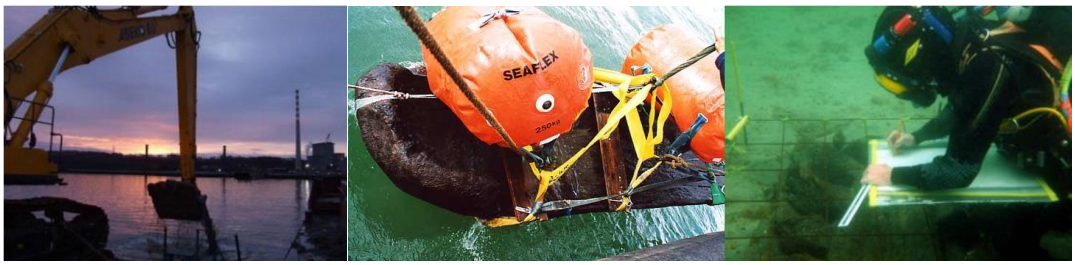
Underwater Archaeological Impact Assessment

Arklow Bank Wind Park

2020 GI Campaign 1



Underwater Archaeological Impact Assessment

Arklow Bank Wind Park

2020 GI Campaign 1

Issued	06/08/2021
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Project Director	**Niall Brady**
Report Author	**Niall Brady**
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Contents

Abbreviations

ABWP -	Arklow Bank Wind Park
ADCO -	Archaeological Diving Company Ltd
AIA -	Archaeological Impact Assessment
CR -	Cable Route
DCHG -	Department of Culture, Heritage and the Gaeltacht
DPC -	Dublin Port Company
E -	Easting
GI -	Geotechnical Investigations
ITM -	Irish Transverse Mercator
LA -	Lease Area
LAT -	Lowest Astronomical Tide
MHW -	Mean High Water
N -	Northing
NGR -	National Grid Reference
NIAH -	National Inventory of Architectural Heritage
OD -	Ordnance Datum
SI -	Site Investigations
SMR -	Sites and Monuments Record
UAIA -	Underwater Archaeological Impact Assessment
UTM -	Universal Transverse Mercator

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1.0 Executive Summary

A series of fifteen (15) core borehole locations and eleven (11) spare borehole locations were being considered for the 2020 Geotechnical Investigations (GI) on Arklow Bank to inform the proposed Arklow Bank Wind Park phase 2.

A programme of GI took place between October and November 2020.

Two boreholes were achieved; one in the northeast of the project area (Borehole BH02) and the second in the southeast (Borehole BH14)

The actual location of each borehole was close to the proposed location in both instances.

Borehole BH02 comprised a single excavation and achieved a depth of 13.7m below seabed.

Borehole BH14 comprised seven attempts, achieving depths between 0m and 48.7m below seabed.

The boreholes revealed natural deposits of sand and clay with mudstone, siltstone and sandstone recorded at depth in BH14.

No archaeological features were recorded.

A further campaign of GI work is planned for 2022.

2.0 Introduction

A series of fifteen (15) core borehole locations and eleven (11) spare borehole locations were being considered for the 2020 Geotechnical Investigations (GI) on Arklow Bank to inform the proposed Arklow Bank Wind Park phase 2 (Figure 1).

The locations were pre-selected to avoid known sites of archaeological potential.

The National Monuments Service agreed in this instance that the work could proceed without the requirement for an archaeological licence and without the requirement for an on-board archaeological monitor, provided the following conditions were met:

- The Archaeological Diving Company (ADCO) to be appointed as project archaeologist to maintain an off-site contact with the project
- An Archaeology Management Plan to be adopted to safeguard any potential archaeological material recovered during the works
- ADCO to deliver a Toolbox Talk to the GI team prior to works commencing
- An active communication to be maintained with ADCO throughout the GI works
- Any material of archaeological interest recovered during the works to be handed over to ADCO before the vessel departs Ireland
- The GI logs and report be made available to ADCO on conclusion of the GI works

The above conditions were met.

A programme of Geotechnical Investigations took place between October and November 2020.

The Archaeology Management Plan was developed and adopted by the project sponsor.

The toolbox talk was presented to the contractor crew (Geoquip) on 13 October 2020 when the work vessel was mobilising in Dun Laoghaire harbour and prior to its arrival to Arklow Bank.

Correspondence was maintained between ADCO and Geoquip in the course of the GI work.

No material was recovered that was required to be handed over to ADCO.

The GI report was presented to ADCO following the completion of works.

