.4**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447860

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48896**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:56.85 Depth Base:56.93**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :447860 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 48896

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	70	12.0	4200	5348	2.24	1.19	2.66	63.9
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**63.9**

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Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447863

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 48899**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:62.76 Depth Base:62.86**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :447863- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 48899

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	18.2	5100	6494	2.80	1.24	3.47	83.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**83.4**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447865

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50857**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:63.05 Depth Base:63.16**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447865 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50857

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	125	14.6	7500	9549	1.53	1.35	2.07	49.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**49.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447870

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50862**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:66.00 Depth Base:66.10**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447870 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50862

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	80	14.5	4800	6112	2.37	1.22	2.90	69.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**69.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447872

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50864**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:66.34 Depth Base:66.45**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447872- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50864

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	105	16.1	6300	8021	2.01	1.30	2.61	62.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**62.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447880

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50872**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:79.10 Depth Base:79.18**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :447880 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50872

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	11.3	5100	6494	1.74	1.24	2.16	51.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**51.8**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447882

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50874**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:79.40 Depth Base:79.52**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447882 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50874

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	110	12.8	6600	8403	1.52	1.31	2.00	48.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**48.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447891

Order No:

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50883**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:92.35 Depth Base:92.47**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447891- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50883

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	16.0	5100	6494	2.46	1.24	3.05	73.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**73.3**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447893

Order No:

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50885**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:92.70 Depth Base:92.79**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447893- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50885

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	80	14.8	4800	6112	2.42	1.22	2.96	71.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**71.1**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447901

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50893**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:108.15 Depth Base:108.22**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447901- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50893

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	70	11.5	4200	5348	2.15	1.19	2.55	61.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**61.2**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447903

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No.: **S56595**
Client Ref. No.: **BH01 - 50895**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab.: **18/1/2016**
Date of Start of Test.: **18/1/2016**
Sampling Location: **Depth Top:108.51 Depth Base:108.62**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Testing**
Target Specification: **N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447903 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50895

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	75	13.9	4500	5730	2.43	1.21	2.92	70.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**70.2**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447909

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50901**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:115.89 Depth Base:116.05**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447909- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50901

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	110	14.0	6600	8403	1.67	1.31	2.19	52.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**52.5**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447911

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50903**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:116.29 Depth Base:116.39**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :447911- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50903

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	14.8	5700	7257	2.04	1.27	2.59	62.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**62.2**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447916

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50908**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:128.80 Depth Base:128.89**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447916- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50908

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	75	16.0	4500	5730	2.79	1.21	3.37	80.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**80.8**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447918

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50910**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:129.14 Depth Base:129.21**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447918 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50910

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	60	14.0	3600	4584	3.05	1.15	3.50	84.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**84.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447922

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50914**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:133.21 Depth Base:133.32**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447922 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50914

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	15.1	5100	6494	2.33	1.24	2.88	69.2
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**69.2**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447924

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50916**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:133.54 Depth Base:133.63**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :447924 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50916

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	13.5	5100	6494	2.08	1.24	2.58	61.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**61.8**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447931

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50923**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:146.20 Depth BaseBase:146.30**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447931 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50923

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	12.0	5100	6494	1.85	1.24	2.29	55.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**55.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447933

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50925**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:146.52 Depth Base146.61**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447933 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50925

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	14.9	5700	7257	2.05	1.27	2.61	62.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**62.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447942

Order No:

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50933**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:156.33 Depth Base:156.44**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447942- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50933

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	110	11.2	6600	8403	1.33	1.31	1.75	42.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**42.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447944

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50935**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:156.68 Depth Base:156.76**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447944- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50935

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	90	10.8	5400	6875	1.57	1.26	1.97	47.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**47.3**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447946

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50937**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:165.17 Depth Base:165.25**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447946 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50937

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	75	15.4	4500	5730	2.69	1.21	3.24	77.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**77.7**

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447948

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50939**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:166.00 Depth Base:166.10**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447948 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50939

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	14.1	5100	6494	2.17	1.24	2.69	64.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**64.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447953

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50944**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:175.18 Depth Base:175.26**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447953 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50944

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	12.8	5100	6494	1.97	1.24	2.44	58.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**58.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447956

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50946**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:175.50 Depth Base:175.59**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :447956- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50944

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	12.8	5100	6494	1.97	1.24	2.44	58.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**58.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447961

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50951**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:183.90 Depth Base:184.20**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447961 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50951

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	110	13.0	6600	8403	1.55	1.31	2.03	48.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**48.8**

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Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447963

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50953**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:184.25 Depth Base:184.34**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR :447963- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50953

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	90	16.0	5400	6875	2.33	1.26	2.92	70.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**70.1**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447967

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50957**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:194.60 Depth Base:194.67**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447967 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50957

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	60	8.0	3600	4584	1.75	1.15	2.00	48.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**48.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447969

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50959**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:194.90 Depth Base:194.99**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447969 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50959

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	80	12.0	4800	6112	1.96	1.22	2.40	57.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**57.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447972

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50962**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:204.62 Depth Base:204.70**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447972- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50962

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive
no	type	type		mm	mm	KN	=W*D					Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	80	17.4	4800	6112	2.85	1.22	3.48	83.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**83.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 11th April 2016
Test Report Ref:. STR: 447974

Page 1 of 2

Order No:

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50964**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:204.95 Depth Base:205.02**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447974 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50964

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	13.2	5100	6494	2.03	1.24	2.52	60.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**60.5**

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447980

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50970**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:211.77 Depth Base:211.85**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447980- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50970

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	75	11.2	4500	5730	1.95	1.21	2.36	56.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**56.5**

Point load test results
STR : 447982- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50972

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	100	17.0	6000	7639	2.23	1.29	2.86	68.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**68.7**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447982

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50972**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:212.10 Depth Base:212.20**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447989

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50979**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:225.65 Depth Base:225.74**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447989- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50979

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	19.1	5700	7257	2.63	1.27	3.34	80.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**80.3**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447991

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50981**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:225.95 Depth Base:226.03**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447991 Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50981

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	17.2	5700	7257	2.37	1.27	3.01	72.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**72.3**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447995

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50985**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:231.65 Depth Base:231.78**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 447994- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50985

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample	Sample	Test		D	W	P	A	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
no	type	type		mm	mm	KN	=W*D					
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	120	15.1	7200	9167	1.65	1.34	2.21	53.0
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**53.0**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 447997

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50987**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:232.00 Depth Base:232.10**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 447997- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50987

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	70	14.0	4200	5348	2.62	1.19	3.11	74.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**74.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448003

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50993**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:242.82 Depth Base:242.92**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 448003- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50993

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	12.8	5700	7257	1.76	1.27	2.24	53.8
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**53.8**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448005

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50995**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:243.14 Depth Base:243.23**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 448005 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50995

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	14.1	5100	6494	2.17	1.24	2.69	64.6
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**64.6**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448007

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50997**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:251.81 Depth Base:251.95**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 448007 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 50997

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	110	14.0	6600	8403	1.67	1.31	2.19	52.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**52.5**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448009

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 50999**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:252.22 Depth Base:252.32**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results

STR : 448009- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 50999

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	90	14.0	5400	6875	2.04	1.26	2.56	61.4
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**61.4**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448011

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 51001**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:259.72 Depth Base:259.82**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 448011- Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 51001

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	85	14.0	5100	6494	2.16	1.24	2.67	64.1
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**64.1**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448013

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 51003**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:260.06 Depth Base:260.18**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :448013- Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 51003

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	120	12.8	7200	9167	1.40	1.34	1.87	44.9
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**44.9**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448015

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 51005**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:262.63 Depth Base:262.73**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 448015 - Page 2 of 2

Client Priority Construction Ltd
Sample Number S56595
Date Recived 18.1.16
Sample Ref BH01 51005

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	95	16.1	5700	7257	2.22	1.27	2.82	67.7
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**67.7**

Priority Construction Ltd
Killmor
Ballinasloe
Co. Galway
Ireland

Date: 24th February 2016
Test Report Ref:. STR: 448016

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56595**
Client Ref. No.:	**BH01 - 51006**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**18/1/2016**
Date of Start of Test.:	**18/1/2016**
Sampling Location:	**Depth Top:264.80 Depth Base:164.93**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR :448016 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S56595
Date Recived	18.1.16
Sample Ref	BH01 51006

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	a		60	100	12.0	6000	7639	1.57	1.29	2.02	48.5
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**48.5**

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 15th February 2016
Test Report Ref:. STR: 451474

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Point Load Index of Rock in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No.:	**S56158**
Client Ref. No.:	**BH05 - 50740**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab.:	**08/12/2015**
Date of Start of Test.:	**15/12/2015**
Sampling Location:	**Depth Top: 37.92 Depth Base: 38.08**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The specimens were perpendicular to the axis of loading with respect to the existing planes of anisotropy.

Nick Dumbarton – Assistant Laboratory Manager

Point load test results
STR : 451474 - Page 2 of 2

Client	Priority Construction Ltd
Sample Number	S6158
Date Recived	8.12.15
Sample Ref	BH05 50740

Key : -

D	Always distance between platen contact points	D*D	= 4A/pi for axial (a) and irregular block (b) tests
W	Smallest width perpendicular to loading direction	P	Load failure in KN
	ie core diameter for axial tests.	Is	Uncorrected strength index
	W =(W1 + W2)/2 for irregular blocks.	Is (50)	Point load strength index
A	W*D minimum x-sectional area	F	Size correction factor
	For axial or irregular block test 0.3W < D < W	#	Test perpendicular to fabric
D*D	= D*D for diametral (d) tests	//	Test parallel to fabric

Sample no	Sample type	Test type		D mm	W mm	P KN	A =W*D	D*D	Is	F	Is (50)	Approx. Compressive Strength (MPa)
*	*	*	*	*	*	*						
Axial, Block or Lump Tests												
1	Core	d		80	140	21.0	11200	14260	1.47	1.48	2.18	52.3
2												
3												
4												
5												
6												
7												
8												
9												
10												
											Mean	**52.3**

Porosity / Density Testing

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 22nd March 2016
Test Report No: STR: 443026

LABORATORY TEST REPORT

REQUIREMENTS: To determine the Porosity & Density using saturation and calliper in accordance with **ISRM Part 1: Test 2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref.:	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**11/02/2016**
Sampling Location:	**Various**
Name of Supplier:	**Lackagh Quarry**
Name and Location of Quarry	**Unknown**
Sampled By:	**Client**
Method of Sampling:	**Rock Testing**

Nick Dumbarton – Laboratory Manager

Test Report No: STR 443026 Page 2 of 2

RESULTS:

Sample ref:	Porosity (%)	Dry Density of Rock (Kg/m^3)
BH4 - 48929	0.4	2.69
BH4 - 48936	0.5	2.65
BH5 - 48974	0.4	2.68
BH5 – 50702	0.4	2.69
BH5 – 50730	0.6	2.69

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 22nd March 2016
Test Report No: STR: 443115

LABORATORY TEST REPORT

REQUIREMENTS: To determine the Porosity & Density using saturation and buoyancy in accordance with **ISRM Part 1: Test 3**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref.:	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**11/02/2016**
Sampling Location:	**Various**
Name of Supplier:	**Lackagh Quarry**
Name and Location of Quarry	**Unknown**
Sampled By:	**Client**
Method of Sampling:	**Rock Testing**

Nick Dumbarton – Laboratory Manager

Test Report No: STR: 443115 Page 2 of 2

RESULTS:

Sample ref:	**Porosity (%)**	**Dry Density of Rock (Kg/m^3)**
BH4 - 48914	0.2	2.72
BH4 - 48968	0.4	2.69
BH5 - 48976	0.3	2.65
BH5 - 48999	0.3	2.69
BH5 - 50735	0.4	2.68

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date:17th March 2016
Test Report No: STR: 447826

Page 1 of 2

LABORATORY TEST REPORT

REQUIREMENTS: To determine the Porosity & Density using saturation and buoyancy in accordance with **ISRM Part 1: Test 3**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref.:	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/1/2016**
Date of Start of Test:	**21/2/2016**
Sampling Location:	**Various**
Name of Supplier:	**Lackagh Quarry**
Name and Location of Quarry	**Unknown**
Sampled By:	**Client**
Method of Sampling:	**Rock Testing**

Nick Dumbarton – Laboratory Manager

Test Report No: STR: 447826 Page 1 of 2

RESULTS:

Sample ref:	Porosity (%)	Dry Density of Rock (Kg/m^3)
BH01 - 48865	0.5	2.63
BH01 - 48876	1.2	2.70
BH01 - 48889	0.5	2.68
BH01 - 50860	0.2	2.72
BH01 - 50867	0.2	2.63
BH01 - 50881	1.0	2.70
BH01 - 50898	0.7	2.59
BH01 - 50919	0.3	2.63
BH01 - 50928	0.7	2.67
BH01 - 50942	0.4	2.72
BH01 - 50960	0.5	2.71
BH01 - 50967	0.3	2.85
BH01 - 50978	0.3	2.63
BH01 - 50983	0.4	2.65
BH01 - 51009	0.5	2.64

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 17th March 2016
Test Report No: STR: 447828

LABORATORY TEST REPORT

REQUIREMENTS: To determine the Porosity & Density using saturation and calliper in accordance with **ISRM Part 1: Test 2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref.:	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**21/02/2016**
Sampling Location:	**Various**
Name of Supplier:	**Lackagh Quarry**
Name and Location of Quarry	**Unknown**
Sampled By:	**Client**
Method of Sampling:	**Rock Testing**

Nick Dumbarton – Laboratory Manager

Test Report No: STR: 447828 Page 1 of 2

RESULTS:

Sample ref:	Porosity (%)	Dry Density of Rock (Kg/m^3)
BH01 - 48866	0.47	2.69
BH01 - 48875	0.58	2.65
BH01 - 48885	0.54	2.70
BH01 - 50861	0.64	2.69
BH01 - 50866	0.57	2.71
BH01 - 50880	0.49	2.71
BH01 - 50897	0.57	2.69
BH01 - 50918	0.76	2.81
BH01 - 50927	0.61	2.75
BH01 - 50941	0.49	2.68
BH01 - 50956	0.54	2.69
BH01 - 50966	0.65	2.69
BH01 - 50977	0.56	2.75
BH01 - 50982	0.64	2.70
BH01 - 51008	0.63	2.65

Polish Stone Value

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 01 March 2016
Test Report Ref: STR 448027

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2009**

SAMPLE DETAILS:

Certificate of sampling received:	**No**	Name of Source:	**Lackagh Quarry**
Laboratory Ref. No:	**S56595**	Method of Sampling:	**Unknown**
Client Ref. No:	**Bulk Sample**	Sampled By:	**Client**
Date and Time of Sampling:	**Unknown**		
Date of Receipt at Lab:	**18/01/2016**		
Date of Start of Test:	**23/02/2016**		
Sampling Location:	**Unknown**		
Material Description:	**Aggregate**		

RESULTS:

Recorded Polished Stone Value

Test Specimen	Test Run 1	(i)	35.3	Mean Recorded Value (S) = **35.8**
		(ii)	35.7	
	Test Run 2	(iii)	35.0	
		(iv)	37.0	
Control Stone	Test Run 1	(i)	47.7	Mean Recorded Value (C) = **47.2**
		(ii)	47.3	
	Test Run 2	(iii)	47.0	
		(iv)	46.7	

Corrected Polished Stone Value: S + 49* - C = **38**

Comments

*New Control Stone

Certificate Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Slake Durability

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 29 February 2016
Test Report Ref: STR 448028

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Slake Durability Index of an aggregate sample in accordance with **ISRM guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**Bulk Sample**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**18/02/2016**
Sampling Location:	**Unknown**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Aggregate**
Target Specification:	**N/A**

RESULTS:

Slake Durability Index = **99.4 %**

Comments

None

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Soil Testing

PRIORITY GEOTECHNICAL	Natural Moisture Content/Atterberg Limits Summary BS 1377 : Part 2 : 1990 : Clause 3	Job Ref
Location	Galway PDL	P16005

Hole ID	Sample Ref	Depth (m)	Sample Type	Sample Description	MC	LL	PL	PI	% Pass 425
BH03		13.65	B		26				
BH03		13.73	B			34	NP	NP	100
BH03		19.1	B			29	NP	NP	100
BH03		19.25	B		30				
BH03		19.9	B		30				
BH03		21.3	B		30				
BH03		27.45	B			28	NP	NP	100
BH03		31.2	B		25				
BH03		33.95	B		27				
BH03		38.6	B		36				
BH03		39.25	B			56	44	12	100
BH03		39.8	B		38				
BH03		40.65	B			27	20	7	100
BH03		42.3	B		31				
BH03		47.2	B		32				
BH03		48.2	B			54	43	11	100
BH03		49.3	B		37				
BH03		63.5	B		20				
BH03		64.3	B		29				
BH03		65.5	B		24				
BH03		66.95	B		38				
BH03		68.4	B		37				

PRIORITY GEOTECHNICAL

Natural Moisture Content/Atterberg Limits Summary

BS 1377 : Part 2 : 1990 : Clause 3

Location	Galway PDL	Job Ref P16005

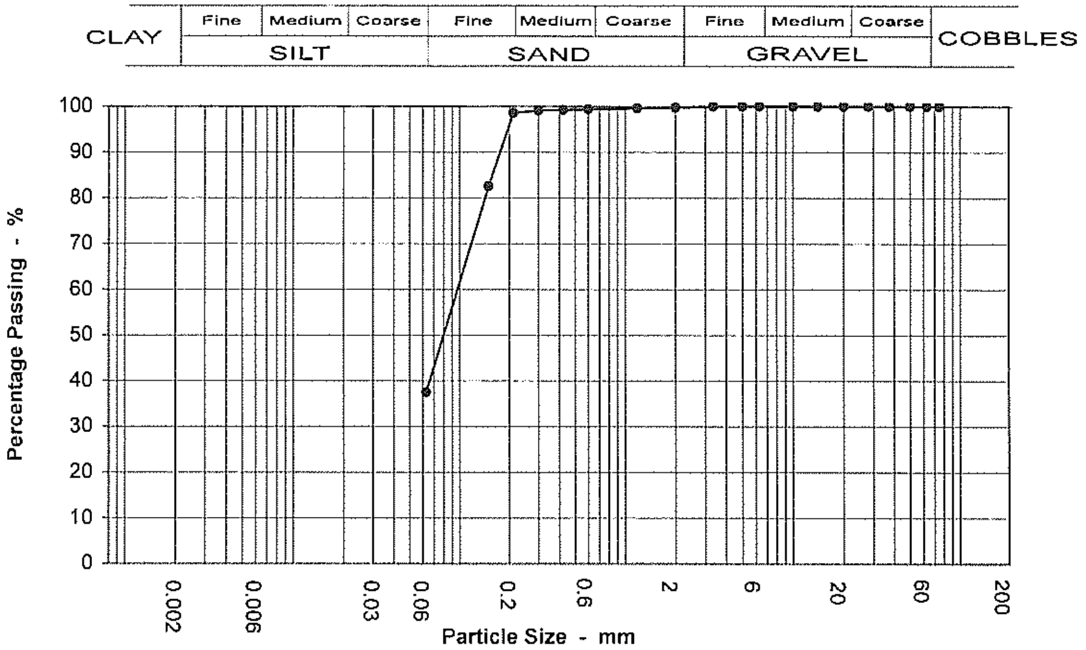
Hole ID	Sample Ref	Depth (m)	Sample Type	Sample Description	MC	LL	PL	PI	% Pass 425
BH03		70.4	B		21				
BH03		70.75	B		21				
BH03		71.6	B		25				
BH06		16.6	B		22				
BH06		16.7	B			38	27	11	100
BH06		18.25	B		28				
BH06		18.65	B			49	38	11	100
BH06		21.45	B		26				
BH06		21.52	B			39	30	9	100

PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Location	**Galway PDL**	**Job Ref**	**P16005**
		Borehole / Pit No	BH03
		Sample No	0
Soil Description		Depth	14.90 m
		Sample type	B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	99		
0.425	99		
0.3	99		
0.212	99		
0.15	82		
0.063	38		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.3
Sand	62.2
Silt & Clay	37.5

Grading Analysis	
D100	3.350
D60	0.106
D10	
Uniformity Coefficient	N/A

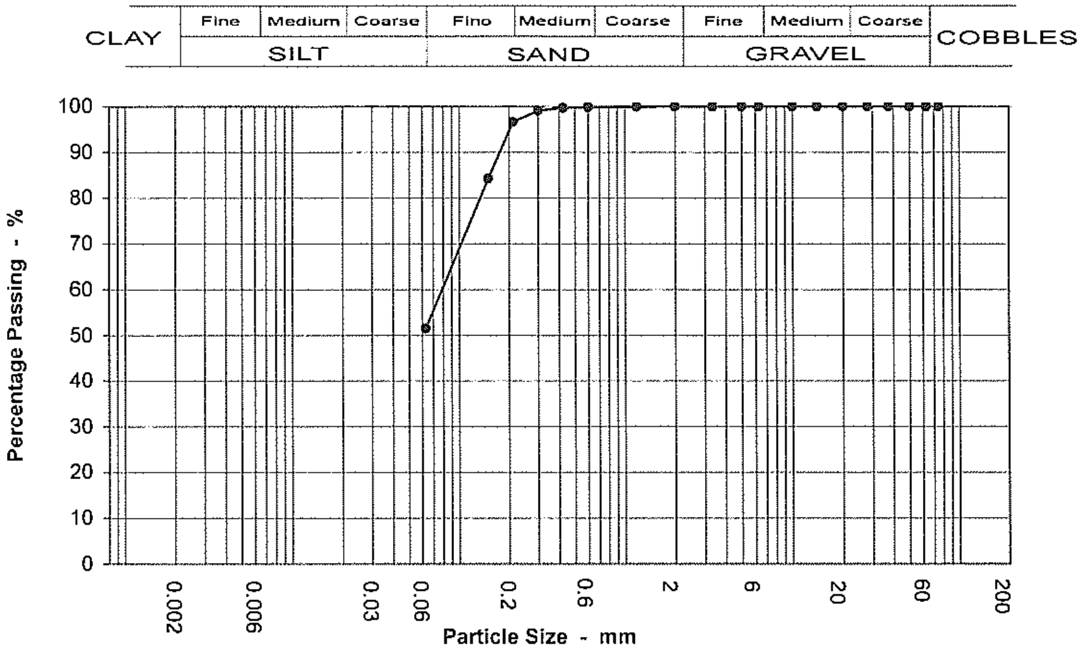
PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Job Ref	P16005
Borehole / Pit No	BH03
Sample No	0
Depth	19.00 m
Sample type	B

Location	**Galway PDL**
Soil Description	



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	99		
0.212	97		
0.15	84		
0.063	51		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	48.5
Silt & Clay	51.5

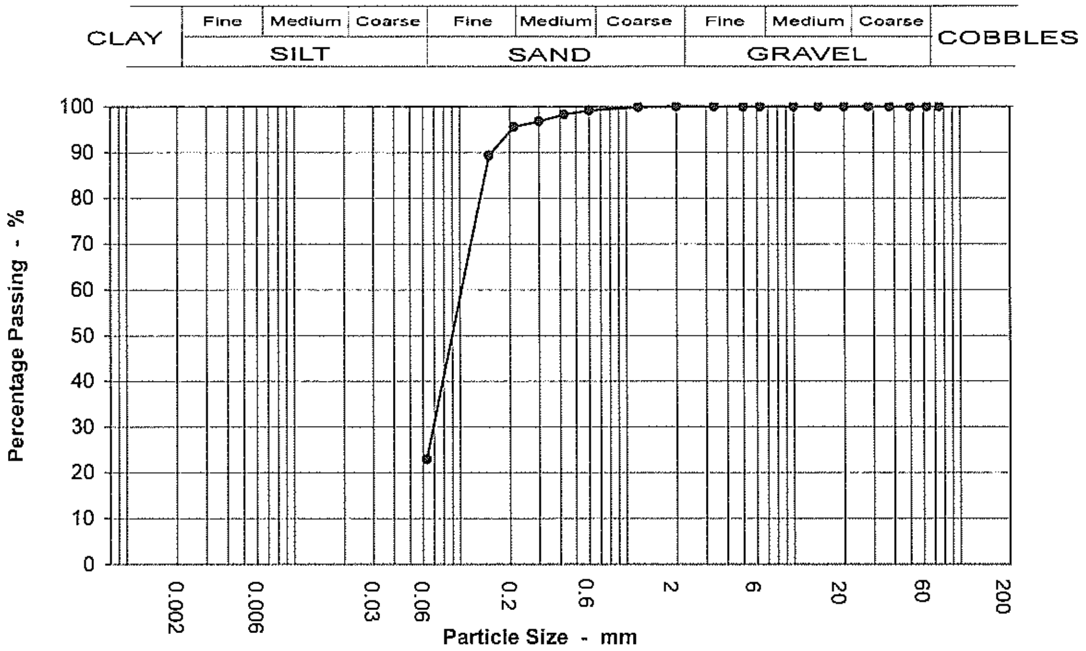
Grading Analysis	
D100	2.000
D60	0.086
D10	
Uniformity Coefficient	N/A

PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Job Ref	P16005
Borehole / Pit No	BH03
Location	Galway PDL
Sample No	0
Depth	25.50 m
Soil Description	
Sample type	B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	99		
0.425	98		
0.3	97		
0.212	95		
0.15	89		
0.063	23		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	77.1
Silt & Clay	22.9

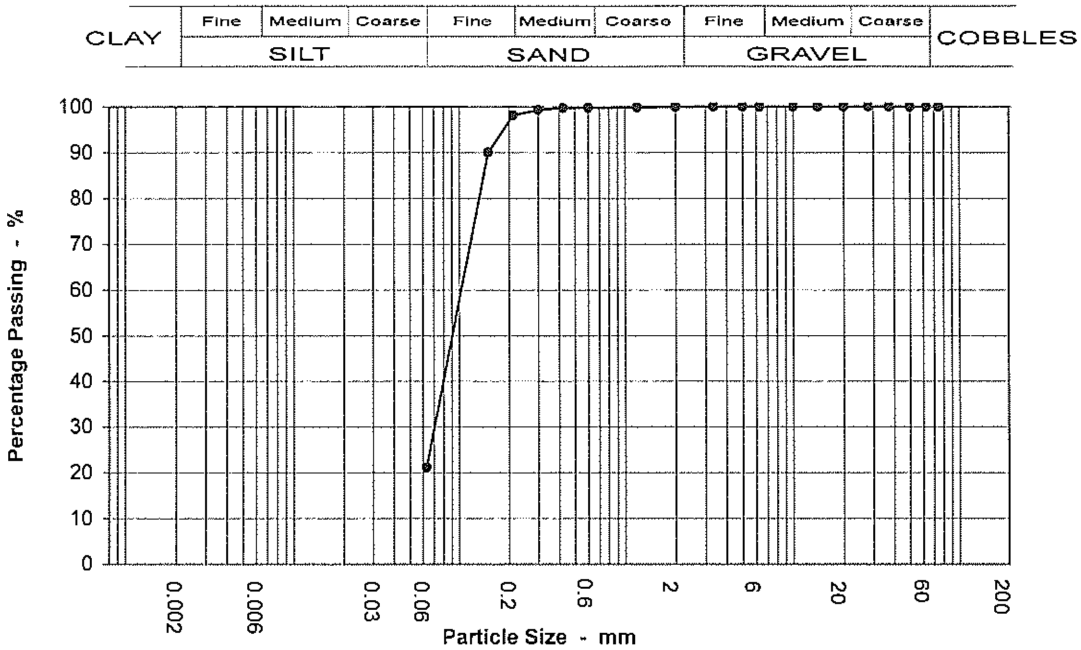
Grading Analysis	
D100	2.000
D60	0.112
D10	
Uniformity Coefficient	N/A

PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Job Ref	P16005
Borehole / Pit No	BH03
Sample No	0
Depth	25.80 m
Sample type	B
Location	Galway PDL
Soil Description	



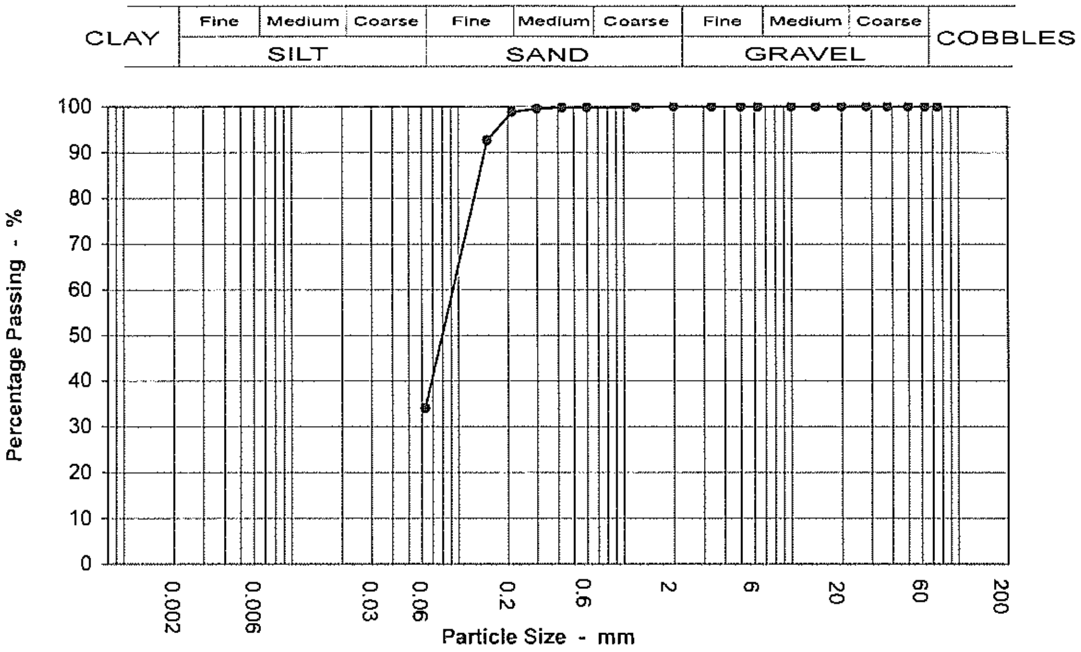
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	99		
0.212	98		
0.15	90		
0.063	21		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	78.8
Silt & Clay	21.2

Grading Analysis	
D100	3.350
D60	0.112
D10	
Uniformity Coefficient	N/A

PRIORITY GEOTECHNICAL	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P16005**
		Borehole / Pit No	BH03
Location	**Galway PDL**	Sample No	0
		Depth	26.50 m
Soil Description		Sample type	B



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	99		
0.212	99		
0.15	93		
0.063	34		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	66.0
Silt & Clay	34.0

Grading Analysis	
D100	2.000
D60	0.102
D10	
Uniformity Coefficient	N/A

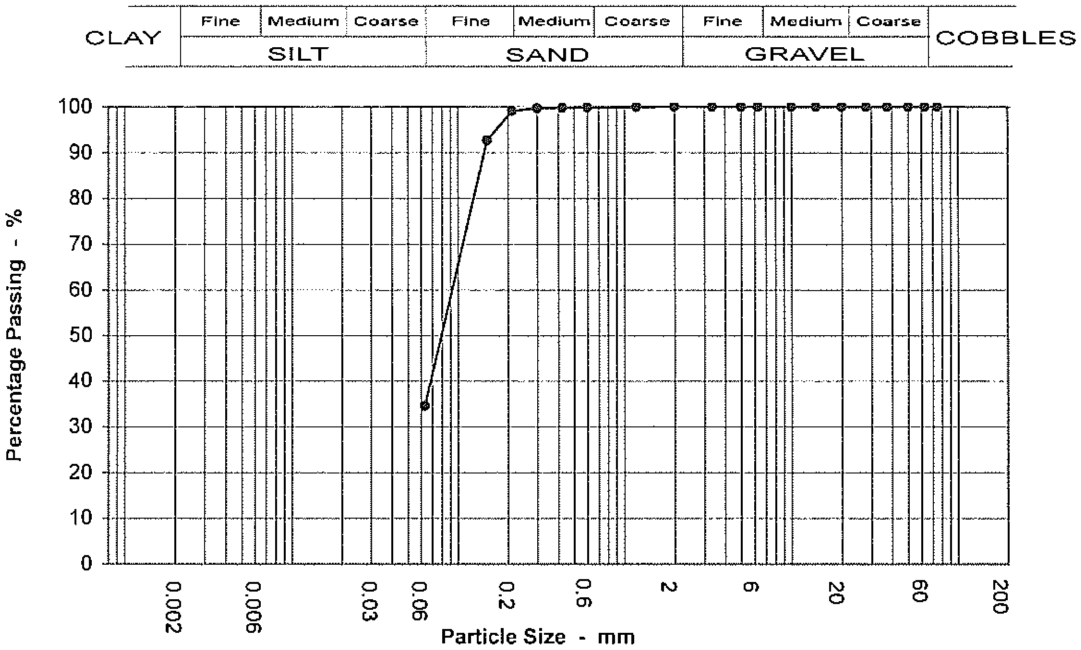
PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Job Ref	P16005
Borehole / Pit No	BH03
Sample No	0
Depth	26.70 m
Sample type	B

Location	**Galway PDL**
Soil Description	



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	100		
0.212	99		
0.15	93		
0.063	35		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	65.4
Silt & Clay	34.6

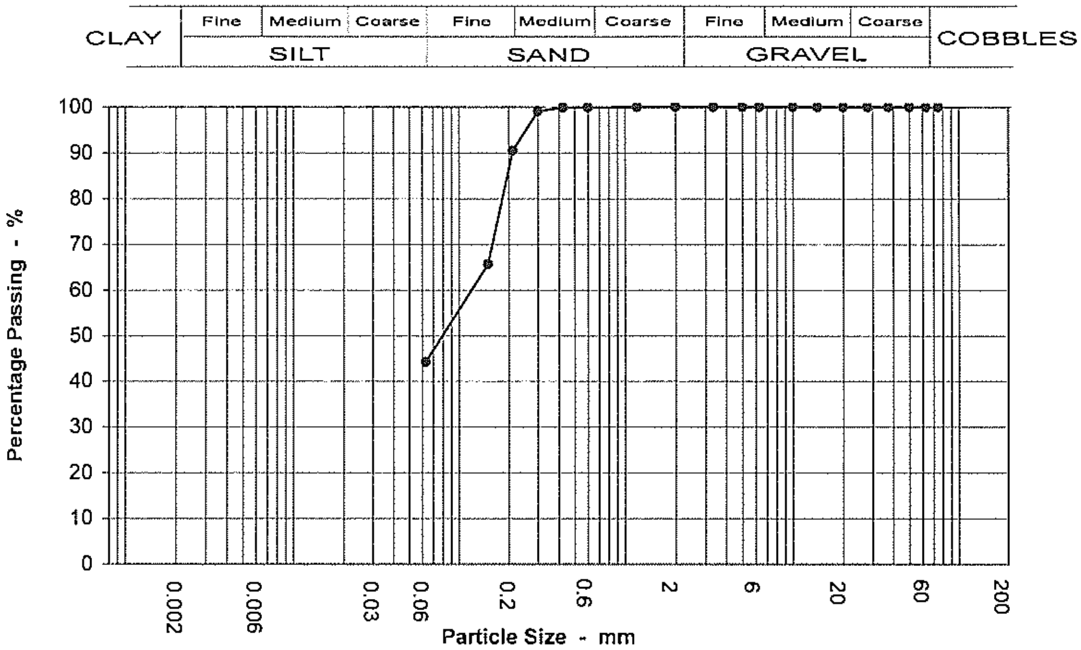
Grading Analysis	
D100	2.000
D60	0.101
D10	
Uniformity Coefficient	N/A

PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Job Ref	P16005
Borehole / Pit No	BH03
Sample No	0
Depth	27.55 m
Sample type	B
Location	**Galway PDL**
Soil Description	



