

REPORT ON THE

GEOPHYSICAL LOGGING

OF

SIX BOREHOLES

FOR THE

NORTH IRISH SEA ARRAY

NEAR BALBRIGGAN, NORTHERN IRELAND



8 DRUMAHISKEY ROAD BALLYMONEY CO. ANTRIM BT53 7QL

MAY2022/CAUSE2022_NISA_Report

	Name	Date
Logged by:	M. Hand	04.05.2022 06.05.2022
Report by:	M. Hand	07.06.2022
Checked by:	M. Kynaston	17.06.2022

EUROPEAN GEOPHYSICAL SERVICES LTD

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1.0 INTRODUCTION

At the request of Causeway Geotech geophysical logging was carried out in the following boreholes.

The work was carried out by European Geophysical Services on the 4^{th} May 2022 and the 6^{th} May 2022.

The following logs were run:

вн	Logs	From (m)	To (m)
1		0.6	22.2
2	Natural Gamma (GV NGRS) 3-Arm Caliper (GV CAL3)	0.9	28
4	Focused Resistivity (GV DLL3) Sonic Velocity (GV ASNC) Fluid Temperature & Conductivity (GV TCIS)	0.6	17.7
9	Fluid Velocity (GV IFM)	1	19.6
17		1	25
18		1	27

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 4x4 van 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.

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 (FWS)

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 dependent 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.

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.

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. Flow (Q) in I/s may then be derived from the fluid velocity (FV) and caliper (Cal) data.Optional paragraph

Where practicable the log may be run in conjunction with a temporary and easily removable pumping system.

2.0 THE GEOPHYSICAL LOGGING METHODS

P Wave Velocity (Vp) - unlined

Within the unlined section the full wave form is recorded and analysed for the first arrival i.e. P Wave. The time of this arrival is corrected for tool stand off and inverted to produce the P Wave velocity of the formation.

The P Wave velocity log may be used for identifying variations in hardness and porosity.

Estimates of S wave velocity *may only be obtained under suitable conditions*. These waves are normally identified by higher amplitudes and phase changes after the P wave arrivals.

Shear wave arrivals occur after the P-wave. They are waves that have travelled across the borehole fluid to the rock as P-waves and have undergone P to S conversion. Shear waves which refract at the fluid/rock boundary at the S-wave critical angle travel through the rock at V_s and if modal conversion back to P wave occurs the waves can be received by the tool.

Results can be affected by the competency of the rock material, low velocity zones, irregular boundary conditions and complex interactions of non-direct P-waves and other fast waves. This last factor can be the main limiter on Shear wave identification in wireline logging.



3.0 SITE DETAILS North Irish Sea Array, Balbriggan

Figure 3.1 Location map showing the main area of investigation highlighted by the red striped area © Ordnance Survey Ireland 2022.



Figure 3.2 Aerial image showing the location of five of the six boreholes, just north of Balbriggan © Applemaps 2022.

3.0 SITE DETAILS North Irish Sea Array

EIR Code: O19 Post Code: K67 R2K0



Figure 3.3 Location map showing the location of borehole 9, just north of Swords (highlighted by the red striped circle) © Ordnance Survey Ireland 2022.



Figure 3.4 Aerial map showing borehole 9's location © Applemaps 2022.

5.0 BOREHOLE LOGGING CONSTRAINTS

- Vehicle access restrictions Offroad
- Tool access restrictions None
- **Borehole conditions** Most of the boreholes had either collapsed or silted up slightly from their drilled depths.
- Lack of fluid filled column
 None
- Time constraint None

Appendix 1 Geophysical Logs



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Causeway Geotech

Log Type:

Borehole: BH01

Composite Final

Locatio	on: Bal l	briggan	l			Area:	Count	y Dubl	in	Grid Ref: 719758.67E 765371.97N Elevation: 3.5						53					
Drilled	Depth:	(m)			30					Date:					0	4.05.2	022				
Logged	d Depth	: (m)			22.2					Record	ed By:				N	I. Han	d				
Loggin	g Datur	n:			Grou	nd lev	el			Remarks: The borehole has collapsed to around 21.5m (dipped on the									e		
Logged	l Interv	al: (m)			0.6 -	22.2					ter	mina	ated at a	round 2	0.5m	to prev	ent th	natery ne imp	peller fr	om co	ming
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Client:	Causeway	/ Geotech	Log Type:						

Borehole: BH02

Composite Final

Locatio	on: Bal	briggan		,	Area:	Count	y Dubli	in		G	id Re	əf:	719788.43E 76	5520.35N	Elevat	tion: 5.43	
Drilled	Depth:	(m)		30					Da	te:				04.05.20)22		
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 Causeway Geotech

Borehole: BH04

Composite Final

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EUROPEAN GEOPHYSICAL SERVICES LTD												
Client:	Causewav 0	Geotech	Log Type:									

Borehole:

BH09

Composite Final

Locatio	on: Swor	ds				Area:	Count	ty Dubli	in	Grid Ref: 718991E 749337N Elevation						ation: 10.54		
Drilled	Depth: (r	n)			20					Date:					06.05.2	2022		
Logged	d Depth: ((m)			19.6					Recorde	Recorded By: M. Han							
Loggin	g Datum:				Grou	nd le	vel			Remark	s: He	avy	mud be	elow 15.5r	n. Fluid vel	ocity log	s terminated at	t 15m
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Client: Causeway Ge	otech	Log Type:

**Causeway Geotech** 

**BH17** Borehole:

Composite Final

Location: Balbriggan Area: County Dublin Grid Ref: 719790.17										17E 7	6525	52.88N	Eleva	ition: <b>5.8</b>	15						
Drilled Depth: (m) 30								Da	te:			_		C	)4.05.2	022			_		
Logged Depth: (m) 25							Re	cordeo	l By:				_ N	VI. Hand	d						
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Logged Interval: (m) 1 - 25																					
Fluid Level: (m) 2.5							$\bot$											_			
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EUROPEAN GEOPHYSICAL SERVICES LTD										
Client: Causeway Geotech	Log Type:									

**Causeway Geotech** 

**BH18** Borehole:

Composite Final

Locatio	on: Balbriggan		A	Area: (	County	Dubli	n		Gı	id Re	ef: <b>71</b> 9	9790.1	3E 76	5252	.97N	Elevat	ion: <b>8.09</b>				
Drilled Depth: (m) 30								Da	Date: 04.05.2022												
Logged Depth: (m) 27								Re	Recorded By:							M. Hand					
Logging Datum: Ground level							Re	Remarks: Borehole has collapsed to around 27.5m.													
Logged Interval: (m) 1 - 27																					
Fluid Level: (m) 1.4																					
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