Two boreholes were achieved; one in the northeast of the project area (Borehole BH02) and the second in the southeast (Borehole BH14) (Figure 2).

The actual location of each borehole was close to the proposed location in both instances.

3.0 Borehole BH02

Borehole BH02 comprised a single excavation and achieved a depth of 13.7m below seabed. The log is reproduced in Appendix 1.

The borehole revealed natural deposits of a very dark greyish brown silty fine sand reaching 3.5m deep. Pockets of organic matter were observed between 3.5m and 4m deep and lying over clay. At 5.2m depth, sand was recorded over clay with some gravel at 7.2m that reached 9m and overlay lenses of sand and clay that in turn overlay sand, which continued to the end of the borehole at 13.7m depth.

No archaeological features were recorded.

4.0 Borehole BH14

Borehole BH14 comprised seven attempts, achieving depths between 0m and 48.7m below seabed. The log is reproduced in Appendix 1.

The boreholes revealed a dense dark greyish brown sand with a level of gravel close to the surface, with the sand continuing to 5.5m and lying on top of a coarse sand. At 9.5m a fine sand was encountered that continued to a gravel layer at 12.5m which overlay clay and 14.15m. At 19.25m a gley silt was recorded, overlying sandier material at 20.5m, with pockets of organic matter recorded at 21.5m, which overlay dense sand at 23.3m. Alternating layers of clay and sand continue to 33.6m where mudstone was recorded, overlying siltstone at 34.1m. This anticipates layers sandstone and siltstone and the borehole was concluded at a depth of 48.7m.

No archaeological features were recorded.

5.0 Conclusions

The 2020 campaign completed two geotechnical investigations at two locations, revealing sand and clay, with mudstone, siltstone and sandstone observed at depth in BH14.

No archaeological features were recorded.

A further campaign of GI work is planned for 2022.

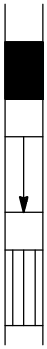
6.0 Appendix 1: Borehole logs for BH02 and BH14

Arklow Bank Wind Park

Client:	Project Number:	Report Reference:
SPL & SSE	GMOP20-G-007	GMOP20-G-007-FLD-01

GEOQUIPMARINE

Samples and Tests



Soil Sample

In Situ PCPT

Core Run

Sampling/Testing Method

PU/P	Push/piston with Shelby Tube
H	Hammer
CR	Core Run
C	PCPT

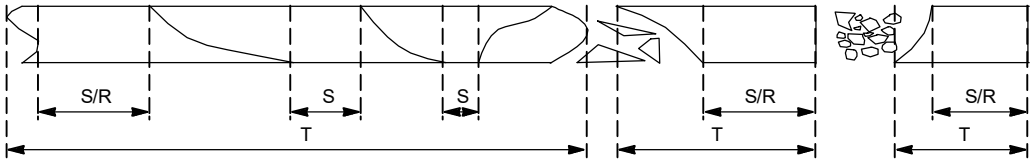
All lengths of sample or test represent actual recovery or tested depth range

Legend of Soil Types

CLAY		MUDSTONE	
SILT		SILTSTONE	
SAND		SANDSTONE	
GRAVEL		LIMESTONE / CALCAREOUS / CARBONATE ROCKS	
PEAT		IGNEOUS ROCKS	

Rock Core Recovery

(based on BS EN ISO 14689-1)



Term	*Definition*
TCR	Core Recovered (**Σ**T) / Length Drilled
SCR	Core Recovered at Full Diam. (**Σ**S) / Length Drilled
RQD	Core Recovered at Full Diam., >0.1m in length (**Σ**R) / Length Drilled

Strength	*UCS(MPa)*
Extremely Weak	< 1.0
Very Weak	1.0 - 5.0
Weak	5.0 - 12.5
Moderately Weak	12.5 - 25.0
Medium Strong	25.0 - 50.0
Strong	50.0 - 100.0
Very Strong	100.0 - 250.0
Extremely Strong	> 250.0

Strength of Fine Grained Soils

(based on BS EN ISO 14688-2)

Strength	*Su(kPa)*
Extremely Low	< 10
Very Low	10 - 20
Low	20 - 40
Medium	40 - 75
High	75 - 150
Very High	150 - 300
Extremely High	300 - 600

Relative Density of Coarse Grained Soils

(based on Jamiolkowski et al. (2001)

Density	*Relative Density (%)*
Very Loose	< 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	> 85