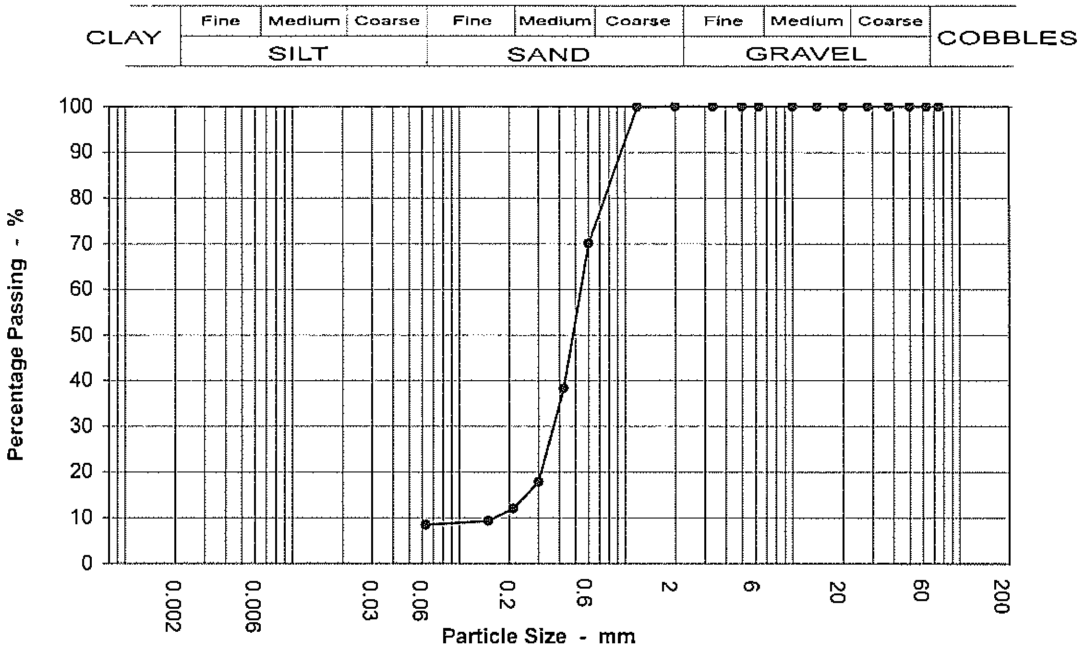
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	99		
0.212	90		
0.15	66		
0.063	44		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	55.8
Silt & Clay	44.2

Grading Analysis	
D100	2.000
D60	0.127
D10	
Uniformity Coefficient	N/A

PRIORITY GEOTECHNICAL	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Job Ref	P16005
		Borehole / Pit No	BH03
Location	Galway PDL	Sample No	0
		Depth	30.25 m
Soil Description		Sample type	B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	70		
0.425	38		
0.3	18		
0.212	12		
0.15	9		
0.063	8		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	91.5
Silt & Clay	8.4

Grading Analysis	
D100	3.350
D60	0.545
D10	0.165
Uniformity Coefficient	3

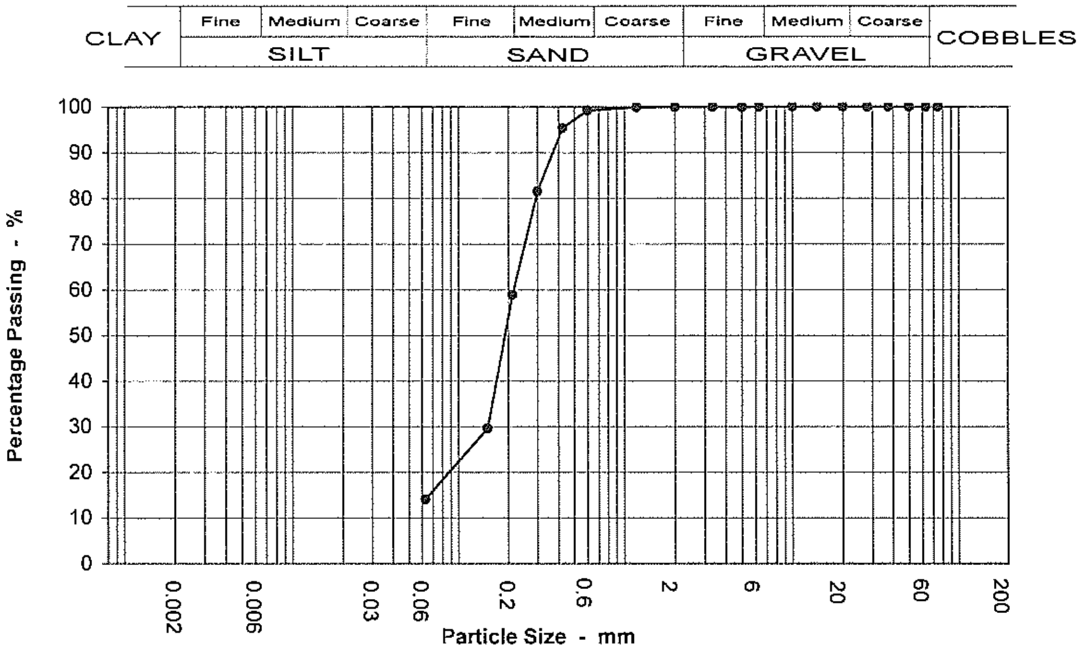
PRIORITY GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION

BS 1377 : Part 2 : 1990 : Clause 9

Job Ref	P16005
Borehole / Pit No	BH03
Sample No	0
Depth	36.70 m
Sample type	B

Location	**Galway PDL**
Soil Description	



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	99		
0.425	95		
0.3	81		
0.212	59		
0.15	30		
0.063	14		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A

Sample Proportions	
Cobbles	0.0
Gravel	0.1
Sand	85.8
Silt & Clay	14.1

Grading Analysis	
D100	6.300
D60	0.217
D10	
Uniformity Coefficient	N/A

PRIORITY GEOTECHNICAL

Sulphate Content & pH Value

BS 1377 : Part 3 : 1990 : Clause 5.5 & 9.5

Job Ref

Location

Galway PDL

P16005

Hole ID	Sample Ref	Depth (m)	Sample Type	Sample Description	% < 2.0 mm	pH Value	Sulphate Content as SO3			Sulphate Content as SO4		
							GW g/L	Total Sulphate %	Water Soluble g/L	GW g/L	Total Sulphate %	Water Soluble g/L
BH03		20.95	B			9.08						
BH03		27.20	B			8.93						
BH03		41.20	B			8.27						
BH03		47.00	B			7.77						
BH03		63.38	B			7.5						

PRIORITY GEOTECHNICAL	Organic Matter Content BS 1377 : Part 3 : 1990 : Clause 3	Job Ref
Location	Galway PDL	P16005

Hole ID	Sample Ref	Depth (m)	Sample Type	Sample Description	% Mass < 2 mm	Organic Matter Content %
BH03		38.95	B		100	8.85
BH03		39.45	B		100	5.63
BH03		42.35	B		100	7.04
BH03		46.20	B		100	15.12
BH03		47.45	B		99.97	6.64
BH03		49.00	B		100	6.49
BH03		63.15	B		98.97	10.22
BH03		63.90	B		100	5.99
BH03		64.90	B		99.3	7.68
BH06		17.13	B		99.51	3.15
BH06		18.95	B		99.5	3.17
BH06		21.75	B		99.93	12.51

UNDRAINED TRIAXIAL COMPRESSION

BS 1377 : Part 7 : 1990 Clause 8

Job Ref	**P16005**
Borehole / Pit No	BH03
Sample No	
Depth	4.15 m
Date	

Location	**Galway PDL**
Soils Description	

Sample Details **Specimen** 1

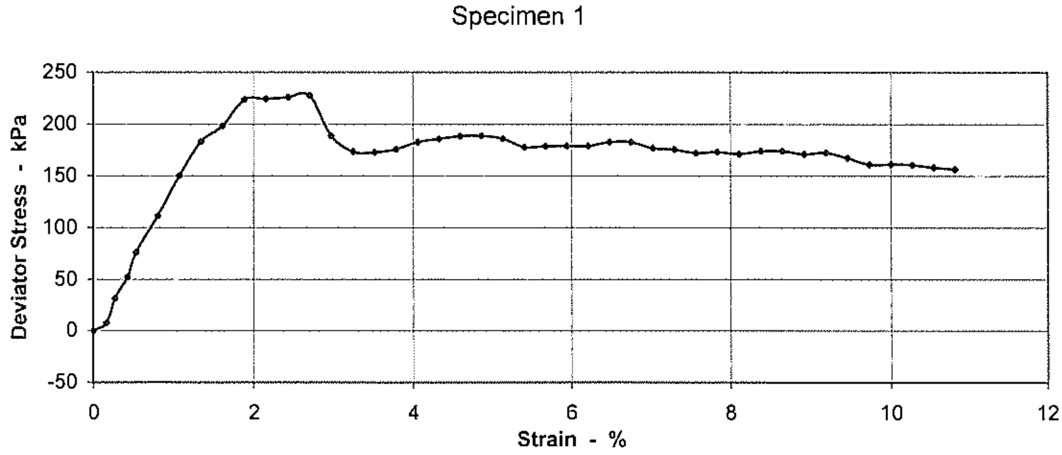
Sample Condition		Undisturbed
Height	mm	185.0
Diameter	mm	82.0
Moisture Content	%	7.9
Bulk Density	Mg/m^3	2.34
Dry Density	Mg/m^3	2.17

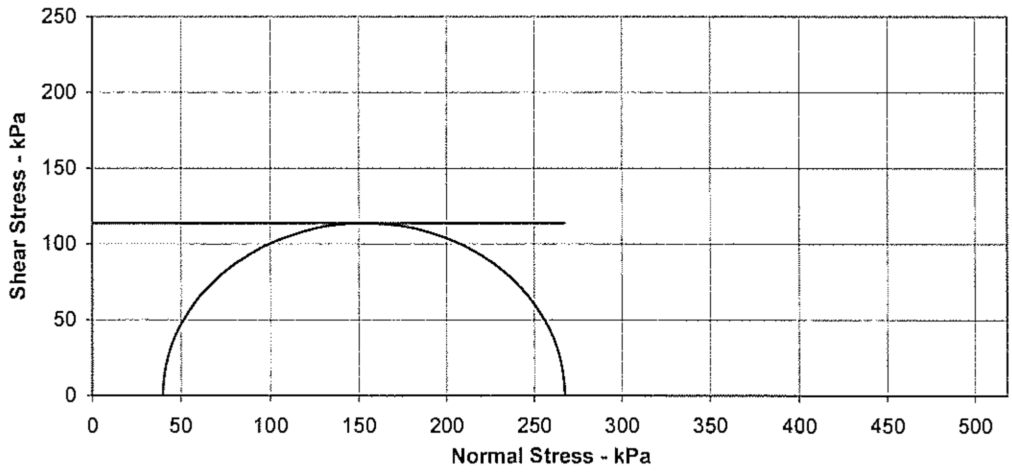
Test Details

Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.33
Rate of Axial Displacement	%/min	1.62
Cell Pressure	kPa	40
Strain at Failure	%	2.7
Maximum Deviator Stress	kPa	227
Shear Strength	kPa	114
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters	
C	114 kPa
Phi	0.0 °





UNDRAINED TRIAXIAL COMPRESSION

BS 1377 : Part 7 : 1990 Clause 8

Location	**Galway PDL**	Job Ref	**P16005**
		Borehole / Pit No	BH03
		Sample No	
Soils Description		Depth	41.85 m
		Date	

Sample Details **Specimen 1**

Sample Condition		Undisturbed
Height	mm	208.0
Diameter	mm	83.0
Moisture Content	%	41
Bulk Density	Mg/m³	1.78
Dry Density	Mg/m³	1.26

Test Details

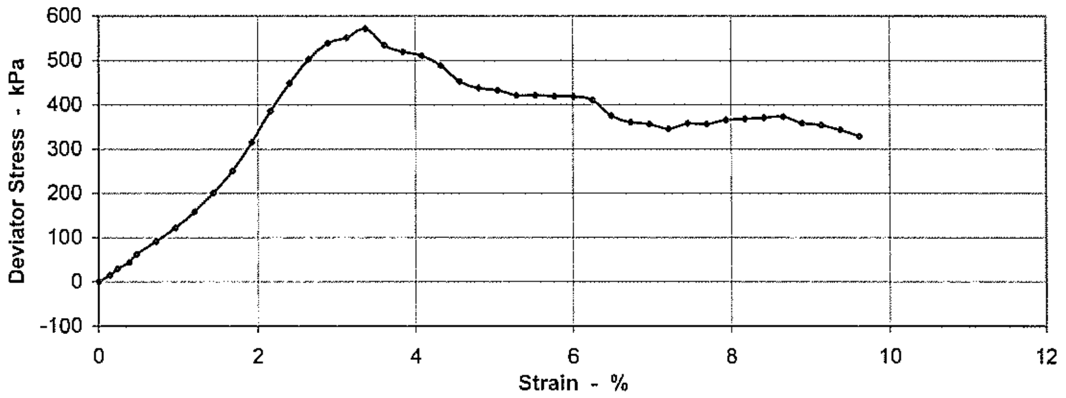
Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.40
Rate of Axial Displacement	%/min	1.44
Cell Pressure	kPa	400
Strain at Failure	%	3.4
Maximum Deviator Stress	kPa	571
Shear Strength	kPa	286
Mode of Failure		Brittle

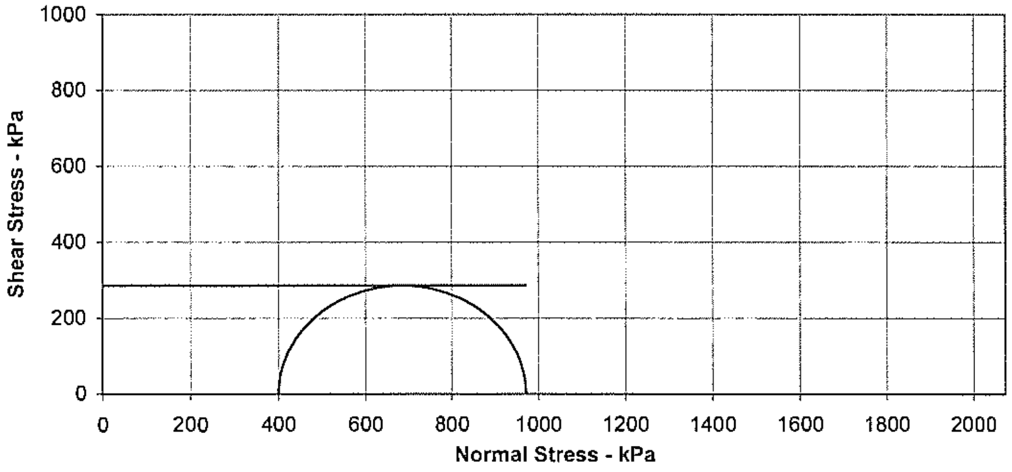
Position and orientation within the original sample

Shear Strength Parameters

C	286	kPa
Phi	0.0	°

Specimen 1





UNDRAINED TRIAXIAL COMPRESSION

BS 1377 : Part 7 : 1990 Clause 8

Location	Galway PDL	Job Ref	P16005
		Borehole / Pit No	BH03
		Sample No	
Soils Description		Depth	42.81 m
		Date	

Sample Details **Specimen 1**

Sample Condition		Undisturbed
Height	mm	205.0
Diameter	mm	83.0
Moisture Content	%	43
Bulk Density	Mg/m³	1.95
Dry Density	Mg/m³	1.36

Test Details

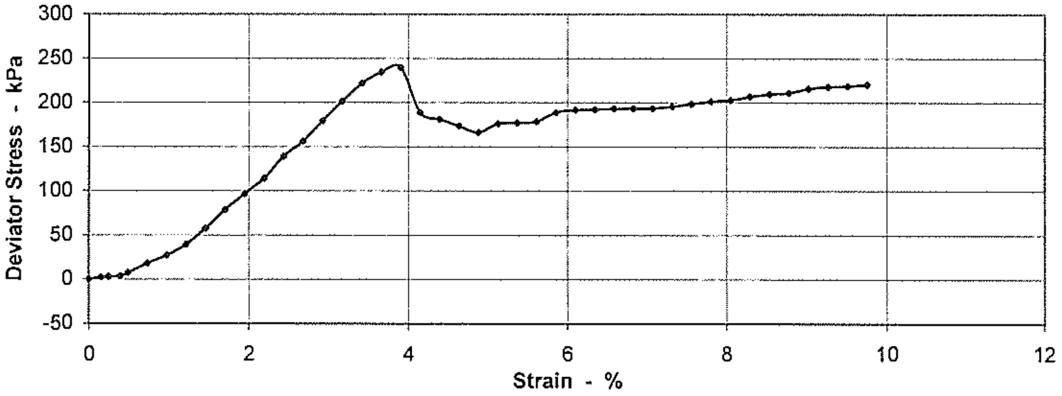
Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.45
Rate of Axial Displacement	%/min	1.46
Cell Pressure	kPa	410
Strain at Failure	%	3.9
Maximum Deviator Stress	kPa	239
Shear Strength	kPa	120
Mode of Failure		Brittle

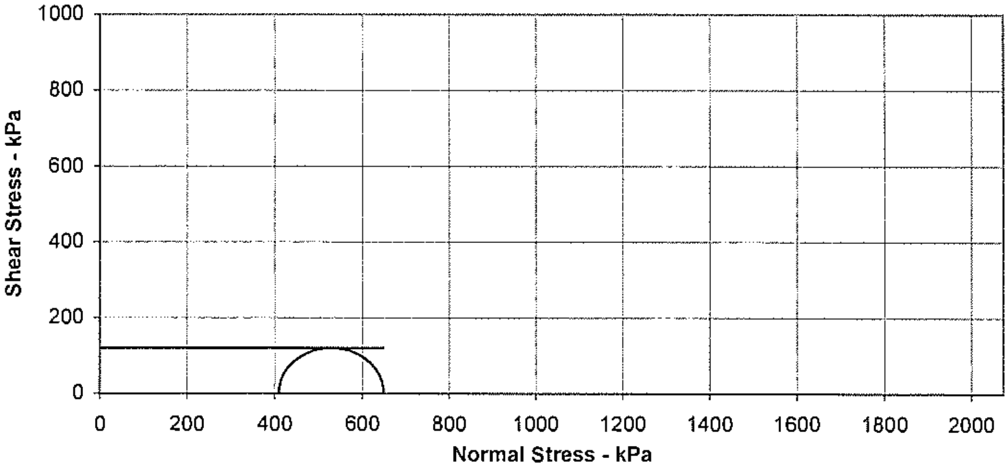
Position and orientation within the original sample

Shear Strength Parameters

C	120 kPa
Phi	0.0 °

Specimen 1





UNDRAINED TRIAXIAL COMPRESSION

BS 1377 : Part 7 : 1990 Clause 8

		Job Ref	**P16005**
		Borehole / Pit No	BH03
Location	**Galway PDL**	Sample No	
Soils Description		Depth	46.43 m
		Date	

Sample Details **Specimen** **1**

Sample Condition		Undisturbed
Height	mm	201.0
Diameter	mm	80.0
Moisture Content	%	38
Bulk Density	Mg/m³	1.73
Dry Density	Mg/m³	1.26

Test Details

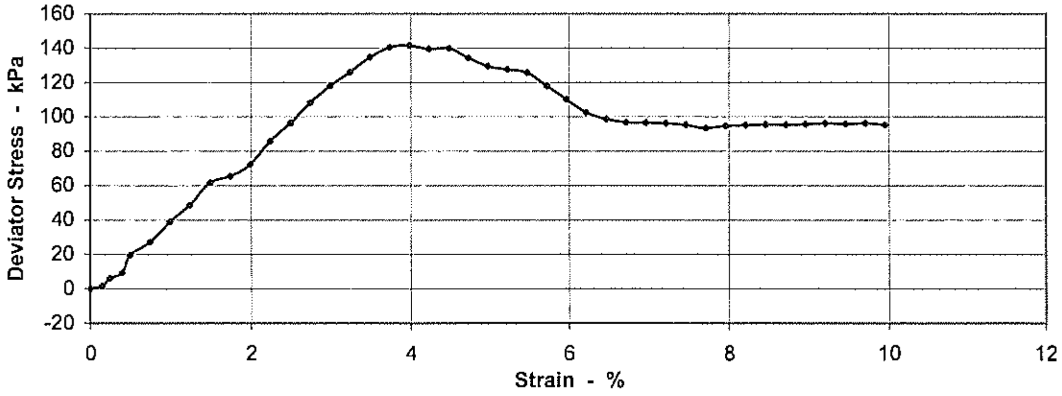
Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.48
Rate of Axial Displacement	%/min	1.49
Cell Pressure	kPa	440
Strain at Failure	%	4.0
Maximum Deviator Stress	kPa	141
Shear Strength	kPa	71
Mode of Failure		Compound

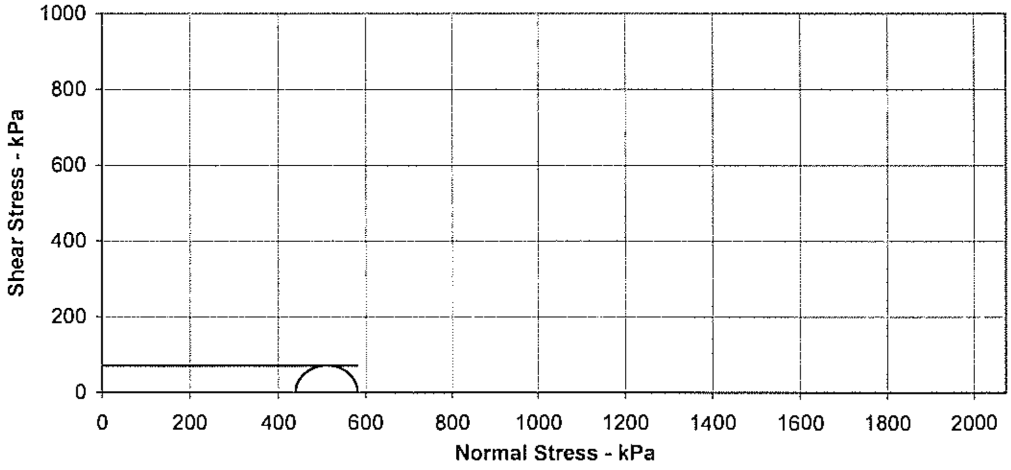
Position and orientation within the original sample

Shear Strength Parameters

C	71 kPa
Phi	0.0 °

Specimen 1





UNDRAINED TRIAXIAL COMPRESSION

BS 1377 : Part 7 : 1990 Clause 8

		Job Ref	**P16005**
Location	**Galway PDL**	Borehole / Pit No	BH03
		Sample No	
Soils Description		Depth	48.45 m
		Date	

Sample Details **Specimen** 1

Sample Condition		Undisturbed
Height	mm	210.0
Diameter	mm	83.0
Moisture Content	%	31
Bulk Density	Mg/m³	1.92
Dry Density	Mg/m³	1.47

Test Details

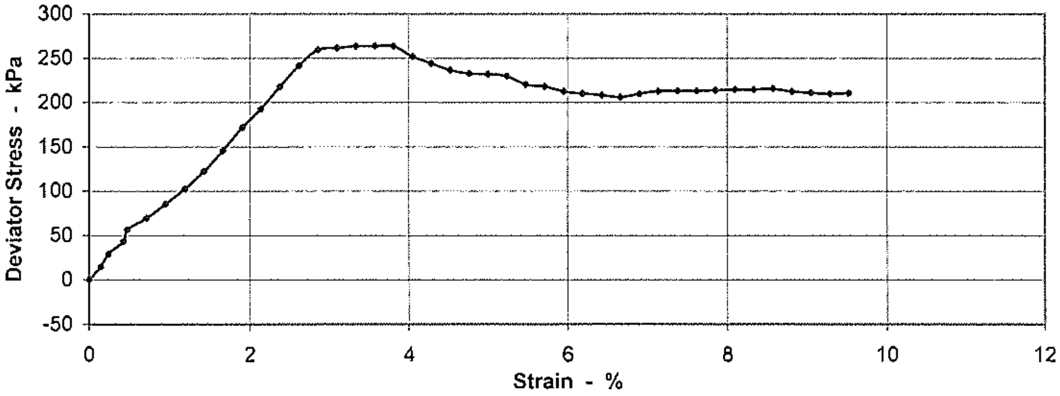
Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.44
Rate of Axial Displacement	%/min	1.43
Cell Pressure	kPa	460
Strain at Failure	%	3.8
Maximum Deviator Stress	kPa	264
Shear Strength	kPa	132
Mode of Failure		Brittle

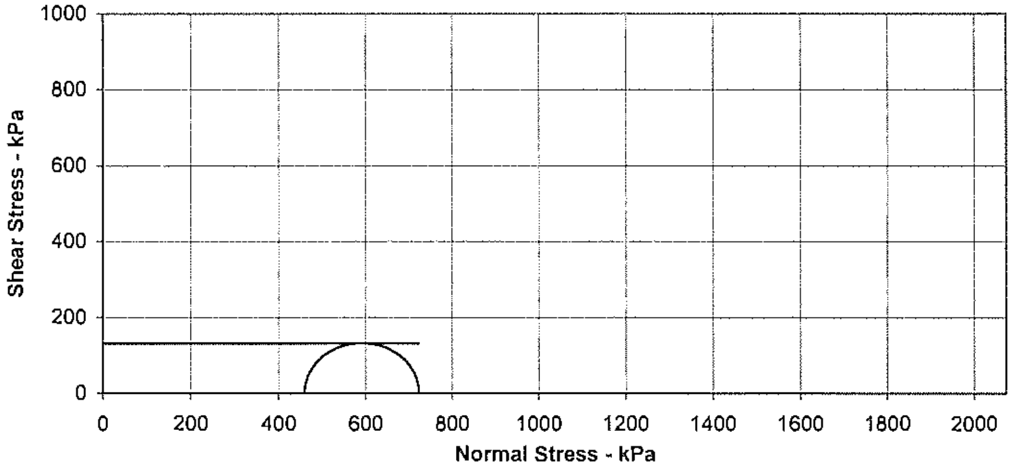
Position and orientation within the original sample

Shear Strength Parameters

C	132	kPa
Phi	0.0	°

Specimen 1





UNDRAINED TRIAXIAL COMPRESSION

BS 1377 : Part 7 : 1990 Clause 8

Location	Galway PDL	Job Ref	P16005
		Borehole / Pit No	BH06
		Sample No	
Soils Description		Depth	5.25 m
		Date	

Sample Details **Specimen 1**

Sample Condition		Undisturbed
Height	mm	196.0
Diameter	mm	82.0
Moisture Content	%	6.1
Bulk Density	Mg/m³	2.39
Dry Density	Mg/m³	2.26

Test Details

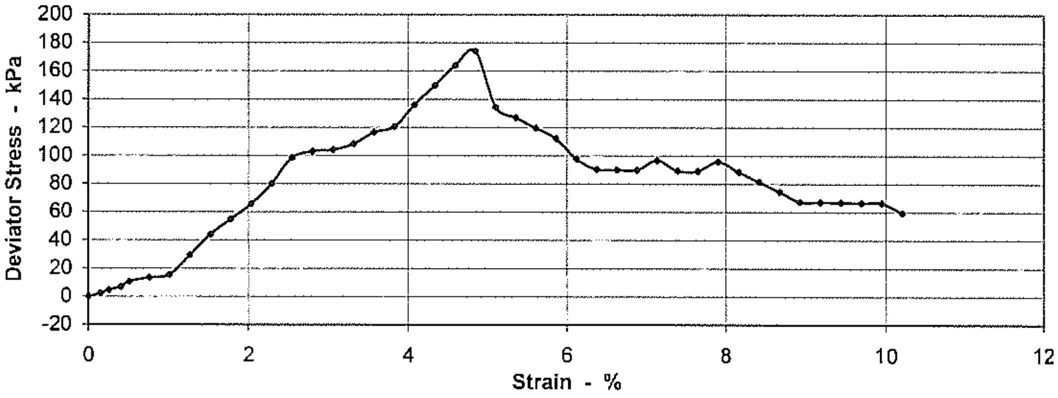
Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.55
Rate of Axial Displacement	%/min	1.53
Cell Pressure	kPa	51
Strain at Failure	%	4.8
Maximum Deviator Stress	kPa	174
Shear Strength	kPa	87
Mode of Failure		Brittle

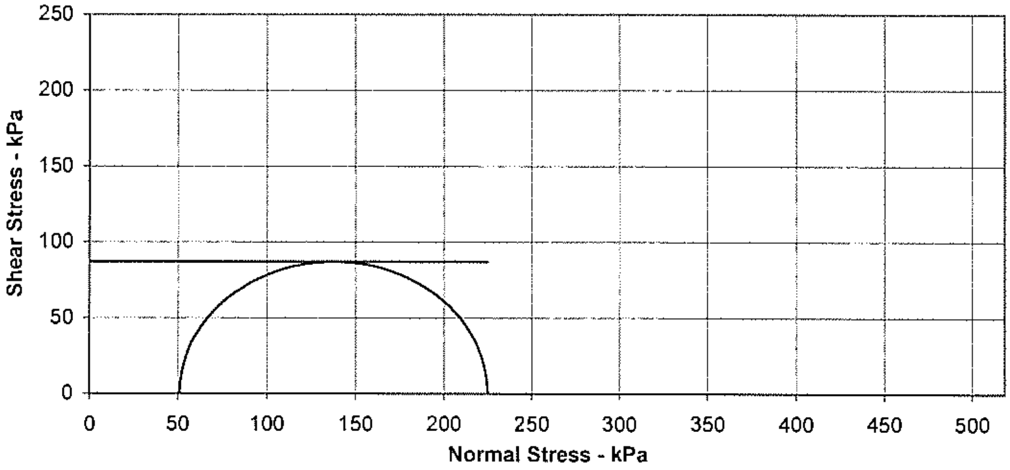
Position and orientation within the original sample

Shear Strength Parameters

C	87 kPa
Phi	0.0 °

Specimen 1





UNDRAINED TRIAXIAL COMPRESSION BS 1377 : Part 7 : 1990 Clause 8		Job Ref	P16005
Location	Galway PDL	Borehole / Pit No	BH06
		Sample No	
Soils Description		Depth	18 m
		Date	

Sample Details **Specimen** 1

Sample Condition		Undisturbed
Height	mm	206.0
Diameter	mm	82.0
Moisture Content	%	30
Bulk Density	Mg/m³	2.09
Dry Density	Mg/m³	1.61

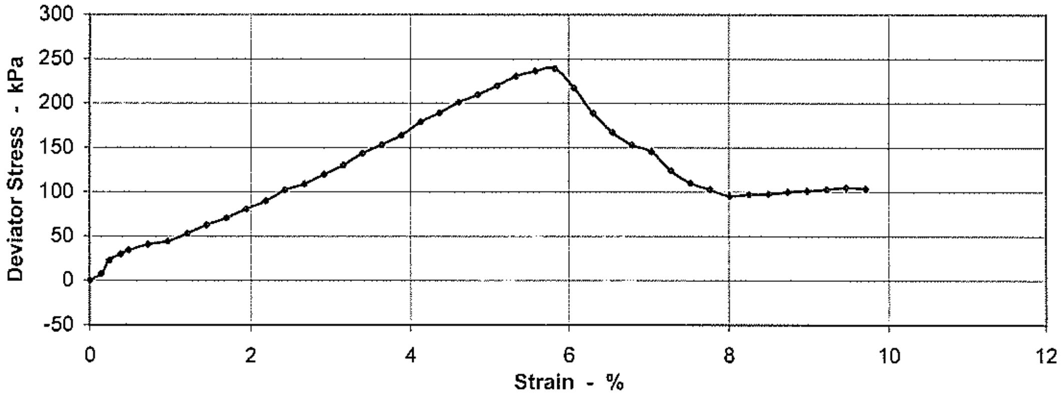
Test Details

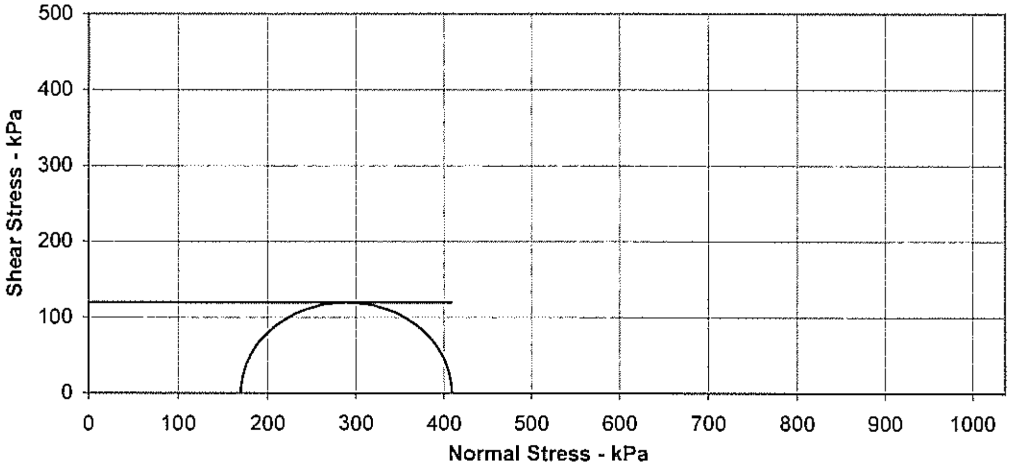
Membrane Thickness	mm	0.36
Membrane Correction	kPa	0.65
Rate of Axial Displacement	%/min	1.46
Cell Pressure	kPa	170
Strain at Failure	%	5.8
Maximum Deviator Stress	kPa	239
Shear Strength	kPa	119
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters	
C	119 kPa
Phi	0.0 °

Specimen 1





Contract Number: 30522

Client's Reference:	**P16005**	Report Date:	**09-05-2016**

Client **Priority Geotechnical Limited**
Unit 12
Owenacurra Business Park
Midleton
Co. Cork.

Contract Title: **N6 Galway Bypass**
For the attention of: **Colette Kelly**

Date Received: **07-04-2016**
Date Commenced: **07-04-2016**
Date Completed: **09-05-2016**

Test Description	Qty
One-dimensional Consolidation 75mm or 50mm diameter specimens (5 days) 1377 : 1990 Part 5 : 3 - * UKAS	7
As 4.01 each additional day 1377 : 1990 Part 5 : 3	18
Disposal of Samples on Project	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

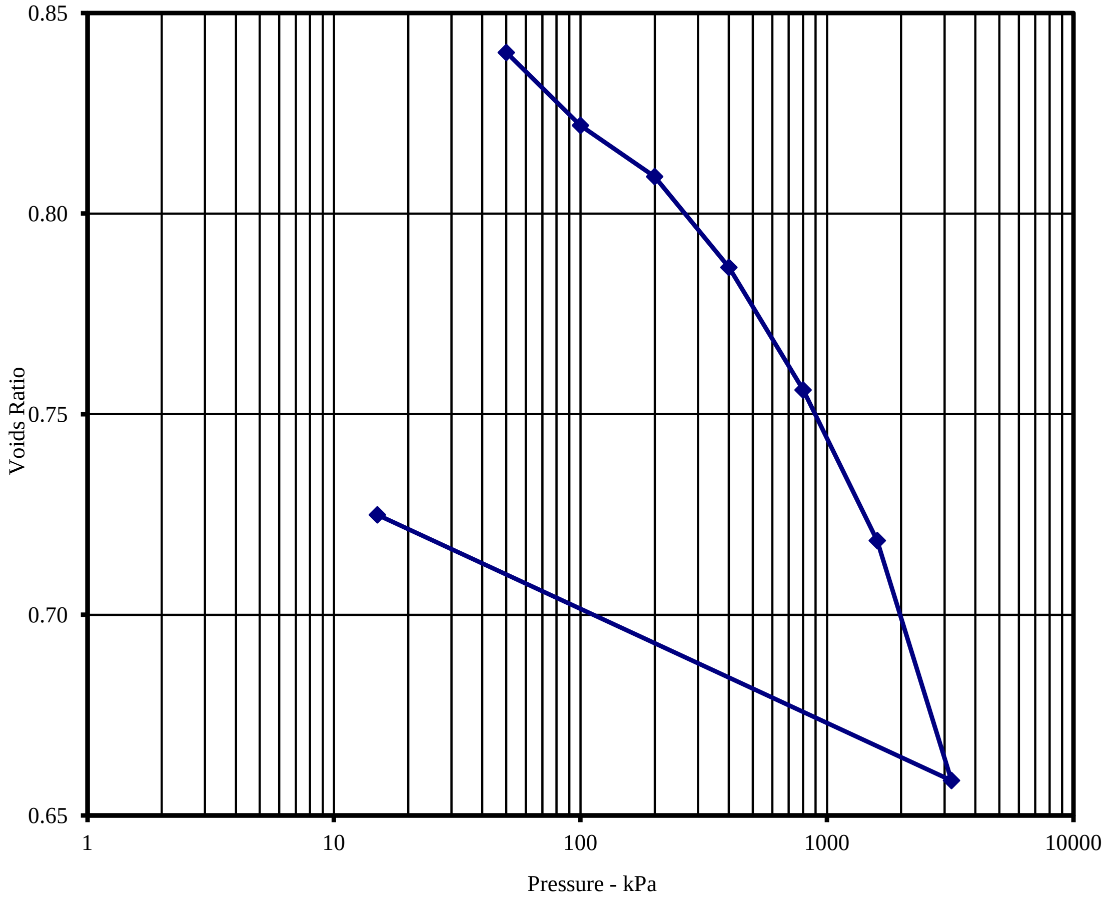
Approved Signatories:
Alex Wynn (Associate Director) - Benjamin Sharp (Contracts Manager) - Emma Sharp (Office Manager)
Paul Evans (Quality/Technical Manager) - Vaughan Edwards (Managing Director)

ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref:	**P16005**
Location:	**N6 Galway Bypass**
Contract Number:	**30522-070416**
Hole/Sample Number:	**BH03**
Depth (m):	**41.30 - 41.50**
Sample Type:	**B**

Initial Conditions		Pressure Range			Mv	Cv	Method of time fitting used
Moisture Content (%):	33	kPa			m2/MN	m2/yr	Cv Calculated using t90
Bulk Density (Mg/m3):	1.89	0	-	50	0.20	23	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.43	50	-	100	0.20	15	20'C
Voids Ratio:	0.8590	100	-	200	0.070	24	Location of specimen with sample
Degree of saturation:	101.4	200	-	400	0.063	13	top
Height (mm):	19.96	400	-	800	0.043	7.4	Remarks:
Diameter (mm)	50.06	800	-	1600	0.027	9.8	
Particle Density (Mg/m3):	2.65	1600	-	3200	0.022	11	
Assumed		3200	-	15	0.013	20	



Katam

Checked By

Date 09/05/16

D P Evans

Approved By

Date 09/05/16

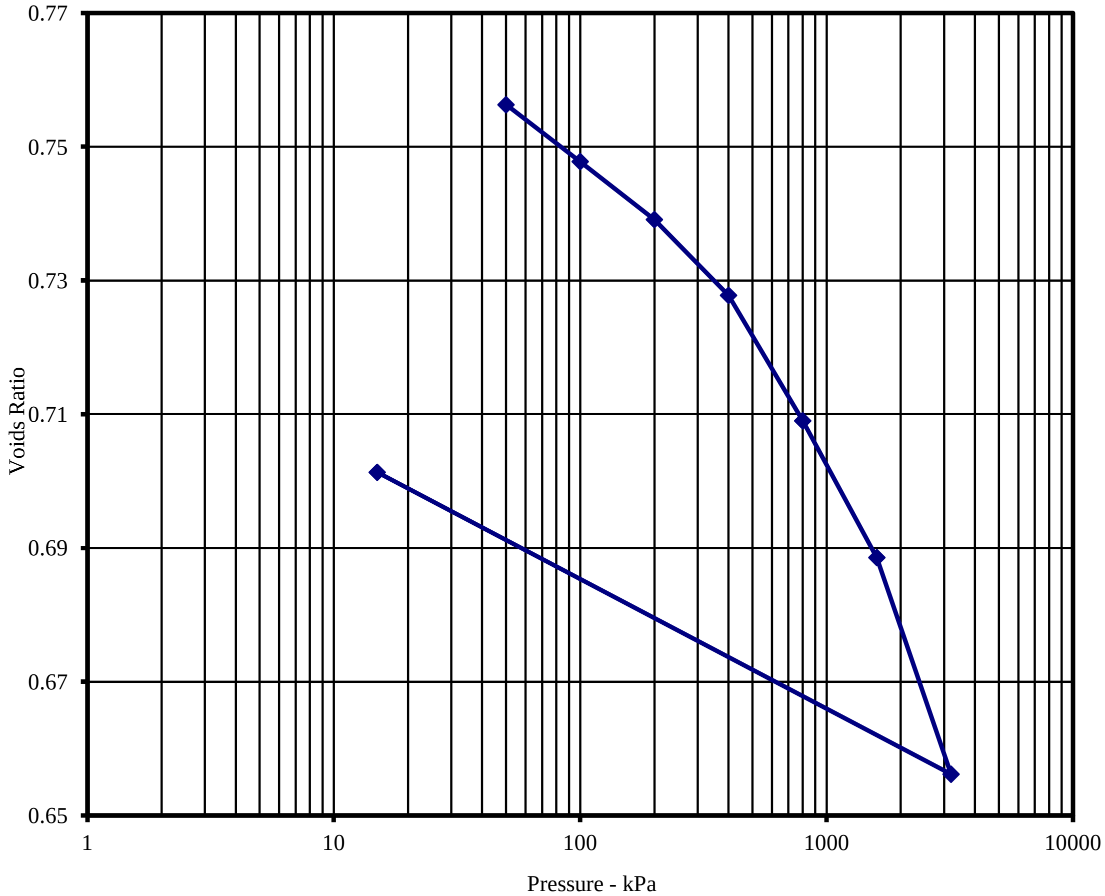
UKAS TESTING 2788

ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref:	**P16005**
Location:	**N6 Galway Bypass**
Contract Number:	**30522-070416**
Hole/Sample Number:	**BH03**
Depth (m):	**42.97 - 43.00**
Sample Type:	**B**

Initial Conditions		Pressure Range kPa	Mv m2/MN	Cv m2/yr	Method of time fitting used Cv Calculated using t90
Moisture Content (%):	29				
Bulk Density (Mg/m3):	1.93	0 - 50	0.18	31	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.50	50 - 100	0.10	11	20'C
Voids Ratio:	0.7721	100 - 200	0.050	36	Location of specimen with sample
Degree of saturation:	99.6	200 - 400	0.033	11	top
Height (mm):	20.02	400 - 800	0.027	12	Remarks:
Diameter (mm)	50.05	800 - 1600	0.015	25	
Particle Density (Mg/m3):	2.65	1600 - 3200	0.012	10	
Assumed		3200 - 15	0.0086	31	



Katan

Checked By 09/05/16 **Date**

D P Evans

Approved By 09/05/16 **Date**

GSTL GEO SITE & TESTING SERVICES LTD

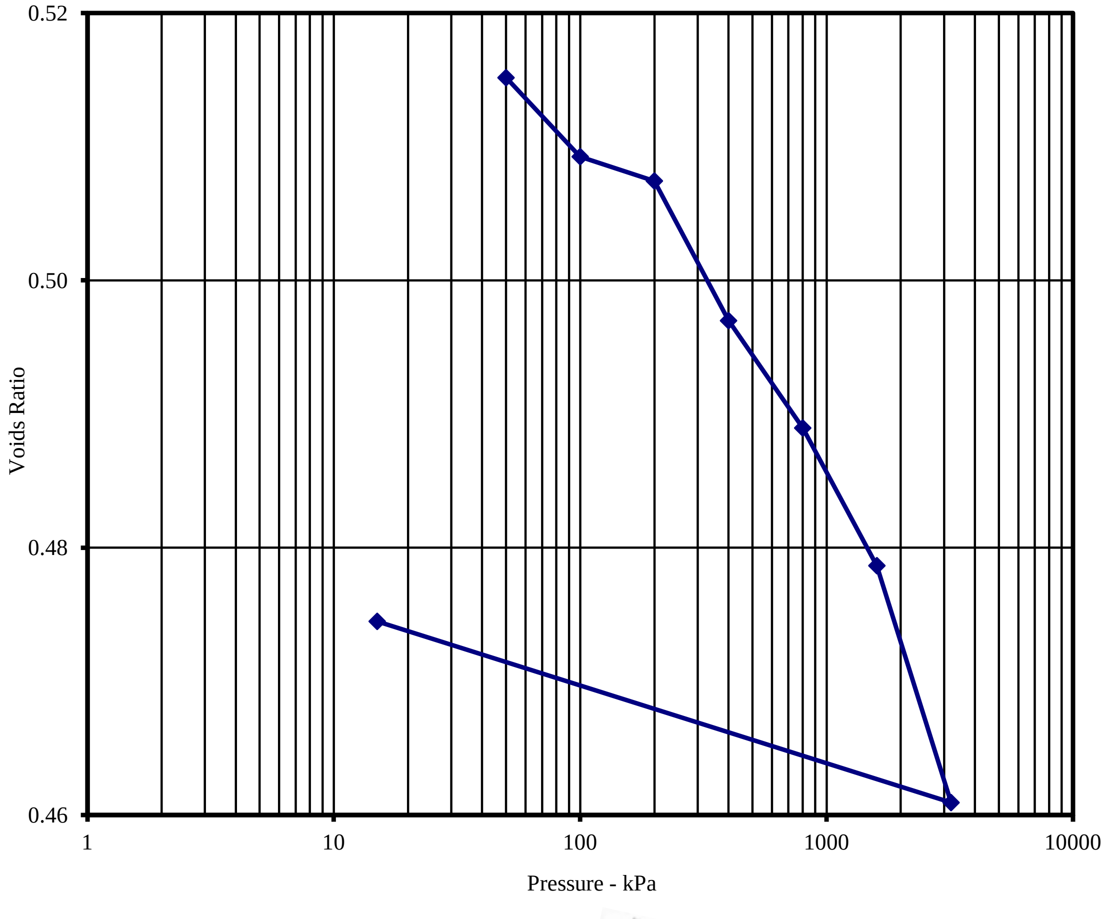
UKAS TESTING 2788

ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref:	**P16005**
Location:	**N6 Galway Bypass**
Contract Number:	**30522-070416**
Hole/Sample Number:	**BH03**
Depth (m):	**44.05 - 44.20**
Sample Type:	**B**

Initial Conditions		Pressure Range kPa	Mv m2/MN	Cv m2/yr	Method of time fitting used Cv Calculated using t90
Moisture Content (%):	21				
Bulk Density (Mg/m3):	2.11	0 - 50	0.025	19	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.75	50 - 100	0.078	0.53	20'C
Voids Ratio:	0.5171	100 - 200	0.012	19	Location of specimen with sample
Degree of saturation:	105.2	200 - 400	0.035	4.8	top
Height (mm):	20.03	400 - 800	0.013	6.2	Remarks:
Diameter (mm)	50	800 - 1600	0.0086	19	
Particle Density (Mg/m3):	2.65	1600 - 3200	0.0075	10	
Assumed		3200 - 15	0.0029	53	



Katam

Checked By 09/05/16 **Date**

D P Evans

Approved By 09/05/16 **Date**

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GEO SITE & TESTING SERVICES LTD

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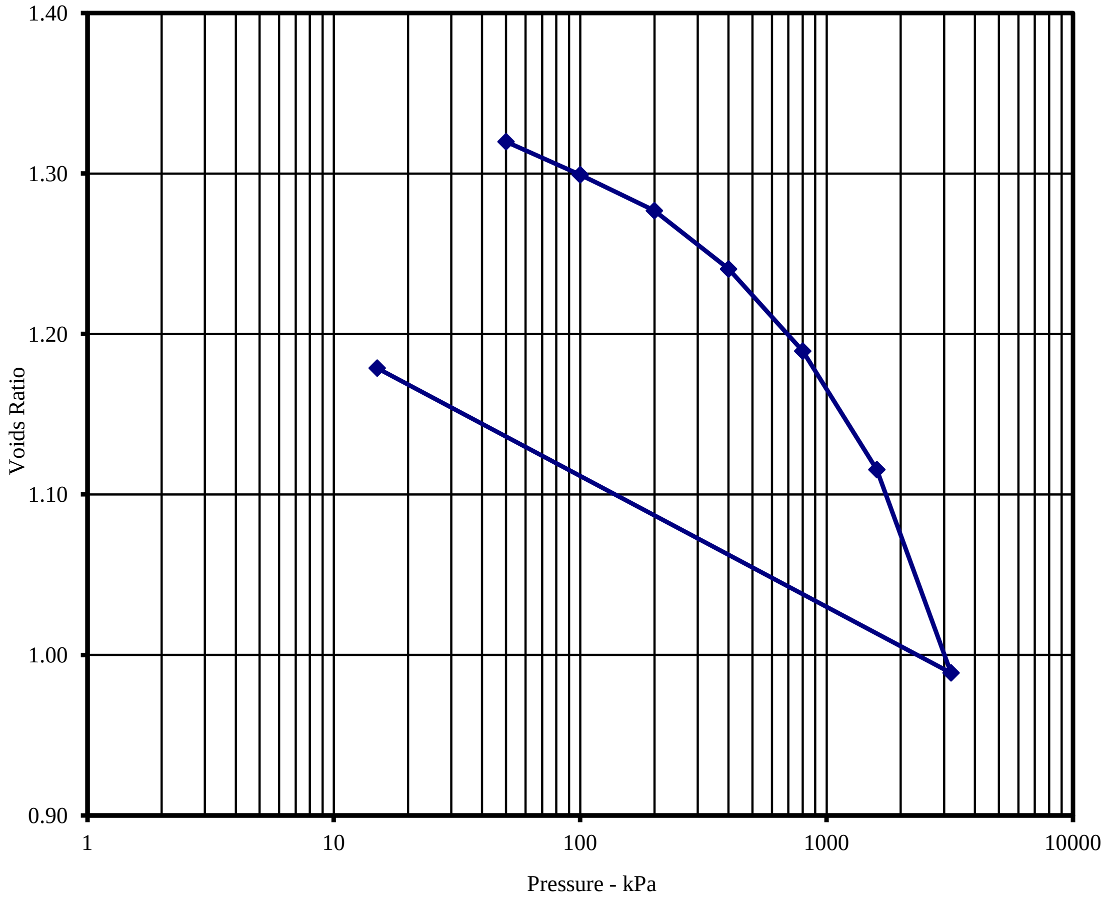
ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref:	**P16005**
Location:	**N6 Galway Bypass**
Contract Number:	**30522-070416**
Hole/Sample Number:	**BH03**
Depth (m):	**47.85 - 48.02**
Sample Type:	**B**

Initial Conditions		Pressure Range			Mv	Cv	Method of time fitting used
Moisture Content (%):	40	kPa			m2/MN	m2/yr	Cv Calculated using t90
Bulk Density (Mg/m3):	1.59	0	-	50	0.13	18	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.14	50	-	100	0.18	5.6	20'C
Voids Ratio:	1.3346	100	-	200	0.097	18	Location of specimen with sample
Degree of saturation:	79.1	200	-	400	0.080	4.1	top
Height (mm):	20.04	400	-	800	0.057	0.63	Remarks:
Diameter (mm)	50.02	800	-	1600	0.042	15	
Particle Density (Mg/m3):	2.65	1600	-	3200	0.037	9.2	
Assumed		3200	-	15	0.030	2.8	



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Checked By

09/05/16

Date

D P Evans

Approved By

09/05/16

Date

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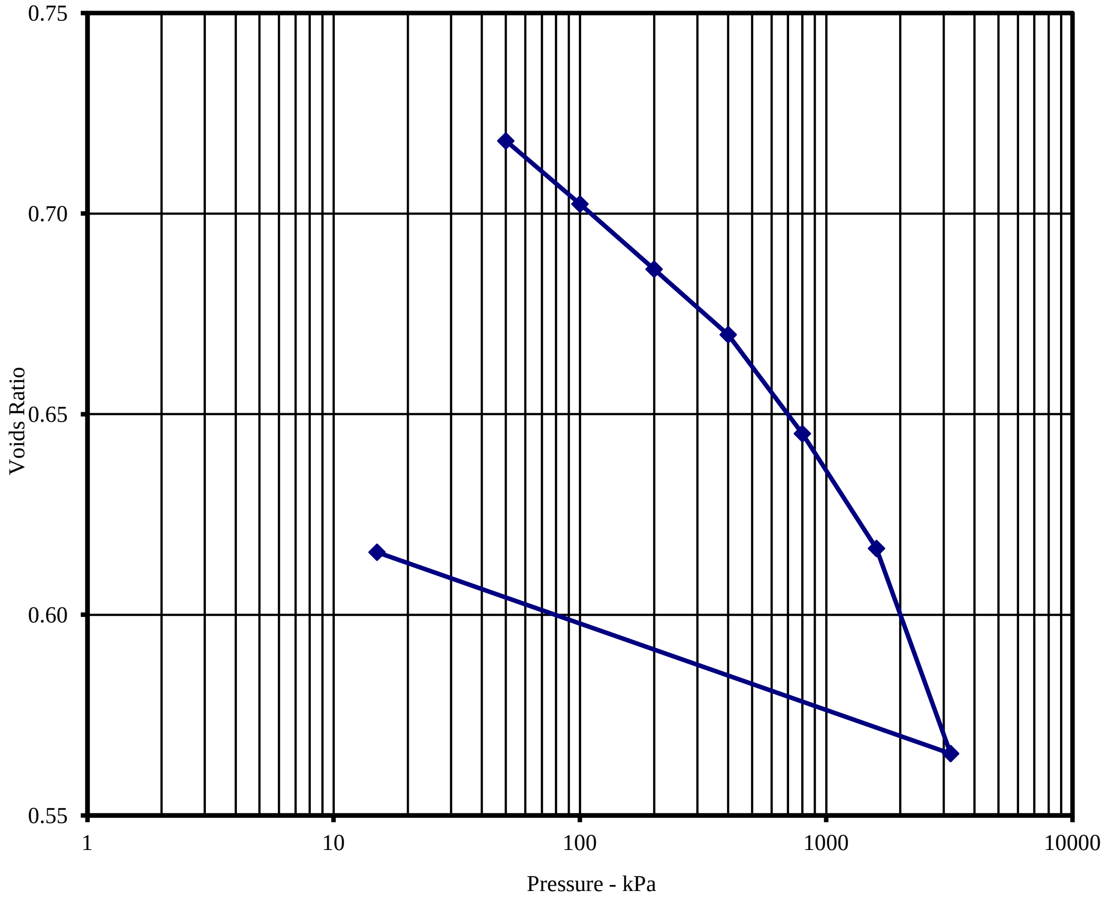
ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref:	**P16005**
Location:	**N6 Galway Bypass**
Contract Number:	**30522-070416**
Hole/Sample Number:	**BH06**
Depth (m):	**16.20 - 16.50**
Sample Type:	**B**

Initial Conditions		Pressure Range	Mv	Cv	Method of time fitting used
Moisture Content (%):	26	kPa	m2/MN	m2/yr	Cv Calculated using t90
Bulk Density (Mg/m3):	1.95	0 - 50	0.046	17	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.54	50 - 100	0.18	12	20'C
Voids Ratio:	0.7221	100 - 200	0.10	10	Location of specimen with sample
Degree of saturation:	96.9	200 - 400	0.048	16	top
Height (mm):	20.04	400 - 800	0.037	6.2	Remarks:
Diameter (mm)	50.02	800 - 1600	0.022	11	
Particle Density (Mg/m3):	2.65	1600 - 3200	0.020	14	
Assumed		3200 - 15	0.010	10	



Katam

Checked By 09/05/16 **Date**

Approved By 09/05/16 **Date**

GEO SITE & TESTING SERVICES LTD

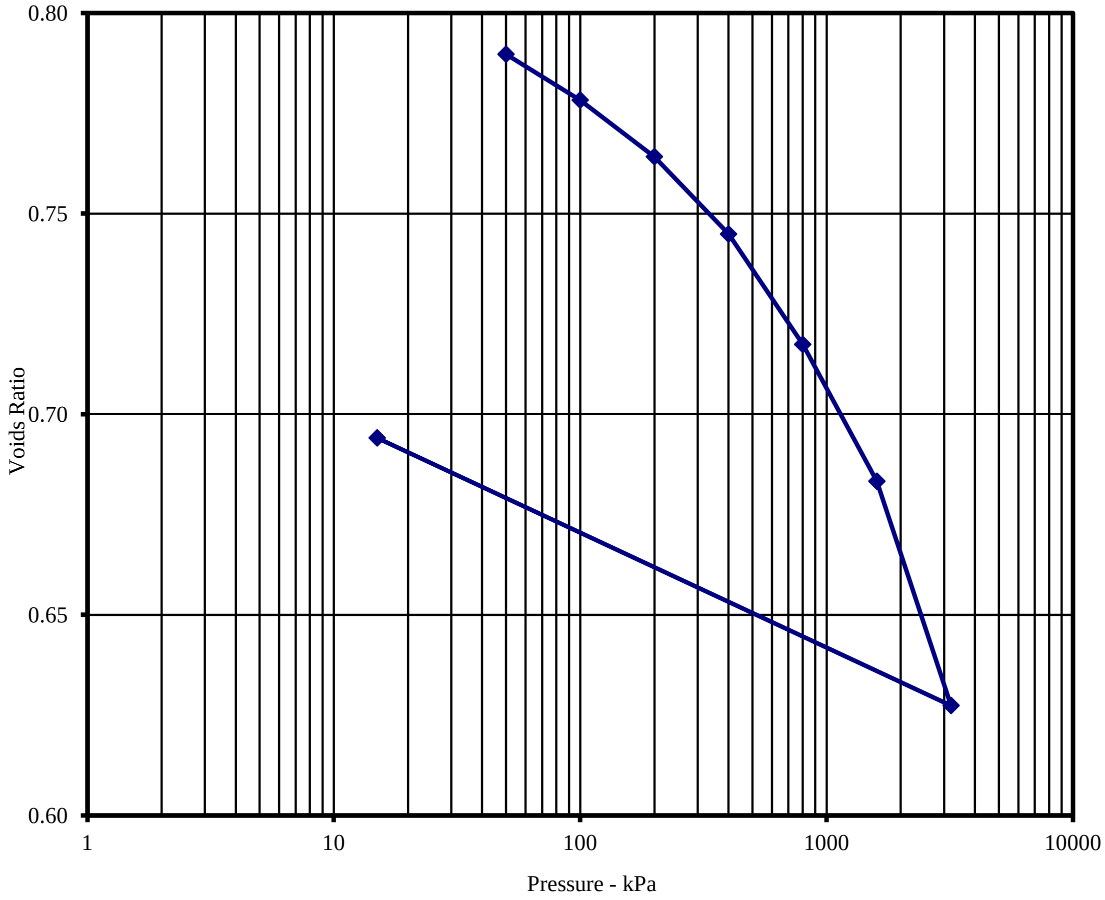
UKAS TESTING 2788

ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref: P16005
Location: N6 Galway Bypass
Contract Number: 30522-070416
Hole/Sample Number: BH06
Depth (m): 19.70 - 19.95
Sample Type: B

Initial Conditions		Pressure Range			Mv	Cv	Method of time fitting used
Moisture Content (%):	27	kPa			m2/MN	m2/yr	Cv Calculated using t90
Bulk Density (Mg/m3):	1.87	0	-	50	0.084	12	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.47	50	-	100	0.13	12	20'C
Voids Ratio:	0.7973	100	-	200	0.079	27	Location of specimen with sample
Degree of saturation:	90.1	200	-	400	0.055	11	top
Height (mm):	20.13	400	-	800	0.039	4.3	Remarks:
Diameter (mm)	50.01	800	-	1600	0.025	16	
Particle Density (Mg/m3):	2.65	1600	-	3200	0.021	15	
Assumed		3200	-	15	0.013	16	



Checked By **Date** 09/05/16

Approved By **Date** 09/05/16

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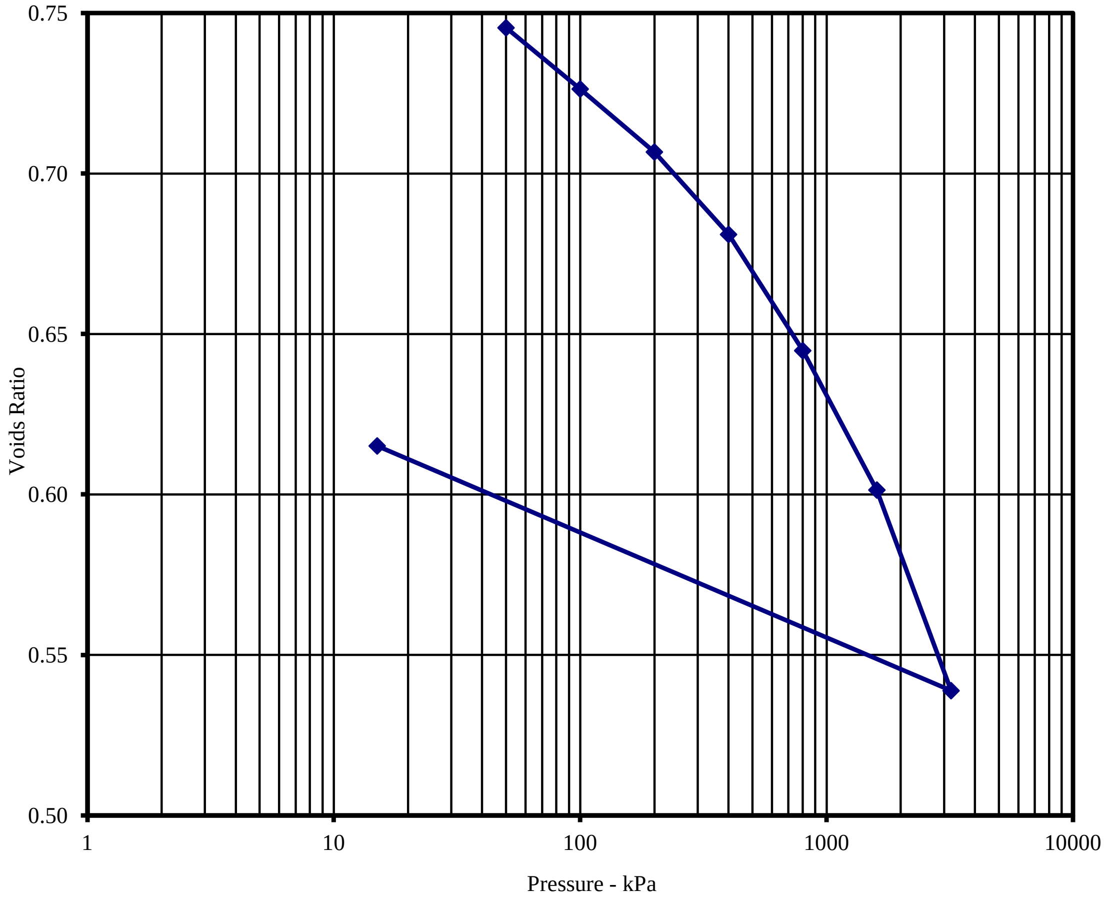
ONE DIMENSIONAL CONSOLIDATION

BS1377: Part 5: 1990

Client ref:	**P16005**
Location:	**N6 Galway Bypass**
Contract Number:	**30522-070416**
Hole/Sample Number:	**BH06**
Depth (m):	**20.00 - 20.25**
Sample Type:	**B**

Initial Conditions		Pressure Range			Mv	Cv	Method of time fitting used
Moisture Content (%):	30	kPa			m2/MN	m2/yr	Cv Calculated using t90
Bulk Density (Mg/m3):	1.94	0	-	50	0.35	18	Nominal Laboratory Temperature
Dry Density (Mg/m3):	1.49	50	-	100	0.22	15	20'C
Voids Ratio:	0.7762	100	-	200	0.11	27	Location of specimen with sample top
Degree of saturation:	101.7	200	-	400	0.075	16	
Height (mm):	19.92	400	-	800	0.054	7.0	Remarks:
Diameter (mm)	50.02	800	-	1600	0.033	21	
Particle Density (Mg/m3):	2.65	1600	-	3200	0.024	14	
Assumed		3200	-	15	0.016	7.1	



Checked By 09/05/16 **Date**

Approved By 09/05/16 **Date**

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UKAS TESTING 2788

Thin Section / Petrography

celtest
INDEPENDENT MATERIALS TESTING | DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 16th February 2016
Test Report Ref.: 443031

LABORATORY TEST REPORT

Test Requirements: Petrographic Examination of Natural Stone in accordance with BS EN 12047:2007

Sample details:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48919**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**29/1/2016**
Date of Start of Test.:	**21/1/2016**
Sampling Location:	**Depth Top: 20.05 Depth Base: 20.12**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.

RESULTS

See Attached

Nick Dumbarton – Assistant Laboratory Manager

Petrographic Examination Natural Stone– BS EN 12407:2007

HAND SPECIMEN DESCRIPTION

The sample was hard, fine to very coarse grained, anisotropic limestone breccia. The sample exhibited small to very large, medium grey limestone clasts (up to >70mm across), cemented or surrounded by dark grey materials comprising chiefly much smaller limestone and calcite grains, and including some clay materials. The sample did not appear macroporous.

MICROSCOPICAL DESCRIPTION

Constituents[1]	Visual Estimated Proportions[2] %	Range of Crystal/Grain Size	Petrographic Details	Origin
Calcite	94	Up to 4mm	Fresh, angular to well rounded calcium carbonate, including abundant bioclasts. The sample was partially stained in accordance with Dickson's method. This suggested that the calcite was non-ferroan.	Primary
Clay materials	2-3	<4µm	Very fine grained materials beyond the conclusive resolution of the petrographic microscope, which could be better investigated by scanning electron microscopy (SEM).	Primary
Opaque minerals	1-2	Up to 800µm	Irregular, anhedral to euhedral, fresh to partially oxidised isotropic minerals apparently comprising both framboidal and facetted, probably pyritic materials. Scanning electron microscopy should be used if necessary for better resolution and description of the opaque minerals.	Primary
Iron oxide compounds	<<1	N/A	Small amorphous by-products of the partial or complete oxidation of opaque minerals.	Secondary

The sample was a fine to very coarse grained LIMESTONE BRECCIA, comprising chiefly calcium carbonate (chiefly as limestone clasts), with a minor proportion of clay materials and trace to minor proportion of opaque minerals.

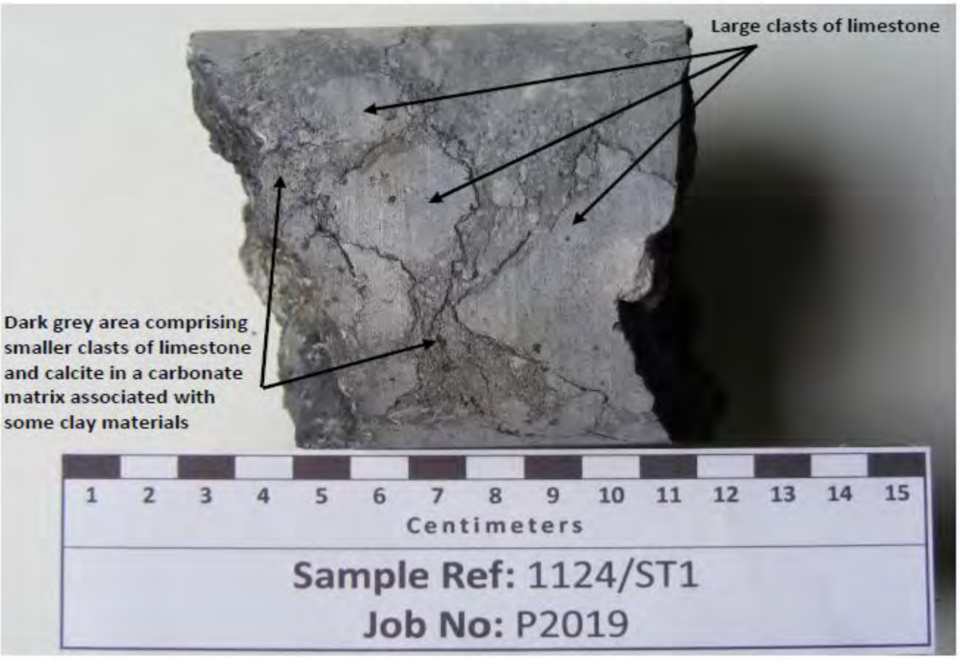
The individual limestone constituents were typically fine to medium grained. The dark grey areas of the sample comprised chiefly smaller calcium carbonate, with a minor proportion of clay materials. The opaque minerals were unevenly distributed and were frequently observed concentrated in thin, irregular and randomly orientated layers within the dark grey areas of the sample.

The sample fractured relatively easily along irregular and randomly distributed fracture surfaces within the dark grey areas of the sample during the cutting process to produce the thin section slice. This suggested that the dark grey areas of the sample exhibited frequent planes of weakness, which were probably associated with clay materials and the irregular layers of opaque minerals.

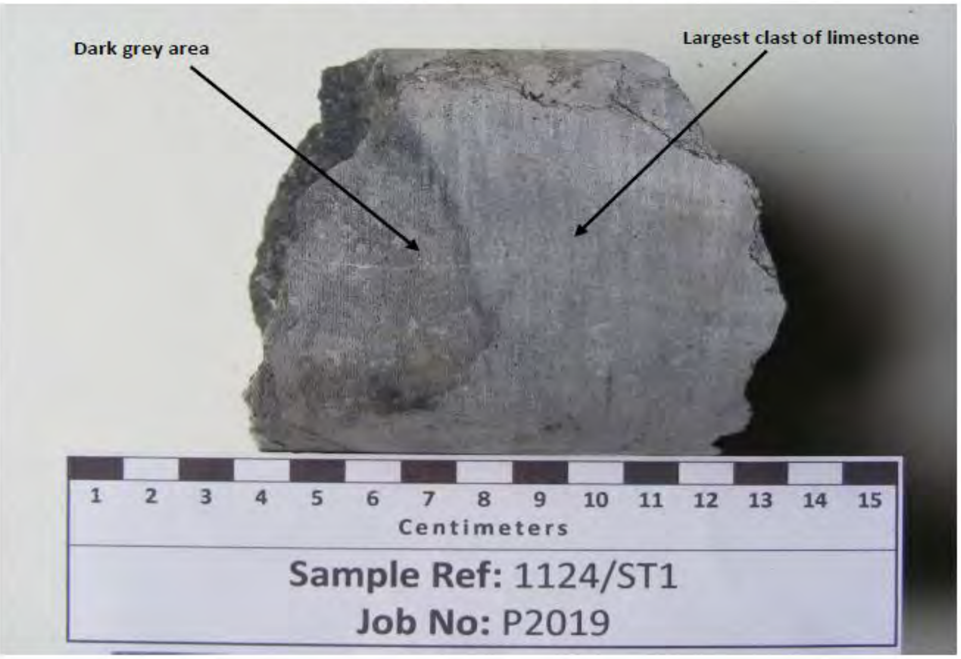
Only rare voids up to 0.4mm were observed. These voids appeared chiefly associated with loss of materials during the sampling process and did not appear interconnected. The void content was visually estimated as being well below 1%.

The sample was fresh and exhibited Grade I weathering.

Profile view of the sample as received

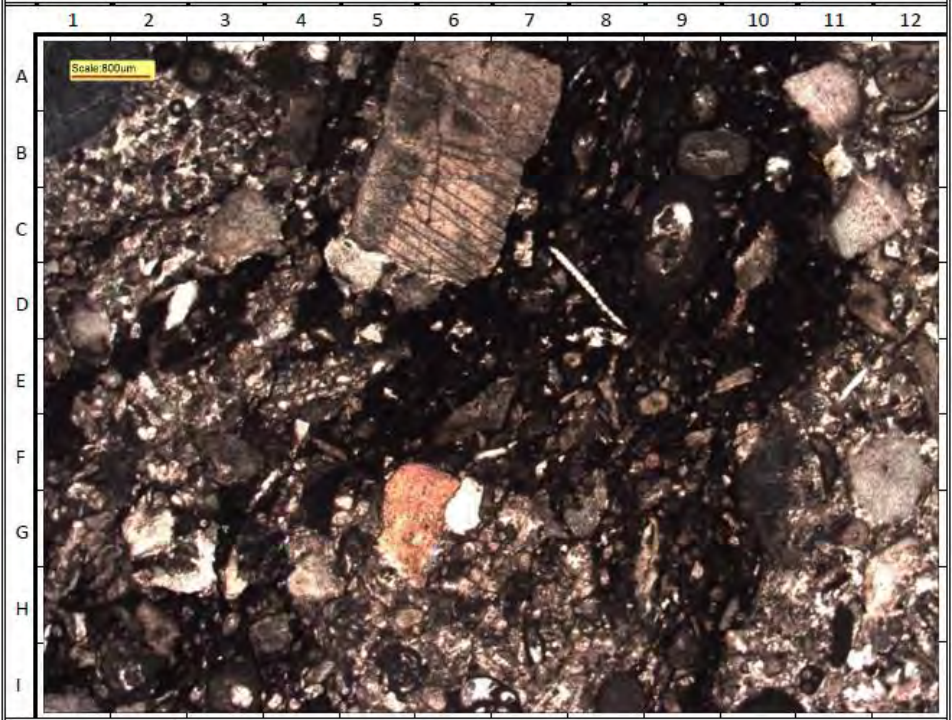


Another profile view of the sample as received



Petrographic Examination Natural Stone– BS EN 12407:2007

RECORD PHOTOMICROGRAPH



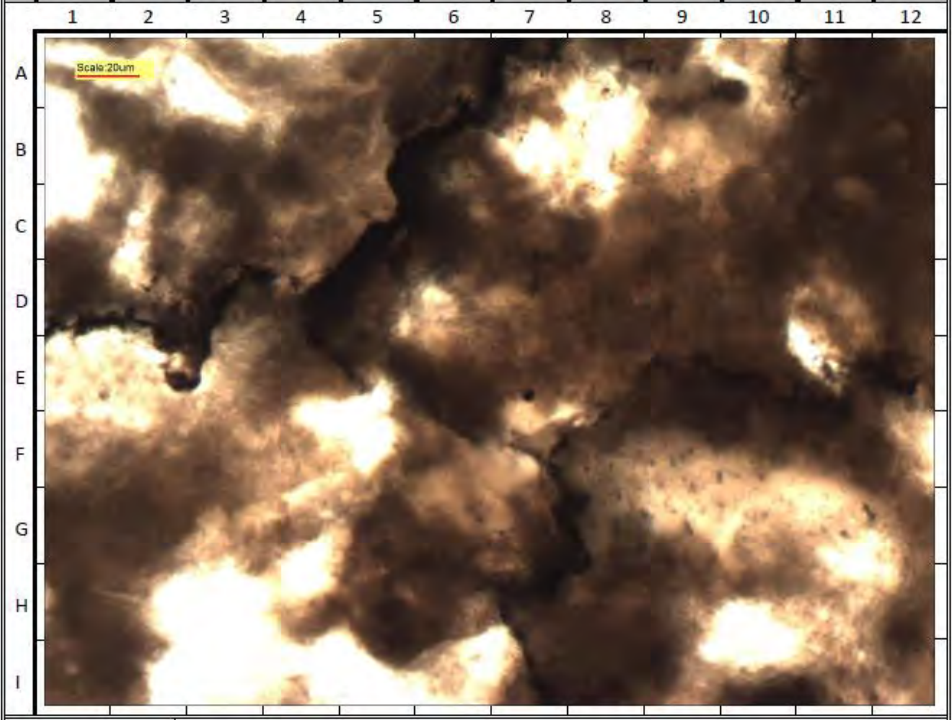
Viewing Light	Cross-polarised

Description

View of a section through the limestone, showing limestone and calcite clasts (grey/pale brown/white, pale pink/greyish brown: B2, B6, B9, B12, F2 and H6) and section of the dark grey areas (greyish black: A8, D3 and I2) comprising smaller limestone and calcite clasts/grains and some clay materials.