Borehole Log Legend

Client: SPL & SSE
Project Name: Arklow Bank Wind Park
Project No.: GMOP20-G-007
Location: Arklow Bank

Borehole No.:	Date Commenced:	Coordinates[1]:		Water Depth[2]:
BH02	24/11/2020	304806mE	5865811mN	33.8m

GEOQUIPMARINE

DEPTH (m)	SAMPLE	*IN SITU* TEST	LEGEND	STRATA DESCRIPTION
0	P01	C01		00.00m Medium dense to dense very dark greyish brown (2.5Y 3/2) silty fine SAND with very closely spaced very thin to thin beds of very dark grey (2.5Y 3/1) clay, rare to frequent shell fragments, rare to frequent mica and rare subangular fine gravel of mixed lithologies
1	P02			
2				
3				03.50m to 04.00m - with occasional pockets of organic matter
4	P03			04.00m High strength very dark grey (2.5Y 3/1) CLAY with occasional pockets and extremely closely spaced thin beds of grey (2.5Y 6/1) fine sand
5	P04			
6	P05			05.20m Medium dense to dense dark grey (2.5Y 4/1) silty fine SAND with occasional very closely spaced thin beds of dark grey (2.5Y 4/1) clay, rare mica and rare organic matter
7		C02		07.20m to 07.35m - thin bed of high strength dark grey (2.5Y 4/1) clay with with rare subangular fine gravel
8	PU06			
9	PU07	C03		09.00m Medium dense to dense (locally loose) very dark grey (2.5Y 3/1) silty fine to medium SAND with extremely closely spaced thin beds of very dark grey (2.5Y 3/1) coarse sand and frequent fine mica
10	PU08			10.25m - very thin bed of dark grey (2.5Y 3/1) clay
11	PU09			10.50m - becoming very dark greyish brown (2.5Y 3/2) clayey with occasional pockets of silt, occasional fine to coarse mica, rare subangular fine to medium gravel of mixed lithologies and rare shell fragments
12	PU10			
13		C04		12.75m Dense SAND
14				End of borehole at 13.70m
15				
16				
17				
18				
19				

CONE PENETROMETER TEST
Net Cone Resistance q_{net} (MPa): 12.5 25.0 37.5 50.0 62.5 75.0 87.5
Sleeve Friction f_s (MPa): 0.5 1.0 1.5
Pore Pressure Ratio, Bq: -0.4 0.4 1.2

UNDRAINED SHEAR STRENGTH (kPa)
Torvane; Laboratory Vane; Pocket Penetrometer; DSS; CIU Triaxial Test; S_u from q_{net}, For N_k values please see the report; CAU Triaxial Test; UU Triaxial Test
150.0 300.0 450.0 600.0 750.0

DENSITY (Mg/m^3)
Bulk Density; Dry Density
* Hollow symbols represent offshore results
1.5 1.9 2.3 2.7

CLASSIFICATION (%)
Water Content; Plastic Limit; Carbonate Content; Liquid Limit; Fines Content; Plasticity Index; Relative Density[3]
20 40 60 80

[1] Local Geodetic Datum: UTM Zone 30N
[2] Water Depth: LAT
[3] Relative densities derived from Jamiolkowski et al. (2003)

Client:	SPL & SSE
Project Name:	Arklow Bank Wind Park
Project No.:	GMOP20-G-007
Location:	Arklow Bank

Borehole No.:	Date Commenced:	Coordinates[1]:		Water Depth[2]:
BH14	15/10/2020	299523mE	5843065mN	33.4m
BH14B	26/10/2020	299525mE	5843063mN	33.4m
BH14C	07/11/2020	299523mE	5843062mN	34.6m
BH14E	19/11/2020	299520mE	5843064mN	34.4m
BH14F	21/11/2020	299523mE	5843065mN	35.1m

GEOQUIPMARINE

DEPTH (m) | SAMPLE | *IN SITU* TEST | LEGEND | STRATA DESCRIPTION | FRACTURE STATE (RQD / SCR / TCR: 30 60 90) | CONE PENETROMETER TEST (Net Cone Resistance q_{net} (MPa); Sleeve Friction f_s (MPa): 12.5 25.0 37.5 50.0 62.5 75.0 87.5; 0.5 1.0 1.5; 0.0 0.5 1.0) | POINT LOAD STRENGTH INDEX (MPa)[4] (Axial, Diametrel, Irregular Lump: 2 3) | UNDRAINED SHEAR STRENGTH (kPa)[4] (Torvane, Pocket Penetrometer, Undrained Triaxial Test, Laboratory Vane, CIU Triaxial, S_u from q_{net}. For N_k values please see the report: 150.0 300.0 450.0 600.0 750.0) | DENSITY (Mg/m^3)[4] (Bulk Density, Dry Density: 1.6 2.1 2.6) | CLASSIFICATION (%)[4] (Water Content, Carbonate Content, Fines Content, Plasticity Index, Relative Density[3]: 25 50 75)