Petrographic Examination Natural Stone– BS EN 12407:2007

RECORD PHOTOMICROGRAPH

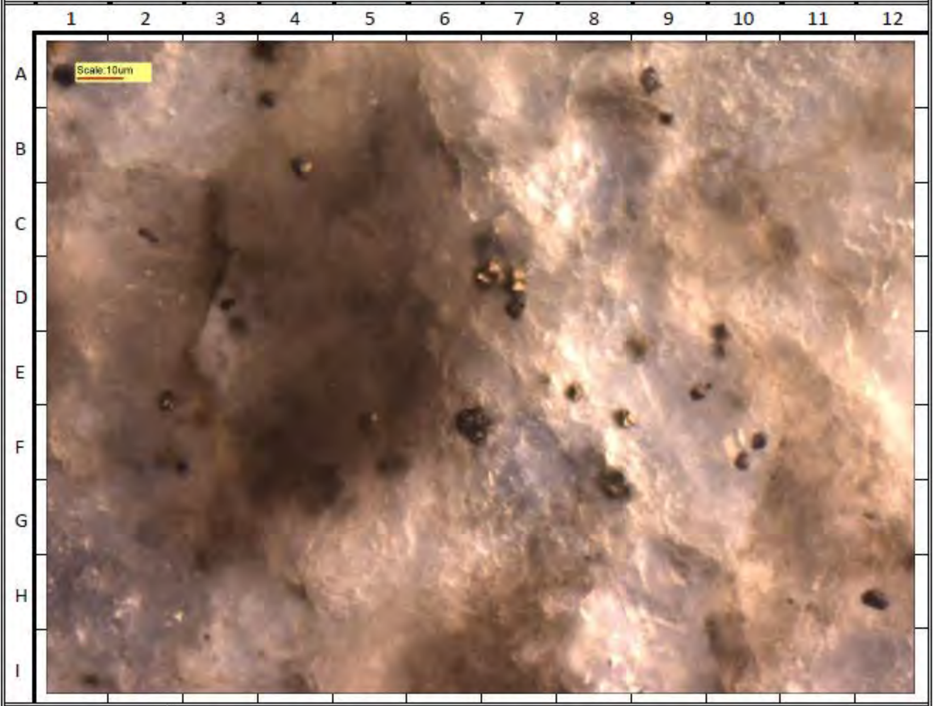


Viewing Light	Plane-polarised

Description

Closer view of a section through a dark grey area of the sample, showing clay materials (brown: A6, A11 and G1) and randomly distributed layers of opaque minerals (black: A7 to D1, D4 to F7 and E12 to I7).

RECORD PHOTOMICROGRAPH



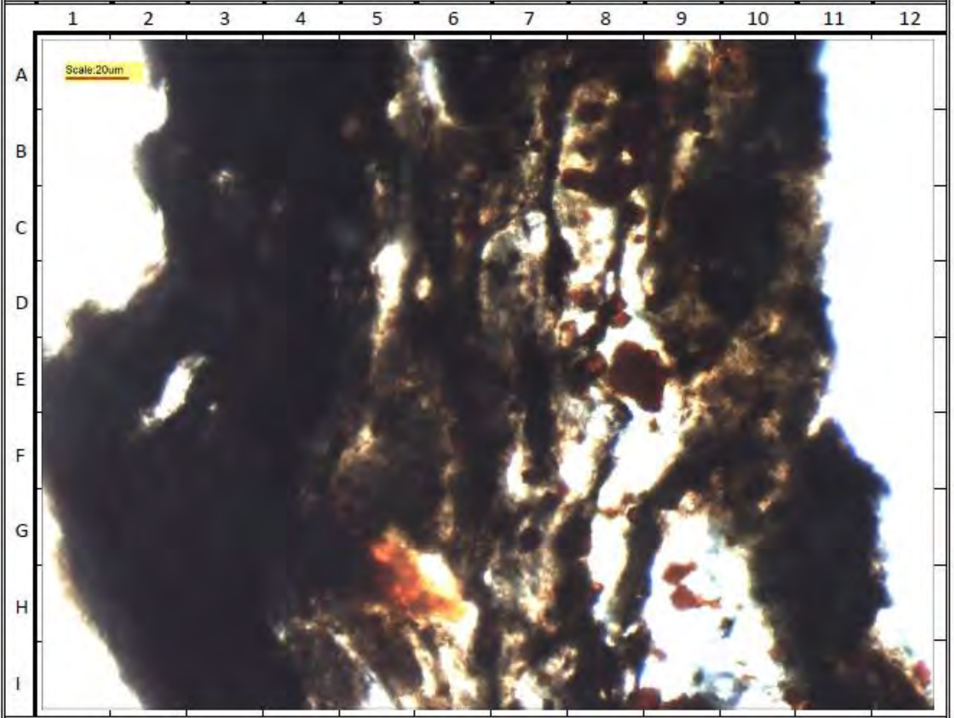
Viewing Light	Reflected light

Description

Closer view of a section through the sample, showing faceted opaque minerals (brass coloured: A9, B4, D7 and F8) and apparent framboidal opaque minerals (black/brass: A1, D7 and F6).

Petrographic Examination Natural Stone– BS EN 12407:2007

RECORD PHOTOMICROGRAPH



Viewing Light	Plane-polarised

Description

View of a section through the sample, showing opaque minerals (black: A3, A6 and C9) an oxidised opaque minerals (dusky red, reddish orange: A10, E8, H5/6 and H9irregular voids (yellow: B6, D6 and H9).

Petrographic Examination Natural Stone– BS EN 12407:2007

Glossary of Terms Used in the Descriptions

Proportions	**Major**: constituent present at a level ≥10%; **Minor**: constituent present at level ≥2% but <10; **Trace**: constituent present at <2% level
Frequency	• Rare – only found by thorough searching • Sporadic – only occasionally observed during normal examination • Common – easily observed during normal examination • Frequent – easily observed with minimal examination • Abundant – immediately apparent to initial examination
Hardness	• Very soft: can be penetrated easily by a finger • Soft: scores with a fingernail • Moderately soft: scores using a copper coin • Moderately hard: scores easily with a penknife • Hard: not easily scored with a penknife • Very hard: cannot be scored with a steel point or knife.
Weathering/ alteration	• Grade I (**Fresh**): Unchanged from original state • Grade II (**Slightly Weathered**): Slight discoloration, slight weakening; • Grade III (**Moderately Weathered**): Considerably weakened, penetrative discoloration, large pieces cannot be broken by hand • Grade IV (**Highly Weathered**): large pieces can be broken by hand, does not readily disaggregate (slake) when dry sample immersed in water • Grade V (**Completely Weathered**): considerably weakened, slakes, original texture apparent; Grade VI (**Residual Soil**) • Soil derived by in-situ weathering but retaining none of the original texture or fabric.
Origin	• **Primary constituents:** Constituents present within the rock at its formation. • **Secondary constituents:** Constituents formed by the alteration of pre-existing primary constituents or introduced from an external source after the rock was formed
Size	**Mega**: >60mm; **Macro**: 2-60mm; **Meso**: 60µm-2mm; **Micro**: 2-60µm; **Crypto**: <2µm; **Glassy**: without visible crystallinity
Bedding/Layering	**Thick**: >600mm; **Medium**: 200-600mm; **Thin**: 60-200mm; **Very thin**: 20-60mm
Lamination	**Thick**: 6-20mm; **Thin**: 2-6mm; **Very thin**: 600µm-2mm; **Extremely thin**: <600µm
Cleavage	**Extremely wide**: >2mm; **Very wide**: 600µm-2mm; **Wide**: 200-600µm; **Medium**: 60-200µm; **Close**: 20-60µm; **Very close**: 6-20µm; **Extremely close**: <6µm.
Cracks	• Fine microcracks (<1µm wide) • Microcracks (1-10µm wide) • Fine cracks (10-100µm wide) • Cracks (100µm-1mm wide) • Large cracks (>1mm wide).
Limestone Classification Schemes	**Folk**, R. L. 1959. Practical petrographic classification of limestones. *Bull. Am. Ass. Petro. Geol.* **43**, 1-38. **Dunham**, R. J. 1962. Classification of carbonate rocks according to depositional texture. In: Classification of Carbonate Rocks (Ed. By W. E. Ham), pp. 108-121. *Mem. Am. Ass. Petrol. Geol.* **1**, Tulsa.

Priority Construction Ltd
162 Clontarf Road
Dublin 3
Ireland
VAT No: 9D53971I

Date: 16th February 2016
Test Report Ref.: 443144

LABORATORY TEST REPORT

Test Requirements: Petrographic Examination of Natural Stone in accordance with BS EN 12047:2007

Sample details:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50728**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**29/1/2016**
Date of Start of Test.:	**21/1/2016**
Sampling Location:	**Depth Top: 32.92 Depth Base: 33**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.

RESULTS

See Attached

Nick Dumbarton – Assistant Laboratory Manager

Petrographic Examination Natural Stone– BS EN 12407:2007

HAND SPECIMEN DESCRIPTION

The sample was hard, fine grained, massive, not macroporous limestone. The sample was almost isotropic, except for the presence of a small stylolite (irregular suture) typically <200µm across, running more or less perpendicular to the coring direction. Sporadic small irregular voids up to approximately 1mm across were observed chiefly associated with apparent loss of materials along the stylolite.

MICROSCOPICAL DESCRIPTION

Constituents[1]	Visual Estimated Proportions[2] %	Range of Crystal/Grain Size	Petrographic Details	Origin
Calcite	99	Up to 800µm	Fresh, angular to well rounded calcium carbonate, including frequent bioclasts. The sample was partially stained in accordance with Dickson's method. This suggested that the calcite was non-ferroan.	Primary
Opaque minerals	<1	Up to 80µm	Fresh to partially altered, chiefly euhedral isotropic minerals apparently comprising facetted, probably pyritic materials. SEM should be used if necessary for better resolution and description of the opaque minerals.	Primary
Iron oxide compounds	<<1	N/A	Rare amorphous by-products of the partial or complete oxidation of opaque minerals.	Secondary

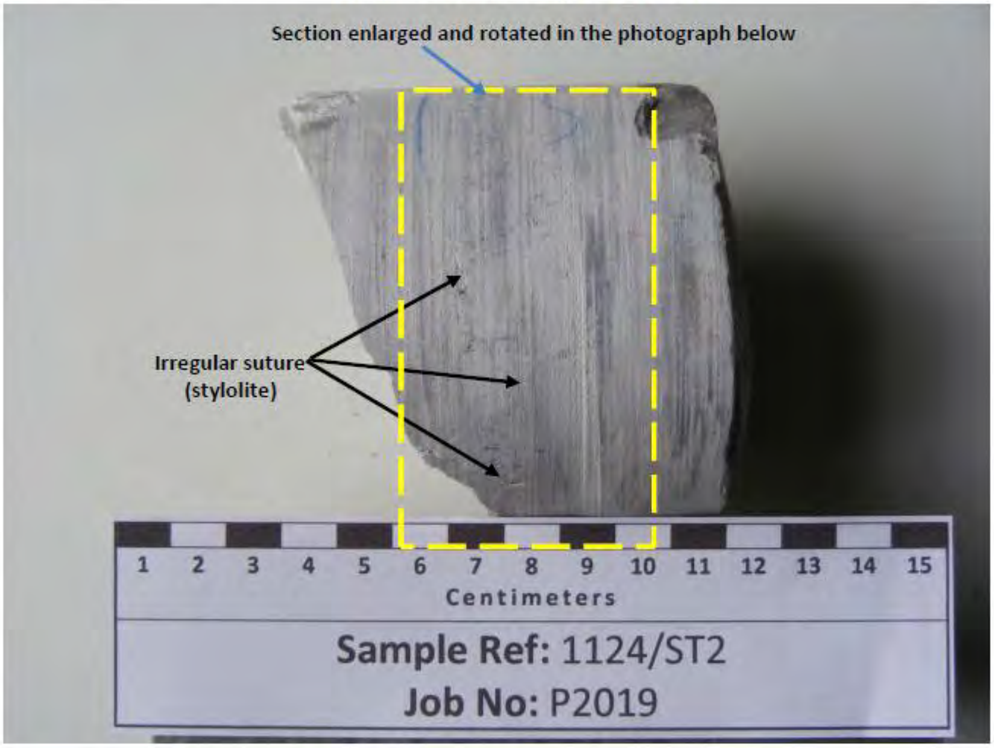
The sample was a fine grained LIMESTONE, comprising almost entirely calcium carbonate, with trace amounts of opaque minerals and associated iron oxide compounds.

The sample exhibited stylolite comprising coarser crystals of calcite.

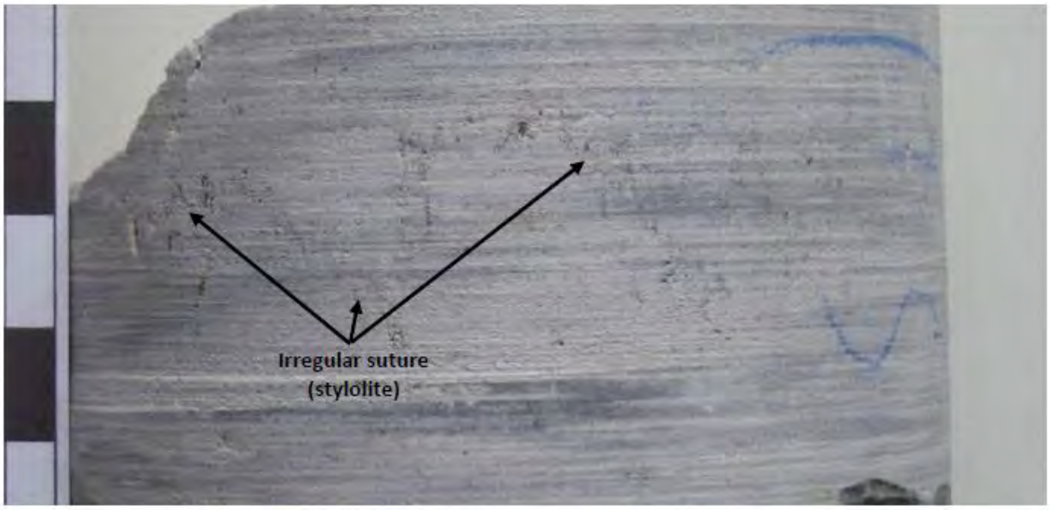
The sporadic voids observed associated with the stylolite did not appeared interconnected. The void content was visually estimated as being well below 1%.

The sample was fresh and exhibited Grade I weathering.

Profile view of the sample as received

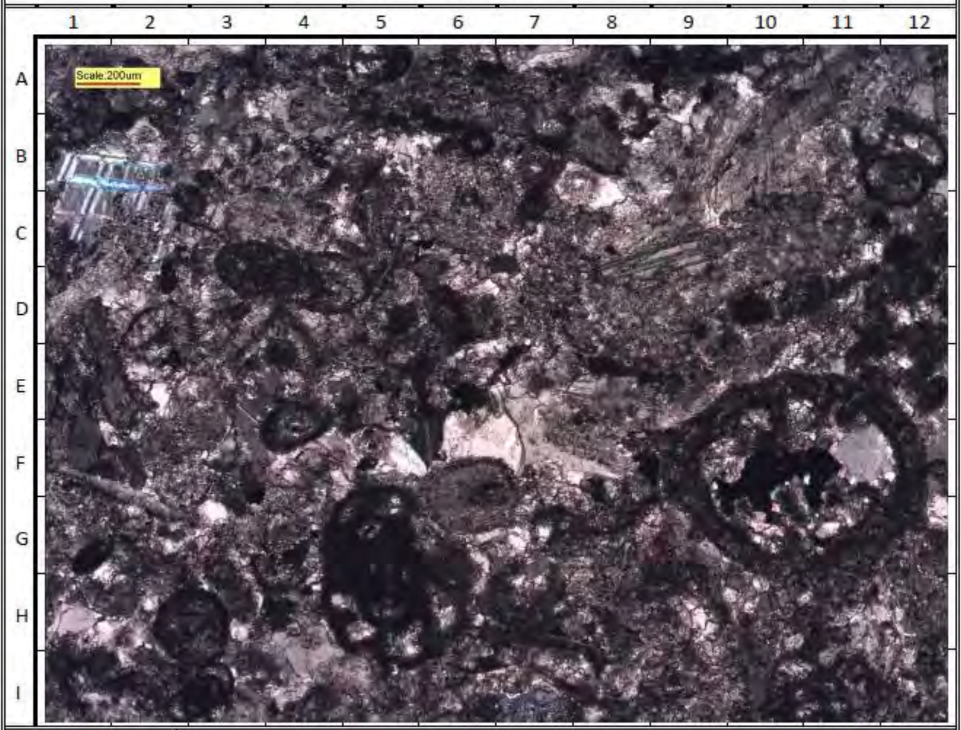


Closer view of the stylolite with 90 degrees rotation of the photograph



Petrographic Examination Natural Stone– BS EN 12407:2007

RECORD PHOTOMICROGRAPH



Viewing Light	Cross-polarised

Description

View of a section through the limestone particles showing almost entire calcium carbonate (brown, dusky brown, greyish brown, grey/blue/green, pale pink: A9, B/C1, C9, F7 and G5), including bioclasts (dusky brown/greyish black: A5, C/D4, F10 and G5).

Petrographic Examination Natural Stone– BS EN 12407:2007

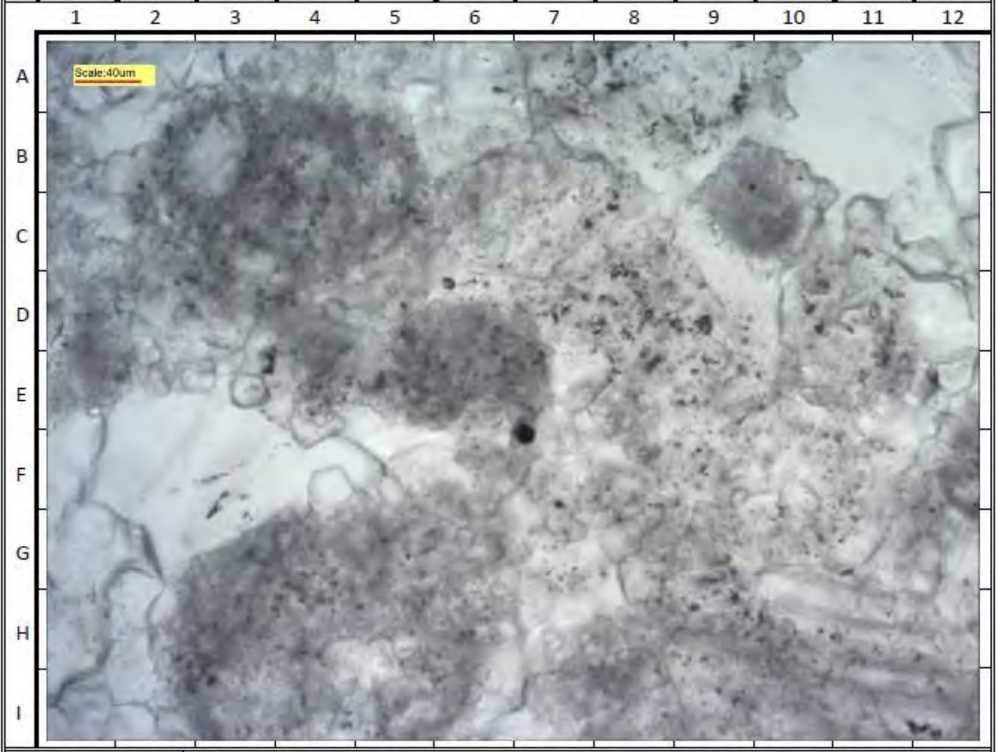
RECORD PHOTOMICROGRAPH

Viewing Light	Cross-polarised

Description

Closer view of a section through the limestone, showing sections of the stylolite (pale pink: A7, E5, E9, H4 and I9) and voids (yellow: B7/8, D8, F8 and I9) associated with the stylolite.

RECORD PHOTOMICROGRAPH

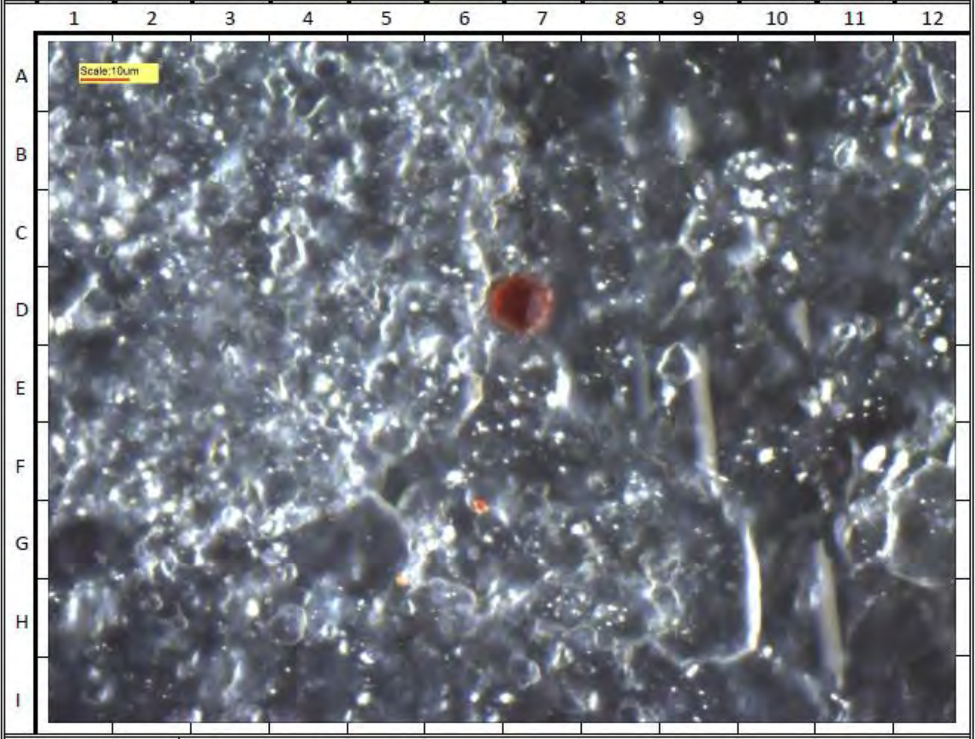


Viewing Light	Plane-polarised

Description

View of a section through the limestone, showing opaque minerals (black: E/F7).

RECORD PHOTOMICROGRAPH



Viewing Light	Reflected light

Description

View of a section through the limestone, showing partially oxidised opaque mineral (red: D7) and iron oxide compounds (reddish orange: G6 and G/H5).

Glossary of Terms Used in the Descriptions

Proportions	**Major**: constituent present at a level ≥10%; **Minor**: constituent present at level ≥2% but <10; **Trace**: constituent present at <2% level
Frequency	• Rare – only found by thorough searching • Sporadic – only occasionally observed during normal examination • Common – easily observed during normal examination • Frequent – easily observed with minimal examination • Abundant – immediately apparent to initial examination
Hardness	• Very soft: can be penetrated easily by a finger • Soft: scores with a fingernail • Moderately soft: scores using a copper coin • Moderately hard: scores easily with a penknife • Hard: not easily scored with a penknife • Very hard: cannot be scored with a steel point or knife.
Weathering/ alteration	• Grade I (**Fresh**): Unchanged from original state • Grade II (**Slightly Weathered**): Slight discoloration, slight weakening; • Grade III (**Moderately Weathered**): Considerably weakened, penetrative discoloration, large pieces cannot be broken by hand • Grade IV (**Highly Weathered**): large pieces can be broken by hand, does not readily disaggregate (slake) when dry sample immersed in water • Grade V (**Completely Weathered**): considerably weakened, slakes, original texture apparent; Grade VI (**Residual Soil**) • Soil derived by in-situ weathering but retaining none of the original texture or fabric.
Origin	• **Primary constituents:** Constituents present within the rock at its formation. • **Secondary constituents:** Constituents formed by the alteration of pre-existing primary constituents or introduced from an external source after the rock was formed
Size	**Mega**: >60mm; **Macro**: 2-60mm; **Meso**: 60µm-2mm; **Micro**: 2-60µm; **Crypto**: <2µm; **Glassy**: without visible crystallinity
Bedding/Layering	**Thick**: >600mm; **Medium**: 200-600mm; **Thin**: 60-200mm; **Very thin**: 20-60mm
Lamination	**Thick**: 6-20mm; **Thin**: 2-6mm; **Very thin**: 600µm-2mm; **Extremely thin**: <600µm
Cleavage	**Extremely wide**: >2mm; **Very wide**: 600µm-2mm; **Wide**: 200-600µm; **Medium**: 60-200µm; **Close**: 20-60µm; **Very close**: 6-20µm; **Extremely close**: <6µm.
Cracks	• Fine microcracks (<1µm wide) • Microcracks (1-10µm wide) • Fine cracks (10-100µm wide) • Cracks (100µm-1mm wide) • Large cracks (>1mm wide).
Limestone Classification Schemes	**Folk**, R. L. 1959. Practical petrographic classification of limestones. *Bull. Am. Ass. Petro. Geol.* **43**, 1-38. **Dunham**, R. J. 1962. Classification of carbonate rocks according to depositional texture. In: Classification of Carbonate Rocks (Ed. By W. E. Ham), pp. 108-121. *Mem. Am. Ass. Petrol. Geol.* **1**, Tulsa.

Priority Drilling Ltd.
Killimor
Ballinasloe
Co Galway
Ireland
8D23036i

Date: 6th April 2016
Test Report Ref.: 447907

LABORATORY TEST REPORT

Test Requirements: Petrographic Examination of Natural Stone in accordance with BS EN 12047:2007

Sample details:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50899**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test.:	**18/03/2016**
Sampling Location:	**Depth Top:113.00 Depth Base:113.08**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.

RESULTS

See Attached

Nick Dumbarton – Assistant Laboratory Manager

Petrographic Examination Natural Stone– BS EN 12407:2007

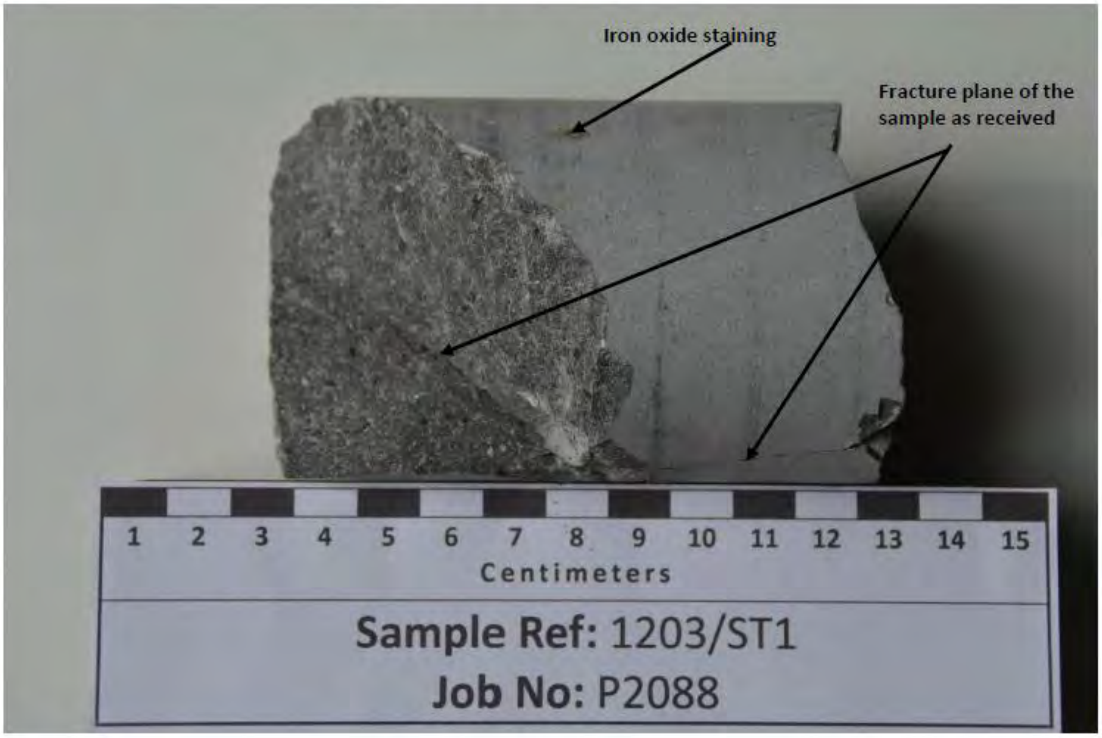
HAND SPECIMEN DESCRIPTION

The sample was a moderately hard, fine to medium grained, massive, not macroporous limestone. The sample was chiefly medium dark grey, but exhibited common, randomly distributed, very light grey to medium grey grains that constituted the medium sized grains of the rock. The sample was almost isotropic, except for the presence of sporadic, randomly orientated small dark grey apparent stylolite (irregular suture) typically <500µm across and rare vein <400µm. Sporadic unevenly distributed patches of iron oxide compounds were observed.

MICROSCOPICAL DESCRIPTION

Constituents[1]	**Visual Estimated Proportions**[2] **%**	**Range of Crystal/Grain Size**	**Petrographic Details**	**Origin**
Calcite	99	Up to 2500µm	Fresh, anhedral to euhedral crystals comprising chiefly microcrystalline calcite (calcite crystals <4µm), with a lesser proportion of sparry calcite (calcite crystals >4µm) and large discrete calcium carbonate grains. The sparry calcite and larger discrete calcium carbonate grains were chiefly observed within randomly distributed, abundant bioclasts and rare calcite veins. The sample was partially stained in accordance with Dickson's method. This suggested that the calcite was predominantly non-ferroan, with a trace amount of possibly ferroan calcite.	Primary
Opaque minerals	<1	Up to 50µm	Fresh, chiefly anhedral isotropic minerals apparently comprising chiefly framboidal, probably pyritic grains. Scanning electron microscopy (SEM) should be used if necessary for better resolution and description of the opaque minerals.	Primary
Iron oxide compounds	<<1	N/A	Rare amorphous by-products of the oxidation of opaque minerals on the surface of the rock core.	Secondary
The sample was a fine to medium grained bioclastic LIMESTONE, comprising almost entirely calcium carbonate, with trace amounts of opaque minerals. No iron oxide compounds was observed in the thin section, suggesting that the patches observed on the hand specimen were superficial oxidation of the opaque minerals exposed to the element. The sample exhibited sporadic, unevenly distributed and randomly orientated stylolites comprising abundant opaque minerals. Rare irregular voids up to 100µm across were only observed associated with stylolites. The void content was visually estimated as being approximately 0%. The sample was fresh and exhibited Grade I weathering.				

Profile view of the sample as received



RECORD PHOTOMICROGRAPH

Viewing Light	Cross-polarised

Description

View of a section through the sample, showing bioclasts (brown, yellowish grey, pale green: A9, B3, C/D2, D6, G2, G6 and G10), discrete calcite (dark grey (I2/3) cemented by microcrystalline calcite matrix (brown/dusky brown: A8, E8 and H3).

Petrographic Examination Natural Stone– BS EN 12407:2007

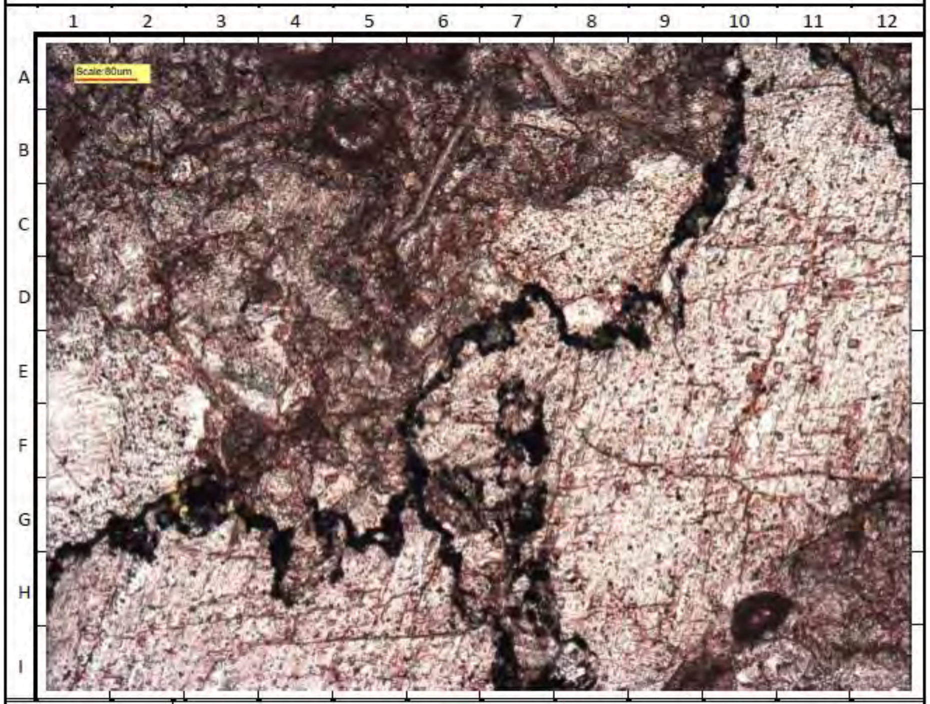
RECORD PHOTOMICROGRAPH

Viewing Light	Cross-polarised

Description

View of a section through the sample, showing calcite vein (C112 to H1)

RECORD PHOTOMICROGRAPH



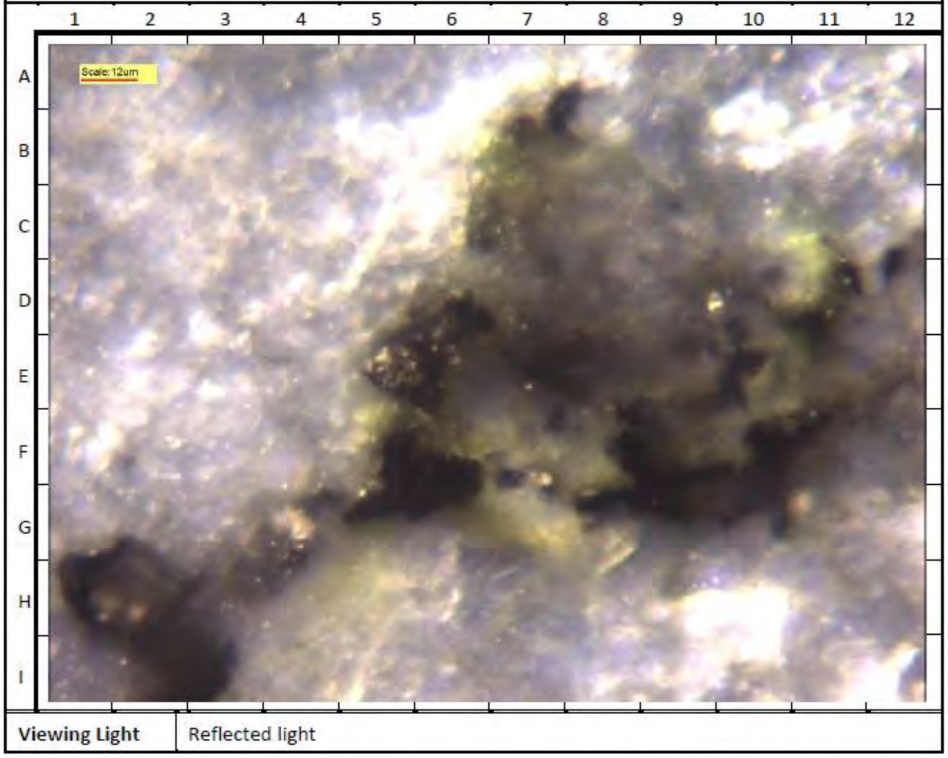
Viewing Light	Plane-polarised

Description

View through the stained section of the sample, showing stylolite rich in opaque minerals (black: A10 to H1, A11 to B12 and G6 to I7).

The reddish brown colours (F3) observed throughout the field of view are due to the staining compound used and not due to oxidation.

RECORD PHOTOMICROGRAPH



Viewing Light	Reflected light

Description

Closer view of the section through a stylolite, showing apparent framboidal pyritic grains (black, bras coloured: E5, F6 and G4).

Glossary of Terms Used in the Descriptions

Proportions	**Major**: constituent present at a level ≥10%; **Minor**: constituent present at level ≥2% but <10; **Trace**: constituent present at <2% level
Frequency	• Rare – only found by thorough searching • Sporadic – only occasionally observed during normal examination • Common – easily observed during normal examination • Frequent – easily observed with minimal examination • Abundant – immediately apparent to initial examination
Hardness	• Very soft: can be penetrated easily by a finger • Soft: scores with a fingernail • Moderately soft: scores using a copper coin • Moderately hard: scores easily with a penknife • Hard: not easily scored with a penknife • Very hard: cannot be scored with a steel point or knife.
Weathering/ alteration	• Grade I (**Fresh**): Unchanged from original state • Grade II (**Slightly Weathered**): Slight discoloration, slight weakening; • Grade III (**Moderately Weathered**): Considerably weakened, penetrative discoloration, large pieces cannot be broken by hand • Grade IV (**Highly Weathered**): large pieces can be broken by hand, does not readily disaggregate (slake) when dry sample immersed in water • Grade V (**Completely Weathered**): considerably weakened, slakes, original texture apparent; Grade VI (**Residual Soil**) • Soil derived by in-situ weathering but retaining none of the original texture or fabric.
Origin	• **Primary constituents:** Constituents present within the rock at its formation. • **Secondary constituents:** Constituents formed by the alteration of pre-existing primary constituents or introduced from an external source after the rock was formed
Size	**Mega**: >60mm; **Macro**: 2-60mm; **Meso**: 60µm-2mm; **Micro**: 2-60µm; **Crypto**: <2µm; **Glassy**: without visible crystallinity
Bedding/Layering	**Thick**: >600mm; **Medium**: 200-600mm; **Thin**: 60-200mm; **Very thin**: 20-60mm
Lamination	**Thick**: 6-20mm; **Thin**: 2-6mm; **Very thin**: 600µm-2mm; **Extremely thin**: <600µm
Cleavage	**Extremely wide**: >2mm; **Very wide**: 600µm-2mm; **Wide**: 200-600µm; **Medium**: 60-200µm; **Close**: 20-60µm; **Very close**: 6-20µm; **Extremely close**: <6µm.
Cracks	• Fine microcracks (<1µm wide) • Microcracks (1-10µm wide) • Fine cracks (10-100µm wide) • Cracks (100µm-1mm wide) • Large cracks (>1mm wide).
Colour	Description based on geological rock-color chart, produced by Munsell Color, 2009 Revised, 2011 Production.
Limestone Classification Schemes	Folk, R. L. 1959. Practical petrographic classification of limestones. *Bull. Am. Ass. Petro. Geol.* **43**, 1-38. Dunham, R. J. 1962. Classification of carbonate rocks according to depositional texture. In: Classification of Carbonate Rocks (Ed. By W. E. Ham), pp. 108-121. *Mem. Am. Ass. Petrol. Geol.* **1**, Tulsa.

Priority Drilling Ltd.
Killimor
Ballinasloe
Co Galway
Ireland
8D23036i

Date: 6th April 2016
Test Report Ref.: 447934

LABORATORY TEST REPORT

Test Requirements: Petrographic Examination of Natural Stone in accordance with BS EN 12047:2007

Sample details:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50926**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test.:	**18/03/2016**
Sampling Location:	**Depth Top:148.97 Depth Base:149.05**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.

RESULTS

See Attached

Nick Dumbarton – Assistant Laboratory Manager

Petrographic Examination Natural Stone– BS EN 12407:2007

HAND SPECIMEN DESCRIPTION

The sample was a moderately hard, fine to very coarse grained, not macroporous limestone. The sample was anisotropic. The sample exhibited medium grey to greyish black variously thick band/layers, unevenly distributed white bioclastic calcite materials up to 8mm across and a large irregular pyritic material up to approximated 2mm across. The sample also exhibited sporadic, randomly distributed and randomly orientated calcite veins up to <200µm across.

MICROSCOPICAL DESCRIPTION

Constituents[1]	Visual Estimated Proportions[2] %	Range of Crystal/Grain Size	Petrographic Details	Origin
Calcite	97	Up to 1600µm	Fresh, anhedral to euhedral crystals comprising significant amounts of both microcrystalline calcite (calcite crystals <4µm) and sparry calcite (calcite crystals >4µm), with minor proportion of discrete calcium carbonate grains that appeared to have replaced bioclasts. The bioclasts chiefly comprised both microcrystalline calcite and sparry calcite. The sample was partially stained in accordance with Dickson's method. The result of the staining process suggests that the calcite was chiefly non-ferroan	Primary
Opaque minerals	1-2	Up to 2000µm	Fresh, chiefly anhedral isotropic minerals apparently comprising almost entirely framboidal, probably pyritic grains. Scanning electron microscopy (SEM) should be used if necessary for better resolution and description of the opaque minerals.	Primary
Clay materials	1-2	<4µm	Very fine grained materials associated with abundant microcrystalline calcite, thus beyond the conclusive resolution of the petrographic microscope. This could be investigated further by scanning electron microscopy (SEM).	Primary

The sample was a fine to very coarse grained bioclastic LIMESTONE, comprising almost entirely calcium carbonate, with trace to minor proportions of opaque minerals, and trace to minor proportions of potentially clay minerals that were beyond the resolution of the petrographic microscope.

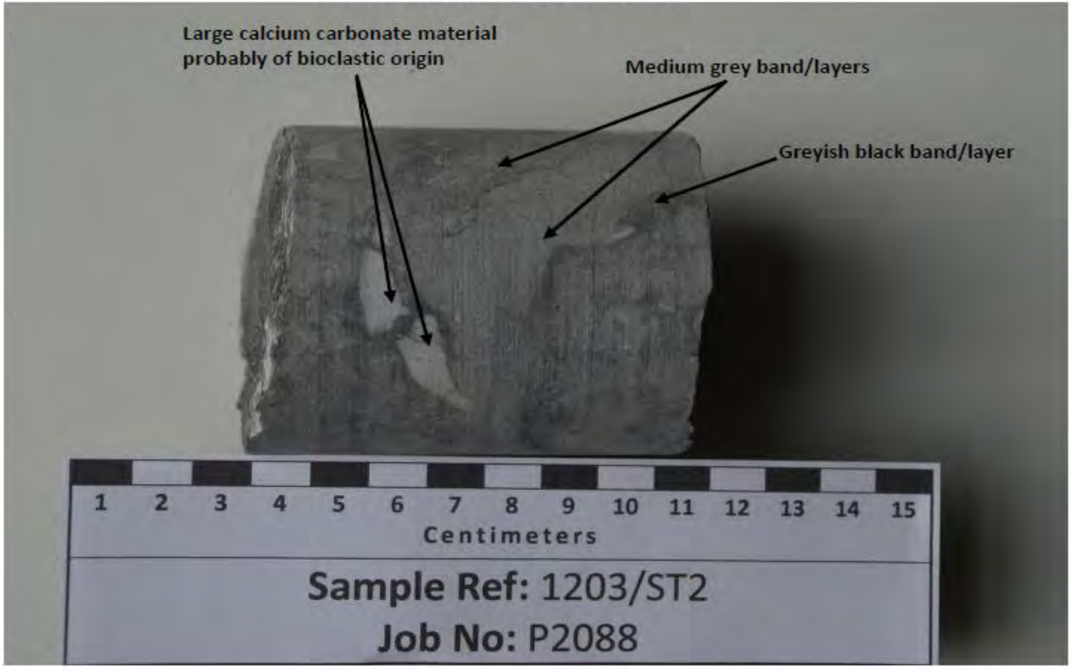
The limestone also exhibited abundant intraclasts (apparently reworked limestone fragments probably from nearby sediments).

The greyish black bands/layers appeared brecciated as they comprised limestone fragments and discrete calcite grains cemented by very fine grained matrix comprising chiefly microcrystalline calcite, with trace to minor proportions of opaque minerals and possibly trace to minor proportions of clay materials.

No void was observed. The void content was visually estimated as being 0%.

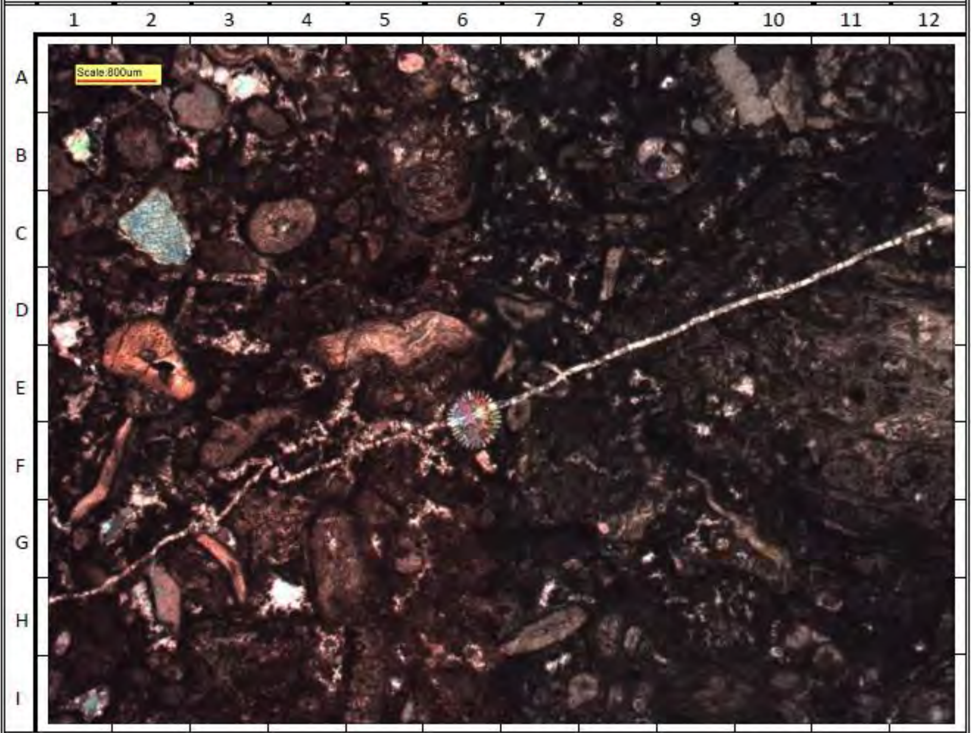
The sample was fresh and exhibited Grade I weathering.

Profile view of the sample as received



Profile view of another side of the sample as received

RECORD PHOTOMICROGRAPH

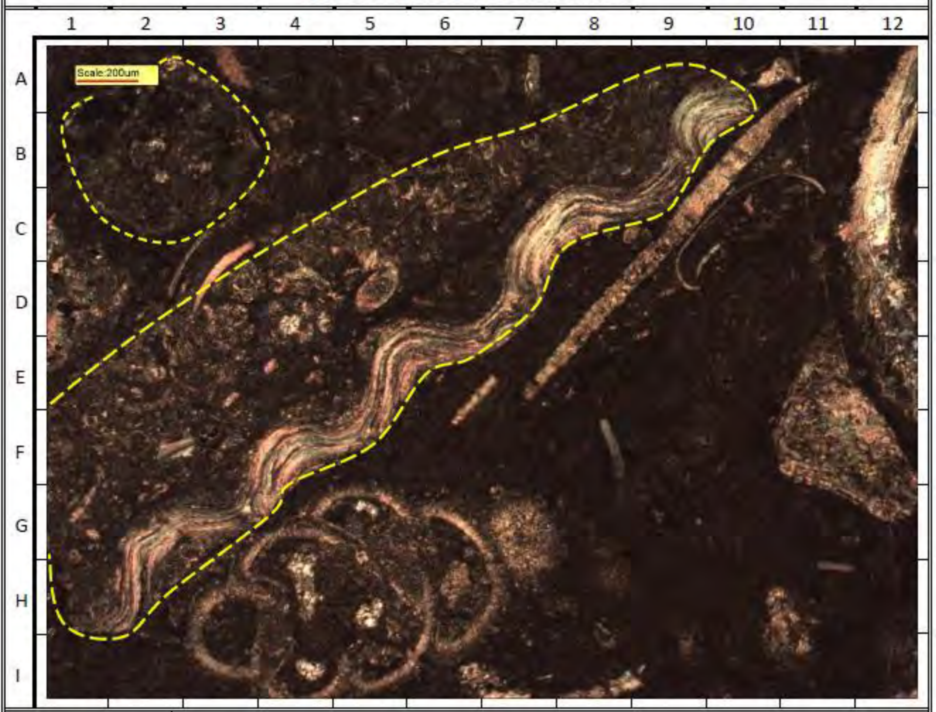


Viewing Light	Cross-polarised

Description

View of a section through a part-stained section of the sample, showing bioclasts (pink, pale ink, light brown, purple/green: A3, A11, B5, D5, E6 and E11) and calcite vein (light brown/pale pink/white: C12 to H1).

RECORD PHOTOMICROGRAPH



Viewing Light	Cross-polarised

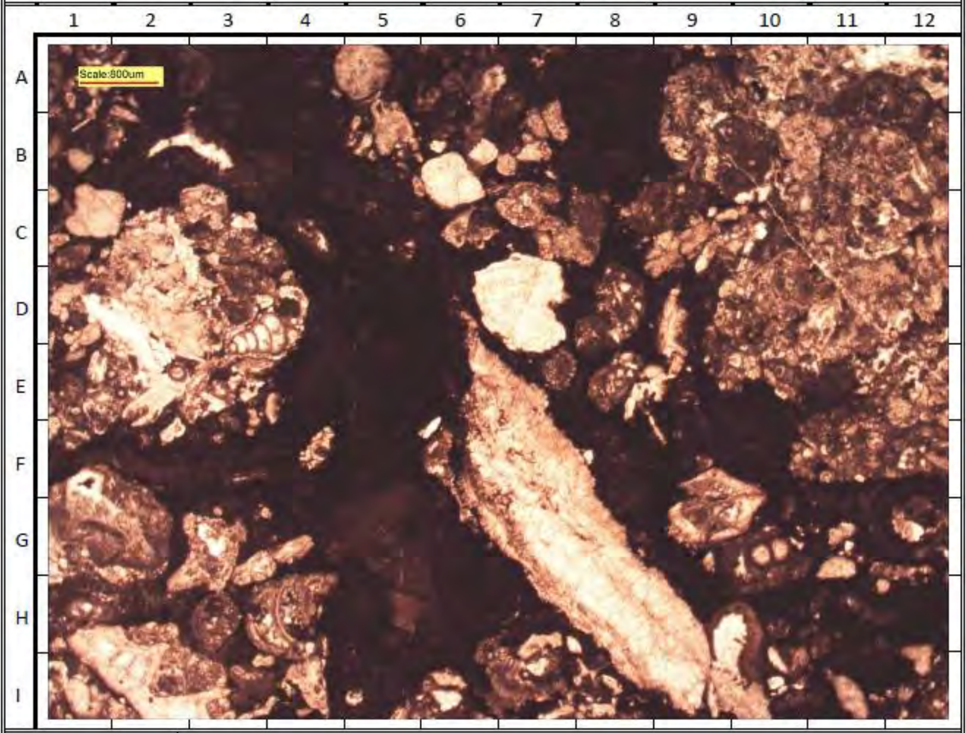
Description

View through a typical medium grey section of the sample, showing bioclasts (pale pink, light brown, pale yellow: D3, D5, D7, D8, D12 and H5) cemented by chiefly microcrystalline calcite (brownish grey: E9).

An apparent intraclasts are highlighted in yellow.

Petrographic Examination Natural Stone– BS EN 12407:2007

RECORD PHOTOMICROGRAPH



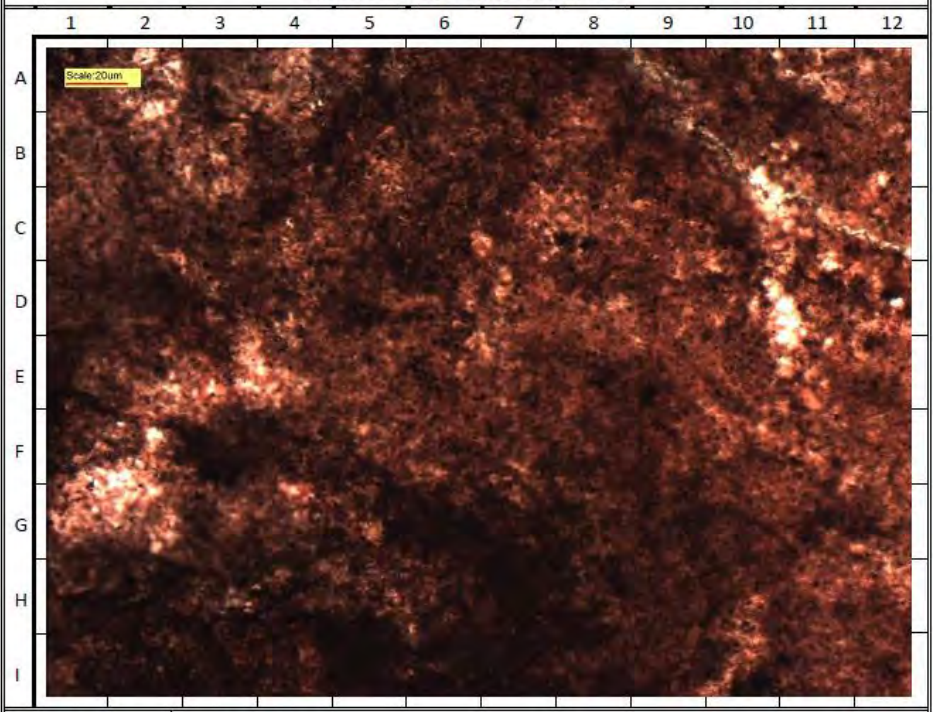
Viewing Light	Plane-polarised

Description

View of a section through a greyish black band/layer, showing apparent limestone fragments (pale pink, light brown, pale yellow: A5, C1, D2, D7, D11, G7 and G9), cemented by very fine grained matrix (dusky brown: A8, E5 and H12).

Petrographic Examination Natural Stone– BS EN 12407:2007

RECORD PHOTOMICROGRAPH



Viewing Light	Plane-polarised

Description

Closer view through the matrix of the greyish black section of the sample, showing very fine grained materials beyond the conclusive resolution of the petrographic microscope. Opaque minerals appear black (A5 and E6). The remainder of the field of view appear to comprise both microcrystalline calcite and possibly some clay minerals.

The moderate red colour (D9) observed throughout the photomicrograph are due to the staining compound used and not due to oxidation.

RECORD PHOTOMICROGRAPH

Viewing Light	Reflected light

Description

Closer view of the section through the sample, showing framboidal pyritic grains (brass colour: C7 and G5).

Glossary of Terms Used in the Descriptions

Proportions	**Major**: constituent present at a level ≥10%; **Minor**: constituent present at level ≥2% but <10; **Trace**: constituent present at <2% level
Frequency	• Rare – only found by thorough searching • Sporadic – only occasionally observed during normal examination • Common – easily observed during normal examination • Frequent – easily observed with minimal examination • Abundant – immediately apparent to initial examination
Hardness	• Very soft: can be penetrated easily by a finger • Soft: scores with a fingernail • Moderately soft: scores using a copper coin • Moderately hard: scores easily with a penknife • Hard: not easily scored with a penknife • Very hard: cannot be scored with a steel point or knife.
Weathering/ alteration	• Grade I (**Fresh**): Unchanged from original state • Grade II (**Slightly Weathered**): Slight discoloration, slight weakening; • Grade III (**Moderately Weathered**): Considerably weakened, penetrative discoloration, large pieces cannot be broken by hand • Grade IV (**Highly Weathered**): large pieces can be broken by hand, does not readily disaggregate (slake) when dry sample immersed in water • Grade V (**Completely Weathered**): considerably weakened, slakes, original texture apparent; Grade VI (**Residual Soil**) • Soil derived by in-situ weathering but retaining none of the original texture or fabric.
Origin	• **Primary constituents:** Constituents present within the rock at its formation. • **Secondary constituents:** Constituents formed by the alteration of pre-existing primary constituents or introduced from an external source after the rock was formed
Size	**Mega**: >60mm; **Macro**: 2-60mm; **Meso**: 60µm-2mm; **Micro**: 2-60µm; **Crypto**: <2µm; **Glassy**: without visible crystallinity
Bedding/Layering	**Thick**: >600mm; **Medium**: 200-600mm; **Thin**: 60-200mm; **Very thin**: 20-60mm
Lamination	**Thick**: 6-20mm; **Thin**: 2-6mm; **Very thin**: 600µm-2mm; **Extremely thin**: <600µm
Cleavage	**Extremely wide**: >2mm; **Very wide**: 600µm-2mm; **Wide**: 200-600µm; **Medium**: 60-200µm; **Close**: 20-60µm; **Very close**: 6-20µm; **Extremely close**: <6µm.
Cracks	• Fine microcracks (<1µm wide) • Microcracks (1-10µm wide) • Fine cracks (10-100µm wide) • Cracks (100µm-1mm wide) • Large cracks (>1mm wide).
Colour	Description based on geological rock-color chart, produced by Munsell Color, 2009 Revised, 2011 Production.
Limestone Classification Schemes	Folk, R. L. 1959. Practical petrographic classification of limestones. *Bull. Am. Ass. Petro. Geol.* 43, 1-38. Dunham, R. J. 1962. Classification of carbonate rocks according to depositional texture. In: Classification of Carbonate Rocks (Ed. By W. E. Ham), pp. 108-121. *Mem. Am. Ass. Petrol. Geol.* 1, Tulsa.

Total Sulphur

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447855

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 48891**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**19/02/2016**
Sampling Location:	**Depth Top:53.80 Depth Base:453.93**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447867

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50859**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:65.40 Depth Base:65.50**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447887

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received: **No**
Laboratory Ref. No: **S56595**
Client Ref. No: **BH01 - 50879**
Date and Time of Sampling: **Unknown**
Date of Receipt at Lab: **18/01/2016**
Date of Start of Test: **19/02/2016**
Sampling Location: **Depth Top:91.10 Depth Base:91.20**
Name of Source: **Lackagh Quarry**
Method of Sampling: **Unknown**
Sampled By: **Client**
Material Description: **Rock Testing**
Target Specification: **N/A**

RESULTS:

Total Sulfur Content as S (%) = **<0.1**
*95% Confidence limit** *<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447937

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50929**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:152.97 Depth Base:153.04**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 447965

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50955**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:193.60 Depth Base:193.68**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 16 March 2016
Test Report Ref: STR 448000

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. No:	**BH01 - 50990**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**17/02/2016**
Sampling Location:	**Depth Top:235.64 Depth Base:235.73**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Testing**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 15 February 2016
Test Report Ref: STR 443067

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH04 - 48954**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**21/12/2015**
Sampling Location:	**Depth Top: 31.66 Depth Base: 31.7**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 15 February 2016
Test Report Ref: STR 443131

Page 1 of 1

Contract: Lackagh Quarry

LABORATORY TEST REPORT

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

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. No:	**BH05 - 50715**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**21/12/2015**
Sampling Location:	**Depth Top: 29.09 Depth Base: 29.18**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

Total Sulfur Content as S (%) =	**<0.1**
*95% Confidence limit**	*<0.06% - <0.14%*

Comments / Departure from specified Procedure

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

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

UCS

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Drilling Ltd,
Killimor,
Ballinasloe,
Co. Galway,
Ireland

Date: 10 March 2016
Test Report Ref: STR 447821a
Revision 1

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Uniaxial Compressive Strength in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56595**
Client Ref. :	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**18/01/2016**
Date of Start of Test:	**18/01/2016**
Sampling Location:	**Various**
Name of Source:	**Lackagh Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Rock Cores**
Target Specification:	**N/A**

RESULTS:

See attached

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: - EGoulden
Eric Goulden
Technical Manager

Test Report Ref: STR 447821a - Page 2 of 2

BH	**Core Diameter (mm)**	**Height/ Diameter Ratio**	**Uniaxial compressive strength (MPa)**	**Mode of Failure**	**EN ISO 14689-1 Term**	**Water content (%)**
BH01 48863	60.7	3.5:1	**97**	N	Strong	0.3
Bh01 48870	60.8	3.5:1	**59**	N	Strong	0.2
BH01 48873	60.7	3.5:1	**73**	N	Strong	0.1
BH01 48878	60.7	3:1	**100**	N	Strong	0.1
BH01 48883	60.7	3:1	**69**	N	Strong	0.3
BH01 48887	60.7	3:1	**83**	N	Strong	0.2
BH01 50943	60.8	3:1	**76**	N	Strong	0.1
BH01 48895	61	3.4:1	**138**	N	Very Strong	0.3
BH01 48900	60.8	2.5:1	**65**	N	Strong	0.1
BH01 50863	60.6	1.7:1	**104**	N	Very Strong	0.2
BH01 50873	60.7	3:1	**62**	N	Strong	0.2
BH01 50884	60.6	3:1	**76**	N	Strong	0.2
BH01 50894	60.7	3.4:1	**107**	N	Very Strong	0.2
BH01 50902	60.7	3:1	**104**	N	Very Strong	0.1
BH01 50909	60.8	2.1:1	**79**	N	Strong	0.2
Bh01 50915	60.8	3.1:1	**110**	N	Very Strong	0.3
Bh01 50924	60.7	1.4:1	**100**	N	Very Strong	0.2
BH01 50934	60.7	3.1:1	**86**	N	Strong	0.4
BH01 50938	60.6	3.4:1	**83**	N	Strong	0.2
BH01 50945	60.8	3.4:1	**86**	N	Strong	0.2
BH01 50952	60.6	3.2:1	**97**	N	Strong	0.5
BH01 50958	60.8	3.2:1	**114**	N	Very Strong	0.3
BH01 50963	60.6	3.1:	**132**	N	Very Strong	0.2
BH01 50968	60.6	3.3:1	**111**	N	Very Strong	0.1
BH01 50971	60.5	3.5:1	**52**	N	Strong	0.3
BH01 50980	60.5	2.8:1	**77**	N	Strong	0.2
BH01 50986	60.5	3:1	**111**	N	Very Strong	0.4
BH01 50991	60.6	3.5:1	**80**	N	Strong	0.2
BH01 50992	60.6	2.3:1	**76**	N	Strong	0.2
BH01 50994	60.6	3:1	**118**	N	Very Strong	0.2
BH01 50998	60.7	2.1:1	**121**	N	Very Strong	0.3
BH01 51002	60.4	3.3:1	**143**	N	Very Strong	0.2

BH01 51004	60.4	2.6:	**66**	N	Strong	0.2
BH01 51007	60.8	2.5:1	**83**	N	Strong	0.3
BH01 51010	60.6	2.5:1	**90**	N	Strong	0.3
BH01 51011	60.3	2.9:1	**91**	N	Strong	0.2

Comments

1) The uniaxial compressive strength was carried out in accordance with ISRM guidelines.
2) Stress Rate: 0.7Mpa/s.

3)

EN ISO 14689-1 : 2003 Rock Strength Terms	
Compressive Strength mpa	Term
<1.0	Extremely Weak
1 to 5	Very Weak
5 to 25	Weak
25 to 50	Meduim Strong
50 to 100	Strong
100 to 250	Very Strong
> 250	Extremely Strong

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INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Priority Construction Ltd
162 Clontarf Road

Dublin 3
Ireland
VAT No: 9D53971I

Date: 21 December 2015
Test Report Ref: STR 443020

Contract: Lackagh Quarry

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Uniaxial Compressive Strength in accordance with **ISRM Guidelines**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S56158**
Client Ref. :	**Various**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**08/12/2015**
Date of Start of Test:	**08/12/2015**
Sampling Location:	**Various**
Name of Source:	**Lackagh Quarry SI**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description:	**Core**
Target Specification:	**N/A**

RESULTS:

See attached

Certificate
Prepared by:-
Mathew Sayer
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

BH	**Core Diameter (mm)**	**Height/ Diameter Ratio**	**Uniaxial compressive strength (MPa)**	**Mode of Failure**	**EN ISO 14689-1 Term**	**Water content (%)**
BH04 48908	82	2.6:1	**76**	N	Strong	0.1
BH04 48912	82.3	1.9:1	**86**	N	Strong	0.3
BH04 48921	82.3	1.5:1	**55**	N	Strong	0.1
BH04 48927	82.1	1.6:1	**53**	N	Strong	0.2
BH04 48931	82.2	2.6:1	**111**	N	Very Strong	0.1
BH04 48933	82	2.1:1	**91**	N	Strong	0.2
BH04 48950	82	2.5:1	**76**	N	Strong	0.2
BH04 48957	82	2:1	**78**	N	Strong	0.3
BH04 48963	82.2	2.4:1	**92**	N	Strong	0.1
BH05 48982	82	1.8:1	**91**	N	Strong	0.2
BH05 48986	81.5	2.6:1	**86**	N	Strong	0.4
BH05 48991	81.4	2.5:1	**94**	N	Strong	0.1
BH05 48994	82	1.9:1	**72**	N	Strong	0.2
BH05 48998	82.2	2.6:1	**77**	N	Strong	0.2
BH05 50711	78.5	1.8:1	**79**	N	Strong	0.2
BH05 50729	79	2.5:1	**116**	N	Very Strong	0.3
BH05 50731	81.4	2.6:1	**51**	N	Strong	0.1
BH05 50733	81.6	2.1:1	**54**	N	Strong	0.2
BH05 50737	82	1.5:1	**131**	N	Very Strong	0.2

Comments

1) The uniaxial compressive strength was carried out in accordance with ISRM guidelines.
2) Stress Rate: 0.7Mpa/s.

3)

EN ISO 14689-1 : 2003 Rock Strength Terms	
Compressive Strength mpa	Term
<1.0	Extremely Weak
1 to 5	Very Weak
5 to 25	Weak
25 to 50	Meduim Strong
50 to 100	Strong
100 to 250	Very Strong
> 250	Extremely Strong

Water Tests

IAS LABORATORIES

Independent Analytical Supplies

Test Report

Lab Report Number: 2165I01 **Analysis Number:** 99A/89470

Customer ID: BRG.L1
Analysis Type: Misc. Tests (99A)
Contact Name: DAVID BLANEY
Delivery By: An Post
Company Name: BRG LTD
Sample Card Number: AAAQ1194/3
Address: 8B UNIT 3
ATHY BUSINESS CAMPUS
ATHY
CO KILDARE
Sample Condition: Acceptable
Sample Type: Ground Water
Date Sample Received: 15/03/2016
Sample Reference: GROUND WATER
Date Analysis Commenced: 15/03/2016
Sample Description: BH-04
Date Certificate Issued: 29/03/2016

Parameter	Method	Result	Unit
Calcium	ICP-MS	82.9	mg/l
Chloride	Konelab Aquakem SOP 2065	32.10	mg/l
Potassium	ICP-MS	0.94	mg/l
Magnesium	ICP-MS	2.50	mg/l
Sodium	ICP-MS	17.1	mg/l
Nitrite	Konelab Aquakem SOP 2059	<0.03	mg/l NO2
Sulphate	Konelab Aquakem SOP 2062	6.26	mg/l SO4

Signed: W McCall Date: 29/03/2016

Wendy McCall - Laboratory Manager

*** = not INAB Accredited** **^ = Subcontracted**

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INAB ISO 17025 ACCREDITED TESTING DETAILED IN SCOPE REG NO.275T

Independent Analytical Supplies

Test Report

Lab Report Number:	2165I02	**Analysis Number:**	99A/89471

Customer ID:	BRG.L1	**Analysis Type:**	Misc. Tests (99A)
Contact Name:	DAVID BLANEY	**Delivery By:**	An Post
Company Name:	BRG LTD	**Sample Card Number:**	AAAQ1194/3
Address:	8B UNIT 3 ATHY BUSINESS CAMPUS ATHY CO KILDARE	**Sample Condition:**	Acceptable
Sample Type:	Ground Water	**Date Sample Received:**	15/03/2016
Sample Reference:	GROUND WATER	**Date Analysis Commenced:**	15/03/2016
Sample Description:	BH-05	**Date Certificate Issued:**	29/03/2016

Parameter	Method	Result	Unit
Calcium	ICP-MS	92.6	mg/l
Chloride	Konelab Aquakem SOP 2065	25.38	mg/l
Potassium	ICP-MS	6.26	mg/l
Magnesium	ICP-MS	2.98	mg/l
Sodium	ICP-MS	14.4	mg/l
Nitrite	Konelab Aquakem SOP 2059	0.03	mg/l NO2
Sulphate	Konelab Aquakem SOP 2062	15.41	mg/l SO4

Signed: W McCall Date: 29/03/2016

Wendy McCall - Laboratory Manager

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ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.275T

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IAS LABORATORIES

Independent Analytical Supplies

Test Report

Lab Report Number: 2165I03 **Analysis Number:** 99A/89472

Customer ID:	BRG.L1	**Analysis Type:**	Misc. Tests (99A)
Contact Name:	DAVID BLANEY	**Delivery By:**	An Post
Company Name:	BRG LTD	**Sample Card Number:**	AAAQ1194/3
Address:	8B UNIT 3 ATHY BUSINESS CAMPUS ATHY CO KILDARE	**Sample Condition:**	Acceptable
Sample Type:	Ground Water	**Date Sample Received:**	15/03/2016
Sample Reference:	GROUND WATER	**Date Analysis Commenced:**	15/03/2016
Sample Description:	BH-06	**Date Certificate Issued:**	29/03/2016

Parameter	Method	Result	Unit
Calcium	ICP-MS	430.1	mg/l
Chloride	Konelab Aquakem SOP 2065	152.22	mg/l
Potassium	ICP-MS	39.3	mg/l
Magnesium	ICP-MS	<0.5	mg/l
Sodium	ICP-MS	306.1	mg/l
Nitrite	Konelab Aquakem SOP 2059	1.02	mg/l NO2
Sulphate	Konelab Aquakem SOP 2062	36.32	mg/l SO4

Signed: W McCall Date: 29/03/2016

Wendy McCall - Laboratory Manager

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ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.275T

APPENDIX VIII

Monitoring Well Sampling Log

Well Number:BH-04

Project Details

Project No.:	Lackagh	Location (GPS):	530150 728400
Date:	12-3-16	Sampler:	Ronan Doyle

Sample Details

Well No.:	BH-04	Measurement Point:	TOR
Stick Up:		T.O.C Elevation:	
Water Level:	19.65m	Well Depth:	33.06m
Head:	13.41m	Well Diameter:	
Volume in Well (L):		Volume Purged (L):	Pumped for 1 hr
Decon. Procedure:		Bailer Type:	Watterra Pump
Containers Used:			

Field Parameters

Observed Colour:	Brown Tint	Odour:	None
Temperature (°C):	10.5C	Conductivity (µS):	295
pH:	7.47	pHMV:	-58mv ORP=231mv

Comments

DO=0.21mg/l 1.8%

Ronan Doyle Monitoring Solutions,

Castlebar Road, Ballinrobe, County Mayo.