Depth (m)	Sample	*In Situ* Test	Strata Description
0	P01, P01A	C01	00.00m Medium dense dark greyish brown (2.5Y 4/2) fine to medium SAND with rare shell fragments and mica 00.30m to 00.40m - with rare subrounded fine to medium gravel
2	P02	C02	02.00m Dense to very dense greyish brown (2.5Y 5/2) fine to medium SAND with rare shell fragments, subrounded fine to medium gravel and mica
4	P03		
5		C03	05.50m Very dense dark grey (2.5Y 4/1) fine to coarse SAND with occasional shell fragments and rare subangular to subrounded fine to medium gravel and mica
6	P04		
8	P05		
9	P06	C04	09.50m Medium dense to dense very dark grey (2.5Y 3/1) fine SAND with rare shell fragments and mica
10		C05	
11		C06	
12	P07		12.50m - becoming grey (2.5Y 5/1) fine to medium with rare subangular to subrounded fine to medium gravel
13			
14	P08	C07	14.15m High to very high strength light greyish brown (2.5Y 4/2) CLAY with rare medium spaced thin to thick beds of fine sand
15	P09		
16			
17	P01	C08	17.50m - becoming dark grey (5Y 4/1)
18	P02, P03		
19		C01	19.25m High to very high strength dark grey (GLEY 1 N 4/) SILT with rare pockets of sand, closely to

[1] Local Geodetic Datum: UTM Zone 30N

[2] Water Depth: LAT

[3] Relative densities derived from Jamiolkowski et al. (2003)

[4] Hollow symbols represent offshore results

Client:	SPL & SSE
Project Name:	Arklow Bank Wind Park
Project No.:	GMOP20-G-007
Location:	Arklow Bank

Borehole No.:	Date Commenced:	Coordinates[1]:		Water Depth[2]:
BH14	15/10/2020	299523mE	5843065mN	33.4m
BH14B	26/10/2020	299525mE	5843063mN	33.4m
BH14C	07/11/2020	299523mE	5843062mN	34.6m
BH14E	19/11/2020	299520mE	5843064mN	34.4m
BH14F	21/11/2020	299523mE	5843065mN	35.1m

GEOQUIPMARINE

DEPTH (m) | SAMPLE | *IN SITU* TEST | LEGEND | STRATA DESCRIPTION | FRACTURE STATE (RQD / SCR / TCR) | CONE PENETROMETER TEST (Net Cone Resistance q_{net} (MPa); Sleeve Friction f_s (MPa)) | POINT LOAD STRENGTH INDEX (MPa)[4] | UNDRAINED SHEAR STRENGTH (kPa)[4] | DENSITY (Mg/m^3)[4] | CLASSIFICATION (%)[4]

STRATA DESCRIPTION

20.50m to 21.10m - becoming slightly sandy

21.50m to 22.00m - with rare pockets of organic matter

23.30m Dense to very dense SAND

24.50m High to very high strength dark grey (2.5Y 4/1) CLAY with rare pockets and extremely closely spaced laminations of light grey (2.5Y 7/1) silt

24.70m - with occasional subrounded medium gravel of mixed lithologies

25.50m - with rare pockets and medium bends of fine sand and rare shell fragments

28.15m Dense to very dense dark grey (2.5Y 4/1) fine SAND with rare thin laminations of dark grey (2.5Y 4/1) clay, rare subrounded fine to coarse gravel, shell fragments and mica

32.30m - becoming very high to extremely high strength

32.30m Extremely high strength reddish brown (5Y 4/3) CLAY with rare subrounded fine gravel of mudstone

33.60m Extremely weak weathered thinly laminated reddish brown (5YR 4/3) MUDSTONE with clay coating along the laminations. RMR=34, GSI=10, FI=2

34.10m Extremely weak weathered mottled reddish brown (5YR 4/3) and grey (GLEY 2 5BG 6/1) SILTSTONE with very closely spaced thin laminations of mudstone and clay and rare pockets of calcite. RMR=29-54, GSI=10, FI=0-1