Monitoring Well Sampling Log

Well Number:BH-05

Project Details

Project No.:	Lackagh	Location (GPS):	530186 728378
Date:	12-3-16	Sampler:	Ronan Doyle

Sample Details

Well No.:	BH-05	Measurement Point:	TOR
Stick Up:		T.O.C Elevation:	
Water Level:	21.70m	Well Depth:	39.53m
Head:	17.83m	Well Diameter:	
Volume in Well (L):		Volume Purged (L):	Pumped for 1 hr
Decon. Procedure:		Bailer Type:	Watterra Pump
Containers Used:			

Field Parameters

Observed Colour:	Brown Tint	Odour:	None
Temperature (°C):	10.5C	Conductivity (µS):	420
pH:	7.77	pHMV:	-74.8mv ORP=216.9mv

Comments

DO=0.8mg/l   9.2%

Monitoring Well Sampling Log

Well Number:BH-06

Project Details

Project No.:	Lackagh	Location (GPS):	530125 728383
Date:	12-3-16	Sampler:	Ronan Doyle

Sample Details

Well No.:	BH-06	Measurement Point:	TOR
Stick Up:		T.O.C Elevation:	
Water Level:	4.02m	Well Depth:	7.48m
Head:	3.46m	Well Diameter:	
Volume in Well (L):		Volume Purged (L):	Pumped for 30min
Decon. Procedure:		Bailer Type:	Watterra Pump
Containers Used:			

Field Parameters

Observed Colour:	Milky brown	Odour:	None
Temperature (°C):	9.8C	Conductivity (µS):	6187
pH:	12.53	pHMV:	-333mv ORP=51.7mv

Comments

DO=0.8mg/l 9.4%

APPENDIX IX

Borehole ID	**BH5**
Water Level Start	**19.45m**
Water volume inserted	**215 ltrs**

Time (min)	Water Level (m)
1	18.1
1.5	18.52
2	18.82
2.5	19
3	19.14
3.5	19.22
4	19.26
4.5	19.29
5	19.31
5.5	19.32
6	19.33
8	19.35
11	19.38
14	19.39
18	19.4
22	19.405
26	19.41
30	19.41
34	19.415
40	19.42

Borehole ID **BH5**

Water Level Start **19.42m**

Water volume inserted **1000 ltrs**

Time (min)	Water Level (m)	Comments
1	17.62	
1.5	18.22	
2	18.51	
2.5	18.74	
3	18.93	
3.5	19.04	
4	19.11	
4.5	19.17	
5	19.21	
5.5	19.24	
6	19.26	
6.5	19.28	
7.5	19.29	
9	19.31	
12	19.33	
14	19.335	
17	19.34	
20	19.345	
24	19.345	
30	19.35	
40	19.34	Could feel material in the hole test stopped - driller reports clearing clay after test in oreder to install piezometer.

APPENDIX X

BH04 - Packer Test 18/12/15

Water Depth **Start** 16.8m **Finish** 16.8m

Depth						**Time minutes** →											
Top	**Bottom**	**Midpoint**	**Packer Pressure (psi)**	**Pressure (psi)**	**Flow (litres)**	1	2	3	4	5	6	7	8	9	10		
28	30	29	175	49		59	113	168	225	282	343	399	456	518	579	**Total**	
						59	57	56	56	56	57	57	57	58	58	**l/m**	Unable to continue at
24	26	25	175	50		18.5	35	52	70	86	103	121	138	155.6	174	**Total**	
						19	18	17	18	17	17	17	17	17	17	**l/m**	
				65		29	58	87	117	147	176	207	236	267	297	**Total**	
						29	29	29	29	29	29	30	30	30	30	**l/m**	
				84		44	89	134	179	224	270	316	363	410	456	**Total**	
						44	45	45	45	45	45	45	45	46	46	**l/m**	
				65		32	73	113	152	193	232	273	313	354	395	**Total**	
						32	37	38	38	39	39	39	39	39	40	**l/m**	
				50		34	67	101	135	169	202	236	270	303	337	**Total**	
						34	34	34	34	34	34	34	34	34	34	**l/m**	
21	23	22	175	40		60	120	179	237	296	355	414	473	533	591	**Total**	
						60	60	60	59	59	59	59	59	59	59	**l/m**	
				50		67	134	200	266	331	397	464	530	576	662	**Total**	
						67	67	67	67	66	66	66	66	64	66	**l/m**	Unable to continue at
18	20	19	160	40		20	42	66	91	115	140	164	189	214	240	**Total**	
						20	21	22	23	23	23	23	24	24	24	**l/m**	
				60		31	64	96	128	160	192	225	257	289	322	**Total**	
						31	32	32	32	32	32	32	32	32	32	**l/m**	
				80		37	75	113	152	190	228	267	306	345	383	**Total**	
						37	38	38	38	38	38	38	38	38	38	**l/m**	
				60		33	66	99	132	165	198	231	264	297	328	**Total**	
						33	33	33	33	33	33	33	33	33	33	**l/m**	
				40		25	50	75	101	126	150	175	200	224	249	**Total**	
						25	25	25	25	25	25	25	25	25	25	**l/m**	

BH05 - Packer Test 6/1/16 **Water Depth Start** 19.26m **Finish** 19.2

Depth **Time minutes** →

Top	**Bottom**	**Midpoint**	**Packer Pressure (psi)**	**Pressure (psi)**	**Flow (litres)**	1	2	3	4	5	6	7	8	9	10	
36	38	37	160	30		58.9	117.1	176.1	234.4	292.9	350.1	408.7	466.7	524.9	581.7	**Total**
						59	59	59	59	59	58	58	58	58	58	**l/m**
				45		70.1	139.9	209.1	279.1	348.7	417.9	485.1	554.6	620.5	686.1	**Total**
						70	70	70	70	70	70	69	69	69	69	**l/m**
				60		76.8	153.7	231.2	304.4	383.7	461.5	537.7	613.7	691.6	768.4	**Total**
						77	77	77	76	77	77	77	77	77	77	**l/m**
				45		73	145.7	212.8	278.1	351.5	421.4	493.3	564.4	634.6	705.9	**Total**
						73	73	71	70	70	70	70	71	71	71	**l/m**
				30		64.2	128.6	192.7	256.3	319.1	383.6	448.5	513.7	576.7	641.5	**Total**
						59	59	59	59	59	58	58	58	58	58	**l/m**
30	32	31	175	30		54.2	110.3	166.4	222.2	278.7	335.7	392.4	448.1	505.2	561.7	**Total**
						54	55	55	56	56	56	56	56	56	56	**l/m**
				45		67.3	135.1	204.1	273.5	342.4	411.7	481.2	530.4	619.3	688.1	**Total**
						67	68	68	68	68	69	69	66	69	69	**l/m**
				60		78.7	155.8	234.8	311.7	390.1	468.4	546.7	633.5	701.3	779.4	**Total**
						79	78	78	78	78	78	78	79	78	78	**l/m**
				45		69.7	139.7	209.6	286.5	346.5	414.5	481.7	550.7	621.8	693	**Total**
						70	70	70	72	69	69	69	69	69	69	**l/m**
				30		61.1	122.4	184.7	247.5	309.7	372.5	435.1	498.3	563.5	626.7	**Total**
						61	61	62	62	62	62	62	62	63	63	**l/m**
24	27	25.5	175	30		54.1	111.4	166.5	222.3	277	332.4	387.4	462.1	497.1	551.7	**Total**
						54	56	56	56	55	55	55	58	55	55	**l/m**
				45		67.1	135.4	200.4	268.2	335.3	402.1	468.3	535.3	602.7	667.1	**Total**
						67	68	67	67	67	67	67	67	67	67	**l/m**
				60		77.3	153.7	231.2	308.9	385.7	463.7	540.1	617.5	695	772.6	**Total**
						77	77	77	77	77	77	77	77	77	77	**l/m**
				45		65.6	130.5	196.3	261.1	326.7	391.6	457.5	512.9	587.2	652.5	**Total**
						66	65	65	65	65	65	65	64	65	65	**l/m**
				30		56.9	112.5	167.7	223.5	279.4	335.2	390.1	446	501.7	557.1	**Total**
						57	56	56	56	56	56	56	56	56	56	**l/m**
20	23	21.5	175	30		54.2	108.5	162	216.7	270.3	324.5	378	421.7	480	539	**Total**
						54	54	54	54	54	54	54	53	53	54	**l/m**
				45		65.6	131.8	197.3	262.5	328.3	394.5	459.8	524.7	590.3	655.7	**Total**
						66	66	66	66	66	66	66	66	66	66	**l/m**
				60		77.1	154.1	230.4	306.9	383.7	459.7	536.2	611.9	688.5	764.1	**Total**
						77	77	77	77	77	77	77	76	77	76	**l/m**
				45		67.7	135.2	203.1	271.4	337.9	403.3	468.2	530.7	592.8	656.7	**Total**
						68	68	68	68	68	67	67	66	66	66	**l/m**
				30		57.7	115.4	173.2	230.8	287.1	342.9	399.1	455.5	512.5	567.1	**Total**
						58	58	58	58	57	57	57	57	57	57	**l/m**

APPENDIX XI

A2

TRIAL PIT RECORD

REPORT NUMBER	18963
CONTRACT	N6 Galway City Transport Project - Phase 3
TRIAL PIT NO.	**TP3/24**
SHEET	Sheet 1 of 1
LOGGED BY	A.Chryst
CO-ORDINATES	529,752.24 E 728,388.27 N
GROUND LEVEL (m)	13.69
DATE STARTED	26/01/2016
DATE COMPLETED	26/01/2016
CLIENT	Galway County Council
ENGINEER	ARUP
EXCAVATION METHOD	Hitachi Zaxis 80

	Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Sample Ref	Type	Depth		
0.0	TOPSOIL		0.10	13.59						
	Light brown clayey slightly sandy very gravelly angular COBBLES and BOULDERS of limestone		0.70	12.99		AA49456 AA49457	D B	0.50 0.50		
	Obstruction - Possible Rockhead End of Trial Pit at 0.70m									
1.0										
2.0										
3.0										
4.0										

Groundwater Conditions
Dry

Stability
Good

General Remarks
0.75hr Tracking to stone wall en route to trial pit location. 0.15hr Taking down stone wall. 0.50hr Reinstating wall upon trial pit completion.

TRIAL PIT RECORD

REPORT NUMBER 18963

CONTRACT	N6 Galway City Transport Project - Phase 3	**TRIAL PIT NO.**	**TP3/41**
		SHEET	Sheet 1 of 1
LOGGED BY	A.Chryst	**DATE STARTED**	19/04/2016
CO-ORDINATES	529,897.01 E 728,377.37 N	**DATE COMPLETED**	19/04/2016
GROUND LEVEL (m)	22.57	**EXCAVATION METHOD**	Hitachi Zaxis 80
CLIENT	Galway County Council		
ENGINEER	ARUP		

	Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Sample Ref	Type	Depth		
0.0	TOPSOIL									
	Firm orange brown sandy gravelly CLAY with a high cobble and boulder content. Cobbles and boulders are of limestone.		0.40	22.17		AA43057 AA43058	B D	0.50 0.50		
	Possible Highly Weathered Rockhead recovered as Grey COBBLES and BOULDERS of limestone		0.80	21.77						
1.0										
	Obstruction - Possible Rockhead End of Trial Pit at 1.40m		1.40	21.17						
2.0										
3.0										
4.0										

Groundwater Conditions
Dry

Stability
Good

General Remarks
Pit terminated on possible shallow rockhead

TRIAL PIT RECORD

REPORT NUMBER	18963
CONTRACT	N6 Galway City Transport Project - Phase 3
TRIAL PIT NO.	**TP3/42**
SHEET	Sheet 1 of 1
LOGGED BY	A.Chryst
CO-ORDINATES	529,931.08 E 728,410.99 N
GROUND LEVEL (m)	23.89
DATE STARTED	19/04/2016
DATE COMPLETED	19/04/2016
CLIENT	Galway County Council
ENGINEER	ARUP
EXCAVATION METHOD	Hitachi Zaxis 80

	Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Sample Ref	Type	Depth		
0.0	TOPSOIL		0.20	23.69						
	Firm dark brown slightly sandy silty CLAY with frequent rootlets		0.50	23.39		AA43059	B	0.40		
1.0	Firm light grey slightly sandy slightly gravelly silty CLAY		1.40	22.49		AA43060 AA43061	B D	0.80 0.80		
2.0 3.0	Brown slightly gravelly fine to coarse SAND		3.20	20.69		AA43062 AA43063	B B	1.50 2.50		
4.0	Grey brown slightly clayey very sandy subangular to rounded fine to coarse GRAVEL		4.40	19.49		AA43064	B	3.50		
	End of Trial Pit at 4.40m									

Groundwater Conditions
Dry

Stability
Good

General Remarks

Low resistivity values indicate overburden or weathered/karstified rock

Low resistivity values indicate weathered or karstified limestone

Low resistivity values indicate weathered or karstified limestone
Core hole recommended at 10760

High resistivities indicate a clean limestone

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Web: www.mgx.ie

CLIENT: I□S□ A□□□

PROJECT: N□□□T□ □hase □ Geophysical Survey

TITLE: Plan □g: Survey Locations and Models for □□□□□

SCALE: □or □:□□□□ A□, □er □:□□□□ A□, □□□□□

□□□□□□T: □□□□

DRAWN: □□

DATE: □□□□□□□□□□

M□□ □I□□: □□□□d□□lans.dwg

STATUS: Draft

LEGEND:

Geophysical Survey Locations:

▬	R2	2D-Resistivity Profile
▬	S1	Seismic Refraction Profile

Chainage based on Alignment received 12.02.2016

Locations are in Irish Transverse Mercator, Elevations are in □OD (Malin Head)

Geophysical Survey Locations:

- Ground Surface along Survey Profile
- Existing Ground Level along Centre Line
- Proposed Vertical Alignment Centre Line

2D Resistivity and Seismic Refraction results are projected onto the Centre Line

2D-Resistivity Model Values:

Resistivities (Ohm□□) for 2D-Resistivity Model

🟪	🟥	🟥	🟥	🟧	🟧	🟨	🟩	🟩	🟩	🟩	🟦	🟦	🟦	🟦	🟦	🟦
20.0		40.0		80.0		160		320		640		1280		2560		

A draft interpretation is indicated by yellow/magenta text.
At this stage of the project this is intended to give guidance for targeted boreholes and coreholes.

Low resistivity values indicate weathered or karstified limestone Core hole recommended at 480m

Low resistivity values indicate weathered or karstified limestone Core hole recommended at 200m

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CLIENT IGSL
ARUP

PROJECT N6 GCTP Phase 3
Geophysical Survey

TITLE Plan 1n: Survey Locations and Models for GP3/19

SCALE:	Hor 1:1000 @ A1, Ver 1:100 @ A1, VE x 10
PROJECT:	6031
DRAWN:	RJ
DATE:	18/02/2016
MGX FILE:	6031d_Plans.dwg
STATUS:	Draft

LEGEND: Geophysical Survey Locations:

R2	2D-Resistivity Profile
S1	Seismic Refraction Profile

Chainage based on Alignment received 12.02.2016

Locations are in Irish Transverse Mercator, Elevations are in mOD (Malin Head)

Geophysical Survey Locations:

Ground Surface along Survey Profile
Existing Ground Level along Centre Line
Proposed Vertical Alignment Centre Line

2D Resistivity and Seismic Refraction results are projected onto the Centre Line

Layers from Seismic Refraction Model:

Ground Surface/Top of Layer 1 (200 - 340 m/s)
Top of Layer 2 (1000 - 1200 m/s)
Top of Layer 3 (2000 - 2400 m/s)
Top of Layer 4 (4500 - 5000 m/s)

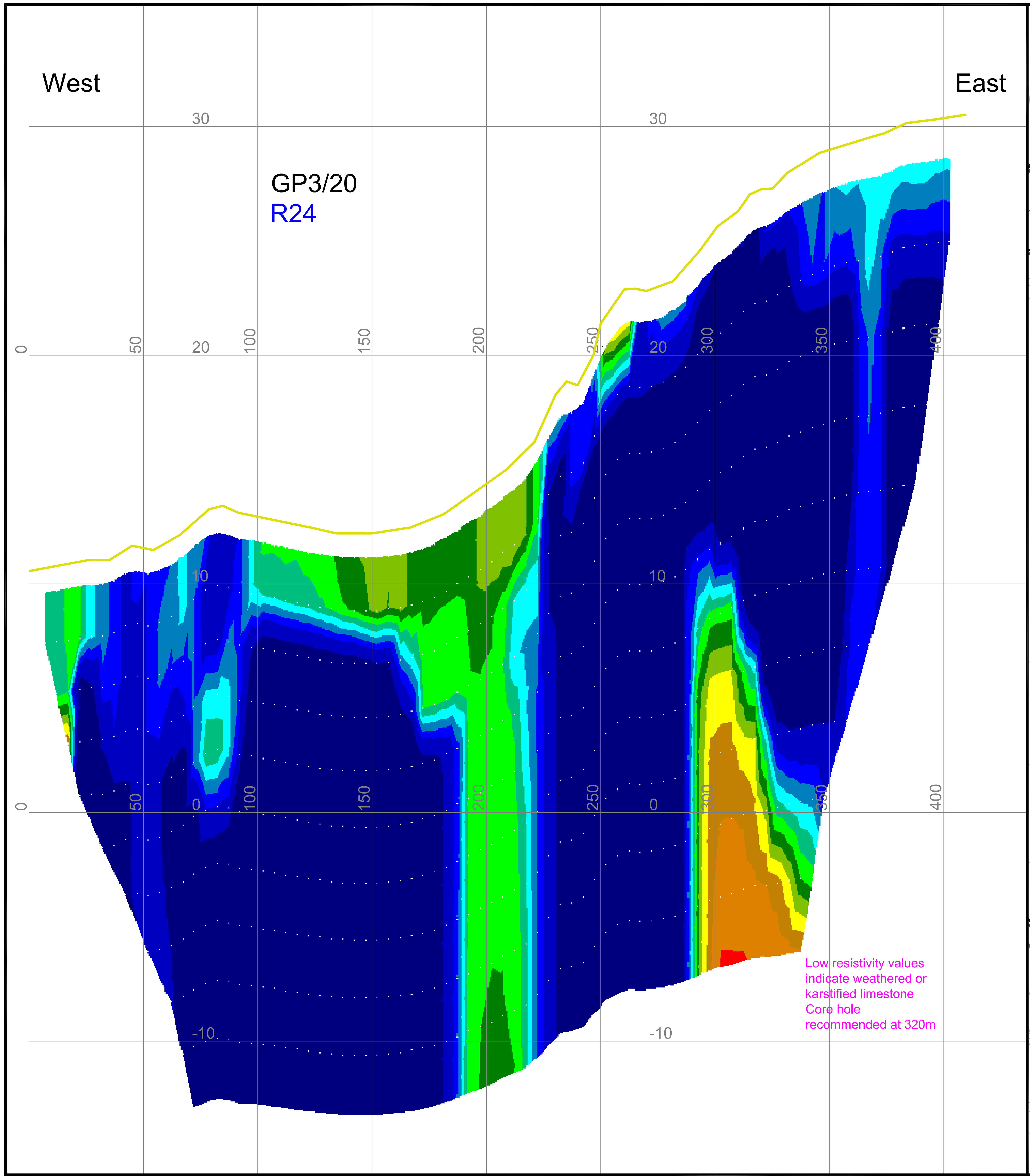
1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

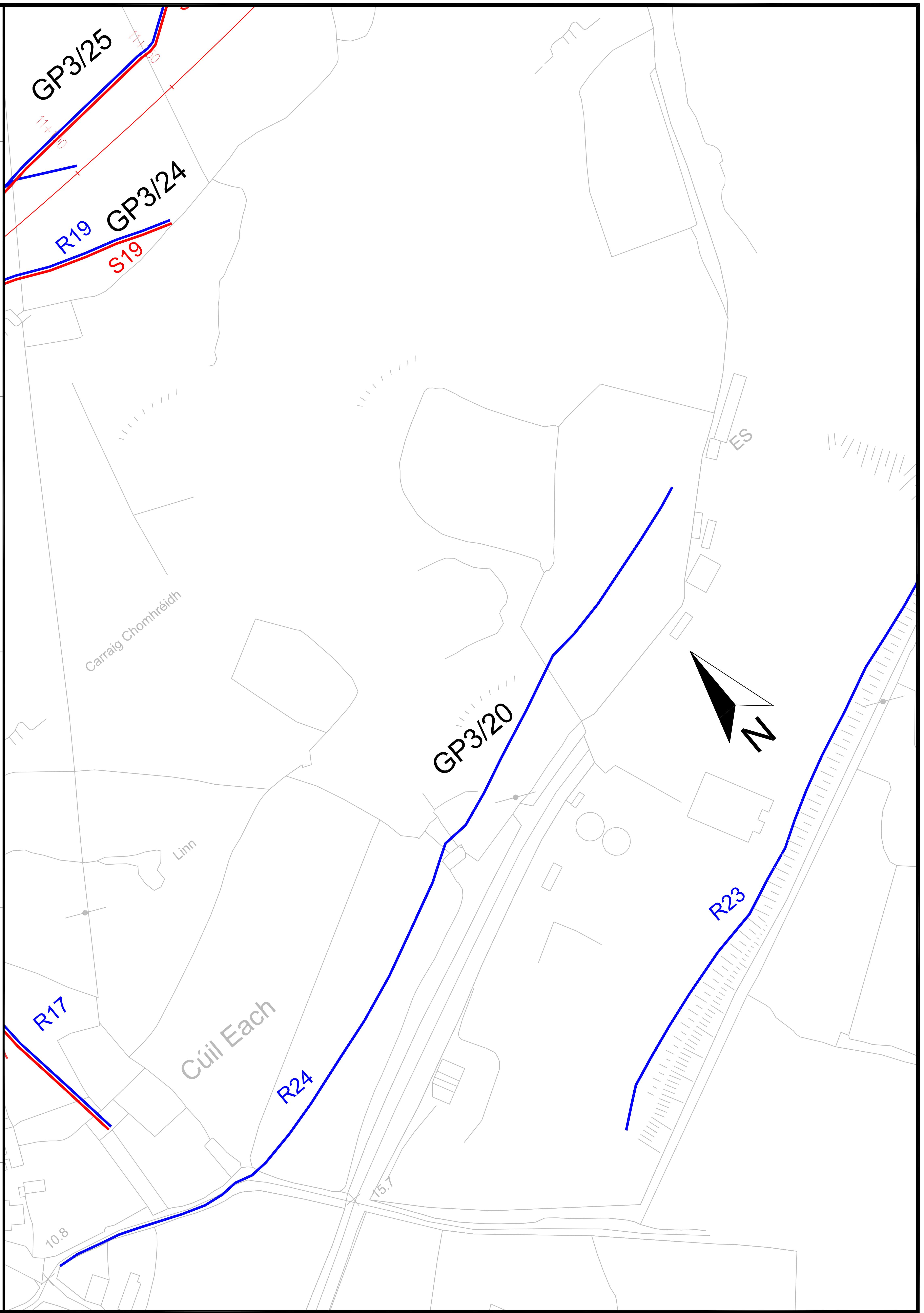
Resistivities (Ohmm) for 2D-Resistivity Model

20.0 40.0 80.0 160 320 640 1280 2560

A draft interpretation is indicated by yellow/magenta text.
At this stage of the project this is intended to give guidance for targeted boreholes and coreholes.



Low resistivity values indicate weathered or karstified limestone
Core hole recommended at 320m



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PROJECT N6 GCTP Phase 3
Geophysical Survey

TITLE Plan 1o: Survey Locations and
Models for GP3/20

SCALE: Hor 1:1000 @ A1, Ver 1:100 @ A1, VE x 10
PROJECT: 6031
DRAWN: RJ
DATE: 18/02/2016
MGX FILE: 6031d_Plans.dwg
STATUS: Draft

LEGEND: Geophysical Survey Locations:

R2	2D-Resistivity Profile
S1	Seismic Refraction Profile

Chainage based on Alignment received 12.02.2016

Locations are in Irish Transverse Mercator, Elevations are in mOD (Malin Head)

Geophysical Survey Locations:

Ground Surface along Survey Profile
Existing Ground Level along Centre Line
Proposed Vertical Alignment Centre Line

2D Resistivity and Seismic Refraction results are projected onto the Centre Line

Layers from Seismic Refraction Model:

Ground Surface/Top of Layer 1 (200 - 340 m/s)
Top of Layer 2 (1000 - 1200 m/s)
Top of Layer 3 (2000 - 2400 m/s)
Top of Layer 4 (4500 - 5000 m/s)

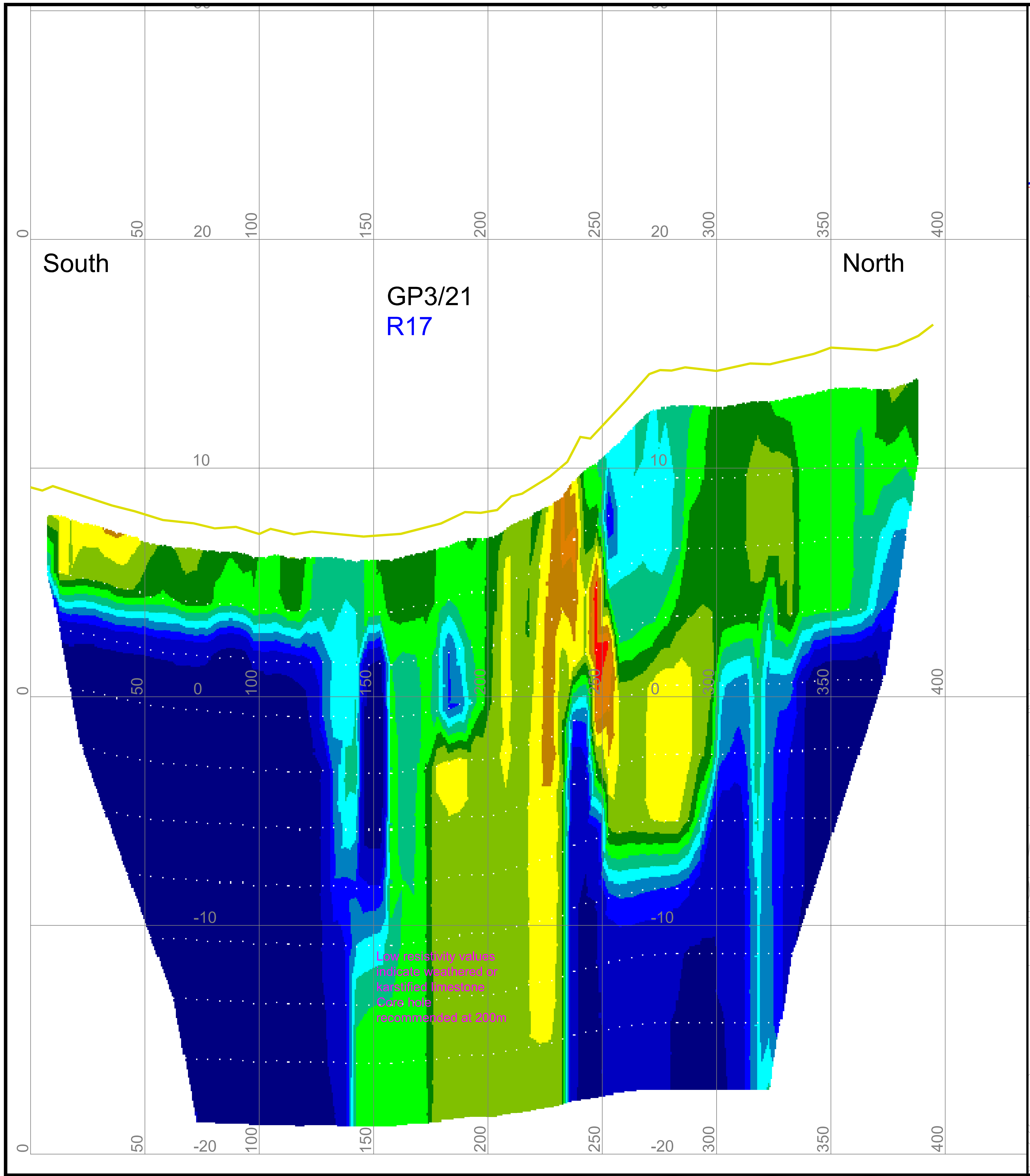
1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

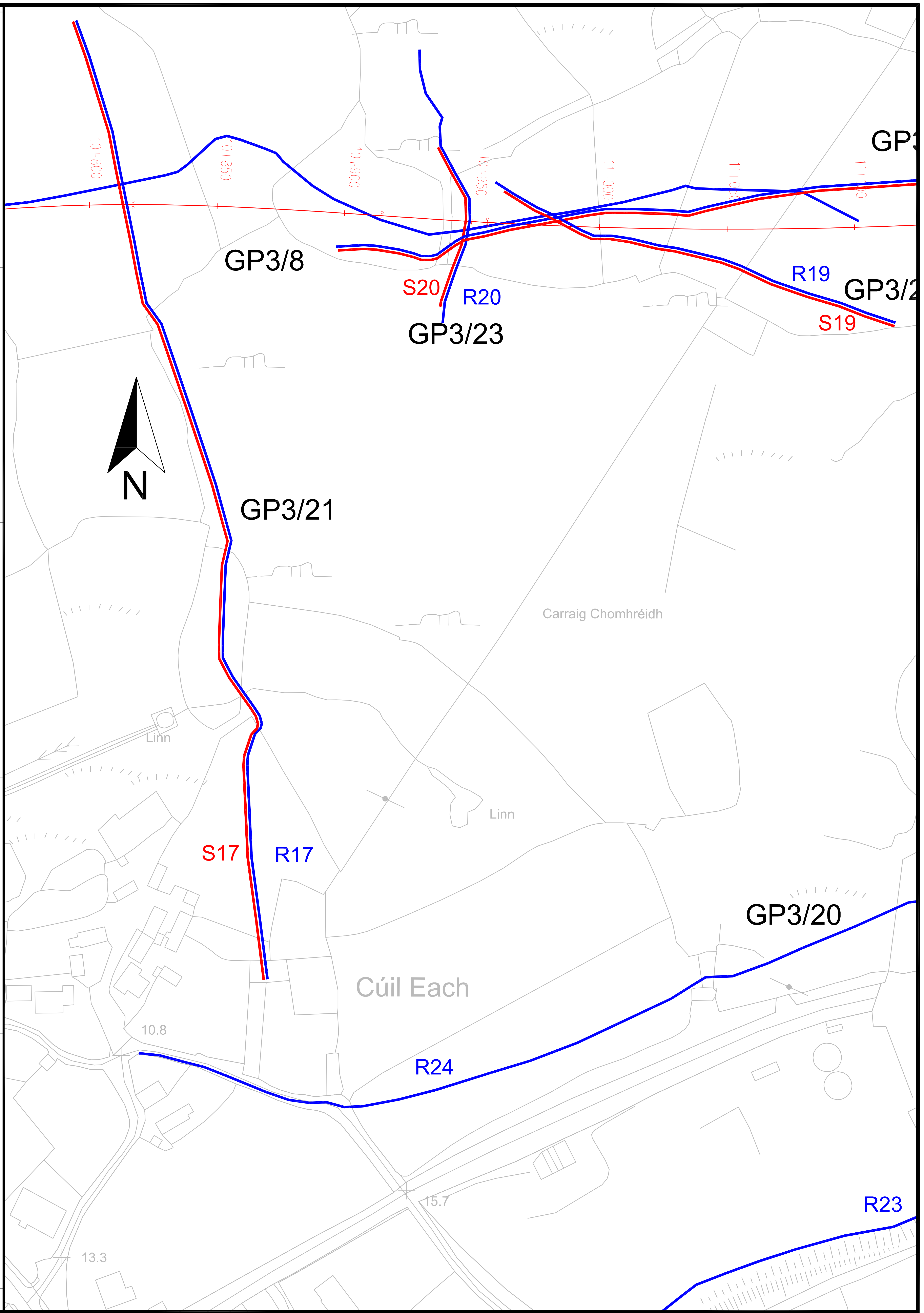
Resistivities (Ohmm) for 2D-Resistivity Model

20.0 40.0 80.0 160 320 640 1280 2560

A draft interpretation is indicated by yellow/magenta text.
At this stage of the project this is intended to give guidance for targeted boreholes and coreholes.