38.45m to 38.90m - with very thick bed of bluish grey (GLEY 2 5BG 7/1) quartzite

39.00m to 40.50m - becoming very thinly bedded

CONE PENETROMETER TEST: Net Cone Resistance q_{net} (MPa) 12.5 25.0 37.5 50.0 62.5 75.0 87.5; Sleeve Friction f_s (MPa) 0.5 1.0 1.5; 0.0 0.5 1.0

POINT LOAD STRENGTH INDEX (MPa)[4]: Axial, Diametrel, Irregular Lump; 2 3

UNDRAINED SHEAR STRENGTH (kPa)[4]: Torvane, Pocket Penetrometer, Undrained Triaxial Test, Laboratory Vane, CIU Triaxial, S_u from q_{net}. For N_k values please see the report; 150.0 300.0 450.0 600.0 750.0

DENSITY (Mg/m^3)[4]: Bulk Density, Dry Density; 1.6 2.1 2.6

CLASSIFICATION (%)[4]: Water Content, Carbonate Content, Fines Content, Plasticity Index, Relative Density[3]; 25 50 75

8.045048425

[1] Local Geodetic Datum: UTM Zone 30N

[2] Water Depth: LAT

[3] Relative densities derived from Jamiolkowski et al. (2003)

[4] Hollow symbols represent offshore results

Client:	SPL & SSE
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Project No.:	GMOP20-G-007
Location:	Arklow Bank

Borehole No.:	Date Commenced:	Coordinates[1]:		Water Depth[2]:
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BH14B	26/10/2020	299525mE	5843063mN	33.4m
BH14C	07/11/2020	299523mE	5843062mN	34.6m
BH14E	19/11/2020	299520mE	5843064mN	34.4m
BH14F	21/11/2020	299523mE	5843065mN	35.1m

GEOQUIPMARINE

DEPTH (m) | SAMPLE | *IN SITU* TEST | LEGEND | STRATA DESCRIPTION | FRACTURE STATE (RQD / SCR / TCR) | CONE PENETROMETER TEST (Net Cone Resistance q_{net} (MPa); Sleeve Friction f_s (MPa)) | POINT LOAD STRENGTH INDEX (MPa)[4] | UNDRAINED SHEAR STRENGTH (kPa)[4] | DENSITY (Mg/m^3)[4] | CLASSIFICATION (%)[4]

CR02
CR02A
CR03
CR03A
CR04
CR05
CR05A
CR05B
CR06
CR06A
CR07
CR08

40.50m to 40.65m - thin bed of weak to medium strong grey (GLEY 1 N 6/) fine sandstone with occasional mica

41.20m Medium strong to strong weathered very closely thickly laminated grey (GLEY 1 N 5/) and reddish brown (5YR 4/3) fine SANDSTONE. RMR=60, GSI=25, FI=0

42.20m Extremely weak to weak weathered mottled reddish brown (5YR 4/3) and grey (GLEY 1 N 6/) SILTSTONE with very closely spaced thin to thick laminations of mudstone, closely to medium spaced thin beds of medium strong grey (GLEY 1 N 6/) fine sandstone and rare pockets of calcite. RMR=34-52, GSI=10-15, FI=0-1

44.70m to 45.10m - with occasional fine mica and pockets of fine sand

45.10m - becoming very weak to weak

45.90m to 46.30m - medium bed of weak greenish grey (GLEY 2 5BG 6/1) sandstone with very closely spaced thin laminations of siltstone, occasional fine mica and rare pockets of calcite

46.30m - with rare fine mica

End of borehole at 48.70m

[1] Local Geodetic Datum: UTM Zone 30N

[2] Water Depth: LAT

[3] Relative densities derived from Jamiolkowski et al. (2003)

[4] Hollow symbols represent offshore results

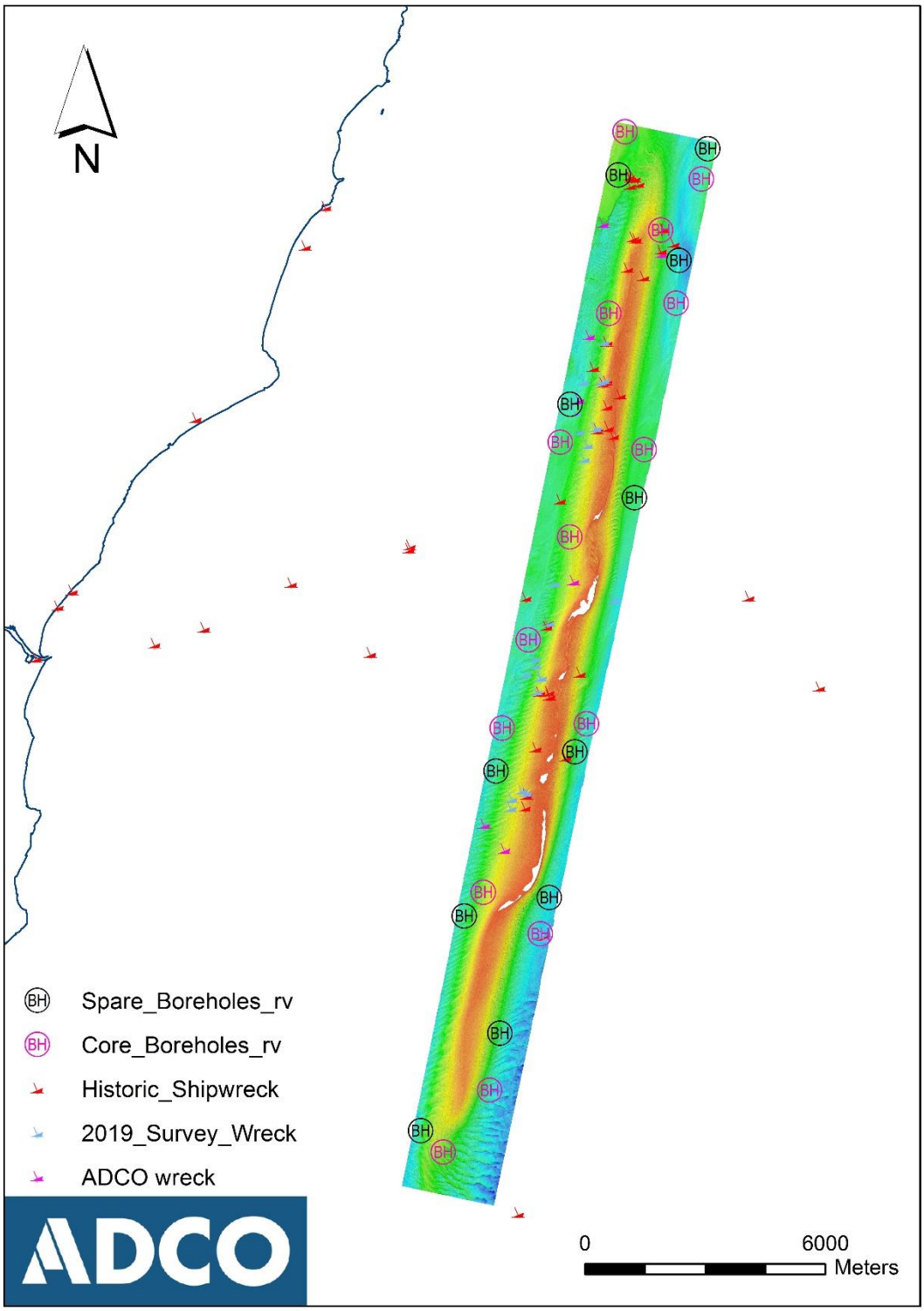


Figure 1: Proposed location of Boreholes for the 2020 GI campaign, Arklow Bank Wind Park.