Low resistivity values indicate weathered or karstified limestone. Core hole recommended at 200m



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CLIENT: IGSL
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PROJECT: N6 GCTP Phase 3
Geophysical Survey

TITLE: Plan 1p: Survey Locations and
Models for GP3/21

SCALE: Hor 1:1000 @ A1, Ver 1:100 @ A1, VE x 10
PROJECT: 6031
DRAWN: RJ
DATE: 13/04/2016
MGX FILE: 6031d_Plans.dwg
STATUS: Draft

LEGEND: Geophysical Survey Locations:

🟦	R2	2D-Resistivity Profile
🟥	S1	Seismic Refraction Profile

Chainage based on Alignment received 12.02.2016

Locations are in Irish Transverse Mercator, Elevations are in mOD (Malin Head)

Geophysical Survey Locations:

- Ground Surface along Survey Profile
- Existing Ground Level along Centre Line
- Proposed Vertical Alignment Centre Line

2D Resistivity and Seismic Refraction results are projected onto the Centre Line

Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (200 - 340 m/s)
- Top of Layer 2 (1000 - 1200 m/s)
- Top of Layer 3 (2000 - 2400 m/s)
- Top of Layer 4 (4500 - 5000 m/s)

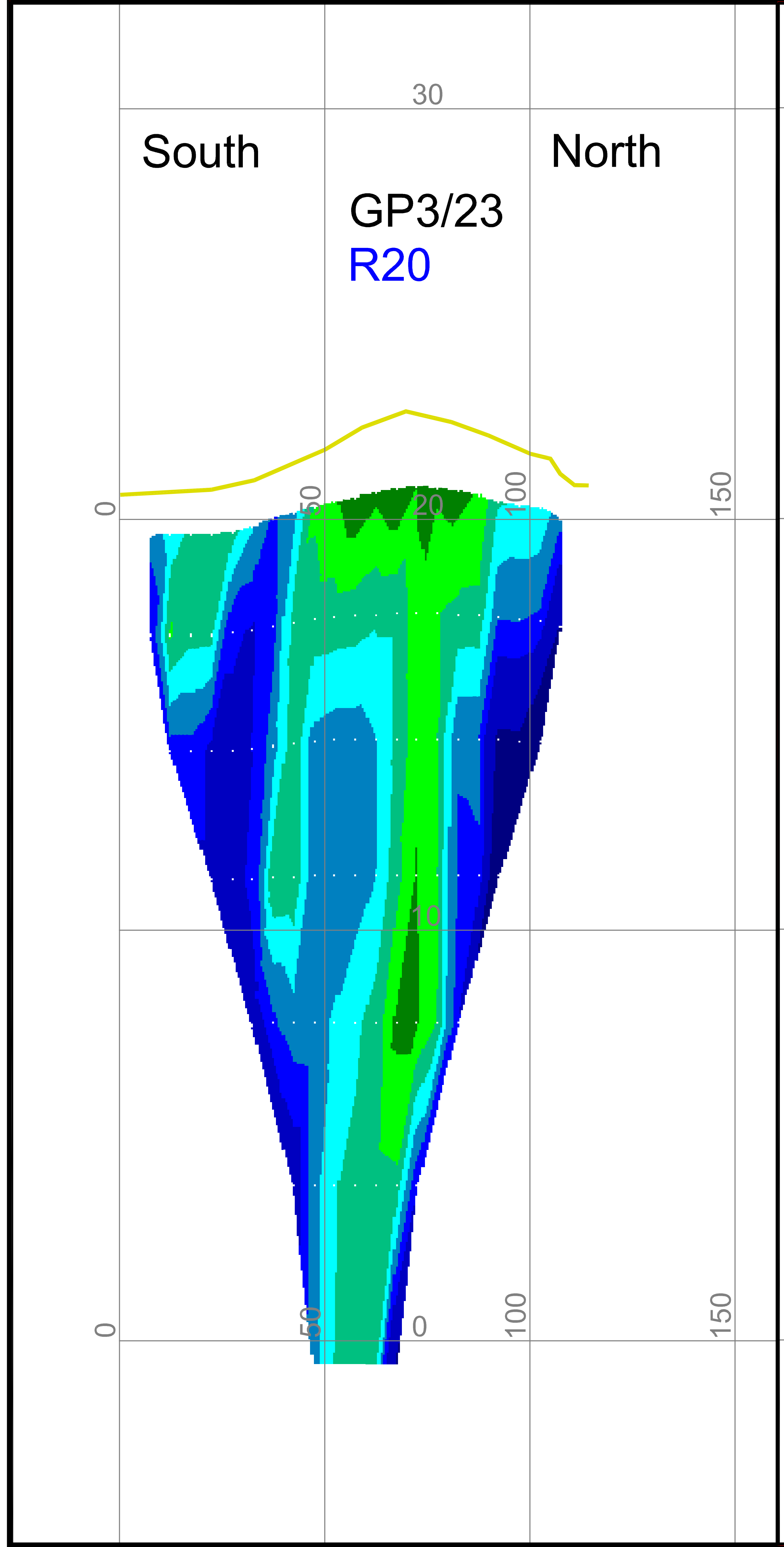
1800 Seismic Velocity in m/s

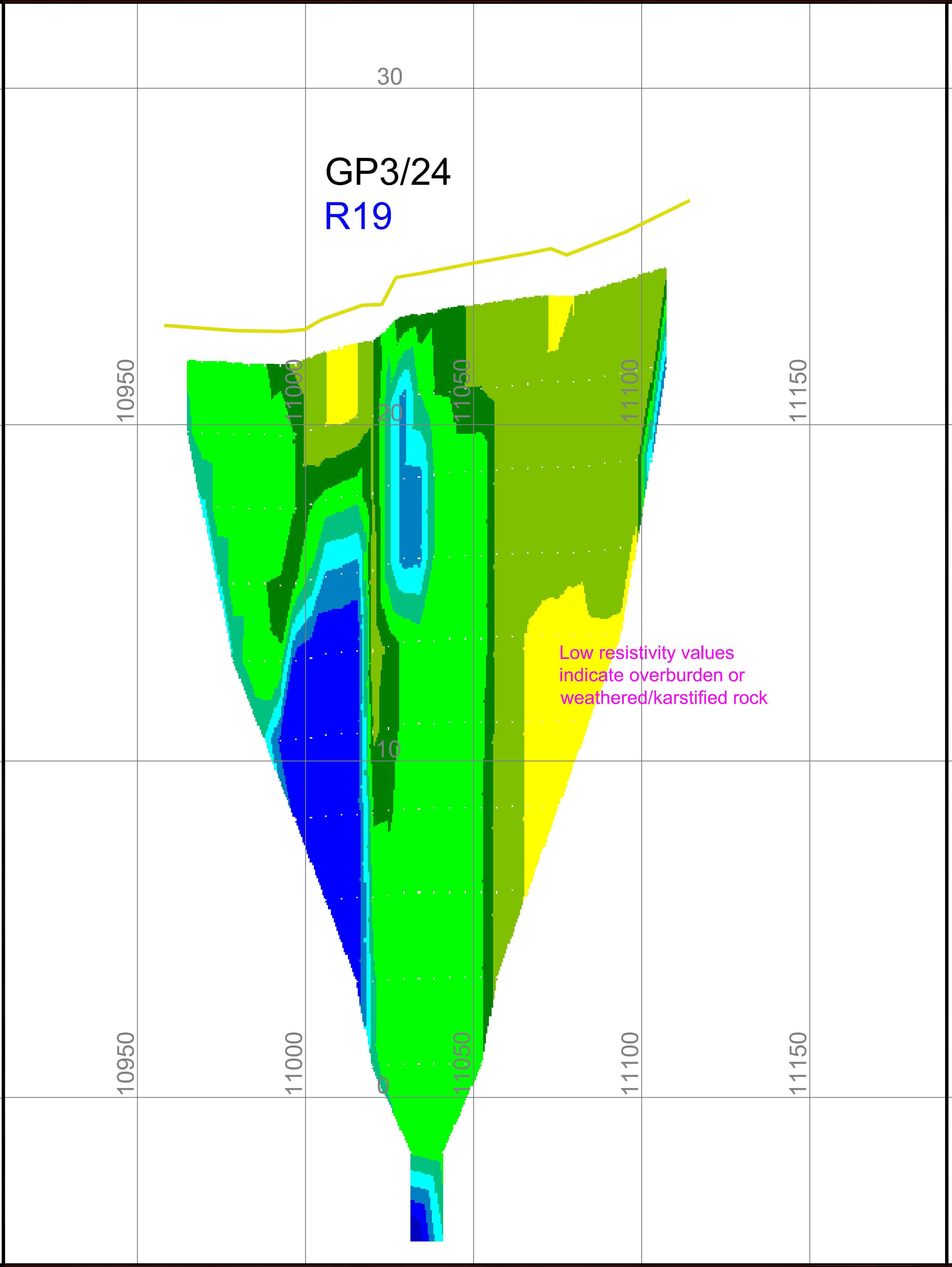
2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model

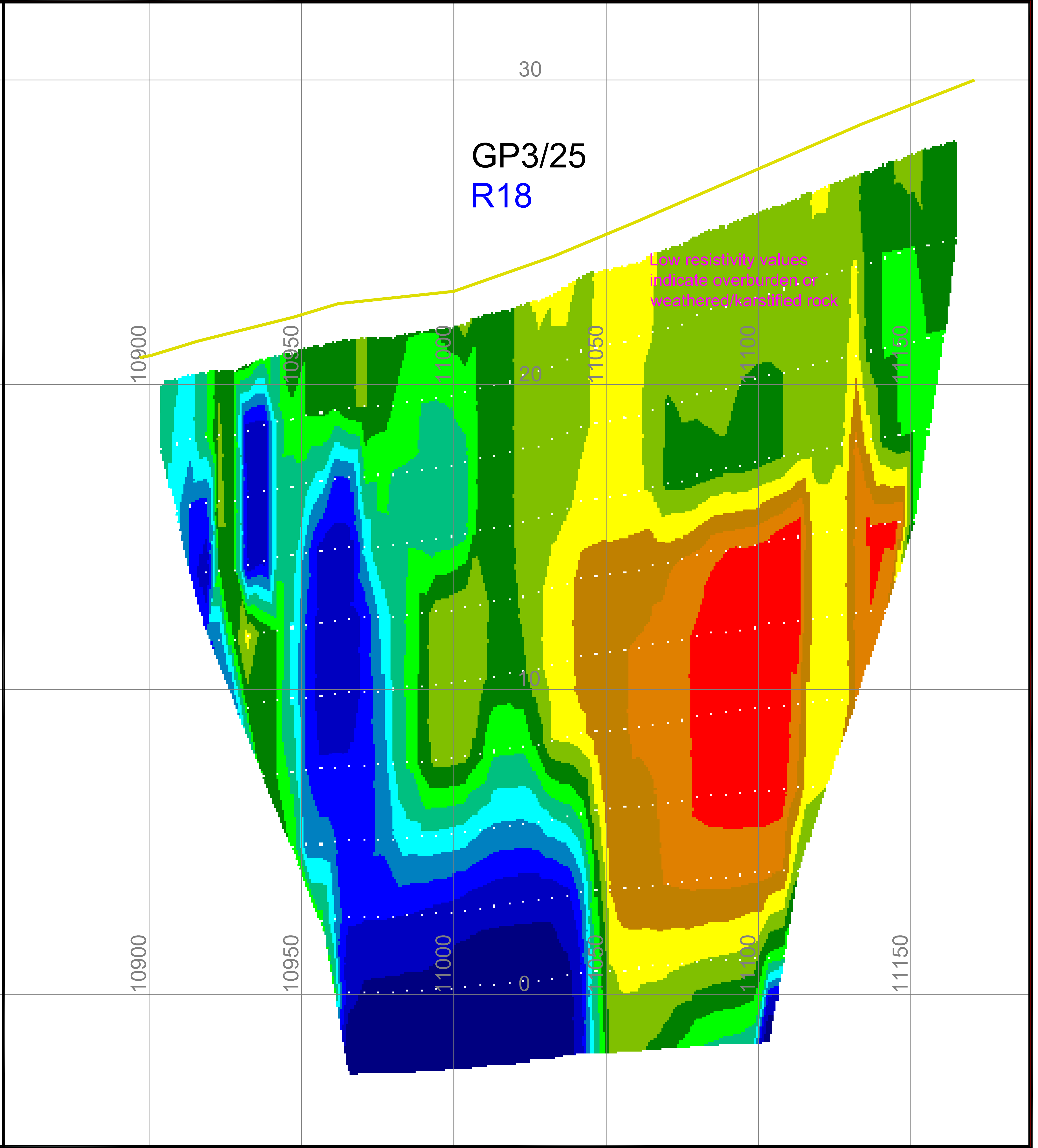
20.0 40.0 80.0 160 320 640 1280 2560

A draft interpretation is indicated by yellow/magenta text.
At this stage of the project this is intended to give guidance for targeted boreholes and coreholes.





Low resistivity values indicate overburden or weathered/karstified rock



Low resistivity values indicate overburden or weathered/karstified rock

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CLIENT	IGSL ARUP
PROJECT	N6 GCTP Phase 3 Geophysical Survey
TITLE	Plan 1m: Survey Locations and Models for GP3/23,GP3/24,GP3/25

SCALE:	Hor 1:1000 @ A1, Ver 1:100 @ A1, VE x 10
PROJECT:	6031
DRAWN:	RJ
DATE:	18/02/2016
MGX FILE:	6031d_Plans.dwg
STATUS:	Draft

LEGEND: Geophysical Survey Locations:

🟦	R2	2D-Resistivity Profile
🟥	S1	Seismic Refraction Profile

Chainage based on Alignment received 12.02.2016

Locations are in Irish Transverse Mercator, Elevations are in mOD (Malin Head)

Geophysical Survey Locations:

- Ground Surface along Survey Profile
- Existing Ground Level along Centre Line
- Proposed Vertical Alignment Centre Line

2D Resistivity and Seismic Refraction results are projected onto the Centre Line

Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (200 - 340 m/s)
- Top of Layer 2 (1000 - 1200 m/s)
- Top of Layer 3 (2000 - 2400 m/s)
- Top of Layer 4 (4500 - 5000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

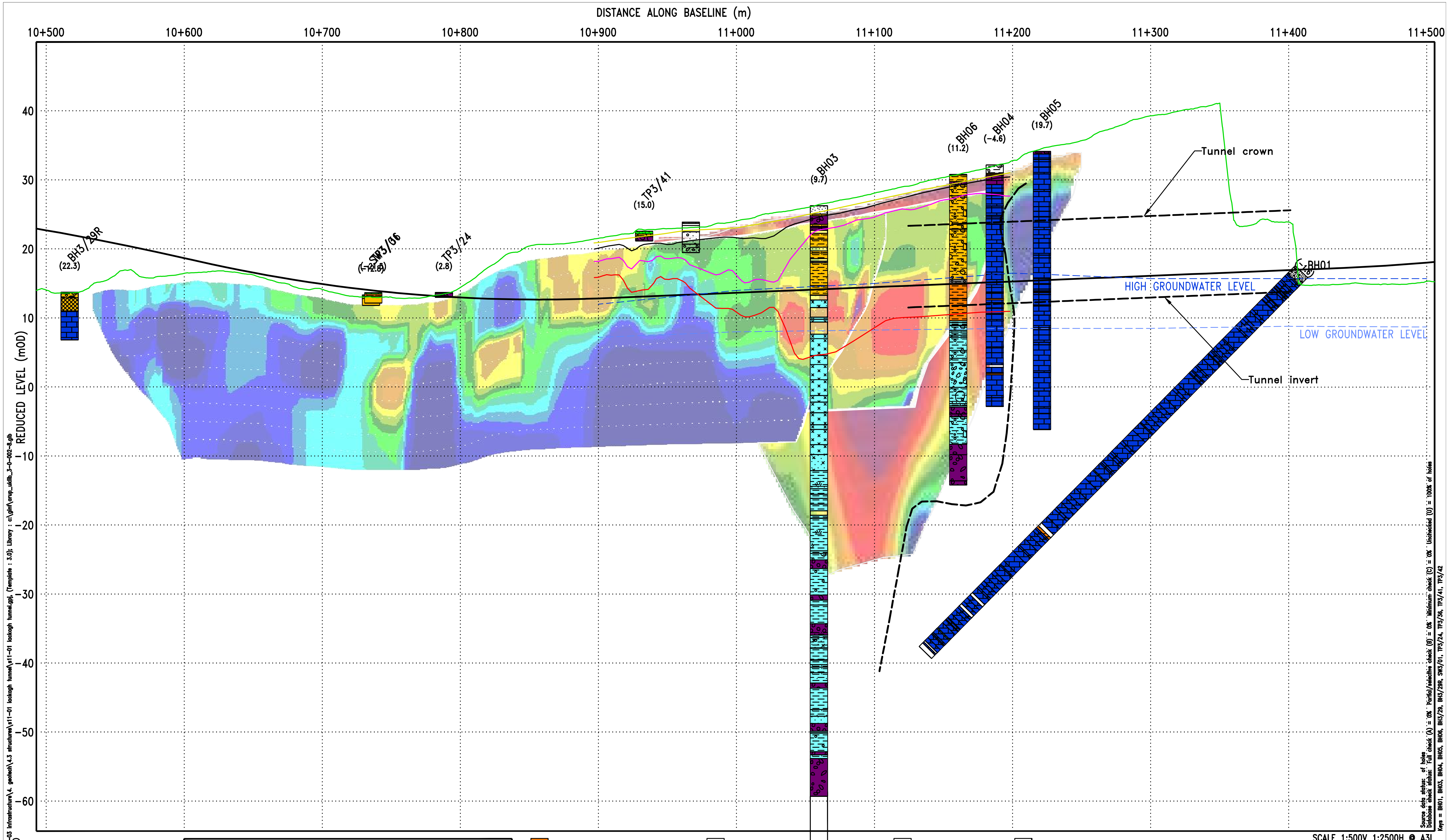
Resistivities (Ohmm) for 2D-Resistivity Model

20.0 40.0 80.0 160 320 640 1280 2560

A draft interpretation is indicated by yellow/magenta text. At this stage of the project this is intended to give guidance for targeted boreholes and coreholes.

Appendix B

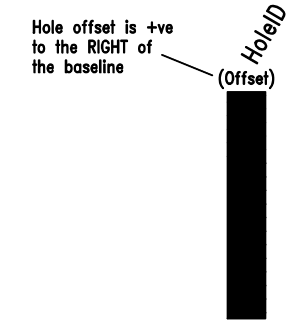
Lackagh Tunnel Design Details



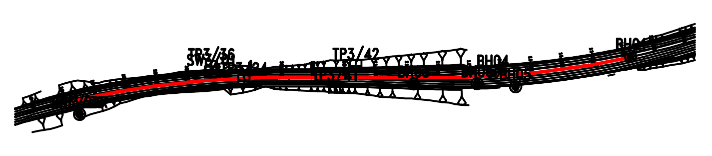
Source data status: of holes
Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 100% of holes
Keys = BH01, BH03, BH04, BH05, BH06, BH3/29, BH3/29R, SW3/01, TP3/24, TP3/36, TP3/41, TP3/42

SCALE 1:500V 1:2500H @ A3L

LEGEND



PLAN



- 🟧 Clay [Cl]
- 🟪 Cobbles [Cb]
- 🟩 Mudstone [Mud]
- 🟨 Glacial Till Deposits [GTD]
- ⬛ Glacial Gravel [GG]
- 🟦 Carboniferous Limestone and Shale [CLS]
- 🟩 Topsoil [TOP]
- 🟦 Palaeolandscape Fill [PF]
- ☐ NO RECOVERY
- ▨ TOPSOIL
- ▨ Sandy CLAY
- ▨ Gravelly COBBLES
- ▨ Clayey COBBLES
- ▨ COBBLES
- ▨ GRAVEL
- ▨ Sandy SILT
- ▨ CLAY
- ▨ SAND
- ▨ Gravelly CLAY
- ▨ Silty sandy gravelly CLAY
- ▨ Sandy cobbly CLAY
- ▨ COBBLES and BOULDERS
- ▨ Sandy gravelly cobbly CLAY
- ▨ Clayey GRAVEL
- ▨ Cobbly CLAY
- ▨ BOULDERS
- ▨ CONCRETE
- ▨ LIMESTONE
- ▨ MUDSTONE
- ▨ SILT
- ▨ Silty SAND
- ▨ Organic CLAY

*** DRAFT ***

Galway City Transport Project
Galway City Ring Road (GCRR)
S11/01 Lackagh Tunnel

233985-19

FIGURE 1.0

Project : j:\233000\233985-00\4. internal\4-03 design\4-03-03 infrastructure\4. geotech\4.3 structures\s11-01 lackagh tunnel\s11-01 lackagh tunnel.gpj, (Template : 3.0); Library : c:\gint\arup_uklib_3-0-002-8.glb
Fence: 2.4.01 SECTION WITH PLOTTED DATA (A3) (rev 7Nov13)
gINT output page 0 of 0. Made 23Jun16 10:45

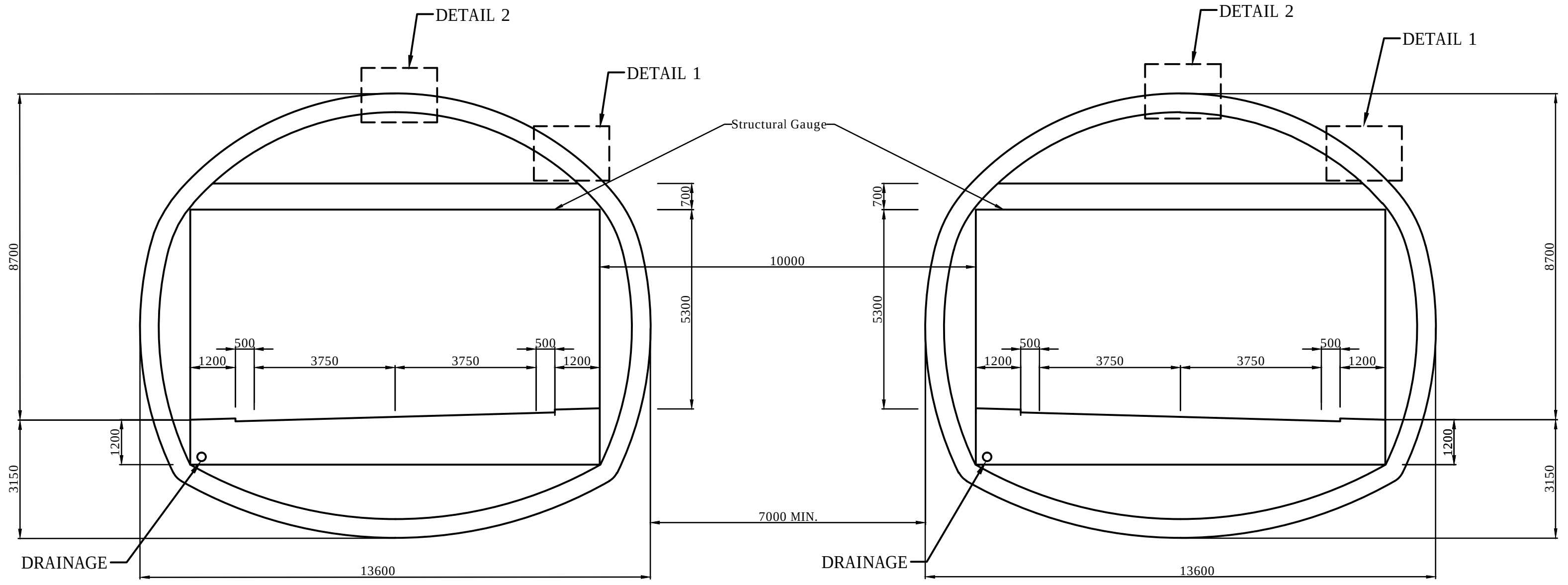
<<DrawingFileSpec>>

A1

FOR INFORMATION

NOTES:

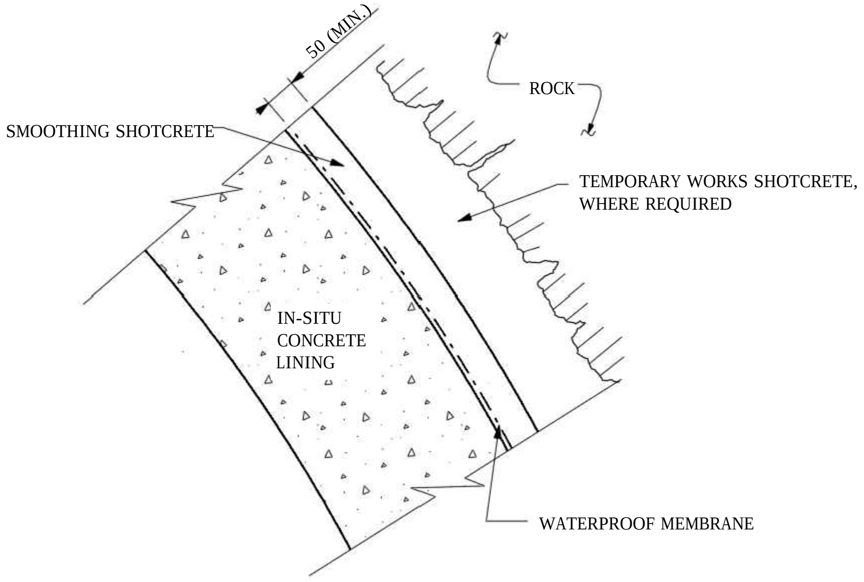
1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE STATED.
2. DRAWING TO BE READ IN CONJUNCTION WITH ALIGNMENT DRAWINGS AND TUNNEL PLAN AND PROFILE DRAWINGS.



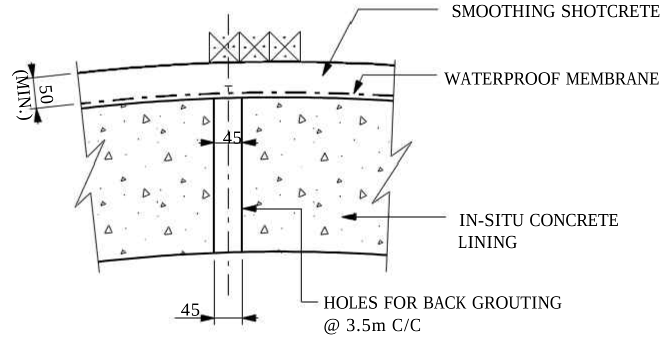
Eastbound Bore

Westbound Bore

TYPICAL CROSS SECTION FOR LACKAGH TUNNEL



DETAIL 1



DETAIL 2

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Clients

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Galway County Council

N6 Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt
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Scale N.T.S.

Date: July 2016

Issue	Date	By	Chkd	Appd
I2	08/06/2017	KJ	PS	JC
I1	27/02/2017	DC	PS	JC

Drawing Title
Lackagh Tunnel and Western Approach Mined Tunnel General Arrangement

Drawing Status
For Information

Job No **233985**
Drawing No **GCOB-D-ST11-01-011**
Issue **I2**

Do not scale

\\dubnts03\Dublin_Jobs\233000\233985-00\4. Internal\4-02 Drawings\4-02-7 Geotechnical\2. Lackagh Tunnel and Approach\Preliminary Design\GCOB-D-ST11-01-011_Lackagh Tunnel Cross Section – General Arrangement_I2.dwg

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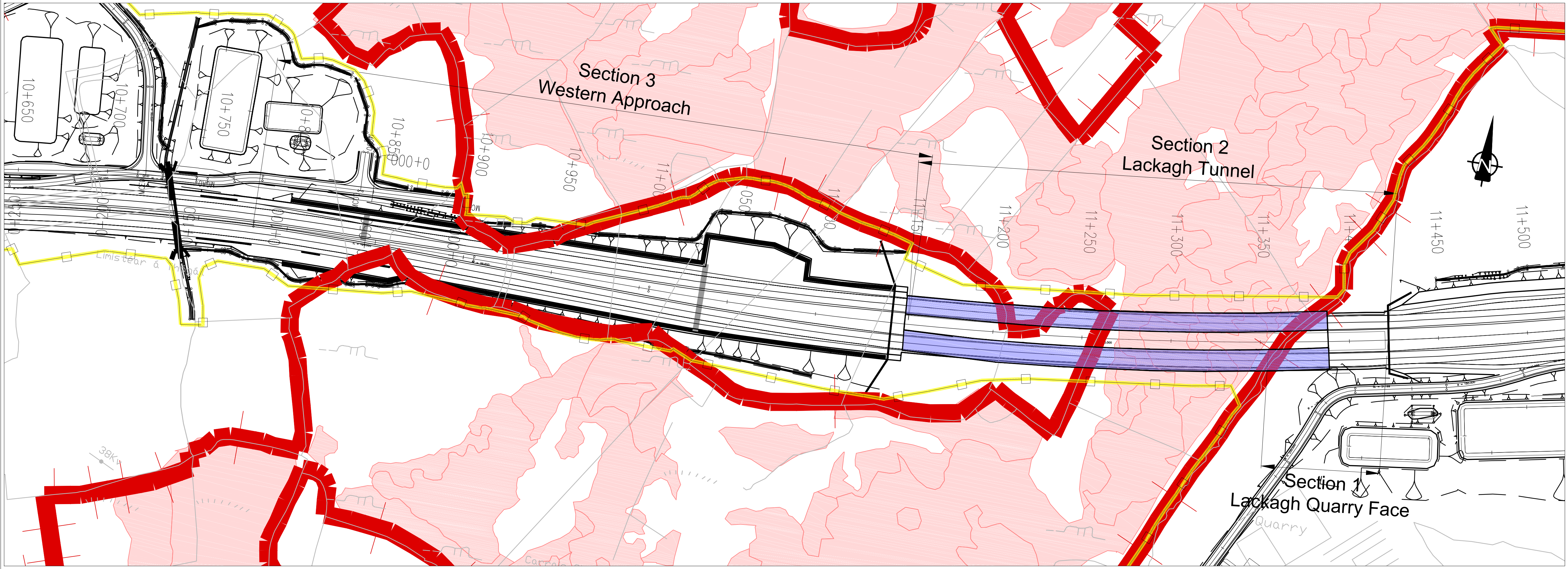
A3



FOR INFORMATION

Legend:

Plan

▭	Proposed Development Boundary
▤	Proposed Geometry Plan
▤	Proposed Tunnel Section
┼	Lough Corrib cSAC Boundary
🟥	Annex I Habitat

Profile

- - - - - -	Existing Ground (Indicative Levels based on 2m grid LiDAR Data DTM.)
——	Proposed Geometry Profile

MX REFERENCE INFO
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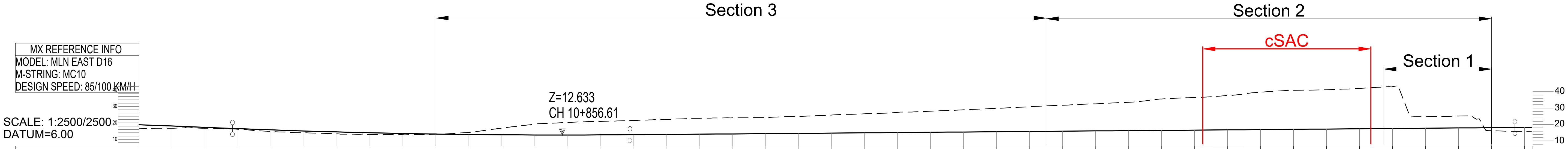
M-STRING: MC10
DESIGN SPEED: 85/100 KM/H

SCALE: 1:2500/2500
DATUM=6.00



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PROPOSED LEV	18.90	18.10	17.30	16.50	15.75	15.09	14.50	13.99	13.57	13.22	12.95	12.77	12.66	12.63	12.69	12.82	12.98	13.15	13.31	13.48	13.64
GROUND LEV.	16.48	16.77	16.77	16.14	14.76	13.99	13.33	12.97	12.79	13.11	14.24	16.85	19.23	20.26	20.88	21.48	22.16	22.82	23.06	23.25	23.89
HORIZ. SCHEM.	R=1440.00 L=449.54									CL=125.00						D=99.65					
VERT. SCHEM.	L=106.90 P=-4.00%			R=5000.00 L=240.96												P=0.82% L=536.75					
SUPER. SCHEM.	S=2.5% S=2.5%																				
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CHAINAGE	11+020	11+040	11+060	11+080	11+100	11+120	11+140	11+160	11+180	11+200	11+220	11+240	11+260	11+280	11+300	11+320	11+340	11+360	11+380	11+400	11+420	11+440
PROPOSED LEV	13.80	13.97	14.13	14.29	14.46	14.62	14.78	14.95	15.11	15.28	15.44	15.60	15.77	15.93	16.09	16.26	16.42	16.59	16.75	16.91	17.08	17.24
GROUND LEV.	24.75	25.50	26.37	27.15	27.95	28.86	29.80	30.72	31.61	32.56	34.56	35.44	36.64	38.65	39.81	40.18	41.02	42.03	23.72	24.19	15.26	14.86
HORIZ. SCHEM.	R=-2040.00 L=601.01																					
VERT. SCHEM.																						
SUPER. SCHEM.										S=2.5%			S=2.5%									
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GCRR - LACKAGH TUNNEL PROFILE

San áireamh tá sonraíocht Shuirbhéireacht Ordanáis Éireann arna atáirgeadh faoi Cheadúnas OSI Uimh. 2016/17CCMA/Comhairle Contae na Gaillimhe.Sáraíonn atáirgeadh neamhúdaraithe cóipcheart Shuirbhéireacht Ordanáis Éireann agus Rialtas na hÉireann.
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Clients
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Galway City Transport Project
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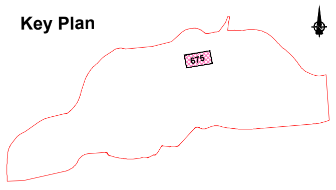
Department Transport, Tourism and Sport
Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Key Plan



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Scale
1:2500 @ A1
Date:
Julu 2018

Issue	Date	By	Chkd	Appd
I5	26/07/2018	KJ	MH	EMC
I4	27/03/2018	KJ	MH	EMC
I3	05/05/2017	KJ	MH	EMC
I2	07/06/2016	KJ	MH	EMC
I1	27/05/2016	KJ	MH	EMC

Drawing Title
Lackagh Tunnel Plan & Profile

Drawing Status
For Information

Job No	Drawing No	Issue
233985	**GCOB-SK-D-675**	**I5**

Do not scale
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Appendix C

Rock Arch Cover

ARUP	Job No.	233985-00	Sheet No.		Rev.	
	Member/Location					
Job Title: N6 Galway City Ring Road	Drg. Ref.					
Calculation: Appendix C: Rock Arch Cover	Made by	PS	Date	09/06/2017	Chd.	PC

Introduction: As part of the proposed N6 Galway City Ring Road a tunnel is proposed at Lackagh Quarry connecting Section 1 to Section 3 tunnelling beneath the Lough Corrib cSAC. This note is prepared to calculate the minimum rock arch cover required before tunnelling works will cease. Based on the available information, the rock cover from ground level to the crown of the proposed tunnel at the eastern extent of the cSAC is approximately 15m and 13m at the western extent. As the tunnel travels west away from the western extent of the cSAC the rock cover gradually lowers. Once the minimum rock arch cover is reached, a transition structure will be constructed connecting the tunnel to the western approach.

Geology: The proposed tunnel will be entirely excavated within limestone bedrock.

Limestone rock parameters:

Geotechnical site investigation work (Phase 3 GI Contract 2) has been carried out along the proposed tunnel alignment and rock samples have been taken from various depths to assess the engineering geological parameters of the ground.

Based on a preliminary assessment the following parameters were developed:

Rock mass parameters for limestone rock at Lackagh Quarry

Unit weight	27	kN/m^3
Young's Modulus	14	GPa
Poisson's ratio	0.2	
Cohesion	1.9	MPa
Friction Angle	61	°

The above parameters represent a typical set of parameters for the limestone at Lackagh Quarry, which take into account the intact propertied of the limestone and the effect of the jointing and weathering, however adopting a conservative approach and to ensure the worst case scenario is covered a reduced set of rock mass parameters are used in this assessment, as shown below.

Lower bound rock mass parameters for limestone rock at Lackagh Quarry

Unit weight	27	kN/m^3
Young's Modulus	1	GPa
Poisson's ratio	0.3	
Cohesion	0.2	MPa
Friction Angle	45	°

Methodology: The lower bound rock mass parameters are used to determine the stability of the tunnel using Plaxis, a finite element computer program. This software is standard practice for these type of works in the tunnelling industry and can be used to analyse tunnels, excavations and other geotechnical engineering problems

The two tunnels at Lackagh were modelled sequentially and assessed in Plaxis. The model includes the installation of a temporary sprayed concrete lining and rock bolts. A typical pattern of 5m long rock bolts at 2m spacing has been applied in the model with a 150mm thick sprayed concrete lining. In the permanent condition a 500mm reinforced concrete lining is installed. In the permanent case, no benefit is taken from the temporary sprayed concrete and rock bolts.

ARUP	Job No. 233985-00	Sheet No.	Rev.
	Member/Location		
Job Title: N6 Galway City Ring Road	Drg. Ref.		
Calculation: Appendix C: Rock Arch Cover	Made by: PS	Date: 09/06/2017	Chd.: PC

Inputs

Standard practice for calculating rock cover is to set a minimum rock cover at half the tunnel span. Each tunnel bore at Lackagh Quarry is 13.6m wide. To account for potential resizing of the tunnel a conservative assumed width of 16m will be adopted for this calculation, therefore a minimum rock cover of 8m is used in the calculation.

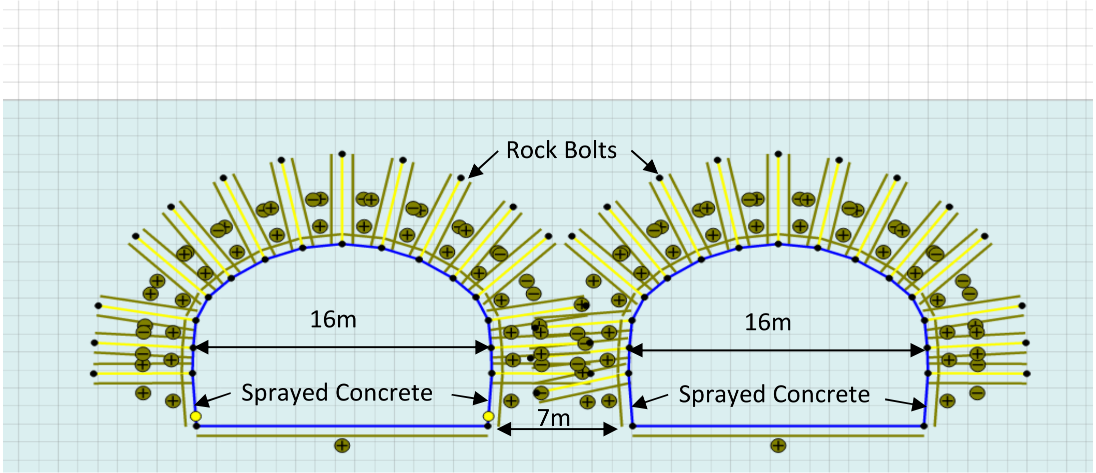
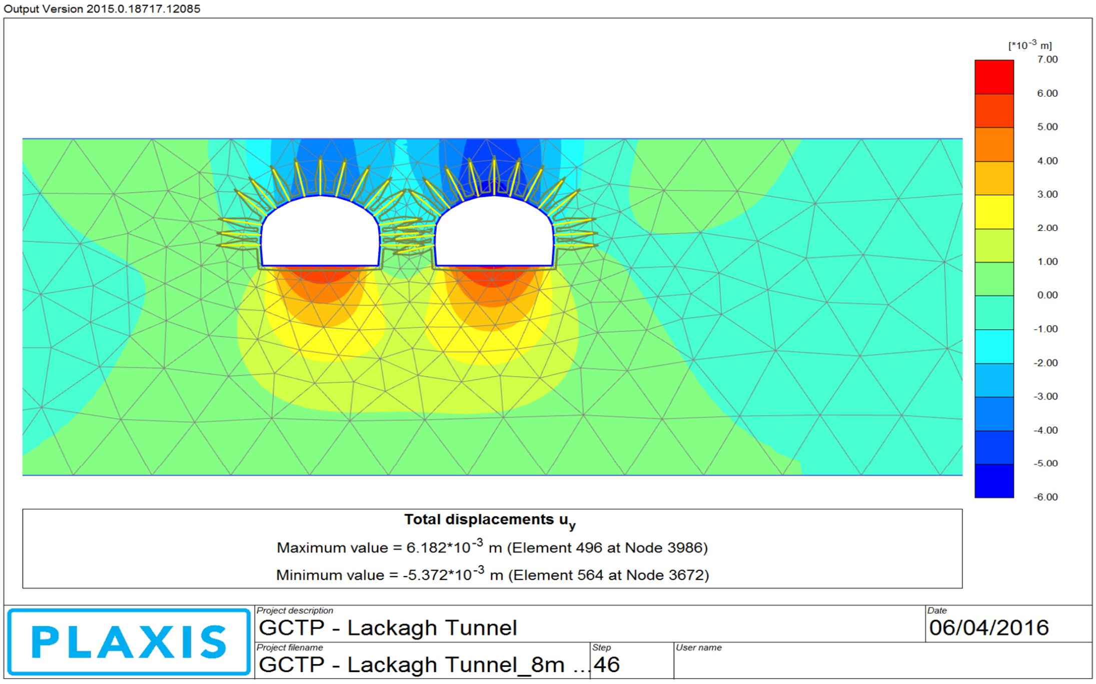


Figure C1: Model graphics showing twin bored tunnels with rock bolts installed around the lining.

As per the design sequence the tunnels were excavated and modelled sequentially. The rock stress is allowed to relax up to 50% prior to the installation of the tunnel lining. Relaxing the rock stress allows Plaxis to realistically model the behaviour of the tunnel between the short term condition (during excavation) and the long term condition (tunnel lining support installed).