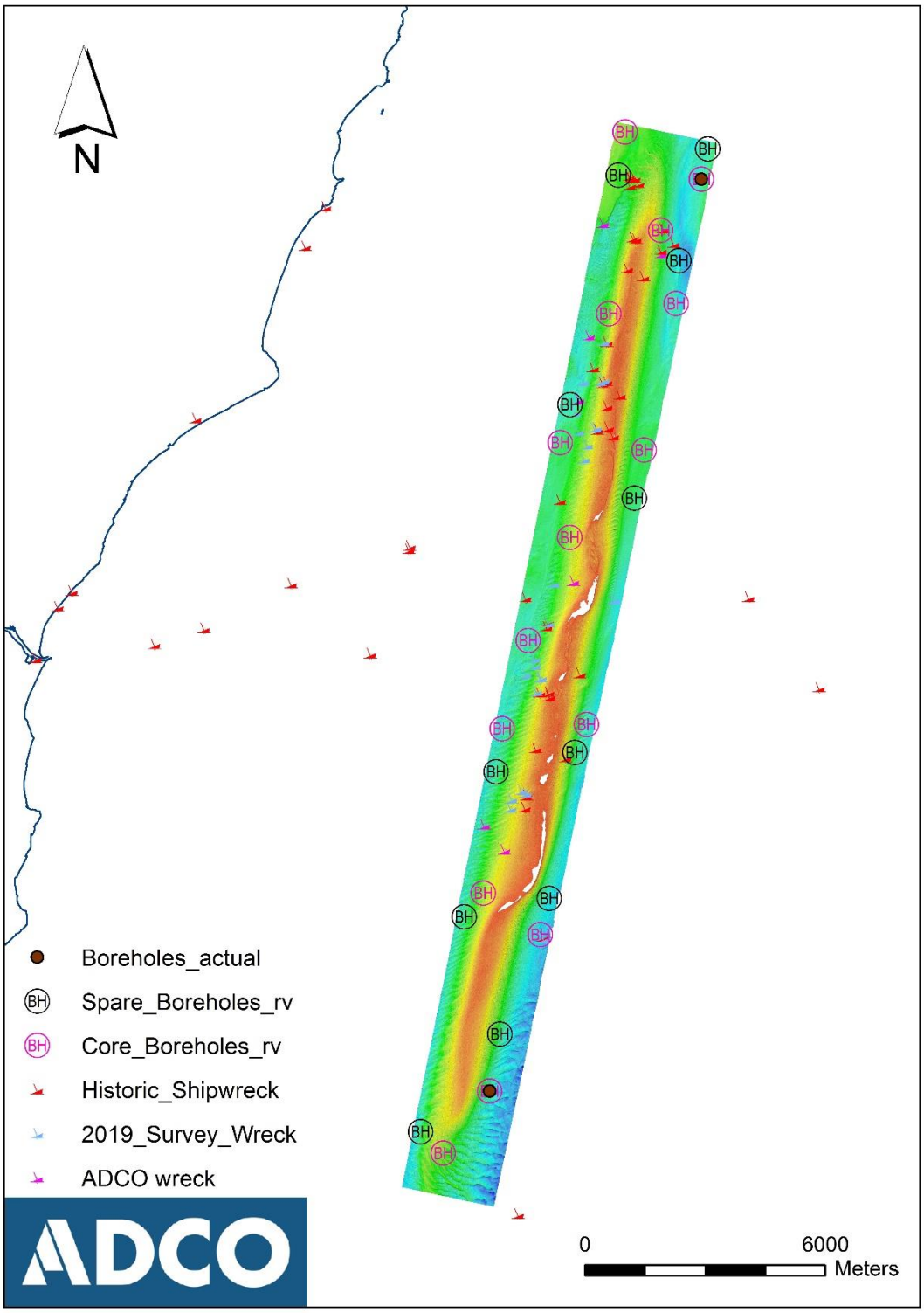


Figure 2: Actual boreholes achieved, Arklow Bank Wind Park.

Figure 3: Borehole BH02 achieved, Arklow Bank Wind Park.

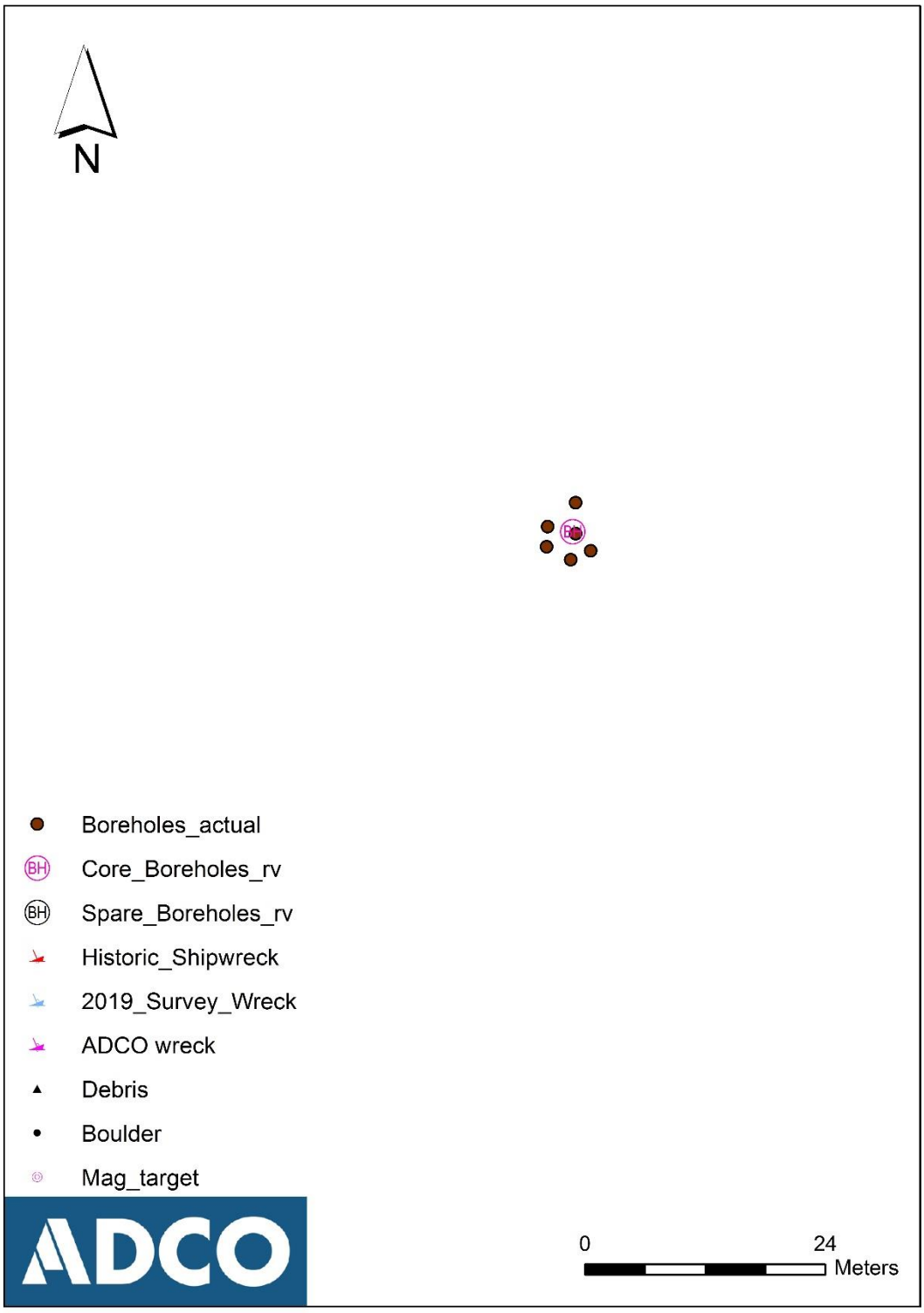
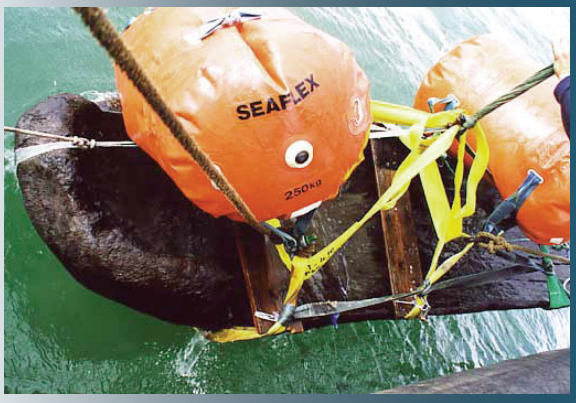
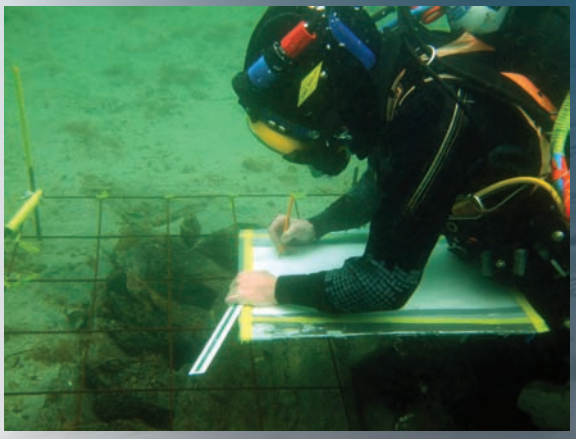


Figure 4: Borehole BH14 achieved, Arklow Bank Wind Park.

ADCO

Leading Maritime Archaeology





Providing effective underwater and land-based archaeological solutions since 1999.

Conducting intelligent diving and underwater/marine inspections for the civils and scientific sectors.

Specialised in marine geophysical data interpretation.

ADCO works closely with clients from project inception, through EIS, to full construction stages, delivering the highest quality effectively.

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