The diagram below shows the expected movement of the ground around the tunnels before installation of the permanent lining. In total a settlement of 6mm is observed directly above the tunnel crown this is less than 3mm of movement occurring at the surface.


Output Version 2015.0.18717.12085

Total displacements u_y

Maximum value = 6.182*10^{-3} m (Element 496 at Node 3986)

Minimum value = -5.372*10^{-3} m (Element 564 at Node 3672)

Project description: GCTP - Lackagh Tunnel

Date: 06/04/2016

Project filename: GCTP - Lackagh Tunnel_8m ..

Step: 46

User name

Figure C2: Vertical ground movement after excavation

The figure below shows the principal (major and minor) stresses and stress directions in the rock mass. The direction of the major stress indicates that the rock arch load is being transferred effectively into the rock pillar between the tunnels and the ground either side. This demonstrates that an effective rock arch is forming above the tunnels where the depth of rock is least (8m from ground level to the tunnel crown).

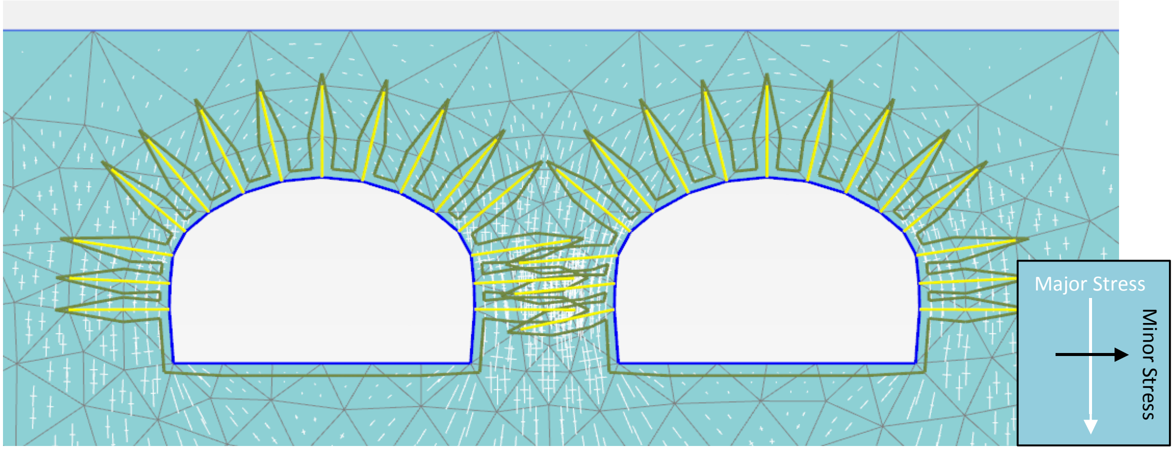
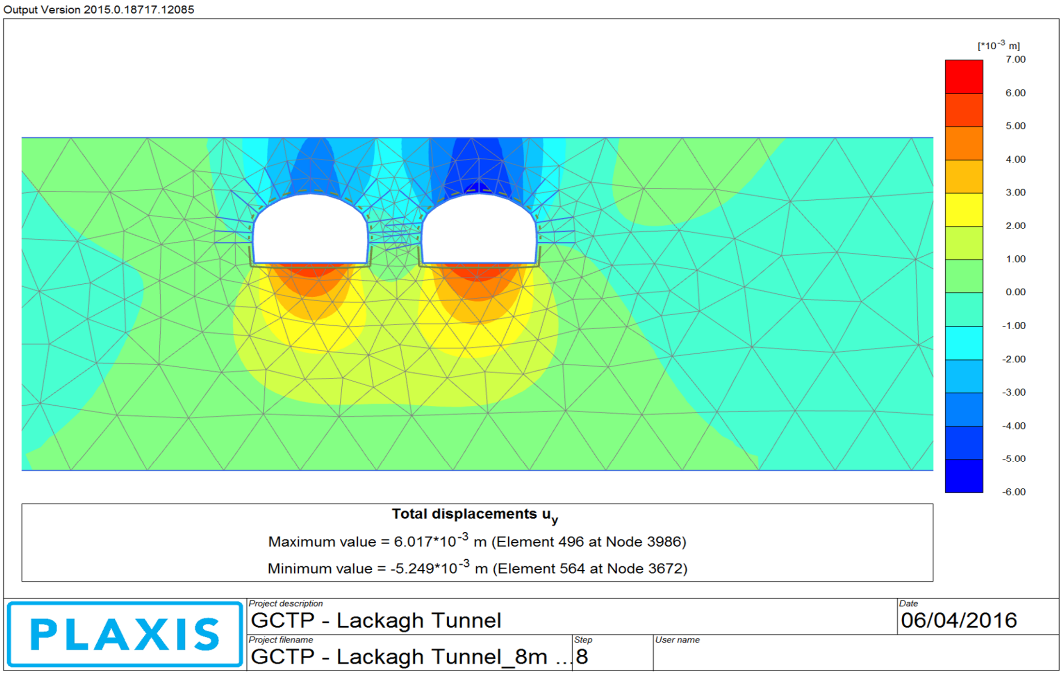


Figure C3 Principal stresses and stress directions in the limestone rock

The below figure illustrates the ground model and the anticipated stresses around the twin bore tunnel post construction. When compared with Figure C2 it can be observed that little or no additional settlement occurs during the operational stage (i.e. after the installation of the permanent lining).



Output Version 2015.0.18717.12085

Total displacements u_y

Maximum value = 6.017*10^{-3} m (Element 496 at Node 3986)

Minimum value = -5.249*10^{-3} m (Element 564 at Node 3672)

Project description: GCTP - Lackagh Tunnel

Date: 06/04/2016

Project filename: GCTP - Lackagh Tunnel_8m ..

Step: 8

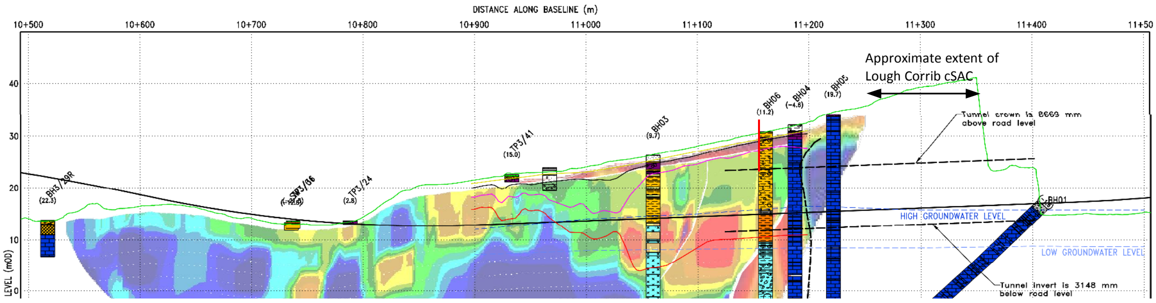
User name

Figure C4 - Vertical ground movement after permanent lining

ARUP

Job No. 233985-00
Sheet No.
Rev.
Member/Location
Job Title N6 Galway City Ring Road
Calculation Appendix C: Rock Arch Cover
Drg. Ref.
Made by PS Date 09/06/2017 Chd. PC

Conclusion: This analysis shows that at least 8m of clear rock must be maintained above the crown to the top of rock/ground level. This 8m allows a stable rock arch to develop around the tunnel which will ensure the stability of the tunnel in the temporary case. The proposed alignment for Lackagh Tunnel provides bedrock cover ranging from approximately 10m to 14.5m above the tunnel crown below the Lough Corrib cSAC which is greater than the minimum requirement of 8m.



A calculation showing that minimal settlement or deformation of the tunnel lining is expected based on the conservative design approach. Any slight movement that does occur will not impact to the overlying Annex I Habitat.

Appendix D

Tunnel Bore Separation

ARUP

Job No.	Sheet No.	Rev.
233985-00		

Member/Location Appendix D

Job Title N6 Galway City Ring Road

Drg. Ref.

Calculation Appendix D: Rock Pillar Calculation

Made by PS Date 09/06/2017 Chd. PC

Introduction: This calculation is prepared to determine the minimum separation between the twin bores tunnel bores for Lackagh Tunnel (Section 2) . The tunnel bores are expected to be approximately 16m wide through limestone bedrock. The bore separation is based on the Phase 3 Ground Investigation Contract 2 including laboratory test results.

Figure D1(a) - Site overview of Lackagh Tunnel (Section 2)

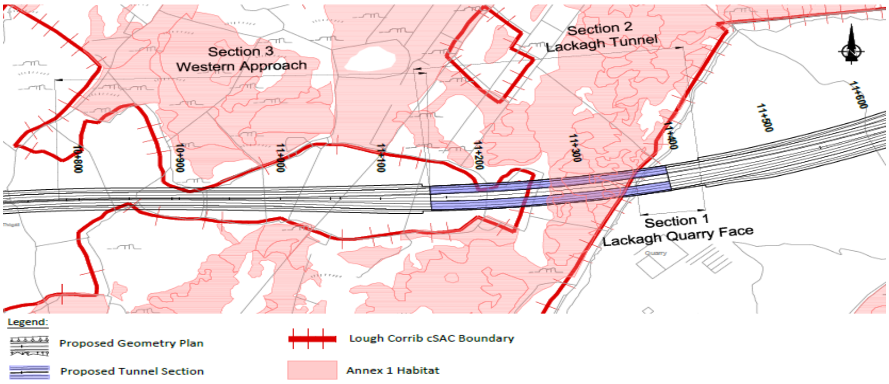


Figure D1(b) - Plan overview of Lackagh Tunnel (Section 2)

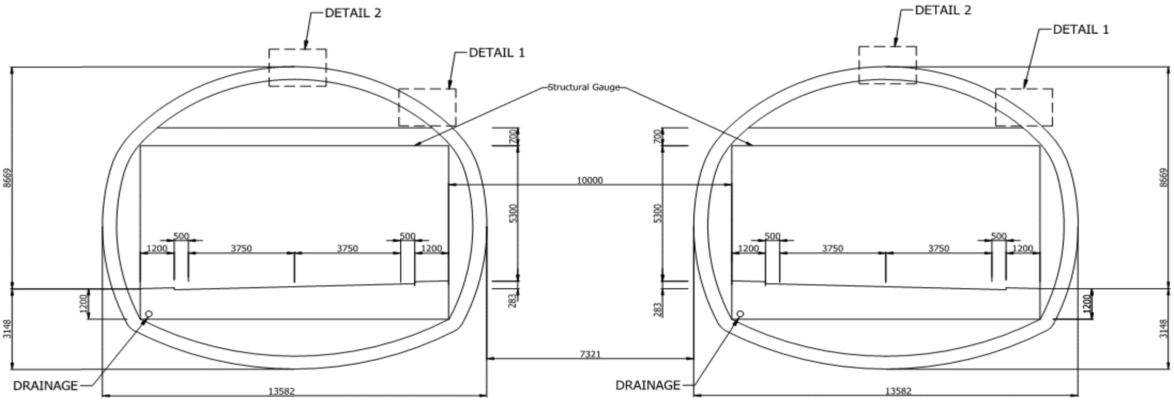


Figure D2 - Tunnel cross section, showing separation between bores

ARUP		Job No.	233985-00	Sheet No.		Rev.	
		Member/Location	Appendix D				
Job Title	N6 Galway City Ring Road	Drg. Ref.					
Calculation	Appendix D: Rock Pillar Calculation	Made by	PS	Date	09/06/2017	Chd.	PC

Geology: The tunnel bores will be excavated through limestone bedrock. The tunnel works will cease before Section 3 (Western Approach), which is to excavated from surface.

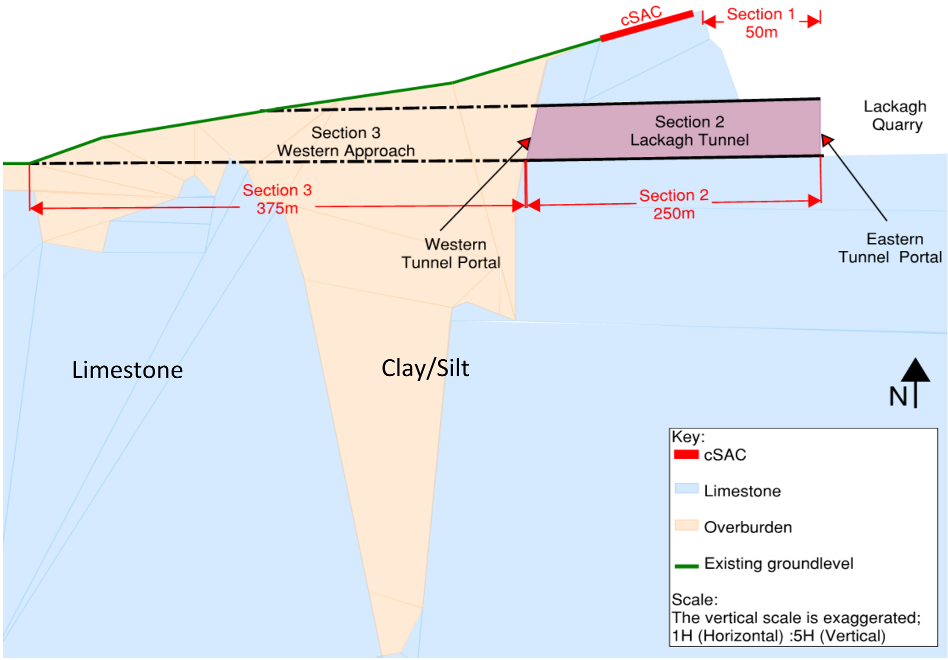


Figure D3 - Schematic geological long section showing the geological boundaries

Methodology: Typically the ground surrounding a tunnel in hard rock is supported through an arching effect caused by the confining stress. If the rock cover is too low then the surrounding rock could become unstable and lead to progressive collapse to ground level. The minimum rock cover of 8m from ground level to the tunnel crown shall be maintained. Details of the minimum rock cover analysis are provided in Appendix C.

An commonly used empirical method for calculating the width of rock pillars in tunnels and mining was developed by Martin & Maybee (2000) where the width and height of the pillar has a direct relationship on the pillar strength.

Figure D4 shows a summary of empirical data for rock pillars where σc is the Unconfined Compressive Strength (UCS) of the rock. A Factor of Safety (FOS) = 1.4 line will be used for the Lackagh Tunnel calculation. As illustrated in Figure D4, a FOS of 1.4 is a conservative approach as it encompasses the various design methods for rock pillar design.

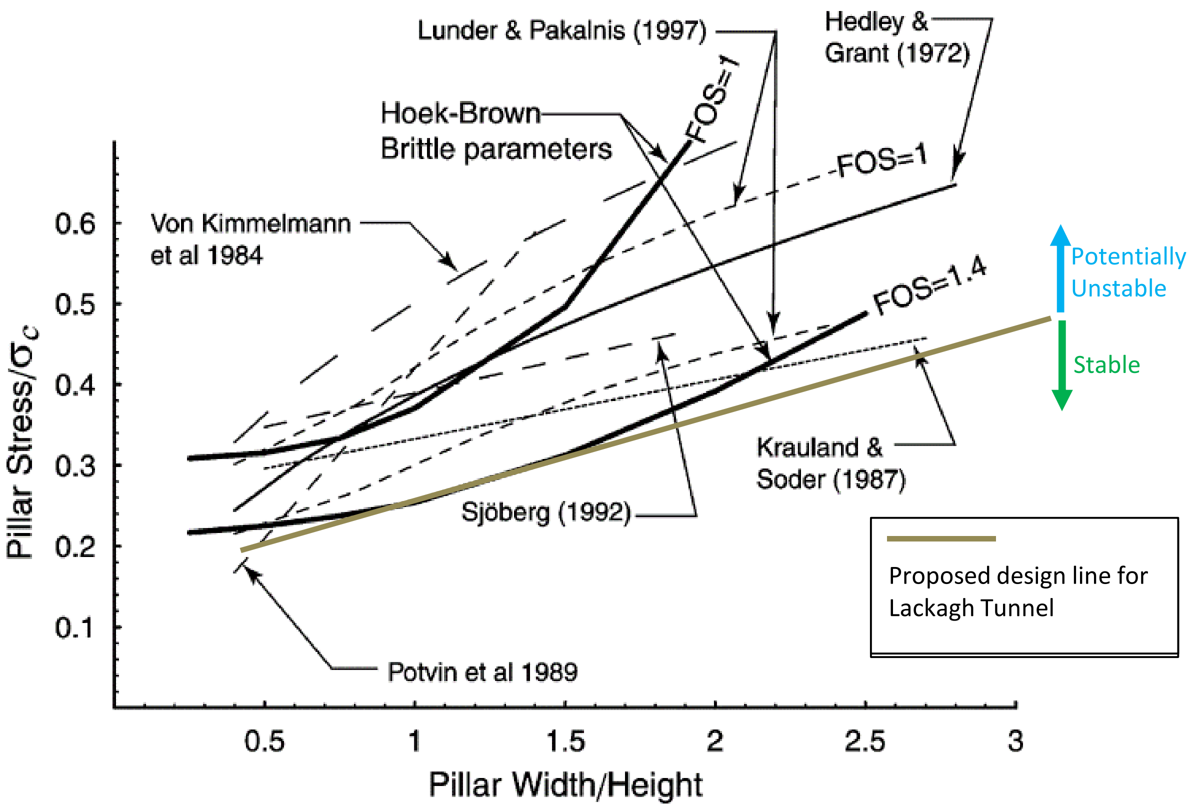


Figure D4 - Hard rock pillar design (after Martin & Maybee, 2000)

ARUP	Job No.	Sheet No.	Rev.
	233985-00		
	Member/Location	Appendix D	
Job Title: N6 Galway City Ring Road	Drg. Ref.		
Calculation: Appendix D: Rock Pillar Calculation	Made by: PS	Date: 09/06/2017	Chd.: PC

Inputs: Conservative values for rock strength have been selected to determine the minimum rock pillar width . A factor of safety (FOS) of 2 on the lower bound UCS values has been used. This ensures that the rock pillar will remain stable during the temporary and permanent works.

UCS and point load laboratory test results from 69 samples that were taken from the Lackagh Tunnel site specific ground investigation. Figure D5 illustrates a plot of the UCS strength values versus depth below ground level. Based on this information an unconfined compressive strength (UCS) of 15MPa is used in the calculation, this value is the lower bound UCS value.

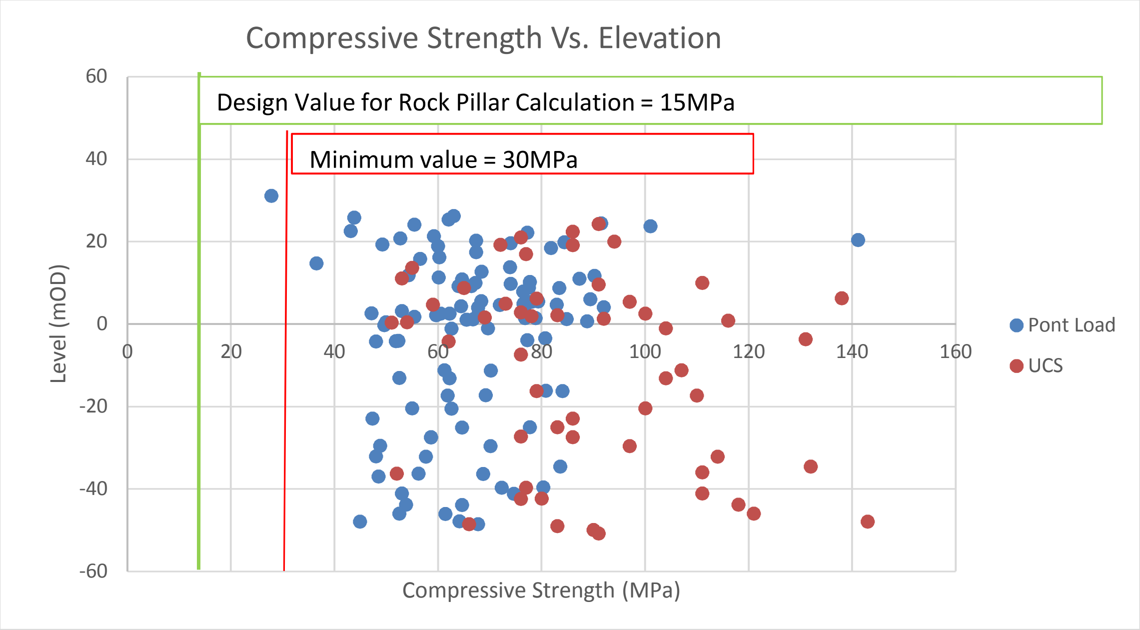


Figure D4 - Compressive strength of rock Vs. Sample level (mOD)

Calculation: *Calculation Input:*

Actual tunnel span	13.6	m	(At the widest tunnel span to extrados)
Factored Tunnel span	16	m	
Tunnel height	10.2	m	(At centre to extrados)
Unconfined compressive strength	15	MPa	(Assumed damaged)
Unit weight of limestone rock	27	kN/m^3	

The above design values are applicable only to Lackagh Tunnel.
The span of the tunnel is assumed as a conservative 16m to allow for potential resizing of tunnel

Based on the alignment and geology the range of rock cover is expected

Highest calculated rock cover above tunnel crown	20	m
Minimum calculated rock cover above tunnel crown	8	m

ARUP

Job No.	Sheet No.	Rev.
233985-00		

Member/Location Appendix D

Job Title N6 Galway City Ring Road

Drg. Ref.

Calculation Appendix D: Rock Pillar Calculation

Made by PS Date 09/06/2017 Chd. PC

Results

Table D1 - Hard rock pillar design (after Martin & Maybee, 2000) - refer to Figure D6

Separation	Stress at Invert (kPa)		Width	Stress/UCS		
(m)	20m	8m	/Height	20m	8m	
20	1468	885	2.0	0.10	0.06	
19	1502	905	1.9	0.10	0.06	
18	1540	928	1.8	0.10	0.06	
17	1583	954	1.7	0.11	0.06	
16	1631	983	1.6	0.11	0.07	
15	1685	1016	1.5	0.11	0.07	
14	1747	1053	1.4	0.12	0.07	
13	1819	1096	1.3	0.12	0.07	
12	1903	1147	1.2	0.13	0.08	
11	2001	1206	1.1	0.13	0.08	
10	2120	1278	1.0	0.14	0.09	
9	2265	1365	0.9	0.15	0.09	
8	2446	1474	0.8	0.16	0.10	
7	2679	1615	0.7	0.18	0.11	*
6	2990	1802	0.6	0.20	0.12	
5	3425	2064	0.5	0.23	0.14	
4	4077	2457	0.4	0.27	0.16	
3	5164	3112	0.3	0.34	0.21	
2	7339	4423	0.2	0.49	0.29	
1	13862	8354	0.1	0.92	0.56	

*Critical point for pillar width

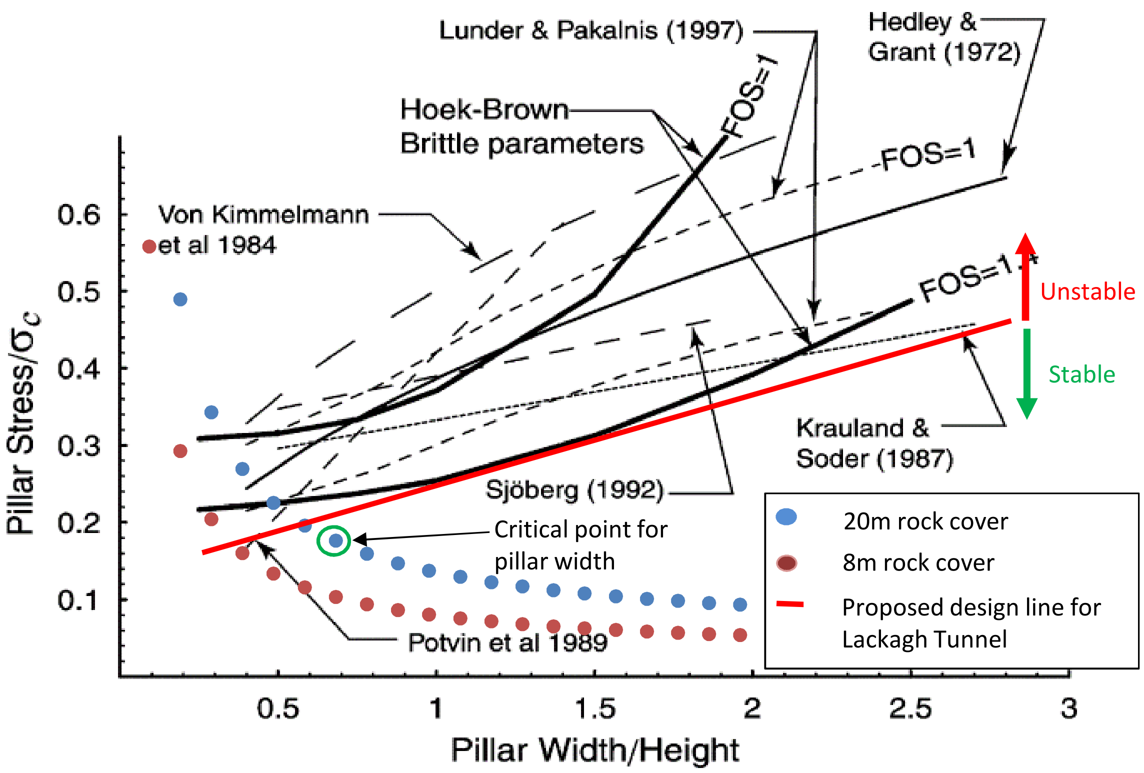


Figure D6: Pillar Stress versus pillar width/height

Table D1 and Figure D6 show the stress in the pillar for each separation from 1-20m. The resulting W/H values and stress/UCS values are plotted above.

The minimum separation between the two bores shall be 7m based on the above analysis as this is the lowest separation which results in a stable point plotted in Figure D6 (highlighted in green). This separation is conservative as factors of safety have been applied to both the rock mass strength and the stability assessment.

References

Martin & Maybee (2000), The Strength of Hard Rock Pillars. International Journal of Rock Mechanics and Mining Sciences 37 (2000) 1239-1246.

Guideline for the Geotechnical Design of Underground Structures with Conventional Excavation, Austrian Society of Geomechanics (2010)

Marcher & Aydogmus (2013). Some Aspects on the Design of Near Surface Tunnels - Theory and Practice. - 6th Colloquium Rock Mechanics "Theory and Practice", Vienna 2013

Appendix E

Drill and blast assessment

ARUP

Job No.	233985-00	Sheet No.		Rev.	
Member/Location					
Job Title	N6 Galway City Ring Road	Drg. Ref.	Appendix E		
Calculation	Appendix E: Blasting assessment	Made by	PS	Date	09/06/2017
		Chd.	PC		

Introduction: Section 2 (Lackagh Tunnel) will be excavated by drill and blast methods. This note is prepared to demonstrate that there will be no impact to the Lough Corrib cSAC at ground surface from the effects of tunnel blasting and demonstrates the limitations that apply to blasting works due to vibration limits on this sensitive receptors.

Geology: Lackagh Tunnel is expected to be excavated entirely through limestone rock as shown in Figure E1.

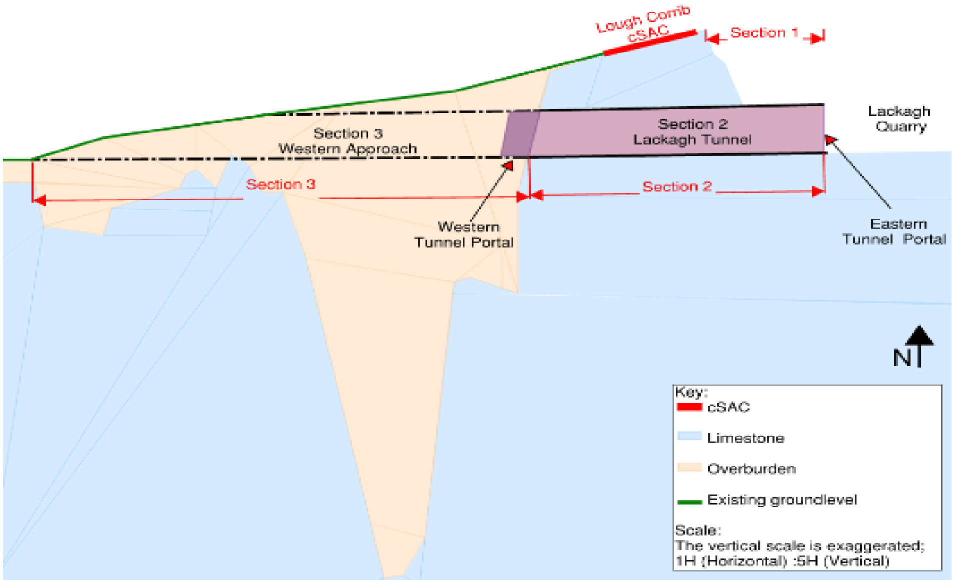


Figure E1 - Schematic geological section showing Lackagh Tunnel and Lough Corrib cSAC

The minimum rock cover above the tunnel crown at Lough Corrib cSAC is approximately 12m, however a minimum rock cover of 8m (Appendix C) is used for this blast assessment.

An equation for calculating the peak particle velocity at a distance from an underground blast is shown below (from US Bureau of Mines):

Equation E1:

$$PPV = K \cdot (R / \sqrt{W})^{-B}$$

Where:

PPV is the predicted peak particle velocity (mm/sec)
K is the rock transmission constant
R is the distance between the blast and the monitoring point (m)
W is the maximum charge weight per interval (kg)
B is the attenuation exponent

The common practice to reduce vibration is to introduce a sequential blast pattern with a delay between successive blasts, generally 8 milliseconds delay is standard. Having successive blasts leads to lower blast vibrations. An example successive blast pattern is shown in Figure E2.

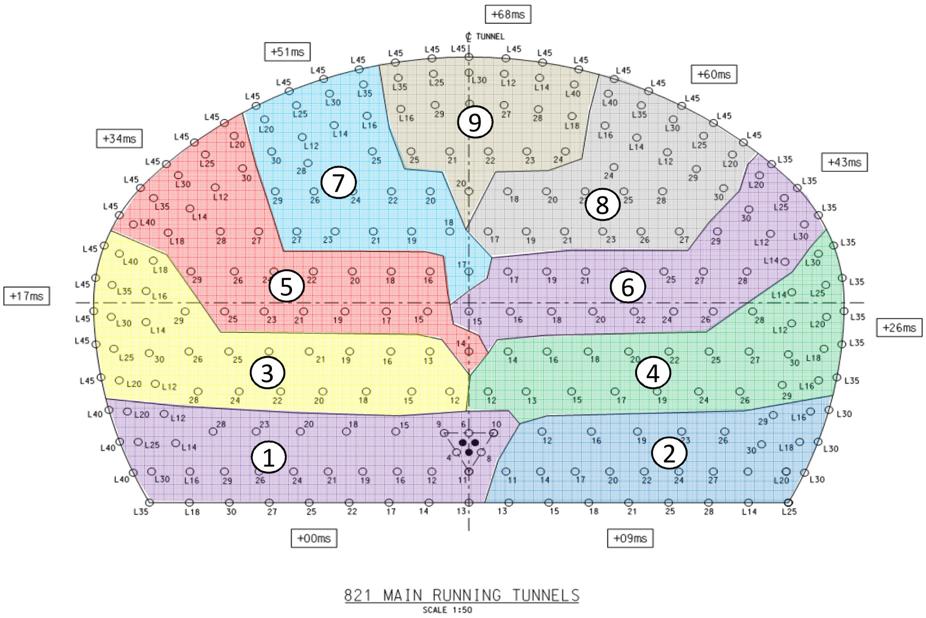


Figure E2 - Example blast pattern and sequence for a rail tunnel in Hong Kong (XRL C821)

Assessment:

For Lackagh Tunnel the above method is used to calculate the maximum instantaneous charge that can be used during drill and blast. There is no specific guidance on vibration limits for Limestone Pavement. As a result, a conservative limit based on cosmetic damage to structures is selected and applied in this assessment which is considered comparable to impacting sensitive surface features on the Limestone Pavement environment.

Vibration Limit for Lough Corrib cSAC

BS7385-2:1993 (A Guide to Damage Levels from Ground-borne vibrations) has been used to determine appropriate vibration limits to be applied to the limestone pavement for this preliminary blast assessment. The limits apply to cosmetic damage which relates to damage to non-structural elements such as plaster.

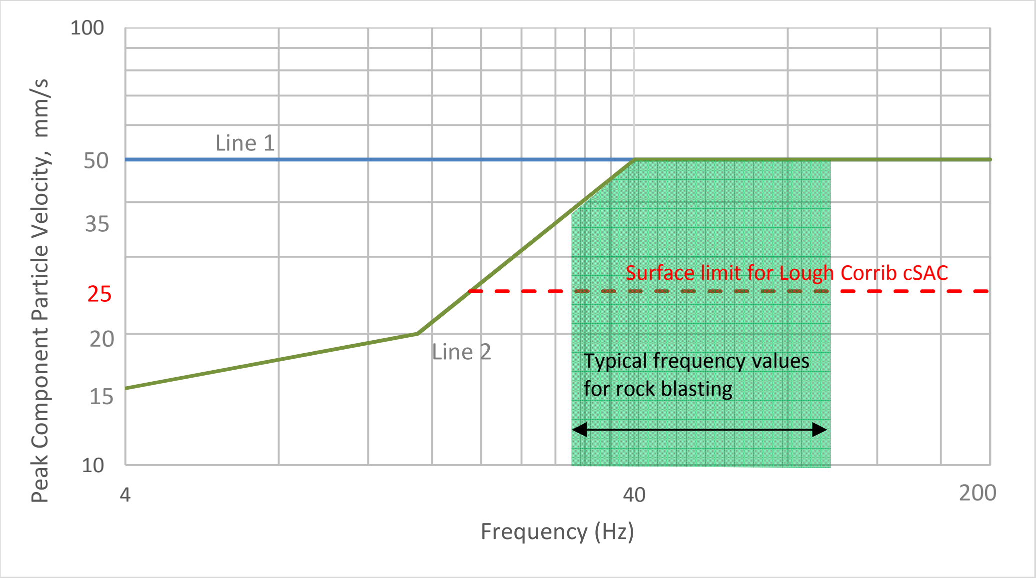


Figure E3 - (reproduced from BS7385: Figure 1 - Transient vibration guide values for cosmetic damage)

Figure E3 shows the vibration limits for cosmetic damage for:
- Line 1: Reinforced or framed structures Industrial and heavy commercial buildings.
- Line 2: Unreinforced or light framed structures Residential or light commerical type buildings.

Typical frequency values for underground blasting in rock range between 30-100Hz. These frequencies are added to Figure E3 to evaluate target vibration limits for Limestone Pavement in Lough Corrib cSAC. Within this vibration frequency ranges the vibration particle velociy limit range between 35-50mm/s. As a conservative design approach a limit of 25mm/sec peak particle velocity for vibration on Limestone pavement surface and the Lough Corrib cSAC is adopted.

Typical K and B values (refer to equation E1) have been applied. Site specific values will be determined during trial blasts.

Calculation:

Vibration limit		25	mm/sec (from above)
	K=	600	(rock transmission constant)
	B=	1.22	(attenuation exponent)

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Calculation	Appendix E: Blasting assessment	Made by	PS	Date	09/06/2017	Chd.	PC

Table E1 - MIC limits in Lackagh tunnel due to cSAC

Distance of the blast from the ground surface (cSAC).	Vibration Limit	Maximum Instantaneous Charge
(m)	(mm/sec)	(kg)
8	25	0.32
9	25	0.41
10	25	0.50
11	25	0.61
12	25	0.72
13	25	0.85
14	25	0.98
15	25	1.13
16	25	1.28
17	25	1.45
18	25	1.62
19	25	1.81
20	25	2.00

Depth from Lough Corrib cSAC ground level to the proposed tunnel crown.

Reference: BS 7385-2:1993 : Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration.

Results: This preliminary blasting assessment shows that for a vibration limit of 25 mm/sec, the Maximum Instantaneous Charge that can be used for tunnel excavation ranges from 0.72kg to 1.28kg directly below the Lough Corrib cSAC. The MIC will be refined following the trial blast during the blast design stage.

Conclusion: It has been determined that a vibration limit at surface level of 25mm/sec from blasting is conservative. Vibrations of this magnitude will not impact the structural integrity of the limestone pavement. Using this vibration level as a limit, the maximum instantaneous charge that may be used in blasting works within the expected distance range has been determined.

The above assumptions on the site specific ground conditions, including the rock transmission constant the attenuation exponent will be established and confirmed during trial blasts which will take place prior to blast works on the Lackagh Tunnel.

Referencea: BS 7385-2:1993 : Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration.