ALCATEL SUBMARINE NETWORK

Havhingsten

Appendix I1 - Marine Survey Report - BU Port Erin to BMH Loughshinny

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Havhingsten Subsea Cable Network

Volume - Segment 1-1
BU Port Erin to BMH Loughshinny

Book 01
Survey Report

Final ISSUE

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Havhingsten Subsea Cable Network
VOLUME - Segment 1-1
BU Port Erin to BMH Loughshinny
Book 1 Survey Report - FINAL

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Date: 19/06/2019

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SURVEY REPORT
FOR CABLE ROUTE DESIGN AND ENGINEERING

For

HAVHINGSTEN CABLE ROUTE SURVEY

SEGMENT S1-1 (BU Port Erin to BMH Loughshinny)

Irish Sea

Revision	Date	Description	Prepared by	Revised by	Approved by
0	05/12/2018	Preliminary	F. Hesemann, L. Palamenghi	M. Wagner	B. Wichand
1	22/03/2019	Provisional	D. Pryne, L. Palamenghi	M. Wagner	B. Wichand
2	19/06/2019	Final	L. Palamenghi S. Burmann	M. Wagner	B. Wichand

EXECUTIVE SUMMARY

This report presents the results obtained during the inshore and shallow water survey for Segment S1-1 of the Havhingsten Cable Route Survey from BU Port Erin to BMH Loughshinny. There are no deep water parts along this segment.

Alcatel Submarine Networks (ASN) commissioned Fugro, to undertake the survey for cable route design and engineering.

The proposed Segment S1-1 route between BU Port Erin to BMH Loughshinny, is 80.626 km long (PSR03_29 APR 2019).

This report presents detailed results for the survey. It comprises a descriptive text and charts showing the bathymetry and geology along the route, together with appendices of supporting information.

The topographic survey was carried out on 25 and 26 September 2018. Beach probing was completed on 06 June 2019. The inshore survey was carried out from 25 September to 03 October 2018 using the inshore vessel Alumaster.

The offshore geophysical survey for this segment was carried out by MV Fugro Helmert. MV Fugro Helmert operated between 4-8, 17-18, 20 and 23 October 2018 on this segment.

The offshore geotechnical survey for segment 1 was conducted from 16 to 26 November by OSV Cecilia

The following table summarises the operations performed for the survey area.

Vessel	SSS	SBP	MBES	MAG	PC	GC	GS	CPT	Diver	Topo	SBES
MV Fugro Helmert	✓	✓	✓	✓							
OSV Cecilia						✓	✓	✓			
Alumaster	✓	✓	✓	✓			✓		N/A	✓	

The different route positions lists (RPLs) used are discussed and compared in Section 3 of this report, Appendix A, and the Operations Report.

The proposed route from BU Port Erin to BMH Loughshinny crosses one in service pipelines (Interconnector 1).

The target burial depth was specified as 1.5 m. The Burial Assessment Survey (BAS) is discussed in Section 5 part of this report.

The following table summarises the hazards and issues encountered during the survey:

Hazards/Issues	Yes	No	Comments
Presence of CORAL Reef		✓	None
Presence of Sea grass		✓	None
Presence of ROCK within target burial depth	✓		Rock subcrops in the inshore survey and in isolated location in the shallow water survey
Presence of gravel beds within target burial depth	✓		Gravel is encountered at the seafloor near the BU and near the inshore survey area
Presence of HARDGROUND within target burial depth	✓		Localized areas of hardground subcrops in the inshore and shallow water
Presence of Pockmarks and gas seepage		✓	none
Presence of Sonar Contacts within the survey corridor	✓		82 sonar contacts
Presence of Ice Gouges		✓	None
Presence of In-service Cables		✓	None
Presence of In-service Pipeline	✓		Inteconntector 1, detected with SSS, MBES, SBP, and magnetometer
Indication of fishing activities (Trawl scars, FADs, etc...)	✓		Fishing is part of the local economy in Loughshinny, and a small fishing boat fleet is based there. High to very high fishing activity is visible in the numerous seabed trawling scars
High level of shipping activity	✓		Shipping route in the Irish Sea directed toward Liverpool, Cardiff and Dublin
The route traverses traffic separations schemes (TSS)		✓	None
Presence of anchorage areas along the route		✓	None observed
Presence of wrecks along the route	✓		SSS contact S1-1_FHE_SC0010, <140 from route
Presence of dumping areas along the route		✓	None
Military activities		✓	none
The route traverses military exercise areas		✓	none
The route traverses hydrocarbon concessions	✓		The route crosses ten (10) concession blocks
Risk of Piracy		✓	None
Presence of adverse currents		✓	None
Occurrence of adverse weather (ice, storms, etc...)	✓		Strong winds, formation of extra tropical cyclones

Table 0.1: Review of S1-1 main hazards and concerning issues

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Alignment Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
HVH_S1-1_AS_10k-001	1:10,000	001/012	0.000	6.840	2	2
HVH_S1-1_AS_10k-002	1:10,000	002/012	5.813	13.690	2	2
HVH_S1-1_AS_10k-003	1:10,000	003/012	12.660	20.541	2	2
HVH_S1-1_AS_10k-004	1:10,000	004/012	19.511	26.332	2	2
HVH_S1-1_AS_10k-005	1:10,000	005/012	24.214	32.124	2	2
HVH_S1-1_AS_10k-006	1:10,000	006/012	31.092	41.257	2	2
HVH_S1-1_AS_10k-007	1:10,000	007/012	40.225	48.126	2	2
HVH_S1-1_AS_10k-008	1:10,000	008/012	47.368	57.549	2	2
HVH_S1-1_AS_10k-009	1:10,000	009/012	56.709	66.899	2	2
HVH_S1-1_AS_10k-010	1:10,000	010/012	65.864	73.784	2	2
HVH_S1-1_AS_10k-011	1:10,000	011/012	72.748	80.626	2	2
HVH_S1-1_AS_10k-012	1:10,000	012/012	79.468	80.626	2	2
HVH_S1-1_AS_5k-001	1:5,000	001/001	77.368	80.628	2	2

North-Up Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
HVH_S1-1_NU_10k-001	1:10,000	001/010	0.000	5.321	3	2
HVH_S1-1_NU_10k-002	1:10,000	002/010	3.939	15.606	3	2
HVH_S1-1_NU_10k-003	1:10,000	003/010	11.192	22.202	3	2
HVH_S1-1_NU_10k-004	1:10,000	004/010	20.894	32.080	3	2
HVH_S1-1_NU_10k-005	1:10,000	005/010	30.808	42.206	3	2
HVH_S1-1_NU_10k-006	1:10,000	006/010	37.848	49.288	3	2
HVH_S1-1_NU_10k-007	1:10,000	007/010	48.018	59.388	3	2
HVH_S1-1_NU_10k-008	1:10,000	008/010	55.045	66.413	3	2
HVH_S1-1_NU_10k-009	1:10,000	009/010	65.144	76.087	3	2
HVH_S1-1_NU_10k-010	1:10,000	010/010	74.920	80.626	3	2
HVH_S1-1_NU_5k-001	1:5,000	001/001	75.700	80.626	3	2
HVH_S1-1_NU_0.5k-001	1: 500	001/001	80.309	80.626	3	2

Index Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
HVH_S1_ID-001	1:125,000	001/001	Segment 1		3	2

XING Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
S1.1_xing5k 001	1:5000	001/001	22.546	27.997	3	2

ABBREVIATIONS

Abbreviation	Meaning	Typical Use
ABxx	As-Built	AB01
AC	Alter Course	AC1
ADCP	Acoustic Doppler Current Profiler	ADCP
AF	As Found (Cable)	CX IS AF CABLE 1
ALxx	As-Laid	AL01
AS	Alignment Sheet	AS-014
ASN	Alcatel Submarine Networks	Alcatel Submarine Networks (ASN)
AP	Articulated Pipe	AP START
BA	Beach Allowance	BA 50m
BMH	Beach Manhole	BMH
BU-xxx	Branching Unit	BU-1 (ABJ)
CA	Cable Allowance (Beach/Final Splice)	CABLE ALLOWANCE
CB	Concession Block	CB ENTER SHELL B2
CC	Cable Corridor	CC ENTER
C.M.	Central Meridian	
cm	Centimetre	
CPT	Cone Penetration Test	
CRE	Cable route Estimate	CRE01
CRS	Cable Route Study	CRS01
CT	Comment	CT ENTER SOFT SEDIMENT
CX	Cable Crossing	CX IS CABLE 1
CZ	Contiguous Zone	MB CZ ISO/EZ ISO
DA	Double Armour	DA-14
DB	Database position of cable	CX IS DB CABLE 1
DE	Duct End	DE
DIS	Disputed Maritime Boundary	MB TW ISO/EZ DIS
DOB	Depth of Burial	DOB 1m
DOL	Distance off line	DOL m
DS	Duct start	DS
DTS	Desk Top Study	See "CRS"
EA	Earth Plate	EA SEA EARTH PLATE
EOB	End of burial	PLUP EOB
EZ / EEZ	Exclusive Economic Zone	MB EZ ISO/CZ ISO
FS	Final Splice	FS-ISN-001
FZ	Fishing Zone	MB FZ ISO/TW ISO
GNSS	Global Navigation Satellite System	
HSE	Health, Safety & Environmental	
HWM	High Water Mark	
IS	In-Service	CX IS CABLE 1
IS	Initial Splice	IS-IBZ-001
JB	Joint Box	JB 1002AB-1
JBT	Technical Joint Box	JBT 1004AB
Km	Kilometre	
KP	Kilometre Point	KP 15.222

Abbreviation	Meaning	Typical Use
LAT	Lowest Astronomical Tide	LAT
LC	Land Cable	LC
LP	Landing Point	LP Port Erin
LW	Lightweight	LW-17
LWM	Low Water Mark	
LWP	Lightweight Protected	LWP-17
MB	Maritime Boundary	MB TW ISO/EZ ISO
MDA	Medium Double Armour	MDA-17
MG	Magnetometer Identified Cable	CX IS AF MG CABLE 1
MAG	Magnetometer	
MBES	Multibeam Echosounder	MBES image
MSL	Mean Sea Level	
MV	Motor Vessel	
nm	Nautical Mile	
nmh	No measurable height	
NU	North Up	
OOS	Out of Service	CX OOS CABLE 1
OSV	Offshore supply Vessel	OSV Cecilia
PL	Post load	PL01
PLB	Post Lay Burial	PLB START
PLDN	Plough Down	PLDN
PLI	Post-Lay Inspection	PLI START
PLIB	Post Lay Inspection and Burial	PLIB START
PLN	Planned cable	CX PLN CABLE 1
PLUP	Plough Up	PLUP
PL-xxx	Post Load	PL01
POL	Point On Line	POL
PSR-xxx	Post Survey Route	PSR01
PTEQ	Passive Tilt Equaliser	PTEQ-01101
PTQ	PTEQ	PTQ 01101
PWC (HG)	Plough With Caution - Hardground layer within target burial	PWC (SC)
PWC (HT)	Plough With Caution - High Tensions possible - stiff Sediments	PWC (HG)
PWC (SC)	Plough With Caution -Strong Currents	PWC (HT)
PWC (SL)	Plough With Caution -marginal slopes	PWC (SL)
PWC (SR)	Plough With Caution -Subcropping Rock within target burial	PWC (SR)
PWC (SS)	Plough With Caution - Soft sediment - Potential run away	PWC (SS)
PX	Pipeline Crossing	PX PIPELINE 1
REH	Route Engineering Handbook	REH
RPL	Route Position List	RPL
R-xxx /RPTR	Repeater	R01101
SA	Single Armour	SA-14
SAH	Single Armour Heavy	TR LWP-17/SAH-20
SAL	Single Armour Light	SAL-17
SBES	Single Beam Echosounder	
SBP	Sub-bottom Profiler	
SC	Slack Change	SC 3%
SEQ-xxx	Shape Equaliser	SEQ-001

Abbreviation	Meaning	Typical Use
SJ-YYY-xxx	Ship Joint	SJ-ISN-001
SLD	Straight Line Diagram	SLD
SOB	Start of burial	PLDN SOB
SRxx	Survey Route	SR01
SS	Sidescan Identified Cable	CX IS AF SS CABLE 2
SSS	Side Scan Sonar	
SVP	Sound Velocity Profile	No of SVP's
SSE	Separate Shore End	SSE
ST	Seabed Temperature	ST 15
TEQ-xxx	Tilt Equaliser	TEQ-01101
TM	TranMVerse Mercator Projection	
TO	Tolerance	TO +350m/-25m
TP	Temperature	
TR	Transition	TR LWP-17/LW-17
TS	Terminal Station	TS PORTH CURNO
TW	Territorial Waters	MB TW ISO/CZ ISO
WD	Water Depth	WD 2300
UKHO	United Kingdom Hydrographic Office	
UTM	Universal TranMVerse Mercator Projection	Zone UTM 5N
VORF	Vertical Offshore Reference Frame	
WD	Water Depth	15m WD
WGS84	World Geodetic System 1984	Input/Output WGS84 Geographical

DEFINITIONS

Terminology	Definition
Purchaser	Havhingsten Subsea Consortium
Main Contractor/Customer	Alcatel Submarine Networks (ASN).
Survey Contractor	Fugro Germany Marine GmBH (Fugro)
Acoustic penetration	The ability of acoustic waves to travel through the subsurface.
Acoustic reflector	A subsurface that causes the velocity of seismic waves to change.
Beach Landing Areas	The area immediately surrounding the Beach Manhole location extending down to the LWM Landing Point (Shoreline). This is also referred to as the onshore area.
Bedding/Layering	A stratified or layered feature associated with sedimentary rocks and/or loose sediments.
Bedform	Any oscillatory topographic deviations from a flat bed produced by fluid movement including wave and current activity, generally in a sandy domain.
Boulder	A separated rock mass larger than a cobble, having a diameter greater than 200 mm. It is rounded in form or shaped by abrasion.
Burial depth	Required target burial depth is 1.5 m in the burial areas.
Carbonate	A mineral type containing the carbonate radical (CO_3).
Chart Datum	A level so low that the tide will not frequently fall below it. British Hydrographic Office interprets it as the approximate level of Lowest Astronomical Tide (LAT).
Clay	A complex mineral assemblage with particle size <0.002 mm

Terminology	Definition
Coarse sediment	Sediment composed mainly sand (may include gravel).
Cobble	Detrital sediment with particle size between 60mm and 200mm diameter.
Cohesive sediment	Sediments, typically clay and/or silt that resist separation due to nature of bonds between fine grained particles.
Concretion	Lumps or nodules found in loose sediment, rounded or irregular in shape, usually harder than surrounding medium.
Continental Shelf	A gently sloping, shallow-water platform extending from the coast to a point where there begins a comparatively sharp descent down the continental slope to the Abyssal floor.
Coral reef	Reef comprising hard material composed predominantly of corals and calcareous algae.
Corestone	Rounded boulder, occurring individually or in piles at the ground surface, or in exposed sections. It results from an initial phase of subsurface chemical weathering, of a joint-bounded block, followed or accompanied by surface erosion that exposes the corestone.
Debris	Sonar contacts attributed to human activity. Generally angular and distant from areas of rock outcrop and high energy environments.
Deep water areas	Water depths greater than 1000 metres.
Diagenesis	Process by which chemical and physical properties of soils change
Escarpment	A high continuous cliff or long, steep slope situated between a lower, more gently inclined surface and a higher surface.
Fine sediment	Sediment composed mainly of silt and clay.
FAD	A fish-aggregating device comprising a sinker/weight with lines and attached buoys, possibly palm fronds designed to attract fish.
Gas seepage	Escape of fluids (gas) from the seabed.
Gravel	An unconsolidated accumulation consisting of particles larger than sand (diameter 2 mm - 60mm).
Hardground	Sediment affected by diagenetic processes that produce a hard surface (with variable geotechnical properties).
Inshore Water Areas	Nominally those waters shallower than 15m or shallower than the safe working limit of the primary survey vessel.
Induration	Process where soft sediment becomes hard rock
Ice (First year ice)	Ice that has formed during the current winter freeze-up season. Typically less than 1 m thick
Ice (Multiyear ice)	Ice that survived one or more summer seasons and has reached an average thickness of 3 to 5 m.
Ice gouges	Linear scars/trenches caused by grounded ice ridges in the contact zone of landfast ice and pack ice.
Ice Islands	Large tabular icebergs that break away from the ice shelves. Ice islands can reach a thickness greater than 60 m.
Iceberg scars	Linear scars caused by the submerged keels of icebergs scrapping the ocean floor.
Landfast Sea Ice	Ice that is attached to the land in the region of the bottom fast ice zone and extends offshore to the zone of grounded ice ridges.
LAT	This is the lowest level to which sea level can be predicted to fall under normal meteorological conditions and under any combination of astronomical conditions. LAT is not an extreme level, as meteorological conditions can cause a lower level: the level under these conditions is known as a storm surge or negative surge.
Liquid CLAY	CLAY with very high water content and non-measurable shear strength (consistency close to water).

Terminology	Definition
Loose sediment	Not cemented sediment, either cohesive or not.
Megaripples	Undulations produced by fluid movement (waves and currents) over sediments, generally with λ of 0.5m to 25m.
Offshore Water Areas	Water depths from 20 metres to maximum water depths
Outcrop	Rock/Hardground that is exposed at the seafloor.
Pack Ice	Sea ice which is not fastened to shore and drifts under the influence of winds and currents. If pack ice converges, it may deform into ridges with a thickness of 30 m or more.
Pebble	Term not used (too subjective - superseded by gravel & cobbles).
Plateau	A comparatively flat-topped seafloor elevation, usually rising at least 200m above its surroundings.
Pockmark	Shallow seabed depression typically several ten metres across and a few metres deep. Generally formed in soft fine-grained seabed sediments by the escape of fluids into the water column.
Post Survey Route	The agreed final route upon completion of all survey and post survey route engineering.
Pycnocline	Cline or layer where the density gradient is greatest within a body of water
Quartz	Crystalline silica, SiO_2, the principal mineral in unconsolidated sand and gravel.
Ridge	A long narrow raised portion of the seafloor, relatively to its surroundings.
Ripples	Undulations (<0.5m λ) produced by fluid movement (waves and currents) over sediments.
Rock	Solid mineral aggregate
Sand	A detrital particle larger than a silt grain and smaller than a gravel, having a diameter in the range of 0.062 mm to 2 mm.
Sand Concession	Sand Extraction License
Sandwave	Undulations produced by fluid movement (waves and currents) over sediments, generally with λ > 25 metre.
Seamount	The generally accepted geological definition of a seamount is: "*a mountain rising from the ocean seafloor that does not reach to the water's surface and that rise to at least 1,000 meters above the seafloor*".
Silt	A detrital particle, finer than very fine sand and coarser than clay, in the range of 0.004 mm to 0.062 mm.
Shallow water areas	Water depths from 15 metres to 1500 metres.
Slumping area	The slipping or sliding down of a mass of sediment relatively soon after its deposition in a sub-aqueous slope.
Stamukhi Zone	Region of dynamic interaction between stable ice of the landfast-ice zone and the mobile ice of the pack-ice zone. Occurrence of ice ridges, leads and polynyas.
Subcropping	Rock/hardground covered by a layer of loose sediment less 1.5m thick and where rock/hardground may be intermittently exposed at the seabed surface.
Survey Route	The agreed route at the start of survey operations. In the case of Segment S1-1 this route was based on SR02 19-Oct-2018

1. INTRODUCTION

1.1 System Description

This report presents the results obtained during the inshore and shallow water survey for Segment S1-1 of the Havhingsten Cable Route survey from BU Port Erin to BMH Loughshinny (Figure 1.1). There are no deep water parts along this segment.

Alcatel Submarine Networks (ASN) commissioned Fugro to undertake the survey for cable route design and engineering.

Fugro surveyed and reported on twelve (12) planned route segments of the Havhingsten Cable Route Survey. Segment 1 is in the Irish Sea and is made up of five (5) sub-segments and Segment 2 is in the North Sea and is made up of seven (7) sub-segments:

- Segment S1-1 is connecting BU Port Erin with BMH Loughshinny;
- Segment S1-2 is connecting BMH Port Erin with BU Port Erin;
- Segment S1-3 is connecting BU Port Grenaugh with BU Port Erin;
- Segment S1-4 is connecting BMH Port Grenaugh with BU Port Grenaugh;
- Segment S1-5 is connecting BMH Squires Gate Lane with BU Port Grenaugh.
- Segment S2-1 is connecting BU Valhal with BMH Seaton-Sluice;
- Segment S2-1a is an option called UK Copper Stub;
- Segment S2-2 is a stub called Valhal Stub;
- Segment S2-3 connecting BU Halfdan and BU Valhal;
- Segment S2-4 is a stub called Halfdan Stub;
- Segment S2-5 is connecting BMH Houstrup and BU Halfdan;
- Segment S2-5A is a stub called Denmark Copper Stub.

Figure 1.1: Havhingsten Subsea, Segment S1-1, BU Port Erin to BMH Loughshinny

1.2 Purpose

Fugro was contracted by ASN to determine with offshore and inshore survey a safe and economical route for the proposed cable by determining, water depth, seabed hazards, geomorphology and other oceanographic and anthropogenic data.

In addition, it is essential that special attention should be given to the recording and charting of coral and any other hard-bottom substrates, as well as all areas of Posidonia, sea grass and other sensitive organisms.

The findings of the Cable Route Survey are to be reported to ASN in the form of narrative and chart information.

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2. SURVEY PROCEDURES

2.1 General

The Havhingsten Subsea cable route survey comprised an investigation of the bathymetry, seabed features and shallow geology along the proposed route. Also, a geotechnical sampling programme was undertaken to establish sediment types for correlation with geophysical data.

2.2 Project Survey Parameters

2.2.1 Geodetic parameters

Due to the large-scale factors associated with the Mercator projection, the offshore survey was conducted using the local UTM projection (Zone UTM 30N) using the parameters listed below. Survey results were then converted to Mercator projection during data processing.

Datum Parameters	
Datum	WGS-84
Spheroid	WGS-84
Semi-Major Axis (a)	6378137.000m
Inverse Flattening (1/f)	298.2572235634
Projection Parameters	
Grid Projection	UTM (Zone 30N)
Latitude of Origin of Projection	0° (Equator)
Longitude of Origin of Projection	3°W
False Easting (metres)	500 000
False Northing (metres)	0
Scale Factor	0.9996

Table 2.1 Geodetic parameters for survey of the offshore survey route

Datum Parameters	
Datum	WGS-84
Spheroid	WGS-84
Semi-Major Axis (a)	6378137.000m
Inverse Flattening (1/f)	298.2572235634
Projection Parameters	
Grid Projection	Mercator
Latitude of Origin of Projection	0°N
Longitude of Origin of Projection	1°E
False Easting (metres)	1 000 000
False Northing (metres)	0 000
Standard Parallel	55°N
Scale Factor	1.00000 at Standard Parallel

Table 2.2 Geodetic parameters for charting for the offshore survey route

Name	Input/Output WGS84 Geographical	Input/Output Mercator Grid
BMH Loughshinny	Latitude: 53° 32.8293'N Longitude: 006°04.8724'W	Easting: 546844.3 Northing: 4053092.2 Scale factor: 0.9654333
BU Port Erin	Latitude: 53° 50.9808'N Longitude: 004°59.3756'W	Easting: 616701.2 Northing: 4085715.7 Scale factor: 0.9723809
Remarks: None		

Table 2.3 Numerical data for checking transformation computation for the offshore survey route

2.2.2 Vertical Datum

The tide correction for Segment 1 within the Irish Sea was independent of tide gouges but based using GNSS tide logged referred to the ellipsoid as provided in the VORF data, supplied by the UKHO.

The VORF model provides a grid of positions and values giving the difference between ellipsoid height and LAT, the required target depth reference. In this case the grid has a resolution of 1km.

The reduction to LAT was carried out during processing within the software package CARIS HIPS and SIPS. The VORF model can be subtracted from the ellipsoid based GNSS heights so that a LAT related tide file for each data file is generated and can be applied (Figure 2.1). The advantage in comparison to tide gouges is the continuously constant accuracy across the complete survey segment.

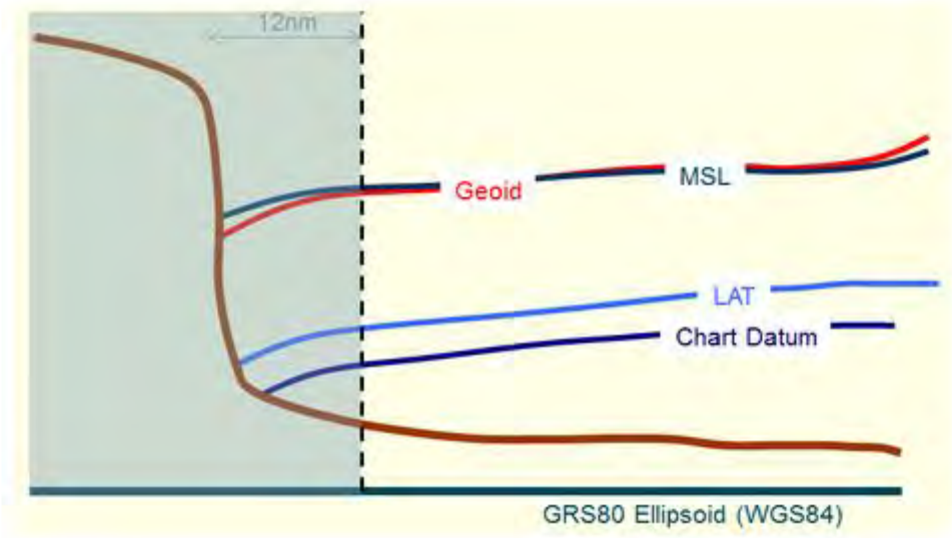

Figure 2.1: Schematic sketch of the VORF concept: high resolution digital models of reference surfaces such as mean sea level (MSL), lowest astronomical tide (LAT) and Chart Datum (CD) all modelled with respect to the terrestrial reference frame used for GPS/GNSS positioning (credit: http://www.ucl.ac.uk/vorf)

2.2.3 Time

All data were logged in Coordinated Universal Time (UTC) and all survey systems and equipment were synchronised to this time reference system.

2.3 Summary of Survey Design

The survey plan for the offshore S1-1 survey operations was based on SR01 03-Aug-2018 and SR02 19-Oct-2018 provided by ASN.

The survey plan for the inshore survey operations was based on SR02 19-Oct-2018 provided by ASN.

The RPL's are presented in APPENDIX A - PRE AND POST SURVEY RPLS of this report.

The following criteria were agreed between ASN und Fugro representatives before the start of the survey:

Water Depth (LAT)	Survey Corridor Width	Survey Line Spacing	No. of survey lines	SSS Range	Nominal Vessel Speed
0 m - 15 m	500m	40	13+	50m	3 Knots
15 m - 1500 m	500m	70m	7+	125m	3 Knots

Table 2.4 Summary of shallow water and inshore survey design

Water Depth (LAT)	Survey Corridor Width	Survey Line Spacing	No. of survey lines	SSS Range	Nominal Vessel Speed
250 m inland of BMH - 0 m	500m	N/A	N/A	N/A	N/A

Table 2.5 Summary of land survey design

In the Segment S1-1 a burial depth of 1.5 m was specified.

During the shallow water survey, coring/grab and CPT soil samples were collected at a nominal 10 km interval.

During the inshore survey, grab soil samples were collected at a nominal 500 m interval, with locations approved by ASN rep and onsite geophysicist. Beach probes were collected at a nominal 25 m interval.

During the topographic survey, sufficient detail and scale should enable to recover or locate topographic and geomorphologic features from site later. Record of any relevant features and detail of the beach and surroundings was noted.

2.4 Summary of Operations

Refer to the Book4 - Operations Report for the complete set of information on the survey vessel specifics, HSE, personnel, equipment and detailed operational summaries. Hereafter only a brief overview will be reported on the operating vessels and their activity.

The offshore geophysical survey for this segment was carried out by MV Fugro Helmert. MV Fugro Helmert operated between 4-8, 17-18, 20 and 23 October 2018 on this segment.

The data shown in the following Table 2.6 and Figure 2.2 were taken from the final survey Daily Progress Reports of MV Fugro Helmert. They give the breakdown of operations during the vessel based survey operations for the Havhingsten project during the Segment 1 operational times.

Description	Total Hours	Total Percent
Mob/Demob	99.12	4.03
Trials, Cals, Safety	8	0.33
Transit	319.83	13.00
Operational Transit	9.04	0.37
Operational (Seg1)	273.88	11.13
Route Development (Seg1)	3.74	0.15
Stdby Weather (Seg1)	156.93	6.38
Scheduled Port Call	352.34	14.32
Dwnt. Vessel	121.33	4.93
Dwnt. Equipment	59.2	2.41
Dwnt. Other	3	0.12
Total	**1406.41**	100.00

Table 2.6 Summary table of operations MV *Fugro Helmert*, Segment 1

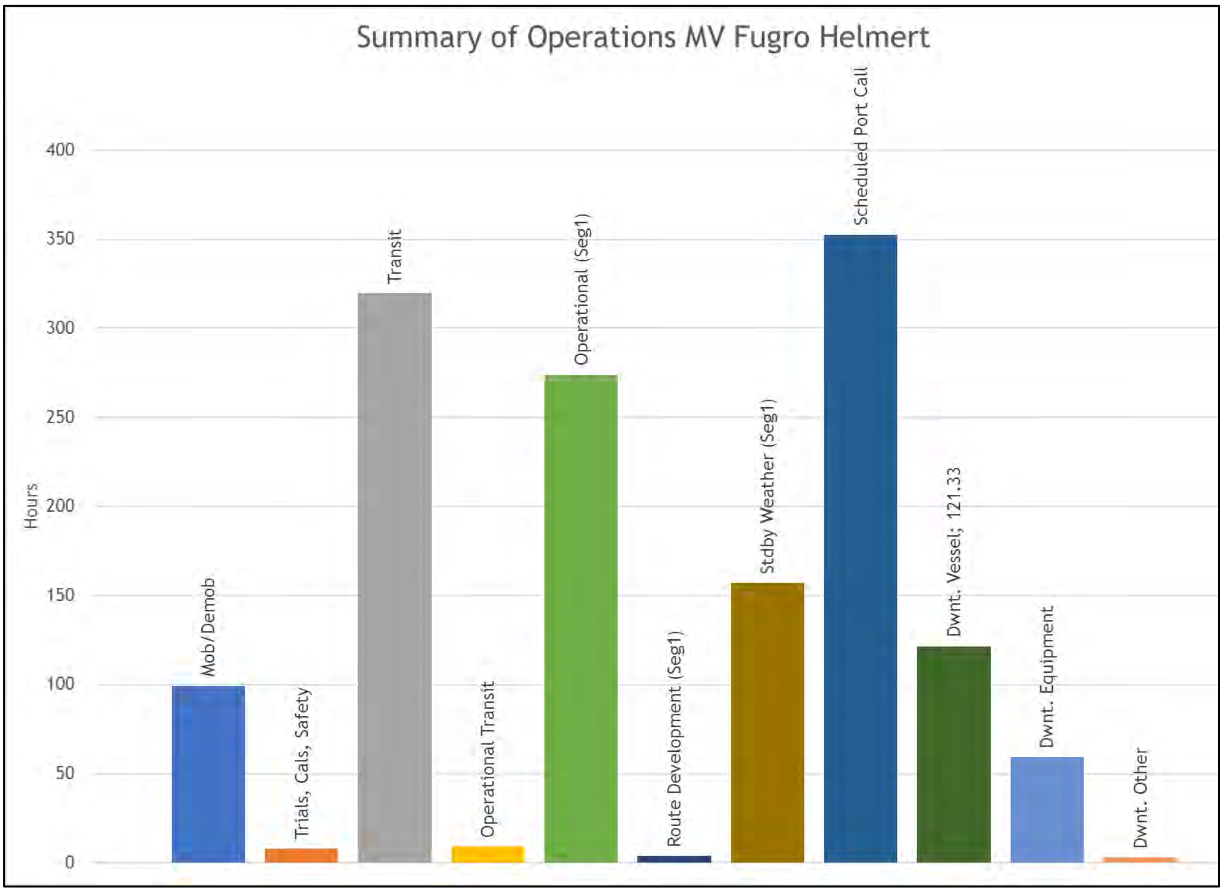

Figure 2.2: Summary of Operations MV *Fugro Helmert*, Segment 1

The inshore survey was carried out from 25 September to 03 October 2018 using the inshore vessel Alumaster. Beach probing was completed on 06 June 2019.

The data shown in the following Table 2.7 and Figure 2.3 were taken from the final survey Daily Progress Reports of Alumaster. They give the breakdown of operations during the vessel based survey operations for the Havhingsten project, with annotated the operational time for S1-1.

Type	Time	Percentage
Mob/Demob	129.75	15.19
Operational Transit	51.58	6.04
Operational S1	84.01	9.83
Operational S1-1	44.34	
Stdby Weather	104.67	12.25
Stdby Other	484.33	56.69
Total	854.34	100.00

Table 2.7 Summary of Operations *Alumaster* and annotated Segment S1-1

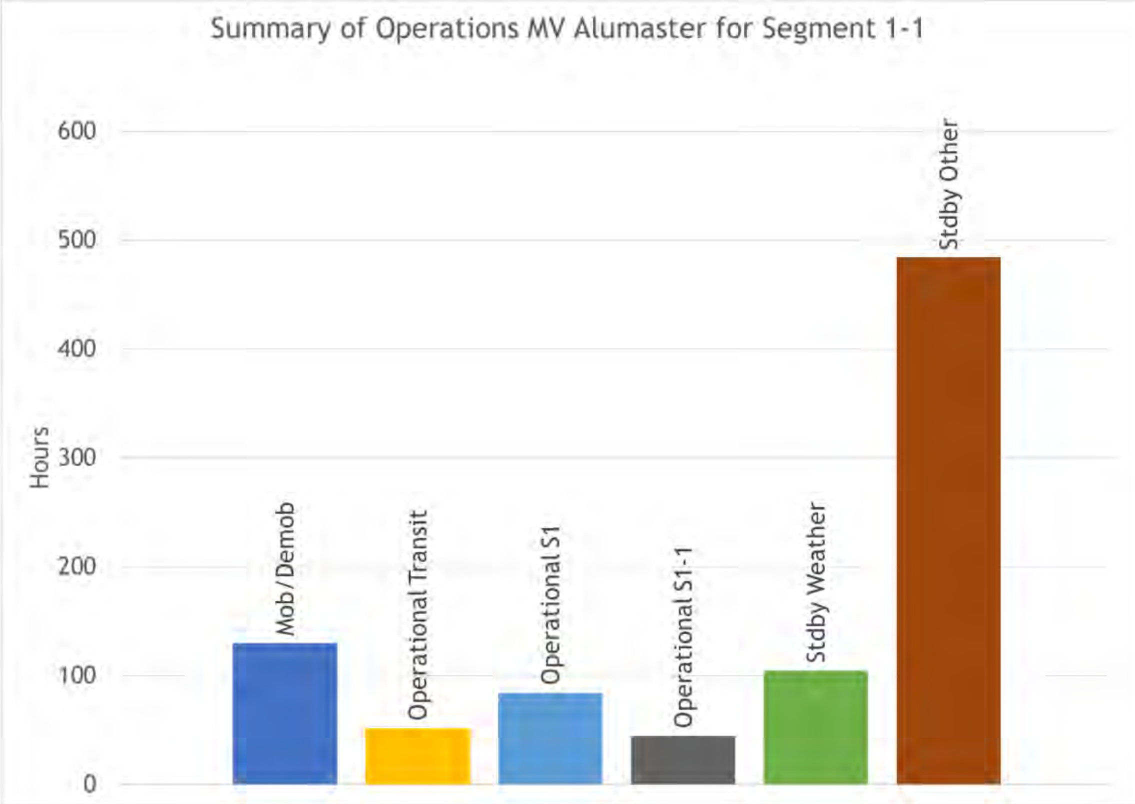

Figure 2.3 Summary of Operations *Alumaster* and annotated Segment S1-1

The offshore geotechnical survey for Segment 1 was conducted from 16 to 26 November by OSV Cecilia.

The vessel completed the geotechnical sampling along the Segment 1 routes on 26.11.2018 and then started the transit towards the North Sea to continue with geotechnical sampling along the Segment 2 routes.

The following Table 2.8 and Figure 2.4 show the operational statistics of the OSV Cecilia II operations. The operation was affected by a lot of bad weather (22%). Another 21% of the project time was spent on mobilisation. This was mainly due to the fact that OSV Cecilia had to be mobilised form an empty ship to a fully equipped geotechnics vessel. Due to the work to be performed a lot of time was spent on operational transits (19%) and transits (13%). Only 36 hours (14%) were necessary to carry out the actual sampling.

Type	Time	Percentage
Mob/Demob	56.00	21.21
Trials, Cals, Safety	2.58	0.98
Transit	33.92	12.85
Operational Transit	51.10	19.36
Operational (Seg1)	36.10	13.67
Stdby Weather (Seg1)	57.33	21.72
Scheduled Port Call	8.75	3.31
Dwnt. Equipment	16.39	6.21
Extra Work	1.83	0.69
Total	264.00	100.00

Table 2.8: Summary table of OSV Cecilia survey operations, Segment 1

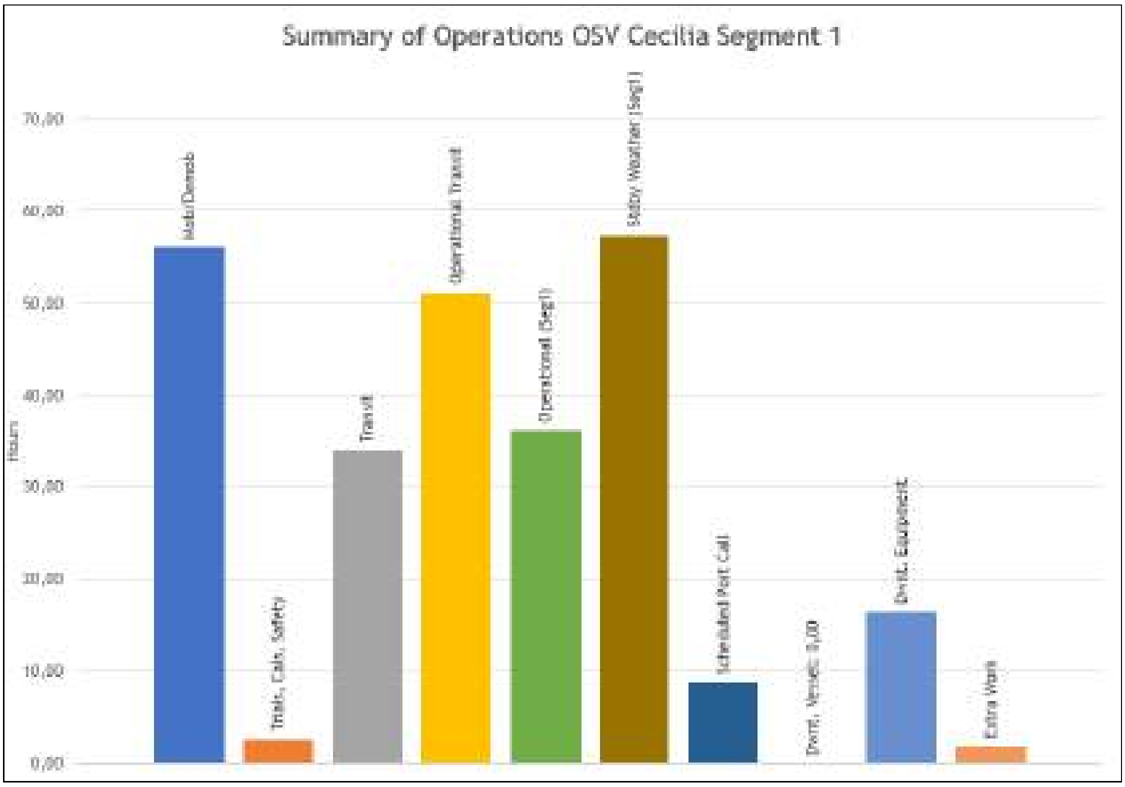

Figure 2.4: Summary of Operations OSV Cecilia, Segment 1

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3. RPL VERSIONS AND DEVIATIONS FROM THE SURVEY ROUTE

ASN provided Fugro with a proposed Route Position List which became the initial survey RPL and was therefore the basis for all operations along this route section. This RPL was named SR01 03-AUG-2018. For further details on RPL history, refer to APPENDIX A - PRE AND POST SURVEY RPLS and the Operations Report.

A new proposed route was issued on 19 October 2018. This RPL was named SR02 19-Oct-2018.

On 15-February 2019 ASN provided Fugro with a Post Survey Route (PSR) entitled HAVHINGSTEN_S1.1_PORT ERIN - BMH LOUGHSHINNY_PSR02_15 FEB 2019. The major change of this version was the revising of the route direction from west-east (BMH LOUGHSHINNY to BU PORT ERIN) to east-west (BU PORT ERIN to BMH LOUGHSHINNY). The HAVHINGSTEN_S1.1_BU PORT ERIN - BMH LOUGHSHINNY_PSR03_29 APR 2019 has been released with the BMH position updated and articulated pipe extended. This latter is used for reporting and charting.

Received RPLs:

- HAVHINGSTEN_S1_BMH LOUGHSHINNY - BU PORT ERIN_SR01_03 AUG 2018
- HAVHINGSTEN_S1_BMH LOUGHSHINNY - BU PORT ERIN_SR02_19 OCT 2018
- HAVHINGSTEN_S1.1_ BU PORT ERIN - BMH LOUGHSHINNY_PSR02_15 FEB 2019
- HAVHINGSTEN_S1.1_BU PORT ERIN - BMH LOUGHSHINNY_PSR03_29 APR 2019

	Cable Type	Post Survey Route PSR03 29-APR-2019
Overall Route		80.626
Overall Cable		80.859
By Cable Type	DA-14	80.859
	TOTAL	80.859

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4. SURVEY RESULTS

4.1 Introduction

The following narrative summarizes the route results along Segment S1-1. Examples of the survey records are provided to show distinctive features. The route, KPs, and coordinates quoted in the text and shown on figures are referenced to RPL PSR02 from 15 February 2019.

The occurrence of seabed features, such as outcrops, debris targets, boulders, pockmarks, was described by the percentage occurrence as shown in the table below.

Description	% Occurrence of Feature
Isolated	<5%
Occasionally	5-25%
Numerous	>25%

Table 4.1 Percentage Occurrence Classification of seabed features

Sediments with shear strengths >150kPa (very stiff) and relative densities >85% (very dense / cemented) are categorized as Hardground. The term “cemented” refers to the density/soil consistency only and does not give evidence for any chemical cementation processes.

In boulder fields (areas with numerous boulders) only exemplary large single boulder targets were picked and are displayed on the charts.

4.1.1 Seabed Features Overview

The seabed features along the Segment S1-1 survey route are summarised in Table 4.2. For more detailed descriptions, refer to Section 4.2.5.

Start KP	End KP	Seabed Features Summary
BU Port Erin	70.055	CLAY and SILT with isolated patches of SAND/GRAVEL overlying CLAY or isolated subcropping HARDGROUND. Occasional to numerous trawl scars.
70.055	73.132	SAND/GRAVEL overlying subcropping HARDGROUND
73.132	79.866	SAND/GRAVEL overlying SAND with isolated subcropping HARDGROUND
79.866	80.466	SAND and boulder fields overlying subcropping ROCK
80.466	BMH	SAND (beach)

Table 4.2 Seabed Features KP Summary Table

4.2 Topographic, Inshore and Shallow Water Survey BU Port Erin to BMH Loughshinny

The inshore survey limits were defined as 0m to 15m water depth.

Shallow waters are defined as >15m WD.

4.2.1 Samples

Within the inshore area, with vessel Alumaster, seven (7) grab samples (GS) were taken (Table 4.3 and Figure 4.1). No sample was taken at location S1-1_AL_GS_01 because the water depths were too shallow for the Alumaster to safely operate.

Ten (10) gravity cores (GC) at approximately 10 km intervals were performed onboard the OSV Cecilia along the Segment S1-1 survey route and at the BU Port Erin (S1-3_CEC_GC_09) (Table 4.5 and Figure 4.1).

The sample logs are presented as APPENDIX G - CORE & GRAB SAMPLING RESULTS of this report.

Sample No.	KP	CHART No. NU10k	Latitude	Longitude	DOL [m]	WD [m]	Description
S1-1_AL_GS_08	77.427	010	53° 32.9314'N	006° 02.3039'W	-22	14	No recovery
S1-1_AL_GS_07	78.144	010	53° 32.8654'N	006° 02.9450'W	26	13	Slightly silty fine to medium SAND
S1-1_AL_GS_06	78.606	010	53° 32.8128'N	006° 03.3542'W	37	12	Slightly silty fine to medium SAND
S1-1_AL_GS_05	79.080	010	53° 32.7455'N	006° 03.7684'W	24	9	Fine to medium SAND
S1-1_AL_GS_04	79.620	010	53° 32.6742'N	006° 04.2419'W	18	6	Fine to medium SAND
S1-1_AL_GS_03	80.039	010	53° 32.6119'N	006° 04.6069'W	0	4	Fine to medium SAND
S1-1_AL_GS_02	80.282	010	53° 32.5997'N	006° 04.8838'W	-126	1	Slightly silty fine to medium SAND
S1-1_AL_GS_01	-	-	53° 32.7702'N	006° 04.8546'W	-	-	Not performed-WD too shallow

Table 4.3 Grab Samples (GS) taken by Alumaster along the S1-1 inshore survey

The 4 beach probes (Table 4.4) conducted on the beach all show a penetration of less than 0.5m and were likely stopped by highly consolidated SAND.

Sample No.	KP	CHART No. NU10k	Latitude	Longitude	DOL [m]	Pene-tration [m]	Description
S1-1_LS_BP_01	80.616	10	53° 32.8242'N	006° 04.8718'W	0	0.35	Fine SAND with sparse PEBBLES (<50mm)
S1-1_LS_BP_02	80.590	10	53° 32.8099'N	006° 04.8701'W	0	0.28	Fine SAND with moderate PEBBLES (<80mm)
S1-1_LS_BP_03	80.564	10	53° 32.7958'N	006° 04.8684'W	0	0.5	Fine to medium SAND
S1-1_LS_BP_04	80.537	10	53° 32.7813'N	006° 04.8666'W	0	0.4	Fine to medium SAND
S1-1_LS_BP_05	80.510	10	53° 32.7671'N	006° 04.8649'W	0	-	Not accessible (below water)

Table 4.4 Beach Samples (BP) taken along the inshore survey of S1-1

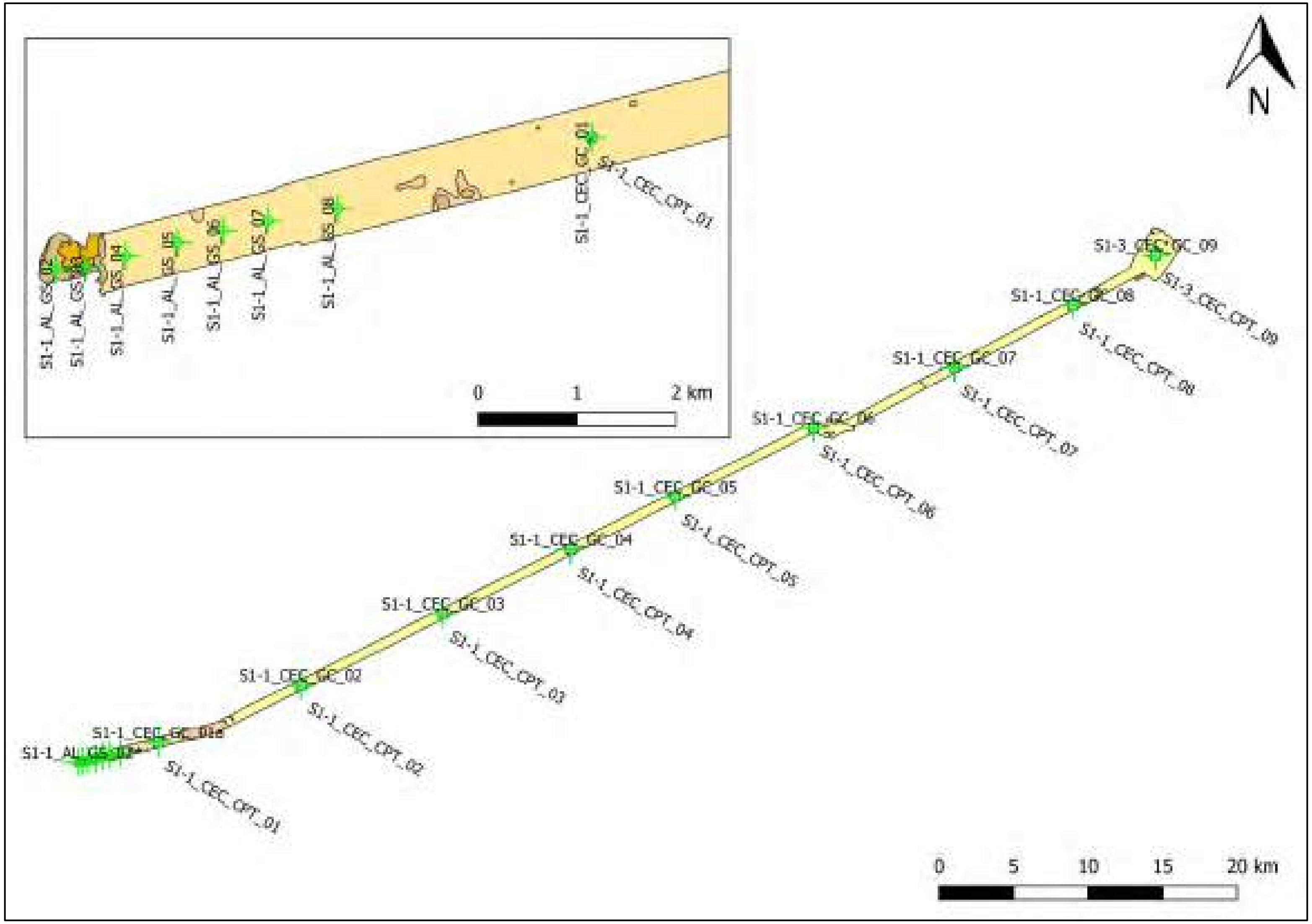

Figure 4.1: GS, GC, and CPT locations acquired along Segment S1-1; seabed feature polygons mimic those shown on Charts.

Sample No.	Kp	CHART No. NU10k	Latitude	Longitude	DOL [m]	WD [m]	Penetration [m]	Recovery [m]	Seabed Sediment Type
S1-3_CEC_GC_09	0.366	001	53° 50.8098'N	004° 59.6137'W	-186	79	3.00	2.00	Very soft CLAY
S1-1_CEC_GC_08	6.846	002	53° 49.0199'N	005° 04.6350'W	-79	75	3.00	2.60	SILT
S1-1_CEC_GC_07	15.733	003	53° 46.7802'N	005° 11.7840'W	137	69	3.00	3.00	Very soft CLAY with shell fragments
S1-1_CEC_GC_06	26.190	004	53° 44.6221'N	005° 20.3339'W	-41	80	3.00	3.00	Very soft CLAY
S1-1_CEC_GC_05	36.478	005	53° 42.1498'N	005° 28.6921'W	-7	104	3.00	3.00	Very soft CLAY
S1-1_CEC_GC_04	44.264	006	53° 40.2662'N	005° 35.0152'W	83	101	3.00	2.70	Very soft CLAY
S1-1_CEC_GC_03	53.816	007	53° 37.9590'N	005° 42.7568'W	95	77	3.00	3.00	Very soft CLAY
S1-1_CEC_GC_02	64.445	008	53° 35.3881'N	005° 51.3681'W	38	58	3.00	2.70	Clayey SILT with shell fragments
S1-1_CEC_GC_01a	74.767	009	53° 33.3168'N	005° 59.9883'W	-3	24	0.40	005	Fine silty SAND
S1-1_CEC_GC_01	74.768	009	53° 33.3150'N	005° 59.9882'W	-6	24	0.00	0.00	No recovery

Table 4.5: Gravity Core (GC) samples taken by OSV Cecilia along the S1-1 shallow water survey

4.2.2 CPTs

Ten (10) CPTs at approximately 10 km intervals were successfully performed onboard the OSV Cecilia along the Segment S1-1 survey route and at the BU Port Erin (Table 4.6 and Figure 4.1). Location S1-1_CEC_CPT_04 was repeated due to communication loss with the CPT during deployment. The CPT logs are presented in APPENDIX H - CPT RESULTS.

The table below shows the location of all CPTs taken during the shallow water survey, sorted by KP.

CPT No.	KP	CHART No. NUP 10K	Latitude	Longitude	DOL [m]	WD [m]	Penetration [m]
S1-3_CEC_CPT_09	0.363	001	53° 50.8107'N	004° 59.6113'W	-185	80	3.00
S1-1_CEC_CPT_08	6.849	002	53° 49.0187'N	005° 04.6371'W	-80	75	3.00
S1-1_CEC_CPT_07	15.734	003	53° 46.7802'N	005° 11.7848'W	137	69	3.00
S1-1_CEC_CPT_06	26.191	004	53° 44.6213'N	005° 20.3342'W	-42	80	3.00
S1-1_CEC_CPT_05	36.476	005	53° 42.1523'N	005° 28.6930'W	-3	104	3.00
S1-1_CEC_CPT_04a	44.269	006	53° 40.2663'N	005° 35.0205'W	86	101	3.00
S1-1_CEC_CPT_04	44.271	006	53° 40.2635'N	005° 35.0189'W	81	101	1.59
S1-1_CEC_CPT_03	53.816	007	53° 37.9598'N	005° 42.7568'W	96	77	3.00
S1-1_CEC_CPT_02	64.444	008	53° 35.3891'N	005° 51.3673'W	39	58	3.00
S1-1_CEC_CPT_01	74.767	009	53° 33.3156'N	005° 59.9871'W	-5	24	3.00

Table 4.6 Summary of CPT Positions

4.2.3 Sonar Contacts

During the survey of Segment S1-1, 82 sonar contacts were observed.

Within the forty (40) sonar contacts identified by the Alumaster in the Inshore Survey area, thirty-six (36) were boulders and four (4) were debris.

Within the 42 sonar contacts identified by the MV Helmert in the Shallow Water Survey area, thirty-eight (38) were boulders, three (3) debris, and one (1) wreck (Figure 4.6).

SSS data examples of boulder fields can be seen below. All sonar contacts (boulders, debris, and wreck) are listed in APPENDIX E - SONAR CONTACTS of this report and depicted on accompanying north-up and alignment charts.

Figure 4.2: SSS Image of Sonar Contacts S1-1_AL_SC0017, Boulder, 4.8m x 2.3m x 0.9m; and S-1_AL_SC0018, Boulder, 1.6m x 1.6m x 0.9m.

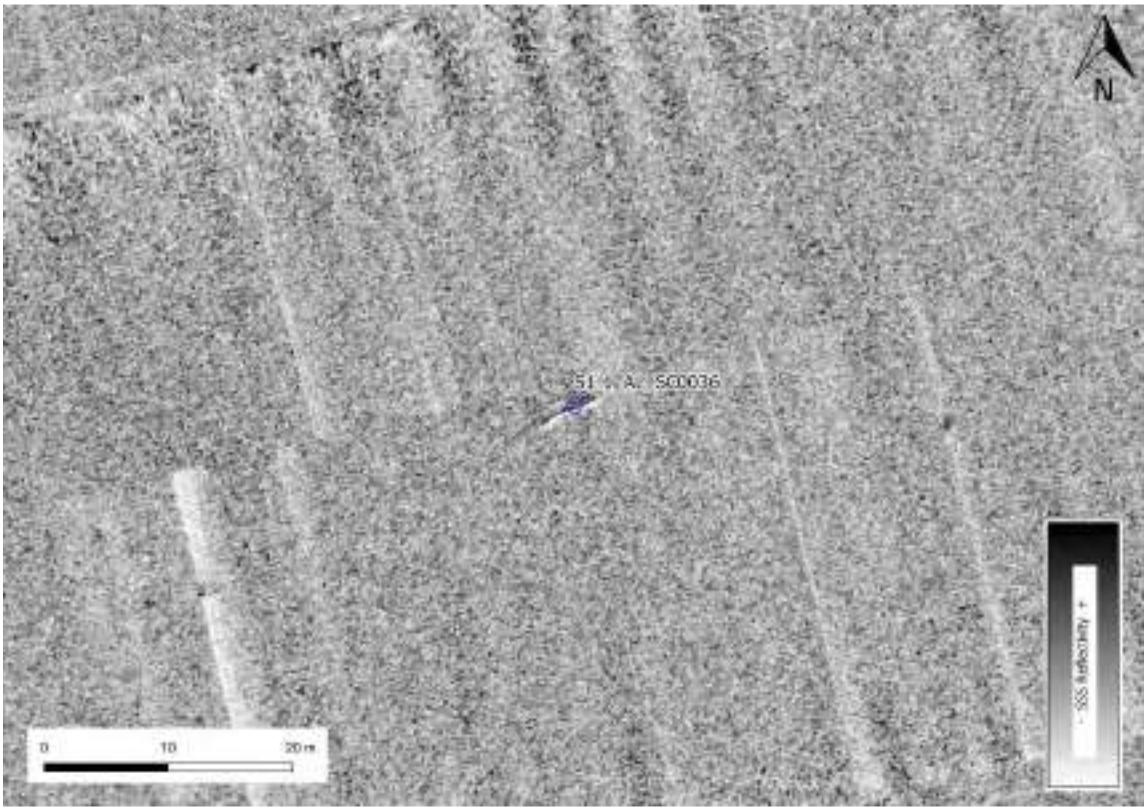

Figure 4.3: SSS Image of Sonar Contact S1-1_AL_SC0036, debris, 4.6m x 0.8m x 0.5m.

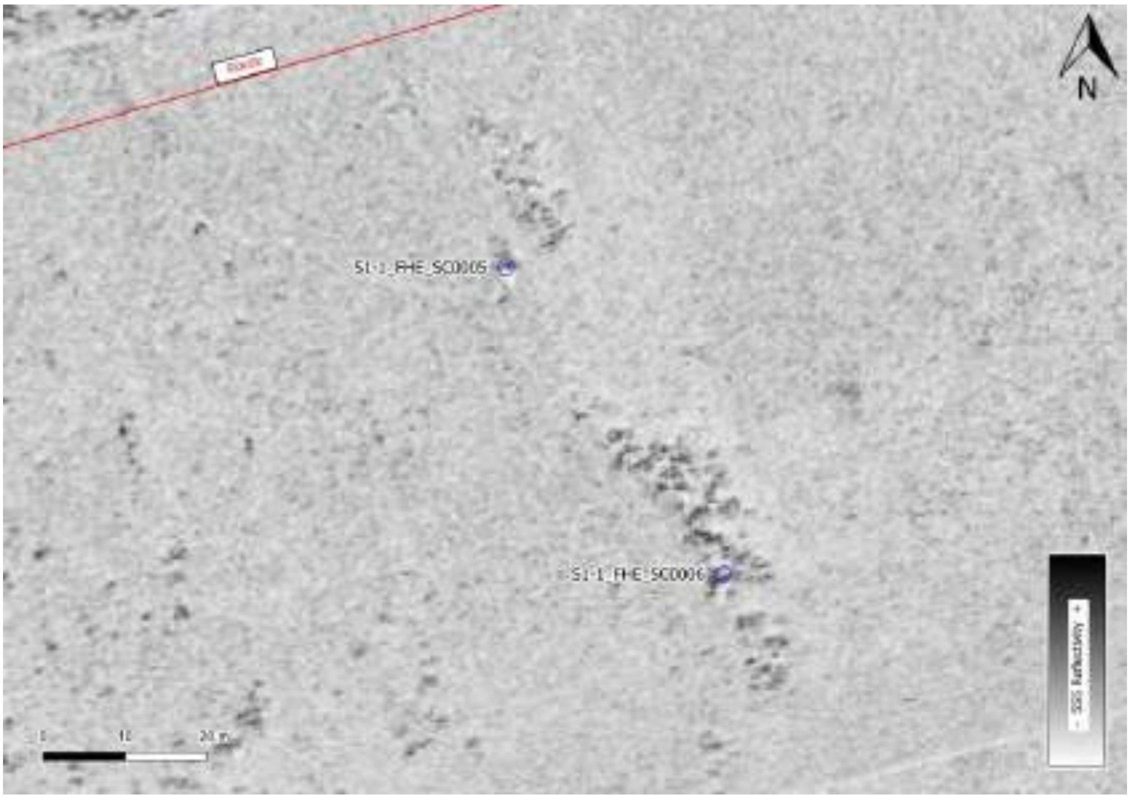

Figure 4.4: SSS Image of Sonar Contact S1-1_FHE_SC0005, boulder, 1.8mx0.8mx0.5m, and S1-1_FHE_SC0006, boulder, 1.5mx0.8mx0.3m.

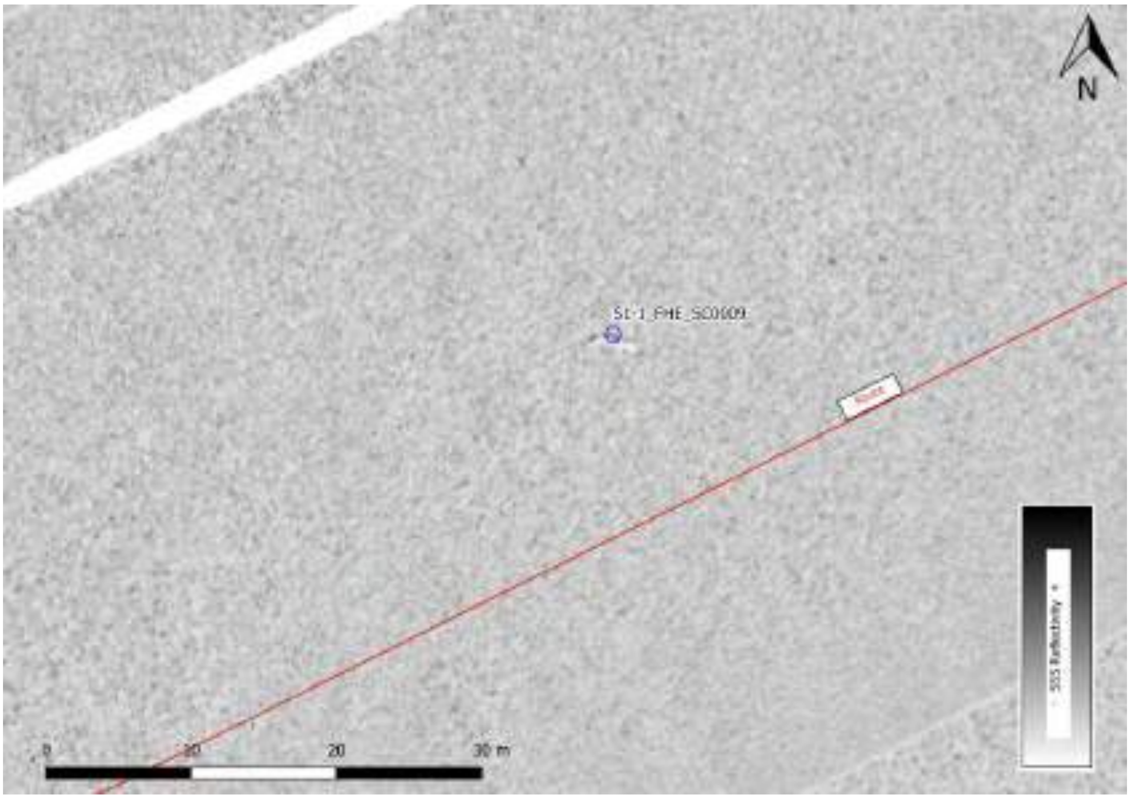

Figure 4.5: SSS Image of Sonar Contact S1-1_FHE_SC0009, debris, 6.6mx0.6mx0.2m.

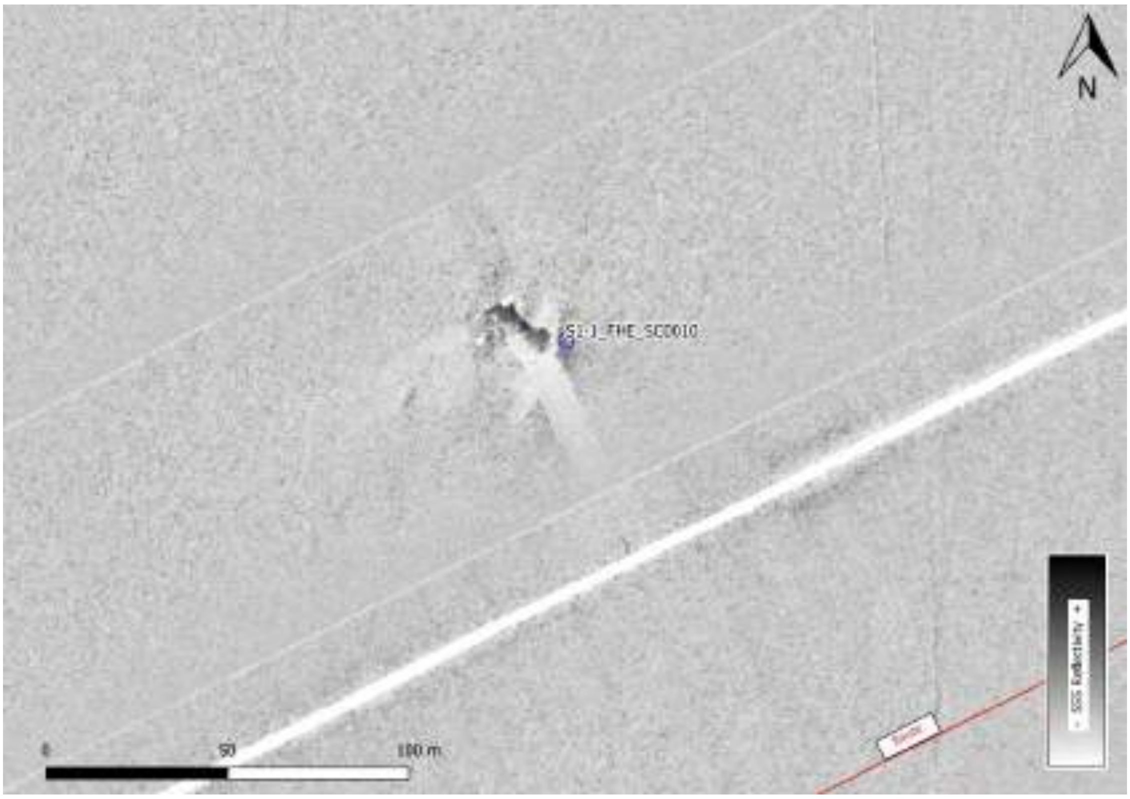

Figure 4.6:SSS Image of Sonar Contact S1-1_FHE_SC0010, wreck, 24.2mx8.9mx4.2 m.

4.2.4 Magnetometer Contacts

The Magnetometer survey was conducted using Geometrics G-882 Marine Magnetometer. One hundred seven (107) magnetic anomalies were observed, including eleven (11) anomalies within the BU Port Erin area detected during the S1-2 survey.

No known pipeline or cables exist in the inshore survey area. Three linear trends of magnetic contacts with NE-SW orientations are observed but do not correspond to SSS or bathymetric features (Figure 4.7). They may represent buried ferrous debris or be of geologic nature.

One (1) known in-service pipeline (Interconnector 1) exists in the survey area and corresponds to seven (7) magnetic contacts, and likewise it is detected in the bathymetry (Figure 4.8) and SSS surveys (APPENDIX P - CABLE REPORT).

Four linear trends of magnetic contacts with similar orientations are observed but do not correspond to SSS or bathymetric features. The first one is located at 53° 33.5972'N, 005° 57.9695'W (KP 72.477) and is oriented NW-SE (Figure 4.9); three more are present in the vicinity of the BU Port Erin with NW-SE orientation (Figure 4.10). They may likely be of geologic nature (e.g. buried igneous intrusions).

Examples of magnetometer contacts are shown in the figures below. All magnetic contacts (unknown and identified) are listed in APPENDIX F - MAGNETOMETER CONTACTS of this report and depicted on accompanying north-up and alignment charts.

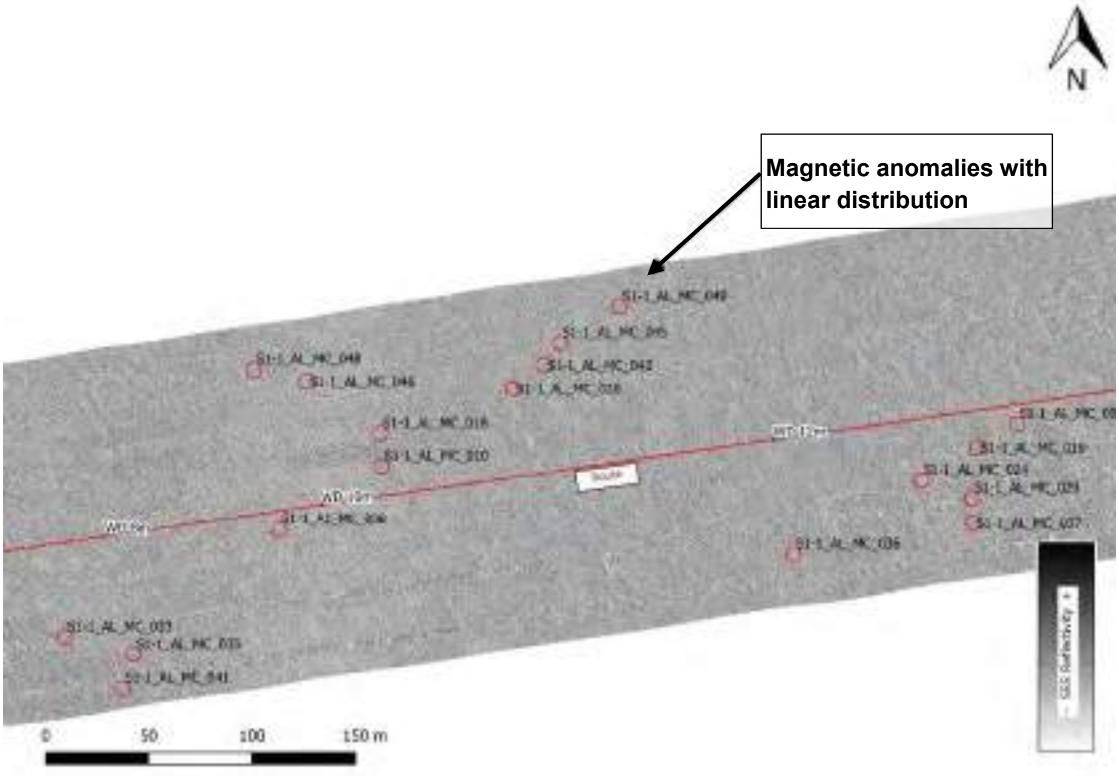

Figure 4.7: SSS image of Magnetic Anomalies. Arrow shows NE-SW magnetic contact lineaments.

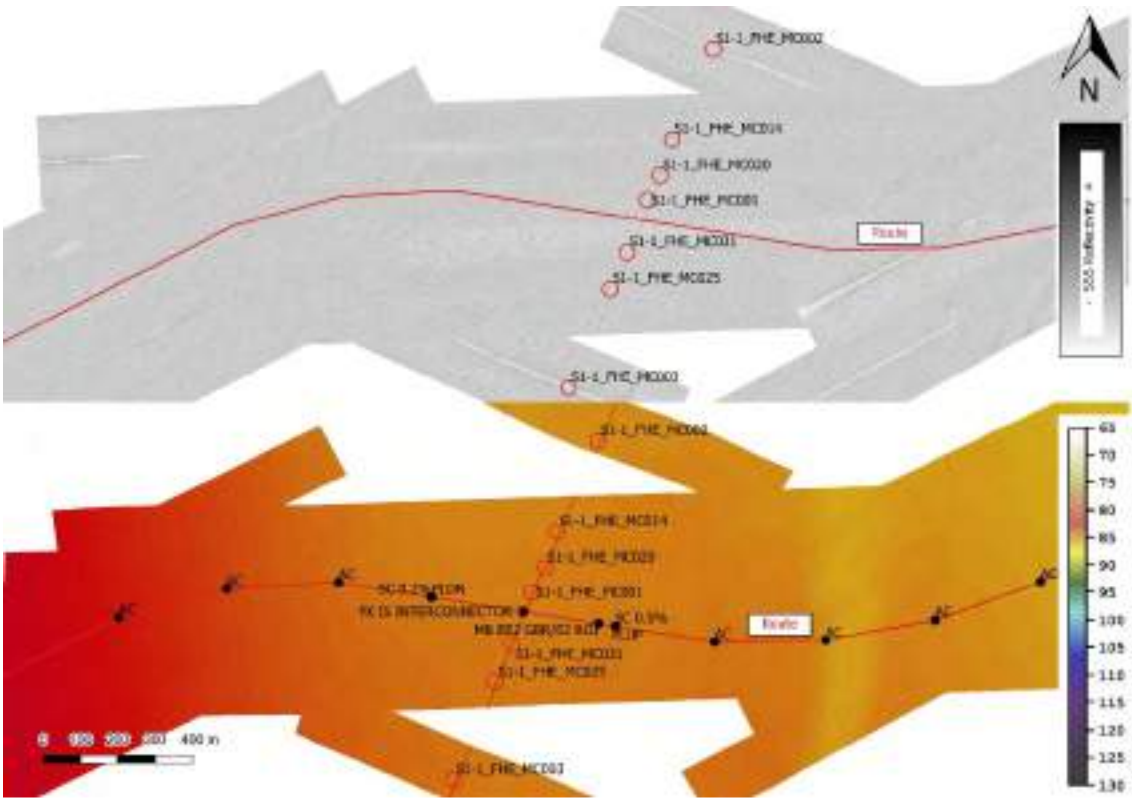

Figure 4.8: MBES and SSS image of Magnetic Anomalies and bathymetry corresponding to the in-service pipeline Interconnector 1

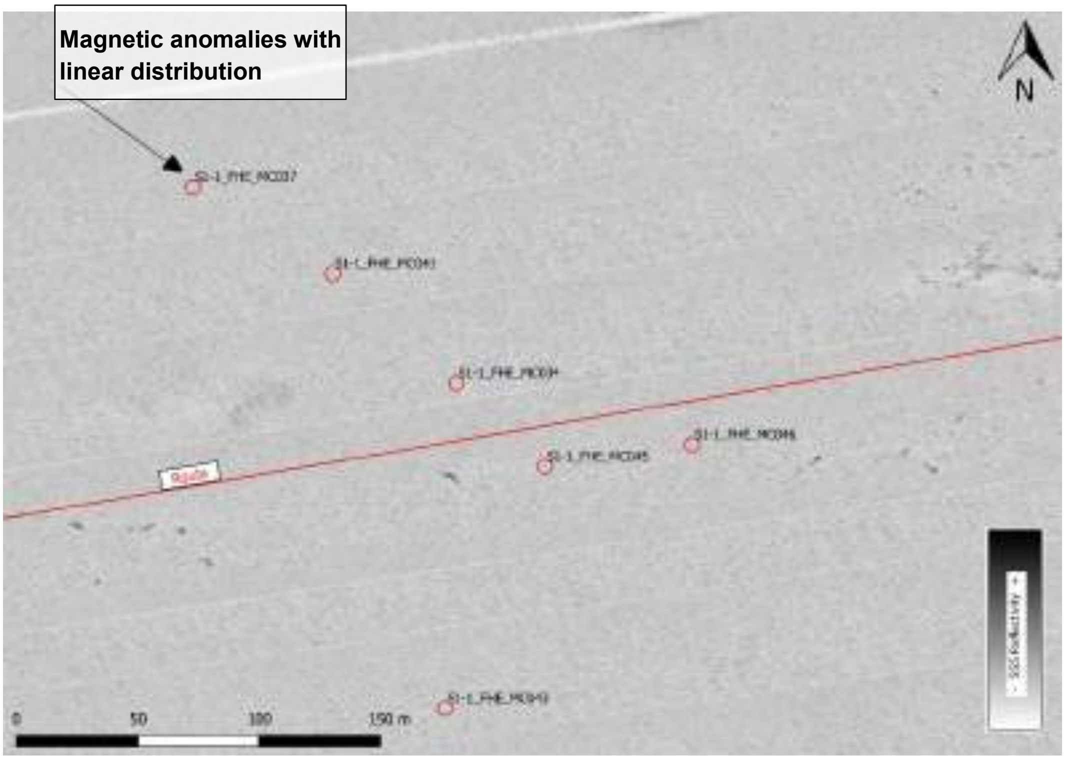

Figure 4.9: SSS image of unknown origin Magnetic Anomalies 53° 33.5972'N, 005° 57.9695'W (KP 72.477). Arrow shows NW-SE magnetic contact lineaments.

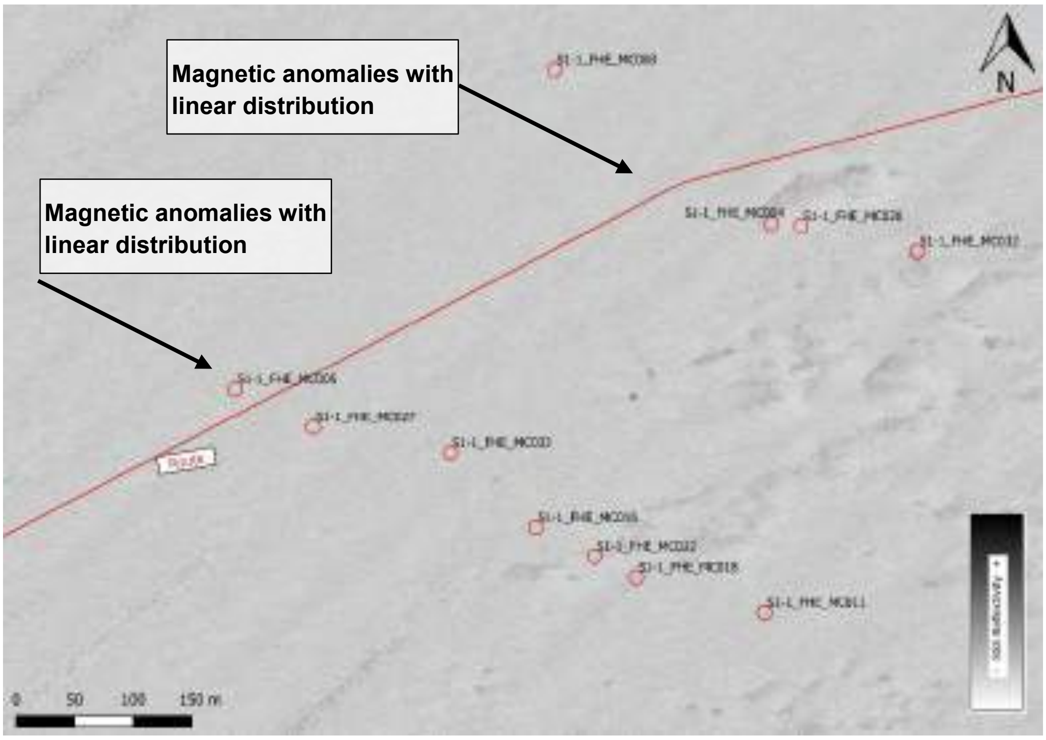

Figure 4.10: SSS image of unknown origin Magnetic Anomalies close to the BU. Arrow shows NW-SE magnetic contact lineaments.

4.2.5 Route Description Segment S1-1 BU Port Erin to BMH Loughshinny

The geology along Segment S1-1 (Figure 4.11) is characterized by the presence of the Western Irish Sea Mudbelt formed during Holocene time and surrounded by muddy sands and silts (*Mellet et al., 2015. Geology of the seabed and shallow subsurface: The Irish Sea. British Geological Survey Commissioned Report, CR/15/057. 52pp.* and *Ward et al., 2015. Classifying seabed sediment type using simulated tidal-induced bed shear stress. Marine Geology 367, 94-104pp*). The mudbelt attains it maximum thickness in the centre and western part of the eastern Irish Sea and decreases asymmetrically toward its margins.

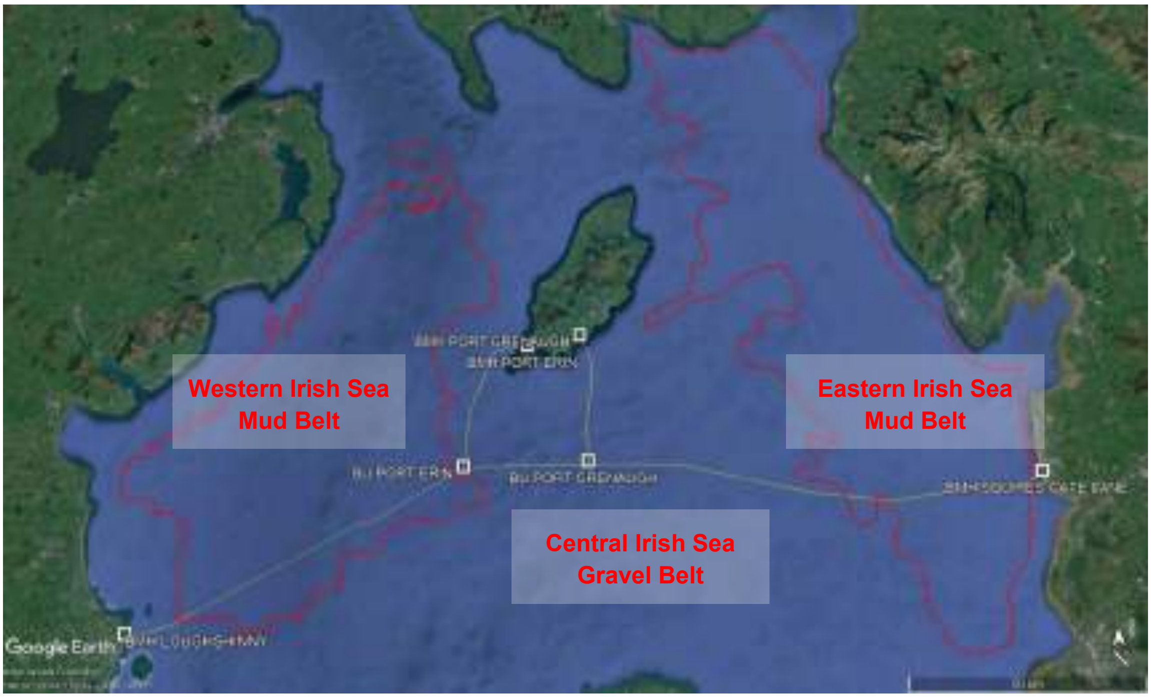

Figure 4.11 General shallow geology of the Irish Sea (boundaries modified from Mellet et al., 2015. Geology of the seabed and shallow subsurface: The Irish Sea. British Geological Survey Commissioned Report, CR/15/057. 52pp. The boundary in the Irish Territorial Waters is modified from Ward et al., 2015. Classifying seabed sediment type using simulated tidal-induced bed shear stress. Marine Geology 367, 94-104pp)

4.2.5.1 Shallow Water Route Description

Depending on the relative thickness and characteristics of the Western Irish Sea Mud Belt, the Segment S1-1 route can be separated in two broad areas and route description is therefore separated into: the Mudbelt itself and the Mudbelt surrounding.

I. Western Irish Sea Mudbelt: from 53° 50.7181'N, 005° 00.3277'W (KP 1.154) to approximately 53° 33.9561'N, 005° 56.1586'W (KP 70.363)

II. Western Irish Sea Mudbelt surrounding: from 53° 33.9561'N, 005° 56.1586'W (KP 70.363) to approximately 53° 32.9296'N, 006° 02.4010'W (KP 77.532)

Due to these geological characteristics of the Western Irish Sea along the shallow water route survey maximum acoustic penetration was up to approximately 30 m.

I. Western Irish Sea Mudbelt: from 53° 50.7181'N, 005° 00.3277'W (KP 1.154) to approximately 53° 33.9561'N, 005° 56.1586'W (KP 70.363)

From the BU Port Erin at 53° 50.9808'N, 004° 59.3756'W (KP 0.000) the Segment S1-1 route begins on seabed comprising SILT overlying very soft CLAY, which is the general sediment type within the BU area including intermitted patches of coarse SAND to sandy GRAVEL. This sediment composition corresponds with the Western Irish Sea Mudbelt pinched out against this very soft CLAY unit showing chaotic to hummocky internal reflection. Its thickness rapidly increases southward from 53° 50.6208'N, 005° 00.5004'W (KP 1.416) to 53° 49.5147'N, 005° 03.3421'W (KP 5.161) (Figure 4.12).

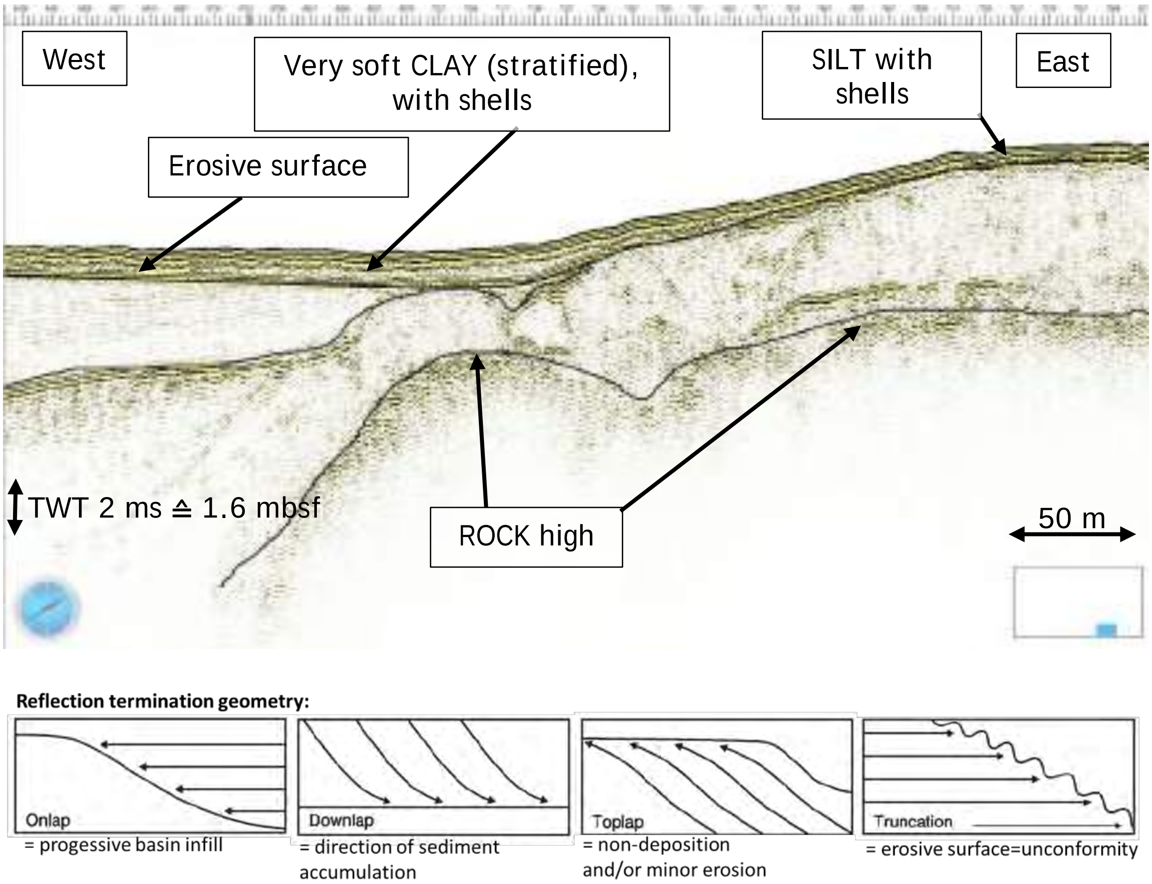

Figure 4.12 The stratified Western Irish Sea Mudbelt pinches out against a very soft hummocky-chaotic CLAY unit at the BU Port Erin.

The route heads southwest from the BU on seabed characterized by a slope of 1.0°SW due to the underlying ROCK around 53° 50.8674'N, 004° 59.8132'W (KP 0.524) (Figure 4.13).

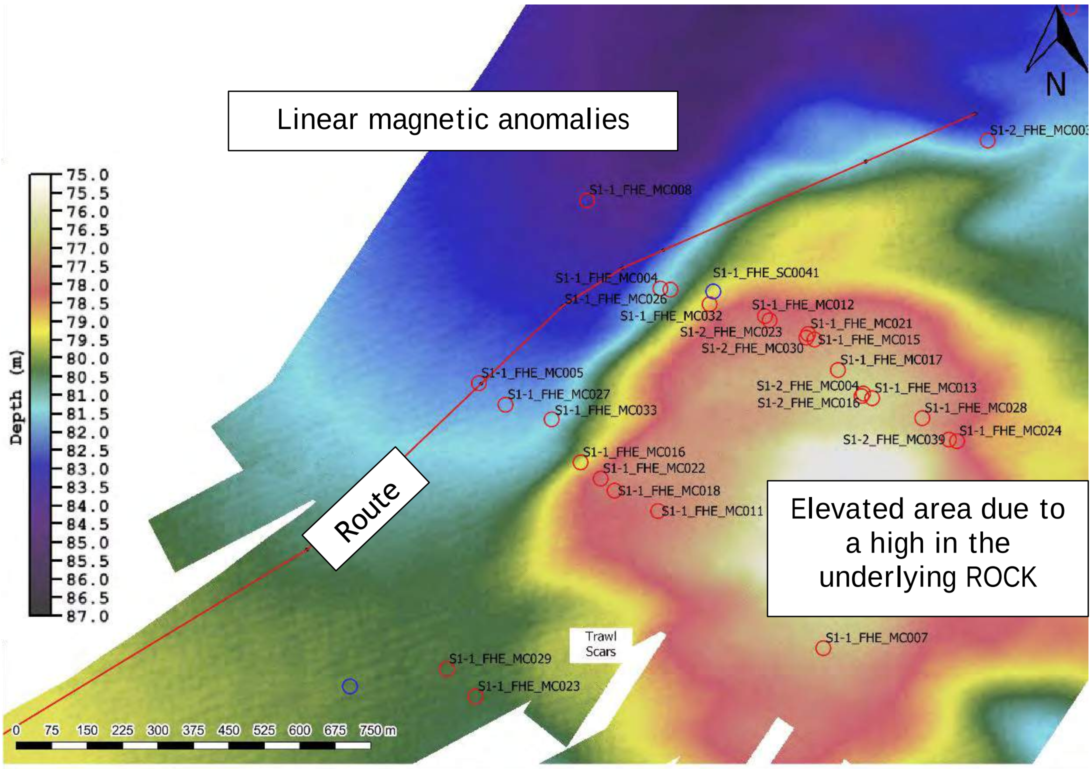

Figure 4.13: MBES-illustrating the beginning of the S1-1 at the BU area and the linear magnetic anomalies of either natural or anthropogenic origin.

Furthermore, two (2) NW-SE running linearly ordered anomalies are located at 53° 50.7778'N, 005° 00.1595'W (KP 0.939) and 53° 50.6124'N, 005° 00.5152'W (KP 1.438) (Figure 4.13 and Figure 4.14). These anomalies may have natural or anthropogenic origin. SE-trending Palaeogene dykes, with normally and reversely magnetisation are frequent in the Isle of Man surrounding. However, man made debris cannot be excluded too. Further detailed description of the BU area can be found in Chapter 4.2.6.

At 53° 50.7946'N,005°0.0949'W (KP 0.861) Concession Block 109/1 is left for Concession Block 108/5. The route alters course to more S-SW at 53° 50.7702'N,005°0.1893'W (KP 0.974), again back to SW at 53° 50.3857'N,005°0.9174'W (KP 2.048), then exits the BU Port Erin area. Seabed sediments continue as SILT with intermitted patches of coarser sediments, overlying very soft CLAY and gradients remain low at 0.1° (Figure 4.14). At 53° 49.9491'N,005°2.1326'W (KP 3.608) the route run beside Concession Block 108/5 and 108/10.

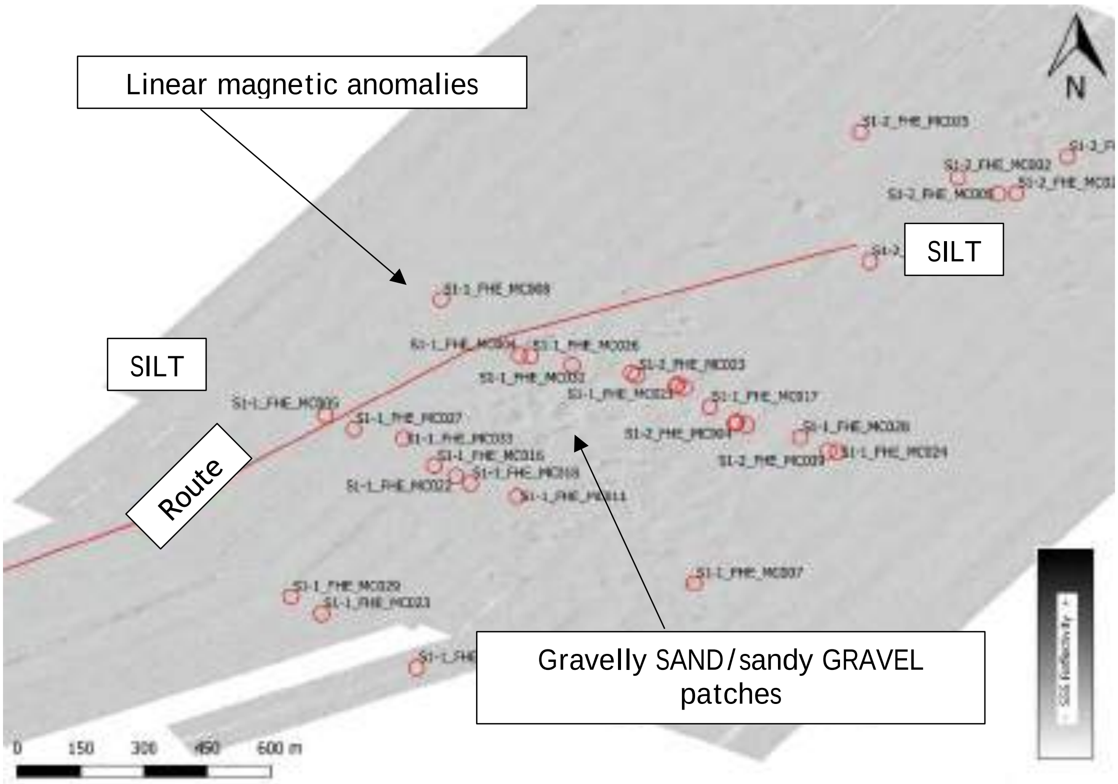

Figure 4.14: SSS-image illustrating the BU Port-Erin showing the patchy, probably sandy to gravelly areas as well as the surrounding fine sediments.

Looking into the SBP-data further westward along the route, an erosive surface (as seen by toplap terminations) appears in the sedimentary succession as a medium amplitude, intermittent horizon (Figure 4.15). The deeper strata begin to diverge westward at 53° 49.1367'N, 005° 04.4147'W (KP 6.531), due to an underlying morphological depression and the Mudbelt attains a thickness of > 20 m. In the deeper strata, there appear soft sediment deformations.

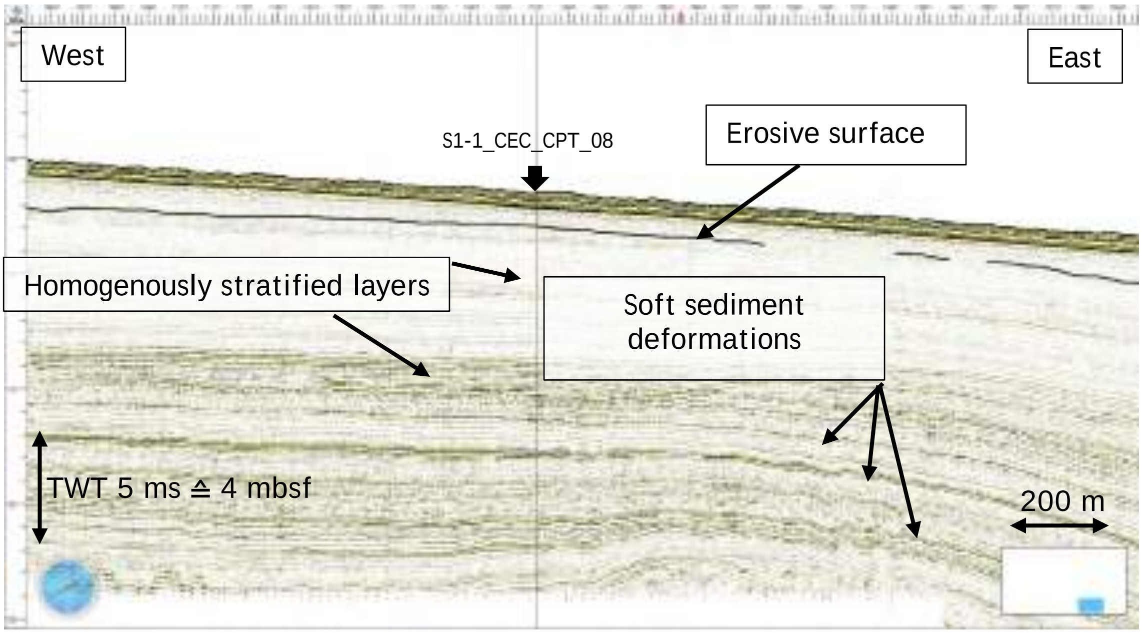

Figure 4.15 Western Irish Sea Mudbelt > 20 m thick with no further indication of bottom current activity

At 53° 47.9250'N, 005° 08.2079'W (KP 11.264) the seafloor changes from SILT to CLAY, with intermittent patches of coarser sediments (Figure 4.16).

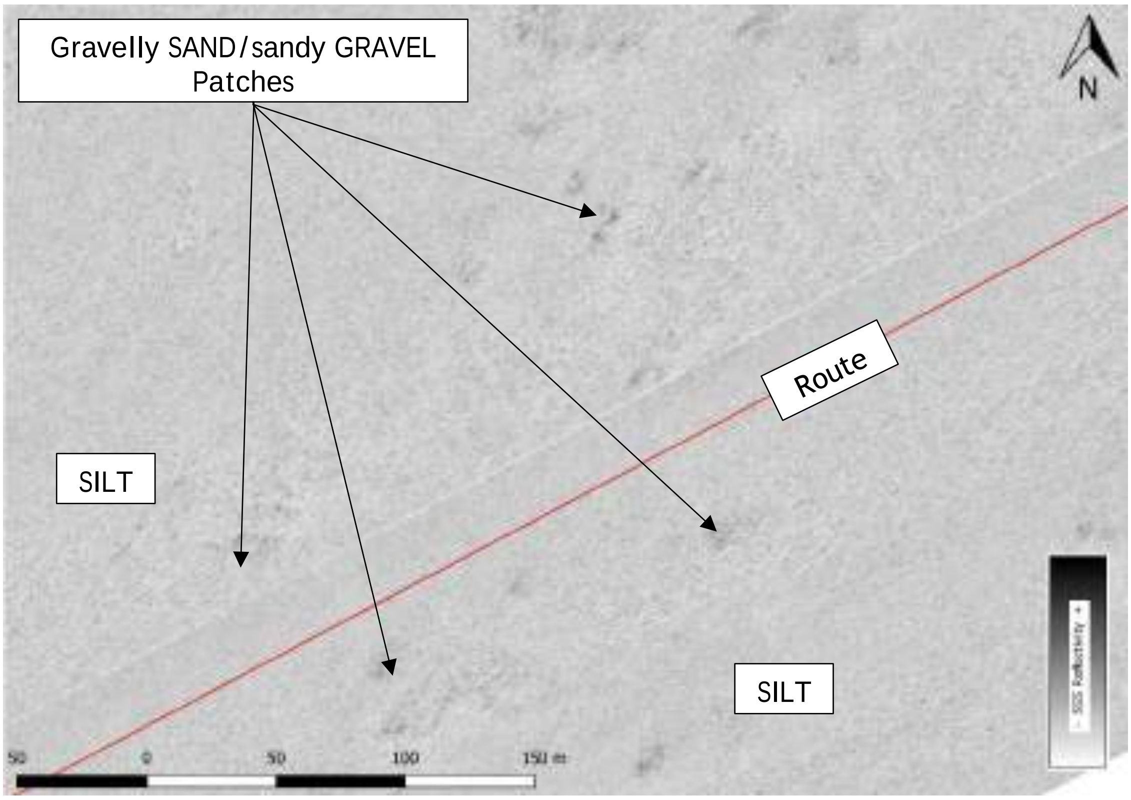

Figure 4.16: Example of patches of gravelly Sand/sandy GRAVEL on top of the seabed lying between generally silty sediments (53° 46.2955'N,005° 13.0648'W, KP 17.397).

Beforehand, from approximately 53° 48.1196'N, 005° 07.6095'W (KP 10.514) until 53° 45.0944'N, 005° 16.8976'W (KP 22.166), an internal erosive surface revealed by SBP-data is observed within the Mudbelt, as indicated by the presence of toplap and downlap terminations (Figure 4.17). The strata below the truncation, initially maintain a homogeneously stratified horizontal layering, but become hummocky to locally chaotic in depth. The strata above the erosive surface display a hummocky to complex geometry with frequent downlap and toplap termination, indicating the possible activity of a complex bottom current dynamics in the area.

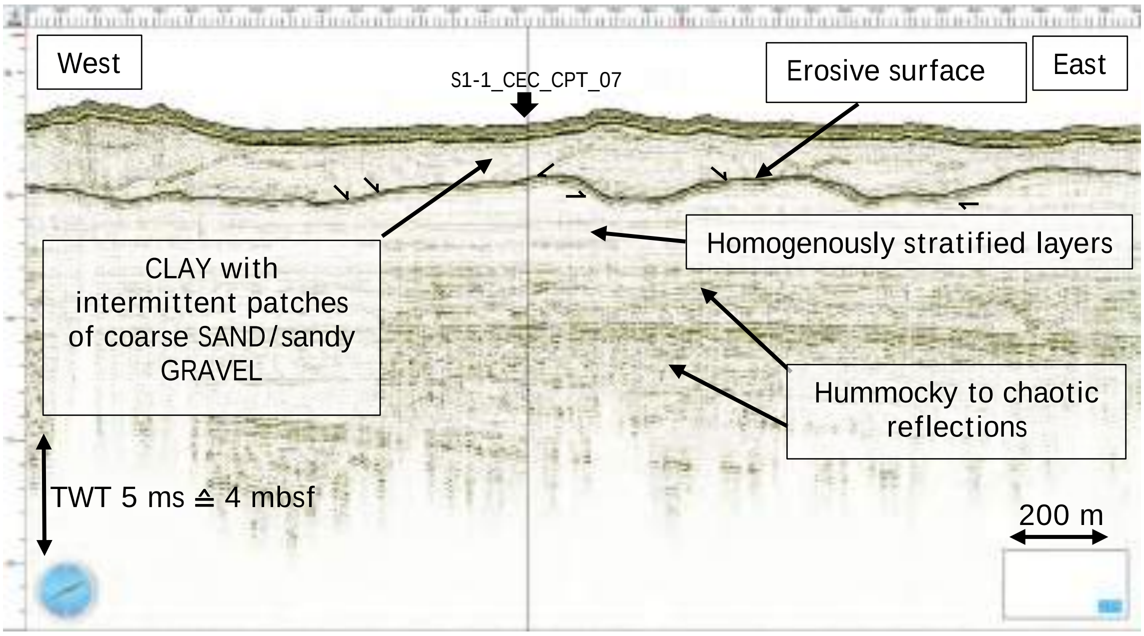

Figure 4.17 Western Irish Sea Mudbelt > 10 m thick with possible indication of bottom current activity. See Figure 4.12 for reflection geometry legend.

At 53° 46.6176'N, 005° 12.0371'W (KP 16.120) Concession Block 108/10 is left for Concession Block 108/9. Sediments on the seabed remain to be CLAY, although there are intermitted patches of coarse SAND/ sandy GRAVEL in certain areas. The route leaves the EEZ of the United Kingdom (Concession Block 108/9) and enters the EEZ of Ireland (Concession Block 33/9) at 53° 44.6099'N,005°19.3300'W (KP 25.062).

From location 53° 44.6768'N, 005° 18.2296'W (KP 23.823) the route from here on crosses frequent trawl scars, indicative of intensive fishing activity, until 53° 33.8392'N,005°56.5558'W (KP 70.853) (Figure 4.18).

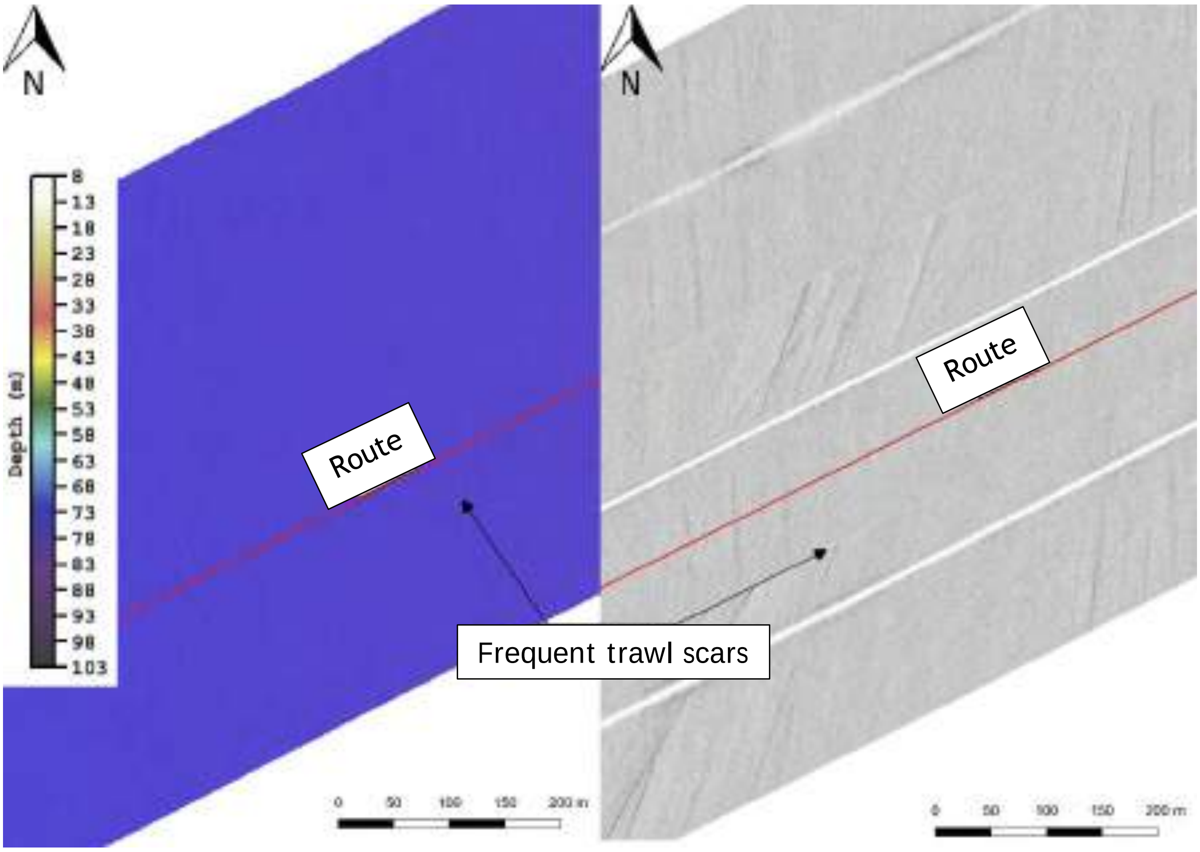

Figure 4.18: Example of frequent trawl scars scattered on top of the seabed at about 53° 37.8086'N, 005° 43.0727'W (KP 54.252).

Between 53° 44.6699'N, 005°18.2508'W (KP 23.850) and 53° 44.6184'N, 005°20.5000'W (KP 26.369), the route takes a westerly course to cross the in-service Interconnector 1 pipeline at 53° 44.6268'N,005°19.5120'W (KP 25.265) then continues towards the SW again (Figure 4.19). The crossing with the in-service pipeline Interconnector 1 appears as a very marked trench approximately 18 m wide and 0.7 m deep (Figure 4.20).

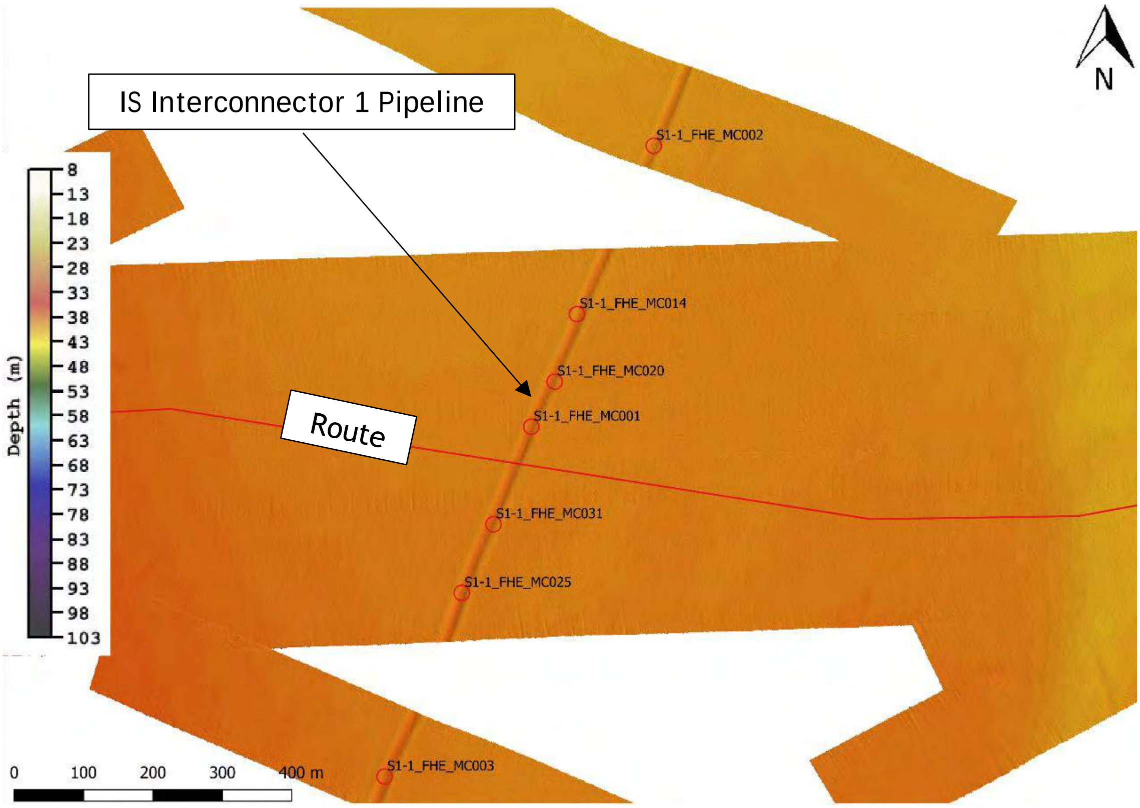

Figure 4.19 Pipeline crossing of IS Interconnector 1 at 53° 44.6268'N,005°19.5120'W (KP 25.265). The linearly distributed magnetic anomalies detected during survey can confirm the expected pipeline.

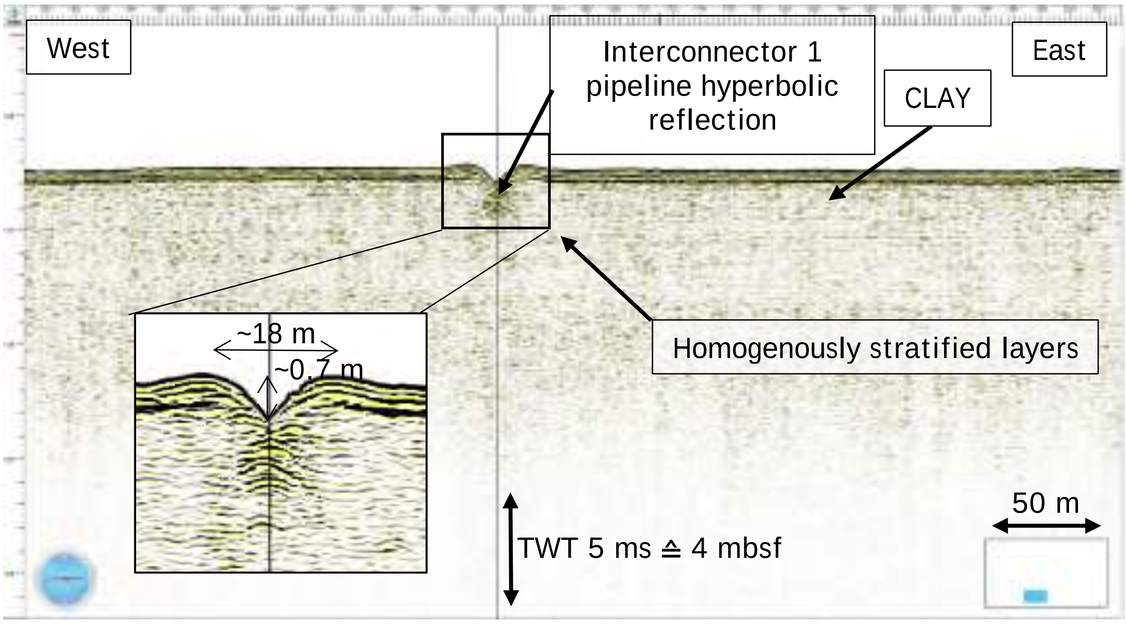

Figure 4.20 Western Irish Sea Mudbelt > 10 m thick at the crossing with the in service pipeline Interconnector 1

During its further westward course of the route, the Mudbelt attains thicknesses of up to 12 m of homogeneously stratified horizontal layers of soft CLAY (Figure 4.21).

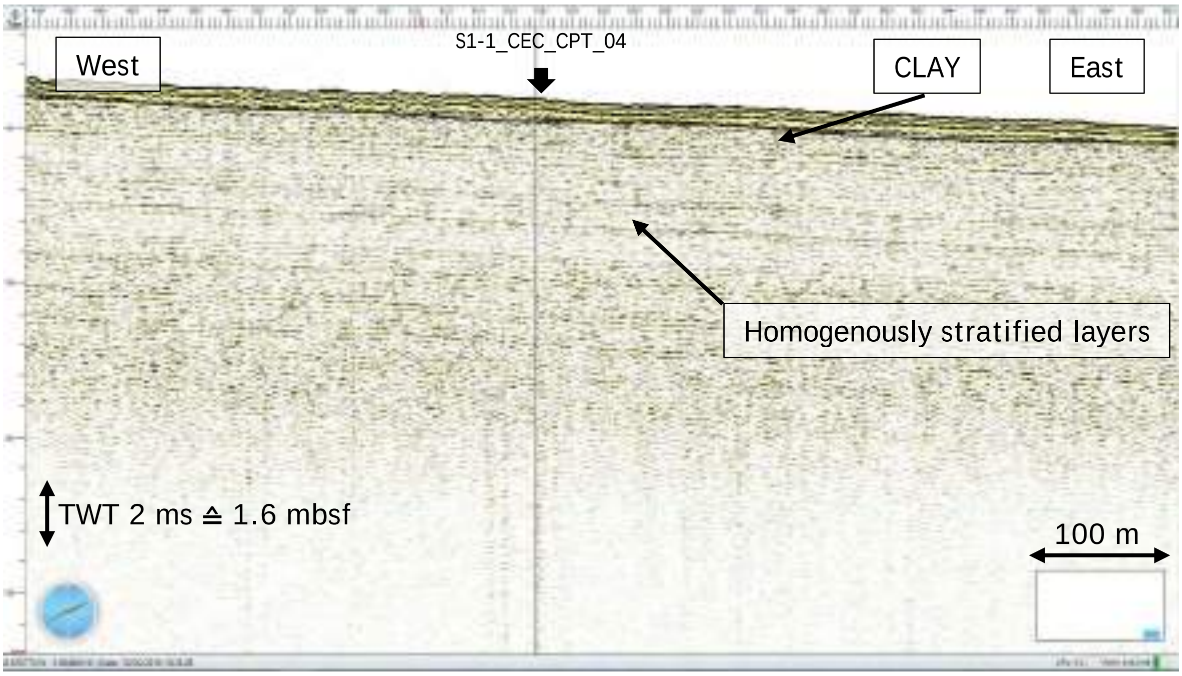

Figure 4.21 Western Irish Sea Mudbelt > 10 m thick at the location of S1-1_CEC_CPT_04.

While taking no route adjustments between 53° 43.6009'N, 005° 23.8838'W (KP 30.541) and 53° 42.3053'N, 005° 28.1901'W (KP 35.854) the seafloor crosses a valley with maximum 125m water depth (Figure 4.22), showing slope gradients from 0.5-1.0°, and relatively rough seafloor, mostly due to the presence of trawl scars.

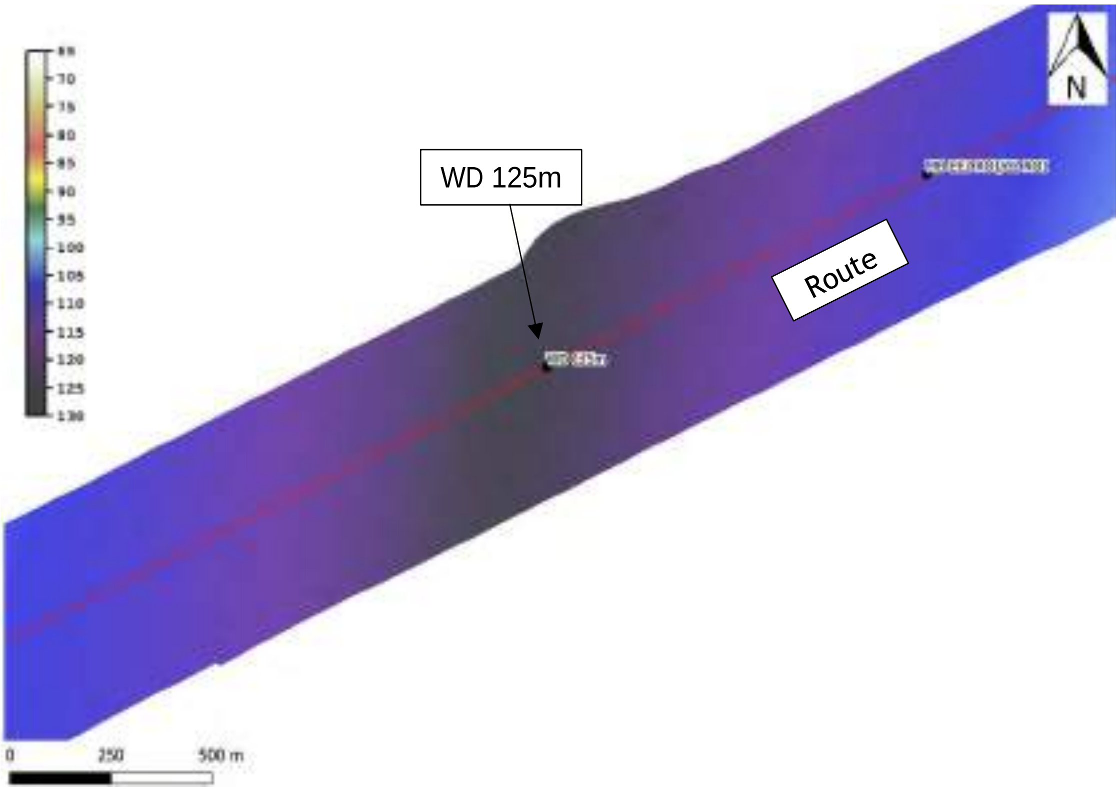

Figure 4.22: Valley between 53° 42.3053'N, 005° 28.1901'W (KP 35.854) and 53° 42.8808'N, 005° 26.2778'W (KP 33.495) reaching maximum water depths along S1-1 of 125m.

At 53° 39.8825'N, 005° 36.0581'W (KP 45.617) the route passes a ship wreck lying 140 m to the northwest of the route, having dimensions of 24.2m x 8.9 m x 4.2 m (Figure 4.23). At the same location the route exits Concession Block 33/8 and enters Concession Block 33/12. Refer to APPENDIX O - WRECK REPORT for further detailed information.

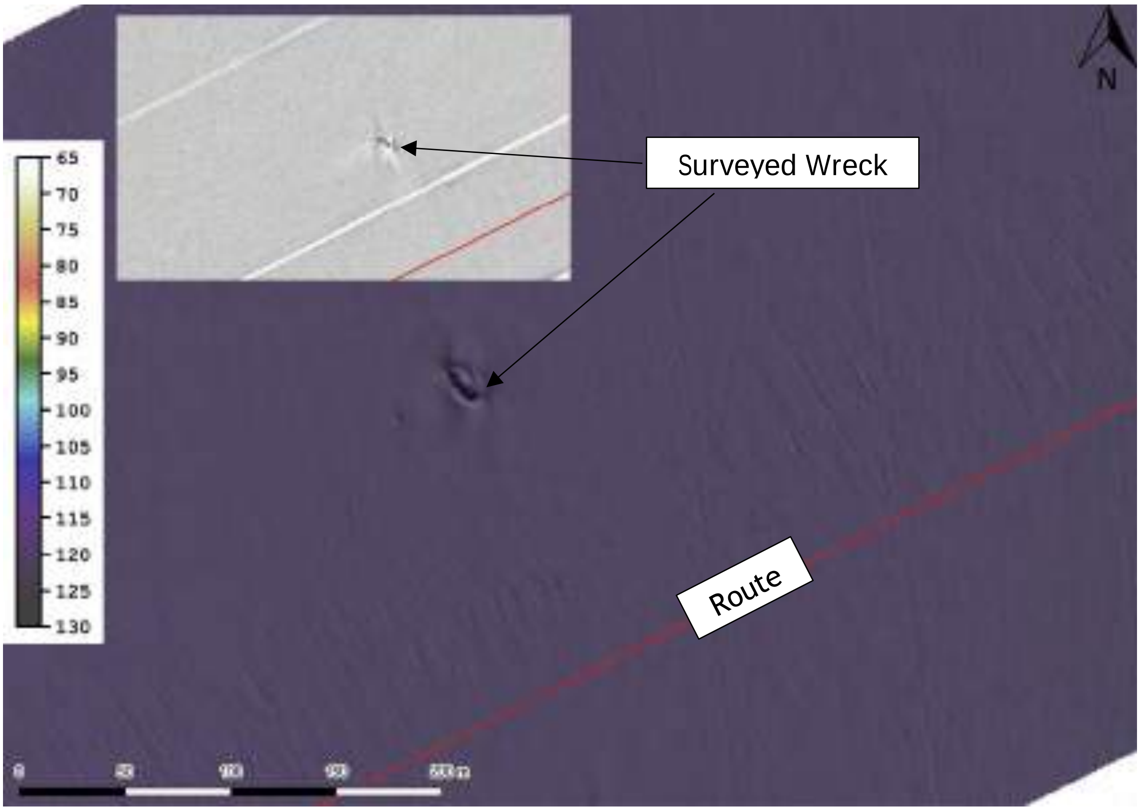

Figure 4.23: SSS and MBES image of showing the ship wreck located at 53° 39.9508'N, 005° 36.1172'W (KP 45.619). The wreck lies approximately 140 m to the northwest of the route.

At 53° 38.5737'N,005°40.4853'W (KP 51.066) the route leaves the Contiguous Zone and enters Irish Territorial Waters. Gradients remain low and trawl scars frequent along this route section.

Within the route area and while crossing into Concession Block 33/11 at 53° 36.3277'N,005°48.0954'W (KP 60.436) the sediments on the seafloor become coarser from >2m of very soft CLAY to clayey SILT with shell fragments.

SBP-data along this route section reveal that the Western Irish Sea Mudbelt becomes thinner westward, attaining ca. 2.5 m thickness resting on HARDGROUND (Figure 4.24). The sediments within this section are continuous, well stratified and no terminations indicative of erosional processes are visible. Ground truthing indicate the Mudbelt consists of clayey SILT over silty sandy CLAY.

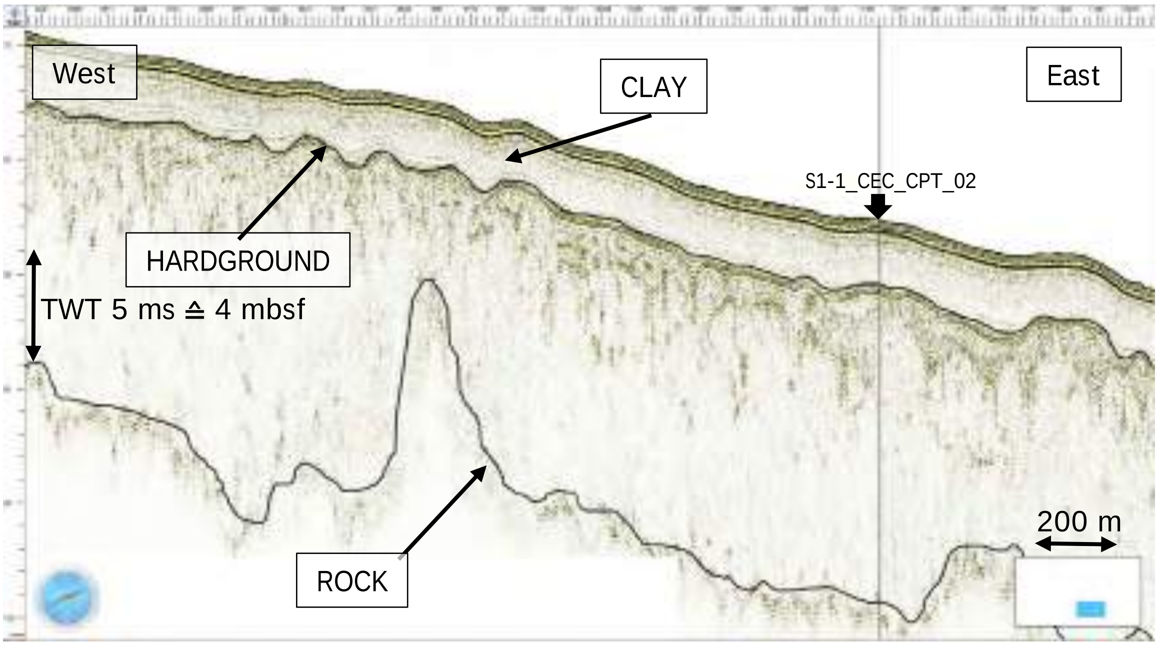

Figure 4.24 Western Irish Sea Mudbelt < 3 m thick

The route from there crosses two small areas of clayey SILT with shell fragments overlying subcropping HARDGROUND from between 53° 35.1652'N, 005° 52.0482'W (KP 65.302) and 53° 35.1290'N, 005° 52.1720'W (KP 65.454) and between 53° 35.0807'N, 005° 52.3360'W (KP 65.656) and 53° 35.0485'N, 005° 52.4455'W (KP 65.791) until reaching the limits of the Western Irish Mudbelt.

II. **Western Irish Sea Mudbelt surrounding: from 53° 33.9561'N, 005° 56.1586'W (KP 70.363) to approximately 53° 32.9296'N, 006° 02.4010'W (KP 77.532)**

Entering the surrounding Mudbelt area to the west, the shallow geology is expressed by HARDGROUND subcrops covered by a thin layer of coarse GRAVEL from 53° 34.0299'N, 005° 55.9079'W (KP 70.055) to 53° 33.5091'N, 005° 58.5437'W (KP 73.132). The sediment cover can locally reach >2 m thickness where the morphological depressions are present (Figure 4.25).

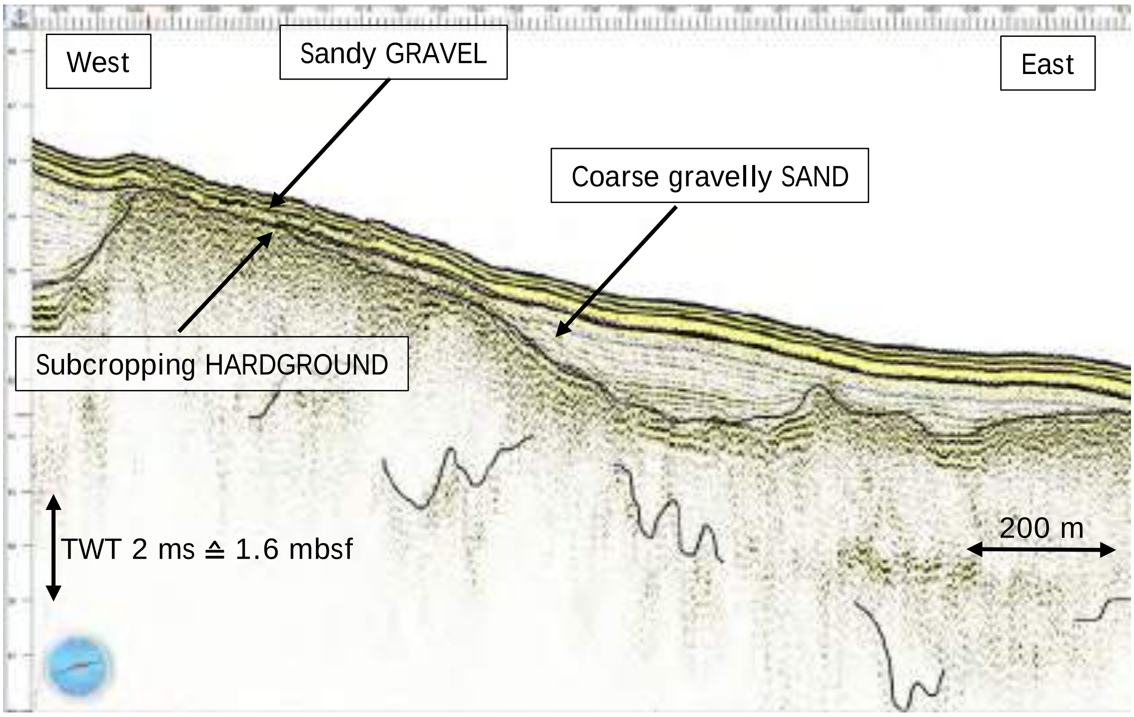

Figure 4.25 Western Irish Sea Mudbelt surrounding with subcropping ROCK

The route alters course towards a more westerly direction (53° 33.8392'N, 005° 56.5558'W, KP 70.853), but remains on seabed characterized by small slope gradients of 0.1 to 0.3°. In contrast to the seabed prior to this point, the route from here on westward does not cross trawl scars again until it reaches the inshore survey area.

Between 53° 34.0299'N, 005° 55.9079'W (KP 70.055) and 53° 33.5091'N, 005° 58.5437'W (KP 73.132) seabed sediments change from clayey SILT with shell fragments to coarse gravelly SAND to sandy GRAVEL overlying subcropping HARDGROUND, while changing to coarse gravelly SAND to sandy GRAVEL at 53° 33.5091'N, 005° 58.5437'W (KP 73.132). At 53° 33.3041'N,006°0.0955'W (KP 74.882) the route enters Concession Block 32/15.

The SBP-data reveals that in the prior described route section from 53° 33.6158'N, 005° 57.8650'W (KP 72.357) to approximately 53° 32.9270'N, 006° 02.4188'W (KP 77.552), the seabed sediments of silty SAND have thicknesses of >2 m with internal stratification. The internal layers display a medium to low amplitude and are continuous. The presence of reflection terminations either downlapping or onlapping onto the underlying HARDGROUND and ROCK indicate that the major direction of sediment accumulation surrounding the mudbelt is toward the west. Toplap terminations indicate the occurrence of erosive events during the late Holocene time.

From 53° 33.1619'N, 006° 01.1714'W (KP 76.105) to 53° 33.0401'N, 006° 01.7712'W (KP 76.806) the route crosses two isolated patches of coarse gravelly SAND to sandy GRAVEL (corresponding to a high-amplitude SBP data with hummocky reflections) overlying subcropping HARDGROUND (Figure 4.26). At this area the seabed sediments transition gradually from coarse gravelly SAND to fine to medium SAND, as shown by grab samples from the inshore survey.

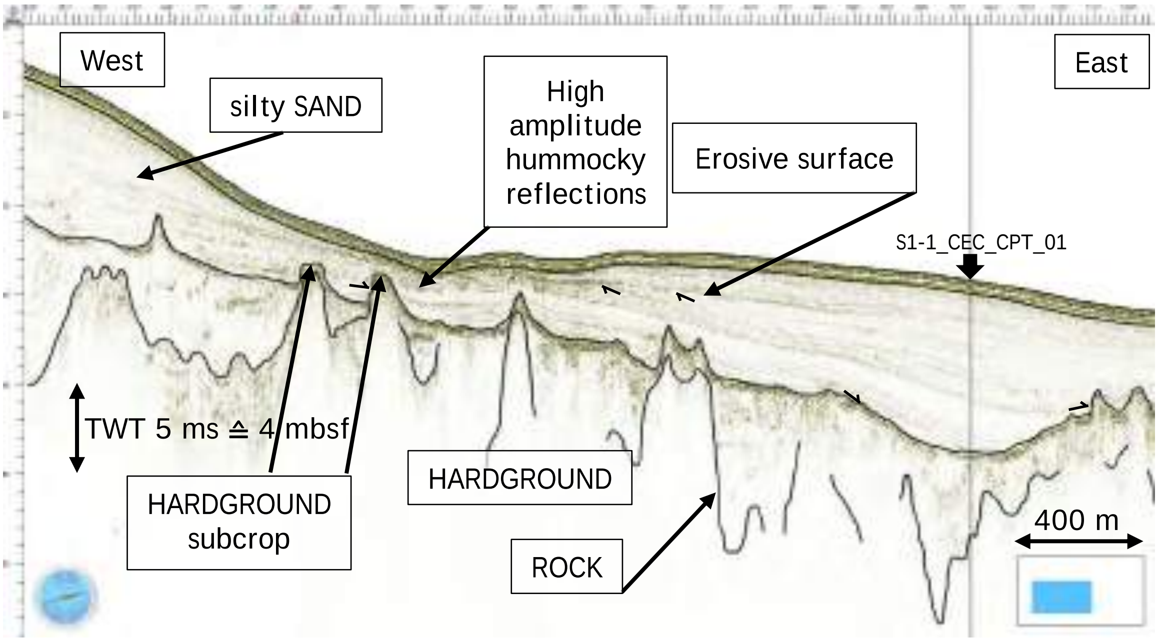

Figure 4.26 Western Irish Sea Mudbelt surrounding with peaks of HARDGROUND. See Figure 4.12 for reflection geometry legend.

Where the shallow water survey overlaps with the inshore survey area the seafloor of the route comprises fine to medium SAND to silty fine to medium SAND. The inshore and shallow water survey areas overlap approximately 960m in 15m water depth.

4.2.5.2 Inshore Route Description

The inshore survey began between the 15 m and 20 m WD LAT contours (53° 33.0523'N,006° 02.0014'W, KP 77.040), where seafloor is flat and featureless along the route. At approximately deeper than the 5 m WD LAT contour (53° 32.6335'N,006° 04.4544'W, KP 79.867) seafloor properties change to more diverse features, therefore making it possible to divide the inshore survey into two distinctive zones (Figure 4.27).

During the inshore route survey maximum acoustic penetration of approximately 8 m was achieved. However, most of the SBP-data along the inshore route between 53° 32.9990'N, 006° 01.9723'W (KP 77.040) and the BMH achieved penetration depths of 5 m due to the very high amplitude signal response allowing minimal resolvable stratigraphy.

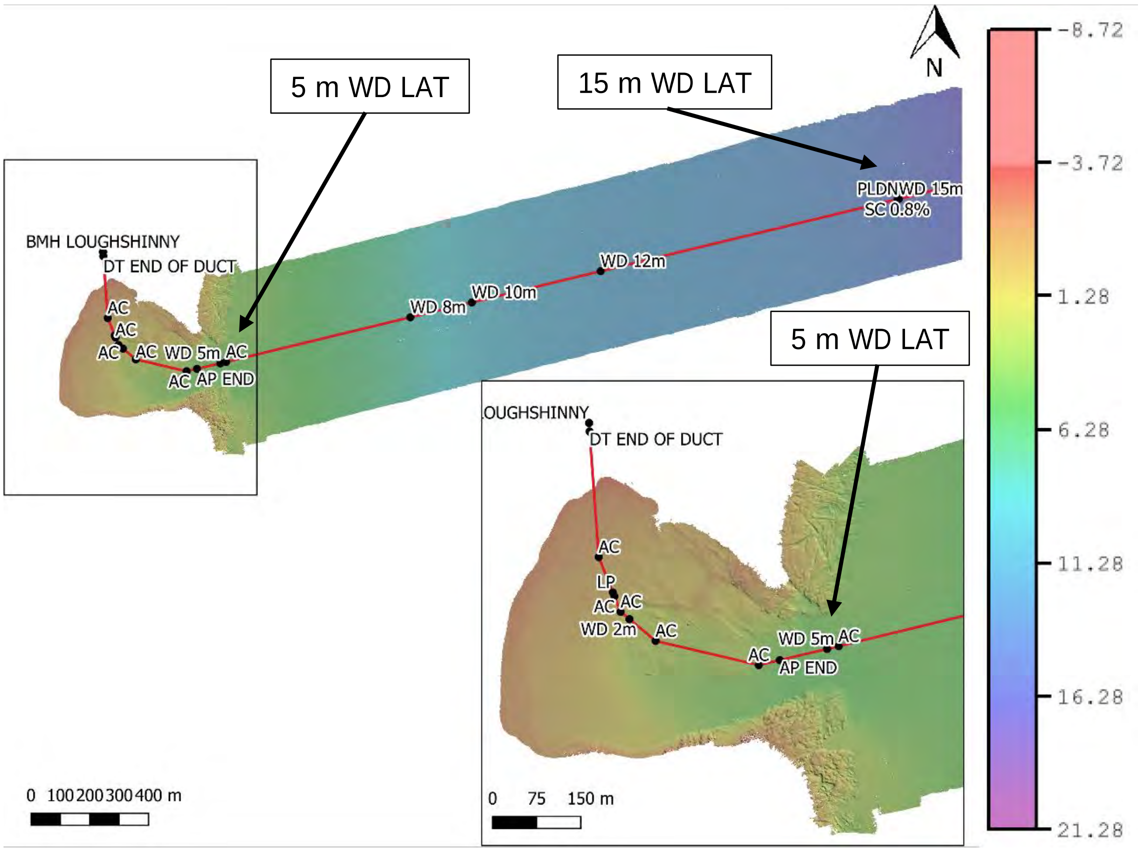

Figure 4.27 Hillshaded bathymetry image- Illustrating two distinctive geologic zones of Inshore survey area separated by approximate 5 m WD contour

Between 53° 32.9990'N, 006° 01.9723'W (KP 77.040) and the 5m WD contour (53° 32.6253'N,006° 04.5114'W, KP 79.931), subcropping ROCK dips eastward away from the shoreline and is overlain by a SAND unit becoming thinner westward toward the shoreline (Figure 4.28). The subcropping ROCK can be seen outcropping to the north and south of the survey route in the SSS and MBES data (Figure 4.29). The silty fractions of the SAND unit decrease westward towards shallower waters. Several trawl scars are observed near the 5 m WD contour and one is crossed at 53° 32.6487'N, 006° 04.3492'W (KP 79.746)

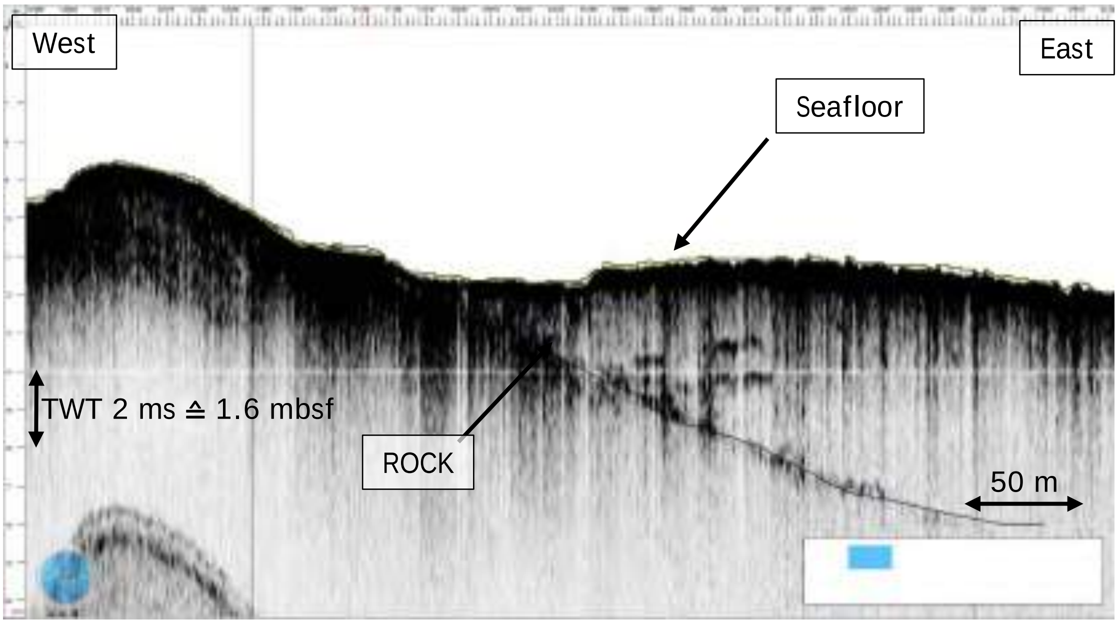

Figure 4.28 SBP- Illustrating the ROCK unit dipping east overlain by SAND.

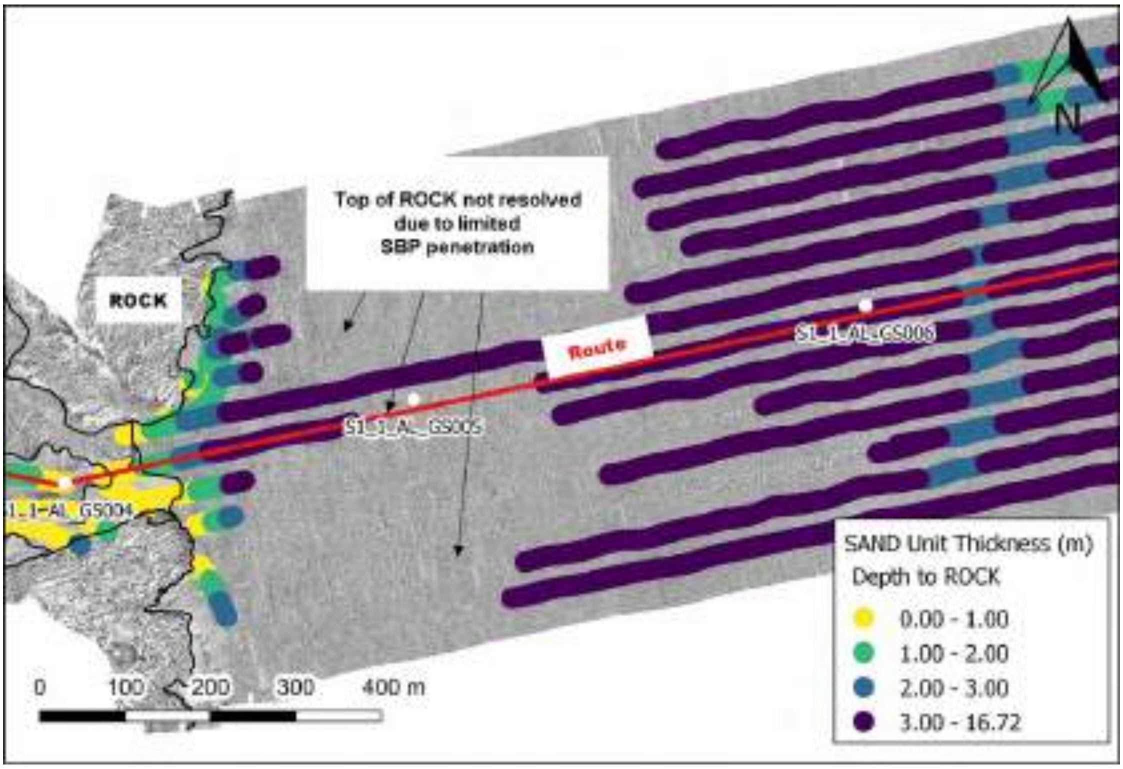

Figure 4.29 SSS with layer thickness of SAND Unit (Seafloor to ROCK)- Illustrating spatial extend of SAND unit. Where the top of ROCK was not detected due to limited penetration, the SAND thickness is extrapolated.

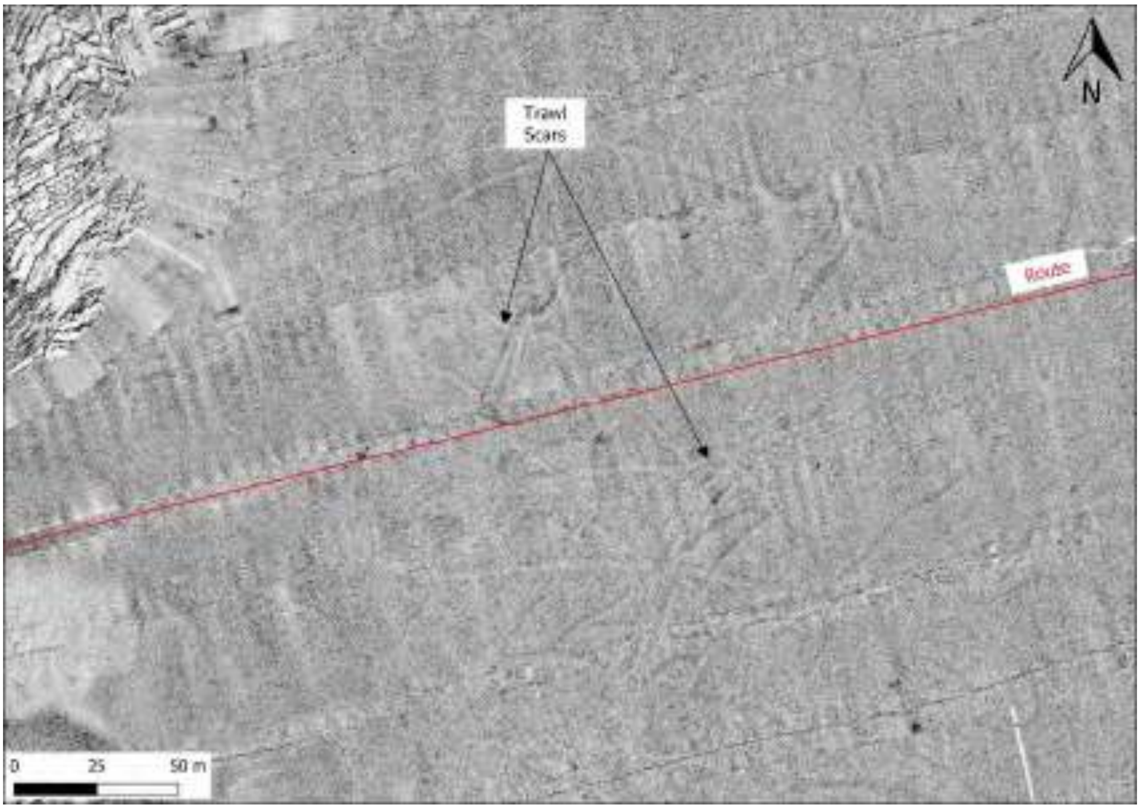

Figure 4.30 SSS data- Illustrating trawl scars.

Shallower than 5m at 53° 32.6334'N, 006° 04.4542'W (KP 79.866) the route crosses over seabed sediments of silty fine to medium SAND overlying subcropping ROCK. SBP profiles identify these areas of subcropping ROCK (Figure 4.31) and the layer thickness map shows the SAND overlaying the ROCK is predominately less than 2m thick (Figure 4.32)

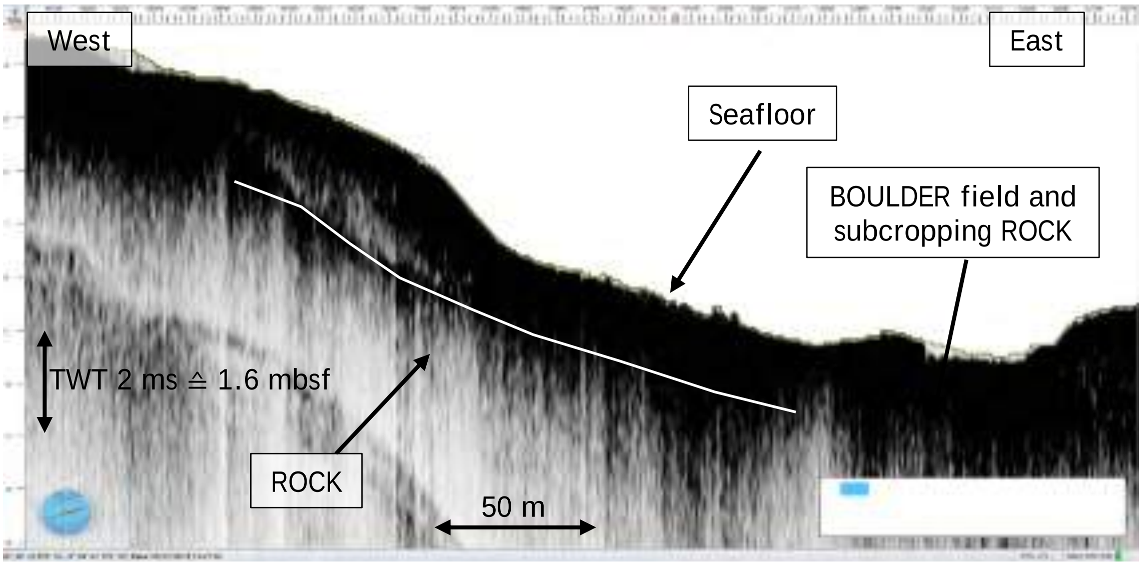

Figure 4.31 SBP- Illustrating diffuse contact between ROCK and BOULDER area

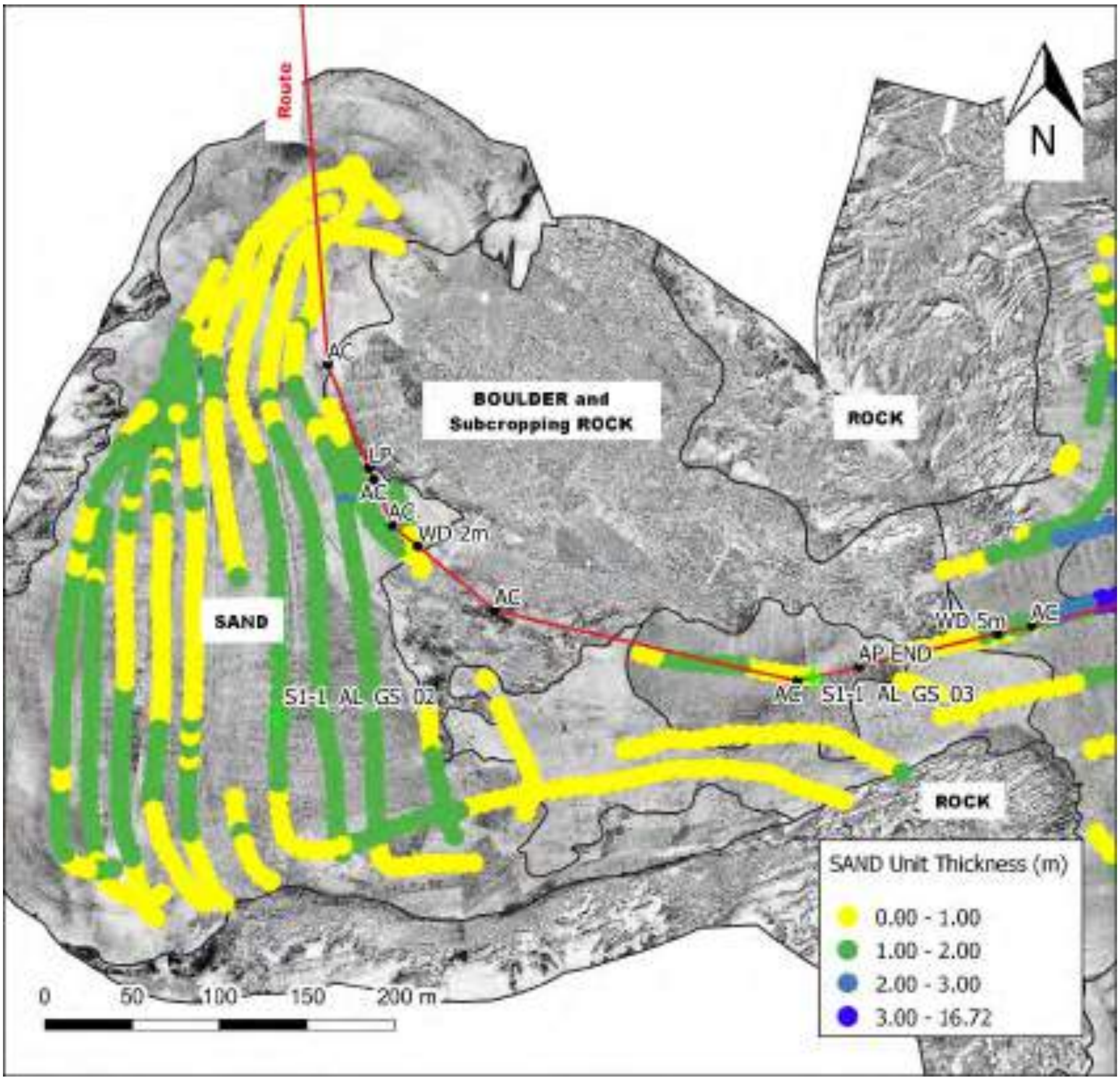

Figure 4.32 SSS with thickness map of SAND unit (Seafloor to ROCK)- illustrating spatial extend of SAND unit in relation to subcropping and outcropping ROCK.

At about 53° 32.6197'N, 006° 04.5514'W (KP 79.976) the route crosses over a boulder field of fine to medium SAND with numerous boulders overlying the subcropping ROCK (Figure 4.33).

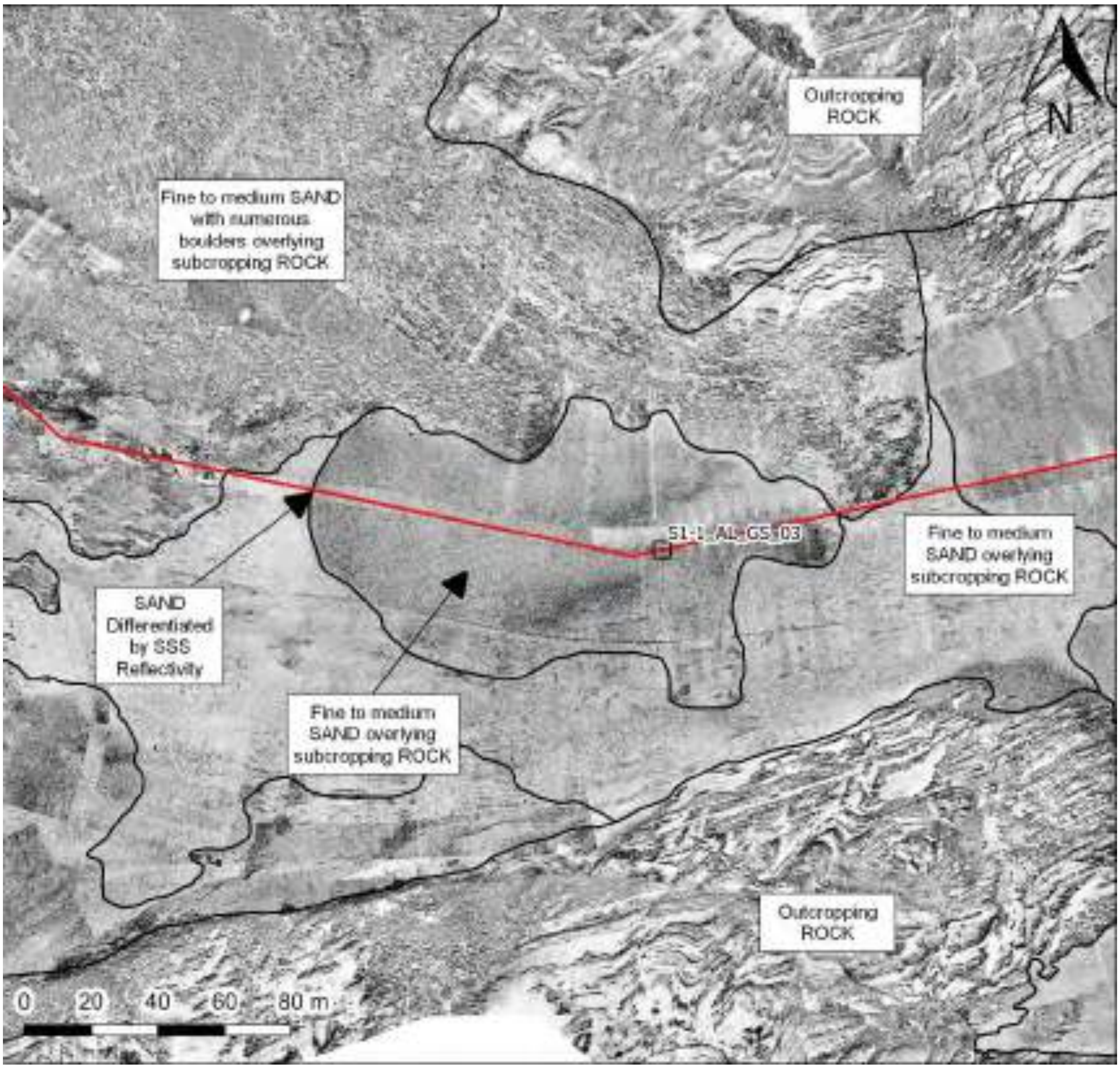

Figure 4.33: SSS- Illustrating SAND unit differentiated by SSS reflectivity.

At 53° 32.6107'N, 006° 04.6150'W (KP 80.048) the route turns from SW to W-NW and continues over subcropping ROCK until 53° 32.6239'N, 006° 04.7097'W (KP 80.156) (Figure 4.33). The SAND in this area is differentiated by relatively low (to the west) and moderate (to the east) SSS reflectivity character (Figure 4.33). The difference may represent relatively lower and higher coarse fractions of the SAND seabed sediments.

At 53° 32.6239'N, 006° 04.7097'W (KP 80.156) the route crosses into a boulder field overlying subcropping ROCK, turns from a W-NW to NW orientation, then exits the boulder field at 53° 32.6508'N, 006° 04.8083'W (KP 80.279)(Figure 4.34).

Between 53° 32.6798'N,006° 04.8386'W (KP 80.344) and 53° 32.7063'N,006° 04.8564'W (KP 80.397) the route crosses a boulder field and then turns from NW to N at 53° 32.7082'N,006°4.8577'W (KP 80.401) (Figure 4.34). For the remainder of the inshore survey heading towards the BMH, the route crosses seabed sediments comprising fine to medium SAND with occasional boulders overlying subcropping ROCK.

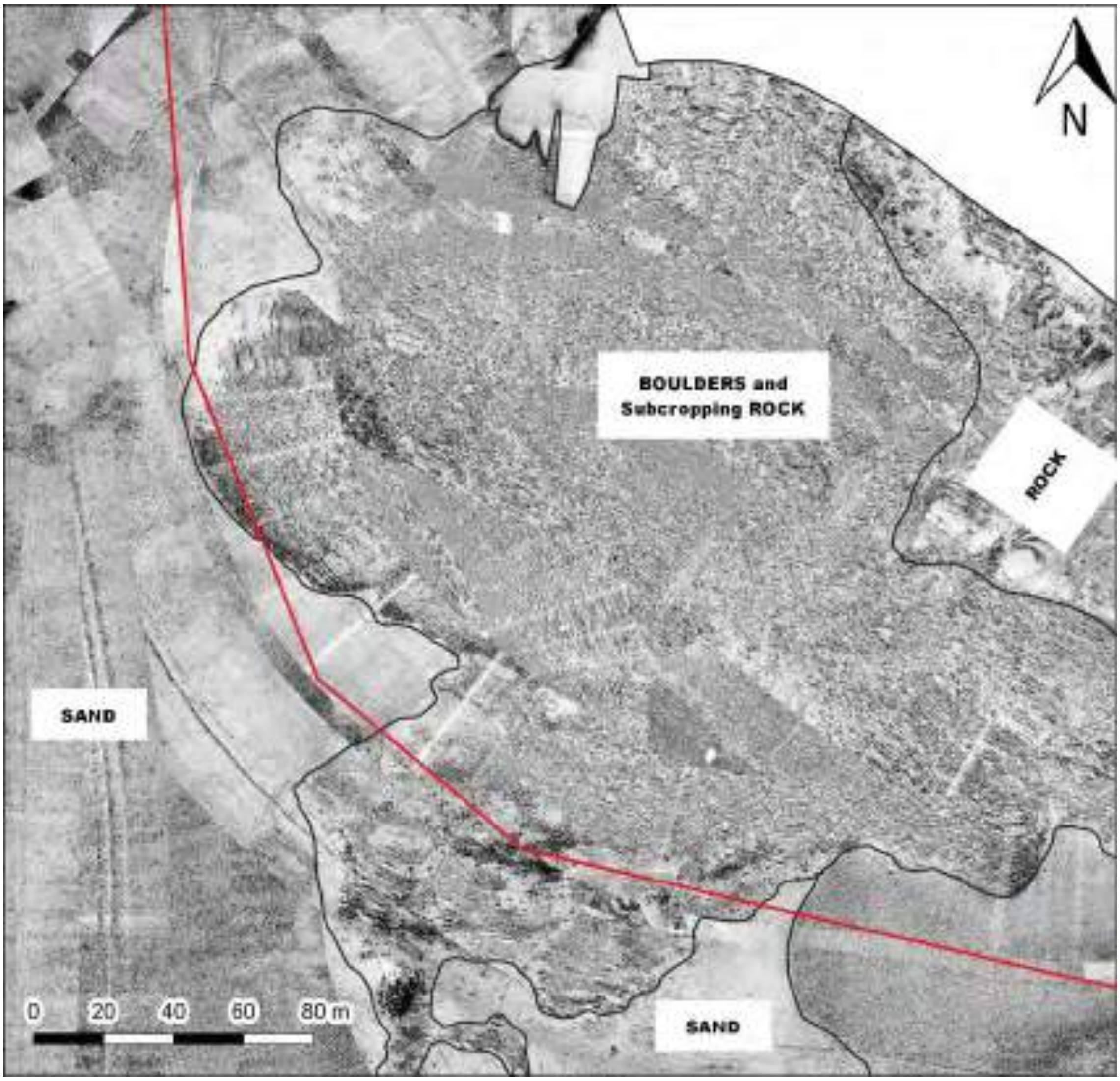

Figure 4.34: SSS- Illustrating route proximity to BOULDER field and subcropping ROCK.

4.2.5.3 Topographic land survey Loughshinny

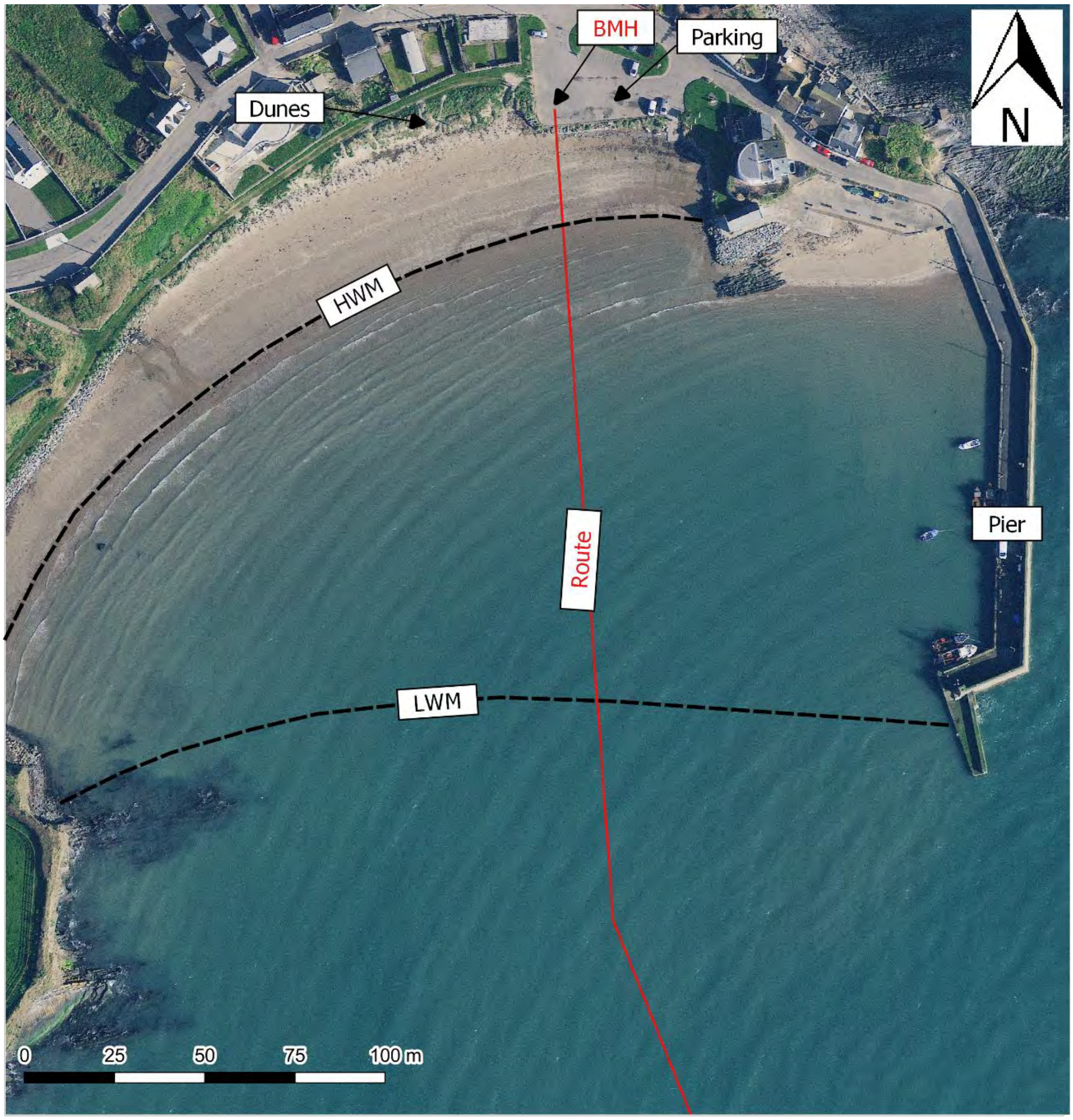

Figure 4.35: Orthographic photo compiled through data gathered during land survey showing the Loughshinny beach area with its most prominent features.

The route continues NE from the inshore survey directly towards the BMH and crosses the low water mark of Loughshinny Beach at approximately 53° 32.7432'N, 006° 04.8620'W (KP 80.466) (Figure 4.35).

The route then continues for approximately 160 m farther along sandy tidal flats with ripples before reaching the fair water, high water mark at 53° 32.8122'N, 006° 04.8704'W (KP 80.594).

The shore itself is made up of fine to medium SAND, with saprse PEBBLES towards the BMH. Vegetation is limited to the dunes to the west of the BMH area and in case of the route direction increases due to the fortified stone blocks before reaching the parking lot at the BMH location (Figure 4.36). A belt characterized by COBBLES and gravelly

SAND densely accumulated during storm whether tides and/or high tides is located directly before these manmade structures.

The Loughshinny pier is located to the east of the BMH, which was used as stopping place for the survey conducted by the Alumaster.

Figure 4.36: View from parking lot towards the south onto the shoreline depicting the flat beach area mostly covered by SAND and the COBBLE belt formed during high tides as well as man-made structures (Pier and man-made fortification).

The BMH is located at 53° 32.8293'N, 006° 04.8724'W (KP80.626) in the southeastern corner of the parking lot. The parking lot is easily accessible by following the Loughshinny Park Drive to the east until reaching the pier in the small harbor area (Figure 4.36 and Figure 4.37).

Figure 4.37: Land survey chart- illustrating the BMH position at the southwestern corner of the parking lot.

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4.2.6 BU Port Erin

A square of approximately 2.8 km x 2.1 km has been surveyed centered on the proposed BU Port Erin position (Figure 4.38). In general, the BU Port Erin area is mostly levelled and is characterized by a nearly featureless seabed. The only significant topographic anomalies are in the southeast and northeast, where the underlying ROCK defines a high.

Water depths (LAT) across the BU varies from minimum values of 75 m in the southeastern elevated area, to maximum values of 86 m in the lower northwestern survey area. Water depth at the proposed BU Port Erin position is 83 m LAT. Gradients near the proposed BU Port Erin position are about 1°. However, gradients are mostly smaller and about 0.1-0.5°in the more levelled areas to the W, NW and NE of the BU Port Erin.

In general, the BU area is covered with fine sediments, mostly being SILT overlying very soft CLAY. Intermitted patches of coarse SAND and sandy GRAVEL are also scattered on the seabed. The BU location at 53° 50.9808'N, 004° 59.3756'W (KP 0.000) itself is covered by >0.3m sandy SILT overlying at least 1.7m very soft CLAY (S1-3_CEC_GC_09).

Only two (2) sonar contacts were detected within this area, being S1-1_FHE SC0041 and S1-2_FHE_SC0309. In contrast magnetic contacts are abundant and show a linear distribution. These anomalies may have natural or anthropogenic origin. SE-trending Palaeogene dykes, with normally and reversely magnetisation are frequent in the Isle of Mann surrounding. However, man made debris cannot be excluded too.

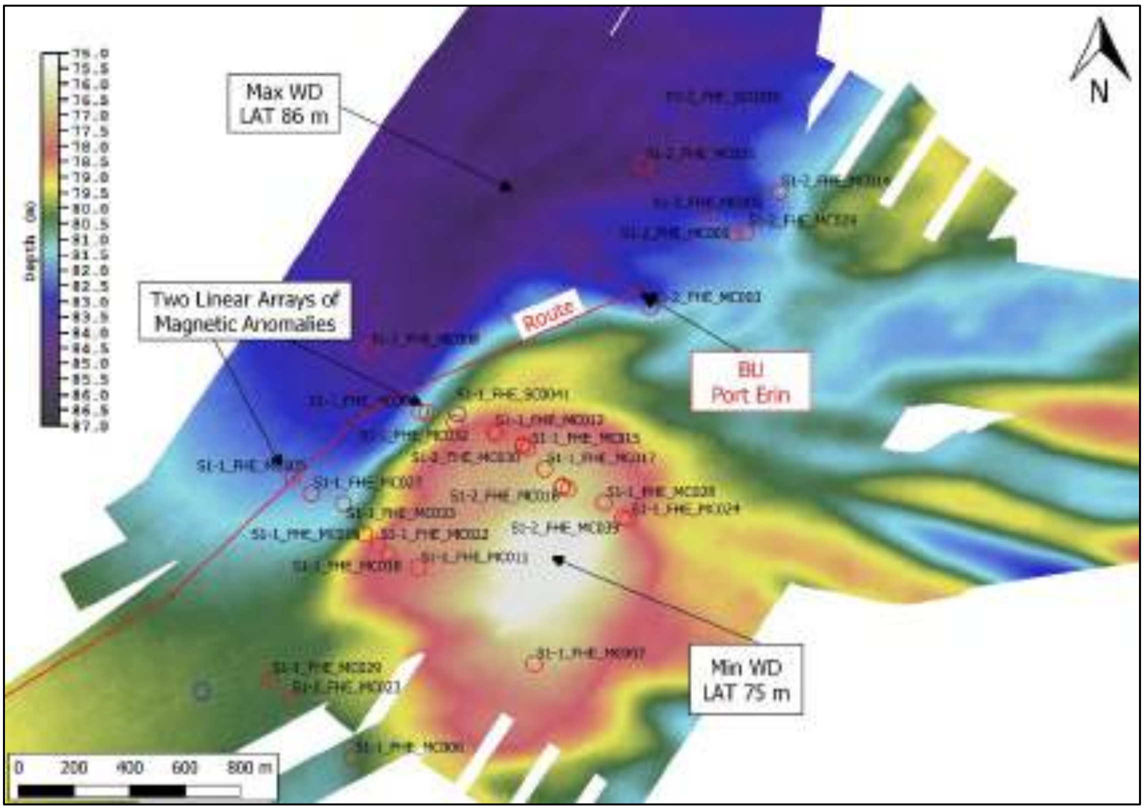

Figure 4.38: BU Port Erin survey area illustrated by MBES-data. Most prominent features are the elevated areas due to a high in the underlying ROCK and the linearly distributed magnetic anomalies either natural or of anthropogenic origin.

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5. BURIAL ASSESSMENT SURVEY (BAS)

The Burial Assessment Survey (BAS) is covered by ASN including all necessary and obligatory information, conditions, risks as well as recommendations for a successful and low-risk cable burial/cable laying operation.

A detailed BAS report is provided in APPENDIX R - BURIAL ASSESSMENT SURVEY REPORT

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6. HAZARDS AND OBSTRUCTIONS

6.1 Cable/Pipeline Crossings, Sonar, and Magnetometer contacts

The Table 6.1 lists the single pipeline crossing within the Havhingsten Segment S1-1 BU Port Erin to BMH Loughshinny. The RPL position and the as found position coincide; the database position is located 34m eastward.

Please refer to APPENDIX P - CABLE REPORT for detailed report on cable and pipeline crossings.

Please refer to APPENDIX E - SONAR CONTACTS for detailed list of sidescan sonar contacts.

Please refer to APPENDIX F - MAGNETOMETER CONTACTS for detailed list of magnetometer contacts.

Pipeline Name	Status	KP	CHART No. NU 10k	Latitude	Longitude	Depth [m]	System Type	Xing Angle [°]	Source
PX IS AF INTERCONNECTOR 1	In-service	25.265	007	53°44.6268'N	005°19.5120'W	78	DA-14	76°	RPL/ As Found (all sensors)
INTERCONNECTOR 1	In-service	25.231	007	53° 44.6240'N	005°19.4815'W	78	DA-14	76°	Fugro database

Table 6.1 Cable/pipeline crossing list

6.2 Maritime Boundaries and Special Areas

Havhingsten Segment S1-1 BU Port Erin to BMH Loughshinny crosses the Irish Territorial Water, Contiguous Zone and Economical Exclusive Zone boundaries and the UK Exclusive Zone boundary (Table 6.2).

Segment	Country	Boundary	Latitude	Longitude	Source
S1-1	UK	EEZ GBR/ EZ ROI	53° 44.6099'N	005°19.3300'W	RPL
S1-1	Ireland	EEZ ROI/ CZ ROI	53° 42.9640'N	005°26.0012'W	RPL
S1-1	Ireland	CZ ROI/ TW ROI	53° 38.5737'N	005°40.4853'W	RPL

Table 6.2 List of Maritime Boundaries and Special Areas

6.3 Fishing Activities

Fishing activity in the S1-1 as expected from aerial surveillance on the relative frequency of boats observed trawling, beam trawling or scallop dredging from 1997 to 2002 is low in the territorial waters and becomes high to very high in the EEZ (*Vincent, et al., 2004. Marine nature conservation and sustainable development - the Irish Sea Pilot. Report to Defra by the JNCC, Peterborough*).

No fishing activities are reported by the bridge observation logs during S1-1 shallow water survey operations, but numerous trawl scars are evident at the seafloor in the MBES and SSS records.

The shelter offered by the pier in Loughshinny, hosts a small fleet of fishing boat (Figure 6.1). Visual observation of fishing buoys (Figure 6.2), gears and vessels have been reported during the inshore survey (Figure 6.3). Numerous trawl scars are evident at the seafloor in the MBES and SSS records (Chapter 4.2.5).

Figure 6.1 Fishing boat fleet in Loughshinny

Figure 6.2: Fishing buoys off Loughshinny

Figure 6.3: Fishing gears and boats (registration number DA116, left, and DK72, right,) in operation off Loughshinny

6.4 Shipping

The S1-1 crosses some of the main shipping route in the Irish Sea directed toward Liverpool, Cardiff and Dublin (Vincent, et al., 2004. Marine nature conservation and sustainable development - the Irish Sea Pilot. Report to Defra by the JNCC, Peterborough).

The Table 6.3 below lists the shipping activities in the bridge observation logs during S1-1 survey operations

Segment	Country	Date, Time	Latitude	Longitude	Remark
S1-1	IRL/UK	17/10/2018, 16:00-20:00	53°44.7'N	005°18.4'W	4 Merchant VSL in transit
S1-1	IRL	18/10/2018 12:00-16:00	53°43.5'N	005°23.9'W	5 Merchant VSL in transit

Table 6.3 S1-1 shipping activities from BOLs

6.5 Anchorages

There are no relevant anchorages along the Segment S1-1.

6.6 Piracy

No risk of piracy in the S1-1 survey area.

6.7 Dumping Grounds

There are no dumping ground areas designated in S1-1.

6.8 Wrecks

One shipwreck corresponding to SSS contact S1-1_FHE_SC0010 is observed along the Segment S1-1 survey route at 53° 39.9508'N, 005° 36.1172'W at less than 140 m from the route (Figure 4.6 and Figure 4.23). The wreck dimensions are 24.2m x 8.9m x 4.0 m.

6.9 Dredging

No dredging activities were observed along the Segment S1-1.

6.10 Hydrocarbon Exploitation

Segment S1-1 survey route crosses ten (10) known concession blocks.

Segment	Country	Concession	Latitude	Longitude	Source
S1-1	UK	CB 109/1/ 108/5	53° 50.7946'N	05°0.0949'W	RPL
S1-1	UK	CB 108/5/ 108/10	53° 49.9491'N	05°2.1326'W	RPL
S1-1	UK	CB 108/10/ 108/9	53° 46.5995'N	05°12.095'W	RPL
S1-1	UK	CB 108/9/ 33/9	53° 44.6098'N	05°19.329'W	RPL
S1-1	Ireland	CB 33/9/ 33/8	53° 43.5374'N	05°24.095'W	RPL
S1-1	Ireland	CB 33/8/ 33/13	53° 39.9503'N	05°35.828'W	RPL
S1-1	Ireland	CB 33/13/ 33/12	53° 39.8705'N	05°36.0979'W	RPL
S1-1	Ireland	CB 33/12/ 33/11	53° 36.3277'N	05°48.0954'W	RPL
S1-1	Ireland	CB 33/11/ 32/15	53° 33.3041'N	06°0.0955'W	RPL

Table 6.4 List of Concession Blocks

6.11 Military Activity

There are no military designated areas in S1-1.

6.12 Ice

No ice forms in the Irish Sea during winter time.

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7. ENVIRONMENTAL OBSERVATIONS

7.1 Sound Velocity

In total the MV Fugro Helmert took 10 sound velocity dips during the proposed route.

In total the Alumaster took 17 sound velocity dips during the inshore survey of Segment S1-1.

Refer to APPENDIX J - OBSERVED VELOCITY & TEMPERATURE DATA for SVP plots collected during S1-1 shallow water survey operations.

7.2 Currents

There were no direct current direction nor speed measurements made during the Segment S1-1 BU Port Erin to BMH Loughshinny.

Indirect measurement could be derived from the weather forecasts, which predicts currents were mostly southward oriented or either eastward, with velocity low to moderate from 0.1 m/s to 0.4 m/s. During strong to near gale winds events (e.g. 7 and 8 October 2018), currents were also expected to reverse and tend to be oriented northward or either north-eastward with moderate velocity.

No sidescan sonar fish feathering due to currents was observed during survey nor processing.

7.3 Waves

The observed wave heights varied from 0m to more than 4m. The following graphs visualise observations recorded on the Bridge Observation Logs. During strong to near gale winds events (e.g. 7 and 8 October 2018) max wave height reached up to 4.5 m.

The data is presented according to the sea state scale. The scale translates to metre wave height as shown in Table 7.1.

Sea State	Wave Height	Descriptive
0	0 - 0 m	Calm
1	0.1 - 0.1 m	Very smooth
2	0.2 - 1.0 m	Smooth
3	1.0 - 1.5 m	Slight
4	2.0 - 2.5 m	Moderate
5	3.0 - 4.0 m	Rather rough
6	4.0 - 5.5 m	Rough
7	5.5 - 7.5 m	High
8	7.0 - 10.0 m	Very high
9	9.0 - 12.5m	Precipitous
10	11.0 - 16 m	Precipitous

Table 7.1: Sea State - Wave Height

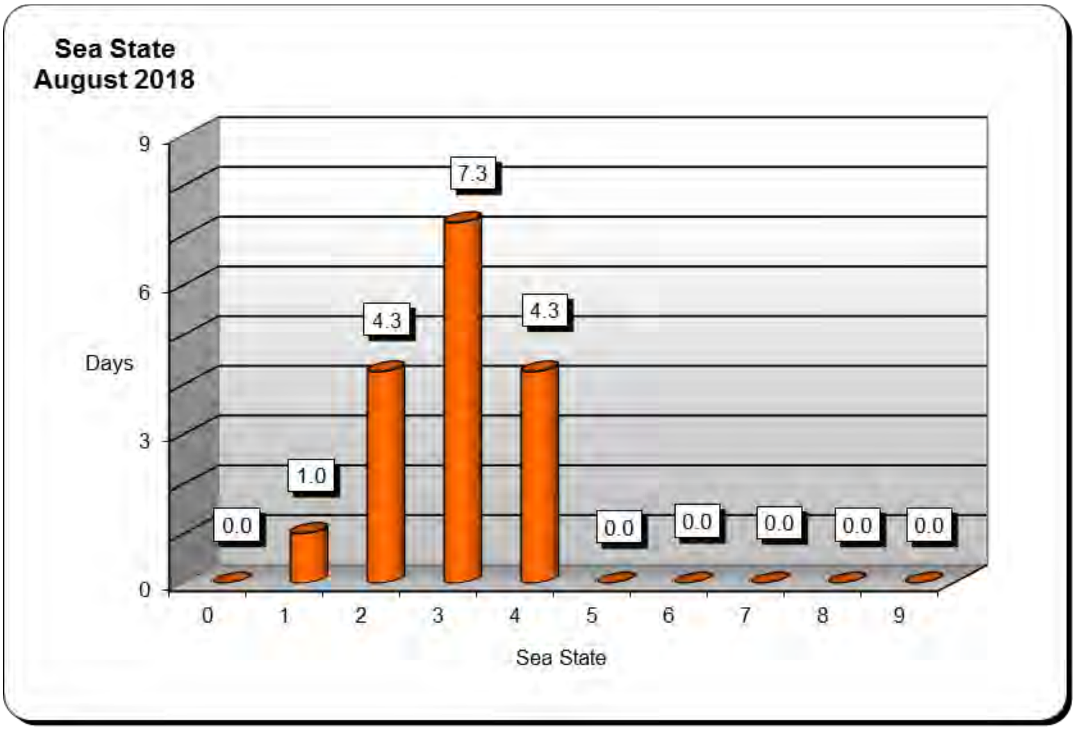

Figure 7.1: Sea state during the MV Fugro Helmert S1 operations

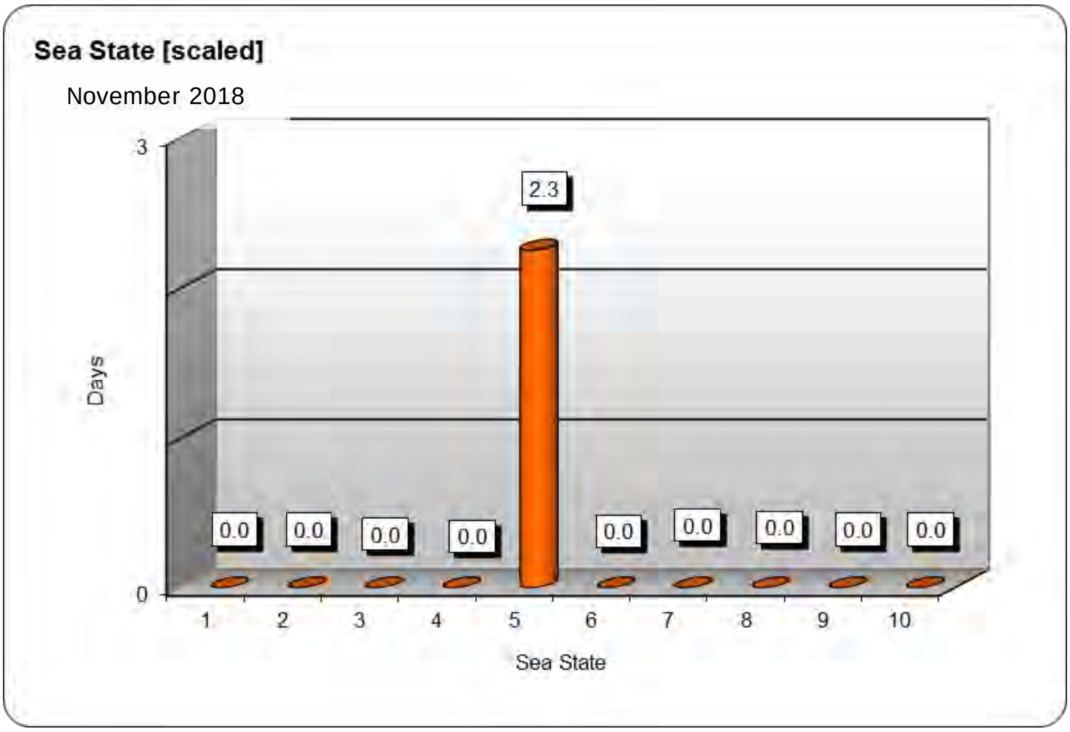

Figure 7.2: Sea state during the OSV Cecilia S1 operations

7.4 Pack Ice

No pack ice was observed during segment 1 survey operations.

7.5 Tides

There was no direct tide measurement made during the Segment S1-1 BU Port Erin to BMH Loughshinny.

The tide correction for S1-1 within the Irish Sea is based on GNSS tide logged referred to the ellipsoid as provided in the VORF data, supplied by the UKHO.

Refer to Chapter 2.2.2 for vertical datum methodology description.

7.6 Meteorological Observations

Meteorological observations were recorded daily in the bridge observation logs. The following data was acquired during the survey operations. Gales (Beaufort 7-8) were recorded on 01, 08, 11, 12, 25 and 26 October 2018. Extra tropical cyclones weren't recorded, but they could form/cross the Irish Sea (e.g. Ophelia, October 2017).

The figures below summarize the observations onboard the MV Fugro Helmert during October 2018 and OSV Cecilia in late November 2018.

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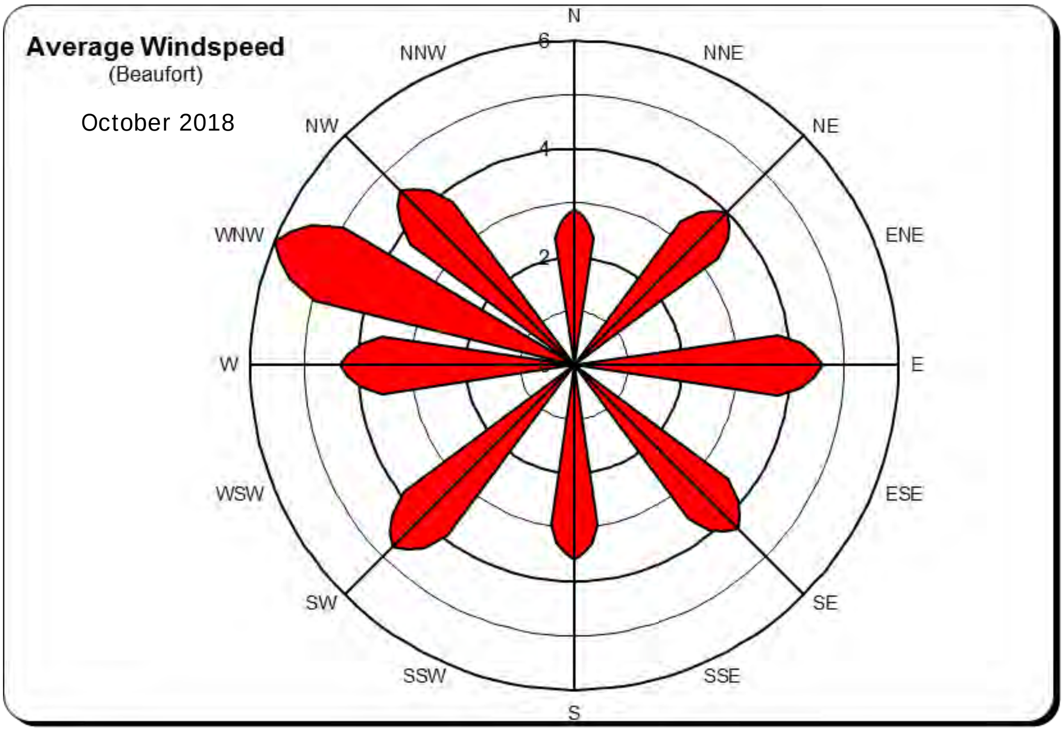

Figure 7.3: Average wind speed during the MV Fugro Helmert S1 operations

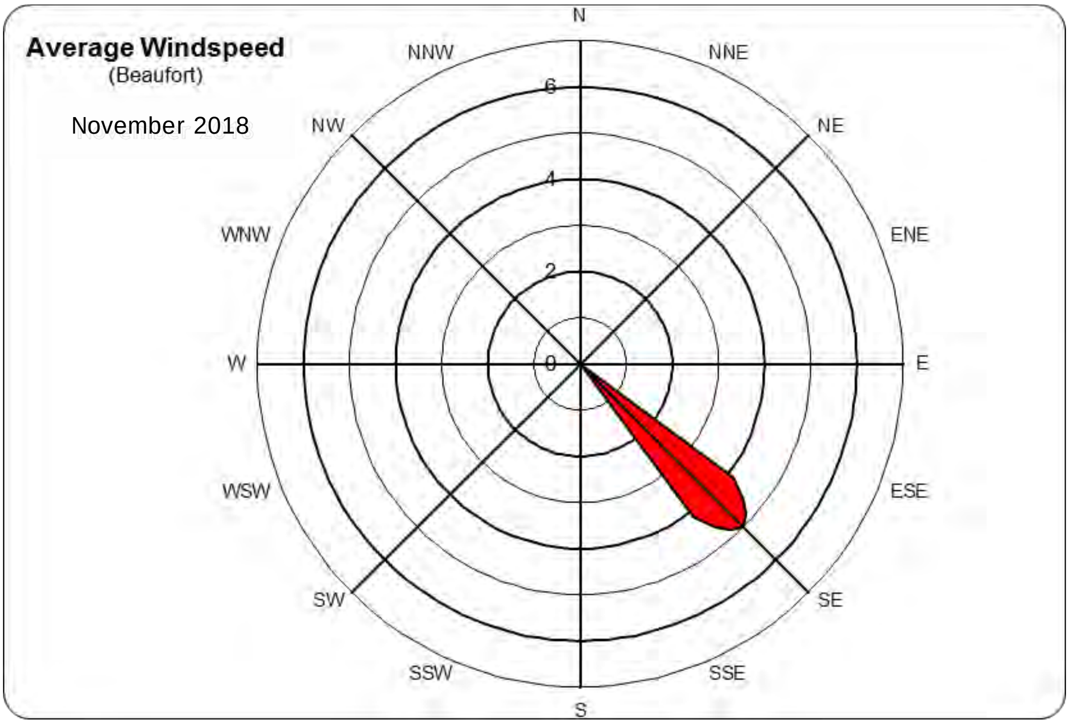

Figure 7.4: Average wind speed during the OSV Cecilia S1 operations

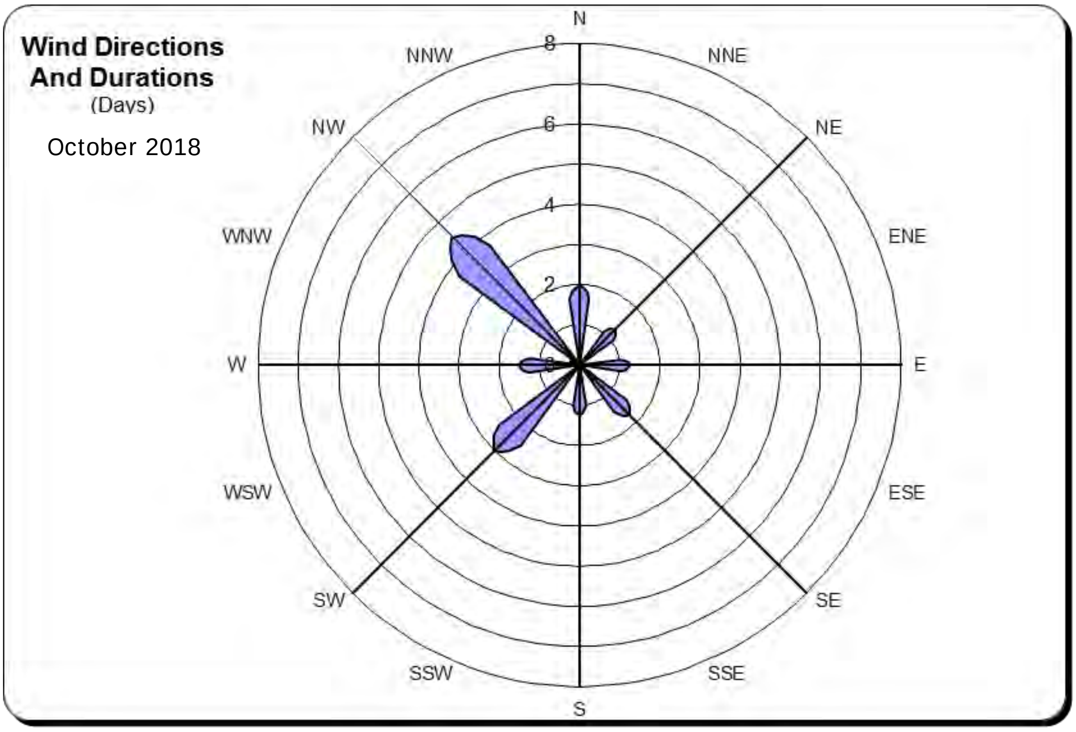

Figure 7.5: Wind directions and durations during the MV Fugro Helmert S1 operations

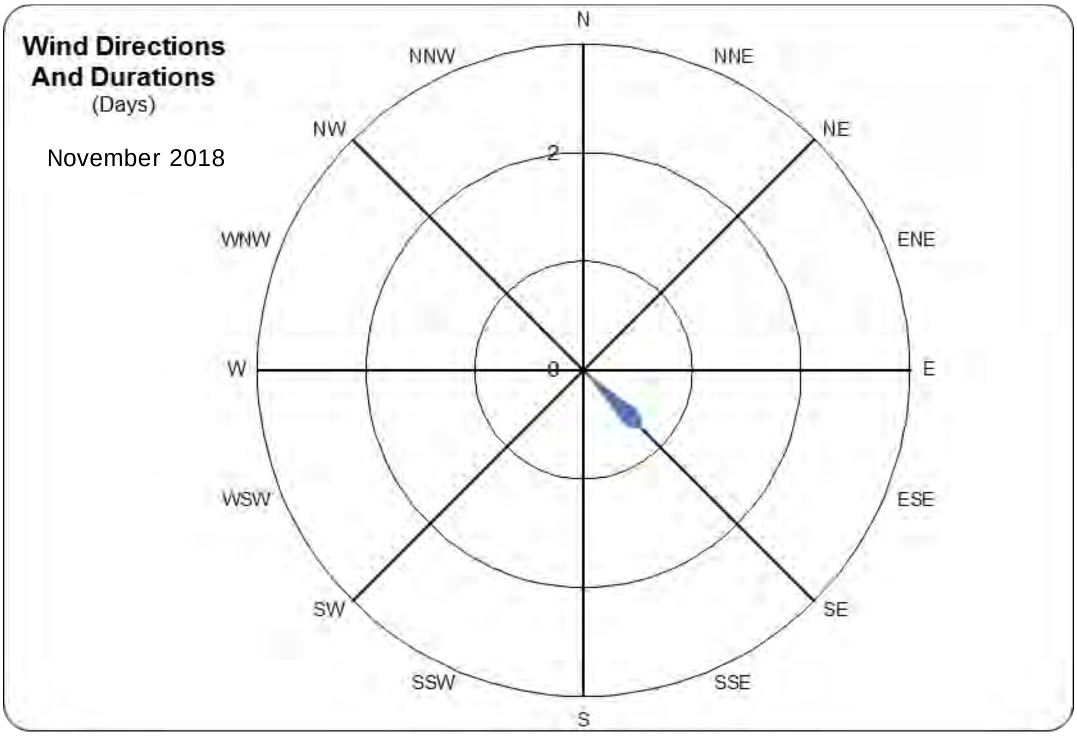

Figure 7.6: Wind directions and durations during the OSV Cecilia S1 operations

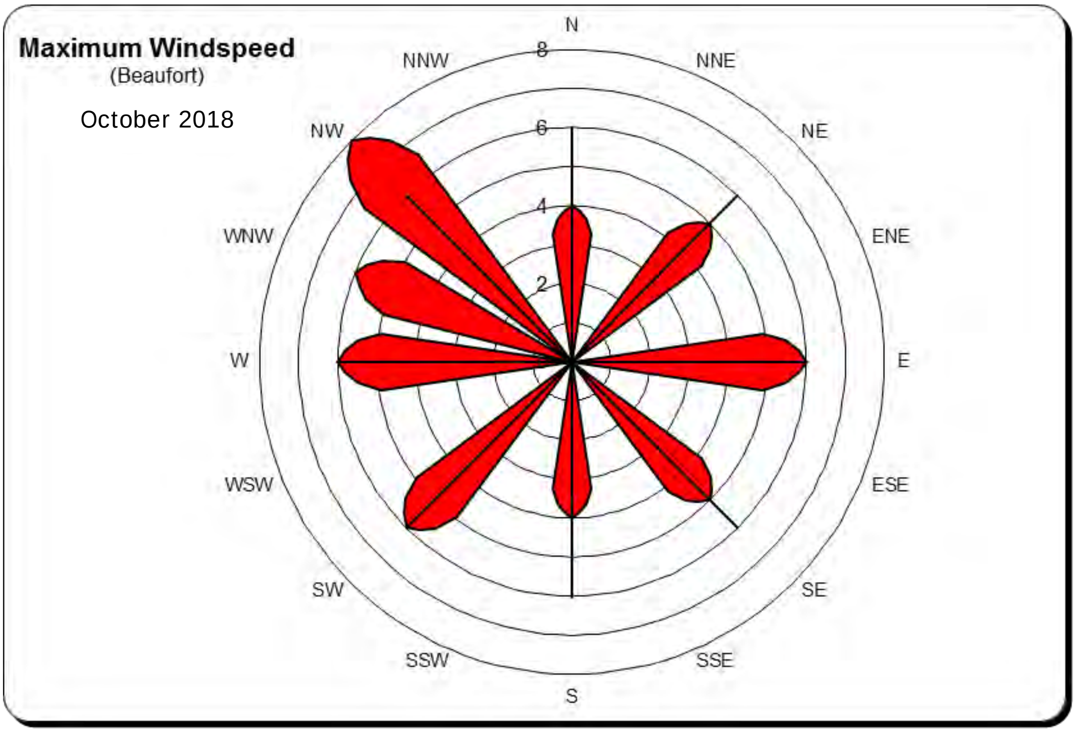

Figure 7.7: Maximum wind speed during the MV Fugro Helmert S1 operations

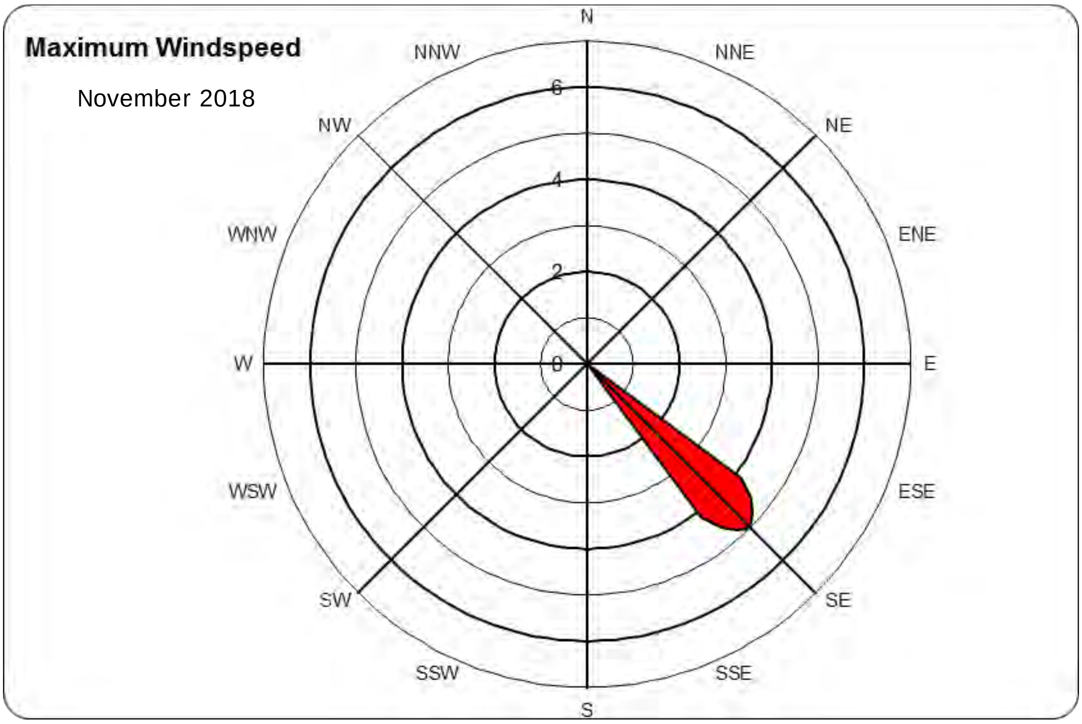

Figure 7.8: Maximum wind speed during the OSV Cecilia S1 operations

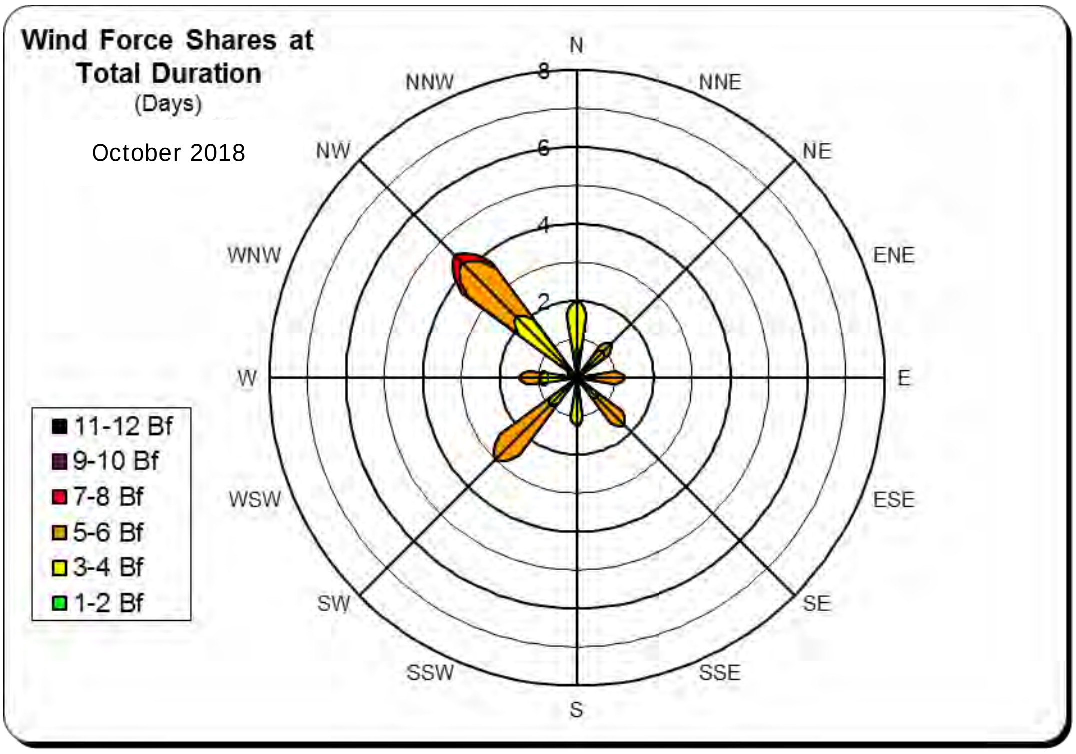

Figure 7.9: Overview of wind speed, direction and duration observations during the MV Fugro Helmert S1 operations

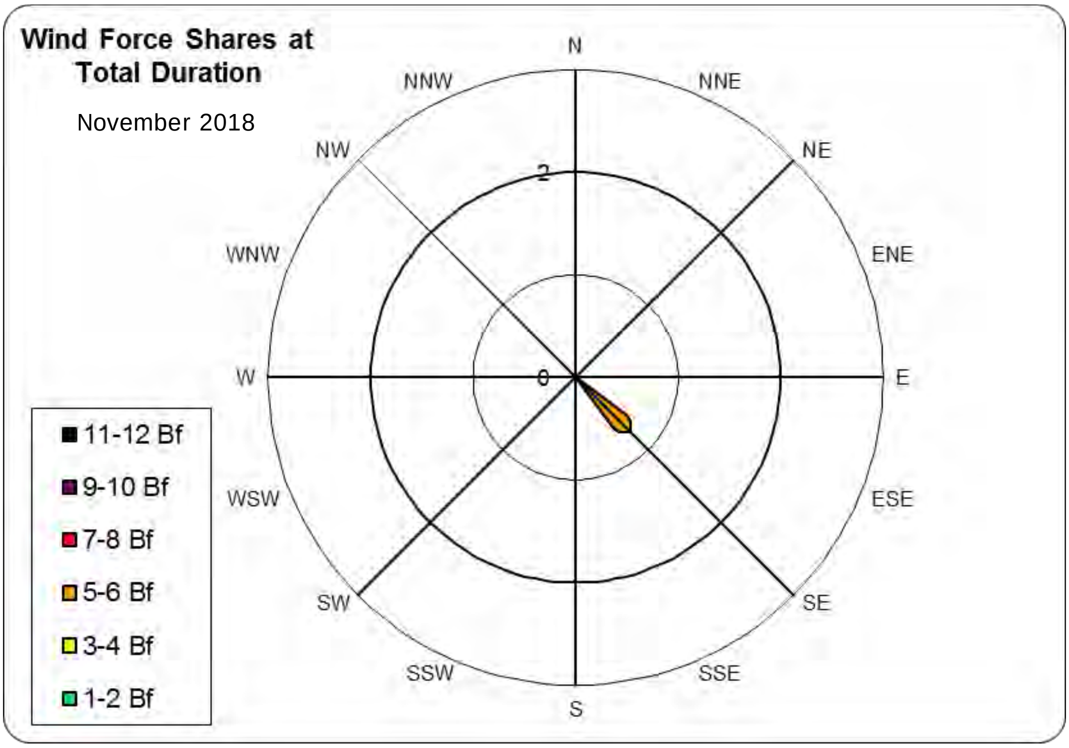

Figure 7.10: Overview of wind speed, direction and duration observations during the OSV Cecilia S1 operations

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8. SAFETY

The following table shows the HSSE stats for the Havhingsten Cable Route Survey of the MV Fugro Helmert, Alumaster and OSV Cecilia.

Havhingsten Cable Route Survey	Man Hours	Accidents/ Incidents	Unsafe Acts	Safety Drills	Safety Inductions	Toolbox Talks
MV Fugro Helmert	26376	0	5	11	24	275
Alumaster	5892	0	0	0	0	31
OSV Cecilia	5484	0	0	6	5	41

Table 8.1 Summary of HSE statistics for the Havhingsten Cable Route Survey

Please note, the man hours and all other statistics account for survey personnel only.

Safety was always the first topic during discussed during the daily meetings.

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9. ENVIRONMENTAL CONSIDERATIONS

Refer to APPENDIX S - ENVIRONMENTAL REPORT for the environmental characterisation survey and visual cable crossing investigation.

Hereafter they will be reported the environmental considerations that could be derived and/or observed during the geophysical and geotechnical survey operations.

9.1 Coral Areas

No indications of living corals were identified during the Segment S1-1 BMH Loughshinny to BU Port Erin survey.

9.2 Seagrass Areas

No indications of marine benthic growth were identified during the Segment S1-1 BU Port Erin to BMH Loughshinny.

9.3 Wildlife

There is a requirement for Marine Mammal Observers (MMO) stationed on vessels to monitor for marine mammal presence during vessel and survey operations. Survey operations need to be stopped and vessel might be required to alter course when a protected mammal is spotted in a certain radius around the ship. See Operations Report for more details.

No mammal sightings were reported during the shallow water survey operation for Segment S1-1.

Seals alone and in couple were observed during the inshore survey operation for Segment S1-1 on the 26 October 2018 off Loughshinny (Figure 9.1).

Figure 9.1: Seals offshore Loughshinny

9.4 Other Environmental Issues

The S1-1 BU Port Erin to BMH Loughshinny survey enters the North Anglesey Candidate Special Area of Conservation (cSAC) at 53° 47.9459'N, 005° 08.1460'W (KP11.186).

9.5 Tourism and Leisure

The seaside village of Loughshinny is a recreational beach area. In 1803 the Martello Tower was erected on Drumanagh headland and it's a touristic destination. Fishing for crabs and lobsters still forms a big part of the local economy together with vegetables and flowers cultivation.

The Skerries Islands Natural Heritage Area lies few kilometres to the north.

9.6 Archaeological Sites

In the foreshore archaeological survey at Loughshinny nothing of particular archaeological interest was identified in the desk-based assessment, neither in the concentration of metal detection on the beach.

In the offhore archeological survey, the analysis of the marine geophysical datasets collected in Irish waters identified 18 anomalies with archaeological potential, of which:

- One wreck was observed during the Segment S1-1, BU Port Erin to BMH Loughshinny. For further details on the wreck, refer to Chapter 4.2.3, 6.8 and Appendix P - Wreck Report;
- Two were deemed to have medium potential: CA2003 and CA2017;
- All remaining are of low archaeological potential.

A review of the SBP seismic survey data has identified a consistent stratigraphic sequence by moving offshore from the Irish landfall, which has been assessed for features containing archaeological potential. However, these will generally be beyond the depth of impact of the proposed installation.

For further details and illustrations refer to Appendix Q - Archeological Report.

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10. ENGINEERING CONSIDERATIONS AND RECOMMENDATIONS

This report provides the findings of the geophysical work undertaken for the Havhingsten Cable Route Survey Segment S1-1 BU Port Erin to BMH Loughshinny.

The following table summarises the hazards and issues encountered during the survey:

Hazards/Issues	Yes	No	Comments
Presence of CORAL Reef		✓	None
Presence of Sea grass		✓	None
Presence of ROCK within target burial depth	✓		Rock subcrops in the inshore survey and in isolated location in the shallow water survey
Presence of gravel beds within target burial depth	✓		Gravel is encountered at the seafloor near the BU and near the inshore survey area
Presence of HARDGROUND within target burial depth	✓		Localized areas of hardground subcrops in the inshore and shallow water
Presence of Pockmarks and gas seepage		✓	none
Presence of Sonar Contacts within the survey corridor	✓		82 sonar contacts
Presence of Ice Gouges		✓	None
Presence of In-service Cables		✓	None
Presence of In-service Pipeline	✓		Inteconntector 1, detected with SSS, MBES, SBP, and magnetometer
Indication of fishing activities (Trawl scars, FADs, etc...)	✓		Fishing is part of the local economy in Loughshinny, and a small fishing boat fleet is based there. High to very high fishing activity is visible in the numerous seabed trawling scars
High level of shipping activity	✓		Shipping route in the Irish Sea directed toward Liverpool, Cardiff and Dublin
The route traverses traffic separations schemes (TSS)		✓	None
Presence of anchorage areas along the route		✓	None observed
Presence of wrecks along the route	✓		SSS contact S1-1_FHE_SC0010, <140 from route
Presence of dumping areas along the route		✓	None
Military activities		✓	none
The route traverses military exercise areas		✓	none
The route traverses hydrocarbon concessions	✓		The route crosses ten (10) concession blocks
Risk of Piracy		✓	None

Hazards/Issues	Yes	No	Comments
Presence of adverse currents		✓	None
Occurrence of adverse weather (ice, storms, etc...)	✓		Strong winds, formation of extra tropical cyclones

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11. APPENDICES

A. APPENDIX A - PRE AND POST SURVEY RPLS

The following RPL version was used in the course of the survey for Segment S1-1:

- HAVHINGSTEN_S1_BMH LOUGHSHINNY - BU PORT ERIN_SR01_03 AUG 2018

The following RPL revision was used in the course of the survey for Segment S1-1:

- HAVHINGSTEN_S1_BMH LOUGHSHINNY - BU PORT ERIN_SR02_19 OCT 2018

The following PSR revisions were issued and the PSR03 is used for reporting and charting:

- HAVHINGSTEN_S1.1_ BU PORT ERIN - BMH LOUGHSHINNY_PSR02_15 FEB 2019
- HAVHINGSTEN_S1.1_BU PORT ERIN - BMH LOUGHSHINNY_PSR03_29 APR 2019

System: HAVHINGSTEN
Segment: 1

Datum: WGS84
Distances: KM
Cable Family: OALC4

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
1	BMH LOUGHSHINNY	53	32,8300	N	006	04,8420	W				0		0,000	80,430				0,000		
									187,1°			0,000			DA-14	N/A	0,050			
2	Cable Allowance	53	32,8300	N	006	04,8420	W				0		0,000	80,430				0,050		
									187,1°			0,191			DA-14	0,50%	0,192			
3	CB ENTER 32/15	53	32,7276	N	006	04,8635	W				0		0,191	80,239				0,242		
									187,1°			0,041			DA-14		0,041			
4	AC	53	32,7061	N	006	04,8680	W	AC		28,9° Port	0		0,232	80,198				0,283		
									158,2°			0,098			DA-14		0,099			
5	AC	53	32,6568	N	006	04,8348	W	AC		29,0° Port	0		0,330	80,100				0,382		
									129,2°			0,091			DA-14		0,091			
6	AC	53	32,6258	N	006	04,7709	W	AC		29,9° Port	1		0,421	80,009				0,473		
									099,2°			0,175			DA-14		0,176			
7	AC	53	32,6107	N	006	04,6150	W	AC		23,6° Port	3		0,596	79,834				0,649		
									075,6°			0,175			DA-14		0,176			
8	WD 5m	53	32,6341	N	006	04,4615	W				5		0,771	79,659				0,825		
									075,6°			0,722			DA-14		0,725			
9	WD 10m	53	32,7306	N	006	03,8284	W				10		1,493	78,937				1,550		
									075,6°			1,583			DA-14		1,591			
10	WD 15m	53	32,9422	N	006	02,4404	W				15		3,076	77,354				3,141		
									075,6°			0,516			DA-14		0,519			
11	WD 20m	53	33,0112	N	006	01,9878	W				20		3,592	76,838				3,660		
									075,6°			2,157			DA-14		2,168			
12	CB EXIT 32/15 / ENTER 33/11	53	33,2997	N	006	00,0955	W				25		5,749	74,681				5,828		
									075,6°			2,478			DA-14		2,490			
13	WD 30m	53	33,6310	N	005	57,9221	W				30		8,227	72,203				8,318		
									075,6°			1,558			DA-14		1,566			
14	AC	53	33,8392	N	005	56,5558	W	AC		12,3° Port	35		9,785	70,645				9,884		
									063,4°			4,420			DA-14		4,442			
15	WD 50m	53	34,9078	N	005	52,9777	W				50		14,205	66,225				14,326		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									063,4°			6,028			DA-14		6,058			
16	CB EXIT 33/11 / ENTER 33/12	53	36,3652	N	005	48,0954	W				54		20,233	60,197				20,384		
									063,4°			9,355			DA-14		9,402			
17	MB TW ROI/CZ ROI	53	38,6271	N	005	40,5124	W				60		29,588	50,842				29,786		
									063,4°			5,446			DA-14		5,473			
18	CB EXIT 33/12 / ENTER 33/13	53	39,9437	N	005	36,0953	W				63		35,034	45,396				35,259		
									063,4°			0,019			DA-14		0,019			
19	CB EXIT 33/13 / ENTER 33/8	53	39,9483	N	005	36,0799	W				63		35,053	45,377				35,278		
									063,4°			1,396			DA-14		1,403			
20	WD 100m	53	40,2858	N	005	34,9474	W				64		36,449	43,981				36,681		
									063,4°			8,329			DA-14		8,371			
21	WD 106 Max	53	42,2994	N	005	28,1865	W				70		44,778	35,652				45,052		
									063,4°			2,700			DA-14		2,713			
22	MB CZ ROI/EZ ROI	53	42,9522	N	005	25,9937	W				72		47,478	32,952				47,765		
									063,4°			1,164			DA-14		1,171			
23	WD 100m	53	43,2337	N	005	25,0476	W				72		48,642	31,788				48,936		
									063,4°			1,174			DA-14		1,179			
24	CB EXIT 33/8 / ENTER 33/9	53	43,5174	N	005	24,0945	W				73		49,816	30,614				50,115		
									063,4°			4,554			DA-14		4,577			
25	AC	53	44,6185	N	005	20,3933	W	AC		24,8° Stbd	76		54,370	26,060				54,692		
									088,1°			1,015			DA-14		1,020			
26	PX IS INTERCONNECTOR 1	53	44,6363	N	005	19,4707	W				76		55,385	25,045				55,712		
									088,1°			0,156			DA-14		0,157			
27	MB EZ ROI/EZ GBR	53	44,6391	N	005	19,3290	W				76		55,541	24,889				55,869		
									088,1°			0,000			DA-14		0,000			
28	CB EXIT 33/9 / ENTER 108/9	53	44,6391	N	005	19,3290	W				76		55,541	24,889				55,869		
									088,1°			0,851			DA-14		0,855			
29	AC	53	44,6541	N	005	18,5558	W	AC		26,0° Port	76		56,392	24,038				56,724		
									062,1°			8,036			DA-14		8,076			
30	CB EXIT 108/9 / ENTER 108/10	53	46,6816	N	005	12,0950	W				76		64,428	16,002				64,800		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									062,1°			12,951			DA-14		13,015			
31	CB EXIT 108/10 / ENTER 108/5	53	49,9491	N	005	01,6720	W				75		77,379	3,051				77,815		
									062,1°			1,958			DA-14		1,968			
32	CB EXIT 108/5 / ENTER 109/1	53	50,4431	N	005	00,0949	W				75		79,337	1,093				79,783		
									062,1°			0,606			DA-14		0,610			
33	AC	53	50,5961	N	004	59,6064	W	AC		1,5° Stbd	75		79,943	0,487				80,393		
									063,6°			0,487			DA-14		0,489			
34	Start Allowance	53	50,7127	N	004	59,2091	W				75		80,430	0,000				80,882		
												0,000			DA-14		0,500			
35	BU PORT ERIN	53	50,7127	N	004	59,2091	W				75		80,430	0,000				81,382	81,382	

Cable Type	Length
DA-14	81,382
TOTAL	81,382

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
1	BMH LOUGHSHINNY	53	32,8300	N	006	04,8420	W				0		0,000	80,143				0,000		
									187,1°			0,000			DA-14	N/A	0,050			
2	Cable Allowance	53	32,8300	N	006	04,8420	W				0		0,000	80,143				0,050		
									187,1°			0,191			DA-14	0,50%	0,192			
3	CB ENTER 32/15	53	32,7276	N	006	04,8635	W				0		0,191	79,952				0,242		
									187,1°			0,041			DA-14		0,041			
4	AC	53	32,7061	N	006	04,8680	W	AC		28,9° Port	0		0,232	79,911				0,283		
									158,2°			0,098			DA-14		0,099			
5	AC	53	32,6568	N	006	04,8348	W	AC		29,0° Port	0		0,330	79,813				0,382		
									129,2°			0,091			DA-14		0,091			
6	AC	53	32,6258	N	006	04,7709	W	AC		29,9° Port	1		0,421	79,722				0,473		
									099,2°			0,175			DA-14		0,176			
7	AC	53	32,6107	N	006	04,6150	W	AC		23,6° Port	3		0,596	79,547				0,649		
									075,6°			0,253			DA-14		0,255			
8	WD 5m	53	32,6446	N	006	04,3927	W				6		0,849	79,294				0,904		
									075,6°			0,695			DA-14		0,698			
9	WD 10m	53	32,7374	N	006	03,7836	W				10		1,544	78,599				1,602		
									075,6°			1,532			DA-14		1,539			
10	WD 15m	53	32,9422	N	006	02,4404	W				15		3,076	77,067				3,141		
									075,6°			1,109			DA-14		1,115			
11	WD 20m	53	33,0905	N	006	01,4675	W				21		4,185	75,958				4,256		
									075,6°			1,564			DA-14		1,572			
12	CB EXIT 32/15 / ENTER 33/11	53	33,2997	N	006	00,0955	W				25		5,749	74,394				5,828		
									075,6°			2,319			DA-14		2,331			
13	WD 30m	53	33,6097	N	005	58,0615	W				30		8,068	72,075				8,159		
									075,6°			1,717			DA-14		1,725			
14	AC	53	33,8392	N	005	56,5558	W	AC		12,3° Port	35		9,785	70,358				9,884		
									063,4°			4,551			DA-14		4,574			
15	WD 50m	53	34,9396	N	005	52,8712	W				50		14,336	65,807				14,458		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									063,4°			5,897			DA-14		5,926			
16	CB EXIT 33/11 / ENTER 33/12	53	36,3652	N	005	48,0954	W				54		20,233	59,910				20,384		
									063,4°			9,355			DA-14		9,402			
17	MB TW ROI/CZ ROI	53	38,6271	N	005	40,5124	W				60		29,588	50,555				29,786		
									063,4°			5,446			DA-14		5,473			
18	CB EXIT 33/12 / ENTER 33/13	53	39,9437	N	005	36,0953	W				63		35,034	45,109				35,259		
									063,4°			0,019			DA-14		0,019			
19	CB EXIT 33/13 / ENTER 33/8	53	39,9483	N	005	36,0799	W				63		35,053	45,090				35,278		
									063,4°			1,396			DA-14		1,403			
20	WD 100m	53	40,2858	N	005	34,9474	W				64		36,449	43,694				36,681		
									063,4°			8,329			DA-14		8,371			
21	WD 106 Max	53	42,2994	N	005	28,1865	W				70		44,778	35,365				45,052		
									063,4°			2,700			DA-14		2,713			
22	MB CZ ROI/EZ ROI	53	42,9522	N	005	25,9937	W				72		47,478	32,665				47,765		
									063,4°			1,164			DA-14		1,171			
23	WD 100m	53	43,2337	N	005	25,0476	W				72		48,642	31,501				48,936		
									063,4°			1,174			DA-14		1,179			
24	CB EXIT 33/8 / ENTER 33/9	53	43,5174	N	005	24,0945	W				73		49,816	30,327				50,115		
									063,4°			4,554			DA-14		4,577			
25	AC	53	44,6185	N	005	20,3933	W	AC		24,8° Stbd	76		54,370	25,773				54,692		
									088,1°			1,015			DA-14		1,020			
26	PX IS INTERCONNECTOR 1	53	44,6363	N	005	19,4707	W				76		55,385	24,758				55,712		
									088,1°			0,156			DA-14		0,157			
27	MB EZ ROI/EZ GBR	53	44,6391	N	005	19,3290	W				76		55,541	24,602				55,869		
									088,1°			0,000			DA-14		0,000			
28	CB EXIT 33/9 / ENTER 108/9	53	44,6391	N	005	19,3290	W				76		55,541	24,602				55,869		
									088,1°			0,851			DA-14		0,855			
29	AC	53	44,6541	N	005	18,5558	W	AC		26,0° Port	76		56,392	23,751				56,724		
									062,1°			8,032			DA-14		8,072			
30	CB EXIT 108/9 / ENTER 108/10	53	46,6768	N	005	12,0950	W				76		64,424	15,719				64,796		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									062,1°			5,093			DA-14		5,119			
31	AC	53	47,9596	N	005	07,9952	W			0,1° Port	76		69,517	10,626				69,915		
									062,0°			6,189			DA-14		6,219			
32	AC	53	49,5233	N	005	03,0156	W	AC		1,5° Port	76		75,706	4,437				76,134		
									060,5°			1,606			DA-14		1,614			
33	CB EXIT 108/10 / ENTER 108/5	53	49,9491	N	005	01,7418	W				76		77,312	2,831				77,748		
									060,5°			0,501			DA-14		0,504			
34	AC	53	50,0819	N	005	01,3442	W	AC		6,0° Port	76		77,813	2,330				78,252		
									054,6°			1,682			DA-14		1,690			
35	CB EXIT 108/5 / ENTER 109/1	53	50,6075	N	005	00,0949	W				76		79,495	0,648				79,942		
									054,6°			0,648			DA-14		0,652			
36	Start Allowance	53	50,8102	N	004	59,6129	W				76		80,143	0,000				80,594		
												0,000			DA-14		0,500			
37	BU PORT ERIN	53	50,8102	N	004	59,6129	W				76		80,143	0,000				81,094	81,094	

Cable Type	Length
DA-14	81,094
TOTAL	81,094

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
1	BU PORT ERIN	53	50.9808	N	004	59.3756	W				83		0.000	80.628				0.000		
									246.4°			0.300			DA-14	0.50%	0.302			
2	PLDN	53	50.9160	N	004	59.6262	W				81		0.300	80.328				0.302		
									246.4°			0.002			DA-14	0.50%	0.002			
3	SC 0.2%	53	50.9155	N	004	59.6278	W				81		0.302	80.326				0.304		
									246.4°			0.559			DA-14	0.20%	0.560			
4	CB 109/1 / 108/5	53	50.7946	N	005	00.0949	W				83		0.861	79.767				0.864		
									246.4°			0.090			DA-14	0.20%	0.089			
5	AC	53	50.7753	N	005	00.1695	W	AC		17.7° Port	83		0.951	79.677				0.953		
									228.6°			1.093			DA-14	0.20%	1.096			
6	AC	53	50.3857	N	005	00.9174	W	AC		10.1° Stbd	81		2.044	78.584				2.049		
									238.7°			1.560			DA-14	0.20%	1.563			
7	CB 108/5 / 108/10	53	49.9491	N	005	02.1326	W				78		3.604	77.024				3.612		
									238.7°			2.721			DA-14	0.20%	2.726			
8	AC	53	49.1876	N	005	04.2513	W	AC		3.5° Stbd	75		6.325	74.303				6.338		
									242.2°			1.956			DA-14	0.20%	1.960			
9	AC	53	48.6963	N	005	05.8281	W	AC		0.9° Port	73		8.281	72.347				8.298		
									241.3°			2.922			DA-14	0.20%	2.928			
10	AC	53	47.9406	N	005	08.1625	W	AC		1.5° Port	71		11.203	69.425				11.226		
									239.8°			4.511			DA-14	0.20%	4.521			
11	AC	53	46.7188	N	005	11.7140	W	AC		2.3° Stbd	69		15.714	64.914				15.747		
									242.1°			0.474			DA-14	0.20%	0.474			
12	CB 108/10 / 108/9	53	46.5995	N	005	12.0950	W				69		16.188	64.440				16.221		
									242.1°			7.655			DA-14	0.20%	7.670			
13	AC	53	44.6699	N	005	18.2508	W	AC		8.0° Stbd	76		23.843	56.785				23.891		
									250.1°			0.300			DA-14	0.20%	0.301			
14	AC	53	44.6148	N	005	18.5073	W	AC		9.6° Stbd	77		24.143	56.485				24.192		
									259.6°			0.300			DA-14	0.20%	0.300			
15	AC	53	44.5857	N	005	18.7757	W	AC		9.6° Stbd	77		24.443	56.185				24.492		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									269.2°			0.298			DA-14	0.20%	0.299			
16	AC	53	44.5834	N	005	19.0468	W	AC		9.8° Stbd	77		24.741	55.887				24.791		
									279.0°			0.268			DA-14	0.20%	0.269			
17	PLUP	53	44.6059	N	005	19.2879	W				77		25.009	55.619				25.060		
									279.0°			0.002			DA-14	0.20%	0.002			
18	SC 0.5%	53	44.6061	N	005	19.2895	W				77		25.011	55.617				25.062		
									279.0°			0.044			DA-14	0.50%	0.044			
19	CB 108/9 / 33/9	53	44.6098	N	005	19.3290	W				77		25.055	55.573				25.106		
									279.0°			0.001			DA-14	0.50%	0.001			
20	MB EEZ GBR/EZ ROI	53	44.6099	N	005	19.3300	W				77		25.056	55.572				25.107		
									279.0°			0.153			DA-14	0.50%	0.154			
21	START URADUCT	53	44.6227	N	005	19.4675	W				78		25.209	55.419				25.261		
									279.0°			0.050			DA-14	0.50%	0.050			
22	PX IS INTERCONNECTOR 1	53	44.6268	N	005	19.5120	W				78		25.259	55.369				25.311		
									279.0°			0.050			DA-14	0.50%	0.050			
23	END URADUCT	53	44.6310	N	005	19.5569	W				78		25.309	55.319				25.361		
									279.0°			0.199			DA-14	0.50%	0.201			
24	PLDN	53	44.6478	N	005	19.7361	W				78		25.508	55.120				25.562		
									279.0°			0.002			DA-14	0.50%	0.002			
25	SC 0.2%	53	44.6480	N	005	19.7382	W				78		25.510	55.118				25.564		
									279.0°			0.252			DA-14	0.20%	0.252			
26	AC	53	44.6691	N	005	19.9640	W	AC		12.1° Port	78		25.762	54.866				25.816		
									266.9°			0.300			DA-14	0.20%	0.300			
27	AC	53	44.6602	N	005	20.2365	W	AC		11.9° Port	79		26.062	54.566				26.116		
									255.0°			0.300			DA-14	0.20%	0.301			
28	AC	53	44.6184	N	005	20.5000	W	AC		11.9° Port	81		26.362	54.266				26.417		
									243.1°			4.433			DA-14	0.20%	4.442			
29	CB 33/9 / 33/8	53	43.5374	N	005	24.0950	W				91		30.795	49.833				30.859		
									243.1°			1.315			DA-14	0.20%	1.317			
30	WD 100m	53	43.2169	N	005	25.1605	W				100		32.110	48.518				32.176		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									243.1°			1.037			DA-14	0.20%	1.040			
31	MB EEZ ROI/CZ ROI	53	42.9640	N	005	26.0012	W				109		33.147	47.481				33.216		
									243.1°			1.055			DA-14	0.21%	1.057			
32	WD 125m	53	42.7067	N	005	26.8563	W				125		34.202	46.426				34.273		
									243.1°			9.097			DA-14	0.20%	9.115			
33	AC	53	40.4885	N	005	34.2254	W	AC		3.4° Port	102		43.299	37.329				43.388		
									239.7°			1.599			DA-14	0.20%	1.603			
34	AC	53	40.0534	N	005	35.4788	W	AC		3.9° Stbd	100		44.898	35.730				44.991		
									243.5°			0.113			DA-14	0.20%	0.113			
35	WD 100m	53	40.0263	N	005	35.5707	W				100		45.011	35.617				45.104		
									243.5°			0.317			DA-14	0.20%	0.317			
36	CB 33/8 / 33/13	53	39.9503	N	005	35.8280	W				99		45.328	35.300				45.421		
									243.5°			0.332			DA-14	0.20%	0.333			
37	CB 33/13 / 33/12	53	39.8705	N	005	36.0979	W				99		45.660	34.968				45.754		
									243.5°			5.400			DA-14	0.20%	5.411			
38	MB CZ ROI/TW ROI	53	38.5737	N	005	40.4853	W				87		51.060	29.568				51.165		
									243.5°			6.251			DA-14	0.20%	6.263			
39	AC	53	37.0726	N	005	45.5610	W			0.2° Stbd	68		57.311	23.317				57.428		
									243.7°			3.118			DA-14	0.20%	3.125			
40	CB 33/12 / 33/11	53	36.3277	N	005	48.0954	W				64		60.429	20.199				60.553		
									243.7°			6.135			DA-14	0.20%	6.147			
41	WD 50m	53	34.8621	N	005	53.0792	W				50		66.564	14.064				66.700		
									243.7°			3.787			DA-14	0.20%	3.795			
42	START MBC (HG)	53	33.9575	N	005	56.1538	W				35		70.351	10.277				70.495		
									243.7°			0.495			DA-14	0.20%	0.496			
43	AC	53	33.8392	N	005	56.5558	W	AC		10.3° Stbd	34		70.846	9.782				70.991		
									254.0°			1.468			DA-14	0.20%	1.471			
44	END MBC (HG)	53	33.6205	N	005	57.8331	W				31		72.314	8.314				72.462		
									254.0°			0.238			DA-14	0.20%	0.238			
45	WD 30m	53	33.5851	N	005	58.0400	W				30		72.552	8.076				72.700		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									254.0°			0.278			DA-14	0.20%	0.278			
46	AC	53	33.5437	N	005	58.2820	W	AC		3.5° Stbd	29		72.830	7.798				72.978		
									257.5°			2.052			DA-14	0.20%	2.056			
47	CB 33/11 / 32/15	53	33.3041	N	006	00.0955	W				24		74.882	5.746				75.034		
									257.5°			2.149			DA-14	0.20%	2.154			
48	WD 20m	53	33.0531	N	006	01.9950	W				20		77.031	3.597				77.188		
									257.5°			0.416			DA-14	0.21%	0.417			
49	AC	53	33.0044	N	006	02.3632	W	AC		10.9° Port	16		77.447	3.181				77.605		
									246.6°			0.102			DA-14	0.20%	0.102			
50	PLUP	53	32.9827	N	006	02.4472	W				15		77.549	3.079				77.707		
									246.6°			0.002			DA-14	0.20%	0.002			
51	WD 15m	53	32.9822	N	006	02.4491	W				15		77.551	3.077				77.709		
									246.6°			0.002			DA-14	0.20%	0.002			
52	SC 0.8%	53	32.9818	N	006	02.4506	W				15		77.553	3.075				77.711		
									246.6°			0.672			DA-14	0.80%	0.678			
53	AC	53	32.8376	N	006	03.0090	W	AC		10.1° Stbd	13		78.225	2.403				78.389		
									256.7°			0.376			DA-14	0.80%	0.379			
54	WD 12m	53	32.7908	N	006	03.3401	W				12		78.601	2.027				78.768		
									256.7°			0.451			DA-14	0.80%	0.454			
55	WD 10m	53	32.7347	N	006	03.7369	W				10		79.052	1.576				79.222		
									256.7°			0.214			DA-14	0.80%	0.216			
56	WD 8m	53	32.7080	N	006	03.9262	W				8		79.266	1.362				79.438		
									256.7°			0.645			DA-14	0.80%	0.650			
57	AC	53	32.6278	N	006	04.4939	W				5		79.911	0.717				80.088		
									256.7°			0.020			DA-14	0.80%	0.020			
58	WD 5m	53	32.6253	N	006	04.5114	W				5		79.931	0.697				80.108		
									256.7°			0.118			DA-14	0.81%	0.119			
59	AC	53	32.6107	N	006	04.6150	W	AC		26.6° Stbd	4		80.049	0.579				80.227		
									283.2°			0.177			DA-14	0.81%	0.179			
60	AC	53	32.6325	N	006	04.7714	W	AC		26.5° Stbd	3		80.226	0.402				80.406		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									309.7°			0.057			DA-14	0.81%	0.057			
61	WD 2m	53	32.6522	N	006	04.8111	W				2		80.283	0.345				80.463		
									309.7°			0.019			DA-14	0.92%	0.020			
62	AC	53	32.6588	N	006	04.8245	W	AC		28.5° Stbd	1		80.302	0.326				80.483		
									338.2°			0.014			DA-14	0.85%	0.013			
63	AP END	53	32.6654	N	006	04.8290	W				1		80.316	0.312				80.496		
									338.2°			0.014			DA-14	0.85%	0.015			
64	AC	53	32.6727	N	006	04.8339	W				0		80.330	0.298				80.511		
									338.2°			0.007			DA-14	0.85%	0.007			
65	LP	53	32.6763	N	006	04.8363	W				0		80.337	0.291				80.518		
									338.2°			0.064			DA-14	0.81%	0.064			
66	AC	53	32.7082	N	006	04.8577	W	AC		26.2° Stbd	-1		80.401	0.227				80.582		
									004.4°			0.212			DA-14	0.80%	0.214			
67	DT END OF DUCT	53	32.8221	N	006	04.8430	W				-2		80.613	0.015				80.796		
									004.4°			0.015			DA-14	0.80%	0.015			
68	CABLE ALLOWANCE	53	32.8300	N	006	04.8420	W				-2		80.628	0.000				80.811		
												0.000			DA-14	N/A	0.050			
69	BMH LOUGHSHINNY	53	32.8300	N	006	04.8420	W				-2		80.628	0.000				80.861	80.861	

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
1	BU PORT ERIN	53	50.9808	N	004	59.3756	W				83		0.000	80.626				0.000		
									246.4°			0.300			DA-14	0.50%	0.302			
2	PLDN	53	50.9160	N	004	59.6262	W				81		0.300	80.326				0.302		
									246.4°			0.002			DA-14	0.50%	0.002			
3	SC 0.2%	53	50.9155	N	004	59.6278	W				81		0.302	80.324				0.304		
									246.4°			0.559			DA-14	0.20%	0.560			
4	CB EXIT 109/1 / ENTER 108/5	53	50.7946	N	005	00.0949	W				83		0.861	79.765				0.864		
									246.4°			0.113			DA-14	0.20%	0.113			
5	AC	53	50.7702	N	005	00.1893	W	AC		8.9° Port	83		0.974	79.652				0.977		
									237.5°			0.180			DA-14	0.20%	0.181			
6	AC	53	50.7181	N	005	00.3277	W	AC		11.1° Port	83		1.154	79.472				1.158		
									226.4°			0.284			DA-14	0.20%	0.284			
7	POL	53	50.6124	N	005	00.5152	W				82		1.438	79.188				1.442		
									226.4°			0.610			DA-14	0.20%	0.611			
8	AC	53	50.3857	N	005	00.9174	W	AC		12.3° Stbd	81		2.048	78.578				2.053		
									238.7°			1.560			DA-14	0.20%	1.563			
9	CB EXIT 108/5 / ENTER 108/10	53	49.9491	N	005	02.1326	W				78		3.608	77.018				3.616		
									238.7°			2.721			DA-14	0.20%	2.726			
10	AC	53	49.1876	N	005	04.2513	W	AC		3.5° Stbd	75		6.329	74.297				6.342		
									242.2°			1.956			DA-14	0.20%	1.960			
11	AC	53	48.6963	N	005	05.8281	W	AC		0.9° Port	73		8.285	72.341				8.302		
									241.3°			2.922			DA-14	0.20%	2.928			
12	AC	53	47.9406	N	005	08.1625	W	AC		1.5° Port	71		11.207	69.419				11.230		
									239.8°			4.511			DA-14	0.20%	4.521			
13	AC	53	46.7188	N	005	11.7140	W	AC		2.3° Stbd	69		15.718	64.908				15.751		
									242.1°			0.474			DA-14	0.20%	0.474			
14	CB EXIT 108/10 / ENTER 108/9	53	46.5995	N	005	12.0950	W				69		16.192	64.434				16.225		
									242.1°			2.480			DA-14	0.20%	2.485			
15	AC	53	45.9743	N	005	14.0899	W	AC		1.2° Stbd	69		18.672	61.954				18.710		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									243.3°			2.690			DA-14	0.20%	2.696			
16	AC	53	45.3226	N	005	16.2769	W	AC		5.3° Port	72		21.362	59.264				21.406		
									238.0°			0.774			DA-14	0.20%	0.775			
17	AC	53	45.1017	N	005	16.8737	W	AC		4.1° Stbd	74		22.136	58.490				22.181		
									242.1°			1.713			DA-14	0.20%	1.717			
18	AC	53	44.6699	N	005	18.2508	W	AC		8.0° Stbd	76		23.849	56.777				23.898		
									250.1°			0.300			DA-14	0.20%	0.300			
19	AC	53	44.6148	N	005	18.5073	W	AC		9.6° Stbd	77		24.149	56.477				24.198		
									259.6°			0.300			DA-14	0.20%	0.301			
20	AC	53	44.5857	N	005	18.7757	W	AC		9.6° Stbd	77		24.449	56.177				24.499		
									269.2°			0.298			DA-14	0.20%	0.299			
21	AC	53	44.5834	N	005	19.0468	W	AC		9.8° Stbd	77		24.747	55.879				24.798		
									279.0°			0.269			DA-14	0.20%	0.269			
22	PLUP	53	44.6059	N	005	19.2879	W				77		25.016	55.610				25.067		
									279.0°			0.001			DA-14	0.20%	0.001			
23	SC 0.5%	53	44.6061	N	005	19.2895	W				77		25.017	55.609				25.068		
									279.0°			0.044			DA-14	0.50%	0.045			
24	CB EXIT 108/9 / ENTER 33/9	53	44.6098	N	005	19.3290	W				77		25.061	55.565				25.113		
									279.0°			0.002			DA-14	0.50%	0.001			
25	MB EEZ GBR/EZ ROI	53	44.6099	N	005	19.3300	W				77		25.063	55.563				25.114		
									279.0°			0.153			DA-14	0.50%	0.154			
26	START URADUCT	53	44.6227	N	005	19.4675	W				78		25.216	55.410				25.268		
									279.0°			0.049			DA-14	0.50%	0.049			
27	PX IS AF INTERCONNECTOR 1	53	44.6268	N	005	19.5120	W				78		25.265	55.361				25.317		
									279.0°			0.050			DA-14	0.50%	0.051			
28	END URADUCT	53	44.6310	N	005	19.5569	W				78		25.315	55.311				25.368		
									279.0°			0.200			DA-14	0.50%	0.200			
29	PLDN	53	44.6478	N	005	19.7361	W				78		25.515	55.111				25.568		
									279.0°			0.002			DA-14	0.50%	0.002			
30	SC 0.2%	53	44.6480	N	005	19.7382	W				78		25.517	55.109				25.570		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									279.0°			0.251			DA-14	0.20%	0.252			
31	AC	53	44.6691	N	005	19.9640	W	AC		12.1° Port	78		25.768	54.858				25.822		
									266.9°			0.300			DA-14	0.20%	0.301			
32	AC	53	44.6602	N	005	20.2365	W	AC		11.9° Port	79		26.068	54.558				26.123		
									255.0°			0.300			DA-14	0.20%	0.301			
33	AC	53	44.6184	N	005	20.5000	W	AC		11.9° Port	81		26.368	54.258				26.424		
									243.1°			4.434			DA-14	0.20%	4.442			
34	CB EXIT 33/9 / ENTER 33/8	53	43.5374	N	005	24.0950	W				91		30.802	49.824				30.866		
									243.1°			1.314			DA-14	0.20%	1.317			
35	WD 100m	53	43.2169	N	005	25.1605	W				100		32.116	48.510				32.183		
									243.1°			1.037			DA-14	0.20%	1.039			
36	MB EEZ ROI/CZ ROI	53	42.9640	N	005	26.0012	W				109		33.153	47.473				33.222		
									243.1°			1.055			DA-14	0.21%	1.058			
37	WD 125m	53	42.7067	N	005	26.8563	W				125		34.208	46.418				34.280		
									243.1°			9.097			DA-14	0.20%	9.115			
38	AC	53	40.4885	N	005	34.2254	W	AC		3.4° Port	102		43.305	37.321				43.395		
									239.7°			1.599			DA-14	0.20%	1.602			
39	AC	53	40.0534	N	005	35.4788	W	AC		3.9° Stbd	100		44.904	35.722				44.997		
									243.5°			0.107			DA-14	0.20%	0.107			
40	WD 100m	53	40.0278	N	005	35.5656	W				100		45.011	35.615				45.104		
									243.5°			0.323			DA-14	0.20%	0.324			
41	CB EXIT 33/8 / ENTER 33/13	53	39.9503	N	005	35.8280	W				99		45.334	35.292				45.428		
									243.5°			0.332			DA-14	0.20%	0.332			
42	CB EXIT 33/13 / ENTER 33/12	53	39.8705	N	005	36.0979	W				99		45.666	34.960				45.760		
									243.5°			5.400			DA-14	0.20%	5.411			
43	MB CZ ROI/TW ROI	53	38.5737	N	005	40.4853	W				87		51.066	29.560				51.171		
									243.5°			6.251			DA-14	0.20%	6.264			
44	AC	53	37.0726	N	005	45.5610	W			0.2° Stbd	68		57.317	23.309				57.435		
									243.7°			3.119			DA-14	0.20%	3.125			
45	CB EXIT 33/12 / ENTER 33/11	53	36.3277	N	005	48.0954	W				64		60.436	20.190				60.560		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									243.7°			6.135			DA-14	0.20%	6.147			
46	WD 50m	53	34.8621	N	005	53.0792	W				50		66.571	14.055				66.707		
									243.7°			3.787			DA-14	0.20%	3.794			
47	START MBC (HG)	53	33.9575	N	005	56.1538	W				35		70.358	10.268				70.501		
									243.7°			0.495			DA-14	0.20%	0.496			
48	AC	53	33.8392	N	005	56.5558	W	AC		10.3° Stbd	34		70.853	9.773				70.997		
									254.0°			1.468			DA-14	0.20%	1.471			
49	END MBC (HG)	53	33.6205	N	005	57.8331	W				31		72.321	8.305				72.468		
									254.0°			0.156			DA-14	0.20%	0.157			
50	POL	53	33.5972	N	005	57.9695	W				30		72.477	8.149				72.625		
									254.0°			0.081			DA-14	0.20%	0.081			
51	WD 30m	53	33.5851	N	005	58.0400	W				30		72.558	8.068				72.706		
									254.0°			0.278			DA-14	0.20%	0.279			
52	AC	53	33.5437	N	005	58.2820	W	AC		3.5° Stbd	29		72.836	7.790				72.985		
									257.5°			2.052			DA-14	0.20%	2.056			
53	CB EXIT 33/11 / ENTER 32/15	53	33.3041	N	006	00.0955	W				24		74.888	5.738				75.041		
									257.5°			1.231			DA-14	0.20%	1.233			
54	AC	53	33.1603	N	006	01.1836	W	AC		6.4° Port	23		76.119	4.507				76.274		
									251.1°			0.921			DA-14	0.20%	0.923			
55	WD 20m	53	32.9990	N	006	01.9723	W				20		77.040	3.586				77.197		
									251.1°			0.148			DA-14	0.21%	0.148			
56	AC	53	32.9733	N	006	02.0984	W	AC		5.3° Stbd	18		77.188	3.438				77.345		
									256.4°			0.370			DA-14	0.20%	0.371			
57	WD 15m	53	32.9262	N	006	02.4244	W				15		77.558	3.068				77.716		
									256.4°			0.003			DA-14	0.20%	0.003			
58	PLDN	53	32.9259	N	006	02.4264	W				15		77.561	3.065				77.719		
									256.4°			0.002			DA-14	0.20%	0.002			
59	SC 0.8%	53	32.9257	N	006	02.4282	W				15		77.563	3.063				77.721		
									256.4°			1.038			DA-14	0.80%	1.046			
60	WD 12m	53	32.7940	N	006	03.3414	W				12		78.601	2.025				78.767		

Point No	Comment	Latitude (WGS 84)			Longitude (WGS 84)			A/C	Brg (°)	Alter Course (- P + S)	Depth (m)	Leg Dist (km)	Cum KP Dist (km)	Reverse KP Dist (km)	Cable Type	Surface Slack (%)	Leg Cable (km)	Cum Cable (km)	Cable by Type (km)	Target Burial (m)
									256.4°			0.450			DA-14	0.80%	0.454			
61	WD 10m	53	32.7368	N	006	03.7378	W				10		79.051	1.575				79.221		
									256.4°			0.215			DA-14	0.80%	0.217			
62	WD 8m	53	32.7096	N	006	03.9268	W				8		79.266	1.360				79.438		
									256.4°			0.645			DA-14	0.80%	0.650			
63	AC	53	32.6278	N	006	04.4939	W			0.3° Stbd	5		79.911	0.715				80.088		
									256.7°			0.019			DA-14	0.80%	0.020			
64	WD 5m	53	32.6253	N	006	04.5114	W				5		79.930	0.696				80.108		
									256.7°			0.082			DA-14	0.80%	0.082			
65	AP END	53	32.6152	N	006	04.5832	W				4		80.012	0.614				80.190		
									256.7°			0.036			DA-14	0.81%	0.036			
66	AC	53	32.6107	N	006	04.6150	W	AC		26.6° Stbd	4		80.048	0.578				80.226		
									283.2°			0.178			DA-14	0.81%	0.179			
67	AC	53	32.6325	N	006	04.7714	W	AC		26.5° Stbd	3		80.226	0.400				80.405		
									309.7°			0.057			DA-14	0.81%	0.058			
68	WD 2m	53	32.6522	N	006	04.8111	W				2		80.283	0.343				80.463		
									309.7°			0.019			DA-14	0.92%	0.019			
69	AC	53	32.6588	N	006	04.8245	W	AC		28.5° Stbd	1		80.302	0.324				80.482		
									338.2°			0.028			DA-14	0.85%	0.028			
70	AC	53	32.6727	N	006	04.8339	W				0		80.330	0.296				80.510		
									338.2°			0.007			DA-14	0.85%	0.007			
71	LP	53	32.6763	N	006	04.8363	W				0		80.337	0.289				80.517		
									338.2°			0.064			DA-14	0.81%	0.064			
72	AC	53	32.7082	N	006	04.8577	W	AC		17.7° Stbd	-1		80.401	0.225				80.581		
									355.8°			0.210			DA-14	0.80%	0.213			
73	DT END OF DUCT	53	32.8215	N	006	04.8715	W				-2		80.611	0.015				80.794		
									355.8°			0.015			DA-14	0.80%	0.015			
74	CABLE ALLOWANCE	53	32.8293	N	006	04.8724	W				-2		80.626	0.000				80.809		
												0.000			DA-14	N/A	0.050			
75	BMH LOUGHSHINNY	53	32.8293	N	006	04.8724	W				-2		80.626	0.000				80.859	80.859	

B. APPENDIX B - MOBILISATION REPORT

Mobilisation Reports of the Fugro Helmert, Alumaster and OSV Cecilia can be found in the Operations Report (Book 4).

C. APPENDIX C - DPRS & DAILY MEETING MINUTES

DPRs and daily meeting minutes can be found in the Operations Report (Book 4)

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D. APPENDIX D - ROUTE DEVELOPMENT

HAVHINGSTEN Route Development Sheet

RD Sheet Number:	001
Segment:	Segment 1-1, Seg 1-2 and Seg 1-3
RPL:	1. HAVHINGSTEN_S1_BMH LOUGHSHINNY - BU PORT ERIN_SR02_19 OCT 2018 2. HAVHINGSTEN_S1_BMH PORT ERIN - BU PORT ERIN_SR02_19 OCT 2018 3. HAVHINGSTEN_S1_BU PORT ERIN - BU PORT GRENAUGH_SR02_19 OCT 2018
Location:	Irish Sea
Date:	20-Oct-2018
Vessel:	MV Fugro Helmert
Survey Company:	Fugro
ASN SPM:	Luigi Martini

Summary:

Due to a conflict with the proposed Rockabill fibre optic cable system the proposed HAVHINGSTEN cable systems will be altered to create space for Rockabill and this will involve some route development surrounding the current survey routes.

There are two areas where route development is proposed:

(1) BU Port Erin position

(2) Approach to Blackpool in the UK EEZ

This document refers to the changes required at the BU Port Erin location.

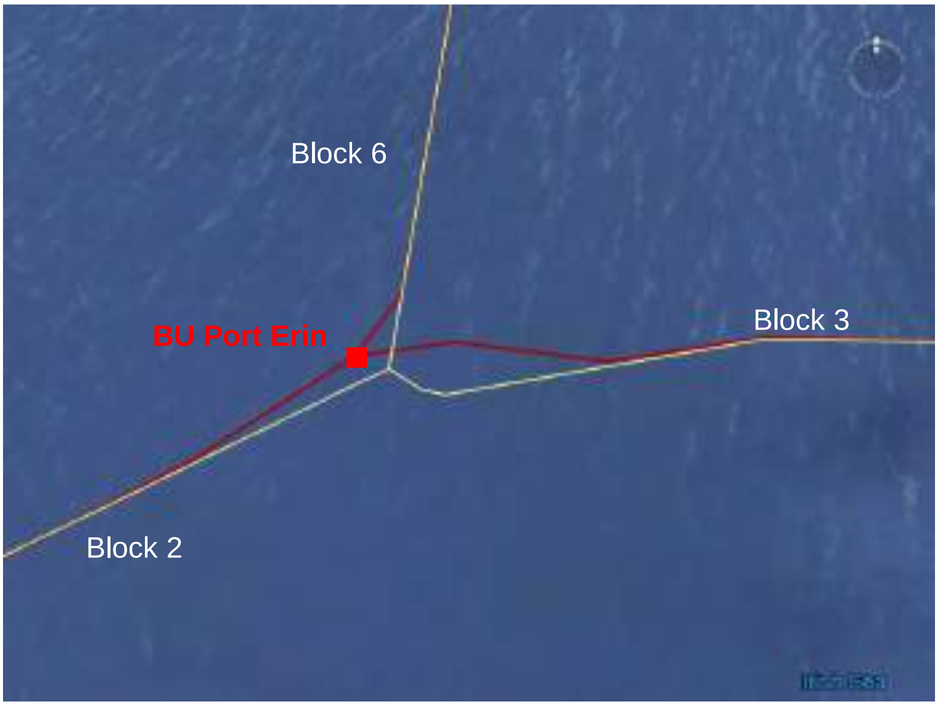


Figure 1: BU Port Erin with the BU Port Erin route development proposal in red

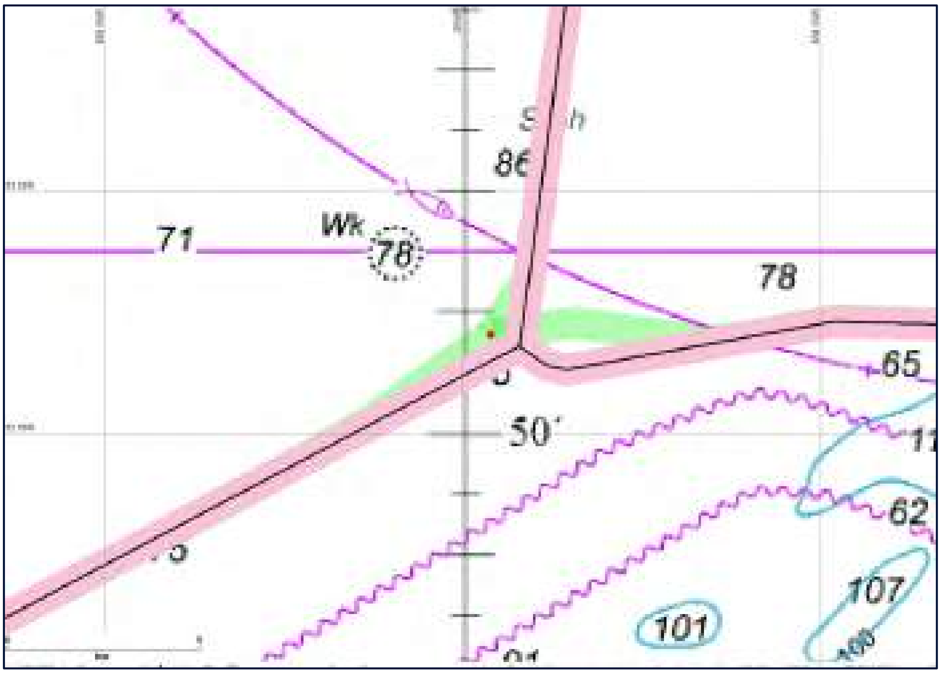


Figure 2: BU Port Erin RD Proposal. The red buffer is the current survey routes and green is the proposed RD. BU box not included.

Activity	Start Time	End Time	Duration (*HH:mm*)	Duration (*HH.mm*)	Route Distance (*km*)	Distance Line (km)	Comments
20-Oct-2018	02:07	07:51	05:44	5.73	7.597	28.840	Average of all lines, including line turns
20-Oct-2018	17:15	24:00	06:45	6.75	9.933	28.097	Average of all lines, including line turns
Total Route Development at this site (to date)			**12:29**	**12.48**	**17.530**	**56.937**	

Notes

Surveyed to date:

Total Time agreed on Route Development	12:29 hrs (12.48 hrs)
Total Route Kilometres	17.530 km
Total Line Kilometres	56.937 km

Approved By

Purchaser SPM:

Tim Payne

Fugro Party Chief:

Chris Maree

ASN SPM:

Luigi Martini

HAVHINGSTEN Route Development Sheet

RD Sheet Number:	002
Segment:	Segment 1-1, Seg 1-2 and Seg 1-3
RPL:	1. HAVHINGSTEN_S1_BMH LOUGHSHINNY - BU PORT ERIN_SR02_19 OCT 2018 2. HAVHINGSTEN_S1_BMH PORT ERIN - BU PORT ERIN_SR02_19 OCT 2018 3. HAVHINGSTEN_S1_BU PORT ERIN - BU PORT GRENAUGH_SR02_19 OCT 2018
Location:	Irish Sea
Date:	21-Oct-2018
Vessel:	MV Fugro Helmert
Survey Company:	Fugro
ASN SPM:	Luigi Martini

Summary:

Due to a conflict with the proposed Rockabill fibre optic cable system the proposed HAVHINGSTEN cable systems will be altered to create space for Rockabill and this will involve some route development surrounding the current survey routes.

There are two areas where route development is proposed:

(1) BU Port Erin position

(2) Approach to Blackpool in the UK EEZ

This document refers to the changes required at the BU Port Erin location.

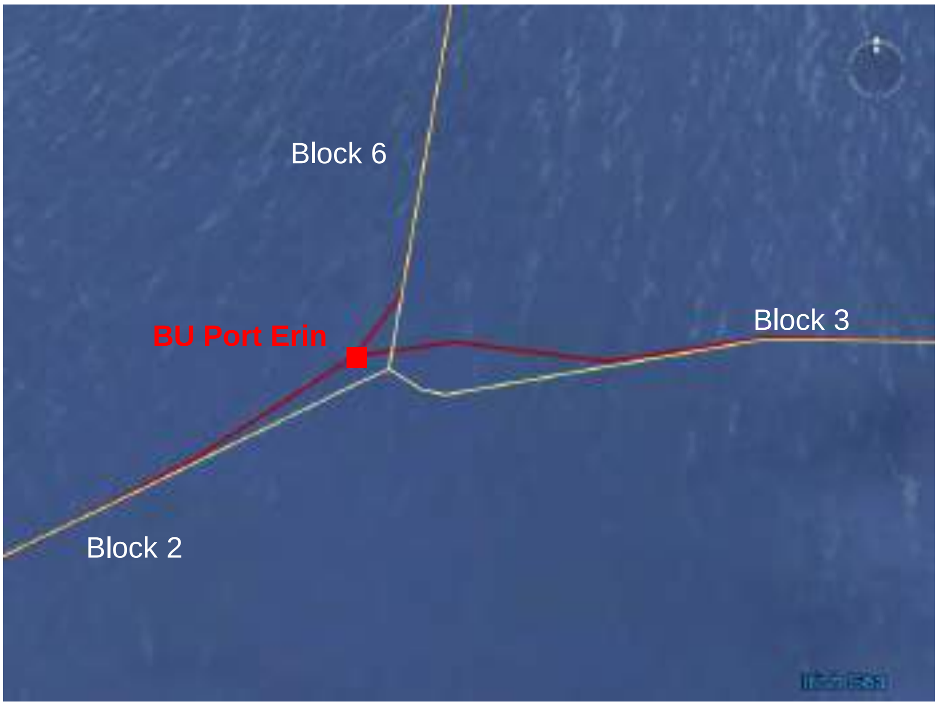


Figure 1: BU Port Erin with the BU Port Erin route development proposal in red

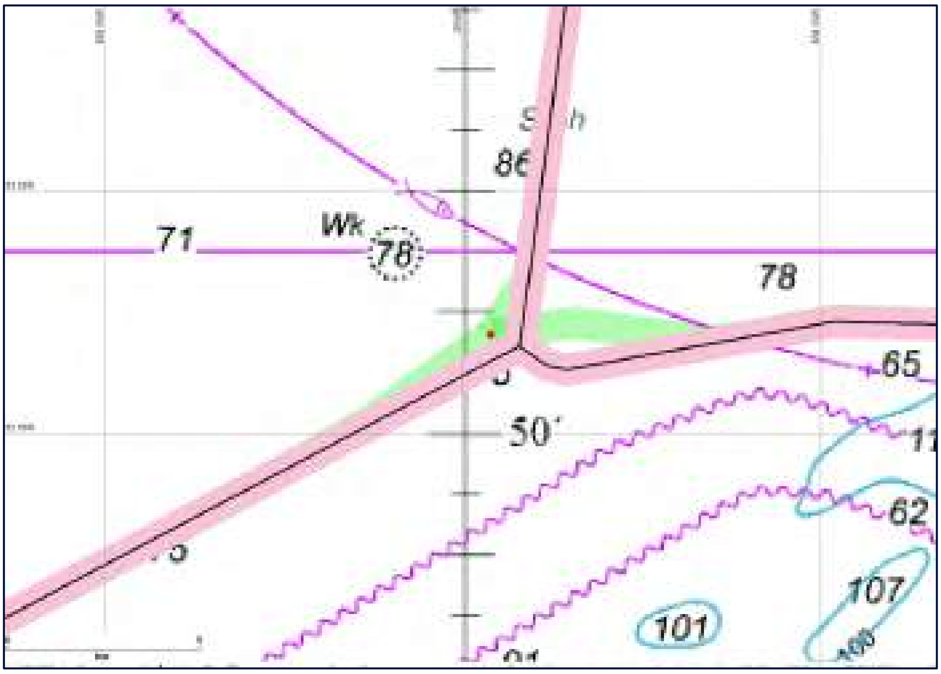


Figure 2: BU Port Erin RD Proposal. The red buffer is the current survey routes and green is the proposed RD. BU box not included.

Activity	Start Time	End Time	Duration (*HH:mm*)	Duration (*HH.mm*)	Route Distance (*km*)	Distance Line (km)	Comments
21-Oct-2018	00:00	00:30	0:30	0.50	1.600	1.770	Average of all lines, including line turns
21-Oct-2018	06:05	06:25	0:20	0.33	0.950	1.095	Average of all lines, including line turns
Total Route Development at this site (Completed)			**13:19**	**13.31**	**20.080**	**59.802**	

Notes

Surveyed to date:

Total Time agreed on Route Development 13:19 hrs (13.31 hrs)

Total Route Kilometres 20.080 km

Total Line Kilometres 59.802 km

All required lines according to the revised RPLs at BU Port Erin completed.

Approved By

Purchaser SPM: 

Tim Payne

Fugro Party Chief:

Chris Maree

ASN SPM:

Luigi Martini

HAVHINGSTEN Route Development Sheet

RD Sheet Number:	003
Segment:	Segment 1-1, Seg 1-2 and Seg 1-3
RPL:	HAVHINGSTEN_S1_BU PORT GRENAUGH - BMH SQUIRES GATE LANE_SR03_19 OCT 2018
Location:	Irish Sea
Date:	28-Oct-2018
Vessel:	MV Fugro Helmert
Survey Company:	Fugro
ASN SPM:	Luigi Martini

Summary:

Due to a conflict with the proposed Rockabill fibre optic cable system the proposed HAVHINGSTEN cable systems will be altered to create space for Rockabill and this will involve some route development surrounding the current survey routes.

There are two areas where route development is proposed:

(1) BU Port Erin position

(2) Approach to Blackpool in the UK EEZ

This document refers to the changes required along the approach to Blackpool in the UK EEZ between approximately KP47 and KP75.

Figure 1: Segment 1-5 route development proposal along BU Port Grenaugh to BMH Squires Gate Lane in red

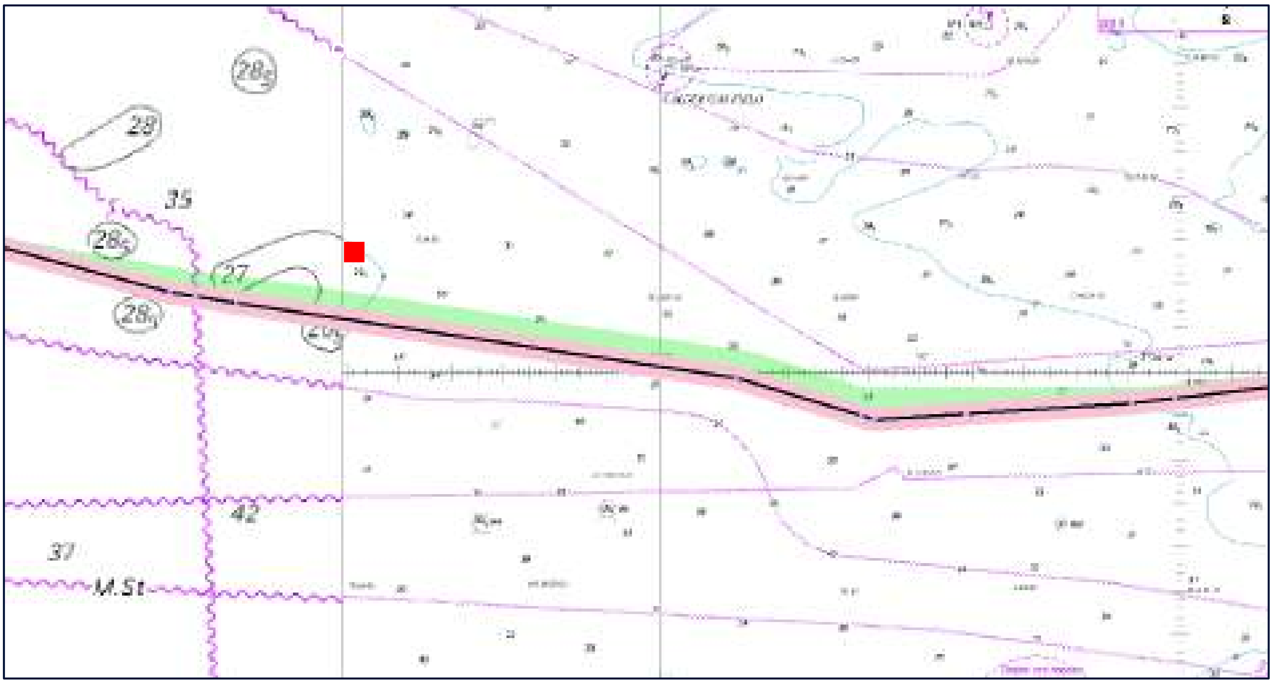


Figure 2: BU Port Grenaugh to BMH Squires Gate Lane route development proposal. The red buffer is the current survey routes and green is the proposed RD between KP47 and KP70.

Activity	Start Time	End Time	Duration (*HH:mm*)	Duration (*HH.mm*)	Route Distance (*km*)	Distance Line (km)	Comments
28-Oct-2018	15:02	24:00	8:58	8.97	27.770	42.350	Average of all lines, including line turns
Total Route Development at this site (To Date)			**8:58**	**8.97**	**27.770**	**42.350**	

Notes

Surveyed to date:

Total Time agreed on Route Development	8:58 hrs (8.97 hrs)
Total Route Kilometres	27.770 km
Total Line Kilometres	42.350 km

Approved By

Purchaser SPM:

Tim Payne

Fugro Party Chief:

Chris Maree

ASN SPM:

Luigi Martini

E. APPENDIX E - SONAR CONTACTS

SSS CONTACTS ALONG S1-1

Sonar Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route (m)	Dimensions (LxWxH) in m	Description
S1-2_FHE_SC0309		001	53° 51.3179'N	004° 59.2900'W		1.5x0.7x0.2	Boulder
S1-1_FHE_SC0041	0.787	001	53° 50.7383'N	004° 59.9791'W	-147	1.6x1.0x0.4	Boulder
S1-1_FHE_SC0042	2.135	001	53° 50.1988'N	005° 00.8181'W	-353	4.7x0.5x0.2	Boulder
S1-1_FHE_SC0030	5.000	001,002	53° 49.4066'N	005° 03.0594'W	-332	1.2x0.3x0.1	Boulder
S1-1_FHE_SC0031	6.733	002	53° 49.0440'N	005° 04.5396'W	-88	1.5x1.7x0.1	Boulder
S1-1_FHE_SC0036	6.761	002	53° 48.9968'N	005° 04.5266'W	-172	1.7x0.7x0.1	Debris
S1-1_FHE_SC0032	8.416	002	53° 48.6253'N	005° 05.8989'W	-78	4.6x1.7x0.8	Boulder
S1-1_FHE_SC0035	12.077	002	53° 47.5758'N	005° 08.7210'W	-277	1.2x0.7x0.2	Boulder
S1-1_FHE_SC0033	12.080	002	53° 47.6068'N	005° 08.7553'W	-208	1.7x0.5x0.2	Boulder
S1-1_FHE_SC0038	12.492	002	53° 47.6564'N	005° 09.2376'W	137	1.2x0.8x0.3	Boulder
S1-1_FHE_SC0037	16.332	003	53° 46.6300'N	005° 12.2666'W	138	1.8x0.6x0.1	Boulder
S1-1_FHE_SC0039	33.489	005	53° 43.0088'N	005° 26.3812'W	263	2.4x0.4x0.2	Boulder
S1-1_FHE_SC0040	38.035	005	53° 41.7061'N	005° 29.8988'W	-141	1.3x0.8x0.3	Debris
S1-1_FHE_SC0010	45.619	006	53° 39.9508'N	005° 36.1172'W	143	24.2x8.9x4.2	Wreck
S1-1_FHE_SC0009	45.802	006	53° 39.8501'N	005° 36.2180'W	25	6.6x0.6x0.2	Debris
S1-1_FHE_SC0028	52.089	007	53° 38.4766'N	005° 41.4399'W	308	1.2x0.6x0.1	Boulder
S1-1_FHE_SC0029	57.353	007	53° 37.1173'N	005° 45.6341'W	110	1.5x0.8x0.3	Boulder
S1-1_FHE_SC0007	70.813	009	53° 33.8710'N	005° 56.5419'W	46	1.0x1.0x0.4	Boulder
S1-1_FHE_SC0014	70.899	009	53° 33.7029'N	005° 56.5334'W	-250	0.6x1.0x0.5	Boulder
S1-1_FHE_SC0016	70.912	009	53° 33.6873'N	005° 56.5385'W	-276	1.3x0.8x0.4	Boulder
S1-1_FHE_SC0015	70.916	009	53° 33.6794'N	005° 56.5386'W	-290	2.7x1.7x0.3	Boulder
S1-1_FHE_SC0006	71.897	009	53° 33.6451'N	005° 57.4456'W	-74	1.5x0.8x0.3	Boulder
S1-1_FHE_SC0005	71.912	009	53° 33.6653'N	005° 57.4697'W	-31	1.8x0.8x0.5	Boulder
S1-1_FHE_SC0003	72.083	009	53° 33.6891'N	005° 57.6428'W	64	1.4x1.0x0.5	Boulder
S1-1_FHE_SC0004	72.094	009	53° 33.7027'N	005° 57.6591'W	93	1.0x1.0x0.3	Boulder
S1-1_FHE_SC0013	72.140	009	53° 33.7647'N	005° 57.7330'W	227	1.0x1.0x0.3	Boulder
S1-1_FHE_SC0012	72.144	009	53° 33.7682'N	005° 57.7379'W	234	1.0x0.8x0.2	Boulder
S1-1_FHE_SC0027	72.146	009	53° 33.8044'N	005° 57.7578'W	305	1.8x1.4x0.4	Boulder

Sonar Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route (m)	Dimensions (LxWxH) in m	Description
S1-1_FHE_SC0011	72.173	009	53° 33.7860'N	005° 57.7742'W	277	1.1x1.1x0.3	Boulder
S1-1_FHE_SC0002	72.226	009	53° 33.6981'N	005° 57.7818'W	123	1.2x0.7x0.2	Boulder
S1-1_FHE_SC0023	72.234	009	53° 33.7128'N	005° 57.7957'W	153	0.8x0.8x0.3	Boulder
S1-1_FHE_SC0008	72.266	009	53° 33.6883'N	005° 57.8146'W	115	1.2x1.0x0.3	Boulder
S1-1_FHE_SC0026	73.573	009	53° 33.5424'N	005° 58.9647'W	161	1.2x1.0x0.2	Boulder
S1-1_FHE_SC0022	73.729	009	53° 33.4123'N	005° 59.0609'W	-52	2.1x1.2x0.2	Boulder
S1-1_FHE_SC0017	74.741	009	53° 33.2345'N	005° 59.9333'W	-165	1.1x1.1x0.2	Boulder
S1-1_FHE_SC0021	74.754	009	53° 33.2627'N	005° 59.9559'W	-108	1.4x1.2x0.4	Boulder
S1-1_FHE_SC0024	75.475	009,010	53° 33.2152'N	006° 00.6070'W	-39	1.0x1.0x0.1	Boulder
S1-1_FHE_SC0001	76.174	009,010	53° 33.1054'N	006° 01.2039'W	-89	1.0x0.8x0.4	Boulder
S1-1_FHE_SC0018	76.357	009,010	53° 32.9661'N	006° 01.2988'W	-299	1.0x1.2x0.4	Boulder
S1-1_FHE_SC0019	76.386	009,010	53° 32.9647'N	006° 01.3260'W	-292	1.0x1.0x0.3	Boulder
S1-1_FHE_SC0020	76.781	010	53° 32.9716'N	006° 01.7077'W	-143	2.6x1.6x0.4	Boulder
S1-1_AL_SC0036	77.389	010	53° 33.0300'N	006° 02.3089'W	157	4.6x0.8x0.5	Debris
S1-1_FHE_SC0025	77.653	010	53° 32.9481'N	006° 02.5216'W	65	1.1x0.7x0.2	Boulder
S1-1_AL_SC0035	79.167	010	53° 32.6966'N	006° 03.8291'W	-49	1.3x0.9x0.5	Boulder
S1-1_AL_SC0033	79.898	010	53° 32.5926'N	006° 04.4681'W	-70	1.7x1.6x0.3	Boulder
S1-1_AL_SC0039	79.923	010	53° 32.5319'N	006° 04.4668'W	-180	4.2x1.9x0.6	Boulder
S1-1_AL_SC0040	79.929	010	53° 32.5324'N	006° 04.4722'W	-178	2.8x0.7x0.8	Boulder
S1-1_AL_SC0032	79.945	010	53° 32.5903'N	006° 04.5106'W	-63	2.4x0.7x0.2	Boulder
S1-1_AL_SC0034	79.958	010	53° 32.6560'N	006° 04.5489'W	65	1.9x0.8x0.3	Boulder
S1-1_AL_SC0031	80.048	010	53° 32.6007'N	006° 04.6108'W	-19	2.2x0.5x0.1	Debris
S1-1_AL_SC0030	80.048	010	53° 32.6000'N	006° 04.6106'W	-20	4x0.5x0	Debris
S1-1_AL_SC0029	80.048	010	53° 32.5967'N	006° 04.6158'W	-26	1.5x0.3x0.2	Boulder
S1-1_AL_SC0027	80.081	010	53° 32.6333'N	006° 04.6363'W	35	1x0.6x0.5	Boulder
S1-1_AL_SC0002	80.089	010	53° 32.6538'N	006° 04.6357'W	73	1.4x1.8x0.7	Boulder
S1-1_AL_SC0028	80.091	010	53° 32.6335'N	006° 04.6458'W	34	1.1x0.8x0.5	Boulder
S1-1_AL_SC0038	80.163	010	53° 32.6308'N	006° 04.7136'W	12	2.8x0.4x0.5	Boulder
S1-1_AL_SC0019	80.172	010	53° 32.5966'N	006° 04.7353'W	-56	2.4x1.8x0.3	Boulder
S1-1_AL_SC0021	80.173	010	53° 32.6340'N	006° 04.7219'W	15	1.3x0.6x0.4	Boulder
S1-1_AL_SC0022	80.175	010	53° 32.6374'N	006° 04.7222'W	21	1.1x0.6x0.6	Boulder

Sonar Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route (m)	Dimensions (LxWxH) in m	Description
S1-1_AL_SC0020	80.180	010	53° 32.6494'N	006° 04.7222'W	43	2.8x2.3x0.6	Boulder
S1-1_AL_SC0023	80.204	010	53° 32.6203'N	006° 04.7565'W	-18	1.3x0.7x0.2	Boulder
S1-1_AL_SC0018	80.207	010	53° 32.5866'N	006° 04.7724'W	-83	1.6x1.6x0.9	Boulder
S1-1_AL_SC0024	80.210	010	53° 32.6220'N	006° 04.7610'W	-16	1.6x1.4x0.3	Boulder
S1-1_AL_SC0017	80.222	010	53° 32.5934'N	006° 04.7836'W	-74	4.8x2.3x0.9	Boulder
S1-1_AL_SC0026	80.238	010	53° 32.6403'N	006° 04.7748'W	9	1.1x0.5x0.2	Boulder
S1-1_AL_SC0015	80.242	010	53° 32.6290'N	006° 04.7959'W	-22	1.6x0.6x0.4	Boulder
S1-1_AL_SC0025	80.245	010	53° 32.6540'N	006° 04.7641'W	36	1.3x0.3x0.2	Boulder
S1-1_AL_SC0014	80.247	010	53° 32.6283'N	006° 04.8026'W	-28	1x0.8x0.2	Boulder
S1-1_AL_SC0012	80.248	010	53° 32.6295'N	006° 04.8017'W	-26	1x0.8x0.5	Boulder
S1-1_AL_SC0016	80.249	010	53° 32.6357'N	006° 04.7940'W	-11	1.1x0.5x0.4	Boulder
S1-1_AL_SC0013	80.251	010	53° 32.6306'N	006° 04.8040'W	-26	1.2x0.3x0.4	Boulder
S1-1_AL_SC0037	80.266	010	53° 32.6312'N	006° 04.8213'W	-37	1.1x0.3x0.5	Boulder
S1-1_AL_SC0010	80.318	010	53° 32.6716'N	006° 04.8102'W	23	2x0.5x0.3	Boulder
S1-1_AL_SC0009	80.325	010	53° 32.6750'N	006° 04.8123'W	24	1.9x1x0.4	Debris
S1-1_AL_SC0011	80.351	010	53° 32.6974'N	006° 04.7819'W	70	1.3x0.8x0.3	Boulder
S1-1_AL_SC0003	80.361	010	53° 32.7139'N	006° 04.7383'W	126	1.8x1.9x0.4	Boulder
S1-1_AL_SC0004	80.362	010	53° 32.7145'N	006° 04.7373'W	128	1.1x1.5x0.4	Boulder
S1-1_AL_SC0001	80.363	010	53° 32.7039'N	006° 04.7845'W	72	2.5x2.5x0.5	Boulder
S1-1_AL_SC0007	80.364	010	53° 32.7028'N	006° 04.7911'W	65	1.2x1.1x0.3	Boulder
S1-1_AL_SC0006	80.365	010	53° 32.7041'N	006° 04.7893'W	67	2.1x0.6x0.4	Boulder
S1-1_AL_SC0005	80.368	010	53° 32.7173'N	006° 04.7409'W	126	1.8x0.9x0.1	Boulder
S1-1_AL_SC0008	80.437	010	53° 32.7301'N	006° 04.8027'W	64	1.3x0.8x0.3	Boulder

F. APPENDIX F - MAGNETOMETER CONTACTS

MAG TARGETS ALONG S1-1

Magnetometer Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route [m]	Anomaly [nT]	Description
S1-2_FHE_MC014		001	53° 51.1702'N	004° 58.9193'W		195	unknown
S1-2_FHE_MC029		001	53° 51.0925'N	004° 59.0302'W		35	unknown
S1-2_FHE_MC005		001	53° 51.0902'N	004° 59.0694'W		29	unknown
S1-2_FHE_MC002		001	53° 51.1263'N	004° 59.1555'W		36	unknown
S1-2_FHE_MC025		001	53° 51.2237'N	004° 59.3661'W		19	unknown
S1-2_FHE_MC003		001	53° 50.9445'N	004° 59.3454'W		5	unknown
S1-1_FHE_MC024	0.373	001	53° 50.5338'N	004° 59.4162'W	-742	66	unknown
S1-2_FHE_MC039	0.390	001	53° 50.5360'N	004° 59.4349'W	-730	67	unknown
S1-1_FHE_MC028	0.430	001	53° 50.5653'N	004° 59.4964'W	-653	72	unknown
S1-1_FHE_MC013	0.526	001	53° 50.5925'N	004° 59.6121'W	-556	119	unknown
S1-2_FHE_MC016	0.543	001	53° 50.5989'N	004° 59.6329'W	-536	121	unknown
S1-2_FHE_MC004	0.549	001	53° 50.5954'N	004° 59.6368'W	-540	138	unknown
S1-1_FHE_MC017	0.577	001	53° 50.6310'N	004° 59.6912'W	-456	44	unknown
S1-1_FHE_MC015	0.601	001	53° 50.6727'N	004° 59.7454'W	-361	86	unknown
S1-1_FHE_MC021	0.610	001	53° 50.6803'N	004° 59.7602'W	-341	87	unknown
S1-2_FHE_MC030	0.618	001	53° 50.6752'N	004° 59.7642'W	-348	124	unknown
S1-2_FHE_MC023	0.685	001	53° 50.6989'N	004° 59.8491'W	-271	98	unknown
S1-1_FHE_MC012	0.692	001	53° 50.7046'N	004° 59.8598'W	-256	49	unknown
S1-1_FHE_MC032	0.808	001	53° 50.7209'N	004° 59.9875'W	-172	62	unknown
S1-1_FHE_MC026	0.884	001	53° 50.7407'N	005° 00.0781'W	-99	33	unknown
S1-1_FHE_MC004	0.907	001	53° 50.7424'N	005° 00.1013'W	-86	52	unknown
S1-1_FHE_MC008	0.974	001	53° 50.8628'N	005° 00.2706'W	194	121	unknown
S1-1_FHE_MC007	1.274	001	53° 50.2511'N	004° 59.7250'W	-1083	165	unknown
S1-1_FHE_MC011	1.337	001	53° 50.4384'N	005° 00.1065'W	-543	42	unknown

Magnetometer Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route [m]	Anomaly [nT]	Description
S1-1_FHE_MC033	1.372	001	53° 50.5636'N	005° 00.3524'W	-189	49	unknown
S1-1_FHE_MC018	1.381	001	53° 50.4663'N	005° 00.2070'W	-429	40	unknown
S1-1_FHE_MC022	1.385	001	53° 50.4827'N	005° 00.2393'W	-383	44	unknown
S1-1_FHE_MC016	1.394	001	53° 50.5048'N	005° 00.2855'W	-318	22	unknown
S1-1_FHE_MC027	1.431	001	53° 50.5836'N	005° 00.4589'W	-81	19	unknown
S1-1_FHE_MC005	1.442	001	53° 50.6131'N	005° 00.5203'W	5	22	unknown
S1-1_FHE_MC006	1.981	001	53° 50.0690'N	005° 00.3227'W	-875	31	unknown
S1-1_FHE_MC023	1.996	001	53° 50.1850'N	005° 00.5283'W	-564	15	unknown
S1-1_FHE_MC029	2.001	001	53° 50.2223'N	005° 00.5946'W	-464	16	unknown
S1-1_FHE_MC019	19.029	003	53° 45.9975'N	005° 14.4736'W	228	34	unknown
S1-1_FHE_MC030	19.113	003	53° 45.8784'N	005° 14.4583'W	23	48	unknown
S1-1_FHE_MC009	22.581	003,004	53° 45.0639'N	005° 17.2979'W	156	23	unknown
S1-1_FHE_MC002	25.139	003,004	53° 44.8735'N	005° 19.3310'W	483	6150	IS Interconnector 1 Pipeline
S1-1_FHE_MC014	25.211	003,004	53° 44.7427'N	005° 19.4315'W	226	262	IS Interconnector 1 Pipeline
S1-1_FHE_MC020	25.228	003,004	53° 44.6903'N	005° 19.4608'W	125	255	IS Interconnector 1 Pipeline
S1-1_FHE_MC001	25.251	003,004	53° 44.6552'N	005° 19.4914'W	56	101	IS Interconnector 1 Pipeline
S1-1_FHE_MC031	25.283	003,004	53° 44.5794'N	005° 19.5409'W	-92	157	IS Interconnector 1 Pipeline
S1-1_FHE_MC025	25.313	003,004	53° 44.5261'N	005° 19.5825'W	-197	455	IS Interconnector 1 Pipeline
S1-1_FHE_MC003	25.381	003,004	53° 44.3833'N	005° 19.6835'W	-475	380	IS Interconnector 1 Pipeline
S1-1_FHE_MC047	45.404	006	53° 40.0865'N	005° 36.0131'W	317	4	unknown
S1-1_FHE_MC038	62.273	008	53° 35.9621'N	005° 49.6493'W	152	21	unknown
S1-1_FHE_MC039	63.847	008	53° 35.5813'N	005° 50.9237'W	142	12	unknown
S1-1_FHE_MC036	63.856	008	53° 35.6250'N	005° 50.9694'W	237	23	unknown
S1-1_FHE_MC040	70.880	009	53° 33.8861'N	005° 56.6037'W	98	10	unknown
S1-1_FHE_MC042	71.589	009	53° 33.7801'N	005° 57.2210'W	98	141	unknown
S1-1_FHE_MC035	71.701	009	53° 33.8374'N	005° 57.3543'W	241	203	unknown
S1-1_FHE_MC046	72.406	009	53° 33.5926'N	005° 57.9005'W	-29	100	unknown
S1-1_FHE_MC045	72.469	009	53° 33.5844'N	005° 57.9555'W	-27	213	unknown

Magnetometer Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route [m]	Anomaly [nT]	Description
S1-1_FHE_MC034	72.488	009	53° 33.6155'N	005° 57.9885'W	38	241	unknown
S1-1_FHE_MC041	72.516	009	53° 33.6562'N	005° 58.0347'W	125	161	unknown
S1-1_FHE_MC037	72.555	009	53° 33.6887'N	005° 58.0868'W	199	135	unknown
S1-1_FHE_MC043	72.555	009	53° 33.4942'N	005° 57.9927'W	-176	124	unknown
S1-1_FHE_MC044	74.863	009	53° 33.1854'N	006° 00.0284'W	-231	8	unknown
S1-1_AL_MC_028	77.188	010	53° 32.9333'N	006° 02.0753'W	-79	0.9	unknown
S1-1_AL_MC_012	77.374	010	53° 32.9848'N	006° 02.2766'W	67	5.8	unknown
S1-1_AL_MC_027	77.394	010	53° 32.9059'N	006° 02.2630'W	-79	7.4	unknown
S1-1_AL_MC_001	77.413	010	53° 32.9540'N	006° 02.3001'W	18	10.4	unknown
S1-1_AL_MC_031	77.456	010	53° 32.8731'N	006° 02.3073'W	-126	4.5	unknown
S1-1_AL_MC_003	77.466	010	53° 32.9215'N	006° 02.3368'W	-31	7.5	unknown
S1-1_AL_MC_013	77.482	010	53° 32.9074'N	006° 02.3455'W	-55	6.7	unknown
S1-1_AL_MC_026	77.663	010	53° 32.8671'N	006° 02.4975'W	-88	6	unknown
S1-1_AL_MC_032	77.673	010	53° 32.8457'N	006° 02.4982'W	-126	6.2	unknown
S1-1_AL_MC_040	77.836	010	53° 32.7778'N	006° 02.6232'W	-216	16.2	unknown
S1-1_AL_MC_039	77.837	010	53° 32.8003'N	006° 02.6327'W	-173	3.9	unknown
S1-1_AL_MC_043	77.868	010	53° 32.9854'N	006° 02.7369'W	188	29.2	unknown
S1-1_AL_MC_004	77.889	010	53° 32.8708'N	006° 02.7100'W	-26	12.1	unknown
S1-1_AL_MC_025	77.917	010	53° 32.8345'N	006° 02.7216'W	-88	7.7	unknown
S1-1_AL_MC_002	77.921	010	53° 32.8859'N	006° 02.7456'W	11	9.5	unknown
S1-1_AL_MC_015	77.967	010	53° 32.8454'N	006° 02.7719'W	-55	7.1	unknown
S1-1_AL_MC_030	77.991	010	53° 32.8011'N	006° 02.7769'W	-134	7	unknown
S1-1_AL_MC_014	78.019	010	53° 32.8395'N	006° 02.8178'W	-54	0.3	unknown
S1-1_AL_MC_050	78.029	010	53° 32.9958'N	006° 02.8913'W	247	19.2	unknown
S1-1_AL_MC_011	78.058	010	53° 32.8951'N	006° 02.8776'W	62	29.2	unknown
S1-1_AL_MC_044	78.090	010	53° 32.9697'N	006° 02.9376'W	212	17.2	unknown
S1-1_AL_MC_019	78.117	010	53° 32.9082'N	006° 02.9378'W	101	29.2	unknown
S1-1_AL_MC_038	78.130	010	53° 32.7607'N	006° 02.8895'W	-177	4.9	unknown

Magnetometer Contact No.	KP	CHART No. NU 10k	Latitude	Longitude	Lateral offset from Route [m]	Anomaly [nT]	Description
S1-1_AL_MC_005	78.366	010	53° 32.8078'N	006° 03.1284'W	-31	18.3	unknown
S1-1_AL_MC_016	78.412	010	53° 32.7871'N	006° 03.1632'W	-59	13.9	unknown
S1-1_AL_MC_029	78.436	010	53° 32.7425'N	006° 03.1676'W	-138	13.4	unknown
S1-1_AL_MC_037	78.445	010	53° 32.7208'N	006° 03.1666'W	-177	6.9	unknown
S1-1_AL_MC_024	78.477	010	53° 32.7585'N	006° 03.2123'W	-98	7.1	unknown
S1-1_AL_MC_036	78.626	010	53° 32.6938'N	006° 03.3241'W	-185	5.2	unknown
S1-1_AL_MC_049	78.694	010	53° 32.9106'N	006° 03.4761'W	245	19.7	unknown
S1-1_AL_MC_045	78.764	010	53° 32.8788'N	006° 03.5286'W	202	17.1	unknown
S1-1_AL_MC_042	78.788	010	53° 32.8591'N	006° 03.5426'W	170	44.4	unknown
S1-1_AL_MC_020	78.826	010	53° 32.8388'N	006° 03.5700'W	140	72.7	unknown
S1-1_AL_MC_018	78.968	010	53° 32.7995'N	006° 03.6858'W	100	40.6	unknown
S1-1_AL_MC_010	78.979	010	53° 32.7708'N	006° 03.6848'W	47	20.2	unknown
S1-1_AL_MC_046	79.018	010	53° 32.8448'N	006° 03.7508'W	198	21.5	unknown
S1-1_AL_MC_048	79.063	010	53° 32.8553'N	006° 03.7967'W	229	19.5	unknown
S1-1_AL_MC_006	79.100	010	53° 32.7153'N	006° 03.7745'W	-29	12.9	unknown
S1-1_AL_MC_035	79.285	010	53° 32.6067'N	006° 03.9028'W	-192	7.6	unknown
S1-1_AL_MC_041	79.308	010	53° 32.5765'N	006° 03.9120'W	-244	21.9	unknown
S1-1_AL_MC_033	79.343	010	53° 32.6209'N	006° 03.9622'W	-151	11.3	unknown
S1-1_AL_MC_023	79.678	010	53° 32.6012'N	006° 04.2662'W	-107	4.4	unknown
S1-1_AL_MC_007	79.688	010	53° 32.6371'N	006° 04.2908'W	-36	63.8	unknown
S1-1_AL_MC_021	79.754	010	53° 32.7123'N	006° 04.3819'W	123	3	unknown
S1-1_AL_MC_034	79.756	010	53° 32.5395'N	006° 04.3144'W	-206	3.8	unknown
S1-1_AL_MC_022	79.801	010	53° 32.7059'N	006° 04.4240'W	123	2.3	unknown
S1-1_AL_MC_047	79.802	010	53° 32.7532'N	006° 04.4437'W	213	1.9	unknown
S1-1_AL_MC_017	79.859	010	53° 32.5962'N	006° 04.4330'W	-73	2.7	unknown
S1-1_AL_MC_009	79.882	010	53° 32.6551'N	006° 04.4781'W	45	59.4	unknown
S1-1_AL_MC_008	80.044	010	53° 32.5907'N	006° 04.6029'W	-39	9.3	unknown

G. APPENDIX G - CORE & GRAB SAMPLING RESULTS

G.1 Geotechnical Locations Reports

The following Geotechnical Reports show the proposed and as taken positions with corresponding MBES; SSS and SBP example images for each geotechnical location within Segment 1.

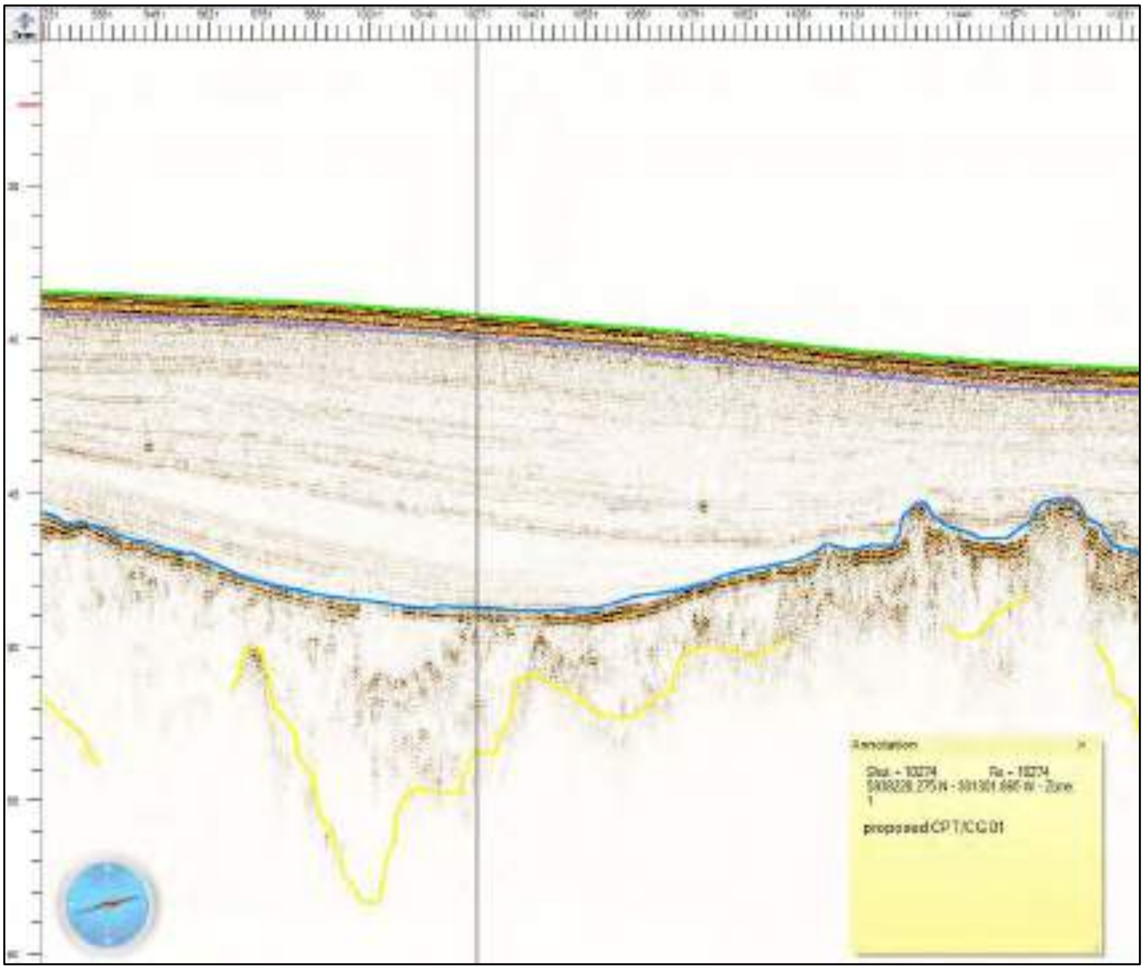
S1-1_CEC_CPT_01 / S1-1_CEC_GC_01 / S1-1_CEC_GC_01a
(S1-1_BLOCK01)

Proposed: 53° 33.3159' N, 005° 59.9875' W

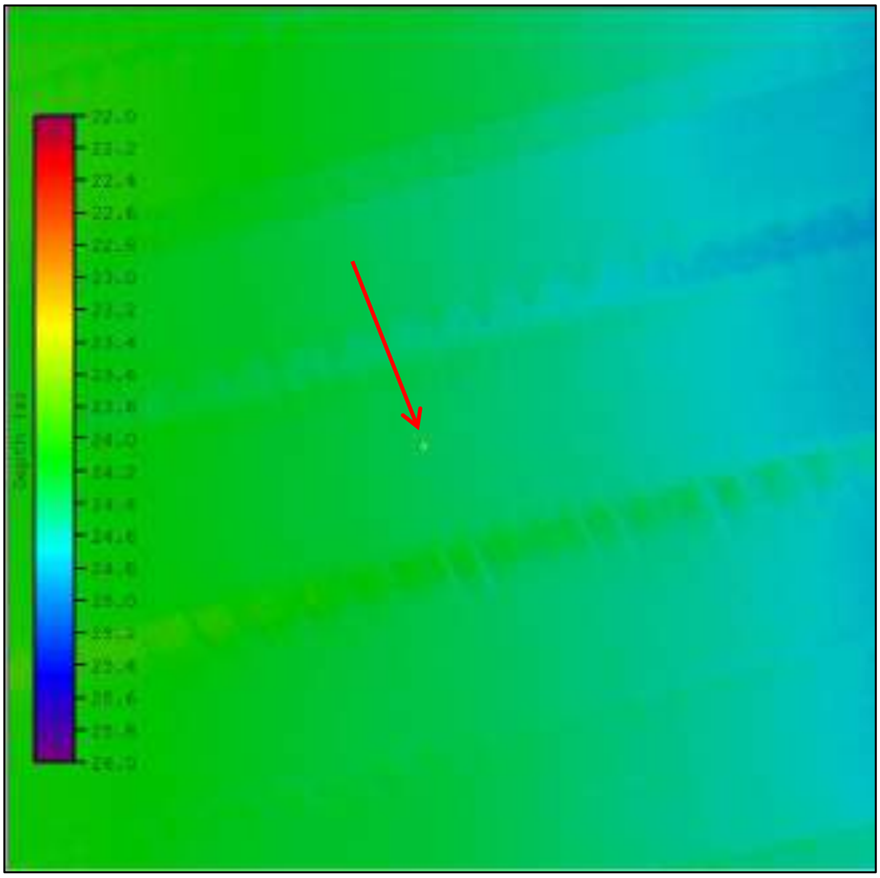
CPT As Taken: 53° 33.3156'N, 005° 59.9871'W

GC As Taken: 53° 33.3150'N, 005° 59.9882'W / 53° 33.3168'N, 005° 59.9883'W

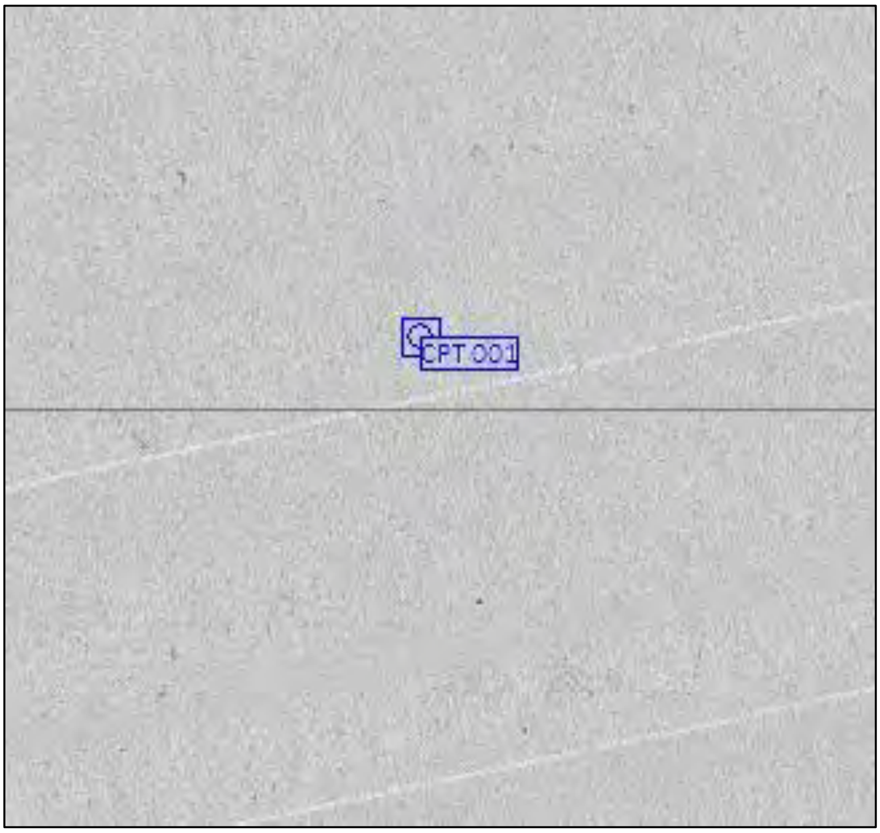
Depth: 24.4 m
Expected sediments: succession of sandy layers and silty-muddy sand units
Anomalies: No magnetic anomalies within the 300m x 300m area.



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

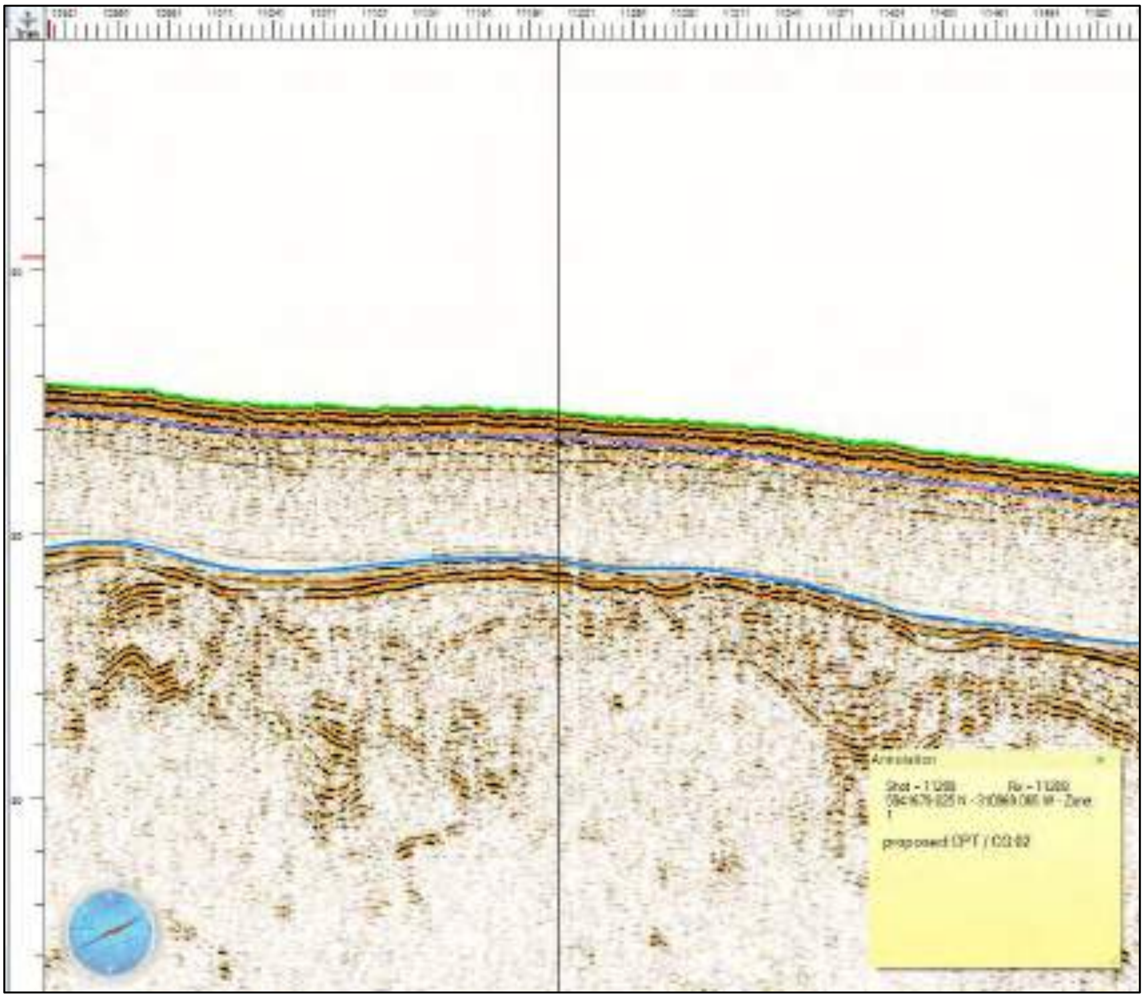
S1-1_CEC_CPT_02 / S1-1_CEC_GC_02
(S1-1_BLOCK01)

Proposed: 53° 35.3889' N, 005° 51.3682' W

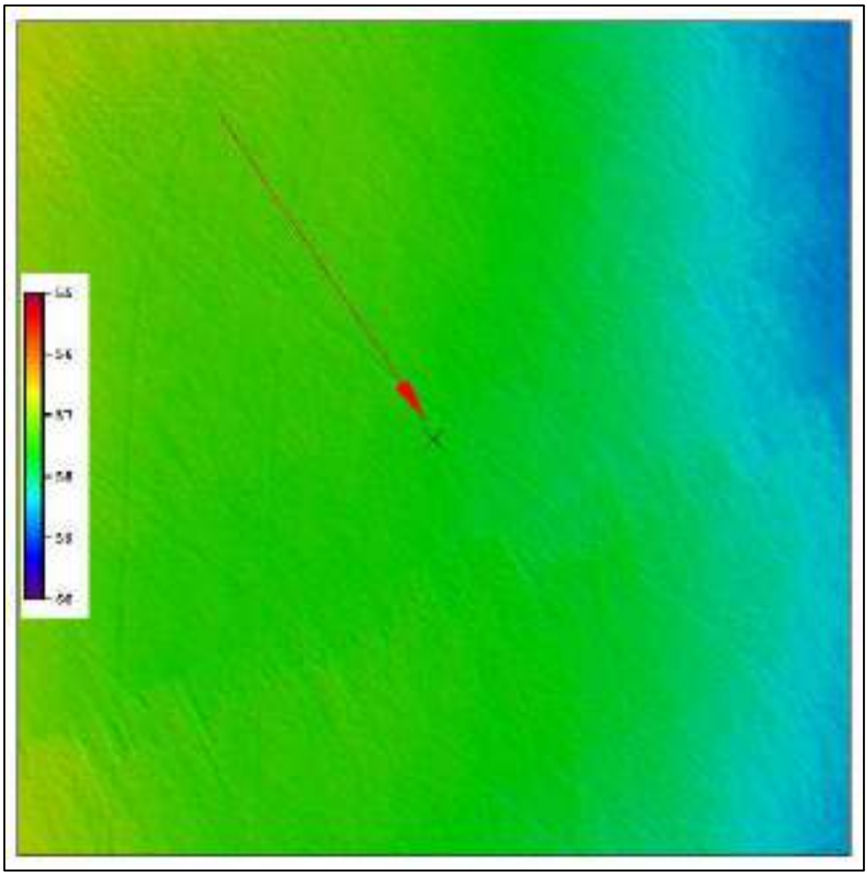
CPT As Taken: 53° 35.3891'N, 005° 51.3673'W

GC As Taken: 53° 35.3881'N, 005° 51.3681'W

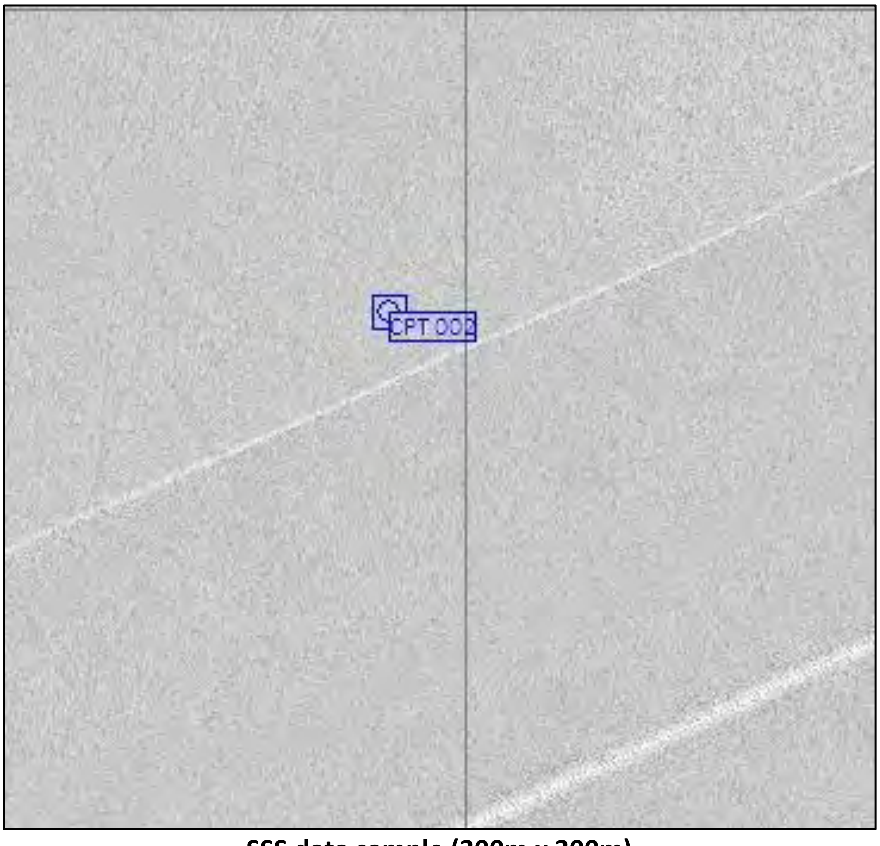
Depth: 57.5 m
Expected sediments: succession of muddy-sandy layers overlaying coarse sediment
Anomalies: No magnetic anomalies within the 300m x 300m area.



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

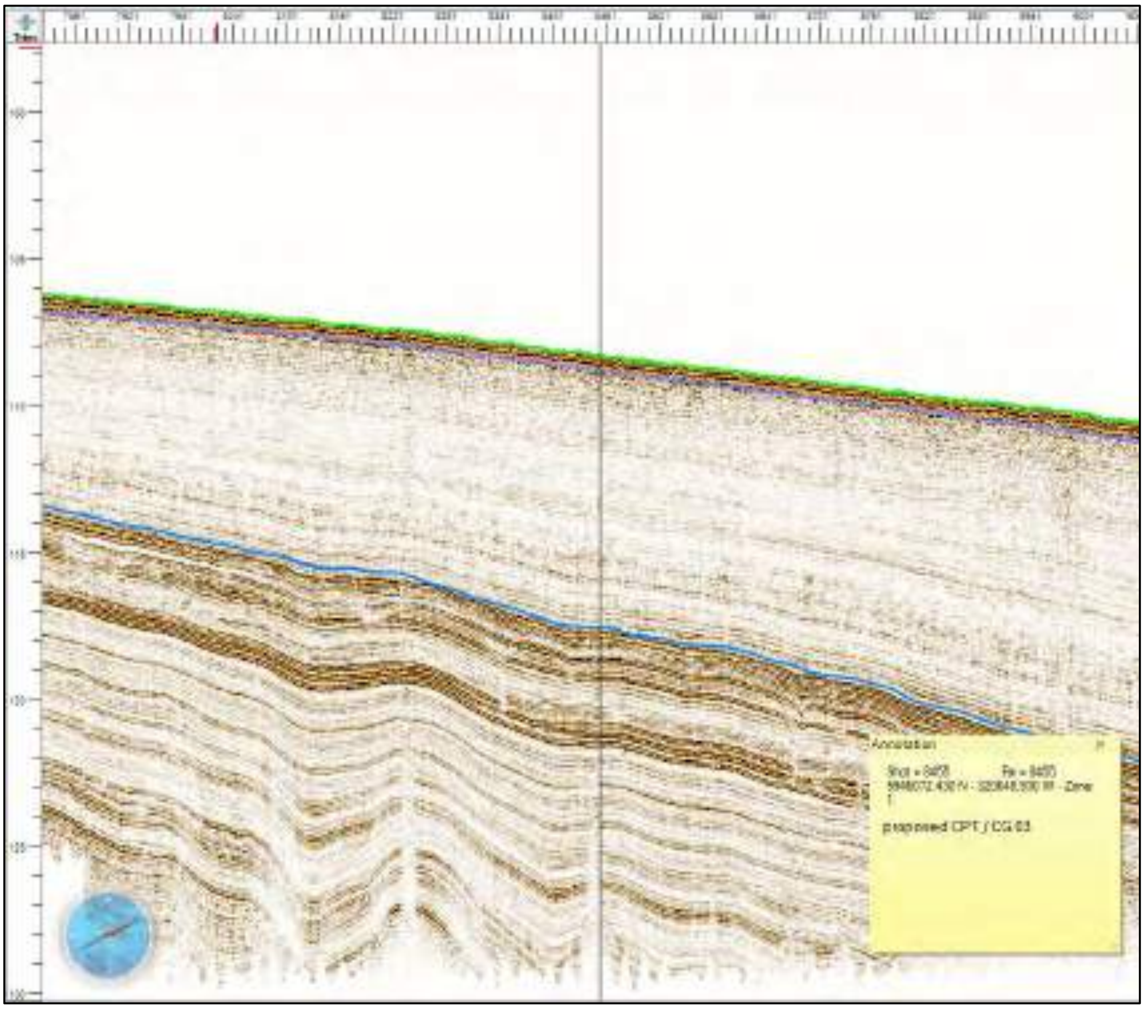
S1-1_CEC_CPT_03 / S1-1_CEC_GC_03
(S1-1_BLOCK01)

Proposed: 53° 37.9597' N, 005° 42.7556' W

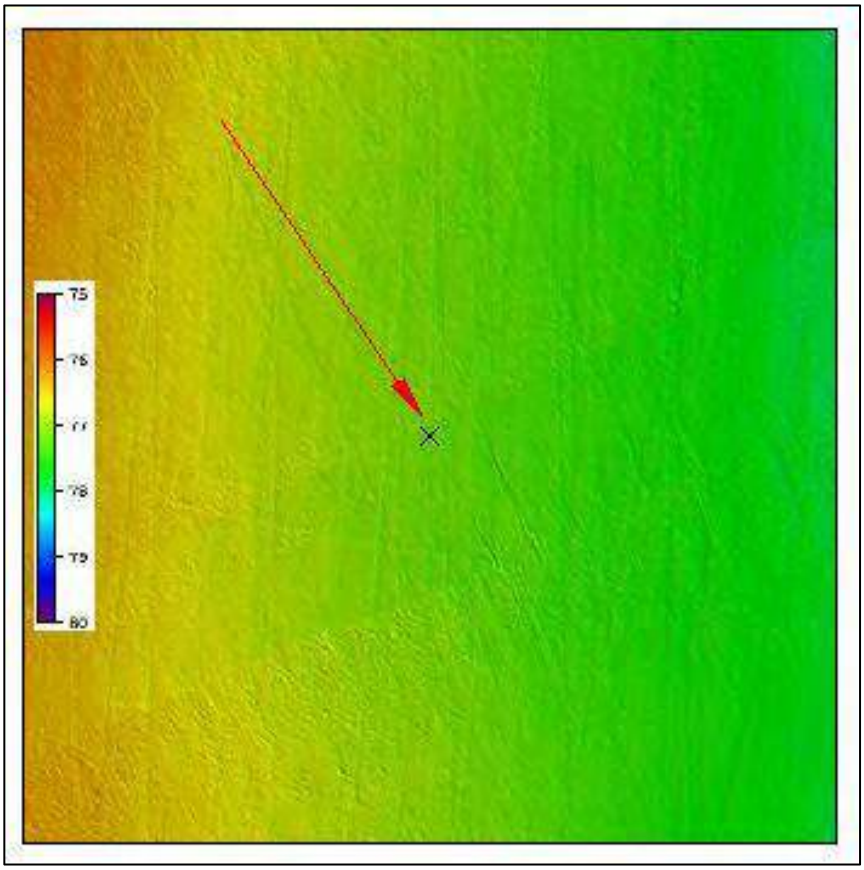
CPT As Taken: 53° 37.9598'N, 005° 42.7568'W

GC As Taken: 53° 37.9590'N, 005° 42.7568'W

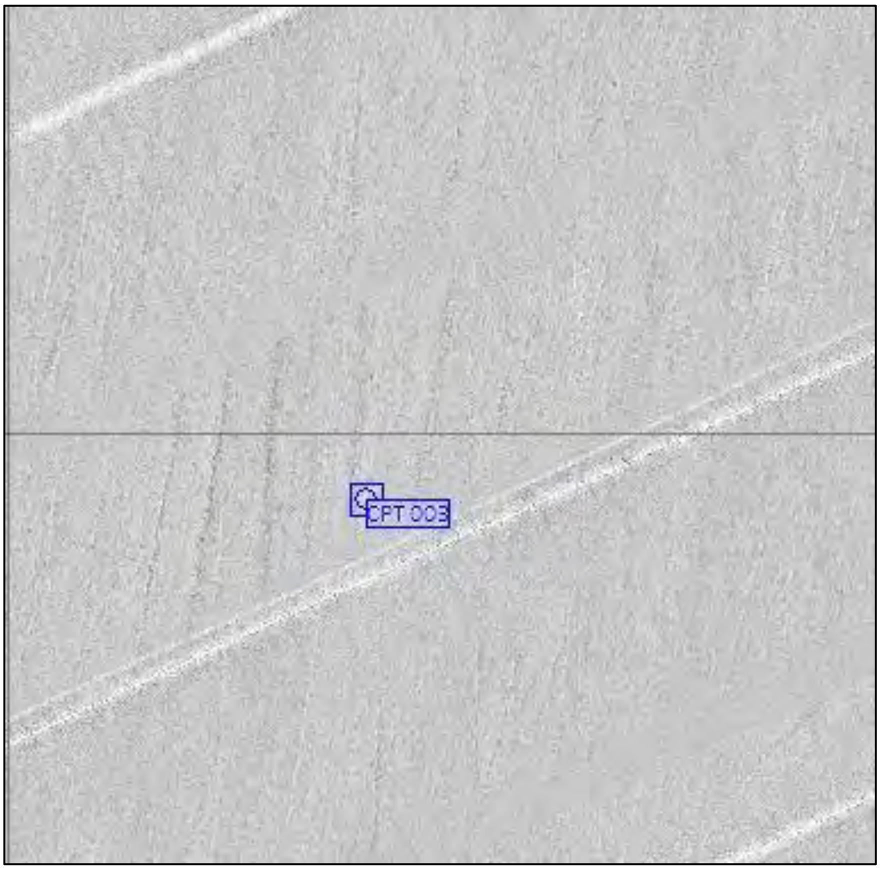
Depth: 77.3 m
Expected sediments: succession of sandy layers and muddy.sily units, overlaying coarse sediment
Anomalies: No magnetic anomalies within the 300m x 300m area.



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

S1-1_CEC_CPT_04 / S1-1_CEC_GC_04
(S1-1_BLOCK01)

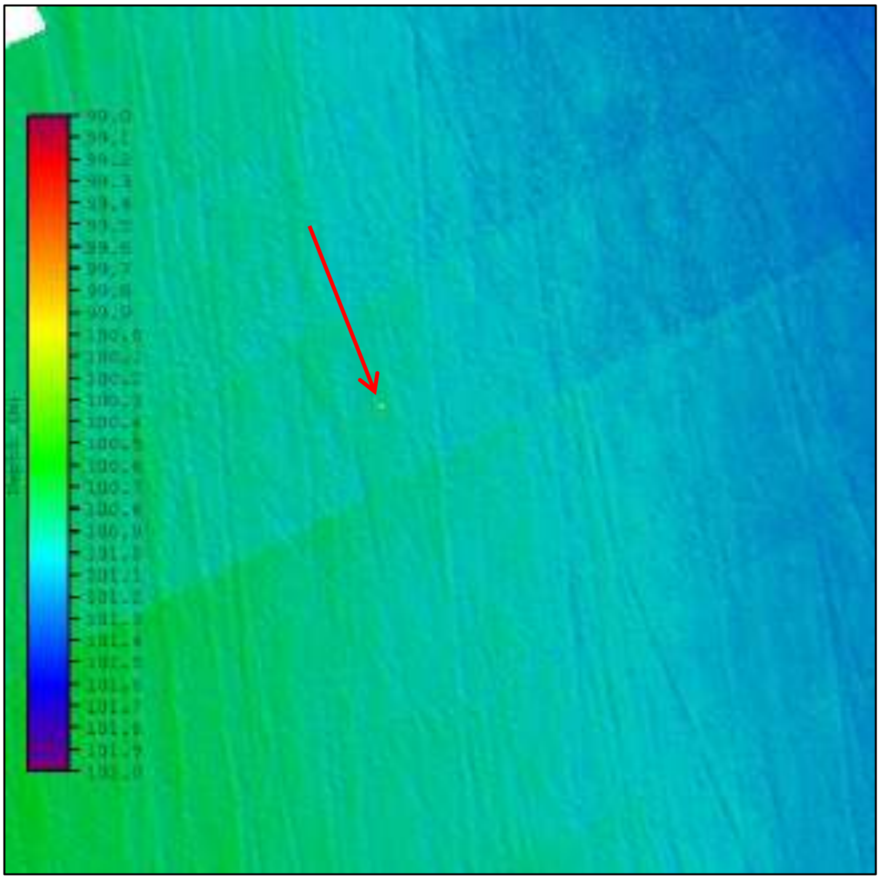
Proposed: 53° 40.2649' N, 005° 35.0173' W

CPT As Taken: 53° 40.2635'N, 005° 35.0189'W / 53° 40.2663'N, 005° 35.0205'W

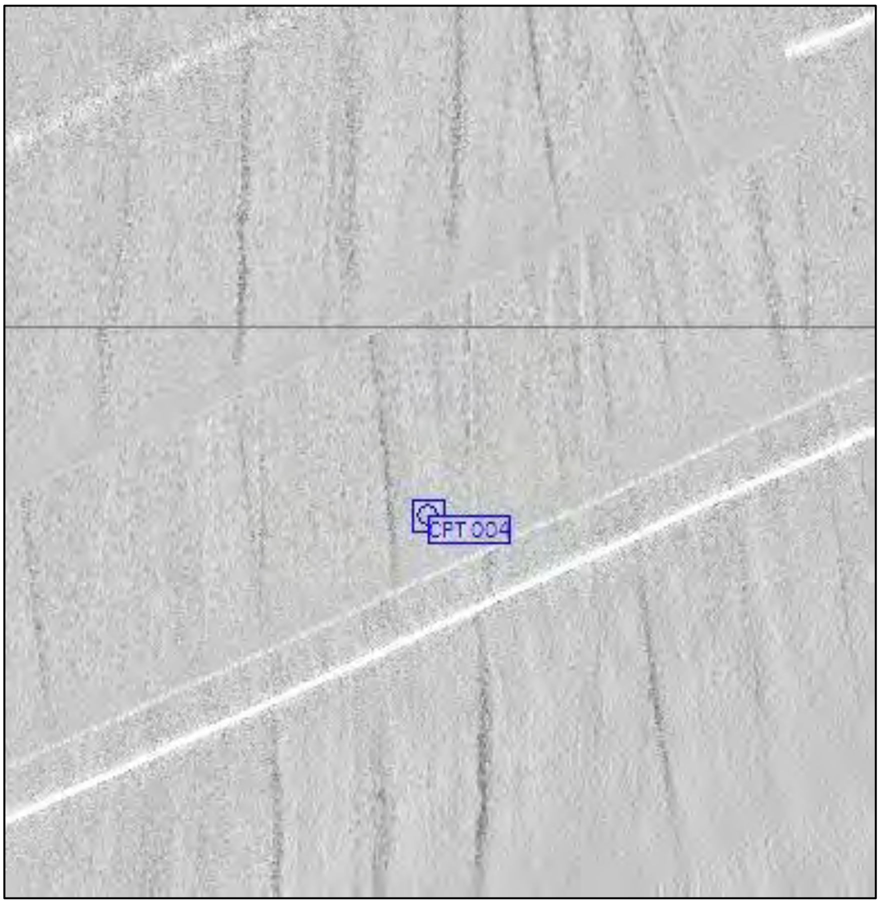
GC As Taken: 53° 40.2662'N, 005° 35.0152'W

Depth: 100.9 m
Expected sediments: succession of coarse sandy layer
Anomalies: No magnetic anomalies within the 300m x 300m area.

SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

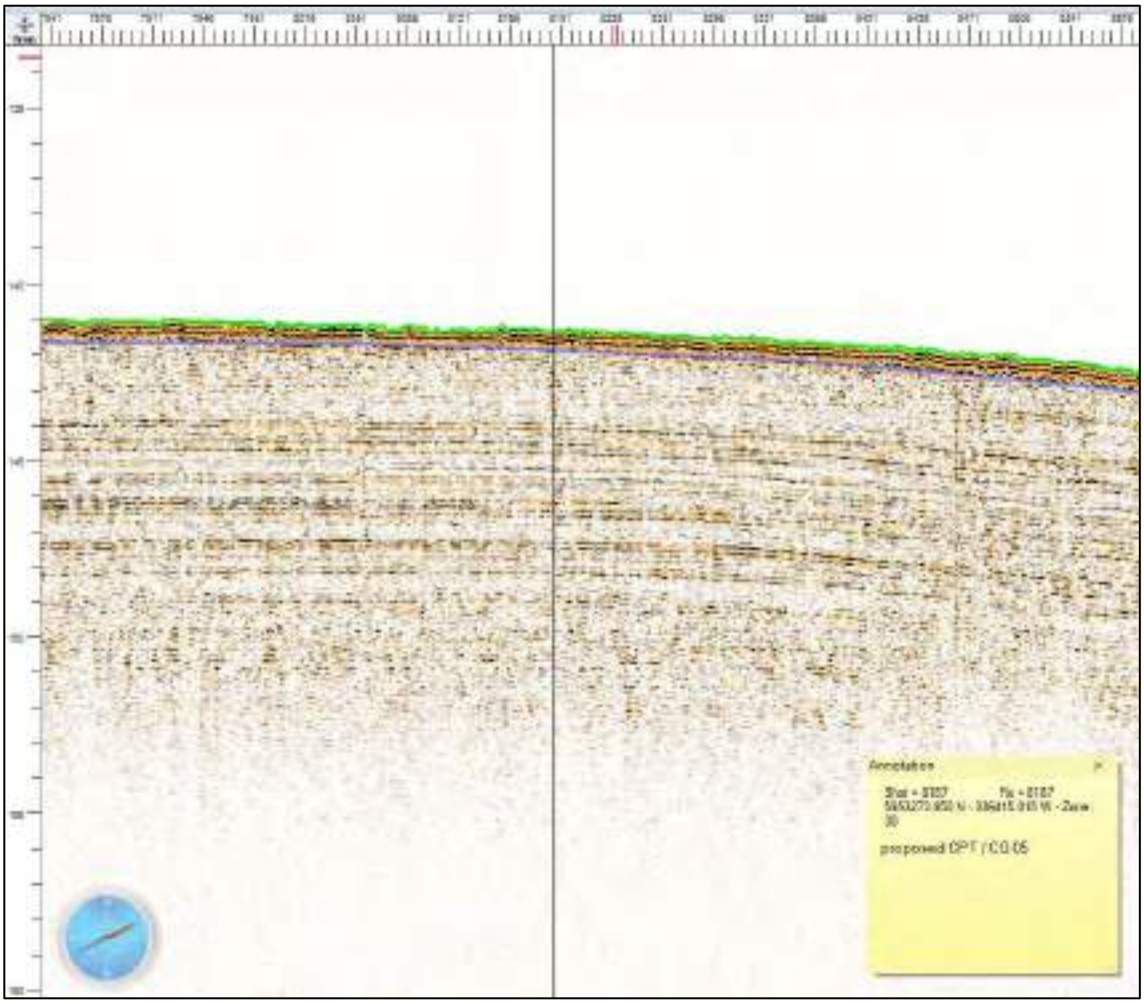
S1-1_CEC_CPT_05 / S1-1_CEC_GC_05
(S1-1_BLOCK02)

Proposed: 53° 42.1497' N, 005° 28.6914' W

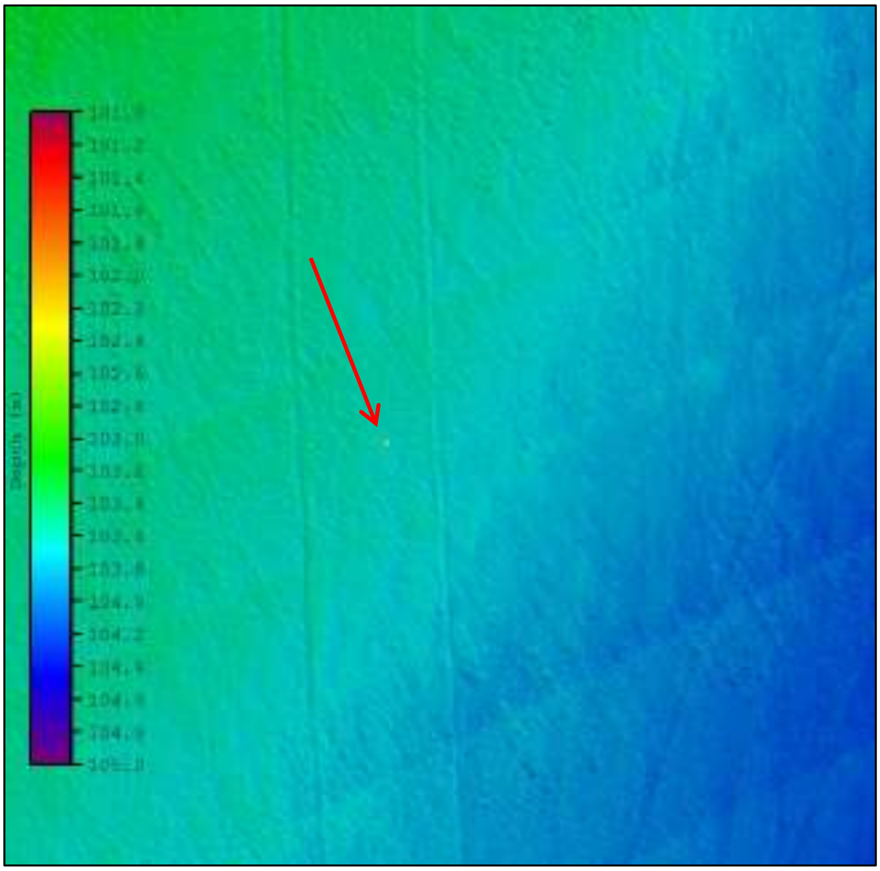
CPT As Taken: 53° 42.1523'N, 005° 28.6930'W

GC As Taken: 53° 42.1498'N, 005° 28.6921'W

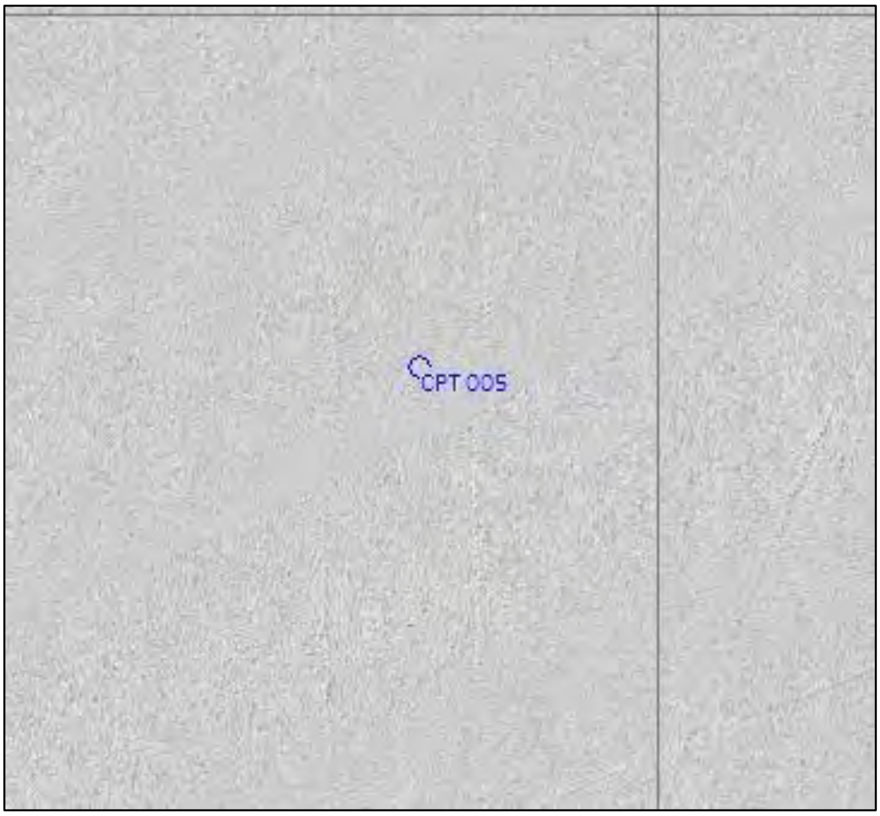
Depth: 103.7 m
Exected sediments: silty-sandy sediments overlaying a succession of coarse sandy layers
Anomalies: No magnetic anomalies within the 300m x 300m area.



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

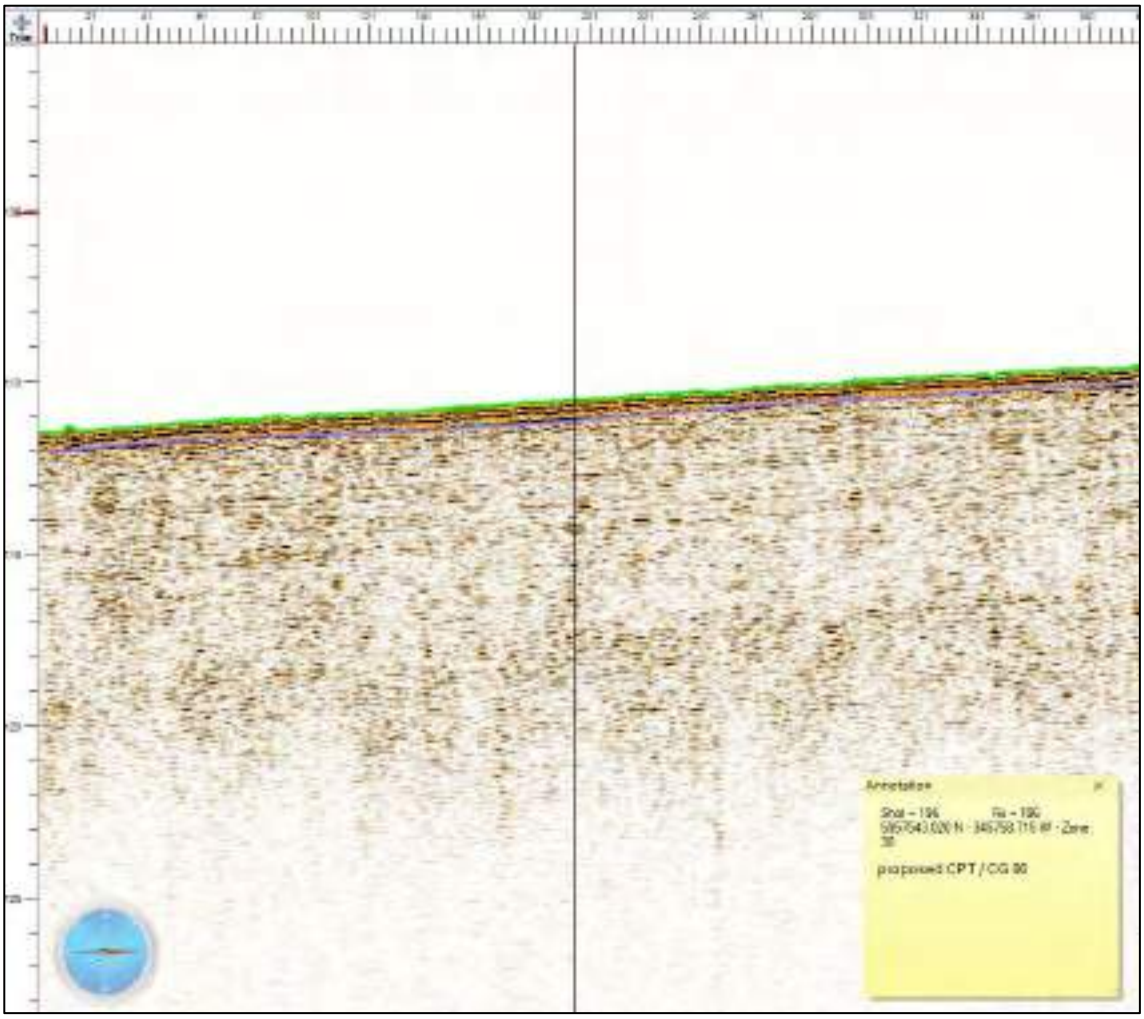
S1-1_CEC_CPT_06 / S1-1_CEC_GC_06
(S1-1_BLOCK02)

Proposed: 53° 44.6207' N, 005° 20.3341' W

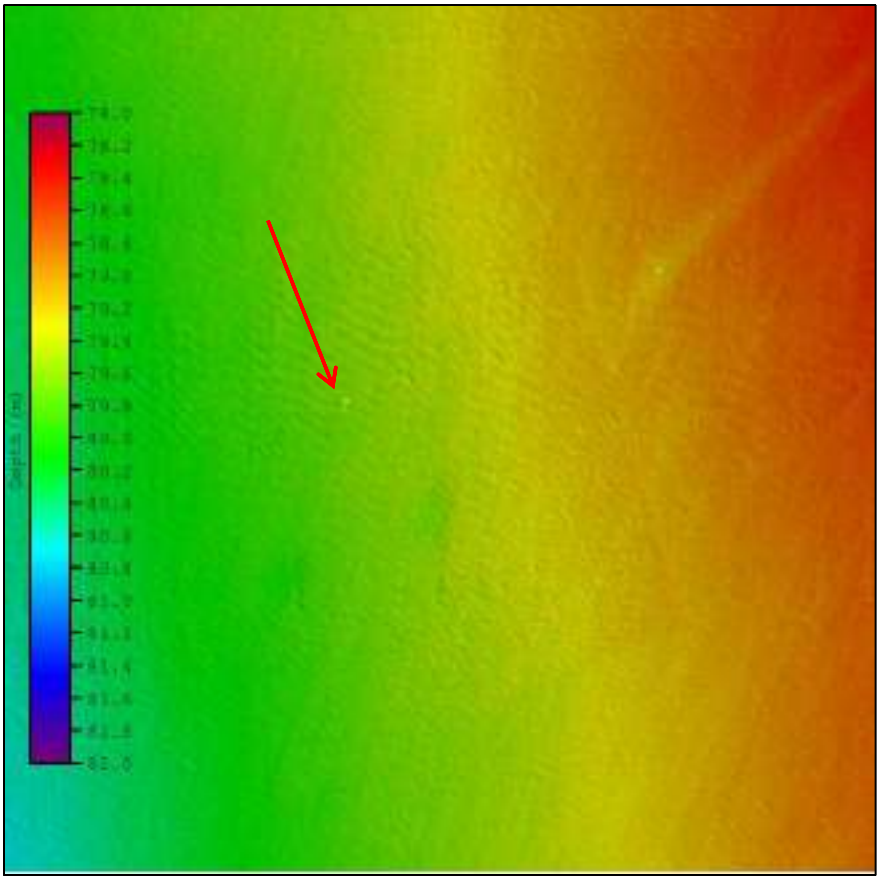
CPT As Taken: 53° 44.6213'N, 005° 20.3342'W

GC As Taken: 53° 44.6221'N, 005° 20.3339'W

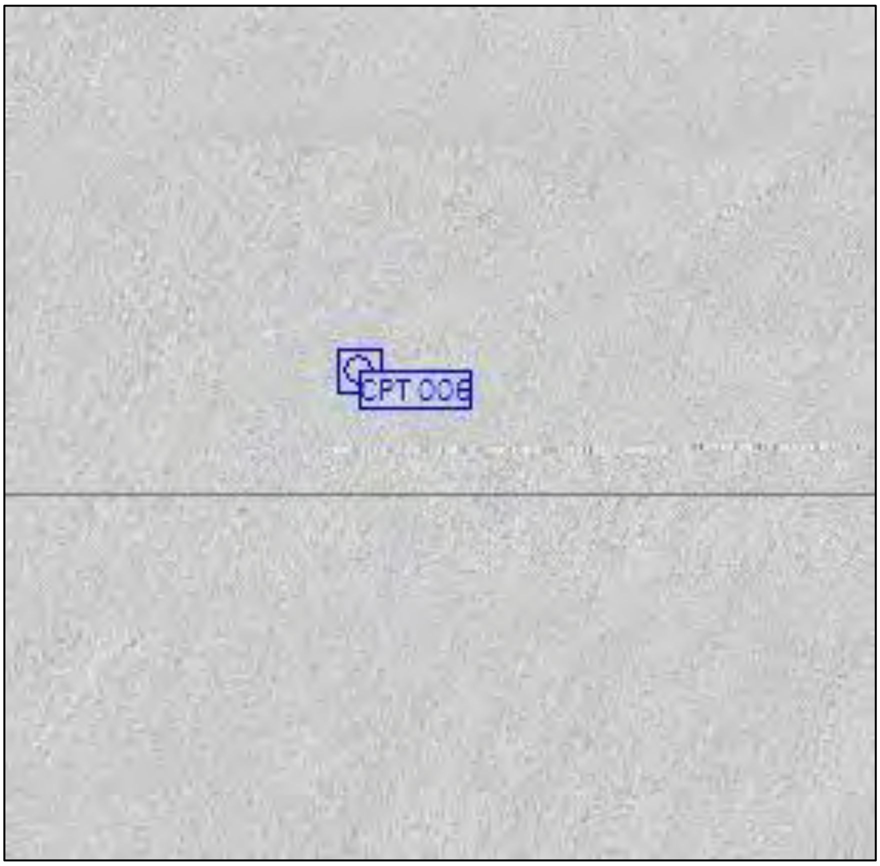
Depth: 79.6 m
Expected sediments: medium to coarse sediment
Anomalies: No magnetic anomalies within the 300m x 300m area.



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

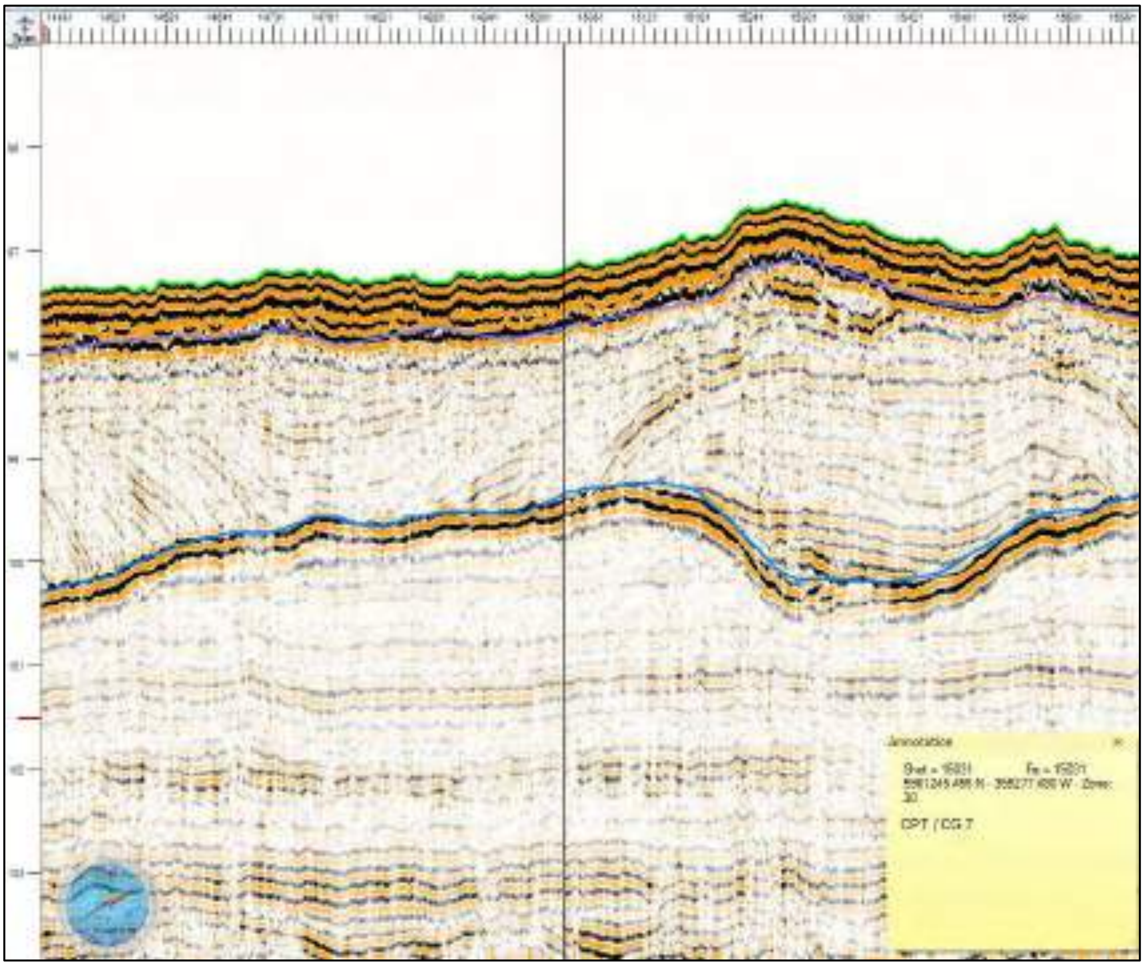
S1-1_CEC_CPT_07 / S1-1_CEC_GC_07
(S1-1_BLOCK02)

Proposed: 53° 46.78' N, 005° 11.78' W

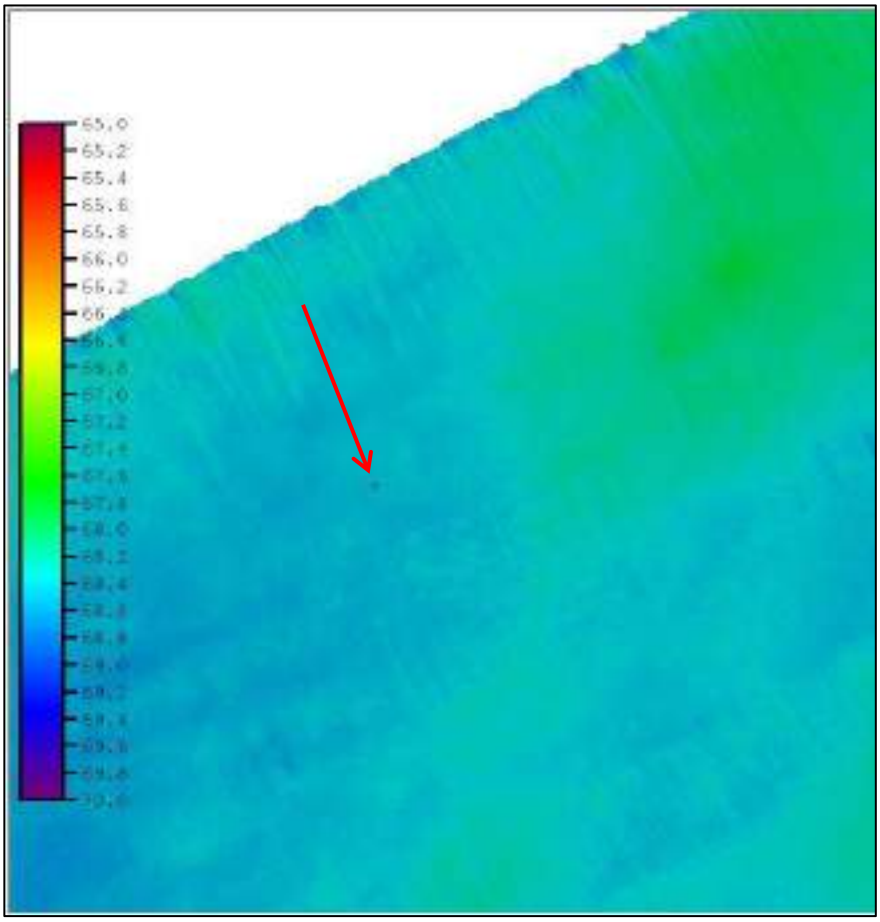
CPT As Taken: 53° 46.7802'N, 005° 11.7848'W

GC As Taken: 53° 46.7802'N, 005° 11.7840'W

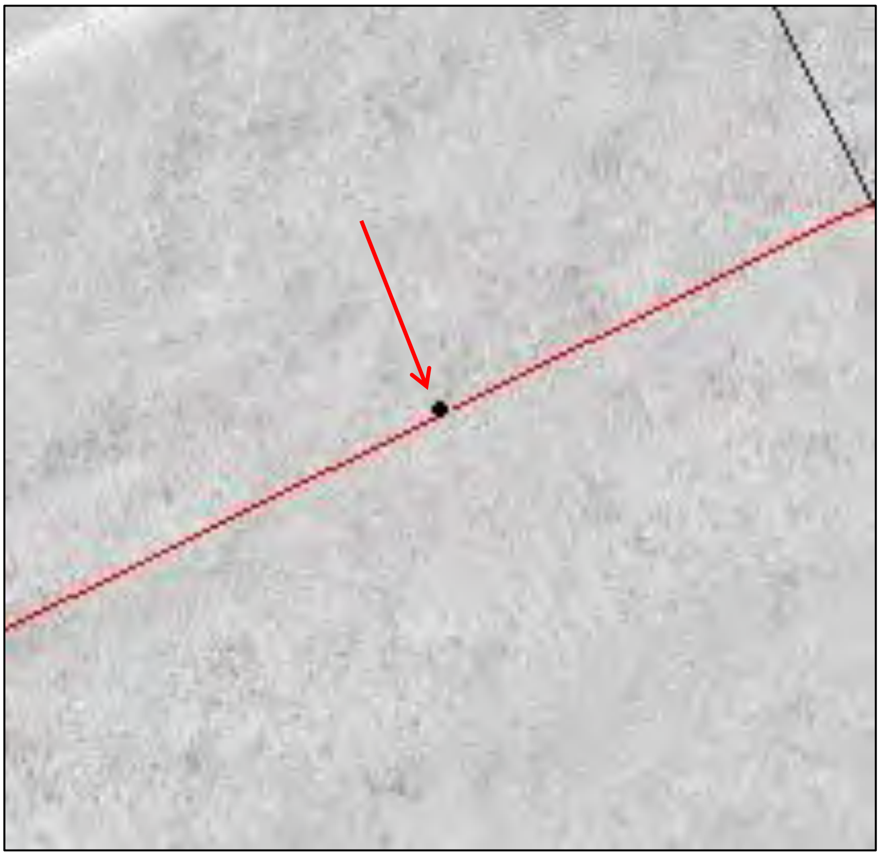
Depth: 68.5 m
Expected sediments: succession of sandy layers overlaying coarse sediments



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

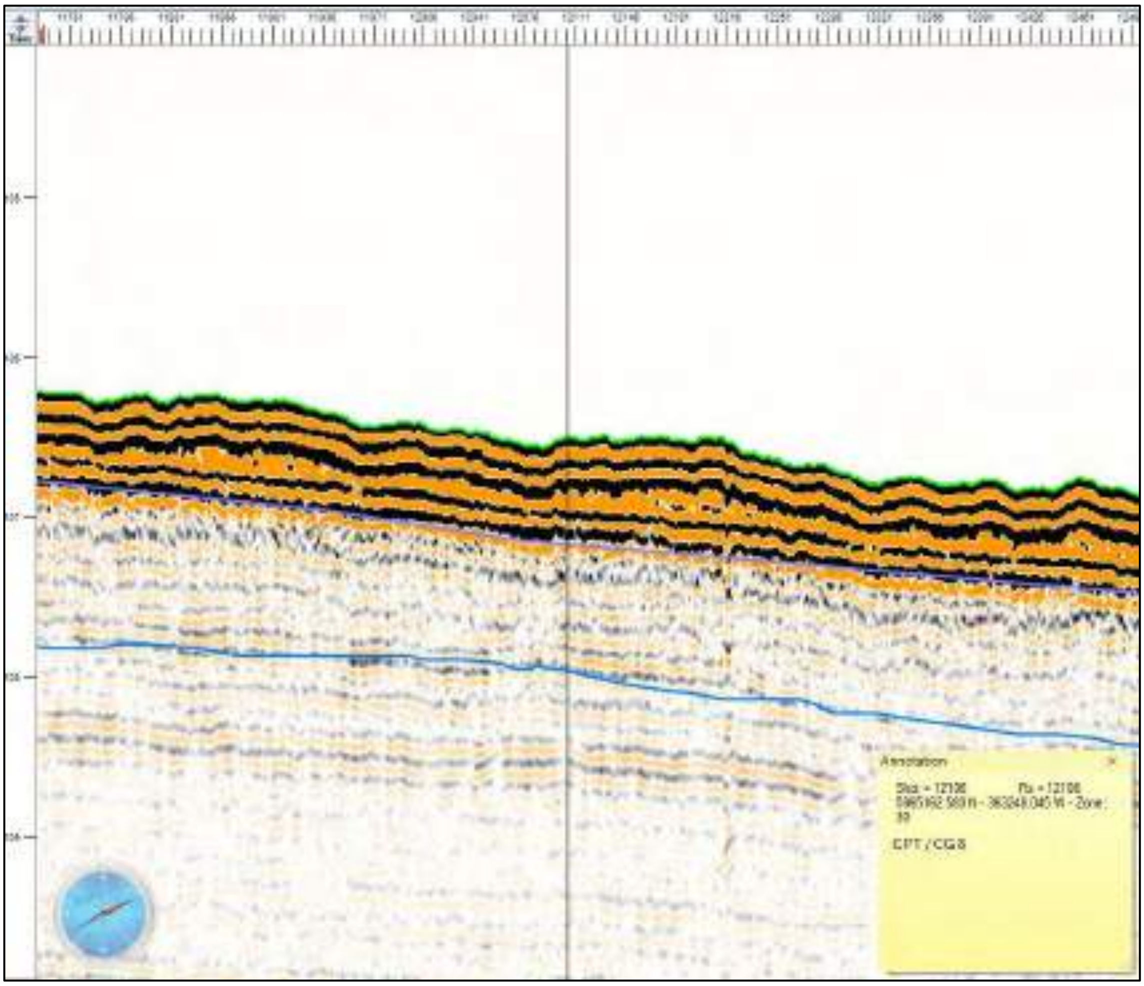
S1-1_CEC_CPT_08 / S1-1_CEC_GC_08
(S1-1_BLOCK02)

Proposed: 53° 49.02' N, 005° 04.64' W

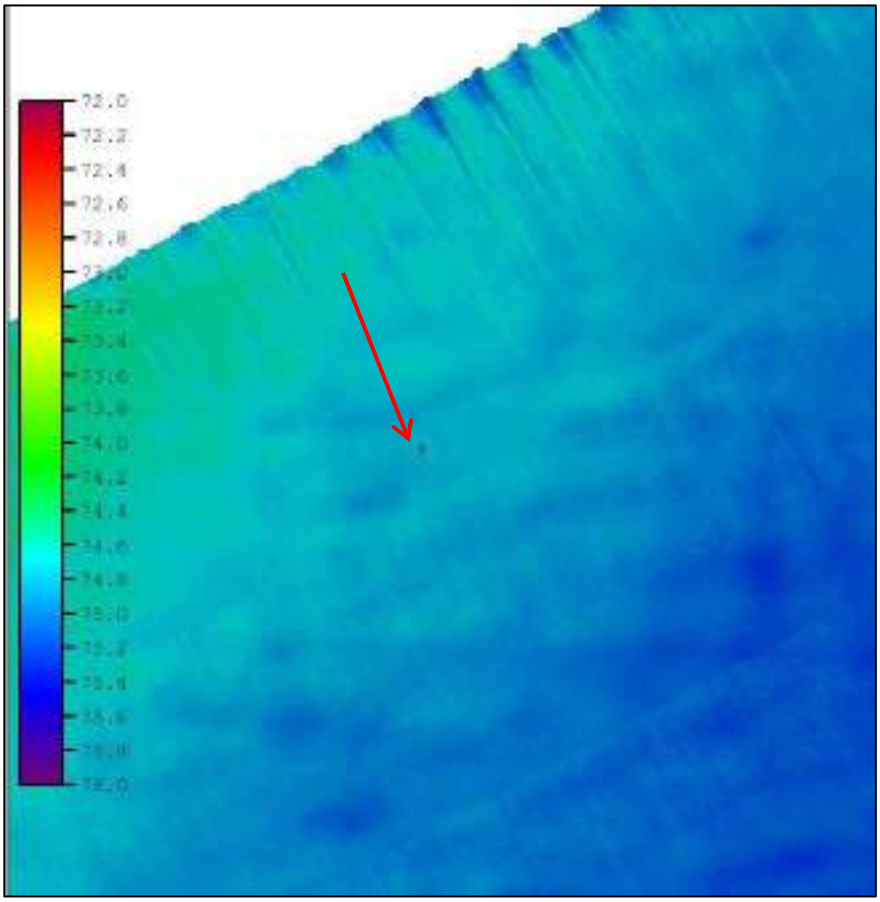
CPT As Taken: 53° 49.0187'N, 005° 04.6371'W

GC As Taken: 53° 49.0199'N, 005° 04.6350'W

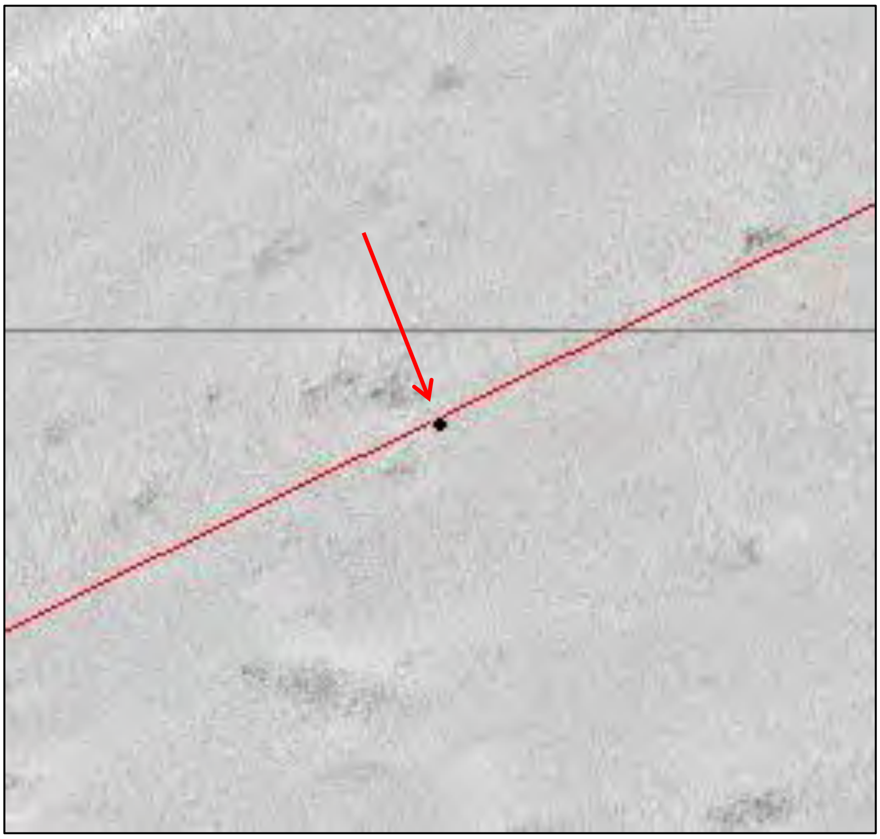
Depth: 74.8 m
Expected sediments: succession of muddy-sandy layers



SBP data sample



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

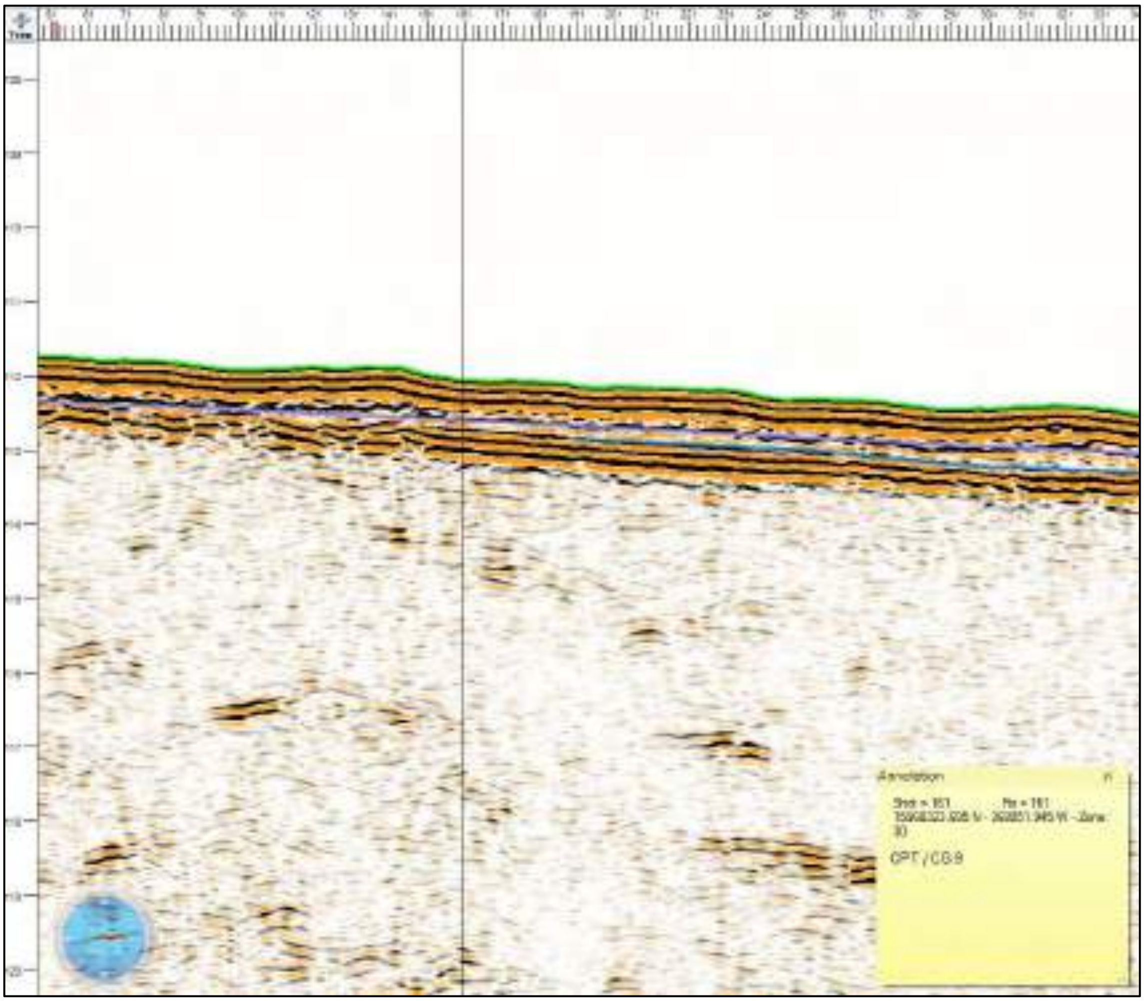
S1-3_CEC_CPT_09 / S1-3_CEC_GC_09
(S1_BU Port Erin)

Proposed: 53° 50.81' N, 004° 59.61' W

CPT As Taken: 53° 50.8107'N, 004° 59.6113'W

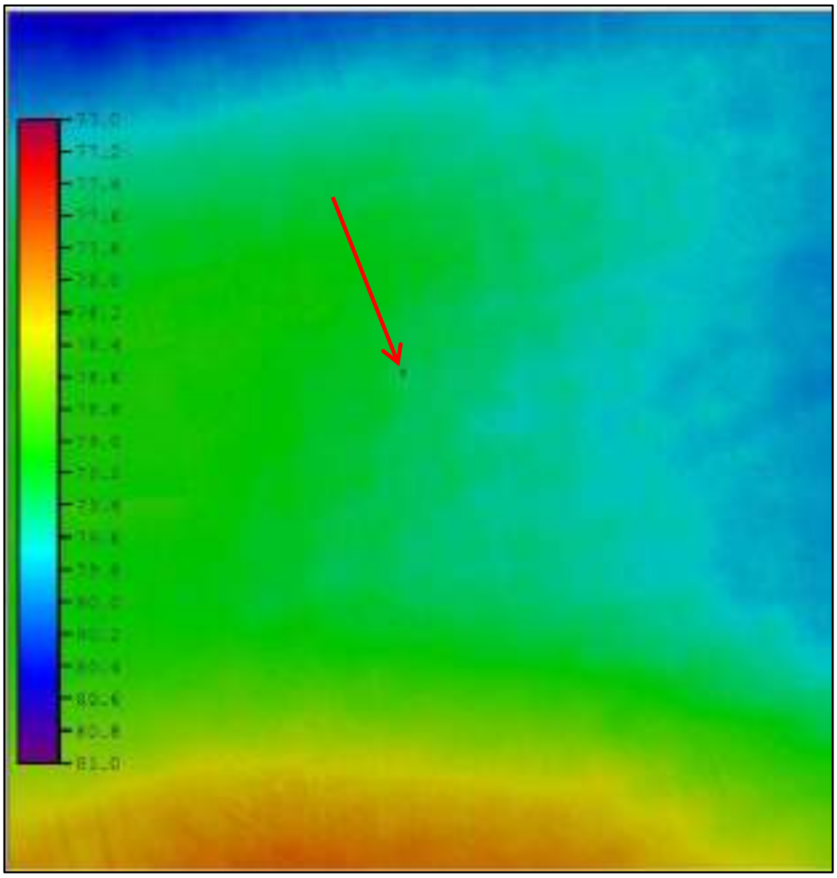
GC As Taken: 53° 50.8098'N, 004° 59.6137'W

Depth: 79.4 m
Expected sediments: sandy unit overlaying a succession of silty sandy layers

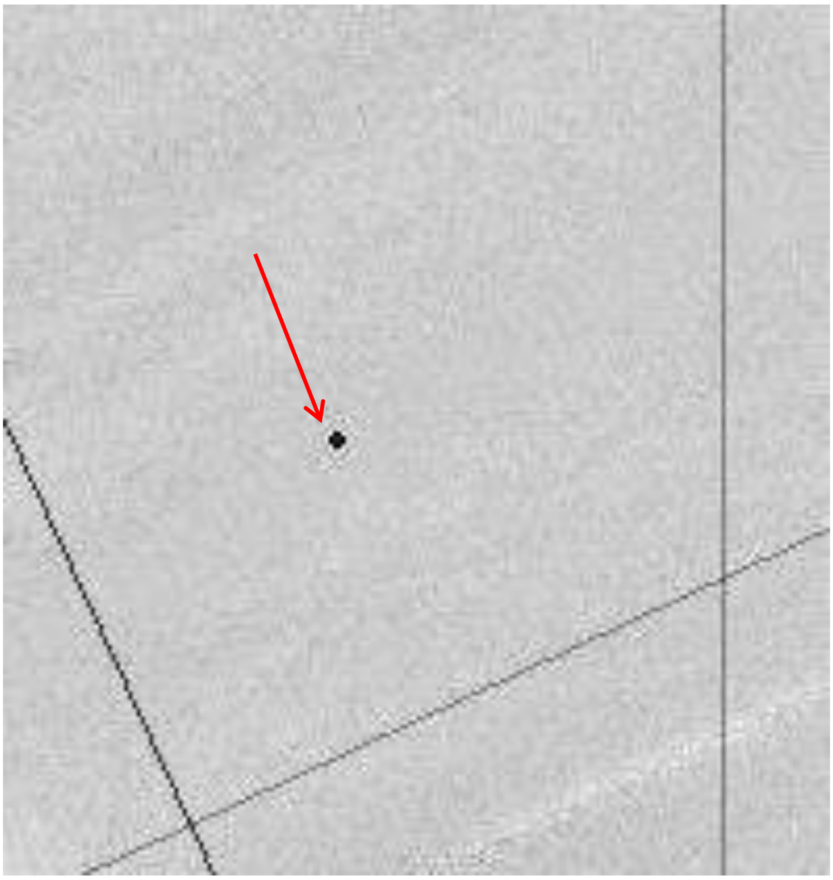


SBP data sample

Proposed Geotechnical Locations



MBES data sample (300m x 300m)



SSS data sample (300m x 300m)

G.2 Core and Grab Sample Results

Havhingsten

S1-1_AL_GS_02

Grab Sample

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	0.5	1

Position Details

Easting:	546835	**Latitude:**	53°32.5997 N	**Ellipsoid:**	WGS 84
Northing:	4052685	**Longitude:**	6°04.8838 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	
	Slightly silty fine to medium SAND with common shell fragments and black particles (possible organic remains),rare elongated,fibrous organic matter up to 10mm	2.5Y 3/2	very dark grayish brown

Comments:

Havhingsten

S1-1_AL_GS_03

Grab Sample

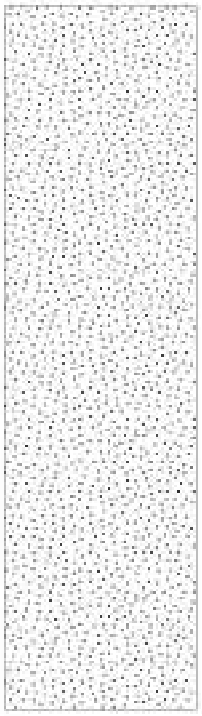
Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	4	1

Position Details

Easting:	547127	**Latitude:**	53°32.6119 N	**Ellipsoid:**	WGS 84
Northing:	4052703	**Longitude:**	6°04.6069 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	
	Fine to medium SAND with common fine grained shell fragments and black particles (possible organic remains)	5Y 4/2	olive gray

Comments:

Havhingsten

S1-1_AL_GS_04

Grab Sample

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	6	1

Position Details

Easting:	547517	**Latitude:**	53°32.6742 N	**Ellipsoid:**	WGS 84
Northing:	4052814	**Longitude:**	6°04.2419 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	
	Fine to medium SAND with common fine grained shell fragments and black particles (possible organic remains), rare shell fragments 5mm to 10mm	5Y 3/2	dark olive gray

Comments:

Havhingsten

S1-1_AL_GS_05

Grab Sample

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	9	1

Position Details

Easting:	548022	**Latitude:**	53°32.7455 N	**Ellipsoid:**	WGS 84
Northing:	4052943	**Longitude:**	6°03.7684 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	
	Fine to medium SAND with common fine grained black particle (possible organic remains) and shell fragments (5mm - 10mm), rare shells (<10mm)	5Y 3/2	dark olive gray

Comments:

Havhingsten

S1-1_AL_GS_06

Grab Sample

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	12	1

Position Details

Easting:	548463	**Latitude:**	53°32.8128 N	**Ellipsoid:**	WGS 84
Northing:	4053063	**Longitude:**	6°03.3542 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	
	Silty fine to medium SAND, rare shell fragments and organic contant	5Y 3/1	very dark gray

Comments:

Havhingsten

S1-1_AL_GS_07

Grab Sample

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	13	1

Position Details

Easting:	548900	**Latitude:**	53°32.8654 N	**Ellipsoid:**	WGS 84
Northing:	4053157	**Longitude:**	6°02.9450 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	
	Silty fine to medium SAND, occasiona fine grained shell fragments (<1mm), rare fine grained black particles (possible organic remains)	5Y 3/1	very dark gray

Comments:

Havhingsten

S1-1_AL_GS_08

Grab Sample

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Grab Vol [m³]
MV Alumaster	10/3/18	14	0

Position Details

Easting:	549317.8	**Latitude:**	53.32.9314 N	**Ellipsoid:**	WGS 84
Northing:	4053240.4	**Longitude:**	6°02.3039 W	**Projection:**	Mercator

Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)
	NO RECOVERY Silty fine to medium SAND, rare shell fragments and organic contant (Volume too small, sample unsucessful)	

Comments:

HAVHINGSTEN

S1-1_CEC_GC_01

Gravity core

Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/21/18	24.4	0	0	3

Position Details

Easting:	552053.7	**Latitude:**	53° 33.3150' N	**Ellipsoid:**	WGS 84
Northing:	4053962	**Longitude:**	05° 59.9882' W	**Projection:**	Mercator 55N 01E

Depth [cm]	Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	Shear strength [kPa] 16.0 – 26.0
0–10		NO RECOVERY.		

Comments:
NO RECOVERY.

HAVHINGSTEN

S1-1_CEC_GC_01a

Gravity core

Irish Sea

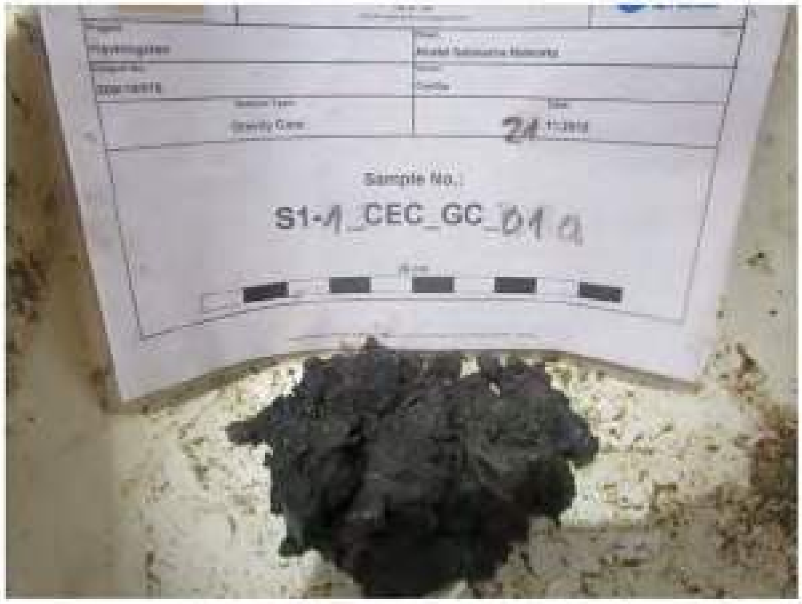
Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/21/18	24.4	0.05	0.4	3

Position Details

Easting:	552053.6	**Latitude:**	53° 33.3168' N	**Ellipsoid:**	WGS 84
Northing:	4053965.4	**Longitude:**	05° 59.9883' W	**Projection:**	Mercator 55N 01E

Depth [cm]	Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)		Shear strength [kPa] 16.0 – 26.0
0–5		Fine silty SAND	2.5Y 2.5/1	black	



Comments:

Small sample collected from bottom end of liner.

HAVHINGSTEN

S1-1_CEC_GC_02

Gravity core

Irish Sea

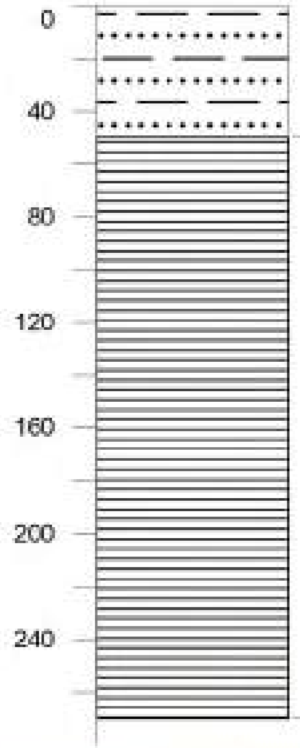
Sampling Details

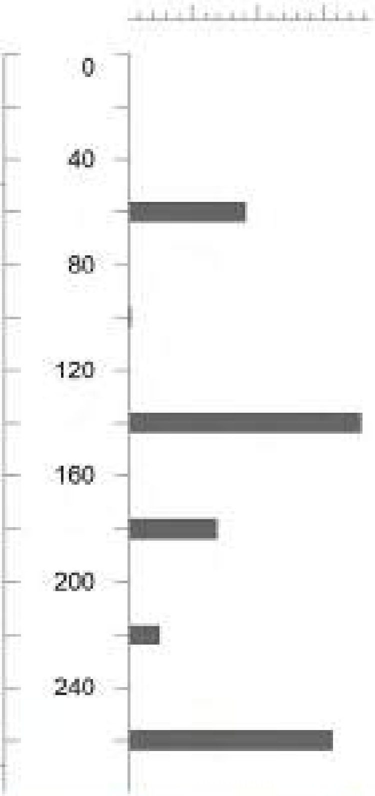
Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/22/18	57.5	2.7	3	3

Position Details

Easting:	561247.7	**Latitude:**	53° 35.3881' N	**Ellipsoid:**	WGS 84
Northing:	4057676.9	**Longitude:**	05° 51.3681' W	**Projection:**	Mercator 55N 01E

Depth [cm]	Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)		Shear strength [kPa]
0–50		Clayey SILT with shell fragments	2.5Y 4/1	black	
50–270		Very soft CLAY with shell fragments	2.5Y 2.5/1	black	





Comments:

HAVHINGSTEN

S1-1_CEC_GC_03

Gravity core

Irish Sea

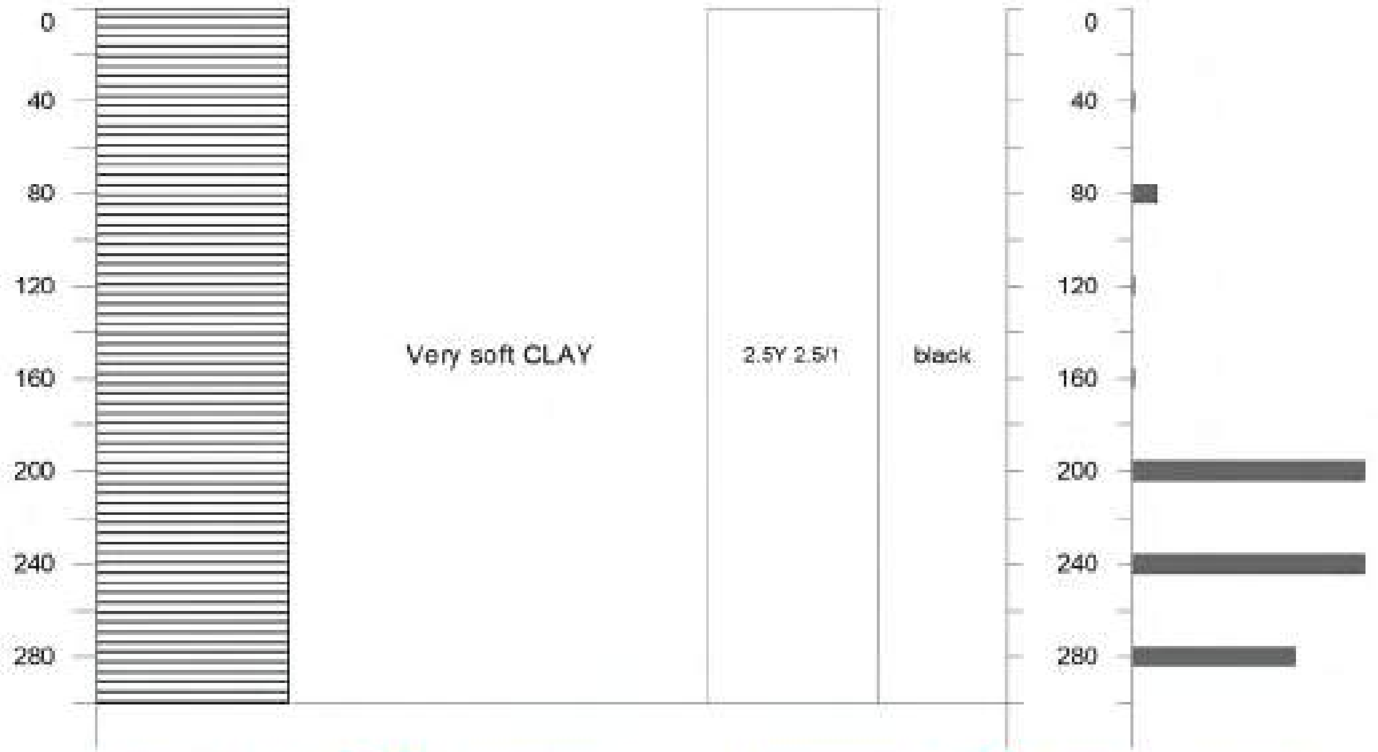
Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/22/18	77.3	3	3	3

Position Details

Easting:	570432.1	**Latitude:**	53° 37.9590' N	**Ellipsoid:**	WGS 84
Northing:	4062287.8	**Longitude:**	05° 42.7568' W	**Projection:**	Mercator 55N 01E

Depth [cm]	Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)	Shear strength [kPa] 1.0 – 11.0



Comments:

HAVHINGSTEN

S1-1_CEC_GC_04

Gravity core

Irish Sea

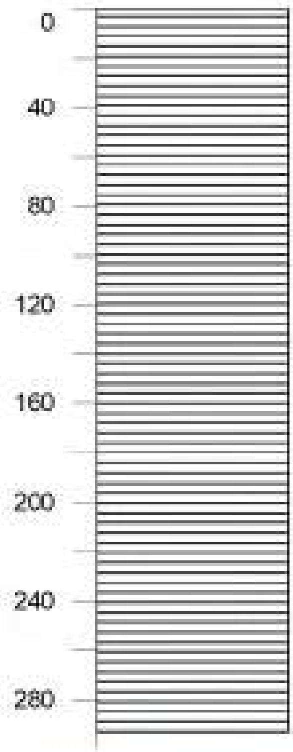
Sampling Details

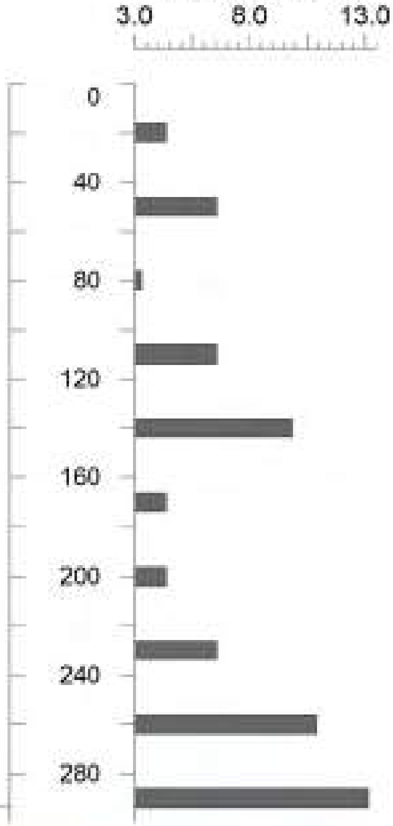
Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/22/18	100.9	2.7	3	3

Position Details

Easting:	578689.1	**Latitude:**	53° 40.2662' N	**Ellipsoid:**	WGS 84
Northing:	4066430	**Longitude:**	05° 35.0152' W	**Projection:**	Mercator 55N 01E

Depth [cm]	Lithology log	Sediment description	Sediment colour (after Munsell Soil Color Chart)		Shear strength [kPa]
		Very soft CLAY	2.5Y 2.5/1	black	





Comments:

Organic smell.

HAVHINGSTEN

S1-1_CEC_GC_05

Gravity core

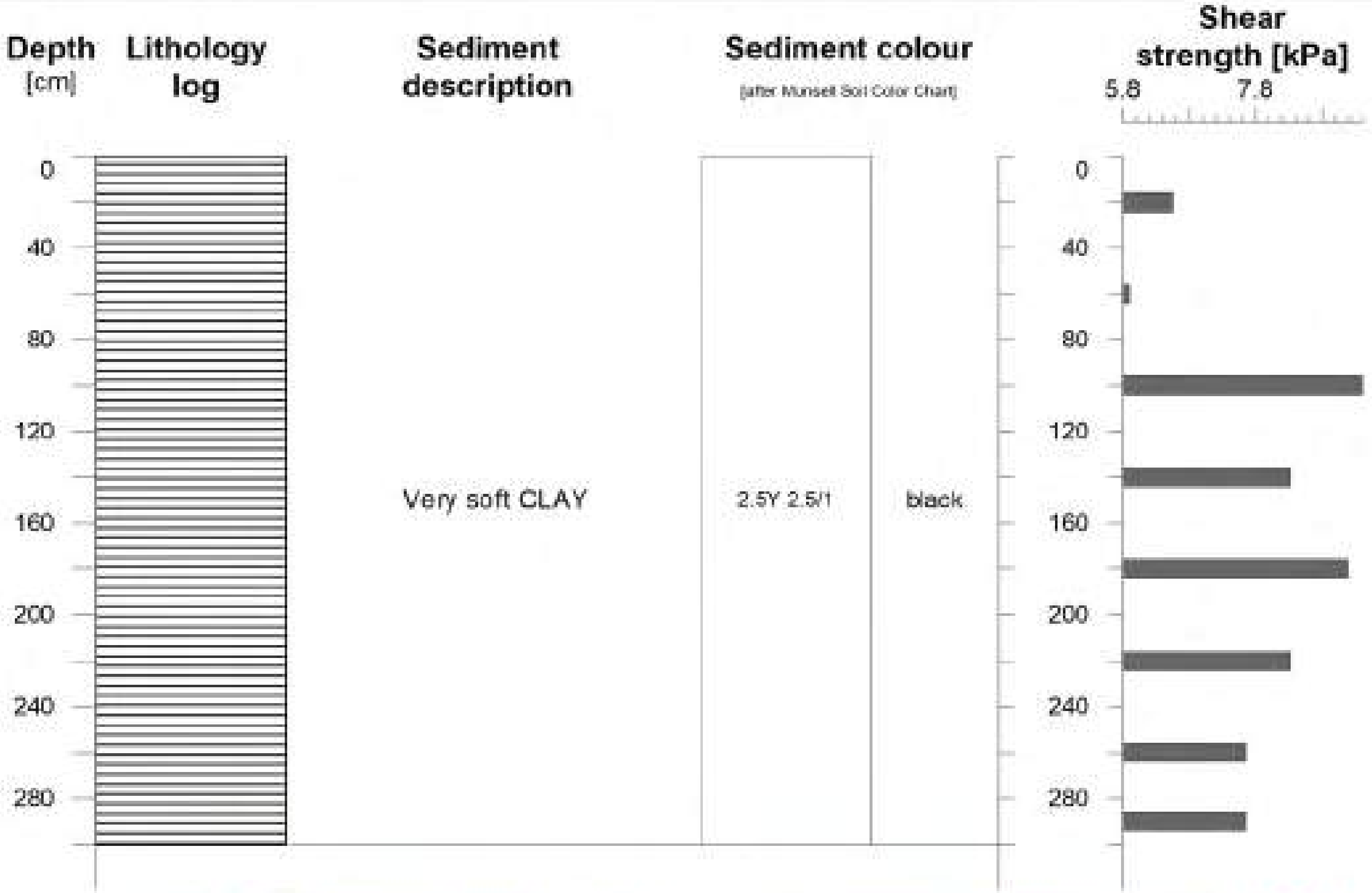
Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/22/18	103.7	3	3	3

Position Details

Easting:	585433.1	**Latitude:**	53° 42.1498' N	**Ellipsoid:**	WGS 84
Northing:	4069814.5	**Longitude:**	05° 28.6921' W	**Projection:**	Mercator 55N 01E



Comments:

Strong organic smell.

HAVHINGSTEN

S1-1_CEC_GC_06

Gravity core

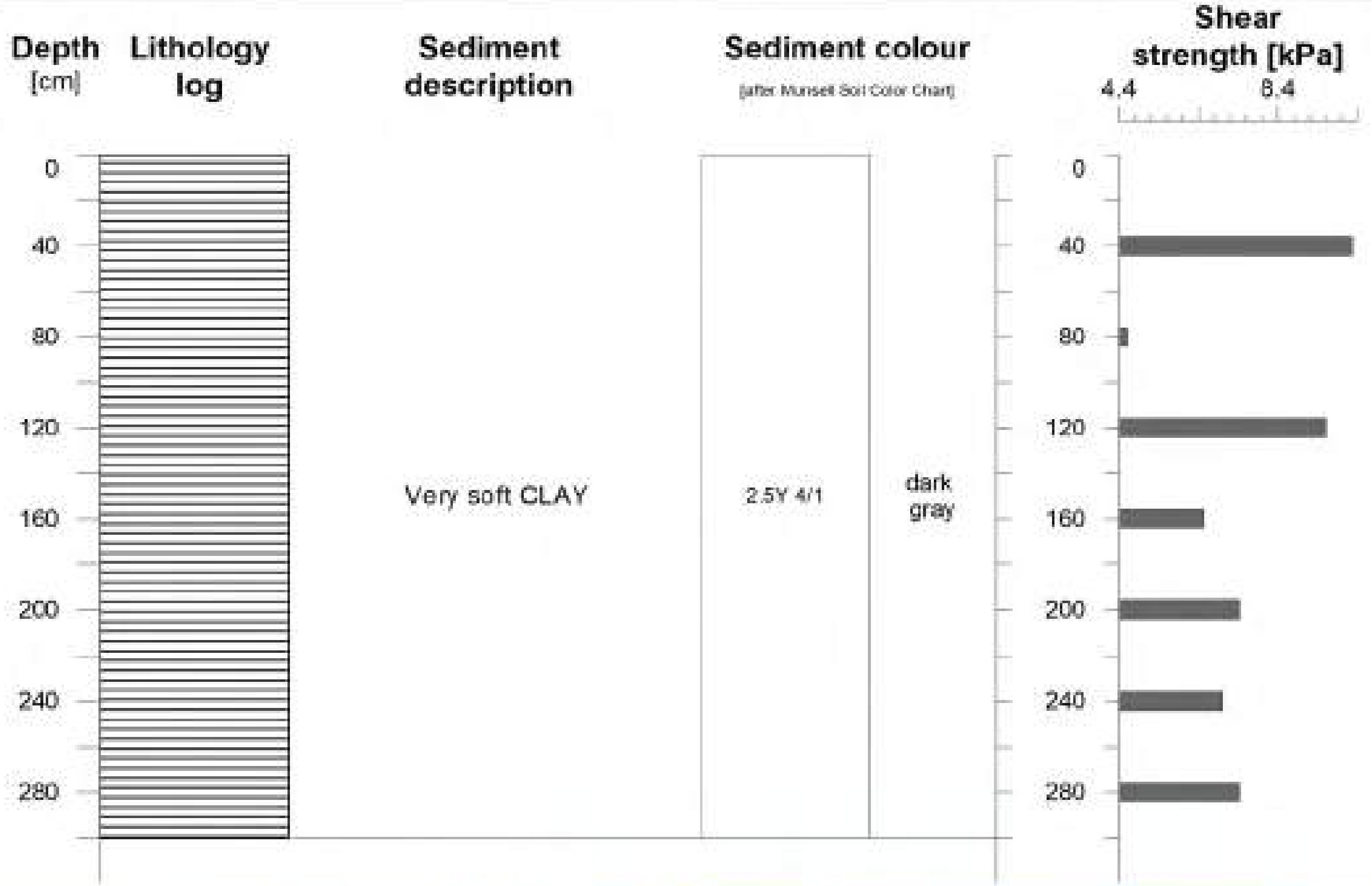
Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/23/18	79.6	3	3	3

Position Details

Easting:	594347.7	**Latitude:**	53° 44.6221' N	**Ellipsoid:**	WGS 84
Northing:	4074260.5	**Longitude:**	05° 20.3339' W	**Projection:**	Mercator 55N 01E



Comments:

HAVHINGSTEN

S1-1_CEC_GC_07

Gravity core

Irish Sea

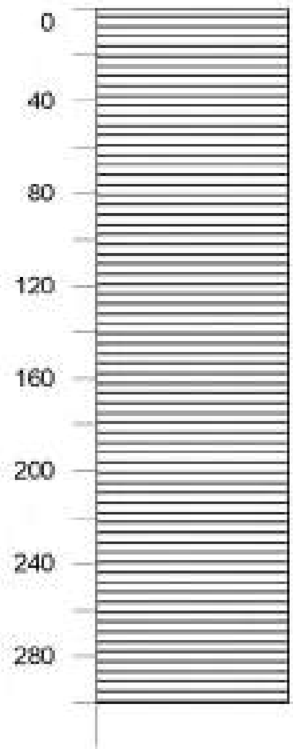
Sampling Details

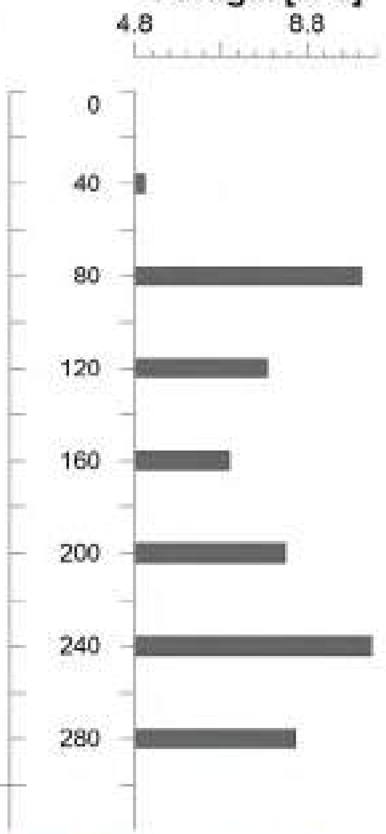
Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/23/18	68.5	3	3	3

Position Details

Easting:	603466.7	**Latitude:**	53° 46.7802' N	**Ellipsoid:**	WGS 84
Northing:	4078145	**Longitude:**	05° 11.7840' W	**Projection:**	Mercator 55N 01E

Depth [cm]	Lithology log	Sediment description	Sediment colour [after Munsell Soil Color Chart]		Shear strength [kPa]
0–300		Very soft CLAY with shell fragments	2.5Y 4/1	dark gray	





Comments:

HAVHINGSTEN

S1-1_CEC_GC_08

Gravity core

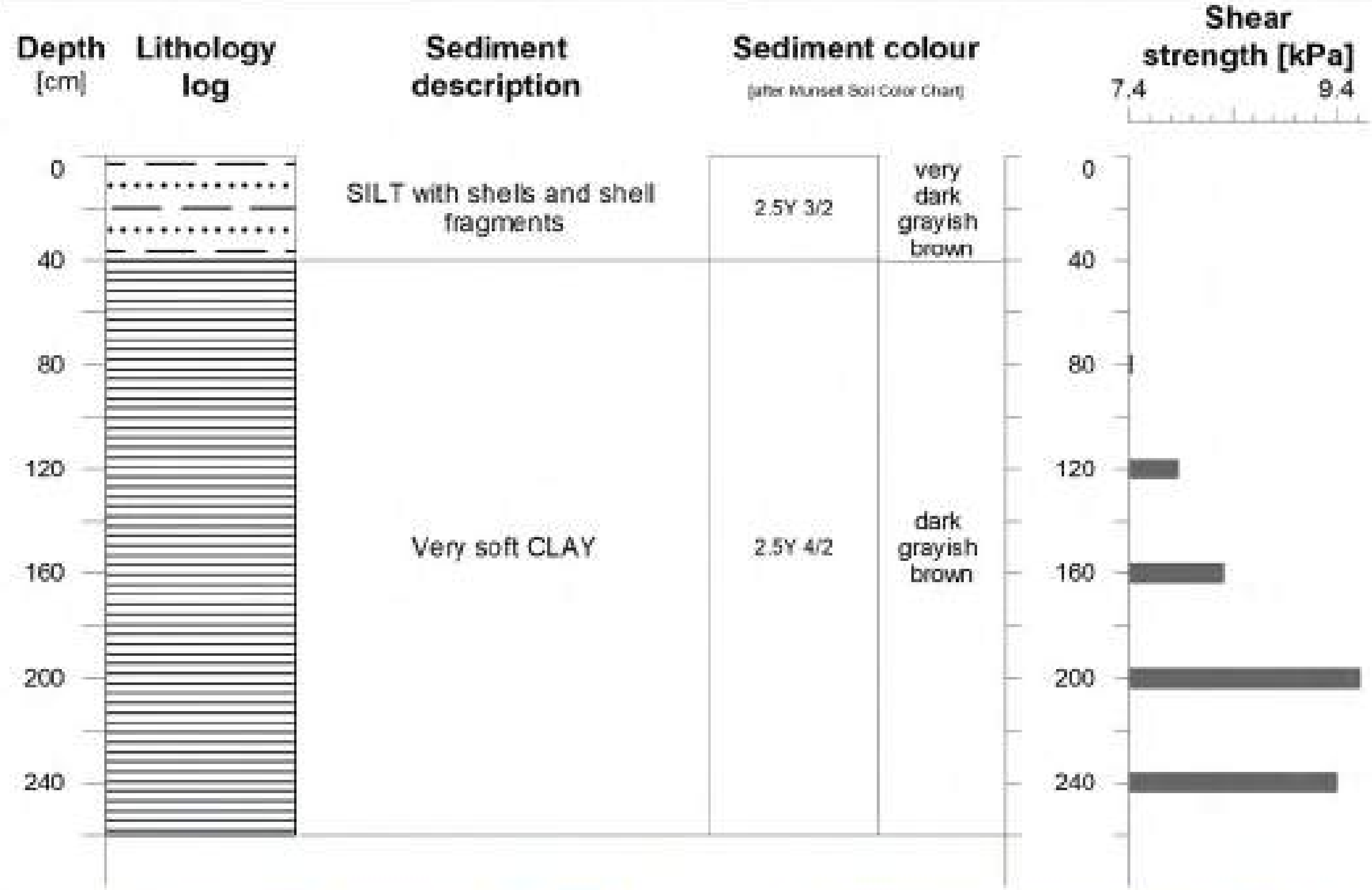
Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/23/18	74.8	2.6	3	3

Position Details

Easting:	611091.7	**Latitude:**	53° 49.0199' N	**Ellipsoid:**	WGS 84
Northing:	4082180.1	**Longitude:**	05° 04.6350' W	**Projection:**	Mercator 55N 01E



Comments:

HAVHINGSTEN

S1-3_CEC_GC_09

Gravity core

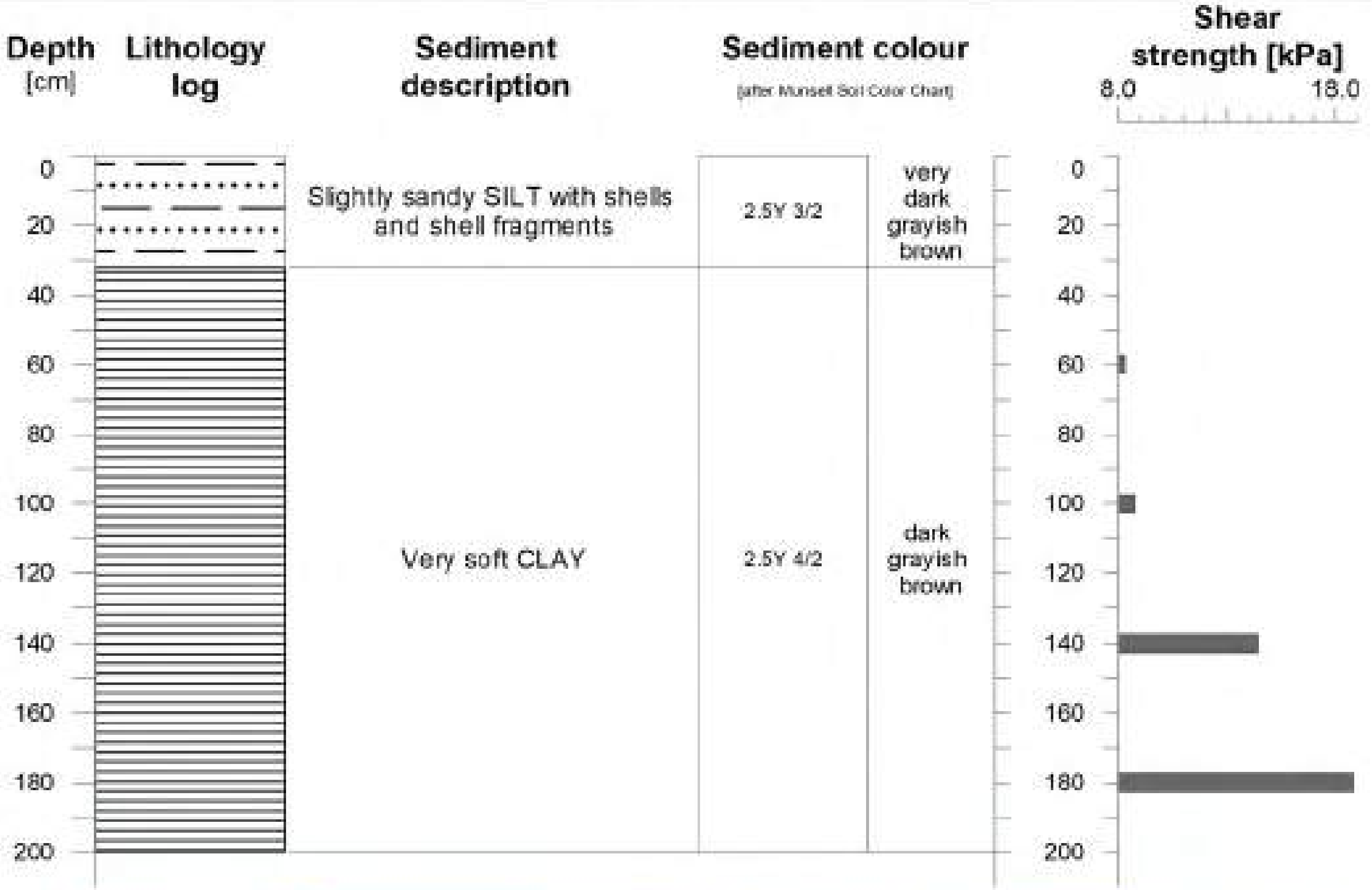
Irish Sea

Sampling Details

Vessel	Date	Water Depth [m]	Recovery [m]	Penetration [m]	Barrel length [m]
OSV Cecilia	11/23/18	79.4	2	3	3

Position Details

Easting:	616447.3	**Latitude:**	53° 50.8098' N	**Ellipsoid:**	WGS 84
Northing:	4085407.3	**Longitude:**	04° 59.6137' W	**Projection:**	Mercator 55N 01E



Comments:

H. APPENDIX H - CPT RESULTS

H.1 Geotechnical Locations Reports

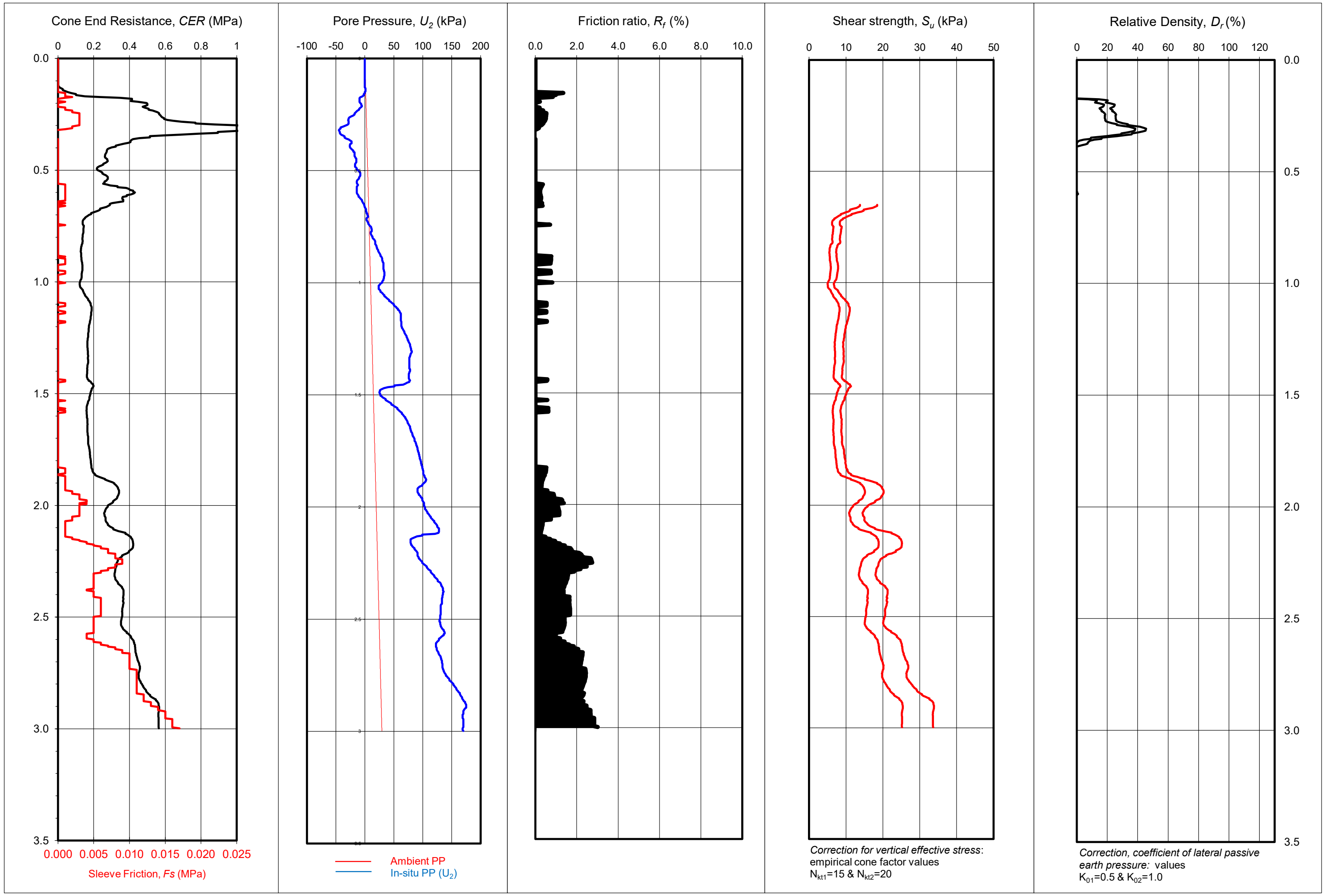
For geotechnical locations reports of the CPT locations please refer to Appendix G.1.

H.2 CPT Plots

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title	Coordinates	53° 50.8107' N	04° 59.6113' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	79.4		**S1-3_CEC_CPT_09**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	25/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Slightly sandy SILT	
0.65	Very soft to soft CLAY	
3.00	*End of CPT.* *Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

S1-3_CEC_CPT_09

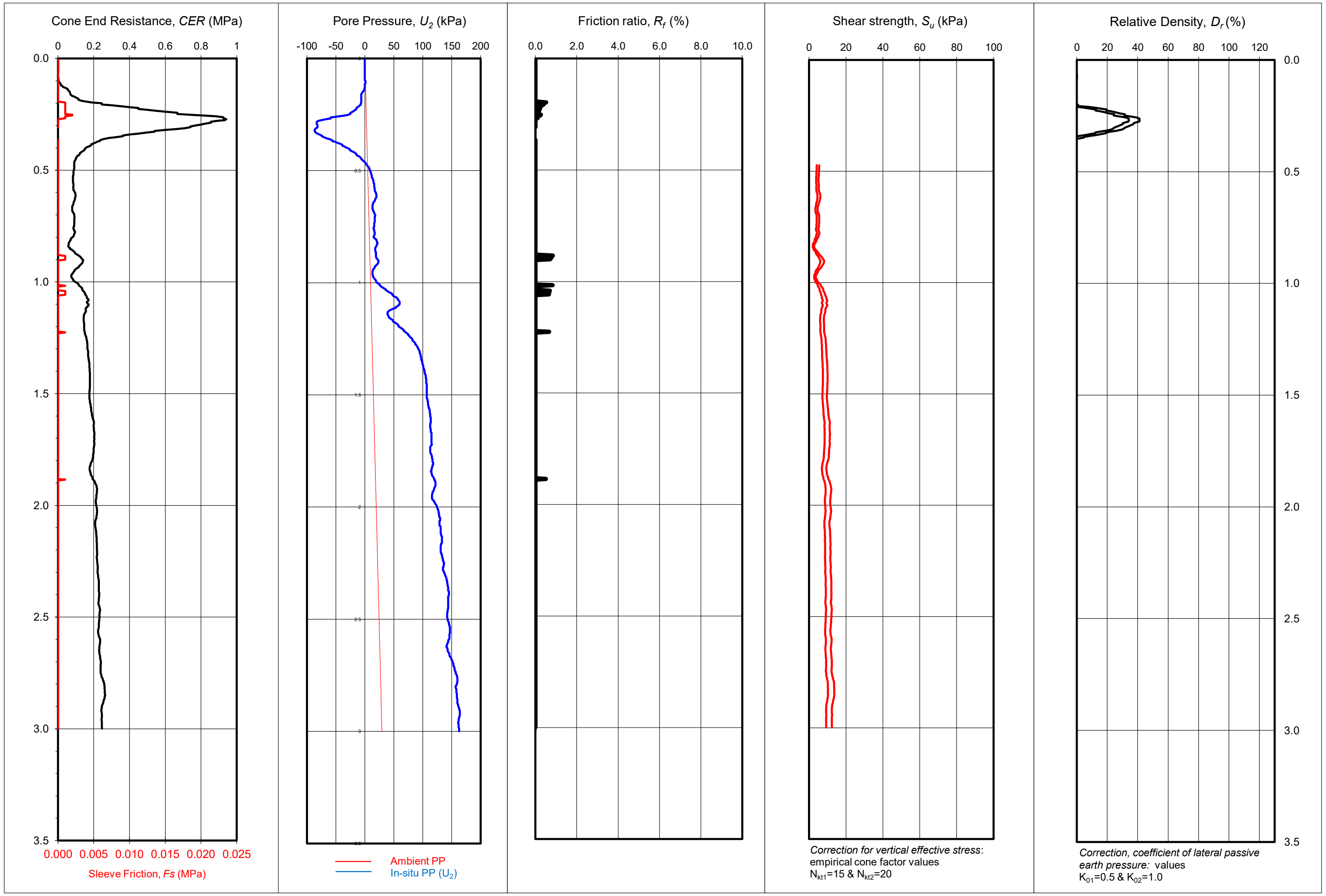
Raw Data Filename : **CPT-090001.cdf**

CONE PENETRATION TEST RESULTS

FUGRO | ALCATEL SUBMARINE NETWORKS

Contract No.	208-18-675	Project Title	Coordinates	53° 49.0187' N	05° 04.6371' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	74.8		**S1-1_CEC_CPT_08**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	25/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Loose SILT	
0.47	Very soft CLAY	
3.00	*End of CPT.* *Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

S1-1_CEC_CPT_08

Raw Data Filename : **CPT-080001.cdf**

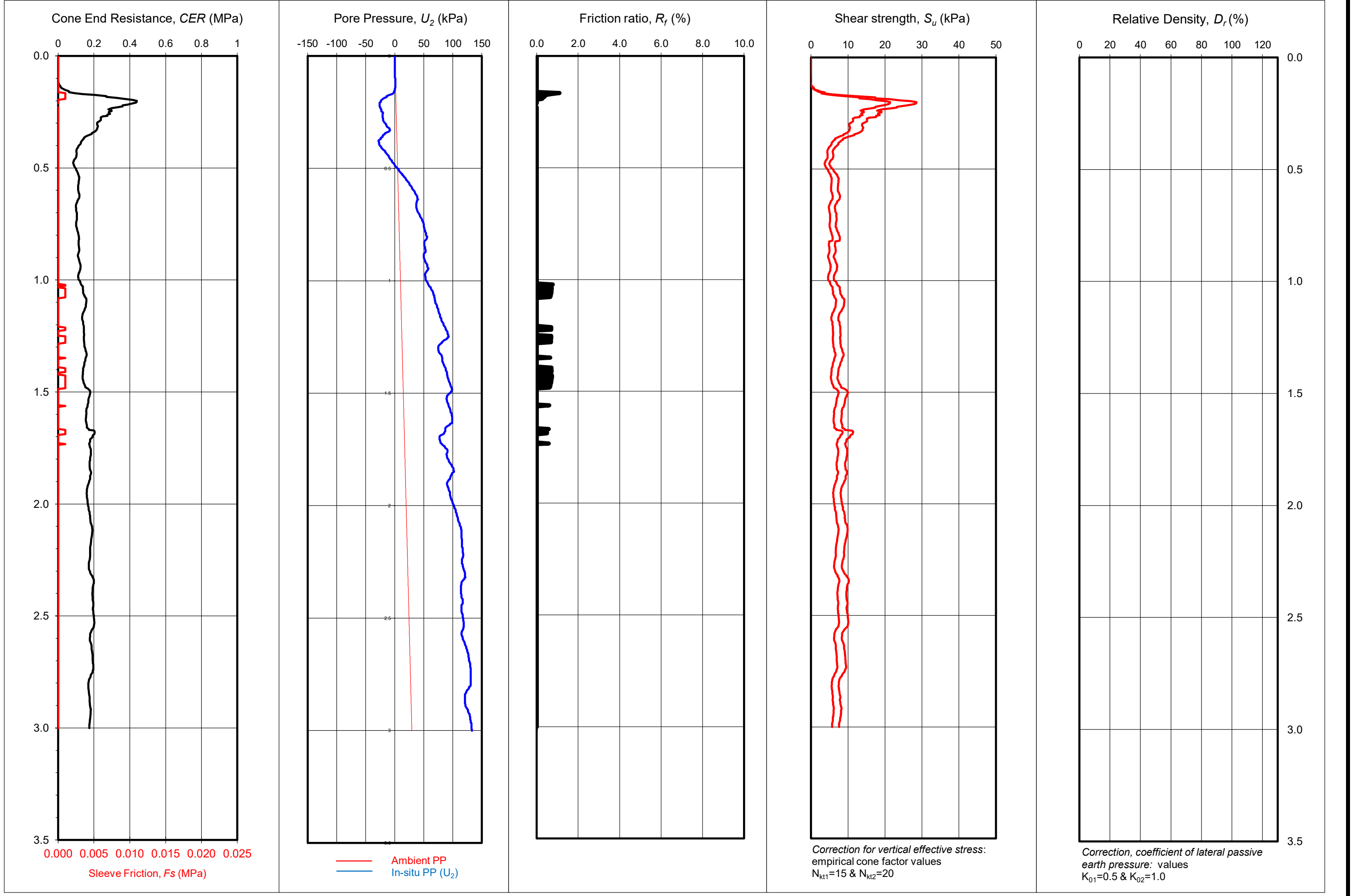
CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Coordinates	53° 46.7802' N	05° 11.7848' W	CPT Number:
Vessel	OSV Cecilia	Water Depth(m) - uncorrected	68.5		S1-1_CEC_CPT_07
Client	Alcatel Submarine Networks	Date of Test (dd/mm/yyyy)	25/11/2018		
Area	Irish Sea	Cone Number/Size	350	2cm2	
Comments:	Depth Achieved	Base Inclination (X Y) - degrees	0	0	

Project Title

Marine Cable Route Survey
HAVHINGSTEN

Soil Depth [m]	Estimated Soil Type	Legend
	Very soft CLAY	
3.00	*End of CPT.* *Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

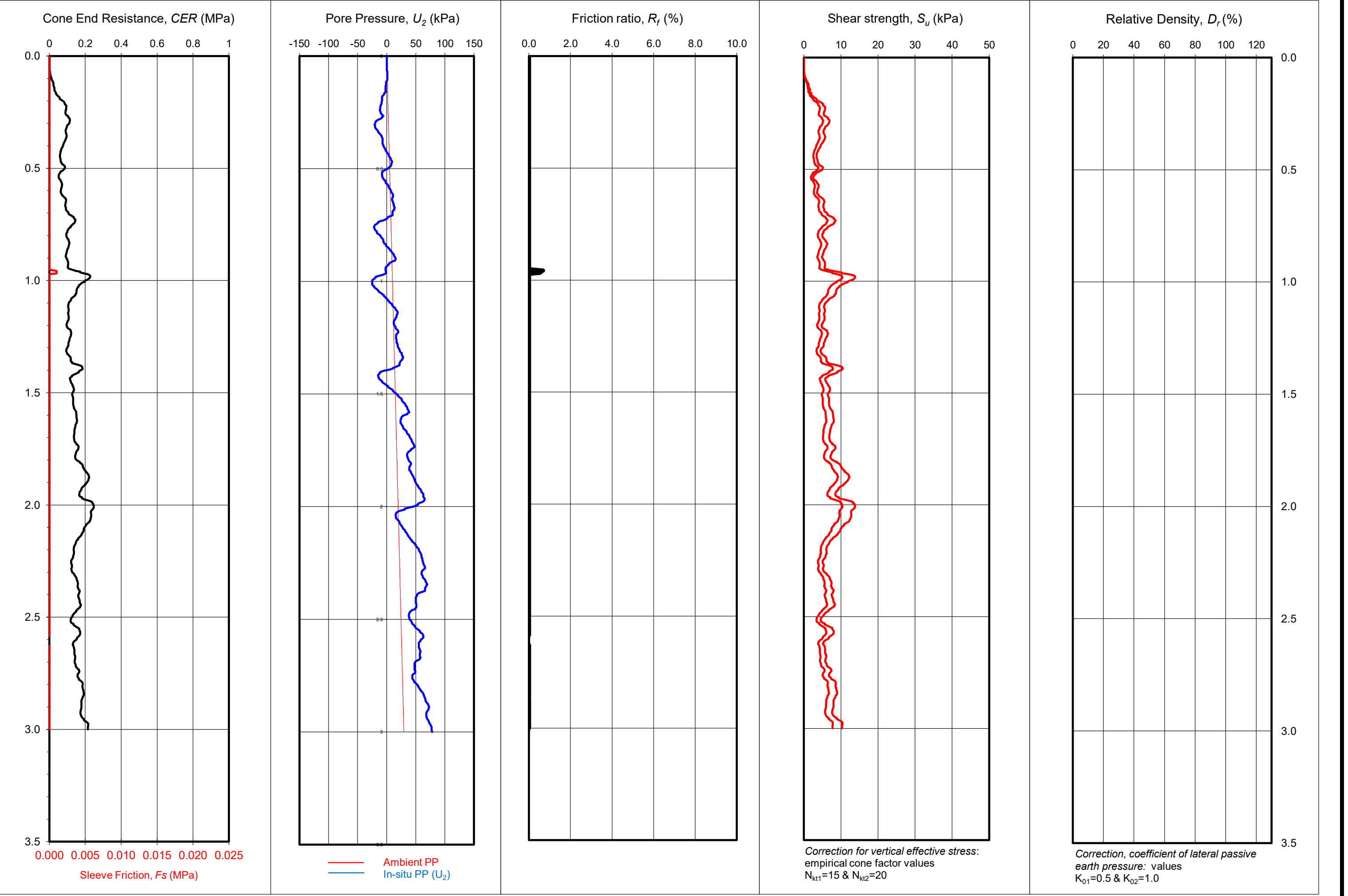
S1-1_CEC_CPT_07

Raw Data Filename : **CPT-070001.cdf**

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title	Coordinates	53° 44.6213' N	05° 20.3342' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	79.6		**S1-1_CEC_CPT_06**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	25/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Very soft CLAY	
3.00	*End of CPT.* *Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

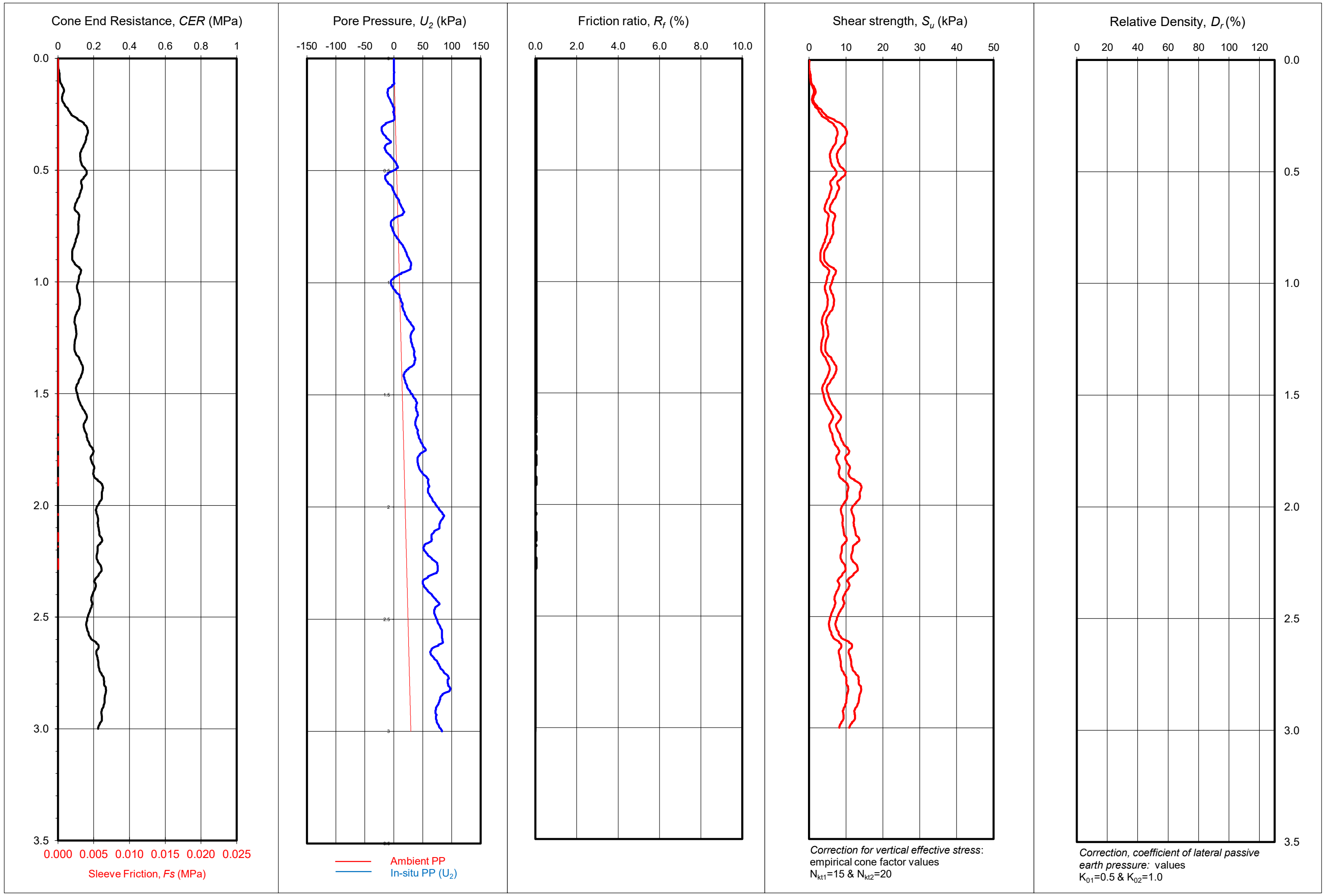
S1-1_CEC_CPT_06

Raw Data Filename : **CPT-060001.cdf**

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title	Coordinates	53° 42.1523' N	05° 28.6930' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	103.7		**S1-1_CEC_CPT_05**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	25/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Very soft CLAY	
3.00	*End of CPT.* *Test depth achieved.*	

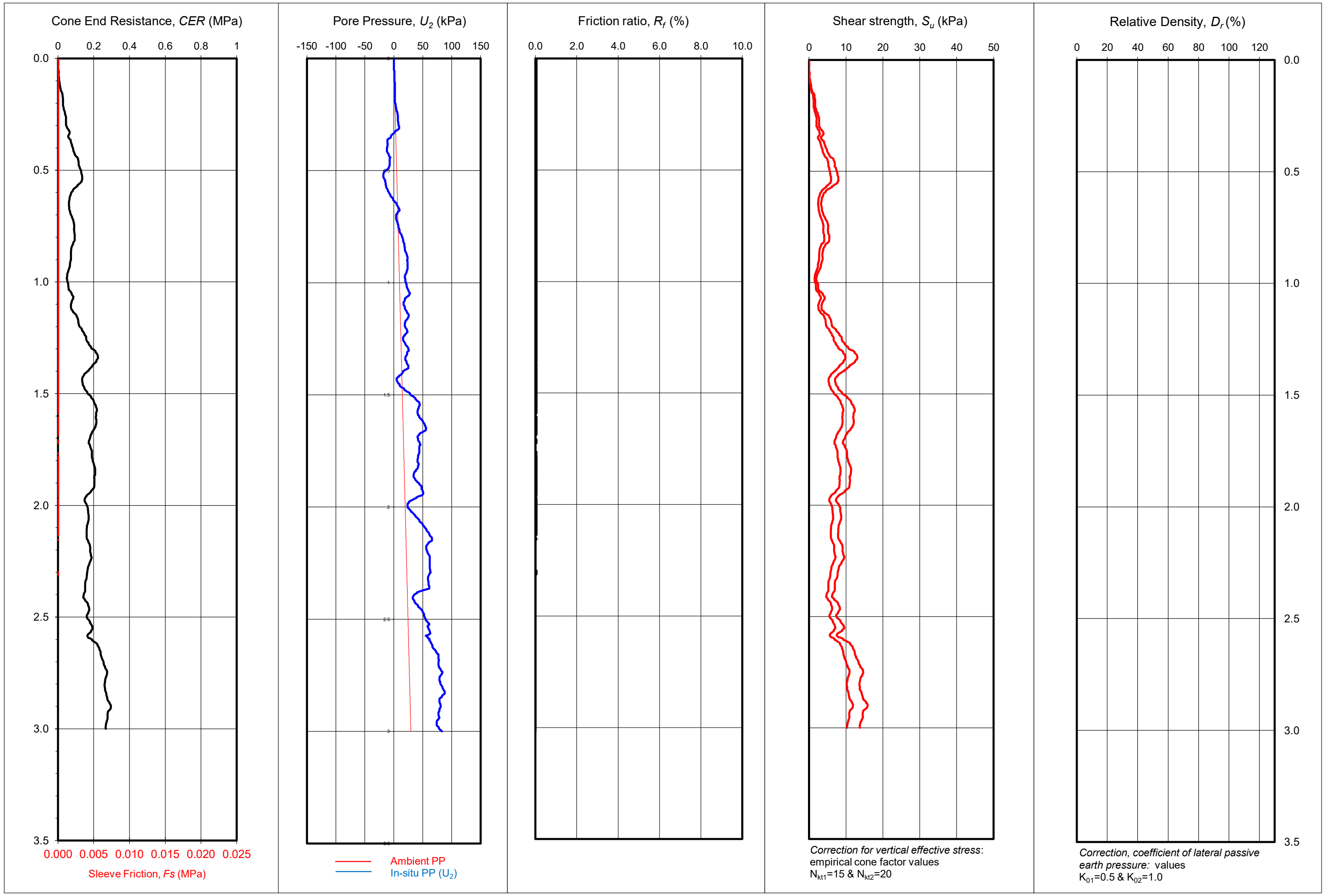


Relative Density (%)		Shear Strength (kPa)		Interpretation Comments:	CPT Number:
Very Loose	**<15%**	**Very Soft**	**<20kPa**	Taken at flat and featureless seabed.	
Loose	**15-35%**	**Soft**	**20-40kPa**		
Medium Dense	**35-65%**	**Firm**	**40-75kPa**		**S1-1_CEC_CPT_05**
Dense	**65-85%**	**Stiff**	**75-150kPa**		
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**		
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**		**Raw Data Filename :** CPT-05-B0001.cdf

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title	Coordinates	53° 40.2663' N	05° 35.0205' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	100.9		**S1-1_CEC_CPT_04a**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	26/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Very soft CLAY	
3.00	*End of CPT. Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

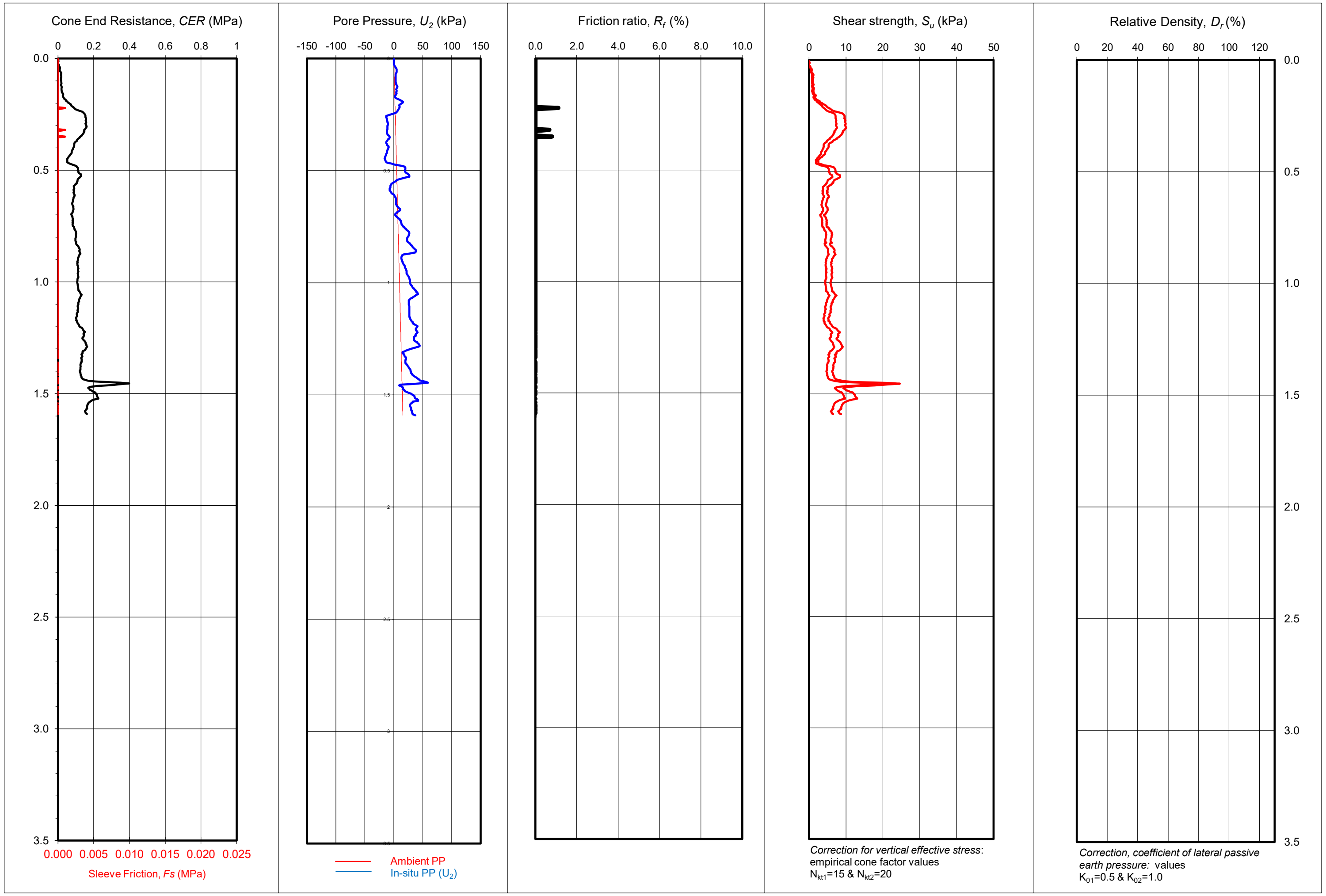
S1-1_CEC_CPT_04a

Raw Data Filename : **CPT-04-A0001.cdf**

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title	Coordinates	53° 40.2635'N	05° 35.0189' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	100.9		**S1-1_CEC_CPT_04**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	22/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Communication Lost		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Very soft CLAY	
1.59	*End of CPT.* *Test depth not achieved.* *Communication to CPT lost.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

S1-1_CEC_CPT_04

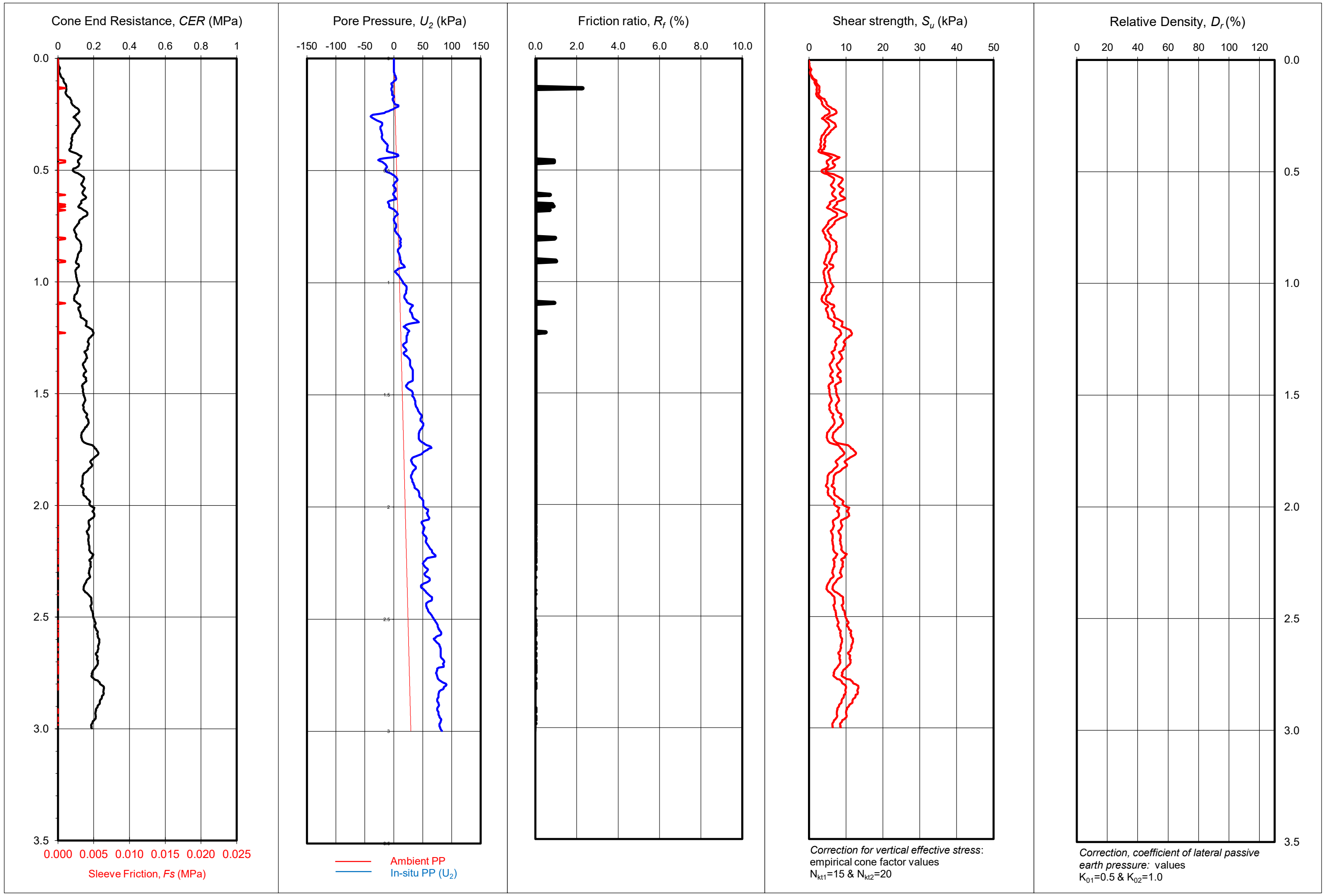
Raw Data Filename : **CPT-40001.cdf**

CONE PENETRATION TEST RESULTS

FUGRO — ALCATEL SUBMARINE NETWORKS

Contract No.	208-18-675	Project Title	Coordinates	53° 37.9598' N	05° 42.7568' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	77.3		**S1-1_CEC_CPT_03**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	22/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Very soft CLAY	
3.00	*End of CPT.* *Test depth achieved.*	

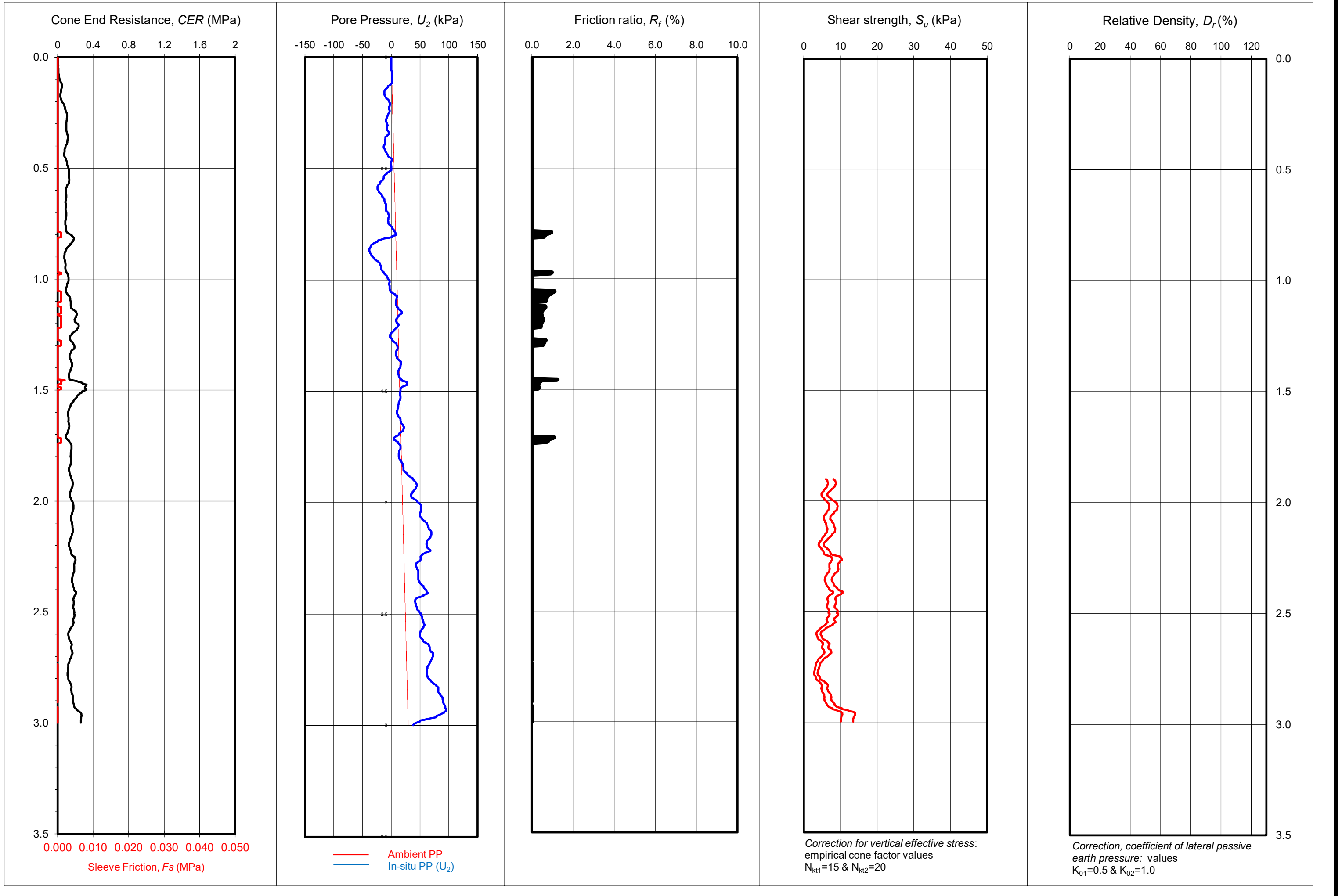


Relative Density (%)		Shear Strength (kPa)		Interpretation Comments:	CPT Number:
Very Loose	**<15%**	**Very Soft**	**<20kPa**	Taken at flat and featureless seabed.	
Loose	**15-35%**	**Soft**	**20-40kPa**		**S1-1_CEC_CPT_03**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**		
Dense	**65-85%**	**Stiff**	**75-150kPa**		
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**		
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**		**Raw Data Filename :** CPT-30001.cdf

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title	Coordinates	53° 35.3891' N	05° 51.3673' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**	Water Depth(m) - uncorrected	57.5		**S1-1_CEC_CPT_02**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**	Date of Test (dd/mm/yyyy)	22/11/2018		
Area	Irish Sea		Cone Number/Size	350	2cm2	
Comments:	Depth Achieved		Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Clayey SILT with shell fragments	
1.89	Very soft silty sandy CLAY	
3.00	*End of CPT.* *Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	<15%	Very Soft	<20kPa
Loose	15-35%	Soft	20-40kPa
Medium Dense	35-65%	Firm	40-75kPa
Dense	65-85%	Stiff	75-150kPa
Very Dense	85-95%	Very Stiff	150-300kPa
Weath'd rock/Indur Sed	>95%	Weath'd rock/Indur Sed	>300kPa

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

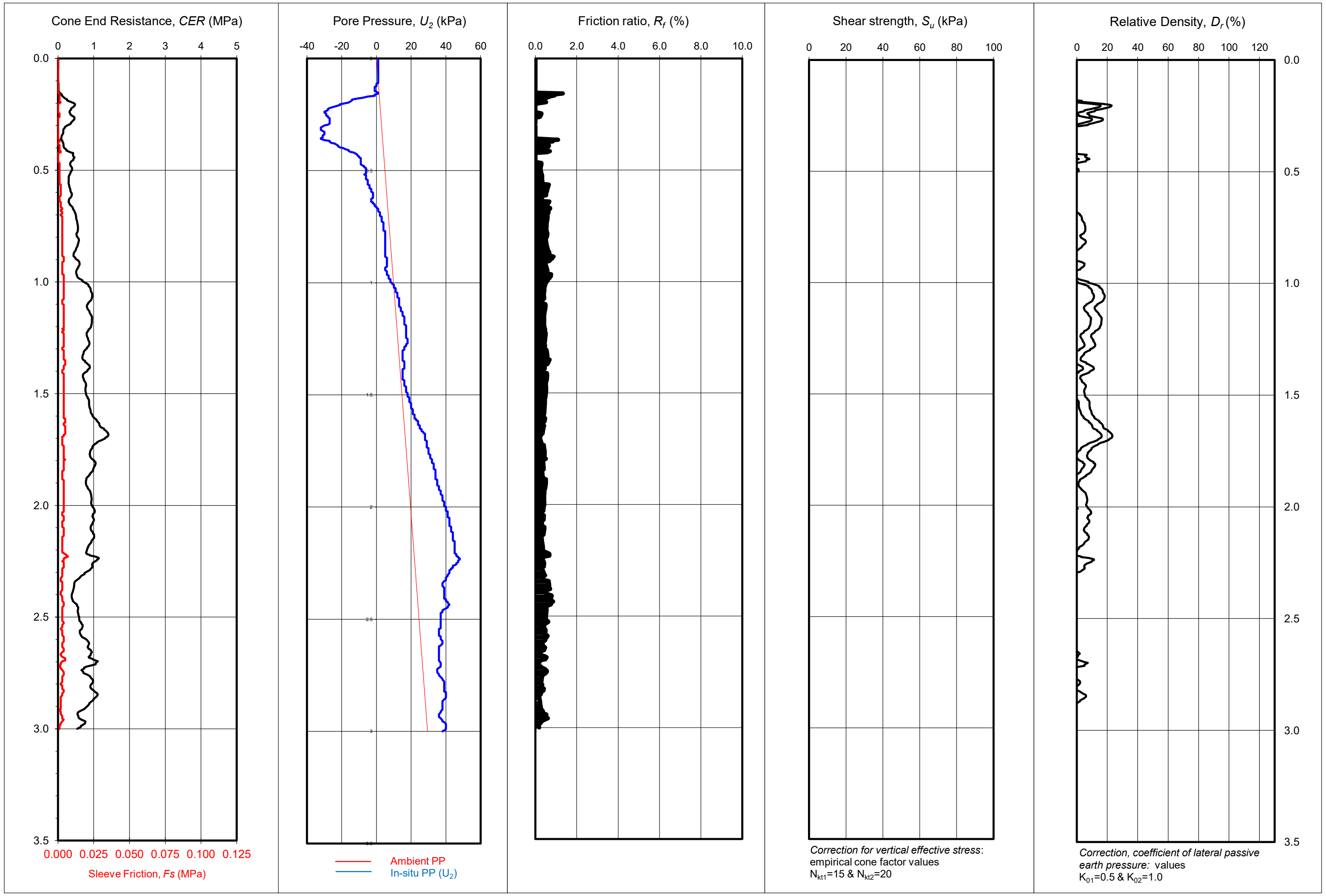
S1-1_CEC_CPT_02

Raw Data Filename : CPT-20001.cdf

CONE PENETRATION TEST RESULTS

Contract No.	208-18-675	Project Title		Coordinates	53° 33.3156'N	05° 59.9871' W	CPT Number:
Vessel	OSV Cecilia	**Marine Cable Route Survey**		Water Depth(m) - uncorrected	24.4		**S1-1_CEC_CPT_01**
Client	Alcatel Submarine Networks	**HAVHINGSTEN**		Date of Test (dd/mm/yyyy)	21/11/2018		
Area	Irish Sea			Cone Number/Size	350	2cm2	
Comments:	Depth Achieved			Base Inclination (X Y) - degrees	0	0	

Soil Depth [m]	Estimated Soil Type	Legend
	Very loose to loose silty SAND	
1.50	Very loose to loose clayey SAND	
3.00	*End of CPT. Test depth achieved.*	



Relative Density (%)		Shear Strength (kPa)	
Very Loose	**<15%**	**Very Soft**	**<20kPa**
Loose	**15-35%**	**Soft**	**20-40kPa**
Medium Dense	**35-65%**	**Firm**	**40-75kPa**
Dense	**65-85%**	**Stiff**	**75-150kPa**
Very Dense	**85-95%**	**Very Stiff**	**150-300kPa**
Weath'd rock/Indur Sed	**>95%**	**Weath'd rock/Indur Sed**	**>300kPa**

Interpretation Comments:

Taken at flat and featureless seabed.

CPT Number:

S1-1_CEC_CPT_01

Raw Data Filename : **CPT-10001.cdf**

I. APPENDIX I - OBSERVED MARINE ACTIVITY LOGS

FRE. NO. 2202

BRIDGE OBSERVATION LOG (BOL)

Date: 04.10.18	Vessel: FUGRO HELMERT Client:	Project: Project No.:

Please record any observations such as: strong currents, Fishing Activities, Buoys, Vessel Traffic Density, Incidents.

Time [Vsl Time]	Survey Area	Comment [No. of vessels, incidents, etc.] [Position Lat Lon if necessary]	Vessel Type [Fishing/Cont./etc]	Flag / Nation	Fishing gear Type [Net/Line/Bottom]	Fishing gear [Fixed / Mobile]	VHF response? [Y/N, N/A]	AIS [Y / N]

Weather Report:

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	52°47.3 N	005°33.6 W	SW5 / 17 kt	2 / 0.5m	7nm	1025	13	
06:00	53°30.0 N	005°54.2 W	SW3 / 10kt	2 / 0.3m	7nm	1026	14	
12:00	53 40.2 N	05 35.1 W	SW 5 / 20kt	4 / 1.2m	6 nm	1018	13	12
18:00	53° 33.8 N	005° 57.0 W	SW 4 / 11 KT	4 / 1.1M	7 nm	1016	16	

FRE. NO. 2202

BRIDGE OBSERVATION LOG (BOL)

Date: 05.10.18	Vessel: FUGRO HELMERT Client:	Project: Project No.:

Please record any observations such as: strong currents, Fishing Activities, Buoys, Vessel Traffic Density, Incidents.

Time [Vsl Time]	Survey Area	Comment [No. of vessels, incidents, etc.] [Position Lat Lon if necessary]	Vessel Type [Fishing/Cont./etc]	Flag / Nation	Fishing gear Type [Net/Line/Bottom]	Fishing gear [Fixed / Mobile]	VHF response? [Y/N, N/A]	AIS [Y / N]

Weather Report:

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	53 33.1 N	05 33.2 W	NW 5/18kt	04 / 0.8m	7nm	1016	+ 11	
06:00	53° 45.3 N	05° 14.8 W	NW 5/10kt	3 / 0.8m	7nm	1016	+ 11	
12:00	53 50.3 N	04 22.6 W	N 4/15kts	3 / 0.9m	7	1013	12	12
18:00	53° 45.5 N	003° 45.0 W	N 4/14kts	3 / 1.2m	7nm	1014	13	

Bridge Observation Log

Date: [illegible] 10 18	Vessel: FUGRO HELMERT Client:	Project: Project No.:

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600		
1600 – 2000	LOW	4 MERCHANT VSL IN TRANSIT
2000 – 2400		

WEATHER REPORT

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	54°22.1N	04°33.9W	SW 5/18kt	4 / 1.0m	7nm	1010	+13	
06:00	53°50.1N	04°59.4W	SW5/18k	3/ 0.7m	7nm	1005	+11	
12:00	53 43.7N	05 20.0W	W 3/10kt	2/0.6m	7	1015	13	12
18:00	53° 44.7N	003° 18.4 W	NW 3/10kt	2/ 0.5M	7	1022	13	

FRE-No. 2202

Bridge Observation Log

FUGRO

Date: 18.10.18	Vessel: FUGRO HELMERT Client:	Project: Project No.:

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600	~~HEAV~~ LOW	5 MERCHANT VESSEL IN TRANSIT
1600 – 2000		
2000 – 2400		

WEATHER REPORT

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	53°50.2 N	05°01.7 W	NW 3	2	7 nm	1025	+11	
06:00	53 42.3 N	05 28.3 W	N 2	1	7	1027	13	12
12:00	53 43.5 N	05 23.9 W	N 2	1	7	1029	14	
18:00	53° 35.5 N	005° 51.1 W	SE 2	1	7	1025	12	

FRE-No. 2202

Bridge Observation Log

FUGRO

Date: 20.10.18	Vessel: FUGRO HELMERT Client:	Project: Project No.:

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600		
1600 – 2000		
2000 – 2400		

WEATHER REPORT

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	53°54,4N	04°57,3W	SW 4/18kt	3 / 0,5m	7nm	1025	11	
06:00	53°49,7N	05°02,7W	SW 5/20kt	5 / 1,2m	7nm	1025	11	
12:00	54 05.2 N	04 46.9 W	SW 4 / 15kts	3/1,0 m	7	1027	15	12
18:00	53°50.8 N	004° 57.6W	SW 5/ 20kt	4 / 1.2m	7	1026	14	

Leo

FRE-No. 2202

Bridge Observation Log

Date: 21. 11. 2018	**Vessel:** OSV Cecilia **Client:** ASN	**Project:** Havhingsten CRS **Project No.:** 208-18-675	

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600		
1600 – 2000		
2000 – 2400		

WEATHER REPORT

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	54°06,5'N	004°43,0'W	5/6 22kn	5	Good	1010		
06:00	54°08,4'N	004°52,2'W	E 6 20kn	5	MOD	1007		
12:00	54°01,5'N	004°52,2'W	E 7/8 31kn	6	Good	1009		
18:00	53°58,0'N	005°50,3'W	ESE 7 23kn	6	MOD	1012		

FRE-No. 2202

Bridge Observation Log

Date: 22.11.2018	Vessel: OSV Cecilia Client: ASN	Project: Havhingsten CRS Project No.: 208-18-675

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600		
1600 – 2000		
2000 – 2400		

WEATHER REPORT

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	53°37,3'N	006°00,0W	SE 5/6	5 2,5m	Good	1016		
06:00	53°35,3'N	005°51,3'W	SE 8	5 1,5m	Good	1012		
12:00	5					1016		
18:00	53°52,1'N	005°28,8'W	E 6	5 1.5m	Good	1016		

FRE-No. 2202

Bridge Observation Log

FUGRO

Date:	23/11/18.	**Vessel:**	OSV Cecilia	**Project:**	Havhingsten CRS
		Client:	ASN	**Project No.:**	208-18-675

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]
16:00		N/A	N/A	N/A.	N/A	N/A

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600		
1600 – 2000		
2000 – 2400		

WEATHER REPORT

Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00	53°40,3N	005°35,0'W	E 22kn 5/6B	5B 2m	0000	1015		
06:00	53°48.2'N	005°03.9'W	E 6 22kn	5 1.2m	6000.	1015		
12:00	53°50,6N	004°34,7'W	E 22kn 6B	5B 1.5m	MOD	1013		
18:00	53°58.5'N	004°41.5'W	E 6 22kn	5 1.5m	MOD	1014.		

Last update of FRE: 01.05.2018

FRE-No. 2202

Bridge Observation Log

Date: 25. 11. 2018	Vessel: OSV Cecilia	Project: Havhingsten CRS
	Client: ASN	Project No.: 208-18-675

FISHING ACTIVITIES Please record any observations in regards to fishing: fishing activities, buoys, incidents with fishers etc.

Time [Vsl Time]	Survey Area	Comment [Name of vessel, Call sign, in case of incident pls note Lat Lon]	Flag / Nation	Type of Fishing gear [Buoys Net/Line/Bottom]	VHF call? [Y/N or N/A]	AIS [Y / N]

VESSEL ACTIVITIES: Please record Vessel Traffic Density and special events such as interferences or close encounters

Time	Vessel density [total No. of vessel i.e. low/moderate/heavy traffic]	Comment [special events with vessels, type of operation: transit, survey or geotechnical]
0000 – 0400		
0400 – 0800		
0800 – 1200		
1200 – 1600		
1600 – 2000		
2000 – 2400		

WEATHER REPORT

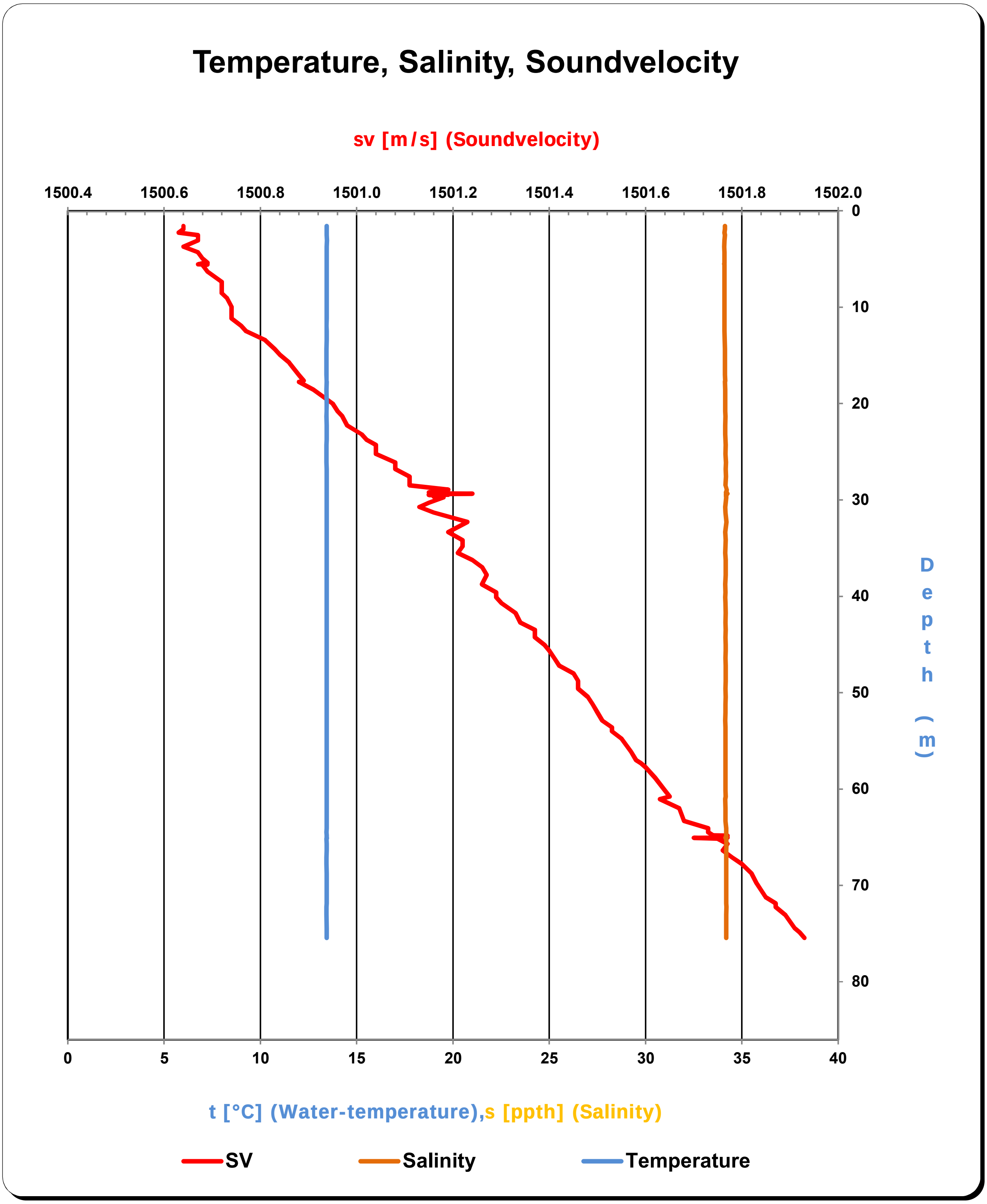
Time [Vessel time]	Latitude [DD° MM.m']	Longitude [DD° MM.m']	Wind Direction [bft + kt]	Sea [state and m]	Visibility	Air Pressure [mbar]	Air Temp. [deg]	Water Temp. [deg]
00:00								
06:00								
12:00	53°59,2N	004°56,5W	E 5/6 22k	5	GOOD	1015		
18:00	53°[illegible]N	005°09,7'W	E 5/6 21kt	5	GOOD	1015		

c

J. APPENDIX J - OBSERVED VELOCITY & TEMPERATURE DATA

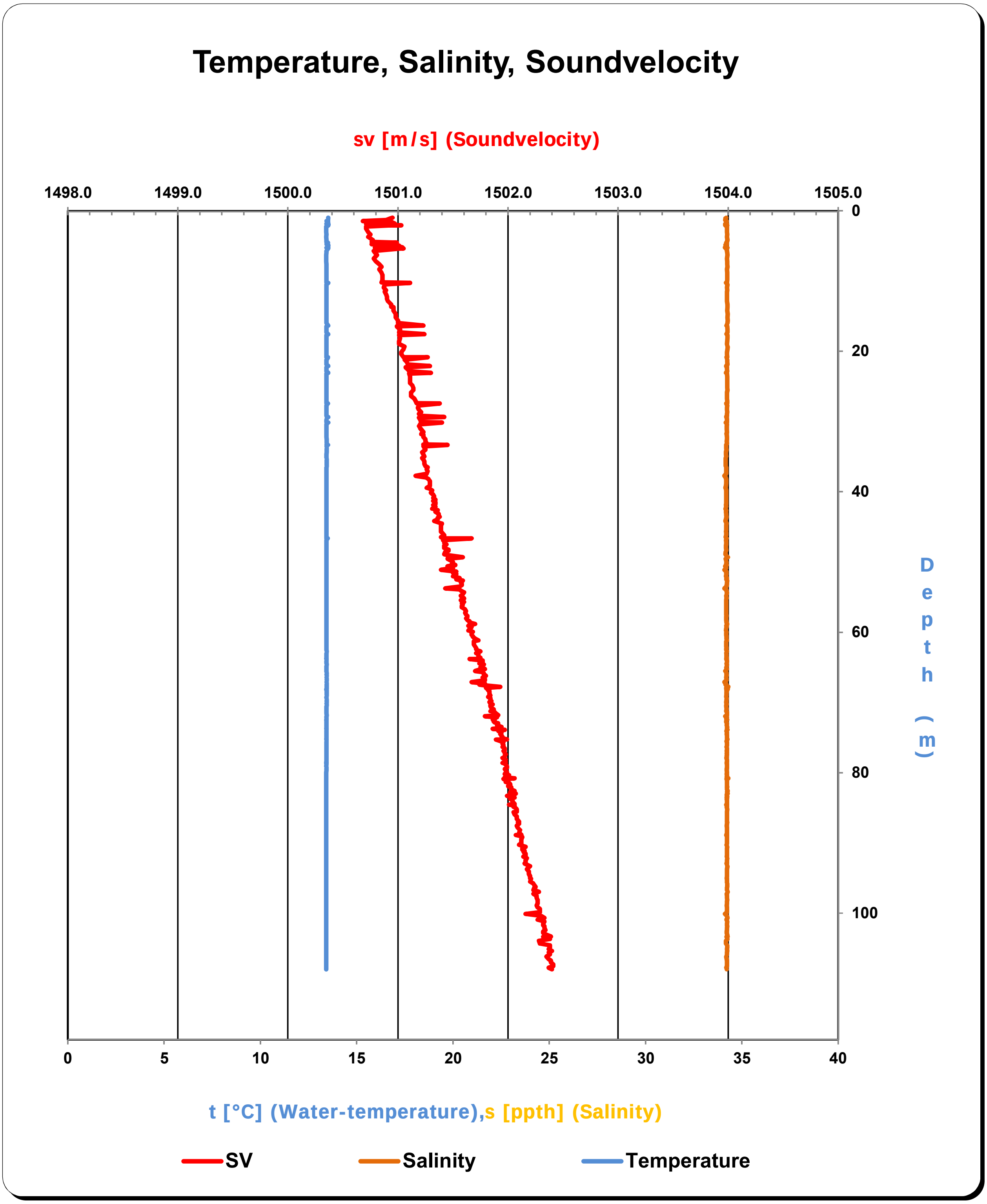
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	53	Temp_Mean 13.4	Temp End 13.4	Date / Time:	181017 10:50
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	53;44.0549024 N			Operator:	Luca/Agosta
Lon:	5;20.1367970 W	SV_Mean 1501.25	SV Head 1500.67	Area:	S1-1 B02
Depth:	75.45			Salinity :	34.15



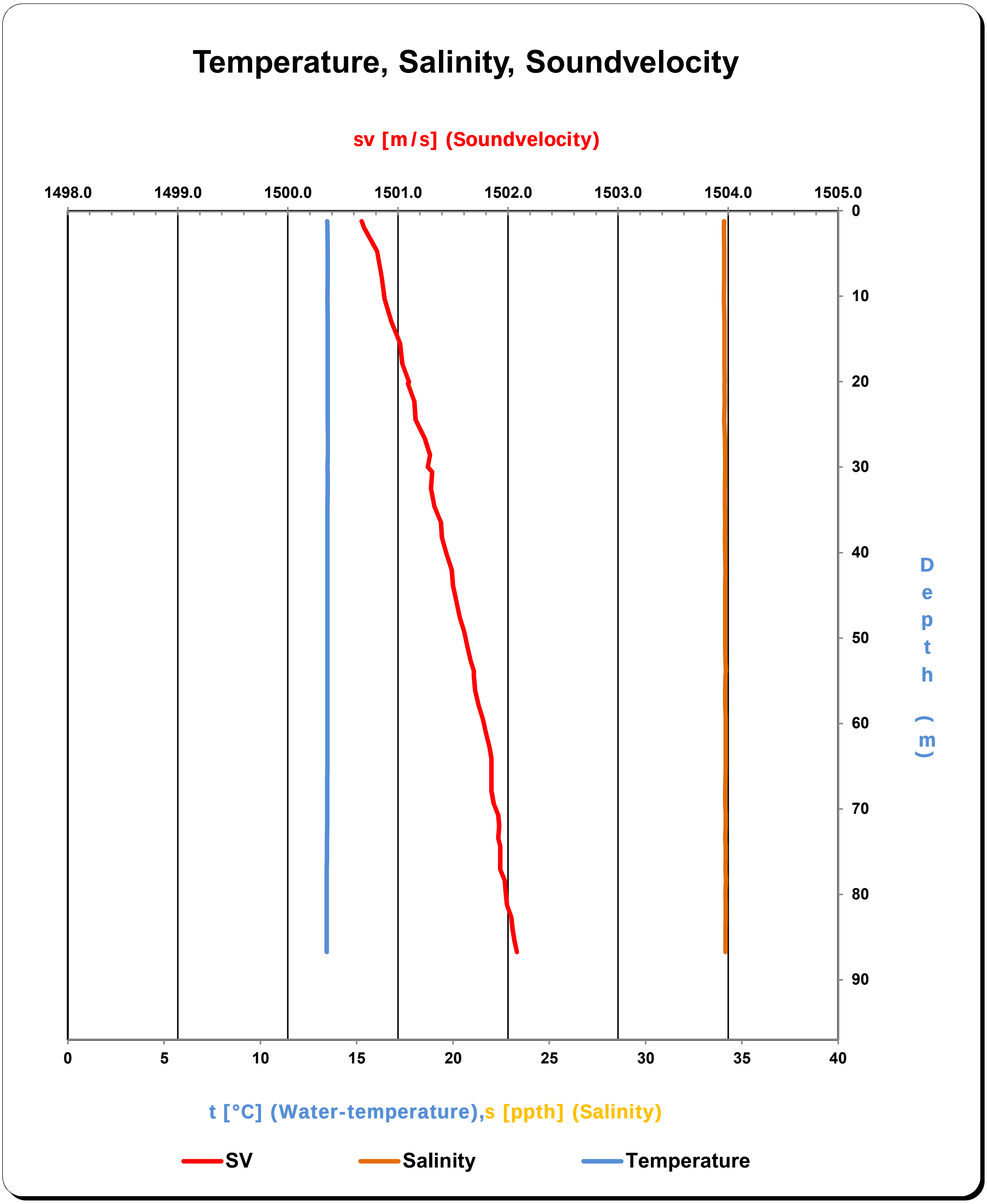
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	54	Temp_Mean 13.4	Temp End 13.4	Date / Time:	181018 02:15
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	53;42.4889885 N			Operator:	Luca/Agosta
Lon:	5;26.2753073 W	SV_Mean 1501.61	SV Head 1500.75	Area:	S1-1 B02
Depth:	107.99			Salinity :	34.21



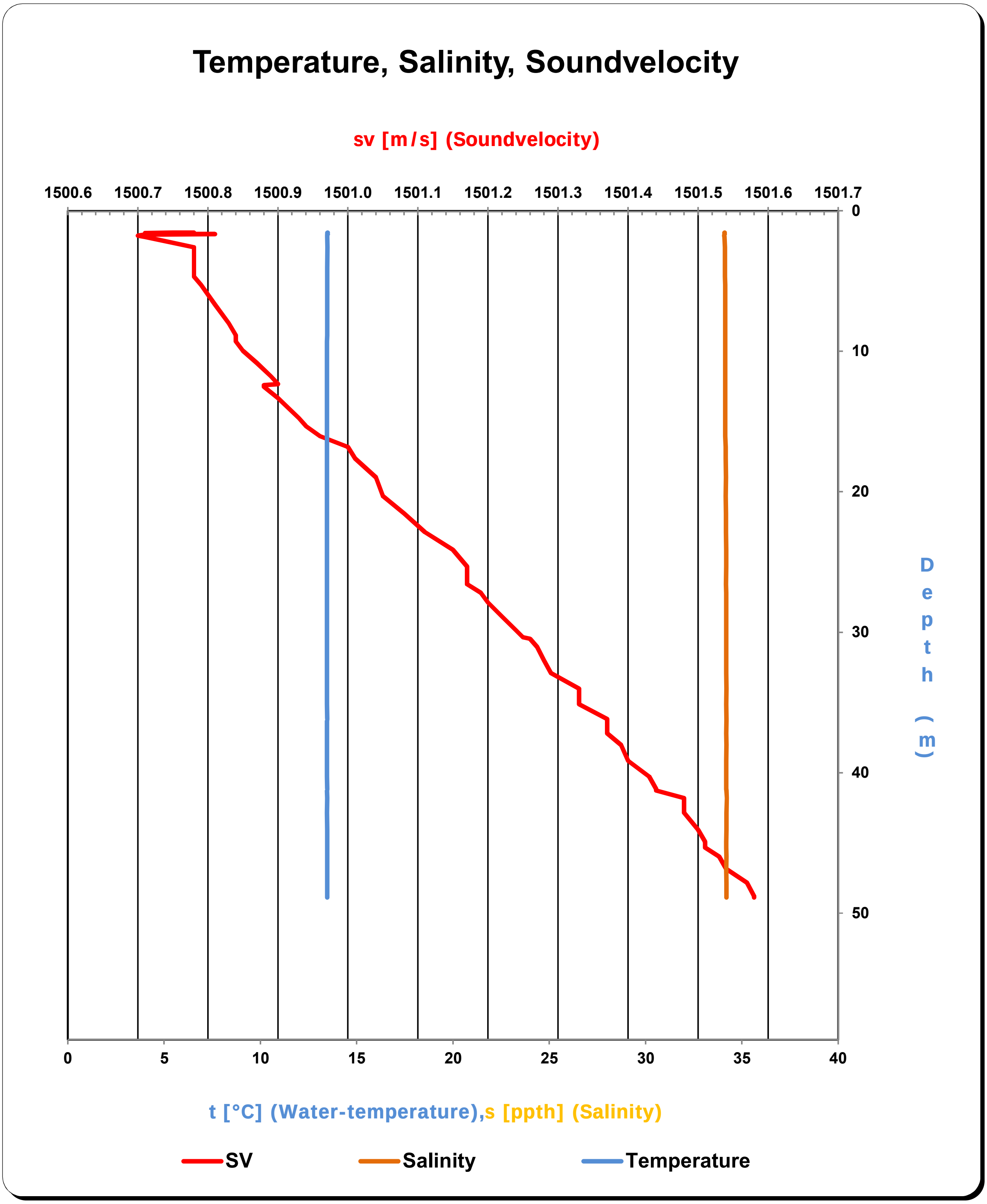
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	55	Temp_Mean 13.5	Temp End 13.4	Date / Time:	181018 21:51
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	53;38.6644669 N			Operator:	Luca/Agosta
Lon:	5;40.7869013 W	SV_Mean 1501.50	SV Head 1500.69	Area:	S1-1 B01
Depth:	86.76			Salinity :	34.13



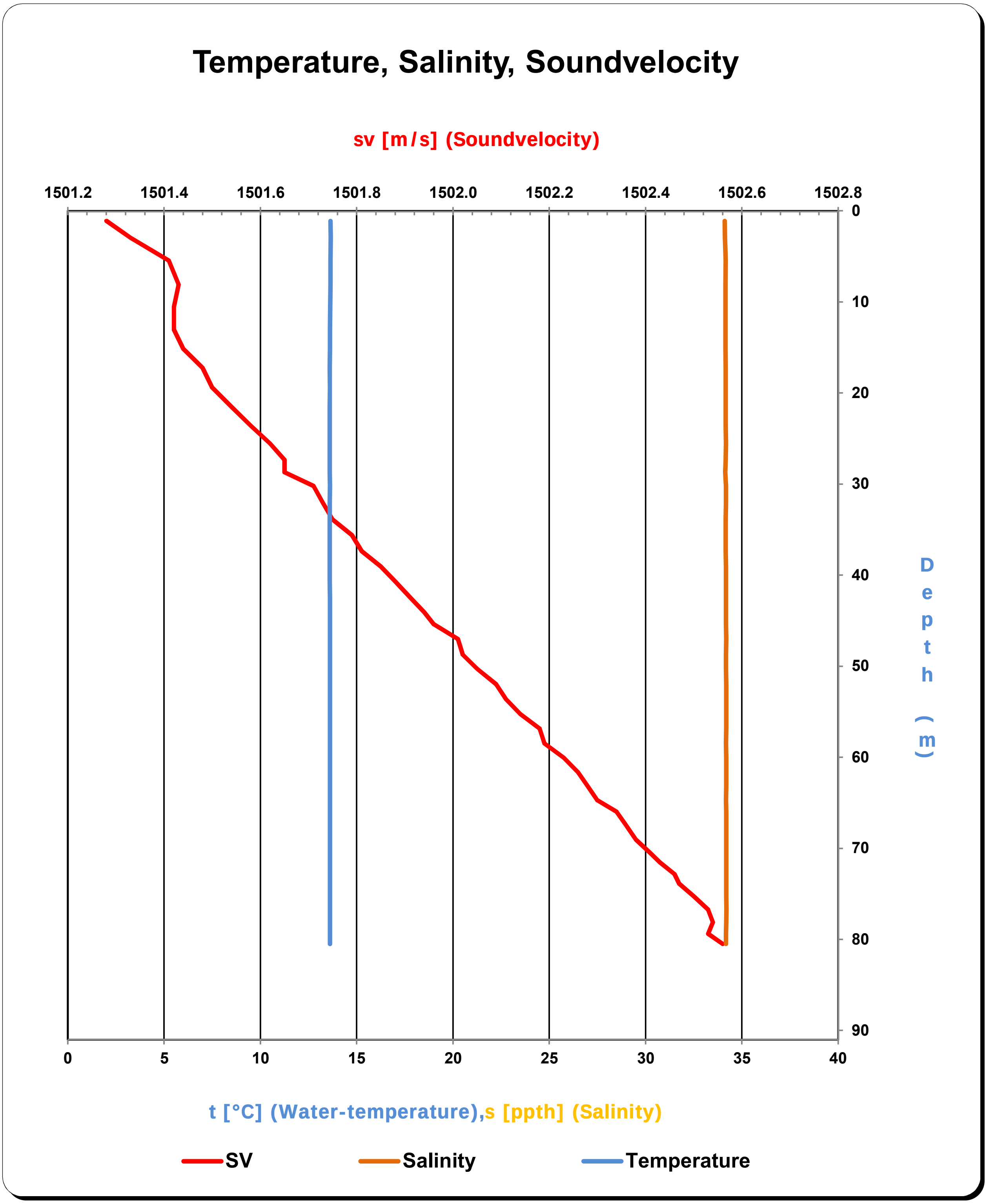
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	58	Temp_Mean 13.5	Temp End 13.5	Date / Time:	181020 09:50
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	54;04.2051854 N			Operator:	Luca/Agosta
Lon:	4;54.1076282 W	SV_Mean 1501.12	SV Head 1500.78	Area:	S1-2 B06
Depth:	48.88			Salinity :	34.16



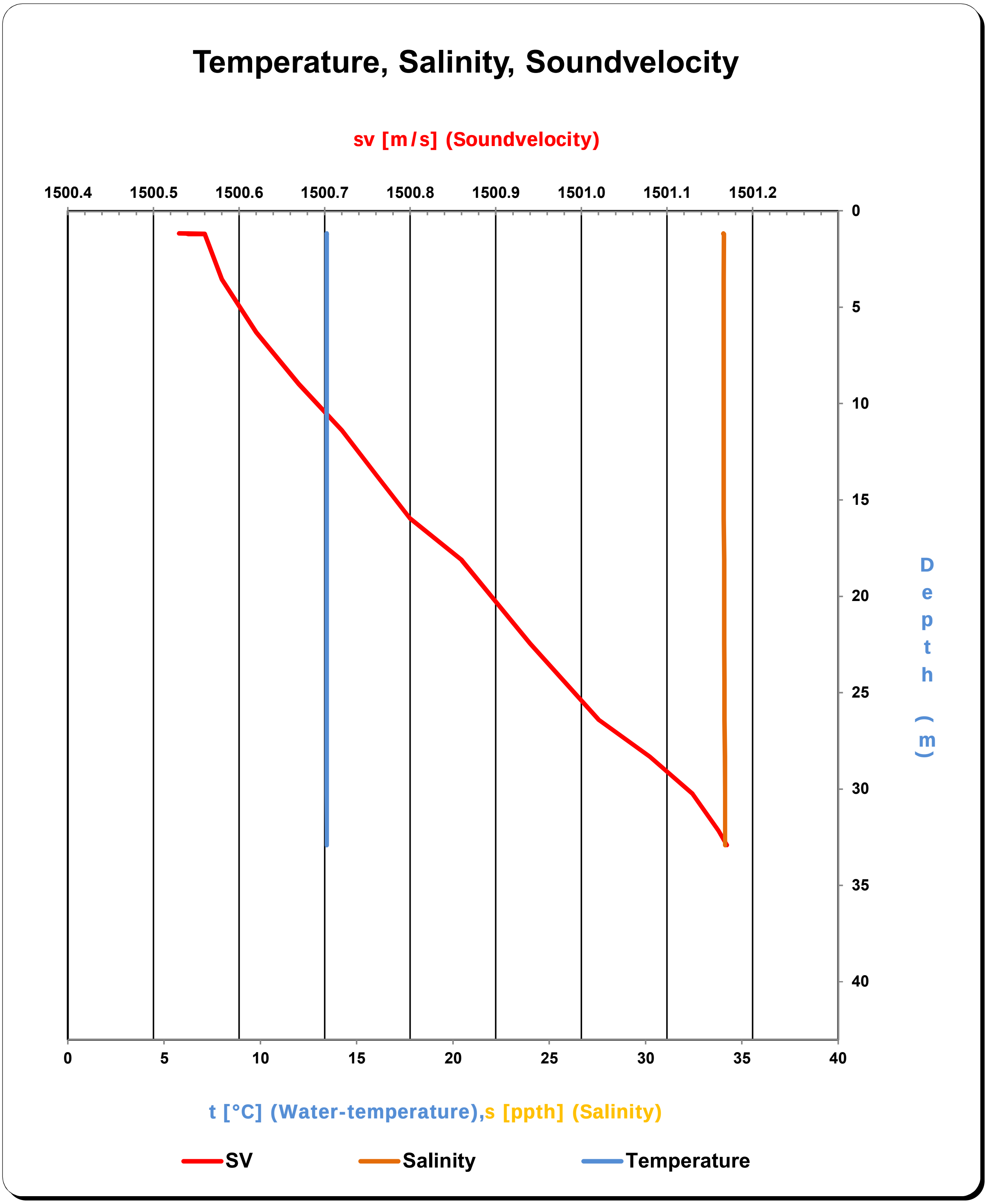
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	59	Temp_Mean 13.6	Temp End 13.6	Date / Time:	181020 17:20
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	53;50.8132645 N			Operator:	Luca/Agosta
Lon:	4;59.6033388 W	SV_Mean 1501.97	SV Head 1501.33	Area:	S1-2 B03
Depth:	80.5			Salinity :	34.17



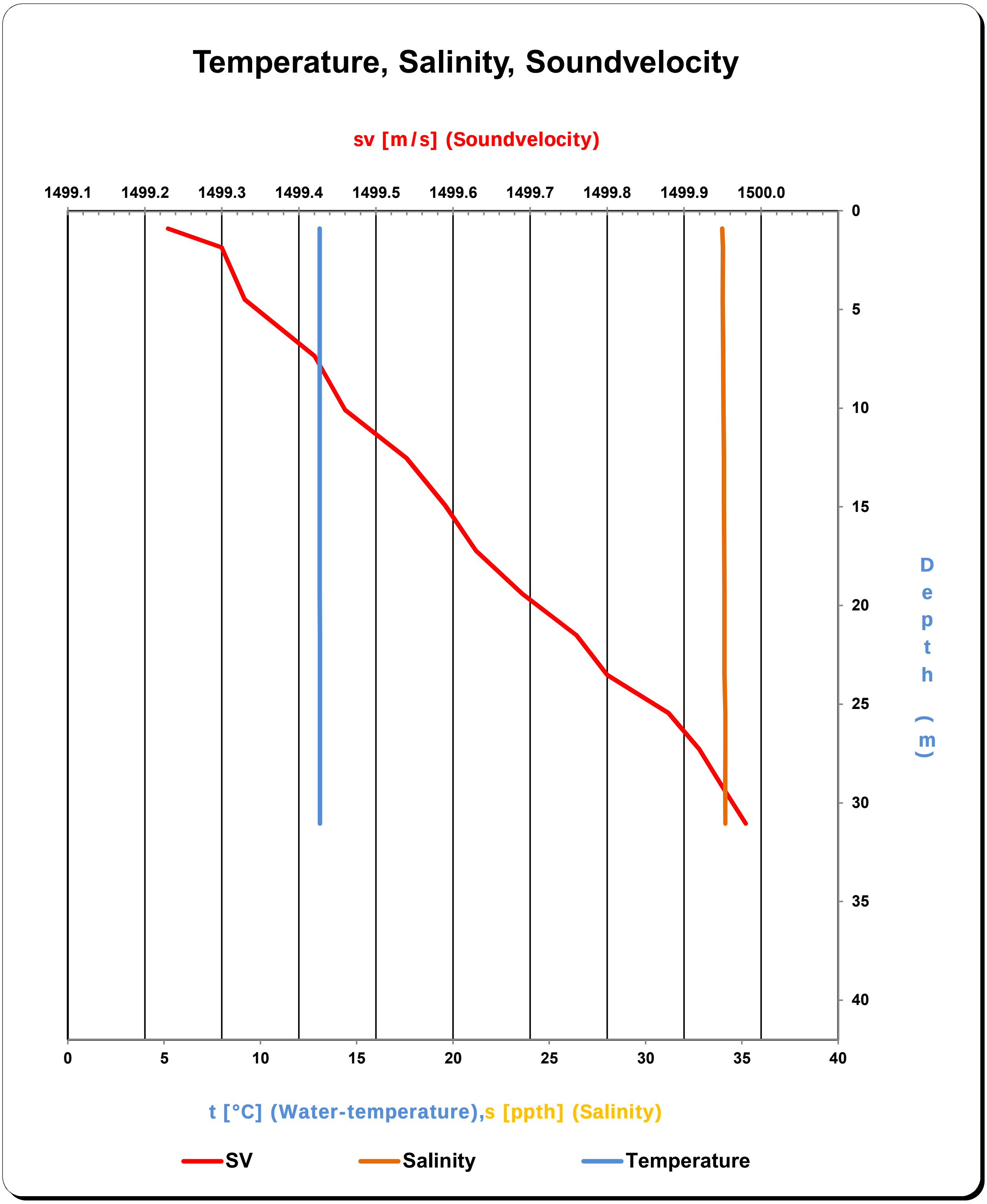
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	60	Temp_Mean 13.4	Temp End 13.4	Date / Time:	181021 16:06
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	54;03.3750953 N			Operator:	Luca/Agosta
Lon:	4;32.3453343 W	SV_Mean 1500.82	SV Head 1500.56	Area:	S1-4 B07
Depth:	32.91			Salinity :	34.08



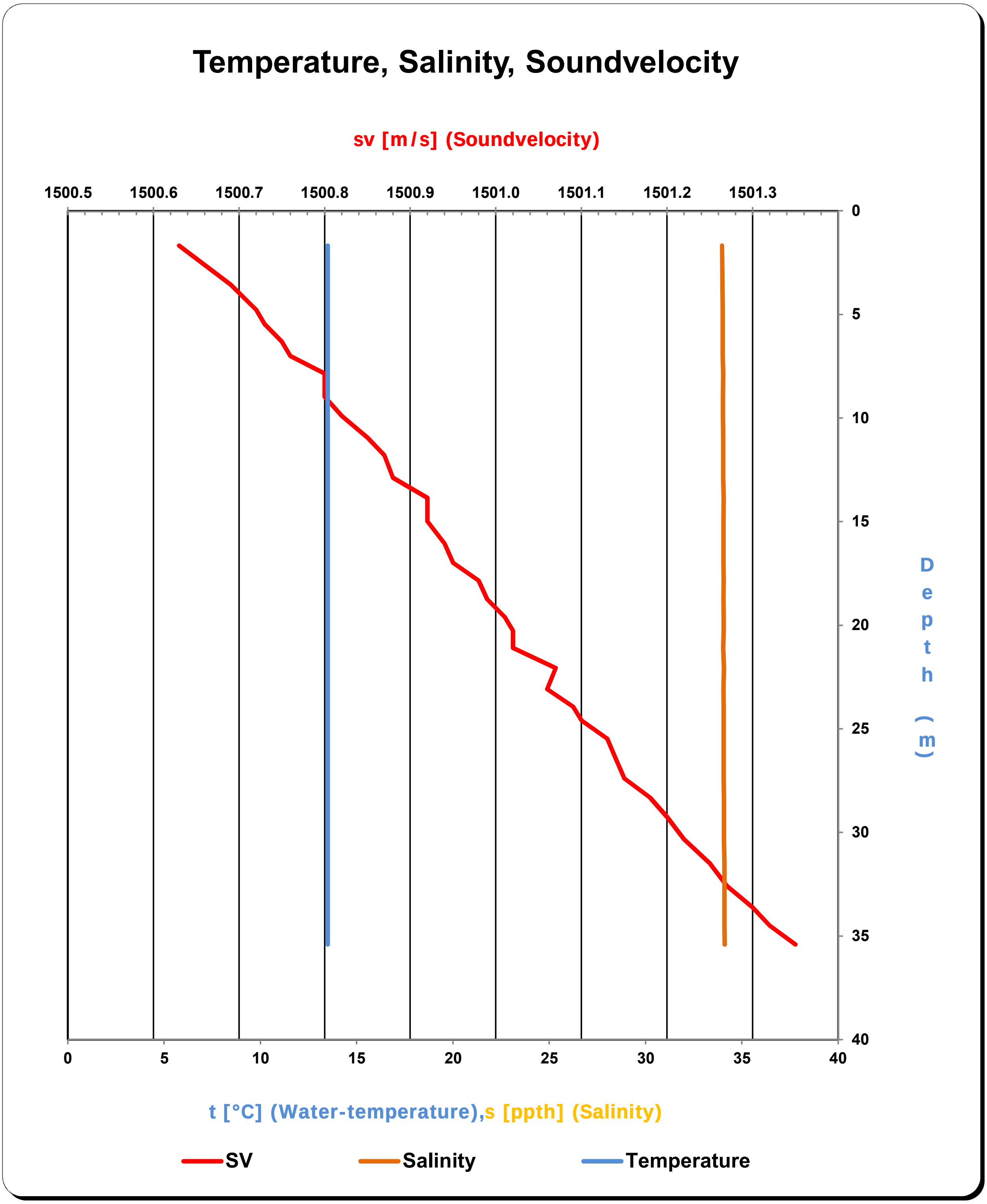
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	61	Temp_Mean 13.1	Temp End 13.1	Date / Time:	181023 15:56
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	53;33.6139411 N			Operator:	Luca/Agosta
Lon:	5;57.2700899 W	SV_Mean 1499.63	SV Head 1499.30	Area:	S1-1 B01
Depth:	31.05			Salinity :	34.08



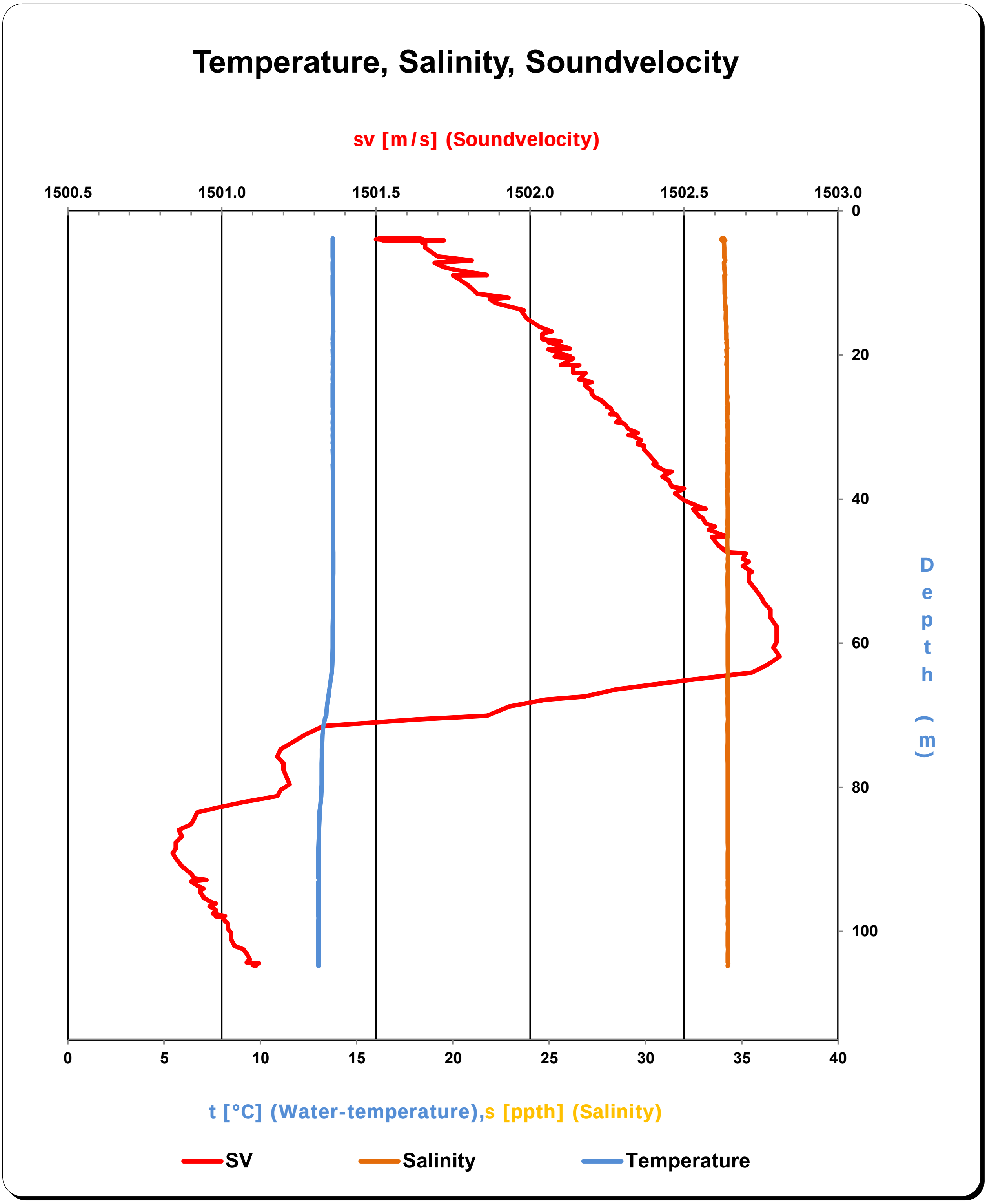
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	42	Temp_Mean 13.5	Temp End 13.5	Date / Time:	181004 05:30
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	53;32.7548832 N			Operator:	Milne/Agosta
Lon:	5;56.9150375 W	SV_Mean 1501.00	SV Head 1501.00	Area:	S1 B01
Depth:	35.41			Salinity :	34.05



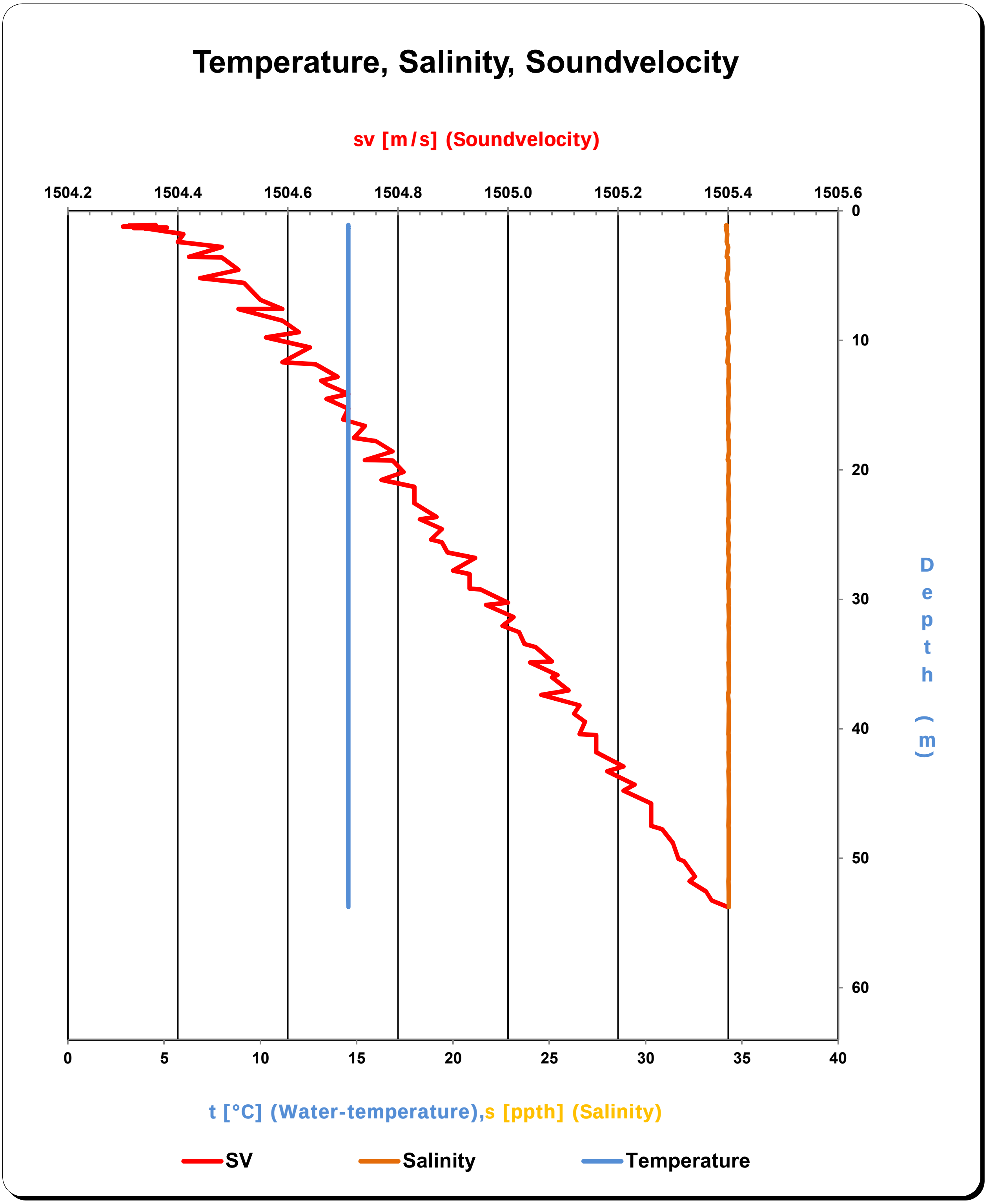
FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	43	Temp_Mean 13.5	Temp End 13.0	Date / Time:	181005 00:15
SV-Probe:	SAIV CTD			Vessel:	Fugro Helmert
Lat:	54;40.727843 N			Operator:	Milne/Agosta
Lon:	5;34.184075 W	SV_Mean 1501.83	SV Head 1501.83	Area:	S1 B02
Depth:	104.81			Salinity :	34.22



FUGRO
HAVHINSTEN CRS
Cable Route Survey

Profile-No:	44	Temp_Mean	Temp End	Date / Time:	181005 12:20
SV-Probe:	SAIV CTD	14.6	14.6	Vessel:	Fugro Helmert
Lat:	55;32.7548832 N			Operator:	Milne/Agosta
Lon:	5;56.9150375 W	SV_Mean	SV Head	Area:	S1 B04
Depth:	53.77	1504.82	1504.82	Salinity :	34.28



K. APPENDIX K - CURRENT METER RESULTS & CURRENT OBSERVATION LOG

There was no direct measurement of currents performed during the Segment 1-1 survey operations.

L. APPENDIX L - CHARTS (NU & AS)

The chart drawings in dwg format are part of Revision 2 deliverables.

Alignment Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
HVH_S1-1_AS_10k-001	1:10,000	001/012	0.000	6.840	2	2
HVH_S1-1_AS_10k-002	1:10,000	002/012	5.813	13.690	2	2
HVH_S1-1_AS_10k-003	1:10,000	003/012	12.660	20.541	2	2
HVH_S1-1_AS_10k-004	1:10,000	004/012	19.511	26.332	2	2
HVH_S1-1_AS_10k-005	1:10,000	005/012	24.214	32.124	2	2
HVH_S1-1_AS_10k-006	1:10,000	006/012	31.092	41.257	2	2
HVH_S1-1_AS_10k-007	1:10,000	007/012	40.225	48.126	2	2
HVH_S1-1_AS_10k-008	1:10,000	008/012	47.368	57.549	2	2
HVH_S1-1_AS_10k-009	1:10,000	009/012	56.709	66.899	2	2
HVH_S1-1_AS_10k-010	1:10,000	010/012	65.864	73.784	2	2
HVH_S1-1_AS_10k-011	1:10,000	011/012	72.748	80.626	2	2
HVH_S1-1_AS_10k-012	1:10,000	012/012	79.468	80.626	2	2
HVH_S1-1_AS_5k-001	1:5,000	001/001	77.368	80.628	2	2

North-Up Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
HVH_S1-1_NU_10k-001	1:10,000	001/010	0.000	5.321	3	2
HVH_S1-1_NU_10k-002	1:10,000	002/010	3.939	15.606	3	2
HVH_S1-1_NU_10k-003	1:10,000	003/010	11.192	22.202	3	2
HVH_S1-1_NU_10k-004	1:10,000	004/010	20.894	32.080	3	2
HVH_S1-1_NU_10k-005	1:10,000	005/010	30.808	42.206	3	2
HVH_S1-1_NU_10k-006	1:10,000	006/010	37.848	49.288	3	2
HVH_S1-1_NU_10k-007	1:10,000	007/010	48.018	59.388	3	2
HVH_S1-1_NU_10k-008	1:10,000	008/010	55.045	66.413	3	2
HVH_S1-1_NU_10k-009	1:10,000	009/010	65.144	76.087	3	2
HVH_S1-1_NU_10k-010	1:10,000	010/010	74.920	80.626	3	2
HVH_S1-1_NU_5k-001	1:5,000	001/001	75.700	80.626	3	2
HVH_S1-1_NU_0.5k-001	1: 500	001/001	80.309	80.626	3	2

Index Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
HVH_S1_ID-001	1:125,000	001/001	Segment 1		3	2

XING Charts	Scale	Chart Numbers	Start KP	End KP	Book	Rev
S1.1_xing5k 001	1:5000	001/001	22.546	27.997	3	2

M. APPENDIX M - MDB & XYZ DATA

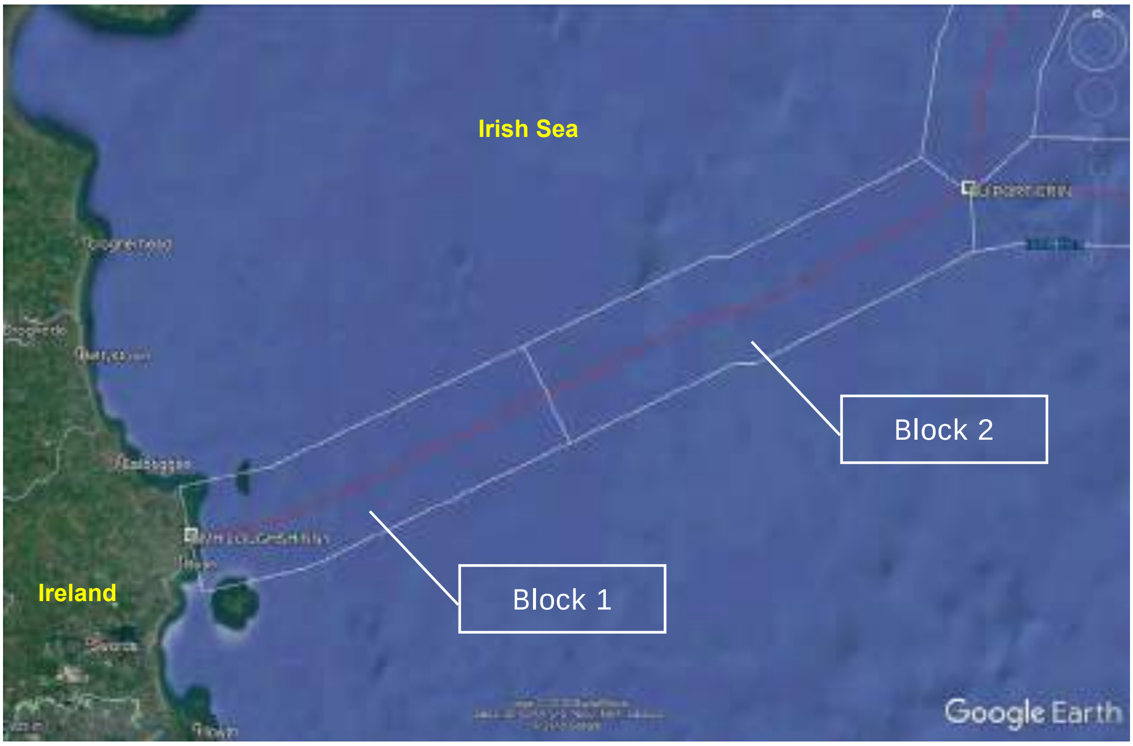
The following data are delivered with Revision 2:

- GIS files MakaiPlan compatible, MDB-format
- Digital profiles, ascii format
- DTM of Bathymetry
- Text KP Z file (Point No., KP, Depth)
- Magnetometer Data (Lat, Long, nT)
- Text XYZ file (Point No., Lat, Long, Easting, Northing, Depth)

N. APPENDIX N - GEOTIFFS

The Sidescan Mosaics in geotiff-format are delivered with the Segment S1-1 BU Port Erin to BMH Loughshinny Revision 2.

The geotiff files are divided into shallow water (Block 1 and 2) and inshore segment as done during operations.



O. APPENDIX O - WRECK REPORT

WRECK NO. S1-1_FHE_SC0010			
Ship / Unit:		MV Fugro Helmert	
Survey:		208-18-675	
Date Located:	04/10/2018	Date Examined:	18/10/2018

KP (PSR03_29 APR 2019):	45.619	
DOL (PSR03_29 APR 2019):	143	
Position (PSR03_29 APR 2019):	LAT: 53° 39.9508'N	LON: 005° 36.1172'W
Method of Positioning: Fugro Starfix HP DGPS	Accuracy: <50 cm	

Depth Data (ELLIPSOID)	
Swept Clear:	No sweep performed
Swept Foul:	No sweep performed
Least E/S Depth:	93.7. m
General Depth:	99 m
Scour Depth:	100.2 m

Tidal Observations	
Tidal Observations at:	Reduced to LAT (VORF Irish Sea)
Co-tidal adjustments by:	N/A

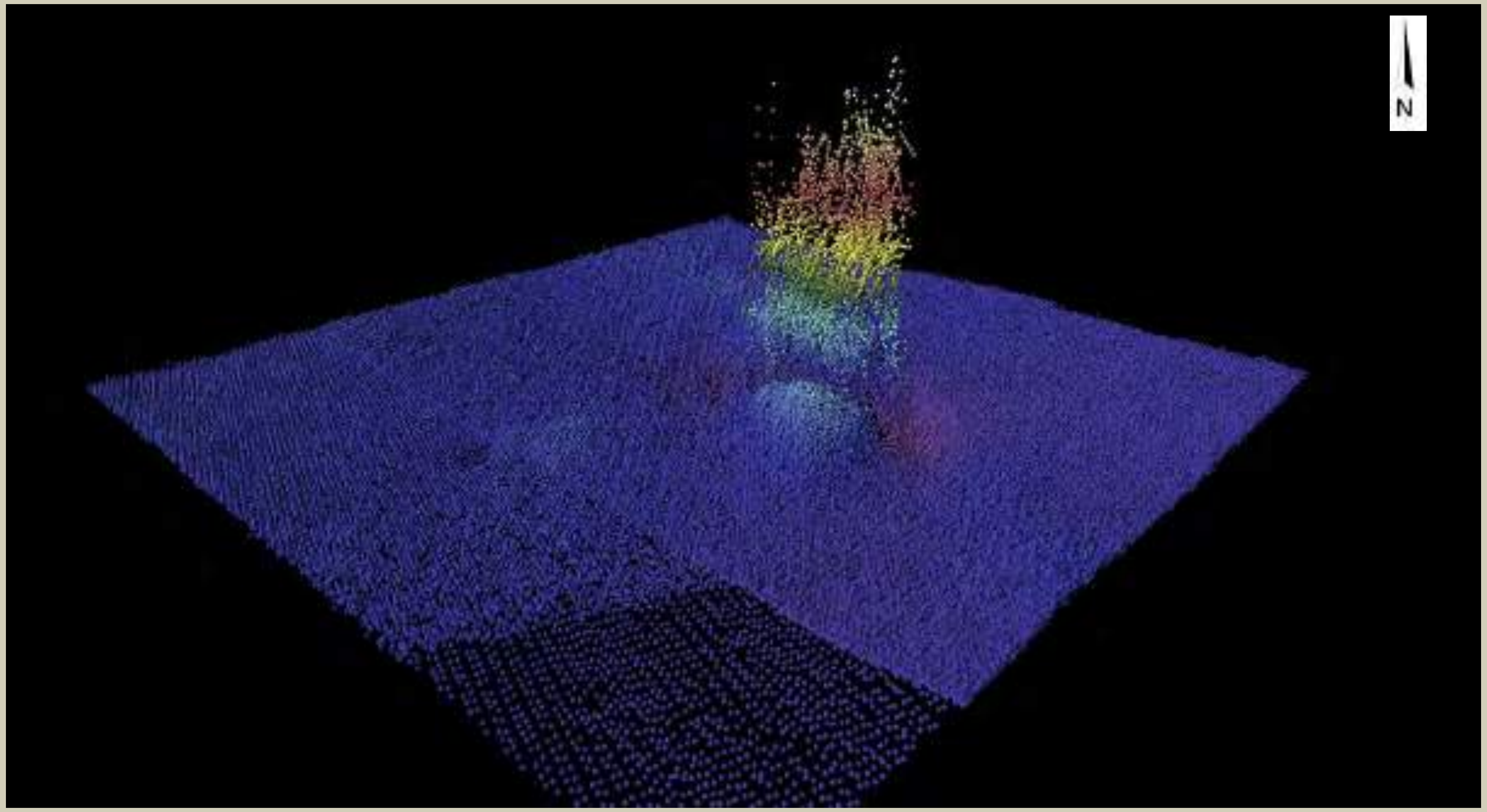
Contact Data	
Sonar Height:	4.16 m (at highest point)
Sonar Length:	24 m
Sonar Width:	8.9 m
Orientation:	53° / 147°
Bow Orientation:	Unknown
Sonar Signal Strength:	Strong
Magnetic Anomaly:	Not observed
Scour Length:	All around the wreck
Seabed Texture:	Soft sediment
Debris Field:	Some debris within 3 m radius of the wreck
Buoyage:	Unknown

Description:
The wreck was found in Segment S1-1, Block 01, inside the survey corridor.

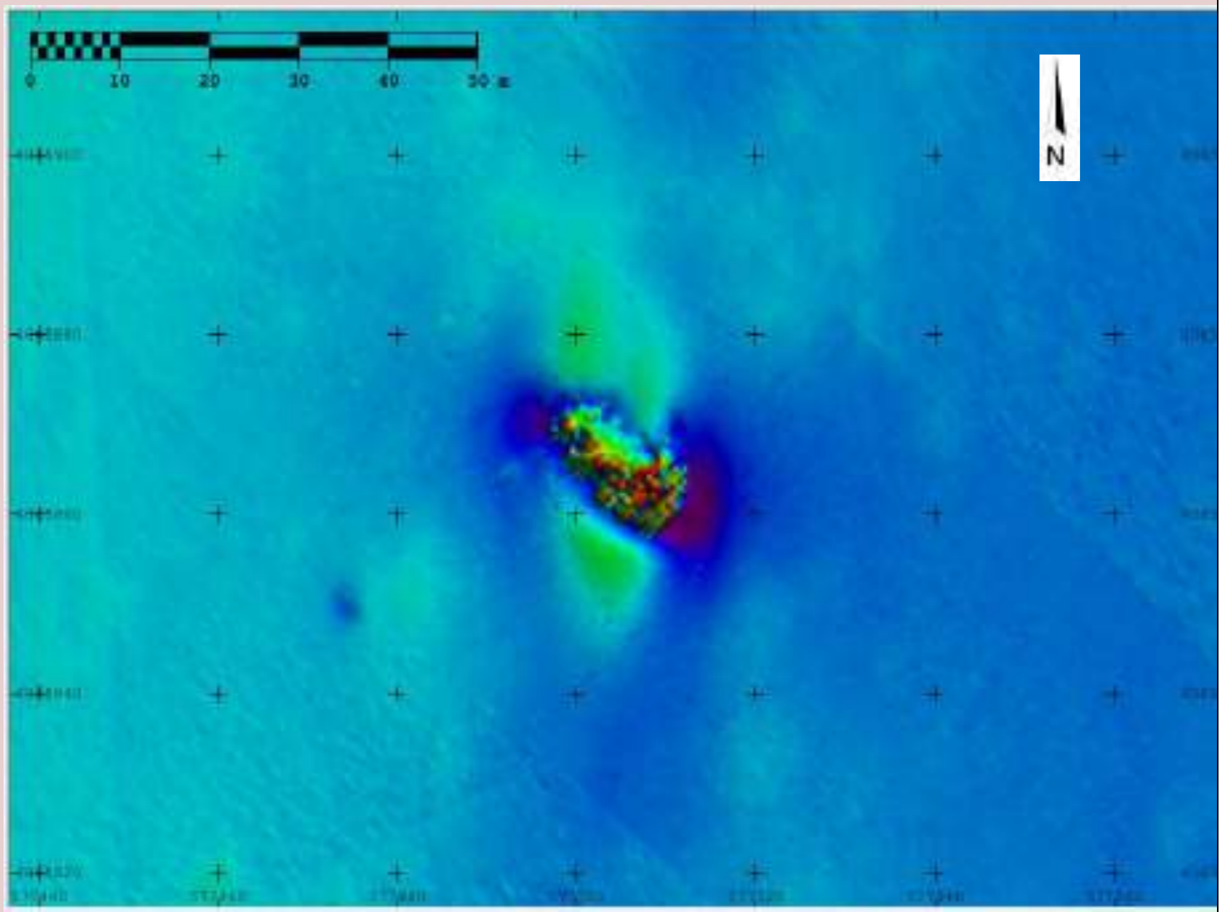
Multibeam Sonar data showing Wreck S1-1_FHE_SC0010

Project No:	Client:	Area / Site:	Project Title:	Survey Type:	Line No / Heading
208-18-675	ASN	Segment S1-1, Block 01	HAVHINGSTEN	CABLE ROUTE SURVEY	N/A

MBES 3D View – Sounding Points

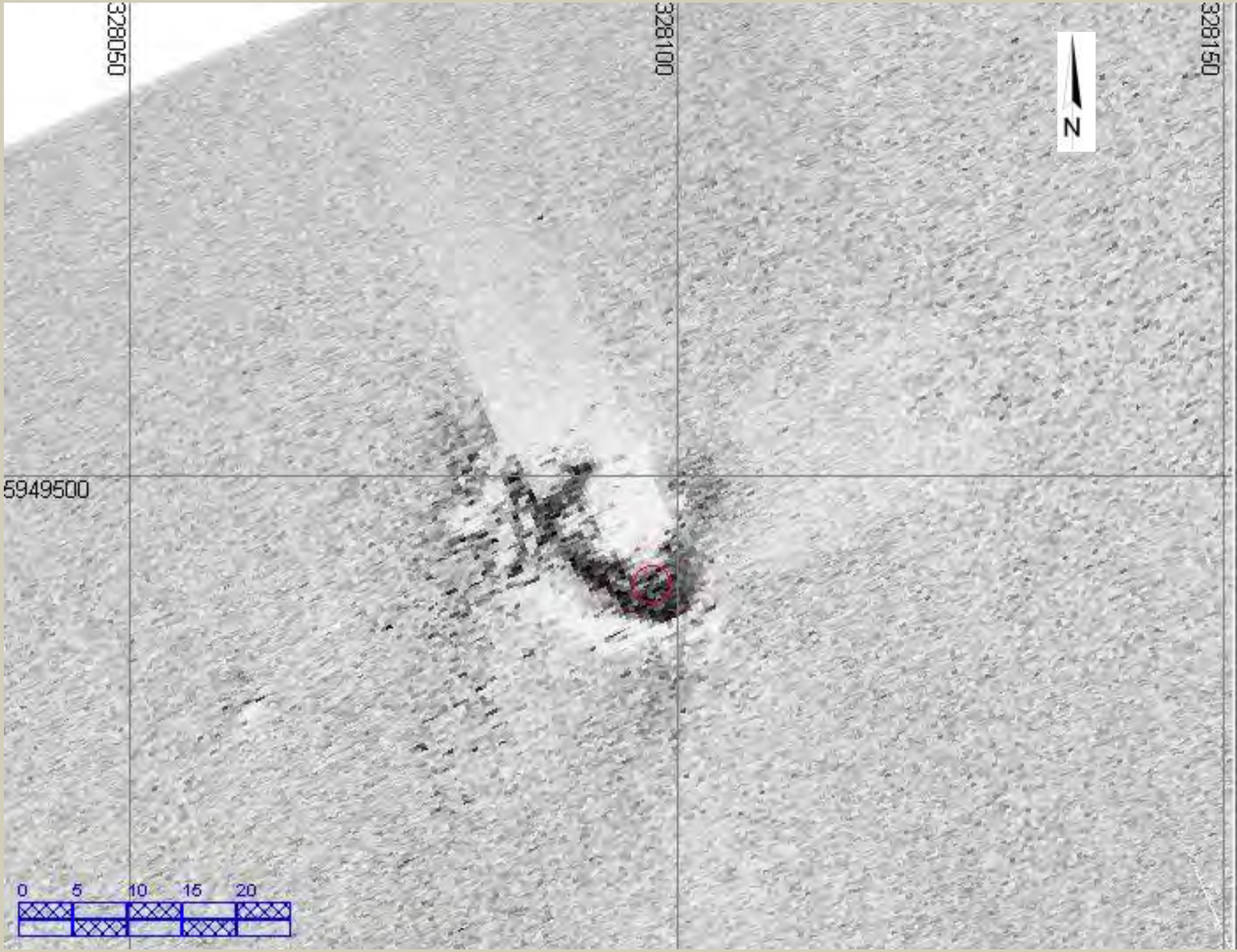


MBES Overview



Date of Survey:	04/10/2018	Survey Sensor:	Kongsberg EM2040 Multibeam Echosounder	Image Source:	Digital – not to scale	Frequency : 400 kHz
Vessel:	MV Fugro Helmert	Recording Medium:	SIS 4.3.2 / CARIS HIPS- SIPS 10.4.4	Velocity of Sound in Water:	1500 m/s	Range: N/A

Side-Scan Sonar data showing Wreck S1-1_FHE_SC0010					
Project No:	Client:	Area / Site:	Project Title:	Survey Type:	Line No / Heading
208-18-675	ASN	Segment S1-1, Block 01	HAVHINGSTEN	CABLE ROUTE SURVEY	N/A



Date of Survey:	04/10/2018	Survey Sensor:	Edgetech 4200 Side Scan Sonar	Image Source:	Digital – not to scale	Frequency : 600 kHz	
Vessel:	MV Fugro Helmert	Recording Medium:	Discover / SonarWiz 6.04.0007 64bit	Velocity of Sound in Water:	1500 m/s	Range: 125 m	

P. APPENDIX P - CABLE REPORT

CHARTED PIPELINE CROSSING REPORT PX IS INTERCONNECTOR 1			
Ship / Unit:		MV Fugro Helmert	
Survey:		208-18-675	
Date Located:	17/10/2018	Date Examined:	17/10/2018

Position (as found):	**53°44.6268'N**	**005°19.5120'W**
KP on RPL (as found)	**25.265**	
Position on RPL (PSR03_29 APR 2019):	**53°44.6268'N**	**005°19.5120'W**
KP on RPL (PSR03_29 APR 2019)	**25.265**	
Method of Positioning: Fugro Starfix HP DGPS	Accuracy: <50 cm	

Depth Data (LAT)	
General Depth:	77 m (LAT)

Contact Data	
Pipeline Status:	In service
Orientation:	025° / 335°
Crossing Angle:	Approx. 65°
Sonar Contact:	Yes
MBES Data:	Yes
Number of Magnetic Anomalies:	7
Magnetic Anomaly Strength:	Strong (Min: 101; Max 6150)

Description:

The charted Interconnector 1 pipeline was confirmed during the survey by 7 magnetic anomalies of similar values distributed in a straight line with roughly NE-SW orientation.

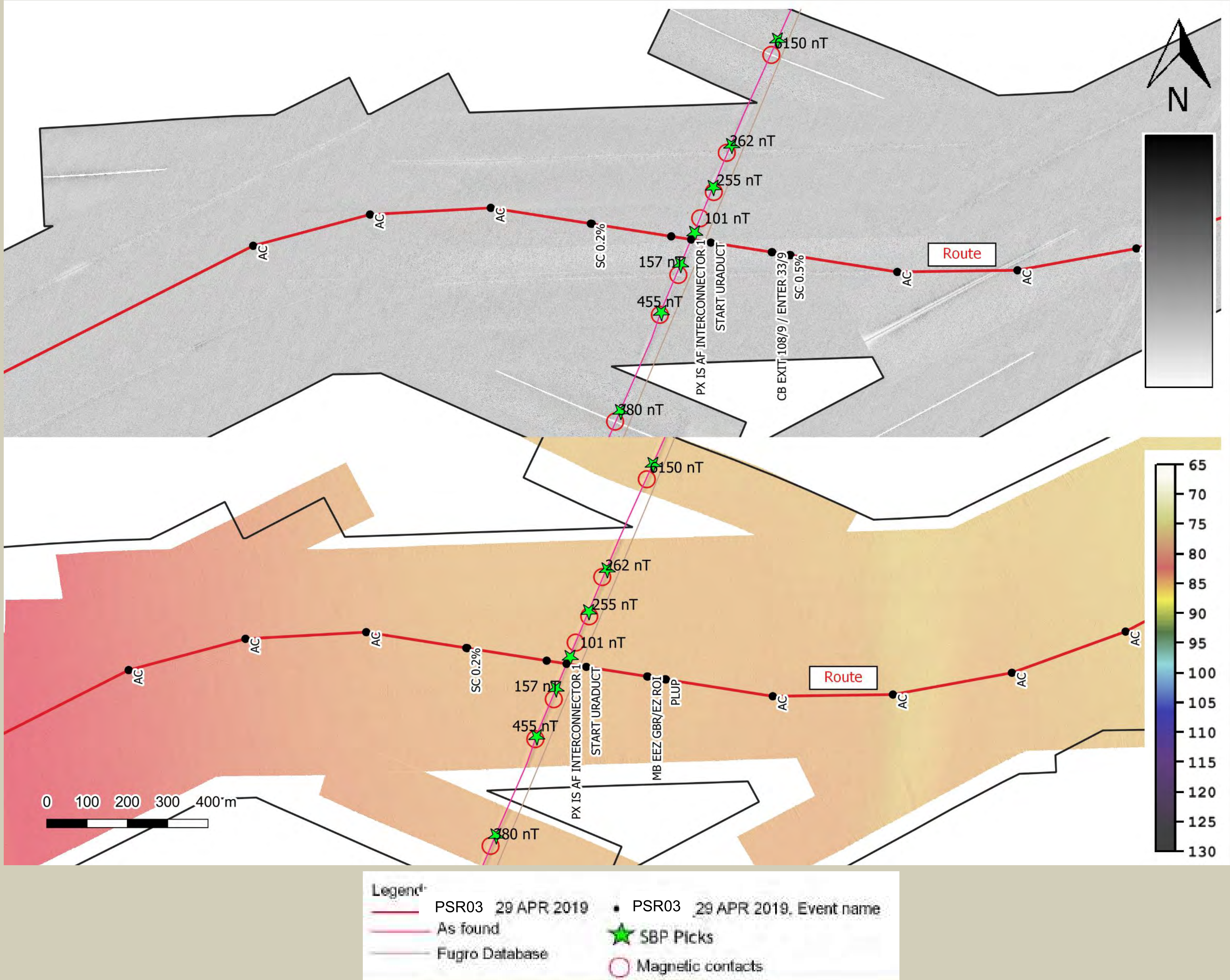
Gas Networks Ireland is the owner of the 24" gas pipeline Interconnector 1.

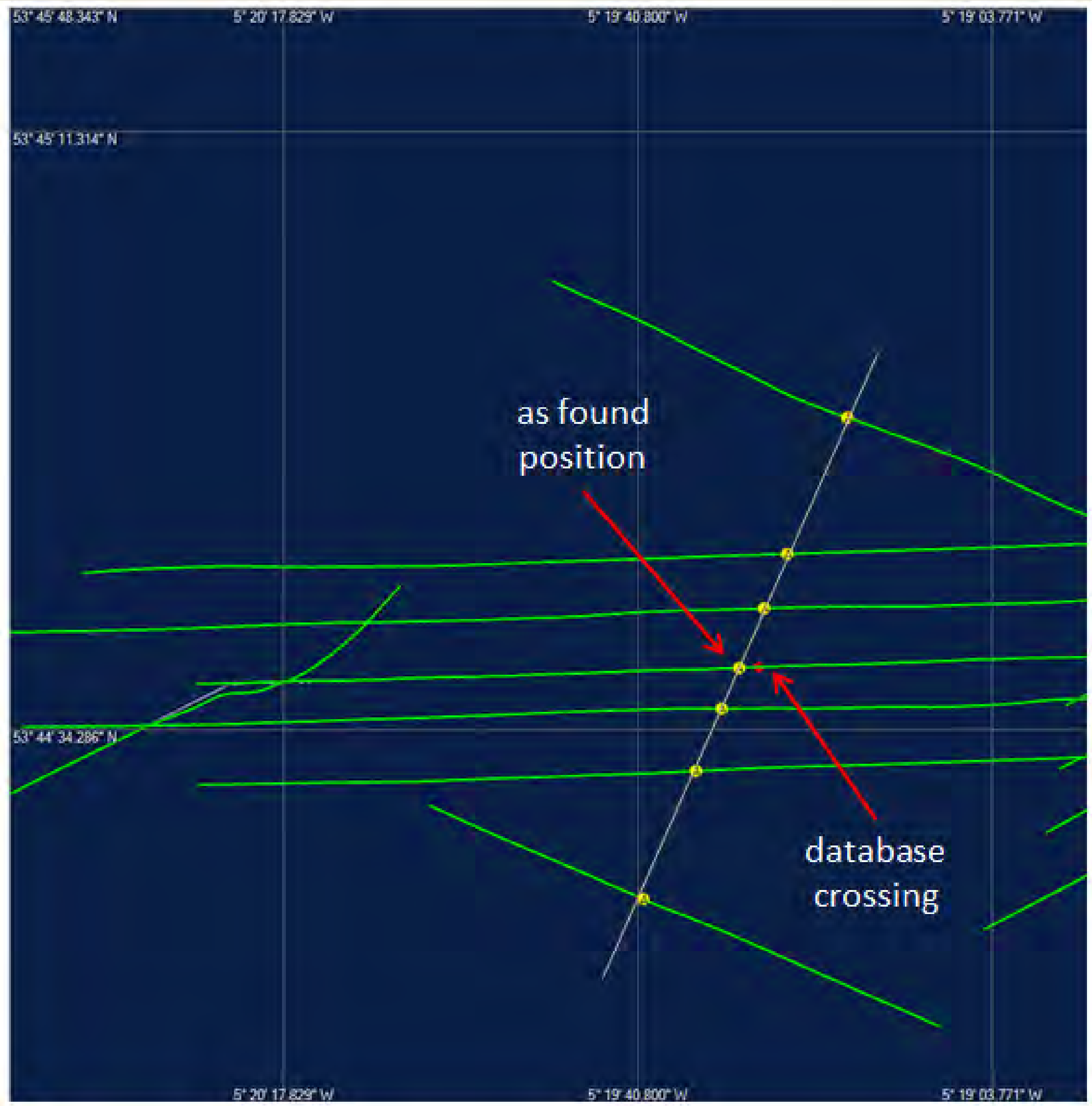
The trench of the pipeline is visible on MBES, SBP and SSS data (see figures for details). The pipeline reflections are visible on the SBP data and its estimated that the depth of burial is about 1 m, of which the depth of cover is about 0.3 m. The SBP picks are listed hereafter in table format.

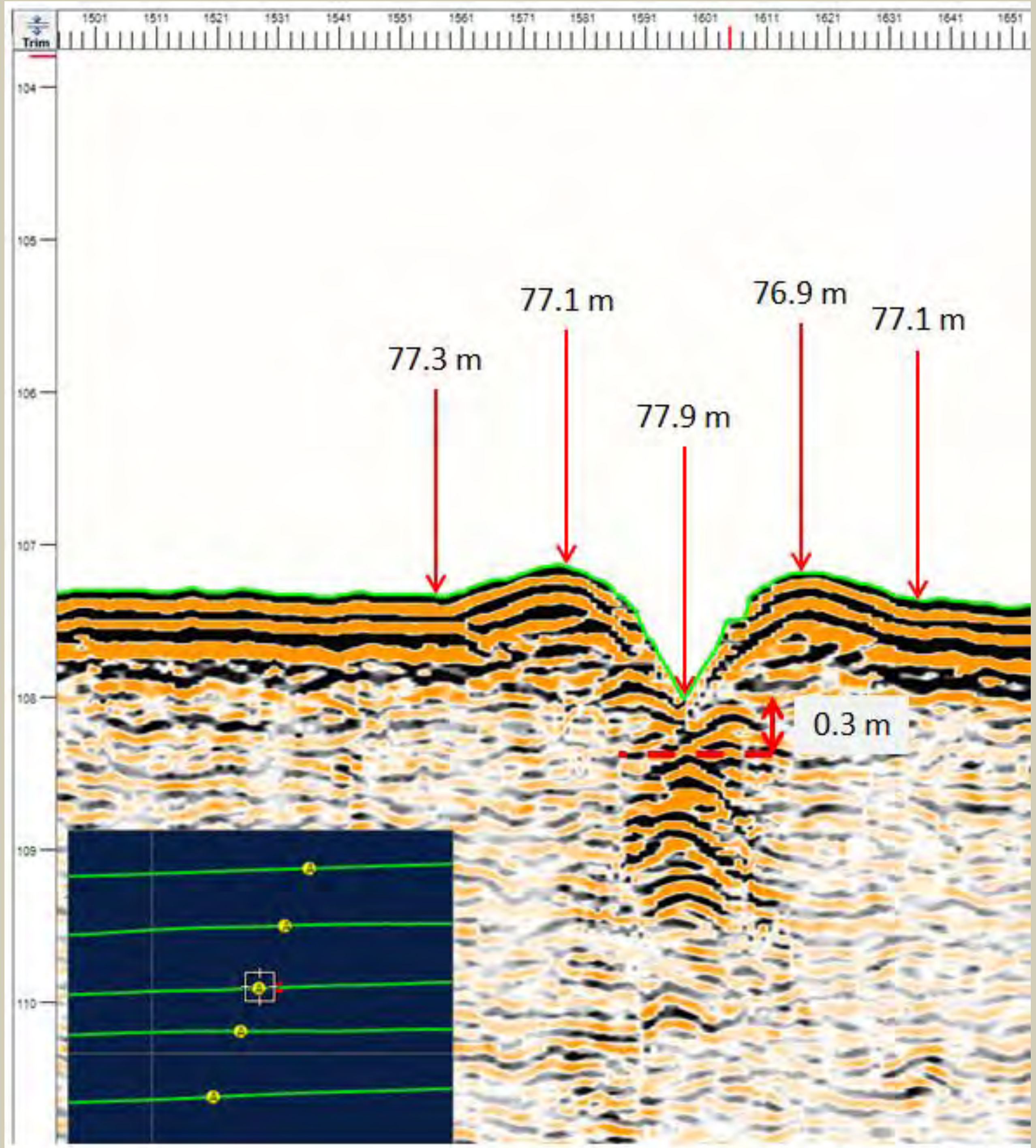
No trawl scars are visible in this sector.

Position as found and RPL coincide.

MBES, magnetometer, SSS and SBP data for charted pipeline crossing PX IS INTERCONNECTOR 1				
Project No:	Client:	Area / Site:	Project Title:	Survey Type:
208-18-675	ASN	Segment 1-1, Block 02	HAVHINGSTEN	CABLE ROUTE SURVEY







CX-PX name	Fix/KP	Easting	Northing	Line name
PIPELINE INTERCONNECTOR 1	1599	346672	5957541	FHE_S1-1_B02_CL_B_20181005_032454
PIPELINE INTERCONNECTOR 1	2614	346634.2	5957464	FHE_S1-1_B02_+100_B_20181017_180701
PIPELINE INTERCONNECTOR 1	1753	346582.5	5957347	FHE_S1-1_B02_+200_B_20181017_173240
PIPELINE INTERCONNECTOR 1	2284	346721.8	5957653	FHE_S1-1_B02_-100_B_20181017_170210
PIPELINE INTERCONNECTOR 1	2352	346770.6	5957755	FHE_S1-1_B02_-200_B_20181017_183843
PIPELINE INTERCONNECTOR 1	898	346893.2	5958012	FHE_S1-1_CX_B02_01_20181017_191254
PIPELINE INTERCONNECTOR 1	802	346473.8	5957105	FHE_S1-1_CX_B02_02_20181017_194038

Date of Survey:	**17/10/2018**	**Survey Sensor:**	**MBES, SBP, SSS and Magnetometer**	**Image Source:**	**Digital**
Vessel:	**MV Fugro Helmert**			**Velocity of Sound in Water:**	**N/A**

Q. APPENDIX Q - ARCHAEOLOGICAL REPORT

Cotswold Archaeology marine

Havhingsten submarine cable system

Archaeological review of foreshore and intertidal survey data for the whole route and of marine survey data for Irish waters only

for

Fugro Germany Marine GmbH

CA Project: 770835

CA Report: 770835_02

April 2019

Andover Cirencester Exeter Milton Keynes Suffolk

Havhingsten submarine cable system

Archaeological review of foreshore and intertidal survey data for the whole route and of marine survey data for Irish waters only

CA project: 770835
CA report: 770835_02

prepared by date	Michael Walsh, Senior Marine Consultant, Cotswold Archaeology Michael Grant, Senior Geophysicist, Coastal and Offshore Archaeological Research Services (COARS), University of Southampton David Harrison, Senior Geophysicist, Headland Archaeology and Rebecca Ferreira, Marine Archaeologist, Cotswold Archaeology April 2019
checked by date	Michael Walsh, Senior Marine Consultant April 2019
approved by signed date	Michael Walsh, Senior Marine Consultant April 2019
issue	1.2

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SUMMARY

Project name: Havhingsten submarine cable system

Cotswold Archaeology was commissioned by Fugro Germany Marine GmbH to undertake non-intrusive archaeological assessments at six proposed landfall locations at:

- Loughshinny, Co Dublin, Ireland;
- Port Erin, Isle of Man;
- Port Grenaugh, Isle of Man;
- Lytham St Anne's, west coast of England;
- Seaton Sluice, east coast of England; and
- Whitley Bay, east coast of England.

As well as an archaeological assessment of marine geophysical survey data along the potential cable route in Irish territorial waters only for a proposed fibre optic cable (Havhingsten submarine cable system) between Ireland and Denmark.

In total, the proposed cable route will run for approximately 607.7km. The cable route is proposed to run beneath the Irish Sea, with landfall locations on the east coast of Ireland, on the south-east and south-west coasts of the Isle of Man, and on the west coast of England. The proposed cable route continues beneath the North Sea, with landfall at two potential locations on the north-east coast of England. The cable route above mean high water springs (MHWS) and in English territorial waters is beyond the remit of this report.

This report includes the results from the foreshore and intertidal geophysical, hand-held metal detector and walkover surveys, as well as the archaeological assessment of near shore and offshore geophysical survey data for the route through Irish waters only. The assessment of marine data includes the identification of archaeological remains in proximity to the proposed cable route, as well as an assessment of archaeological potential.

Fugro undertook the marine geophysical surveys along the proposed route between August and November 2018. These surveys collected multibeam echo sounder (MBES), sidescan sonar (SSS), magnetometer and sub-bottom profiler (SBP) data. The archaeological assessment of marine data from Irish waters has identified 18 anomalies with archaeological potential along the proposed route. One of these anomalies represents a previously unknown cohesive wreck site. Appropriately-sized archaeological exclusion zones (AEZs) have been proposed for each of the identified anomalies.

The landfall surveys were conducted in March 2019 over the foreshore and intertidal zones at Loughshinny, Co Dublin, Ireland, Port Erin and Port Grenaugh on the Isle of Man, Lytham St Anne's, on the west coast, and Seaton Sluice and Whitley Bay on the east coast of England. The foreshore surveys comprised walk-over, hand-held metal detector and terrestrial geophysical (electrical conductivity) surveys. All find spot locations were recorded using the geodetic datum World Geodetic System (WGS) 1984 using a hand-held Global Positioning System (GPS) devices, while features of archaeological potential were recorded with digital photography.

These surveys have successfully evaluated the six potential landfall locations and have identified no anomalies of clear archaeological potential. At Port Grenaugh, however, where a possible fish trap or barrier against small vessels is recorded (Cotswold Archaeology 2019), linear anomalies detected perpendicular to the tide, may be anthropogenic in origin, perhaps resulting from buried walls or the accumulation of deposits against them. These anomalies are assessed as of low to moderate archaeological potential. No other anomalies of archaeological potential have been identified at any of the potential landfall locations. Elsewhere, four linear anomalies identified at Port Erin, and a fifth at Lytham St Anne's, indicate buried service pipes / cables. On the basis of the walkover geophysical, and metal detecting surveys, therefore, these landfall locations are assessed as of low archaeological potential, which corroborates the results of the marine archaeology desk-based assessment (Cotswold Archaeology 2019).

CONTENTS

LIST OF ILLUSTRATIONS

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1. INTRODUCTION

Outline

1.1. Cotswold Archaeology (CA) was commissioned by Fugro Germany Marine GmbH, at the end of November 2018, to undertake marine archaeological assessments for the proposed Havhingsten submarine cable system. These assessments included foreshore and intertidal surveys at six potential landfall locations, and the archaeological assessment of marine geophysical survey data collected along the proposed cable route corridor in Irish territorial waters only.

1.2. This report presents the results of the archaeological assessment of foreshore and intertidal archaeological survey data for all six potential landfall locations in the British Isles and of marine geophysical survey data in Irish waters only. This report includes an assessment of marine and coastal cultural assets potentially affected by this project, up to the mean high water springs (MHWS).

1.3. The Havhingsten submarine cable system (henceforth 'the project') is proposed to run beneath the Irish Sea with potential landfall locations at Loughshinny in Ireland, at Port Erin and Port Grenaugh on the Isle of Man and at Lytham St Anne's on the west coast of England. The cable will also run under the North Sea with two potential landfall locations at Seaton Sluice and at Whitley Bay on the north-east coast of England.

Project background

1.4. The proposed cable route runs for approximately 607.7km; 57.3km through Irish waters, 59.4km through Isle of Man waters and 491km through English waters (see figures 1 & 2). This report presents the results from the six potential landfall locations and from Irish territorial waters following the relevant national frameworks and guidance of each respective nation through whose waters the cable may be laid.

1.5. The foreshore, intertidal and marine assessments have been undertaken by Cotswold Archaeology in collaboration with our colleagues at Headland Archaeology, who undertook the collection and analysis of foreshore and intertidal geophysical survey data, at the six potential landfall locations, and with our colleagues at Coastal and Offshore Archaeological Research Services (COARS), University of Southampton, who undertook the assessment of marine geophysical survey data collected by Fugro.

1.6. The purpose of these archaeological assessments is to identify known and potential sites and features of archaeological interest at the six potential landfall locations and along the proposed cable route in Irish waters that might be impacted by the project. The potential impact of the project on those sites will then be limited through the adoption of appropriate mitigation measures, such as the adoption of AEZs where necessary. Archaeological potential is evaluated through the assessment of the nature and density of known sites in the vicinity of the proposed development.

2. METHOD

2.1. All surveys were positioned using the geodetic datum WGS 1984, with projection in the appropriate Universal Transverse Mercator Zone.

Foreshore survey

2.2. The surveys were conducted during the most favourable Spring tides and extended to the low water mark in an effort to achieve overlap coverage with the offshore marine surveys.

2.3. The landfall surveys, conducted on the foreshore and in the intertidal zone, comprised walkover, hand-held metal detector, and geophysical (electro-magnetic conductivity) surveys. The aim of the surveys was to assess and map the extent of any archaeological remains along, and in proximity to, the proposed cable route.

Metal detector and walkover surveys

2.4. Hand-held metal detector and walkover surveys were conducted following 5m wide traverses to match those used for the geophysical survey. The metal detector was set to detect all metal, but the sensitivity was adjusted to compensate for the high salt content of the beach sand. All identified features and detected finds spots were recorded photographically with a brief description, if deemed necessary. Locations were recorded using a hand-held Garmin GPS and plotted into an AutoCAD base plan. As this survey was non-intrusive, no finds spots were excavated. A Minelab X-Terra 705 metal detector was used to conduct the surveys (Fig. 3).

Legend

N

- Ireland CSC
- IoM CSC
- UK west merge CSC

0 32.5km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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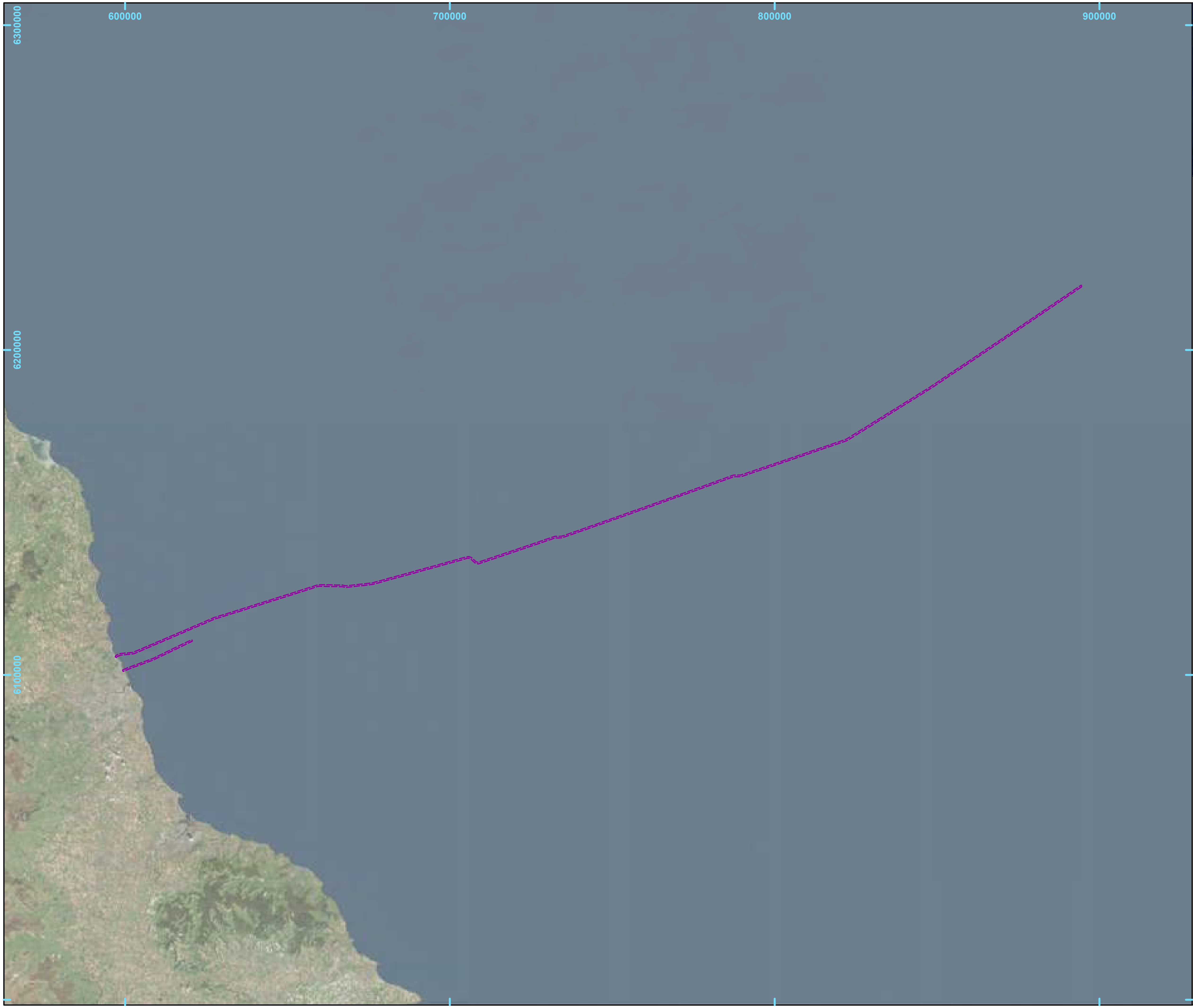
PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Irish Sea cable study corridors (CSCs)

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	1
APPROVED BY	MTW	SCALE@A3	1:750,000	



Legend

UK east merge

N

0 40km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
North Sea CSC

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	2
APPROVED BY	MTW	SCALE@A3	1:1,100,000	

2.6. The numeric values displayed on the detector were also recorded as they can potentially assist in the identification of the type of metal detected, with higher values more likely to be indicative of non-ferrous metals (Minelab 2017:11).

Figure 3 Metal detecting on Port Erin beach

Geophysics

2.7. Geophysical survey was undertaken by a geophysicist from Headland Archaeology using a Geophex GEM-2 multi-frequency broadband electromagnetic (EM) instrument (Fig. 4) to perform a terrain electrical conductivity survey. The instrument is a non-intrusive frequency-domain electrical conductivity measuring device that records the spatial variations of apparent ground conductivity of the earth in units of milliSiemens / metre (mS/m). The ‘siemen’ is the international unit of measurement for volume electrical conductance and is the equivalent to an ampere/volt. Differences in deposits, principally variations in thickness between deposits with different conductivities, can produce spatial variations in conductivity readings.

2.8. The system provides two measurements:

- Quadrature (apparent conductivity); and
- In-phase data (metallic response).

2.9. The GEM-2 can acquire data over multiple frequencies, which is equivalent to measuring the earth response from multiple depths (depending upon the earth medium targeted). Five frequencies were utilised and subsequently analysed on each of the landfall locations (475 Hertz (Hz), 1525Hz, 5325Hz, 18325Hz and 63025Hz).

Figure 4 GEM2 in operation at Port Erin

2.10. A survey grid was set out at the required locations and subdivided into 5m transects, using a GPS system utilising WGS84 30N Universal Transverse Mercator (UTM) with an accuracy of 0.5m or greater.

2.11. The primary focus of the survey was to identify buried metal objects on the beach that might relate to heritage assets. In addition, some success was obtained in mapping variations in silting patterns in the foreshore area. Variations in response might occur where timber structures have influenced the deposition of sediments and could therefore be used to identify the presence of wooden material which could be indicative of wreck material or other wooden structures buried in the sand.

2.12. In addition, as ground conductivity is influenced by soil moisture content, an electromagnetic conductivity survey could be used to differentiate between areas of solid substrata and sand. This could help to define the former physical topography of the survey area by identifying former channels or basins in the sub-strata.

Identification of these features would help to define areas of archaeological potential within the survey area.

2.13. The data was digitally recorded and periodically downloaded to a field computer for quality assurance and preliminary interpretation.

2.14. At the conclusion of the survey, the Geophex GEM-2 data was interpreted and mapped using Terrasurveyor V3.0.32.4 software (DWConsulting), a surface mapping software that allows topographic data to be contoured and presented in a manner that enables the interpretation of sub-surface features.

2.15. The illustrations of the foreshore and intertidal geophysical survey data in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different frequencies. All graphics are displayed using the 5325Hz frequency which has been presented to most suitably display and interpret the data from each site based on the experience and knowledge of the assessors.

2.16. The geophysical survey and report were completed in accordance with relevant best practice guidance documents (see Bonsall *et al*. 2014; David *et al*. 2008; Gaffney *et al*. 2002; Schmidt *et al*. 2015).

Offshore survey

2.17. The offshore geophysical survey was undertaken by Fugro between August and November 2018 using the survey vessel MV Fugro Helmert (Fig. 5). The survey corridor was c. 500m wide, with seven survey lines spaced c. 60m apart, resulting in >100% MBES and SSS coverage.

2.18. Bathymetric data were acquired using a Kongsberg EM2040 (200-400 kHz) MBES, with positioning provided using a Seastar 3610 DGNSS receiver. The SSS survey was undertaken using an Edgetech 4200 series dual frequency (600 and 300 kHz) fish, with position provided by a Kongsberg HiPAP 501 USBL system. The magnetometer survey was undertaken using a Geometrics G882 magnetometer with positioning provided by ultra-short baseline (USBL). The SBP seismic data were acquired using an Innomar SES 2000 medium, with position provided by USBL.

2.19. Survey positions were recorded in the geodetic datum WGS84, with projection in the Universal Transverse Mercator (UTM) Zone 30 North. The vertical reference level is Lowest Astronomical Tide (LAT), with MBES elevation corrected to mLAT using the VORF vertical reference.

2.20. Geophysical assessment was undertaken utilising the programs Coda Octopus survey engine 4.3 and ArcGIS 10.6.1, following the guidelines of Plets et al. (2013). The SSS and SBP data were analysed using Coda with the positions of surface and sub-surface anomalies exported into ArcGIS as shapefiles alongside processed magnetometer data provided by Fugro. MBES was provided at a gridded resolution of 1.0m and imported into ArcGIS. The geophysical data was assessed for anomalies with archaeological potential, with selection based on the presence of multiple lines of evidence (confirming datasets).

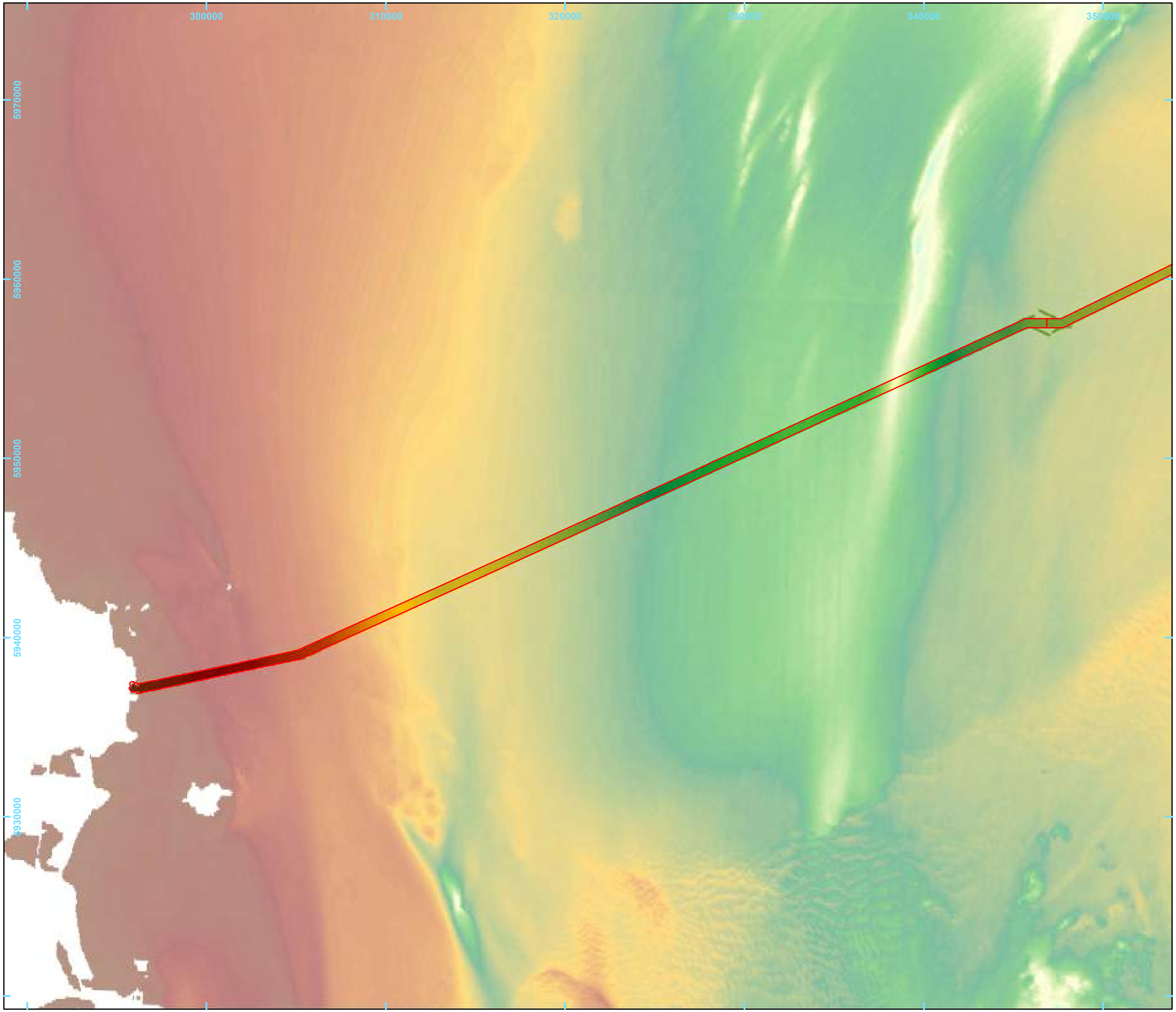
3. RESULTS

Foreshore survey

Loughshinny

3.1. Nothing of particular archaeological interest was identified in the desk-based assessment (DBA) at Loughshinny (Cotswold Archaeology 2019). Rather than emanating from a marine context, archaeological discoveries in the vicinity appear to have eroded from the promontory fort.

3.2. Complimentary quadrature (conductivity) and in-phase (magnetic susceptibility) geophysical datasets collected at Loughshinny recorded clear contrasts between high conductivity / high magnetic susceptibility in the harbour area adjacent to the wharf in the east and lower values generally in the west of the survey area (Fig. 6). This variation is probably caused by the accumulation of marine deposits behind the harbour wall where the silts are sheltered from the Irish Sea. Clearly interpretable metallic responses have been identified in the in-phase dataset (Fig. 7) as discrete anomalies with extreme values, mostly occurring towards the high-water mark at the head of the beach and within the harbour area in the east. This observation is reflected in the results from the metal-detection survey. The concentration of metal detection locations higher up the beach, to the north-west (Fig. 7), probably represents casual losses indicative of the area of the beach that is most likely favoured by bathers and walkers.



N

Legend

Route Corridor

Bathymetry (m LAT)

80

-160

0 7,500m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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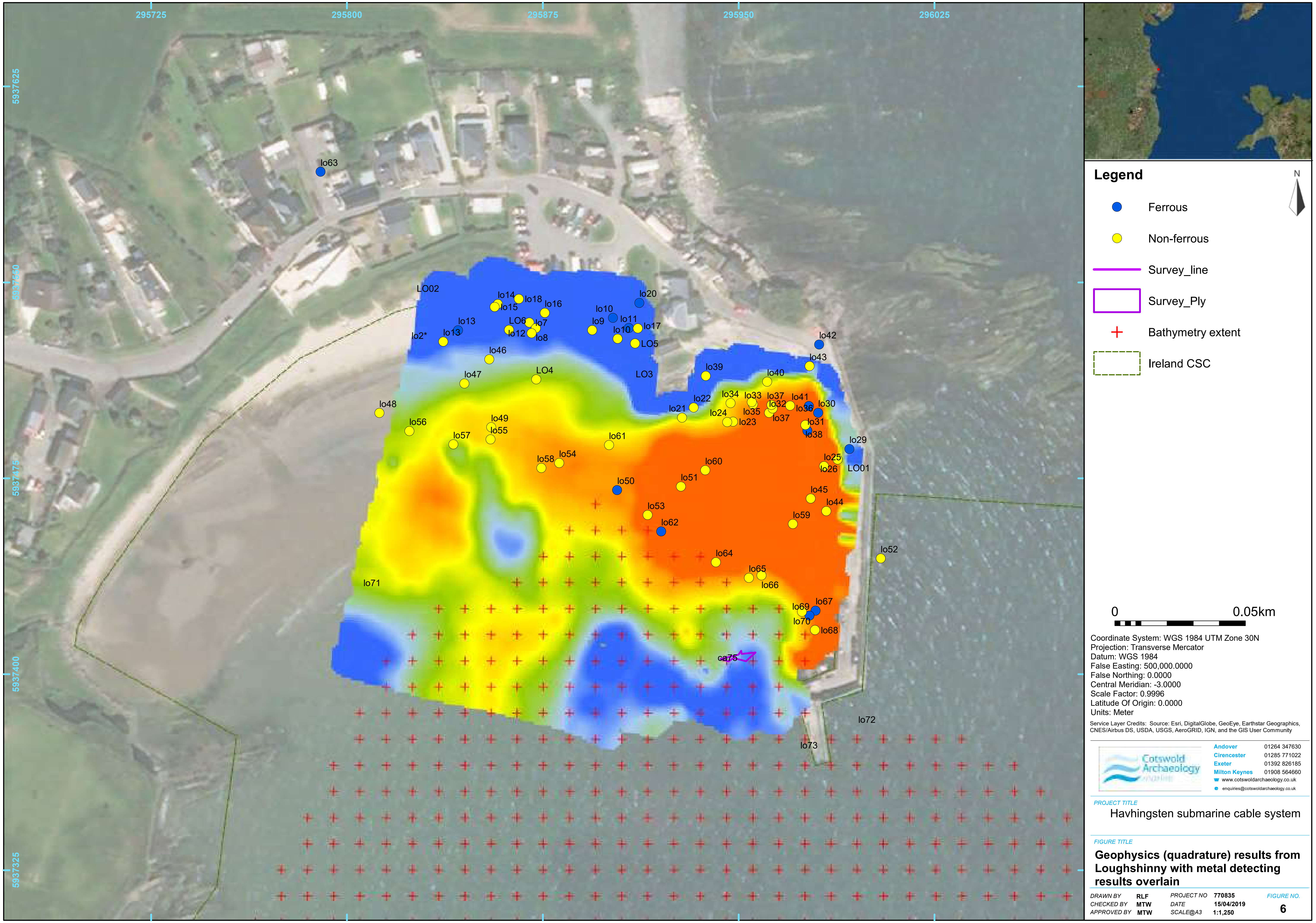
PROJECT TITLE

Havhingsten submarine cable system

FIGURE TITLE

Proposed route and survey corridor through Irish Waters

DRAWN BY	**MJG (UoS)**	*PROJECT NO*	**770835**	*FIGURE NO.*
CHECKED BY	**RK**	*DATE*	**25/09/2018**	**5**
APPROVED BY	**MW**	*SCALE@A3*	**1:200,000**	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Legend
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Ferrous
Non-ferrous
Survey_line
Survey_Ply
Bathymetry extent
Ireland CSC
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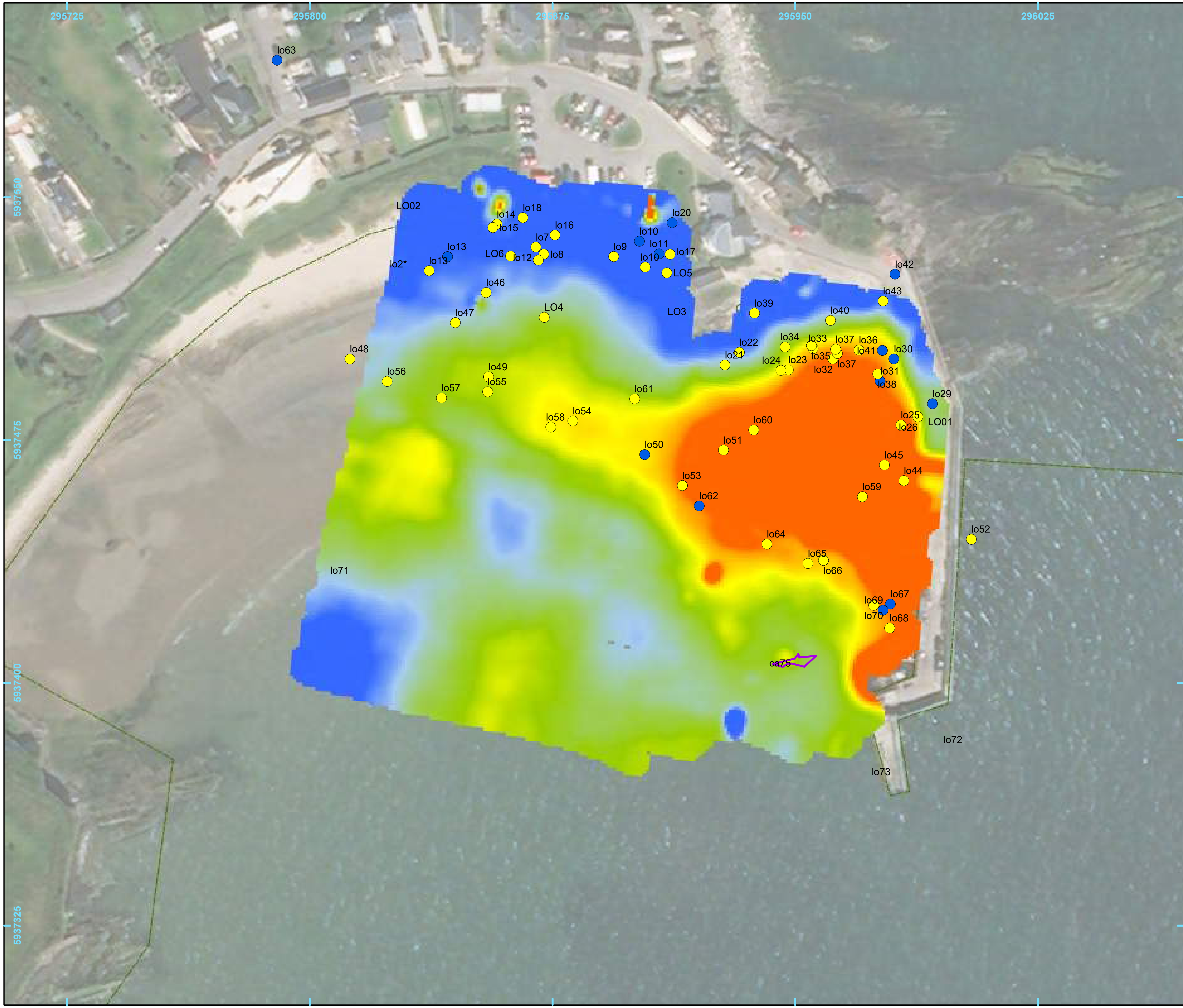
PROJECT TITLE
Havhingsten submarine cable system
FIGURE TITLE
Geophysics (quadrature) results from Loughshinny with metal detecting results overlain
DRAWN BY RLF
CHECKED BY MTW
APPROVED BY MTW
PROJECT NO 770835
DATE 15/04/2019
SCALE@A3 1:1,250
FIGURE NO.
6



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PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Geophysics (in-phase) results from Loughshinny with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.	
CHECKED BY	MTW	DATE	15/04/2019		7
APPROVED BY	MTW	SCALE@A3	1:1,102		

Port Erin

3.3. All sites recorded in the DBA on the Isle of Man appear to be above MHWS or without the CSC (Cotswold Archaeology 2019). This was confirmed by the archaeological walkover which identified nothing of archaeological potential within the study area.

3.4. Four linear anomalies are clearly visible in the Port Erin geophysical datasets, radiating from a concrete ramp that provides access to the beach in the east of the survey area (Fig. 8). These anomalies represent buried services which were not located by the metal detector, probably because they were too deeply buried. The broad area of low conductivity / low magnetic susceptibility in the east of the dataset corresponds to the outflow from a minor watercourse and is probably due to variation in the depth and composition of the beach deposits in this area. The concentration of non-ferrous metal detections at the upper (western) end of the beach could again represent isolated finds on the more frequently used section of the beach although the linear nature of the finds, parallel to the waterline, might suggest detritus washed ashore.

Port Grenaugh

3.5. One of the sites mentioned in the DBA (Cotswold Archaeology 2019), *Cronk ny Merriu*, a presumed Iron Age defended promontory, which was later built over by a Viking longhouse, was visited during the walkover (Fig. 10) and was confirmed to be well away from the study area. The possible remains of a fish trap, or a rudimentary barrier against small vessels was also inspected at low tide but the surviving remains (Fig. 11) are difficult to interpret with any certainty.

3.6. At Port Grenaugh the geophysical survey has identified at least four parallel linear anomalies, aligned north-east / south-west, perpendicular to the tide (Fig. 12 and Fig. 13). The alignment of the anomalies corresponds to the surrounding inter-bedded siltstone / mudstone / sandstone bedrock. The anomalies probably represent an accumulation of deposits within fissures in the bedrock or by the bands of Caledonian Supersuite (metamorphic rock) which are also recorded on this alignment. Potential alignments in the metal detection survey seem to reflect those found in the geophysical survey data. This could represent items trapped in the fissures or could represent built structures. A possible fish trap or barrier against small vessels is recorded in the bay and therefore an anthropogenic origin cannot be discounted. It is possible that the anomalies represent buried walls, or the accumulation of deposits against them.

Lytham St Anne's

3.7. None of the three sites (**CA6-8**) identified in the DBA (Cotswold Archaeology 2019) in the vicinity of the proposed landfall location at Lytham St Anne's were immediately apparent during the walkover survey, which suggests either that they are well beyond the study area or that little remains.

3.8. An east / west linear anomaly has been clearly identified in the in-phase (magnetic susceptibility) geophysical dataset (Fig. 14). The anomaly represents a buried service pipe. Towards the eastern end of the anomaly it deviates southwards, maintaining a constant distance from the sea defences which delimit the north-west corner of the survey area. Buried sea defences have also been clearly detected within this dataset as high magnetic susceptibility linear anomalies adjacent to the north-western survey limit.

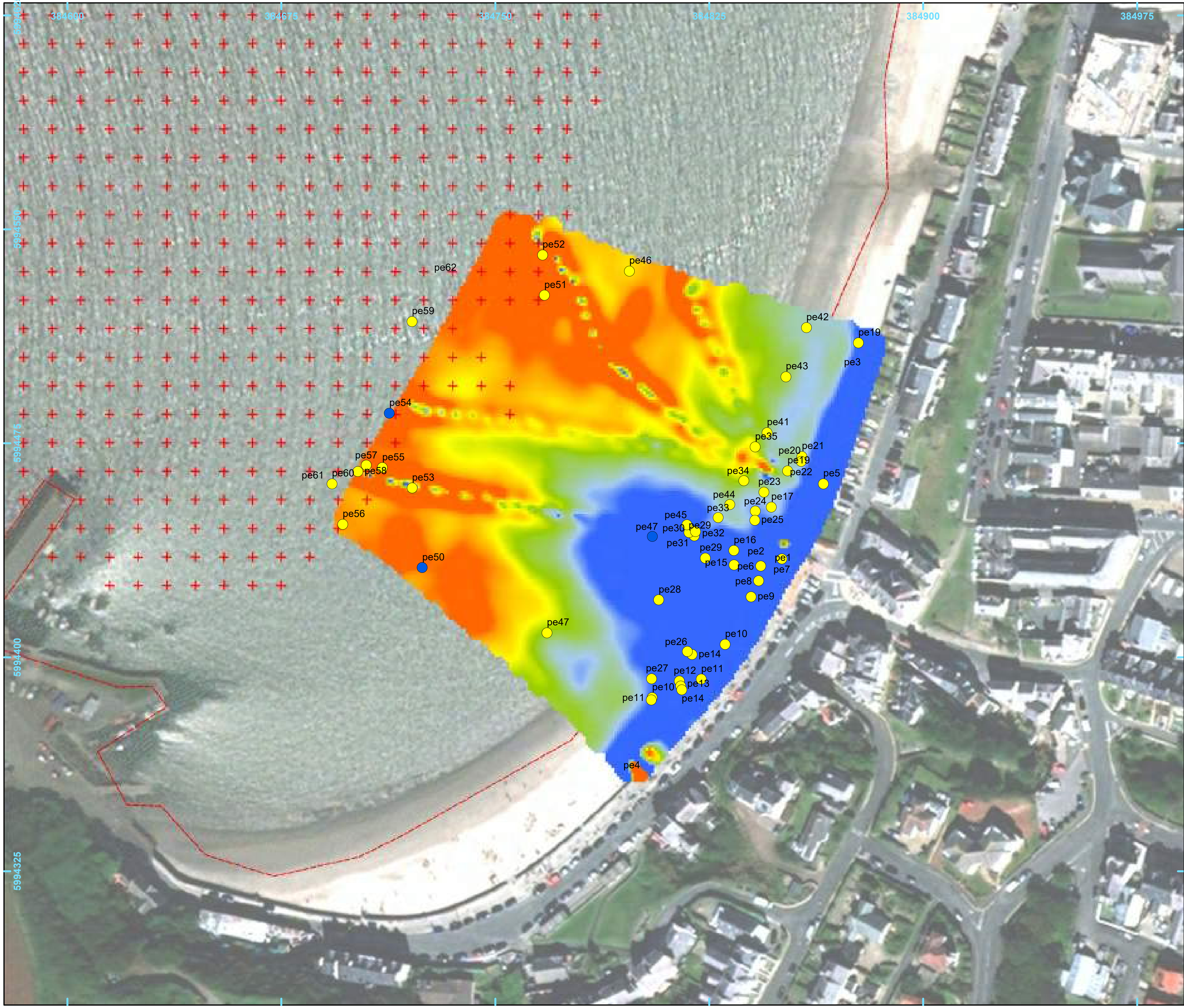
3.9. Broad and amorphous areas of electrical conductivity (Fig. 15) and magnetic susceptibility variation across the dataset are probably a result of natural silting patterns.

3.10. There is no obvious patterning in the metal detection survey; the bulk of the locations again appear to represent casual losses in the upper (eastern) section of the beach which is more frequently used by walkers and bathers.

Seaton Sluice

3.11. None of the four sites recorded in the DBA (Cotswold Archaeology 2019) in the north-east (**CA57-60**) were identified during the walkover surveys which suggests either that remains are beyond the study area, they no longer exist, or they have been buried, removed, or built over.

3.12. The geophysical data at Seaton Sluice is characterised by a broad band of low conductivity / low magnetic susceptibility along the south-western side of the dataset. This anomaly corresponds with the elevated section of the beach. The north-eastern half of the dataset contains broad and amorphous areas of variation which again are probably a result of natural silting patterns (Fig. 16 and Fig. 17).



Legend

N

- Ferrous
- Non-ferrous
- Survey_line
- Survey_Ply
- Bathymetry extent
- IoM CSC

0 0.05km

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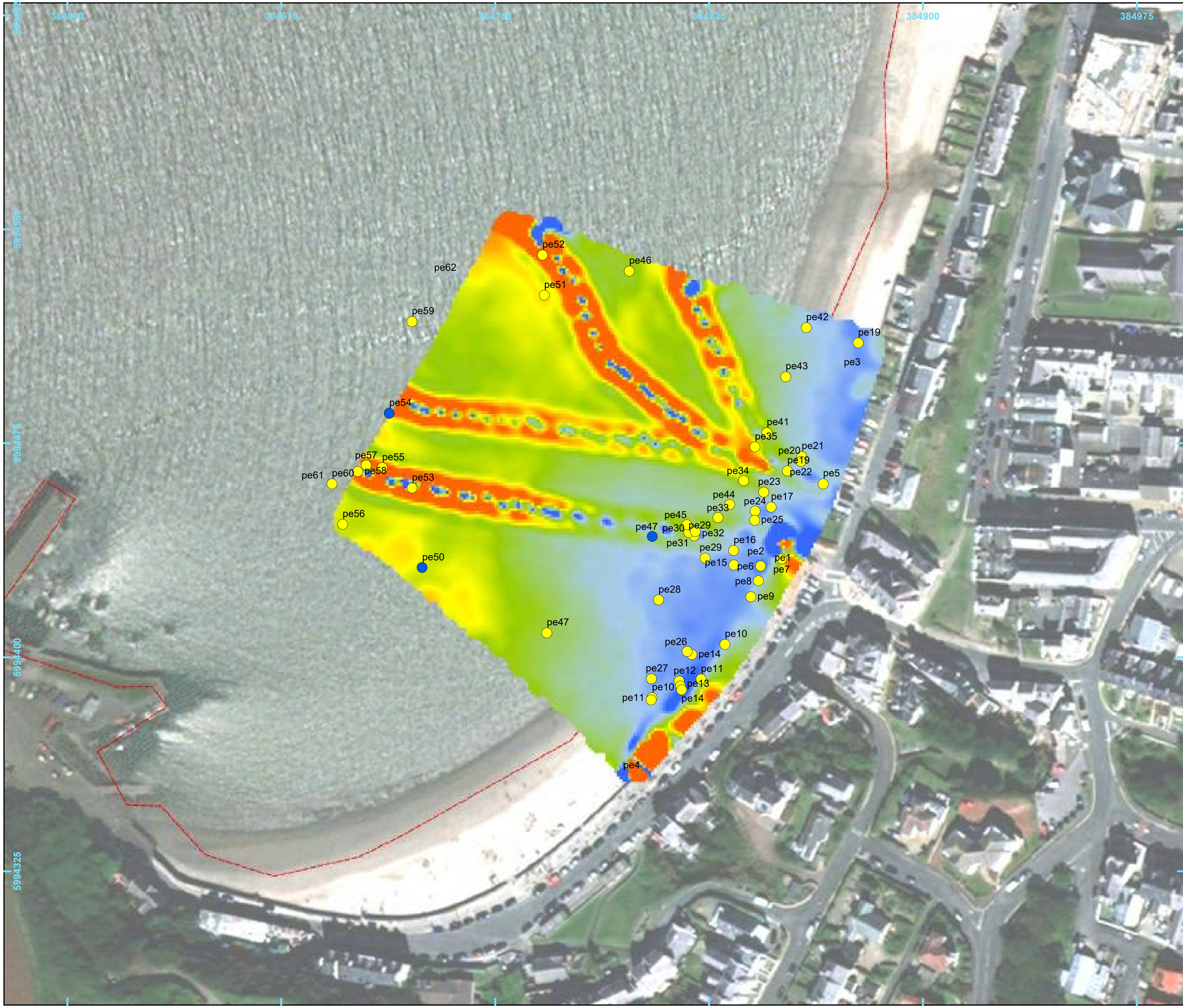
PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Geophysics (quadrature) results from Port Erin with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	8
APPROVED BY	MTW	SCALE@A3	1:1,250	



Legend

N

Ferrous

Non-ferrous

Survey_line

Survey_Ply

IoM CSC

0 0.05km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
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Units: Meter

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PROJECT TITLE

Havhingsten submarine cable system

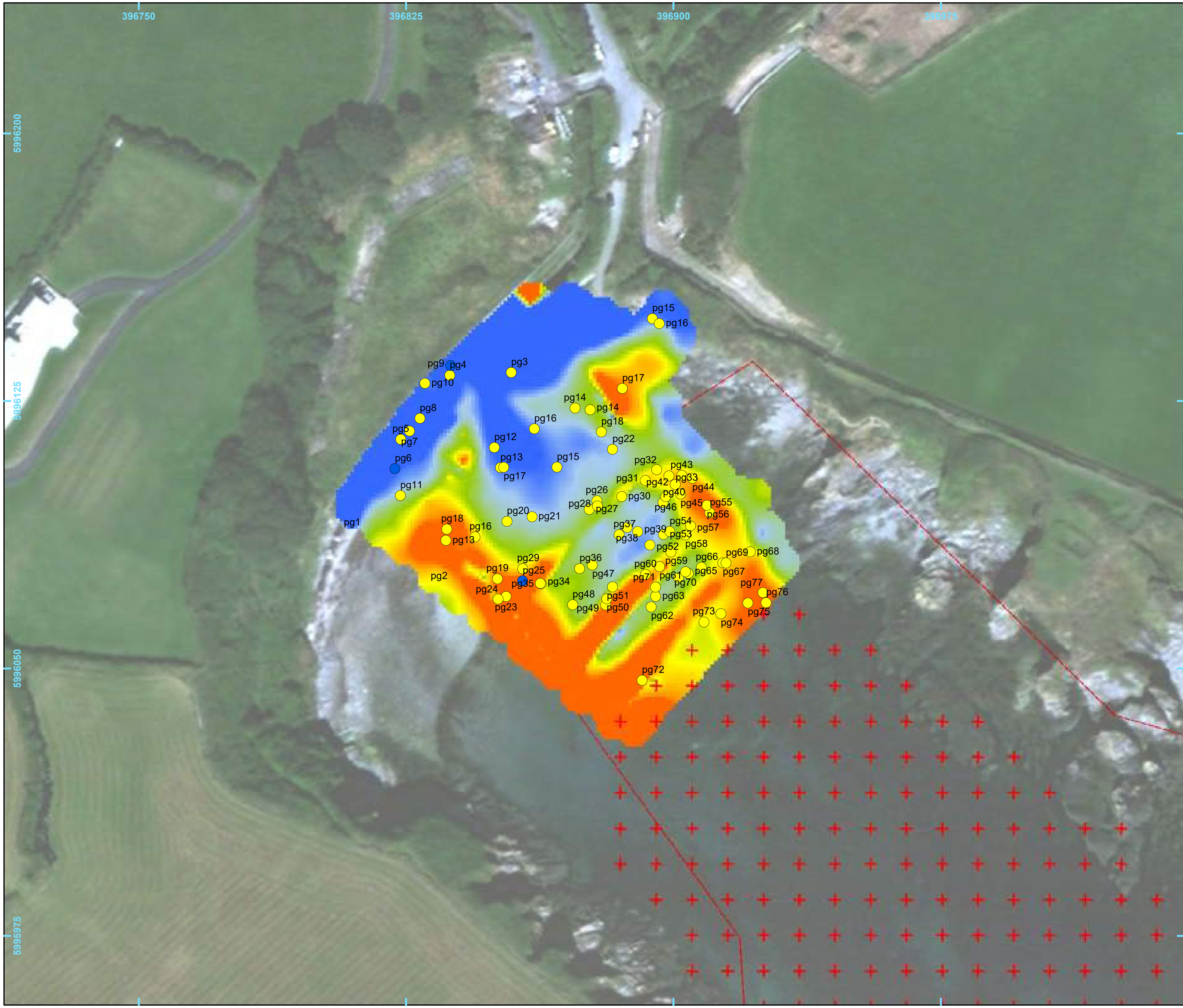
FIGURE TITLE

Geophysics (in-phase) results from Port Erin with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	9
APPROVED BY	MTW	SCALE@A3	1:1,250	

Figure 10 *Cronk ny Merriu*, a presumed Iron Age defended promontory (background facing landward), later built over by a Viking longhouse (foreground)

Figure 11 Boulders located in the lower intertidal zone at Port Grenaugh interpreted as a possible fishtrap or barrier to small vessels



Legend

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- Ferrous
- Non-ferrous
- Survey_line
- Survey_Ply
- Bathymetry extent
- IoM CSC

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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Geophysics (quadrature) results from Port Grenaugh with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	12
APPROVED BY	MTW	SCALE@A3	1:1,000	

Legend

N

- Ferrous
- Non-ferrous
- Survey_line
- Survey_Ply
- IoM CSC

0 0.0425km

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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Geophysics (in-phase) results from Port Grenaugh with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.	
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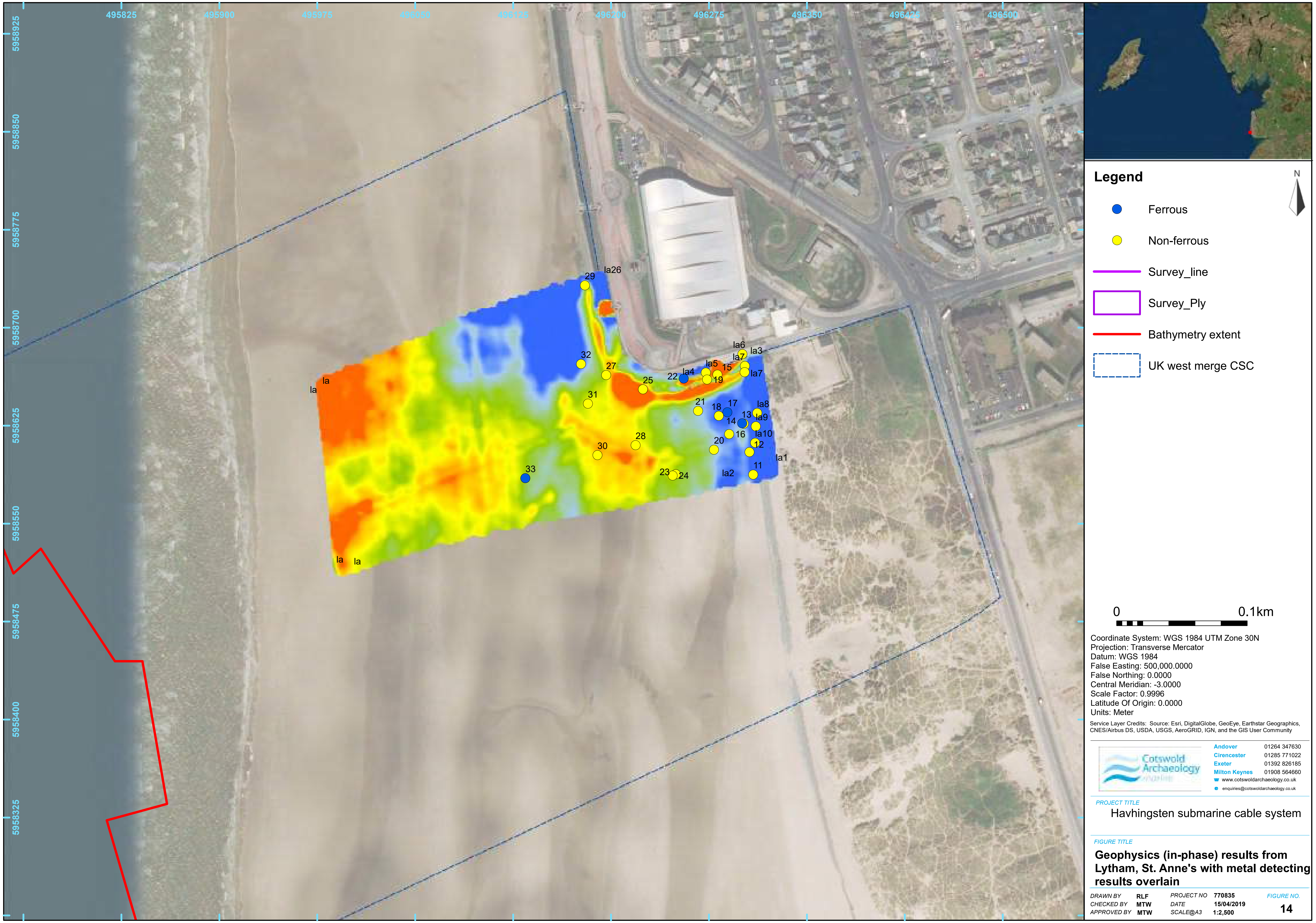
APPROVED BY	MTW	SCALE@A3	1:1,000		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Legend
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Ferrous
Non-ferrous
Survey_line
Survey_Ply
Bathymetry extent
UK west merge CSC
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PROJECT TITLE
Havhingsten submarine cable system
FIGURE TITLE
Geophysics (in-phase) results from Lytham, St. Anne's with metal detecting results overlain
DRAWN BY RLF
CHECKED BY MTW
APPROVED BY MTW
PROJECT NO 770835
DATE 15/04/2019
SCALE@A3 1:2,500
FIGURE NO.
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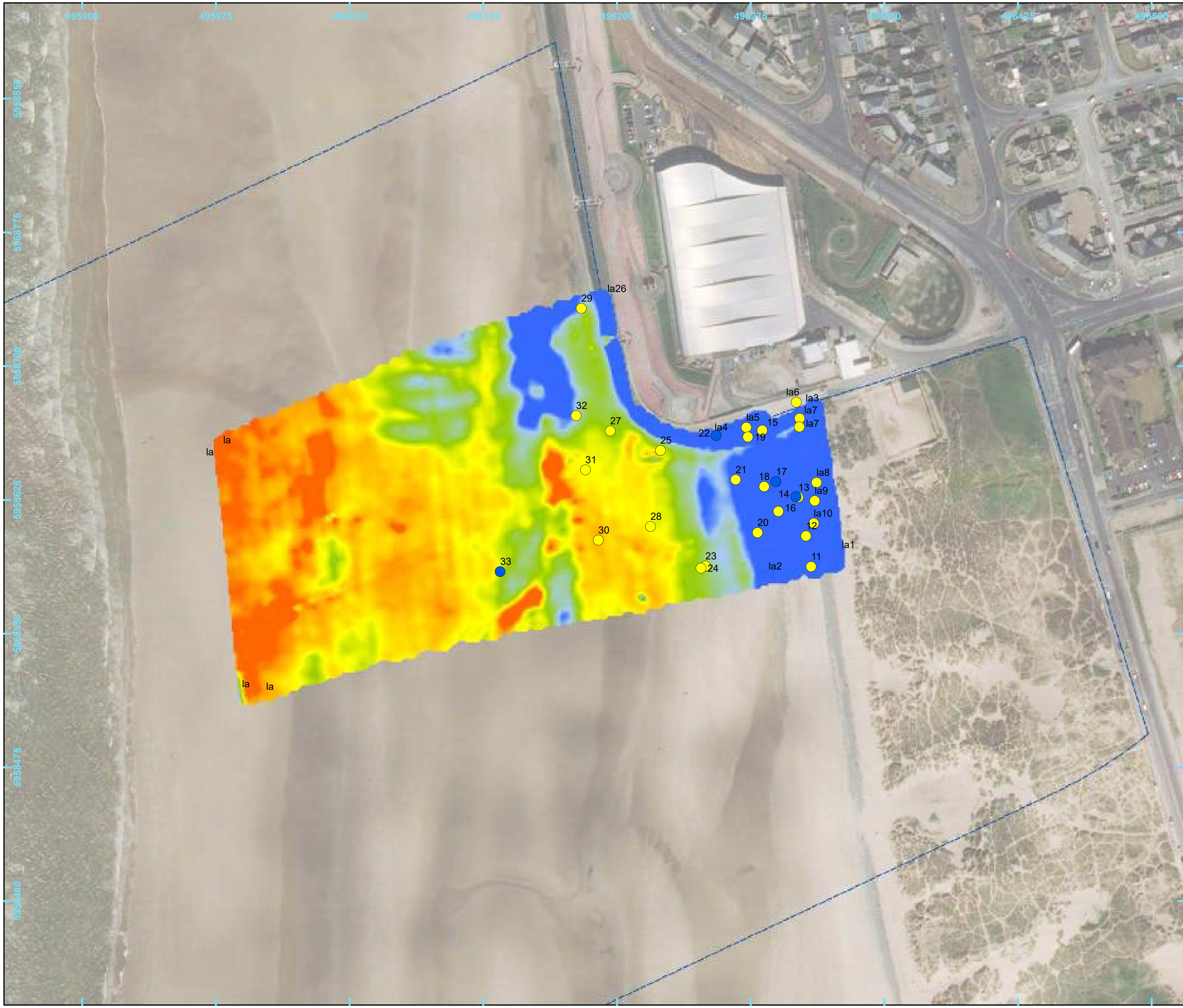

Legend

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Non-ferrous

Survey_line

Survey_Ply

UK west merge CSC

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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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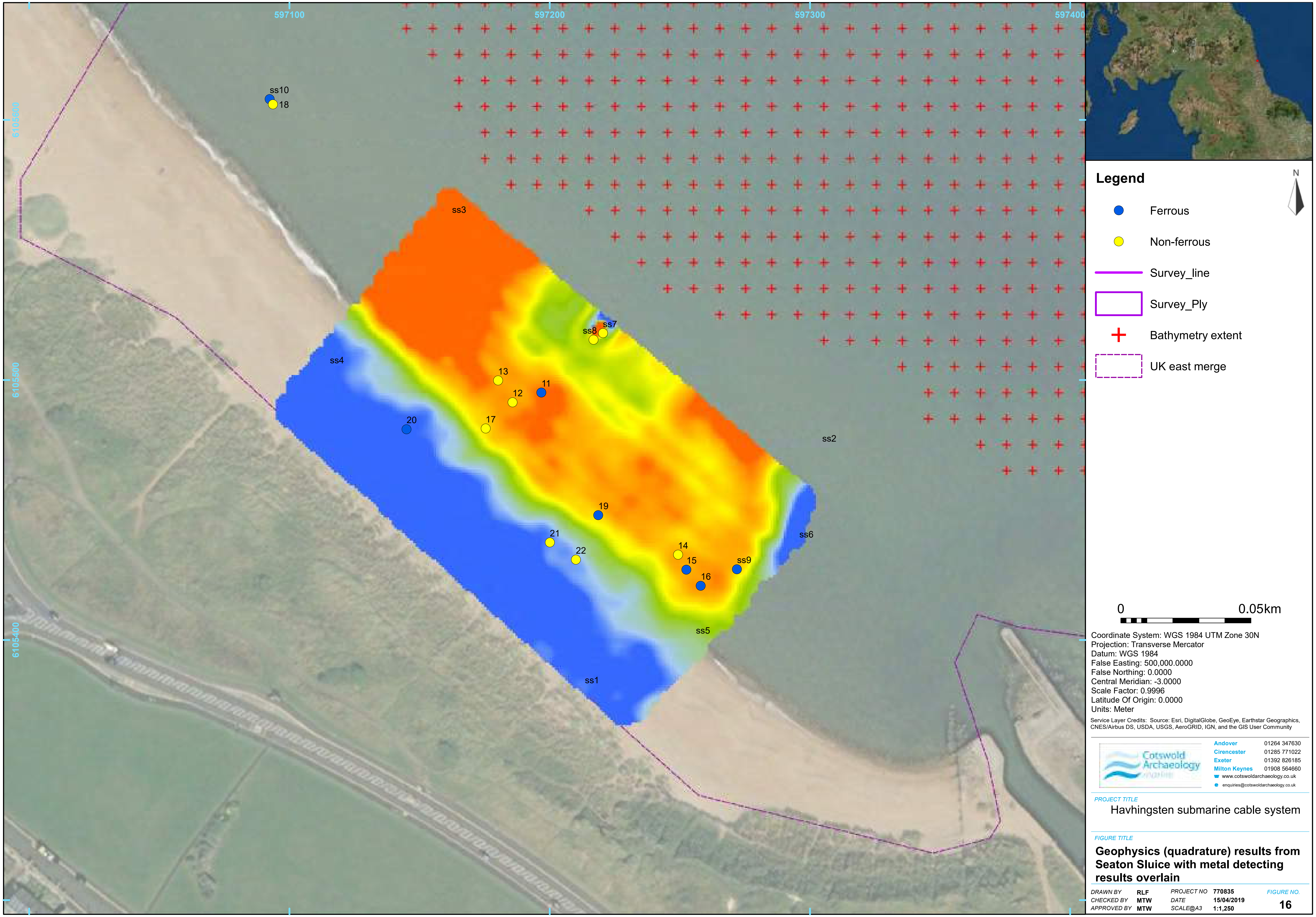
PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Geophysics (quadrature) results from Lytham, St. Anne's with metal detecting results overlain

DRAWN BY RLF
CHECKED BY MTW
APPROVED BY MTW
PROJECT NO 770835
DATE 15/04/2019
SCALE@A3 1:2,000
FIGURE NO. 15



N

Legend

- Ferrous
- Non-ferrous
- Survey_line
- Survey_Ply
- Bathymetry extent
- UK east merge

0 0.05km

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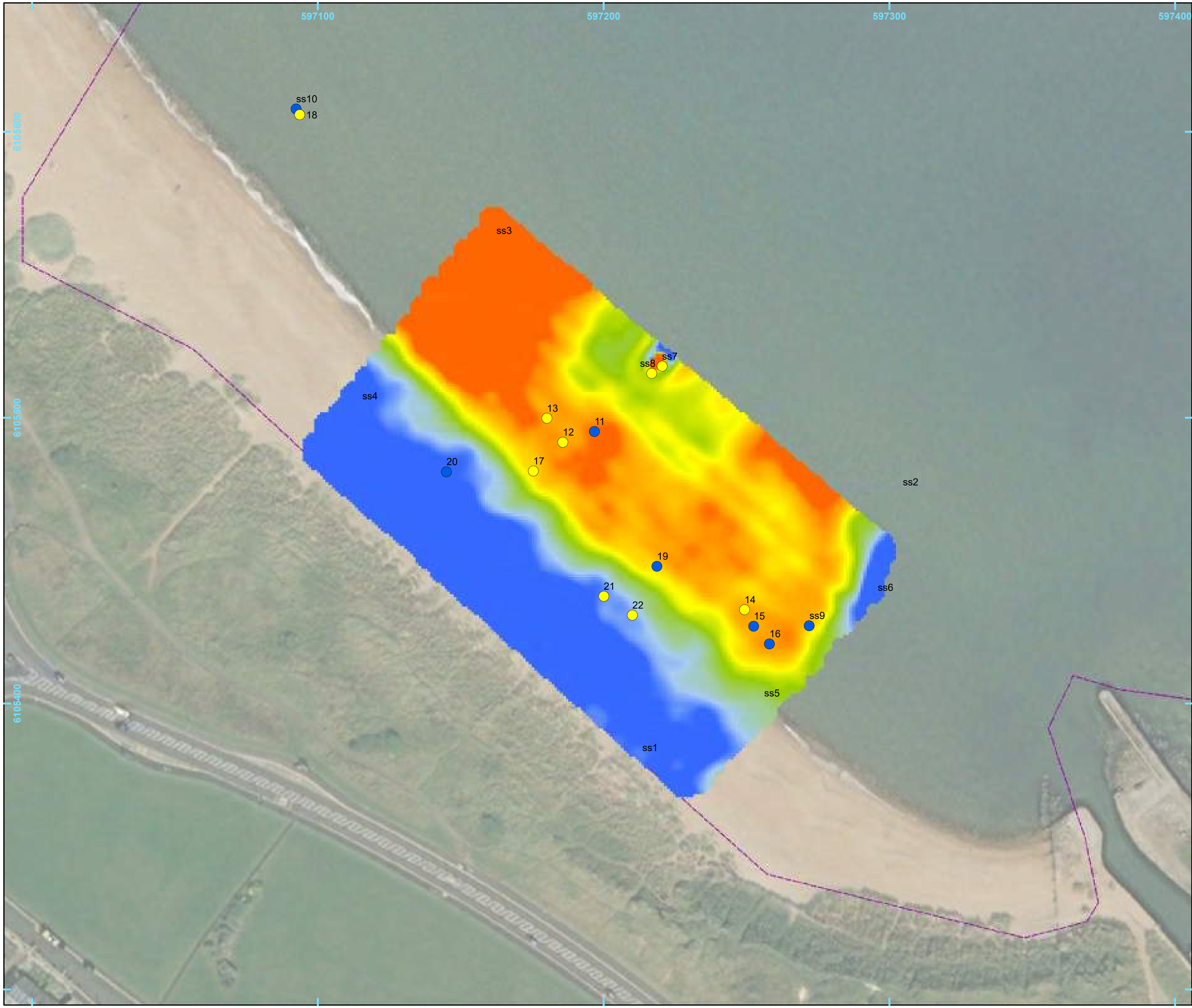
PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Geophysics (quadrature) results from Seaton Sluice with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	16
APPROVED BY	MTW	SCALE@A3	1:1,250	



Legend

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- Ferrous
- Non-ferrous
- Survey_line
- Survey_Ply
- UK east merge

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PROJECT TITLE

Havhingsten submarine cable system

FIGURE TITLE

Geophysics (in-phase) results from Seaton Sluice with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	17
APPROVED BY	MTW	SCALE@A3	1:1,250	

Whitley Bay

3.13. Extreme values along the south-western edge of the geophysical survey area are caused by the presence of concrete sea defences. The broad and amorphous area of low conductivity in the north of the quadrature plot corresponds to an area of outcropping bedrock. Elsewhere the variations recorded are probably again the result of natural silting patterns (Fig. 18). Highly magnetic discrete anomalies along the low water mark (the north-eastern edge of the dataset) represent buried metal objects (Fig. 19). These were not detected by the metal-detecting survey, possibly as they were buried too deeply. The lines of non-ferrous metal detections parallel to the waterline may represent detritus from the construction of the concrete sea defences detected in the geophysical data further offshore.

Offshore survey

3.14. Analysis of the marine geophysical datasets collected in Irish waters identified 18 anomalies with archaeological potential (see Figure 20 and 21 and Table 1; each anomaly with medium to high archaeological potential is illustrated in Figures 22, 23 and 24). Other geophysical anomalies identified in the survey data, notably SSS, consisted of small (<2m) boulders, sometimes with associated scour, in areas where bedrock was not exposed on the surface. These anomalies did not have associated magnetic signals so are interpreted as being natural in origin and are not listed as having archaeological potential.

Table 1 Description of geophysical anomalies identified with archaeological potential

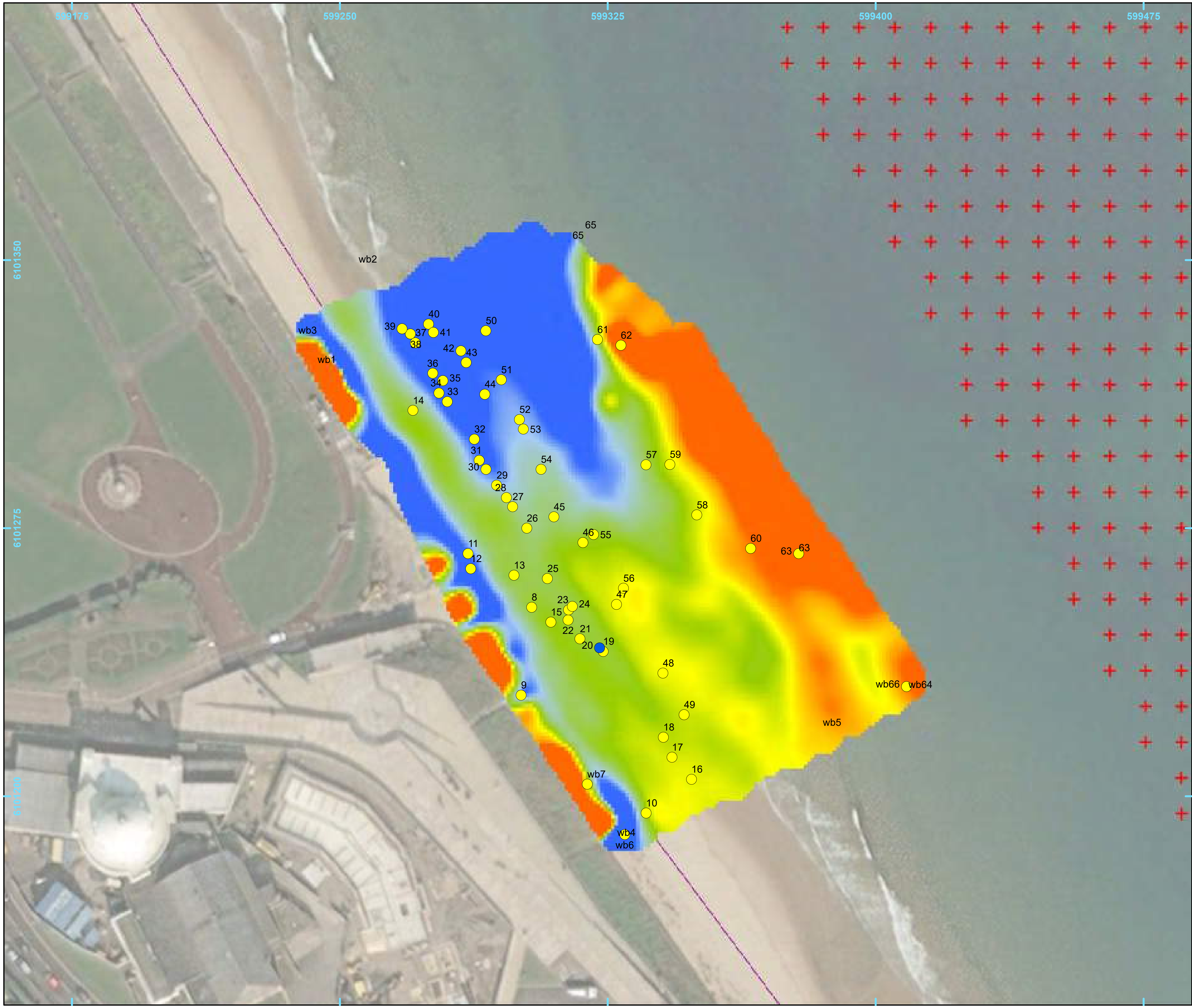
Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA2001	295926	5937268	Side Scan Sonar Anomaly S1-1_AL_SC009 (1.9x1.0x0.4m)	Low	10
CA2002	296293	5937215	Mag Anomaly S1-1_AL_MC009 (59nT)	Low	10
CA2003	296498	5937173	Mag Anomaly S1-1_AL_MC007 (64nT) with accompanying SSS anomaly 2m NW measuring 1.8 x 1.0m	Medium	10
CA2004	297127	5937316	Small bathymetric feature 6x6m with corresponding SSS signature inc.possible angular feature immediately east.	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA2005	297179	5937445	Mag Anomaly S1-1_AL_MC018 (41nT). Survey notes possible natural origin	Low	10
CA2006	297310	5937512	Mag Anomaly S1-1_AL_MC020 (73nT). Survey notes possible natural origin	Low	10
CA2007	297342	5937548	Mag Anomaly S1-1_AL_MC042 (44nT). Survey notes possible natural origin	Low	10
CA2008	303428	5938831	Mag Anomaly S1-1_AL_MC037 (135nT). Survey notes possible natural origin. No sub-bottom anomaly to suggest buried cable	Low	5
CA2009	303517	5938466	Mag Anomaly S1-1_AL_MC043 (124nT). Survey notes possible natural origin. No sub-bottom anomaly to suggest buried cable	Low	5
CA2010	303483	5938768	Mag Anomaly S1-1_AL_MC041 (161nT). Survey notes possible natural origin. No sub-bottom anomaly to suggest buried cable	Low	5
CA2011	303531	5938691	Mag Anomaly S1-1_AL_MC034 (241nT). Survey notes possible natural origin. No sub-bottom anomaly to suggest buried cable	Low	5
CA2012	303565	5938632	Mag Anomaly S1-1_AL_MC045 (213nT). Survey notes possible natural origin. No sub-bottom anomaly to suggest buried cable	Low	5
CA2013	303627	5938644	Mag Anomaly S1-1_AL_MC046 (100nT). Survey notes possible natural origin. No sub-bottom anomaly to suggest buried cable	Low	5
CA2014	304248	5939073	Mag Anomaly S1-1_AL_MC035 (203nT). Survey notes possible natural origin.	Low	5
CA2015	304391	5938961	Mag Anomaly S1-1_AL_MC042 (141nT). Survey notes possible natural origin.	Low	5

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA2016	328090	5949489	SSS Anomaly S1-1_FHE_SC0010 (24.2x8.9x4.2m) associated with distinct bathymetric feature 20 x 12m with scour at NW and SE edge. Probable wreck	High	50
CA2017	327980	5949307	SSS Anomaly S1-1_FHE_SC0009 (6.6x0.5x0.2m) – linear angular anomaly	Medium	10
CA2018	346687	5957577	Cable and trench, clearly visible in SSS and Bathymetry, with Mag Anomalies S1-1_FHE_MC003, 025, 031, 001, 020, 014 and 002 (100-6150nT). Runs between 346440 5957032 and 346927 5958086 (UTM 30N).	Low	N/A

3.15. Of the 18 anomalies identified, only one was identified as a probable wreck site (CA2016; see Figure 22) and therefore of high archaeological potential; any unidentified wrecks in Irish waters are automatically protected under Irish legislation (Section 3 of the National Monuments (Amendment) Act, 1987) until they have been further assessed. Two were deemed to have medium potential: CA2003 consisted of a pair of SSS and magnetic anomalies (Fig. 23); and CA2017 was a clearly defined linear SSS anomaly (Fig. 24) located SW of the wreck site (CA2016).

3.16. CA2018 is a clearly defined cable trench running approximately north-south perpendicular to the cable corridor, visible in all geophysical datasets; this is of low archaeological potential as it is clearly a recent infrastructure installation. The remaining 14 anomalies were identified as having low archaeological potential, either consisting of sole SSS anomalies or magnetometer anomalies with high values but questioned by the survey team as possibly being of a natural origin.



Legend

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- Survey_line
- Survey_Ply
- Bathymetry extent
- UK east merge

N

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Scale Factor: 0.9996
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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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PROJECT TITLE
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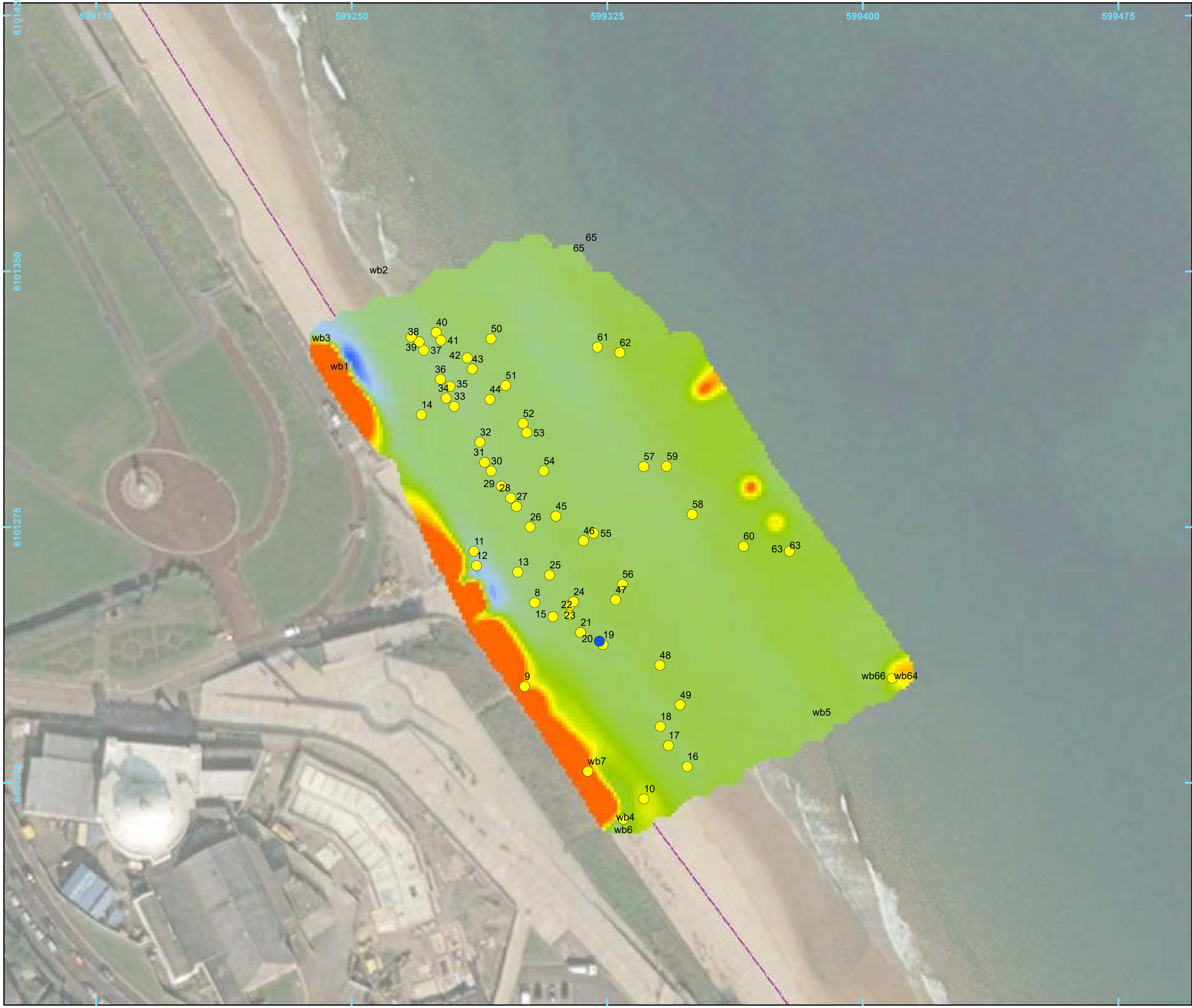
FIGURE TITLE
Geophysics (quadrature) results from Whitley Bay with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
CHECKED BY	MTW	DATE	15/04/2019	18
APPROVED BY	MTW	SCALE@A3	1:1,000	



Legend

N

Ferrous

Non-ferrous

Survey_line

Survey_Ply

UK east merge

0 0.045km

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Projection: Transverse Mercator
Datum: WGS 1984
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Units: Meter

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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PROJECT TITLE
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FIGURE TITLE
Geophysics (in-phase) results from Whitley Bay with metal detecting results overlain

DRAWN BY	RLF	PROJECT NO	770835	FIGURE NO.
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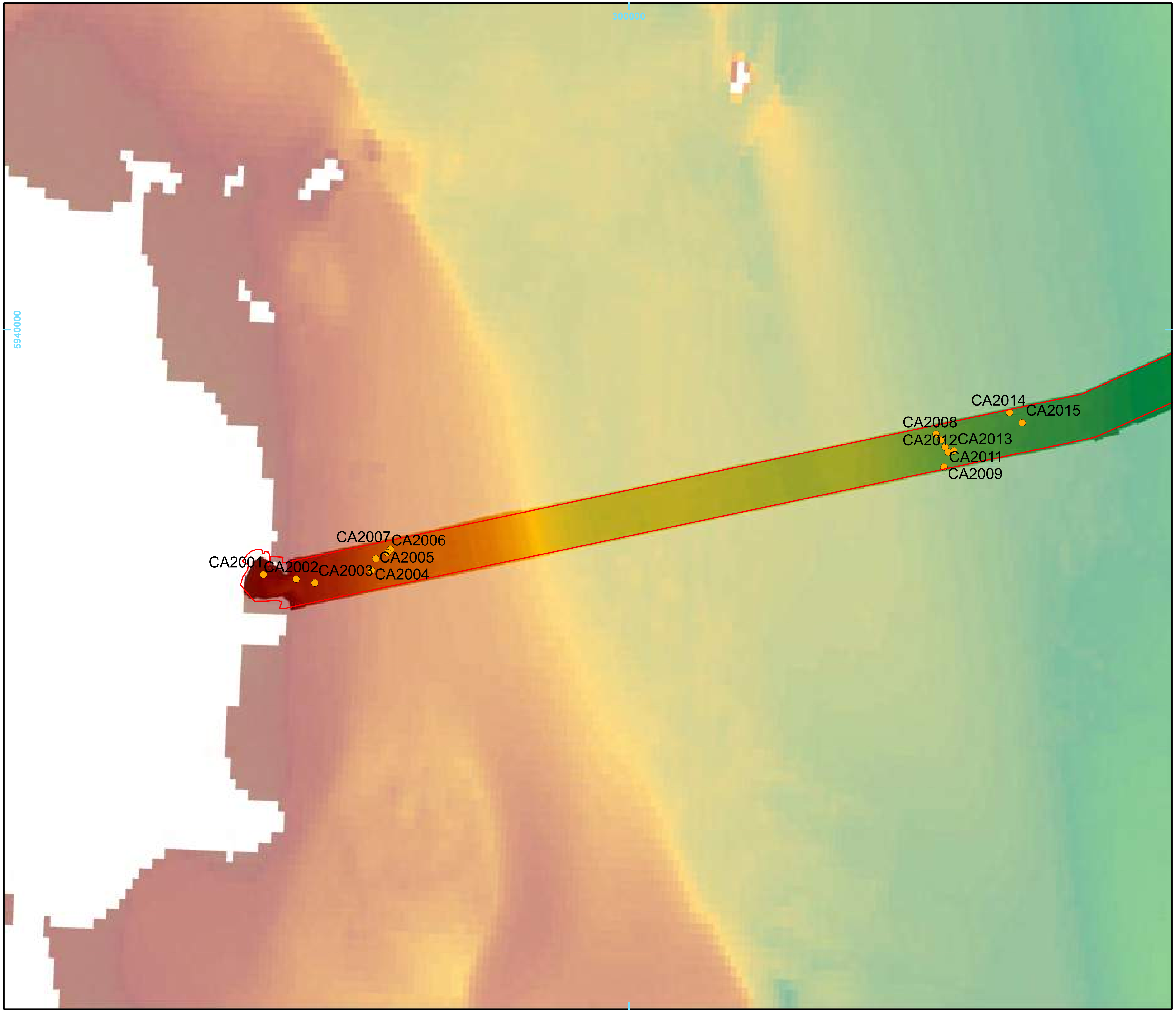
APPROVED BY	MTW	SCALE@A3	1:1,048	



N

Legend

Route Corridor

Archaeological Anomaly

Bathymetry (m LAT)

80

-160

0 1,500m

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Projection: Transverse Mercator
Datum: WGS 1984
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Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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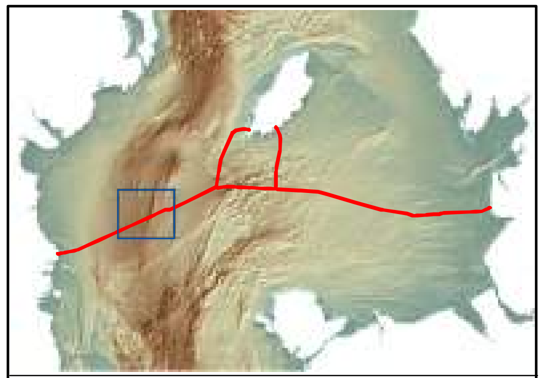
PROJECT TITLE

Havhingsten submarine cable system

FIGURE TITLE

Distribution of geophysical anomalies with archaeological potential

DRAWN BY	MJG (UoS)	PROJECT NO	770835	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	**20**
APPROVED BY	MW	SCALE@A3	1:40,000	



N

Legend

Route Corridor

Archaeological Anomaly

Bathymetry (m LAT)
-60
-160

0 3,000m

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Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Distribution of geophysical anomalies with archaeological potential

DRAWN BY	MJG (UoS)	PROJECT NO	770835	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	21
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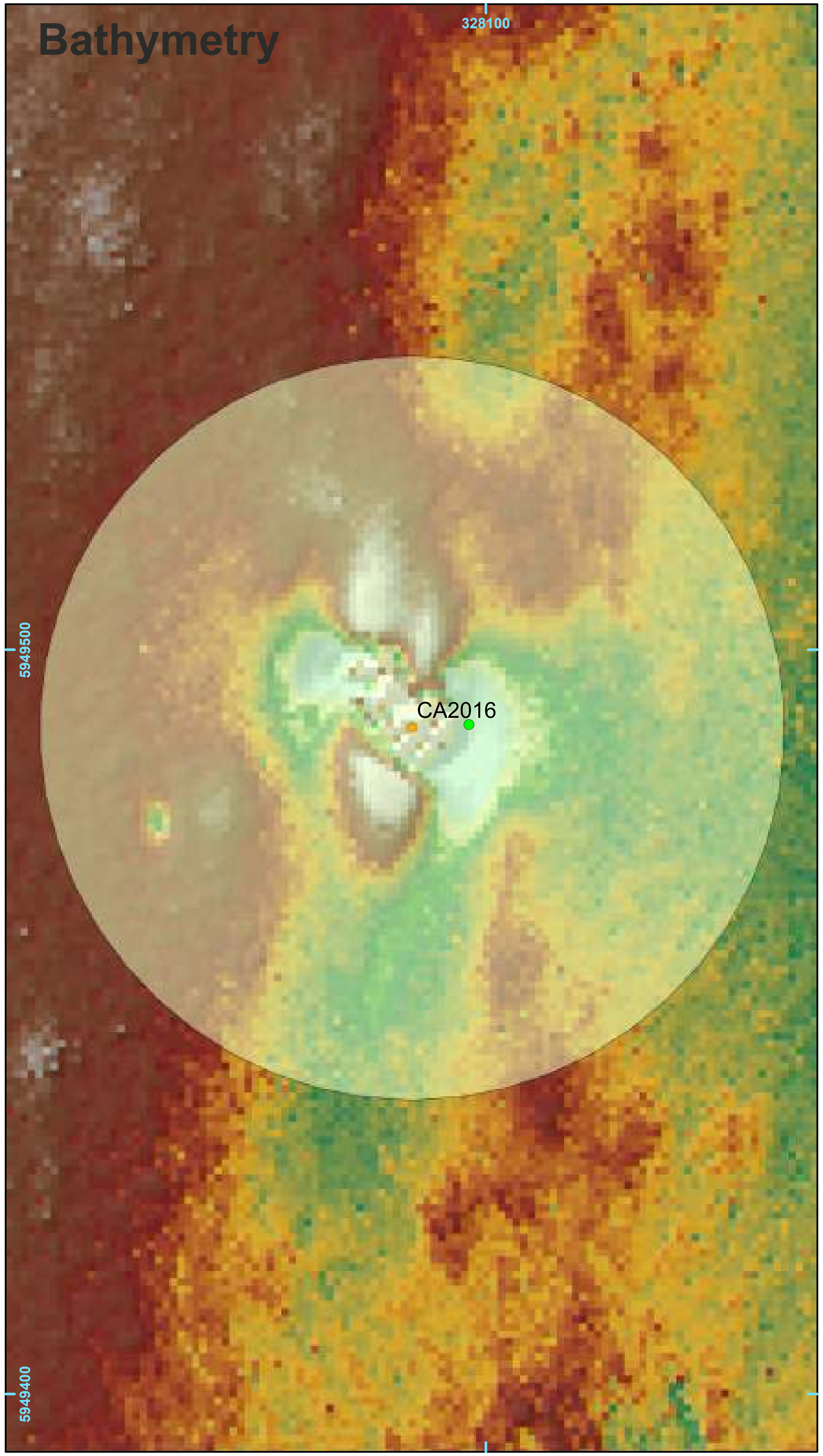

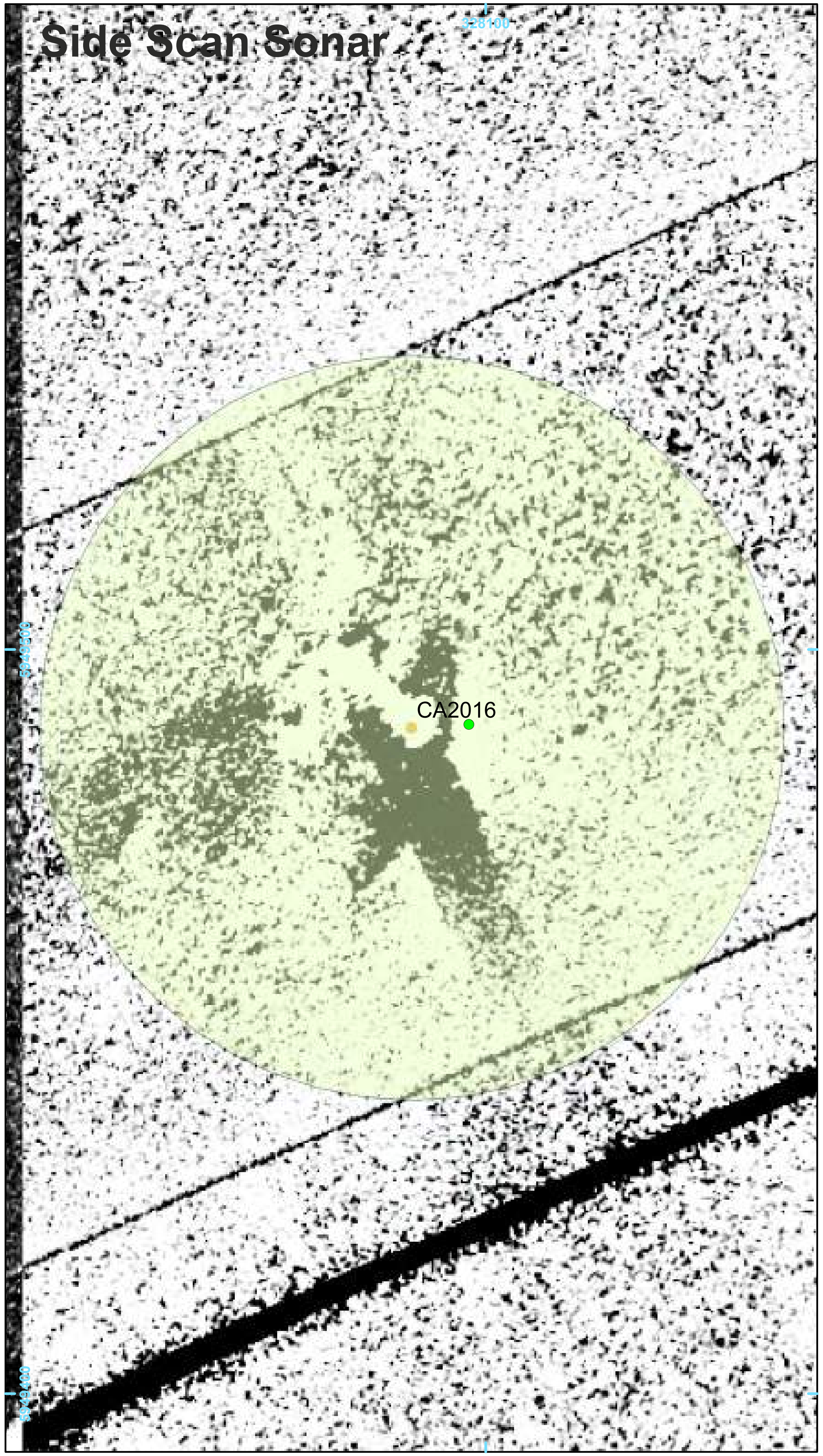

N

Legend

- Route Corridor
- Side Scan Sonar Anomaly
- 1 - 5
- 6 - 10
- 11 - 25
- 26 - 50
- >50
- Archaeological Anomaly
- AEZ

Bathymetry (m LAT)
-95
-100

0 25m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
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Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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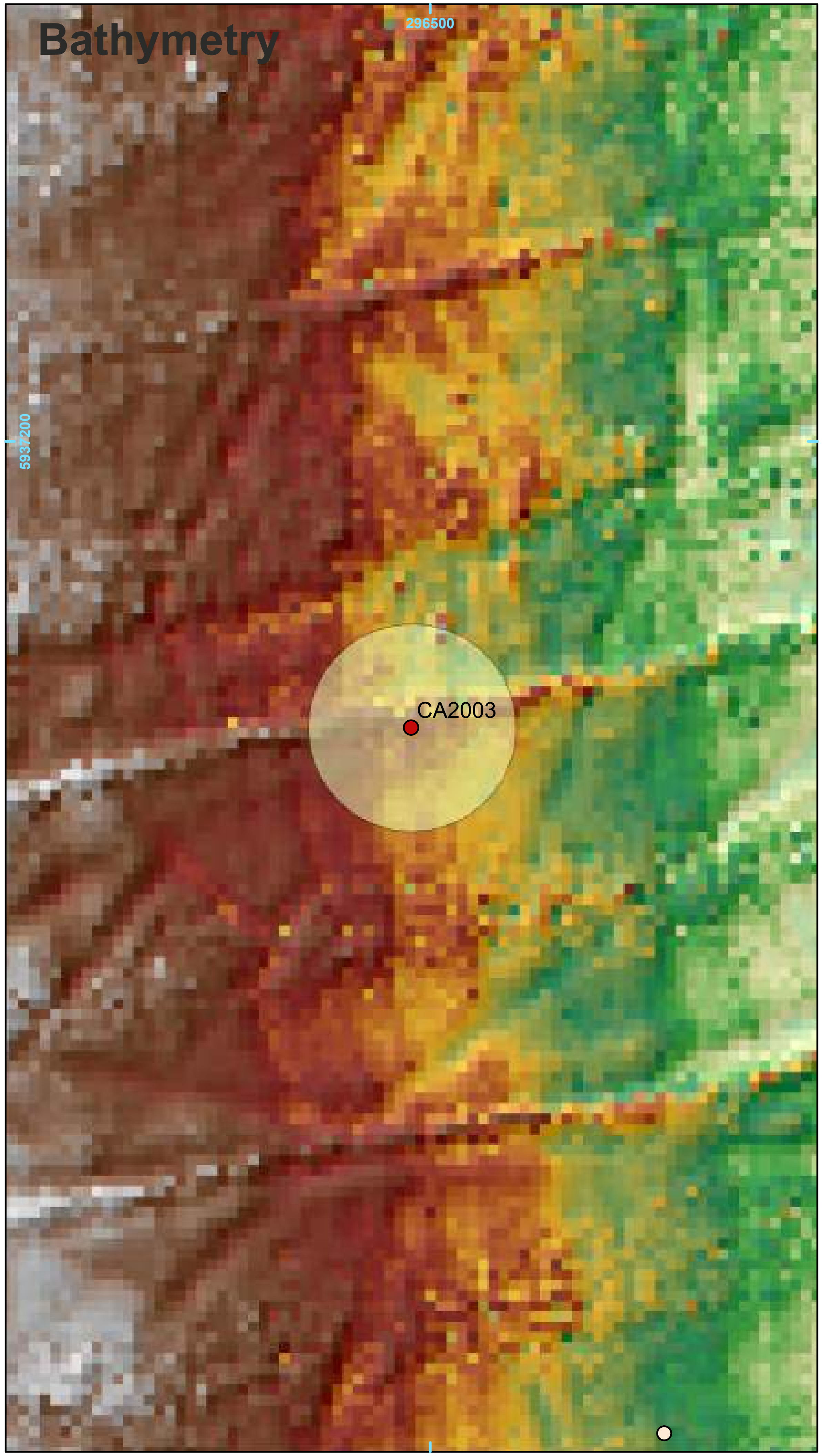
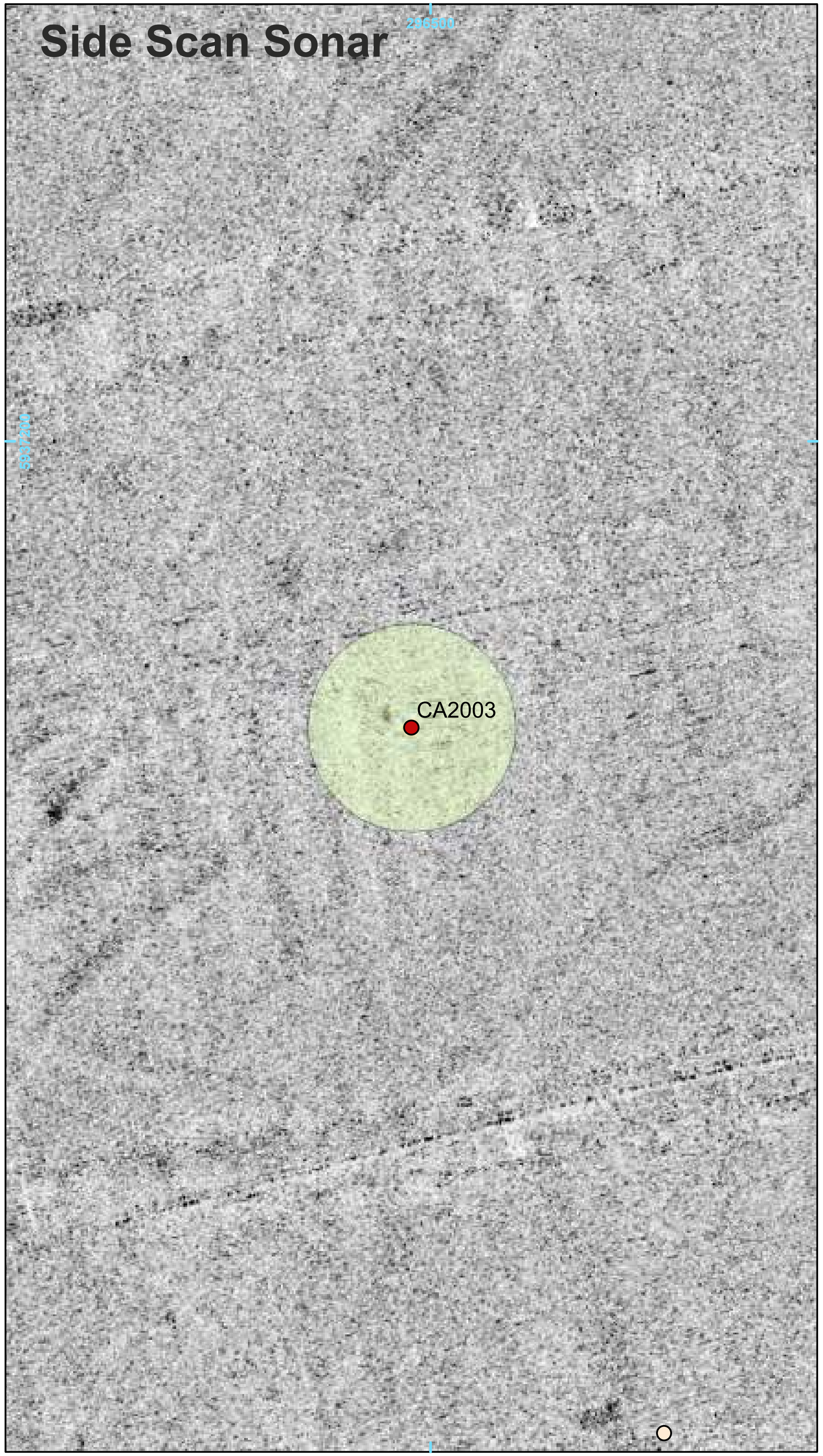
PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Sub-bottom feature CA_2016

DRAWN BY	MJG (UoS)	PROJECT NO	770835	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	22
APPROVED BY	MW	SCALE@A3	1:700	





N

Legend

- Route Corridor
- Side Scan Sonar Anomaly
- 1 - 5
- 6 - 10
- 11 - 25
- 26 - 50
- >50
- Archaeological Anomaly
- AEZ

Bathymetry (m LAT)
-4.8
-5.5

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
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Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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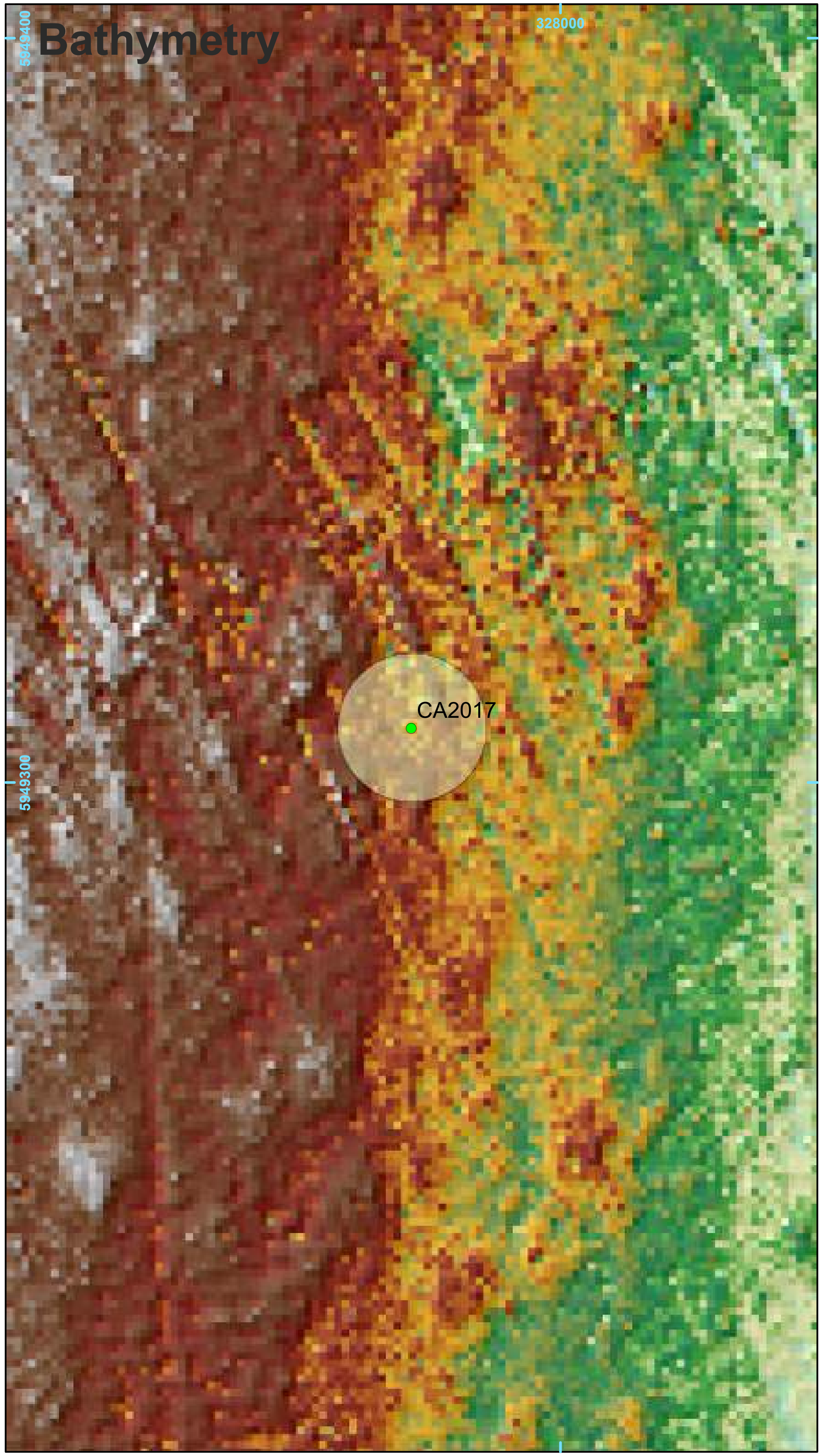
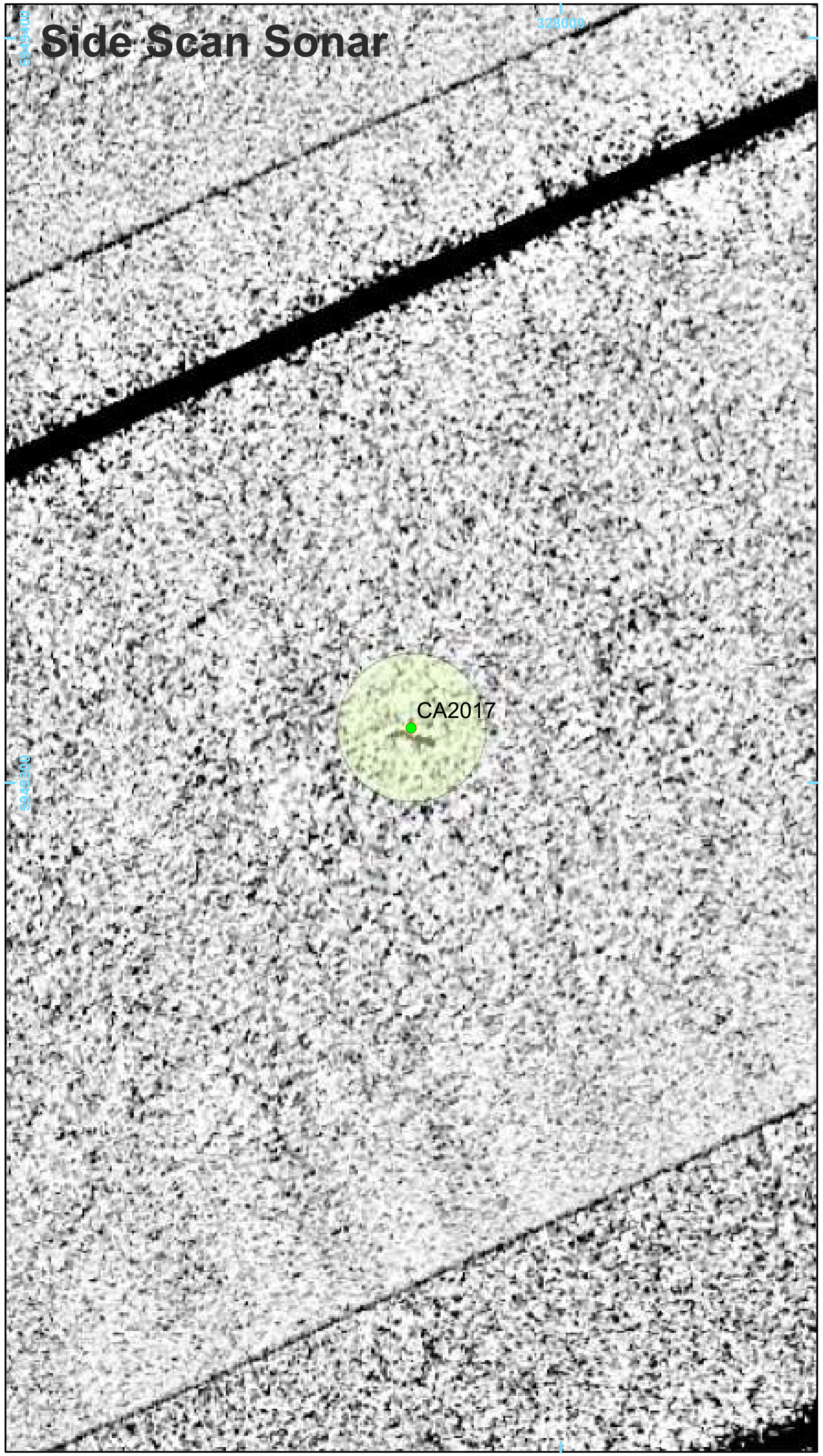
PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Sub-bottom feature CA_2003

DRAWN BY	MJG (UoS)	PROJECT NO	770835	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	23
APPROVED BY	MW	SCALE@A3	1:500	





N

Legend

- Route Corridor
- Side Scan Sonar Anomaly
- 1 - 5
- 6 - 10
- 11 - 25
- 26 - 50
- >50
- Archaeological Anomaly
- AEZ

Bathymetry (m LAT)

-98.4

-98.9

0 25m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE

Havhingsten submarine cable system

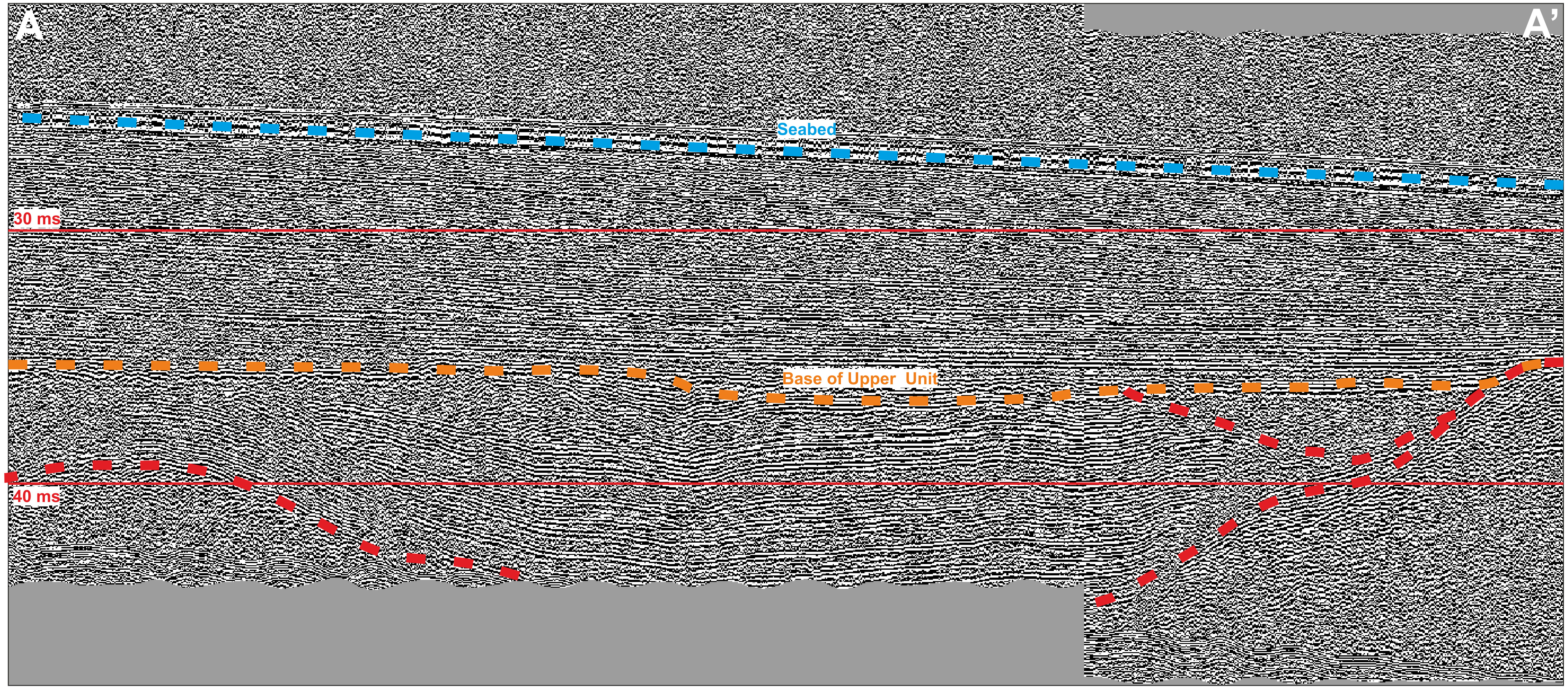
FIGURE TITLE

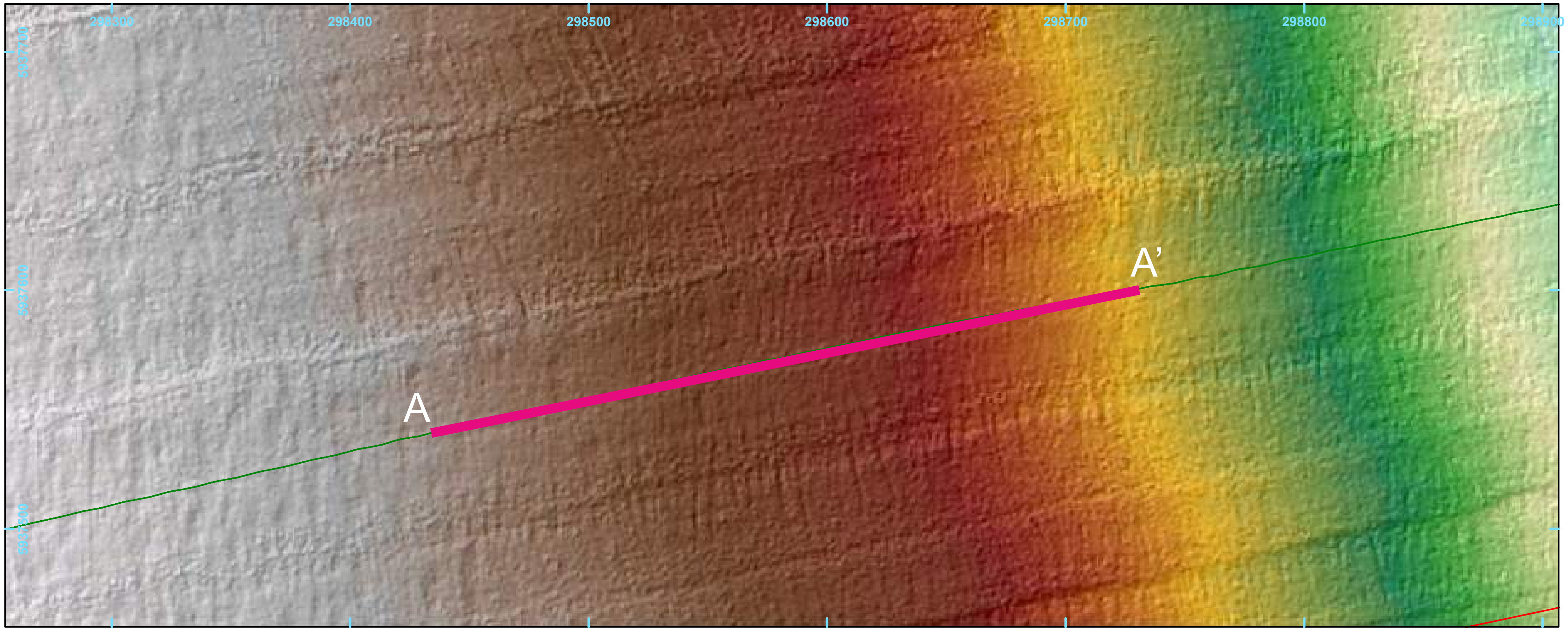
Sub-bottom feature CA_2017

DRAWN BY	MJG (UoS)	PROJECT NO	770835	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	24
APPROVED BY	MW	SCALE@A3	1:700	

Submerged palaeo-landscape

3.17. A review of the SBP seismic survey data has identified a consistent stratigraphic sequence. Moving offshore from the Irish landfall, an upper unit consisting of horizontally bedded deposits, probably sands and muds, is present along the corridor in thicknesses up to 8-10m. This overlies earlier features, often with more chaotic seismic signatures probably reflecting coarser-grained sediments, along with some infilled channels (e.g. centred on 298592 5937574; Fig. 25), with a base c. 20m below the seabed, some showing multiple phases of channel cutting. The upper unit thins to c. 1-2m thickness in some locations where the underlying seismic reflector approaches the seabed surface (e.g. 298886 5937632 and 299969 5937856; Fig. 26), and outcrops at the surface at 304073 5938722. Between this point and c. 305325 5939124 the upper horizon is inpersistent and, when present, rarely thicker than 2m. North-east of 305325 5939124 the upper horizon again begins to thicken, typically retaining thicknesses of c.3-4m albeit with some areas reaching thicknesses of up to c. 8m. North east of c. 311835 5942072 this upper unit shows consistent thickening in excess of 12-14m, although it thins again to c. 7m east of the bathymetric depression centred on 338397 5954150 (shown in Figure 21).





N

Legend

Route Corridor

Sub-bottom Profile Survey Line

Bathymetry (m LAT)

-13.16

-18.13

0 50m

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Projection: Transverse Mercator
Datum: WGS 1984
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Central Meridian: -3.0000
Scale Factor: 0.9996
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Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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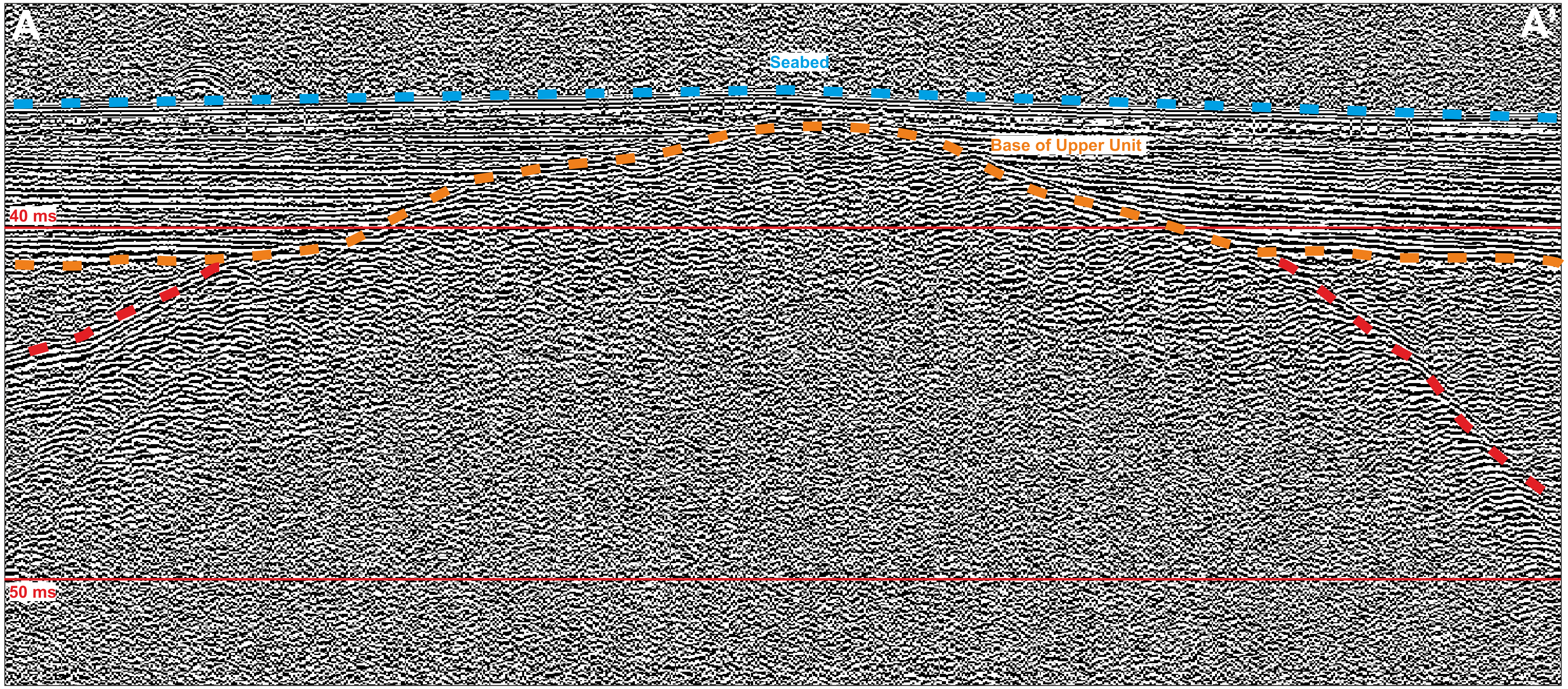
PROJECT TITLE

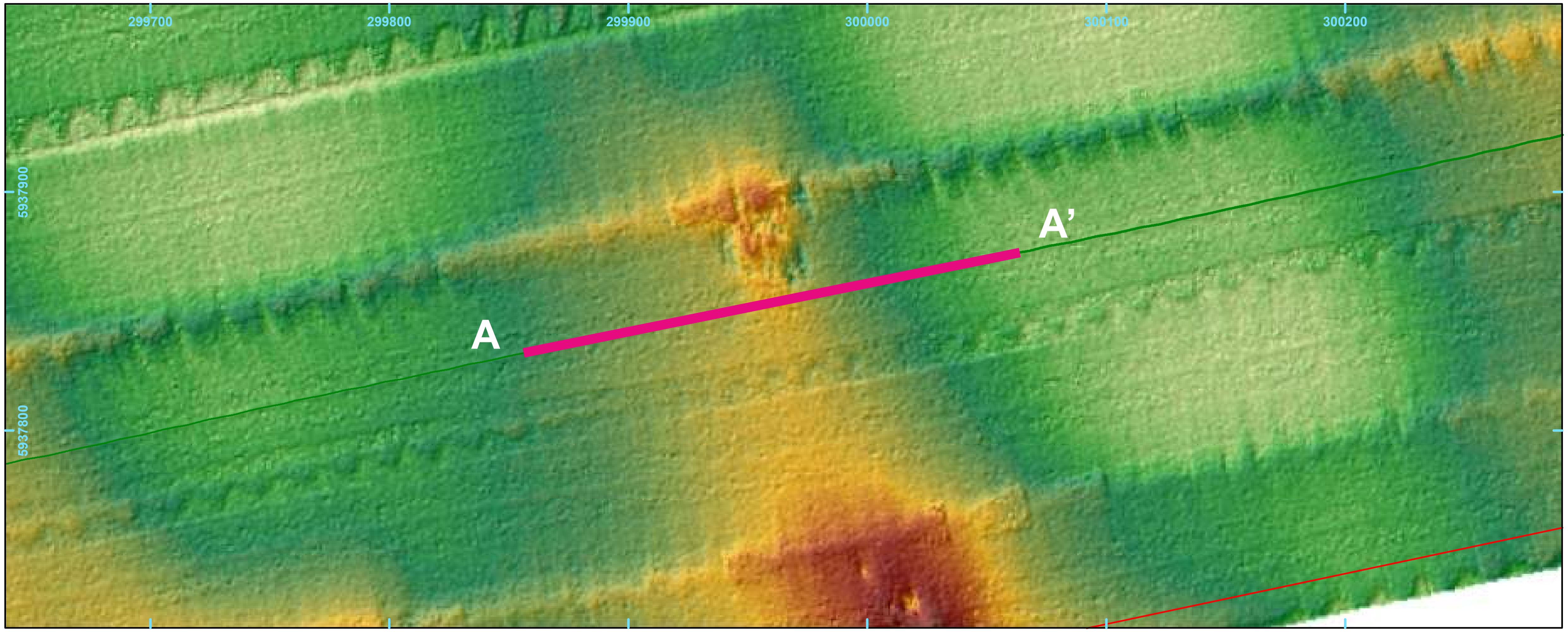
Havhingsten submarine cable system

FIGURE TITLE

Sub-bottom feature CA_3001

DRAWN BY	MJG (UoS)	PROJECT NO	770800	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	25
APPROVED BY	MW	SCALE@A3	1:2,000	





N

Legend

Route Corridor
Sub-bottom Profile Survey Line
Bathymetry (m LAT)
-22.0
-24.0

0 50m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE
Havhingsten submarine cable system

FIGURE TITLE
Sub-bottom feature CA_3002

DRAWN BY	MJG (UoS)	PROJECT NO	770800	FIGURE NO.
CHECKED BY	RK	DATE	25/09/2018	26
APPROVED BY	MW	SCALE@A3	1:2,000	

4. DISCUSSION AND CONCLUSION

4.1. These foreshore surveys have successfully evaluated the six potential landfall locations and have identified no anomalies of clear archaeological potential. At Port Grenaugh, however, where a possible fish trap or barrier against small vessels is recorded (Cotswold Archaeology 2019), linear anomalies detected perpendicular to the tide, may be anthropogenic in origin, perhaps resulting from buried walls or the accumulation of deposits against them. These anomalies are assessed as of low to moderate archaeological potential. No other anomalies of archaeological potential have been identified at any of the potential landfall locations. Elsewhere, four linear anomalies identified at Port Erin, and a fifth at Lytham St Anne's, indicate buried service pipes / cables. On the basis of the walkover geophysical, and metal detecting surveys, therefore, these landfall locations are assessed as of low archaeological potential, which corroborates the results of the marine archaeology DBA (Cotswold Archaeology 2019).

4.2. The offshore geophysical surveys of the proposed route through Irish waters has been assessed for features containing archaeological potential. The area is covered by an upper drape of probably sandy and clayey deposits, in places over 14m in thickness. Below this are earlier features that may include a series of palaeo-channels, but these will generally be beyond the depth of impact of the proposed installation. It is probable that much of the sediment will be comprised of glacio-marine deposits, which would have low archaeological potential. Geophysical anomalies along the route corridor are of low to medium abundance, with only a single probable wreck site identified in the available data. For each of the 18 archaeological anomalies identified, AEZs have been defined.

5. REFERENCES

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Plets, R., Dix, J. & Bates, R. 2013. *Marine Geophysics Data Acquisition, Processing and Interpretation: Guidance Notes*. Swindon: Historic England.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. & Fassbinder, J. 2015. *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider*. EAC Guidelines 2. Europae Archaeologiae Consilium, Belgium.

Online Resources

Minelab International Ltd. X-Terra 705 Instruction Manual [accessed October 2018] https://www.minelab.com/__files/f/4051/4901-0073-4%20Inst%20Manual%20X-TERRA%20705%20EN_WEB.pdf

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R. APPENDIX R - BURIAL ASSESSMENT SURVEY REPORT

HAVHINGSTEN FIBRE OPTIC CABLE SYSTEM

SEGMENT 1-1

BU PORT ERIN TO BMH LOUGHSHINNY

BURIAL ASSESSMENT STUDY

Rev	Date	Description	Prepared by
Rev 1	Jan 2019	Issued for internal review	GH
Rev 2	May 2019	Final Issue	GH

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Revision 02 of this report reflects the PSR03 Route Position List (RPL) and survey data supplied to Alcatel Submarine Networks by Fugro Germany Marine GmbH.

This burial feasibility study is for the proposed Havhingsten Fibre Optic Cable Project Segment 1-1 which runs from BU Port Erin to BMH Loughshinny (Ireland). See Figure 1-1 for an overview. The PSR03 RPL cable route is 80.626km long. Burial is planned throughout the segment, where seabed conditions allow.

Target Burial Cover Depth	Nominal CPT Spacing	Nominal Core Spacing
1.5m	10km	10km

Table 1-1: Target Burial Depth & Nominal CPT/Gravity Core Spacing

Appendix 1 provides the burial assessment statements. The predictions are based on the data supplied from the marine geophysical and geotechnical survey. Data used in the compilation of this report included CPT and core data, bathymetry data, sidescan sonar data and sub-bottom profiler data.

Appendix 1 gives the BAS Summary and a summary of sediment sample and CPT data is shown in Appendix 2

The main method of installation is assumed to be a SMD HD 1.5m-share seabed plough, weighing 37 Tonnes in air, deployed from an Ile de Class installation vessel. The direction of installation is assumed to be from the BU Port Erin location to the BMH at Loughshinny, Ireland.

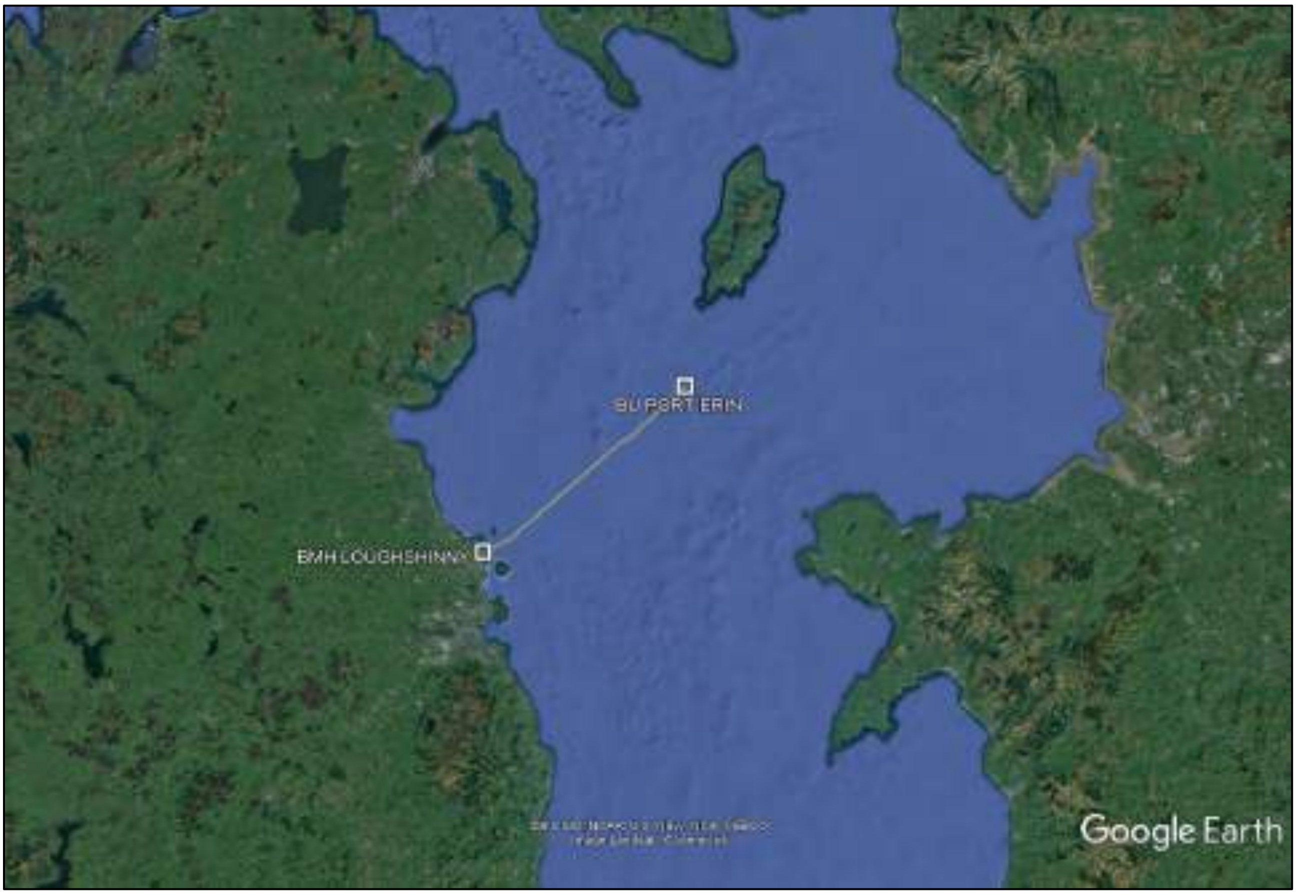

Figure 1-1: Location Map for the Havhingsten Segment S1-1

1.1 Route Summary & Recommendations

- 100% of the route is expected to be subject to a burial operation:
  - *95.21% of the route is ploughable*
  - *4.79% will be surface laid then subject to PLB. This includes pipeline crossings, BU integration and shore end.*

Burial conditions along the entire route are generally expected to be very good. Seabed sediment and to the target burial depth are predominantly very soft to soft clay with some denser sandy surficial deposits near the start of the route at the BU.

Some of the CPT and Gravity Core samples have shown that the shear strength is often very low and sometimes below 5kPa which is regarding as the minimum strength required to support the plough. In these cases, there may be the tendency for some overburial to occur.

From approximately KP 25 to KP 70 numerous trawl scars are observed which may pose a threat to the cable if there is reduced burial. Research work has identified the expected maximum penetration depth for trawl boards is 300mm and the cable will be buried beneath this external threat.

At KP 45.610 the proposed route passes approximately 100m to the southeast of a wreck identified with dimensions of 24.2m length x 8.9m width and 4.2m height.

Where areas of boulders have been encountered routing has been designed to avoid them, however, there does remain the possibility of additional buried boulders which may cause localised high tensions.

Sub-bottom profile data indicates a thick layer of sediments all the way to the mouth of Loughshinny harbour.

The seabed only shows very gentle to gentle gradients and no problems are expected with steep slopes causing plough instability.

1.2 Target Burial Depth, the Burial Protection Index & Predicted Burial Depths

The Burial Protection Index (BPI) concept tells us that a cable will be as adequately protected against most external threats in stiffer/denser sediment with a shallower burial depth, as it would be in softer/looser sediment to a greater depth.

The BPI concept is based on a value of 1 providing adequate protection against the majority of bottom fishing (trawling) and the most common fishing gear in a soft/firm clay of 40kPa shear strength. Allan (1998) recommends that a BPI of 2 to 3 would be required to protect against ships' anchors, depending on size.

Figure 1-2 below shows the Burial Protection Index concept for various sediment types. For example, in denser sands, a burial depth of 0.75m would provide the same protection as >2m burial in very soft clay.

Figure 1-3 builds on the initial BPI concept, providing the burial depth required to achieve a BPI of 1 in various clay shear strengths. Similarly, Figure 1-5 provides the depths required in various relative densities for sands. Table 1-2 summarises the burial depths that would provide a BPI of 1 in various sediment types and strengths and provides a recommendation for the mid-range of each sediment classification.

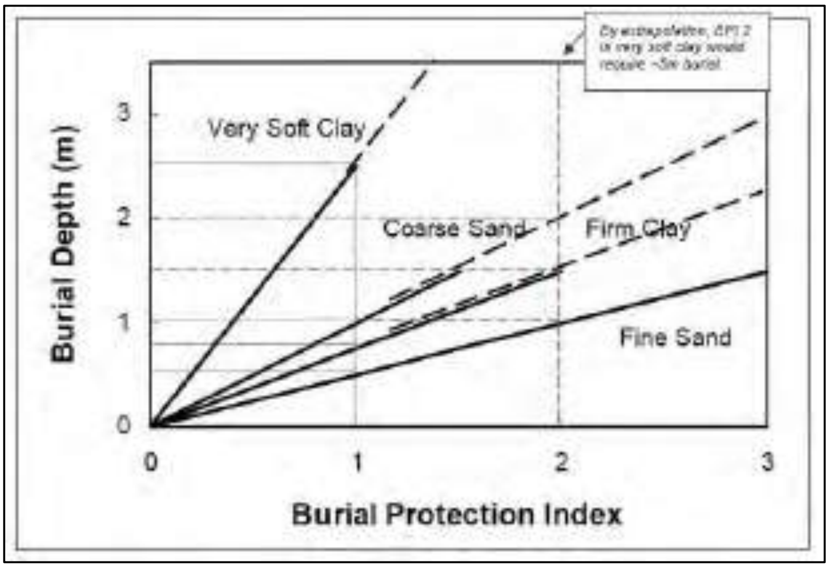

Figure 1-2: Burial Protection Index in Various Sediments (modified, after Mole et al, 1997)

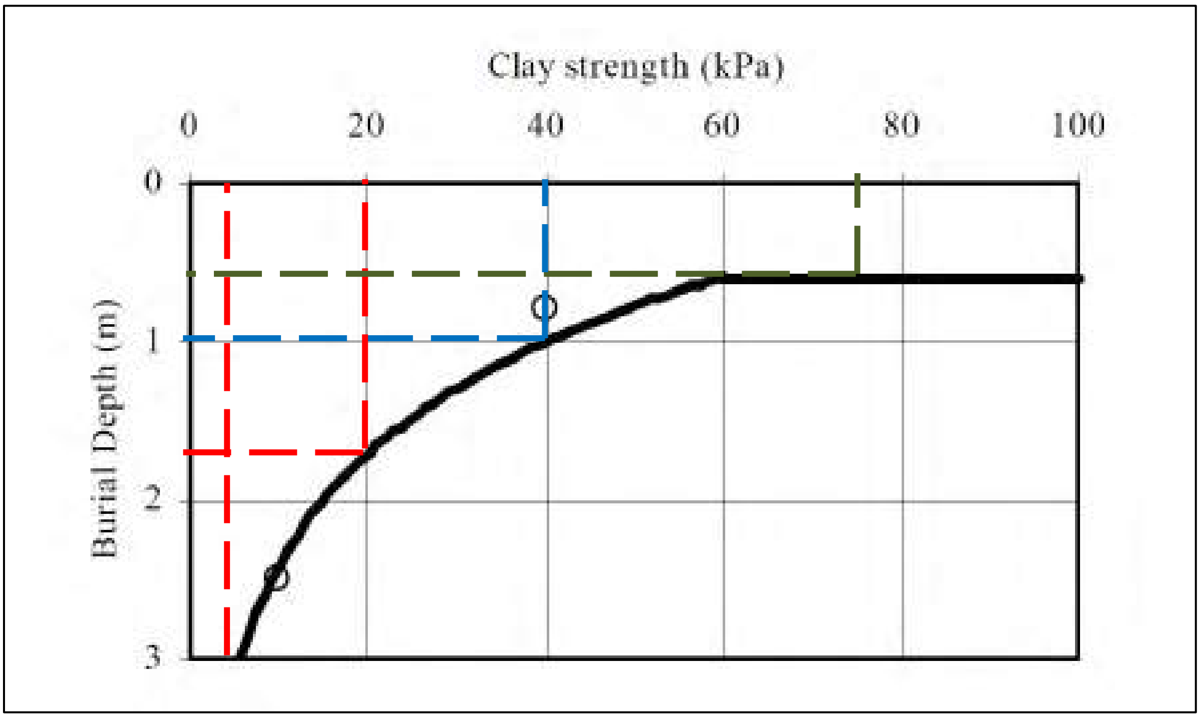

Figure 1-3: Recommended Burial Depth for BPI=1 with Varying Shear Strength in Clays (modified, from Allan & Comrie, 2001). O=Values recommended by Mole (1997)

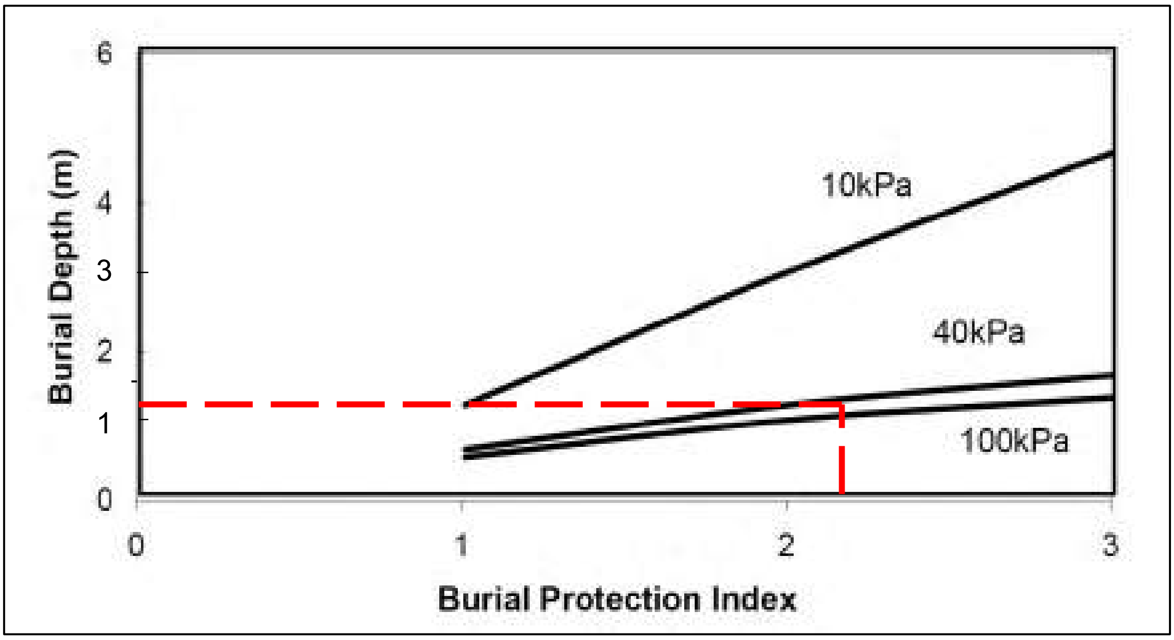

Figure 1-4: Burial Depth vs. BPI in Various Clay Shear Strengths (from Allan, 1998)

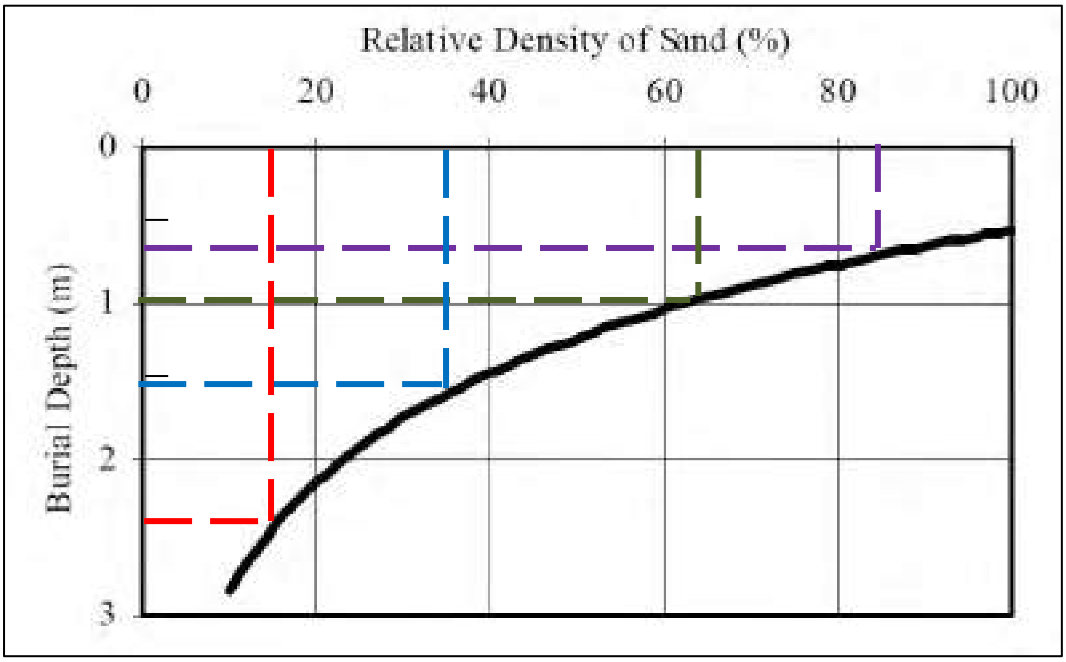

Figure 1-5: Recommended Depth to Achieve BPI=1 with Varying Relative Density in Sand (after Allan & Comrie, 2001)

Sediment Type	Relative Density (Sand)/ Shear Strength (Clay) Ranges		Burial Depth Range for Lower & Upper Bounds of Strength Range
CLAYS	Extremely low to very low	0-20kPa	>3.0m to 1.75m
	Low (II)	20-40kPa	1.75m to 1.0m
	Medium (III)	40-75kPa	1.0m to 0.6m
	High to Extremely High (IV-	>75kPa	0.6m
SANDS	Very Loose (I)	<15% RD	>2.5m
	Loose (II)	15-35% RD	2.5m to 1.6m
	Medium Dense (III)	35-65% RD	1.6m to 1.0m
	Dense (IV)	65-85% RD	1.0m to 0.75m
	Very Dense (V)	>85% RD	0.75m to <0.5m

Table 1-2: Recommended Burial Depths to Achieve BPI=1 in Various Seabeds

References:

Allan P.G., and Comrie R.J. (2001) The Selection of Appropriate Burial Tools and Burial Depths. SubOptic 2001 Kyoto

Allan, P.G. (1998) Selecting Appropriate Cable Burial Depths—A Methodology. IBC Conference on Submarine Communications. The Future of Network Infrastructure, Cannes, November 1998.

*Mole, P., Featherstone, J. and Winter, S. (1997) Cable Protection - Solutions Through New Installation and Burial Approaches. S**ubOptic '97. San Francisco.** P 750-757.*

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2 EXPLANATION OF BURIAL FEASIBILITY METHOD

The burial assessment predictions are provided in Appendix 1. Burial predictions are based on the following Route Position Lists

- *Havhingsten_S1.1_BU Port Erin - BMH Loughshinny_PSR03_29 April 2019*

If the installation is conducted to a different RPL, the KPs referenced in this report might be slightly incorrect.

The various components of the report are examined and described in more detail in Sections 2.1 through 11 below.

2.1 Classification of Seabed Types

Seabed lithologies identified by the survey have been classified as shown in Table 2-1.

Table 2-1: Seabed Type Classification

Sediment Type	Shear Strength, C_u (kPa)	Relative Density, D_r (%)	Sediment Description
I	<10 - 20	<15	Very Soft, Low Strength CLAY/SILT Very Loose SAND/SILT
II	20 - 40	15 - 35	Soft, Low Strength CLAY/SILT Loose SAND SILT
III	40 - 75	35 - 65	Firm, Medium Strength CLAY/SILT Medium Dense SAND/SILT
IV	75 - 150	65 - 85	Stiff, High Strength CLAY/SILT Dense SAND/SILT
V	150 - 300	85 - 100	Very Stiff, Very High Strength CLAY/SILT Very Dense SAND/SILT
VI	>300	>100	Extremely High Strength CLAY/SILT Weak rock, weathered bedrock or indurated/partially cemented sediment
VII	-	-	Rock

2.2 Trenchability

The route has been assigned five trenchability categories—A through E. These categories are described in Table 2-2.

Table 2-2: Trenchability Classification

Trenchability Class	Criteria
A FULL PLOUGH BURIAL	Full plough cable burial expected to target cover depth of 1.5m • *Extremely low to medium strength clays and up to medium dense sand/silt* • *BPI =0.60-2.0 in V Soft to Firm clay & = ~1.5 in med dense sand* • *Generally flat seabed (no sedimentary bedforms; low slopes)* • *Clays—shear strength >5kPa (no plough sinkage expected)* • *Constant burial conditions with low variability* • *Tow tensions generally low and consistent - <20T* • *Low plough pitch/roll expected* • *Optimal plough progress rate* • *Low plough share tip wear rate*
B REDUCED VARIABLE PLOUGH BURIAL	Target burial cover depth might not be achieved due to seabed conditions. Reduced cable cover depth predicted, ≤1.5m but >0.5m • *High to very high strength clay and medium dense to dense sand/silt; where loose/low strength sediment sits over a dense to very dense unit, which lies within the burial depth; or where rock sits within the burial depth* • *Burial Protection Index = 0.75-2.0 in high strength clay & = 0.5-1.5 in dense sand* • *Minor sedimentary features/seabed topography; slopes are generally <10°* • *Variable burial conditions possible, but >0.5m deep* • *Tow tensions generally 20T to 50T, but occasional high tensions >50T with high variability and possible renders.* • *Increased plough pitch and roll possible* • *Reduced plough progress rate likely* • *Medium to high plough share tip wear rate*
C POOR VARIABLE PLOUGH BURIAL	Poor burial, to a predicted ≤0.5m cover depth • *Very to extremely high strength clay and up to very dense sand/silt; or where a thin unit of loose/low strength sediment sits over a dense to very dense unit/rock that could reach the upper 0.5m of the seabed.* • *Burial Protection Index = <0.5* • *Complex seabed topography and variable conditions, consisting of rock or coral outcrop/shallow subcrop, high relief bedforms, boulders, seabed debris* • *Slopes are generally <10-12° downslope, 12-14° upslope, or 6° sideslope.* • *Poor/variable burial expected—generally <0.5m deep* • *Possible spot plough rideouts* • *Possibility for areas of cable very close to the seabed* • *Tow tensions likely to exceed 50T, with high variability and possible renders* • *High plough pitch/roll events possible* • *Slow plough progress rate* • *High plough share tip wear rate*
D UNPLOUGHABLE	Not ploughable, due to seabed conditions or route design criteria • *Complex seabed topography and variable conditions, consisting of rock or coral outcrop/very shallow subcrop, high relief bedforms, boulders, seabed debris* • *Seabed slopes generally >10-12° downslope, 12-14° upslope, or 6° sideslopes*
E PLOUGH OVERBURIAL	Uncontrolled cable overburial, ≥1.5m • *Thick, extremely low strength clay, with low seabed bearing capacity; shear strength <5kPa.* • *Burial Protection Index = 0.5-1.0* • *Plough sinkage and uncontrolled cable overburial possible* • *Low, consistent tow tensions, generally <20T* • *Low plough share tip wear rate*
SE	Surface Lay • Post lay burial required for shore end section

Trenchability Class	Criteria
IS	Surface Lay • Post lay burial required for existing infrastructure crossing of cables, pipelines, power cables
BU	Surface Lay • Post lay burial required following Branching Unit integration

2.3 Plough Tow Forces

The predicted plough tow forces are incorporated in the trenchability classifications outlined in Table 2-2 above. Table 2-3 below provides more information on these tow forces.

Table 2-3: Plough Tow Force Classification

Classification	Criteria
Low	Tow force less than 20 Tonnes (200kN)
Medium	Tow force 20 to 50 Tonnes (200kN to 500kN)
High	Tow force might exceed 50 Tonnes (500kN) • *High variability and possible DP slowdowns and renders*

2.4 Plough Wear Rates

Plough wear rates are related to the abrasiveness of the seabed sediments through which the plough passes. Table 2-4 summarises the wear categories used in the burial feasibility.

'Maintenance' is assumed to mean: share wear tip replacement, potential re-welding of new wear-plates on the share, skids, stabilisers, depressor and share guides, along with general checks for corrosion and coherency of corrosion-insulation materials.

Table 2-4: Plough Wear Rate Classification

Classification	Criteria
Low	Extremely low to low strength CLAY/SILT or very loose to loose SAND/SILT • *Plough recovery unlikely to be needed for maintenance reasons*
Medium	Medium to very high strength CLAY/SILT or medium dense to very dense SAND/SILT, • *Plough recovery unlikely to be needed for maintenance reasons*
High	Hardground/rock within the burial depth, or boulder areas • *Plough recovery likely needed every 50km for plough maintenance*

2.5 Plough Tow Speeds

Table 2-5 summarises the plough tow speed classification used in the Burial Assessment table. Predicted plough tow speeds have assumed a standard installation vessel, which has sufficient vessel power/bollard pull for a HD plough and the ability to maintain a constant speed while ploughing.

Table 2-5: Plough Tow Speeds

Speed	Criteria
Low	• <0.17-0.25m/s (<600-900m/hr) • *Type V or VI seabeds (Table 2-1)* • *Very high strength/very dense sediment or heterogeneous/layered seabeds; thin surficial sediment over subcropping rock; or a thin layer of loose/soft sediment sitting over a very dense/hard sediment layer*
Medium	• 0.25-0.50m/s (900-1800m/hr) • *Type III or IV seabeds (Table 2-1)* • *Relatively homogeneous sediment; medium dense to dense unlayered sand or medium to high strength unlayered clay* • *Or relatively short sections of otherwise high speed ground, in which it is not possible to get the plough up to its optimal speed*
High	• >0.50m/s (>1800m/hr) • *Type I or II seabeds (Table 2-1)* • *Thick, homogeneous extremely low to low strength clay or very loose to loose sand*

2.6 Burial Cover Depth

The target burial cover depth (depth below mean seabed) is 1.5m.

In general, burial depth predictions are based on known plough behaviour under given seabed conditions, and on:

- Seabed geology and its lateral variability
- Sediment lithology and geotechnical properties—shear strength/relative density
- Seabed topography—seabed slopes, sedimentary bedforms, pockmarks/depressions
- Obstructions (sonar contacts)—natural or manmade

The classification for burial depth categories is shown in Table 2-2.

Please also see the note on target burial depth, predicted burial depth and the Burial Protection Index, in Section 1.2.

2.7 Installation Risk Assessment

The Installation Risk Assessment (IRA) score shown in Table 2-6 refers to the safety of the burial equipment during the cable lay operations. The burial equipment is primarily a seabed plough, although a remotely operated vehicle (ROV) is sometimes used to conduct post-lay burial (PLB). Table 2-7 provides a summary of the typical risk elements that can lead to IRA 2 (MBC) or IRA 3 (Surface Lay) designation.

Table 2-6: Installation Risk Assessment (IRA) Score

Installation Risk Assessment (IRA) Category	Risk Assessment Conditions
1 *Low Risk*	PLOUGHABLE/PLB ATTEMPT *No significant risk to the burial equipment due to seabed conditions*
2 *Moderate Risk*	MARGINAL BURIAL CONDITIONS (MBC) *Identified risk to the burial equipment due to seabed conditions; potential damage repairable onboard, using shipboard spares. A plough/PLB attempt will be made.*
3 *High Risk*	SURFACE LAY/UNPLOUGHABLE/NO PLB ATTEMPT *High risk to the burial equipment due to seabed conditions; potential severe damage not repairable onboard using shipboard spares*

Table 2-7: Typical Risk Elements Leading to IRA 2 or 3 Designation

Category	Marginal Burial Conditions (MBC) Element	Seabed Conditions	RPL Abbrev'n
IRA 2 *Marginal Burial Conditions*	*Sediment*	Extremely Low Strength Clay (<5kPa) on Slopes—plough sinkage and uncontrolled cable overburial possible. Low traction on slopes, potential loss of plough control, especially in deeper water.	MBC (SS)
		High Strength Sediment—dense to very dense granular sediment (sand/silty sand), with relative density (RD) >85%; or stiff to very stiff cohesive sediment (clay) with shear strength >150kPa. Reduced burial possible, with high tensions and potential renders.	MBC (HT)
		Hardground—at the seabed or within the burial depth. Hardground is partially indurated (cemented) sediment or very weathered rock (>95% RD in granular sediment, or >300kPa in cohesive sediments). Difficult burial conditions and plough damage possible.	MBC (HG)
		Rock Subcrop—rock sitting within the target burial depth. Reduced burial expected and the potential for high tensions, renders and plough damage, depending on the roughness of the buried rock surface.	MBC (SR)
	Slopes	Increased Topography—slopes regularly >8-10°, or sideslopes >4°.	MBC (SL)

<table>
<tr><th>Category</th><th>Marginal Burial Conditions (MBC) Element</th><th>Seabed Conditions</th><th>RPL Abbrev'n</th></tr>
<tr><td rowspan="5">IRA 2

Marginal Burial Conditions</td><td rowspan="4">Seabed Features</td><td><u>Seabed Depressions</u>—moderately dense, >1m deep, but with marginal sidewall slopes and the potential for plough sinkage in sediment <5kPa. Possible avoidance using plough's forward-looking sonar.</td><td rowspan="4">MBC (SB)</td></tr>
<tr><td><u>Sediment Bedforms</u>—sandwaves >3m in height, and/or with crests aligned parallel or sub-parallel to the route.</td></tr>
<tr><td><u>Rock/Coral Outcrops</u>—within half water depth of the route.</td></tr>
<tr><td><u>Boulders/Other Sonar Contacts</u>—>0.5m high, within half water depth of the route.</td></tr>
<tr><td>Surface Currents</td><td><u>Strong Surface Currents</u>—consistently >1-2m/s.</td><td>MBC (SC)</td></tr>
<tr><td rowspan="5">IRA 3

Surface Lay

Not Ploughable

No PLB</td><td>Sediment</td><td><u>Rock Outcrop</u>—rock sitting at the seabed.</td><td rowspan="5">PLUP/PLDN half water depth either side of the feature</td></tr>
<tr><td>Slopes</td><td><u>Complex Topography</u>—downslopes regularly >12°, upslopes >14°, sideslopes >6°.</td></tr>
<tr><td rowspan="3">Seabed Features</td><td><u>Seabed Depressions</u>—unavoidable, dense, large, deep features with unploughable sidewall slopes and the potential for plough sinkage in sediment <5kPa.</td></tr>
<tr><td><u>Rock/Coral Outcrops</u>—unavoidable and very close to the route.</td></tr>
<tr><td><u>Boulders/Other Sonar Contacts</u>—>0.5m high, unavoidable and very close to the route.</td></tr>
</table>

2.8 Seabed Gradient Classification

The following table defines the categories for describing the seabed gradients encountered along the route.

Classification	Gradient (degrees)
Very Gentle	<1
Gentle	1 – 4.9
Moderate	5 – 9.9
Steep	10 – 14.9
Very Steep	>15

2.9 Classification of Seabed Sedimentary Structures

Areas of shallow water with high current velocities can often have associated seabed features such as ripples, megaripples and sandwaves. The one of most concern for installation are sandwaves. These can be several metres high and if crossed obliquely cause plough stability problems. Crossing perpendicular can also cause problems as the plough transits over the crest and then has a steep descent putting extra strain on the cable causing it to become exposed if not enough slack is inserted.

The following tables defines the sizes of these features.

Structure	Wavelength (metres)
Ripple	<0.5
Megaripple	0.5 - 25
Sandwave	>25

2.10 Marginal Burial Conditions (MBC) Areas

Areas of the route designated within the RPL as 'Marginal Burial Conditions' or 'MBC' denote that conditions are borderline for plough or ROV operations, due to the presence of steep up, down or side slopes, hard or very soft sediment conditions, gas/hydrothermal release features, subcropping rock or other seabed irregularities. It is intended to attempt burial in these areas; however, in the event that conditions become unjustifiably hazardous to the plough or cable, the Master and Subsea Team Leader will, at their discretion, relocate the plough and recommence burial where the seabed conditions show improvement. Hazardous conditions include but are not limited to: damage to the plough, plough runaway, uncontrolled plough sinkage, very high tow tensions/renders, highly variable plough pitch/roll in rough topography or steep slopes, and the inability to prevent the plough tow wire from interacting with the cable. Table 2-7 provides a more detailed list. Such plough skips will not be subject to any post lay burial attempts because the conditions as found by the plough will be equally hazardous to the burial ROV and may result in damage to the cable.

2.11 Notes on Using the Burial Assessment

The Burial Assessment table, Appendix 1 provides professional-judgment level predi ctions of the burial conditions likely to be experienced during the installation. The following points list some general assumptions made during report compilation, along with points that should be understood when using the Burial Feasibility table.

- Based on RPL version Havhingsten _S1.1_BU Port Erin - BMH Loughshinny_PSR03_29 April 2019. KP references in the report might be slightly inaccurate if the installation RPL differs from this version.
- Predictions are subject to inherent inaccuracies—the predictions are based only on available geotechnical data, which is limited to discrete, spot locations,

and on marine geophysical survey data. This is why there are bridging categories in the report (e.g., A/B) when conditions are not expected to be steady state.

   - Predictions are based on extrapolations between single geotechnical data points, as provided by CPTs and physical seabed samples. Summaries of the CPTs and Sediment Samples can be found in Appendix 2.

- Burial conditions can never be described definitively—the burial depth and tow tensions experienced during the installation can, given the exact same seabed conditions, vary by altering the plough speed and share/trench depth settings. It is difficult to express the potential for this type of real-time change in Appendix 1

- Burial categories are protective—because it is difficult to provide a definitive burial condition, as described in the bullet point above, burial predictions in Appendix 1 are written as worst case scenarios, in order to be protective to the cable system.

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3 PLOUGH MAINTENANCE POSITIONS

No unplanned plough recoveries should be required for plough maintenance due to the relatively short length of this segment and the fact that it is almost entirely in low wear rate, very soft to soft clay sediments.

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APPENDIX 1 BAS SUMMARY

Burial Assessment for HAVHINGSTEN Segment 1-1, (Rev02, PSR03 RPL)

Abbreviations
ST: Sediment Type TA: Trenchability Assessment IRA: Installation Risk Assessment TBD: Target Burial Depth PBD: Predicted Burial Depth (average for the section) TT: Plough Tow Tension
WR: Plough Share Wear Rate PS: Plough Tow Speed CT: Cable Type (17mm) BM: Burial Method (PL: HD Plough; MBC: Marginal Burial Conditions; PLB: Post Lay Burial by Jetting; SL: Surface Lay; DB:Dive Burial)

RPL INFORMATION					SURVEY INFORMATION		BURIAL ASSESSMENT INFORMATION											PLOUGH TEAM COMMENTS
FROM KP (km)	**EVENT**	**TO KP** (km)	**EVENT (km)**	**DISTANCE (km)**	**DEPTH (m)**	**SURVEY DESCRIPTION**	**ST** I-VII	**TA** A-H	**IRA** 1-3	**TBD** (m)	**PBD** (m)	**BM**	**TT** L M H	**WR** L M H	**PS** L M H	**CT**	**BURIAL COMMENTS**	
0.000	BU Port Erin	0.300	PLDN	0.300	83-81	Very gently sloping seabed. SILT overlying very soft to soft clay	I-II	BU	-	1.5	1.5	PLB	-	-	-	DA		
0.300	PLDN	11.260	INFERRED BOUNDARY	10.960	82-71	Very gently sloping seabed. CPT/GC09 0.54m of loose to medium dense sandy SILT overlying very soft to soft clay CPT/GC08 0.47m of loose to medium dense sandy SILT overlying very soft clay	I-II	A	1	1.5	1.5	PL	L	L	M	DA	Seabed sediments have high negative pore pressure so may be slightly higher tow tensions than expected for loose sand.	
11.260	INFERRED BOUNDARY	23.951	Start of trawl scars	12.691	69-77	Very gently sloping seabed. Trawl scars observed on seabed. Seabed formed of very soft CLAY CPT/GC07 Soft CLAY overlying very soft CLAY	I	A/E	1/2	1.5	1.5 to >1.5	PL	L	L	H	DA	Below 0.5m very low shear strength approx 5kPa so some possibility of overburial	
23.951	Start of trawl scars	25.016	PLUP	1.065	77	Very gently sloping seabed. Trawl scars observed on seabed. Seabed formed of very soft CLAY	I	A/E	1/2	1.5	1.5 to >1.5	PL	L	L	H	DA	Below 0.5m very low shear strength approx 5kPa so some possibility of overburial	
25.016	PLUP	25.515	PLDN	0.499	77	Very gently sloping seabed. Seabed formed of very soft CLAY	I	IS	-	1.5	1.5	PLB	-	-	-	DA	CX IS INTERCONNECTOR 1 @ KP 25.265	
25.515	PLDN	59.211	INFERRED BOUNDARY	33.696	77-65	Very gentle to gently sloping seabed. Route passes southeast of a shipwreck at KP45.610 Trawl scars observed on seabed. Seabed formed of very soft clay CPT/GC06 CPT/GC05 CPT/GC04 CPT/GC03	I	A/E	1/2	1.5	1.5 to >1.5	PL	L	L	H	DA	Proposed route passes approximately 100m southeast of a shipwreck at KP45.610 with dimensions of 24.2mx8.9mx4.2m All geotechnical sample show very soft clay with minimum sherar strength of approx 5kPa giving the possibility of some overburial	
59.211	INFERRED BOUNDARY	70.358	Start MBC (HG) Start Area Of Subcropping Rock	11.147	65-36	Very gently sloping seabed. Trawl scars observed on seabed. Seabed sediments becoming SILT over very soft clay CPT/GC02	I	A	1	1.5	1.5	PL	L	L	H	DA		
70.358	Start MBC (HG) Start Area Of Subcropping Rock	72.321	End MBC (HG) End Subcropping Rock	1.963	36-31	Very gently sloping seabed. Seabed sediments formed of coarse gravelly SAND and sandy GRAVEL	II	B	1	1.5	>0.5 to <1.5	PL	M	M	M	DA	No samples taken in this section but likely to be LOOSE Sand	
72.321	End MBC (HG) End Subcropping Rock	77.561	PLUP	5.240	31-15	Very gently sloping seabed. Seabed formed of very loose to loose silty SAND CPT/GC01 1.5m very loose to loose silty SAND overlying very loose to loose clayey SAND	I, II	A	1	1.5	1.5	PL	M	M	M	DA	Negative pore pressure in the upper 0.5m may result in slightly higher tow tensions than expected for loose SAND	
77.561	PLUP	79.865	Start Subcropping Rock & Boulders	2.304	15-5	Very gently sloping seabed. Seabed formed of very loose to loose silty SAND	I, II	SE	-	1.5	1.5	PLB	-	-	-	DA		
79.865	Start Subcropping Rock & Boulders	80.626	BMH Loughshinny	0.761	5-0	Seabed formed of boulders, subcropping ROCK & ROCK outcrop	VI, VII	SE	-	1.5	0 to 1.5	PLB	-	-	-	DA		

Burial Category	Cumulative Route Length (km)	Percentage of Area	BAS Category Predicted Burial Depth Range (m)	Installation Risk Category
A *Target Burial*	26.233	32.54%	1.5	1
A/E *Target to Overburial*	47.452	58.85%	1.5 to >1.5	1/2
E *Overburial*	0.000	0.00%	>1.5	
A/B *Target to reduced Burial*	0.000	0.00%	>0.5 to ≤1.5	1
B *Reduced Burial*	3.077	3.82%	>0.5 to ≤1.5	2
B/C *Variable layer Reduced to Poor Burial*	0.000	0.00%	<0.5 to <1.5	
C *Poor Burial*	0.000	0.00%	<0.5	
D *Unploughable*	0.000	0.00%		
SE Shore End	3.065	3.80%	1.5	1
IS Crossing Infrastructure	0.499	0.62%	1.5	1
BU BU Integration	0.300	0.37%	1.5	1
HDD	0.000	0.00%	-	
DEEP WATER *Surface Lay*	0.000	0.00%	-	
	76.762	**95.21%**	**Percent of Total Proposed predicted to be buried**	
	80.626	**100.00%**	**Proposed Burial against Total Route Length**	
	80.626	**100%**	**Total Route Length**	

INDIGO WEST S 1A

BURIAL RISK SUMMARY

Installation Risk Category	Cumulative Route Length (km)	Percentage of Area
1 *Low Risk*	29.31	36.35%
1/2 Low to Moderate Risk Due To Possibility Of Overburial/Hardground/ROCK within TBD	47.452	58.85%
2 *Moderate Risk* *Marginal Burial Conditions*	0.000	0.00%
3 *High Risk Seabed* *Surface Lay*	0.000	0.00%
Surface Lay (Shore Ends & In Service Crossings)	3.864	4.79%
HDD	0.000	0.00%
TOTAL PROPOSED BURIAL	**80.626**	**100%**

INDIGO WEST S 1A
BURIAL METHOD SUMMARY

Burial Method	Cumulative Route Length (km)	Percentage of Area
PLOUGH	76.762	95.21%
POST LAY BURIAL	3.864	4.79%
DIVE BURIAL	0.000	0.00%
SURFACE LAY	0.000	0.00%
PLB/SL TBC	0.000	0.00%
HDD	0.000	0.00%
PROPOSED BURIAL	**80.626**	**100%**
DEEP WATER	0.000	0.00%
TOTAL ROUTE LENGTH	**80.626**	

APPENDIX 2 CPT & SEDIMENT SAMPLE LOGS

See Appendix G & H of Main Survey Report

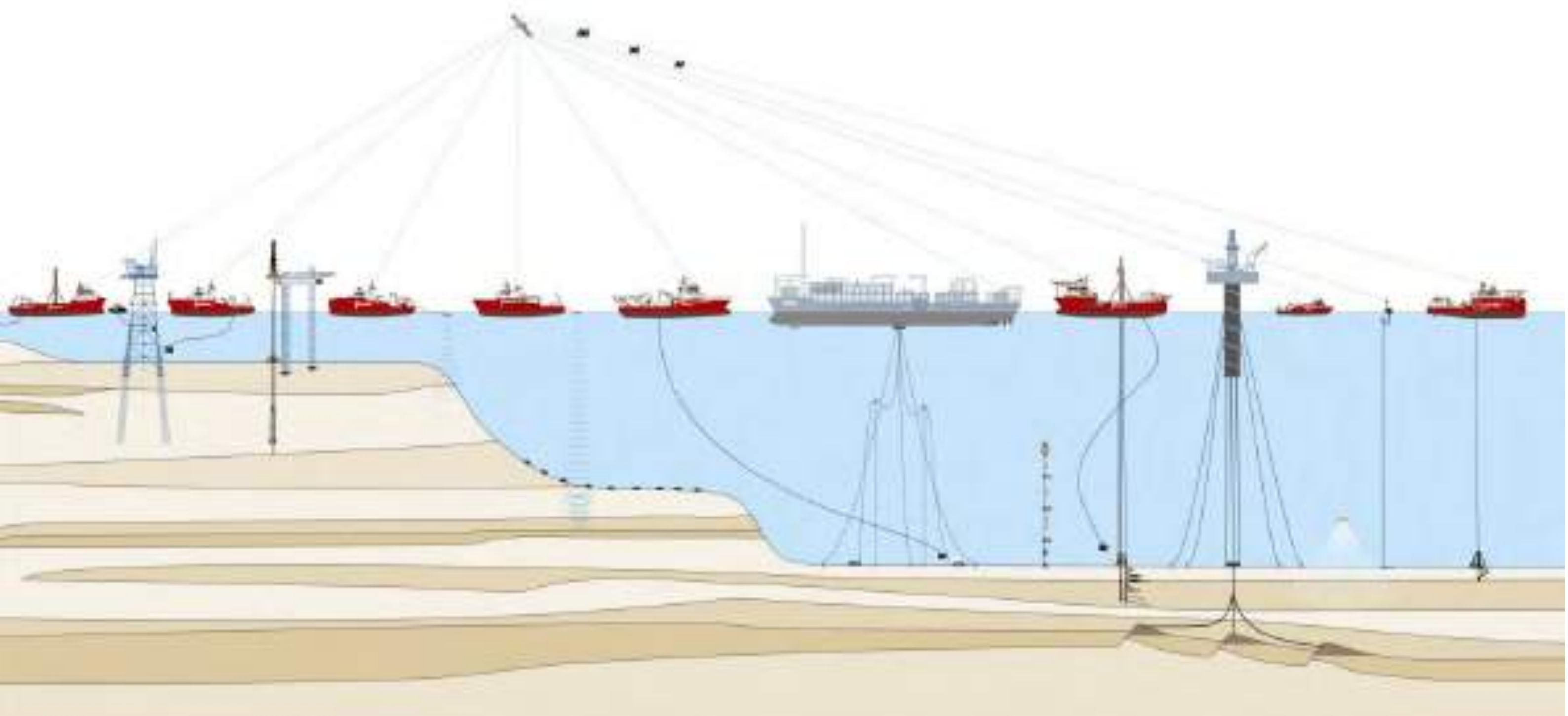
S. APPENDIX S - ENVIRONMENTAL REPORT

Field Report
Havhingsten Cable Route Survey
Irish Sea

Fugro Document No.: 181275-R-002(01)
13 March 2019

Alcatel Submarine Networks UK Limited

Draft Report



Field Report
Havhingsten Cable Route Survey
Irish Sea

Fugro Document No.: 181275-R-002(01)
13 March 2019

Draft Report

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EXECUTIVE SUMMARY

Introduction

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed an environmental characterisation survey and cable crossing investigation between Loughshinny, Ireland and Port Erin, Isle of Man, and between Port Grenaugh, Isle of Man and Squires Gate Lane, UK. The survey was conducted using the RV Prince Madog during the survey period 6 to 26 February 2019.

Environmental Survey

The acquired sidescan sonar data were reviewed prior to survey operations to propose locations for camera investigations and grab sampling. Emphasis was placed on locating areas of potential conservation value, on boundaries between areas of differing sonic reflectivity and areas characteristic of the general background conditions of the site.

Five stations were completed along the Loughshinny cable route, twelve stations along the Port Erin cable route, seven stations along the Port Grenaugh cable route and twelve stations along the Squires Gate Lane cable route by means of drop-down camera and grab sampling. In addition, two camera transects were selected along the Port Erin cable route and one along the Port Grenaugh cable route.

In addition to the environmental sampling stations, four cable crossing locations were selected by the client. These locations were to be investigated by means of two perpendicular camera transects, centred on the cable crossing position. Additionally, at one cable crossing location a grab sampling station was positioned at a distance of 300 m from the pipeline.

Seabed Habitats

Seabed sediments along the Loughshinny cable route were predominantly sand at stations closest to shore and comprised sandy mud and mud with faunal burrows further offshore towards the deeper sites. Fauna associated with sands and sandy muds were generally sparse, with starfish (Asteroidea) and sea urchins (Brissidina) observed. Fauna associated with mud were generally sparse with faunal burrows observed.

Seabed sediments along the Port Erin cable route were variable. The sediments at the shallower stations comprised sand and gravelly sand. Stations further offshore predominantly comprised sandy mud and mud. Fauna associated with sand and gravelly sand included brittlestars (Ophiuroidea), hermit crabs (Paguridae), scallops (Pectininae) and anemones (Actiniaria). The fauna associated with sandy mud was diverse including ross worm (*Sabellaria spinulosa*), soft coral (*Alcyonium digitatum*), scallops (Pectininae), hydroids (Plumulariidae) and brittlestars (Ophiuroidea). Stations comprising mud substrate observed fauna including tube worms (Annelida) and hermit crabs (Paguridae).

Seabed sediments along the Port Grenaugh cable route consisted of sand with cobbles and shell fragments. Fauna diversity increased with the presence of hard substrate. Fauna associated with cobbles and sand included soft coral (*Alcyonium digitatum*) and starfish (*Asterias rubens*). higher density of cobbles, boulders and shells attributed to the higher abundance of soft coral (*Alcyonium digitatum*), sea urchins (*Echinus esculentus*), starfish (*Asterias rubens*) and tube worms (Serpulidae) present.

Seabed sediments along the Squires Gate Lane cable route were varied between sand, muddy sand/sandy mud and mixed sediments (sand, cobbles and boulders). Fauna associated with sandy sediments included sea urchins (Brissidina) and bivalves (Bivalvia). Sediments comprising muddy sand/sandy mud included brittlestars (Ophiuroidea), spider crabs (Brachyura) and sea urchins (Brissidina). The presence of mixed sediment and boulders increased the epifaunal diversity and abundance of species present including small-spotted catshark (*Scyliorhinus canicula*), soft coral (*Alcyonium digitatum*), faunal turf (Hydrozoa/Bryozoa), sea squirts (Ascidiacea), starfish (including *Asterias rubens* and *Henricia* sp.), scallops (Pectininae) and dog cockles (*Glycymeris glycymeris*).

The western HVDC UK cable crossing comprised sandy gravel and cobbles. Fauna observed included soft coral (*Alcyonium digitatum*), whelks (Buccinidae), hermit crabs (Paguridae) and tube worms (Serpulidae).

The western HVDC Port Grenaugh cable crossing comprised sand, gravel and cobbles with a high density of shell fragments. Fauna observed included soft coral (*Alcyonium digitatum*), feather star (Crinoidea), starfish (*Asterias rubens*) and tube worms (Serpulidae).

The western HVDC Port Erin cable crossing comprised sandy mud. Fauna observed included ross worm (*Sabellaria spinulosa*), faunal turf (Hydrozoa/Bryozoa), soft coral (*Alcyonium digitatum*), scallops (Pectininae), hermit crabs (Paguridae), brittlestars (Ophiuroidea) and sea squirts (Ascidiacea).

The interconnecter cable crossing comprised mud with faunal burrows. Fauna observed included small-spotted catshark (*Scyliorhinus canicula*), tube worms (Polychaeta), hermit crabs (Paguridae) and Norway lobster (*Nephrops norvegicus*).

Potentially Sensitive Habitats

Burrows and sea pens, areas of cobbles and boulders, and *Sabellaria* were observed within the survey area. The potential presence of the OSPAR (2008) habitat ‘Sea pens and burrowing megafauna’ and the Annex I habitats ‘stony reef’ and ‘biogenic reef’ will be further assessed in the habitat assessment report.

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FIGURES IN THE MAIN TEXT

ABBREVIATIONS

BSL	Below sea level
CC	Cable crossing
DVV	Dual van Veen grab
EOL	End of line
FA/FB	Fauna sample FA or FB
HG	Hamon grab
HVDC	High voltage direct current
MCZ	Marine Conservation Zone
MPA	Marine Protected Area
NF	No fix
NS	No sample
OSPAR	Oslo and Paris convention
PC	Physico-chemical (grab sub-sample)
PSD	Particle size distribution
RV	Research vessel
SOL	Start of line
ST	Station
T	Transect
UHF	Ultra high frequency
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

1. INTRODUCTION

1.1 Background

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed an environmental characterisation survey and cable crossing investigation between Loughshinny, Ireland and Port Erin, Isle of Man, and between Port Grenaugh, Isle of Man and Squires Gate Lane, UK.

The Havhingsten cable system is a planned subsea telecommunication network and the design spans nearly 920 km with initial landing points in four markets, including Denmark, England, Isle of Man and Ireland.

The environmental survey was conducted to establish whether any sensitive habitats are present within the cable route corridor, specifically habitats listed under Annex I of the EC Habitats Directive and habitats listed by the Oslo-Paris convention (OSPAR) as threatened and/or declining habitats (OSPAR, 2008). In addition, grab samples were collected to establish physico-chemical and biological properties of the sediment.

For the purpose of the environmental surveys, the proposed cable route was divided into four sections, and named according to the landfall location:

- Ireland landing at Loughshinny;
- Isle of Man landing at Port Erin;
- Isle of Man landing at Port Grenaugh;
- UK west coast landing at Squires Gate Lane.

In addition to the environmental characterisation survey there was a requirement for a high level ecological assessment at four locations where the proposed cable route crosses existing pipelines.

This report provides details of environmental survey and presents a preliminary assessment of the data obtained in the field; this interpretation may change following further data analysis.

Appendix A outlines the guidelines for use of this report.

1.2 Coordinate Reference System

All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) projection Zone 30N.

2. SURVEY STRATEGY

The acquired sidescan sonar data were reviewed prior to survey operations to propose locations for camera investigations and grab sampling. Emphasis was placed on locating areas of potential conservation value, on boundaries between areas of differing sonic reflectivity and areas characteristic of the general background conditions of the site.

Five stations were selected along the Loughshinny cable route to be investigated by means of drop-down camera prior to grab sampling.

Twelve stations were selected along the Port Erin cable route, including ten stations with drop-down camera prior to grab sampling and two stations where only drop-down camera was required. Additionally, two camera transects were selected along the Port Erin cable route.

Seven stations were selected along the Port Grenaugh cable with drop-down camera prior to grab sampling and one camera transect.

Twelve stations were selected along the Squires Gate Lane cable route to be investigated by means of drop-down camera prior to grab sampling.

Tables 2.1, 2.2, 2.3 and 2.4 provide the coordinates, data to be acquired and rationale for each location.

Table 2.1: Proposed Sampling Stations, Loughshinny

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
LS_ST01	296 655	5 937 208	Differing reflectivity covering two habitat types. Grab sample location to be defined following video review	Video and stills PC, FA, FB
LS_ST02	298 411	5 937 630	Representative habitat	Video and stills PC, FA, FB
LS_ST03	303 849	5 938 838	Differing reflectivity	Video and stills PC, FA, FB
LS_ST04	307 143	5 939 833	Differing reflectivity	Video and stills PC, FA, FB
LS_ST05	314 915	5 943 502	Representative habitat	Video and stills PC, FA, FB

Notes:
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB

Table 2.2: Proposed Sampling Stations, Port Erin

Geodetic Parameters: WGS84 UTM 30N					
Station		**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
PE_ST01		384 495	5 994 793	Representative of nearshore main substrate type	Video and stills PC, FA, FB
PE_ST02		383 725	5 994 954	Change in reflectivity, crossing a substrate boundary.	Video and stills PC, FA, FB
PE_ST03		380 103	5 994 769	Sand with coarser sediment in ripples/waves	Video and stills PC, FA, FB
PE_ST04		374 510	5 988 022	Sand ripples/waves	Video and stills PC, FA, FB
PE_ST05		371 543	5 981 359	Mixed reflectivity	Video and stills PC, FA, FB
PE_ST06		370 665	5 976 483	Ridge feature	Video and stills PC, FA, FB
PE_ST07		370 210	5 973 875	Sand ripples and sediment waves	Video and stills PC, FA, FB
PE_ST08		362 072	5 964 583	Differing reflectivity, within the Queenie Corner MCZ	Video and stills PC, FA, FB
PE_ST09		357 363	5 962 262	Relatively homogenous substrate, station for spatial coverage within the Queenie Corner MCZ	Video and Stills
PE_ST10		352 850	5 960 071	Relatively homogenous substrate, station for spatial coverage within the Queenie Corner MCZ	Video and Stills
PE_ST11		349 831	5 958 622	Relatively homogenous substrate, station for spatial coverage within the Queenie Corner MCZ	Video and stills PC, FA, FB
PE_ST12		349 831	5 958 622	Relatively homogenous substrate, station for spatial coverage within the Queenie Corner MCZ	Video and stills PC, FA, FB
Transect					
PE_TR01	SOL	384 369	5 994 838	Area of high reflectivity and crossing a substrate boundary	Video and stills
	EOL	384 251	5 994 776		
PE_TR02	SOL	384 165	5 994 656	Feature of high reflectivity	Video and stills
	EOL	384 025	5 994 610		

Notes:
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB
MCZ = Marine Conservation Zone
TR = Transect
SOL = Start of line
EOL = End of line

Table 2.3 Proposed Sampling Stations, Port Grenaugh

Geodetic Parameters: WGS84 UTM 30N					
Station		**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
PG_ST01		396 946	5 995 978	Differing reflectivity, hard substrate	Video and stills PC, FA, FB
PG_ST02		397 916	5 994 282	Differing reflectivity, possible feature of interest	Video and stills PC, FA, FB
PG_ST03		398 687	5 992 176	Regular striation features	Video and stills PC, FA, FB
PG_ST04		399 003	5 985 527	Differing reflectivity	Video and stills PC, FA, FB
PG_ST05		397 084	5 974 814	Differing reflectivity	Video and stills PC, FA, FB
PG_ST06		403 761	5 966 746	Differing reflectivity	Video and stills PC, FA, FB
PG_ST07		409 841	5 966 414	Representative of habitat across section of route	Video and stills PC, FA, FB
Transect					
PG_TR01	SOL	397 321	5 995 317	High reflectivity, hard substrate	Video and stills
	EOL	397 390	5 995 196		

Notes:
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB
TR = Transect
SOL = Start of line
EOL = End of line

Table 2.4 Proposed Sampling Stations, Squires Gate Lane

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
SG_ST01	495 209	5 958 173	Spatial coverage of representative habitat, within MPA	Video and stills PC, FA, FB
SG_ST02	493 553	5 957386	Differing reflectivity, within MPA	Video and stills PC, FA, FB
SG_ST03	490 992	5 956 765	Differing reflectivity, within MPA	Video and stills PC, FA, FB
SG_ST04	488 536	5 956 774	Differing reflectivity, within MPA	Video and stills PC, FA, FB
SG_ST05	483 918	5 956 544	Mixed reflectivity, within MPA	Video and stills PC, FA, FB
SG_ST06	480 913	5 956 334	Mixed reflectivity, within MPA	Video and stills PC, FA, FB
SG_ST07	477 859	5 956 185	Spatial coverage	Video and stills PC, FA, FB
SG_ST08	464 565	5 955 053	Spatial coverage	Video and stills PC, FA, FB
SG_ST09	454 309	5 956 330	Sand waves/ripples	Video and stills PC, FA, FB
SG_ST10	436 745	5 960 253	Spatial coverage	Video and stills PC, FA, FB

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
SG_ST11	429 261	5 962 373	Differing reflectivity	Video and stills PC, FA, FB
SG_ST12	414 096	5 966 135	Different habitat and spatial coverage	Video and stills PC, FA, FB
Notes: ST = Station MPA = Marine Protected Area PC = Physico-chemical sample FA/FB = Faunal sample FA or FB				

In addition to the environmental sampling stations, four cable crossing locations were selected by the client. These locations were to be investigated by means of two perpendicular camera transects (T01 and T02), centred on the cable crossing position (Table 2.5). At one location (CC05_ST01), a grab sampling station was positioned at a distance of 300 m from the interconnector cable.

Table 2.5: Proposed Cable Crossing Survey Locations

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
CC02 (Client ID 10/11)	446 258	5 957 846	Western HVDC UK	Video and stills
CC03 (Client ID 8/9)	396 861	5 973 227	Western HVDC Port Grenaugh	Video and stills
CC04 (Client ID 4/5)	370 377	5 975 486	Western HVDC Port Erin	Video and stills
CC05 (Client ID 2)	346 662	5 957 525	Interconnector	Video and stills
CC05_ST01	346 363	5 957 528	Grab station positioned 300 m from the interconnector cable	Video and stills, PC, FA, FB
Notes: CC = Cable crossing HVDC = High voltage direct current ST = Station PC = Physico-chemical sample FA/FB = Faunal sample FA or FB				

3. METHODS

3.1 Survey Methods

3.1.1 Seabed Video/Photography

Prior to grab sampling, seafloor video footage and stills images were collected. Seabed photography was acquired using a Kongsberg OE 14-208 underwater camera system mounted within a purpose-built camera frame complete with a separate strobe and two lights. During operations where visibility was reduced or high turbidity the freshwater lens system was used. Table 3.1 presents the specifications of the Kongsberg camera system.

Table 3.1: Kongsberg OE 14-208 Camera System

Camera Specifications	
Weight:	350 kg
Dimensions:	1.0 m x 1.0 m x 1.0 m
Required clearance:	3 m
Image Resolution	2592 x 1944 (max) at 5.3 MP
Framing Video	PAL 625 Line / 60 Hz NTSC
Sensor type	1/1.8” format high density CCD sensor
Operating Tolerances	
Water Depth	400 m
Optical	
Optical Zoom	x 5
ISO Sensitivity	50 to 400
Standard Lens	35mm format equivalent to 38-140 mm
Angle of View	60° Diagonal in water

Standard video frame

Seabed video footage was displayed on a computer monitor and recorded directly onto a Climax digital recorder and a backup Mini-DV tape player. An overlay box was used to overlay a navigation string from the ship’s reference point, including the date, time and video frame position. The station number was captured by taking a still of the photo slate at the beginning of the video.

Footage was viewed in real time, assisting in the control of the camera in the water. Where the video passed over sediment type boundaries, additional seabed video was collected, as appropriate, to provide sufficient footage for the analysis phase. Review of the video data also allowed assessment of the sites prior to grab deployment.

Positions for the video footage were logged at the beginning and the end of each station/transect and at each static image location.

Two subsea lasers were used to provide a scale on the video footage, these were set at 17.7 cm initially and then adjusted to 19.5 cm and then to 17.0 cm apart on the standard video frame.

Operational procedures for the seabed photography were as follows:

- The camera system was set up on deck prior to deployment and a station slate photograph taken;

- The camera was deployed into the water until just below the sea surface, at which point the lights were switched on;
- The camera was lowered to the seabed and when the seabed was visible recording started and stills were acquired;
- Still photography commenced with the environmental scientist manually triggering the camera while the camera moved over the seabed;
- At the end of a camera station/transect the video recording stopped;
- The camera was recovered to the deck and the lamps were switched off just beneath the surface.

On completion, photographs were downloaded and backed up onto an external hard drive.

3.1.2 Sediment Grab Sampling

Seabed samples were acquired using a 0.1m^2 dual van Veen grab (Figure 3.1).

Figure 3.1: Dual van Veen grab (0.1 m^2)

Operational procedures for the grab deployment and recovery were as follows:

- The 0.1 m^2 dual van Veen grab was prepared for operations prior to arrival on station. The Bridge communicated to the deck via an ultra high frequency (UHF) radio when the vessel was steady and on location, and the grab was deployed;
- When the engineer operating the winch observed that the grab had reached the seabed (evidenced through a distinct slackening of the wire rope and snatch block), the bridge was informed (via UHF radio) and a positional fix was taken;
- On recovery to the deck, the sample was inspected and judged acceptable or otherwise (see below for rejection criteria);
- Two accepted grab samples were retained for faunal analysis and one grab sample was retained and subsampled for physico-chemical analysis;

- Deck logs were completed for each sample acquired (including no samples) with: date, time, sample number, fix number, sediment type, depth and colour of strata in the sediment (if any), odour (i.e. H_2S), bioturbation or debris.

Samples were considered unacceptable in the following instances:

- Evidence of sediment washout caused through improperly closed grab jaws or inspection hatch;
- Sediment sample taken on an angle; where the grab jaws have not been parallel to the seabed when the grab fired;
- Disruption of the sample through striking the side of the vessel;
- Sample represented less than approximately 7 cm bite depth of the grab or 40 % by volume;
- Sample is more than 50 m from the target location, unless otherwise specified in the proposed locations.

Samples deemed acceptable were photographed. For each of the samples, notes were made on sediment type, and conspicuous species.

Each macrofaunal sample was then transferred into a clean plastic box to be washed though a 1 mm sieve with seawater using the chute and stand method. The residue remaining on the sieve was then carefully transferred into a pre-labelled bucket and fixed using 10% buffered formal saline solution (4% formaldehyde). An additional sample label written on waterproof paper, including date and project reference, was placed inside the bucket in addition to labels on the side and lid of the bucket. The fauna samples were stored in a designated crate on the deck of the survey vessel until demobilisation, upon which they were transferred to Fugro's benthic laboratories.

The third grab sample was used for physico-chemical (particle size distribution (PSD) and chemistry) samples, sub-samples of this grab sample were taken as follows:

- A sub-sample (of approximately 300 ml) was collected for PSD analysis, using a plastic scoop to a nominal depth of 5 cm. The samples were sealed in polythene bags to ensure no loss of fines. The samples were frozen at and stored on the vessel until demobilisation and transfer to the analysis laboratory;
- Hydrocarbon samples were collected using a cleaned metal scoop to a nominal depth of 2 cm and stored in a pre-labelled glass jar. The samples were frozen and stored on the vessel until demobilisation and transfer to the analysis laboratory;
- Samples for heavy metals were collected using a plastic scoop to a nominal depth of 2 cm. The samples were sealed in polythene bags to ensure no loss of fines. The samples were frozen at and stored on the vessel until demobilisation and transfer to the analysis laboratory.

4. RESULTS

4.1 Field Operations

The survey was conducted using the RV Prince Madog during the survey period 6 to 26 February 2019. Due to shallow water depths, four stations and two transects along the Port Erin cable route, four stations and one transect along the Port Grenaugh cable route and two stations along the Squires Gate Lane cable route were not conducted onboard the RV Prince Madog. These will be conducted on a nearshore vessel.

Appendix B presents detailed survey logs.

4.1.1 Seabed Video/Photography

Photographic stills and video footage were successfully acquired at the remaining proposed camera stations and transects. Due to reduced underwater visibility at stations closest to the UK coast and Irish Coast, a freshwater lens system was used for the collection of photographic stills and video footage.

Tables 4.1, 4.2, 4.3 and 4.4 detail the acquired video/photograph data for the sampling stations. Some transects had to be re-run due to environmental conditions, only the successful attempt details have been presented within these tables.

Table 4.1: Completed Camera Transects, Loughshinny

Geodetic Parameters: WGS84 UTM 30N						
Station		Easting [m]	Northing [m]	Depth [m BSL]	Length [m]	Data Acquisition
LS_ST01	SOL	296 658.8	5 937 333.6	11	255	13 mins 36 secs 13 stills
	EOL	296 595.9	5 937 086.4			
LS_ST02	SOL	298 398.8	5 937 662.0	15	60	8 mins 24 secs 15 stills
	EOL	298 416.0	5 937 604.5			
LS_ST03	SOL	303 870.6	5 938 724.0	35	157	6 mins 2 secs 23 stills
	EOL	303 833.3	5 938 876.9			
LS_ST04	SOL	307 144.3	5 939 797.0	41	85	5 mins 26 secs 19 stills
	EOL	307 133.1	5 939 881.0			
LS_ST05	SOL	314 920.0	5 943 457.1	66	161	4 mins 26 secs 19 stills
	EOL	314 885.0	5 943 613.9			
Notes: BSL = Below sea level ST = Station SOL = Start of line EOL = End of line						

Table 4.2: Completed Camera Transects, Port Erin

Geodetic Parameters: WGS84 UTM 30N						
Station		Easting [m]	Northing [m]	Depth [m BSL]	Length [m]	Data Acquisition
PE_ST04	SOL	374 561.1	5 988 005.5	47	98	3 mins 46 secs 10 stills
	EOL	374 464.2	5 988 018.7			
PE_ST05	SOL	371 522.5	5 981 280.8	49	107	9 mins 32 secs 19 stills
	EOL	371 540.2	5 981 385.9			

Geodetic Parameters: WGS84 UTM 30N						
Station		**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Length [m]**	**Data Acquisition**
PE_ST06	SOL	370 598.0	5 976 442.1	63	130	6 mins 16 secs 21 stills
	EOL	370 711.7	5 976 504.1			
PE_ST07	EOL	370 176.8	5 973 932.9	71	86	6 mins 16 secs 26 stills
	SOL	370 245.8	5 973 881.8			
PE_ST08	SOL	362 095.7	5 964 547.1	76	157	5 mins 10 secs 18 stills
	EOL	362 145.0	5 964 696.6			
PE_ST09	SOL	357 369.9	5 962 237.4	71	106	4 mins 48 secs 19 stills
	EOL	357 309.4	5 962 324.0			
PE_ST10	EOL	352 779.8	5 960 017.9	71	110	6 mins 23 secs 18 stills
	SOL	352 870.1	5 960 081.0			
PE_ST11	EOL	349 715.1	5 958 536.7	76	150	9 mins 3 secs 22 stills
	SOL	349 837.2	5 958 623.2			

Notes:
BSL = Below sea level
ST = Station
SOL = Start of line
EOL = End of line

Table 4.3: Completed Camera Transects, Port Grenaugh

Geodetic Parameters: WGS84 UTM 30N						
Station		**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Length [m]**	**Data Acquisition**
PG_ST05	SOL	396 940.1	5 974 805.0	50	440	20 mins 3 secs 58 stills
	EOL	397 379.7	5 974 819.0			
PG_ST06	SOL	403 605.1	5 966 710.3	60	215	8 mins 14 secs 8 stills
	EOL	403 817.8	5 966 741.6			
PG_ST07	SOL	409 893.7	5 966 413.8	56	75	4 mins 32 secs 16 stills
	EOL	409 819.2	5 966 406.4			

Notes:
BSL = Below sea level
ST = Station
SOL = Start of line
EOL = End of line

Table 4.4: Completed Camera Transects, Squires Gate Lane

Geodetic Parameters: WGS84 UTM 30N						
Station		**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Length [m]**	**Data Acquisition**
SG_ST03	SOL	490 949.8	5 956 746.7	11	48	2 mins 14 secs 5 stills
	EOL	490 997.3	5 956 756.1			
SG_ST04	SOL	488 549.0	5 956 737.2	13	82	10 mins 10 secs 16 stills
	EOL	488 540.3	5 956 819.1			
SG_ST05	SOL	483 911.6	5 956 488.8	18	72	7 mins 24 secs 13 stills
	EOL	483 886.2	5 956 556.3			
SG_ST06	EOL	480 876.0	5 956 338.0	20	79	9 mins 57 secs 23 stills
	SOL	480 955.0	5 956 344.1			
SG_ST07	SOL	477 838.3	5 956 142.7	23	55	6 mins 3 secs 12 stills
	EOL	477 892.7	5 956 149.7			
SG_ST08	SOL	464 552.7	5 955 067.0	34	63	5 mins 21 secs 15 stills
	EOL	464 612.9	5 955 086.0			
SG_ST09	EOL	454 319.5	5 956 373.8	41	89	6 mins 8 secs 17 stills
	SOL	454 275.7	5 956 296.4			
SG_ST10	EOL	436 759.3	5 960 253.0	44	59	3 mins 55 secs 16 stills
	SOL	436 706.2	5 960 228.1			
SG_ST11	SOL	429 217.0	5 962 389.3	48	58	10 mins 42 secs 30 stills
	EOL	429 261.6	5 962 425.8			
SG_ST12	SOL	414 057.5	5 966 119.0	54	65	6 mins 2 secs 16 stills
	EOL	414 122.0	5 966 119.2			
Notes: BSL = Below sea level ST = Station SOL = Start of line EOL = End of line						

Table 4.5: Completed Camera Transects, Cable Crossings

Geodetic Parameters: WGS84 UTM 30N						
Transect/Station		Easting [m]	Northing [m]	Depth [m BSL]	Length [m]	Data Acquisition
CC02_T01	SOL	446 505.1	5 957 865.7	40	407	15 mins 30 secs 41 stills
	EOL	446 098.5	5 957 856.2			
CC02_T02	EOL	446 436.4	5 957 927.1	44	362	14 mins 53 secs 30 stills
	SOL	446 104.9	5 957 781.9			
CC03_T01	SOL	396 650.0	5 973 365.3	53	406	19 mins 42 secs 43 stills
	EOL	396 967.9	5 973 113.1			
CC03_T02	SOL	396 371.2	5 972 892.7	55	738	33 mins 54 secs 43 stills
	EOL	396 972.5	5 973 321.2			
CC04_T01	EOL	370 261.0	5 975 570.2	71	300	12 mins 9 secs 39 stills
	SOL	370 497.8	5 975 386.4			
CC04_T02	EOL	370 211.2	5 975 364.8	70	360	17 mins 13 secs 44 stills
	SOL	370 502.8	5 975 576.2			
CC05_T01	SOL	347 174.7	5 957 085.5	83	829	33 mins 38 secs 68 stills
	EOL	346 542.0	5 957 621.4			
CC05_T02	SOL	346 779.4	5 957 515.0	82	272	10 mins 15 secs 26 stills
	EOL	346 508.0	5 957 501.8			
CC05_ST01	EOL	346 266.4	5 957 592.1	82	146	19 mins 59 secs 26 stills
	SOL	346 385.9	5 957 508.6			

Notes:
BSL = Below sea level
T = Transect
ST = Station
CC = Cable crossing
SOL = Start of line
EOL = End of line

4.1.2 Grab Sampling

A complete suite of samples (two macrofauna and one physico-chemical sample) were acquired at four stations along the Loughshinny cable route.

A complete suite of samples (two macrofauna and one physico-chemical sample) were acquired at six stations along the Port Erin cable route.

A complete suite of samples (two macrofauna and one physico-chemical sample) were acquired at two stations along the Port Grenaugh cable route. Grab sampling was not attempted at station PG_ST05 due to the presence of hard substrate which is unsuitable for grab sampling.

On site conditions at station LS_ST01, meant that this station would be re-attempted on the nearshore vessel. Grab sampling was not attempted at stations PG_ST05 and SG_ST11 due to the presence of hard substrate which is unsuitable for grab sampling. At station SG_ST07 only a physico-chemical sample was successfully obtained despite additional attempts made to collect the remaining samples. At station SG_ST12, only a physico-chemical sample was obtained due to the presence of *Glycymeris glycymeris*.

A complete suite of samples (two macrofauna and one physico-chemical sample) were acquired at seven stations along the Squires Gate Lane cable route. At station SG_ST07 only a physico-chemical sample was successfully obtained despite additional attempts made to collect the remaining samples. At station SG_ST12, only a physico-chemical sample was obtained due to the presence of *Glycymeris glycymeris*. Grab sampling was not attempted at station SG_ST11 due to the presence of hard substrate which is unsuitable for grab sampling.

At the cable crossing station (CC05_ST01) a complete suite of samples (two macrofauna and one physico-chemical sample) were obtained.

Tables 4.6, 4.7, 4.8, 4.9 and 4.1 present a summary of the samples acquired.

Table 4.6: Completed Sampling Stations, Loughshinny

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting* [m]**	**Northing* [m]**	**Depth [m BSL]**	**Sample Acquisition**
LS_ST02	298 426.0	5 937 601.7	17	PC, FA, FB
LS_ST03	303 889.9	5 938 821.5	32	PC, FA, FB
LS_ST04	307 185.5	5 939 829.5	41	PC, FA, FB
LS_ST05	314 900.5	5 943 474.5	66	PC, FA, FB

Notes:
* = Position of first accepted sample
BSL = Below sea level
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB

Table 4.7: Completed Sampling Stations, Port Erin

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting* [m]**	**Northing* [m]**	**Depth [m BSL]**	**Sample Acquisition**
PE_ST04	374 497.1	5 988 023.4	47	PC, FA, FB
PE_ST05	371 553.7	5 981 328.4	50	PC, FA, FB
PE_ST06	370 658.2	5 976 474.7	58	PC, FA, FB
PE_ST07	370 200.5	5 973 868.8	70	PC, FA, FB
PE_ST08	362 103.0	5 964 594.7	77	PC, FA, FB
PE_ST11	349 797.6	5 958 638.6	75	PC, FA, FB

Notes:
* = Position of first accepted sample
BSL = Below sea level
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB

Table 4.8: Completed Sampling Stations, Port Grenaugh

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting* [m]**	**Northing* [m]**	**Depth [m BSL]**	**Sample Acquisition**
PG_ST06	403 726.4	5 966 765.0	63	PC, FA, FB
PG_ST07	409 822.3	5 966 397.6	52	PC, FA, FB

Notes:
* = Position of first accepted sample
BSL = Below sea level
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB

Table 4.9: Completed Sampling Stations, Squires Gate Lane

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting* [m]**	**Northing* [m]**	**Depth [m BSL]**	**Sample Acquisition**
SG_ST03	491 023.0	5 956 781.9	11	PC, FA, FB
SG_ST04	488 563.9	5 956 752.7	16	PC, FA, FB
SG_ST05	483 892.7	5 956 525.2	17	PC, FA, FB
SG_ST06	480 918.7	5 956 339.6	20	PC, FA, FB
SG_ST07	477 806.2	5 956 172.2	22	PC
SG_ST08	464 542.3	5 955 025.2	38	PC, FA, FB
SG_ST09	454 316.1	5 956 348.7	45	PC, FA, FB
SG_ST10	436 751.6	5 960 253.8	44	PC, FA, FB
SG_ST12	414 086.2	5 966 127.9	51	PC

Notes:
* = Position of first accepted sample
BSL = Below sea level
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB

Table 4.10: Completed Sampling Stations, Cable Crossing

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting* [m]**	**Northing* [m]**	**Depth [m BSL]**	**Sample Acquisition**
CC05_ST01	346 332.3	5 957 528.3	81	PC, FA, FB

Notes:
* = Position of first accepted sample
BSL = Below sea level
CC = Cable crossing
ST = Station
FA/FB = Faunal sample FA or FB

4.2 Seabed Habitats and Fauna

4.2.1 Loughshinny

Seabed sediments along the Loughshinny cable route were predominantly sand at stations closest to shore (stations LS_ST01 and LS_ST02) and comprised sandy mud at stations LS_ST03 and LS_ST04 and mud with faunal burrows further offshore towards the deepest station (65 m below sea level (BSL)) at station LS_ST05.

Fauna associated with sands and sandy muds were generally sparse, with starfish (Asteroidea), sea urchins (Brissidina) and polychaetes (Polychaeta) recorded.

Fauna associated with mud were generally sparse with faunal burrows observed throughout the video footage at station LS_ST05.

Figure 4.1 presents example seabed sediment photographs from the Loughshinny cable route.

4.2.2 Port Erin

Seabed sediments along the Port Erin cable route were variable. The sediments at the shallower stations PE_ST04, PE_ST05 and PE_ST06 comprised sand and gravelly sand. Stations further offshore were similar to the Loughshinny stations, with the seabed predominantly comprising sandy mud and mud.

Fauna associated with sand and gravelly sand included brittlestars (Ophiuroidea), hermit crabs (Paguridae), scallops (Pectininae) and anemones (Actiniaria).

The fauna associated with sandy mud was diverse at station PE_ST07 including ross worm (*Sabellaria spinulosa*), soft coral (*Alcyonium digitatum*), scallops (Pectininae), hydroids (Plumulariidae) and brittlestars (Ophiuroidea). At stations PE_ST08, PE_ST09, PE_ST10 and PE_ST11, the muddy sediment hosted tube worms (Annelida) and hermit crabs (Paguridae). The greatest depth reached along this cable route was 77 m BSL at station PE_ST08.

Figure 4.2 presents example seabed sediment photographs from the Port Erin cable route.

4.2.3 Port Grenaugh

Seabed sediments along the Port Grenaugh cable route consisted of sand with cobbles and shell. The depths along this section of the cable route ranged from 50 m BSL to 61 m BSL.

Epifauna diversity increased with the presence of hard substrate. Fauna associated with cobbles and sand included soft coral (*Alcyonium digitatum*) and starfish (*Asterias rubens*). At station PE_ST05, the higher density of cobbles, boulders and shells attributed to the higher abundance of soft coral (*Alcyonium digitatum*), sea urchins (*Echinus esculentus*), starfish (*Asterias rubens*) and tube worms (Serpulidae) present.

Figure 4.3 presents example seabed sediment photographs from the Port Grenaugh cable route.

4.2.4 Squires Gate Lane

Seabed sediments along the Squires Gate Lane cable route were variable. Sediments comprised sand closer to shore at depths ranging from 11 m BSL to 20 m BSL (stations SG_ST03, SG_ST04 and SG_ST05) and muddy sand/sandy mud at stations SG_ST06, SG_ST07, SG_ST08 and SG_ST09. Mixed sediments (sand, cobbles and boulders) were recorded at stations SG_ST10, SG_ST11 and SG_ST12 which were the furthest offshore at depths ranging 44 m BSL to 54 m BSL.

Fauna associated with sandy sediments included sea urchins (Brissidina) and bivalves (Bivalvia). Sediments comprising muddy sand/sandy mud included brittlestars (Ophiuroidea), spider crabs (Brachyura) and sea urchins (Brissidina). Stations with mixed substrate (SG_ST10 and SG_ST12) supported hermit crabs (Paguridae), brittlestars (Ophiuroidea), soft coral (*Alcyonium digitatum*) and dog cockles (*Glycymeris glycymeris*). At station SG_ST11 the presence of boulders increased the epifaunal diversity and abundance of taxa present. Fauna present at station SG_ST11 included small-spotted catshark (*Scyliorhinus canicula*), bryozoan (Flustridae), faunal turf (Hydrozoa/Bryozoa), sea squirts (Ascidiacea), starfish (including *Asterias rubens* and *Henricia* sp.), scallops (Pectininae) and whelks (Buccinidae).

Figure 4.4 presents example seabed sediment photographs from the Squires Gate Lane cable route.

4.2.5 Cable Crossings

The seabed at the western HVDC UK cable crossing (CC02) comprised sandy gravel and cobbles. Fauna observed included soft coral (*Alcyonium digitatum*), whelks (Buccinidae), hermit crabs (Paguridae) and tube worms (Serpulidae).

The seabed at the western HVDC Port Grenaugh cable crossing (CC03) comprised sand, gravel and cobbles with a high density of shell fragments. Fauna recorded included soft coral (*Alcyonium digitatum*), feather star (Crinoidea), starfish (*Asterias rubens*) and tube worms (Serpulidae).

The seabed at the western HVDC Port Erin cable crossing (CC04) comprised sandy mud. Fauna recorded included ross worm (*Sabellaria spinulosa*), faunal turf (Hydrozoa/Bryozoa), soft coral (*Alcyonium digitatum*), scallops (Pectininae), hermit crabs (Paguridae), brittlestars (Ophiuroidea) and sea squirts (Ascidiacea).

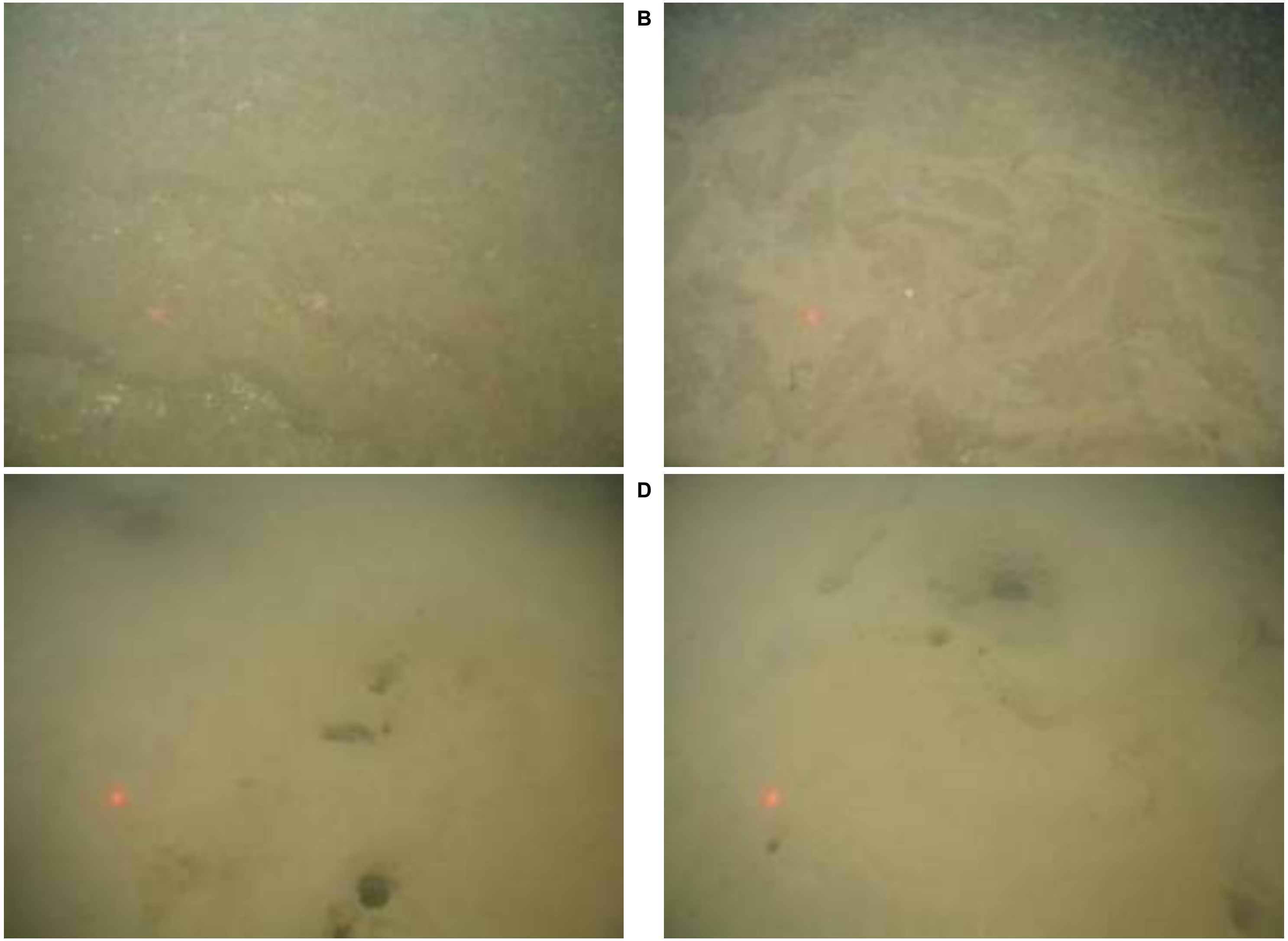
The seabed at the interconnecter cable crossing (CC05) comprised mud with faunal burrows. Fauna recorded included lesser-spotted catshark (*Scyliorhinus canicula*), tube worms (Polychaeta), hermit crabs (Paguridae) and Norway lobster (*Nephrops norvegicus*). The drop-down station, CC05_ST01, located 300 m from the interconnector cable similarly comprised mud with faunal burrows and included hermit crabs (Paguridae) and tube worms (Polychaeta).

Figure 4.5 presents example seabed sediment photographs from the cable crossings.

4.2.6 Potentially Sensitive Habitats or Species

Burrows and sea pens, areas of cobbles and boulders, and *Sabellaria spinulosa* were observed within the survey area. The potential presence of the OSPAR (2008) habitat ‘Sea pens and burrowing megafauna' and the Annex I habitats 'stony reef' and 'biogenic reef' will be further assessed in the habitat assessment report.

A B C D



A: Photograph LS_ST03_22

Sediment description: Sandy mud/muddysand

Fauna description: No visible fauna

B: Photograph LS_ST04_19
Sediment description: Mud

Fauna description: No visible fauna

C: Photograph LS_ST05_09

Sediment description: Mud

Fauna description: No visible fauna, faunal burrows

D: Photograph LS_ST05_11

Sediment description: Mud

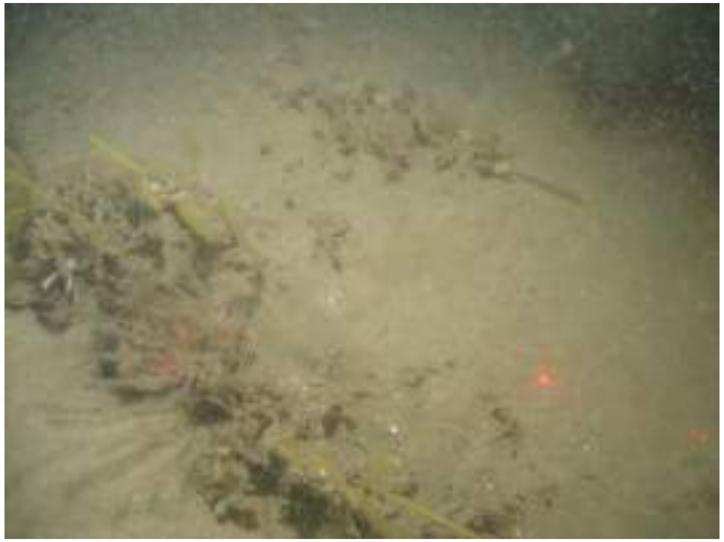
Fauna description: No visible fauna, faunal burrows

Figure 4.1: Example seabed sediment photographs, Loughshinny

A

B

C



D

A: Photograph PE_ST05_15

Sediment description: Rippled sand with cobbles

Fauna description: Anemone (Actiniaria)

B: Photograph PE_ST06_14

Sediment description: Gravelly sand

Fauna description: Scallop (Pectininae), hermit crab (Paguridae), brittlestar (Ophiuroidea)

C: Photograph PE_ST07_11

Sediment description: Muddy sand / sandy mud

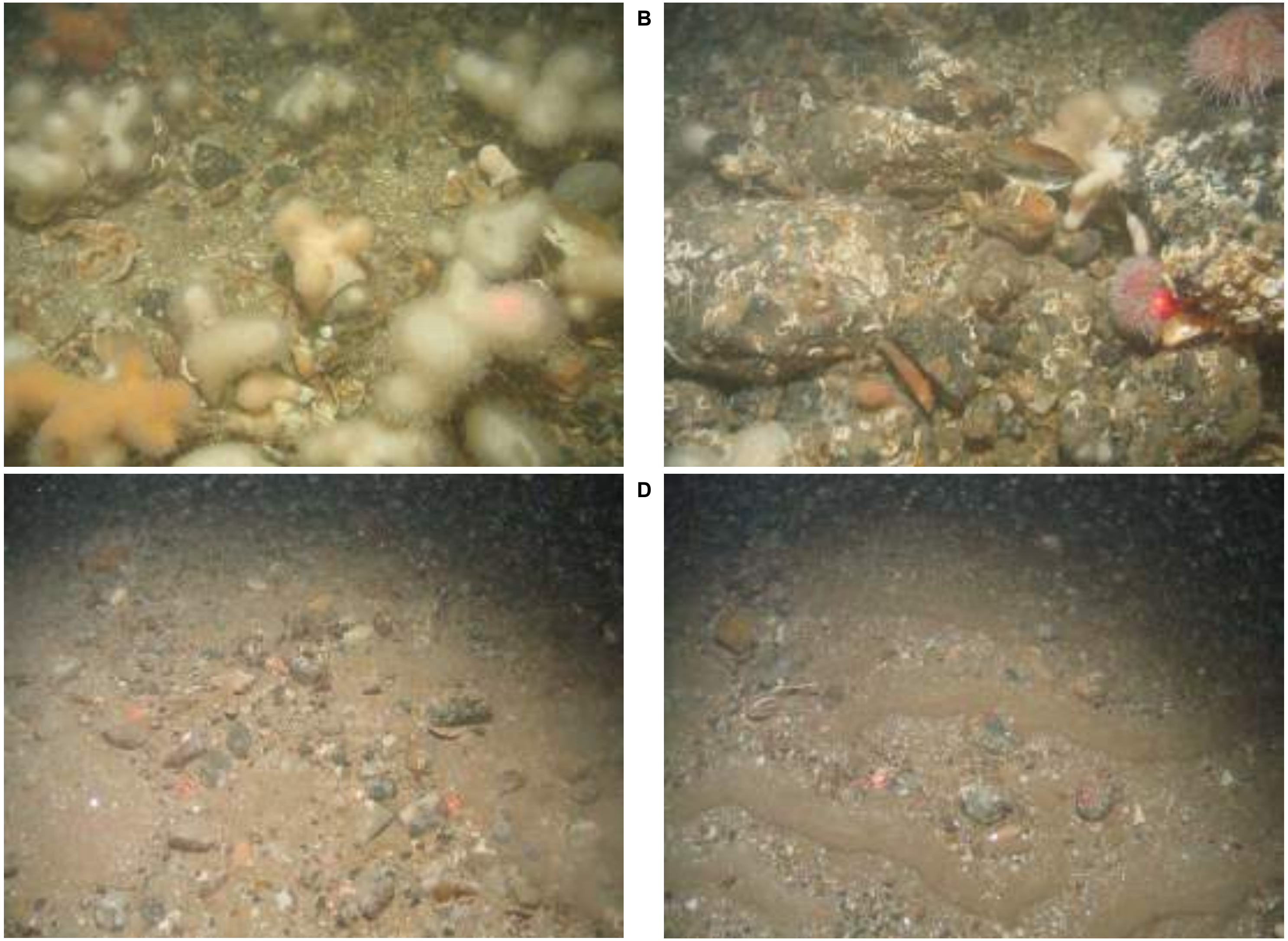
Fauna description: Ross worm (*Sabellaria spinulosa*), hydroids (Plumulariidae), squat lobster (Galatheoidea)

D: Photograph PE_ST09A_07

Sediment description: Sandy mud/ muddy sand
Fauna description: Hermit crab (Paguridae), brittlestar (Ophiuroidea)

Figure 4.2: Example seabed sediment photographs, Port Erin

A B C D



A: Photograph PG_ST05_06

Sediment description: Mixed sediment with cobbles and shell fragments
Fauna description: Soft coral (*Alcyonium digitatum*), brittlestar (Ophiuroidea)

B: Photograph PG_ST05_12

Sediment description: Mixed sediment with cobbles, boulders and shell fragments
Fauna description: Sea urchin (*Echinus esculentus*), soft coral (*Alcyonium digitatum*), tube worms (Serpulidae), faunal turf (Hydrozoa/Bryozoa)

C: Photograph PG_ST07_012

Sediment description: Gravelly sand and cobbles
Fauna description: Faunal turf (Hydrozoa/Bryozoa)

D: Photograph PG_ST07_015

Sediment description: Rippled gravelly sand and cobbles
Fauna description: Faunal turf (including Bryozoa), tube worms (Serpulidae)

Figure 4.3: Example seabed sediment photographs, Port Grenaugh

A

B

C

D

A: Photograph SGST09A_007

Sediment description: Muddy sand/ sandymud
Fauna description: No visible fauna

B: Photograph SG_ST11_17

Sediment description: Sand and boulders

Fauna description: Soft coral (*Alcyonium digitatum*), starfish (*Asterias rubens*), faunal turf (Hydrozoa/Bryozoa)

C: Photograph SG_ST11_23

Sediment description: Sand and boulders

Fauna description: Whelk and eggs (*Buccinum undatum*), faunal turf (Hydrozoa/Bryozoa), bryozoan (Flustridae), barnacles (Balanidae), tube worms (Serpulidae)

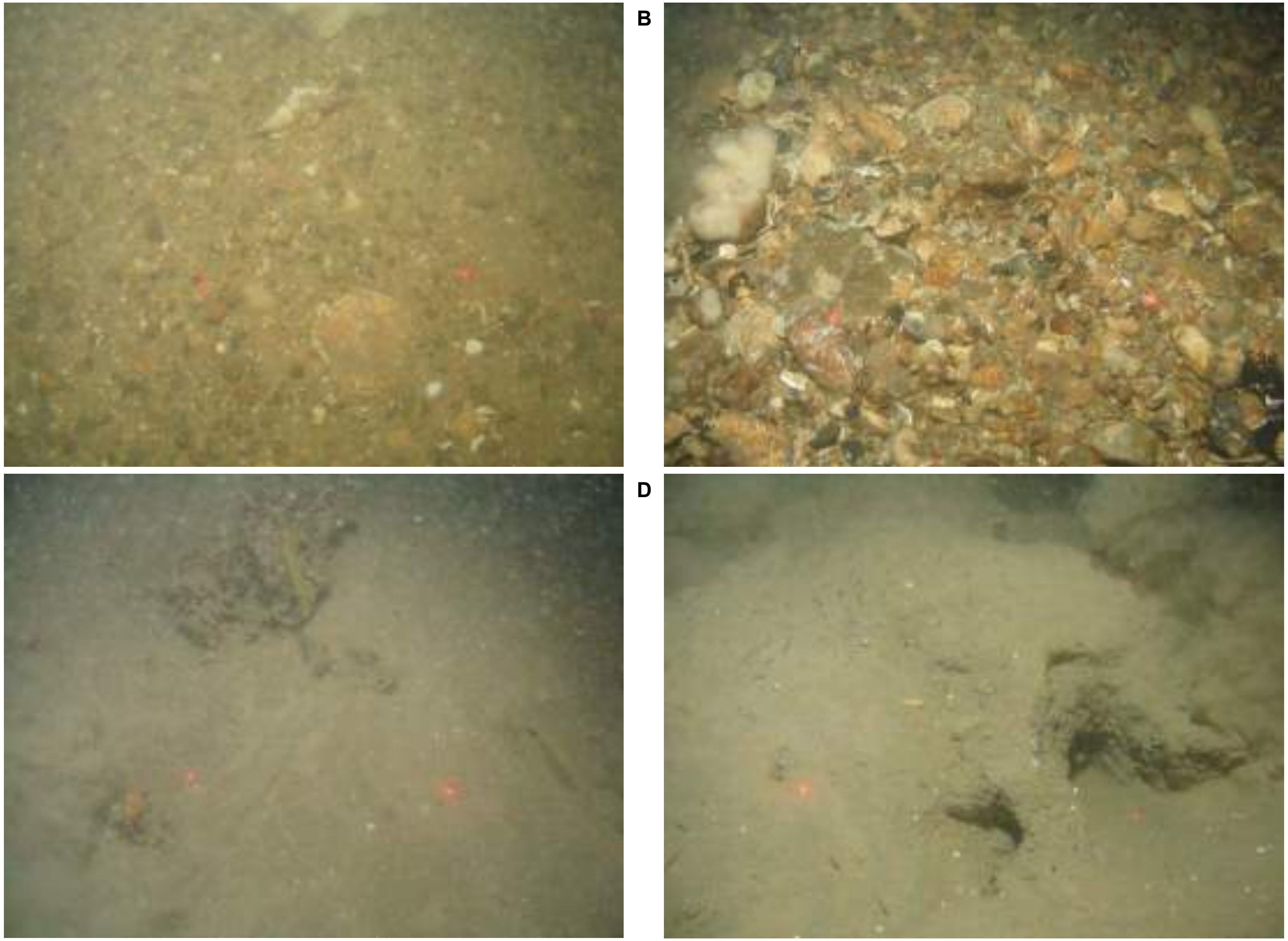
D: Photograph SG_ST12B_11

Sediment description: Gravelly sand and cobbles

Fauna description: Soft coral (*Alcyonium digitatum*), tube worms (Serpulidae), starfish (*Crossaster papposus*)

Figure 4.4: Example seabed sediment photographs, Squires Gate Lane

A B C D



A: Photograph CC02_T01_26

Sediment description: Mixed sediment with cobbles and shells

Fauna description: Hermit crab (Paguridae), soft coral (*Alcyonium digitatum*), brittlestar (Ophiuroidea)

B: Photograph CC03_T01_03

Sediment description: Mixed sediment with cobbles and shells

Fauna description: Soft coral (*Alcyonium digitatum*)

C: Photograph CC04_T01_27

Sediment description: Sandy mud/ muddy sand

Fauna description: Ross worm (*Sabellaria spinulosa*), hydroid (*Nermertesia antennina*), sea squirt (Ascidiacea), scallop (Pectininae)

D: Photograph CC05_T01A_03

Sediment description: Mud
Fauna description: No visible fauna, faunal burrows

Figure 4.5: Example seabed sediment photographs, cable crossings

5. REFERENCES

Oslo and Paris Convention (OSPAR), 2008. *OSPAR List of Threatened and/or Declining Species and Habitats*. Reference Number 2008-06. OSPAR Commission.

APPENDICES

A. GUIDELINES ON USE OF REPORT

This report (the “Report”) was prepared as part of the services (the “Services”) provided by Fugro GB Marine Limited (“Fugro”) for its client (the “Client”) under terms of the relevant contract between the two parties (the “Contract”). The Services were performed by Fugro based on requirements of the Client set out in the Contract or otherwise made known by the Client to Fugro at the time.

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B. LOGS

B.1 SURVEY LOG

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
11/02/2019	18:49:02	PG_ST06	Still	181275_PG_ST06_01								Site slate, laser distance 17.7 cm, transect aborted
11/02/2019	20:52:20	PG_ST06A	Still	181275_PG_ST06A_01								Site slate
11/02/2019	20:58:44	PG_ST06A	Video	SOL	7	61	403 761	5 966 746	403 605.1	5 966 710.3	160	
11/02/2019	20:58:44	PG_ST06A	Still	181275_PG_ST06A_02	7		403 761	5 966 746	403 605.1	5 966 710.3	160	
11/02/2019	21:05:09	PG_ST06A	Still	181275_PG_ST06A_03	8		403 761	5 966 746	403 772.3	5 966 736.2	15	
11/02/2019	21:05:36	PG_ST06A	Still	181275_PG_ST06A_04	9		403 761	5 966 746	403 783.4	5 966 738.0	24	
11/02/2019	21:06:02	PG_ST06A	Still	181275_PG_ST06A_05	10		403 761	5 966 746	403 794.5	5 966 740.0	34	
11/02/2019	21:06:21	PG_ST06A	Still	181275_PG_ST06A_06	11		403 761	5 966 746	403 802.3	5 966 741.2	42	
11/02/2019	21:06:41	PG_ST06A	Still	181275_PG_ST06A_07	12		403 761	5 966 746	403 810.7	5 966 741.9	50	
11/02/2019	21:06:58	PG_ST06A	Still	181275_PG_ST06A_08	13	61	403 761	5 966 746	403 817.8	5 966 741.6	57	
11/02/2019	21:06:58	PG_ST06A	Video	EOL	13	61	403 761	5 966 746	403 817.8	5 966 741.6	57	
11/02/2019	21:20:28	PG_ST06B	Still	181275_PG_ST06B_01								Site slate, aborted due to cable wrapping around winch wire
12/02/2019	07:35:30	SG_ST03	Still	181275_SG_ST03_01								Site slate, aborted due to no visibility
12/02/2019	08:05:53	SG_ST03	Video	SOL	16	12	490 992	5 956 765	490 862.3	5 956 746.2	131	
12/02/2019	08:05:53	SG_ST03	Still	181275_SG_ST03_02	16	12	490 992	5 956 765	490 862.3	5 956 746.2	131	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
12/02/2019	08:06:03	SG_ST03A	Still	181275_SG_ST03A_01								Site slate, freshwater lens
12/02/2019	08:09:16	SG_ST03A	Still	181275_SG_ST03A_02	18	11	490 992	5 956 765	490 949.8	5 956 746.7	46	
12/02/2019	08:10:24	SG_ST03A	Still	181275_SG_ST03A_03	19		490 992	5 956 765	490 977.5	5 956 753.4	19	
12/02/2019	08:10:45	SG_ST03A	Still	181275_SG_ST03A_04	20		490 992	5 956 765	490 984.6	5 956 754.2	13	
12/02/2019	08:11:30	SG_ST03A	Still	181275_SG_ST03A_05	21		490 992	5 956 765	490 997.3	5 956 756.1	10	
12/02/2019	08:11:30	SG_ST03A	Video	EOL	21	11	490 992	5 956 765	490 997.3	5 956 756.1	10	
12/02/2019	09:07:20	SG_ST04	Still	181275_SG_ST04_01								Site slate, freshwater lens, aborted due to vessel drifting in wrong direction
12/02/2019	09:11:19	SG_ST04	Still	181275_SG_ST04_02	24	13	488 536	5 956 774	488 618.2	5 956 833.3	101	
12/02/2019	09:18:21	SG_ST04A	Still	181275_SG_ST04A_01								Site slate, freshwater lens
12/02/2019	09:20:02	SG_ST04A	Video	SOL	26	13	488 536	5 956 774	488 549.0	5 956 737.2	39	
12/02/2019	09:20:02	SG_ST04A	Still	181275_SG_ST04A_02	26		488 536	5 956 774	488 549.0	5 956 737.2	39	
12/02/2019	09:21:28	SG_ST04A	Still	181275_SG_ST04A_03	27		488 536	5 956 774	488 551.6	5 956 744.5	33	
12/02/2019	09:22:31	SG_ST04A	Still	181275_SG_ST04A_04	28		488 536	5 956 774	488 550.8	5 956 751.6	27	
12/02/2019	09:23:06	SG_ST04A	Still	181275_SG_ST04A_05	29		488 536	5 956 774	488 548.9	5 956 755.6	23	
12/02/2019	09:23:24	SG_ST04A	Still	181275_SG_ST04A_06	30		488 536	5 956 774	488 547.6	5 956 758.6	19	
12/02/2019	09:24:25	SG_ST04A	Still	181275_SG_ST04A_07	31		488 536	5 956 774	488 544.3	5 956 767.3	11	
12/02/2019	09:24:47	SG_ST04A	Still	181275_SG_ST04A_08	32		488 536	5 956 774	488 543.9	5 956 770.9	9	
12/02/2019	09:25:22	SG_ST04A	Still	181275_SG_ST04A_09	33		488 536	5 956 774	488 543.1	5 956 776.0	7	
12/02/2019	09:25:56	SG_ST04A	Still	181275_SG_ST04A_10	34		488 536	5 956 774	488 542.0	5 956 781.5	10	
12/02/2019	09:26:18	SG_ST04A	Still	181275_SG_ST04A_11	35		488 536	5 956 774	488 542.4	5 956 784.4	12	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
12/02/2019	09:27:04	SG_ST04A	Still	181275_SG_ST04A_12	36		488 536	5 956 774	488 542.7	5 956 790.3	18	
12/02/2019	09:27:33	SG_ST04A	Still	181275_SG_ST04A_13	37		488 536	5 956 774	488 543.3	5 956 794.5	22	
12/02/2019	09:28:09	SG_ST04A	Still	181275_SG_ST04A_14	38		488 536	5 956 774	488 542.6	5 956 800.1	27	
12/02/2019	09:29:34	SG_ST04A	Still	181275_SG_ST04A_15	39		488 536	5 956 774	488 540.3	5 956 812.4	39	
12/02/2019	09:30:12	SG_ST04A	Still	181275_SG_ST04A_16	40		488 536	5 956 774	488 540.3	5 956 819.1	45	
12/02/2019	09:30:12	SG_ST04A	Video	EOL	40	13	488 536	5 956 774	488 540.3	5 956 819.1	45	
12/02/2019	10:00:23	SG_ST05	Still	181275_SG_ST05_01								Site slate, freshwater lens
12/02/2019	10:05:26	SG_ST05	Video	SOL	42	13	483 918	5 956 544	483 935.5	5 956 513.0	36	
12/02/2019	10:05:26	SG_ST05	Still	181275_SG_ST05_02	42		483 918	5 956 544	483 935.5	5 956 513.0	36	
12/02/2019	10:05:58	SG_ST05	Still	181275_SG_ST05_03	43		483 918	5 956 544	483 942.0	5 956 520.3	34	
12/02/2019	10:06:27	SG_ST05	Still	181275_SG_ST05_04	44		483 918	5 956 544	483 947.2	5 956 526.5	34	
12/02/2019	10:06:49	SG_ST05	Still	181275_SG_ST05_05	45		483 918	5 956 544	483 951.2	5 956 530.9	36	
12/02/2019	10:06:49	SG_ST05	Still	181275_SG_ST05_05	45		483 918	5 956 544	483 951.2	5 956 530.9	36	
12/02/2019	10:06:49	SG_ST05	Video	EOL	45		483 918	5 956 544	483 951.2	5 956 530.9	36	
12/02/2019	11:12:00	SG_ST03	DVV	NS/NS	-	11	490 992	5 956 765	491 023.0	5 956 781.9	35	
12/02/2019	11:35:00	SG_ST03	DVV	PC/FA	-	11	490 992	5 956 765	491 018.6	5 956 770.8	27	
15/02/2019	15:41:00	PG_ST07	Still	181275_PG_ST07_001								Site slate
15/02/2019	15:54:30	PG_ST07	Video	SOL	2	56	409 841	5 966 414	409 893.7	5 966 413.8	53	
15/02/2019	15:54:30	PG_ST07	Still	181275_PG_ST07_002	2		409 841	5 966 414	409 893.7	5 966 413.8	53	
15/02/2019	15:54:46	PG_ST07	Still	181275_PG_ST07_003	3		409 841	5 966 414	409 890.8	5 966 410.4	50	
15/02/2019	15:54:57	PG_ST07	Still	181275_PG_ST07_004	4		409 841	5 966 414	409 888.8	5 966 409.0	48	
15/02/2019	15:55:17	PG_ST07	Still	181275_PG_ST07_005	5		409 841	5 966 414	409 883.9	5 966 408.3	43	
15/02/2019	15:55:36	PG_ST07	Still	181275_PG_ST07_006	6		409 841	5 966 414	409 880.2	5 966 410.8	39	
15/02/2019	15:55:51	PG_ST07	Still	181275_PG_ST07_007	7		409 841	5 966 414	409 877.0	5 966 412.8	36	
15/02/2019	15:56:24	PG_ST07	Still	181275_PG_ST07_008	8		409 841	5 966 414	409 865.5	5 966 415.0	25	
15/02/2019	15:56:38	PG_ST07	Still	181275_PG_ST07_009	9		409 841	5 966 414	409 860.4	5 966 416.7	20	
15/02/2019	15:56:58	PG_ST07	Still	181275_PG_ST07_010	10		409 841	5 966 414	409 857.0	5 966 419.4	17	
15/02/2019	15:57:13	PG_ST07	Still	181275_PG_ST07_011	11		409 841	5 966 414	409 855.5	5 966 421.9	17	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
15/02/2019	15:57:45	PG_ST07	Still	181275_PG_ST07_012	12		409 841	5 966 414	409 850.8	5 966 425.2	15	
15/02/2019	15:57:59	PG_ST07	Still	181275_PG_ST07_013	13		409 841	5 966 414	409 846.2	5 966 423.0	10	
15/02/2019	15:58:30	PG_ST07	Still	181275_PG_ST07_014	14		409 841	5 966 414	409 831.4	5 966 414.8	10	
15/02/2019	15:58:40	PG_ST07	Still	181275_PG_ST07_015	15		409 841	5 966 414	409 827.1	5 966 412.1	14	
15/02/2019	15:59:02	PG_ST07	Still	181275_PG_ST07_016	16		409 841	5 966 414	409 819.2	5 966 406.4	23	
15/02/2019	15:59:02	PG_ST07	Video	EOL	16	54	409 841	5 966 414	409 819.2	5 966 406.4	23	
16/02/2019	05:57:41	SG_ST04	DVV	NS/NS	20	16	488 536	5 956 774	488 534.5	5 956 746.0	28	
16/02/2019	06:12:43	SG_ST04	DVV	PC/FA	21	16	488 536	5 956 774	488 563.9	5 956 752.7	35	
16/02/2019	06:58:40	SG_ST04	DVV	FB	22	16	488 536	5 956 774	488 545.7	5 956 801.5	29	
16/02/2019	07:25:07	SG_ST03	DVV	FB	23	15	490 992	5 956 765	490 983.4	5 956 749.7	17	
16/02/2019	08:48:48	SG_ST05A	Still	181275_SG_ST05A_001								Site slate
16/02/2019	08:52:31	SG_ST05A	Still	181275_SG_ST05A_002	25	18	483 918	5 956 544	483 881.2	5 956 542.4	37	Transect aborted due to visibility
16/02/2019	09:20:36	SG_ST05B	Still	181275_SG_ST05B_001								Site slate, freshwater lens
16/02/2019	09:27:53	SG_ST05B	Video	SOL	27	18	483 918	5 956 544	483 911.6	5 956 488.8	56	
16/02/2019	09:27:53	SG_ST05B	Still	181275_SG_ST05B_002	27		483 918	5 956 544	483 911.6	5 956 488.8	56	
16/02/2019	09:28:50	SG_ST05B	Still	181275_SG_ST05B_003	28		483 918	5 956 544	483 905.0	5 956 498.6	47	
16/02/2019	09:29:41	SG_ST05B	Still	181275_SG_ST05B_004	29		483 918	5 956 544	483 897.4	5 956 507.7	42	
16/02/2019	09:29:54	SG_ST05B	Still	181275_SG_ST05B_005	30		483 918	5 956 544	483 895.3	5 956 509.4	42	
16/02/2019	09:31:00	SG_ST05B	Still	181275_SG_ST05B_006	31		483 918	5 956 544	483 899.8	5 956 517.2	33	
16/02/2019	09:31:50	SG_ST05B	Still	181275_SG_ST05B_007	32		483 918	5 956 544	483 904.2	5 956 520.2	28	
16/02/2019	09:32:36	SG_ST05B	Still	181275_SG_ST05B_008	33		483 918	5 956 544	483 903.8	5 956 526.3	23	
16/02/2019	09:32:53	SG_ST05B	Still	181275_SG_ST05B_009	34		483 918	5 956 544	483 903.6	5 956 529.4	21	
16/02/2019	09:33:40	SG_ST05B	Still	181275_SG_ST05B_010	35		483 918	5 956 544	483 900.2	5 956 537.8	19	
16/02/2019	09:34:10	SG_ST05B	Still	181275_SG_ST05B_011	36		483 918	5 956 544	483 897.1	5 956 542.6	21	
16/02/2019	09:34:33	SG_ST05B	Still	181275_SG_ST05B_012	37		483 918	5 956 544	483 893.3	5 956 547.2	25	
16/02/2019	09:35:18	SG_ST05B	Still	181275_SG_ST05B_013	38		483 918	5 956 544	483 886.2	5 956 556.3	34	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
16/02/2019	09:35:18	SG_ST05B	Video	EOL	38	18	483 918	5 956 544	483 886.2	5 956 556.3	34	
16/02/2019	10:00:53	SG_ST05	DVV	FA/NS	39	17	483 918	5 956 544	483 892.7	5 956 525.2	32	
16/02/2019	10:16:56	SG_ST05	DVV	PC/NS	40	17	483 918	5 956 544	483 924.8	5 956 493.3	51	
16/02/2019	10:31:12	SG_ST05	DVV	NS/NS	41	16	483918	5 956 544	483 875.9	5 956 521.3	48	
16/02/2019	10:48:41	SG_ST05	DVV	FB	42	16	483 918	5 956 544	483 915.1	5 956 564.8	21	
16/02/2019	11:37:07	SG_ST06	Still	181275_SG_ST06_001								Site slate
16/02/2019	11:42:40	SG_ST06	Video	SOL	44	20	480 913	5 956 334	480 876.0	5 956 338.0	37	
16/02/2019	11:42:40	SG_ST06	Still	181275_SG_ST06_002	44		480 913	5 956 334	480 876.0	5 956 338.0	37	
16/02/2019	11:42:55	SG_ST06	Still	181275_SG_ST06_003	45		480 913	5 956 334	480 876.6	5 956 338.8	37	
16/02/2019	11:43:23	SG_ST06	Still	181275_SG_ST06_004	46		480 913	5 956 334	480 880.2	5 956 340.7	34	
16/02/2019	11:43:48	SG_ST06	Still	181275_SG_ST06_005	47		480 913	5 956 334	480 886.4	5 956 341.4	28	
16/02/2019	11:44:07	SG_ST06	Still	181275_SG_ST06_006	48		480 913	5 956 334	480 890.8	5 956 343.2	24	
16/02/2019	11:44:21	SG_ST06	Still	181275_SG_ST06_007	49		480 913	5 956 334	480 894.6	5 956 344.2	21	
16/02/2019	11:44:47	SG_ST06	Still	181275_SG_ST06_008	50		480 913	5 956 334	480 903.3	5 956 345.3	15	
16/02/2019	11:45:36	SG_ST06	Still	181275_SG_ST06_009	51		480 913	5 956 334	480 914.2	5 956 346.9	13	
16/02/2019	11:45:57	SG_ST06	Still	181275_SG_ST06_010	52		480 913	5 956 334	480 917.8	5 956 346.3	13	
16/02/2019	11:46:16	SG_ST06	Still	181275_SG_ST06_011	53		480 913	5 956 334	480 920.8	5 956 345.5	14	
16/02/2019	11:46:51	SG_ST06	Still	181275_SG_ST06_012	54		480 913	5 956 334	480 924.4	5 956 345.1	16	
16/02/2019	11:47:12	SG_ST06	Still	181275_SG_ST06_013	55		480 913	5 956 334	480 926.6	5 956 344.1	17	
16/02/2019	11:47:30	SG_ST06	Still	181275_SG_ST06_014	56		480 913	5 956 334	480 927.2	5 956 345.0	18	
16/02/2019	11:47:51	SG_ST06	Still	181275_SG_ST06_015	57		480 913	5 956 334	480 928.9	5 956 344.5	19	
16/02/2019	11:48:10	SG_ST06	Still	181275_SG_ST06_016	58		480 913	5 956 334	480 930.2	5 956 344.1	20	
16/02/2019	11:48:55	SG_ST06	Still	181275_SG_ST06_017	59		480 913	5 956 334	480 934.9	5 956 343.7	24	
16/02/2019	11:49:52	SG_ST06	Still	181275_SG_ST06_018	60		480 913	5 956 334	480 939.4	5 956 344.2	28	
16/02/2019	11:50:12	SG_ST06	Still	181275_SG_ST06_019	61		480 913	5 956 334	480 940.6	5 956 344.4	30	
16/02/2019	11:50:43	SG_ST06	Still	181275_SG_ST06_020	62		480 913	5 956 334	480 944.1	5 956 344.0	33	
16/02/2019	11:51:16	SG_ST06	Still	181275_SG_ST06_021	63		480 913	5 956 334	480 945.8	5 956 345.2	35	
16/02/2019	11:51:37	SG_ST06	Still	181275_SG_ST06_022	64		480 913	5 956 334	480 947.2	5 956 345.2	36	
16/02/2019	11:52:37	SG_ST06	Still	181275_SG_ST06_023	65		480 913	5 956 334	480 955.0	5 956 344.1	43	
16/02/2019	11:52:37	SG_ST06	Video	EOL	65	19	480 913	5 956 334	480 955.0	5 956 344.1	43	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
16/02/2019	12:22:24	SG_ST07A	Still	181275_SG_ST07A_001								Site slate
16/02/2019	12:33:05	SG_ST07A	Video	SOL	67	23	477 859	5 956 185	477 838.3	5 956 142.7	47	
16/02/2019	12:33:05	SG_ST07A	Still	181275_SG_ST07A_002	67		477 859	5 956 185	477 838.3	5 956 142.7	47	
16/02/2019	12:33:43	SG_ST07A	Still	181275_SG_ST07A_003	68		477 859	5 956 185	477 844.5	5 956 142.8	45	
16/02/2019	12:34:19	SG_ST07A	Still	181275_SG_ST07A_004	69		477 859	5 956 185	477 850.3	5 956 143.1	43	
16/02/2019	12:34:46	SG_ST07A	Still	181275_SG_ST07A_005	70		477 859	5 956 185	477 854.5	5 956 143.8	42	
16/02/2019	12:35:21	SG_ST07A	Still	181275_SG_ST07A_006	71		477 859	5 956 185	477 859.8	5 956 145.1	40	
16/02/2019	12:35:44	SG_ST07A	Still	181275_SG_ST07A_007	72		477 859	5 956 185	477 863.3	5 956 146.0	39	
16/02/2019	12:36:19	SG_ST07A	Still	181275_SG_ST07A_008	73		477 859	5 956 185	477 868.5	5 956 145.4	41	
16/02/2019	12:36:38	SG_ST07A	Still	181275_SG_ST07A_009	74		477 859	5 956 185	477 871.8	5 956 145.9	41	
16/02/2019	12:37:26	SG_ST07A	Still	181275_SG_ST07A_010	75		477 859	5 956 185	477 878.7	5 956 146.6	43	
16/02/2019	12:38:12	SG_ST07A	Still	181275_SG_ST07A_011	76		477 859	5 956 185	477 885.3	5 956 147.3	46	
16/02/2019	12:39:08	SG_ST07A	Still	181275_SG_ST07A_012	77		477 859	5 956 185	477 892.7	5 956 149.7	49	
16/02/2019	12:39:08	SG_ST07A	Video	EOL	77	22	477 859	5 956 185	477 892.7	5 956 149.7	49	
16/02/2019	13:40:47	SG_ST08	Still	181275_SG_ST08_001								Site slate, laser distance changed 19.5 cm
16/02/2019	13:56:21	SG_ST08	Video	SOL	79	34	464 565	5 955 053	464 552.7	5 955 067.0	19	
16/02/2019	13:56:21	SG_ST08	Still	181275_SG_ST08_002	79		464 565	5 955 053	464 552.7	5 955 067.0	19	
16/02/2019	13:56:54	SG_ST08	Still	181275_SG_ST08_003	80		464 565	5 955 053	464 554.2	5 955 067.7	18	
16/02/2019	13:57:09	SG_ST08	Still	181275_SG_ST08_004	81		464 565	5 955 053	464 554.8	5 955 067.5	18	
16/02/2019	13:57:41	SG_ST08	Still	181275_SG_ST08_005	82		464 565	5 955 053	464 557.3	5 955 066.1	15	
16/02/2019	13:58:16	SG_ST08	Still	181275_SG_ST08_006	83		464 565	5 955 053	464 561.3	5 955 064.4	12	
16/02/2019	13:58:55	SG_ST08	Still	181275_SG_ST08_007	84		464 565	5 955 053	464 568.7	5 955 065.0	13	
16/02/2019	13:59:32	SG_ST08	Still	181275_SG_ST08_008	85		464 565	5 955 053	464 578.9	5 955 070.6	22	
16/02/2019	13:59:56	SG_ST08	Still	181275_SG_ST08_009	86		464 565	5 955 053	464 586.2	5 955 074.2	30	
16/02/2019	14:00:16	SG_ST08	Still	181275_SG_ST08_010	87		464 565	5 955 053	464 592.1	5 955 076.5	36	
16/02/2019	14:00:37	SG_ST08	Still	181275_SG_ST08_011	88		464 565	5 955 053	464 597.9	5 955 079.4	42	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
16/02/2019	14:00:59	SG_ST08	Still	181275_SG_ST08_012	89		464 565	5 955 053	464 603.7	5 955 081.5	48	
16/02/2019	14:01:13	SG_ST08	Still	181275_SG_ST08_013	90		464 565	5 955 053	464 606.8	5 955 083.0	52	
16/02/2019	14:01:32	SG_ST08	Still	181275_SG_ST08_014	91		464 565	5 955 053	464 611.2	5 955 085.1	56	
16/02/2019	14:01:42	SG_ST08	Still	181275_SG_ST08_015	92		464 565	5 955 053	464 612.9	5 955 086.0	58	
16/02/2019	14:01:42	SG_ST08	Video	EOL	92	35	464 565	5 955 053	464 612.9	5 955 086.0	58	
16/02/2019	14:47:16	SG_ST09	Still	181275_SG_ST09_001	93		454 309	5 956 330	454 394.9	5 956 083.6		Site slate, transect aborted 3/4 across the site by deployment
16/02/2019	15:12:42	SG_ST09A	Still	181275_SG_ST09A_001								Site slate
16/02/2019	15:25:20	SG_ST09A	Video	SOL	95	41	454 309	5 956 330	454 319.5	5 956 373.8	45	
16/02/2019	15:25:20	SG_ST09A	Still	181275_SG_ST09A_002	95		454 309	5 956 330	454 319.5	5 956 373.8	45	
16/02/2019	15:25:55	SG_ST09A	Still	181275_SG_ST09A_003	96		454 309	5 956 330	454 316.4	5 956 374.4	45	
16/02/2019	15:26:07	SG_ST09A	Still	181275_SG_ST09A_004	97		454 309	5 956 330	454 316.2	5 956 373.0	44	
16/02/2019	15:27:13	SG_ST09A	Still	181275_SG_ST09A_005	98		454 309	5 956 330	454 312.4	5 956 348.0	18	
16/02/2019	15:27:43	SG_ST09A	Still	181275_SG_ST09A_006	99		454 309	5 956 330	454 311.2	5 956 332.1	3	
16/02/2019	15:28:07	SG_ST09A	Still	181275_SG_ST09A_007	100		454 309	5 956 330	454 309.2	5 956 324.8	5	
16/02/2019	15:28:20	SG_ST09A	Still	181275_SG_ST09A_008	101		454 309	5 956 330	454 307.4	5 956 322.0	8	
16/02/2019	15:28:33	SG_ST09A	Still	181275_SG_ST09A_009	102		454 309	5 956 330	454 306.2	5 956 320.0	10	
16/02/2019	15:28:56	SG_ST09A	Still	181275_SG_ST09A_010	103		454 309	5 956 330	454 304.1	5 956 318.5	13	
16/02/2019	15:29:21	SG_ST09A	Still	181275_SG_ST09A_011	104		454 309	5 956 330	454 301.2	5 956 318.9	14	
16/02/2019	15:29:50	SG_ST09A	Still	181275_SG_ST09A_012	106		454 309	5 956 330	454 294.9	5 956 318.8	18	
16/02/2019	15:30:01	SG_ST09A	Still	181275_SG_ST09A_013	107		454 309	5 956 330	454 291.6	5 956 318.0	21	
16/02/2019	15:30:22	SG_ST09A	Still	181275_SG_ST09A_014	108		454 309	5 956 330	454 286.6	5 956 313.5	28	
16/02/2019	15:30:56	SG_ST09A	Still	181275_SG_ST09A_015	109		454 309	5 956 330	454 279.8	5 956 303.8	39	
16/02/2019	15:31:04	SG_ST09A	Still	181275_SG_ST09A_016	110		454 309	5 956 330	454 278.8	5 956 301.5	42	
16/02/2019	15:31:28	SG_ST09A	Still	181275_SG_ST09A_017	111		454 309	5 956 330	454 275.7	5 956 296.4	47	
16/02/2019	15:31:28	SG_ST09A	Video	EOL	111	41	454 309	5 956 330	454 275.7	5 956 296.4	47	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
16/02/2019	17:57:01	SG_ST10	Still	181275_SG_ST10_001								Site slate
16/02/2019	18:17:04	SG_ST10	Video	SOL	113	44	436 745	5 960 253	436 759.3	5 960 253.0	14	
16/02/2019	18:17:04	SG_ST10	Still	181275_SG_ST10_002	113		436 745	5 960 253	436 759.3	5 960 253.0	14	
16/02/2019	18:17:18	SG_ST10	Still	181275_SG_ST10_003	114		436 745	5 960 253	436 753.6	5 960 253.0	9	
16/02/2019	18:17:27	SG_ST10	Still	181275_SG_ST10_004	115		436 745	5 960 253	436 749.7	5 960 251.8	5	
16/02/2019	18:17:46	SG_ST10	Still	181275_SG_ST10_005	116		436 745	5 960 253	436 744.9	5 960 249.6	3	
16/02/2019	18:17:55	SG_ST10	Still	181275_SG_ST10_006	117		436 745	5 960 253	436 742.9	5 960 248.1	5	
16/02/2019	18:18:08	SG_ST10	Still	181275_SG_ST10_007	118		436 745	5 960 253	436 740.8	5 960 245.5	9	
16/02/2019	18:18:22	SG_ST10	Still	181275_SG_ST10_008	119		436 745	5 960 253	436 739.8	5 960 243.1	11	
16/02/2019	18:18:41	SG_ST10	Still	181275_SG_ST10_009	120		436 745	5 960 253	436 737.5	5 960 239.4	16	
16/02/2019	18:18:59	SG_ST10	Still	181275_SG_ST10_010	121		436 745	5 960 253	436 735.0	5 960 235.7	20	
16/02/2019	18:19:12	SG_ST10	Still	181275_SG_ST10_011	122		436 745	5 960 253	436 732.5	5 960 234.6	22	
16/02/2019	18:19:30	SG_ST10	Still	181275_SG_ST10_012	123		436 745	5 960 253	436 727.8	5 960 235.5	25	
16/02/2019	18:19:56	SG_ST10	Still	181275_SG_ST10_013	124		436 745	5 960 253	436 720.6	5 960 237.2	29	
16/02/2019	18:20:18	SG_ST10	Still	181275_SG_ST10_014	125		436 745	5 960 253	436 716.8	5 960 236.3	33	
16/02/2019	18:20:29	SG_ST10	Still	181275_SG_ST10_015	126		436 745	5 960 253	436 713.8	5 960 234.6	36	
16/02/2019	18:20:59	SG_ST10	Still	181275_SG_ST10_016	127		436 745	5 960 253	436 706.2	5 960 228.1	46	
16/02/2019	18:20:59	SG_ST10	Video	EOL	127	45	436 745	5 960 253	436 706.2	5 960 228.1	46	
16/02/2019	18:47:10	SG_ST10	DVV	FA/NS	128	44	436 745	5 960 253	436 751.6	5 960 253.8	7	
16/02/2019	19:06:30	SG_ST10	DVV	NS/NS	129	45	436 745	5 960 253	436 764.3	5 960 245.0	21	
16/02/2019	19:15:08	SG_ST10	DVV	FB/NS	130	45	436 745	5 960 253	436 731.6	5 960 248.4	14	
16/02/2019	19:33:48	SG_ST10	DVV	NS/NS	131	45	436 745	5 960 253	436 751.4	5 960 253.2	6	
16/02/2019	19:44:19	SG_ST10	DVV	NS/NS	132	45	436 745	5 960 253	436 762.9	5 960 259.4	19	
16/02/2019	21:14:22	SG_ST09	DVV	NS/NS	133	45	454 309	5 956 330	454 324.0	5 956 305.0	29	
16/02/2019	21:20:12	SG_ST09	DVV	NS/NS	134	45	454 309	5 956 330	454 257.9	5 956 333.4	51	
16/02/2019	21:32:06	SG_ST09	DVV	PC/NS	135	46	454 309	5 956 330	454 316.1	5 956 348.7	20	
16/02/2019	21:53:12	SG_ST09	DVV	FA/FB	136	45	454 309	5 956 330	454 297.9	5 956 346.5	20	
16/02/2019	22:56:05	SG_ST08	DVV	FA/PC	137	38	464 565	5 955 053	464 542.3	5 955 025.2	36	
16/02/2019	23:18:40	SG_ST08	DVV	FB	138	38	464 565	5 955 053	464 556.9	5 955 032.7	22	
17/02/2019	01:04:01	SG_ST07	DVV	NS/NS	139	22	477 859	5 956 185	477 822.5	5 956 183.6	37	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
17/02/2019	01:18:25	SG_ST07	DVV	PC/NS	140	22	477 859	5 956 185	477 806.2	5 956 172.2	54	
19/02/2019	11:25:49	SG_ST11	Still	181275_SG_ST11_01								Site slate
19/02/2019	11:30:25	SG_ST11	Video	SOL	143	48	429 261	5 962 373	429 217.0	5 962 389.3	47	
19/02/2019	11:30:25	SG_ST11	Still	181275_SG_ST11_02	143		429 261	5 962 373	429 217.0	5 962 389.3	47	
19/02/2019	11:31:02	SG_ST11	Still	181275_SG_ST11_03	144		429 261	5 962 373	429 226.1	5 962 389.6	39	
19/02/2019	11:31:11	SG_ST11	Still	181275_SG_ST11_04	145		429 261	5 962 373	429 228.8	5 962 388.5	36	
19/02/2019	11:31:28	SG_ST11	Still	181275_SG_ST11_05	146		429 261	5 962 373	429 233.6	5 962 385.7	30	
19/02/2019	11:31:47	SG_ST11	Still	181275_SG_ST11_06	147		429 261	5 962 373	429 237.8	5 962 382.9	25	
19/02/2019	11:32:12	SG_ST11	Still	181275_SG_ST11_07	148		429 261	5 962 373	429 240.6	5 962 380.3	22	
19/02/2019	11:32:29	SG_ST11	Still	181275_SG_ST11_08	149		429 261	5 962 373	429 241.7	5 962 379.1	20	
19/02/2019	11:32:52	SG_ST11	Still	181275_SG_ST11_09	150		429 261	5 962 373	429 243.5	5 962 379.3	19	
19/02/2019	11:33:08	SG_ST11	Still	181275_SG_ST11_10	151		429 261	5 962 373	429 244.8	5 962 379.7	18	
19/02/2019	11:33:27	SG_ST11	Still	181275_SG_ST11_11	152		429 261	5 962 373	429 246.6	5 962 381.5	17	
19/02/2019	11:33:45	SG_ST11	Still	181275_SG_ST11_12	153		429 261	5 962 373	429 248.6	5 962 383.3	16	
19/02/2019	11:34:00	SG_ST11	Still	181275_SG_ST11_13	154		429 261	5 962 373	429 250.7	5 962 385.5	16	
19/02/2019	11:34:17	SG_ST11	Still	181275_SG_ST11_14	155		429 261	5 962 373	429 252.3	5 962 387.2	17	
19/02/2019	11:34:36	SG_ST11	Still	181275_SG_ST11_15	156		429 261	5 962 373	429 254.0	5 962 389.7	18	
19/02/2019	11:34:54	SG_ST11	Still	181275_SG_ST11_16	157		429 261	5 962 373	429 255.4	5 962 391.6	19	
19/02/2019	11:35:09	SG_ST11	Still	181275_SG_ST11_17	158		429 261	5 962 373	429 256.7	5 962 393.1	21	
19/02/2019	11:35:27	SG_ST11	Still	181275_SG_ST11_18	159		429 261	5 962 373	429 258.4	5 962 394.7	22	
19/02/2019	11:35:43	SG_ST11	Still	181275_SG_ST11_19	160		429 261	5 962 373	429 259.7	5 962 396.0	23	
19/02/2019	11:36:02	SG_ST11	Still	181275_SG_ST11_20	161		429 261	5 962 373	429 261.7	5 962 397.2	24	
19/02/2019	11:36:23	SG_ST11	Still	181275_SG_ST11_21	162		429 261	5 962 373	429 264.8	5 962 397.8	25	
19/02/2019	11:36:40	SG_ST11	Still	181275_SG_ST11_22	163		429 261	5 962 373	429 266.3	5 962 396.9	25	
19/02/2019	11:36:53	SG_ST11	Still	181275_SG_ST11_23	164		429 261	5 962 373	429 267.3	5 962 395.3	23	
19/02/2019	11:38:06	SG_ST11	Still	181275_SG_ST11_24	165		429 261	5 962 373	429 267.8	5 962 390.1	18	
19/02/2019	11:38:31	SG_ST11	Still	181275_SG_ST11_25	166		429 261	5 962 373	429 269.2	5 962 389.5	18	
19/02/2019	11:39:28	SG_ST11	Still	181275_SG_ST11_26	167		429 261	5 962 373	429 267.6	5 962 398.4	26	
19/02/2019	11:39:45	SG_ST11	Still	181275_SG_ST11_27	168		429 261	5 962 373	429 266.9	5 962 402.7	30	
19/02/2019	11:40:31	SG_ST11	Still	181275_SG_ST11_28	169		429 261	5 962 373	429 264.0	5 962 416.1	43	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
19/02/2019	11:40:55	SG_ST11	Still	181275_SG_ST11_29	170		429 261	5 962 373	429 262.0	5 962 422.6	50	
19/02/2019	11:41:08	SG_ST11	Still	181275_SG_ST11_30	171		429 261	5 962 373	429 261.6	5 962 425.8	53	
19/02/2019	11:41:08	SG_ST11	Video	EOL	171	48	429 261	5 962 373	429 261.6	5 962 425.8	53	
19/02/2019	12:23:16	SG_ST12A	Still	181275_SG_ST12A_001								Site slate, transect aborted, Site over shot
19/02/2019	13:01:22	SG_ST12B	Still	181275_SG_ST12B_01								Site slate
19/02/2019	13:32:36	SG_ST12B	Video	SOL	174	54	414 096	5 966 135	414 057.5	5 966 119.0	42	
19/02/2019	13:32:36	SG_ST12B	Still	181275_SG_ST12B_02	174		414 096	5 966 135	414 057.5	5 966 119.0	42	
19/02/2019	13:33:10	SG_ST12B	Still	181275_SG_ST12B_03	175		414 096	5 966 135	414 062.8	5 966 115.1	39	
19/02/2019	13:33:20	SG_ST12B	Still	181275_SG_ST12B_04	176		414 096	5 966 135	414 063.1	5 966 113.8	39	
19/02/2019	13:33:58	SG_ST12B	Still	181275_SG_ST12B_05	177		414 096	5 966 135	414 066.0	5 966 113.5	37	
19/02/2019	13:34:35	SG_ST12B	Still	181275_SG_ST12B_06	178		414 096	5 966 135	414 075.8	5 966 119.1	26	
19/02/2019	13:34:47	SG_ST12B	Still	181275_SG_ST12B_07	179		414 096	5 966 135	414 078.6	5 966 120.1	23	
19/02/2019	13:35:23	SG_ST12B	Still	181275_SG_ST12B_08	180		414 096	5 966 135	414 085.2	5 966 121.1	18	
19/02/2019	13:35:34	SG_ST12B	Still	181275_SG_ST12B_09	181		414 096	5 966 135	414 086.4	5 966 120.4	18	
19/02/2019	13:36:12	SG_ST12B	Still	181275_SG_ST12B_10	182		414 096	5 966 135	414 089.9	5 966 119.7	16	
19/02/2019	13:36:44	SG_ST12B	Still	181275_SG_ST12B_11	183		414 096	5 966 135	414 091.2	5 966 118.0	18	
19/02/2019	13:37:10	SG_ST12B	Still	181275_SG_ST12B_12	184		414 096	5 966 135	414 092.2	5 966 116.4	19	
19/02/2019	13:37:24	SG_ST12B	Still	181275_SG_ST12B_13	185		414 096	5 966 135	414 094.5	5 966 115.5	20	
19/02/2019	13:37:37	SG_ST12B	Still	181275_SG_ST12B_14	186		414 096	5 966 135	414 097.6	5 966 114.9	20	
19/02/2019	13:37:53	SG_ST12B	Still	181275_SG_ST12B_15	187		414 096	5 966 135	414 102.9	5 966 115.4	21	
19/02/2019	13:38:38	SG_ST12B	Still	181275_SG_ST12B_16	188	54	414 096	5 966 135	414 122.0	5 966 119.2	30	
19/02/2019	13:38:38	SG_ST12B	Video	EOL	188	54	414 096	5 966 135	414 122.0	5 966 119.2	30	
19/02/2019	14:29:34	SG_ST12	HG	NS	189	52	414 096	5 966 135	414 079.0	5 966 151.1	23	
20/02/2019	19:23:15	SG_ST07	DVV	NS/NT	191	20	477 859	5 956 185	477 888.5	5 956 178.9	30	
20/02/2019	19:38:08	SG_ST07	DVV	NS/NT	192	21	477 859	5 956 185	477 882.2	5 956 168.3	29	
20/02/2019	19:56:43	SG_ST07	DVV	NS/NT	193	22	477 859	5 956 185	477 871.6	5 956 168.6	21	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
20/02/2019	20:15:16	SG_ST07	HG	NS	194	22	477 859	5 956 185	477 854.9	5 956 197.8	14	
20/02/2019	20:51:27	SG_ST06	DVV	NS/PC	195	20	480 913	5 956 334	480 918.7	5 956 339.6	8	
20/02/2019	21:10:12	SG_ST06	DVV	NS/FA	196	20	480 913	5 956 334	480 892.7	5 956 339.7	21	
20/02/2019	21:23:38	SG_ST06	DVV	NS/FB	197	21	480 913	5 956 334	480 896.9	5 956 310.0	29	
20/02/2019	22:23:32	SG_ST07	DVV	NS/NT	198	28	477 859	5 956 185	477 857.6	5 956 156.0	29	
23/02/2019	08:57:42	LS_ST02	Still	181275_LS_ST02_01								Site slate
23/02/2019	09:10:44	LS_ST02	Still	181275_LS_ST02_02	200	15	298 411	5 937 630	298 430.7	5 937 554.8	78	
23/02/2019	09:11:21	LS_ST02	Still	181275_LS_ST02_03	201	15	298 411	5 937 630	298 420.8	5 937 596.7	35	
23/02/2019	09:33:26	LS_ST02A	Still	181275_LS_ST02A_01								Site slate
23/02/2019	09:39:30	LS_ST02A	Video	SOL	203	15	298 411	5 937 630	298 398.8	5 937 662.0	34	
23/02/2019	09:39:30	LS_ST02A	Still	181275_LS_ST02A_02	203		298 411	5 937 630	298 398.8	5 937 662.0	34	
23/02/2019	09:39:47	LS_ST02A	Still	181275_LS_ST02A_03	204		298 411	5 937 630	298 395.7	5 937 656.6	31	
23/02/2019	09:40:12	LS_ST02A	Still	181275_LS_ST02A_04	205		298 411	5 937 630	298 393.8	5 937 646.7	24	
23/02/2019	09:41:12	LS_ST02A	Still	181275_LS_ST02A_05	206		298 411	5 937 630	298 387.1	5 937 631.7	24	
23/02/2019	09:41:29	LS_ST02A	Still	181275_LS_ST02A_06	207		298 411	5 937 630	298 384.1	5 937 631.2	27	
23/02/2019	09:41:50	LS_ST02A	Still	181275_LS_ST02A_07	208		298 411	5 937 630	298 383.1	5 937 631.0	28	
23/02/2019	09:42:29	LS_ST02A	Still	181275_LS_ST02A_08	209		298 411	5 937 630	298 385.1	5 937 620.5	28	
23/02/2019	09:42:47	LS_ST02A	Still	181275_LS_ST02A_09	210		298 411	5 937 630	298 389.1	5 937 615.5	26	
23/02/2019	09:43:43	LS_ST02A	Still	181275_LS_ST02A_10	211		298 411	5 937 630	298 395.8	5 937 610.4	25	
23/02/2019	09:43:52	LS_ST02A	Still	181275_LS_ST02A_11	212		298 411	5 937 630	298 396.8	5 937 613.0	22	
23/02/2019	09:45:24	LS_ST02A	Still	181275_LS_ST02A_12	213		298 411	5 937 630	298 398.2	5 937 628.8	13	
23/02/2019	09:46:02	LS_ST02A	Still	181275_LS_ST02A_13	214		298 411	5 937 630	298 401.5	5 937 625.7	11	
23/02/2019	09:47:09	LS_ST02A	Still	181275_LS_ST02A_14	215		298 411	5 937 630	298 408.3	5 937 612.9	17	
23/02/2019	09:47:54	LS_ST02A	Still	181275_LS_ST02A_15	216		298 411	5 937 630	298 416.0	5 937 604.5	26	
23/02/2019	09:47:54	LS_ST02A	Video	EOL	216	15	298 411	5 937 630	298 416.0	5 937 604.5	26	
23/02/2019	10:00:30	LS_ST02	DVV	PC/FA	217	17	298 411	5 937 630	298 426.0	5 937 601.7	32	
23/02/2019	10:26:00	LS_ST02	DVV	FB	218	16	298 411	5 937 630	298 395.1	5 937 617.1	21	
23/02/2019	13:51:17	LS_ST01	Still	181275_LS_ST01_01								Site slate
23/02/2019	14:25:48	LS_ST01A	Still	181275_ST01A_01								Site slate
23/02/2019	14:40:18	LS_ST01A	Still	181275_ST01A_02	221	11	296 655	5 937 208	296 631.8	5 937 201.5	24	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	15:07:56	LS_ST01B	Still	181275_LS_ST01B_01								Site slate
23/02/2019	15:13:22	LS_ST01B	Video	SOL	226	11	296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:13:22	LS_ST01B	Still	181275_LS_ST01B_02	226		296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:14:30	LS_ST01B	Still	181275_LS_ST01B_03	228		296 655	5 937 208	296 649.0	5 937 283.4	76	
23/02/2019	15:15:26	LS_ST01B	Still	181275_LS_ST01B_04	229		296 655	5 937 208	296 646.5	5 937 265.4	58	
23/02/2019	15:16:49	LS_ST01B	Still	181275_LS_ST01B_05	230		296 655	5 937 208	296 642.3	5 937 238.9	33	
23/02/2019	15:18:42	LS_ST01B	Still	181275_LS_ST01B_06	231		296 655	5 937 208	296 632.3	5 937 204.8	23	
23/02/2019	15:20:12	LS_ST01B	Still	181275_LS_ST01B_07	234		296 655	5 937 208	296 623.5	5 937 178.8	43	
23/02/2019	15:20:57	LS_ST01B	Still	181275_LS_ST01B_08	235		296 655	5 937 208	296 619.8	5 937 165.9	55	
23/02/2019	15:22:19	LS_ST01B	Still	181275_LS_ST01B_09	236		296 655	5 937 208	296 612.4	5 937 141.9	79	
23/02/2019	15:23:04	LS_ST01B	Still	181275_LS_ST01B_10	237		296 655	5 937 208	296 607.8	5 937 129.1	92	
23/02/2019	15:23:49	LS_ST01B	Still	181275_LS_ST01B_11	238		296 655	5 937 208	296 604.0	5 937 115.4	106	
23/02/2019	15:24:56	LS_ST01B	Still	181275_LS_ST01B_12	239		296 655	5 937 208	296 598.4	5 937 096.2	125	
23/02/2019	15:25:30	LS_ST01B	Still	181275_LS_ST01B_13	240		296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	15:25:30	LS_ST01B	Video	EOL	240	11	296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	16:23:10	LS_ST03	Still	181275_LS_ST03_01								Site slate
23/02/2019	16:34:36	LS_ST03	Video	SOL	242	35	303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:36	LS_ST03	Still	181275_LS_ST03_02	242		303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:56	LS_ST03	Still	181275_LS_ST03_03	243		303 849	5 938 838	303 867.6	5 938 731.1	109	
23/02/2019	16:35:14	LS_ST03	Still	181275_LS_ST03_04	244		303 849	5 938 838	303 865.4	5 938 737.6	102	
23/02/2019	16:35:27	LS_ST03	Still	181275_LS_ST03_05	245		303 849	5 938 838	303 864.6	5 938 742.6	97	
23/02/2019	16:35:41	LS_ST03	Still	181275_LS_ST03_06	246		303 849	5 938 838	303 864.8	5 938 748.4	91	
23/02/2019	16:36:19	LS_ST03	Still	181275_LS_ST03_07	247		303 849	5 938 838	303 870.3	5 938 764.5	77	
23/02/2019	16:36:46	LS_ST03	Still	181275_LS_ST03_08	248		303 849	5 938 838	303 872.3	5 938 781.4	61	
23/02/2019	16:36:56	LS_ST03	Still	181275_LS_ST03_09	249		303 849	5 938 838	303 870.9	5 938 787.5	55	
23/02/2019	16:37:15	LS_ST03	Still	181275_LS_ST03_10	250		303 849	5 938 838	303 867.1	5 938 797.3	45	
23/02/2019	16:37:32	LS_ST03	Still	181275_LS_ST03_11	251		303 849	5 938 838	303 862.7	5 938 805.0	36	
23/02/2019	16:37:48	LS_ST03	Still	181275_LS_ST03_12	252		303 849	5 938 838	303 858.2	5 938 810.5	29	
23/02/2019	16:38:04	LS_ST03	Still	181275_LS_ST03_13	253		303 849	5 938 838	303 854.4	5 938 815.5	23	
23/02/2019	16:38:21	LS_ST03	Still	181275_LS_ST03_14	254		303 849	5 938 838	303 851.4	5 938 824.1	14	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	16:38:36	LS_ST03	Still	181275_LS_ST03_15	255		303 849	5 938 838	303 850.7	5 938 833.4	5	
23/02/2019	16:39:02	LS_ST03	Still	181275_LS_ST03_16	256		303 849	5 938 838	303 848.1	5 938 847.3	9	
23/02/2019	16:39:13	LS_ST03	Still	181275_LS_ST03_17	257		303 849	5 938 838	303 846.9	5 938 852.5	15	
23/02/2019	16:39:24	LS_ST03	Still	181275_LS_ST03_18	258		303 849	5 938 838	303 845.6	5 938 857.1	19	
23/02/2019	16:39:50	LS_ST03	Still	181275_LS_ST03_19	259		303 849	5 938 838	303 841.8	5 938 865.6	29	
23/02/2019	16:40:05	LS_ST03	Still	181275_LS_ST03_20	260		303 849	5 938 838	303 839.2	5 938 869.1	33	
23/02/2019	16:40:16	LS_ST03	Still	181275_LS_ST03_21	261		303 849	5 938 838	303 837.0	5 938 871.6	36	
23/02/2019	16:40:27	LS_ST03	Still	181275_LS_ST03_22	262		303 849	5 938 838	303 835.2	5 938 873.9	39	
23/02/2019	16:40:38	LS_ST03	Still	181275_LS_ST03_23	263		303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	16:40:38	LS_ST03	Video	EOL	263	35	303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	15:07:56	LS_ST01B	Still	181275_LS_ST01B_01								Site slate
23/02/2019	15:13:22	LS_ST01B	Video	SOL	226		296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:13:22	LS_ST01B	Still	181275_LS_ST01B_02	226		296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:14:30	LS_ST01B	Still	181275_LS_ST01B_03	228		296 655	5 937 208	296 649.0	5 937 283.4	76	
23/02/2019	15:15:26	LS_ST01B	Still	181275_LS_ST01B_04	229		296 655	5 937 208	296 646.5	5 937 265.4	58	
23/02/2019	15:16:49	LS_ST01B	Still	181275_LS_ST01B_05	230		296 655	5 937 208	296 642.3	5 937 238.9	33	
23/02/2019	15:18:42	LS_ST01B	Still	181275_LS_ST01B_06	231		296 655	5 937 208	296 632.3	5 937 204.8	23	
23/02/2019	15:20:12	LS_ST01B	Still	181275_LS_ST01B_07	234		296 655	5 937 208	296 623.5	5 937 178.8	43	
23/02/2019	15:20:57	LS_ST01B	Still	181275_LS_ST01B_08	235		296 655	5 937 208	296 619.8	5 937 165.9	55	
23/02/2019	15:22:19	LS_ST01B	Still	181275_LS_ST01B_09	236		296 655	5 937 208	296 612.4	5 937 141.9	79	
23/02/2019	15:23:04	LS_ST01B	Still	181275_LS_ST01B_10	237		296 655	5 937 208	296 607.8	5 937 129.1	92	
23/02/2019	15:23:49	LS_ST01B	Still	181275_LS_ST01B_11	238		296 655	5 937 208	296 604.0	5 937 115.4	106	
23/02/2019	15:24:56	LS_ST01B	Still	181275_LS_ST01B_12	239		296 655	5 937 208	296 598.4	5 937 096.2	125	
23/02/2019	15:25:30	LS_ST01B	Still	181275_LS_ST01B_13	240		296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	15:25:30	LS_ST01B	Video	EOL	240	11	296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	16:23:10	LS_ST03	Still	181275_LS_ST03_01								Site slate
23/02/2019	16:34:36	LS_ST03	Video	SOL	242	35	303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:36	LS_ST03	Still	181275_LS_ST03_02	242	35	303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:56	LS_ST03	Still	181275_LS_ST03_03	243		303 849	5 938 838	303 867.6	5 938 731.1	109	
23/02/2019	16:35:14	LS_ST03	Still	181275_LS_ST03_04	244		303 849	5 938 838	303 865.4	5 938 737.6	102	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	16:35:27	LS_ST03	Still	181275_LS_ST03_05	245		303 849	5 938 838	303 864.6	5 938 742.6	97	
23/02/2019	16:35:41	LS_ST03	Still	181275_LS_ST03_06	246		303 849	5 938 838	303 864.8	5 938 748.4	91	
23/02/2019	16:36:19	LS_ST03	Still	181275_LS_ST03_07	247		303 849	5 938 838	303 870.3	5 938 764.5	77	
23/02/2019	16:36:46	LS_ST03	Still	181275_LS_ST03_08	248		303 849	5 938 838	303 872.3	5 938 781.4	61	
23/02/2019	16:36:56	LS_ST03	Still	181275_LS_ST03_09	249		303 849	5 938 838	303 870.9	5 938 787.5	55	
23/02/2019	16:37:15	LS_ST03	Still	181275_LS_ST03_10	250		303 849	5 938 838	303 867.1	5 938 797.3	45	
23/02/2019	16:37:32	LS_ST03	Still	181275_LS_ST03_11	251		303 849	5 938 838	303 862.7	5 938 805.0	36	
23/02/2019	16:37:48	LS_ST03	Still	181275_LS_ST03_12	252		303 849	5 938 838	303 858.2	5 938 810.5	29	
23/02/2019	16:38:04	LS_ST03	Still	181275_LS_ST03_13	253		303 849	5 938 838	303 854.4	5 938 815.5	23	
23/02/2019	16:38:21	LS_ST03	Still	181275_LS_ST03_14	254		303 849	5 938 838	303 851.4	5 938 824.1	14	
23/02/2019	16:38:36	LS_ST03	Still	181275_LS_ST03_15	255		303 849	5 938 838	303 850.7	5 938 833.4	5	
23/02/2019	16:39:02	LS_ST03	Still	181275_LS_ST03_16	256		303 849	5 938 838	303 848.1	5 938 847.3	9	
23/02/2019	16:39:13	LS_ST03	Still	181275_LS_ST03_17	257		303 849	5 938 838	303 846.9	5 938 852.5	15	
23/02/2019	16:39:24	LS_ST03	Still	181275_LS_ST03_18	258		303 849	5 938 838	303 845.6	5 938 857.1	19	
23/02/2019	16:39:50	LS_ST03	Still	181275_LS_ST03_19	259		303 849	5 938 838	303 841.8	5 938 865.6	29	
23/02/2019	16:40:05	LS_ST03	Still	181275_LS_ST03_20	260		303 849	5 938 838	303 839.2	5 938 869.1	33	
23/02/2019	16:40:16	LS_ST03	Still	181275_LS_ST03_21	261		303 849	5 938 838	303 837.0	5 938 871.6	36	
23/02/2019	16:40:27	LS_ST03	Still	181275_LS_ST03_22	262		303 849	5 938 838	303 835.2	5 938 873.9	39	
23/02/2019	16:40:38	LS_ST03	Still	181275_LS_ST03_23	263		303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	16:40:38	LS_ST03	Video	EOL	263	35	303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	17:00:32	LS_ST03	DVV	NS/NS	264	34	303 849	5 938 838	303 831.7	5 938 833.1	18	
23/02/2019	17:16:30	LS_ST03	DVV	NS/NS	265	34	303 849	5 938 838	303 874.5	5 938 836.5	26	
23/02/2019	17:36:03	LS_ST03	DVV	NS/NS	266	33	303 849	5 938 838	303 843.4	5 938 833.9	7	
23/02/2019	17:46:48	LS_ST03	DVV	NS/NS	267	33	303 849	5 938 838	303 862.7	5 938 819.2	23	
23/02/2019	17:53:50	LS_ST03	DVV	NS/NS	268	33	303 849	5 938 838	303 858.8	5 938 799.8	40	
23/02/2019	18:35:00	LS_ST03	DVV	PC/FA	269	32	303 849	5 938 838	303 889.9	5 938 821.5	44	
23/02/2019	18:54:40	LS_ST03	DVV	NS/NS	270	33	303 849	5 938 838	303 835.1	5 938 852.6	20	
23/02/2019	18:55:33	LS_ST03	DVV	NS/NS	271	32	303 849	5 938 838	303 836.5	5 938 847.2	16	
23/02/2019	19:05:29	LS_ST03	DVV	FB	272	32	303 849	5 938 838	303 829.1	5 938 867.0	35	
23/02/2019	20:03:59	LS_ST04	Still	181275_LS_ST04_01								Site slate

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	20:25:48	LS_ST04	Video	SOL	274	41	307 143	5 939 833	307 144.3	5 939 797.0	36	
23/02/2019	20:25:48	LS_ST04	Still	181274_LS_ST04_02	274		307 143	5 939 833	307 144.3	5 939 797.0	36	
23/02/2019	20:26:19	LS_ST04	Still	181274_LS_ST04_03	275		307 143	5 939 833	307 143.3	5 939 803.8	29	
23/02/2019	20:26:34	LS_ST04	Still	181274_LS_ST04_04	276		307 143	5 939 833	307 143.0	5 939 807.5	26	
23/02/2019	20:26:50	LS_ST04	Still	181274_LS_ST04_05	277		307 143	5 939 833	307 142.4	5 939 811.9	21	
23/02/2019	20:27:03	LS_ST04	Still	181274_LS_ST04_06	278		307 143	5 939 833	307 141.9	5 939 815.5	18	
23/02/2019	20:27:14	LS_ST04	Still	181274_LS_ST04_07	279		307 143	5 939 833	307 141.5	5 939 818.3	15	
23/02/2019	20:27:33	LS_ST04	Still	181274_LS_ST04_08	280		307 143	5 939 833	307 140.9	5 939 823.0	10	
23/02/2019	20:27:52	LS_ST04	Still	181274_LS_ST04_09	281		307 143	5 939 833	307 140.5	5 939 827.6	6	
23/02/2019	20:28:10	LS_ST04	Still	181274_LS_ST04_10	282		307 143	5 939 833	307 139.5	5 939 831.0	4	
23/02/2019	20:28:29	LS_ST04	Still	181274_LS_ST04_11	283		307 143	5 939 833	307 138.8	5 939 835.8	5	
23/02/2019	20:28:45	LS_ST04	Still	181274_LS_ST04_12	284		307 143	5 939 833	307 138.4	5 939 839.6	8	
23/02/2019	20:29:34	LS_ST04	Still	181274_LS_ST04_13	286		307 143	5 939 833	307 137.4	5 939 852.9	21	
23/02/2019	20:29:46	LS_ST04	Still	181274_LS_ST04_14	287		307 143	5 939 833	307 136.8	5 939 856.2	24	
23/02/2019	20:30:00	LS_ST04	Still	181274_LS_ST04_15	288		307 143	5 939 833	307 136.4	5 939 859.7	28	
23/02/2019	20:30:11	LS_ST04	Still	181274_LS_ST04_16	289		307 143	5 939 833	307 136.0	5 939 862.3	30	
23/02/2019	20:30:43	LS_ST04	Still	181274_LS_ST04_17	290		307 143	5 939 833	307 134.4	5 939 872.3	40	
23/02/2019	20:31:03	LS_ST04	Still	181274_LS_ST04_18	291		307 143	5 939 833	307 133.8	5 939 878.1	46	
23/02/2019	20:31:14	LS_ST04	Still	181274_LS_ST04_19	292		307 143	5 939 833	307 133.1	5 939 881.0	49	
23/02/2019	20:31:14	LS_ST04	Video	EOL	292	41	307 143	5 939 833	307 133.1	5 939 881.0	49	
23/02/2019	20:48:32	LS_ST04	DW	PC/FA	293	41	307 143	5 939 833	307 185.5	5 939 829.5	43	
23/02/2019	21:04:36	LS_ST04	DW	FB	294	42	307 143	5 939 833	307 129.0	5 939 813.1	24	
23/02/2019	17:00:32	LS_ST03	DW	NS/NS	264	34	303 849	5 938 838	303 831.7	5 938 833.1	18	
23/02/2019	17:16:30	LS_ST03	DW	NS/NS	265	34	303 849	5 938 838	303 874.5	5 938 836.5	26	
23/02/2019	17:36:03	LS_ST03	DW	NS/NS	266	33	303 849	5 938 838	303 843.4	5 938 833.9	7	
23/02/2019	17:46:48	LS_ST03	DW	NS/NS	267	33	303 849	5 938 838	303 862.7	5 938 819.2	23	
23/02/2019	17:53:50	LS_ST03	DW	NS/NS	268	33	303 849	5 938 838	303 858.8	5 938 799.8	40	
23/02/2019	18:35:00	LS_ST03	DW	PC/FA	269	32	303 849	5 938 838	303 889.9	5 938 821.5	44	
23/02/2019	18:54:40	LS_ST03	DW	NS/NS	270	33	303 849	5 938 838	303 835.1	5 938 852.6	20	
23/02/2019	18:55:33	LS_ST03	DW	NS/NS	271	32	303 849	5 938 838	303 836.5	5 938 847.2	16	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	19:05:29	LS_ST03	DVV	FB	272	32	303 849	5 938 838	303 829.1	5 938 867.0	35	
23/02/2019	20:03:59	LS_ST04	Still	181275_LS_ST04_01								Site slate
23/02/2019	20:25:48	LS_ST04	Video	SOL	274	41	307 143	5 939 833	307 144.3	5 939 797.0	36	
23/02/2019	20:25:48	LS_ST04	Still	181274_LS_ST04_02	274		307 143	5 939 833	307 144.3	5 939 797.0	36	
23/02/2019	20:26:19	LS_ST04	Still	181274_LS_ST04_03	275		307 143	5 939 833	307 143.3	5 939 803.8	29	
23/02/2019	20:26:34	LS_ST04	Still	181274_LS_ST04_04	276		307 143	5 939 833	307 143.0	5 939 807.5	26	
23/02/2019	20:26:50	LS_ST04	Still	181274_LS_ST04_05	277		307 143	5 939 833	307 142.4	5 939 811.9	21	
23/02/2019	20:27:03	LS_ST04	Still	181274_LS_ST04_06	278		307 143	5 939 833	307 141.9	5 939 815.5	18	
23/02/2019	20:27:14	LS_ST04	Still	181274_LS_ST04_07	279		307 143	5 939 833	307 141.5	5 939 818.3	15	
23/02/2019	20:27:33	LS_ST04	Still	181274_LS_ST04_08	280		307 143	5 939 833	307 140.9	5 939 823.0	10	
23/02/2019	20:27:52	LS_ST04	Still	181274_LS_ST04_09	281		307 143	5 939 833	307 140.5	5 939 827.6	6	
23/02/2019	20:28:10	LS_ST04	Still	181274_LS_ST04_10	282		307 143	5 939 833	307 139.5	5 939 831.0	4	
23/02/2019	20:28:29	LS_ST04	Still	181274_LS_ST04_11	283		307 143	5 939 833	307 138.8	5 939 835.8	5	
23/02/2019	20:28:45	LS_ST04	Still	181274_LS_ST04_12	284		307 143	5 939 833	307 138.4	5 939 839.6	8	
23/02/2019	20:29:34	LS_ST04	Still	181274_LS_ST04_13	286		307 143	5 939 833	307 137.4	5 939 852.9	21	
23/02/2019	20:29:46	LS_ST04	Still	181274_LS_ST04_14	287		307 143	5 939 833	307 136.8	5 939 856.2	24	
23/02/2019	20:30:00	LS_ST04	Still	181274_LS_ST04_15	288		307 143	5 939 833	307 136.4	5 939 859.7	28	
23/02/2019	20:30:11	LS_ST04	Still	181274_LS_ST04_16	289		307 143	5 939 833	307 136.0	5 939 862.3	30	
23/02/2019	20:30:43	LS_ST04	Still	181274_LS_ST04_17	290		307 143	5939833	307134.4	5939872.3	40	
23/02/2019	20:31:03	LS_ST04	Still	181274_LS_ST04_18	291		307 143	5939833	307133.8	5939878.1	46	
23/02/2019	20:31:14	LS_ST04	Still	181274_LS_ST04_19	292		307 143	5939833	307133.1	5939881.0	49	
23/02/2019	20:31:14	LS_ST04	Video	EOL	292	41	307 143	5939833	307133.1	5939881.0	49	
23/02/2019	20:48:32	LS_ST04	DVV	PC/FA	293	41	307 143	5939833	307185.5	5939829.5	43	
23/02/2019	21:04:36	LS_ST04	DVV	FB	294	42	307 143	5939833	307129.0	5939813.1	24	
23/02/2019	-	LS_ST05	Still	181275_LS_ST05_01								Site slate
23/02/2019	22:03:51	LS_ST05	Video	SOL	295	66	314 915	5943502	314920.0	5943457.1	45	
23/02/2019	22:03:51	LS_ST05	Still	181275_LS_ST05_02	295		314 915	5943502	314920.0	5943457.1	45	
23/02/2019	22:04:05	LS_ST05	Still	181275_LS_ST05_03	296		314 915	5943502	314917.9	5943464.6	38	
23/02/2019	22:04:15	LS_ST05	Still	181275_LS_ST05_04	297		314 915	5943502	314916.5	5943471.4	31	
23/02/2019	22:04:36	LS_ST05	Still	181275_LS_ST05_05	298		314 915	5943502	314913.6	5943484.3	18	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	22:04:53	LS_ST05	Still	181275_LS_ST05_06	299		314 915	5943502	314911.6	5943493.6	9	
23/02/2019	22:05:02	LS_ST05	Still	181275_LS_ST05_07	300		314 915	5943502	314909.8	5943499.7	6	
23/02/2019	22:05:13	LS_ST05	Still	181275_LS_ST05_08	301		314 915	5943502	314908.2	5943506.5	8	
23/02/2019	22:05:25	LS_ST05	Still	181275_LS_ST05_09	302		314 915	5943502	314906.5	5943513.6	14	
23/02/2019	22:05:36	LS_ST05	Still	181275_LS_ST05_10	303		314 915	5943502	314905.1	5943520.1	21	
23/02/2019	22:05:55	LS_ST05	Still	181275_LS_ST05_11	304		314 915	5943502	314902.7	5943531.5	32	
23/02/2019	22:06:17	LS_ST05	Still	181275_LS_ST05_12	305		314 915	5943502	314900.2	5943543.5	44	
23/02/2019	22:06:27	LS_ST05	Still	181275_LS_ST05_13	306		314 915	5943502	314898.4	5943550.7	52	
23/02/2019	22:06:43	LS_ST05	Still	181275_LS_ST05_14	307		314 915	5943502	314896.6	5943560.6	61	
23/02/2019	22:07:06	LS_ST05	Still	181275_LS_ST05_15	308		314 915	5943502	314893.7	5943574.0	75	
23/02/2019	22:07:18	LS_ST05	Still	181275_LS_ST05_16	309		314 915	5943502	314891.9	5943580.8	82	
23/02/2019	22:07:44	LS_ST05	Still	181275_LS_ST05_17	310		314 915	5943502	314888.9	5943595.5	97	
23/02/2019	22:07:58	LS_ST05	Still	181275_LS_ST05_18	311		314 915	5943502	314887.1	5943603.0	105	
23/02/2019	22:08:17	LS_ST05	Still	181275_LS_ST05_19	312		314 915	5943502	314885.0	5943613.9	116	
23/02/2019	22:08:17	LS_ST05	Video	EOL	312	65.7	314 915	5943502	314885.0	5943613.9	116	
23/02/2019	22:31:26	LS_ST05	DVV	PC/FA	313	66.2	314 915	5943502	314900.5	5943474.5	31	
23/02/2019	22:50:31	LS_ST05	DVV	NS/NS	314	66.8	314 915	5943502	314910.4	5943498.5	6	
23/02/2019	22:59:26	LS_ST05	DVV	FB	315	66.3	314 915	5943502	314912.6	5943512.4	11	
24/02/2019	02:00:16	CC05_T01	Still	181275_CC05_T01_01								Site slate
24/02/2019	02:17:17	CC05_T01A	Still	181275_CC05_T01A_01								Site slate
24/02/2019	02:29:09	CC05_T01A	Video	SOL	318	83	346 662	5 957 525	347 174.7	5 957 085.5	675	
24/02/2019	02:29:09	CC05_T01A	Still	181275_CC05_T01A_02	318		346 662	5 957 525	347 174.7	5 957 085.5	675	
24/02/2019	02:29:41	CC05_T01A	Still	181275_CC05_T01A_03	319		346 662	5 957 525	347 164.0	5 957 092.9	662	
24/02/2019	02:30:08	CC05_T01A	Still	181275_CC05_T01A_04	320		346 662	5 957 525	347 156.0	5 957 098.2	652	
24/02/2019	02:30:47	CC05_T01A	Still	181275_CC05_T01A_05	321		346 662	5 957 525	347 144.7	5 957 106.2	639	
24/02/2019	02:31:16	CC05_T01A	Still	181275_CC05_T01A_06	322		346 662	5 957 525	347 136.0	5 957 113.1	627	
24/02/2019	02:31:27	CC05_T01A	Still	181275_CC05_T01A_07	323		346 662	5 957 525	347 132.0	5 957 116.1	623	
24/02/2019	02:31:48	CC05_T01A	Still	181275_CC05_T01A_08	324		346 662	5 957 525	347 125.7	5 957 121.6	614	
24/02/2019	02:32:01	CC05_T01A	Still	181275_CC05_T01A_09	325		346 662	5 957 525	347 121.7	5 957 124.6	609	
24/02/2019	02:32:21	CC05_T01A	Still	181275_CC05_T01A_10	326		346 662	5 957 525	347 115.6	5 957 129.8	601	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:32:36	CC05_T01A	Still	181275_CC05_T01A_11	327		346 662	5 957 525	347 111.0	5 957 134.2	595	
24/02/2019	02:32:44	CC05_T01A	Still	181275_CC05_T01A_12	328		346 662	5 957 525	347 108.1	5 957 136.7	591	
24/02/2019	02:33:01	CC05_T01A	Still	181275_CC05_T01A_13	329		346 662	5 957 525	347 103.3	5 957 141.1	584	
24/02/2019	02:33:19	CC05_T01A	Still	181275_CC05_T01A_14	330		346 662	5 957 525	347 097.7	5 957 146.4	577	
24/02/2019	02:33:33	CC05_T01A	Still	181275_CC05_T01A_15	331		346 662	5 957 525	347 093.9	5 957 149.4	572	
24/02/2019	02:33:45	CC05_T01A	Still	181275_CC05_T01A_16	332		346 662	5 957 525	347 089.8	5 957 153.4	566	
24/02/2019	02:34:09	CC05_T01A	Still	181275_CC05_T01A_17	333		346 662	5 957 525	347 083.0	5 957 158.7	558	
24/02/2019	02:34:54	CC05_T01A	Still	181275_CC05_T01A_18	334		346 662	5 957 525	347 071.2	5 957 168.9	542	
24/02/2019	02:36:05	CC05_T01A	Still	181275_CC05_T01A_19	335		346 662	5 957 525	347 050.0	5 957 184.9	515	
24/02/2019	02:36:22	CC05_T01A	Still	181275_CC05_T01A_20	336		346 662	5 957 525	347 044.8	5 957 188.6	509	
24/02/2019	02:36:38	CC05_T01A	Still	181275_CC05_T01A_21	337		346 662	5 957 525	347 039.5	5 957 192.7	502	
24/02/2019	02:36:53	CC05_T01A	Still	181275_CC05_T01A_22	338		346 662	5 957 525	347 035.0	5 957 196.0	497	
24/02/2019	02:37:30	CC05_T01A	Still	181275_CC05_T01A_23	339		346 662	5 957 525	347 022.8	5 957 205.3	482	
24/02/2019	02:37:56	CC05_T01A	Still	181275_CC05_T01A_24	340		346 662	5 957 525	347 014.5	5 957 212.1	471	
24/02/2019	02:38:10	CC05_T01A	Still	181275_CC05_T01A_25	341		346 662	5 957 525	347 010.1	5 957 215.9	465	
24/02/2019	02:38:29	CC05_T01A	Still	181275_CC05_T01A_26	342		346 662	5 957 525	347 003.6	5 957 220.6	457	
24/02/2019	02:39:14	CC05_T01A	Still	181275_CC05_T01A_27	343		346 662	5 957 525	346 988.9	5 957 232.8	438	
24/02/2019	02:39:25	CC05_T01A	Still	181275_CC05_T01A_28	344		346 662	5 957 525	346 985.2	5 957 235.3	434	
24/02/2019	02:40:05	CC05_T01A	Still	181275_CC05_T01A_29	345		346 662	5 957 525	346 972.9	5 957 244.8	418	
24/02/2019	02:40:38	CC05_T01A	Still	181275_CC05_T01A_30	346		346 662	5 957 525	346 963.1	5 957 252.5	406	
24/02/2019	02:41:03	CC05_T01A	Still	181275_CC05_T01A_31	347		346 662	5 957 525	346 956.5	5 957 258.1	397	
24/02/2019	02:41:46	CC05_T01A	Still	181275_CC05_T01A_32	348		346 662	5 957 525	346 944.2	5 957 270.0	380	
24/02/2019	02:42:12	CC05_T01A	Still	181275_CC05_T01A_33	349		346 662	5 957 525	346 937.3	5 957 276.7	370	
24/02/2019	02:43:33	CC05_T01A	Still	181275_CC05_T01A_34	351		346 662	5 957 525	346 914.6	5 957 299.7	338	
24/02/2019	02:43:59	CC05_T01A	Still	181275_CC05_T01A_35	352		346 662	5 957 525	346 906.6	5 957 306.4	328	
24/02/2019	02:44:40	CC05_T01A	Still	181275_CC05_T01A_36	353		346 662	5 957 525	346 894.1	5 957 318.2	310	
24/02/2019	02:45:34	CC05_T01A	Still	181275_CC05_T01A_37	354		346 662	5 957 525	346 877.8	5 957 333.0	288	
24/02/2019	02:46:13	CC05_T01A	Still	181275_CC05_T01A_38	355		346 662	5 957 525	346 864.8	5 957 342.5	272	
24/02/2019	02:46:51	CC05_T01A	Still	181275_CC05_T01A_39	356		346 662	5 957 525	346 852.3	5 957 350.6	258	
24/02/2019	02:47:24	CC05_T01A	Still	181275_CC05_T01A_40	357		346 662	5 957 525	346 841.9	5 957 357.7	245	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:48:20	CC05_T01A	Still	181275_CC05_T01A_41	358		346 662	5 957 525	346 824.9	5 957 370.5	224	
24/02/2019	02:48:43	CC05_T01A	Still	181275_CC05_T01A_42	359		346 662	5 957 525	346 817.8	5 957 375.6	215	
24/02/2019	02:49:21	CC05_T01A	Still	181275_CC05_T01A_43	360		346 662	5 957 525	346 805.2	5 957 386.6	199	
24/02/2019	02:49:48	CC05_T01A	Still	181275_CC05_T01A_44	361		346 662	5 957 525	346 796.8	5 957 393.1	188	
24/02/2019	02:50:23	CC05_T01A	Still	181275_CC05_T01A_45	362		346 662	5 957 525	346 785.9	5 957 401.9	174	
24/02/2019	02:51:07	CC05_T01A	Still	181275_CC05_T01A_46	363		346 662	5 957 525	346 772.0	5 957 414.2	156	
24/02/2019	02:51:36	CC05_T01A	Still	181275_CC05_T01A_47	364		346 662	5 957 525	346 762.8	5 957 422.7	143	
24/02/2019	02:52:19	CC05_T01A	Still	181275_CC05_T01A_48	365		346 662	5 957 525	346 748.0	5 957 434.1	125	
24/02/2019	02:52:51	CC05_T01A	Still	181275_CC05_T01A_49	366		346 662	5 957 525	346 737.0	5 957 441.4	112	
24/02/2019	02:53:17	CC05_T01A	Still	181275_CC05_T01A_50	367		346 662	5 957 525	346 728.7	5 957 446.7	102	
24/02/2019	02:53:46	CC05_T01A	Still	181275_CC05_T01A_51	368		346 662	5 957 525	346 719.8	5 957 451.9	93	
24/02/2019	02:54:23	CC05_T01A	Still	181275_CC05_T01A_52	369		346 662	5 957 525	346 706.7	5 957 457.5	81	
24/02/2019	02:54:39	CC05_T01A	Still	181275_CC05_T01A_53	370		346 662	5 957 525	346 701.3	5 957 460.8	75	
24/02/2019	02:55:16	CC05_T01A	Still	181275_CC05_T01A_54	371		346 662	5 957 525	346 687.2	5 957 469.7	60	
24/02/2019	02:55:36	CC05_T01A	Still	181275_CC05_T01A_55	372		346 662	5 957 525	346 680.2	5 957 476.1	52	
24/02/2019	02:56:18	CC05_T01A	Still	181275_CC05_T01A_56	373		346 662	5 957 525	346 668.2	5 957 493.7	32	
24/02/2019	02:57:25	CC05_T01A	Still	181275_CC05_T01A_57	374		346 662	5 957 525	346 650.2	5 957 526.1	12	
24/02/2019	02:58:04	CC05_T01A	Still	181275_CC05_T01A_58	375		346 662	5 957 525	346 640.7	5 957 546.1	31	
24/02/2019	02:58:22	CC05_T01A	Still	181275_CC05_T01A_59	376		346 662	5 957 525	346 636.0	5 957 555.2	40	
24/02/2019	02:58:36	CC05_T01A	Still	181275_CC05_T01A_60	377		346 662	5 957 525	346 631.9	5 957 562.3	49	
24/02/2019	02:59:15	CC05_T01A	Still	181275_CC05_T01A_61	378		346 662	5 957 525	346 618.7	5 957 578.4	69	
24/02/2019	02:59:36	CC05_T01A	Still	181275_CC05_T01A_62	379		346 662	5 957 525	346 612.2	5 957 585.7	79	
24/02/2019	03:00:05	CC05_T01A	Still	181275_CC05_T01A_63	380		346 662	5 957 525	346 601.7	5 957 592.9	91	
24/02/2019	03:01:16	CC05_T01A	Still	181275_CC05_T01A_64	381		346 662	5 957 525	346 575.7	5 957 606.7	119	
24/02/2019	03:01:42	CC05_T01A	Still	181275_CC05_T01A_65	382		346 662	5 957 525	346 566.2	5 957 611.3	130	
24/02/2019	03:02:08	CC05_T01A	Still	181275_CC05_T01A_66	383		346 662	5 957 525	346 556.1	5 957 615.2	140	
24/02/2019	03:02:36	CC05_T01A	Still	181275_CC05_T01A_67	384		346 662	5 957 525	346 546.3	5 957 619.1	150	
24/02/2019	03:02:47	CC05_T01A	Still	181275_CC05_T01A_68	385		346 662	5 957 525	346 542.0	5 957 621.4	154	
24/02/2019	03:02:47	CC05_T01A	Video	EOL	385	82	346 662	5 957 525	346 542.0	5 957 621.4	154	
24/02/2019	03:16:20	CC05_T02	Still	181275_CC05_T02_01								Site slate

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	03:26:17	CC05_T02	Video	SOL	387	82	346 662	5 957 525	346 779.4	5 957 515.0	117	
24/02/2019	03:26:17	CC05_T02	Still	181275_CC05_T02_02	387		346 662	5 957 525	346 779.4	5 957 515.0	117	
24/02/2019	03:26:50	CC05_T02	Still	181275_CC05_T02_03	388		346 662	5 957 525	346 761.5	5 957 519.3	99	
24/02/2019	03:27:04	CC05_T02	Still	181275_CC05_T02_04	NF		346 662	5 957 525	-	-	-	
24/02/2019	03:27:25	CC05_T02	Still	181275_CC05_T02_05	389		346 662	5 957 525	346 742.8	5 957 522.8	80	
24/02/2019	03:27:40	CC05_T02	Still	181275_CC05_T02_06	390		346 662	5 957 525	346 735.8	5 957 524.7	73	
24/02/2019	03:27:55	CC05_T02	Still	181275_CC05_T02_07	391		346 662	5 957 525	346 727.8	5 957 525.9	65	
24/02/2019	03:28:13	CC05_T02	Still	181275_CC05_T02_08	392		346 662	5 957 525	346 719.8	5 957 526.9	57	
24/02/2019	03:28:26	CC05_T02	Still	181275_CC05_T02_09	393		346 662	5 957 525	346 713.7	5 957 528.0	51	
24/02/2019	03:28:40	CC05_T02	Still	181275_CC05_T02_10	394		346 662	5 957 525	346 707.8	5 957 527.5	45	
24/02/2019	03:29:06	CC05_T02	Still	181275_CC05_T02_11	395		346 662	5 957 525	346 696.0	5 957 528.6	34	
24/02/2019	03:29:38	CC05_T02	Still	181275_CC05_T02_12	396		346 662	5 957 525	346 682.4	5 957 531.2	21	
24/02/2019	03:30:11	CC05_T02	Still	181275_CC05_T02_13	397		346 662	5 957 525	346 668.2	5 957 531.7	9	
24/02/2019	03:30:31	CC05_T02	Still	181275_CC05_T02_14	398		346 662	5 957 525	346 660.2	5 957 531.6	7	
24/02/2019	03:31:05	CC05_T02	Still	181275_CC05_T02_15	399		346 662	5 957 525	346 646.3	5 957 530.8	17	
24/02/2019	03:31:26	CC05_T02	Still	181275_CC05_T02_16	400		346 662	5 957 525	346 637.4	5 957 529.5	26	
24/02/2019	03:32:06	CC05_T02	Still	181275_CC05_T02_17	401		346 662	5 957 525	346 621.3	5 957 527.7	41.2	
24/02/2019	03:32:33	CC05_T02	Still	181275_CC05_T02_18	402		346 662	5 957 525	346 610.0	5 957 525.2	52.4	
24/02/2019	03:33:03	CC05_T02	Still	181275_CC05_T02_19	403		346 662	5 957 525	346 597.3	5 957 521.2	65.2	
24/02/2019	03:33:38	CC05_T02	Still	181275_CC05_T02_20	404		346 662	5 957 525	346 581.9	5 957 517.2	80.9	
24/02/2019	03:34:29	CC05_T02	Still	181275_CC05_T02_21	405		346 662	5 957 525	346 562.0	5 957 512.0	101.3	
24/02/2019	03:34:56	CC05_T02	Still	181275_CC05_T02_22	406		346 662	5 957 525	346 550.0	5 957 509.7	113.4	
24/02/2019	03:35:22	CC05_T02	Still	181275_CC05_T02_23	407		346 662	5 957 525	346 539.7	5 957 506.5	124.1	
24/02/2019	03:35:46	CC05_T02	Still	181275_CC05_T02_24	408		346 662	5 957 525	346 528.8	5 957 505.1	135.1	
24/02/2019	03:36:22	CC05_T02	Still	181275_CC05_T02_25	409		346 662	5 957 525	346 513.1	5 957 502.3	151.0	
24/02/2019	03:36:31	CC05_T02	Still	181275_CC05_T02_26	410		346 662	5 957 525	346 508.0	5 957 501.8	156.1	
24/02/2019	03:36:31	CC05_T02	Video	EOL	410	82	346 662	5 957 525	346 508.0	5 957 501.8	156.1	
24/02/2019	03:43:58	CC05_ST01	Still	181275_CC05_ST01_01								Site slate
24/02/2019	03:57:10	CC05_ST01	Video	SOL	412	82	346 363	5 957 528	346 266.4	5 957 592.1	115.5	
24/02/2019	03:57:10	CC05_ST01	Still	181275_CC05_ST01_02	412		346 363	5 957 528	346 266.4	5 957 592.1	115.5	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	03:58:06	CC05_ST01	Still	181275_CC05_ST01_03	413		346 363	5 957 528	346 276.1	5 957 576.5	99.1	
24/02/2019	03:58:22	CC05_ST01	Still	181275_CC05_ST01_04	414		346 363	5 957 528	346 278.7	5 957 571.8	94.6	
24/02/2019	03:58:47	CC05_ST01	Still	181275_CC05_ST01_05	415		346 363	5 957 528	346 281.0	5 957 564.7	89.4	
24/02/2019	03:59:05	CC05_ST01	Still	181275_CC05_ST01_06	416		346 363	5 957 528	346 281.2	5 957 560.3	87.5	
24/02/2019	04:00:10	CC05_ST01	Still	181275_CC05_ST01_07	417		346 363	5 957 528	346 274.3	5 957 560.0	93.8	
24/02/2019	04:02:19	CC05_ST01	Still	181275_CC05_ST01_08	418		346 363	5 957 528	346 250.4	5 957 582.9	124.8	
24/02/2019	04:02:29	CC05_ST01	Still	181275_CC05_ST01_09	419		346 363	5 957 528	346 249.5	5 957 584.7	126.4	
24/02/2019	04:03:19	CC05_ST01	Still	181275_CC05_ST01_10	420		346 363	5 957 528	346 250.1	5 957 591.7	129.1	
24/02/2019	04:05:25	CC05_ST01	Still	181275_CC05_ST01_11	421		346 363	5 957 528	346 259.1	5 957 591.9	121.5	
24/02/2019	04:08:03	CC05_ST01	Still	181275_CC05_ST01_12	422		346 363	5 957 528	346 285.3	5 957 575.1	90.5	
24/02/2019	04:08:38	CC05_ST01	Still	181275_CC05_ST01_13	423		346 363	5 957 528	346 292.3	5 957 570.0	81.8	
24/02/2019	04:09:21	CC05_ST01	Still	181275_CC05_ST01_14	424		346 363	5 957 528	346 302.0	5 957 561.6	69.2	
24/02/2019	04:10:16	CC05_ST01	Still	181275_CC05_ST01_15	425		346 363	5 957 528	346 314.7	5 957 556.8	55.8	
24/02/2019	04:10:42	CC05_ST01	Still	181275_CC05_ST01_16	426		346 363	5 957 528	346 320.9	5 957 556.0	50.1	
24/02/2019	04:11:24	CC05_ST01	Still	181275_CC05_ST01_17	427		346 363	5 957 528	346 330.4	5 957 556.0	42.6	
24/02/2019	04:11:51	CC05_ST01	Still	181275_CC05_ST01_18	428		346 363	5 957 528	346 335.4	5 957 554.5	37.9	
24/02/2019	04:12:31	CC05_ST01	Still	181275_CC05_ST01_19	429		346 363	5 957 528	346 342.1	5 957 552.1	31.5	
24/02/2019	04:13:32	CC05_ST01	Still	181275_CC05_ST01_20	430		346 363	5 957 528	346 350.1	5 957 544.4	20.5	
24/02/2019	04:15:53	CC05_ST01	Still	181275_CC05_ST01_21	431		346 363	5 957 528	346 373.4	5 957 518.8	14.3	
24/02/2019	04:16:07	CC05_ST01	Still	181275_CC05_ST01_22	432		346 363	5 957 528	346 376.1	5 957 516.1	18.1	
24/02/2019	04:16:27	CC05_ST01	Still	181275_CC05_ST01_23	433		346 363	5 957 528	346 379.3	5 957 513.5	22.3	
24/02/2019	04:16:38	CC05_ST01	Still	181275_CC05_ST01_24	434		346 363	5 957 528	346 380.9	5 957 511.6	24.7	
24/02/2019	04:16:59	CC05_ST01	Still	181275_CC05_ST01_25	435		346 363	5 957 528	346 384.2	5 957 509.9	28.3	
24/02/2019	04:17:09	CC05_ST01	Still	181275_CC05_ST01_26	436		346 363	5 957 528	346 385.9	5 957 508.6	30.4	
24/02/2019	04:17:09	CC05_ST01	Video	EOL	436		346 363	5 957 528	346 385.9	5 957 508.6	30.4	
24/02/2019	04:42:59	CC05_ST01	DVV	PC/FA	437	81	346 363	5 957 528	346 332.3	5 957 528.3	30.3	
24/02/2019	05:06:38	CC05_ST01	DVV	FB	438	81	346 363	5 957 528	346 339.6	5 957 506.9	31.3	
24/02/2019	05:36:21	PE_ST11	Still	181275_PE_ST11_01								Site slate
24/02/2019	05:46:22	PE_ST11	Video	SOL	440	76	349 831	5 958 622	349 715.1	5 958 536.7	143.9	
24/02/2019	05:46:22	PE_ST11	Still	181275_PE_ST11_02	440		349 831	5 958 622	349 715.1	5 958 536.7	143.9	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	05:46:59	PE_ST11	Still	181275_PE_ST11_03	441		349 831	5 958 622	349 729.2	5 958 538.1	132.0	
24/02/2019	05:47:19	PE_ST11	Still	181275_PE_ST11_04	442		349 831	5 958 622	349 733.9	5 958 539.6	127.3	
24/02/2019	05:47:40	PE_ST11	Still	181275_PE_ST11_05	443		349 831	5 958 622	349 738.5	5 958 542.2	122.2	
24/02/2019	05:47:58	PE_ST11	Still	181275_PE_ST11_06	444		349 831	5 958 622	349 741.7	5 958 543.9	118.6	
24/02/2019	05:48:15	PE_ST11	Still	181275_PE_ST11_07	445		349 831	5 958 622	349 746.3	5 958 545.9	113.9	
24/02/2019	05:49:00	PE_ST11	Still	181275_PE_ST11_08	446		349 831	5 958 622	349 762.8	5 958 548.0	100.7	
24/02/2019	05:50:03	PE_ST11	Still	181275_PE_ST11_09	447		349 831	5 958 622	349 773.2	5 958 555.5	88.1	
24/02/2019	05:50:36	PE_ST11	Still	181275_PE_ST11_10	448		349 831	5 958 622	349 774.6	5 958 563.1	81.5	
24/02/2019	05:50:53	PE_ST11	Still	181275_PE_ST11_11	449		349 831	5 958 622	349 776.0	5 958 567.5	77.5	
24/02/2019	05:51:07	PE_ST11	Still	181275_PE_ST11_12	450		349 831	5 958 622	349 777.3	5 958 570.1	74.6	
24/02/2019	05:51:53	PE_ST11	Still	181275_PE_ST11_13	451		349 831	5 958 622	349 787.0	5 958 577.0	63.0	
24/02/2019	05:52:17	PE_ST11	Still	181275_PE_ST11_14	452		349 831	5 958 622	349 792.7	5 958 581.9	55.4	
24/02/2019	05:52:33	PE_ST11	Still	181275_PE_ST11_15	453		349 831	5 958 622	349 795.8	5 958 585.9	50.4	
24/02/2019	05:52:54	PE_ST11	Still	181275_PE_ST11_16	454		349 831	5 958 622	349 800.1	5 958 591.6	43.3	
24/02/2019	05:53:37	PE_ST11	Still	181275_PE_ST11_17	455		349 831	5 958 622	349 809.9	5 958 601.8	29.2	
24/02/2019	05:54:06	PE_ST11	Still	181275_PE_ST11_18	456		349 831	5 958 622	349 817.4	5 958 607.5	19.9	
24/02/2019	05:54:25	PE_ST11	Still	181275_PE_ST11_19	457		349 831	5 958 622	349 822.1	5 958 612.0	13.3	
24/02/2019	05:54:56	PE_ST11	Still	181275_PE_ST11_20	458		349 831	5 958 622	349 829.7	5 958 618.2	4.0	
24/02/2019	05:55:07	PE_ST11	Still	181275_PE_ST11_21	459		349 831	5 958 622	349 832.1	5 958 620.4	1.9	
24/02/2019	05:55:25	PE_ST11	Still	181275_PE_ST11_22	460		349 831	5 958 622	349 837.2	5 958 623.2	6.3	
24/02/2019	05:55:25	PE_ST11	Video	EOL	460	75	349 831	5 958 622	349 837.2	5 958 623.2	6.3	
24/02/2019	06:18:54	PE_ST11	DVV	PC/FA	461	75	349 831	5 958 622	349 797.6	5 958 638.6	37.3	
24/02/2019	06:38:11	PE_ST11	DVV	FB	462	75	349 831	5 958 622	349 856.8	5 958 621.1	25.8	
24/02/2019	07:07:22	PE_ST10	Still	181275_PE_ST10_01								Site slate
24/02/2019	07:13:51	PE_ST10	Video	SOL	465	71	352 850	5 960 071	352 779.8	5 960 017.9	88.0	
24/02/2019	07:13:51	PE_ST10	Still	181275_PE_ST10_02	465		352 850	5 960 071	352 779.8	5 960 017.9	88.0	
24/02/2019	07:14:36	PE_ST10	Still	181275_PE_ST10_03	466		352 850	5 960 071	352 794.1	5 960 025.4	72.2	
24/02/2019	07:14:55	PE_ST10	Still	181275_PE_ST10_04	467		352 850	5 960 071	352 799.1	5 960 030.3	65.2	
24/02/2019	07:15:26	PE_ST10	Still	181275_PE_ST10_05	468		352 850	5 960 071	352 808.2	5 960 039.7	52.2	
24/02/2019	07:15:37	PE_ST10	Still	181275_PE_ST10_06	469		352 850	5 960 071	352 811.5	5 960 043.5	47.3	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	07:15:48	PE_ST10	Still	181275_PE_ST10_07	470		352 850	5 960 071	352 815.0	5 960 046.4	42.8	
24/02/2019	07:16:10	PE_ST10	Still	181275_PE_ST10_08	471		352 850	5 960 071	352 819.8	5 960 053.4	35.0	
24/02/2019	07:16:28	PE_ST10	Still	181275_PE_ST10_09	472		352 850	5 960 071	352 823.0	5 960 057.3	30.3	
24/02/2019	07:16:38	PE_ST10	Still	181275_PE_ST10_10	473		352 850	5 960 071	352 824.6	5 960 059.8	27.8	
24/02/2019	07:17:06	PE_ST10	Still	181275_PE_ST10_11	474		352 850	5 960 071	352 831.2	5 960 061.1	21.2	
24/02/2019	07:17:45	PE_ST10	Still	181275_PE_ST10_12	475		352 850	5 960 071	352 845.9	5 960 058.3	13.3	
24/02/2019	07:18:35	PE_ST10	Still	181275_PE_ST10_13	476		352 850	5 960 071	352 857.0	5 960 064.0	9.9	
24/02/2019	07:18:56	PE_ST10	Still	181275_PE_ST10_14	477		352 850	5 960 071	352 859.2	5 960 069.0	9.4	
24/02/2019	07:19:10	PE_ST10	Still	181275_PE_ST10_15	478		352 850	5 960 071	352 861.0	5 960 071.5	11.0	
24/02/2019	07:19:42	PE_ST10	Still	181275_PE_ST10_16	479		352 850	5 960 071	352 865.3	5 960 076.2	16.1	
24/02/2019	07:19:56	PE_ST10	Still	181275_PE_ST10_17	480		352 850	5 960 071	352 867.4	5 960 078.5	19.0	
24/02/2019	07:20:14	PE_ST10	Still	181275_PE_ST10_18	481		352 850	5 960 071	352 870.1	5 960 081.0	22.4	
24/02/2019	07:20:14	PE_ST10	Video	EOL	481	70	352 850	5 960 071	352 870.1	5 960 081.0	22.4	
24/02/2019	09:04:50	PE_ST09A	Still	181275_PE_ST09A_01								Site slate
24/02/2019	09:14:34	PE_ST09A	Video	SOL	486	71	357 363	5 962 262	357 369.9	5 962 237.4	25.5	
24/02/2019	09:14:34	PE_ST09A	Still	181275_PE_ST09A_02	486		357 363	5 962 262	357 369.9	5 962 237.4	25.5	
24/02/2019	09:14:52	PE_ST09A	Still	181275_PE_ST09A_03	487		357 363	5 962 262	357 366.1	5 962 242.5	19.7	
24/02/2019	09:15:01	PE_ST09A	Still	181275_PE_ST09A_04	488		357 363	5 962 262	357 363.9	5 962 245.1	16.9	
24/02/2019	09:15:10	PE_ST09A	Still	181275_PE_ST09A_05	489		357 363	5 962 262	357 362.4	5 962 247.7	14.4	
24/02/2019	09:15:22	PE_ST09A	Still	181275_PE_ST09A_06	490		357 363	5 962 262	357 359.7	5 962 251.3	11.2	
24/02/2019	09:15:45	PE_ST09A	Still	181275_PE_ST09A_07	491		357 363	5 962 262	357 355.3	5 962 257.8	8.8	
24/02/2019	09:15:55	PE_ST09A	Still	181275_PE_ST09A_08	492		357 363	5 962 262	357 353.5	5 962 260.4	9.6	
24/02/2019	09:16:10	PE_ST09A	Still	181275_PE_ST09A_09	493		357 363	5 962 262	357 350.2	5 962 264.7	13.1	
24/02/2019	09:16:23	PE_ST09A	Still	181275_PE_ST09A_10	494		357 363	5 962 262	357 347.8	5 962 268.2	16.4	
24/02/2019	09:16:33	PE_ST09A	Still	181275_PE_ST09A_11	495		357 363	5 962 262	357 346.0	5 962 271.4	19.4	
24/02/2019	09:17:01	PE_ST09A	Still	181275_PE_ST09A_12	496		357 363	5 962 262	357 340.2	5 962 280.0	29.1	
24/02/2019	09:17:17	PE_ST09A	Still	181275_PE_ST09A_13	497		357 363	5 962 262	357 336.4	5 962 285.5	35.5	
24/02/2019	09:17:38	PE_ST09A	Still	181275_PE_ST09A_14	498		357 363	5 962 262	357 332.6	5 962 291.6	42.4	
24/02/2019	09:17:55	PE_ST09A	Still	181275_PE_ST09A_15	499		357 363	5 962 262	357 328.7	5 962 297.5	49.4	
24/02/2019	09:18:25	PE_ST09A	Still	181275_PE_ST09A_16	500		357 363	5 962 262	357 322.2	5 962 307.2	60.9	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	09:18:45	PE_ST09A	Still	181275_PE_ST09A_17	501		357 363	5 962 262	357 316.8	5 962 312.8	68.6	
24/02/2019	09:19:06	PE_ST09A	Still	181275_PE_ST09A_18	502		357 363	5 962 262	357 312.9	5 962 319.6	76.4	
24/02/2019	09:19:22	PE_ST09A	Still	181275_PE_ST09A_19	503		357 363	5 962 262	357 309.4	5 962 324.0	82.0	
24/02/2019	09:19:22	PE_ST09A	Video	EOL	503	70	357 363	5 962 262	357 309.4	5 962 324.0	82.0	
24/02/2019	10:29:17	PE_ST08	Still	181275_PE_ST08_01								Site slate
24/02/2019	10:38:55	PE_ST08	Still	181275_PE_ST08_02	507	76	362 072	5 964 583	362 072.0	5 964 615.6	32.6	
24/02/2019	10:39:13	PE_ST08	Still	181275_PE_ST08_03	NF		362 072	5 964 583	-	-	-	
24/02/2019	10:47:39	PE_ST08A	Still	181275_PE_ST08A_01								Site slate
24/02/2019	10:55:49	PE_ST08A	Video	SOL	508	76	362 072	5 964 583	362 095.7	5 964 547.1	43.0	
24/02/2019	10:55:49	PE_ST08A	Still	181275_PE_ST08A_02	508		362 072	5 964 583	362 095.7	5 964 547.1	43.0	
24/02/2019	10:56:12	PE_ST08A	Still	181275_PE_ST08A_03	509		362 072	5 964 583	362 099.8	5 964 559.6	36.3	
24/02/2019	10:56:36	PE_ST08A	Still	181275_PE_ST08A_04	510		362 072	5 964 583	362 103.6	5 964 572.4	33.4	
24/02/2019	10:56:56	PE_ST08A	Still	181275_PE_ST08A_05	511		362 072	5 964 583	362 106.2	5 964 583.3	34.2	
24/02/2019	10:57:15	PE_ST08A	Still	181275_PE_ST08A_06	512		362 072	5 964 583	362 109.5	5 964 593.5	38.9	
24/02/2019	10:57:29	PE_ST08A	Still	181275_PE_ST08A_07	513		362 072	5 964 583	362 111.2	5 964 601.0	43.2	
24/02/2019	10:57:44	PE_ST08A	Still	181275_PE_ST08A_08	514		362 072	5 964 583	362 115.0	5 964 609.2	50.4	
24/02/2019	10:58:09	PE_ST08A	Still	181275_PE_ST08A_09	515		362 072	5 964 583	362 118.1	5 964 621.3	59.9	
24/02/2019	10:58:29	PE_ST08A	Still	181275_PE_ST08A_10	516		362 072	5 964 583	362 121.1	5 964 630.4	68.2	
24/02/2019	10:58:43	PE_ST08A	Still	181275_PE_ST08A_11	517		362 072	5 964 583	362 123.0	5 964 636.7	74.0	
24/02/2019	10:58:57	PE_ST08A	Still	181275_PE_ST08A_12	518		362 072	5 964 583	362 126.0	5 964 643.3	80.9	
24/02/2019	10:59:09	PE_ST08A	Still	181275_PE_ST08A_13	519		362 072	5 964 583	362 125.9	5 964 647.9	84.4	
24/02/2019	10:59:43	PE_ST08A	Still	181275_PE_ST08A_14	520		362 072	5 964 583	362 132.3	5 964 662.5	99.8	
24/02/2019	11:00:13	PE_ST08A	Still	181275_PE_ST08A_15	521		362 072	5 964 583	362 137.6	5 964 675.9	113.7	
24/02/2019	11:00:36	PE_ST08A	Still	181275_PE_ST08A_16	522		362 072	5 964 583	362 141.4	5 964 685.6	123.9	
24/02/2019	11:00:45	PE_ST08A	Still	181275_PE_ST08A_17	523		362 072	5 964 583	362 142.8	5 964 689.6	128.0	
24/02/2019	11:00:59	PE_ST08A	Still	181275_PE_ST08A_18	524		362 072	5 964 583	362 145.0	5 964 696.6	135.0	
24/02/2019	11:00:59	PE_ST08A	Video	EOL	524	77	362 072	5 964 583	362 145.0	5 964 696.6	135.0	
24/02/2019	11:13:29	PE_ST08	DVV	FA/NS	525	77	362 072	5 964 583	362 103.0	5 964 594.7	33.2	
24/02/2019	11:23:34	PE_ST08	DVV	PC/NS	526	77	362 072	5 964 583	362 090.5	5 964 578.9	19.0	
24/02/2019	11:38:17	PE_ST08	DVV	FB	527		362 072	5 964 583	362 063.4	5 964 599.9	18.9	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	12:40:26	PE_ST07	Still	181275_PE_ST07_01								Site slate
24/02/2019	13:56:09	PE_ST07	Video	SOL	529	71	370 210	5 973 875	370 176.8	5 973 932.9	66.7	
24/02/2019	13:56:09	PE_ST07	Still	181275_PE_ST07_02	529		370 210	5 973 875	370 176.8	5 973 932.9	66.7	
24/02/2019	13:56:38	PE_ST07	Still	181275_PE_ST07_03	530		370 210	5 973 875	370 181.8	5 973 930.0	61.8	
24/02/2019	13:56:54	PE_ST07	Still	181275_PE_ST07_04	531		370 210	5 973 875	370 182.8	5 973 928.2	59.7	
24/02/2019	13:57:03	PE_ST07	Still	181275_PE_ST07_05	532		370 210	5 973 875	370 183.1	5 973 927.1	58.6	
24/02/2019	13:57:12	PE_ST07	Still	181275_PE_ST07_06	533		370 210	5 973 875	370 182.4	5 973 925.5	57.6	
24/02/2019	13:57:24	PE_ST07	Still	181275_PE_ST07_07	534		370 210	5 973 875	370 181.5	5 973 923.7	56.4	
24/02/2019	13:57:34	PE_ST07	Still	181275_PE_ST07_08	535		370 210	5 973 875	370 180.3	5 973 921.3	55.0	
24/02/2019	13:58:07	PE_ST07	Still	181275_PE_ST07_09	536		370 210	5 973 875	370 177.0	5 973 914.3	51.4	
24/02/2019	13:58:27	PE_ST07	Still	181275_PE_ST07_10	537		370 210	5 973 875	370 175.5	5 973 909.7	48.9	
24/02/2019	13:58:41	PE_ST07	Still	181275_PE_ST07_11	538		370 210	5 973 875	370 175.9	5 973 904.8	45.3	
24/02/2019	13:58:52	PE_ST07	Still	181275_PE_ST07_12	539		370 210	5 973 875	370 176.9	5 973 901.4	42.4	
24/02/2019	13:58:59	PE_ST07	Still	181275_PE_ST07_13	540		370 210	5 973 875	370 177.6	5 973 898.9	40.3	
24/02/2019	13:59:12	PE_ST07	Still	181275_PE_ST07_14	541		370 210	5 973 875	370 179.3	5 973 894.4	36.4	
24/02/2019	13:59:34	PE_ST07	Still	181275_PE_ST07_15	542		370 210	5 973 875	370 183.3	5 973 888.7	30.0	
24/02/2019	13:59:55	PE_ST07	Still	181275_PE_ST07_16	543		370 210	5 973 875	370 187.4	5 973 883.6	24.1	
24/02/2019	14:00:11	PE_ST07	Still	181275_PE_ST07_17	544		370 210	5 973 875	370 191.7	5 973 880.0	19.0	
24/02/2019	14:00:23	PE_ST07	Still	181275_PE_ST07_18	545		370 210	5 973 875	370 195.6	5 973 877.0	14.5	
24/02/2019	14:00:32	PE_ST07	Still	181275_PE_ST07_19	546		370 210	5 973 875	370 199.0	5 973 875.4	11.0	
24/02/2019	14:01:03	PE_ST07	Still	181275_PE_ST07_20	547		370 210	5 973 875	370 214.7	5 973 872.3	5.4	
24/02/2019	14:01:17	PE_ST07	Still	181275_PE_ST07_21	548		370 210	5 973 875	370 221.2	5 973 873.9	11.3	
24/02/2019	14:01:30	PE_ST07	Still	181275_PE_ST07_22	549		370 210	5 973 875	370 226.4	5 973 876.4	16.4	
24/02/2019	14:01:39	PE_ST07	Still	181275_PE_ST07_23	550		370 210	5 973 875	370 230.1	5 973 878.5	20.4	
24/02/2019	14:01:49	PE_ST07	Still	181275_PE_ST07_24	551		370 210	5 973 875	370 233.9	5 973 879.9	24.4	
24/02/2019	14:02:06	PE_ST07	Still	181275_PE_ST07_25	552		370 210	5 973 875	370 239.6	5 973 882.7	30.6	
24/02/2019	14:02:26	PE_ST07	Still	181275_PE_ST07_26	553		370 210	5 973 875	370 245.8	5 973 881.8	36.4	
24/02/2019	14:02:26	PE_ST07	Video	EOL	553	72	370 210	5 973 875	370 245.8	5 973 881.8	36.4	
24/02/2019	14:24:20	PE_ST07	DVV	PC/NS	554	70	370 210	5 973 875	370 200.5	5 973 868.8	11.4	
24/02/2019	14:43:36	PE_ST07	DVV	NS/NS	555	70	370 210	5 973 875	370 195.4	5 973 857.8	22.6	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	14:55:42	PE_ST07	DVV	NS/NS	556	70	370 210	5 973 875	370 217.8	5 973 887.1	14.4	
24/02/2019	15:03:42	PE_ST07	DVV	FA/FB	557	70	370 210	5 973 875	370 217.9	5 973 861.9	15.3	
24/02/2019	15:56:46	CC04_T01	Still	181275_CC04_T01_01								Site slate
24/02/2019	15:56:48	CC04_T01	Still	181275_CC04_T01_02								Site slate
24/02/2019	16:21:37	CC04_T01	Video	SOL	559	71	370 377	5 975 486	370 261.0	5 975 570.2	143.4	
24/02/2019	16:21:37	CC04_T01	Still	181275_CC04_T01_03	559		370 377	5 975 486	370 261.0	5 975 570.2	143.4	
24/02/2019	16:22:57	CC04_T01	Still	181275_CC04_T01_04	560		370 377	5 975 486	370 293.6	5 975 550.4	105.4	
24/02/2019	16:23:21	CC04_T01	Still	181275_CC04_T01_05	561		370 377	5 975 486	370 302.7	5 975 546.1	95.6	
24/02/2019	16:23:33	CC04_T01	Still	181275_CC04_T01_06	562		370 377	5 975 486	370 305.4	5 975 544.6	92.6	
24/02/2019	16:23:51	CC04_T01	Still	181275_CC04_T01_07	563		370 377	5 975 486	370 308.8	5 975 540.7	87.5	
24/02/2019	16:24:10	CC04_T01	Still	181275_CC04_T01_08	564		370 377	5 975 486	370 311.5	5 975 535.5	82.2	
24/02/2019	16:24:27	CC04_T01	Still	181275_CC04_T01_09	565		370 377	5 975 486	370 314.6	5 975 531.0	77.0	
24/02/2019	16:24:37	CC04_T01	Still	181275_CC04_T01_10	566		370 377	5 975 486	370 316.7	5 975 528.1	73.6	
24/02/2019	16:24:50	CC04_T01	Still	181275_CC04_T01_11	567		370 377	5 975 486	370 319.8	5 975 523.7	68.6	
24/02/2019	16:25:01	CC04_T01	Still	181275_CC04_T01_12	568		370 377	5 975 486	370 322.9	5 975 520.4	64.2	
24/02/2019	16:25:15	CC04_T01	Still	181275_CC04_T01_13	569		370 377	5 975 486	370 327.4	5 975 515.1	57.6	
24/02/2019	16:25:33	CC04_T01	Still	181275_CC04_T01_14	570		370 377	5 975 486	370 334.9	5 975 509.8	48.5	
24/02/2019	16:25:44	CC04_T01	Still	181275_CC04_T01_15	571		370 377	5 975 486	370 339.2	5 975 507.4	43.5	
24/02/2019	16:25:59	CC04_T01	Still	181275_CC04_T01_16	572		370 377	5 975 486	370 346.1	5 975 504.9	36.3	
24/02/2019	16:26:30	CC04_T01	Still	181275_CC04_T01_17	573		370 377	5 975 486	370 362.0	5 975 498.2	19.3	
24/02/2019	16:26:52	CC04_T01	Still	181275_CC04_T01_18	574		370 377	5 975 486	370 373.4	5 975 491.1	6.2	
24/02/2019	16:27:01	CC04_T01	Still	181275_CC04_T01_19	575		370 377	5 975 486	370 377.0	5 975 487.4	1.1	
24/02/2019	16:27:17	CC04_T01	Still	181275_CC04_T01_20	576		370 377	5 975 486	370 383.2	5 975 478.9	9.4	
24/02/2019	16:27:26	CC04_T01	Still	181275_CC04_T01_21	577		370 377	5 975 486	370 385.3	5 975 475.0	13.8	
24/02/2019	16:27:52	CC04_T01	Still	181275_CC04_T01_22	578		370 377	5 975 486	370 390.7	5 975 467.4	23.2	
24/02/2019	16:28:33	CC04_T01	Still	181275_CC04_T01_23	579		370 377	5 975 486	370 400.4	5 975 458.4	36.2	
24/02/2019	16:28:41	CC04_T01	Still	181275_CC04_T01_24	580		370 377	5 975 486	370 403.3	5 975 457.1	39.1	
24/02/2019	16:28:53	CC04_T01	Still	181275_CC04_T01_25	581		370 377	5 975 486	370 407.9	5 975 455.3	43.5	
24/02/2019	16:29:11	CC04_T01	Still	181275_CC04_T01_26	582		370 377	5 975 486	370 416.1	5 975 452.1	51.7	
24/02/2019	16:29:43	CC04_T01	Still	181275_CC04_T01_27	583		370 377	5 975 486	370 432.9	5 975 443.9	69.9	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	16:29:54	CC04_T01	Still	181275_CC04_T01_28	584		370 377	5 975 486	370 439.0	5 975 440.0	77.1	
24/02/2019	16:30:11	CC04_T01	Still	181275_CC04_T01_29	585		370 377	5 975 486	370 445.6	5 975 434.7	85.6	
24/02/2019	16:30:30	CC04_T01	Still	181275_CC04_T01_30	586		370 377	5 975 486	370 450.9	5 975 429.4	93.0	
24/02/2019	16:31:02	CC04_T01	Still	181275_CC04_T01_31	587		370 377	5 975 486	370 456.3	5 975 422.1	101.8	
24/02/2019	16:31:41	CC04_T01	Still	181275_CC04_T01_32	588		370 377	5 975 486	370 460.0	5 975 413.3	110.3	
24/02/2019	16:32:01	CC04_T01	Still	181275_CC04_T01_33	589		370 377	5 975 486	370 463.1	5 975 409.6	115.0	
24/02/2019	16:32:31	CC04_T01	Still	181275_CC04_T01_34	590		370 377	5 975 486	370 471.6	5 975 405.1	124.5	
24/02/2019	16:32:55	CC04_T01	Still	181275_CC04_T01_35	591		370 377	5 975 486	370 481.5	5 975 400.0	135.3	
24/02/2019	16:33:05	CC04_T01	Still	181275_CC04_T01_36	592		370 377	5 975 486	370 485.5	5 975 397.4	140.1	
24/02/2019	16:33:19	CC04_T01	Still	181275_CC04_T01_37	593		370 377	5 975 486	370 490.8	5 975 393.1	146.9	
24/02/2019	16:33:31	CC04_T01	Still	181275_CC04_T01_38	594		370 377	5 975 486	370 494.2	5 975 390.4	151.2	
24/02/2019	16:33:46	CC04_T01	Still	181275_CC04_T01_39	595		370 377	5 975 486	370 497.8	5 975 386.4	156.5	
24/02/2019	16:33:46	CC04_T01	Video	EOL	595	69	370 377	5 975 486	370 497.8	5 975 386.4	156.5	
24/02/2019	16:54:24	CC04_T02	Still	181275_CC04_T02_01								Site slate
24/02/2019	18:02:16	CC04_T02A	Still	181275_CC04_T02A_01								Site slate
24/02/2019	18:32:44	CC04_T02A	Video	SOL	598	70	370 377	5 975 486	370 211.2	5 975 364.8	205.9	
24/02/2019	18:32:44	CC04_T02A	Still	181275_CC04_T02A_02	598		370 377	5 975 486	370 211.2	5 975 364.8	205.9	
24/02/2019	18:33:03	CC04_T02A	Still	181275_CC04_T02A_03	599		370 377	5 975 486	370 217.9	5 975 372.3	196.0	
24/02/2019	18:33:17	CC04_T02A	Still	181275_CC04_T02A_04	600		370 377	5 975 486	370 222.6	5 975 376.4	189.8	
24/02/2019	18:33:32	CC04_T02A	Still	181275_CC04_T02A_05	601		370 377	5 975 486	370 225.8	5 975 381.3	184.3	
24/02/2019	18:33:52	CC04_T02A	Still	181275_CC04_T02A_06	602		370 377	5 975 486	370 229.9	5 975 385.6	178.5	
24/02/2019	18:34:07	CC04_T02A	Still	181275_CC04_T02A_07	603		370 377	5 975 486	370 232.8	5 975 389.4	174.0	
24/02/2019	18:34:24	CC04_T02A	Still	181275_CC04_T02A_08	604		370 377	5 975 486	370 236.3	5 975 394.2	168.4	
24/02/2019	18:34:42	CC04_T02A	Still	181275_CC04_T02A_09	605		370 377	5 975 486	370 240.2	5 975 399.1	162.5	
24/02/2019	18:35:19	CC04_T02A	Still	181275_CC04_T02A_10	606		370 377	5 975 486	370 253.1	5 975 405.0	148.4	
24/02/2019	18:35:47	CC04_T02A	Still	181275_CC04_T02A_11	607		370 377	5 975 486	370 265.9	5 975 406.4	137.1	
24/02/2019	18:36:18	CC04_T02A	Still	181275_CC04_T02A_12	608		370 377	5 975 486	370 278.0	5 975 410.6	124.9	
24/02/2019	18:37:00	CC04_T02A	Still	181275_CC04_T02A_13	609		370 377	5 975 486	370 290.5	5 975 423.4	107.2	
24/02/2019	18:37:31	CC04_T02A	Still	181275_CC04_T02A_14	610		370 377	5 975 486	370 298.8	5 975 431.7	95.6	
24/02/2019	18:38:13	CC04_T02A	Still	181275_CC04_T02A_15	611		370 377	5 975 486	370 310.3	5 975 439.0	82.0	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	18:38:41	CC04_T02A	Still	181275_CC04_T02A_16	612		370 377	5 975 486	370 318.9	5 975 442.4	73.1	
24/02/2019	18:39:03	CC04_T02A	Still	181275_CC04_T02A_17	613		370 377	5 975 486	370 325.8	5 975 444.7	66.2	
24/02/2019	18:39:18	CC04_T02A	Still	181275_CC04_T02A_18	614		370 377	5 975 486	370 330.1	5 975 447.2	61.3	
24/02/2019	18:39:44	CC04_T02A	Still	181275_CC04_T02A_19	615		370 377	5 975 486	370 337.1	5 975 454.3	51.4	
24/02/2019	18:40:19	CC04_T02A	Still	181275_CC04_T02A_20	616		370 377	5 975 486	370 346.2	5 975 462.8	39.0	
24/02/2019	18:40:36	CC04_T02A	Still	181275_CC04_T02A_21	617		370 377	5 975 486	370 350.2	5 975 466.3	33.7	
24/02/2019	18:41:22	CC04_T02A	Still	181275_CC04_T02A_22	618		370 377	5 975 486	370 362.9	5 975 468.2	23.1	
24/02/2019	18:41:41	CC04_T02A	Still	181275_CC04_T02A_23	619		370 377	5 975 486	370 367.6	5 975 471.3	17.9	
24/02/2019	18:42:09	CC04_T02A	Still	181275_CC04_T02A_24	620		370 377	5 975 486	370 375.1	5 975 477.4	9.2	
24/02/2019	18:42:19	CC04_T02A	Still	181275_CC04_T02A_25	621		370 377	5 975 486	370 376.7	5 975 481.7	4.7	
24/02/2019	18:42:32	CC04_T02A	Still	181275_CC04_T02A_26	622		370 377	5 975 486	370 380.4	5 975 486.6	3.1	
24/02/2019	18:42:45	CC04_T02A	Still	181275_CC04_T02A_27	623		370 377	5 975 486	370 382.3	5 975 492.2	7.7	
24/02/2019	18:43:43	CC04_T02A	Still	181275_CC04_T02A_28	624		370 377	5 975 486	370 394.2	5 975 509.4	28.6	
24/02/2019	18:44:11	CC04_T02A	Still	181275_CC04_T02A_29	625		370 377	5 975 486	370 401.4	5 975 515.1	37.5	
24/02/2019	18:44:33	CC04_T02A	Still	181275_CC04_T02A_30	626		370 377	5 975 486	370 407.2	5 975 518.1	43.7	
24/02/2019	18:45:19	CC04_T02A	Still	181275_CC04_T02A_31	627		370 377	5 975 486	370 418.8	5 975 524.4	56.3	
24/02/2019	18:45:53	CC04_T02A	Still	181275_CC04_T02A_32	628		370 377	5 975 486	370 427.8	5 975 528.2	65.6	
24/02/2019	18:46:28	CC04_T02A	Still	181275_CC04_T02A_33	629		370 377	5 975 486	370 438.4	5 975 532.5	76.6	
24/02/2019	18:46:41	CC04_T02A	Still	181275_CC04_T02A_34	630		370 377	5 975 486	370 442.2	5 975 535.0	81.1	
24/02/2019	18:46:55	CC04_T02A	Still	181275_CC04_T02A_35	631		370 377	5 975 486	370 447.0	5 975 537.9	86.7	
24/02/2019	18:47:04	CC04_T02A	Still	181275_CC04_T02A_36	632		370 377	5 975 486	370 449.5	5 975 539.6	89.8	
24/02/2019	18:47:32	CC04_T02A	Still	181275_CC04_T02A_37	633		370 377	5 975 486	370 458.0	5 975 545.3	100.0	
24/02/2019	18:47:42	CC04_T02A	Still	181275_CC04_T02A_38	634		370 377	5 975 486	370 461.0	5 975 547.4	103.6	
24/02/2019	18:47:59	CC04_T02A	Still	181275_CC04_T02A_39	635		370 377	5 975 486	370 466.8	5 975 551.3	110.6	
24/02/2019	18:48:23	CC04_T02A	Still	181275_CC04_T02A_40	636		370 377	5 975 486	370 474.1	5 975 555.7	119.1	
24/02/2019	18:48:36	CC04_T02A	Still	181275_CC04_T02A_41	NF		370 377	5 975 486	-	-	-	
24/02/2019	18:49:00	CC04_T02A	Still	181275_CC04_T02A_42	637		370 377	5 975 486	370 485.7	5 975 564.0	133.4	
24/02/2019	18:49:16	CC04_T02A	Still	181275_CC04_T02A_43	638		370 377	5 975 486	370 490.3	5 975 567.9	139.4	
24/02/2019	18:49:57	CC04_T02A	Still	181275_CC04_T02A_44	639		370 377	5 975 486	370 502.8	5 975 576.2	154.4	
24/02/2019	18:49:57	CC04_T02A	Video	EOL	639	66	370 377	5 975 486	370 502.8	5 975 576.2	154.4	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	19:31:02	PE_ST06	Still	181275_PE_ST06_01								Site slate
24/02/2019	19:53:15	PE_ST06	Video	SOL	641	63	370 665	5 976 483	370 598.0	5 976 442.1	78.4	
24/02/2019	19:53:15	PE_ST06	Still	181275_PE_ST06_02	641		370 665	5 976 483	370 598.0	5 976 442.1	78.4	
24/02/2019	19:53:39	PE_ST06	Still	181275_PE_ST06_03	642		370 665	5 976 483	370 603.2	5 976 449.8	70.1	
24/02/2019	19:53:51	PE_ST06	Still	181275_PE_ST06_04	643		370 665	5 976 483	370 605.8	5 976 454.1	65.9	
24/02/2019	19:54:04	PE_ST06	Still	181275_PE_ST06_05	644		370 665	5 976 483	370 608.5	5 976 458.3	61.7	
24/02/2019	19:54:19	PE_ST06	Still	181275_PE_ST06_06	645		370 665	5 976 483	370 612.0	5 976 464.0	56.4	
24/02/2019	19:54:46	PE_ST06	Still	181275_PE_ST06_07	646		370 665	5 976 483	370 617.2	5 976 473.0	49.0	
24/02/2019	19:55:09	PE_ST06	Still	181275_PE_ST06_08	647		370 665	5 976 483	370 621.7	5 976 477.6	43.8	
24/02/2019	19:55:26	PE_ST06	Still	181275_PE_ST06_09	648		370 665	5 976 483	370 625.3	5 976 480.5	40.0	
24/02/2019	19:55:36	PE_ST06	Still	181275_PE_ST06_10	649		370 665	5 976 483	370 627.1	5 976 482.2	38.2	
24/02/2019	19:55:53	PE_ST06	Still	181275_PE_ST06_11	650		370 665	5 976 483	370 629.2	5 976 483.8	36.0	
24/02/2019	19:56:12	PE_ST06	Still	181275_PE_ST06_12	651		370 665	5 976 483	370 631.7	5 976 482.5	33.5	
24/02/2019	19:56:28	PE_ST06	Still	181275_PE_ST06_13	652		370 665	5 976 483	370 634.0	5 976 479.7	31.4	
24/02/2019	19:57:02	PE_ST06	Still	181275_PE_ST06_14	653		370 665	5 976 483	370 640.1	5 976 472.9	26.9	
24/02/2019	19:57:16	PE_ST06	Still	181275_PE_ST06_15	654		370 665	5 976 483	370 644.1	5 976 468.7	25.2	
24/02/2019	19:57:33	PE_ST06	Still	181275_PE_ST06_16	655		370 665	5 976 483	370 650.4	5 976 463.6	24.0	
24/02/2019	19:57:55	PE_ST06	Still	181275_PE_ST06_17	656		370 665	5 976 483	370 661.0	5 976 462.2	20.7	
24/02/2019	19:58:05	PE_ST06	Still	181275_PE_ST06_18	657		370 665	5 976 483	370 666.9	5 976 465.2	17.4	
24/02/2019	19:59:00	PE_ST06	Still	181275_PE_ST06_19	658		370 665	5 976 483	370 702.3	5 976 492.1	38.3	
24/02/2019	19:59:18	PE_ST06	Still	181275_PE_ST06_20	659		370 665	5 976 483	370 709.1	5 976 499.4	47.0	
24/02/2019	19:59:31	PE_ST06	Still	181275_PE_ST06_21	660		370 665	5 976 483	370 711.7	5 976 504.1	51.3	
24/02/2019	19:59:31	PE_ST06	Video	EOL	660	59	370 665	5 976 483	370 711.7	5 976 504.1	51.3	
24/02/2019	20:19:02	PE_ST06	DVV	PC/FA	661	58	370 665	5 976 483	370 658.2	5 976 474.7	10.5	
24/02/2019	20:31:54	PE_ST06	DVV	FB	662	55	370 665	5 976 483	370 637.8	5 976 494.6	30.0	
24/02/2019	21:24:26	PE_ST05	Still	181275_PE_ST05_01								Site slate
24/02/2019	21:35:05	PE_ST05	Video	SOL	664	49	371 543	5 981 359	371 522.5	5 981 280.8	80.8	
24/02/2019	21:35:05	PE_ST05	Still	181275_PE_ST05_02	664		371 543	5 981 359	371 522.5	5 981 280.8	80.8	
24/02/2019	21:35:23	PE_ST05	Still	181275_PE_ST05_03	665		371 543	5 981 359	371 523.8	5 981 283.7	77.8	
24/02/2019	21:36:13	PE_ST05	Still	181275_PE_ST05_04	666		371 543	5 981 359	371 526.8	5 981 293.1	67.9	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	21:36:27	PE_ST05	Still	181275_PE_ST05_05	667		371 543	5 981 359	371 527.5	5 981 295.4	65.4	
24/02/2019	21:36:58	PE_ST05	Still	181275_PE_ST05_06	668		371 543	5 981 359	371 529.5	5 981 301.1	59.4	
24/02/2019	21:37:21	PE_ST05	Still	181275_PE_ST05_07	669		371 543	5 981 359	371 531.1	5 981 304.2	56.1	
24/02/2019	21:38:08	PE_ST05	Still	181275_PE_ST05_08	671		371 543	5 981 359	371 532.1	5 981 313.7	46.6	
24/02/2019	21:39:12	PE_ST05	Still	181275_PE_ST05_09	672		371 543	5 981 359	371 532.7	5 981 325.2	35.3	
24/02/2019	21:39:37	PE_ST05	Still	181275_PE_ST05_10	673		371 543	5 981 359	371 532.7	5 981 328.5	32.2	
24/02/2019	21:40:12	PE_ST05	Still	181275_PE_ST05_11	674		371 543	5 981 359	371 531.8	5 981 334.0	27.4	
24/02/2019	21:40:45	PE_ST05	Still	181275_PE_ST05_12	675		371 543	5 981 359	371 530.9	5 981 339.2	23.2	
24/02/2019	21:41:03	PE_ST05	Still	181275_PE_ST05_13	676		371 543	5 981 359	371 529.6	5 981 342.6	21.2	
24/02/2019	21:41:24	PE_ST05	Still	181275_PE_ST05_14	677		371 543	5 981 359	371 529.0	5 981 345.1	19.8	
24/02/2019	21:42:30	PE_ST05	Still	181275_PE_ST05_15	678		371 543	5 981 359	371 528.9	5 981 357.6	14.1	
24/02/2019	21:42:40	PE_ST05	Still	181275_PE_ST05_16	679		371 543	5 981 359	371 528.7	5 981 359.3	14.3	
24/02/2019	21:43:30	PE_ST05	Still	181275_PE_ST05_17	680		371 543	5 981 359	371 531.9	5 981 370.3	15.8	
24/02/2019	21:44:13	PE_ST05	Still	181275_PE_ST05_18	681		371 543	5 981 359	371 537.1	5 981 379.5	21.3	
24/02/2019	21:44:38	PE_ST05	Still	181275_PE_ST05_19	682		371 543	5 981 359	371 540.2	5 981 385.9	27.1	
24/02/2019	21:44:38	PE_ST05	Video	EOL	682	49	371 543	5 981 359	371 540.2	5 981 385.9	27.1	
24/02/2019	21:57:55	PE_ST05	DVV	PC/FA	683	50	371 543	5 981 359	371 553.7	5 981 328.4	32.4	
24/02/2019	22:11:29	PE_ST05	DVV	FB	684	50	371 543	5 981 359	371 549.4	5 981 355.5	7.3	
24/02/2019	23:09:47	PE_ST04	Still	181275_PE_ST04_01								Site slate
24/02/2019	23:40:07	PE_ST04	Video	SOL	686	47	374 510	5 988 022	374 561.1	5 988 005.5	53.7	
24/02/2019	23:40:07	PE_ST04	Still	181275_PE_ST04_02	686		374 510	5 988 022	374 561.1	5 988 005.5	53.7	
24/02/2019	23:40:47	PE_ST04	Still	181275_PE_ST04_03	687		374 510	5 988 022	374 554.3	5 987 996.0	51.4	
24/02/2019	23:41:07	PE_ST04	Still	181275_PE_ST04_04	688		374 510	5 988 022	374 547.7	5 987 990.3	49.3	
24/02/2019	23:41:30	PE_ST04	Still	181275_PE_ST04_05	689		374 510	5 988 022	374 533.1	5 987 993.5	36.7	
24/02/2019	23:41:52	PE_ST04	Still	181275_PE_ST04_06	690		374 510	5 988 022	374 517.3	5 988 000.4	22.8	
24/02/2019	23:42:44	PE_ST04	Still	181275_PE_ST04_07	691		374 510	5 988 022	374 486.7	5 988 012.5	25.2	
24/02/2019	23:42:59	PE_ST04	Still	181275_PE_ST04_08	692		374 510	5 988 022	374 480.5	5 988 014.5	30.4	
24/02/2019	23:43:14	PE_ST04	Still	181275_PE_ST04_09	693		374 510	5 988 022	374 475.4	5 988 016.6	35.0	
24/02/2019	23:43:53	PE_ST04	Still	181275_PE_ST04_10	694		374 510	5 988 022	374 464.2	5 988 018.7	45.9	
24/02/2019	23:43:53	PE_ST04	Video	EOL	694	47	374 510	5 988 022	374 464.2	5 988 018.7	45.9	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	00:44:20	PE_ST04	DVV	PC/FA	695	47	374 510	5 988 022	374 497.1	5 988 023.4	13.0	
25/02/2019	00:58:05	PE_ST04	DVV	NT/NT	696	47	374 510	5 988 022	374 500.9	5 988 010.0	15.1	
25/02/2019	01:01:54	PE_ST04	DVV	NT/NT	697	47	374 510	5 988 022	374 513.1	5 987 999.7	22.5	
25/02/2019	01:04:06	PE_ST04	DVV	FB	698	47	374 510	5 988 022	374 496.9	5 988 015.6	14.6	
25/02/2019	03:19:03	CC03_T01	Still	181275_CC03_T01_01								Site slate
25/02/2019	03:25:58	CC03_T01	Video	SOL	700	53	396 861	5 973 227	396 650.0	5 973 365.3	252.1	
25/02/2019	03:25:58	CC03_T01	Still	181275_CC03_T01_02	700		396 861	5 973 227	396 650.0	5 973 365.3	252.1	
25/02/2019	03:26:25	CC03_T01	Still	181275_CC03_T01_03	701		396 861	5 973 227	396 660.4	5 973 362.8	242.2	
25/02/2019	03:26:54	CC03_T01	Still	181275_CC03_T01_04	702		396 861	5 973 227	396 671.0	5 973 361.6	232.8	
25/02/2019	03:27:29	CC03_T01	Still	181275_CC03_T01_05	703		396 861	5 973 227	396 683.3	5 973 359.3	221.4	
25/02/2019	03:27:53	CC03_T01	Still	181275_CC03_T01_06	704		396 861	5 973 227	396 692.0	5 973 358.8	214.2	
25/02/2019	03:28:06	CC03_T01	Still	181275_CC03_T01_07	705		396 861	5 973 227	396 696.8	5 973 357.5	209.6	
25/02/2019	03:28:30	CC03_T01	Still	181275_CC03_T01_08	706		396 861	5 973 227	396 705.6	5 973 355.8	201.6	
25/02/2019	03:29:16	CC03_T01	Still	181275_CC03_T01_09	707		396 861	5 973 227	396 723.3	5 973 353.9	187.1	
25/02/2019	03:29:27	CC03_T01	Still	181275_CC03_T01_10	708		396 861	5 973 227	396 727.3	5 973 352.8	183.5	
25/02/2019	03:30:07	CC03_T01	Still	181275_CC03_T01_11	709		396 861	5 973 227	396 742.4	5 973 351.6	171.9	
25/02/2019	03:30:58	CC03_T01	Still	181275_CC03_T01_12	710		396 861	5 973 227	396 758.5	5 973 350.0	159.9	
25/02/2019	03:31:12	CC03_T01	Still	181275_CC03_T01_13	711		396 861	5 973 227	396 762.1	5 973 348.5	156.6	
25/02/2019	03:31:41	CC03_T01	Still	181275_CC03_T01_14	712		396 861	5 973 227	396 768.0	5 973 344.0	149.3	
25/02/2019	03:32:04	CC03_T01	Still	181275_CC03_T01_15	713		396 861	5 973 227	396 771.4	5 973 337.7	142.3	
25/02/2019	03:32:16	CC03_T01	Still	181275_CC03_T01_16	714		396 861	5 973 227	396 772.5	5 973 333.3	138.2	
25/02/2019	03:32:33	CC03_T01	Still	181275_CC03_T01_17	715		396 861	5 973 227	396 772.8	5 973 326.7	132.9	
25/02/2019	03:32:53	CC03_T01	Still	181275_CC03_T01_18	716		396 861	5 973 227	396 772.4	5 973 318.0	126.9	
25/02/2019	03:33:27	CC03_T01	Still	181275_CC03_T01_19	717		396 861	5 973 227	396 771.3	5 973 303.9	118.0	
25/02/2019	03:33:42	CC03_T01	Still	181275_CC03_T01_20	718		396 861	5 973 227	396 771.1	5 973 297.8	114.3	
25/02/2019	03:34:12	CC03_T01	Still	181275_CC03_T01_21	719		396 861	5 973 227	396 771.9	5 973 284.3	105.8	
25/02/2019	03:34:49	CC03_T01	Still	181275_CC03_T01_22	720		396 861	5 973 227	396 778.8	5 973 269.6	92.5	
25/02/2019	03:35:17	CC03_T01	Still	181275_CC03_T01_23	721		396 861	5 973 227	396 787.7	5 973 259.8	80.2	
25/02/2019	03:35:56	CC03_T01	Still	181275_CC03_T01_24	722		396 861	5 973 227	396 804.8	5 973 244.3	58.7	
25/02/2019	03:36:43	CC03_T01	Still	181275_CC03_T01_25	723		396 861	5 973 227	396 829.6	5 973 225.3	31.4	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	03:37:17	CC03_T01	Still	181275_CC03_T01_26	724		396 861	5 973 227	396 844.8	5 973 212.5	21.7	
25/02/2019	03:37:46	CC03_T01	Still	181275_CC03_T01_27	725		396 861	5 973 227	396 855.8	5 973 203.1	24.5	
25/02/2019	03:38:09	CC03_T01	Still	181275_CC03_T01_28	726		396 861	5 973 227	396 863.4	5 973 196.1	31.1	
25/02/2019	03:39:01	CC03_T01	Still	181275_CC03_T01_29	727		396 861	5 973 227	396 878.9	5 973 185.3	45.5	
25/02/2019	03:39:22	CC03_T01	Still	181275_CC03_T01_30	728		396 861	5 973 227	396 884.2	5 973 182.3	50.5	
25/02/2019	03:39:52	CC03_T01	Still	181275_CC03_T01_31	729		396 861	5 973 227	396 891.4	5 973 178.0	57.8	
25/02/2019	03:40:32	CC03_T01	Still	181275_CC03_T01_32	730		396 861	5 973 227	396 900.4	5 973 173.1	66.9	
25/02/2019	03:40:56	CC03_T01	Still	181275_CC03_T01_33	731		396 861	5 973 227	396 905.7	5 973 170.8	72.0	
25/02/2019	03:41:23	CC03_T01	Still	181275_CC03_T01_34	732		396 861	5 973 227	396 911.6	5 973 164.4	80.6	
25/02/2019	03:42:08	CC03_T01	Still	181275_CC03_T01_35	733		396 861	5 973 227	396 921.6	5 973 154.2	94.8	
25/02/2019	03:42:40	CC03_T01	Still	181275_CC03_T01_36	734		396 861	5 973 227	396 928.9	5 973 147.3	104.9	
25/02/2019	03:42:56	CC03_T01	Still	181275_CC03_T01_37	735		396 861	5 973 227	396 932.8	5 973 145.2	109.0	
25/02/2019	03:43:16	CC03_T01	Still	181275_CC03_T01_38	736		396 861	5 973 227	396 937.3	5 973 141.7	114.6	
25/02/2019	03:43:55	CC03_T01	Still	181275_CC03_T01_39	737		396 861	5 973 227	396 945.6	5 973 134.5	125.5	
25/02/2019	03:44:33	CC03_T01	Still	181275_CC03_T01_40	738		396 861	5 973 227	396 953.8	5 973 127.0	136.6	
25/02/2019	03:45:00	CC03_T01	Still	181275_CC03_T01_41	739		396 861	5 973 227	396 959.7	5 973 121.4	144.7	
25/02/2019	03:45:24	CC03_T01	Still	181275_CC03_T01_42	740		396 861	5 973 227	396 964.6	5 973 116.1	152.0	
25/02/2019	03:45:40	CC03_T01	Still	181275_CC03_T01_43	741		396 861	5 973 227	396 967.9	5 973 113.1	156.4	
25/02/2019	03:45:40	CC03_T01	Video	EOL	741	58	396 861	5 973 227	396 967.9	5 973 113.1	156.4	
25/02/2019	03:58:48	CC03_T02	Still	181275_CC03_T02_01								Site slate
25/02/2019	04:06:45	CC03_T02	Video	SOL	743	55	396 861	5 973 227	396 371.2	5 972 892.7	593.0	
25/02/2019	04:06:45	CC03_T02	Still	181275_CC03_T02_02	743	55	396 861	5 973 227	396 371.2	5 972 892.7	593.0	
25/02/2019	04:07:56	CC03_T02	Still	181275_CC03_T02_03	744		396 861	5 973 227	396 392.1	5 972 908.5	566.8	
25/02/2019	04:08:37	CC03_T02	Still	181275_CC03_T02_04	745		396 861	5 973 227	396 412.6	5 972 921.0	542.9	
25/02/2019	04:09:38	CC03_T02	Still	181275_CC03_T02_05	746		396 861	5 973 227	396 436.7	5 972 951.2	506.1	
25/02/2019	04:12:07	CC03_T02	Still	181275_CC03_T02_06	747		396 861	5 973 227	396 446.2	5 972 994.5	475.5	
25/02/2019	04:14:11	CC03_T02	Still	181275_CC03_T02_07	748		396 861	5 973 227	396 523.0	5 973 002.0	406.1	
25/02/2019	04:14:55	CC03_T02	Still	181275_CC03_T02_08	749		396 861	5 973 227	396 542.9	5 973 004.7	388.1	
25/02/2019	04:15:43	CC03_T02	Still	181275_CC03_T02_09	750		396 861	5 973 227	396 560.0	5 973 010.9	370.6	
25/02/2019	04:16:41	CC03_T02	Still	181275_CC03_T02_10	751		396 861	5 973 227	396 575.7	5 973 022.4	351.1	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	04:17:09	CC03_T02	Still	181275_CC03_T02_11	752		396 861	5 973 227	396 585.5	5 973 026.5	340.7	
25/02/2019	04:18:02	CC03_T02	Still	181275_CC03_T02_12	753		396 861	5 973 227	396 604.7	5 973 028.3	324.3	
25/02/2019	04:19:12	CC03_T02	Still	181275_CC03_T02_13	754		396 861	5 973 227	396 633.4	5 973 027.2	302.9	
25/02/2019	04:20:23	CC03_T02	Still	181275_CC03_T02_14	755		396 861	5 973 227	396 657.4	5 973 039.2	276.9	
25/02/2019	04:21:24	CC03_T02	Still	181275_CC03_T02_15	756		396 861	5 973 227	396 675.9	5 973 054.7	252.9	
25/02/2019	04:22:56	CC03_T02	Still	181275_CC03_T02_16	757		396 861	5 973 227	396 698.7	5 973 080.5	218.7	
25/02/2019	04:23:19	CC03_T02	Still	181275_CC03_T02_17	758		396 861	5 973 227	396 702.6	5 973 087.1	211.3	
25/02/2019	04:24:12	CC03_T02	Still	181275_CC03_T02_18	759		396 861	5 973 227	396 714.9	5 973 095.7	196.4	
25/02/2019	04:24:38	CC03_T02	Still	181275_CC03_T02_19	760		396 861	5 973 227	396 721.9	5 973 098.2	189.6	
25/02/2019	04:25:30	CC03_T02	Still	181275_CC03_T02_20	761		396 861	5 973 227	396 737.9	5 973 108.0	171.2	
25/02/2019	04:26:36	CC03_T02	Still	181275_CC03_T02_21	762		396 861	5 973 227	396 761.6	5 973 128.8	139.8	
25/02/2019	04:28:18	CC03_T02	Still	181275_CC03_T02_22	763		396 861	5 973 227	396 789.2	5 973 154.8	101.9	
25/02/2019	04:29:39	CC03_T02	Still	181275_CC03_T02_23	764		396 861	5 973 227	396 811.4	5 973 172.0	74.0	
25/02/2019	04:30:47	CC03_T02	Still	181275_CC03_T02_24	765		396 861	5 973 227	396 826.6	5 973 192.3	48.8	
25/02/2019	04:31:11	CC03_T02	Still	181275_CC03_T02_25	766		396 861	5 973 227	396 832.5	5 973 198.2	40.6	
25/02/2019	04:31:48	CC03_T02	Still	181275_CC03_T02_26	767		396 861	5 973 227	396 842.5	5 973 206.9	27.3	
25/02/2019	04:32:19	CC03_T02	Still	181275_CC03_T02_27	768		396 861	5 973 227	396 852.2	5 973 211.3	18.0	
25/02/2019	04:32:52	CC03_T02	Still	181275_CC03_T02_28	769		396 861	5 973 227	396 861.3	5 973 219.0	8.1	
25/02/2019	04:33:20	CC03_T02	Still	181275_CC03_T02_29	770		396 861	5 973 227	396 866.2	5 973 228.6	5.5	
25/02/2019	04:33:46	CC03_T02	Still	181275_CC03_T02_30	771		396 861	5 973 227	396 870.3	5 973 236.2	13.1	
25/02/2019	04:34:24	CC03_T02	Still	181275_CC03_T02_31	772		396 861	5 973 227	396 879.2	5 973 244.4	25.1	
25/02/2019	04:35:10	CC03_T02	Still	181275_CC03_T02_32	773		396 861	5 973 227	396 892.0	5 973 251.2	39.3	
25/02/2019	04:35:45	CC03_T02	Still	181275_CC03_T02_33	774		396 861	5 973 227	396 900.8	5 973 258.4	50.7	
25/02/2019	04:36:39	CC03_T02	Still	181275_CC03_T02_34	775		396 861	5 973 227	396 915.3	5 973 269.7	69.1	
25/02/2019	04:37:20	CC03_T02	Still	181275_CC03_T02_35	776		396 861	5 973 227	396 925.9	5 973 278.8	83.0	
25/02/2019	04:37:44	CC03_T02	Still	181275_CC03_T02_36	777		396 861	5 973 227	396 932.1	5 973 283.7	90.9	
25/02/2019	04:38:18	CC03_T02	Still	181275_CC03_T02_37	778		396 861	5 973 227	396 940.2	5 973 291.0	101.9	
25/02/2019	04:38:37	CC03_T02	Still	181275_CC03_T02_38	779		396 861	5 973 227	396 944.5	5 973 294.9	107.6	
25/02/2019	04:39:14	CC03_T02	Still	181275_CC03_T02_39	780		396 861	5 973 227	396 953.0	5 973 303.3	119.5	
25/02/2019	04:39:42	CC03_T02	Still	181275_CC03_T02_40	781		396 861	5 973 227	396 959.3	5 973 309.0	128.0	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	04:40:05	CC03_T02	Still	181275_CC03_T02_41	782		396 861	5 973 227	396 964.6	5 973 313.6	135.0	
25/02/2019	04:40:26	CC03_T02	Still	181275_CC03_T02_42	783		396 861	5 973 227	396 969.5	5 973 318.1	141.7	
25/02/2019	04:40:39	CC03_T02	Still	181275_CC03_T02_43	784		396 861	5 973 227	396 972.5	5 973 321.2	146.0	
25/02/2019	04:40:39	CC03_T02	Video	EOL	784	52	396 861	5 973 227	396 972.5	5 973 321.2	146.0	
25/02/2019	05:09:07	PG_ST05	Still	181275_PG_ST05_01								Site slate
25/02/2019	05:19:36	PG_ST05	Video	SOL	786	50	397 084	5 974 814	396 940.1	5 974 805.0	144.2	
25/02/2019	05:19:36	PG_ST05	Still	181275_PG_ST05_02	786		397 084	5 974 814	396 940.1	5 974 805.0	144.2	
25/02/2019	05:19:54	PG_ST05	Still	181275_PG_ST05_03	787		397 084	5 974 814	396 946.4	5 974 804.1	138.0	
25/02/2019	05:20:07	PG_ST05	Still	181275_PG_ST05_04	788		397 084	5 974 814	396 951.4	5 974 803.5	133.0	
25/02/2019	05:20:23	PG_ST05	Still	181275_PG_ST05_05	789		397 084	5 974 814	396 957.2	5 974 802.7	127.3	
25/02/2019	05:20:36	PG_ST05	Still	181275_PG_ST05_06	790		397 084	5 974 814	396 961.4	5 974 802.4	123.2	
25/02/2019	05:20:55	PG_ST05	Still	181275_PG_ST05_07	791		397 084	5 974 814	396 967.0	5 974 802.6	117.6	
25/02/2019	05:21:04	PG_ST05	Still	181275_PG_ST05_08	792		397 084	5 974 814	396 969.6	5 974 802.9	114.9	
25/02/2019	05:21:26	PG_ST05	Still	181275_PG_ST05_09	793		397 084	5 974 814	396 974.6	5 974 806.1	109.7	
25/02/2019	05:21:48	PG_ST05	Still	181275_PG_ST05_10	NF		397 084	5 974 814	-	-	-	
25/02/2019	05:22:10	PG_ST05	Still	181275_PG_ST05_11	794		397 084	5 974 814	396 985.5	5 974 806.9	98.8	
25/02/2019	05:22:24	PG_ST05	Still	181275_PG_ST05_12	NF		397 084	5 974 814	-	-	-	
25/02/2019	05:22:39	PG_ST05	Still	181275_PG_ST05_13	795		397 084	5 974 814	396 993.7	5 974 801.7	91.2	
25/02/2019	05:22:52	PG_ST05	Still	181275_PG_ST05_14	796		397 084	5 974 814	396 997.7	5 974 799.1	87.6	
25/02/2019	05:23:00	PG_ST05	Still	181275_PG_ST05_15	797		397 084	5 974 814	397 000.4	5 974 797.9	85.1	
25/02/2019	05:23:16	PG_ST05	Still	181275_PG_ST05_16	798		397 084	5 974 814	397 004.9	5 974 800.3	80.3	
25/02/2019	05:23:45	PG_ST05	Still	181275_PG_ST05_17	799		397 084	5 974 814	397 013.3	5 974 801.0	71.9	
25/02/2019	05:24:08	PG_ST05	Still	181275_PG_ST05_18	800		397 084	5 974 814	397 019.7	5 974 805.5	64.9	
25/02/2019	05:24:29	PG_ST05	Still	181275_PG_ST05_19	801		397 084	5 974 814	397 025.7	5 974 809.3	58.5	
25/02/2019	05:24:47	PG_ST05	Still	181275_PG_ST05_20	802		397 084	5 974 814	397 031.8	5 974 811.3	52.2	
25/02/2019	05:25:11	PG_ST05	Still	181275_PG_ST05_21	803		397 084	5 974 814	397 039.6	5 974 811.6	44.5	
25/02/2019	05:25:20	PG_ST05	Still	181275_PG_ST05_22	NF		397 084	5 974 814	-	-	-	
25/02/2019	05:25:44	PG_ST05	Still	181275_PG_ST05_23	804		397 084	5 974 814	397 051.3	5 974 809.3	33.1	
25/02/2019	05:25:56	PG_ST05	Still	181275_PG_ST05_24	805		397 084	5 974 814	397 056.2	5 974 808.7	28.3	
25/02/2019	05:26:10	PG_ST05	Still	181275_PG_ST05_25	806		397 084	5 974 814	397 061.6	5 974 808.6	23.1	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	05:26:28	PG_ST05	Still	181275_PG_ST05_26	807		397 084	5 974 814	397 068.1	5 974 809.9	16.4	
25/02/2019	05:26:36	PG_ST05	Still	181275_PG_ST05_27	808		397 084	5 974 814	397 070.7	5 974 810.8	13.6	
25/02/2019	05:26:54	PG_ST05	Still	181275_PG_ST05_28	809		397 084	5 974 814	397 077.1	5 974 812.0	7.2	
25/02/2019	05:27:11	PG_ST05	Still	181275_PG_ST05_29	810		397 084	5 974 814	397 083.2	5 974 813.4	1.0	
25/02/2019	05:27:30	PG_ST05	Still	181275_PG_ST05_30	811		397 084	5 974 814	397 090.3	5 974 813.0	6.4	
25/02/2019	05:27:57	PG_ST05	Still	181275_PG_ST05_31	NF		397 084	5 974 814	-	-	-	
25/02/2019	05:28:16	PG_ST05	Still	181275_PG_ST05_32	812		397 084	5 974 814	397 108.9	5 974 810.2	25.1	
25/02/2019	05:28:32	PG_ST05	Still	181275_PG_ST05_33	813		397 084	5 974 814	397 115.3	5 974 810.5	31.5	
25/02/2019	05:28:51	PG_ST05	Still	181275_PG_ST05_34	814		397 084	5 974 814	397 121.6	5 974 814.5	37.6	
25/02/2019	05:29:10	PG_ST05	Still	181275_PG_ST05_35	815		397 084	5 974 814	397 128.6	5 974 814.9	44.6	
25/02/2019	05:29:33	PG_ST05	Still	181275_PG_ST05_36	816		397 084	5 974 814	397 137.6	5 974 816.2	53.7	
25/02/2019	05:29:58	PG_ST05	Still	181275_PG_ST05_37	817		397 084	5 974 814	397 147.6	5 974 816.7	63.7	
25/02/2019	05:30:23	PG_ST05	Still	181275_PG_ST05_38	818		397 084	5 974 814	397 157.4	5 974 817.2	73.5	
25/02/2019	05:30:42	PG_ST05	Still	181275_PG_ST05_39	819		397 084	5 974 814	397 165.3	5 974 817.5	81.4	
25/02/2019	05:30:54	PG_ST05	Still	181275_PG_ST05_40	820		397 084	5 974 814	397 169.8	5 974 817.4	85.9	
25/02/2019	05:31:45	PG_ST05	Still	181275_PG_ST05_41	821		397 084	5 974 814	397 190.4	5 974 818.5	106.5	
25/02/2019	05:32:14	PG_ST05	Still	181275_PG_ST05_42	822		397 084	5 974 814	397 202.1	5 974 816.9	118.1	
25/02/2019	05:32:36	PG_ST05	Still	181275_PG_ST05_43	823		397 084	5 974 814	397 210.9	5 974 815.7	126.9	
25/02/2019	05:33:07	PG_ST05	Still	181275_PG_ST05_44	824		397 084	5 974 814	397 223.0	5 974 815.8	139.0	
25/02/2019	05:33:34	PG_ST05	Still	181275_PG_ST05_45	825		397 084	5 974814	397 233.7	5 974 816.2	149.7	
25/02/2019	05:33:47	PG_ST05	Still	181275_PG_ST05_46	826		397 084	5 974814	397 238.7	5 974 816.0	154.7	
25/02/2019	05:34:18	PG_ST05	Still	181275_PG_ST05_47	827		397 084	5 974814	397 251.2	5 974 816.4	167.2	
25/02/2019	05:34:37	PG_ST05	Still	181275_PG_ST05_48	828		397 084	5 974814	397 259.0	5 974 816.4	175.0	
25/02/2019	05:35:03	PG_ST05	Still	181275_PG_ST05_49	829		397 084	5 974814	397 269.3	5 974 817.1	185.4	
25/02/2019	05:35:48	PG_ST05	Still	181275_PG_ST05_50	830		397 084	5 974814	397 287.1	5 974 817.2	203.1	
25/02/2019	05:36:22	PG_ST05	Still	181275_PG_ST05_51	831		397 084	5 974814	397 300.8	5 974 817.2	216.8	
25/02/2019	05:36:51	PG_ST05	Still	181275_PG_ST05_52	832		397 084	5 974814	397 312.7	5 974 816.5	228.8	
25/02/2019	05:37:09	PG_ST05	Still	181275_PG_ST05_53	833		397 084	5 974814	397 320.0	5 974 816.4	236.0	
25/02/2019	05:38:05	PG_ST05	Still	181275_PG_ST05_54	834		397 084	5 974814	397 342.3	5 974 816.1	258.3	
25/02/2019	05:38:26	PG_ST05	Still	181275_PG_ST05_55	835		397 084	5 974814	397 351.0	5 974 816.6	267.0	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	05:38:43	PG_ST05	Still	181275_PG_ST05_56	836		397 084	5 974814	397 357.8	5 974 817.2	273.8	
25/02/2019	05:39:12	PG_ST05	Still	181275_PG_ST05_57	837		397 084	5 974814	397 369.0	5 974 817.9	285.1	
25/02/2019	05:39:39	PG_ST05	Still	181275_PG_ST05_58	838		397 084	5 974814	397 379.7	5 974 819.0	295.7	
25/02/2019	05:39:39	PG_ST05	Video	EOL	838	52	397 084	5 974814	397 379.7	5 974 819.0	295.7	
25/02/2019	07:12:11	PG_ST06	DVV	PC/NS	839	63	403 761	5 966746	403 726.4	5 966 765.0	39.5	
25/02/2019	07:26:45	PG_ST06	DVV	NS/FA	840	63	403 761	5 966746	403 741.1	5 966 739.2	21.0	
25/02/2019	07:33:41	PG_ST06	DVV	FB	841	63	403 761	5 966746	403 754.3	5 966 742.1	7.8	
25/02/2019	08:27:08	PG_ST07	DVV	PC/FA	842	52	409 841	5 966414	409 822.3	5 966 397.6	24.9	
25/02/2019	08:36:18	PG_ST07	DVV	FB	843	52	409 841	5 966414	409 803.6	5 966 375.6	53.6	
25/02/2019	09:05:05	SG_ST12	DVV	NS/NS	844	51	414 096	5 966135	414 069.8	5 966 133.7	26.2	
25/02/2019	09:16:30	SG_ST12	DVV	PC/NS	845	51	414 096	5 966135	414 086.2	5 966 127.9	12.1	
25/02/2019	10:53:37	SG_ST10	DVV	PC	846	41	436 745	5 960253	436 780.3	5 960 237.0	38.8	
25/02/2019	11:41:20	CC02_T01	Still	181275_CC02_T01_01								Site slate
25/02/2019	11:47:17	CC02_T01	Video	SOL	848	40	446 258	5 957 846	446 505.1	5 957 865.7	247.6	
25/02/2019	11:47:17	CC02_T01	Still	181275_CC02_T01_02	848		446 258	5 957 846	446 505.1	5 957 865.7	247.6	
25/02/2019	11:47:29	CC02_T01	Still	181275_CC02_T01_03	849		446 258	5 957 846	446 500.6	5 957 865.3	243.0	
25/02/2019	11:47:41	CC02_T01	Still	181275_CC02_T01_04	850		446 258	5 957 846	446 495.8	5 957 864.8	238.2	
25/02/2019	11:48:01	CC02_T01	Still	181275_CC02_T01_05	851		446 258	5 957 846	446 487.2	5 957 863.4	229.5	
25/02/2019	11:48:25	CC02_T01	Still	181275_CC02_T01_06	852		446 258	5 957 846	446 475.5	5 957 862.0	217.7	
25/02/2019	11:48:56	CC02_T01	Still	181275_CC02_T01_07	853		446 258	5 957 846	446 460.2	5 957 860.0	202.3	
25/02/2019	11:49:13	CC02_T01	Still	181275_CC02_T01_08	854		446 258	5 957 846	446 451.3	5 957 858.6	193.4	
25/02/2019	11:49:27	CC02_T01	Still	181275_CC02_T01_09	855		446 258	5 957 846	446 444.2	5 957 857.4	186.2	
25/02/2019	11:49:41	CC02_T01	Still	181275_CC02_T01_10	856		446 258	5 957 846	446 437.1	5 957 856.3	179.0	
25/02/2019	11:49:55	CC02_T01	Still	181275_CC02_T01_11	857		446 258	5 957 846	446 429.9	5 957 855.2	171.8	
25/02/2019	11:50:33	CC02_T01	Still	181275_CC02_T01_12	858		446 258	5 957 846	446 410.8	5 957 851.8	152.5	
25/02/2019	11:50:52	CC02_T01	Still	181275_CC02_T01_13	859		446 258	5 957 846	446 400.6	5 957 849.9	142.3	
25/02/2019	11:51:37	CC02_T01	Still	181275_CC02_T01_14	860		446 258	5 957 846	446 377.3	5 957 844.8	118.9	
25/02/2019	11:51:56	CC02_T01	Still	181275_CC02_T01_15	861		446 258	5 957 846	446 367.4	5 957 842.7	109.0	
25/02/2019	11:52:19	CC02_T01	Still	181275_CC02_T01_16	862		446 258	5 957 846	446 356.1	5 957 840.3	97.9	
25/02/2019	11:52:50	CC02_T01	Still	181275_CC02_T01_17	863		446 258	5 957 846	446 339.5	5 957 837.0	81.6	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	11:53:07	CC02_T01	Still	181275_CC02_T01_18	NF		446 258	5 957 846	-	-	-	
25/02/2019	11:53:28	CC02_T01	Still	181275_CC02_T01_19	864		446 258	5 957 846	446 319.8	5 957 833.0	62.7	
25/02/2019	11:53:58	CC02_T01	Still	181275_CC02_T01_20	865		446 258	5 957 846	446 304.3	5 957 830.0	48.5	
25/02/2019	11:54:12	CC02_T01	Still	181275_CC02_T01_21	866		446 258	5 957 846	446 296.8	5 957 828.3	42.2	
25/02/2019	11:54:30	CC02_T01	Still	181275_CC02_T01_22	867		446 258	5 957 846	446 288.1	5 957 826.8	35.3	
25/02/2019	11:54:44	CC02_T01	Still	181275_CC02_T01_23	868		446 258	5 957 846	446 280.4	5 957 826.5	29.3	
25/02/2019	11:55:03	CC02_T01	Still	181275_CC02_T01_24	869		446 258	5 957 846	446 270.3	5 957 828.1	21.4	
25/02/2019	11:55:37	CC02_T01	Still	181275_CC02_T01_25	870		446 258	5 957 846	446 251.7	5 957 831.7	15.7	
25/02/2019	11:56:05	CC02_T01	Still	181275_CC02_T01_26	871		446 258	5 957 846	446 236.5	5 957 833.9	24.9	
25/02/2019	11:56:22	CC02_T01	Still	181275_CC02_T01_27	872		446 258	5 957 846	446 227.7	5 957 835.1	32.5	
25/02/2019	11:56:37	CC02_T01	Still	181275_CC02_T01_28	873		446 258	5 957 846	446 220.4	5 957 836.3	39.1	
25/02/2019	11:56:49	CC02_T01	Still	181275_CC02_T01_29	874		446 258	5 957 846	446 215.1	5 957 837.6	44.0	
25/02/2019	11:57:55	CC02_T01	Still	181275_CC02_T01_30	875		446 258	5 957 846	446 188.3	5 957 841.5	70.3	
25/02/2019	11:58:21	CC02_T01	Still	181275_CC02_T01_31	876		446 258	5 957 846	446 178.2	5 957 843.2	80.2	
25/02/2019	11:58:41	CC02_T01	Still	181275_CC02_T01_32	877		446 258	5 957 846	446 171.8	5 957 844.2	86.6	
25/02/2019	11:59:23	CC02_T01	Still	181275_CC02_T01_33	878		446 258	5 957 846	446 157.3	5 957 846.4	101.0	
25/02/2019	12:00:10	CC02_T01	Still	181275_CC02_T01_34	879		446 258	5 957 846	446 142.9	5 957 848.6	115.5	
25/02/2019	12:00:30	CC02_T01	Still	181275_CC02_T01_35	880		446 258	5 957 846	446 137.2	5 957 849.9	121.3	
25/02/2019	12:00:49	CC02_T01	Still	181275_CC02_T01_36	881		446 258	5 957 846	446 131.4	5 957 850.7	127.0	
25/02/2019	12:01:13	CC02_T01	Still	181275_CC02_T01_37	882		446 258	5 957 846	446 124.4	5 957 851.8	134.2	
25/02/2019	12:01:36	CC02_T01	Still	181275_CC02_T01_38	883		446 258	5 957 846	446 117.7	5 957 853.1	140.8	
25/02/2019	12:02:16	CC02_T01	Still	181275_CC02_T01_39	884		446 258	5 957 846	446 106.8	5 957 855.3	151.8	
25/02/2019	12:02:31	CC02_T01	Still	181275_CC02_T01_40	885		446 258	5 957 846	446 102.8	5 957 855.7	155.9	
25/02/2019	12:02:47	CC02_T01	Still	181275_CC02_T01_41	886		446 258	5 957 846	446 098.5	5 957 856.2	160.2	
25/02/2019	12:02:47	CC02_T01	Video	EOL	886	41	446 258	5 957 846	446 098.5	5 957 856.2	160.2	
25/02/2019	12:34:51	CC02_T02	Still	181275_CC02_T02_01								Site slate, laser distance changed 17.0 cm

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	12:49:52	CC02_T02	Video	SOL	888	44	446 258	5 957 846	446 436.4	5 957 927.1	195.7	
25/02/2019	12:49:52	CC02_T02	Still	181285_CC02_T02_02	888		446 258	5 957 846	446 436.4	5 957 927.1	195.7	
25/02/2019	12:50:04	CC02_T02	Still	181285_CC02_T02_03	889		446 258	5 957 846	446 431.8	5 957 925.7	190.9	
25/02/2019	12:50:16	CC02_T02	Still	181285_CC02_T02_04	890		446 258	5 957 846	446 427.0	5 957 924.1	185.9	
25/02/2019	12:50:31	CC02_T02	Still	181285_CC02_T02_05	891		446 258	5 957 846	446 421.1	5 957 922.4	179.8	
25/02/2019	12:50:44	CC02_T02	Still	181285_CC02_T02_06	892		446 258	5 957 846	446 415.8	5 957 921.0	174.5	
25/02/2019	12:51:13	CC02_T02	Still	181285_CC02_T02_07	893		446 258	5 957 846	446 404.6	5 957 917.6	162.9	
25/02/2019	12:51:29	CC02_T02	Still	181285_CC02_T02_08	894		446 258	5 957 846	446 398.3	5 957 915.6	156.4	
25/02/2019	12:51:40	CC02_T02	Still	181285_CC02_T02_09	895		446 258	5 957 846	446 394.3	5 957 914.3	152.2	
25/02/2019	12:51:54	CC02_T02	Still	181285_CC02_T02_10	896		446 258	5 957 846	446 388.9	5 957 912.8	146.7	
25/02/2019	12:52:19	CC02_T02	Still	181285_CC02_T02_11	897		446 258	5 957 846	446 379.2	5 957 910.4	137.0	
25/02/2019	12:52:46	CC02_T02	Still	181285_CC02_T02_12	898		446 258	5 957 846	446 369.4	5 957 907.2	126.8	
25/02/2019	12:53:42	CC02_T02	Still	181285_CC02_T02_13	899		446 258	5 957 846	446 347.8	5 957 901.3	105.2	
25/02/2019	12:54:36	CC02_T02	Still	181285_CC02_T02_14	900		446 258	5 957 846	446 327.8	5 957 892.5	83.7	
25/02/2019	12:55:07	CC02_T02	Still	181285_CC02_T02_15	901		446 258	5 957 846	446 317.6	5 957 885.3	71.1	
25/02/2019	12:55:43	CC02_T02	Still	181285_CC02_T02_16	902		446 258	5 957 846	446 305.4	5 957 878.1	57.1	
25/02/2019	12:56:14	CC02_T02	Still	181285_CC02_T02_17	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:56:48	CC02_T02	Still	181285_CC02_T02_18	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:57:04	CC02_T02	Still	181285_CC02_T02_19	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:57:55	CC02_T02	Still	181285_CC02_T02_20	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:58:17	CC02_T02	Still	181285_CC02_T02_21	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:58:36	CC02_T02	Still	181285_CC02_T02_22	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:59:00	CC02_T02	Still	181285_CC02_T02_23	NF		446 258	5 957 846	-	-	-	
25/02/2019	12:59:21	CC02_T02	Still	181285_CC02_T02_24	903		446 258	5 957 846	446 225.5	5 957 838.1	33.8	
25/02/2019	13:00:37	CC02_T02	Still	181285_CC02_T02_25	905		446 258	5 957 846	446 196.6	5 957 824.7	65.3	
25/02/2019	13:01:28	CC02_T02	Still	181285_CC02_T02_26	906		446 258	5 957 846	446 178.6	5 957 815.2	85.4	
25/02/2019	13:01:49	CC02_T02	Still	181285_CC02_T02_27	907		446 258	5 957 846	446 171.0	5 957 811.8	93.8	
25/02/2019	13:02:18	CC02_T02	Still	181285_CC02_T02_28	908		446 258	5 957 846	446 159.0	5 957 808.3	106.2	
25/02/2019	13:03:41	CC02_T02	Still	181285_CC02_T02_29	909		446 258	5 957 846	446 128.3	5 957 792.8	140.4	
25/02/2019	13:04:45	CC02_T02	Still	181285_CC02_T02_30	910	43	446 258	5 957 846	446 104.9	5 957 781.9	166.3	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
25/02/2019	13:04:45	CC02_T02	Video	EOL	910	43	446 258	5 957 846	446 104.9	5 957 781.9	166.3	

Notes:
UTC = Coordinated Universal Time
BSL = Below sea level
ST = Station
T = Transect
SOL = Start of line
EOL = End of line
NF = No fix
DVV = Dual van Veen grab
CC = Cable crossing
HG = Hamon grab

B.2 GRAB LOG

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [Depth cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
12/02/2019	11:12:00	SG_ST03	NS	-	0		Lid open
12/02/2019	11:12:00	SG_ST03	NS	-	4	Sandy mud	
12/02/2019	11:35:00	SG_ST03	PC	-	11	Sandy mud	2 cm depth anoxic layer; brittlestars (Ophiuroidea)
12/02/2019	11:35:00	SG_ST03	FA	-	9	Sandy mud	3 cm depth anoxic layer; brittlestars (Ophiuroidea)
16/02/2019	05:57:41	SG_ST04	NS	20	0		Water only
16/02/2019	05:57:41	SG_ST04	NS	20	0		
16/02/2019	06:12:43	SG_ST04	PC	21	18	Mud	3 cm depth anoxic layer
16/02/2019	06:12:43	SG_ST04	FA	21	15	Mud	3 cm depth anoxic layer; brittlestars (Ophiuroidea), sea urchin (Brissidina)
16/02/2019	06:58:40	SG_ST04	FB	22	15	Mud	3 cm depth anoxic layer; brittlestars (Ophiuroidea)
16/02/2019	07:25:07	SG_ST03	FB	23	8	Mud	3 cm depth anoxic layer, razor shell (*Ensis* sp.), brittlestars (Ophiuroidea)
16/02/2019	10:00:53	SG_ST05	FA	39	11	Sand	
16/02/2019	10:00:53	SG_ST05	NS	39	0		
16/02/2019	10:16:56	SG_ST05	PC	40	10	Sand	
16/02/2019	10:16:56	SG_ST05	NS	40	9	Sand	Sediment washed out
16/02/2019	10:31:12	SG_ST05	NS	41	0		
16/02/2019	10:31:12	SG_ST05	NS	41	0		
16/02/2019	10:48:41	SG_ST05	FB	39	9	Sand	
16/02/2019	18:47:10	SG_ST10	FA	128	7	Sand	Brittlestars (Ophiuroidea)
16/02/2019	18:47:10	SG_ST10	NS	128	2	Sand	Washout
16/02/2019	19:06:30	SG_ST10	NS	129	0		Strong current
16/02/2019	19:06:30	SG_ST10	NS	129	0		Strong current
16/02/2019	19:15:08	SG_ST10	FB	130	7.5	Sand	Brittlestars (Ophiuroidea), polychaete tubes
16/02/2019	19:15:08	SG_ST10	NS	130	6	Sand	

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [Depth cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
16/02/2019	19:33:48	SG_ST10	NS	131	0		
16/02/2019	19:33:48	SG_ST10	NS	131	0		Not triggered
16/02/2019	19:44:19	SG_ST10	NS	132	0		
16/02/2019	19:44:19	SG_ST10	NS	132	0		
16/02/2019	21:14:22	SG_ST09	NS	133	0		
16/02/2019	21:20:12	SG_ST09	NS	133	0		
16/02/2019	21:20:12	SG_ST09	NS	134	0		
16/02/2019	21:20:12	SG_ST09	NS	134	0		
16/02/2019	21:32:06	SG_ST09	PC	135	8	Sandy mud	
16/02/2019	21:32:06	SG_ST09	NS	135	0		
16/02/2019	21:53:12	SG_ST09	FA	136	11	Muddy sand with shells	
16/02/2019	21:53:12	SG_ST09	FB	136	8	Muddy sand with shells	
16/02/2019	22:56:05	SG_ST08	PC	137	11	Sandy mud	
16/02/2019	22:56:05	SG_ST08	FA	137	12	Sandy mud	Sea urchin (Brissidina), spider crab (*Inachus* sp.), cockle (Cardiidae), brittlestar (Ophiuroidea)
16/02/2019	23:18:40	SG_ST08	FB	138	17	Sandy mud	Brittlestars (Ophiuroidea) and sea urchin (Brissidina)
17/02/2019	01:04:01	SG_ST07	NS	139	3		
17/02/2019	01:04:01	SG_ST07	NS	139	1		
17/02/2019	01:18:25	SG_ST07	PC	140	10	Mud	
17/02/2019	01:18:25	SG_ST07	NS	140	4		
17/02/2019	14:29:34	SG_ST12	NS	189	2 L	Slightly gravelly sand with cobbles	HG used
20/02/2019	19:23:15	SG_ST07	NS	191	0		
20/02/2019	19:23:15	SG_ST07	NS	191	0		Not triggered
20/02/2019	19:38:08	SG_ST07	NS	192	0		
20/02/2019	19:38:08	SG_ST07	NS	192	0		Not triggered

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [Depth cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
20/02/2019	19:56:43	SG_ST07	NS	193	0		
20/02/2019	19:56:43	SG_ST07	NS	193	0		Not triggered
20/02/2019	20:15:16	SG_ST07	NS	194	0		HG used
20/02/2019	20:51:27	SG_ST06	PC	195	17	Muddy sand	
20/02/2019	20:51:27	SG_ST06	NS	195	2	Muddy sand	
20/02/2019	21:10:12	SG_ST06	FA	196	18	Sandy mud	Brittlestars (Ophiuroidea) and razor shells (*Ensis* sp.)
20/02/2019	21:10:12	SG_ST06	NS	196	2	Sandy mud	
20/02/2019	21:23:38	SG_ST06	FB	197	17	Sandy mud	Brittlestars (Ophiuroidea), bivalves
20/02/2019	21:23:38	SG_ST06	NS	197	5	Sandy mud	
20/02/2019	22:23:32	SG_ST07	NS	198	0		
20/02/2019	22:23:32	SG_ST07	NS	198	0		No triggered
23/02/2019	10:00:30	LS_ST02	PC	217	14	Muddy sand	1 cm depth anoxic layer, H_2S smell
23/02/2019	10:00:30	LS_ST02	FA	217	12	Muddy sand	1 cm depth anoxic layer, H_2S smell; brittlestars (Ophiuroidea)
23/02/2019	10:26:00	LS_ST02	FB	218	10	Muddy sand	1 cm anoxic depth; brittlestars (Ophiuroidea) and sea urchin (Brissidina)
23/02/2019	17:00:32	LS_ST03	NS	264	0		Water only
23/02/2019	17:00:32	LS_ST03	NS	264	0		Water only
23/02/2019	17:16:30	LS_ST03	NS	265	5	Sandy mud	
23/02/2019	17:16:30	LS_ST03	NS	265	6	Sandy mud	
23/02/2019	17:36:03	LS_ST03	NS	266	0		Water only
23/02/2019	17:36:03	LS_ST03	NS	266	0		Water only
23/02/2019	17:46:48	LS_ST03	NS	267	0		Water only
23/02/2019	17:46:48	LS_ST03	NS	267	0		Water only
23/02/2019	17:53:50	LS_ST03	NS	268	0		Water only
23/02/2019	17:53:50	LS_ST03	NS	268	0		Water only
23/02/2019	18:35:00	LS_ST03	PC	269	13	Sandy mud	

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [Depth cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
23/02/2019	18:35:00	LS_ST03	FA	269	9	Sandy mud	Bivalves, brittlestars (Ophiuroidea)
23/02/2019	18:54:40	LS_ST03	NS	270	7		Not triggered
23/02/2019	18:54:40	LS_ST03	NS	270	0		Not triggered
23/02/2019	18:55:33	LS_ST03	NS	271	0		Water only
23/02/2019	18:55:33	LS_ST03	NS	271	0		Water only
23/02/2019	19:05:29	LS_ST03	FB	272	13	Sandy mud	Bivalves, brittlestars (Ophiuroidea) and sea urchin (Brissidina)
23/02/2019	20:48:32	LS_ST04	PC	293	12	Mud	1 cm Anoxic depth
23/02/2019	20:48:32	LS_ST04	FA	293	11	Mud	1 cm anoxic depth; bivalves, brittlestars (Ophiuroidea) and sea urchin (Brissidina)
23/02/2019	21:04:36	LS_ST04	FB	294	14	Mud	1 cm anoxic depth; H_2S; bivalves and brittlestars (Ophiuroidea)
23/02/2019	22:31:26	LS_ST05	PC	313	20	Mud	
23/02/2019	22:31:26	LS_ST05	FA	313	20	Mud	
23/02/2019	22:50:31	LS_ST05	NS	314	0		Water only
23/02/2019	22:50:31	LS_ST05	NS	314	0		
23/02/2019	22:59:26	LS_ST05	FB	315	20	Mud	
24/02/2019	04:42:59	CC05_ST01	PC	437	16	Mud	1 cm Anoxic layer depth, Turritellidae shells
24/02/2019	04:42:59	CC05_ST01	FA	437	15	Mud and clay	1 cm Anoxic layer depth, Turritellidae shells
24/02/2019	05:06:38	CC05_ST01	FB	438	16	Mud	1 cm Anoxic layer depth, Turritellidae shells
24/02/2019	06:18:54	PE_ST11	PC	461	16	Mud	
24/02/2019	06:18:54	PE_ST11	FA	461	13	Mud	
24/02/2019	06:38:11	PE_ST11	FB	462	9	Mud	3 cm anoxic layer; H_2S smell
24/02/2019	11:13:29	PE_ST08	FA	525	10	Muddy sand	
24/02/2019	11:13:29	PE_ST08	NS	525	1	Muddy sand	
24/02/2019	11:23:34	PE_ST08	PC	526	0	Muddy sand	

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [Depth cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
24/02/2019	11:23:34	PE_ST08	NS	526	9	Muddy sand	
24/02/2019	11:38:17	PE_ST08	FB	527	13	Muddy sand	
24/02/2019	14:24:20	PE_ST07	PC	554	11	Muddy sand	
24/02/2019	14:24:20	PE_ST07	NS	554	2	Muddy sand	
24/02/2019	14:43:36	PE_ST07	NS	555	0		
24/02/2019	14:43:36	PE_ST07	NS	555	0		
24/02/2019	14:55:42	PE_ST07	NS	556	0		
24/02/2019	14:55:42	PE_ST07	NS	556	0		
24/02/2019	15:03:42	PE_ST07	FA	557	7	Muddy sand	Worm tubes (*Sabellaria* sp.), brittlestars (Ophiuroidea), sea urchin (Brissidina)
24/02/2019	15:03:42	PE_ST07	FB	557	7	Muddy sand	Worm tubes (*Sabellaria* sp., sea squirt (Ascidiacea), faunal turf (Bryozoa/Hydrozoa), sea urchin (Brissidina)
24/02/2019	20:19:02	PE_ST06	PC	661	10	Slightly gravelly sand	
24/02/2019	20:19:02	PE_ST06	FA	661	8	Slightly gravelly sand	Hydroid (Hydrozoa), bivalves
23/02/2019	19:31:54	PE_ST06	FB	662	10	Slightly gravelly sand	Clams, anemones (Actinaria), worm tubes (*Sabellaria* sp.), hydroid (Hydrozoa)
24/02/2019	21:57:55	PE_ST05	PC	683	9	Slightly gravelly sand	
24/02/2019	21:57:55	PE_ST05	FA	683	9	Slightly gravelly sand	
23/02/2019	21:11:29	PE_ST05	FB	684	8	Slightly gravelly sand	
25/02/2019	00:44:20	PE_ST04	PC	695	17	Sand	
25/02/2019	00:44:20	PE_ST04	FA	695	16	Sand	
25/02/2019	00:58:05	PE_ST04	NS	696	0		Not triggered
25/02/2019	00:58:05	PE_ST04	NS	696	0		Not triggered
25/02/2019	01:01:54	PE_ST04	NS	697	0		Not triggered
25/02/2019	01:01:54	PE_ST04	NS	697	0		Not triggered
25/02/2019	01:04:06	PE_ST04	FB	698	13	Sand	

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [Depth cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
25/02/2019	07:12:11	PG_ST06	PC	839	10	Sand	
25/02/2019	07:12:11	PG_ST06	NS	839	4	Sand	
25/02/2019	07:26:45	PG_ST06	FA	840	11	Sand	
25/02/2019	07:26:45	PG_ST06	NS	840	5	Sand	
25/02/2019	07:33:41	PG_ST06	FB	841	9	Sand	
25/02/2019	08:27:08	PG_ST07	PC	842	8	Sand and cobbles	
25/02/2019	08:27:08	PG_ST07	FA	842	7	Sand and cobbles	Soft coral *(Alcyonium digitatum)*
25/02/2019	08:36:18	PG_ST07	FB	843	7	Sand and cobbles	
25/02/2019	09:05:05	SG_ST12	NS	844	2	Gravelly sand and cobbles	
25/02/2019	09:05:05	SG_ST12	NS	844	0	Gravelly sand and cobbles	Cobble stuck in jaw
25/02/2019	09:16:30	SG_ST12	PC	845	9	Gravelly sand and cobbles	
25/02/2019	09:16:30	SG_ST12	NS	845	2	Gravelly sand and cobbles	Soft coral *(Alcyonium digitatum)*, dog cockle (*Glycymeris glycymeris*)
25/02/2019	10:53:37	SG_ST10	PC	846	12	Sand and pebbles	

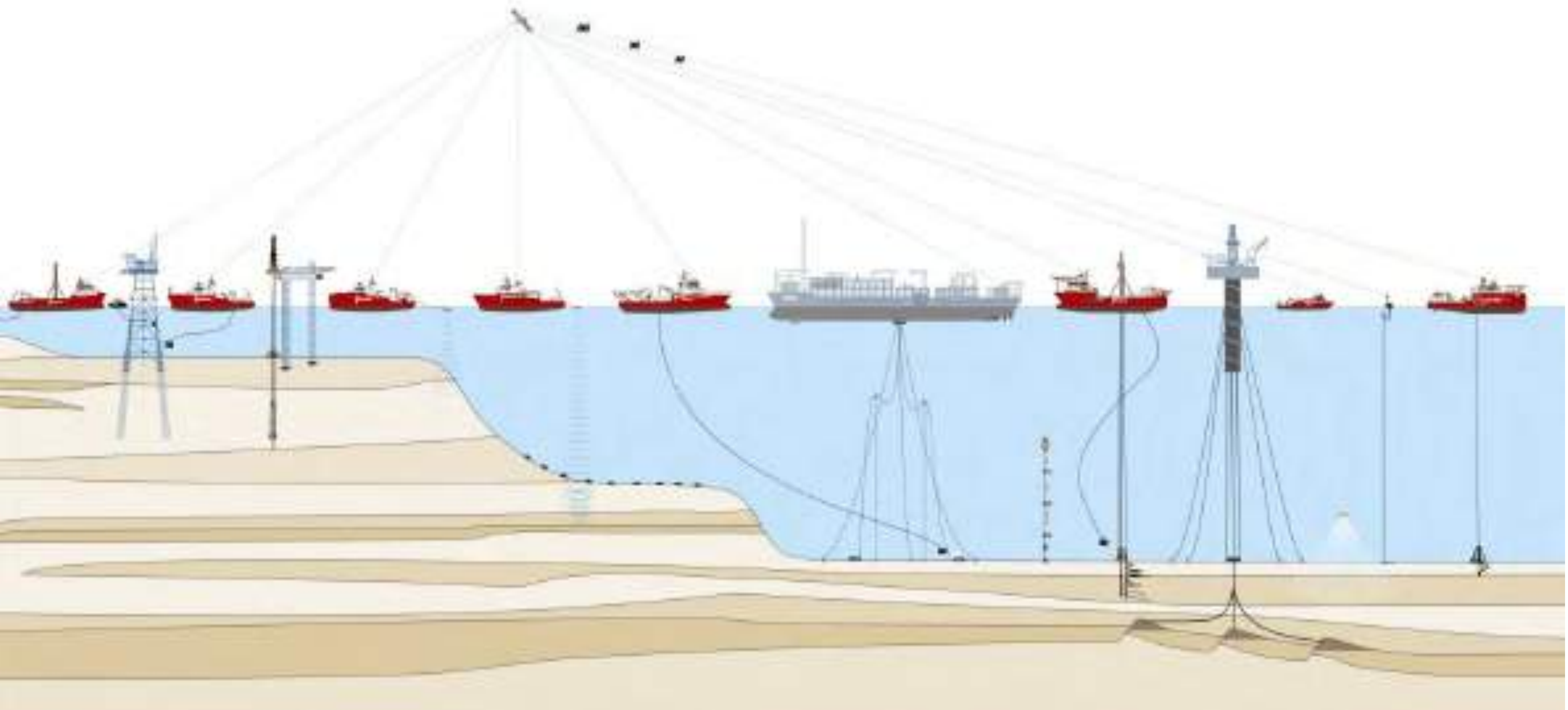
Notes:
UTC = Coordinated Universal Time
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB
NS = No sample
HG = Hamon grab

Field Report
Havhingsten Cable Route Survey
Intertidal

Fugro Document No.: 181275-R-003(01)
8 March 2019

Alcatel Submarine Networks UK Limited

Draft Report



Field Report
Havhingsten Cable Route Survey
Intertidal

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8 March 2019

Draft Report

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EXECUTIVE SUMMARY

Introduction

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed intertidal surveys at five proposed cable landings. These were located at Seaton Sluice and Whitley Bay (UK east coast), Squires Gate Lane (UK west coast), Port Erin and Port Grenaugh (Isle of Man) and Loughshinny (Ireland), The surveys were conducted on spring tide occasions between 18 and 22 February 2019.

Environmental Survey

The Seaton Sluice foreshore was predominantly comprised of medium to coarse sand backed by sand dunes. The mid to lower upper shore throughout the survey area was predominantly comprised of a mosaic of coarse sand, pebbles and cobbles with water run-off evident when exposed by the tide. A harbour was present to the south-east of the survey area with a region of boulders immediately to the north-west. In the centre of the survey area, the mid shore was comprised of a mosaic of sandstone bedrock and boulders. To the north-east of the survey area, an area of boulder clay was exposed. Limited epifauna and macroalgae were observed, likely due to the season and sand scour.

The Whitley Bay foreshore was predominantly comprised of medium to coarse sand, backed by a promenade on top of vertical concrete sea defenses. South of the cable route, the top shore was comprised of a narrow strip of mixed sediment. The mid to lower upper shore throughout the survey area was predominantly comprised of medium sand with varying degrees of coarse sand, pebbles and cobbles. Limestone bedrock projected from the mid-shore to the low water mark in the south-east of the survey area, surrounded by boulders. Large shallow rockpools and small deep rockpools were present within the limestone bedrock. An area of sandstone bedrock was exposed in the mid-shore to the north-west of the limestone, south of the proposed cable route. An area of sandstone bedrock was also exposed in the north-west of the survey area. An outflow was present to the south of the survey area, forming a deep pool of standing water. Generally, limited epifauna and macroalgae were observed, likely due to the season and sand scour.

The Squires Gate Lane foreshore was backed by a high rock armour construction, and the southern half was backed by a natural dune area. The survey area was bisected by a slipway on to the upper shore. Coarse shingle deposits were present along the rear shore, in front of the dune section. Overall the beach comprised sand with shell hash and gravel present in small varying amounts. The rear shore rock armour displayed a sparse algal presence. The zonation observed comprised upper lichens, upper shore green algae and occasional additional algae dominated by sparse fucoids.

The Port Grenaugh foreshore was backed by a man-made wall that protected the rear of the bay, and bordered an active fresh water source that poured strongly into the bay, and formed a band of wide fresh water. The beach was largely coarse shingle with varying amount of sediment, with large areas of cobbles and boulders, particularly across the mid shore and formed deposits at the base of the visible bedrock edges to the bay. The bedrock and boulders that framed the bay displayed the expected flora zonation for a rocky shore, and comprised upper shore lichens, upper shore green algae, and various algae dominated by fucoid algae across most areas of the shore.
Due to the time of year, the beach was covered by dense swathes of drift algae, resulting from winter storm activity.

The Port Erin foreshore was backed by a low wall with occasional fresh water sources entering the beach. Sand was the dominant substrate with areas of coarse mixed sediment surface deposits, which formed a larger component of the substrate in places. The south side of the bay comprised a higher wall forming a small harbour and breakwater area around which small boats were moored. Rear shore rock armour can be seen in these areas alongside small slipways onto the shore. The rear shore walls, rock armour and rock substrates near the small harbour displayed the expected flora zonation, comprising upper shore lichens, upper shore green algae, and various algae dominated by fucoid algae across the lower sections of any harder substrate surveyed.

Loughshinny is a predominantly sandy bay enclosed to the west by layered limestone and shale bedrock extending directly from coastal cliffs, and to the east by a concrete pier used by creel fishermen. Some emergent boulders were present to the east of the sandy bay and near the low water mark. The lower shore to the east of the bay was comprised of mixed sediment (sand, pebbles, cobbles and boulders). The upper shore featured boulder sea defenses upon which small white sand dunes have formed. A small area of gabion sea defense was present in the north-west of the bay. Several outflows were observed along the upper shore, through the boulder sea defenses. To the north-east of the bay, a small area of bedrock was emergent, with cobbles and boulders to the west and boulder sea defenses to the north.

Generally, limited epifauna and macroalgae were observed, likely due to the season and sand scour. However, both epifauna and macroalgal diversity and abundance were elevated on the layered limestone and shale bedrock and associated rockpools in the east of the survey area and on the mixed sediment and boulders on the lower shore.

CONTENTS

APPENDICES

TABLES IN THE MAIN TEXT

FIGURES IN THE MAIN TEXT

ABBREVIATIONS

FA/FB/FC	Fauna replicate FA, FB, FC
OSPAR	Oslo and Paris convention
PSD	Particle size distribution analysis sample
WGS84	World Geodetic System 1984

1. INTRODUCTION

1.1 Background

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed intertidal surveys at five proposed cable landings. These were located at Seaton Sluice and Whitley Bay (UK east coast), Squires Gate Lane (UK west coast), Port Erin and Port Grenaugh (Isle of Man) and Loughshinny (Ireland).

The Havhingsten cable system is a planned subsea telecommunication network and the design spans nearly 920 km with initial landing points in four markets, including Denmark, England, Isle of Man and Ireland.

The intertidal surveys were conducted to establish whether any sensitive habitats are present within the cable route corridor, specifically habitats listed under Annex I of the EC Habitats Directive and habitats listed by the Oslo-Paris convention (OSPAR) as threatened and/or declining habitats (OSPAR, 2008). In addition, core samples were collected to establish physico-chemical and biological properties of the sediment.

This report provides details of intertidal surveys and presents a preliminary assessment of the data obtained in the field; this interpretation may change following further data analysis.

Appendix A outlines the guidelines for use of this report.

1.2 Coordinate Reference System

All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84).

2. SURVEY METHODS

At each intertidal location a cable route corridor of 500 m was surveyed, where safe access allowed.

Phase 1 habitat mapping was derived as a rapid broad-scale mapping technique in the 1970s. The Phase 1 habitat classification and methodology was originally published by the Nature Conservancy Council in 1990 and has subsequently been reprinted with minor revisions by the Joint Nature Conservation Committee (JNCC). This manual presents a standardised approach to classifying and mapping wildlife habitats throughout the UK, from planning to execution of habitat surveys.

A modified Phase I walkover biotope mapping survey was conducted to record conspicuous intertidal fauna and flora and habitats within the survey area, broadly following the above methodology. The entire vertical profile of the shore was investigated, from the supralittoral zone to the low water spring tide level, (where safe access allowed), as identified by standard Admiralty tidal predictions.

Colour aerial photographs covering the survey area were produced as field maps. Habitat boundaries were established and manually mapped onto field maps and any associated faunal and floral assemblages recorded. Photographs were captured within each biotope to facilitate detailed ground-truthing.

Target notes were used to record further information including features that were too small (< 5 m^2) to be portrayed accurately on a map, features on vertical faces and fine scale biotopes that existed as mosaics. Target notes were also used at each photographic sampling location and to describe human activities, such as coastal protection measures and large items of anthropogenic debris.

Determination of the substrate composition was undertaken. Descriptions are based on the Folk classification (Long, 2006), as presented within Table 2.1, which uses the descriptive terms ‘mud’, ‘sand’ and ‘gravel’ in combinations depending on the estimated proportions of each component. For example, a description of ‘muddy sand’ defines sediment that has sand as the principle component and a mud proportion of between > 10 % and < 50 %. Further descriptive terms have also been used to better describe the observations where necessary, for example terms such as ‘shell fragments’. In addition, to describe the larger sediment fractions, pebbles, cobbles and boulders were defined using the Wentworth classification. Any anthropogenic features evident were also recorded.

Table 2.1: Sediment Particle Sizes and Classification Terms

Particle Size	Corresponding Folk Class Used in Long (2006) Classification	Wentworth (1922) Classification
> 256 mm	NA	Boulder
> 64 to 256 mm		Cobble
> 2 to 64 mm	Gravel	Gravel/pebble
> 62.5 µm to 2 mm	Sand	Sand
> 4 to 62.5 µm	Mud	Silt
> 1 to 4 µm		Clay

In addition to the walkover and recording survey, at all sites, with the exception of Loughshinny, core samples were collected in the upper shore, mid shore and lower shore. Stainless steel core samplers with an internal diameter of 11.2 cm (0.01 m^2) were used to collect three macrofaunal samples and one particle size distribution (PSD) sample to a depth of 15 cm.

Garmin GPSmap 78 hand held Global Positioning System units, accurate to 10 m but often achieving < 5 m accuracy, were used to geo-reference biotope boundaries, photographs, sampling locations and target notes.

3. RESULTS

The intertidal surveys were conducted on spring tide occasions between 18 and 22 February 2019.

3.1 Seaton Sluice

The Seaton Sluice foreshore was predominantly comprised of medium to coarse sand backed by sand dunes. The mid to lower upper shore throughout the survey area was predominantly comprised of a mosaic of coarse sand, pebbles and cobbles with water run-off evident when exposed by the tide. A harbour was present to the south-east of the survey area with a region of boulders immediately to the north-west. In the centre of the survey area, the mid shore was comprised of a mosaic of sandstone bedrock and boulders. To the north-east of the survey area, an area of boulder clay was exposed.

Limited epifauna and macroalgae were observed, likely due to the season and sand scour. Macroalgae included several green and red ephemeral seaweeds, red turf forming seaweeds and wracks. Kelp (*Laminaria digitata*) was also visible below the tidal extremes in the south-east of the survey.

Birds included Black headed gulls (*Chroicocephalus ridibundus*) and Herring gulls (*Larus argentatus*).

Figure 3.1 presents a view across the Seaton Sluice survey area from the edge of the harbour in the south-east, north-west towards the town of Blyth. Table 3.1 summarises the core sampling locations and core samples acquired.

Figure 3.1: View across Seaton Sluice survey area from south-east

Table 3.1: Summary of Completed Core Samples, Seaton Sluice

Geodetic Parameters: WGS84 UTM Z 30N			
Station	**Latitude**	**Longitude**	**Samples Acquired**
SS_I01	55° 05.2472′ N	001° 28.8032′ W	FA/FB/FC/PSD
SS_I02	55° 05.2570′ N	001° 28.7826′ W	FA/FB/FC/PSD
SS_I03	55° 05.2711′ N	001° 28.7648′ W	FA/FB/FC/PSD
Notes: FA/FB/FC = Faunal replicates FA, FB, FC PSD = Particle size distribution analysis sample			

3.2 Whitely Bay

The Whitley Bay foreshore was predominantly comprised of medium to coarse sand, backed by a promenade on top of vertical concrete sea defenses. South of the cable route, the top shore was comprised of a narrow strip of mixed sediment. The mid to lower upper shore throughout the survey area was predominantly comprised of medium sand with varying degrees of coarse sand, pebbles and cobbles. Mobile kelp debris was present throughout the survey area, particularly along the lower shore. Limestone bedrock projected from the mid-shore to the low water mark in the south-east of the survey area, surrounded by boulders. Large shallow rockpools and small deep rockpools were present within the limestone bedrock. An area of sandstone bedrock was exposed in the mid-shore to the north-west of the limestone, south of the proposed cable route. An area of sandstone bedrock was also exposed in the north-west of the survey area. An outflow was present to the south of the survey area, forming a deep pool of standing water.

Generally, limited epifauna and macroalgae were observed, likely due to the season and sand scour. However, both epifauna and macroalgal diversity and abundance were elevated on the limestone projection and within the rockpools in the south-east of the survey area. A thin veneer of *Sabellaria* sp. tubes was observed underneath overhanging limestone ledges. Macroalgae included several green and red ephemeral seaweeds, red turf forming seaweeds and several wracks. Coralline macroalgae were abundant in rockpools. Kelp (*Laminaria digitata*) was present in deep rockpools on the exposed limestones, and also on boulders and bedrock at the low tide mark.

Birds included Black headed gulls (*Chroicocephalus ridibundus*) and Herring gulls (*Larus argentatus*).

Figure 3.2 and 3.3 present views across the Whitley Bay survey area from the top and bottom of the shore. Table 3.2 summarises the core sampling locations and core samples acquired.

Figure 3.2: View north-west across Whitley Bay survey area from top of the shore

Figure 3.3: View west across Whitley Bay survey area from bottom of limestone promenade

Table 3.2: Summary of Completed Core Samples, Whitely Bay

Geodetic Parameters: WGS84 UTM Z 30N			
Station	**Latitude**	**Longitude**	**Samples Acquired**
WB_I01	55° 02.8961′ N	001° 26.7550′ W	FA/FB/FC/PSD
WB_I02	55° 02.8997′ N	001° 26.7312′ W	FA/FB/FC/PSD
WB_I03	55° 02.9050′ N	001° 26.7115′ W	FA/FB/FC/PSD
Notes: FA/FB/FC = Faunal replicates FA, FB, FC PSD = Particle size distribution analysis sample			

3.3 Squires Gate Lane

Squires Gate Lane is a west facing foreshore area on the west coast of the UK, to the south of the main urban area of Blackpool. The rear shore of the northern half of the survey area was backed by a high rock armour construction, and the southern half was backed by a natural dune area. The survey area was bisected by a slipway on to the upper shore. Coarse shingle deposits were present along the rear shore, in front of the dune section. Overall the foreshore comprised sand with shell hash and gravel present in small varying amounts.

The rear shore rock armour displayed a sparse algal presence. The zonation observed comprised upper lichens, upper shore green algae and occasional additional algae dominated by sparse fucoids.

Figure 3.4 and 3.5 present views across the Squires Gate Lane survey area. Table 3.3 summarises the core sampling locations and core samples acquired.

Figure 3.4: View south across Squires Gate Lane survey area

Figure 3.5: View north across Squires Gate Lane survey area

Table 3.3: Summary of Completed Core Samples, Squires Gate Lane

Geodetic Parameters: WGS84 UTM Z 30N			
Station	**Latitude**	**Longitude**	**Samples Acquired**
SG_I01	53° 46.5721′ N	003° 03.4620′ W	FA/FB/FC/PSD
SG_I02	53° 46.5101′ N	003° 03.6471′ W	FA/FB/FC/PSD
SG_I03	53° 46.4448′ N	003° 03.8220′ W	FA/FB/FC/PSD
Notes: FA/FB/FC = Faunal replicates FA, FB, FC PSD = Particle size distribution analysis sample			

3.4 Port Grenaugh

Port Grenaugh is a small south-east facing bay on the south-east coast of the Isle of Man. A man-made wall protected the rear of the bay and bordered an active fresh water source that poured strongly into the bay, and formed a band of wide fresh water that was visibly discharging as far as the sea, even at low water on spring tides.

The foreshore was largely coarse shingle with varying amount of sediment, with large areas of cobbles and boulders, particularly seen across the mid shore and forming deposits at the base of the visible bedrock edges to the bay.

The bedrock and boulders that framed the bay displayed the expected flora zonation for a rocky shore, and comprised upper shore lichens, upper shore green algae, and various algae dominated by fucoid algae across most areas of the shore.

Due to the time of year, the beach was covered by dense swathes of drift algae, resulting from winter storm activity.

Three faunal cores and one PSD core were expected to be taken at an upper shore, mid shore and low shore position. The entire beach was largely shingle with sand forming a thin veneer over the coarser substrate, with denser deposits in places. As a result, it was found that the lower core position was not possible to achieve, as the substrate was completely impenetrable. The mid shore core position was achieved by finding a slightly denser patch of sand over the coarse sediment, but this cannot be said to be representative of the sediment in the area. The upper shore core position had a greater sandy and gravel fraction and was successfully acquired.

Figure 3.6 and Figure 3.7 present a view north across the Port Grenaugh survey area. Table 3.4 summarises the core sampling locations and core samples acquired.

Figure 3.6: View north across Port Grenaugh survey area

Figure 3.7: View north across Port Grenaugh survey area

Table 3.4: Summary of Completed Core Samples, Port Grenaugh

Geodetic Parameters: WGS84 UTM Z 30N			
Station	**Latitude**	**Longitude**	**Samples Acquired**
PG_I01	54° 06.1837′ N	004° 34.6267′ W	FA/FB/FC/PSD
PG_I02	54° 06.1271′ N	004° 34.5806′ W	FA/FB/FC/PSD
PG_I03	54° 06.0931′ N	004° 34.5339′ W	None
Notes: FA/FB/FC = Faunal replicates FA, FB, FC PSD = Particle size distribution analysis sample			

3.5 Port Erin

Port Erin is a west facing bay on the south west side of the Isle of Man. The beach was backed by a low wall with occasional fresh water sources entering the beach. Sand was the dominant substrate with areas of coarse mixed sediment surface deposits, which formed a larger component of the substrate in places. The south side of the bay comprised a higher wall forming a small harbour and breakwater area around which small boats were moored. Rear shore rock armour was seen in these areas alongside small slipways on to the shore.

The rear shore walls, rock armour and rock substrates near the small harbour displayed the expected flora zonation, comprising upper shore lichens, upper shore green algae, and various algae dominated by fucoid algae across the lower sections of any harder substrate surveyed.

Figure 3.8 and 3.9 present a view south across the Port Erin survey area. Table 3.4 summarises the core sampling locations and core samples acquired.

Figure 3.8: View south across Port Erin survey area

Figure 3.9: View south across Port Erin survey area

Table 3.5: Summary of Completed Core Samples, Port Erin

Geodetic Parameters: WGS84 UTM Z 30N			
Station	**Latitude**	**Longitude**	**Samples Acquired**
PE_I01	54° 05.1164′ N	004° 45.6320′ W	FA/FB/FC/PSD
PE_I02	54° 05.1405′ N	004° 45.7078′ W	FA/FB/FC/PSD
PE_I03	54° 05.1557′ N	004° 45.7562′ W	None
Notes: FA/FB/FC = Faunal replicates FA, FB, FC PSD = Particle size distribution analysis sample			

3.6 Loughshinny

Loughshinny is a predominantly sandy bay enclosed to the west by layered limestone and shale bedrock extending directly from coastal cliffs, and to the east by a concrete pier used by creel fishermen. Some emergent boulders were present to the east of the sandy bay and near the low water mark. The lower shore to the east of the bay was comprised of mixed sediment (sand, pebbles, cobbles and boulders). The upper shore featured boulder sea defenses upon which small white sand dunes have formed. A small area of gabion sea defense was present in the north-west of the bay. Several outflows were observed along the upper shore, through the boulder sea defenses. To the north-east of the bay, a small area of bedrock was emergent, with cobbles and boulders to the west and boulder sea defenses to the north.

Generally, limited epifauna and macroalgae were observed, likely due to the season and sand scour. However, both epifauna and macroalgal diversity and abundance were elevated on the layered limestone and shale bedrock and associated rockpools in the east of the survey area and on the mixed sediment and boulders on the lower shore. A thin veneer of *Sabellaria spinulosa* tubes was observed on mixed sediments on the lower shore to the east of the survey area. Piddock holes were observed in boulders in the lower shore from the centre to the east side of the bay. Macroalgae included several green and red ephemeral seaweeds, red turf forming seaweeds and several wracks. Coralline macroalgae were present in rockpools. Kelp (*Laminaria digitata*) was on mixed sediments on the lower shore to the east of the survey area. Additionally, lug worm (*Arenicola marina*) casts and sand mason worms (*Lanice conchilega*) tubes were observed, the latter in high abundance in sandy sediments in the low shore.

Birds included fulmar (*Fulmarus glacialis*), pale-bellied brent geese (*Branta bernicla hrota*), eurasian oystercatcher (*Haematopus ostralegus*), turnstone (*Arenaria interpres*), great black-backed gulls (*Larus marinus*) and herring gulls (*Larus argentatus*). A solitary grey heron was observed (*Ardea cinerea*). Fulmar were nesting in the sedimentary upper edges of the cliffs to the east of survey area.

Figure 3.10 and 3.1 present views across the Loughshinny survey area from the top and bottom of the shore, towards layered limestone and shale cliffs.

Figure 3.10: View west across Loughshinny from top of the shore

Figure 3.11: View west across Loughshinny from lower shore

4. REFERENCES

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APPENDICES

A. GUIDELINES ON USE OF REPORT

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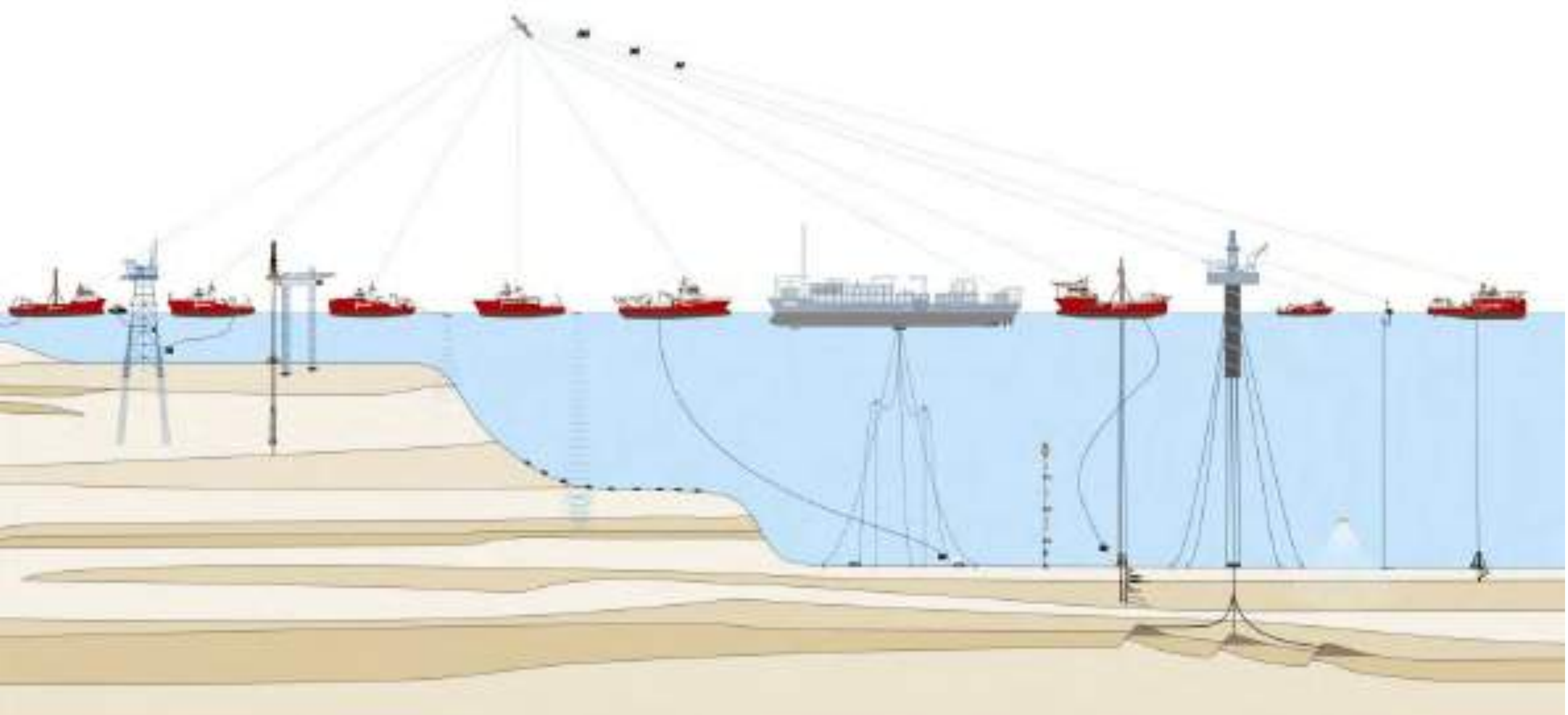
Field Report
Havhingsten Cable Route Survey
Nearshore Loughshinny

Fugro Document No.: 181275-R-009(01)
27 March 2019

Alcatel Submarine Networks UK Limited

Draft Report



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EXECUTIVE SUMMARY

Introduction

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed a nearshore environmental characterisation survey at Loughshinny, Ireland. The survey was conducted using the MV Fastnet Petrel during the survey period 21 to 22 March 2019.

Environmental Survey

The acquired sidescan sonar data were reviewed prior to survey operations to propose locations for camera investigations and grab sampling. Emphasis was placed on locating areas of potential conservation value, on boundaries between areas of differing sonic reflectivity and areas characteristic of the general background conditions of the site. The nearshore surveys comprised stations that were not completed by the offshore vessel, RV Prince Madog.

Two stations were selected along the Loughshinny proposed cable route. Station LS_ST01 was relocated 151 m south-east of the proposed location due to shallow water and numerous fishing pots. Video data were acquired for both stations using a drop-down camera and grab sampling was conducted at station LS_ST01 only.

Seabed Habitats

Seabed sediments along the Loughshinny cable route were predominantly muddy sand with an area of boulders. The hard substrate present closest to the shore hosted epifauna and flora such as tube building worms (Serpulidae), starfish (*Asterias rubens*), red algae and faunal turf (Hydrozoa/Bryozoa). Further from the shore, the sediment comprised muddy sand with shell fragments with small faunal burrows. Fauna present included starfish (Asteroidea) and anemone (Actiniaria).

Potentially Sensitive Habitats

No Annex I habitats or Oslo-Paris (OSPAR) threatened and/or declining habitats were recorded.

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ABBREVIATIONS

BSL	Below sea level
DVV	Dual van Veen grab
EOL	End of line
FA/FB	Fauna sample FA or FB
MV	Motor vessel
NF	No fix
OSPAR	Oslo and Paris
PC	Physico-chemical (grab sub-sample)
PSD	Particle size distribution
RV	Research vessel
SOL	Start of line
ST	Station
UHF	Ultra high frequency
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

1. INTRODUCTION

1.1 Background

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed a nearshore environmental characterisation survey at Loughshinny, Ireland. The survey was conducted using the MV Fastnet Petrel during the survey period 21 to 22 March 2019.

The Havhingsten cable system is a planned subsea telecommunication network and the design spans nearly 920 km with initial landing points in four markets, including Denmark, England, Isle of Man and Ireland.

The environmental survey was conducted to establish whether any sensitive habitats are present within the cable route corridor, specifically habitats listed under Annex I of the EC Habitats Directive and habitats listed by the Oslo-Paris (OSPAR) convention as threatened and/or declining habitats (OSPAR, 2008). In addition, grab samples were collected to establish physico-chemical and biological properties of the sediment.

For the purpose of the environmental surveys, the proposed cable route was divided into four sections, and named according to the landfall location:

- Ireland landing at Loughshinny;
- Isle of Man landing at Port Erin;
- Isle of Man landing at Port Grenaugh;
- UK west coast landing at Squires Gate Lane.

This report provides details of the nearshore environmental survey along the Loughshinny proposed cable route and presents a preliminary assessment of the data obtained in the field; this interpretation may change following further data analysis.

Appendix A outlines the guidelines for use of this report.

1.2 Coordinate Reference System

All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) projection Zone 30N.

2. SURVEY STRATEGY

The acquired sidescan sonar data were reviewed prior to survey operations to propose locations for camera investigations and grab sampling. Emphasis was placed on locating areas of potential conservation value, on boundaries between areas of differing sonic reflectivity and areas characteristic of the general background conditions of the site.

The nearshore surveys comprised stations that were not completed by the offshore vessel, RV Prince Madog. The details of the offshore survey undertaken within the Irish Sea are presented in report 181275-R-002(01) (Fugro, 2019).

The following stations are those which were not completed by the offshore vessel, RV Prince Madog. Two stations were proposed along the Loughshinny cable route. Station LS_ST01 required video data prior to grab sampling. Video data and grab samples had been acquired at station LS_ST02 onboard RV Prince Madog. Due to poor underwater visibility at this station previously, it was planned to be repeated to obtain better quality footage.

Table 2.1 provides the coordinates, data to be acquired and rationale for each location.

Table 2.1: Proposed Sampling Stations, Loughshinny

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
LS_ST01	296 201	5 937 197	Differing reflectivity covering two habitat types. Transect to be run due south from point location. Grab sample location to be defined following video review	Video and stills PC, FA, FB
LS_ST02	298 411	5 937 630	Representative habitat	Video and stills
Notes: ST = Station PC = Physico-chemical sample FA/FB = Faunal sample FA or FB				

3. METHODS

3.1 Survey Methods

3.1.1 Seabed Video/Photography

Prior to grab sampling, seafloor video footage and stills images were collected. Seabed photography was acquired using a Kongsberg OE 14-208 underwater camera system mounted within a purpose-built freshwater lens frame complete with a separate light, due to predicted low visibility. Table 3.1 presents the specifications of the Kongsberg camera system.

Table 3.1: Kongsberg OE 14-208 Camera System

Camera Specifications	
Weight:	228 kg (filled and with ballast weights)
Dimensions:	1.2 m x 1.0 m x 0.9 m
Required clearance:	1.5 m
Image Resolution	2592 x 1944 (max) at 5.3 MP
Framing Video	PAL 625 Line / 60 Hz NTSC
Sensor type	1/1.8" format high density CCD sensor
Operating Tolerances	
Water Depth	100 m
Optical	
Optical Zoom	x 5
ISO Sensitivity	50 to 400
Standard Lens	35mm format equivalent to 38-140 mm
Angle of View	0° to the seabed

Freshwater lens camera system

Seabed video footage was displayed on a computer monitor and recorded directly onto a Climax digital recorder and a backup Mini-DV tape player. An overlay box was used to overlay a navigation string from the ship's reference point, including the date, time and video frame position. The station number was updated on the navigation string automatically by HYDROpro software.

Footage was viewed in real time, assisting in the control of the camera in the water. Where the video passed over sediment type boundaries, additional seabed video was collected, as appropriate, to provide sufficient footage for the analysis phase. Review of the video data also allowed assessment of the sites prior to grab deployment.

Positions for the video footage were logged at the beginning and the end of each station and at each static image location.

Operational procedures for the seabed photography were as follows:

- The camera system was set up on deck prior to deployment and a station number slate picture taken;
- The camera was deployed into the water until just below the sea surface, at which point the lights were switched on;

- The camera was lowered to the seabed and when the seabed was visible recording started and stills were acquired;
- Still photography commenced with the environmental scientist manually triggering the camera while the camera moved over the seabed;
- At the end of a camera station/transect the video recording stopped;
- The camera was recovered to the deck and the lamps were switched off just beneath the surface.

On completion, photographs were downloaded and backed up onto an external hard drive.

3.1.2 Sediment Grab Sampling

Seabed samples were acquired using a 0.1 m^2 dual van Veen grab (Figure 3.1).

Figure 3.1: Dual Van Veen grab (0.1 m^2)

Operational procedures for the grab deployment and recovery were as follows:

- The 0.1 m^2 dual van Veen grab was prepared for operations prior to arrival on station. The Bridge communicated to the deck via an ultra high frequency (UHF) radio when the vessel was steady and on location, and the grab was deployed;
- When the engineer operating the winch observed that the grab had reached the seabed (evidenced through a distinct slackening of the wire rope), the bridge was informed (via UHF radio) and a positional fix was taken;
- On recovery to the deck, the sample was inspected and judged acceptable or otherwise (see below for rejection criteria);
- Two accepted grab samples were retained for faunal analysis and one grab sample was retained and subsampled for physico-chemical analysis;

- Deck logs were completed for each sample acquired (including no samples) with: date, time, sample number, fix number, sediment type, depth and colour of strata in the sediment (if any), odour (i.e. H_2S), bioturbation or debris.

Samples were considered unacceptable in the following instances:

- Evidence of sediment washout caused through improperly closed grab jaws or inspection hatch;
- Sediment sample taken on an angle; where the grab jaws have not been parallel to the seabed when the grab fired;
- Disruption of the sample through striking the side of the vessel;
- Sample represented less than approximately 7 cm bite depth of the grab;
- Sample is more than 50 m from the target location, unless otherwise specified in the proposed locations.

Samples deemed acceptable were photographed. For each of the samples, notes were made on sediment type, and conspicuous species.

Each macrofaunal sample was then transferred into a clean plastic box to be washed though a 1 mm sieve with seawater using a chute and stand method. The residue remaining on the sieve was then carefully transferred into a pre-labelled bucket and fixed using 10% buffered formal saline solution (4% formaldehyde). An additional sample label written on waterproof paper, including date and project reference, was placed inside the bucket in addition to labels on the side and lid of the bucket. The fauna samples were stored in a designated crate on the deck of the survey vessel until demobilisation, upon which they were transferred to Fugro’s benthic laboratories.

The third grab sample was used for physico-chemical (particle size distribution (PSD) and chemistry) samples, sub-samples of this grab sample were taken as follows:

- A sub-sample (of approximately 300 ml) was collected for PSD analysis, using a plastic scoop to a nominal depth of 5 cm. The samples were sealed in polythene bags to ensure no loss of fines. The samples were frozen at and stored on the vessel until demobilisation and transfer to the analysis laboratory;
- Hydrocarbon samples were collected using a cleaned metal scoop to a nominal depth of 2 cm and stored in a pre-labelled glass jar. The samples were frozen and stored on the vessel until demobilisation and transfer to the analysis laboratory;
- Samples for heavy metals were collected using a plastic scoop to a nominal depth of 2 cm. The samples were sealed in polythene bags to ensure no loss of fines. The samples were frozen at and stored on the vessel until demobilisation and transfer to the analysis laboratory.

4. RESULTS

4.1 Field Operations

The survey was conducted using the MV Fastnet Petrel during the survey period 21 to 22 March 2019.

Appendix B presents detailed survey logs.

4.1.1 Seabed Video/Photography

Photographic stills and video footage were successfully acquired at both proposed camera stations.

Due to shallow water and the presence of numerous fishing pots at station LS_ST01, this station was relocated 151 m south-east while still targeting the same sidescan sonar feature of interest. The new station was renamed LS_ST01A. The grab location was repositioned accordingly on review of the video footage.

Table 4.1 details the acquired video/photograph data for the sampling stations.

Table 4.1: Completed Camera Transects, Loughshinny

Geodetic Parameters: WGS84 UTM 30N						
Station		**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Length [m]**	**Data Acquisition**
LS_ST01A	SOL	296 293.1	5 937 015.3	6.8	249	11 mins 34 secs 19 stills
	EOL	296 258.6	5 937 262.1			
LS_ST02	SOL	298 418.7	5 937 591.1	15.0	65	9 mins 34 secs 32 stills
	EOL	298 408.3	5 937 655.2			
Notes: BSL = Below sea level ST = Station SOL = Start of line EOL = End of line						

4.1.2 Grab Sampling

A complete suite of samples (two macrofauna and one physico-chemical sample) were acquired at station LS_ST01.

Table 4.2 presents a summary of the samples acquired.

Table 4.2: Completed Sampling Stations, Loughshinny

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting* [m]**	**Northing* [m]**	**Depth [m BSL]**	**Sample Acquisition**
LS_ST01	296 285.6	5 937 148.2	8.6	PC, FA, FB
Notes: BSL = Below sea level ST = Station PC = Physico-chemical sample FA/FB = Faunal sample FA or FB				

4.2 Seabed Habitats and Fauna

4.2.1 Loughshinny

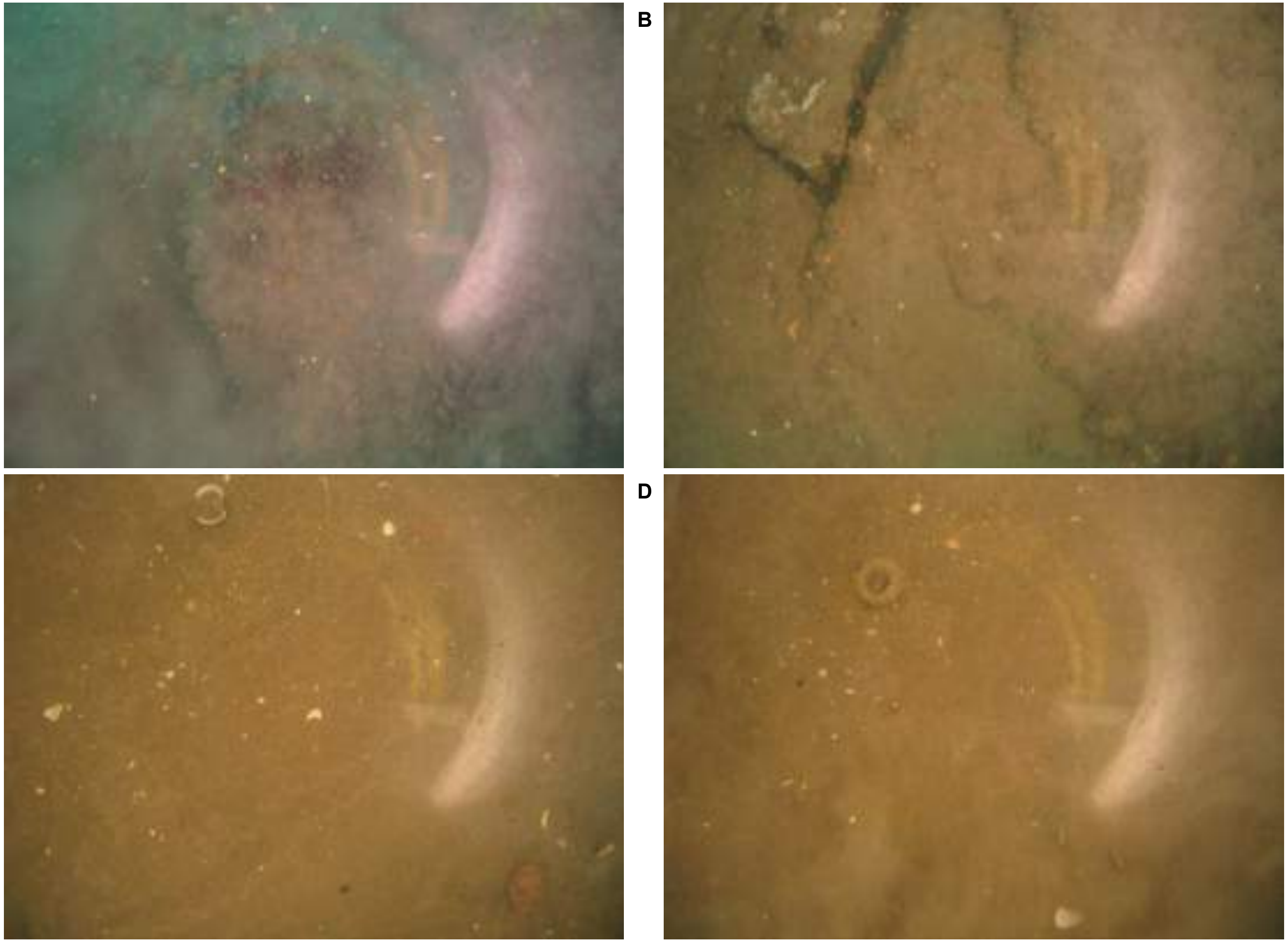
Seabed sediments along the Loughshinny cable route were predominantly muddy sand with an area of boulders at station LS_ST01. The hard substrate present at station LS_ST01 hosted epifauna such as tube building worms (Serpulidae), starfish (*Asterias rubens*) and faunal turf (Hydrozoa/Bryozoa), and red algae. Station LS_ST02 comprised muddy sand with shell fragments and small faunal burrows. Epifauna at station LS_ST02 included starfish (Asteroidea) and anemones (Actiniaria).

Figure 4.1 presents example seabed sediment photographs from the Loughshinny proposed cable route.

4.2.2 Potentially Sensitive Habitats or Species

No Annex I habitats or Oslo-Paris (OSPAR) threatened and/or declining habitats were recorded.

A B C D



A: Photograph 181275_LS_ST01A_2_04

Sediment description: Muddy sand/sandy mud and boulders

Flora and fauna description: Red algae and encrusting fauna

B: Photograph 181275_LS_ST01A_2_18

Sediment description: Muddy sand/ sandy mud and boulders

Fauna description: Encrusting fauna, tube worms (Serpulidae)

C: Photograph 181275_LS_ST02_20

Sediment description: Muddy sand/ sandy mud and small faunal burrows

Fauna description: No visible fauna

D: Photograph 181275_LS_ST02_28

Sediment description: Muddy sand/sandy mud

Fauna description: Anemone (Actiniaria)

Figure 4.1: Example seabed sediment photographs, Loughshinny

5. REFERENCES

Fugro, 2019. *Havhingsten Cable Route Survey, Irish Sea Field Report.* Fugro Report No. 181275-R-002(01). Portchester, Fugro GB Marine Limited.

Oslo and Paris (OSPAR) Convention, 2008. *OSPAR List of Threatened and/or Declining Species and Habitats*. Reference Number 2008-06. OSPAR Commission.

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B. LOGS

B.1 SURVEY LOG

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
21/03/2019	10:57:20	LS_ST01A	Video	SOL	-	6.8	296 270	5 937 063	296 287.8	5 937 016.9	49.1	System crashed - no fixes
21/03/2019	10:57:53	LS_ST01A	Still	181275_LS_ST01A_02	NF	-	-	-	-	-	-	
21/03/2019	11:10:06	LS_ST01A	Video	EOL	-	8.3	296 270	5 937 063	296 262.7	5 937 262.3	199.6	
21/03/2019	11:39:46	LS_ST01A_2	Video	SOL	-	6.8	296 270	5 937 063	296 293.1	5 937 015.3	52.7	
21/03/2019	11:40:32	LS_ST01A_2	Still	181275_LS_ST01A_2_02	3		296 270	5 937 063	296 288.7	5 937 032.5	35.5	
21/03/2019	11:41:00	LS_ST01A_2	Still	181275_LS_ST01A_2_03	4		296 270	5 937 063	296 285.9	5 937 044.8	23.9	
21/03/2019	11:41:17	LS_ST01A_2	Still	181275_LS_ST01A_2_04	5		296 270	5 937 063	296 285.3	5 937 050.9	19.2	
21/03/2019	11:41:26	LS_ST01A_2	Still	181275_LS_ST01A_2_05	6		296 270	5 937 063	296 285.4	5 937 053.4	17.8	
21/03/2019	11:41:44	LS_ST01A_2	Still	181275_LS_ST01A_2_06	7		296 270	5 937 063	296 285.5	5 937 060.0	15.5	
21/03/2019	11:42:00	LS_ST01A_2	Still	181275_LS_ST01A_2_07	8		296 270	5 937 063	296 284.6	5 937 065.7	14.6	
21/03/2019	11:42:19	LS_ST01A_2	Still	181275_LS_ST01A_2_08	9		296 270	5 937 063	296 283.8	5 937 073.8	17.4	
21/03/2019	11:43:00	LS_ST01A_2	Still	181275_LS_ST01A_2_09	10		296 270	5 937 063	296 281.4	5 937 088.2	27.7	
21/03/2019	11:43:59	LS_ST01A_2	Still	181275_LS_ST01A_2_10	11		296 270	5 937 063	296 279.3	5 937 108.0	46.1	
21/03/2019	11:44:26	LS_ST01A_2	Still	181275_LS_ST01A_2_11	12		296 270	5 937 063	296 278.0	5 937 117.7	55.4	
21/03/2019	11:45:25	LS_ST01A_2	Still	181275_LS_ST01A_2_12	13		296 270	5 937 063	296 276.4	5 937 139.6	77.0	
21/03/2019	11:46:17	LS_ST01A_2	Still	181275_LS_ST01A_2_13	14		296 270	5 937 063	296 274.0	5 937 158.4	95.7	
21/03/2019	11:47:18	LS_ST01A_2	Still	181275_LS_ST01A_2_14	15		296 270	5 937 063	296 269.9	5 937 179.8	117.0	
21/03/2019	11:48:00	LS_ST01A_2	Still	181275_LS_ST01A_2_15	16		296 270	5 937 063	296 270.6	5 937 198.7	135.8	
21/03/2019	11:49:10	LS_ST01A_2	Still	181275_LS_ST01A_2_16	17		296 270	5 937 063	296 271.2	5 937 223.5	160.7	
21/03/2019	11:49:43	LS_ST01A_2	Still	181275_LS_ST01A_2_17	18		296 270	5 937 063	296 269.4	5 937 233.2	170.4	
21/03/2019	11:50:14	LS_ST01A_2	Still	181275_LS_ST01A_2_18	19		296 270	5 937 063	296 265.4	5 937 241.0	178.3	
21/03/2019	11:50:52	LS_ST01A_2	Still	181275_LS_ST01A_2_19	20		296 270	5 937 063	296 260.1	5 937 253.5	191.0	
21/03/2019	11:51:20	LS_ST01A_2	Video	EOL	-	8.3	296 270	5 937 063	296 258.6	5 937 262.1	199.6	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
21/03/2019	12:05:56	LS_ST02	Video	SOL	-	15.0	298 411	5 937 630	298 418.7	5 937 591.1	39.7	
21/03/2019	12:06:21	LS_ST02	Still	181275_LS_ST02_02	21		298 411	5 937 630	298 420.0	5 937 595.4	35.7	
21/03/2019	12:06:27	LS_ST02	Still	181275_LS_ST02_03	22		298 411	5 937 630	298 420.3	5 937 596.5	34.8	
21/03/2019	12:07:05	LS_ST02	Still	181275_LS_ST02_04	23		298 411	5 937 630	298 420.7	5 937 603.1	28.6	
21/03/2019	12:07:53	LS_ST02	Still	181275_LS_ST02_05	24		298 411	5 937 630	298 416.3	5 937 608.4	22.2	
21/03/2019	12:08:30	LS_ST02	Still	181275_LS_ST02_06	25		298 411	5 937 630	298 415.1	5 937 613.9	16.6	
21/03/2019	12:08:40	LS_ST02	Still	181275_LS_ST02_07	26		298 411	5 937 630	298 416.0	5 937 615.8	15.0	
21/03/2019	12:08:54	LS_ST02	Still	181275_LS_ST02_08	27		298 411	5 937 630	298 416.3	5 937 618.3	12.8	
21/03/2019	12:09:22	LS_ST02	Still	181275_LS_ST02_09	28		298 411	5 937 630	298 417.8	5 937 622.6	10.1	
21/03/2019	12:09:35	LS_ST02	Still	181275_LS_ST02_10	29		298 411	5 937 630	298 417.8	5 937 625.0	8.5	
21/03/2019	12:09:44	LS_ST02	Still	181275_LS_ST02_11	30		298 411	5 937 630	298 416.4	5 937 626.6	6.3	
21/03/2019	12:10:15	LS_ST02	Still	181275_LS_ST02_12	31		298 411	5 937 630	298 415.0	5 937 629.7	4.0	
21/03/2019	12:10:30	LS_ST02	Still	181275_LS_ST02_13	32		298 411	5 937 630	298 413.2	5 937 631.6	2.7	
21/03/2019	12:10:38	LS_ST02	Still	181275_LS_ST02_14	33		298 411	5 937 630	298 412.8	5 937 631.7	2.5	
21/03/2019	12:11:00	LS_ST02	Still	181275_LS_ST02_15	34		298 411	5 937 630	298 411.4	5 937 633.9	3.9	
21/03/2019	12:11:17	LS_ST02	Still	181275_LS_ST02_16	35		298 411	5 937 630	298 409.2	5 937 637.0	7.2	
21/03/2019	12:11:32	LS_ST02	Still	181275_LS_ST02_17	36		298 411	5 937 630	298 407.9	5 937 639.4	9.9	
21/03/2019	12:11:46	LS_ST02	Still	181275_LS_ST02_18	37		298 411	5 937 630	298 407.7	5 937 640.7	11.2	
21/03/2019	12:12:26	LS_ST02	Still	181275_LS_ST02_19	38		298 411	5 937 630	298 410.9	5 937 643.2	13.2	
21/03/2019	12:12:31	LS_ST02	Still	181275_LS_ST02_20	39		298 411	5 937 630	298 411.4	5 937 643.4	13.4	
21/03/2019	12:12:59	LS_ST02	Still	181275_LS_ST02_21	40		298 411	5 937 630	298 412.5	5 937 650.0	20.1	
21/03/2019	12:13:06	LS_ST02	Still	181275_LS_ST02_22	41		298 411	5 937 630	298 412.6	5 937 650.6	20.7	
21/03/2019	12:13:15	LS_ST02	Still	181275_LS_ST02_23	42		298 411	5 937 630	298 411.8	5 937 652.1	22.1	
21/03/2019	12:13:25	LS_ST02	Still	181275_LS_ST02_24	43		298 411	5 937 630	298 412.0	5 937 652.5	22.5	
21/03/2019	12:13:32	LS_ST02	Still	181275_LS_ST02_25	44		298 411	5 937 630	298 412.2	5 937 652.6	22.6	
21/03/2019	12:13:55	LS_ST02	Still	181275_LS_ST02_26	45		298 411	5 937 630	298 413.4	5 937 653.2	23.3	
21/03/2019	12:14:03	LS_ST02	Still	181275_LS_ST02_27	46		298 411	5 937 630	298 413.4	5 937 653.3	23.5	
21/03/2019	12:14:26	LS_ST02	Still	181275_LS_ST02_28	47		298 411	5 937 630	298 412.9	5 937 653.1	23.2	
21/03/2019	12:14:31	LS_ST02	Still	181275_LS_ST02_29	48		298 411	5 937 630	298 413.1	5 937 652.6	22.7	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect / Station	Type	Sample Rep / Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
21/03/2019	12:15:02	LS_ST02	Still	181275_LS_ST02_30	49		298 411	5 937 630	298 410.6	5 937 652.7	22.7	
21/03/2019	12:15:23	LS_ST02	Still	181275_LS_ST02_31	50		298 411	5 937 630	298 408.6	5 937 654.7	24.8	
21/03/2019	12:15:30	LS_ST02	Still	181275_LS_ST02_32	51		298 411	5 937 630	298 408.3	5 937 655.2	25.3	
21/03/2019	12:15:30	LS_ST02	Video	EOL	-	15.0	298 411	5 937 630	298 408.3	5 937 655.2	25.3	
22/03/2019	12:09:49	LS_ST01	DVV	FA/FB	52	8.6	298 411	5 937 630	296 285.6	5 937 148.2	13.3	
22/03/2019	12:25:32	LS_ST01	DVV	PC	53	8.6	298 411	5 937 630	296 277.1	5 937 144.1	5.2	

Notes:

UTC = Coordinated Universal Time
BSL = Below sea level
ST = Station
NF = No fix

DVV = Dual van Veen
FA/FB = Faunal sample FA or FB
PC = Physico-chemical sample

B.2 GRAB LOG

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
22/03/2019	12:09	LS_ST01	FA	52	12	Muddy sand	Anoxic streaks
22/03/2019	12:09	LS_ST01	FB	52	7	Muddy sand	Anoxic streaks
22/03/2019	12:25	LS_ST01	PC	53	15	Muddy sand	Anoxic streaks

Notes:
UTC = Coordinated Universal Time
ST = Station
FA/FB = Faunal sample FA or FB
PC = Physico-chemical sample

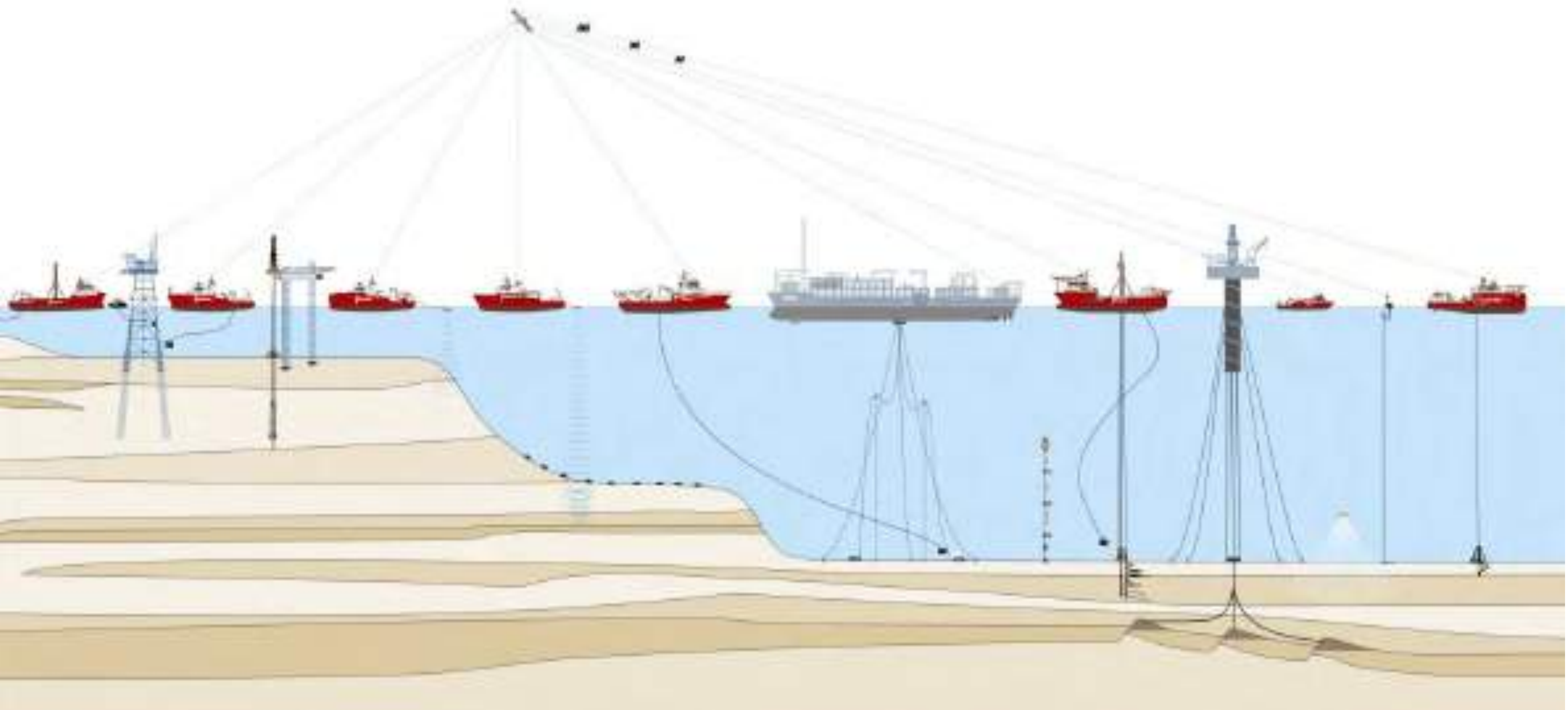
Habitat Assessment Report
Havhingsten Cable Route Surveys
UK West Coast Cable Crossings

Fugro Document No.: 181275-R011_04(01)
5 April 2019

Alcatel Submarine Networks UK Limited

Volume 4 of 4

Draft report



Habitat Assessment Report
Havhingsten Cable Route Surveys
UK West Coast Cable Crossings

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5 April 2019

Volume 4 of 4

Draft report

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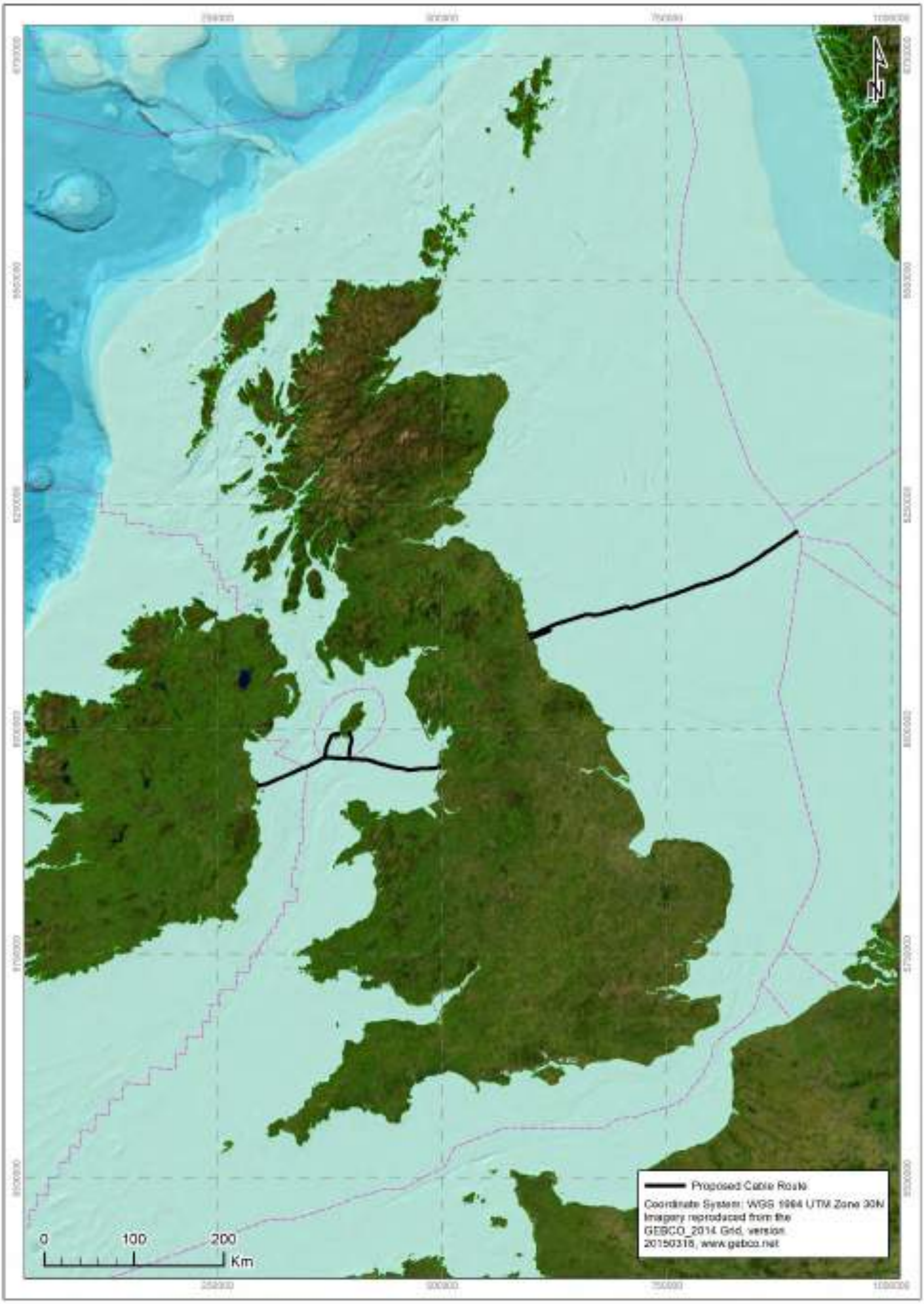
Issue	**Document Status**	**Prepared**	**Checked**	**Approved**	**Date**



FRONTISPIECE

EXECUTIVE SUMMARY

Introduction

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed an environmental characterisation survey and cable crossing investigation along the Irish Sea cable route. The cable crossing survey to investigate the interconnector cable was conducted using the RV Prince Madog on 24 February 2019. Table S.1 presents the proposed cable crossing location.

Table S.1: Proposed Cable Crossing Survey Locations

Geodetic Parameters: WGS84 UTM 30N				
Location	Easting [m]	Northing [m]	Latitude	Longitude
CC_05 (Client ID 2)	346 662	5 957 525	53° 44′ 37.60 N	005° 19′ 30.80 W
CC05_ST01	346 363	5 957 528	53° 44′ 37.40 N	005° 19′ 47.10 W

Survey Strategy

The interconnector cable crossing location was investigated by means of two perpendicular camera transects centred on the cable crossing position. One grab station was positioned 300 m from the interconnector cable to establish physico-chemical and biological properties of the sediment.

Seabed Habitats

One habitat was observed in the interconnector cable crossing survey area. The habitat was assigned the European Nature Information System (EUNIS) habitat classification ‘Deep circalittoral mud’ (A5.37). Epifauna associated with the ‘Deep circalittoral mud’ was relatively sparse and was characterised by sea pens (Pennatulacea, including *Virgularia mirabilis*), hermit crab (Paguroidea, including *Pagurus bernhardus*), Norway lobster (*Nephrops norvegicus*), faunal turf (Hydrozoa/Bryozoa) and faunal tracks, burrows and tubes (Polychaeta, including Sabellidae and numerous *Pseudopolydora*). Fish observed in this habitat included flatfish (Pleuronectiformes), gurnard (Triglidae), unidentified fish (Pisces) and lesser spotted dogfish (*Scyliorhinus canicula*).

Potentially Sensitive Habitats or Species

The interconnector cable crossing survey area comprised one sediment type defined by the EUNIS (2012) habitat classifications; ‘Deep circalittoral mud’ (A5.37).

Due to the observation of sea pens (*Virgularia mirabilis*) and faunal burrows, there was the potential for the OSPAR listed threatened and/or declining habitat ‘sea pens and burrowing megafauna communities’ to occur within the survey area. Although the sediments within the survey area were burrowed, they were not “heavily bioturbated by burrowing megafauna” and there were no mounds with conspicuous burrows forming a prominent feature of the sediment surface.

Species observed on the video footage and stills images indicated that the priority habitat ‘mud habitats in deep water’ could occur in the survey area. This habitat is found in large areas of the Irish Sea (EMODnet, 2019) and is represented in the West of Walney MCZ and North Anglesey Marine/Gogledd Môn Forol SAC. No other potentially sensitive habitats or species were identified from the interconnector cable crossing.

DOCUMENT ARRANGEMENT

Volume 1 Western HVDC Link UK
Volume 2 Western HVDC Link Port Grenaugh
Volume 3 Western HVDC Link Port Erin
Volume 4 Interconnector

CONTENTS

APPENDICES

TABLES IN THE MAIN TEXT

FIGURES IN THE MAIN TEXT

ABBREVIATIONS

BAP	Biodiversity Action Plan
BSL	Below sea level
CATS	Central Area Transmission System
CBD	Convention on Biological Diversity
CC	Cable crossing
Defra	Department for Environment, Food and Rural Affairs
DSV	Dive support vessel
DVV	Dual van Veen grab
EMODnet	European Marine Observation Data Network
EOL	End of line
EU	European Union
EUNIS	European Nature Information System
FA/FB	Fauna sample FA or FB
FOCI	Feature of conservation importance
JNCC	Joint Nature Conservation Committee
MCZ	Marine Conservation Zone
MNR	Marine Nature Reserves
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
NE	Natural England
NS	No sample
OSPAR	Oslo and Paris
PC	Physico-chemical (grab subsample)
SAC	Special Area of Conservation
SOL	Start of line
ST	Station
TR	Transect
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WCA	Wildlife and Countryside Act
WGS84	World Geodetic System 1984

1. INTRODUCTION

1.1 Background

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed an environmental characterisation survey and cable crossing investigation between Loughshinny, Ireland and Port Erin, Isle of Man, and between Port Grenaugh, Isle of Man and Squires Gate Lane, UK.

The Havhingsten cable system is a planned subsea telecommunication network and the design spans nearly 920 km with initial landing points in four markets, including Denmark, England, Isle of Man and Ireland.

The environmental survey was conducted to establish whether any sensitive habitats are present within the cable route corridor, specifically habitats listed under Annex I of the EC Habitats Directive and habitats listed by the Oslo-Paris (OSPAR) convention as threatened and/or declining habitats (OSPAR, 2008). In addition, grab samples were collected to establish physico-chemical and biological properties of the sediment.

A total of four cable crossings were selected by the client for investigation by means seabed video and photographic stills. This report provides details of the habitat assessment of the interconnector cable crossing. Table 1.1 presents the location of the cable crossing.

Table 1.1: Proposed Cable Crossing Survey Location

Geodetic Parameters: WGS84 UTM 30N				
Location	**Easting [m]**	**Northing [m]**	**Latitude**	**Longitude**
CC_05 (Client ID 2)	346 662	5 957 525	53° 44′ 37.60 N	005° 19′ 30.80 W
CC05_ST01	346 363	5 957 528	53° 44′ 37.40 N	005° 19′ 47.10 W

Appendix A outlines the guidelines for use of this report.

1.2 Environmental Scope of Work

The objectives of the habitat assessment surveys were to acquire sufficient environmental data to describe the habitats recorded within the survey area and to identify and delineate the extent of any potentially sensitive habitats or species, particularly Annex I habitats, if present.

1.3 Environmental Legislation UK

Marine legislation in the UK has been in operation for over a century and it has developed in a sectoral way resulting in regional, national, European and international laws.

Within the European Union (EU) the key legislative measures requiring the protection of habitats and species are the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, as amended), and the Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council on the Conservation of Wild Birds). These Directives fulfil the EU's commitment to international conventions and provide a framework for the designation of a network of protected sites for species and features across all EU member states, known as the Natura 2000 network.

An additional European measure applicable to the marine environment is the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy). This provides a legislative framework for marine biodiversity and sets out a target of achieving or maintaining good environmental status of the EU's marine waters. The targets are outlined by several indicators, many linking to habitats and ecological status to be reached by 2020.

At a national level, the Wildlife and Countryside (WCA) Act 1981 consolidates and amends existing national legislation to implement the Bern Convention and the Birds Directive in Great Britain. The WCA also provides for the designation of Marine Nature Reserves (MNRs) and gives powers to enact byelaws to protect such reserves.

The Habitats and Offshore Regulations allow for the designation of Special Areas of Conservation (SACs) which act to protect ecologically vulnerable or valuable habitats; and Special Protection Areas (SPAs) for sites which are considered important for bird populations. Under these regulations, the Joint Nature Conservation Committee (JNCC) is responsible for the designation of marine SACs and SPAs beyond 12 nautical miles (nm) and Natural England (NE) is responsible for marine sites within 12 nm.

The Marine and Coastal Access Act 2009 aims at developing a marine spatial planning system, which provides a planning framework for marine development. The Act also enables the creation of protected marine sites for nationally and regionally important marine species and habitats, known as Marine Protected Areas (MPAs). This includes designation of Marine Conservation Zones (MCZ), to protect nationally important marine wildlife, habitats, geology and geomorphology and can be designated anywhere in English inshore waters, by the Department for Environment, Food and Rural Affairs (Defra), and UK offshore waters by JNCC and NE. These measures are intended to fulfil the UK's international commitments to protection of habitats and species.

The two types of MPA features covering marine biodiversity are: broadscale habitats and features of conservation importance (FOCI). Broadscale habitats represents the main types of seabed and associated biota in UK waters; protection of each habitat and biota, ensure protection of the full range of marine biodiversity. As such, MPAs include the range of marine wildlife, not just rare or threatened features. FOCI represent habitats and/or species that may be highly sensitive to human activities and therefore need protection.

The UK Biodiversity Action Plan (BAP) produced a list of habitats and species of importance across the UK, as a response to commitment to the protection of the UK's biological resources, under the Convention of Biological Diversity (CBD). In 2012, the UK Post-2010 Biodiversity Framework succeeded the UKBAP, as the result of new drivers and requirements following the publication of the CBD's Strategic Plan for Biodiversity 2011 to 2020 and its 20 Aichi Biodiversity Targets. The UKBAP lists of priority species and habitats remain important and valuable reference sources to help draw up statutory lists of priority species and habitats in England, Scotland, Wales and Northern Ireland.

1.4 Environmental Legislation Republic of Ireland

In the republic of Ireland, the EU Habitats and Birds Directives are transposed into Irish law by the European Communities (Birds and Natural Habitats) Regulations (2011) (Classen, 2018). This law forms the legal basis for the selection and designation of SPAs and SACs in Ireland and is currently the only legislative instrument providing protection for marine habitats (Classen, 2018). Unlike SACs and SPAs, MPAs do not yet have any legal status in the Republic of Ireland and are not protected under any legislation. All MPAs currently overlap with either SPAs or SACs so are protected under the European Communities (Birds and Natural Habitats) Regulations 2018 (Classen, 2018). Currently, the Irish government is working on an integrated marine plan for Ireland, ‘Harnessing our Ocean Wealth’. The plan is intended to assemble an expert group to advise the Minister for Housing, Planning and Local Government on the establishment of Spatial Protection Measures (SPMs), including Marine Protected Areas (MPAs) (National Parks and Wildlife Service, 2018a).

1.5 Protected Sites and Potentially Sensitive Habitats

In the UK’s territorial waters, the relevant protected areas include the West of Walney MCZ, Queenie Corner proposed MCZ, North Anglesey Marine/Gogledd Môn Forol SAC and the Irish Sea Front SPA.

The West of Walney MCZ is located 112 km north-east of the survey area. This MCZ protects 388 km^2 of seabed made up of the two broadscale habitats ‘subtidal sand’ and ‘subtidal mud’. The MCZ includes part of the ‘eastern Irish Sea mud belt’ which supports the OSPAR threatened and/or declining habitat ‘sea pen and burrowing megafauna communities’. This mud habitat is also of high commercial fishing interest due to Norway lobster (*Nephrops norvegicus*) populations (JNCC, 2018a).

Queenie Corner is a proposed MCZ, covering an area of 146 km^2. This proposed MCZ would support ‘subtidal mud’ habitats and ‘sea pen and burrowing megafauna communities’, as well as the commercially important Norway lobster (*Nephrops norvegicus*) (Defra, 2018).

North Anglesey Marine/Gogledd Môn Forol SAC lies 8 km east of the survey area. This SAC covers an area of 3249 km^2 and is designated for the protection of the harbour porpoise (*Phocoena phocoena*). The site covers a mix of habitats, including rock, coarse and sandy sediments and mud (JNCC, 2019).

The Irish Sea Front SPA is situated 9 km east of the survey area. The SPA covers 180 km^2 and is identified as a hotspot for marine birds such as the Manx shearwater (*Puffinus puffinus*) due to the rich food source available during the breeding season (JNCC, 2017a).

In the Republic of Ireland’s territorial waters, the three protected areas that are in place that are remotely situated around the cable crossing survey area are Lambay Island SPA and SAC, and the Codling fault zone SAC.

The Lambay Island SPA is of special conservation interest for a wide variety of bird species including; Fulmar, Cormorant, Shag, Greylag goose, Lesser black-backed gull, Herring gull, Kittiwake, Guillemot, Razorbill and Puffin (National Parks and Wildlife Service, 2018b). The Lambay Island SAC protects extensive reef habitat with typical algal species (*Palmaria palmata*, *Cystoclonium purpureum*, *Delesseria sanguinea*, *Membranoptera alata*, *Hypoglossum hypoglossoides*, *Chorda filum, Laminaria saccharina* and *Halidrys siliquosa*) as well as typical invertebrate species (*Obelia geniculata, Alcyonium digitatum,* *Caryophyllia smithii, Pomatoceros triqueter, Helcion pellucidum, Balanus crenatus, Echinus esculentus* and *Asterias rubens*). It is also the principle breeding colony of Grey seals (Halichoerus grypus) for the east coast of Ireland (National Parks and Wildlife Service, 2018c).

The coding fault zone SAC is selected to protect the Annex I habitat 'submarine structures made by leaking gases'. The structure found in the Irish Sea is bubbling reef. These mounds are formed by anaerobic bacteria oxidising methane to drive their metabolism. The reduction phase of this chemical reaction within the bacterial cell produces a very small amount of waste carbonate. The Codling fault zone has been documented to have in excess of 23 seep mounds. The hard structures associated with the 'submarine structures made by leaking gases' habitat attract species not usually found in the neighbouring sand and mud. Hydroids such as *Hydrallmania falcata* and *Tubularia indivisa* and a wide variety of anemones can be found, as well as large crustaceans such as *Cancer pagurus, Homarus gammarus* and *Munida sp.* (National Parks and Wildlife Service, 2018d).

Table 1.2 provides a list of sensitive species and habitats that may occur within the current survey area, along with their relevant legislation. Figure 1.1 spatially displays the predicted seabed habitats and protected areas in relation to the Havhingsten cable route cable crossing. Table 1.3 provides a key for the EUNIS codes. Information contained within this figure has been derived from data that is made available under the European Marine Observation Data Network (EMODnet) Seabed Habitats project (EMODnet, 2019), funded by the European Commission's Directorate-General for Maritime Affairs and Fisheries.

Table 1.2: Potential Sensitive Species/Habitats

Species/Habitat	Legislation	Description	Designation/Status
Sublittoral sands and gravels	UK Post-2010 Biodiversity Framework	Subtidal sands and gravel	Priority habitat
Mud habitats in deepwater	UK Post-2010 Biodiversity Framework	Mud habitats in deepwater	Priority habitat
Sea pens and burrowing megafauna communities	UK Post-2010 Biodiversity Framework	Sea pens and burrowing megafauna communities	Habitat Feature of Conservation Importance (FOCI)
	OSPAR; List of Threatened and / or Declining Species and Habitats		Threatened and/or Declining habitat

1.5.1 Offshore Subtidal Sands and Gravels

Offshore subtidal sands and gravels is a priority habitat that has been identified as potentially occurring in the survey area. This is a broadscale habitat which comprises many component biotopes or species thought to be of conservation importance.

1.5.2 Offshore Deep-sea Muds and Sea Pen and Burrowing Megafauna Communities

'Sea pen and burrowing megafauna communities' is a habitat feature of conservation importance and is listed on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008). This biotope comprises plains of fine mud, in water depths ranging from 15 m to 200 m or more, which are heavily bioturbated by burrowing megafauna. The burrowing megafauna may include the crustaceans

N. norvegicus, *Calocaris macandreae* or *C. subterranea*. In the UK this habitat is principally encountered in sheltered sea lochs, voes and in the deeper offshore waters of the North Sea and Irish Sea (OSPAR, 2010).

'Burrowed mud' incorporates the component of the OSPAR (2008) list of threatened and/or declining habitat biotopes 'Sea pens and burrowing megafauna in circalittoral fine mud' (A5.361) and 'Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud' (A5.362) as well as three component species, including the tall sea pen (*Funiculina quadrangularis*), firework anemones (*Pachycerianthus multiplicatus*) and mud burrowing amphipods (*Maera loveni*), all of which can be found within the component biotopes. The habitats were included on the OSPAR (2008) list due to the vulnerability of the habitat to impacts including bottom trawling fishing and destruction of habitat. This habitat is described as plains of fine mud with conspicuous populations of sea pens (*Virgularia mirabilis* and *Pennatula phosphorea*), which are heavily bioturbated by burrowing megafauna crustacea such as *N. norvegicus*, *C. macandreae* or *C. subterranea*.

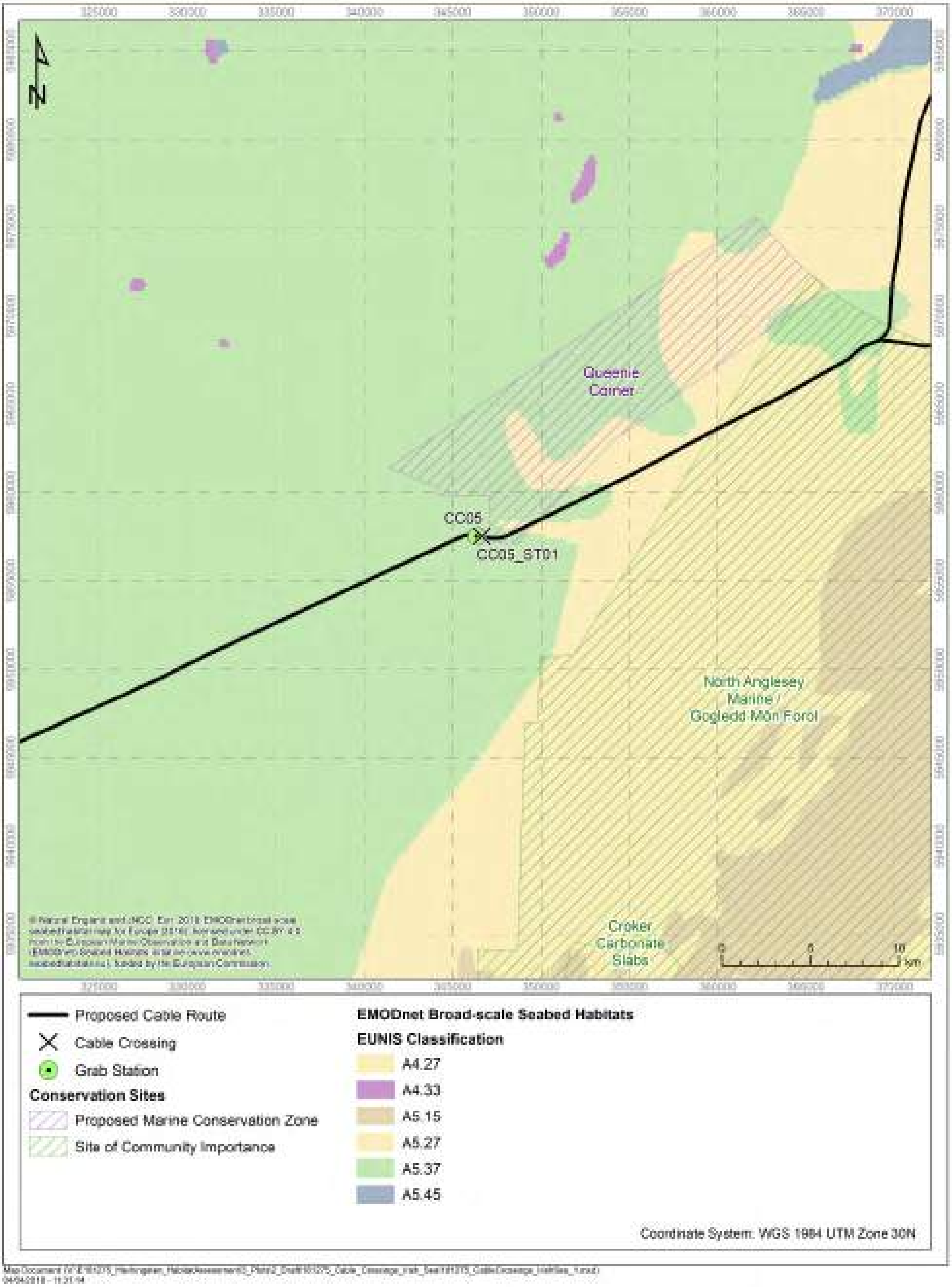


Figure 1.1: Predicted seabed habitats and protected areas relevant to the survey area

Table 1.3: EMODnet Broadscale Seabed Habitats EUNIS Classification Key

EMODnet Broadscale Seabed Habitats EUNIS Classification			
Code	**Description**	**Code**	**Description**
A4.27	Faunal communities on deep moderate energy circalittoral rock	A5.27	Deep circalittoral sand
A4.33	Faunal communities on deep low energy circalittoral rock	A5.37	Deep circalittoral mud
A5.15	Deep circalittoral coarse sediment	A5.45	Deep circalittoral mixed sediments

1.6 Coordinate Reference System

All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) Projection Zone 30N Central Meridian 3° West (CM 3° W). Table 1.4 provides the detailed geodetic and projection parameters.

Table 1.4: Project Geodetic and Projection Parameters

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Reciprocal flattening:	1/f = 298.257 223 563
Project Projection Parameters	
Grid Projection:	Universal Transverse Mercator (UTM), Northern Hemisphere
UTM Zone:	30 N
Central Meridian:	3° 00′ 00″ West
Latitude of Origin:	00° 00′ 00″ North
False Easting:	500 000 m
False Northing:	0 m
Scale factor on Central Meridian:	0.9996
Units:	metre

2. SURVEY STRATEGY

2.1 Habitat Assessment

The Interconnector cable crossing location was selected by the client and was investigated by means of two perpendicular camera transects (CC_05_TR01 and CC_05_TR02), centred on the cable crossing position. A proposed grab sampling station was positioned 300 m from the interconnector pipeline.

Table 2.1 provides the coordinates, data to be acquired and rationale for each location**.**

Table 2.1: Proposed Cable Crossing Survey Locations

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
CC_05 (Client ID 2)	346 662	5 957 525	Interconnector	Video and stills
CC05_ST01	346 363	5 957 528	Grab station positioned 300 m from the interconnector pipeline crossing	Video and stills, PC, FA, FB
Notes: CC = Cable crossing ST = Station PC = Physico-chemical sample FA/FB = Faunal sample FA or FB				

3. METHODS

3.1 Survey Methods

3.1.1 Seabed Video/Photography

Seabed photography was acquired using a Kongsberg OE 14-208 underwater camera system mounted within a purpose-built camera frame complete with a separate strobe and two lights. Two subsea lasers were used to provide a scale on the video footage, these were set at 19.5 cm apart.

Seabed video footage was displayed on a computer monitor and recorded directly onto a Climax digital DVD recorder hard drive. An Ocean Tools video overlay was used to overlay a navigation string from the ship's reference point, including the date, time and video frame position. The station number was also displayed (manually updated).

Footage was viewed in real time, assisting in the control of the camera in the water. Where the video passed over sediment type boundaries, additional seabed video was collected, as appropriate, to provide sufficient footage for the analysis phase.

Positions for the video footage were logged at the beginning and the end of each transect and at each static image location.

3.2 Interpretation Methods

3.2.1 Seabed Habitats/Biotopes Classification

3.2.2 General Review

Detailed analysis of video and stills photography data was undertaken by experienced Fugro marine biologists/taxonomists to assess the habitats that were present within the survey area. The video photography data were reviewed in conjunction with the still photographs, noting the locations of any observed changes in sediment type and/or associated faunal community, if observed. For each transect, video photography was initially reviewed rapidly (at approximately four times the normal speed) to separate different substrates/habitats, if appropriate. If substrate changes were evident, but were less than 5 m, these were considered incidental patches and, as such, were not analysed as a separate segment. Instead, notes regarding these patches were made in the substrate description, if applicable. Following the initial analysis stage, the video segments were then analysed at normal speed and slower, on software that enabled freeze frame. Taxa were recorded to the lowest possible taxonomic level. It should be noted that many species cannot be identified fully from video photography alone and, as such, higher taxonomic levels were used.

Determination of the substrate composition was undertaken per video segment. Seabed sediments have been described based on the seabed video/photographic data, supplemented with field descriptions of the grab sample taken at station CC05_ST01. Descriptions are based on the Folk classification (Long, 2006) as presented within Table 3.1, which uses the descriptive terms 'mud', 'sand' and 'gravel' in combinations depending on the estimated proportions of each component. For example, a description of 'muddy sand' defines sediment that has sand as the principle component and a mud proportion of between 10% and 50%. Further descriptive terms have also been used to better describe the observations where necessary, for example terms such as 'shell fragments'. In addition, to describe the larger sediment fractions, pebbles, cobbles and boulders were defined using the Wentworth (1922) classification. Any anthropogenic features evident were also recorded, if present.

Table 3.1: Sediment Particle Sizes and Classification Terms

Particle Size	Corresponding Folk Class Used in Long (2006) Classification	Wentworth (1922) Classification
> 256 mm	NA	Boulder
> 64 to 256 mm		Cobble
> 2 to 64 mm	Gravel	Gravel/pebble
> 62.5 µm to 2 mm	Sand	Sand
> 4 to 62.5 µm	Mud	Silt
> 1 to 4 µm		Clay

3.2.3 Hierarchical Habitat/Biotope Classification

Habitats within the survey area were classified in accordance with the European Nature Information System (EUNIS) habitat classification, which has compiled habitat information from across Europe into a single database. This classification system is based around hierarchical analysis, where abiotic habitats are initially defined (at four levels) and biological communities are then linked to these (at two lower levels) to produce a biotope classification. Table 3.2 summarises the EUNIS hierarchy, with an example of the coding system. The equivalent classification from 'The Marine Habitat Classification for Britain and Ireland – Version 15.03' (JNCC, 2015) was also noted. The EUNIS classification system is designed to incorporate small scale temporal variations (e.g. seasonal) into the biotope/habitat categories. However, biological communities and marine environments can be highly dynamic and temporally variable. Therefore, the biotopes and habitats identified by the current assessment are representative of the survey area at the time of sampling only.

EUNIS classifications were assigned to each habitat type observed within the video photography. High resolution still photographs were used to aid identification of fauna and biotope designation. Although theoretically a biotope can be assigned to any sized area of seabed, for the purposes of this assessment the commonly accepted minimum habitat size of 25 m^2 (Connor et al., 2004) was adopted.

Table 3.2: EUNIS (2012a) Biotope Classification Hierarchy Example

Level	Example Classification Name	Example Classification Code
1. Environment	Marine habitats	A
2. Broad habitat types	Sublittoral sediments	A5
3. Main habitats	Sublittoral sand	A5.2
4. Biotope complexes	Circalittoral muddy sand	A5.26
5 & 6. Biotopes and sub-biotopes	*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	A5.262

3.2.4 Sensitive Habitats and Species

Sensitive habitat and species of potential relevance within the region surrounding the survey area have been outlined in Section 1.5. the following methods for assessment were utilised if needed.

3.2.4.1 Offshore Subtidal Sands and Gravels

The 'Offshore subtidal sands and gravels' priority habitat incorporates the 'Sublittoral coarse sediment' and 'Sublittoral sand' broad habitats within the EUNIS habitat classification (EUNIS, 2012a). Seabed photographic data were reviewed in detail to characterise the sediments within the survey area and broad habitat types were selected, which are comparable to the priority habitats. Associated epifaunal assemblages were identified to determine whether they constituted component habitats. The assigned EUNIS main habitat type will be used to assess the presence of any potential priority habitats.

3.2.4.2 Sea Pens and Burrowing Megafauna Communities

Following an initial assessment of the seabed video and photographs, a full assessment would be performed if faunal burrows were present. To assess the abundance and density of sea pens and burrowing megafauna, the numbers of each species and burrows visible in each video transect would be counted. The total area of view along the video was calculated and used to convert the number of sea pens and burrows to the SACFOR (Super-abundant, Abundant, Common, Frequent, Occasional, Rare) abundance scale used by Marine Nature Conservation Review and JNCC to record the abundance and density of marine benthic flora and fauna (JNCC, 2017b). When assessing density, the SACFOR scale considers the size of the species being assessed, using size classes to group species, although the guidance provided in Connor et al. (2004) suggests the species take precedence over their actual size in deciding which scale to use. The slender sea pen (*V. mirabilis*) and the phosphorescent sea pen (*P. phosphorea*) were classed as 3 cm to 15 cm (Greathead et al., 2011; Allan et al., 2012, Connor et al., 2004), and the tall sea pen (*F. quadrangularis*) was classed as > 15 cm (Connor et al., 2004). The Norway lobster (*N. norvegicus*) has also been listed as > 15 cm in Connor et al. (2004), however, megafauna responsible for creating burrows may also include the mud shrimps *C. subterranea* and *C. macandreae* (JNCC, 2014). Both of which are described as burrowers sized between 3 cm and 10 cm (MarLIN, 2015a; 2015b). Due to the difficulties of identifying species from burrow type, the size class of 3 cm to 15 cm was used to allow for the size variation of possible species responsible for creating the burrows. Using the visible laser scale, the calculated average width of view along the video transects was 2 m. Table 3.3 shows the size classes applied to each species and the SACFOR scale conversion used.

Table 3.3: The SACFOR Scale used for Sea Pen and Burrow Density Assessment

SACFOR Scale	Individuals per m^2			
	3 cm to 15 cm*		> 15 cm†	
Super-Abundant	100.0 – 1000.0	1–9/0.01 m^2 (10 × 10 cm)	10.0 – 99.0	1–9/0.1 m^2
Abundant	10.0 – 99.0	1–9/0.1 m^2	1.0 – 9.0	1–9/m^2
Common	1.0 – 9.0	1–9/ m^2	0.1 – 0.99	1–9/10 m^2 (3.16 × 3.16 m)
Frequent	0.1 – 1.0	1–9/10 m^2 (3.16 × 3.16 m)	0.01 – 0.09	1–9/100 m^2 (10 × 10 m)
Occasional	0.01 – 0.09	1–9/100 m^2 (10 × 10 m)	0.001 – 0.009	1–9/1000 m^2 (31.6 × 31.6 m)
Rare	0.001 – 0.009	1–9/1000 m^2 (31.6 × 31.6 m)	0.0001 – 0.0009	< 1/1000 m^2

Notes:
* = 3 cm to 15 cm: *Pennatula phosphorea*, *Virgularia mirabilis*, megafaunal burrows
† = > 15 cm: *Funiculina quadrangularis*

To confirm this habitat type, sightings of burrows and/or mounds must be present as at least ‘frequent’ abundance on the SACFOR scale to confirm this habitat type (JNCC, 2014).

4. RESULTS

4.1 Field Operations

The cable crossing survey to investigate the interconnector cable crossing was conducted using the RV Prince Madog on 24 February 2019.

4.1.1 Seabed Video/Photography

Photographic stills and video footage were successfully acquired along the two proposed camera transects and at the grab sampling station. Table 4.1 details the acquired video and photographic data acquired at each station and transect. Appendix B provides detailed survey logs.

Table 4.1: Completed Camera Transects

Geodetic Parameters: WGS84 UTM 30N						
Transect/Station		**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Length [m]**	**Data Acquisition**
CC_05_TR01A	SOL	347174.7	5957085.5	83	829	33 mins 38 secs 68 stills
	EOL	346542.0	5957621.4			
CC_05_TR02	EOL	346779.4	5957515.0	82	272	10 mins 15 secs 26 stills
	SOL	346508.0	5957501.8			
CC05_ST01	EOL	346266.4	5957592.1	82	146	19 mins 59 secs 26 stills
	SOL	346385.9	5957508.6			

Notes:
BSL = Below sea level
TR = Transect
ST = Station
CC = Cable crossing
OL = Start of line
EOL = End of line

4.1.2 Grab Sampling

A complete suite of samples was acquired at CC05_ST01 (two macrofaunal and one physico-chemical sample). Table 4.2 presents the details of the sample acquired.

Table 4.2: Completed Sampling Stations, Cable Crossing

Geodetic Parameters: WGS84 UTM 30N				
Station	**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Sample Acquisition**
CC05_ST01	346 332.3	5 957 528.3	81	FA, FB, and PC

Notes:
BSL = Below sea level
CC = Cable crossing
ST = Station
FA/FB = Faunal sample
PC = Physico-chemical sample

4.2 Seabed Habitats and Fauna

The seabed primarily consisted of rippled sandy mud with shell fragments. Table 4.3 presents the habitat classification hierarchy for the habitats observed within the survey area. Appendix C presents example seabed photographs.

Table 4.3: Habitat Classifications

EUNIS (2012a) Habitat Classification				Equivalent JNCC (2015) Classification
Environment Level 1	**Broad Habitat Level 2**	**Habitat Level 3**	**Biotope Complex Level 4**	
A Marine	A5 Sublittoral sediment	A5.3 Sublittoral mud	A5.37 Deep circalittoral mud	SS.SMu.OMu Offshore circalittoral mud
Notes: EUNIS = European Nature Information System JNCC = Joint Nature Conservation Committee				

4.2.1 Deep Circalittoral Mud (A5.37)

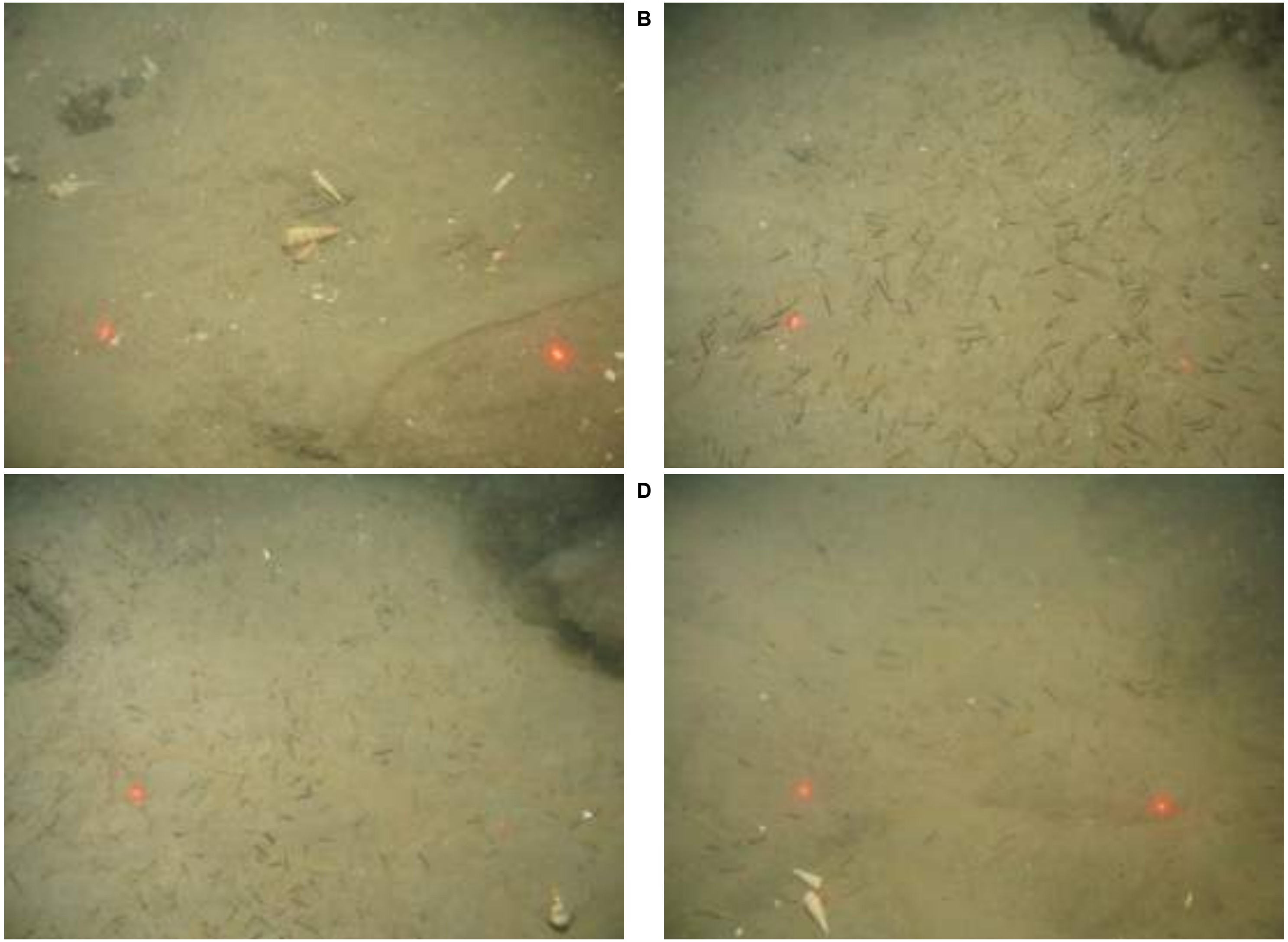
This biotope complex is described as “mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50 m to 70 m. A variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.” (EUNIS, 2012b).

The biotope complex ‘Deep circalittoral mud’ was recorded along the two transects and at the grab station CC05_ST01 with a drop-down camera. The sandy mud sediment comprised varying quantities of shell debris. The epifauna included seapen (Pennatulacea, including *Virgularia mirabilis*), hermit crab (Paguroidea, including *Pagurus bernhardus*), Norway lobster (*Nephrops norvegicus*), faunal turf (Hydrozoa/Bryozoa) and faunal tracks, burrows and tubes (Polychaeta, including Sabellidae and numerous *Pseudopolydora*).

Fish observed in this habitat included flatfish (Pleuronectiformes), gurnard (Triglidae), unidentified fish (Pisces) and lesser spotted dogfish (*Scyliorhinus canicula*).

Figure 4.1 presents example photographs of the observed habitat.

A B C D



A: Photograph CC05_ST01_03

Mud
Faunal turf (Hydrozoa/Byozoa)

B: Photograph CC05_TR01A_19

Mud
Faunal turf (Hydrozoa/Byozoa)

C: Photograph CC05_TR01A_44

Mud
Faunal turf (Hydrozoa/Byozoa)
Faunal burrows

D: Photograph CC05_TR02_13

Mud
Faunal turf (Hydrozoa/Byozoa)
Hermit crab (Paguridae)

Figure 4.1:Example seabed photographs of 'Deep circalittoral mud' (A5.37)

4.3 Potential Sensitive Habitats and Species

Analysis of seabed video and stills photography data was undertaken to establish whether any potentially sensitive habitats were likely to be present within the survey area.

4.3.1 Sea Pen and Burrowing Megafauna Communities

Burrows were observed on all locations surveyed and sea pens were observed on transect (CC05_TR01A). The video and stills images were analysed for the presence of the habitat 'sea pen and burrowing megafauna communities' using the method described in Section 3.2.4.2. Table 4.4 presents the results of the assessment.

Table 4.4: SACFOR Densities of Sea Pens and Burrows

Transect/Station	Time [UTC]	Easting [m]	Northing [m]	Length [m]	*V. mirabilis* [3 – 15 cm size class]	Burrows [3 – 15 cm size class]
CC05_TR01A	02:29:09	347174.7	5957085.5	829	Rare	Frequent
	03:02:47	346542.0	5957621.4			
CC05_TR02	03:26:17	346779.4	5957515.0	272	0	Frequent
	03:36:31	346508.0	5957501.8			
CC05_ST01	03:57:10	346266.4	5957592.1	146	0	Common
	04:17:09	346385.9	5957508.6			

Notes:
SACFOR Classifications (3 cm to 15 cm)
S = 1–9/0.01 m2
A = 1–9/0.1 m2
C = 1–9/1 m2
F = 1–9/10 m2
O = 1–9/100 m2
R = 1–9/1000 m2

Key:	Absent	Rare	Occasional	Frequent	Common	Abundant	Super abundant

Burrows were classified as 'frequent' and the sea pen *V. mirabilis* was classified as 'rare' along transect CC05_TR01A. Burrows were classified as 'frequent', but no sea pens were observed along transect CC05_TR02. Burrows were classified at 'common' with no sea pens on the drop-down video footage at grab station CC05_ST01. Although the sediments within the survey area were burrowed (at varied densities), mounds with conspicuous burrows did not appear to form a prominent feature of the sediments.

No other Annex I habitats, OSPAR threatened and/or declining species and habitats, priority habitats or priority species were observed within the survey area.

5. CONCLUSIONS

The Interconnector cable crossing survey area comprised one sediment type defined by the EUNIS (2012) habitat classifications; ‘Deep circalittoral mud’ (A5.37).

Faunal burrows were observed along two transects and at the grab station CC05_ST01 with a drop-down camera. The sea pen *V. mirabilis* was observed on transect CC05_TR01A, and the Norway lobster (*Nephrops norvegicus*) was present on transects CC05_TR01A and CC05_TR02. These observations indicate that the OSPAR listed threatened and/or declining habitat ‘Sea pens and burrowing megafauna communities’ could occur in the survey area. However, although the sediments within the survey area were burrowed (at varied densities), mounds with conspicuous burrows did not appear to form a prominent feature of the sediments.

The biotope complex ‘Deep circalittoral mud’ (A5.37) is categorised within the broadscale habitat ‘mud habitats in deep water’. However, this habitat is found in large areas of the Irish Sea (EMODnet, 2019) and is represented in the West of Walney MCZ and North Anglesey Marine/Gogledd Môn Forol SAC.

No other potentially sensitive habitats were identified from the Interconnector cable crossing survey area.

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APPENDICES

A. GUIDELINES ON USE OF REPORT

This report (the “Report”) was prepared as part of the services (the “Services”) provided by Fugro GB Marine Limited (“Fugro”) for its client (the “Client”) under terms of the relevant contract between the two parties (the “Contract”). The Services were performed by Fugro based on requirements of the Client set out in the Contract or otherwise made known by the Client to Fugro at the time.

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B. LOGS

B.1 SURVEY LOG

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect/Station	Type	Sample Rep/Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:00:16	CC05_T01	Still	181275_CC05_T01_01	316		346662.4	5957524.7	346866.9	5957401.6	238.6	
24/02/2019	02:17:17	CC05_T01A	Still	181275_CC05_T01A_01	317		346662.4	5957524.7	346894.9	5957324.6	306.7	
24/02/2019	02:29:09	CC05_T01A	Still	181275_CC05_T01A_02	318	83.0	346662.4	5957524.7	347174.7	5957085.5	674.8	
24/02/2019	02:29:41	CC05_T01A	Still	181275_CC05_T01A_03	319		346662.4	5957524.7	347164.0	5957092.9	661.8	
24/02/2019	02:30:08	CC05_T01A	Still	181275_CC05_T01A_04	320		346662.4	5957524.7	347156.0	5957098.2	652.3	
24/02/2019	02:30:47	CC05_T01A	Still	181275_CC05_T01A_05	321		346662.4	5957524.7	347144.7	5957106.2	638.5	
24/02/2019	02:31:16	CC05_T01A	Still	181275_CC05_T01A_06	322		346662.4	5957524.7	347136.0	5957113.1	627.4	
24/02/2019	02:31:27	CC05_T01A	Still	181275_CC05_T01A_07	323		346662.4	5957524.7	347132.0	5957116.1	622.5	
24/02/2019	02:31:48	CC05_T01A	Still	181275_CC05_T01A_08	324		346662.4	5957524.7	347125.7	5957121.6	614.1	
24/02/2019	02:32:01	CC05_T01A	Still	181275_CC05_T01A_09	325		346662.4	5957524.7	347121.7	5957124.6	609.0	
24/02/2019	02:32:21	CC05_T01A	Still	181275_CC05_T01A_10	326		346662.4	5957524.7	347115.6	5957129.8	601.1	
24/02/2019	02:32:36	CC05_T01A	Still	181275_CC05_T01A_11	327		346662.4	5957524.7	347111.0	5957134.2	594.7	
24/02/2019	02:32:44	CC05_T01A	Still	181275_CC05_T01A_12	328		346662.4	5957524.7	347108.1	5957136.7	590.9	
24/02/2019	02:33:01	CC05_T01A	Still	181275_CC05_T01A_13	329		346662.4	5957524.7	347103.3	5957141.1	584.4	
24/02/2019	02:33:19	CC05_T01A	Still	181275_CC05_T01A_14	330		346662.4	5957524.7	347097.7	5957146.4	576.6	
24/02/2019	02:33:33	CC05_T01A	Still	181275_CC05_T01A_15	331		346662.4	5957524.7	347093.9	5957149.4	571.9	
24/02/2019	02:33:45	CC05_T01A	Still	181275_CC05_T01A_16	332		346662.4	5957524.7	347089.8	5957153.4	566.1	
24/02/2019	02:34:09	CC05_T01A	Still	181275_CC05_T01A_17	333		346662.4	5957524.7	347083.0	5957158.7	557.5	
24/02/2019	02:34:54	CC05_T01A	Still	181275_CC05_T01A_18	334		346662.4	5957524.7	347071.2	5957168.9	541.9	
24/02/2019	02:36:05	CC05_T01A	Still	181275_CC05_T01A_19	335		346662.4	5957524.7	347050.0	5957184.9	515.4	
24/02/2019	02:36:22	CC05_T01A	Still	181275_CC05_T01A_20	336		346662.4	5957524.7	347044.8	5957188.6	509.1	
24/02/2019	02:36:38	CC05_T01A	Still	181275_CC05_T01A_21	337		346662.4	5957524.7	347039.5	5957192.7	502.4	
24/02/2019	02:36:53	CC05_T01A	Still	181275_CC05_T01A_22	338		346662.4	5957524.7	347035.0	5957196.0	496.8	
24/02/2019	02:37:30	CC05_T01A	Still	181275_CC05_T01A_23	339		346662.4	5957524.7	347022.8	5957205.3	481.5	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect/Station	Type	Sample Rep/Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:37:56	CC05_T01A	Still	181275_CC05_T01A_24	340		346662.4	5957524.7	347014.5	5957212.1	470.8	
24/02/2019	02:38:10	CC05_T01A	Still	181275_CC05_T01A_25	341		346662.4	5957524.7	347010.1	5957215.9	465.0	
24/02/2019	02:38:29	CC05_T01A	Still	181275_CC05_T01A_26	342		346662.4	5957524.7	347003.6	5957220.6	457.1	
24/02/2019	02:39:14	CC05_T01A	Still	181275_CC05_T01A_27	343		346662.4	5957524.7	346988.9	5957232.8	437.9	
24/02/2019	02:39:25	CC05_T01A	Still	181275_CC05_T01A_28	344		346662.4	5957524.7	346985.2	5957235.3	433.5	
24/02/2019	02:40:05	CC05_T01A	Still	181275_CC05_T01A_29	345		346662.4	5957524.7	346972.9	5957244.8	418.1	
24/02/2019	02:40:38	CC05_T01A	Still	181275_CC05_T01A_30	346		346662.4	5957524.7	346963.1	5957252.5	405.6	
24/02/2019	02:41:03	CC05_T01A	Still	181275_CC05_T01A_31	347		346662.4	5957524.7	346956.5	5957258.1	396.9	
24/02/2019	02:41:46	CC05_T01A	Still	181275_CC05_T01A_32	348		346662.4	5957524.7	346944.2	5957270.0	379.9	
24/02/2019	02:42:12	CC05_T01A	Still	181275_CC05_T01A_33	349		346662.4	5957524.7	346937.3	5957276.7	370.2	
24/02/2019	02:43:03	CC05_T01A	Still	No Still	350		346662.4	5957524.7	346923.5	5957291.5	350.0	
24/02/2019	02:43:33	CC05_T01A	Still	181275_CC05_T01A_34	351		346662.4	5957524.7	346914.6	5957299.7	337.9	
24/02/2019	02:43:59	CC05_T01A	Still	181275_CC05_T01A_35	352		346662.4	5957524.7	346906.6	5957306.4	327.5	
24/02/2019	02:44:40	CC05_T01A	Still	181275_CC05_T01A_36	353		346662.4	5957524.7	346894.1	5957318.2	310.3	
24/02/2019	02:45:34	CC05_T01A	Still	181275_CC05_T01A_37	354		346662.4	5957524.7	346877.8	5957333.0	288.3	
24/02/2019	02:46:13	CC05_T01A	Still	181275_CC05_T01A_38	355		346662.4	5957524.7	346864.8	5957342.5	272.3	
24/02/2019	02:46:51	CC05_T01A	Still	181275_CC05_T01A_39	356		346662.4	5957524.7	346852.3	5957350.6	257.6	
24/02/2019	02:47:24	CC05_T01A	Still	181275_CC05_T01A_40	357		346662.4	5957524.7	346841.9	5957357.7	245.1	
24/02/2019	02:48:20	CC05_T01A	Still	181275_CC05_T01A_41	358		346662.4	5957524.7	346824.9	5957370.5	224.0	
24/02/2019	02:48:43	CC05_T01A	Still	181275_CC05_T01A_42	359		346662.4	5957524.7	346817.8	5957375.6	215.3	
24/02/2019	02:49:21	CC05_T01A	Still	181275_CC05_T01A_43	360		346662.4	5957524.7	346805.2	5957386.6	198.6	
24/02/2019	02:49:48	CC05_T01A	Still	181275_CC05_T01A_44	361		346662.4	5957524.7	346796.8	5957393.1	188.1	
24/02/2019	02:50:23	CC05_T01A	Still	181275_CC05_T01A_45	362		346662.4	5957524.7	346785.9	5957401.9	174.2	
24/02/2019	02:51:07	CC05_T01A	Still	181275_CC05_T01A_46	363		346662.4	5957524.7	346772.0	5957414.2	155.6	
24/02/2019	02:51:36	CC05_T01A	Still	181275_CC05_T01A_47	364		346662.4	5957524.7	346762.8	5957422.7	143.1	
24/02/2019	02:52:19	CC05_T01A	Still	181275_CC05_T01A_48	365		346662.4	5957524.7	346748.0	5957434.1	124.6	
24/02/2019	02:52:51	CC05_T01A	Still	181275_CC05_T01A_49	366		346662.4	5957524.7	346737.0	5957441.4	111.8	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect/Station	Type	Sample Rep/Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:53:17	CC05_T01A	Still	181275_CC05_T01A_50	367		346662.4	5957524.7	346728.7	5957446.7	102.3	
24/02/2019	02:53:46	CC05_T01A	Still	181275_CC05_T01A_51	368		346662.4	5957524.7	346719.8	5957451.9	92.7	
24/02/2019	02:54:23	CC05_T01A	Still	181275_CC05_T01A_52	369		346662.4	5957524.7	346706.7	5957457.5	80.5	
24/02/2019	02:54:39	CC05_T01A	Still	181275_CC05_T01A_53	370		346662.4	5957524.7	346701.3	5957460.8	74.8	
24/02/2019	02:55:16	CC05_T01A	Still	181275_CC05_T01A_54	371		346662.4	5957524.7	346687.2	5957469.7	60.2	
24/02/2019	02:55:36	CC05_T01A	Still	181275_CC05_T01A_55	372		346662.4	5957524.7	346680.2	5957476.1	51.7	
24/02/2019	02:56:18	CC05_T01A	Still	181275_CC05_T01A_56	373		346662.4	5957524.7	346668.2	5957493.7	31.5	
24/02/2019	02:57:25	CC05_T01A	Still	181275_CC05_T01A_57	374		346662.4	5957524.7	346650.2	5957526.1	12.3	
24/02/2019	02:58:04	CC05_T01A	Still	181275_CC05_T01A_58	375		346662.4	5957524.7	346640.7	5957546.1	30.5	
24/02/2019	02:58:22	CC05_T01A	Still	181275_CC05_T01A_59	376		346662.4	5957524.7	346636.0	5957555.2	40.4	
24/02/2019	02:58:36	CC05_T01A	Still	181275_CC05_T01A_60	377		346662.4	5957524.7	346631.9	5957562.3	48.5	
24/02/2019	02:59:15	CC05_T01A	Still	181275_CC05_T01A_61	378		346662.4	5957524.7	346618.7	5957578.4	69.3	
24/02/2019	02:59:36	CC05_T01A	Still	181275_CC05_T01A_62	379		346662.4	5957524.7	346612.2	5957585.7	79.0	
24/02/2019	03:00:05	CC05_T01A	Still	181275_CC05_T01A_63	380		346662.4	5957524.7	346601.7	5957592.9	91.3	
24/02/2019	03:01:16	CC05_T01A	Still	181275_CC05_T01A_64	381		346662.4	5957524.7	346575.7	5957606.7	119.4	
24/02/2019	03:01:42	CC05_T01A	Still	181275_CC05_T01A_65	382		346662.4	5957524.7	346566.2	5957611.3	129.5	
24/02/2019	03:02:08	CC05_T01A	Still	181275_CC05_T01A_66	383		346662.4	5957524.7	346556.1	5957615.2	139.6	
24/02/2019	03:02:36	CC05_T01A	Still	181275_CC05_T01A_67	384		346662.4	5957524.7	346546.3	5957619.1	149.7	
24/02/2019	03:02:47	CC05_T01A	Still	181275_CC05_T01A_68	385	82.0	346662.4	5957524.7	346542.0	5957621.4	154.4	
24/02/2019	03:16:20	CC05_T02	Still	181275_CC05_T02_01	386		346662.4	5957524.7	347084.4	5957558.3	423.3	
24/02/2019	03:26:17	CC05_T02	Still	181275_CC05_T02_02	387	82.0	346662.4	5957524.7	346779.4	5957515.0	117.4	
24/02/2019	03:26:50	CC05_T02	Still	181275_CC05_T02_03	388		346662.4	5957524.7	346761.5	5957519.3	99.2	
24/02/2019	03:27:04	CC05_T02	Still	181275_CC05_T02_04	No Fix		346662.4	5957524.7				
24/02/2019	03:27:25	CC05_T02	Still	181275_CC05_T02_05	389		346662.4	5957524.7	346742.8	5957522.8	80.4	
24/02/2019	03:27:40	CC05_T02	Still	181275_CC05_T02_06	390		346662.4	5957524.7	346735.8	5957524.7	73.3	
24/02/2019	03:27:55	CC05_T02	Still	181275_CC05_T02_07	391		346662.4	5957524.7	346727.8	5957525.9	65.4	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect/Station	Type	Sample Rep/Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	03:28:13	CC05_T02	Still	181275_CC05_T02_08	392		346662.4	5957524.7	346719.8	5957526.9	57.4	
24/02/2019	03:28:26	CC05_T02	Still	181275_CC05_T02_09	393		346662.4	5957524.7	346713.7	5957528.0	51.4	
24/02/2019	03:28:40	CC05_T02	Still	181275_CC05_T02_10	394		346662.4	5957524.7	346707.8	5957527.5	45.4	
24/02/2019	03:29:06	CC05_T02	Still	181275_CC05_T02_11	395		346662.4	5957524.7	346696.0	5957528.6	33.8	
24/02/2019	03:29:38	CC05_T02	Still	181275_CC05_T02_12	396		346662.4	5957524.7	346682.4	5957531.2	21.0	
24/02/2019	03:30:11	CC05_T02	Still	181275_CC05_T02_13	397		346662.4	5957524.7	346668.2	5957531.7	9.1	
24/02/2019	03:30:31	CC05_T02	Still	181275_CC05_T02_14	398		346662.4	5957524.7	346660.2	5957531.6	7.3	
24/02/2019	03:31:05	CC05_T02	Still	181275_CC05_T02_15	399		346662.4	5957524.7	346646.3	5957530.8	17.2	
24/02/2019	03:31:26	CC05_T02	Still	181275_CC05_T02_16	400		346662.4	5957524.7	346637.4	5957529.5	25.5	
24/02/2019	03:32:06	CC05_T02	Still	181275_CC05_T02_17	401		346662.4	5957524.7	346621.3	5957527.7	41.2	
24/02/2019	03:32:33	CC05_T02	Still	181275_CC05_T02_18	402		346662.4	5957524.7	346610.0	5957525.2	52.4	
24/02/2019	03:33:03	CC05_T02	Still	181275_CC05_T02_19	403		346662.4	5957524.7	346597.3	5957521.2	65.2	
24/02/2019	03:33:38	CC05_T02	Still	181275_CC05_T02_20	404		346662.4	5957524.7	346581.9	5957517.2	80.9	
24/02/2019	03:34:29	CC05_T02	Still	181275_CC05_T02_21	405		346662.4	5957524.7	346562.0	5957512.0	101.3	
24/02/2019	03:34:56	CC05_T02	Still	181275_CC05_T02_22	406		346662.4	5957524.7	346550.0	5957509.7	113.4	
24/02/2019	03:35:22	CC05_T02	Still	181275_CC05_T02_23	407		346662.4	5957524.7	346539.7	5957506.5	124.1	
24/02/2019	03:35:46	CC05_T02	Still	181275_CC05_T02_24	408		346662.4	5957524.7	346528.8	5957505.1	135.1	
24/02/2019	03:36:22	CC05_T02	Still	181275_CC05_T02_25	409		346662.4	5957524.7	346513.1	5957502.3	151.0	
24/02/2019	03:36:31	CC05_T02	Still	181275_CC05_T02_26	410	82.0	346662.4	5957524.7	346508.0	5957501.8	156.1	
24/02/2019	03:43:58	CC05_ST01	Still	181275_CC05_ST01_01	411		346363	5957528	346486.7	5957470.3	137.0	
24/02/2019	03:57:10	CC05_ST01	Still	181275_CC05_ST01_02	412	82.0	346363	5957528	346266.4	5957592.1	115.5	
24/02/2019	03:58:06	CC05_ST01	Still	181275_CC05_ST01_03	413		346363	5957528	346276.1	5957576.5	99.1	
24/02/2019	03:58:22	CC05_ST01	Still	181275_CC05_ST01_04	414		346363	5957528	346278.7	5957571.8	94.6	
24/02/2019	03:58:47	CC05_ST01	Still	181275_CC05_ST01_05	415		346363	5957528	346281.0	5957564.7	89.4	
24/02/2019	03:59:05	CC05_ST01	Still	181275_CC05_ST01_06	416		346363	5957528	346281.2	5957560.3	87.5	
24/02/2019	04:00:10	CC05_ST01	Still	181275_CC05_ST01_07	417		346363	5957528	346274.3	5957560.0	93.8	
24/02/2019	04:02:19	CC05_ST01	Still	181275_CC05_ST01_08	418		346363	5957528	346250.4	5957582.9	124.8	

Geodetic Parameters: WGS84 UTM 30N												
Date	Time [UTC]	Transect/Station	Type	Sample Rep/Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	04:02:29	CC05_ST01	Still	181275_CC05_ST01_09	419		346363	5957528	346249.5	5957584.7	126.4	
24/02/2019	04:03:19	CC05_ST01	Still	181275_CC05_ST01_10	420		346363	5957528	346250.1	5957591.7	129.1	
24/02/2019	04:05:25	CC05_ST01	Still	181275_CC05_ST01_11	421		346363	5957528	346259.1	5957591.9	121.5	
24/02/2019	04:08:03	CC05_ST01	Still	181275_CC05_ST01_12	422		346363	5957528	346285.3	5957575.1	90.5	
24/02/2019	04:08:38	CC05_ST01	Still	181275_CC05_ST01_13	423		346363	5957528	346292.3	5957570.0	81.8	
24/02/2019	04:09:21	CC05_ST01	Still	181275_CC05_ST01_14	424		346363	5957528	346302.0	5957561.6	69.2	
24/02/2019	04:10:16	CC05_ST01	Still	181275_CC05_ST01_15	425		346363	5957528	346314.7	5957556.8	55.8	
24/02/2019	04:10:42	CC05_ST01	Still	181275_CC05_ST01_16	426		346363	5957528	346320.9	5957556.0	50.1	
24/02/2019	04:11:24	CC05_ST01	Still	181275_CC05_ST01_17	427		346363	5957528	346330.4	5957556.0	42.6	
24/02/2019	04:11:51	CC05_ST01	Still	181275_CC05_ST01_18	428		346363	5957528	346335.4	5957554.5	37.9	
24/02/2019	04:12:31	CC05_ST01	Still	181275_CC05_ST01_19	429		346363	5957528	346342.1	5957552.1	31.5	
24/02/2019	04:13:32	CC05_ST01	Still	181275_CC05_ST01_20	430		346363	5957528	346350.1	5957544.4	20.5	
24/02/2019	04:15:53	CC05_ST01	Still	181275_CC05_ST01_21	431		346363	5957528	346373.4	5957518.8	14.3	
24/02/2019	04:16:07	CC05_ST01	Still	181275_CC05_ST01_22	432		346363	5957528	346376.1	5957516.1	18.1	
24/02/2019	04:16:27	CC05_ST01	Still	181275_CC05_ST01_23	433		346363	5957528	346379.3	5957513.5	22.3	
24/02/2019	04:16:38	CC05_ST01	Still	181275_CC05_ST01_24	434		346363	5957528	346380.9	5957511.6	24.7	
24/02/2019	04:16:59	CC05_ST01	Still	181275_CC05_ST01_25	435		346363	5957528	346384.2	5957509.9	28.3	
24/02/2019	04:17:09	CC05_ST01	Still	181275_CC05_ST01_26	436		346363	5957528	346385.9	5957508.6	30.4	
24/02/2019	04:42:59	CC05_ST01	DVV	PC/FA	437	81.0	346363	5957528	346332.3	5957528.3	30.3	
24/02/2019	05:06:38	CC05_ST01	DVV	FB	438	81.0	346363	5957528	346339.6	5957506.9	31.3	

Notes:
UTC = Coordinated Universal Time
BSL = Below sea level
ST = Station
SOL = Start of line
EOL = End of line
DVV = Dual van Veen grab

B.2 GRAB LOG

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [%]	Sediment Description (including stratigraphy)		Comments (fauna, smell, bioturbation, debris)
						Sediment Type	Sediment Description	
24/02/2019	04:42:59	CC05_ST01	PC	437	16	M	Mud	Anoxic layer depth 1cm; *Turritella* shells
24/02/2019	04:42:59	CC05_ST01	FA	437	15	M	Mud and clay	Anoxic layer depth 1cm; *Turritella* shells
24/02/2019	05:06:38	CC05_ST01	FB	438	16	M	Mud	Anoxic layer depth 1cm; *Turritella* shells

Notes:
ST = Station
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB

B.3 VIDEO AND PHOTOGRAPHIC LOG

Geodetic Parameters: WGS84 UTM 30N										
Date	Transect/ Station	Video File	Point on Line	Time [UTC]	Video Coordinates		Length [m]	Still No	Sediment Description	Fauna/Bioturbation/Debris
					Easting [m]	Northing [m]				
24/02/2019	CC05_T01A	181275_CC05_T01A	SOL	02:29:09	347174.7	5957085.5	829	68	Rippled sandy mud with shell fragments	Seapen (Pennatulacea, including *Virgularia mirabilis*), hermit crab (Paguroidea, including *Pagurus bernhardus*), Norway lobster (*Nephrops norvegicus),* faunal turf (Hydrozoa/Bryozoa). Gurnard (Triglidae), unidentified fish (Pisces), lesser spotted dogfish (*Scyliorhinus canicula*), flatfish (Pleuronectiformes). Faunal tracks, burrows and tubes (Polychaeta, including Sabellidae and numerous ?*Pseudopolydora/Polydora*)
			EOL	03:02:47	346542.0	5957621.4				
24/02/2019	CC05_T02	181275_CC05_T02	SOL	03:26:17	346779.4	5957515.0	272	26	Rippled sandy mud with shell fragments	Hermit crab (Paguroidea), Norway lobster (*Nephrops norvegicus*), faunal turf (Hydrozoa/Bryozoa). Lesser spotted dogfish (*Scyliorhinus canicula*). Faunal burrows and tubes (Polychaeta, including numerous ?*Pseudopolydora/Polydora*)
			EOL	03:36:31	346508.0	5957501.8				
24/02/2019	CC05_ST01	181275_CC05_ST01	SOL	03:57:10	346266.4	5957592.1	146	26	Rippled sandy mud with shell fragments	Hermit crab (Paguroidea, including *Pagurus bernhardus*), faunal turf (Hydrozoa/Bryozoa). Lesser spotted dogfish (*Scyliorhinus canicula*), flatfish (Pleuronectiformes), unidentified fish (Pisces). Faunal tracks, burrows and tubes (Polychaeta, including Sabellidae and ?*Pseudopolydora*/*Polydora*
			EOL	04:17:09	346385.9	5957508.6				

Notes:
UTC = Coordinated Universal Time
ST = Station
SOL = Start of line
EOL = End of line

C. SEABED PHOTOGRAPHS

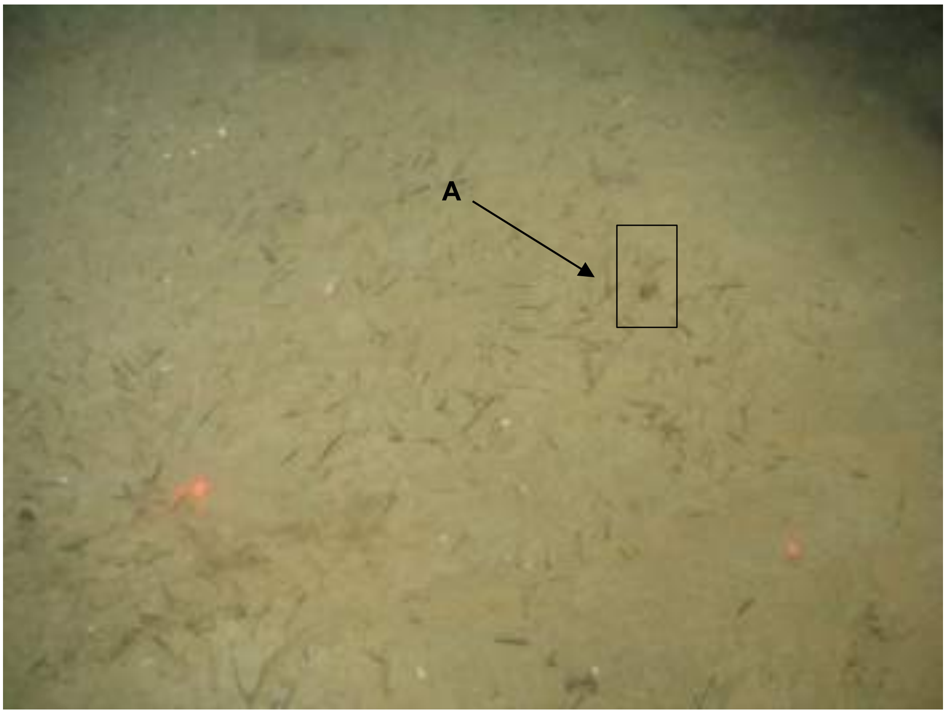
TRANSECT CC05_TR01A

Photograph:
CC05_TR01A_09

Easting: 347 121.7 mE
Northing: 5 957 124.6 mN
Depth: 83.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
Faunal turf and faunal tubes (Sabellidae)



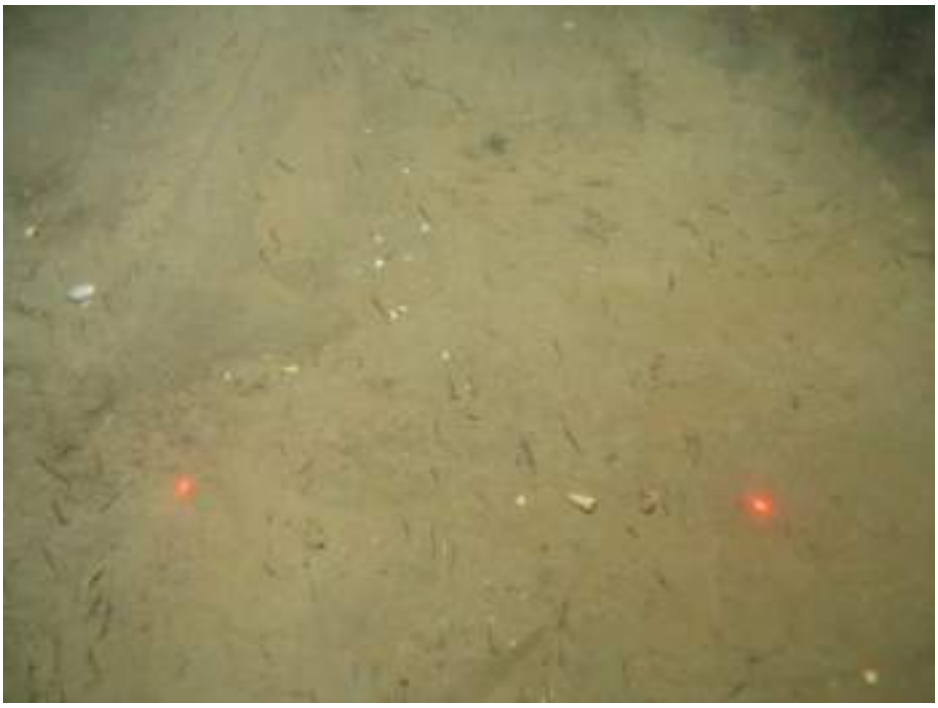
Photograph:
CC05_TR01A_30

Easting: 346 963.1 mE
Northing: 5 957 252.5 mN
Depth: 83.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
A. Sea pen (*Virgularia mirabilis*)
Faunal turf and faunal tubes (Sabellidae)

TRANSECT CC05_TR02

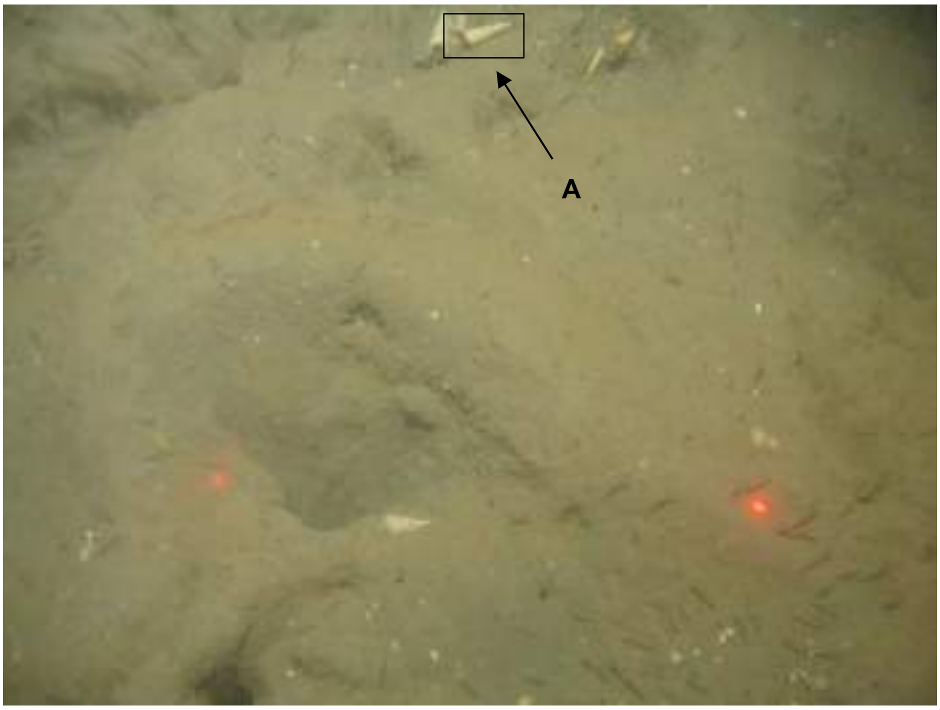


Photograph: CC05_TR02_12

Easting: 346 682.4 mE
Northing: 5 957 531.2 mN
Depth: 82.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
Faunal turf and faunal burrow



Photograph: CC05_TR02_22

Easting: 346 550.0 mE
Northing: 5 957 509.7 mN
Depth: 82.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
A. Hermit crab (Paguridae)
Faunal turf and faunal burrow

DROP-DOWN STATION CC05_ST01

Photograph:
CC05_ST01_07

Easting: 346 274.3 mE
Northing: 5 957 560.0 mN
Depth: 82.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
Faunal turf and faunal tubes (Sabellidae)

Photograph:
CC05_ST01_19

Easting: 346 342.1 mE
Northing: 5 957 552.1 mN
Depth: 82.0 m BSL

Sediment Type:
Mud with shell fragments

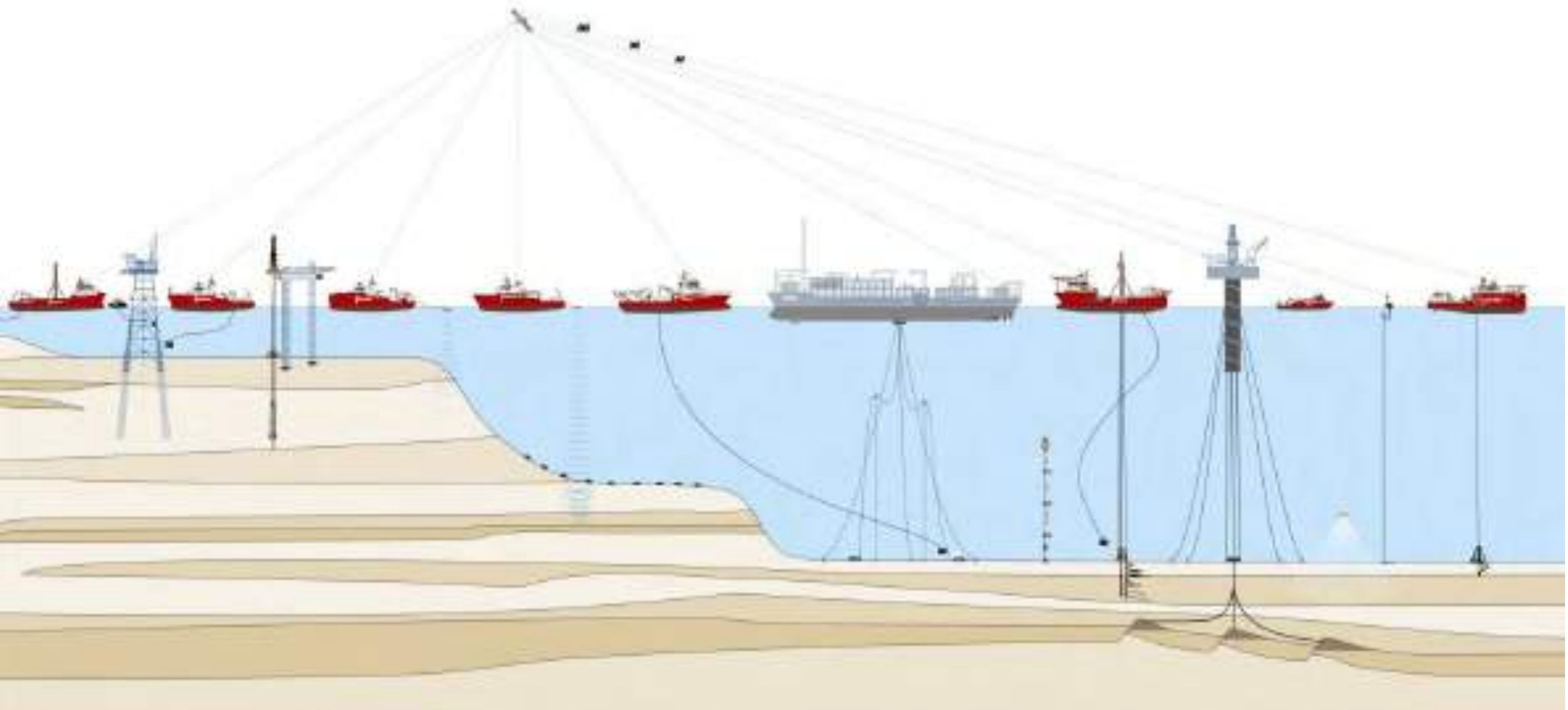
Fauna:
Faunal turf

Benthic Characterisation Report
Havhingsten Cable Route
Ireland

Fugro Document No.: 181275-R-015(01)
23 May 2019

Alcatel Submarine Networks UK Limited

Draft report



Benthic Characterisation Report
Havhingsten Cable Route
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23 May 2019

Draft report

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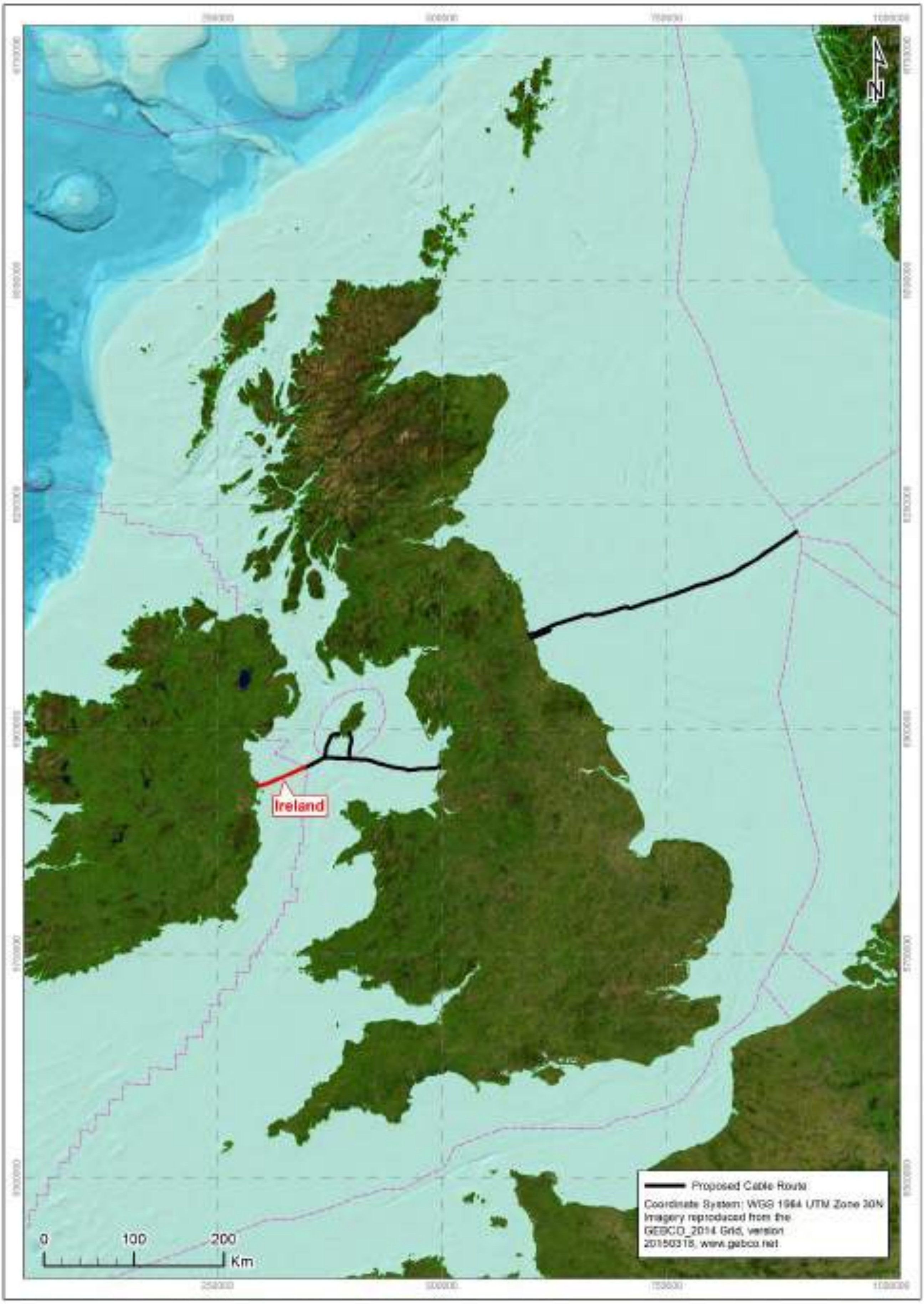
Issue	**Document Status**	**Prepared**	**Checked**	**Approved**	**Date**



FRONTISPIECE

EXECUTIVE SUMMARY

Introduction

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed a benthic characterisation survey for the installation of a telecommunications cable along the Irish section of the proposed Havhingsten cable route. The offshore survey was conducted using the RV Prince Madog during the survey period 23 to 24 February 2019. The nearshore survey was conducted using the MV Fastnet Petrel during the period 21 to 22 March 2019.

The benthic characterisation survey was conducted to establish the presence of any sensitive habitats or species within the cable route corridor, specifically habitats listed under Annex I of the European Commission (EC) Habitats Directive and habitats or species considered threatened and/or declining under the Oslo-Paris (OSPAR) convention (OSPAR, 2008). Grab samples were also collected to establish physico-chemical and biological properties of the sediment.

Survey Strategy

A total of six environmental stations were selected along the Irish section of the Havhingsten cable route. At each of these stations, drop-down camera was undertaken prior to grab sampling.

Sediment Characterisation

The sediments within the Irish section of the Havhingsten cable route demonstrated moderate variability in mean diameter and low to high variability for the proportions of sand, gravel and fines, indicating the presence of varied sediments. Using the Wentworth description, sediments varied from fine sand to coarse silt across the survey area.

Sediment Chemistry

The gas chromatographic profiles shared a common underlying hydrocarbon distribution, characterised by a ‘hump’ of unresolved material (UCM) peaking late in the chromatogram window and a range of low-level resolved n-alkanes.

Variation in total hydrocarbon content (THC) concentrations was moderate (RSD 43 %). Higher concentrations of THC were generally found at stations with a greater total organic matter content.

The total 2 to 6 ring polycyclic aromatic hydrocarbon (PAH) concentrations across the survey area were below the effects range low (ERL) value. The United States Environmental Protection Agency 16 (US EPA 16) PAH concentrations were below their respective effects range low (ERL) values at all stations. When normalised to 2.5 % total organic carbon (TOC), the US EPA 16 PAH concentrations (individual and total) exceeded background assessment concentration (BAC) values, for naphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene at all stations and benzo(ghi)perylene at one station. However, TOC levels were low and may lead to overestimation of normalised PAH values.

Variability of metals concentrations across the survey area ranged from low to moderate (≤ 47 %), with the highest variability observed for aluminium. All metals concentrations were below their respective ERL value.

Macrofauna

There was a low to moderate degree of infaunal similarity between the stations sampled. The most nearshore of the stations sampled a community dominated by the bivalve mollusc *Abra alba.* Slightly further offshore, a diverse and densely populated community characterised by the brittlestar *Amphiura filiformis* and bivalve *Kurtiella bidentata* was identified. The stations located along the offshore, easterly end of the route were shown to have variably rich communities of bivalves and polychaetes.

Benthic Habitats and Biotopes

Two European Nature Information System (EUNIS) biotopes and two biotope complexes were recorded along the route. One biotope complex was associated with bedrock and/or boulder habitat adjacent to Loughshinny Bay and the remainder were sediment biotopes/biotope complexes.

Due to the occurrence of sea pens and faunal burrows on the offshore section of the route, these were assessed to determine their resemblance to the OSPAR threatened and/or declining habitat 'sea pens and burrowing megafauna communities'. None of the stations/transects assessed were thought to strongly resemble this priority habitat.

Boulder and/or cobble substrata identified adjacent to Loughshinny Bay (station LS_ST01) were assessed to determine their resemblance to 'stony reef' habitat listed under Annex I of the EC Habitats Directive. While the results of this assessment suggested that these areas only demonstrated a 'low' level of resemblance to this priority habitat, bedrock substrata, which could be considered Annex I 'bedrock reef', were also thought to be present in this area. There are currently no guidelines available for the assessment of the potential conservation importance of 'bedrock reef' habitats.

No other OSPAR threatened and/or declining species and habitats, Annex I habitats or Annex II species were observed within the survey area.

CONTENTS

APPENDICES

TABLES IN THE MAIN TEXT

FIGURES IN THE MAIN TEXT

ABBREVIATIONS

1-λ	Simpson's diversity index
BAC	Background assessment concentration
BC	Background concentration
BSH	Broadscale habitats
BSL	Below sea level
CBD	Convention on Biological Diversity
CEMP	Coordinated Environmental Monitoring Programme
CITES	Convention on International Trade in Endangered Species
CLUSTER	Hierarchical agglomerative clustering
CM	Central meridian
CPIs	Carbon preference indices
CV-AFS	Cold vapour-atomic fluorescence spectroscopy
DCM	Dichloromethane
DOEHLG	Department of the Environment, Heritage and Local Government
DTI	Department of Trade and Industry
DVV	Dual van Veen grab
EC	European Community
EMODnet	European Marine Observation Data Network
EOL	End of line
ERL	Effects range low
EU	European Union
EUNIS	European Nature Information System
FA/FB	Fauna sample FA or FB
FID	Flame ionisation detection
FGBML	Fugro GB Marine Limited
GC	Gas chromatography
GC-FID	Gas chromatography – flame ionisation detection
GC-MS	Gas chromatography with mass spectrometry
$H'Log_2$	Shannon-Wiener index
Hb	Brillouin's diversity index
ICP-MS	Inductively coupled plasma-mass spectrometry
ICP-OES	Inductively coupled plasma-optical emission spectroscopy
IDA	Industrial denatured alcohol
J	Pielou's evenness
JNCC	Joint Nature Conservation Committee
KP	Kilometre point
MCS	Marine Conservation Society
MRV	Minimum reporting value
MSFD	Marine Strategy Framework Directive
MV	Motor vessel
NHA	Natural Heritage Area
NM	Nautical miles
NMBAQC	National Marine Biological Association Quality Control
nMDS	Non-metric multidimensional scaling
NOAA	National Oceanic and Atmospheric Administration
NPWS	National Parks and Wildlife Service
NS	No sample
OSPAR	Oslo and Paris

PAH	Polycyclic aromatic hydrocarbon
PC	Physico-chemical (sample)
PRIMER	Plymouth Routines in Multivariate Ecological Research
PSA	Particle size analysis
PSD	Particle size distribution
RSD	Relative standard deviation
RV	Research vessel
SAC	Special Area of Conservation
SACFOR	Super-abundant, abundant, common, frequent, occasional and rare
SCI	Site of Community Importance
SD	Standard deviation
SIMPROF	Similarity profiling
SOL	Start of line
SPA	Special Protection Areas
SSS	Side scan sonar
THC	Total hydrocarbon content
TOC	Total organic carbon
TOM	Total organic matter
UCM	Unresolved complex mixture
UNESCO	United Nation Educational, Scientific and Cultural Organisation
USB	Universal serial bus
US EPA	United States Environmental Protection Agency
US EPA 16	United States Environmental Protection Agency's 16 priority PAH pollutants
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

1. INTRODUCTION

1.1 Background

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed a benthic characterisation survey for the installation of a telecommunications cable along the Irish section of the Havhingsten Cable Route. Offshore survey operations were conducted using the RV Prince Madog during the survey period 23 to 24 February 2019, while nearshore operations were undertaken from the MV Fastnet Petrel during the period 21 to 22 March 2019.

The Havhingsten cable system is a planned subsea telecommunication network and the design spans nearly 920 km with initial landing points in four markets, including Denmark, England, Isle of Man and Ireland.

Appendix A outlines the guidelines for use of this report.

1.2 Scope of Work

The benthic characterisation survey was conducted to establish whether any sensitive habitats or species are present within the cable route corridor, specifically habitats listed under Annex I of the European Community (EC) Habitats Directive and habitats or species considered threatened and/or declining under the Oslo-Paris (OSPAR) convention (OSPAR, 2008). In addition, grab samples were collected to establish physico-chemical and biological properties of the sediment.

In addition, a habitat assessment was required at the cable crossing with the interconnector near the eastern boundary of the Irish sector. The results of this survey are included in this report, but also reported separately (Fugro, 2019a).

1.3 Environmental Legislation

Marine legislation in Ireland has been developed in a sectoral way, with national, European and international laws applied for the protection of marine habitats and species.

At a national level, the Wildlife Acts 1976-2000 provide a wide-ranging basis for the protection of wildlife throughout Ireland. The original Wildlife Act 1976 legislated to protect wildlife reserves and refuges and placed restrictions on hunting of certain birds and mammals. A later revision of the Act in 2000 expanded the original national legislation and incorporated reference to implementation of the EC Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, as amended).

Within the European Union (EU) the key legislative measures requiring the protection of habitats and species are the Habitats Directive, and the Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council on the Conservation of Wild Birds). These Directives fulfil the EU's commitment to international conventions and provide a framework for the designation of a network of protected sites for species and features across all EU member states, known as the Natura 2000 network.

An additional European measure applicable to the marine environment is the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy). This provides a legislative framework for marine biodiversity and sets out a target of achieving or maintaining good environmental status of the EU's marine waters. The targets are outlined by several indicators, many linking to habitats and ecological status to be reached by 2020.

Internationally, Ireland is a signatory to the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species (CITES) of Wild Flora and Fauna, the Bonn Convention on Wetlands of International Importance as Waterfowl Habitat, the Bern Convention on the Conservation of European Wildlife and Natural Habitats, the Ramsar Convention on Wetlands of International Importance and the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic.

The National Parks and Wildlife Service (NPWS) is part of the Department of the Environment, Heritage and Local Government (DOEHLG) and manages the Irish State's nature conservation responsibilities under national, European and international law. The NPWS is responsible for the designation and protection of conservation areas within Ireland. The Wildlife (Amendment) Act 2000 makes provision for the creation of a national network of Natural Heritage Areas (NHAs) throughout Ireland. The EU Habitats and Birds Directives allow for the designation of Special Areas of Conservation (SACs) which act to protect ecologically vulnerable or valuable habitats; and Special Protection Areas (SPAs) for sites that are considered important for bird populations.

1.4 Protected Sites and Potentially Sensitive Habitats

The Irish section of the proposed Havhingsten cable route passes through the large (273 km^2) Rockabill to Dalkey Island SAC, which extends from Rockabill (approximately 7.3 km north of the proposed route) to Dalkey Island (approximately 31.0 km south of the route). This SAC has been designated for the protection of the marine Annex I habitat 'reef' and the Annex II species *Phocoena phocoena* (harbour porpoise). The Annex I habitat comprises intertidal and subtidal reef communities. The intertidal reef community comprises exposed reef on the east side of Dalkey Island, on the east and southern shores of Ireland's Eye and on all shores of Rockabill and the Muglins. The subtidal reef community occurs off the islands and off the coast between Lambay Island and Rush Village, in moderately exposed to exposed conditions. The substrate ranges from flat and sloping bedrock, to bedrock with boulders and cobbles. Vertical rock walls occur on the north and east of Ireland's Eye and to the east of Lambay Island (NPWS, 2013a). The shallow areas of this community (less than 10 m depth) comprise the kelp *Laminaria hyperborea* and an undercover of red algae (*Hypoglossum hypoglossoides*, *Brongniartella byssoides*, *Membranoptera alata*, *Phycodrys rubens* and *Delesseria sanguinea*). Deeper water (greater than 10 m depth) hosts cnidarians (*Alcyonium digitatum* and *Metridium* sp.), with faunal crusts of bryozoans (*Flustra foliacea* and *Chartella papyracea*), hydroids (*Nemertesia antennina*) and ascidians (*Aplidium punctum*). The onshore areas of Rockabill and Dalkey Island are designated as SPAs for supporting Annex II bird species, namely the roseate tern (*Sterna dougallii*), common tern (*Sterna hirundo*) and arctic tern (*Sterna paradisea*).

The Rogerstown Estuary SAC and SPA, 4.6 km south of the proposed cable route landfall, is separated from the sea by a sand and shingle bar and drains almost completely at low tide, resulting in a salinity range from near full sea water to near full fresh water. This SAC is designated for the protection of the marine Annex I habitats 'estuaries' and 'mudflats and sandflats not covered by seawater at low tides' and coastal Annex I habitats 'saltmarsh' and 'sand dune'. The Annex I marine habitats comprise four community types, including a mussel (*Mytlis edulis*) dominated community and a seagrass (*Zostera noltii*) dominated community, in addition to two sedimentary communities. The Rogerstown Estuary SPA is the most important estuary for wildfowl and waders in County Dublin after North Bull Island. Much of the outer part of the estuary is designated as a nature reserve (NPWS, 2013b).

Lambay is the largest Irish east coast island and lies approximately 5.7 km south of the proposed cable route. The Lambay Island SAC is designated for the protection of the Annex I 'reef' habitats. Of most relevance to the current project are the subtidal reefs, which are documented to contain a kelp (*Laminaria* spp.) dominated community complex, which occurs off the north, east and southern shores of the island and in a narrow band on its western shore, in water depths of up to 20 m. The substrate of this community comprises bedrock, often overlain with boulders, cobble and pebbles. Vertical or near vertical faces are recorded throughout. The species associated with this community are algae (*L. hyperborea*, *Phycodrys rubens*, *Delesseria sanguinea*, *H. hypoglossoides*, *M. alata*, *P. palmata* and Corallinaceae), barnacles (*Balanus crenatus*), echinoderms (*Asterias rubens*), crustaceans (*Necora puber*), cnidarians (*A. digitatum*) and bryozoans (*Membranipora membranacea*). Lambay Island supports a long-established breeding colony of grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*), which are listed as Annex II species under the EU Habitats Directive (NPWS, 2013c).

Lying approximately 11.2 km south-south-west of the proposed landfall, the Malahide Estuary SAC, SPA and Site of Community Importance (SCI) comprises the River Broadmeadow estuary. This SAC is designated for the protection of the marine Annex I habitats 'estuaries' and 'mudflats and sandflats not covered by seawater at low tides' and coastal Annex I habitats 'saltmarsh' and 'sand dune'. The mudflat and sandflat habitats contain five community types, including a seagrass (*Zostera* sp.) dominated community and a mussel (*Mytilus edulis*) dominated community, in addition to sandy and sandy mud habitats and associated biotic communities (NPWS, 2013d). The Malahide Estuary SPA is designated for regularly supporting wintering seabird assemblages of national and international importance and it has been classified as an SCI for supporting a good diversity of over-wintering, migratory water-birds (NPWS, 2013e).

Ireland's Eye is a small uninhabited island which lies approximately 15.3 km south of the proposed cable route. It is a SAC designated for the protection of Annex I 'shingle beach' and 'sea cliff' habitats and SPA for holding significant assemblages of migratory birds of national and international importance. The island is also a nesting site for peregrine (*Falco peregrinus*) and contains a gannet (*Morus bassanus*) colony; several pairs of shelduck (*Tadorna tadorna*), oystercatchers (*Haematopus ostralegus*) and ringed plover (C*haradrius hiaticula*) breed on the island (NPWS, 2017).

The North Dublin Bay SAC covers the inner part of north Dublin Bay, with the seaward boundary extending from the Bull Wall Lighthouse across to the Martello Tower at Howth Head. The northern boundary of this SAC lies approximately 17.8 km south of the proposed Havhingsten cable route landfall. The North Dublin Bay SAC is designated for the protection of the marine Annex I habitats 'mudflats and sandflats not covered by sea water at low tide' and coastal Annex I habitats 'saltmarsh' and 'sand dunes'. The North Dublin Bay is also a designated National Nature Reserve (NNR), Wildlife Sanctuary, Ramsar site and United Nation Educational, Scientific and Cultural Organisation (UNESCO) Biosphere Reserve (NPWS, 2013f). The North Bull island SPA and the Baldoyle Island SPA lie within the North Dublin Island SAC and are designated for regularly supporting wintering seabird assemblages of national and international importance (NPWS, 2012; 2014).

The South Dublin Bay and River Tolka Estuary SAC lies approximately 23.6 km south-south-west of the proposed cable route landfall and is designated for the protection of the Annex I marine habitat 'mudflats and sandflats not covered by seawater at low tide'. In the south bay, the intertidal flats comprise predominantly well-aerated sands, while in the Tolka Estuary sediments vary from organically rich soft muds in the inner estuary, to exposed and well-aerated sands off the Bull Wall (NPWS, 2013g). The South Dublin Bay and River Tolka Estuary area is also SPA designated for regularly supporting wintering seabird assemblages of national and international importance (NPWS, 2014).Relevant Marine Habitats of Conservation Importance

The sensitive intertidal and subtidal habitats and species that may occur in the survey area are listed in Table 1.1, with the current relevant legislation and designation. Descriptions of potentially relevant sensitive habitats are provided in Sections 1.4.1.1 to 1.4.1.4.

Table 1.1: Relevant Sensitive Habitats, Havhingsten Cable Route, Ireland

Protected Feature	Legislation	Feature type	Designation/Status
Mudflats and sandflats not covered by sea water at low tide	EC Habitats Directive	Littoral sediment	Annex I habitat
	OSPAR	Intertidal mudflats	Threatened and/or declining habitat
Stony reefs	EC Habitats Directive	Geogenic reefs	Annex I habitat
Mytilus edulis beds	OSPAR	Littoral biogenic reef	Threatened and/or declining habitat
Estuaries	EC Habitats Directive	Estuarine sedimentary habitat	Annex I habitat
Zostera beds	OSPAR	Intertidal seagrass beds	Threatened and/or declining habitat
Sea pen and burrowing megafauna communities	OSPAR	Sea pen and burrowing megafauna communities	Threatened and/or declining habitat
Notes: EC = European Community OSPAR = Oslo and Paris			

1.4.1.1 Mudflats and Sandflats Not Covered by Seawater at Low Tide

The physical structure of intertidal flats ranges from mobile, coarse-sand beaches on wave-exposed coasts to stable, fine-sediment mudflats in estuaries and other marine inlets (JNCC, 2016a). Intertidal mudflats are highly productive providing, at low tide, feeding and resting areas for internationally important populations of migratory and wintering waterfowl. At high tide, they are important nursery areas for flatfish such as sole (*Solea solea*), dab (*Limanda limanda*), flounder (*Platichthys flesus*) and plaice (*Pleuronectes platessa*). Intertidal areas dissipate wave energy, thus reducing the risk of eroding saltmarshes, damaging coastal defences and flooding low-lying land. The mud surface also plays an important role in nutrient chemistry. In areas receiving pollution, organic sediments sequester contaminants and may contain high concentrations of heavy metals (OSPAR, 2009a).

1.4.1.2 Geogenic Reefs and *Mytilus edulis* Beds

Two types of reef are recognised in Irish waters; geogenic and biogenic reefs. Both are listed under Annex I of the EC Habitats Directive and on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008).

Geogenic Reefs

Geogenic reefs are variable in structure but can be classified into two broad categories: bedrock reefs, which comprise sloping or flat bedrock; and stony reefs, which comprise aggregations of boulders and cobbles. Geogenic reefs are characterised by communities of attached algae and invertebrates, usually associated with mobile fauna. The specific communities that occur vary dependent on water depth and turbidity, wave and tidal exposure and substratum type and morphology.

Biogenic Reefs: Mussel (*Mytilus edulis*) Beds

Biogenic reefs are defined as structures made by marine animals that arise from the surrounding seafloor. Mussel (*M*. edulis) beds are important in sediment dynamics of coastal systems as they stabilise the substrate by collecting sediment while the shell layers are relatively erosion resistant thus able to keep up with sea level rise. Mussel beds are an important food source for birds and, in areas of soft sediment, they provide suitable habitat for species such as sea anemones, hydroids and seagrass, by providing hard substrate and shelter in the tidal pools between the ridges formed by the mussels themselves. Other invertebrates, especially deposit feeding worms, profit from the organic matter that is deposited as pseudofaeces (OSPAR, 2015).

1.4.1.3 Estuaries

Estuaries are habitat complexes that comprise a mosaic of subtidal and intertidal habitats, including mudflats and sandflats, which are closely associated with surrounding terrestrial habitats. The structure of estuaries is largely determined by geomorphological and hydrographic factors. The intertidal and subtidal sediments of estuaries support biological communities that vary according to the type of sediment and salinity gradients within the estuary, together with geographic location and the strength of tidal streams. In addition to the sedentary subtidal and intertidal communities, estuaries are a conduit for fish and the juvenile stages of benthic plants and animals and are the transition between the marine and freshwater environments for migratory fish (JNCC, 2016b).

1.4.1.4 Seagrass (*Zostera* sp.) Beds

Seagrasses (*Zostera* sp.) stabilise the substratum and provide shelter and habitat for many organisms. The leaves may be colonised by diatoms, algae, stalked jellyfish and anemones. Seagrass beds are important nursery areas for flatfish and, in some areas, for cephalopods. The diversity of the species will depend on exposure and density of the seagrass microhabitats, but it is generally high in perennial, fully marine, subtidal seagrass beds compared to in intertidal or estuarine, annual beds. Seagrass bed productivity is a major source of food for wildfowl, particularly brent goose and widgeon, but also for mute and whooper swans. Dead plants are a source of organic matter for marine systems (OSPAR, 2009b).

1.4.1.5 Sea Pen and Burrowing Megafauna Communities

Sea pens and burrowing megafauna were identified from the previous Cable Crossing Habitat Assessment undertaken on the Irish section of the Havhingsten cable route (Fugro, 2019a).

'Sea pen and burrowing megafauna communities' is a habitat feature listed on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008). This biotope comprises plains of fine mud, in water depths ranging from 15 m to 200 m or more, heavily bioturbated by burrowing megafauna and with conspicuous populations of sea pens (*Virgularia mirabilis* and *Pennatula phosphorea*). The burrowing megafauna may include the crustaceans *N. norvegicus*, *Calocaris macandreae* or *C. subterranea*. In the Irish sector, this habitat may be encountered in sheltered sea loughs and in deeper offshore waters of the Irish Sea (OSPAR, 2010).

1.5 Regional Standards for Sediment Chemical Concentrations

Comparison was made to OSPAR background values that were derived from data collected from pristine marine sediments in the wider north-east Atlantic (OSPAR, 2014). The OSPAR background concentrations (BCs) reflect contaminant concentrations at "pristine" or "remote" sites, whilst background assessment concentrations (BACs) are statistically derived from background data and are defined as "values for testing whether the concentrations at a location are at or close to background" (OSPAR, 2005; 2009c). Both BCs and BACs are normalised concentrations, with organic substances e.g. polycyclic aromatic hydrocarbons (PAHs) normalised to 2.5 % total organic carbon (TOC) and metals normalised to 5 % aluminium (OSPAR, 2009c; 2014).

Selected data have been compared to the OSPAR effects range low (ERL) concentrations, where available (OSPAR, 2014). ERLs represent the low point (10th percentile) on a continuum of chemical concentrations over which adverse biological effects have been observed from ecotoxicological studies (OSPAR, 2009c). Adverse effects on marine organisms are rarely observed when concentrations are below the ERL value (OSPAR, 2014).

1.6 Coordinate Reference System

All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) Projection Zone 30N Central Meridian 3° West (CM 3° W). Table 1.2 provides the detailed geodetic and projection parameters.

Table 1.2: Project Geodetic and Projection Parameters

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Reciprocal flattening:	1/f = 298.257 223 563
Project Projection Parameters	
Grid Projection:	Universal Transverse Mercator (UTM)
UTM Zone:	30 N
Central Meridian:	3° 00′ 00″ West
Latitude of Origin:	00° 00′ 00″ North
False Easting:	500 000 m
False Northing:	0 m
Scale factor on Central Meridian:	0.9996
Units:	metre

2. ENVIRONMENTAL SURVEY METHODS

2.1 Survey Strategy

The acquired side scan sonar (SSS) data were reviewed prior to survey operations to propose locations for camera investigations and grab sampling. Emphasis was placed on locating areas of potential conservation value, on boundaries between areas of differing sonic reflectivity and areas characteristic of the general background conditions of the site.

Five grab sampling stations were selected along the Irish section of the cable route. At each of these stations, drop-down camera transects were undertaken prior to grab sampling.

Additionally, the interconnector cable crossing location was selected by the client and investigated by means of two perpendicular camera transects, centred on the cable crossing position. A grab sampling station was also positioned 300 m from the interconnector.

Table 2.1 provides the coordinates, data to be acquired and rationale for the selection for each environmental sampling station.

Table 2.1: Proposed Environmental Stations, Havhingsten Cable Route, Ireland

Geodetic Parameters: WGS84 UTM 30N					
Station	**KP***	**Easting [m]**	**Northing [m]**	**Rationale**	**Data/Sample Acquisition**
LS_ST01	1.120	296 655	5 937 208	Differing reflectivity covering two habitat types. Grab sample location to be defined following video review	Video and stills PC, FA, FB
LS_ST02	2.940	298 411	5 937 630	Representative habitat	Video and stills PC, FA, FB
LS_ST03	8.500	303 849	5 938 838	Differing reflectivity	Video and stills PC, FA, FB
LS_ST04	11.960	307 143	5 939 833	Differing reflectivity	Video and stills PC, FA, FB
LS_ST05	20.570	314 915	5 943 502	Representative habitat	Video and stills PC, FA, FB
CC05 (Client ID 2)	54.920	346 662	5 957 525	Interconnector cable crossing	Video and stills
CC05_ST01	55.220	346 363	5 957 528	Positioned 300 m from the interconnector cable crossing	Video and stills PC, FA, FB

Notes:
KP = Kilometre point
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB
* = Approximate KP from landfall at Loughshinny (segment 1.1)

2.2 Survey Methods

2.2.1 Sediment Grab Sampling

Seabed grab samples were collected using a 0.1 m² dual van Veen grab during both the offshore and nearshore survey operations. Two accepted grab samples were retained for faunal analysis and one grab sample was retained and subsampled for physico-chemical analysis. Seabed grab samples were primarily collected for analysis of physico-chemical and biological baseline characterisation; however, observations from the grab sampling have also been used to supplement the seabed video/photographic data in describing the benthic habitat, where appropriate.

2.2.2 Seabed Video/Photography

Seabed photographic data were acquired using a Kongsberg OE 14-208 underwater camera system mounted within purpose-built camera frames, complete with a separate strobe and two lights. Parallel lasers (which provide a scale for faunal size classes and sediment descriptions, specifically cobbles and boulders) were fitted to the video frames. A video overlay was used to display a navigation string from the ship's reference point, including the time, date, station/transect number and location (easting and northing). During operations where visibility was reduced, a freshwater lens system was used. Laser scaling was used with the conventional camera frame (not freshwater lens), with the lasers positioned 17.0 cm to 19.5 cm apart.

Further detail can be found within the Havhingsten cable route field reports (Fugro, 2019a, 2019b) and in Appendix B.1.

2.3 Analytical Strategy

The following list briefly describes the suites of analyses carried out. Further description of the methods used for the analyses are detailed in Appendix B.

- Sediment particle size distribution (PSD) analysis and characterisation including total organic matter (TOM) and total organic carbon (TOC) content (Section 4);
- Sediment chemistry (Section 5), including:
  - Total hydrocarbon content (THC) and n-alkane content by gas chromatography–flame ionisation detection (GC-FID; Section 5.2.2);
  - 2 to 6 ring aromatic hydrocarbons, including the United States Environmental Protection Agency's (US EPA) 16 priority PAHs by gas chromatography-mass spectrometry (GC-MS; Section 5.2);
  - Metals predominantly by aqua regia digest and subsequent instrumental analysis. Arsenic, cadmium, chromium, copper, lead and nickel analysed by inductively coupled plasma-mass spectrometry (ICP-MS), aluminium and tin by inductively coupled plasma-optical emission spectroscopy (ICP-OES) and mercury by cold vapour-atomic fluorescence spectroscopy (CV-AFS) (Section 5.3);
- Macrofauna (as retained on a 1 mm mesh sieve) were identified and enumerated from one sample at each station (Section 6).
- Habitats and biotopes were classified using the European Nature Information Service (EUNIS) Habitat Classification (EUNIS, 2012) with equivalent classifications from the Joint Nature Conservation Committee (JNCC) 'Marine Habitat Classification for Britain and Ireland' (JNCC, 2015) and 'A Guide to Habitats in Ireland' (Fossitt, 2000) also provided (Section 7);
- Sensitive habitat assessments ('Sea pen and burrowing megafauna communities' and 'Geogenic reef') were undertaken in accordance with published guidelines (Section 7.2.3)

3. FIELD OPERATIONS

The majority of the survey along the Loughshinny section of the proposed cable route was conducted onboard the RV Prince Madog during the survey period 23 to 24 February 2019. Due to shallow water depths, and the poor visibility for photographic data collection, encountered during operations on the RV Prince Madog, two stations (LS_ST01 and LS_ST02) were sampled onboard the MV Fastnet Petrel during the survey period 21 to 22 March 2019.

3.1 Seabed Sampling

A complete suite of samples (two macrofauna and one physico-chemical sample) were acquired at each of the six stations originally proposed along the Irish section of the Havhingsten cable route. Figure 3.1 presents the spatial distribution of the survey stations.

All but one of the samples was acquired within the radius of accuracy originally proposed (within 50 m of the proposed location). Due to the water being too shallow to safely survey at station LS_ST01, the grab sampling station was moved to a position approximately 374 m away from that originally proposed. The camera transect undertaken at this station was also relocated for safety reasons (Section 3.2) and the grab sampling station then targeted sediments amenable to sampling that were identified following *in situ* review of the seabed video data.

Table 3.1 presents the details of the acquired samples, together with the approximate kilometre point (KP) of each station.

Table 3.1: Completed Environmental Survey Sampling Stations, Havhingsten Cable Route, Ireland

Geodetic Parameters: WGS84 UTM 30N					
Station	**KP***	**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Sample Acquisition**
LS_ST01	1.120	296 285.6	5 937 148.2	9	PC, FA, FB
LS_ST02	2.940	298 426.0	5 937 601.7	17	PC, FA, FB
LS_ST03	8.500	303 889.9	5 938 821.5	32	PC, FA, FB
LS_ST04	11.960	307 185.5	5 939 829.5	41	PC, FA, FB
LS_ST05	20.570	314 900.5	5 943 474.5	66	PC, FA, FB
CC05_ST01	55.220	346 332.3	5 957 528.3	81	PC, FA, FB

Notes:
KP = Kilometre point
BSL = Below sea level
PC = Physico-chemical sample
FA/FB = Faunal sample FA or FB
* = Approximate KP from landfall at Loughshinny (segment 1.1)

3.2 Seabed Video/Photography

Photographic stills and video footage were successfully acquired at all proposed camera stations and transects. Due to very poor visibility at stations LS_ST01 and LS_ST02 during the offshore phase of operations, these were revisited during the nearshore operations, with data successfully acquired during this phase of work. As previously mentioned with regard to the grab sampling, station LS_ST01 had to be relocated for safety reasons; the proposed transect was moved approximately 151 m south-east of the line originally proposed and extended to target the rock features of interest which occur on either side of Loughshinny bay.

Table 3.2 provides the coordinates for the camera transects undertaken and a summary of the data acquired and Figure 3.1 provides a spatial representation of their positions. As some transects had to be re-run due to poor visibility, only the successful attempts have been shown within the table and figure.

Table 3.2: Completed Environmental Survey Camera Transects, Havhingsten Cable Route, Ireland

Geodetic Parameters: WGS84 UTM 30N							
Station		**KP***	**Easting [m]**	**Northing [m]**	**Depth [m BSL]**	**Length [m]**	**Data Acquisition**
LS_ST01A	SOL	1.310	296 293.1	5 937 015.3	7	249	11 mins 34 secs 19 stills
	EOL		296 258.6	5 937 262.1			
LS_ST02	SOL	2.940	298 418.7	5 937 591.1	15	65	9 mins 34 secs 32 stills
	EOL		298 408.3	5 937 655.2			
LS_ST03	SOL	8.500	303 870.6	5 938 724.0	35	157	6 mins 2 secs 23 stills
	EOL		303 833.3	5 938 876.9			
LS_ST04	SOL	11.960	307 144.3	5 939 797.0	41	85	5 mins 26 secs 19 stills
	EOL		307 133.1	5 939 881.0			
LS_ST05	SOL	20.570	314 922.3	5 943 446.6	66	184	5 mins 3 secs 19 stills
	EOL		314 882.9	5 943 626.6			
CC05_T01	SOL	54.920	347 174.7	5 957 085.5	83	829	33 mins 38 secs 68 stills
	EOL		346 542.0	5 957 621.4			
CC05_T02	SOL	54.920	346 779.4	5 957 515.0	82	272	10 mins 15 secs 26 stills
	EOL		346 508.0	5 957 501.8			
CC05_ST01	SOL	55.220	346 266.4	5 957 592.1	82	146	19 mins 59 secs 26 stills
	EOL		346 385.9	5 957 508.6			

Notes:
KP = Kilometre point
BSL = Below sea level
SOL = Start of line
EOL = End of line
* = Approximate KP from landfall at Loughshinny (segment 1.1)

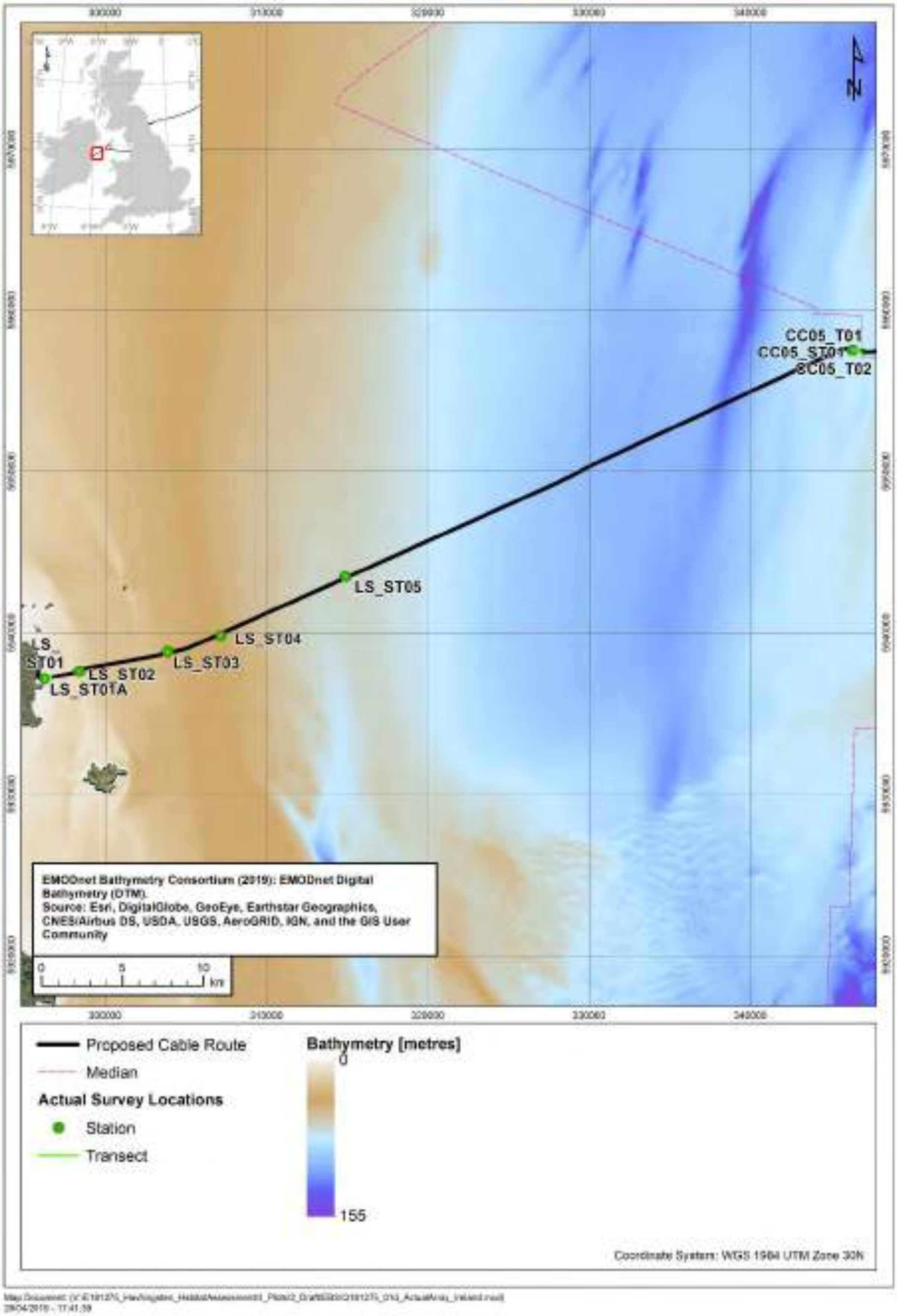


Figure 3.1: Completed environmental sampling locations overlaid on bathymetry, Havhingsten cable route, Ireland

4. SEDIMENT CHARACTERISATION

4.1 Introduction

Sediment samples were analysed for their PSD using a combination of two techniques; sieve analysis for all material retained by a 1 mm sieve followed by laser diffraction analysis of the finer material. The results of the particle size analysis were treated statistically to characterise the sediment type (Wentworth scale) and particle size homogeneity (sorting).

The proportion of TOM present in each sediment sample was determined by loss on ignition at 440 °C for 4 hours, whilst the proportion of TOC was determined by combustion and non-dispersive infrared detection following inorganic carbon removal.

Relative standard deviation (RSD) indicates the extent of variability in a dataset in relation to the mean value. The RSD value expresses the standard deviation as a percentage of the mean. For the purpose of this report, RSD of less than 30 % will be considered low variability, 30 % to 70 % will be considered moderate variability and more than 70 % will be considered high variability.

Appendix B provides full details of the analytical techniques employed and Appendix D displays the histograms of particle size class summary for each station.

4.2 Results

Table 4.1 summarises the particle size distribution, whilst Table 4.2 summarises the sediment characteristics, including granulometry and organic content (TOM and TOC), across the Irish section of the Havhingsten cable route. Figure 4.1 shows the spatial distribution of sediment composition along the surveyed route.

Median particle size across the across the survey area demonstrated moderate variation (RSD 38 %) and ranged from 75.2 µm at station LS_ST05 to 199 µm at station LS_ST03, with a mean of 123 µm (Table 4.1).

Mean particle size across the across the survey area demonstrated moderate variability (RSD 67 %) and ranged from 41.5 µm at station LS_ST05 to 192 µm at station LS_ST03, with a mean of 90.0 µm (Table 4.1). Sediment description using the Wentworth description varied from fine sand to coarse silt (Wentworth, 1922).

Standard deviation (SD) of particle size indicates the degree of spread of individual size classes about the mean and provides the basis of a sorting index, in which low values indicate sediments to be fairly homogeneous (good sorting) while high values suggest a relatively large scatter of particle sizes about the mean (poor sorting). The sorting coefficient ranged from 1.37 phi at station LS_ST04 to 2.29 phi at station LS_ST01, with a mean of 1.93 phi. Poorly sorted to very poorly sorted sediments were recorded across the Irish section of the Havhingsten cable route.

Skewness indicates the tendency of particle size classes to be skewed about the mean, either towards coarser sediment (negative skewness) or finer sediment (positive skewness). Skewness across all stations ranged from 0.26 phi (fine skewed) at station LS_ST03 to 0.66 phi (very fine skewed) at station LS_ST02, with a mean of 0.51 phi.

The sediment across the Irish section of the Havhingsten cable route were comprised predominantly of sand particles, with varying portions of gravel and fines (Table 4.2 and Figure 4.1). Sand content ranged from 57.0 % at station LS_ST05 to 84.5 % at station LS_ST04, with a mean of 71.4 % and low variability (RSD 16 %). Gravel content ranged from 0.00 % at stations LS_ST01 and LS_ST05 to 2.73 % at station LS_ST03, with a mean of 0.68 % and high variability (RSD 158 %) which was predominantly influenced by the comparatively high gravel content at stations LS_ST02 and LS_ST03. The fines fraction ranged from 14.7 % at station LS_ST03 to 43.0 % at station LS_ST05, with moderate variability (RSD 44 %). Sediments description using the modified Folk description (Long, 2006) classed sediments as muddy sand at four stations and slightly gravelly muddy sand at two stations.

The TOM content across the Irish section of the Havhingsten cable route was low and demonstrated low variability (RSD 21 %). TOM content ranged from 1.93 % at station LS_ST03 to 3.31 % at station LS_ST01, with a mean of 2.50 % (Table 4.2).

TOC values were low and demonstrated moderate variability (RSD 38 %). TOC values ranged from 0.27 % at station LS_ST03 to 0.66 % at station LS_ST01, with a mean of 0.39 % (Table 4.2).

Table 4.1: Summary of Particle Size Distribution, Havhingsten Cable Route, Ireland

Station	KP*	Median [µm]†	Mean [µm]†	Mean [phi]†	SD [phi]†	Skewness [phi]†	Wentworth Description‡	Sorting^
LS_ST01	1.120	87.4	50.8	4.30	2.29	0.48	Coarse silt	Very poorly sorted
LS_ST02	2.940	133	69.2	3.85	2.06	0.66	Very fine sand	Very poorly sorted
LS_ST03	8.500	199	192	2.38	1.71	0.26	Fine sand	Poorly sorted
LS_ST04	11.960	152	134	2.90	1.37	0.51	Fine sand	Poorly sorted
LS_ST05	20.570	75.2	41.5	4.59	2.15	0.55	Coarse silt	Very poorly sorted
CC05_ST01	55.220	94.2	53.0	4.24	2.01	0.60	Coarse silt	Very poorly sorted
Minimum	**-**	**75.2**	**41.5**	**2.38**	**1.37**	**0.26**	**-**	**-**
Maximum	**-**	**199**	**192**	**4.59**	**2.29**	**0.66**	**-**	**-**
Mean	**-**	**123**	**90.0**	**3.71**	**1.93**	**0.51**	**-**	**-**
Standard Deviation	**-**	**47.2**	**60.0**	**0.887**	**0.334**	**0.137**	**-**	**-**
RSD [%]	**-**	**38**	**67**	**-**	**-**	**-**	**-**	**-**

Notes:
KP = Kilometre point
RSD = Relative standard deviation
* = Approximate KP from landfall at Loughshinny (segment 1.1)
† = Folk and Ward method (Gradistat statistics)
‡ = Wentworth description (Wentworth, 1922)
^ = Sorting based on geometric Folk and Ward (1957) graphical measures (Gradistat statistics)

Table 4.2: Summary of Sediment Characteristics, Havhingsten Cable Route, Ireland

Station	KP*	Fractional Composition			Fines		Folk Description†	TOM [%]	TOC [%]
		Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]			
LS_ST01	1.120	0.00	59.4	40.6	31.2	9.44	Muddy sand	3.31	0.66
LS_ST02	2.940	1.06	77.0	22.0	14.9	7.05	Slightly gravelly muddy sand	2.34	0.33
LS_ST03	8.500	2.73	82.5	14.7	9.93	4.80	Slightly gravelly muddy sand	1.93	0.27
LS_ST04	11.960	0.03	84.5	15.5	10.5	5.04	Muddy sand	2.08	0.28
LS_ST05	20.570	0.00	57.0	43.0	33.2	9.84	Muddy sand	2.94	0.46
CC05_ST01	55.220	0.28	68.1	31.6	23.8	7.85	Muddy sand	2.41	0.35
Minimum	**-**	**0.00**	**57.0**	**14.7**	**9.93**	**4.80**	**-**	**1.93**	**0.27**
Maximum	**-**	**2.73**	**84.5**	**43.0**	**33.2**	**9.84**	**-**	**3.31**	**0.66**
Mean	**-**	**0.68**	**71.4**	**27.9**	**20.6**	**7.34**	**-**	**2.50**	**0.39**
Standard Deviation	**-**	**1.08**	**11.8**	**12.4**	**10.3**	**2.13**	**-**	**0.526**	**0.148**
RSD [%]	**-**	**158**	**16**	**44**	**50**	**29**	**-**	**21**	**38**

Notes:
Fines = silt and clay content
Silt = +4.0 to +8.0 ø units or 3.9 µm to 62.5 µm
Clay = +8.0 to +10.0 ø units or 0.98 µm to 3.9 µm
TOM = Total organic matter
TOC = Total organic carbon
RSD = Relative standard deviation
* = Approximate KP from landfall at Loughshinny (segment 1.1)
† = BGS modified Folk description from Long (2006)

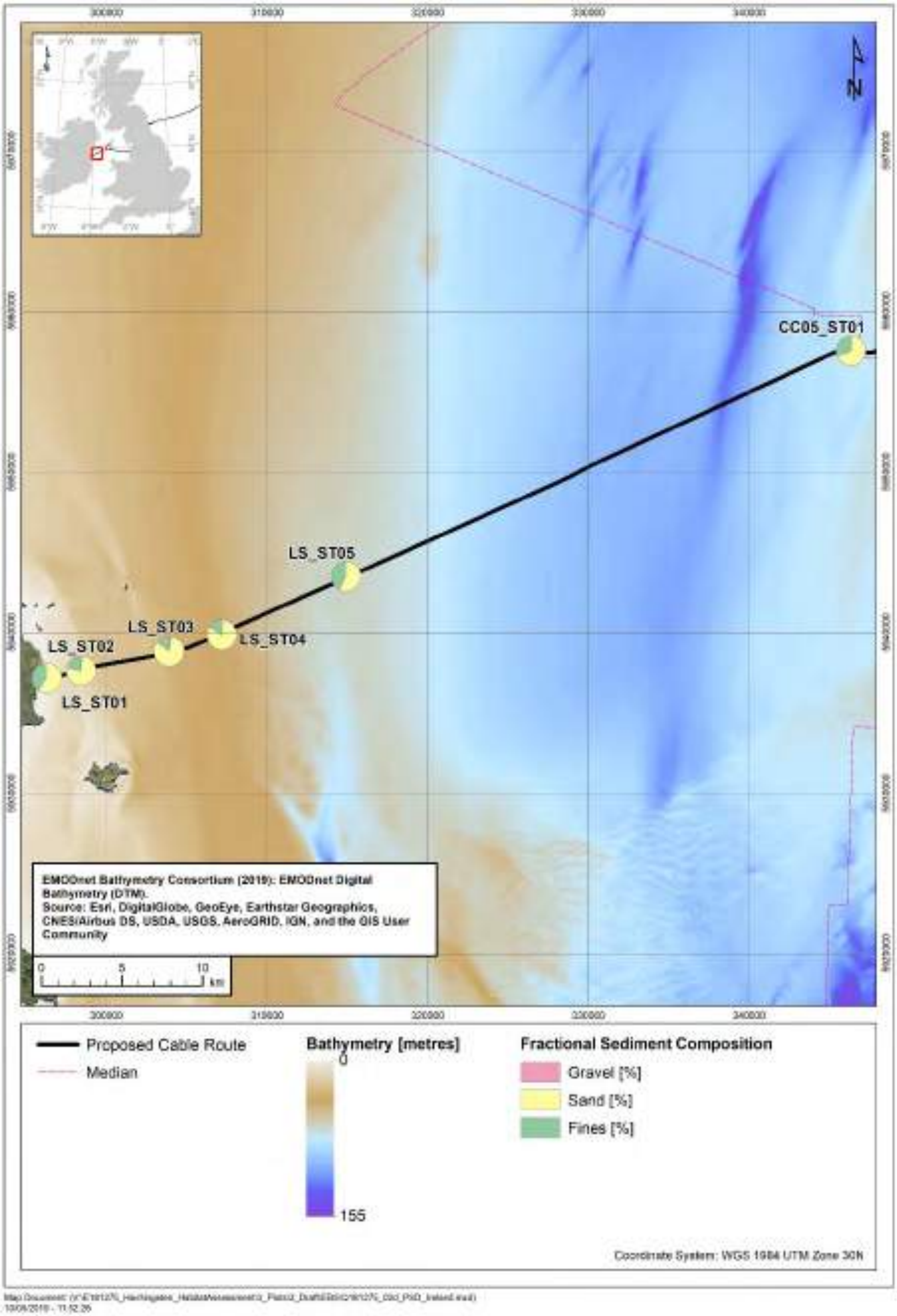


Figure 4.1: The spatial distribution of sediment composition, Havhingsten cable route, Ireland

5. SEDIMENT CHEMISTRY

5.1 Introduction

Sediment samples underwent analysis to assess concentrations of key hydrocarbon and metal analytes, which were compared to published background and probable effect criteria (OSPAR, 2009c; 2014) to establish the likelihood of anthropogenic contamination of sediments within the Irish section of the Havhingsten cable route.

The sediment samples were analysed for hydrocarbon content including THC, total n-alkanes (nC_{12} to nC_{36}) and PAHs, specifically the US EPA 16 PAHs. Samples were extracted by ultrasonication of wet sediments with mixed solvents. The sample extracts were then cleaned-up using absorption column chromatography. The extracts were analysed for THC, unresolved complex mixture (UCM) and n-alkanes (nC_{12} to nC_{36}). Aromatic hydrocarbons were analysed by GC-MS.

Sediments collected were also analysed for selected elements (metals). The majority (aluminium, arsenic, cadmium, chromium, copper, lead, nickel and tin) were quantified after an aqua regia digest followed by multi-element analysis by inductively coupled plasma-mass spectrometry (ICP-MS) or by inductively coupled plasma-optical emission spectroscopy (ICP-OES). Analysis of mercury was by cold vapour-atomic fluorescence spectroscopy (CV-AFS).

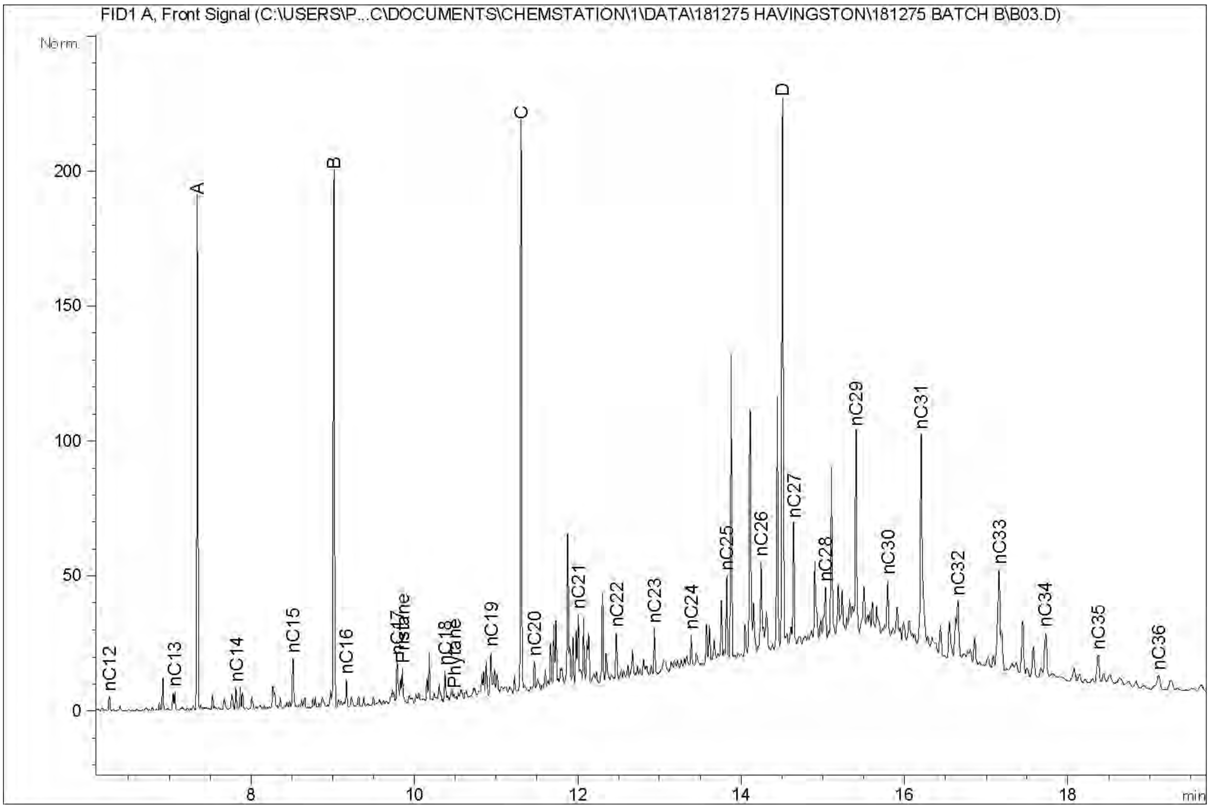
Appendix B provides full details of the analytical techniques employed.

5.2 Sediment Hydrocarbons

5.2.1 Gas Chromatography–Flame Ionisation Detection (GC-FID) Hydrocarbon Profiles

A visual comparison of the GC-FID profiles can provide information on the potential origins of the hydrocarbons present in marine sediments samples. The GC-FID profiles illustrating the hydrocarbon components detected in each of the sediment samples are provided in Appendix E.1. To support more detailed discussions relating to the hydrocarbon components identified by GC-FID analysis of the sediments. Figure 5.1 displays example gas chromatograms, representative of the grab samples across the Irish section of the Havhingsten cable route.

The GC-FID profiles obtained for the majority of the sediment samples were broadly similar to the profile of station LS_ST03 in Figure 5.1. This profile is characterised by a ‘hump’ of UCM peaking late in the chromatogram window and a range of low level resolved n-alkanes. The prevalence of the odd-numbered heavier n-alkanes (those from nC_{25}) are indicative of leaf cuticle waxes originating from terrestrial run-off. A cluster of peaks around nC_{21} was present in some samples and is often seen in marine sediments and thought to be branched isoprenoids of biogenic origin.



Notes:

THC = Total hydrocarbon content

A, B, C and D peaks refer to the internal standards added for quantification

Figure 5.1: Gas chromatographic profile for typical surface sediment Havhingsten cable route, Ireland

5.2.2 Total Hydrocarbon and n-Alkane (nC_{12} to nC_{36}) Content

Table 5.1 presents the concentrations of total hydrocarbons, UCM, total n-alkanes and CPI ratios (nC_{12} to nC_{36}) and pristane/phytane ratios reported from the surface sediment across the Irish section of the Havhingsten cable route. Appendix E.2 presents individual n-alkane concentrations for the sediments analysed.

THC concentrations reported for the survey area ranged from 3.9 µg/g at station LS_ST04 to 12.6 µg/g at station LS_ST01, with a mean concentration of 6.2 µg/g. Variation across all stations was moderate (RSD 54 %).

UCM concentrations ranged from 2.5 µg/g at stations LS_ST04 and CC05_ST01 to 9.2 µg/g at station LS_ST01, with a mean concentration of 4.2 µg/g and moderate variability (RSD 61 %).

The total n-alkane (nC_{12} to nC_{36}) concentrations displayed moderate variability (RSD 52 %), ranging from 0.23 µg/g at station LS_ST04 to 0.76 µg/g at station LS_ST01, with a mean concentration of 0.38 µg/g.

5.2.3 Sediment Aromatic Hydrocarbon Content

The distribution and concentration of aromatic compounds in seabed sediments were analysed by GC-MS. The aromatic compounds quantified were the naphthalenes (2 ring aromatics), 3 to 6 ring PAHs and the dibenzothiophenes (sulphur containing heteroaromatics). Table 5.1 summarises the total concentrations of aromatic hydrocarbons and the sum of the US EPA 16 PAHs. Appendix E.3 presents the individual US EPA 16 PAH concentrations, which are compared to OSPAR (2014) ERL values, and US EPA 16 PAH values normalised to 2.5 % TOC content, which are compared to OSPAR (2009; 2014) BC and BAC criteria.

Total 2 to 6 ring PAH concentrations ranged from 0.171 µg/g at station LS_ST04 to 0.650 µg/g at station LS_ST01, with a mean concentration of 0.309 µg/g and moderate variability (RSD 57 %). All total 2 to 6 ring PAH concentrations were below the ERL value (4.10 µg/g; OSPAR, 2014).

The total US EPA 16 PAH concentrations ranged from 0.060 µg/g to 0.328 µg/g at stations LS_ST04 and LS_ST01 respectively, with a mean concentration of 0.130 µg/g. Variation between stations was high (RSD 77 %). All individual US EPA 16 PAHs and alkylated PAHs were below their respective ERL values (OSPAR, 2014) across the survey area (Appendix E.3).

When normalised to 2.5 % TOC, individual US EPA 16 PAH concentrations exceeded BAC values (OSPAR, 2014) for naphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene at all stations and benzo(ghi)perylene at one station (Appendix E.3).

Table 5.1: Summary of Sediment Hydrocarbon Analysis, Havhingsten Cable Route, Ireland

Station	KP*	THC	UCM	n-alkanes (nC_{12-36})	Total 2-6 Ring PAH	Total US EPA 16 PAH
LS_ST01	1.120	12.6	9.2	0.76	0.650	0.328
LS_ST02	2.940	5.6	3.9	0.31	0.192	0.073
LS_ST03	8.500	6.6	4.4	0.41	0.253	0.088
LS_ST04	11.960	3.9	2.5	0.23	0.171	0.060
LS_ST05	20.570	4.3	2.7	0.28	0.326	0.142
CC05_ST01	55.220	4.1	2.5	0.28	0.262	0.093
Minimum		**3.9**	**2.5**	**0.23**	**0.171**	**0.061**
Maximum		**12.6**	**9.2**	**0.76**	**0.650**	**0.328**
Mean		**6.2**	**4.2**	**0.38**	**0.309**	**0.130**
Standard Deviation		**3.31**	**2.58**	**0.196**	**0.176**	**0.100**
RSD [%]		**54**	**61**	**52**	**57**	**77**
CEMP Assessment Criteria (OSPAR, 2014)						
ERL		**-**	-	-	**4.10**	-

Notes:
THC = Total hydrocarbon content
UCM = Unresolved complex mixture
Total 2 to 6 ring PAH = Total 2 to 6 ring polycyclic aromatic hydrocarbons (PAH), including alkyl homologues
Total US EPA16 PAH = Total United States Environmental Protection Agency's 16 (US EPA 16 PAH) priority polycyclic aromatic hydrocarbons (PAHs)
RSD = Relative standard deviation
Concentrations expressed as µg/g of dry sediment
KP = Kilometre point
ERL = Effects range low (CEMP assessment criteria; OSPAR, 2014)
CEMP = Coordinated Environmental Monitoring Programme
* = Approximate KP from landfall at Loughshinny (segment 1.1)

5.3 Sediment Metals

Sediments collected from the Irish section of the Havhingsten cable route were analysed for selected elements: aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and tin by ICP-OES and ICP-MS.

Table 5.2 summarises the concentrations of the extractable metals in the sediment samples from an aqua regia digest, which are compared to OSPAR (2014) ERL values. Appendix E.6 presents aluminium-normalised metals concentrations for comparison to OSPAR (2009; 2014) BC and BAC criteria.

The concentrations of aqua regia extractable metals did not exceed their respective ERL values at any station. Variability across the survey area ranged from low to moderate (≤ 47 %), with the highest variability observed for aluminium.

Arsenic concentrations ranged from 5.23 µg/g at station LS_ST04 to 6.82 µg/g at station LS_ST05, with a mean of 6.00 µg/g and low variability (RSD 10 %).

Cadmium concentrations were below the MRV at all stations.

Concentrations of chromium displayed moderate variability (RSD 43 %), ranging from 4.13 µg/g at station LS_ST01 to 30.6 µg/g at station LS_ST05, with a mean of 20.0 µg/g.

Concentrations of copper displayed moderate variability (RSD 43 %), ranging from below the MRV (2 µg/g) at station LS_ST01 to 7.42 µg/g at station LS_ST05, with a mean of 5.08 µg/g.

Concentrations of mercury displayed moderate variability (RSD 41 %), ranging from below the MRV (0.01 µg/g) at station LS_ST01 to 0.0245 µg/g at station LS_ST05, with a mean of 0.0168 µg/g.

Nickel concentrations displayed moderate variability (RSD 42 %), with concentrations ranging from 2.65 µg/g at station LS_ST01 to 15.5 µg/g at station LS_ST05, with a mean of 10.2 µg/g.

Concentrations of lead ranged from 5.69 µg/g at station LS_ST01 to 15.1 µg/g at station LS_ST05, with a mean of 11.8 µg/g and low variability (RSD 28 %).

Concentrations of tin ranged from below the MRV (1 µg/g) at five stations to 1.00 µg/g at station LS_ST05.

In general, the highest metal concentrations were found at station LS_ST05 and the lowest at station LS_ST01.

The sediment metals results were also normalised to 5 % aluminium values (Appendix E.4) and compared to OSPAR BAC values (OSPAR, 2014). BAC values were exceeded for chromium, nickel and lead at all stations and mercury and arsenic at two stations.

Table 5.2: Summary of Sediment Metals Analysis, Havhingsten Cable Route, Ireland

Station	KP*	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Sn
LS_ST01	1.120	1880	6.23	< 0.08	4.13	< 2	< 0.01	2.65	5.69	< 1
LS_ST02	2.940	11100	5.35	< 0.2	21.2	5.37	0.0199	10.1	12.4	< 1
LS_ST03	8.500	12200	6.11	< 0.2	22.5	5.22	0.0132	11.8	13.6	< 1
LS_ST04	11.960	10600	5.23	< 0.2	19.0	5.16	0.0175	9.69	11.3	< 1
LS_ST05	20.570	17900	6.82	< 0.2	30.6	7.42	0.0245	15.5	15.1	1.00
CC05_ST01	55.220	12400	6.23	< 0.2	22.0	6.31	0.0209	11.2	13.2	< 1
Minimum		**1880**	**5.23**	**-**	**4.13**	**< 2**	**< 0.01**	**2.65**	**5.69**	**< 1**
Maximum		**17900**	**6.82**	**-**	**30.6**	**7.42**	**0.0245**	**15.5**	**15.1**	**1.00**
Mean		**11000**	**6.00**	**-**	**20.0**	**5.08**	**0.0168**	**10.2**	**11.8**	**-**
Standard Deviation		**5180**	**0.601**	**-**	**8.68**	**2.18**	**0.00690**	**4.22**	**3.28**	**-**
RSD [%]		**47**	**10**	**-**	**43**	**43**	**41**	**42**	**28**	**-**
OSPAR CEMP 2013 (OSPAR, 2014)										
ERL	**-**	**-**	**-**	**1.20**	**81.0**	**34.0**	**0.150**	**-**	**47.0**	**-**

Notes:
Concentrations expressed in µg/g dry sediment
Al = Aluminium As = Arsenic Cd = Cadmium Cr = Chromium Cu = Copper Hg = Mercury
Ni = Nickel Pb = Lead Sn = Tin
KP = Kilometre Point
ERL = Effects Range Low
RSD = Relative standard deviation
Where results were less than the minimum reporting value (MRV), summary statistics were calculated by assigning absolute values generated by MRV/2
* = Approximate KP from landfall at Loughshinny (segment 1.1)

Key:	Below ERL	Above ERL

6. SEDIMENT MACROFAUNA

6.1 Introduction

This section presents the results of the macrofaunal analysis of samples collected across the survey area. A total of six stations were sampled for macrofaunal content using a 0.1 m^2 dual van Veen grab. Appendix B provides full details of the analytical techniques employed.

The sediment macrofauna is defined as those animals living in or on the seabed that are retained on a sieve mesh of 1.0 mm. Before any analysis was undertaken, the reported macrofaunal dataset underwent rationalisation to prevent spurious enhancement of community statistics and allow comparison to historical datasets. Analysis was completed with juveniles removed from the dataset as juveniles are not considered part of the permanent community. Protists and any phyla considered meiofaunal or pelagic were also removed for this reason. Colonial epifauna (e.g. hydroids and bryozoans) and macroalgae could not be enumerated from the analysis so were also excluded from statistical analyses. Appendix F lists the records excluded from the analysis.

In order to focus the analysis of macrofaunal data on characterisation of the biotopes present along the surveyed route an initial multivariate analysis was undertaken to statistically define the different communities present (Section 6.2.1). The phyletic composition of these communities was then calculated (Section 6.2.2), characterising taxa identified (Section 6.2.3) and community structure quantified using a range of community statistics (Section 6.2.4). The results of the macrofaunal analysis are presented in the form of figures and tables, with the main features of the communities highlighted in the text. Appendix F presents the full list of taxa identified and the number enumerated (individuals per 0.1 m^2) from the surveyed route.

6.2 Results

6.2.1 Investigation of Faunal Similarities

Univariate statistics (Section 6.2.4) can summarise large and complex datasets to a certain extent, however, multivariate techniques will condense a large data matrix to a much more manageable form and compare each variable with all others in the process (Appendix B.3). In doing so, subtle trends in the data may be elucidated.

Various multivariable techniques were applied to the survey area data to investigate such patterns of similarity within the macrobenthic community, which were then further considered with the results from the univariate analyses.

Figures 6.1 and 6.2 present the multivariate statistical analyses of the community: hierarchical agglomerative clustering (CLUSTER) and non-metric multidimensional scaling (nMDS) from PRIMER.

6.2.1.1 Cluster Analysis

CLUSTER analysis groups stations according to their faunal similarity and the results are presented in the form of a dendrogram. Figure 6.1 presents the CLUSTER analysis dendrogram and demonstrates the pattern of similarity of square root transformed station data. The SIMPROF algorithm was used to identify statistically significant ($P = 0.05$) differences between stations, with significant splits depicted as black lines and non-significant splits as red lines.

The intra-station similarities along the proposed route ranged between 0.0 % and 58.0 %, indicative of a moderate to very high degree of variability within the macrofaunal communities. The dendrogram indicates that there were two statistically significant clusters and one ungrouped station:

- Cluster A, comprised three of the six stations, specifically stations LS_ST02, LS_ST03 and LS_ST04, grouped together with at least 53.6 % similarity to each other. These stations were located between KP 2.940 and KP 11.960 in water depths of 17 m BSL to 41 m BSL;
- Cluster B comprised stations LS_ST05 and CC05_ST01, which were 25.4 % similar to each other and shared a group average similarity of 21.0 % with cluster A. Stations LS_ST05 and CC05_ST01 were the furthest offshore of the stations sampled (located at KP 20.570 and KP 55.220, respectively) in water depths of 66 m BSL and 81 m BSL, respectively;
- Ungrouped station LS_ST01 was 10.6 % similar to all other stations. This station was located at the nearshore end of the proposed route (KP 1.120) in a water depth of 9 m BSL.

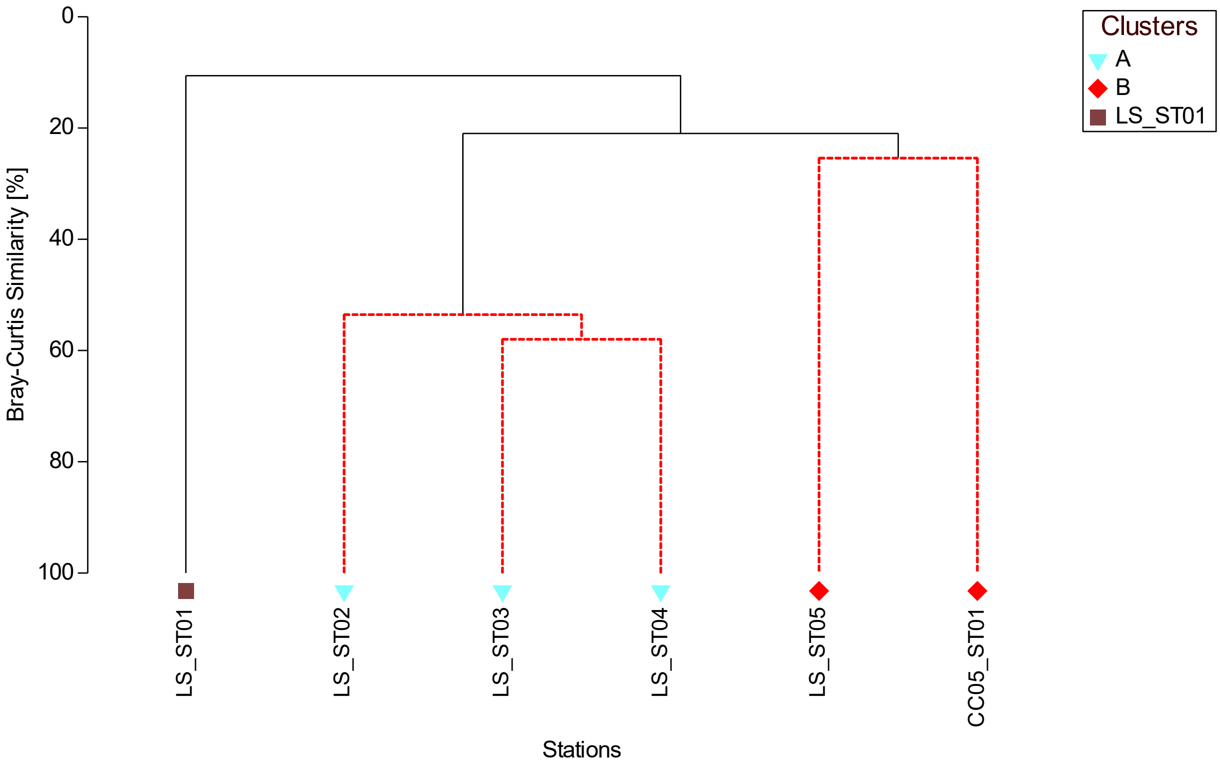


Figure 6.1: Classification by Bray-Curtis similarity for square root transformed macrofaunal abundance station (0.1 m^2) data, Havhingsten cable route, Ireland

6.2.1.2 <u>Non-metric Multidimensional Scaling (nMDS)</u>

Figure 6.2 displays the results of the nMDS, which is an ordination technique that arranges stations on a two-dimensional plot, so that their relative distances from each other reflect their faunal similarities. The stress coefficient of 0 indicates an excellent ordination of the intra-station similarities within the dataset, with little chance of misinterpretation (Clarke and Warwick, 2001). This plot clearly shows the moderate level of similarity between the cluster A stations, the loose association between the cluster B stations and the fact that the ungrouped station LS_ST01 is clearly different from the two clusters.

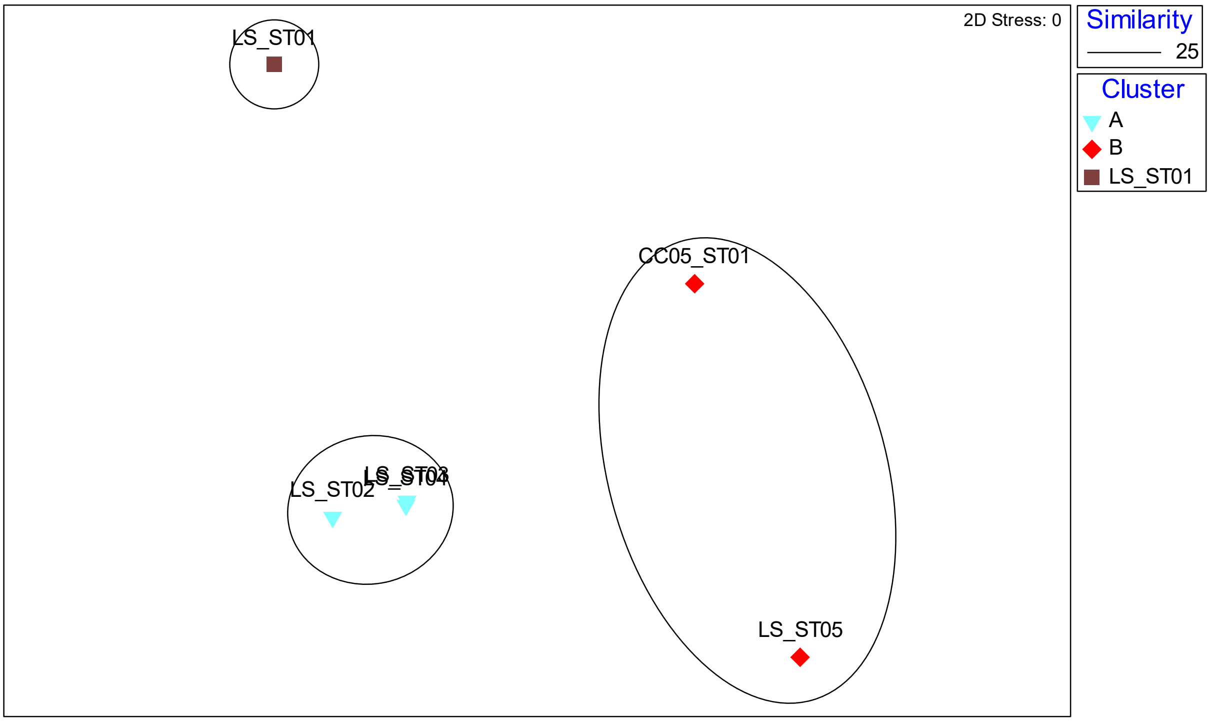


Figure 6.2: Non-metric multidimensional scaling (nMDS) orientation by Bray-Curtis for square root transformed macrofaunal abundance station (0.1 m^2) data, Havhingsten cable route, Ireland

6.2.2 Phyletic Composition

Table 6.1 summarises the abundance of taxonomic groups identified across the survey area and Figures 6.3 and 6.4 display the data graphically. The phyletic composition for each of the clusters identified has been calculated (the mean phyletic composition of the clusters' constituent stations) and this is contrasted with the phyletic composition of the entire dataset.

Over all of the stations sampled within the Irish section of the Havhingsten cable route, a total of 130 taxa and 960 individuals were identified. Of these taxa, 34 were representative of protozoan, meiofaunal, pelagic or juvenile specimens or of colonial epifauna or algae; to avoid spurious enhancement of diversity indices, the dataset was rationalised, and these taxa removed, prior to statistical analysis (Appendix F). The rationalised data comprised 96 benthic taxa, of which 47 (49.0 %) were annelids, 28 (29.2 %) were molluscs, 10 (10.4 %) were arthropods, 4 (4.2 %) were echinoderms and 7 (7.3 %) were representative of other phyla. A total of 877 individual animals were identified in the rationalised data, of which 347(39.6 %) were molluscs, 226 (25.8 %) were echinoderms, 217 (24.7 % were annelids 14 (1.6 %) were arthropods and 73 (8.3 %) belonged to other phyla (Table 6.1).

Although annelids contributed the highest number of taxa within Cluster A (mean of 16 taxa (43.5 %) across its three constituent stations) the Mollusca and Echinodermata contributed the highest abundance of individuals. Across the three stations sampled the Mollusca contributed a mean of 12 taxa per station (32.4 %), with mean abundance of 78 individuals per station (34.6 %). The Echinodermata contributed a mean number of taxa of only 2 per station (6.5 %), with a mean abundance of 75 individuals per station (33.3 %). Representatives of other phyla contributed a mean abundance of 21 individuals (9.3 %) of 4 taxa (10.2 %) per station and arthropods were poorly represented within the community, contributing a mean abundance of 2 individuals (2.7 %) of 2 taxa (5.4 %) per station.

Within cluster B, the Annelida again contributed the highest number of taxa (mean of 16 taxa; 43.5 %), but in contrast to cluster A, also comprised a significant proportion of the total abundance (mean of 49 individuals; 42.0 %). Despite this, the Mollusca were again the most abundant phylum overall, with a mean of 36 individuals (48.0 %) of 8 taxa recorded from the Cluster B stations. Arthropods, echinoderms and other phyla made up relatively small proportions of the cluster B community, with mean contributions of 3 or fewer taxa and 5 or fewer individuals.

Molluscs were numerically-dominant at the ungrouped station LS_ST01 contributing 41 individuals (80.4 %) and 4 taxa (36.4 %). Annelids contributed 8 individuals (15.7 %) of 6 taxa (54.5 %) and arthropods 2 individuals (3.9 %) of 1 taxon (9.1 %). Echinoderms and representatives of other phyla were absent from station LS_ST01.

Table 6.1: Taxonomic Groups, Havhingsten Cable Route, Ireland

Taxonomic Group	Number of Taxa	Composition of Taxa [%]	Abundance	Composition of Abundance [%]
Overall				
Annelida	47	49.0	217	24.7
Arthropoda	10	10.4	14	1.6
Mollusca	28	29.2	347	39.6
Echinodermata	4	4.2	226	25.8
Other Phyla	7	7.3	73	8.3
Total	**96**	**100**	**877**	**100**
Cluster A (Stations LS_ST02, LS_ST03 and LS_ST04)				
Annelida	16	43.5	49	21.6
Arthropoda	3	7.4	3	1.2
Mollusca	12	32.4	78	34.6
Echinodermata	2	6.5	75	33.3
Other Phyla	4	10.2	21	9.3
Total	**36**	**100**	**225**	**100**
Cluster B (Stations LS_ST05 and CC05_ST01)				
Annelida	16	55.4	32	42.0
Arthropoda	2	5.4	2	2.7
Mollusca	8	26.8	36	48.0
Echinodermata	1	1.8	1	0.7
Other Phyla	3	10.7	5	6.7
Total	**28**	**100**	**75**	**100**
Ungrouped Station LS_ST01				
Annelida	6	54.5	8	15.7
Arthropoda	1	9.1	2	3.9
Mollusca	4	36.4	41	80.4
Total	**11**	**100**	**51**	**100**

Notes:
Other phyla include: Cnidaria, Turbellaria, Nemertea, Sipuncula and Phoronida
Macrofaunal sample were processed through a 1.0 mm sieve

Figures 6.3 and 6.4 illustrate the phyletic composition of taxa and individuals for each cluster (per 0.1 m^2). Figure 6.3 shows the broadly similar contribution to the number of taxa made by annelids, arthropods and molluscs in the two clusters and at the ungrouped station and the broadly similar mean proportions of echinoderm taxa and taxa from other phyla within clusters A and B. Figure 6.4 clearly illustrates the differences in the phyletic composition of abundance between the clusters and ungrouped station. The numerical dominance of echinoderms in cluster A, which comprised half of the stations sampled, leads to these contributing the second highest proportion of the total abundance recorded along the surveyed route. The dominance, or codominance, of molluscs in both clusters and at the ungrouped station LS_ST01 is also clearly apparent, with this leading to these making the greatest contribution to the total abundance sampled along the route.

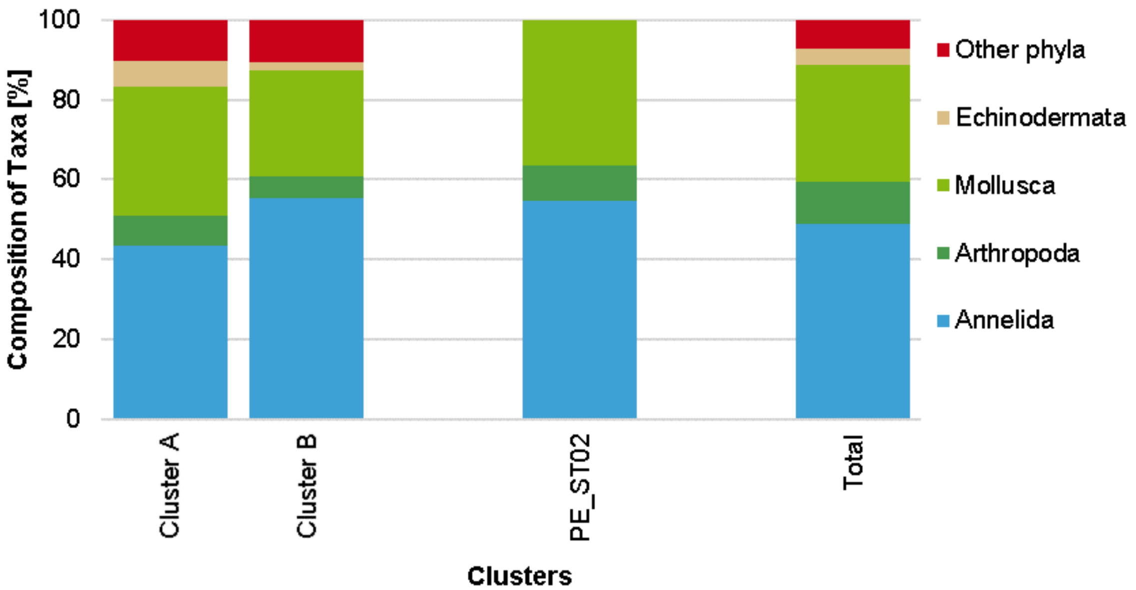


Figure 6.3: Phyletic composition of taxa, Havhingsten cable route, Ireland

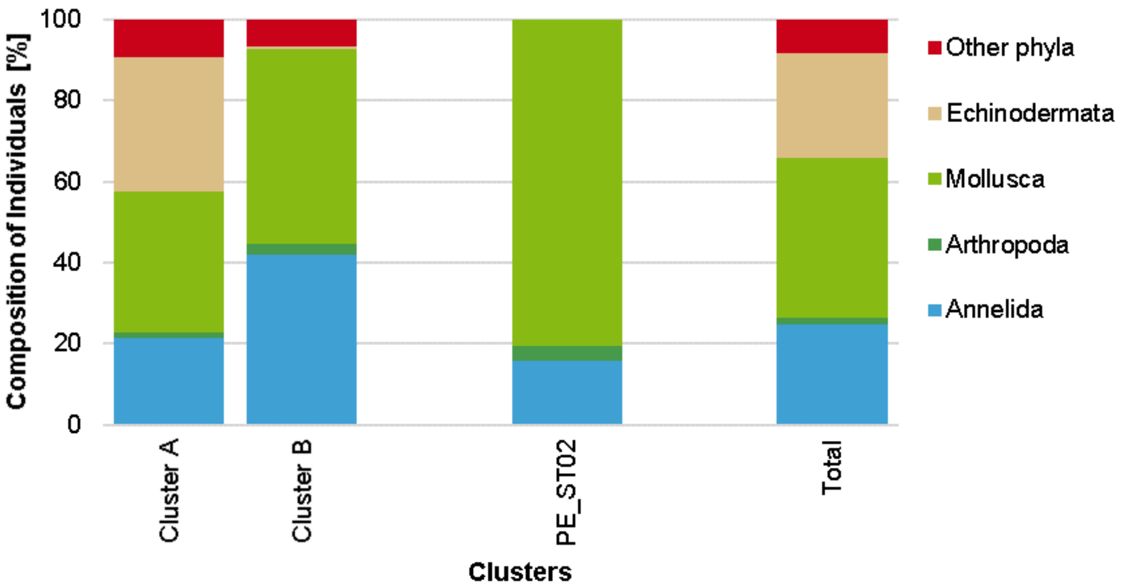


Figure 6.4: Phyletic composition of abundance, Havhingsten cable route, Ireland

6.2.3 Characteristic Taxa

Table 6.2 presents the dominant taxa within the Irish section of the Havhingsten cable route overall and within each of the macrofaunal clusters identified. The top ten most abundant taxa over the overall area are presented and the top five taxa within each cluster.

Members of several phyla were represented within the top ten most abundant taxa within the overall community of the Irish section of the Havhingsten cable route. The most abundant taxon was the brittlestar (echinoderm) *Amphiura filiformis*, which occurred at a mean abundance of 36 individuals per station and was recorded from half of the stations sampled. The bivalve mollusc *Kurtiella bidentata* and polychaete *Diplocirrus glaucus* both occurred at four stations (66.7 % frequency of occurrence) and were recorded at mean abundances of 23 and 10 individuals per station, respectively. The remaining dominant taxa all occurred at mean abundances of 7 or fewer individuals per station and comprised the horseshoe worm (phoronid) *Phoronis* sp., four bivalve molluscs (*Nucula nitidosa*, Abra alba, *Corbula gibba* and *Thyasira flexuosa*) and two polychaetes (*Pholoe baltica* and *Galathowenia oculata*).

The top five taxa of cluster A were the same as those of the survey area overall (Table 6.2); this was due to the fact that this cluster comprised three of the six stations sampled and represented the richest infaunal community (Section 6.2.4). All of the top five taxa were recorded from all of its constituent stations (100 % frequency of occurrence) and there were 7 other taxa within this cluster that also occurred at all stations (Appendix F). The most abundant taxon within the cluster, *A. filiformis*, occurred at mean abundance of 72 individuals per station, followed by *K. bidentata* (45 individuals per station), *D. glaucus* (19 individuals per station), *Phoronis* sp. (14 individuals per station) and *N. nitidosa* (10 individuals per station).

The cluster B community had a noticeably lower abundance of fauna than cluster A (Section 6.2.4) and its dominant taxa were distinctly different from that of cluster A and the survey area overall. The cluster comprised two stations and its top five taxa were clearly not evenly distributed, with most of those listed only occurring at one of the two stations (frequency of occurrence of 50.0 %). The most abundant taxon in this cluster was the bivalve *Thyasira flexuosa*, which occurred at a mean abundance of 8 individuals per station. The second and third most abundant taxa were also bivalve molluscs, with *Abra nitida* occurring at a mean abundance of 7 individuals per station and *N. nitidosa* at a mean abundance of 5 individuals per station. The remaining taxa comprised two additional bivalves (*Ennucula tenuis* and *Abra alba*) and two polychaetes (*Notomastus* sp. and *Mediomastus fragilis*).

The ungrouped station LS_ST01 was dominated by *A. alba*, which occurred at an abundance of 34 individuals. The remaining top five taxa occurred at relatively low abundances of between 2 and 4 individuals and comprised the bivalves *N. nitidosa* and *K. bidentata*, the polychaete *Nephtys hombergii* and the amphipod crustacean *Ampelisca brevicornis*. Only six other taxa were recorded from this station and all occurred at abundances of 1 individual (Appendix F).

Table 6.2: Dominant Taxa by Rank Abundance and Frequency, Havhingsten Cable Route, Ireland

Taxon	Rank Abundance	Mean Station Abundance [0.1 m^2]	Frequency* [%]
Overall			
Amphiura filiformis	1	36	50.0
Kurtiella bidentata	2	23	66.7
Diplocirrus glaucus	3	10	66.7
Phoronis sp.	4	7	66.7
Nucula nitidosa	5	7	83.3
Abra alba	6	7	50.0
Corbula gibba	7	5	66.7
Pholoe baltica (sensu Petersen)	8	4	66.7
Thyasira flexuosa	8	4	66.7
Galathowenia oculata	10	3	83.3
Cluster A (Stations LS_ST02, LS_ST03 and LS_ST04)			
Amphiura filiformis	1	72	100
Kurtiella bidentata	2	45	100
Diplocirrus glaucus	3	19	100
Phoronis sp.	4	14	100
Nucula nitidosa	5	10	100
Cluster B (Stations LS_ST05 and CC05_ST01)			
Thyasira flexuosa	1	8	50.0
Abra nitida	2	7	100
Nucula nitidosa	3	5	50.0
Notomastus sp.	4	4	100
Mediomastus fragilis	5	4	50.0
Ennucula tenuis	5	4	50.0
Abra alba	5	4	50.0
Ungrouped Station LS_ST01			
Abra alba	1	34	-
Nucula nitidosa	2	4	-
Nephtys hombergii	3	3	-
Ampelisca brevicornis	4	2	-
Kurtiella bidentata	5	2	-
Notes: * = Percentage of the stations from which the taxa were recorded			

6.2.4 Community Statistics

Table 6.3 presents the number of taxa and individuals identified from each station along with several commonly used diversity and evenness indices. Summary statistics (minima, maxima, means, standard deviations and RSD) are presented for the Irish section of the Havhingsten cable route as a whole and for each of the macrofaunal clusters differentiated by the multivariate analysis.

Across the Irish section of the Havhingsten cable route as a whole the number of taxa per 0.1 m^2 ranged from 11 (station LS_ST01) to 40 (station SG_ST09), with a mean of 29. The number of individuals per 0.1 m^2 ranged from 24 (station LS_ST05) to 326 (station LS_ST02), with a mean of 146 across the survey area. There was moderate variability in the number of taxa (RSD 43 %) and high variability in the number of individuals (RDS 77 %) along the route.

Across the route as whole mean diversity could be considered good, when based on the mean Shannon-Wiener diversity index (H'Log$_2$) calculated for all stations (3.57) and referenced to the five ecological statuses outlined in Dauvin et al. (2012), classified as: bad if 0.00 to 1.00, poor if 1.00 to 2.00, moderate if 2.00 to 3.00, good if 3.00 to 4.00 and high if ≥ 4.00. Values of the Shannon-Wiener index ranged between 1.13 (station LS_ST01) and 4.75 (station CC05_ST01) and showed strong association with the Brillouin index of diversity which ranged from 1.13 to 2.89 (at the same stations). The variability of diversity across the survey area was moderate (RSD 27 % and 28 % for the two measures used).

The Pielou's index of evenness ranged between 0.564 (station LS_ST01) and 0.943 (station LS_ST05), with a mean of 0.754 across the survey area, and showed low variability across the survey area (RSD 21 %). The high Pielou's index value at station LS_ST05 was associated with the low numbers of taxa and individuals at this station, which resulted in an equitable spread of the faunal abundance across the taxa present, whereas the low value at station LS_ST01 was associated with numerical dominance of *A. alba* (abundance of 34 individuals) in a community which contained only 11 taxa. The Simpson's index of evenness (expressed as 1 – λ, i.e. the complement of dominance), ranged from 0.551 (station LS_ST01) to 0.957 (station CC05_ST01), with a mean of 0.836.

The variability within the number of taxa and diversity and evenness statistics calculated for cluster A was low (RSD ≤15 %), but variability in abundance was moderate (RSD 44 %). Of the clusters identified cluster A had the highest number of taxa (mean of 36 taxa) and highest abundance (mean of 225 individuals). It's mean diversity (mean Shannon-Wiener diversity of 3.65) was good (Dauvin et al., 2012) and evenness moderate (mean Pielou's evenness of 0.707 and Simpson's index of 0.852). Due to the numerical dominance of characteristic taxa such as *A. filiformis* (mean of 72 individuals per station) and *K. bidentata* (mean of 45 individuals per station) the diversity and evenness within cluster A were however, lower than recorded from cluster B.

Within cluster B the number of taxa (16 to 40 taxa) and abundance (24 to 126 individuals) were highly variable (RSD 61 % and 96 %, respectively), however derived measures of diversity and evenness showed low to moderate variability (RSD 0 % to 27 %). The equitable distribution of abundance across the taxa present at its two constituent stations resulted in this cluster having high mean diversity (mean Shannon-Wiener diversity of 4.26) and evenness (mean Pielou's evenness of 0.917 and Simpson's index of 0.955).

The ungrouped station LS_ST01 had the lowest number of taxa (11 taxa) of all stations sampled and second lowest abundance (51 individuals). The aforementioned dominance of *A. alba* at this station resulted in the minima of all derived diversity and evenness indices being calculated for this station.

Table 6.3: Macrofaunal Community Statistics (0.1 m²), Havhingsten Cable Route, Ireland

Station	Numbers		Diversity Indices		Evenness	
	Taxa [S]	Individuals [N]	Shannon-Wiener [H'Log2]	Brillouin [Hb]	Pielou [J]	Simpson [1-λ]
LS_ST01	11	51	1.95	1.13	0.564	0.551
LS_ST02	35	326	3.19	2.07	0.622	0.796
LS_ST03	40	222	3.57	2.26	0.672	0.842
LS_ST04	33	128	4.18	2.57	0.828	0.918
LS_ST05	16	24	3.77	1.97	0.943	0.953
CC05_ST01	40	126	4.75	2.89	0.892	0.957
Overall						
Minimum	**11**	**24**	**1.95**	**1.13**	**0.564**	**0.551**
Maximum	**40**	**326**	**4.75**	**2.89**	**0.943**	**0.957**
Mean	**29**	**146**	**3.57**	**2.15**	**0.754**	**0.836**
Standard Deviation	**13**	**112**	**0.95**	**0.60**	**0.155**	**0.153**
RSD [%]	**43**	**77**	**27**	**28**	**21**	**18**
Cluster A (Stations LS_ST02, LS_ST03 and LS_ST04)						
Minimum	**33**	**128**	**3.19**	**2.07**	**0.622**	**0.796**
Maximum	**40**	**326**	**4.18**	**2.57**	**0.828**	**0.918**
Mean	**36**	**225**	**3.65**	**2.30**	**0.707**	**0.852**
Standard Deviation	**4**	**99**	**0.50**	**0.25**	**0.108**	**0.062**
RSD [%]	**10**	**44**	**14**	**11**	**15**	**7**
Cluster B (Stations LS_ST05 and CC05_ST01)						
Minimum	**16**	**24**	**3.77**	**1.97**	**0.892**	**0.953**
Maximum	**40**	**126**	**4.75**	**2.89**	**0.943**	**0.957**
Mean	**28**	**75**	**4.26**	**2.43**	**0.917**	**0.955**
Standard Deviation	**17**	**72**	**0.69**	**0.65**	**0.036**	**0.003**
RSD [%]	**61**	**96**	**16**	**27**	**4**	**0**

Notes:
RSD = Relative standard deviation

7. BENTHIC HABITATS AND BIOTOPES

7.1 Introduction

To assess the habitats and biotopes present within the survey area, detailed analysis of video and stills photography data were undertaken by experienced Fugro marine biologists/taxonomists. Video photography data were reviewed in conjunction with the still photographs, noting the locations of any observed changes in sediment type and/or associated faunal community.

Appendix C.3 provides the detailed video and photographic log. Appendix G provides example seabed photographs.

Seabed substrata were logged based on the seabed video/photographic data. For the purpose of habitat classification, descriptions are based on the BGS modified Folk classification (Long, 2006), which uses the descriptive terms ‘mud’, ‘sand’ and ‘gravel’ in combination, depending on the estimated proportions of each component. For example, a description of ‘muddy sand’ defines sediment that has sand as the principle component and a mud proportion of between > 10 % and < 50 % Further descriptive terms have been used to better describe the observations where necessary, such as ‘shell fragments’. Any anthropogenic features evident were also recorded.

Seabed substrata observations were then linked to the particle size data (Section 4.2) to provide further detail regarding the composition of sediment areas. The PSD analysis categorised sediment granulometry into ‘gravel’, ‘sand’ and ‘fines’ fractions, with fines referred to as mud within this section of the report.

Epifaunal communities were described from the video/photographic data and the macrofaunal data (Section 6.2.4) were utilised to provide detailed information regarding infaunal community structure.

7.1.1 Seabed Habitats Classification

Habitats within the survey area have been classified in accordance with the hierarchical EUNIS habitat classification (EUNIS, 2012), which has compiled habitat information from across Europe into a single database. The equivalent classification from ‘The Marine Habitat Classification for Britain and Ireland – Version 15.03’ (JNCC, 2015) was also noted, along with the classification from ‘A Guide to Habitats in Ireland’ (Fossitt, 2000).

Although, theoretically, a biotope can be assigned to any sized area of seabed, for the purposes of this assessment the commonly accepted minimum habitat size of 25 m^2 (JNCC, 2015) was adopted.

7.1.2 Sensitive Habitats and Species Assessments

Section 1.4 details the sensitive habitats and species for which protected areas have been designated within 25 km of the Irish section of the Havhingsten cable route (summarised in Table 1.1). All data (video/photographic and grab sample data) were reviewed in detail to assess the potential presence of these habitats and species.

To better assess key habitats of concern, assessment protocols have been developed by regulatory bodies. Sections 7.1.2.1 to 7.1.2.2 detail the sensitive habitat assessments utilised in this report.

7.1.2.1 Sea Pens and Burrowing Megafauna Communities

Following an initial assessment of the seabed video and photographs, a full assessment would be performed if faunal burrows were present. To assess the abundance and density of sea pens and burrowing megafauna, the numbers of each species and burrows visible in each video transect would be counted. The total area of view along the video was calculated and used to convert the number of sea pens and burrows to the SACFOR (Super-abundant, Abundant, Common, Frequent, Occasional, Rare) semi-quantitative abundance scale used by Marine Nature Conservation Review and JNCC to record the abundance and density of marine benthic flora and fauna (JNCC, 2017b). When assessing density, the SACFOR scale considers the size of the species being assessed, using size classes to group species, although the guidance provided in Connor et al. (2004) suggests the species take precedence over their actual size in deciding which scale to use. The slender sea pen (*V. mirabilis*) and the phosphorescent sea pen (*P. phosphorea*) were classed as 3 cm to 15 cm (Greathead et al., 2011; Allan et al., 2012, Connor et al., 2004), whilst the tall sea pen (*F. quadrangularis*) was classed as > 15 cm (Connor et al., 2004). The Norway lobster (*N. norvegicus*) has also been listed as > 15 cm in Connor et al. (2004), however, megafauna responsible for creating burrows may also include the mud shrimps *C. subterranea* and *C. macandreae* (JNCC, 2014a). Both of which are described as burrowers sized between 3 cm and 10 cm (MarLIN, 2015a; 2015b). Due to the difficulties of identifying species from burrow type, the size class of 3 cm to 15 cm was used to allow for the size variation of possible species responsible for creating the burrows. Using the visible laser scale, the calculated average width of view along the video transects was approximately 2 m. Table 7.1 summarises the size classes applied to each species and the SACFOR scale conversion used.

Table 7.1: The SACFOR Scale used for Sea Pen and Burrow Density Assessment

SACFOR Scale	Individuals per m²			
	3 cm to 15 cm*		> 15 cm†	
Super-abundant	100.0 – 1000.0	1–9/0.01 m² (10 × 10 cm)	10.0 – 99.0	1–9/0.1 m²
Abundant	10.0 – 99.0	1–9/0.1 m²	1.0 – 9.0	1–9/m²
Common	1.0 – 9.0	1–9/ m²	0.1 – 0.99	1–9/10 m² (3.16 × 3.16 m)
Frequent	0.1 – 1.0	1–9/10 m² (3.16 × 3.16 m)	0.01 – 0.09	1–9/100 m² (10 × 10 m)
Occasional	0.01 – 0.09	1–9/100 m² (10 × 10 m)	0.001 – 0.009	1–9/1000 m² (31.6 × 31.6 m)
Rare	0.001 – 0.009	1–9/1000 m² (31.6 × 31.6 m)	0.0001 – 0.0009	< 1/1000 m²

Notes:
SACFOR = Super-abundant, Abundant, Common, Frequent, Occasional, Rare
* = 3 cm to 15 cm: *Pennatula phosphorea*, *Virgularia mirabilis*, megafaunal burrows
† = > 15 cm: *Funiculina quadrangularis*

To confirm this habitat type, sightings of burrows and/or mounds must be present as at least 'frequent' abundance on the SACFOR scale (JNCC, 2014).

7.1.2.2 Annex I Geogenic Reef – Stony Reef

When considering the potential of an area as geogenic reef, the composition of the substrate is an important characteristic. Stony reef is defined as comprising coarse sediments with a diameter greater than 64 mm (cobbles and boulders) that provide a hard substratum. The relationship between the coarse material and sediment in which it lies is integral in determining ‘reefiness’. Matrix (soft sediment) supported material is likely to have a patchier distribution than clast (coarse sediment) supported and so have lower ‘reefiness’, additionally matrix supported material is likely to have a larger infaunal component which again reduces its ‘reefiness’ (Irving, 2009). Reefs are also defined as having relief from the seafloor, and as such relief is used as another criterion for assessment. The epifaunal community of potential reef habitat is also a key determinant of its ‘reefiness’; therefore percentage cover of fauna is included as an assessment criterion. Within the Irving (2009) scheme, areas of potential stony reef habitat must have an area of greater than 25 m^2 to be classified as reef; this report also adopts this minimum area. Table 7.2 summarise these criteria. During the video interpretation, habitat transitions (i.e. changes in sediment type and/or bedform) were logged.

Table 7.2: Measures of 'Reefiness' of the Stony Reef Habitat

	‘Reefiness’*			
Characteristic	**Not a Reef**	**Low**	**Medium**	**High**
Cover of cobbles and boulders	< 10 %	10 % – 40 %	> 40 % – 95 %	> 95 %
Elevation above seabed	Flat seabed	< 64 mm	64 mm – 5 m	> 5 m
Cover of visible epifauna	Predominately infaunal species	NA		> 80 %
Colour Coding:				

Notes:
* = ‘Reefiness’ criteria proposed by JNCC (Irving, 2009)
† = Diameter > 64 mm

7.2 Results

7.2.1 Benthic Habitat and Biotope Classification

Statistical analysis of the infaunal data from grab sample stations undertaken during the survey indicated two statistically significant clusters of stations and one ungrouped station (Table 7.3).

Table 7.3: Summary of Macrofaunal Community CLUSTER Analysis Groupings, Havhingsten Cable Route, Ireland

Cluster A	Cluster B	Ungrouped Station
LS_ST02 LS_ST03 LS_ST04	LS_ST05 CC05_ST01	LS_ST01

The PSD and macrofaunal analysis results, together with the video analysis results, have been used to allocate a biotope to each survey location. Soft sediment habitats are often defined on the sediment type and infaunal community composition. Therefore, soft sediments within the survey area have been predominantly classified using the PSD and macrofaunal data, with the video analysis results providing additional habitat information. Habitats comprising hard substrates, where grab sampling was not achieved, have been classified using video analysis data only.

Table 7.4 presents the habitat and biotope classification hierarchy for the Irish section of the Havhingsten cable route.

Table 7.4: Habitat Classification Hierarchy, Havhingsten Cable Route, Ireland

EUNIS (2012) Habitat Classification					**Equivalent JNCC Habitat Classification (JNCC, 2015)**	**Equivalent Irish Habitat Classification (Fossitt, 2000)**
Environment	**Broad Habitat**	**Habitat**	**Biotope Complex**	**Biotope**		
Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
A Marine habitats	A4 Circalittoral rock and other hard substrata	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.21 Echinoderms and crustose communities on circalittoral rock	-	CR.MCR.EcCr Echinoderms and crustose communities on circalittoral rock	SR5 Moderately exposed circalittoral rock
	A5 Sublittoral sediment	A5.2 Sublittoral sand	A5.26 Circalittoral muddy sand	-	SS.SMu.CMuSa Circalittoral muddy sand	SS6 Circalittoral muddy sand
				A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	SS.SSa.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	
		A5.3 Sublittoral mud	A5.35 Circalittoral sandy mud	A5.351 *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit *Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud	SS7 Circalittoral muds

Notes:
EUNIS = European Nature Information Service
JNCC = Joint Nature Conservation Committee

7.2.2 Biotope Descriptions

Table 7.5 summarise the habitats and biotopes observed, including details of their distribution and physical and biological characteristics, along with example photographs. Biotopes assigned are relevant to the time of year, with this survey completed in winter. Sections 7.2.2.1 to 7.2.2.4 detailed descriptions of each biotope. Appendix G provides further example photographs. Figure 7.1 spatially presents the extrapolated distribution of the habitats defined along the Irish section of the Havhingsten cable route. Two biotope complexes and two biotopes assigned to the stations surveyed.

Table 7.5: Summary of Benthic Biotope Characteristics, Havhingsten Cable Route, Ireland

Example Photograph	Distribution	Physical Characteristics	Dominant Taxa
Biotope A4.21: Echinoderms and crustose communities on circalittoral rock			
	**Stations:** - **Transects:** LS_ST01A **KP:** 1.120	**Sediment type:** Boulder/bedrock outcrops with sand **Water Depth:** Circalittoral 7 m to 8 m BSL	**Infauna:** - **Epibiota:** Starfish (*Asterias rubens*), Anemones (including *Metridium* sp.) Red seaweed (including *Palmaria palmata*), Faunal turf (Hydrozoa/ Bryozoa) Tube worms (Serpulidae)
Biotope complex A5.26: Circalittoral muddy sand			
	**Stations:** LS_ST05, CC05_ST01 **Transects:** CC05_T01, CC05_T02 **KP:** 20.570 to 55.220	**Sediment type:** Muddy sand **Water Depth:** Circalittoral 66 m to 82 m BSL	**Infauna:** **Cluster B** Bivalves (*Abra nitida, Thyasira flexuosa, Nucula nitidosa*) Polychaetes (*Nephtys incisa, Notomastus* sp.) Worm (*Phoronis* sp.) **Epibiota:** Hermit crabs (Paguridae) Sea pen (*Virgularia mirabilis*) Norway lobster (*Nephrops norvegicus*) Cat shark (*Scyliorhinus canicula*) Worm tubes (Polychaeta)
Biotope A5.261: ***Abra alba*** **and** ***Nucula nitidosa*** **in circalittoral muddy sand or slightly mixed sediment**			
	**Stations:** LS_ST01 **Transects:** LS_ST01A **KP:** 1.120	**Sediment type:** Muddy sand **Water Depth:** Circalittoral 8 m BSL	**Infauna:** **Ungrouped station LS_ST01** Bivalves (*Abra alba, Nucula nitidosa, Kurtiella bidentata*) Polychaetes (*Nephtys hombergii*) **Epibiota:** Hermit crab (Paguridae)

Example Photograph	Distribution	Physical Characteristics	Dominant Taxa
Biotope A5.351: ***Amphiura filiformis, Kurtiella bidentata*** **and** ***Abra nitida*** **in circalittoral sandy mud**			
	**Stations:** LS_ST02 LS_ST03 LS_ST04 **KP:** 2.940 to 11.960	**Sediment type:** Muddy sand or slightly gravelly muddy sand **Water Depth:** Circalittoral 17 m to 41 m BSL	**Infauna:** **Cluster A** Brittlestar (*Amphiura filiformis*) Bivalves (*K. bidentata, N. nitidosa,*) Polychaete (*Diplocirrus glaucus*) Horseshoe worm (*Phoronis* sp.) **Epibiota:** Hermit crab (Paguridae) Anemone (Actiniaria, including *Metridium* sp.) Brittlestar (Ophiuroidea) Fish (Gadidae)
Notes: KP = Kilometre point BSL = Below sea level * = Approximate KP from landfall at Loughshinny (segment 1.1)			

7.2.2.1 A4.21: Echinoderms and Crustose Communities on Circalittoral Rock

The ‘Echinoderms and crustose communities’ (A4.21) biotope complex is described as occurring on wave-exposed, moderately strong to weakly tide-swept, circalittoral bedrock and boulders. Echinoderms, faunal and algal crusts dominate this biotope complex, giving a sparse appearance (EUNIS, 2012).

This biotope complex was recorded along two short sections of transect LS_ST01A, with its distribution, as ground-truthed by seabed photography, clearly corresponding to SSS data that delineated bedrock outcrops and/or boulder fields extending from the headland to either side of Loughshinny Bay (Figure 7.1). The biotope complex was identified at approximately KP 1.120 in water depths of 7 m to 8 m BSL. Although such shallow depths would often be considered infralittoral (i.e. within the zone of light penetration, where algal communities dominate the epibiota), the minimal algal cover present suggested that the seabed received little light and should therefore be considered circalittoral. The high levels of turbidity evident during camera operations likely limit light penetration to the seabed communities.

Video and still photographic data from this biotope complex identified bedrock outcrops of various morphologies, ranging from steep sided to flat, with what appeared to be sediment isolated boulders. Many of the surfaces were covered with a thin layer of sediment (mud or muddy sand) and similar sediments were identified in low lying areas between the outcropping rocks/boulders.

Consistent with the EUNIS (2012) description of this biotope complex, faunal cover was sparse. The most prominent taxa were the plumose sea anemone *Metridium* sp., the starfish *Asterias rubens* and faunal turf, thought to comprise hydroids (Hydrozoa) and/or bryozoans (Bryozoa). Occasional polychaetes (Serpulidae) were recorded, along with a sponge (Porifera, possibly *Haliclona* sp.). The only macroalgae present were red seaweeds (Rhodophyceae), including *Palmaria palmata*; the presence of only red seaweeds is considered indicative of low light levels, as their distribution extends to greater depths than green or brown seaweed.

Although the rock community encountered during the survey could not be classified to biotope level, some of the constituent fauna do occur in the EUNIS biotope 'Cushion sponges and hydroids on turbid tide-swept sheltered circalittoral rock' (A4.251). However, application of this biotope was not considered appropriate, as the community encountered lacked the sponge taxa characteristic of the biotope.

Due to the presence of cobble and/or boulder substrata within this biotope complex, it has been assessed to determine its potential as the Annex I habitat 'Geogenic reef' (Section 7.1.2.2).

7.2.2.2 A5.26: Circalittoral Muddy Sand

The 'Circalittoral muddy sand' (A5.26) biotope complex characterises circalittoral non-cohesive muddy sands with the silt content of the substratum typically ranging from 5 % to 20 %. This habitat is generally found in water depths of over 15 m to 20 m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves and echinoderms (EUNIS, 2012).

During the current survey, this biotope complex was recorded across the offshore sections of the proposed cable route, extending between stations LS_ST05 and CC05_ST01 (KP 20.570 to KP 55.220). Water depths at these stations ranged between 66 m and 81 m BSL. Sediments within this biotope complex were found to comprise muddy sand, with between 31.6 % and 43.0 % mud content (higher than typical for the biotope complex) and little or no gravel.

The infaunal community recorded from this biotope complex was characterised by cluster B of the multivariate analysis of macrofauna data (Section 6.2.1). Although the two stations within this biotope complex were statistically grouped by the analysis undertaken, they shared relatively few dominant taxa, with only the bivalve *A. nitida* and polychaete *Notomastus* sp. recorded at notable abundance (four or more individuals) from both stations. This suggested that the two stations may represent different communities within the A5.26 biotope complex. The macrofaunal sample analysed from station LS_ST05 comprised a lower abundance of individuals (24) and fewer taxa (16) than were recorded from station CC05_ST01. The dominant taxa at station LS_ST05 were the polychaete *Nephtys incisa* and horseshoe worm *Phoronis* sp. At station CC05_ST01, 126 individuals of 40 taxa were recorded and the dominant taxa were the bivalves *T. flexuosa*, *A. nitida* and *N. nitidosa*. The station CC05_ST01 community bore some resemblance to the EUNIS biotope '*Thyasira* spp. and *Nuculoma tenuis* in circalittoral sandy mud' (A5.352) but contained only a low abundance of *Ennucula tenuis* (currently recognised synonym of *N. tenuis*).

The epifauna present in this biotope complex comprised hermit crabs (Paguridae, including *Pagurus bernhardus*), sea pens (*Virgularia mirabilis*), Norway lobsters (*Nephrops norvegicus*), lesser-spotted cat sharks (*Scyliorhinus canicula*) and worm tubes (Polychaeta).

Due to the presence of *V. mirabilis*, *N. norvegicus,* and burrows formed by *N. norvegicus* or other burrowing crustacea, occurrences of this biotope complex have been assessed to determine whether they could be considered as the OSPAR (2008) threatened and/or declining habitat 'Seapens and burrowing megafauna communities' (Section 7.2.3.1).

7.2.2.3 A5.261: *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment

The biotope '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (A5.261) is defined by EUNIS (2012) as areas of non-cohesive muddy sands or slightly shelly/gravelly muddy sand characterised by the bivalves *A. alba* and *N. nitidosa*.

Along the Irish section of the Havhingsten cable route, this biotope was only recorded from station LS_ST01, which was located at KP 1.120 in a water depth of 8 m BSL. The biotope is expected to extend into Loughshinny bay itself and possibly slightly further offshore from station LS_ST01 (Figure 7.1). The sediment at station LS_ST01 comprised muddy sand (40.6 % mud content).

Station LS_ST01 was an ungrouped station within the multivariate analysis of macrofauna data (Section 6.2.1). The bivalve *A. alba* was dominant (abundance of 34 individuals); other characterising taxa occurred at lower abundance (four or fewer individuals) and included the bivalves *N. nitidosa* and *K. bidentata*, the polychaete *N. hombergii* and the amphipod *A. brevicornis* (Table 6.2). The only epifaunal taxon observed from seabed photographic data acquired in this biotope was a hermit crab (Paguridae).

7.2.2.4 A5.351: *Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud

The biotope '*Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud' (A5.351) occurs in cohesive sandy mud off wave exposed coasts with weak tidal streams or in muddy sands in moderately deep water. It can be characterised by a high abundance of the brittlestar *A. filiformis* with the bivalves *K. bidentata* and *A. nitida* (EUNIS, 2012).

Along the Irish section of the Havhingsten cable route this biotope was recorded from stations LS_ST02, LS_ST03 and LS_ST04, extending from KP 2.940 to KP 11.960 across water depths that ranged from 17 m to 41 m BSL. Particle size analysis data from the biotope's constituent stations identified sediments of muddy sand or slightly gravelly muddy sand, with mud content that ranged from 9.93 % to 14.9 % and gravel content that ranged from 0.03 % to 2.73 % (Section 4.2). Seabed photographic data suggested that the gravel-sized sediment particles were likely comprised of shell fragments.

The stations within this biotope were grouped within cluster A in the multivariate analysis of macrofauna data (Section 6.2.1). This grouping was characterised by an abundance of *A. filiformis* (mean abundance of 72 individuals per station) and *K. bidentata* (45 individuals per station). Other prominent taxa included *D. glaucus*, *Phoronis* sp. and *N. nitidosa*. Unusually for this biotope, only a single individual of *A. nitida* was recorded across the three stations sampled.

Epifauna was comparatively sparsely distributed within this biotope and comprised hermit crabs (Paguridae), anemones (Actiniaria, including *Metridium* sp.), brittlestar (Ophiuroidea, which may have included *A. filiformis*) and occasional fish (Gadidae).

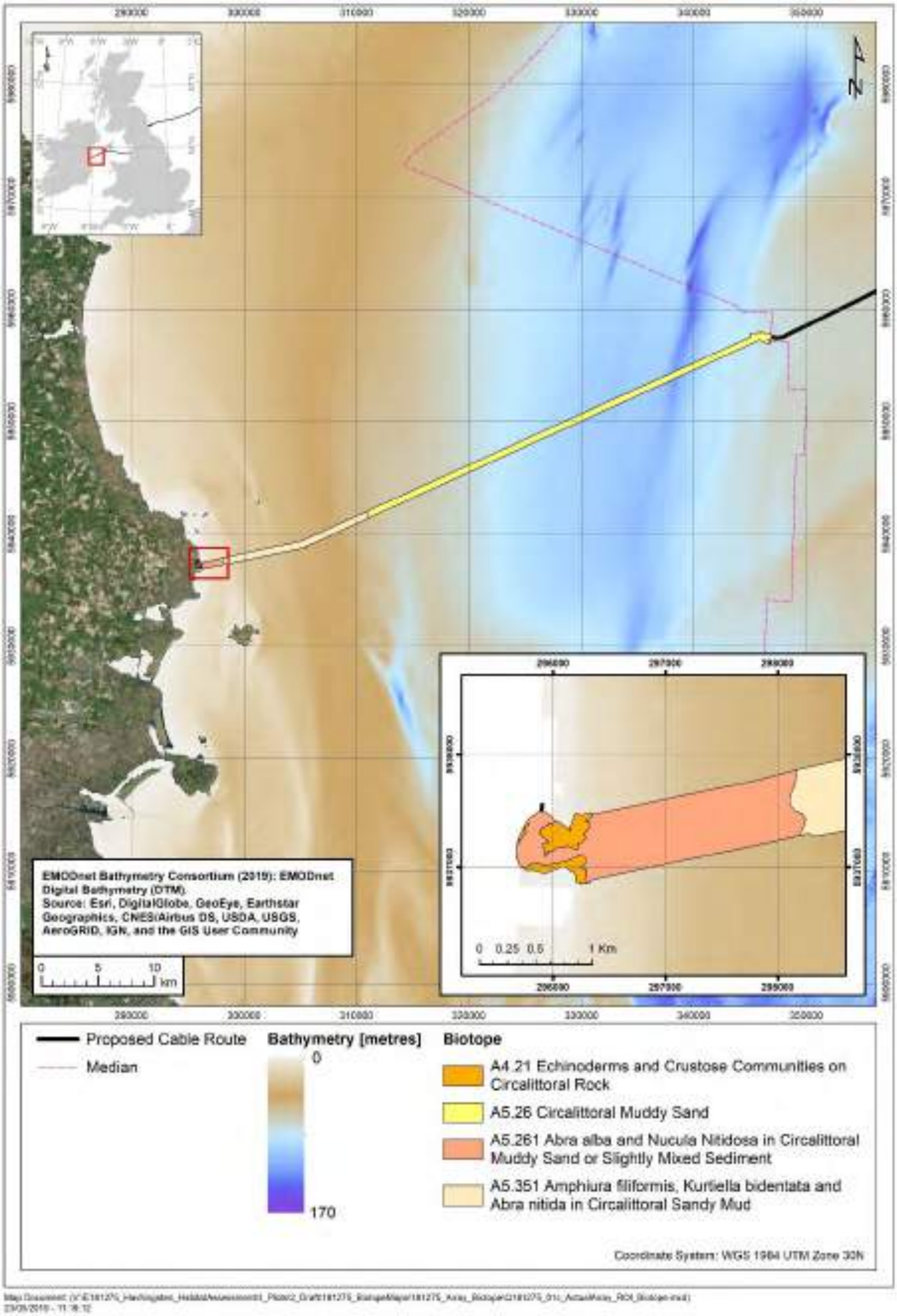


Figure 7.1: The spatial distribution of benthic habitats and biotopes, Havhingsten cable route, Ireland

7.2.3 Potentially Sensitive Habitats and Species

Analysis of seabed video and stills photography data was undertaken to establish whether any potentially sensitive habitats were likely to be present within the survey area.

7.2.3.1 Annex I Geogenic Reef

Cobbles and boulders were recorded from two sections of the transect undertaken at station LS_ST01, located at approximately KP 1.120 in water depths of 7 m BSL to 8 m BSL.

Table 7.6 presents a summary of the stony reef assessment. Appendix H.1 presents the full stony reef assessment.

Table 7.6: Stony Reef Assessment Summary, Havhingsten Cable Route, Ireland

Station/Transect	% Cobbles/boulders	Elevation	Overall Geogenic Reef Classification
LS_ST01A Section 2	10 % - 20 %	64 mm – 5 m	Low
LS_ST01A Section 4	20 % – 30 %	64 mm – 5 m	Low

Key:	Not a Reef	Low	Medium	High

The presence of cobbles and boulders in two areas of station LS_ST01 were classified as 'low' resemblance to stony reef. The seabed appeared to be predominantly bedrock with a cobble and boulder component interspersed with rippled sand. Where cobbles and boulders were present, they were elevated from the surrounding seabed (although at the lower end of the 64 mm to 5 m category). The percentage of cobbles and boulders ranged from approximately 10 % to 30 % coverage. However, underwater visibility was poor at this station, and the percentage coverage has been based on small visible sections of the seabed.

Annex I reefs also include bedrock reef and a wide range of topographical reef forms meet the EU definition of this habitat type (JNCC, 2018c). Bedrock reefs may include vertical rock walls, horizontal ledges, sloping or flat bedrock and broken rock. More extensive rock structures, thought likely to be bedrock outcrops, were seen during camera operations at station LS_ST01. These ranged in morphology from flat, sediment covered surfaces to sloping structures outcropping from muddy sand sediments. No assessment criteria are currently available to assess the quality of bedrock reef habitat and it is therefore not possible to comment on the potential conservation importance of these areas.

7.2.3.2 Sea Pens and Burrowing Megafauna Communities

Sea pens (*V. mirabilis*) and/or faunal burrows were recorded at stations LS_ST05 and CC05_ST01 and transects CC05_TR01 and CC05_TR02, all located in the eastern extents of the surveyed route (KP 20.570 to KP 55.220), in water depths ranging from 66 m BSL to 81 m BSL.

The video and photographs were analysed for the presence of the habitat 'Sea pen and burrowing megafauna communities'. Section 7.1.2.1 presents details of the assessment method. Table 7.7 presents the assessment results.

Table 7.7: SACFOR Densities of Sea Pens and Burrows, Havhingsten Cable Route, Ireland

Geodetic Parameters: WGS84 UTM 30N						
Transect/Station	**Time [UTC]**	**Easting [m]**	**Northing [m]**	**Length [m]**	***V. mirabilis* [3 cm to 15 cm Size Class]**	**Burrows [3 cm to 15 cm Size Class]**
LS_ST05	22:03:33	314922.3	5943446.6	184	Occasional	Common
	22:08:36	314882.9	5943626.6			
CC05_TR01A	02:29:09	347 174.7	5 957 085.5	829	Rare	Frequent
	03:02:47	346 542.0	5 957 621.4			
CC05_TR02	03:26:17	346 779.4	5 957 515.0	272	Absent	Frequent
	03:36:31	346 508.0	5 957 501.8			
CC05_ST01	03:57:10	346 266.4	5 957 592.1	146	Absent	Common
	04:17:09	346 385.9	5 957 508.6			

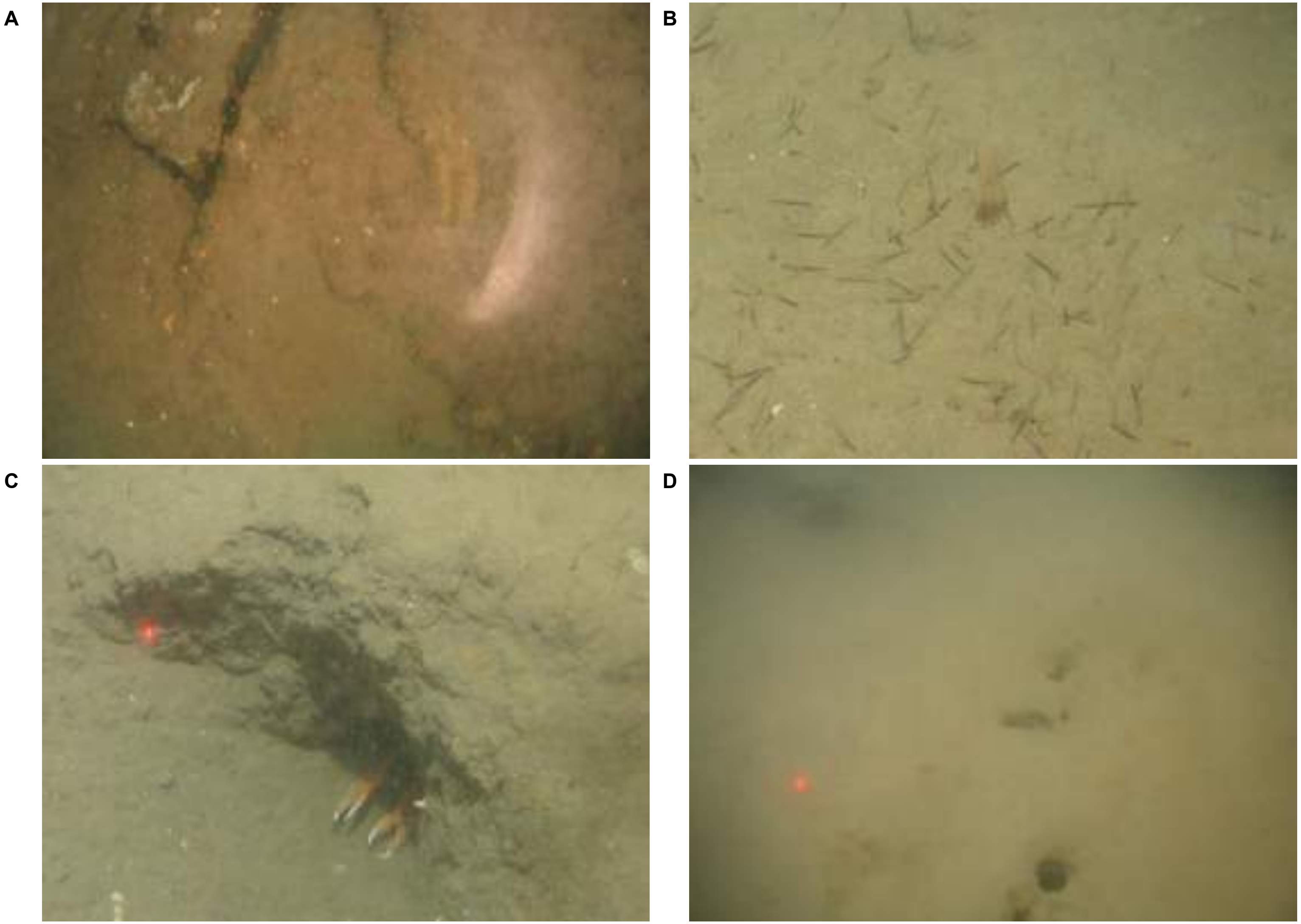
Notes:
SACFOR Classifications (3 cm to 15 cm)
S = 1–9/0.01 m2 F = 1–9/10 m2
A = 1–9/0.1 m2 O = 1–9/100 m2
C = 1–9/1 m2 R = 1–9/1000 m2

Key:	Absent	Rare	Occasional	Frequent	Common	Abundant	Super abundant

The sea pen *V. mirabilis* was occasionally recorded at station LS_ST05, and rarely recorded along transect CC05_TR01A. Burrows were recorded as ‘common’ or ‘frequent’, with both small and large burrows recorded, some of which were created by the Norway lobster (*N. norvegicus*). One individual of *N. norvegicus* was photographed emerging from a burrow on transect CC05_TR01 (Figure 7.2c).

Although the sediments were burrowed, mounds and burrows were not a prominent feature of the seabed.

No other Annex I habitats or Annex II species or threatened and/or declining species and habitats (OSPAR, 2008) were observed within the survey area.



A: Photograph LS_ST01A_2_18

Boulder/bedrock covered and muddy sand
Faunal turf (Hydrozoa/Bryozoa)
Worm tubes (Serpulidae)

B: Photograph CC05_TR01A_30

Muddy sand
Seapen (*Virgularia mirabilis*)
Worm tubes (Polychaeta)

C: Photograph CC05_TR01A_46

Muddy sand
Norway lobster (*Nephrops norvegicus*)

D: Photograph LS_ST05_09

Muddy sand
Burrows

Figure 7.2: Example seabed photographs of potentially sensitive habitats, Havhingsten Cable Route, Ireland

8. DISCUSSION

8.1 Introduction

This survey was undertaken to characterise benthic environmental conditions prior to the proposed cable laying operations along the Irish section of the Havhingsten cable route. The survey and analytical strategies were designed to provide a comprehensive baseline dataset of the biological and physico-chemical characteristics of the seabed along the route, with sampling stations positioned to target variations in seabed habitat identified from the preceding geophysical survey operations. A key aim of the survey was to determine the distribution of seabed habitats and biotopes that may be impacted by the cable laying operations, with particular attention paid to identification of habitats that may be protected under regional, national, European and international laws.

The sampling plan included the collection of surface sediment from six stations for physico-chemical and macrofaunal analysis; sampling was successfully completed at all of these proposed stations. Selected physical characteristics (particle size and TOM) were analysed using surface sediment samples of taken between 0 cm to 5 cm depth (Section 3). Further surface (0 cm to 2 cm depth) sediment samples were analysed for TOC, hydrocarbons (including 2 to 6 ring aromatics) and heavy and trace metal content. Macrofaunal analysis (> 1 mm) was carried out on single 0.1 m^2 grab samples acquired from each station.

8.2 Sediment Characterisation

The general physical and chemical characteristics of sediment particles have a significant effect on how other chemical components and biological species interact with seabed sediments. For example, the silt/clay fraction is known to adsorb petroleum hydrocarbons/heavy metals from seawater and through this pathway, these chemicals become incorporated into the sediment system (Meyers and Quinn, 1973). Granulometry data can therefore be critical when interpreting chemical and biological data obtained in this type of benthic study. In addition, since waste discharges (such as drill cuttings) often possess significantly different physical characteristics from the natural sediments present in the area, such data may also provide some information on the spread of discharged material.

With regard to macrofaunal communities, the species distributions and community structure can be greatly influenced by the nature of the sediment, which represents the effects of a complex set of hydrological factors, such as water movement, turbulence and suspended load, at one particular point in time. Some animals have a behavioural preference for sediment of a particular grain size (Meadows, 1964; Gray, 1981), while this factor and organic matter content are closely associated with other properties of the sediment such as density, porosity, permeability, oxygenation and bacterial count (Buchanan, 1984), all of which affect animal functions such as locomotion, attachment, tube construction and feeding. Specifically, the proportion of fine (silt/clay) material often influences the distribution of macrofaunal communities.

The sediments within the survey area demonstrated moderate variability in mean diameter and low to high variability for the proportions of sand, gravel and fines, indicating the presence of varied sediments. The Wentworth (1922) classification described sediments across all survey areas as fine sand to coarse silt (Section 4). Sediment sorting ranged from poorly sorted to very poorly sorted. The sampling regime consisted of stations ranging from 11 m to 82 m depth BSL, so high variability in sediment composition would be expected and similar variability was observed by McBreen et al. (2008).

In the marine environment, TOM is a primary source of food for the benthos and plays a role in partitioning of contaminants in sediments (Trannum et al., 2006). TOM content displayed low variability across the survey area, with no consistent spatial patterns observed. TOC content was low and displayed moderate variability.

8.3 Sediment Chemistry

The previous sections of this report have presented the data generated from the analysis programme with the aid of data tables and graphics. This discussion section will review the data with respect to cited background and predicted effect levels. The OSPAR CEMP provides assessment criteria for contaminants in sediments in the form of BC, BAC and ERL threshold values. Adverse effects on organisms are rarely observed when concentrations are present below the ERL value (OSPAR, 2009c).

8.3.1 Total and Aliphatic Hydrocarbons

Marine sediments contain hydrocarbons derived from many sources which enter the marine environment via three general processes: biosynthesis (marine and land organisms biosynthesise hydrocarbons), geochemical processes (submarine and coastal/terrestrial oil-seeps) and anthropogenic sources (from accidental or intentional discharge of fossil fuel) (Farrington and Meyer, 1975; Myers and Gunnerson, 1976). Anthropogenic hydrocarbon inputs to the marine environment include marine transportation, offshore oil production, coastal oil refineries, accidental shipping losses, industrial and municipal waste (which includes sewage and dredged spoils). A significant contribution to the global budget enters the marine environment via urban and river run-off, atmospheric deposition (from combustion sources including PAHs) and natural seepages (Johnston, 1980; Dicks et al., 1987; NSTF, 1993; OSPAR, 2000; 2010).

Biosynthesised hydrocarbons are ubiquitous in the marine environment (Harada et al., 1995; Parinos et al., 2013). Odd carbon number, long chain n-alkanes are widely distributed in the plant kingdom (Eglinton et al., 1962; Douglas and Eglinton, 1966; Bush and McInerney, 2013) as components of cuticle waxes. These are common on the surfaces of leaves, stems, flowers and pollen and their presence in sediment is indicative of terrestrial inputs from adjacent land masses. Relatively high concentrations of nC_{29}, nC_{31} and nC_{33} are therefore a common feature of many marine sediments (Farrington et al., 1977), particularly inshore marine sediments (Bouloubassi et al., 1997), but are also evident in sediments from deepwater regions like the Atlantic Margin/west of Shetland regions of the United Kingdom Continental Shelf (McDougall, 2000) and regions such as the South China Sea and West Africa (Fugro, unpublished data).

Anthropogenic hydrocarbon inputs enter the marine environment from a number of sources. For example, from marine transportation, offshore oil production, coastal oil refineries, accidental shipping losses, industrial and municipal waste (which includes sewage and dredged spoils) with a significant contribution to the global budget entering via urban and river run-off, atmospheric deposition (from combustion sources; including PAHs) and natural seepages (e.g. Johnston, 1980; Dicks et al., 1987; NSTF, 1993; OSPAR, 2000, 2010).

The gas chromatographic profiles in sediments collected within the survey area shared a common underlying hydrocarbon distribution. The chromatograms all contained a trace level homologous series of resolved n-alkanes from nC_{12} to nC_{36} and a low-level unresolved hump covering the nC_{13} to nC_{36} range. This feature is the UCM and is composed of a wide range of compounds, including cycloalkanes, which remain after substantial weathering and biodegradation of petrogenic hydrocarbons (Farrington et al., 1977). The presence of the UCM in the samples suggests some contribution to the sediments from petroleum hydrocarbon sources, which may be attributed to fossil fuel discharges from historic or current industrial activities in the marine environment (such as shipping or oil and gas development) or via terrestrial run-off. A cluster of peaks around nC_{21} was present at some stations. This signature is often seen in marine sediments and thought to be branched isoprenoids of biogenic origin.

Variation in THC concentrations was moderate (RSD 54 %), predominantly influenced by the higher concentration at station LS_ST01 (12.6 µg/g). THC content was higher at stations with a higher total organic matter content and concentrations appeared to be highest closest to the shoreline. The observed variability in THC concentrations may be influenced by terrestrial run-off, inputs from shipping or natural heterogeneity in sediment characteristics and associated THC concentrations.

8.3.2 Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) and their alkyl homologues have been detected in a wide range of marine sediments (Youngblood and Blumer, 1975; Laflamme and Hites, 1978; Neff, 1979). These compounds consist of two or more fused benzene rings in linear, angular or cluster arrangements. Polycyclic aromatic hydrocarbons technically contain only carbon and hydrogen atoms. However, other atoms (e.g. nitrogen, sulphur and oxygen) may be readily substituted into the benzene ring to form heterocyclic compounds that are present in significant concentrations in petroleum and refined products.

Monitoring of aromatic hydrocarbon type and content is important due to the particularly toxic nature (mutagenic/carcinogenic) of several PAHs even at very low concentrations. The US EPA has identified 16 priority PAHs to be monitored (Keith, 2015) and the CEMP specifies 9 PAHs of specific concern (OSPAR, 2014), which primarily reflect inputs from man-made combustion sources (further alkylated and parent compounds are normally studied because of the information they provide on PAH origin and fate). Many PAHs have long been recognised as universal environmental pollutants with the heavier molecular weight PAHs (mainly 4 to 6 ring PAH) generally being regarded as carcinogens and mutagens. Indeed, 11 of 40 PAHs ranging from 3 to 6 ring structures have been listed as being strongly carcinogenic or mutagenic with a further 10 listed as weakly carcinogenic or mutagenic (Edwards, 1983).

All total 2 to 6 ring PAH concentrations were below the ERL value (OSPAR, 2014) at all stations (Table 5.1), therefore the concentrations of total 2 to 6 ring PAHs present are unlikely to result in detrimental effects on the benthic community. For all the EPA 16 PAH compounds assessed (individual and total), the concentrations reported within the survey area were below their respective ERL values (OSPAR, 2014) across the survey area (Appendix E.3).

Most natural and anthropogenic contaminants have a higher affinity to fine particulate matter than coarse, due to the increased adsorption capacity of organic matter and clay minerals. Natural sediment contaminant concentrations will be closely related to the distribution of fine-grained material with the effects of other sources of contaminants, for example anthropogenic sources, at least partly obscured by sediment characteristics (ICES, 2009; 2012). PAHs are lipophilic and bind strongly to organic matter in sediments (Davies, 2004). Normalisation of PAH concentrations to total organic carbon content provides a basis for reliable assessment of temporal trends and facilitates a meaningful comparison of sediment substances with OSPAR BC and BAC thresholds (Appendix E.3; ICES, 2009; 2012). When normalised to 2.5 % TOC, individual US EPA 16 PAH concentrations exceeded BAC values (OSPAR, 2014) for naphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene at all stations and benzo(ghi)perylene at one station (Appendix E.3). However, TOC content within the survey area was generally low (≤ 0.66 %; Table 4.2), possibly resulting in an overestimate of the normalised PAH concentrations.

Information on the source(s) of PAHs in the sediment may be obtained from a study of their alkyl homologue distributions (i.e. the degree of methyl, ethyl, substitution of the parent compounds). Pyrolytically derived PAH is predominantly unalkylated whereas petrogenically derived PAH is formed at relatively low temperatures (< 150 °C) and contains mainly alkylated species. The distribution of parent 2 to 6 ring PAH compounds also reflects whether the source is petrogenic or pyrolytic. The trend of parent and alkylated PAHs is represented graphically in Appendix E.3 using three-dimensional plots that present the PAH concentrations in terms of parent compound and alkyl homologue distribution of the aromatic material in the sediments analysed. These figures further indicate that the PAHs recorded within the survey area originated from predominately pyrolytic sources.

8.3.3 Heavy and Trace Metals

Metals and metalloids occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Some are essential to marine life while others have no biological function and therefore are toxic to numerous organisms at certain levels (Paez-Osuna and Ruiz-Fernandez, 1995; Boening, 1999). Metals can enter the environment via natural methods such as riverine transport, coastal discharges, geological weathering and atmospheric fallout (Brady et al., 2015). Other routes into marine sediments are from anthropogenic activities such as direct discharges from industrial activities.

Trace metal contaminants in the marine environment tend to form associations with the non-residual phases of mineral matter, such as iron and manganese oxides and hydroxides, metal sulphides, clays, organics and carbonates (Warren and Zimmerman, 1993; Dang et al., 2015; Wang et al., 2015). Non-residual trace metals are associated with more reactive and available sediment components through processes such as adsorption onto mineral surfaces and organic complexation. Metals associated with these more reactive phases are prone to various environmental interactions and transformations (physical, chemical and biological) potentially increasing their mobility and biological availability (Tessier et al., 1979; Warren and Zimmerman, 1993; Du Laing et al., 2009). Residual trace metals are defined as those which are part of the crystal structure of the component minerals and are generally unavailable to organisms (de Orte et al., 2018). Therefore, in monitoring trace metal contamination of the marine environment, it is important to distinguish the more mobile non-residual trace metals from the residual metals held tightly in the sediment lattice (Chester and Voutsinou, 1981), which are of comparatively lesser environmental significance because of their low reactivity and availability.

The current CEMP's environmental focus around heavy metals is on cadmium, mercury and lead (OSPAR, 2014). Cadmium and lead both occur naturally in the marine environment; however, they are toxic and liable to bio-accumulate so there is a concern for both the overall health of the environment and for the human consumption of seafood. Mercury is an extremely rare element in the earth's crust but does occur naturally in young geologically active areas (volcanic regions). It is extremely toxic to humans and biota and can be transformed once in the environment into more toxic organometallic compounds (OSPAR, 2009c). ERL threshold values have also been established for several other metals and the results obtained have been compared to these (Table 5.2). The CEMP has also defined BC and BAC concentrations for assessing whether metal levels in sediments are at, or close to, background levels (OSPAR, 2014). In Appendix E.6 aluminium-normalised elemental concentrations from the current survey have been compared to CEMP BC and BAC concentrations.

In this study, an analytical procedure involving the digestion of sediment in aqua regia was employed to analyse the elemental content of the sediments. The aqua regia digest releases for analysis the 'non-residual' heavy metals, which are not incorporated in the mineral matrix and are therefore potentially available for biological uptake.

The concentrations of aqua regia extractable metals across the survey area displayed low to moderate variability (≤ 47 %), with the highest variability observed for aluminium. The variability observed in the dataset was expected to be a result of natural variation in sediment characteristics and the currents affecting sedimentation and deposition.

The partially enclosed nature and restrictive dispersive capacity of the Irish Sea can result in sediment accumulation of contaminants such as metals (Charlesworth et al., 2006). However, comparison of the concentrations of CEMP metals (cadmium, lead and mercury) analysed in the sediment samples against their respective assessment criteria (ERL) showed that concentrations were all below the respective ERL values. Although current environmental interest in metals contamination is focused mainly around cadmium, lead and mercury (OSPAR, 2014), ERL values have also been established for several other metals, of which no stations in the survey area exceeded. Therefore, concentrations of these metals are unlikely to result in detrimental effects on the macrofaunal community.

When normalised to 5 % aluminium, concentrations were compared with the cited BAC reference values (OSPAR, 2014; Appendix E.4). BAC values were exceeded for chromium, nickel and lead at all stations and mercury and arsenic at three stations. Aluminium concentrations were low (≤ 1.8 %), potentially resulting in the overestimation of normalised metals concentrations.

8.4 Macrofaunal Communities

Seabed sediments provide support, protection and the food source for many macrofaunal species. The sediment macrofauna, most of which are infaunal (living within the sediment), are therefore particularly vulnerable to external influences which alter the sediments' physical, chemical or biological nature. Such infaunal animals are largely sedentary and are thus unable to avoid unfavourable conditions. Each species has its own response and degree of sensitivity to changes in the physical and/or chemical environment and consequently the species composition and their relative abundance in a particular location provides a reflection of the health and condition of the immediate environment, both current and historical. The recognition that aquatic contaminant inputs may alter sediment characteristics, together with the relative ease of obtaining quantitative samples from specific locations, has led to the widespread use of infaunal communities in monitoring the impact of disturbances to the marine environment over a long period of time.

There was a low to moderate degree of infaunal similarity across the stations sampled, with inter-station similarities ranging between 0.0 % and 58.0 %. Within the multivariate analysis the most nearshore of the stations sampled (station LS_ST01, which was ungrouped by the cluster analysis) was shown to contain a community dominated by the bivalve mollusc *A. alba*, with only low abundances of other taxa recorded. Slightly further offshore, the cluster A stations (stations LS_ST02, LS_ST03 and LS_ST04) identified a diverse and densely populated community dominated by the brittlestar *A. filiformis* and bivalve *K. bidentata*. The stations located along the offshore, easterly section of the route (stations LS_ST05 and CC05_ST01) were grouped within cluster B and shown to have a community of bivalves (including *T. flexuosa* and *A. nitida*) and polychaetes (including *N. incisa* and *Notomastus* sp.). Despite the lack of statistical differentiation of these stations, the communities they represented appeared different, with station LS_ST05 containing fewer taxa and individuals than station CC05_ST01.

The BIOENV algorithm in the PRIMER BEST routine was an additional technique used to identify the environmental variables that correlated significantly with the patterns observed in community structure. BIOENV was run for single variables and a combination of two and three variables, highlighting the physical or chemical parameters that may influence community structure. The single variable that correlated most strongly with the macrofaunal community structure was copper concentration ($P \leq 0.05$; rho = 0.846). When two combined variables were considered, the additive influence of aluminium concentration and depth demonstrated the most significant correlation with the community structure present ($P \leq 0.05$; rho = 0.904). When three combined variables were considered, the concentrations of aluminium and nickel, in conjunction with depth, correlated most strongly with the macrofaunal community ($P \leq 0.05$; rho = 0.950). Although metals concentrations feature in all of the significant correlations identified, these are unlikely to be causative of the community structure seen, as all metals were recorded at concentrations unlikely to negatively impact benthic communities (Section 5.3). It is possible that the variation in metal concentrations was instead indicative of slight variations in sediment particle size (which was not, in itself, significantly correlated with community structure) and that particle size and depth were the main factors influencing benthic community structure.

8.5 Seabed Habitats and Biotopes

Seabed habitats and biotopes within the survey area were classified in accordance with the EUNIS habitat classification (EUNIS, 2012), 'The Marine Habitat Classification for Britain and Ireland – Version 15.03' (JNCC, 2015) and 'A Guide to Habitats in Ireland' (Fossitt, 2000). The primary tool for identification of habitats and their associated communities along the surveyed route was seabed video/photographic data, but further detail regarding sediment composition and infaunal community was provided by integration of the results from laboratory analysis.

Two EUNIS biotope complexes and two EUNIS biotopes were recorded in the survey area, the majority of which were sedimentary, with one rock biotope complex recorded (Section 7.2.1). The 'Echinoderms and crustose communities' (A4.21) biotope complex was recorded from bedrock and/or boulder substrata adjacent to the headlands projecting from either side of Loughshinny Bay (station LS_ST01).

The biotope '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (A5.261) was found in shallow sediments in the mouth of Loughshinny Bay (station LS_ST01A) and was expected to extend into the bay itself and possibly for some distance offshore. As water depth increased with distance along the route, biotope A5.261 transitioned into the biotope '*Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud' (A5.351), which was found at stations LS_ST02, LS_ST03 and LS_ST04, located between KP 2.940 to KP 11.960 in water depths that ranged from 17 m to 41 m BSL. Towards the eastern end of the Irish section of the route, biotope A5.351 transitioned into the biotope complex 'Circalittoral muddy sand' (A5.26), which was recorded from stations LS_ST05 and CC05_ST01 and transects CC05_TR01 and CC05_TR02; these stations were located between KP 20.570 and KP 55.220 in water depths of between 66 m and 81 m BSL. This distribution of reported habitats broadly corresponds with the European Marine Observation Data Network (EMODnet) broadscale habitat map for the Irish Sea (EMODnet, 2019), which predicts a transition from predominantly sand habitats in nearshore waters to mud sediments further offshore.

All sediments sampled along the Irish section of the Havhingsten cable route were classified as either muddy sand or slightly gravelly muddy sand (Section 4.2), but mud content and the size of the sand fractions present was variable. This was reflected in the faunal composition of the route's sediment biotopes. Comparatively high mud content (40.6 %) was recorded from station LS_ST01, where biotope A5.261 was identified. Lower mud content (14.7 % to 22.0 %) was evident from stations LS_ST02, LS_ST03 and LS_ST04, where biotope A5.351 was recorded and mud content increased again (31.6 % to 43.0 %) at the offshore stations LS_ST05 and CC05_ST01 where biotope complex A5.26 was identified.

Due to the cobble and boulder coverage adjacent to the headland near Loughshinny (station LS_ST01), there was the potential for the Annex I 'stony reef' habitat to occur and data were assessed in accordance with JNCC guidelines for identifying the quality of this habitat (Irving, 2009). The guidelines state that "*when determining whether an area of seabed should be considered as Annex I stony reef, if a 'low' is scored in any of the characteristics (composition, elevation, extent or biota), then a strong justification would be required for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive*". Potential stony reef habitat at station LS_ST01 was classified as having a 'low' resemblance to stony reef overall (Section 7.2.3.1). However, there did appear to be outcropping bedrock in this area, which could qualify as bedrock reef. No assessment criteria are currently available to assess the quality of bedrock reef habitat.

Due to the observation of sea pens (*V. mirabilis*) and faunal burrows at stations LS_ST05 and CC05_ST01 and on transects CC05_TR01 and CC05_TR02, located in the easternmost extents of the survey area, there was the potential for the OSPAR listed threatened and/or declining habitat 'sea pens and burrowing megafauna communities' to occur along the route. To qualify as a 'sea pens and burrowing megafauna community', the seabed must be "*heavily bioturbated by burrowing megafauna with burrows and mounds typically forming a prominent feature of the sediment surface*" (JNCC, 2014). Sea pens were absent from two of the stations/transects surveyed and, where found, were only recorded as 'occasional' or 'rare' in accordance with the SACFOR abundance scale (Section 7.2.3.1). Burrows were recorded as 'common' or 'frequent' on the SACFOR scale, and included both small and large burrows, some of which were created by the Norway lobster, *N. norvegicus*. A single *N. norvegicus* was observed from a burrow on transect CC05_TR01 (Figure 7.2c). *Nephrops norvegicus*, which are also known as langoustines or Dublin Bay prawns, are a commercially important fishery in Ireland. In 2016, 9600 tonnes of *N. norvegicus* were landed, with a total market value of €63 million, making it Ireland's most valuable fishery (BIM, 2016).

No other OSPAR threatened and/or declining species and habitats, Annex I habitats or Annex II species, were observed within the survey area.

9. CONCLUSIONS

The aim of this report has been to evaluate the existing physical/chemical and biological components in the marine environment along the Irish section of the Havhingsten cable route. Based on the overall assessment of the route surveyed, the following key conclusions can be stated:

Sediments ranged from fine sand to coarse silt across the survey area using the Wentworth description. Moderate variability was observed in mean diameter and low to high variability for the proportions of sand, gravel and fines, indicating the presence of varied sediments.

The gas chromatographic profiles for the survey area sediments were characteristic of background marine sediments influenced by biogenic inputs. The profiles contained a range of low-level resolved n-alkanes and a UCM peaking late in the chromatogram window. Total 2 to 6 ring PAH concentrations and US EPA 16 PAH concentrations were all below their respective ERL values and therefore unlikely to result in deleterious effects on the macrofaunal community. Source appointment suggested a predominantly pyrolytic source of hydrocarbons to the sediments.

All metals concentrations were below their respective ERL value. Variability in concentrations ranged from low to moderate (≤ 43 %) and was expected to be a result of natural variation in sediment characteristics and the currents affecting sedimentation and deposition.

The macrofaunal community of the most nearshore of the stations sampled (station LS_ST01) was dominated by the bivalve mollusc *A. alba*, with only low abundances of other taxa recorded. Slightly further offshore (stations LS_ST02, LS_ST03 and LS_ST04), a diverse and densely populated community dominated by the brittlestar *A. filiformis* and bivalve *K. bidentata* was identified. The stations located along the offshore, easterly section of the route (stations LS_ST05 and CC05_ST01) were shown to have a community of bivalves (including *T. flexuosa* and *A. nitida*) and polychaetes (including *N. incisa* and *Notomastus* sp.).

Two EUNIS biotopes and two biotope complexes were recorded along the route. One biotope complex was associated with bedrock and/or boulder habitat adjacent to Loughshinny Bay and the remainder with sedimentary habitat.

Due to the occurrence of sea pens (*V. mirabilis*) and faunal burrows at stations LS_ST05 and CC05_ST01 and on transects CC05_TR01 and CC05_TR02, these were assessed to determine their resemblance to the OSPAR threatened and/or declining habitat 'sea pens and burrowing megafauna communities'. None of the stations/transects were thought to strongly resemble this priority habitat.

Boulder and/or cobble substrata identified adjacent to Loughshinny Bay (station LS_ST01) were assessed to determine their resemblance to Annex I 'stony reef' habitat; the results suggested that these areas only demonstrated a 'low' level of resemblance to this priority habitat. Photographic data also suggested that bedrock substrata occurred in this area. 'Bedrock reef' can also be considered as an Annex I habitat but, in the absence of guidance for assessment of this habitat type, its potential conservation importance could not be assessed.

No other OSPAR threatened and/or declining species and habitats, Annex I habitats or Annex II species, were observed within the survey area.

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APPENDICES

A. GUIDELINES ON USE OF REPORT

This report (the "Report") was prepared as part of the services (the "Services") provided by Fugro GB Marine Limited ("Fugro") for its client (the "Client") under terms of the relevant contract between the two parties (the "Contract"). The Services were performed by Fugro based on requirements of the Client set out in the Contract or otherwise made known by the Client to Fugro at the time.

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B. METHODOLOGIES

B.1 SURVEY

Survey operations were conducted using the RV Prince Madog during the period 23 to 24 February 2019 and the MV Fastnet Petrel during the survey period 21 to 22 March 2019. Survey positioning on the RV Prince Madog was achieved using Hemisphere V100 differential global positioning system antennae, configured with Trimble Hydropro navigation software. Whilst positioning on the MV Fastnet Petrel was achieved using a Koden KGP913MKII GPS.

B.1.1 Seabed Video/Photography

Prior to grab sampling, seafloor video footage and stills images were collected. Seabed photography was acquired using a Kongsberg OE 14-208 underwater camera system mounted within purpose built camera frame complete with a separate strobe and two lights. During operations where visibility was reduced or high turbidity the freshwater lens system was used. Table B.1 presents the specifications of the Kongsberg camera systems used.

Table B.1: Kongsberg OE 14-208 Camera System

Camera Specifications	
Weight:	350 kg
Dimensions:	1.0 m × 1.0 m × 1.0 m
Required clearance:	3 m
Image Resolution	2592 × 1944 (max) at 5.3 MP
Framing Video	PAL 625 Line/60 Hz NTSC
Sensor type	1/1.8” format high density CCD sensor
Operating Tolerances	
Water Depth	400 metres
Optical	
Optical Zoom	× 5
ISO Sensitivity	50 to 400
Standard Lens	35 mm format equivalent to 38-140 mm
Angle of View	60° Diagonal in water

Standard video frame

Seabed video footage was displayed on a computer monitor and recorded directly onto a computer hard drive using a Climax Digital video/universal serial bus (USB) converter, with a backup recorded to Mini-DV tape. A Black Box overlay was used to overlay a navigation string from the ship’s reference point, including the date, time and video frame position. Where applicable, the station number was updated on the navigation string automatically through the Hydropro software or was captured by taking a still of the photo slate at the beginning of the video.

Footage was viewed in real time, assisting in the control of the camera in the water. Where the video passed over sediment type boundaries, additional seabed video was collected, as appropriate, to provide sufficient footage for the analysis phase. Review of the video data also allowed assessment of the sites prior to grab deployment.

Positions for the video footage were logged at the beginning and the end of each station/transect and at each static image location.

Two subsea lasers were used to provide a scale on the video footage, these were set apart initially at 17.7 cm and then adjusted to 19.5 cm and 17.0 cm on the standard video frame.

Operational procedures for the seabed photography were as follows:

- The camera system was set-up on deck prior to deployment and a station number slate picture taken;
- The camera was deployed into the water until just below the sea surface, at which point the lights were switched on;
- The camera was lowered to the seabed and when the seabed was visible recording started and stills were acquired;
- Still photography commenced with the environmental scientist manually triggering the camera while the camera moved over the seabed;
- At the end of a camera station/transect the video recording stopped;
- The camera was recovered to the deck and the lamps were switched off just beneath the surface.

On completion, photographs were downloaded and backed up onto an external hard drive.

B.1.2 Sediment Grab Sampling

Seabed samples were acquired using a 0.1 m^2 dual van Veen grab (Figure B.1).

Figure B.1: Dual Van Veen grab (0.1 m^2)

Operational procedures for the grab deployment and recovery were as follows:

- The grab was prepared for operations prior to arrival on station. The Bridge communicated to the deck when the vessel was steady and on location, and the grab was deployed;
- When the mate/AB operating the winch observed that the grab had reached the seabed (evidenced through a distinct slackening of the wire rope and snatch block), a positional fix was taken;
- On recovery to the deck, the sample was inspected and judged acceptable or otherwise (see below for rejection criteria);
- Two accepted grab samples were retained for faunal analysis and one grab sample was retained and subsampled for physico-chemical analysis;
- Deck logs were completed for each sample acquired (including no samples) with: date, time, sample number, fix number, sediment type, depth and colour of strata in the sediment (if any), odour (i.e. H_2S), bioturbation or debris.

Samples were considered unacceptable in the following instances:

- Evidence of sediment washout caused through improperly closed grab jaws or inspection hatch;
- Sediment sample taken on an angle; where the grab jaws have not been parallel to the seabed when the grab fired;
- Disruption of the sample through striking the side of the vessel;
- Sample represented less than approximately 7 cm bite depth of the grab or 40 % by volume;
- Sample is more than 50 m from the target location, unless otherwise specified in the proposed locations.

Samples deemed acceptable were photographed. For each of the samples, notes were made on sediment type, and conspicuous species.

Each macrofaunal sample was then transferred into a clean plastic box to be washed though a 1 mm sieve with seawater using the chute and stand method. The residue remaining on the sieve was then carefully transferred into a pre-labelled bucket and fixed using 10 % buffered formal saline solution (4 % formaldehyde). An additional sample label written on waterproof paper, including date and project reference, was placed inside the bucket in addition to labels on the side and lid of the bucket. The fauna samples were stored in a designated crate on the deck of the survey vessel until demobilisation, upon which they were transferred to Fugro's benthic laboratories.

The third grab sample was used for physico-chemical (particle size distribution (PSD) and chemistry) samples, subsamples of this grab sample were taken as follows:

- A subsample (of approximately 300 mL) was collected for PSD analysis, using a plastic scoop to a nominal depth of 5 cm. The samples were sealed in polythene bags to ensure no loss of fines. The samples were frozen at and stored on the vessel until demobilisation and transfer to the analysis laboratory;
- Hydrocarbon samples were collected using a cleaned metal scoop to a nominal depth of 2 cm and stored in a prelabelled glass jar. The samples were frozen and stored on the vessel until demobilisation and transfer to the analysis laboratory;

- Samples for heavy metals were collected using a plastic scoop to a nominal depth of 2 cm. The samples were sealed in polythene bags to ensure no loss of fines. The samples were frozen at and stored on the vessel until demobilisation and transfer to the analysis laboratory.

B.2 LABORATORY ANALYSIS

B.2.1 Particle Size Analysis (PSA)

B.2.1.1 Dry Sieve Analysis

Particle size distribution analysis was undertaken in accordance with Fugro GB Marine Limited (FGBML) in-house methods based on the National Marine Biological Association Quality Control (NMBAQC) scheme's best practice guidance document – Particle Size Analysis (PSA) for Supporting Biological Analysis, and BS1377: Parts 1: 2016 and 2: 1990.

Representative material > 1 mm was split from the bulk subsample and oven dried before sieving through a series of sieves with apertures corresponding to 0.5 phi intervals between 63 mm and 1 mm as described by the Wentworth scale (Wentworth, 1922). The weight of the sediment fraction retained on each mesh was subsequently measured and recorded.

B.2.1.2 Laser Diffraction

Particle size distribution analysis was undertaken in accordance with FGBML in-house methods based on the NMBAQC scheme's best practice guidance document –PSA for Supporting Biological Analysis, and BS ISO 13320: 2009.

Representative material < 1 mm was removed from the bulk subsample for laser analysis, a minimum of three triplicate analyses (mixed samples) or one triplicate analyses (sands) were analysed using the laser sizer at 0.5 phi intervals between < 1 mm to < 3.9 µm. Laser diffraction was carried out using a Malvern Mastersizer 2000 with a Hydro 2000G dispersion unit.

Sieve and laser data are merged and entered into GRADISTAT to derive statistics including mass and percentage retained within each size fraction, mean and median grain size, bulk sediment classes (percentage gravel, sand and silt/clay), skewness, sorting coefficients and Folk classification.

B.2.2 Total Organic Carbon (TOC)

Sediment samples were analysed for total organic carbon (TOC) by Exova Jones Environmental. The dry, homogenised sample was treated with hydrochloric acid, then rinsed with deionised water to remove mineral carbon. The sample was then combusted in an Eltra TOC furnace/analyser in the presence of oxygen. Organic carbon was oxidised to CO_2 and measured by non-dispersive infrared analysis. This method does not quantify volatile organic carbon, which should be determined by another technique. The limit of detection for this method was < 0.02 % w/w.

B.2.3 Hydrocarbon Analysis in Sediments

Hydrocarbon analysis of sediments was carried out by FGBML.

B.2.3.1 General Precautions

To effectively eliminate all possible sources of hydrocarbon contamination from the analysis the following precautionary measures were taken prior to sample work-up:

- All solvents were purchased as high purity grade. Each batch was checked for purity by concentrating approximately 400 mL down to a small volume (< 1 mL) and analysing by gas chromatography (GC);
- All water used was distilled through an all glass still and dichloromethane (DCM) extracted to minimise contamination from plasticisers;
- All glassware was cleaned using an acid/base machine wash. The glassware was rinsed with acetone then finally with DCM prior to use;
- Procedural blanks, replicate analyses and laboratory reference material were run with each batch.

B.2.3.2 Ultrasonication Extraction for Hydrocarbons in Sediment

Sediment samples were thawed, homogenised and accurately weighed into a 250 mL conical flask. A solution containing an appropriate amount of the following internal standards was added to each sample using a microsyringe.

Aliphatic Standards	Aromatic Standards
Heptamethylnonane	d_8 naphthalene
D_{34} Hexadecane	d_{10} acenaphthene
D_{42} Eicosane	d_{10} phenanthrene
Squalane	d_{10} pyrene
	d_{12} chrysene
	d_{12} perylene

Methanol (50 mL) and solvent were mixed with the sediment. DCM (60 mL) was then added and the sample mixed again. The flasks were then capped with solvent cleaned aluminium foil and ultrasonicated for 30 minutes.

After being allowed to settle the solvent was decanted through a GF-C filter paper into a 1 L separating funnel. The extract was then partitioned with 100 mL of DCM extracted distilled water and the DCM layer run-off into a clean 500 mL round-bottomed flask. The ultrasonic extraction was repeated a further two times using 50 mL DCM and 15 minutes of ultrasonication. Each time the filtered extract was partitioned with the remaining methanol/water in the separating funnel. The DCM extracts were bulked and reduced in volume to approximately 2 mL using a rotary evaporator, then further reduced to approximately 1 mL under a gentle stream of nitrogen prior to clean-up.

Correction factors for wet/dry sediments were obtained by drying a subsample of the homogenised sediment to constant weight at 105 °C.

B.2.3.3 Clean-Up of Extracts by Column Chromatography

Removal of polar material, including lipids was carried out using a silica gel column. The silica gel used was 70 to 230 mesh which was heated at 400 °C for at least 4 hours to remove impurities and residual moisture and then stored at 200 °C prior to use. The sample extract was added to the silica gel column, containing 5 g of adsorbent and eluted with 35 mL of DCM/pentane (1:2). The eluant was reduced in volume using the evaporator to approximately 2 mL, with activated copper powder (for removal of free sulphur), before being further reduced under a gentle stream of nitrogen to an appropriate volume and analysed by both gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS).

	Gas Chromatography [GC]	Gas Chromatography-Mass Spectrometry [GC-MS]
Instrument	HP 6890 Series GC with 7673 autoinjector	HP 7890 Series GC with autoinjector and 5977A MSD
Column	100 %-dimethylpolysiloxane bonded fused silica, 60 m, 0.25 µm film thickness, 0.32 mm internal diameter	(5 %phenyl)-methylpolysiloxane bonded fused silica, 60 m, 0.32 µm film thickness 0.25 mm internal diameter
Carrier Gas	Hydrogen (constant flow 3.5 mL/min)	Hydrogen (constant flow 1.4 mL/min)
Injector	On–column (2 µL injection)	Splitless, 280 °C, split flow 40 mL/min, vent time 1.5 min (1 µL injection)
Oven Temperature Programme	80 °C – 2 min 80 °C to 320 °C at 18 °C/min 320 °C – 13 min 320 °C to 350 °C at 30 °C/min	60 °C – 1 min 60 °C to 180 °C at 11 °C/min 180 °C to 260 °C at 6 °C/min 260 °C to 320 °C at 6 °C/min 330 °C – 7 min
Source/Detector Temperature	350 °C (FID)	230 °C
Electron Energy		70 eV
Selected Ion Monitoring (SIM)		9 groups - 6 ions per group
Dwell Time (per ion)		0.035 second

B.2.3.4 Total Hydrocarbons by Gas Chromatography–Flame Ionisation Detection (GC-FID)

The total hydrocarbon material present was quantified using response factors calculated from the analysis of mixed oil standard solutions over an appropriate range. The unresolved complex mixture (UCM) was determined by subtracting the area of all the resolved peaks from the total hydrocarbon area and applying the total hydrocarbon response factor. The minimum reporting value is 0.5 µg/g dry weight.

B.2.3.5 n-Alkanes

The n-alkanes between nC_{12} and nC_{36} were reported. Calibration was undertaken using a range of n-alkane standard solutions containing the even carbon number compounds between nC_{12} and nC_{36}, and a range of suitable internal standards. Individual response factors were calculated for each of the n-alkanes present in the calibration solution. Response factors for the non-calibrated n-alkanes were taken to be equivalent to closely eluting compounds. The minimum reporting value of individual n-alkanes is 0.5 ng/g dry weight.

B.2.3.6 Polycyclic Aromatic Hydrocarbons (PAHs)

A full range of polycyclic aromatic hydrocarbon (PAH) and alkylated PAH were quantified as specified by Department of Trade and Industry (DTI) regulations (DTI, 1993).

Calibration was undertaken using a range of PAH standard solutions, a number of alkylated PAH, dibenzothiophene and a range of suitable internal standards. Individual response factors were calculated for each of the compounds present in the calibration solution. Response factors for the non-calibrated alkylated PAH were taken to be equivalent to closely related compounds. The minimum reporting value of individual PAHs is 0.1 ng/g and 1 ng/g dry weight for alkylated PAHs.

B.2.4 Total Organic Matter (TOM)

Total organic matter (TOM) analysis was carried out by FGBML. TOM was determined by ignition after the removal of calcium carbonate (shell debris) by treatment with hydrochloric acid. A pre-dried aliquot of the sediment was weighed and then treated with hydrochloric acid to remove inorganic carbon in the form of carbonate. Fresh acid was added until all effervescence ceased; the sediment was then washed over a glass-fibre filter and the residue dried to a constant weight before being ignited in a muffle furnace at 440 °C for 4 hours. The organic content of the sediment is then calculated using the weight difference from the original dry weight to the ignited residue (taking into account the loss of carbonate).

B.2.5 Heavy and Trace Metals in Sediments

Sediment samples were freeze dried and then sieved to the required size fraction (2000 µm). Samples were subjected to an aqua regia microwave digestion. This acid mixture allows a partial dissolution of metals from most soil and sediment types which allows the bioavailable metals content to be analysed. The resulting digests were then analysed by inductively coupled plasma-mass spectrometry (ICP-MS) and/or inductively coupled plasma-optical emission spectroscopy (ICP-OES).

Mercury content was determined by sieving the sample to < 2000 µm followed by a microwave assisted aqua-regia digest, acidic stannous chloride reduction and determination by cold vapour-atomic fluorescence spectroscopy (CV-AFS).

B.2.6 Macrofaunal Analysis

Macrofaunal analysis was carried out by APEM Limited.

On return to the laboratory, the samples were removed from formalin and washed through 1.0 mm mesh sieves. The material retained was then processed to remove fauna. The animals were separated by hand from the retained sediment by using a combination of stereo microscopes for the fine sediments and in white trays for any coarser material. Processed sediment is stored in Phenoxetol (2 %) or returned to the original formalin.

Following extraction, the animals were identified and enumerated by specialist taxonomists. Identification was to species level where possible. Specimens which, due to their immaturity, damage incurred during processing or lack of suitable taxonomic literature, cannot be identified to species level are identified at higher taxonomic levels as appropriate. After identification, samples were stored in 70 % industrial denatured alcohol (IDA) or a mixture of 70 % ethanol/1 % propylene glycol/29 % water. A minimum of 10 % of samples within the project were re-analysed (for extraction, species identification, enumeration and data entry) as per NMBAQC quality control guidelines (Worsfold, 2010).

Species abundances were entered on file in a spreadsheet package or the Unicorn database, both of which store and sort entries into taxonomic order and provide output files for numerical analysis. Nomenclature follows that given on the World Register of Marine Species (WoRMS Editorial Board, 2019). The taxonomic order is based on Species Directory codes (Howson and Picton, 1997) to give an idea of 'evolutionary rank'. Once all the entries had been checked, the resulting quantitative data were subjected to various statistical techniques to investigate community structure. All quantitative analyses were performed on species abundances from single samples from each station, thus the sample size was 0.1 m^2 at all stations.

Prior to statistical analysis, the macrofaunal abundance data was manipulated to avoid spurious enhancement of community statistics. This involved the removal of all meiofaunal taxa (e.g. COPEPODA), pelagic taxa (e.g. CHAETOGNATHA), damaged taxa, fish and juvenile specimens, as they are not considered to be a permanent part of the community. Colonial taxa, which could not be enumerated, were also removed from the dataset.

B.3 STATISTICAL ANALYSIS

B.3.1 Multivariate Analysis

Macrofauna abundance data were analysed by multivariate techniques using the statistical package PRIMER v6. Approaches followed those outlined in Clarke and Gorley (2006). The main techniques used to interrogate the data are detailed below.

Pre-treatment and Transformations: prior to analysis data typically undergo transformation to down weight the effect of dominant data components in determining inter-sample similarities. These transformations vary in their effect through: no transform; square root (√); fourth root/double square root (√√); logarithmic, and; reduction to presence/absence. At the former end of the spectrum (no transform) all attention is focused on the dominant components of the dataset, and at the latter end (reduction to presence/absence) equal weighting is applied to all components (Clarke and Gorley, 2006). Square root transformation was used in this instance, as detailed within the report.

Similarity Matrices: a triangular similarity matrix was produced from the square root transformed data, by calculating the similarity between every pair of samples. The Bray-Curtis similarity coefficient was used for macrofaunal data (Bray and Curtis, 1957). This similarity measure is considered the most suitable as it maintains independence of joint absence (i.e. will not infer similarity between samples based on the absence of a certain parameter in them).

Hierarchical Agglomerative Clustering (CLUSTER) and Similarity Profile Testing (SIMPROF): the CLUSTER programme uses the similarity matrix to successively fuse samples into groups and groups into clusters according to their level of similarity. The end point of this process is a single cluster containing all the samples, which is displayed by means of a dendrogram with similarity displayed on one axis and samples on the other. Similarity profile permutation tests (SIMPROF) were also performed, to look for evidence of genuine statistically significant clusters, in samples that are a-priori unstructured (i.e. with no prior statistical design). By combining this significance testing with the CLUSTER function, dendrograms are produced indicating those clusters that are statistically significant.

Non-metric Multidimensional Scaling (nMDS): non-metric multidimensional scaling (nMDS) uses the similarity matrix to ordinate samples in a two-dimensional plane. The representation of the multidimensional (multiple variable) dataset in two dimensions will inevitably result in some distortion of the real data relationships and this distortion is expressed as a stress value. Stress values above 0.3 indicate arbitrary points and the ordination should be considered unreliable. Stress values between 0.2 and 0.3 are poor representations of the data. Stress < 0.2 can provide meaningful ordinations, while stress < 0.1 demonstrate a good interpretation of the data.

Correlations with Environmental Variables: BEST analysis was also performed on log (X+1) transformed aggregated chemical data and crude particle size data. The BIO-ENV algorithm was adopted, which correlates individual variables and combinations of variables to the macrofauna. Environmental variables that strongly covaried were assessed from draftsman's plots and the correlations analysis and one or other variable was removed from the analysis.

B.3.2 Primary Variables and Diversity Indices

A range of primary variables and derived indices were calculated that attempt to quantify the species richness, evenness and a combination of both. The primary variables (number of individuals and species) and diversity indices (Shannon-Wiener diversity, Brillouin's diversity, Simpson's diversity and Pielou's evenness) were calculated for both the samples and the pooled replicates for each station using the PRIMER v6 DIVERSE procedure.

Shannon Wiener Index (H' or more specifically H'Log$_2$)

The Shannon-Wiener index (or Shannon-Wiener information function) is essentially a measure of how difficult it would be to predict correctly the species of the next individual collected from the community under study. It is a measure of uncertainty and was originally developed to assess the information content of codes. Information content is a measure of uncertainty, so that the larger the value of the index, the greater the uncertainty. It is usually expressed as:

$$= -\sum_i P_i \operatorname{Log}(P_i)$$

Where pi is the proportion of the ith species. For practical application, the formula can be expanded to:

$$H_S = C\left(\log_{10} N - \frac{1}{N}\sum n_i \log_{10} n_i\right)$$

Where N = total number of individuals
ni = number of individuals of ith species
C = conversion factor $\log_{10} - \log_2$.

Two components of diversity are combined in the Shannon-Wiener index. These are species richness (i.e. numbers of species) and the equitability or evenness of distribution of individuals among the species. A greater number of species increases the index value as does more even distribution of individuals amongst species. Theoretically, the Shannon-Wiener index should only be used on random samples drawn from a large community in which the total number of species is known. This is, of course, not usually possible and so the use of the index is always a compromise.

Simpsons (1-λ)

Simpson's index of diversity is derived from probability theory. It is simply a measure of the probability of picking two individuals from a community at random that are different species. The index is calculated from:

$$D = 1 - \sum_{i=1}^{s} (p_i)^2$$

Where pi is the proportion of the ith species. An expanded and more practicable formula is:

$$D = 1 - \sum \frac{n_i(n_i - 1)}{N(N-1)}$$

Where ni = number of individuals of ith species
N = total number of individuals.

Simpson's index assigns relatively little weight to rare species, and more weight to the common ones. It ranges in value from 0 (low diversity) to a maximum of (1 to 1/s) where s = the number of species.

Brillouin's Index (Hb)

This index, like that of Shannon-Wiener, is concerned with information content. However, unlike the Shannon-Wiener index, which provides an estimate of the community diversity, Brillouin's index provides the actual diversity of the fully censused sample. It is not a statistical estimate but an actual measurement of the diversity of the sample unit. The formula, displayed below, contains factorials that can involve very large numbers in computation. In the past, this has been a serious drawback to the use of the index by practical ecologists. This is no longer the case with the advent of personal computers capable of high speed calculations.

The formula for Brillouin's index is:

$$H_b = \frac{1}{N} \log_e \frac{N!}{N_1! N_2! \ldots N_s!}$$

Where N = total number of individuals
Ni = number of individuals of the i^{th} species
S = total number of species in the collection.

As the index provides the exact diversity of the sample, it is most appropriate in surveys where it is not possible to define the limits of the population. Since this is nearly always the case when dealing with benthic communities, Brillouin's index has much to commend it in offshore pollution monitoring studies.

Pielou's Equitability (J)

Equitability refers to the evenness with which individuals are distributed amongst species. Equitability is clearly a component of species diversity and certainly enters into diversity indices such as $H'Log_2$, Hb, and λ.

Equitability can be assessed in several ways, the most commonly used approach being to calculate the theoretical diversity for a given species abundance list if all the species were equal in abundance. The equitability of the sample can then be defined as the ratio of the actual diversity to the theoretical maximum.

This is usually done using the Shannon-Wiener index (H'Log_2)

If all species are equally represented, then the equation can be written:

$$H'(max) = -S\left(\frac{1}{s} log2 \frac{1}{s}\right) = log_s S$$

The equitability ratio is therefore:

$$J = \frac{H_s}{log_2 S}$$

Where	J	=	equitability measure (Pielou)
	H'	=	calculated Shannon-Wiener diversity
	S	=	total number of species.

C. LOGS

C.1 SURVEY LOG

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
21/03/2019	10:57:20	LS_ST01A	Video	SOL	-	6.8	296 270	5 937 063	296 287.8	5 937 016.9	49.1	System crashed - no fixes
21/03/2019	10:57:53	LS_ST01A	Still	181275_LS_ST01A_02	NF	-	-	-	-	-	-	
21/03/2019	11:10:06	LS_ST01A	Video	EOL	-	8.3	296 270	5 937 063	296 262.7	5 937 262.3	199.6	
21/03/2019	11:39:46	LS_ST01A_2	Video	SOL	-	6.8	296 270	5 937 063	296 293.1	5 937 015.3	52.7	
21/03/2019	11:40:32	LS_ST01A_2	Still	181275_LS_ST01A_2_02	3		296 270	5 937 063	296 288.7	5 937 032.5	35.5	
21/03/2019	11:41:00	LS_ST01A_2	Still	181275_LS_ST01A_2_03	4		296 270	5 937 063	296 285.9	5 937 044.8	23.9	
21/03/2019	11:41:17	LS_ST01A_2	Still	181275_LS_ST01A_2_04	5		296 270	5 937 063	296 285.3	5 937 050.9	19.2	
21/03/2019	11:41:26	LS_ST01A_2	Still	181275_LS_ST01A_2_05	6		296 270	5 937 063	296 285.4	5 937 053.4	17.8	
21/03/2019	11:41:44	LS_ST01A_2	Still	181275_LS_ST01A_2_06	7		296 270	5 937 063	296 285.5	5 937 060.0	15.5	
21/03/2019	11:42:00	LS_ST01A_2	Still	181275_LS_ST01A_2_07	8		296 270	5 937 063	296 284.6	5 937 065.7	14.6	
21/03/2019	11:42:19	LS_ST01A_2	Still	181275_LS_ST01A_2_08	9		296 270	5 937 063	296 283.8	5 937 073.8	17.4	
21/03/2019	11:43:00	LS_ST01A_2	Still	181275_LS_ST01A_2_09	10		296 270	5 937 063	296 281.4	5 937 088.2	27.7	
21/03/2019	11:43:59	LS_ST01A_2	Still	181275_LS_ST01A_2_10	11		296 270	5 937 063	296 279.3	5 937 108.0	46.1	
21/03/2019	11:44:26	LS_ST01A_2	Still	181275_LS_ST01A_2_11	12		296 270	5 937 063	296 278.0	5 937 117.7	55.4	
21/03/2019	11:45:25	LS_ST01A_2	Still	181275_LS_ST01A_2_12	13		296 270	5 937 063	296 276.4	5 937 139.6	77.0	
21/03/2019	11:46:17	LS_ST01A_2	Still	181275_LS_ST01A_2_13	14		296 270	5 937 063	296 274.0	5 937 158.4	95.7	
21/03/2019	11:47:18	LS_ST01A_2	Still	181275_LS_ST01A_2_14	15		296 270	5 937 063	296 269.9	5 937 179.8	117.0	
21/03/2019	11:48:00	LS_ST01A_2	Still	181275_LS_ST01A_2_15	16		296 270	5 937 063	296 270.6	5 937 198.7	135.8	
21/03/2019	11:49:10	LS_ST01A_2	Still	181275_LS_ST01A_2_16	17		296 270	5 937 063	296 271.2	5 937 223.5	160.7	
21/03/2019	11:49:43	LS_ST01A_2	Still	181275_LS_ST01A_2_17	18		296 270	5 937 063	296 269.4	5 937 233.2	170.4	
21/03/2019	11:50:14	LS_ST01A_2	Still	181275_LS_ST01A_2_18	19		296 270	5 937 063	296 265.4	5 937 241.0	178.3	
21/03/2019	11:50:52	LS_ST01A_2	Still	181275_LS_ST01A_2_19	20		296 270	5 937 063	296 260.1	5 937 253.5	191.0	
21/03/2019	11:51:20	LS_ST01A_2	Video	EOL	-	8.3	296 270	5 937 063	296 258.6	5 937 262.1	199.6	
21/03/2019	12:05:56	LS_ST02	Video	SOL	-	15.0	298 411	5 937 630	298 418.7	5 937 591.1	39.7	
21/03/2019	12:06:21	LS_ST02	Still	181275_LS_ST02_02	21		298 411	5 937 630	298 420.0	5 937 595.4	35.7	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
21/03/2019	12:06:27	LS_ST02	Still	181275_LS_ST02_03	22		298 411	5 937 630	298 420.3	5 937 596.5	34.8	
21/03/2019	12:07:05	LS_ST02	Still	181275_LS_ST02_04	23		298 411	5 937 630	298 420.7	5 937 603.1	28.6	
21/03/2019	12:07:53	LS_ST02	Still	181275_LS_ST02_05	24		298 411	5 937 630	298 416.3	5 937 608.4	22.2	
21/03/2019	12:08:30	LS_ST02	Still	181275_LS_ST02_06	25		298 411	5 937 630	298 415.1	5 937 613.9	16.6	
21/03/2019	12:08:40	LS_ST02	Still	181275_LS_ST02_07	26		298 411	5 937 630	298 416.0	5 937 615.8	15.0	
21/03/2019	12:08:54	LS_ST02	Still	181275_LS_ST02_08	27		298 411	5 937 630	298 416.3	5 937 618.3	12.8	
21/03/2019	12:09:22	LS_ST02	Still	181275_LS_ST02_09	28		298 411	5 937 630	298 417.8	5 937 622.6	10.1	
21/03/2019	12:09:35	LS_ST02	Still	181275_LS_ST02_10	29		298 411	5 937 630	298 417.8	5 937 625.0	8.5	
21/03/2019	12:09:44	LS_ST02	Still	181275_LS_ST02_11	30		298 411	5 937 630	298 416.4	5 937 626.6	6.3	
21/03/2019	12:10:15	LS_ST02	Still	181275_LS_ST02_12	31		298 411	5 937 630	298 415.0	5 937 629.7	4.0	
21/03/2019	12:10:30	LS_ST02	Still	181275_LS_ST02_13	32		298 411	5 937 630	298 413.2	5 937 631.6	2.7	
21/03/2019	12:10:38	LS_ST02	Still	181275_LS_ST02_14	33		298 411	5 937 630	298 412.8	5 937 631.7	2.5	
21/03/2019	12:11:00	LS_ST02	Still	181275_LS_ST02_15	34		298 411	5 937 630	298 411.4	5 937 633.9	3.9	
21/03/2019	12:11:17	LS_ST02	Still	181275_LS_ST02_16	35		298 411	5 937 630	298 409.2	5 937 637.0	7.2	
21/03/2019	12:11:32	LS_ST02	Still	181275_LS_ST02_17	36		298 411	5 937 630	298 407.9	5 937 639.4	9.9	
21/03/2019	12:11:46	LS_ST02	Still	181275_LS_ST02_18	37		298 411	5 937 630	298 407.7	5 937 640.7	11.2	
21/03/2019	12:12:26	LS_ST02	Still	181275_LS_ST02_19	38		298 411	5 937 630	298 410.9	5 937 643.2	13.2	
21/03/2019	12:12:31	LS_ST02	Still	181275_LS_ST02_20	39		298 411	5 937 630	298 411.4	5 937 643.4	13.4	
21/03/2019	12:12:59	LS_ST02	Still	181275_LS_ST02_21	40		298 411	5 937 630	298 412.5	5 937 650.0	20.1	
21/03/2019	12:13:06	LS_ST02	Still	181275_LS_ST02_22	41		298 411	5 937 630	298 412.6	5 937 650.6	20.7	
21/03/2019	12:13:15	LS_ST02	Still	181275_LS_ST02_23	42		298 411	5 937 630	298 411.8	5 937 652.1	22.1	
21/03/2019	12:13:25	LS_ST02	Still	181275_LS_ST02_24	43		298 411	5 937 630	298 412.0	5 937 652.5	22.5	
21/03/2019	12:13:32	LS_ST02	Still	181275_LS_ST02_25	44		298 411	5 937 630	298 412.2	5 937 652.6	22.6	
21/03/2019	12:13:55	LS_ST02	Still	181275_LS_ST02_26	45		298 411	5 937 630	298 413.4	5 937 653.2	23.3	
21/03/2019	12:14:03	LS_ST02	Still	181275_LS_ST02_27	46		298 411	5 937 630	298 413.4	5 937 653.3	23.5	
21/03/2019	12:14:26	LS_ST02	Still	181275_LS_ST02_28	47		298 411	5 937 630	298 412.9	5 937 653.1	23.2	
21/03/2019	12:14:31	LS_ST02	Still	181275_LS_ST02_29	48		298 411	5 937 630	298 413.1	5 937 652.6	22.7	
21/03/2019	12:15:02	LS_ST02	Still	181275_LS_ST02_30	49		298 411	5 937 630	298 410.6	5 937 652.7	22.7	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
21/03/2019	12:15:23	LS_ST02	Still	181275_LS_ST02_31	50		298 411	5 937 630	298 408.6	5 937 654.7	24.8	
21/03/2019	12:15:30	LS_ST02	Still	181275_LS_ST02_32	51		298 411	5 937 630	298 408.3	5 937 655.2	25.3	
21/03/2019	12:15:30	LS_ST02	Video	EOL	-	15.0	298 411	5 937 630	298 408.3	5 937 655.2	25.3	
22/03/2019	12:09:49	LS_ST01	DVV	FA/FB	52	8.6	298 411	5 937 630	296 285.6	5 937 148.2	13.3	
22/03/2019	12:25:32	LS_ST01	DVV	PC	53	8.6	298 411	5 937 630	296 277.1	5 937 144.1	5.2	
23/02/2019	08:57:42	LS_ST02	Still	181275_LS_ST02_01	-		-	-	-	-	-	Site slate
23/02/2019	09:10:44	LS_ST02	Still	181275_LS_ST02_02	200	15	298 411	5 937 630	298 430.7	5 937 554.8	78	
23/02/2019	09:11:21	LS_ST02	Still	181275_LS_ST02_03	201	15	298 411	5 937 630	298 420.8	5 937 596.7	35	
23/02/2019	09:33:26	LS_ST02A	Still	181275_LS_ST02A_01	-		-	-	-	-	-	Site slate
23/02/2019	09:39:30	LS_ST02A	Video	SOL	203	15	298 411	5 937 630	298 398.8	5 937 662.0	34	
23/02/2019	09:39:30	LS_ST02A	Still	181275_LS_ST02A_02	203		298 411	5 937 630	298 398.8	5 937 662.0	34	
23/02/2019	09:39:47	LS_ST02A	Still	181275_LS_ST02A_03	204		298 411	5 937 630	298 395.7	5 937 656.6	31	
23/02/2019	09:40:12	LS_ST02A	Still	181275_LS_ST02A_04	205		298 411	5 937 630	298 393.8	5 937 646.7	24	
23/02/2019	09:41:12	LS_ST02A	Still	181275_LS_ST02A_05	206		298 411	5 937 630	298 387.1	5 937 631.7	24	
23/02/2019	09:41:29	LS_ST02A	Still	181275_LS_ST02A_06	207		298 411	5 937 630	298 384.1	5 937 631.2	27	
23/02/2019	09:41:50	LS_ST02A	Still	181275_LS_ST02A_07	208		298 411	5 937 630	298 383.1	5 937 631.0	28	
23/02/2019	09:42:29	LS_ST02A	Still	181275_LS_ST02A_08	209		298 411	5 937 630	298 385.1	5 937 620.5	28	
23/02/2019	09:42:47	LS_ST02A	Still	181275_LS_ST02A_09	210		298 411	5 937 630	298 389.1	5 937 615.5	26	
23/02/2019	09:43:43	LS_ST02A	Still	181275_LS_ST02A_10	211		298 411	5 937 630	298 395.8	5 937 610.4	25	
23/02/2019	09:43:52	LS_ST02A	Still	181275_LS_ST02A_11	212		298 411	5 937 630	298 396.8	5 937 613.0	22	
23/02/2019	09:45:24	LS_ST02A	Still	181275_LS_ST02A_12	213		298 411	5 937 630	298 398.2	5 937 628.8	13	
23/02/2019	09:46:02	LS_ST02A	Still	181275_LS_ST02A_13	214		298 411	5 937 630	298 401.5	5 937 625.7	11	
23/02/2019	09:47:09	LS_ST02A	Still	181275_LS_ST02A_14	215		298 411	5 937 630	298 408.3	5 937 612.9	17	
23/02/2019	09:47:54	LS_ST02A	Still	181275_LS_ST02A_15	216		298 411	5 937 630	298 416.0	5 937 604.5	26	
23/02/2019	09:47:54	LS_ST02A	Video	EOL	216	15	298 411	5 937 630	298 416.0	5 937 604.5	26	
23/02/2019	10:00:30	LS_ST02	DVV	PC/FA	217	17	298 411	5 937 630	298 426.0	5 937 601.7	32	
23/02/2019	10:26:00	LS_ST02	DVV	FB	218	16	298 411	5 937 630	298 395.1	5 937 617.1	21	
23/02/2019	13:51:17	LS_ST01	Still	181275_LS_ST01_01	-		-	-	-	-	-	Site slate

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	14:25:48	LS_ST01A	Still	181275_ST01A_01	-		-	-	-	-	-	Site slate
23/02/2019	14:40:18	LS_ST01A	Still	181275_ST01A_02	221	11	296 655	5 937 208	296 631.8	5 937 201.5	24	
23/02/2019	15:07:56	LS_ST01B	Still	181275_LS_ST01B_01	-		-	-	-	-	-	Site slate
23/02/2019	15:13:22	LS_ST01B	Video	SOL	226	11	296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:13:22	LS_ST01B	Still	181275_LS_ST01B_02	226		296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:14:30	LS_ST01B	Still	181275_LS_ST01B_03	228		296 655	5 937 208	296 649.0	5 937 283.4	76	
23/02/2019	15:15:26	LS_ST01B	Still	181275_LS_ST01B_04	229		296 655	5 937 208	296 646.5	5 937 265.4	58	
23/02/2019	15:16:49	LS_ST01B	Still	181275_LS_ST01B_05	230		296 655	5 937 208	296 642.3	5 937 238.9	33	
23/02/2019	15:18:42	LS_ST01B	Still	181275_LS_ST01B_06	231		296 655	5 937 208	296 632.3	5 937 204.8	23	
23/02/2019	15:20:12	LS_ST01B	Still	181275_LS_ST01B_07	234		296 655	5 937 208	296 623.5	5 937 178.8	43	
23/02/2019	15:20:57	LS_ST01B	Still	181275_LS_ST01B_08	235		296 655	5 937 208	296 619.8	5 937 165.9	55	
23/02/2019	15:22:19	LS_ST01B	Still	181275_LS_ST01B_09	236		296 655	5 937 208	296 612.4	5 937 141.9	79	
23/02/2019	15:23:04	LS_ST01B	Still	181275_LS_ST01B_10	237		296 655	5 937 208	296 607.8	5 937 129.1	92	
23/02/2019	15:23:49	LS_ST01B	Still	181275_LS_ST01B_11	238		296 655	5 937 208	296 604.0	5 937 115.4	106	
23/02/2019	15:24:56	LS_ST01B	Still	181275_LS_ST01B_12	239		296 655	5 937 208	296 598.4	5 937 096.2	125	
23/02/2019	15:25:30	LS_ST01B	Still	181275_LS_ST01B_13	240		296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	15:25:30	LS_ST01B	Video	EOL	240	11	296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	16:23:10	LS_ST03	Still	181275_LS_ST03_01	-		-	-	-	-	-	Site slate
23/02/2019	16:34:36	LS_ST03	Video	SOL	242	35	303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:36	LS_ST03	Still	181275_LS_ST03_02	242		303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:56	LS_ST03	Still	181275_LS_ST03_03	243		303 849	5 938 838	303 867.6	5 938 731.1	109	
23/02/2019	16:35:14	LS_ST03	Still	181275_LS_ST03_04	244		303 849	5 938 838	303 865.4	5 938 737.6	102	
23/02/2019	16:35:27	LS_ST03	Still	181275_LS_ST03_05	245		303 849	5 938 838	303 864.6	5 938 742.6	97	
23/02/2019	16:35:41	LS_ST03	Still	181275_LS_ST03_06	246		303 849	5 938 838	303 864.8	5 938 748.4	91	
23/02/2019	16:36:19	LS_ST03	Still	181275_LS_ST03_07	247		303 849	5 938 838	303 870.3	5 938 764.5	77	
23/02/2019	16:36:46	LS_ST03	Still	181275_LS_ST03_08	248		303 849	5 938 838	303 872.3	5 938 781.4	61	
23/02/2019	16:36:56	LS_ST03	Still	181275_LS_ST03_09	249		303 849	5 938 838	303 870.9	5 938 787.5	55	
23/02/2019	16:37:15	LS_ST03	Still	181275_LS_ST03_10	250		303 849	5 938 838	303 867.1	5 938 797.3	45	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	16:37:32	LS_ST03	Still	181275_LS_ST03_11	251		303 849	5 938 838	303 862.7	5 938 805.0	36	
23/02/2019	16:37:48	LS_ST03	Still	181275_LS_ST03_12	252		303 849	5 938 838	303 858.2	5 938 810.5	29	
23/02/2019	16:38:04	LS_ST03	Still	181275_LS_ST03_13	253		303 849	5 938 838	303 854.4	5 938 815.5	23	
23/02/2019	16:38:21	LS_ST03	Still	181275_LS_ST03_14	254		303 849	5 938 838	303 851.4	5 938 824.1	14	
23/02/2019	16:38:36	LS_ST03	Still	181275_LS_ST03_15	255		303 849	5 938 838	303 850.7	5 938 833.4	5	
23/02/2019	16:39:02	LS_ST03	Still	181275_LS_ST03_16	256		303 849	5 938 838	303 848.1	5 938 847.3	9	
23/02/2019	16:39:13	LS_ST03	Still	181275_LS_ST03_17	257		303 849	5 938 838	303 846.9	5 938 852.5	15	
23/02/2019	16:39:24	LS_ST03	Still	181275_LS_ST03_18	258		303 849	5 938 838	303 845.6	5 938 857.1	19	
23/02/2019	16:39:50	LS_ST03	Still	181275_LS_ST03_19	259		303 849	5 938 838	303 841.8	5 938 865.6	29	
23/02/2019	16:40:05	LS_ST03	Still	181275_LS_ST03_20	260		303 849	5 938 838	303 839.2	5 938 869.1	33	
23/02/2019	16:40:16	LS_ST03	Still	181275_LS_ST03_21	261		303 849	5 938 838	303 837.0	5 938 871.6	36	
23/02/2019	16:40:27	LS_ST03	Still	181275_LS_ST03_22	262		303 849	5 938 838	303 835.2	5 938 873.9	39	
23/02/2019	16:40:38	LS_ST03	Still	181275_LS_ST03_23	263		303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	16:40:38	LS_ST03	Video	EOL	263	35	303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	15:07:56	LS_ST01B	Still	181275_LS_ST01B_01	-		-	-	-	-	-	Site slate
23/02/2019	15:13:22	LS_ST01B	Video	SOL	226		296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:13:22	LS_ST01B	Still	181275_LS_ST01B_02	226		296 655	5 937 208	296 652.9	5 937 305.4	97	
23/02/2019	15:14:30	LS_ST01B	Still	181275_LS_ST01B_03	228		296 655	5 937 208	296 649.0	5 937 283.4	76	
23/02/2019	15:15:26	LS_ST01B	Still	181275_LS_ST01B_04	229		296 655	5 937 208	296 646.5	5 937 265.4	58	
23/02/2019	15:16:49	LS_ST01B	Still	181275_LS_ST01B_05	230		296 655	5 937 208	296 642.3	5 937 238.9	33	
23/02/2019	15:18:42	LS_ST01B	Still	181275_LS_ST01B_06	231		296 655	5 937 208	296 632.3	5 937 204.8	23	
23/02/2019	15:20:12	LS_ST01B	Still	181275_LS_ST01B_07	234		296 655	5 937 208	296 623.5	5 937 178.8	43	
23/02/2019	15:20:57	LS_ST01B	Still	181275_LS_ST01B_08	235		296 655	5 937 208	296 619.8	5 937 165.9	55	
23/02/2019	15:22:19	LS_ST01B	Still	181275_LS_ST01B_09	236		296 655	5 937 208	296 612.4	5 937 141.9	79	
23/02/2019	15:23:04	LS_ST01B	Still	181275_LS_ST01B_10	237		296 655	5 937 208	296 607.8	5 937 129.1	92	
23/02/2019	15:23:49	LS_ST01B	Still	181275_LS_ST01B_11	238		296 655	5 937 208	296 604.0	5 937 115.4	106	
23/02/2019	15:24:56	LS_ST01B	Still	181275_LS_ST01B_12	239		296 655	5 937 208	296 598.4	5 937 096.2	125	
23/02/2019	15:25:30	LS_ST01B	Still	181275_LS_ST01B_13	240		296 655	5 937 208	296 595.9	5 937 086.4	135	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	15:25:30	LS_ST01B	Video	EOL	240	11	296 655	5 937 208	296 595.9	5 937 086.4	135	
23/02/2019	16:23:10	LS_ST03	Still	181275_LS_ST03_01	-		-	-	-	-	-	Site slate
23/02/2019	16:34:36	LS_ST03	Video	SOL	242	35	303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:36	LS_ST03	Still	181275_LS_ST03_02	242	35	303 849	5 938 838	303 870.6	5 938 724.0	116	
23/02/2019	16:34:56	LS_ST03	Still	181275_LS_ST03_03	243		303 849	5 938 838	303 867.6	5 938 731.1	109	
23/02/2019	16:35:14	LS_ST03	Still	181275_LS_ST03_04	244		303 849	5 938 838	303 865.4	5 938 737.6	102	
23/02/2019	16:35:27	LS_ST03	Still	181275_LS_ST03_05	245		303 849	5 938 838	303 864.6	5 938 742.6	97	
23/02/2019	16:35:41	LS_ST03	Still	181275_LS_ST03_06	246		303 849	5 938 838	303 864.8	5 938 748.4	91	
23/02/2019	16:36:19	LS_ST03	Still	181275_LS_ST03_07	247		303 849	5 938 838	303 870.3	5 938 764.5	77	
23/02/2019	16:36:46	LS_ST03	Still	181275_LS_ST03_08	248		303 849	5 938 838	303 872.3	5 938 781.4	61	
23/02/2019	16:36:56	LS_ST03	Still	181275_LS_ST03_09	249		303 849	5 938 838	303 870.9	5 938 787.5	55	
23/02/2019	16:37:15	LS_ST03	Still	181275_LS_ST03_10	250		303 849	5 938 838	303 867.1	5 938 797.3	45	
23/02/2019	16:37:32	LS_ST03	Still	181275_LS_ST03_11	251		303 849	5 938 838	303 862.7	5 938 805.0	36	
23/02/2019	16:37:48	LS_ST03	Still	181275_LS_ST03_12	252		303 849	5 938 838	303 858.2	5 938 810.5	29	
23/02/2019	16:38:04	LS_ST03	Still	181275_LS_ST03_13	253		303 849	5 938 838	303 854.4	5 938 815.5	23	
23/02/2019	16:38:21	LS_ST03	Still	181275_LS_ST03_14	254		303 849	5 938 838	303 851.4	5 938 824.1	14	
23/02/2019	16:38:36	LS_ST03	Still	181275_LS_ST03_15	255		303 849	5 938 838	303 850.7	5 938 833.4	5	
23/02/2019	16:39:02	LS_ST03	Still	181275_LS_ST03_16	256		303 849	5 938 838	303 848.1	5 938 847.3	9	
23/02/2019	16:39:13	LS_ST03	Still	181275_LS_ST03_17	257		303 849	5 938 838	303 846.9	5 938 852.5	15	
23/02/2019	16:39:24	LS_ST03	Still	181275_LS_ST03_18	258		303 849	5 938 838	303 845.6	5 938 857.1	19	
23/02/2019	16:39:50	LS_ST03	Still	181275_LS_ST03_19	259		303 849	5 938 838	303 841.8	5 938 865.6	29	
23/02/2019	16:40:05	LS_ST03	Still	181275_LS_ST03_20	260		303 849	5 938 838	303 839.2	5 938 869.1	33	
23/02/2019	16:40:16	LS_ST03	Still	181275_LS_ST03_21	261		303 849	5 938 838	303 837.0	5 938 871.6	36	
23/02/2019	16:40:27	LS_ST03	Still	181275_LS_ST03_22	262		303 849	5 938 838	303 835.2	5 938 873.9	39	
23/02/2019	16:40:38	LS_ST03	Still	181275_LS_ST03_23	263		303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	16:40:38	LS_ST03	Video	EOL	263	35	303 849	5 938 838	303 833.3	5 938 876.9	42	
23/02/2019	17:00:32	LS_ST03	DVV	NS/NS	264	34	303 849	5 938 838	303 831.7	5 938 833.1	18	
23/02/2019	17:16:30	LS_ST03	DVV	NS/NS	265	34	303 849	5 938 838	303 874.5	5 938 836.5	26	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	17:36:03	LS_ST03	DVV	NS/NS	266	33	303 849	5 938 838	303 843.4	5 938 833.9	7	
23/02/2019	17:46:48	LS_ST03	DVV	NS/NS	267	33	303 849	5 938 838	303 862.7	5 938 819.2	23	
23/02/2019	17:53:50	LS_ST03	DVV	NS/NS	268	33	303 849	5 938 838	303 858.8	5 938 799.8	40	
23/02/2019	18:35:00	LS_ST03	DVV	PC/FA	269	32	303 849	5 938 838	303 889.9	5 938 821.5	44	
23/02/2019	18:54:40	LS_ST03	DVV	NS/NS	270	33	303 849	5 938 838	303 835.1	5 938 852.6	20	
23/02/2019	18:55:33	LS_ST03	DVV	NS/NS	271	32	303 849	5 938 838	303 836.5	5 938 847.2	16	
23/02/2019	19:05:29	LS_ST03	DVV	FB	272	32	303 849	5 938 838	303 829.1	5 938 867.0	35	
23/02/2019	20:03:59	LS_ST04	Still	181275_LS_ST04_01	-		-	-	-	-	-	Site slate
23/02/2019	20:25:48	LS_ST04	Video	SOL	274	41	307 143	5 939 833	307 144.3	5 939 797.0	36	
23/02/2019	20:25:48	LS_ST04	Still	181274_LS_ST04_02	274		307 143	5 939 833	307 144.3	5 939 797.0	36	
23/02/2019	20:26:19	LS_ST04	Still	181274_LS_ST04_03	275		307 143	5 939 833	307 143.3	5 939 803.8	29	
23/02/2019	20:26:34	LS_ST04	Still	181274_LS_ST04_04	276		307 143	5 939 833	307 143.0	5 939 807.5	26	
23/02/2019	20:26:50	LS_ST04	Still	181274_LS_ST04_05	277		307 143	5 939 833	307 142.4	5 939 811.9	21	
23/02/2019	20:27:03	LS_ST04	Still	181274_LS_ST04_06	278		307 143	5 939 833	307 141.9	5 939 815.5	18	
23/02/2019	20:27:14	LS_ST04	Still	181274_LS_ST04_07	279		307 143	5 939 833	307 141.5	5 939 818.3	15	
23/02/2019	20:27:33	LS_ST04	Still	181274_LS_ST04_08	280		307 143	5 939 833	307 140.9	5 939 823.0	10	
23/02/2019	20:27:52	LS_ST04	Still	181274_LS_ST04_09	281		307 143	5 939 833	307 140.5	5 939 827.6	6	
23/02/2019	20:28:10	LS_ST04	Still	181274_LS_ST04_10	282		307 143	5 939 833	307 139.5	5 939 831.0	4	
23/02/2019	20:28:29	LS_ST04	Still	181274_LS_ST04_11	283		307 143	5 939 833	307 138.8	5 939 835.8	5	
23/02/2019	20:28:45	LS_ST04	Still	181274_LS_ST04_12	284		307 143	5 939 833	307 138.4	5 939 839.6	8	
23/02/2019	20:29:34	LS_ST04	Still	181274_LS_ST04_13	286		307 143	5 939 833	307 137.4	5 939 852.9	21	
23/02/2019	20:29:46	LS_ST04	Still	181274_LS_ST04_14	287		307 143	5 939 833	307 136.8	5 939 856.2	24	
23/02/2019	20:30:00	LS_ST04	Still	181274_LS_ST04_15	288		307 143	5 939 833	307 136.4	5 939 859.7	28	
23/02/2019	20:30:11	LS_ST04	Still	181274_LS_ST04_16	289		307 143	5 939 833	307 136.0	5 939 862.3	30	
23/02/2019	20:30:43	LS_ST04	Still	181274_LS_ST04_17	290		307 143	5 939 833	307 134.4	5 939 872.3	40	
23/02/2019	20:31:03	LS_ST04	Still	181274_LS_ST04_18	291		307 143	5 939 833	307 133.8	5 939 878.1	46	
23/02/2019	20:31:14	LS_ST04	Still	181274_LS_ST04_19	292		307 143	5 939 833	307 133.1	5 939 881.0	49	
23/02/2019	20:31:14	LS_ST04	Video	EOL	292	41	307 143	5 939 833	307 133.1	5 939 881.0	49	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
23/02/2019	20:48:32	LS_ST04	DVV	PC/FA	293	41	307 143	5 939 833	307 185.5	5 939 829.5	43	
23/02/2019	21:04:36	LS_ST04	DVV	FB	294	42	307 143	5 939 833	307 129.0	5 939 813.1	24	
23/02/2019	-	LS_ST05	Still	181275_LS_ST05_01	-		-	-	-	-	-	Site slate
23/02/2019	22:03:51	LS_ST05	Video	SOL	295	66	314 915	5943502	314920.0	5943457.1	45	
23/02/2019	22:03:51	LS_ST05	Still	181275_LS_ST05_02	295		314 915	5943502	314920.0	5943457.1	45	
23/02/2019	22:04:05	LS_ST05	Still	181275_LS_ST05_03	296		314 915	5943502	314917.9	5943464.6	38	
23/02/2019	22:04:15	LS_ST05	Still	181275_LS_ST05_04	297		314 915	5943502	314916.5	5943471.4	31	
23/02/2019	22:04:36	LS_ST05	Still	181275_LS_ST05_05	298		314 915	5943502	314913.6	5943484.3	18	
23/02/2019	22:04:53	LS_ST05	Still	181275_LS_ST05_06	299		314 915	5943502	314911.6	5943493.6	9	
23/02/2019	22:05:02	LS_ST05	Still	181275_LS_ST05_07	300		314 915	5943502	314909.8	5943499.7	6	
23/02/2019	22:05:13	LS_ST05	Still	181275_LS_ST05_08	301		314 915	5943502	314908.2	5943506.5	8	
23/02/2019	22:05:25	LS_ST05	Still	181275_LS_ST05_09	302		314 915	5943502	314906.5	5943513.6	14	
23/02/2019	22:05:36	LS_ST05	Still	181275_LS_ST05_10	303		314 915	5943502	314905.1	5943520.1	21	
23/02/2019	22:05:55	LS_ST05	Still	181275_LS_ST05_11	304		314 915	5943502	314902.7	5943531.5	32	
23/02/2019	22:06:17	LS_ST05	Still	181275_LS_ST05_12	305		314 915	5943502	314900.2	5943543.5	44	
23/02/2019	22:06:27	LS_ST05	Still	181275_LS_ST05_13	306		314 915	5943502	314898.4	5943550.7	52	
23/02/2019	22:06:43	LS_ST05	Still	181275_LS_ST05_14	307		314 915	5943502	314896.6	5943560.6	61	
23/02/2019	22:07:06	LS_ST05	Still	181275_LS_ST05_15	308		314 915	5943502	314893.7	5943574.0	75	
23/02/2019	22:07:18	LS_ST05	Still	181275_LS_ST05_16	309		314 915	5943502	314891.9	5943580.8	82	
23/02/2019	22:07:44	LS_ST05	Still	181275_LS_ST05_17	310		314 915	5943502	314888.9	5943595.5	97	
23/02/2019	22:07:58	LS_ST05	Still	181275_LS_ST05_18	311		314 915	5943502	314887.1	5943603.0	105	
23/02/2019	22:08:17	LS_ST05	Still	181275_LS_ST05_19	312		314 915	5943502	314885.0	5943613.9	116	
23/02/2019	22:08:17	LS_ST05	Video	EOL	312	65.7	314 915	5943502	314885.0	5943613.9	116	
23/02/2019	22:31:26	LS_ST05	DVV	PC/FA	313	66.2	314 915	5943502	314900.5	5943474.5	31	
23/02/2019	22:50:31	LS_ST05	DVV	NS/NS	314	66.8	314 915	5943502	314910.4	5943498.5	6	
23/02/2019	22:59:26	LS_ST05	DVV	FB	315	66.3	314 915	5943502	314912.6	5943512.4	11	
24/02/2019	02:00:16	CC05_T01	Still	181275_CC05_T01_01	-		-	-	-	-	-	Site slate
24/02/2019	02:17:17	CC05_T01A	Still	181275_CC05_T01A_01	-		-	-	-	-	-	Site slate

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:29:09	CC05_T01A	Video	SOL	318	83.0	346 662	5 957 525	347 174.7	5 957 085.5	675	
24/02/2019	02:29:09	CC05_T01A	Still	181275_CC05_T01A_02	318		346 662	5 957 525	347 174.7	5 957 085.5	675	
24/02/2019	02:29:41	CC05_T01A	Still	181275_CC05_T01A_03	319		346 662	5 957 525	347 164.0	5 957 092.9	662	
24/02/2019	02:30:08	CC05_T01A	Still	181275_CC05_T01A_04	320		346 662	5 957 525	347 156.0	5 957 098.2	652	
24/02/2019	02:30:47	CC05_T01A	Still	181275_CC05_T01A_05	321		346 662	5 957 525	347 144.7	5 957 106.2	639	
24/02/2019	02:31:16	CC05_T01A	Still	181275_CC05_T01A_06	322		346 662	5 957 525	347 136.0	5 957 113.1	627	
24/02/2019	02:31:27	CC05_T01A	Still	181275_CC05_T01A_07	323		346 662	5 957 525	347 132.0	5 957 116.1	623	
24/02/2019	02:31:48	CC05_T01A	Still	181275_CC05_T01A_08	324		346 662	5 957 525	347 125.7	5 957 121.6	614	
24/02/2019	02:32:01	CC05_T01A	Still	181275_CC05_T01A_09	325		346 662	5 957 525	347 121.7	5 957 124.6	609	
24/02/2019	02:32:21	CC05_T01A	Still	181275_CC05_T01A_10	326		346 662	5 957 525	347 115.6	5 957 129.8	601	
24/02/2019	02:32:36	CC05_T01A	Still	181275_CC05_T01A_11	327		346 662	5 957 525	347 111.0	5 957 134.2	595	
24/02/2019	02:32:44	CC05_T01A	Still	181275_CC05_T01A_12	328		346 662	5 957 525	347 108.1	5 957 136.7	591	
24/02/2019	02:33:01	CC05_T01A	Still	181275_CC05_T01A_13	329		346 662	5 957 525	347 103.3	5 957 141.1	584	
24/02/2019	02:33:19	CC05_T01A	Still	181275_CC05_T01A_14	330		346 662	5 957 525	347 097.7	5 957 146.4	577	
24/02/2019	02:33:33	CC05_T01A	Still	181275_CC05_T01A_15	331		346 662	5 957 525	347 093.9	5 957 149.4	572	
24/02/2019	02:33:45	CC05_T01A	Still	181275_CC05_T01A_16	332		346 662	5 957 525	347 089.8	5 957 153.4	566	
24/02/2019	02:34:09	CC05_T01A	Still	181275_CC05_T01A_17	333		346 662	5 957 525	347 083.0	5 957 158.7	558	
24/02/2019	02:34:54	CC05_T01A	Still	181275_CC05_T01A_18	334		346 662	5 957 525	347 071.2	5 957 168.9	542	
24/02/2019	02:36:05	CC05_T01A	Still	181275_CC05_T01A_19	335		346 662	5 957 525	347 050.0	5 957 184.9	515	
24/02/2019	02:36:22	CC05_T01A	Still	181275_CC05_T01A_20	336		346 662	5 957 525	347 044.8	5 957 188.6	509	
24/02/2019	02:36:38	CC05_T01A	Still	181275_CC05_T01A_21	337		346 662	5 957 525	347 039.5	5 957 192.7	502	
24/02/2019	02:36:53	CC05_T01A	Still	181275_CC05_T01A_22	338		346 662	5 957 525	347 035.0	5 957 196.0	497	
24/02/2019	02:37:30	CC05_T01A	Still	181275_CC05_T01A_23	339		346 662	5 957 525	347 022.8	5 957 205.3	482	
24/02/2019	02:37:56	CC05_T01A	Still	181275_CC05_T01A_24	340		346 662	5 957 525	347 014.5	5 957 212.1	471	
24/02/2019	02:38:10	CC05_T01A	Still	181275_CC05_T01A_25	341		346 662	5 957 525	347 010.1	5 957 215.9	465	
24/02/2019	02:38:29	CC05_T01A	Still	181275_CC05_T01A_26	342		346 662	5 957 525	347 003.6	5 957 220.6	457	
24/02/2019	02:39:14	CC05_T01A	Still	181275_CC05_T01A_27	343		346 662	5 957 525	346 988.9	5 957 232.8	438	
24/02/2019	02:39:25	CC05_T01A	Still	181275_CC05_T01A_28	344		346 662	5 957 525	346 985.2	5 957 235.3	434	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:40:05	CC05_T01A	Still	181275_CC05_T01A_29	345		346 662	5 957 525	346 972.9	5 957 244.8	418	
24/02/2019	02:40:38	CC05_T01A	Still	181275_CC05_T01A_30	346		346 662	5 957 525	346 963.1	5 957 252.5	406	
24/02/2019	02:41:03	CC05_T01A	Still	181275_CC05_T01A_31	347		346 662	5 957 525	346 956.5	5 957 258.1	397	
24/02/2019	02:41:46	CC05_T01A	Still	181275_CC05_T01A_32	348		346 662	5 957 525	346 944.2	5 957 270.0	380	
24/02/2019	02:42:12	CC05_T01A	Still	181275_CC05_T01A_33	349		346 662	5 957 525	346 937.3	5 957 276.7	370	
24/02/2019	02:43:33	CC05_T01A	Still	181275_CC05_T01A_34	351		346 662	5 957 525	346 914.6	5 957 299.7	338	
24/02/2019	02:43:59	CC05_T01A	Still	181275_CC05_T01A_35	352		346 662	5 957 525	346 906.6	5 957 306.4	328	
24/02/2019	02:44:40	CC05_T01A	Still	181275_CC05_T01A_36	353		346 662	5 957 525	346 894.1	5 957 318.2	310	
24/02/2019	02:45:34	CC05_T01A	Still	181275_CC05_T01A_37	354		346 662	5 957 525	346 877.8	5 957 333.0	288	
24/02/2019	02:46:13	CC05_T01A	Still	181275_CC05_T01A_38	355		346 662	5 957 525	346 864.8	5 957 342.5	272	
24/02/2019	02:46:51	CC05_T01A	Still	181275_CC05_T01A_39	356		346 662	5 957 525	346 852.3	5 957 350.6	258	
24/02/2019	02:47:24	CC05_T01A	Still	181275_CC05_T01A_40	357		346 662	5 957 525	346 841.9	5 957 357.7	245	
24/02/2019	02:48:20	CC05_T01A	Still	181275_CC05_T01A_41	358		346 662	5 957 525	346 824.9	5 957 370.5	224	
24/02/2019	02:48:43	CC05_T01A	Still	181275_CC05_T01A_42	359		346 662	5 957 525	346 817.8	5 957 375.6	215	
24/02/2019	02:49:21	CC05_T01A	Still	181275_CC05_T01A_43	360		346 662	5 957 525	346 805.2	5 957 386.6	199	
24/02/2019	02:49:48	CC05_T01A	Still	181275_CC05_T01A_44	361		346 662	5 957 525	346 796.8	5 957 393.1	188	
24/02/2019	02:50:23	CC05_T01A	Still	181275_CC05_T01A_45	362		346 662	5 957 525	346 785.9	5 957 401.9	174	
24/02/2019	02:51:07	CC05_T01A	Still	181275_CC05_T01A_46	363		346 662	5 957 525	346 772.0	5 957 414.2	156	
24/02/2019	02:51:36	CC05_T01A	Still	181275_CC05_T01A_47	364		346 662	5 957 525	346 762.8	5 957 422.7	143	
24/02/2019	02:52:19	CC05_T01A	Still	181275_CC05_T01A_48	365		346 662	5 957 525	346 748.0	5 957 434.1	125	
24/02/2019	02:52:51	CC05_T01A	Still	181275_CC05_T01A_49	366		346 662	5 957 525	346 737.0	5 957 441.4	112	
24/02/2019	02:53:17	CC05_T01A	Still	181275_CC05_T01A_50	367		346 662	5 957 525	346 728.7	5 957 446.7	102	
24/02/2019	02:53:46	CC05_T01A	Still	181275_CC05_T01A_51	368		346 662	5 957 525	346 719.8	5 957 451.9	93	
24/02/2019	02:54:23	CC05_T01A	Still	181275_CC05_T01A_52	369		346 662	5 957 525	346 706.7	5 957 457.5	81	
24/02/2019	02:54:39	CC05_T01A	Still	181275_CC05_T01A_53	370		346 662	5 957 525	346 701.3	5 957 460.8	75	
24/02/2019	02:55:16	CC05_T01A	Still	181275_CC05_T01A_54	371		346 662	5 957 525	346 687.2	5 957 469.7	60	
24/02/2019	02:55:36	CC05_T01A	Still	181275_CC05_T01A_55	372		346 662	5 957 525	346 680.2	5 957 476.1	52	
24/02/2019	02:56:18	CC05_T01A	Still	181275_CC05_T01A_56	373		346 662	5 957 525	346 668.2	5 957 493.7	32	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	02:57:25	CC05_T01A	Still	181275_CC05_T01A_57	374		346 662	5 957 525	346 650.2	5 957 526.1	12	
24/02/2019	02:58:04	CC05_T01A	Still	181275_CC05_T01A_58	375		346 662	5 957 525	346 640.7	5 957 546.1	31	
24/02/2019	02:58:22	CC05_T01A	Still	181275_CC05_T01A_59	376		346 662	5 957 525	346 636.0	5 957 555.2	40	
24/02/2019	02:58:36	CC05_T01A	Still	181275_CC05_T01A_60	377		346 662	5 957 525	346 631.9	5 957 562.3	49	
24/02/2019	02:59:15	CC05_T01A	Still	181275_CC05_T01A_61	378		346 662	5 957 525	346 618.7	5 957 578.4	69	
24/02/2019	02:59:36	CC05_T01A	Still	181275_CC05_T01A_62	379		346 662	5 957 525	346 612.2	5 957 585.7	79	
24/02/2019	03:00:05	CC05_T01A	Still	181275_CC05_T01A_63	380		346 662	5 957 525	346 601.7	5 957 592.9	91	
24/02/2019	03:01:16	CC05_T01A	Still	181275_CC05_T01A_64	381		346 662	5 957 525	346 575.7	5 957 606.7	119	
24/02/2019	03:01:42	CC05_T01A	Still	181275_CC05_T01A_65	382		346 662	5 957 525	346 566.2	5 957 611.3	130	
24/02/2019	03:02:08	CC05_T01A	Still	181275_CC05_T01A_66	383		346 662	5 957 525	346 556.1	5 957 615.2	140	
24/02/2019	03:02:36	CC05_T01A	Still	181275_CC05_T01A_67	384		346 662	5 957 525	346 546.3	5 957 619.1	150	
24/02/2019	03:02:47	CC05_T01A	Still	181275_CC05_T01A_68	385		346 662	5 957 525	346 542.0	5 957 621.4	154	
24/02/2019	03:02:47	CC05_T01A	Video	EOL	385	82	346 662	5 957 525	346 542.0	5 957 621.4	154	
24/02/2019	03:16:20	CC05_T02	Still	181275_CC05_T02_01	-		-	-	-	-	-	Site slate
24/02/2019	03:26:17	CC05_T02	Video	SOL	387	82	346 662	5 957 525	346 779.4	5 957 515.0	117	
24/02/2019	03:26:17	CC05_T02	Still	181275_CC05_T02_02	387		346 662	5 957 525	346 779.4	5 957 515.0	117	
24/02/2019	03:26:50	CC05_T02	Still	181275_CC05_T02_03	388		346 662	5 957 525	346 761.5	5 957 519.3	99	
24/02/2019	03:27:04	CC05_T02	Still	181275_CC05_T02_04	NF		346 662	5 957 525	-	-	-	
24/02/2019	03:27:25	CC05_T02	Still	181275_CC05_T02_05	389		346 662	5 957 525	346 742.8	5 957 522.8	80	
24/02/2019	03:27:40	CC05_T02	Still	181275_CC05_T02_06	390		346 662	5 957 525	346 735.8	5 957 524.7	73	
24/02/2019	03:27:55	CC05_T02	Still	181275_CC05_T02_07	391		346 662	5 957 525	346 727.8	5 957 525.9	65	
24/02/2019	03:28:13	CC05_T02	Still	181275_CC05_T02_08	392		346 662	5 957 525	346 719.8	5 957 526.9	57	
24/02/2019	03:28:26	CC05_T02	Still	181275_CC05_T02_09	393		346 662	5 957 525	346 713.7	5 957 528.0	51	
24/02/2019	03:28:40	CC05_T02	Still	181275_CC05_T02_10	394		346 662	5 957 525	346 707.8	5 957 527.5	45	
24/02/2019	03:29:06	CC05_T02	Still	181275_CC05_T02_11	395		346 662	5 957 525	346 696.0	5 957 528.6	34	
24/02/2019	03:29:38	CC05_T02	Still	181275_CC05_T02_12	396		346 662	5 957 525	346 682.4	5 957 531.2	21	
24/02/2019	03:30:11	CC05_T02	Still	181275_CC05_T02_13	397		346 662	5 957 525	346 668.2	5 957 531.7	9	
24/02/2019	03:30:31	CC05_T02	Still	181275_CC05_T02_14	398		346 662	5 957 525	346 660.2	5 957 531.6	7	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	03:31:05	CC05_T02	Still	181275_CC05_T02_15	399		346 662	5 957 525	346 646.3	5 957 530.8	17	
24/02/2019	03:31:26	CC05_T02	Still	181275_CC05_T02_16	400		346 662	5 957 525	346 637.4	5 957 529.5	26	
24/02/2019	03:32:06	CC05_T02	Still	181275_CC05_T02_17	401		346 662	5 957 525	346 621.3	5 957 527.7	41.2	
24/02/2019	03:32:33	CC05_T02	Still	181275_CC05_T02_18	402		346 662	5 957 525	346 610.0	5 957 525.2	52.4	
24/02/2019	03:33:03	CC05_T02	Still	181275_CC05_T02_19	403		346 662	5 957 525	346 597.3	5 957 521.2	65.2	
24/02/2019	03:33:38	CC05_T02	Still	181275_CC05_T02_20	404		346 662	5 957 525	346 581.9	5 957 517.2	80.9	
24/02/2019	03:34:29	CC05_T02	Still	181275_CC05_T02_21	405		346 662	5 957 525	346 562.0	5 957 512.0	101.3	
24/02/2019	03:34:56	CC05_T02	Still	181275_CC05_T02_22	406		346 662	5 957 525	346 550.0	5 957 509.7	113.4	
24/02/2019	03:35:22	CC05_T02	Still	181275_CC05_T02_23	407		346 662	5 957 525	346 539.7	5 957 506.5	124.1	
24/02/2019	03:35:46	CC05_T02	Still	181275_CC05_T02_24	408		346 662	5 957 525	346 528.8	5 957 505.1	135.1	
24/02/2019	03:36:22	CC05_T02	Still	181275_CC05_T02_25	409		346 662	5 957 525	346 513.1	5 957 502.3	151.0	
24/02/2019	03:36:31	CC05_T02	Still	181275_CC05_T02_26	410		346 662	5 957 525	346 508.0	5 957 501.8	156.1	
24/02/2019	03:36:31	CC05_T02	Video	EOL	410	82	346 662	5 957 525	346 508.0	5 957 501.8	156.1	
24/02/2019	03:43:58	CC05_ST01	Still	181275_CC05_ST01_01	-							Site slate
24/02/2019	03:57:10	CC05_ST01	Video	SOL	412	82	346 363	5 957 528	346 266.4	5 957 592.1	115.5	
24/02/2019	03:57:10	CC05_ST01	Still	181275_CC05_ST01_02	412		346 363	5 957 528	346 266.4	5 957 592.1	115.5	
24/02/2019	03:58:06	CC05_ST01	Still	181275_CC05_ST01_03	413		346 363	5 957 528	346 276.1	5 957 576.5	99.1	
24/02/2019	03:58:22	CC05_ST01	Still	181275_CC05_ST01_04	414		346 363	5 957 528	346 278.7	5 957 571.8	94.6	
24/02/2019	03:58:47	CC05_ST01	Still	181275_CC05_ST01_05	415		346 363	5 957 528	346 281.0	5 957 564.7	89.4	
24/02/2019	03:59:05	CC05_ST01	Still	181275_CC05_ST01_06	416		346 363	5 957 528	346 281.2	5 957 560.3	87.5	
24/02/2019	04:00:10	CC05_ST01	Still	181275_CC05_ST01_07	417		346 363	5 957 528	346 274.3	5 957 560.0	93.8	
24/02/2019	04:02:19	CC05_ST01	Still	181275_CC05_ST01_08	418		346 363	5 957 528	346 250.4	5 957 582.9	124.8	
24/02/2019	04:02:29	CC05_ST01	Still	181275_CC05_ST01_09	419		346 363	5 957 528	346 249.5	5 957 584.7	126.4	
24/02/2019	04:03:19	CC05_ST01	Still	181275_CC05_ST01_10	420		346 363	5 957 528	346 250.1	5 957 591.7	129.1	
24/02/2019	04:05:25	CC05_ST01	Still	181275_CC05_ST01_11	421		346 363	5 957 528	346 259.1	5 957 591.9	121.5	
24/02/2019	04:08:03	CC05_ST01	Still	181275_CC05_ST01_12	422		346 363	5 957 528	346 285.3	5 957 575.1	90.5	
24/02/2019	04:08:38	CC05_ST01	Still	181275_CC05_ST01_13	423		346 363	5 957 528	346 292.3	5 957 570.0	81.8	
24/02/2019	04:09:21	CC05_ST01	Still	181275_CC05_ST01_14	424		346 363	5 957 528	346 302.0	5 957 561.6	69.2	

Geodetic Parameters: WGS84, UTM 30N												
Date	Time [UTC]	Transect/ Station	Type	Sample Rep/ Still No.	Fix No.	Water Depth [m BSL]	Proposed Location		Actual Location		Offset [m]	Notes
							Easting [m]	Northing [m]	Easting [m]	Northing [m]		
24/02/2019	04:10:16	CC05_ST01	Still	181275_CC05_ST01_15	425		346 363	5 957 528	346 314.7	5 957 556.8	55.8	
24/02/2019	04:10:42	CC05_ST01	Still	181275_CC05_ST01_16	426		346 363	5 957 528	346 320.9	5 957 556.0	50.1	
24/02/2019	04:11:24	CC05_ST01	Still	181275_CC05_ST01_17	427		346 363	5 957 528	346 330.4	5 957 556.0	42.6	
24/02/2019	04:11:51	CC05_ST01	Still	181275_CC05_ST01_18	428		346 363	5 957 528	346 335.4	5 957 554.5	37.9	
24/02/2019	04:12:31	CC05_ST01	Still	181275_CC05_ST01_19	429		346 363	5 957 528	346 342.1	5 957 552.1	31.5	
24/02/2019	04:13:32	CC05_ST01	Still	181275_CC05_ST01_20	430		346 363	5 957 528	346 350.1	5 957 544.4	20.5	
24/02/2019	04:15:53	CC05_ST01	Still	181275_CC05_ST01_21	431		346 363	5 957 528	346 373.4	5 957 518.8	14.3	
24/02/2019	04:16:07	CC05_ST01	Still	181275_CC05_ST01_22	432		346 363	5 957 528	346 376.1	5 957 516.1	18.1	
24/02/2019	04:16:27	CC05_ST01	Still	181275_CC05_ST01_23	433		346 363	5 957 528	346 379.3	5 957 513.5	22.3	
24/02/2019	04:16:38	CC05_ST01	Still	181275_CC05_ST01_24	434		346 363	5 957 528	346 380.9	5 957 511.6	24.7	
24/02/2019	04:16:59	CC05_ST01	Still	181275_CC05_ST01_25	435		346 363	5 957 528	346 384.2	5 957 509.9	28.3	
24/02/2019	04:17:09	CC05_ST01	Still	181275_CC05_ST01_26	436		346 363	5 957 528	346 385.9	5 957 508.6	30.4	
24/02/2019	04:17:09	CC05_ST01	Video	EOL	436		346 363	5 957 528	346 385.9	5 957 508.6	30.4	
24/02/2019	04:42:59	CC05_ST01	DVV	PC/FA	437	81	346 363	5 957 528	346 332.3	5 957 528.3	30.3	
24/02/2019	05:06:38	CC05_ST01	DVV	FB	438	81	346 363	5 957 528	346 339.6	5 957 506.9	31.3	

Notes:

UTC = Coordinated Universal Time
BSL = Below sea level
SOL = Start of line
NF = No fix
EOL = End of line
DVV = Dual van Veen grab
FA/FB = Fauna sample FA or FB
PC = Physico-chemical sample
NS = No sample

C.2 GRAB LOG

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
22/03/2019	12:09:00	LS_ST01	FA	52	12	Muddy sand	Anoxic streaks
22/03/2019	12:09:00	LS_ST01	FB	52	7	Muddy sand	Anoxic streaks
22/03/2019	12:25:00	LS_ST01	PC	53	15	Muddy sand	Anoxic streaks
23/02/2019	10:00:30	LS_ST02	PC	217	14	Muddy sand	1 cm depth anoxic layer, H_2S smell
23/02/2019	10:00:30	LS_ST02	FA	217	12	Muddy sand	1 cm depth anoxic layer, H_2S smell; brittlestars (Ophiuroidea)
23/02/2019	10:26:00	LS_ST02	FB	218	10	Muddy sand	1 cm anoxic depth; brittlestars (Ophiuroidea) and sea urchin (Brissidina)
23/02/2019	17:00:32	LS_ST03	NS	264	0		Water only
23/02/2019	17:00:32	LS_ST03	NS	264	0		Water only
23/02/2019	17:16:30	LS_ST03	NS	265	5	Sandy mud	
23/02/2019	17:16:30	LS_ST03	NS	265	6	Sandy mud	
23/02/2019	17:36:03	LS_ST03	NS	266	0		Water only
23/02/2019	17:36:03	LS_ST03	NS	266	0		Water only
23/02/2019	17:46:48	LS_ST03	NS	267	0		Water only
23/02/2019	17:46:48	LS_ST03	NS	267	0		Water only
23/02/2019	17:53:50	LS_ST03	NS	268	0		Water only
23/02/2019	17:53:50	LS_ST03	NS	268	0		Water only
23/02/2019	18:35:00	LS_ST03	PC	269	13	Sandy mud	
23/02/2019	18:35:00	LS_ST03	FA	269	9	Sandy mud	Bivalves, brittlestars (Ophiuroidea)
23/02/2019	18:54:40	LS_ST03	NS	270	7		Not triggered
23/02/2019	18:54:40	LS_ST03	NS	270	0		Not triggered
23/02/2019	18:55:33	LS_ST03	NS	271	0		Water only
23/02/2019	18:55:33	LS_ST03	NS	271	0		Water only
23/02/2019	19:05:29	LS_ST03	FB	272	13	Sandy mud	Bivalves, brittlestars (Ophiuroidea) and sea urchin (Brissidina)
23/02/2019	20:48:32	LS_ST04	PC	293	12	Mud	1 cm Anoxic depth
23/02/2019	20:48:32	LS_ST04	FA	293	11	Mud	1 cm anoxic depth; bivalves, brittlestars (Ophiuroidea) and sea urchin (Brissidina)
23/02/2019	21:04:36	LS_ST04	FB	294	14	Mud	1 cm anoxic depth; H_2S; bivalves and brittlestars (Ophiuroidea)
23/02/2019	22:31:26	LS_ST05	PC	313	20	Mud	

Date	Time [UTC]	Station	Sample Rep	Fix No.	Sample Volume [cm]	Sediment Description	Comments (fauna, smell, bioturbation, debris)
23/02/2019	22:31:26	LS_ST05	FA	313	20	Mud	
23/02/2019	22:50:31	LS_ST05	NS	314	0		Water only
23/02/2019	22:50:31	LS_ST05	NS	314	0		
23/02/2019	22:59:26	LS_ST05	FB	315	20	Mud	
24/02/2019	04:42:59	CC05_ST01	PC	437	16	Mud	1 cm Anoxic layer depth, Turritellidae shells
24/02/2019	04:42:59	CC05_ST01	FA	437	15	Mud and clay	1 cm Anoxic layer depth, Turritellidae shells
24/02/2019	05:06:38	CC05_ST01	FB	438	16	Mud	1 cm Anoxic layer depth, Turritellidae shells

Notes:
UTC = Coordinated Universal Time
FA/FB = Faunal sample FA or FB
PC = Physico-chemical sample
NS = No sample

C.3 VIDEO AND PHOTOGRAPHIC LOG

Geodetic Parameters: WGS84, UTM 30N									
Date	Transect/ Station	Point on Line	Time [UTC]	Video Coordinates Easting [m]	Video Coordinates Northing [m]	Length [m]	Still Nos.	Sediment Description	Fauna/Bioturbation/Debris
21/03/2019	LS_ST01A	SOL	11:39:50	296 290.6	5 937 020.5	22	1-2	Rippled sand with shell fragments	Starfish (*Asterias rubens*)
		-	11:40:40	296 286.2	5 937 041.8				
		-	11:40:40	296 286.2	5 937 041.8	54	3-9	Boulder/bedrock outcrops with sand	Starfish (*Asterias rubens*), anemone (Actiniaria including *Metridium dianthus*), sponge (Porifera), red seaweed (Rhodophyceae), faunal turf (Hydrozoa/Bryozoa), encrusting polychaete tubes (Serpulidae). Anthropogenic debris (glass bottle)
		-	11:43:08	296 279.4	5 937 095.0				
		-	11:43:08	296 279.4	5 937 095.0	135	10-16	Rippled muddy sand	Hermit crab (Paguridae)
		-	11:49:15	296 270.8	5 937 229.7				
		-	11:49:15	296 270.8	5 937 229.7	30	17-19	Sand with boulder/bedrock outcrops	Starfish (*Asterias rubens*), sponge (Porifera: possible *Haliclona* sp.), red seaweed (Rhodophyceae, including *Palmaria palmata*), faunal turf (Hydrozoa/Bryozoa), encrusting polychaete tubes (Serpulidae)
		EOL	11:50:49	296 259.3	5 937 256.9				
21/03/2019	LS_ST02	SOL	12:05:54	298 419.1	5 937 592.8	63	1-32	Rippled muddy sand with shell fragments	Starfish (*Asterias rubens*), anemone (Actiniaria). Faunal burrows
		EOL	12:15:20	298 408.4	5 937 655.3				
23/02/2019	LS_ST03	SOL	16:34:25	303 872.4	5 938 719.9	177	1-23	Rippled muddy sand with shell fragments. Single boulder	Brittlestar (Ophiuroidea), hermit crab (Paguridae), faunal turf (Hydrozoa/Bryozoa), fish (possible Gadidae), possible soft coral (*Alcyonium digitatum*), whelk (Buccinidae), starfish (Asteroidea), anemone (*Metridium dianthus*)
		EOL	16:41:23	303 835.2	5 938 892.6				
23/02/2019	LS_ST04	SOL	20:25:42	307 144.6	5 939 795.5	87	1-19	Muddy sand	Hermit crab (Paguridae), brittlestar (Ophiuroidea), possible anemone (?Actiniaria), spider crab (*Macropodia* sp.), foliose bryozoan (Cellariidae: possible *Cellaria* sp.), faunal turf (Hydrozoa/Bryozoa), fish (Gadidae). Faunal tube (Sabellidae) and burrows
		EOL	20:31:14	307 132.8	5 939 881.6				
23/02/2019	LS_ST05	SOL	22:03:33	314 922.3	5 943 446.6	193	1-19	Muddy sand	Sea pen (*Virgularia mirabilis*), fish (Pisces). Faunal burrows and tubes (Polychaeta)
		EOL	22:08:36	314 882.9	5 943 626.6				

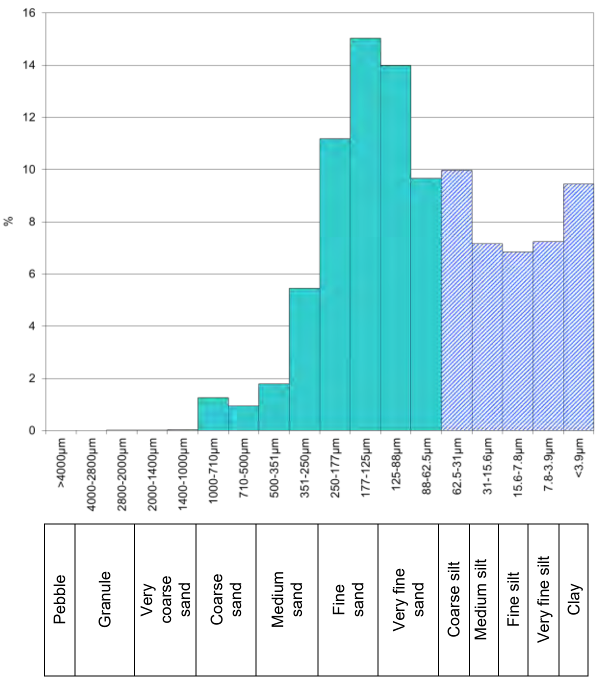
Geodetic Parameters: WGS84, UTM 30N

Date	Transect/ Station	Point on Line	Time [UTC]	Video Coordinates		Length [m]	Still Nos.	Sediment Description	Fauna/Bioturbation/Debris
				Easting [m]	Northing [m]				
24/02/2019	CC05_ST01 CC05_T01A	SOL	03:57:10	346 266.4	5 957 592.1	146	1-26	Rippled muddy sand with shell fragments	Hermit crab (Paguridae, including *Pagurus bernhardus*), faunal turf (Hydrozoa/Bryozoa), lesser spotted catshark (*Scyliorhinus canicula*), flatfish (Pleuronectiformes), unidentified fish (Pisces). Faunal tracks, burrows and tubes (Polychaeta)
		EOL	04:17:09	346 385.9	5 957 508.6				
24/02/2019		SOL	02:29:09	347 174.7	5 957 085.5	829	1-68	Rippled muddy sand with shell fragments	Sea pen (Pennatulacea, including *Virgularia mirabilis*), hermit crab (Paguridae, including *Pagurus bernhardus*), Norway lobster (*Nephrops norvegicus),* faunal turf (Hydrozoa/Bryozoa), gurnard (Triglidae), unidentified fish (Pisces), lesser spotted catshark (*Scyliorhinus canicula*), flatfish (Pleuronectiformes). Faunal tracks, burrows and tubes (Polychaeta)
		EOL	03:02:47	346 542.0	5 957 621.4				
24/02/2019	CC05_T02	SOL	03:26:17	346 779.4	5 957 515.0	272	1-26	Rippled muddy sand with shell fragments	Hermit crab (Paguroidea), Norway lobster (*Nephrops norvegicus*), faunal turf (Hydrozoa/Bryozoa). Lesser spotted catshark (*Scyliorhinus canicula*). Faunal burrows and tubes (Polychaeta)
		EOL	03:36:31	346 508.0	5 957 501.8				

Notes:
UCT = Coordinated Universal Time
SOL = Start of line
EOL = End of line

D. SEDIMENT PARTICLE SIZE

STATION LS_ST01



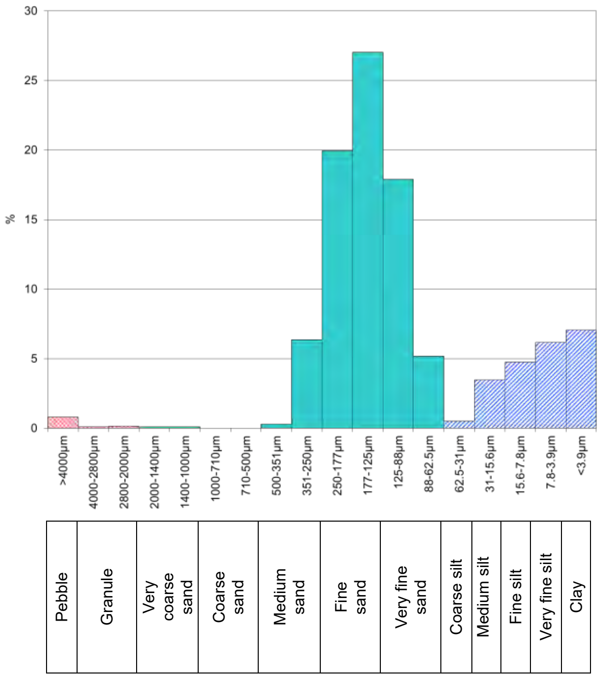
FRACTIONAL DATA

Aperture [µm]	Aperture [phi]	Fractional [%]	Cumulative [%]
4000	-2.00	0.00	0.00
2800	-1.49	0.00	0.00
2000	-1.00	0.00	0.00
1400	-0.49	0.02	0.02
1000	0.00	0.03	0.05
707	0.49	1.27	1.32
500	1.00	0.94	2.25
354	1.51	1.79	4.04
250	2.00	5.45	9.49
177	2.50	11.2	20.7
125	3.00	15.0	35.7
88.0	3.51	14.0	49.7
62.5	4.00	9.67	59.4
31.2	5.01	9.97	69.3
15.6	6.00	7.15	76.5
7.81	7.00	6.84	83.3
3.91	8.00	7.24	90.6
< 3.91	> 8.00	9.44	100
Total		**100**	**100**

STATISTICS

Sorting [phi]	2.29	Very poorly sorted
Skewness [phi]	0.48	Very fine skewed
Mean [µm]	50.8	Coarse silt
Mean [phi]	4.30	
Gravel [%]	0.00	Muddy sand
Sand [%]	59.4	
Mud [%]	40.6	

STATION LS_ST02



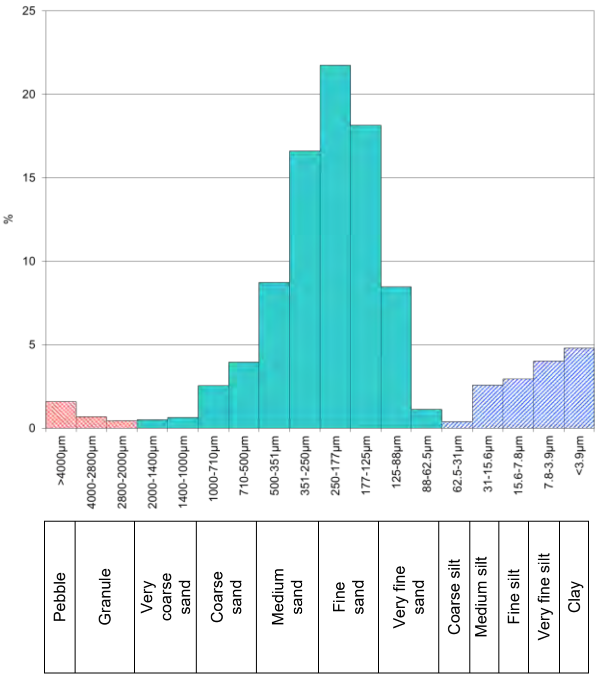
FRACTIONAL DATA

Aperture [µm]	Aperture [phi]	Fractional [%]	Cumulative [%]
4000	-2.00	0.81	0.81
2800	-1.49	0.10	0.92
2000	-1.00	0.15	1.06
1400	-0.49	0.10	1.17
1000	0.00	0.11	1.27
707	0.49	0.00	1.27
500	1.00	0.00	1.27
354	1.51	0.29	1.57
250	2.00	6.37	7.94
177	2.50	20.0	27.9
125	3.00	27.0	54.9
88.0	3.51	17.9	72.8
62.5	4.00	5.18	78.0
31.2	5.01	0.52	78.5
15.6	6.00	3.49	82.0
7.81	7.00	4.75	86.8
3.91	8.00	6.18	93.0
< 3.91	> 8.00	7.05	100
Total		**100**	**100**

STATISTICS

Sorting [phi]	2.06	Very poorly sorted
Skewness [phi]	0.66	Very fine skewed
Mean [µm]	69.2	Very fine sand
Mean [phi]	3.85	
Gravel [%]	1.06	
Sand [%]	77.0	Slightly gravelly muddy sand
Mud [%]	22.0	

STATION LS_ST03



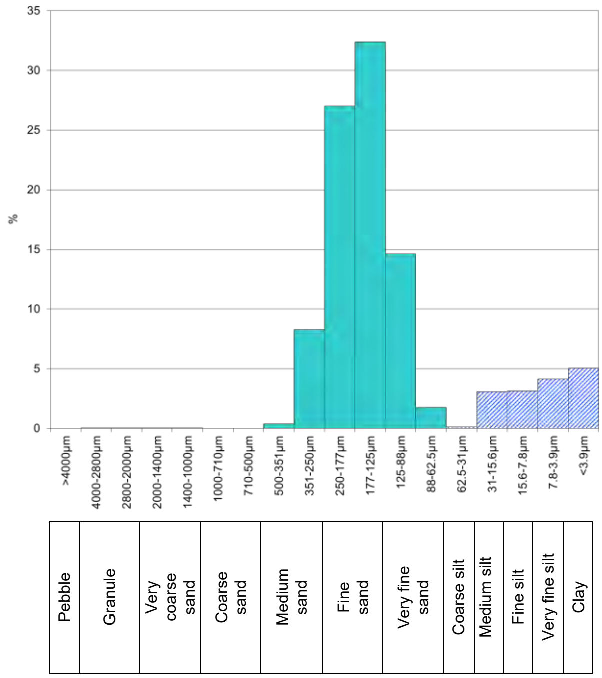
FRACTIONAL DATA

Aperture [µm]	Aperture [phi]	Fractional [%]	Cumulative [%]
4000	-2.00	1.60	1.60
2800	-1.49	0.68	2.28
2000	-1.00	0.45	2.73
1400	-0.49	0.50	3.23
1000	0.00	0.65	3.88
707	0.49	2.56	6.44
500	1.00	3.96	10.4
354	1.51	8.74	19.1
250	2.00	16.6	35.8
177	2.50	21.8	57.5
125	3.00	18.2	75.7
88.0	3.51	8.48	84.1
62.5	4.00	1.13	85.3
31.2	5.01	0.39	85.7
15.6	6.00	2.57	88.2
7.81	7.00	2.95	91.2
3.91	8.00	4.02	95.2
< 3.91	> 8.00	4.80	100
Total		**100**	**100**

STATISTICS

Sorting [phi]	1.71	Poorly sorted
Skewness [phi]	0.26	Fine skewed
Mean [µm]	192	Fine sand
Mean [phi]	2.38	
Gravel [%]	2.73	Slightly gravelly muddy sand
Sand [%]	82.6	
Mud [%]	14.7	

STATION LS_ST04



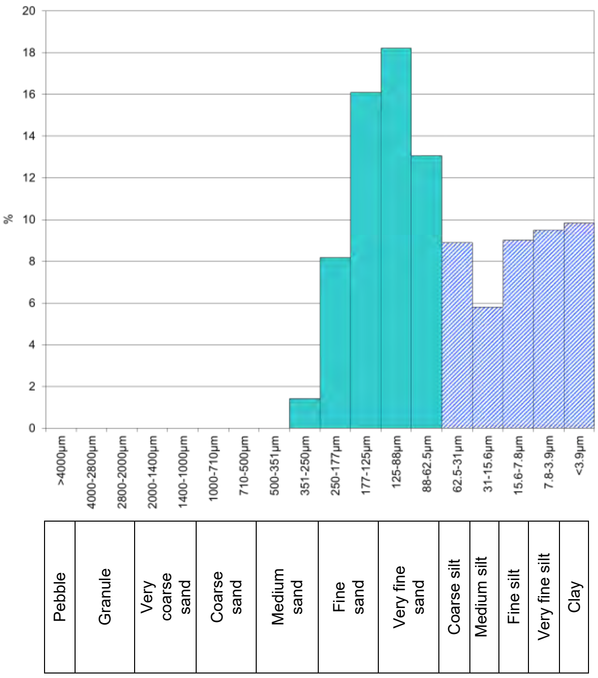
FRACTIONAL DATA

Aperture [µm]	Aperture [phi]	Fractional [%]	Cumulative [%]
4000	-2.00	0.00	0.00
2800	-1.49	0.02	0.02
2000	-1.00	0.01	0.03
1400	-0.49	0.02	0.05
1000	0.00	0.04	0.09
707	0.49	0.00	0.09
500	1.00	0.00	0.09
354	1.51	0.36	0.45
250	2.00	8.27	8.72
177	2.50	27.0	35.8
125	3.00	32.4	68.1
88.0	3.51	14.6	82.8
62.5	4.00	1.75	84.5
31.2	5.01	0.12	84.6
15.6	6.00	3.07	87.7
7.81	7.00	3.13	90.8
3.91	8.00	4.13	95.0
< 3.91	> 8.00	5.04	100
Total		**100**	**100**

STATISTICS

Sorting [phi]	1.37	Poorly sorted
Skewness [phi]	0.51	Very fine skewed
Mean [µm]	134	Fine sand
Mean [phi]	2.90	
Gravel [%]	0.03	Muddy sand
Sand [%]	84.5	
Mud [%]	15.5	

STATION LS_ST05



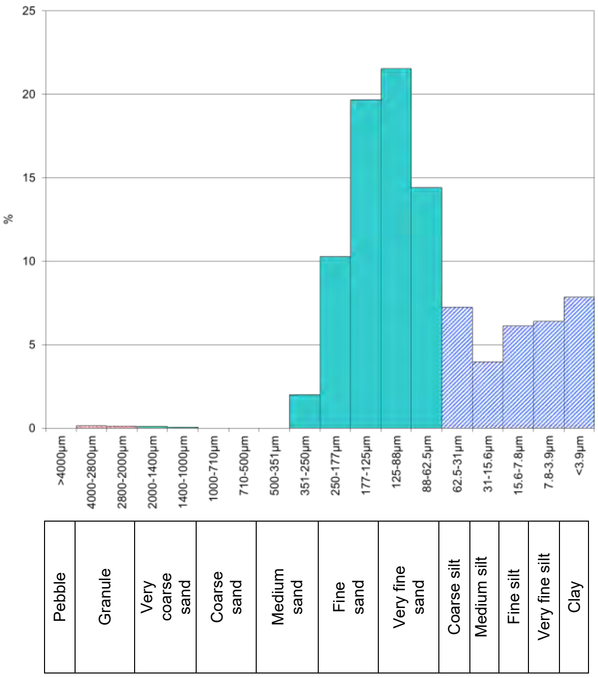
FRACTIONAL DATA

Aperture [µm]	Aperture [phi]	Fractional [%]	Cumulative [%]
4000	-2.00	0.00	0.00
2800	-1.49	0.00	0.00
2000	-1.00	0.00	0.00
1400	-0.49	0.00	0.00
1000	0.00	0.00	0.00
707	0.49	0.00	0.00
500	1.00	0.00	0.00
354	1.51	0.00	0.00
250	2.00	1.41	1.41
177	2.50	8.18	9.59
125	3.00	16.1	25.7
88.0	3.51	18.2	43.9
62.5	4.00	13.1	57.0
31.2	5.01	8.90	65.9
15.6	6.00	5.80	71.7
7.81	7.00	9.01	80.7
3.91	8.00	9.50	90.2
< 3.91	> 8.00	9.84	100
Total		**100**	**100**

STATISTICS

Sorting [phi]	2.15	Very poorly sorted
Skewness [phi]	0.55	Very fine skewed
Mean [µm]	41.5	Coarse silt
Mean [phi]	4.59	
Gravel [%]	0.00	Muddy sand
Sand [%]	57.0	
Mud [%]	43.0	

STATION CC05_ST01



FRACTIONAL DATA

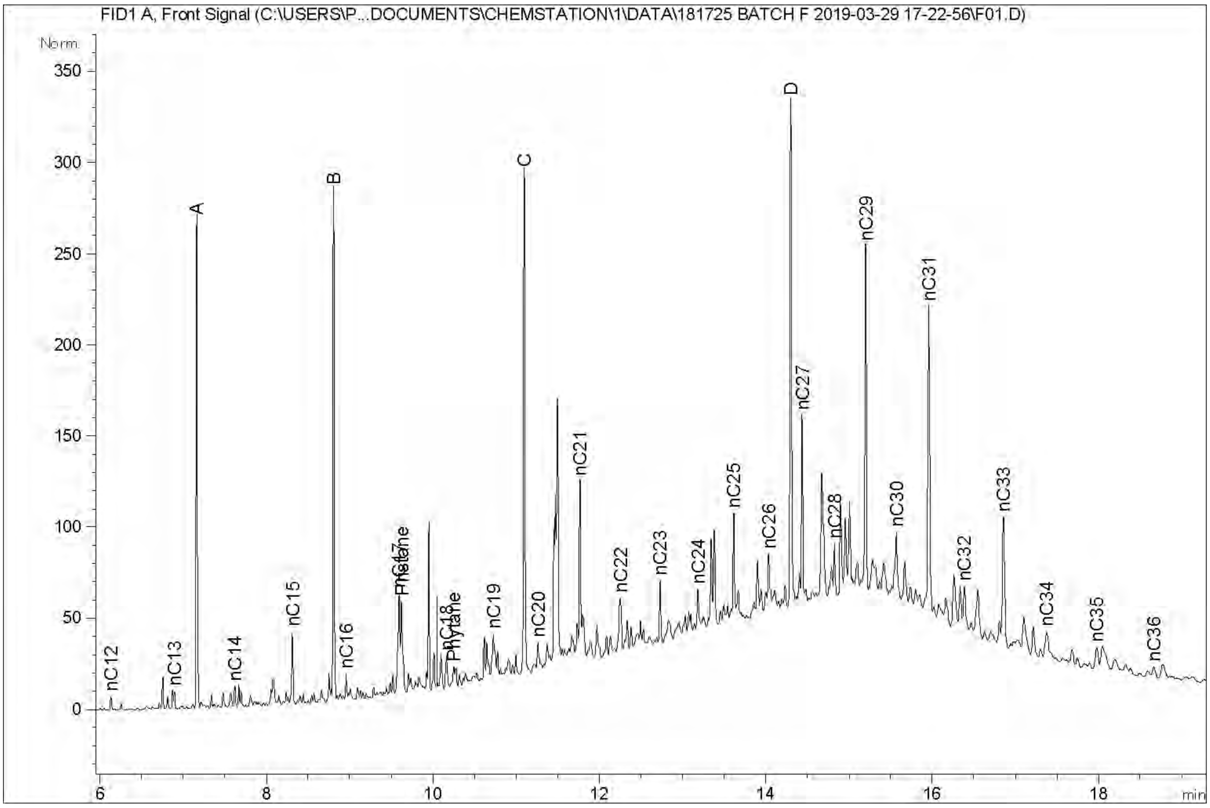
Aperture [µm]	Aperture [phi]	Fractional [%]	Cumulative [%]
4000	-2.00	0.00	0.00
2800	-1.49	0.15	0.15
2000	-1.00	0.13	0.28
1400	-0.49	0.11	0.38
1000	0.00	0.06	0.44
707	0.49	0.00	0.44
500	1.00	0.00	0.44
354	1.51	0.00	0.44
250	2.00	2.01	2.45
177	2.50	10.3	12.7
125	3.00	19.7	32.4
88.0	3.51	21.6	54.0
62.5	4.00	14.4	68.4
31.2	5.01	7.25	75.6
15.6	6.00	3.98	79.6
7.81	7.00	6.13	85.8
3.91	8.00	6.40	92.2
< 3.91	> 8.00	7.85	100
Total		**100**	**100**

STATISTICS

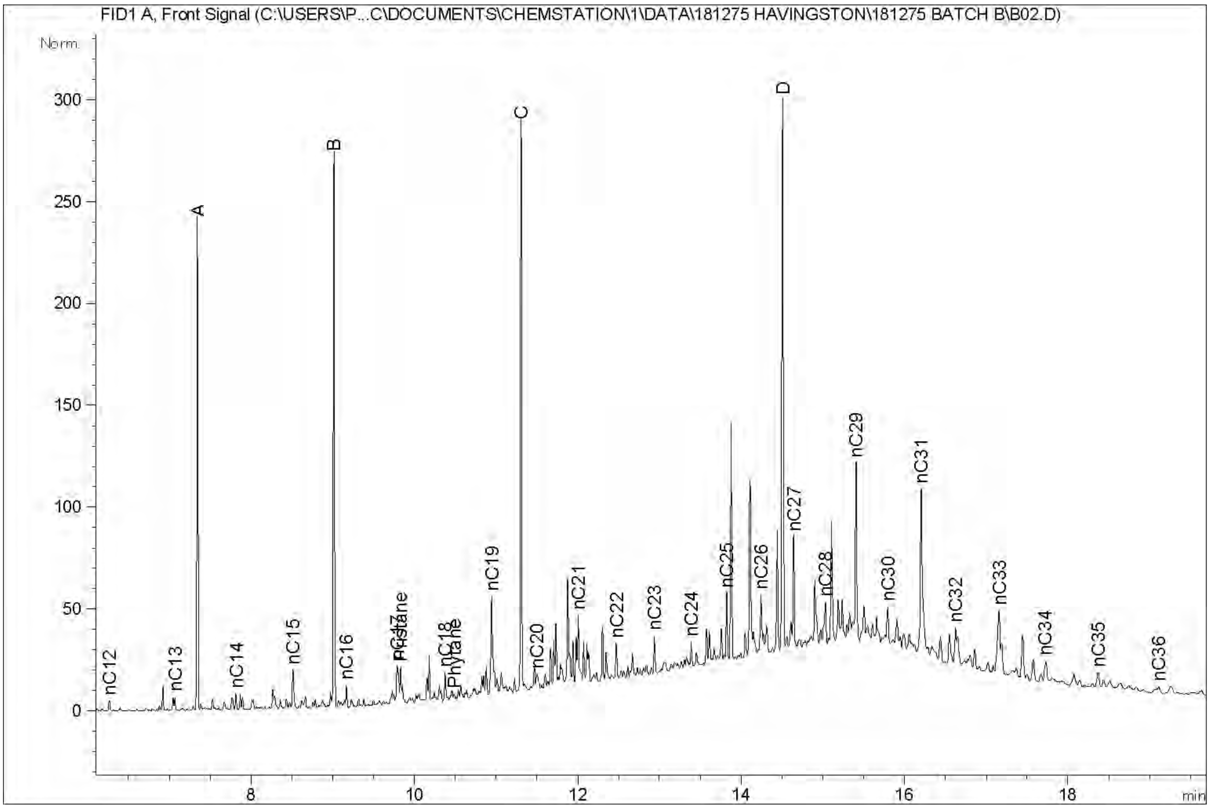
Sorting [phi]	2.01	Very poorly sorted
Skewness [phi]	0.60	Very fine skewed
Mean [µm]	53.0	Coarse silt
Mean [phi]	4.24	
Gravel [%]	0.28	Muddy sand
Sand [%]	68.1	
Mud [%]	31.6	

E. SEDIMENT CHEMISTRY

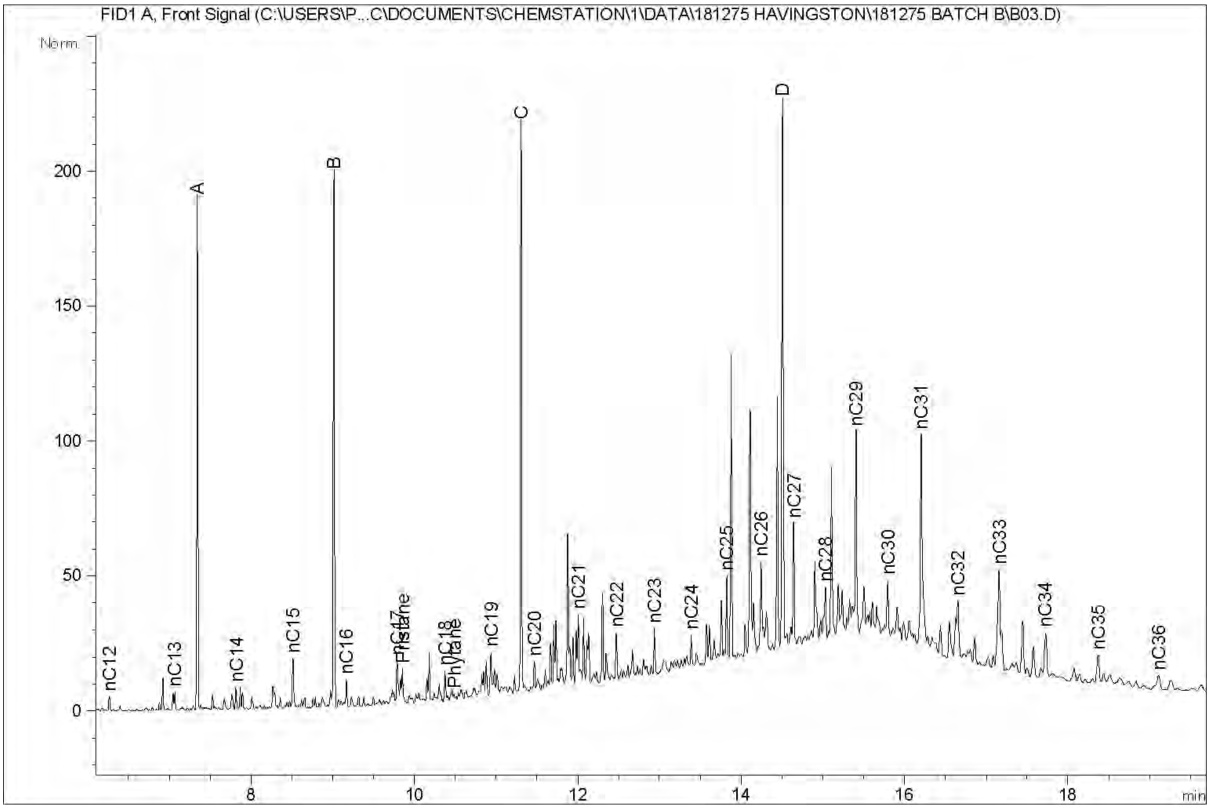
E.1 GAS CHROMATOGRAPHY TRACES



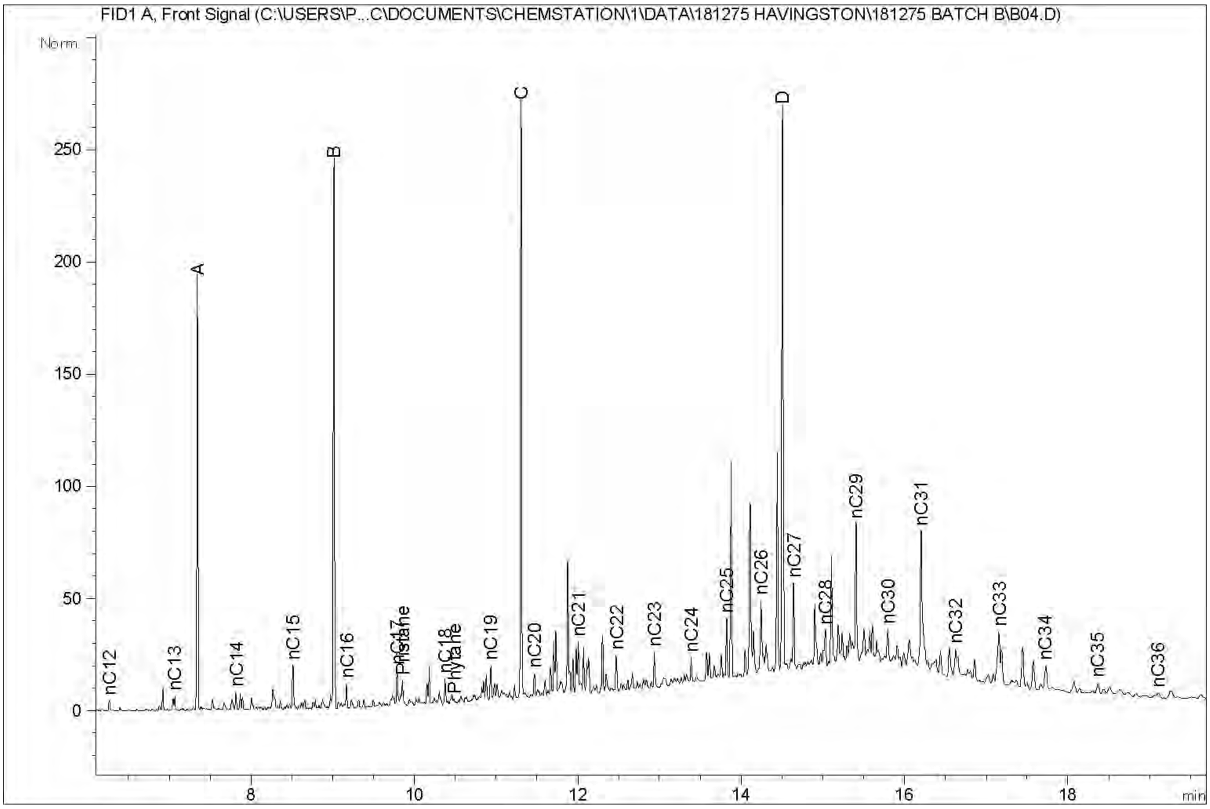
Station LS_ST01



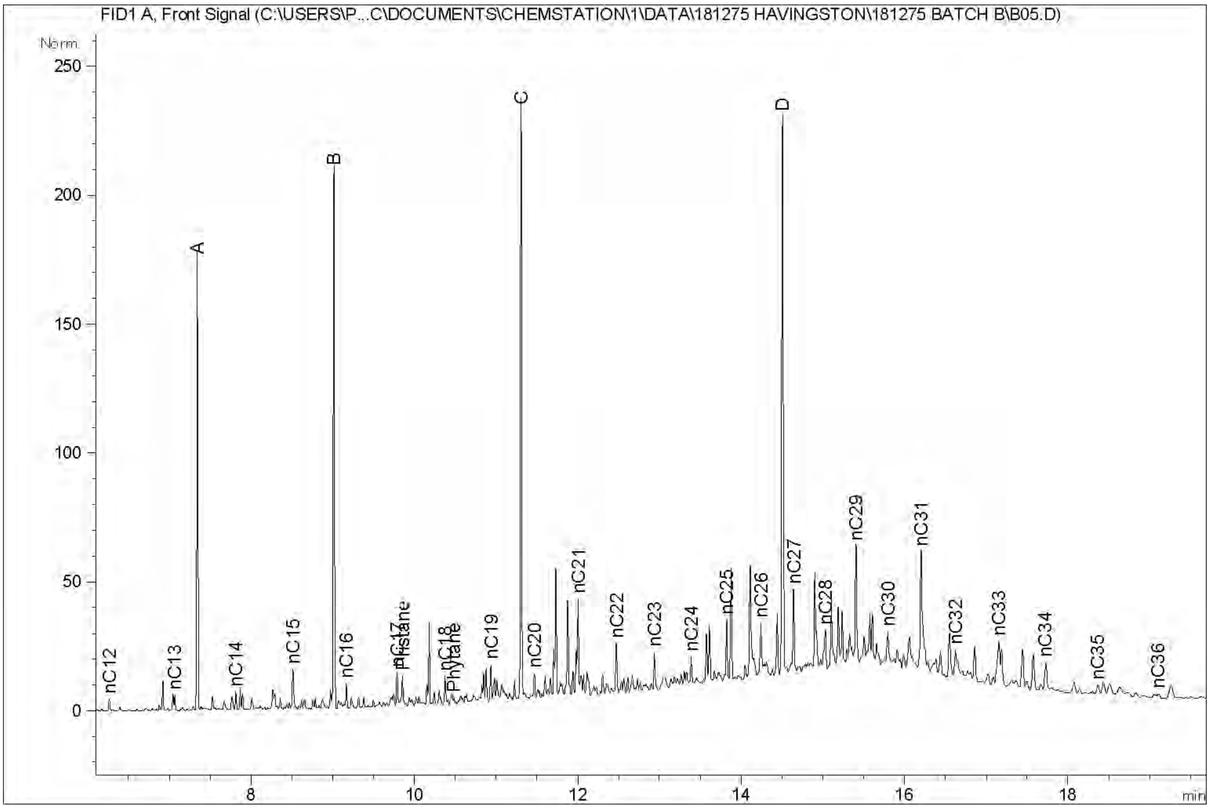
Station LS_ST02



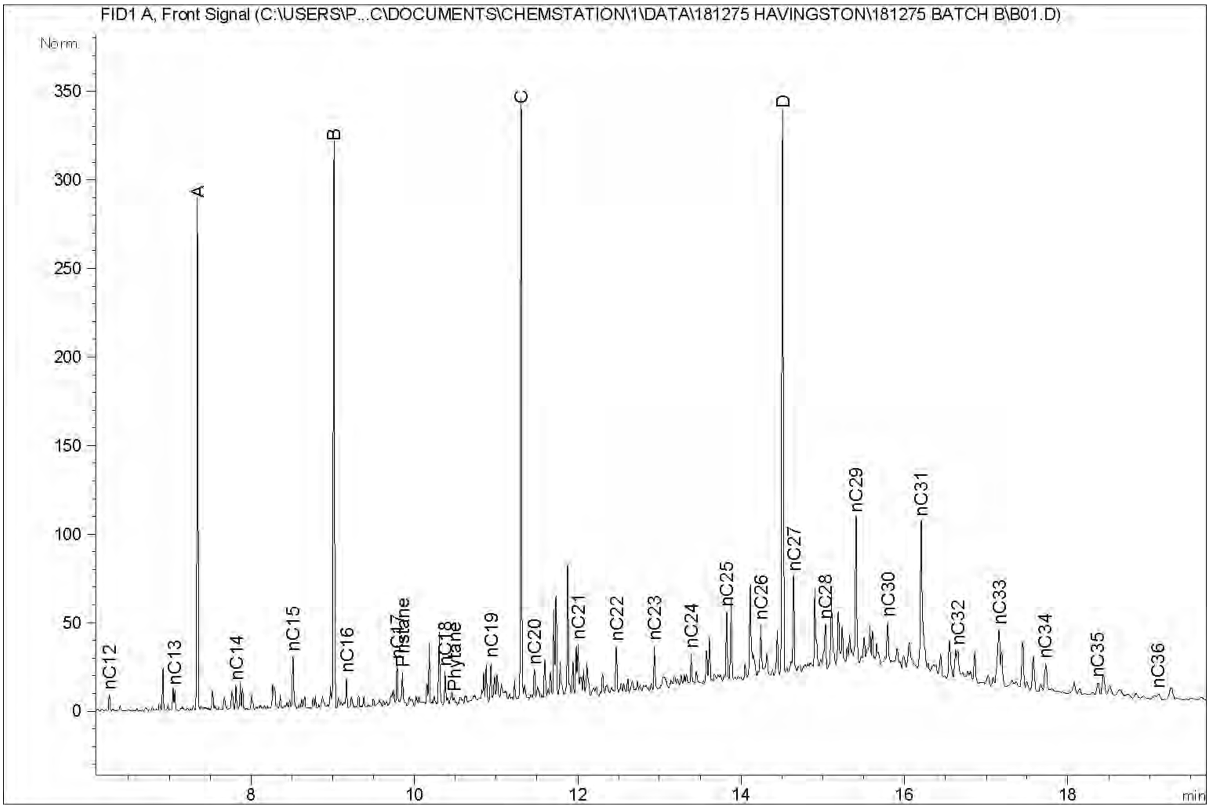
Station LS_ST03



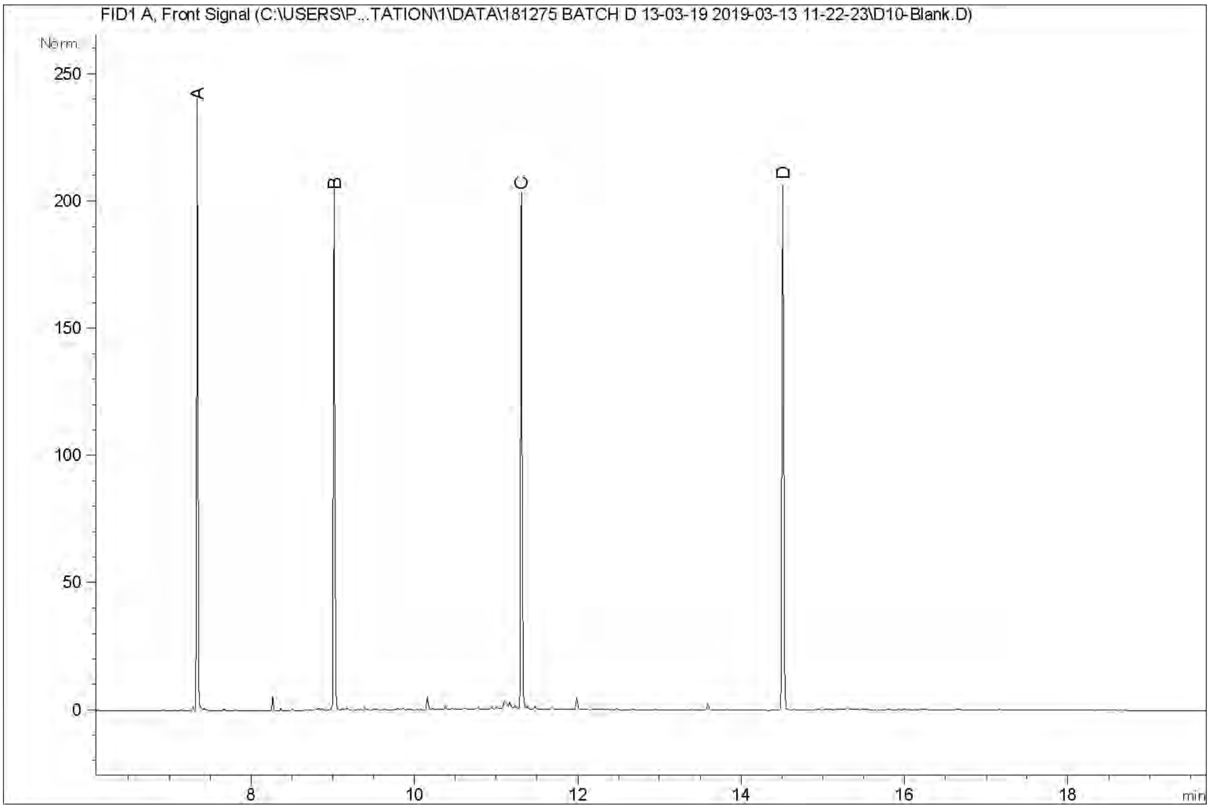
Station LS_ST04



Station LS_ST05



Station CC05_ST01


FID1 A, Front Signal (C:\USERS\P...TATION\1\DATA\181275 BATCH D 13-03-19 2019-03-13 11-22-23\D10-Blank.D)
Norm.
250
200
150
100
50
0
A
B
C
D
8
10
12
14
16
18
min

Blank

E.2 INDIVIDUAL N-ALKANE CONCENTRATIONS

n-Alkane [ng/g]	Station					
	LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01
nC_{12}	4.1	2.0	2.9	1.9	2.6	2.9
nC_{13}	5.3	2.5	3.7	2.5	3.3	3.7
nC_{14}	6.5	3.2	4.6	3.4	4.1	4.7
nC_{15}	25.8	8.4	10.9	9.0	9.5	11.7
nC_{16}	7.1	4.5	6.4	4.9	5.7	6.4
nC_{17}	33.1	7.6	8.4	7.1	7.9	7.7
nC_{18}	14.9	6.9	7.4	5.3	6.8	7.4
nC_{19}	19.6	32.7	12.3	7.8	10.3	9.2
nC_{20}	9.8	3.7	6.1	4.6	5.6	5.4
nC_{21}	47.9	8.8	10.1	7.7	20.4	8.9
nC_{22}	16.3	8.5	11.9	7.8	12.4	11.1
nC_{23}	19.5	7.6	9.5	6.6	8.3	8.8
nC_{24}	13.7	4.8	6.2	4.4	5.4	5.9
nC_{25}	29.8	14.2	18.4	11.0	13.9	15.4
nC_{26}	17.0	3.2	24.1	16.6	13.3	10.5
nC_{27}	56.5	23.2	28.3	18.2	19.2	20.6
nC_{28}	16.7	10.1	12.9	7.5	10.0	10.1
nC_{29}	120	43.6	52.9	30.2	31.0	33.8
nC_{30}	28.3	9.2	16.5	7.9	8.0	10.9
nC_{31}	134	50.0	65.5	34.7	38.7	40.8
nC_{32}	22.8	8.6	18.6	4.8	4.0	6.3
nC_{33}	69.7	27.5	39.0	16.4	18.4	20.9
nC_{34}	18.8	6.9	17.5	7.7	10.0	9.4
nC_{35}	12.8	6.1	11.9	3.8	4.2	4.4
nC_{36}	7.5	3.3	0.5	0.2	2.6	3.1
Total n-alkane [µg/g]	**0.759**	**0.307**	**0.407**	**0.232**	**0.276**	**0.280**
Pristane [ng/g]	27.8	7.0	6.8	4.7	7.4	6.1
Phytane [ng/g]	7.7	2.5	3.6	2.6	1.2	3.6

Notes:
Individual n-alkane, pristane and phytane concentrations expressed as ng/g of dry sediment
Total n-alkane concentrations expressed as µg/g of dry sediment

E.3 US EPA 16 PAH CONCENTRATIONS

E.3.1 United States Environmental Protection Agency (US EPA) 16 Polycyclic Aromatic Hydrocarbon (PAH) Concentrations

PAH [ng/g of Dry Sediment]	LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01	CEMP Assessment Criteria (OSPAR, 2014) ERL
Naphthalene	6.5	3.1	4.1	2.8	4.6	5.4	**160**
Acenaphthylene	1.0	0.3	0.2	0.1	0.8	0.2	**-**
Acenaphthene	3.4	0.5	0.5	0.3	0.6	0.5	**-**
Fluorene	6.2	2.0	2.5	1.7	3.1	2.9	**-**
Phenanthrene	36.9	7.3	8.5	5.7	14.7	9.8	**240**
Anthracene	8.2	1.3	1.2	0.8	2.2	1.2	**85**
Fluoranthene	46.2	7.5	8.8	5.8	20.1	9.5	**600**
Pyrene	39.2	6.1	6.5	4.3	14.6	6.6	**665**
Benzo(a)anthracene	24.1	3.9	4.5	3.0	8.6	4.5	**261**
Chrysene	21.0	4.0	5.0	3.1	8.7	5.5	**384**
Benzo(b)fluoranthene	42.8	12.3	15.6	11.4	21.5	16.4	**-**
Benzo(k)fluoranthene	13.7	3.7	4.6	3.3	6.6	4.6	**-**
Benzo(a)pyrene	25.3	4.9	5.3	3.6	8.9	5.3	**430**
Indeno(1,2,3-cd)pyrene	25.1	7.9	10.4	7.3	13.4	10.2	**240**
Benzo(ghi)perylene	22.2	6.4	8.6	6.0	11.2	8.6	**85**
Dibenzo(a,h)anthracene	5.9	1.5	1.9	1.3	2.5	2.0	**-**
Total US EPA 16	**328**	**72.7**	**88.2**	**60.5**	**142**	**93.2**	**-**

Notes:
PAH = Polycyclic aromatic hydrocarbon
OSPAR = Oslo and Paris Convention
ERL = Effects range low
US EPA 16 = United States Environmental Protection Agency's 16 priority polycyclic aromatic hydrocarbons

Key:	Below ERL	Above ERL

E.3.2 United States Environmental Protection Agency (US EPA) 16 Polycyclic Aromatic Hydrocarbon (PAH) Concentrations, Normalised to 2.5 % Total Organic Carbon (TOC)

PAH [ng/g of Dry Sediment]	LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01	CEMP Assessment Criteria (OSPAR, 2014)	
							BC	BAC
Naphthalene	25	23	38	25	25	39	**5**	**8**
Acenaphthylene	4	2	2	1	4	1	**-**	**-**
Acenaphthene	13	4	5	3	3	4	**-**	**-**
Fluorene	23	15	23	15	17	21	**-**	**-**
Phenanthrene	140	55	79	51	80	70	**17**	**32**
Anthracene	31	10	11	7	12	9	**3**	**5**
Fluoranthene	175	57	81	52	109	68	**20**	**39**
Pyrene	148	46	60	38	79	47	**13**	**24**
Benzo(a)anthracene	91	30	42	27	47	32	**9**	**16**
Chrysene	80	30	46	28	47	39	**11**	**20**
Benzo(b)fluoranthene	162	93	144	102	117	117	**-**	**-**
Benzo(k)fluoranthene	52	28	43	29	36	33	**-**	**-**
Benzo(a)pyrene	96	37	49	32	48	38	**15**	**30**
Indeno(1,2,3-cd)pyrene	95	60	96	65	73	73	**50**	**103**
Benzo(ghi)perylene	84	48	80	54	61	61	**45**	**80**
Dibenzo(a,h)anthracene	22	11	18	12	14	14	**-**	**-**
Total US EPA 16	**1240**	**551**	**817**	**540**	**772**	**666**	**-**	**-**

Notes:
PAH = Polycyclic aromatic hydrocarbon
OSPAR = Oslo and Paris Convention
BC = Background concentration
BAC = Background assessment concentration
US EPA 16 = United States Environmental Protection Agency's 16 priority polycyclic aromatic hydrocarbons

Key:	Below BC	Above BC	Above BAC

E.4 TOTAL 2 TO 6 RING PAH CONCENTRATIONS

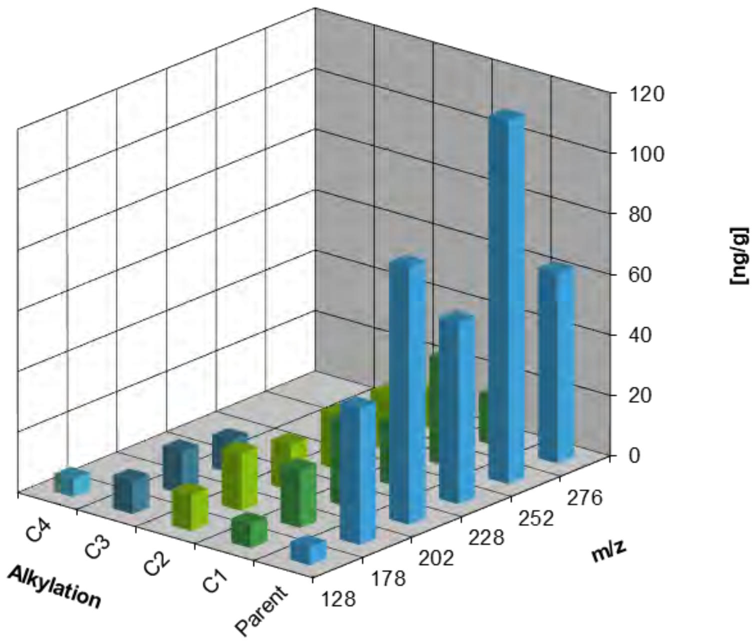
PAH	Station					
	LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01
Naphthalene (128)	6	3	4	3	5	5
C_1 128	8	5	7	5	8	9
C_2 128	12	7	10	7	10	12
C_3 128	11	3	3	1	1	1
C_4 128	6	3	5	3	5	5
TOTAL 128	**43**	**21**	**29**	**19**	**29**	**32**
Phenanthrene/anthracene (178)	45	8	9	7	17	11
C_1 178	19	7	10	7	11	11
C_2 178	19	8	12	8	12	12
C_3 178	14	6	9	6	9	9
TOTAL 178	**97**	**29**	**40**	**28**	**49**	**43**
Dibenzothiophene (184)	2	1	1	<1	1	1
C_1 184	2	1	1	1	1	1
C_2 184	2	1	2	1	2	1
C_3 184	2	1	1	1	1	1
TOTAL 184	**8**	**4**	**5**	**3**	**5**	**4**
Fluoranthene/pyrene (202)	85	14	15	10	35	17
C_1 202	28	7	10	6	13	9
C_2 202	15	7	10	6	10	10
C_3 202	11	7	10	7	10	10
TOTAL 202	**139**	**35**	**45**	**29**	**68**	**46**
Benzanthracenes/ benzphenanthrenes (228)	60	11	14	9	23	15
C_1 228	21	7	9	6	11	10
C_2 228	18	7	11	7	11	10
TOTAL 228	**99**	**25**	**34**	**22**	**45**	**35**
m/z 252*	120	31	38	27	54	39
C_1 252	35	11	14	10	17	15
C_2 252	18	8	11	8	12	11
TOTAL 252	**173**	**50**	**63**	**45**	**83**	**65**
m/z 276†	63	18	24	17	32	24
C_1 276	16	5	6	4	8	6
C_2 276	12	5	7	4	7	7
TOTAL 276	**91**	**28**	**37**	**25**	**47**	**37**
NPD‡	**148**	**54**	**74**	**50**	**83**	**79**
NPD [%]	**23**	**28**	**29**	**29**	**25**	**30**
Total 2 to 6 ring PAH	**650**	**192**	**253**	**171**	**326**	**262**

Notes:
* = m/z 252 - benzfluoranthenes/benzpyrenes/perylene
† = m/z 276 - anthanthrene/indenopyrenes/benzperylenes
‡ = NPD - naphthalenes, phenanthrenes and dibenzothiophenes (totals)
Concentrations expressed as ng/g dry sediment

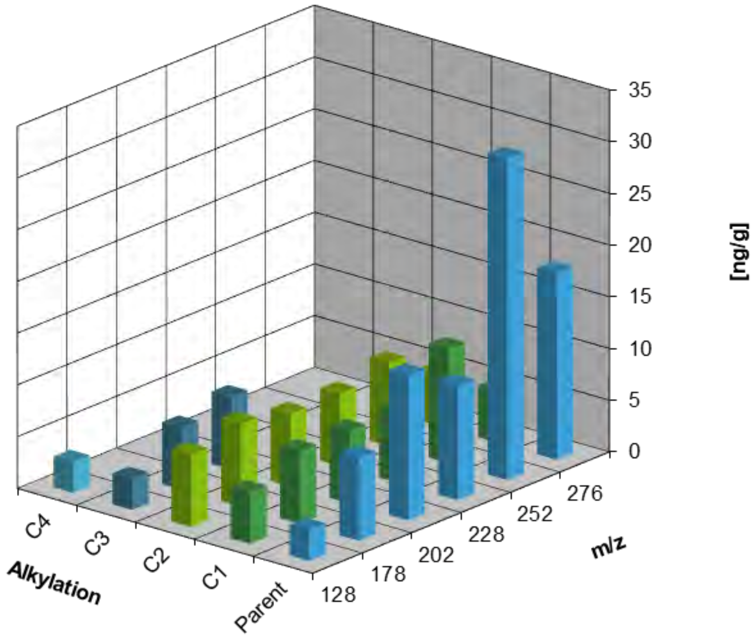
E.5 DISTRIBUTION OF AROMATIC HYDROCARBONS

The layout of the three-dimensional plots are as follows:

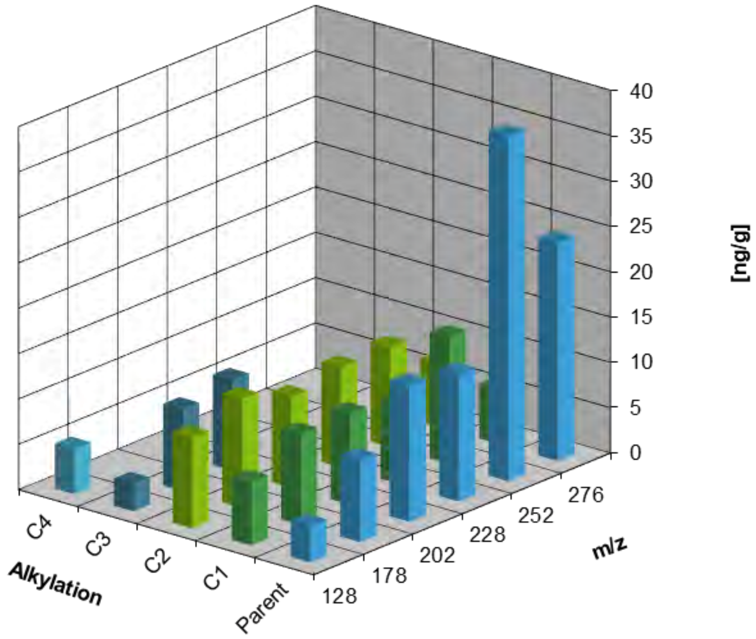
- Naphthalenes (molecular mass 128, 142, 156, 170, 184);
- Phenanthrenes/anthracenes (molecular mass 178, 192, 206, 220);
- Fluoranthenes/pyrenes (molecular mass 202, 216, 230, 244);
- Chrysene/benzanthracenes (molecular mass 228, 242, 256);
- Benzfluoranthenes/benzpyrenes/perylenes (molecular mass 252, 266, 280);
- Anthanthrenes/indenopyrenes/benzoperylenes (molecular mass 276, 290, 304).



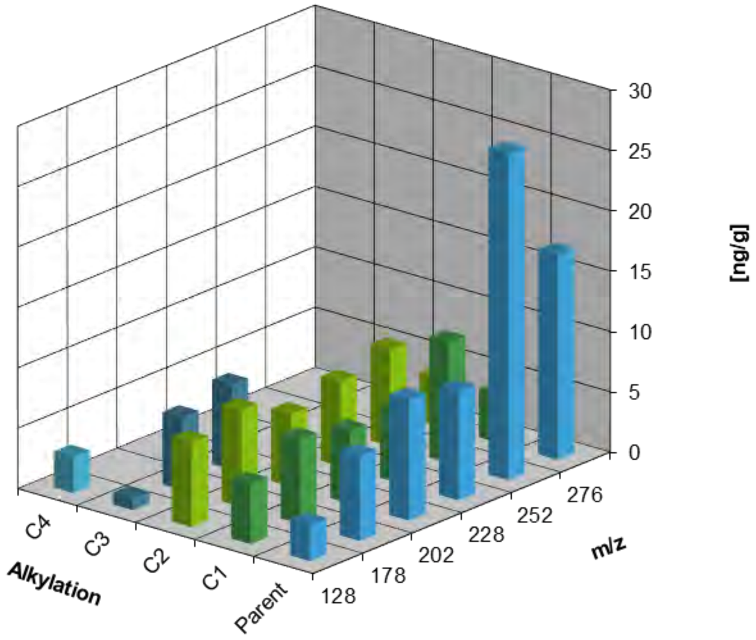
Station LS_ST01



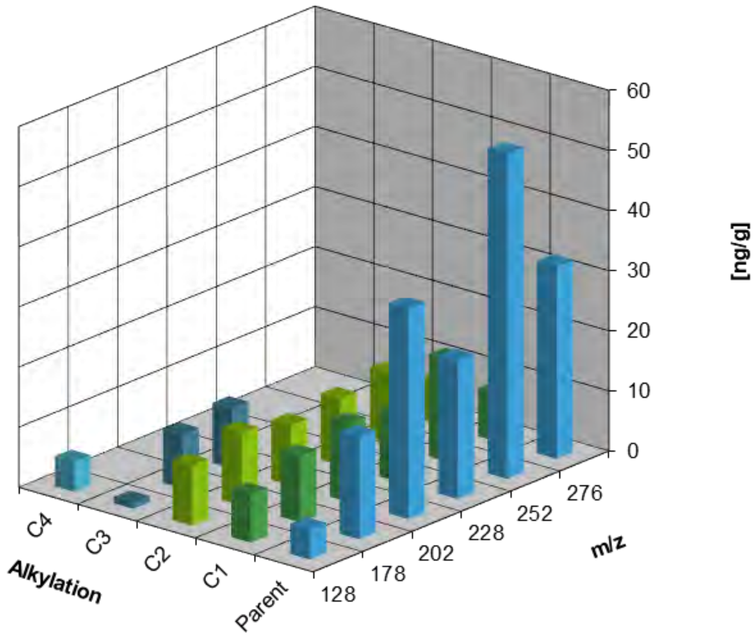
Station LS_ST02



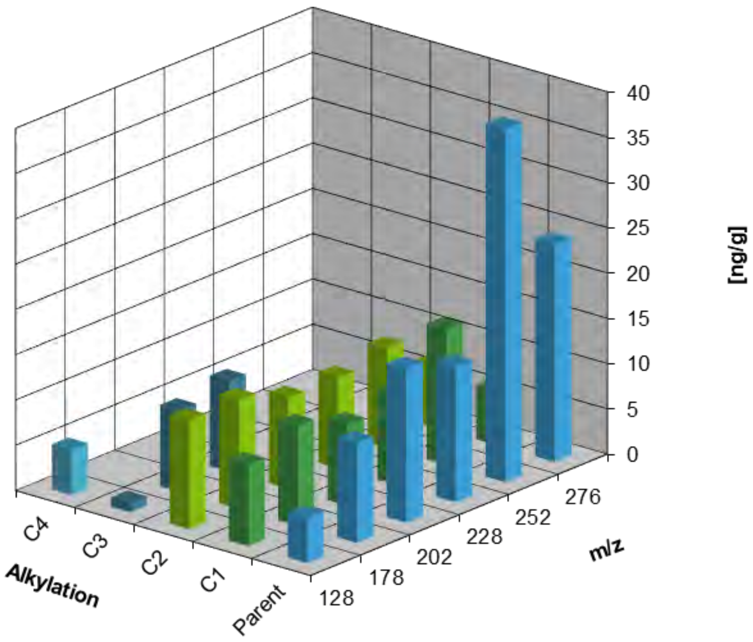
Station LS_ST03



Station LS_ST04



Station LS_ST05



Station CC05_ST01

E.6 5 % ALUMINIUM-NORMALISED HEAVY AND TRACE METAL CONCENTRATIONS

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Sn
LS_ST01	166	-	110	-	-	70.5	151	-
LS_ST02	24.1	-	95.5	24.2	0.0896	45.5	55.9	-
LS_ST03	25.0	-	92.2	21.4	0.0541	48.4	55.7	-
LS_ST04	24.7	-	89.6	24.3	0.0825	45.7	53.3	-
LS_ST05	19.1	-	85.5	20.7	0.0684	43.3	42.2	2.79
CC05_ST01	25.1	-	88.7	25.4	0.0843	45.2	53.2	-
Minimum	**19.1**	**-**	**85.5**	**20.7**	**0.0541**	**43.3**	**42.2**	**2.79**
Maximum	**166**	**-**	**110**	**25.4**	**0.0896**	**70.5**	**151**	**2.79**
Mean	**47.2**	**-**	**93.6**	**23.2**	**0.0758**	**49.8**	**68.6**	**-**
Standard Deviation	**58.0**	**-**	**8.66**	**2.04**	**0.0144**	**10.2**	**40.8**	**-**
RSD [%]	**123**	**-**	**9**	**9**	**19**	**20**	**60**	**-**
CEMP Assessment Criteria (OSPAR, 2014)								
BC	**15.0**	**0.200**	**60.0**	**20.0**	**0.05**	**30.0**	**25.0**	**-**
BAC	**25.0**	**0.310**	**81.0**	**27.0**	**0.07**	**36.0**	**38.0**	**-**

Notes:
Concentrations expressed in µg/g dry sediment
Summary statistics exclude concentrations below MRV
As = Arsenic Cd = Cadmium Cr = Chromium Cu = Copper Hg = Mercury Ni = Nickel
Pb = Lead Sn = Tin
RSD = Relative standard deviation
BC = Background concentration
BAC = Background assessment concentration

Key:	Below BC and BAC	Above BC	Above BAC

F. MACROFAUNAL ANALYSIS

MCS Code	Taxa	Sample							Total
		LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01		
D0759	Edwardsiidae		2	6	5	1	1		15
F0002	Turbellaria				1		1		2
G0001	Nemertea			2			2		4
G0034	*Tubulanus polymorphus*		2						2
G0039	Cerebratulus		3	1					4
N0034	*Phascolion strombus*						2		2
P0092	*Pholoe baltica* (sensu Petersen)		7	6	7		2		22
P0141	*Phyllodoce groenlandica*	1							1
P0164	*Eumida bahusiensis*			1					1
P0256	*Glycera alba*	1		1					2
P0263	*Glycera unicornis*			1	1	1	2		5
P0268	*Glycinde nordmanni*			1					1
P0291	*Sphaerodorum gracilis*	1							1
P0313	*Oxydromus flexuosus*				1				1
P0319	*Podarkeopsis capensis*		1						1
P0340	*Glyphohesione klatti*						1		1
P0358	*Syllis garciai*			1					1
P0421	*Parexogone hebes*			1					1
P0475	*Eunereis longissima*		1						1
P0499	*Nephtys hombergii*	3	1	3					7
P0501	*Nephtys incisa*					4	2		6
P0502	*Nephtys kersivalensis*				1	1			2
P0574	*Lumbrineris cingulata*		3	1	1				5
P0580	*Abyssoninoe hibernica*					2	4		6
P0643	*Schistomeringos rudolphi*						1		1
P0672	*Scoloplos armiger*		1						1
P0699	*Paradoneis lyra*			1					1

MCS Code	Taxa	Sample						Total
		LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01	
P0746	*Prionospio cf. multibranchiata*						4	4
P0751	*Dipolydora caulleryi*			1				1
P0765	*Prionospio fallax*						1	1
P0766	*Aurospio banyulensis*					1		1
P0794	*Spiophanes bombyx*	1	1		1			3
P0796	*Spiophanes kroyeri*				1		1	2
P0804	*Magelona alleni*		4		2			6
P0807	*Magelona johnstoni*	1						1
P0834	*Chaetozone setosa*				2			2
P0843	*Kirkegaardia*						1	1
P0846	*Tharyx killariensis*		1	1				2
P0878	*Diplocirrus glaucus*		31	14	11		2	58
P0919	*Mediomastus fragilis*						7	7
P0923	*Notomastus*			1	1	1	7	10
P0925	*Peresiella clymenoides*			1				1
P0971	*Praxillella affinis*				2		1	3
P1014	*Ophelina acuminata*				1			1
P1093	*Galathowenia oculata*		6	5	4	1	1	17
P1094	Myriochele						2	2
P1098	*Owenia*						1	1
P1102	*Amphictene auricoma*			1	2	1	1	5
P1107	*Lagis koreni*			3	5		1	9
P1124	*Melinna palmata*		1					1
P1135	*Ampharete falcata*						3	3
P1139	*Ampharete lindstroemi*						2	2
P1174	*Terebellides*			1		1	3	5
Q0044	*Anoplodactylus petiolatus*		1		1			2
S0177	*Leucothoe incisa*						2	2

MCS Code	Taxa	Sample						Total
		LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01	
S0410	*Nototropis falcatus*			1				1
S0427	*Ampelisca brevicornis*	2		1				3
S0440	*Ampelisca tenuicornis*		1					1
S0951	*Astacilla dilatata*					1		1
S1142	*Tanaopsis graciloides*		1					1
S1208	*Eudorella truncatula*			1				1
S1251	*Diastylis laevis*						1	1
S1456	*Pagurus bernhardus*			1				1
W0009	*Chaetoderma nitidulum*			1	2			3
W0011	*Falcidens crossotus*						1	1
W0410	*Hyala vitrea*					1		1
W0909	*Odostomia acuta*		1					1
W0960	*Ondina divisa*			1			1	2
W1026	*Cylichna cylindracea*		1	1	2			4
W1048	*Laona pruinosa*					1		1
W1519	*Antalis entalis*			1	4			5
W1569	*Nucula nitidosa*	4	19	9	1		10	43
W1571	*Nucula sulcata*						2	2
W1577	*Ennucula tenuis*						7	7
W1827	*Myrtea spinifera*						6	6
W1837	*Thyasira flexuosa*		2	2	2		15	21
W1902	*Tellimya ferruginosa*			3	2			5
W1906	*Kurtiella bidentata*	2	60	57	19			138
W1950	*Parvicardium minimum*				1	1		2
W1972	*Mactra stultorum*		1					1
W1978	*Spisula subtruncata*			1				1
W2004	*Pharus legumen*		2					2
W2006	*Phaxas pellucidus*		3					3

MCS Code	Taxa	Sample							Total
		LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01		
W2019	*Fabulina fabula*	1	1						2
W2059	*Abra alba*	34			1		7		42
W2061	*Abra nitida*			1		3	11		15
W2098	*Chamelea striatula*		3	2					5
W2128	*Dosinia lupinus*				2				2
W2157	*Corbula gibba*		18	4	2		5		29
W2166	*Hiatella arctica*						1		1
W2231	*Thracia phaseolina*		2						2
ZA0003	*Phoronis*		13	18	10	3			44
ZB0152	*Amphiura chiajei*		1				1		2
ZB0154	*Amphiura filiformis*		128	63	26				217
ZB0223	*Echinocardium cordatum*		2		4				6
ZB0292	*Leptosynapta bergensis*		1						1
Number of Taxa		**11**	**35**	**40**	**33**	**16**	**40**		**96**
Abundance		**51**	**326**	**222**	**128**	**24**	**126**		**877**
The following taxa were excluded from the statistical analysis									
Protists									
A5021	*Astrorhiza*			2					2
A5025	Ciliophora	P							P
A5050	Folliculinidae					P			P
Meiofauna									
HD0001	Nematoda						1		1
Pelagic									
R2413	Myodocopida				1				1
Eggs									
C0000	Animalia			P	P		P		P
ZG0001	Actinopterygii						1		1
Juvenile									

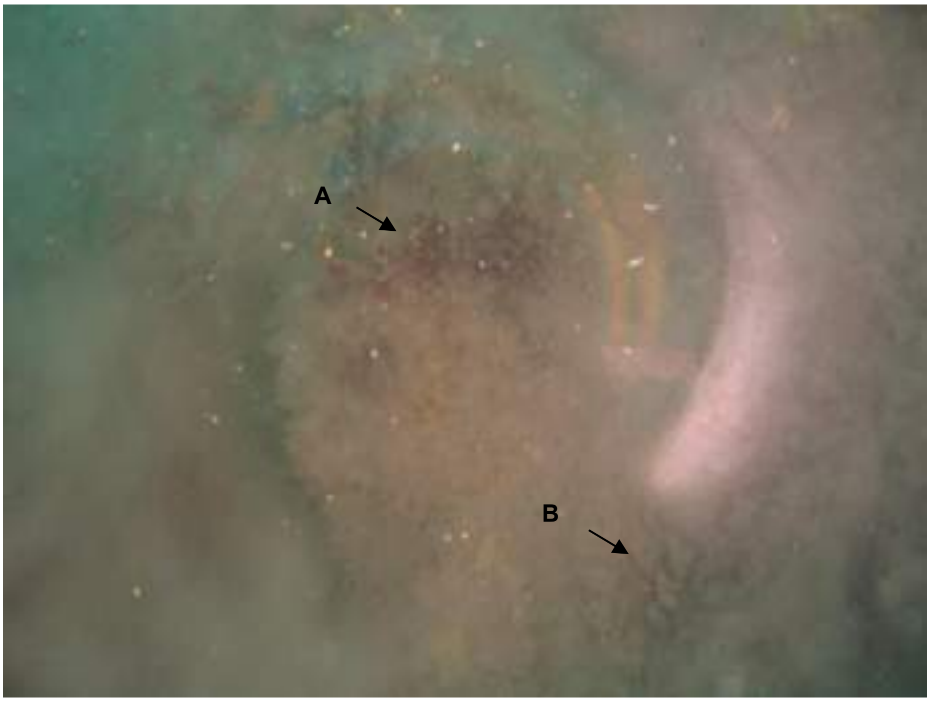
MCS Code	Taxa	Sample						Total
		LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01	
P0017	Aphroditidae						1	1
P0096	Sigalionidae		2					2
P0494	*Nephtys*	3				1		4
W0270	*Turritella communis*			1				1
W1696	*Mytilus edulis*	2	1					3
W1978	*Spisula subtruncata*			1	1			2
W2041	*Donax vittatus*	13						13
W2098	*Chamelea striatula*		2		1			3
W2126	*Dosinia*			1				1
W2227	*Thracia*		1					1
ZB0148	Amphiuridae		4	7	10			21
ZB0165	Ophiuridae		7	7	11			25
ZB0213	Spatangoida				1			1
Colonial								
D0216	Filifera		P				P	P
D0240	*Leuckartiara octona*				P			P
D0272	*Hydractinia*			P				P
D0335	*Lovenella clausa*		P		P			P
D0491	Campanulariidae			P				P
Y0008	*Crisidia cornuta*	P						P
Y0013	*Crisia*	P	P					P
Y0081	*Alcyonidium parasiticum*		P					P
Y0165	*Eucratea loricata*				P			P
Y0239	Bugulidae	P						P
Y0279	*Scrupocellaria scruposa*	P						P
Algae								
ZM0443	*Plocamium cartilagineum*	P						P
ZM0655	*Polysiphonia*	P						P

MCS Code	Taxa	Sample							Total
		LS_ST01	LS_ST02	LS_ST03	LS_ST04	LS_ST05	CC05_ST01		
ZS0195	*Cladophora*	P							P

Notes:
MCS = Marine Conservation Society

G. SEABED PHOTOGRAPHS

STATION LS ST01



Photograph:
181275_LS_ST01A_04

Easting: 296 285.3 mE
Northing: 5 937 050.9 mN
Depth: 7 m BSL

Sediment Type:
Rippled sand with bedrock/boulder

Fauna:
A: Red seaweed (Rhodophyceae)
B: Faunal turf (Hydrozoa/Bryozoa)

STATION LS_ST02

Photograph:
181275_LS_ST02_05

Easting: 298 416.3 mE
Northing: 5 937 608.4 mN
Depth: 15 m BSL

Sediment Type:
Rippled muddy sand with shell fragments

Fauna:
No observed fauna

STATION LS_ST03

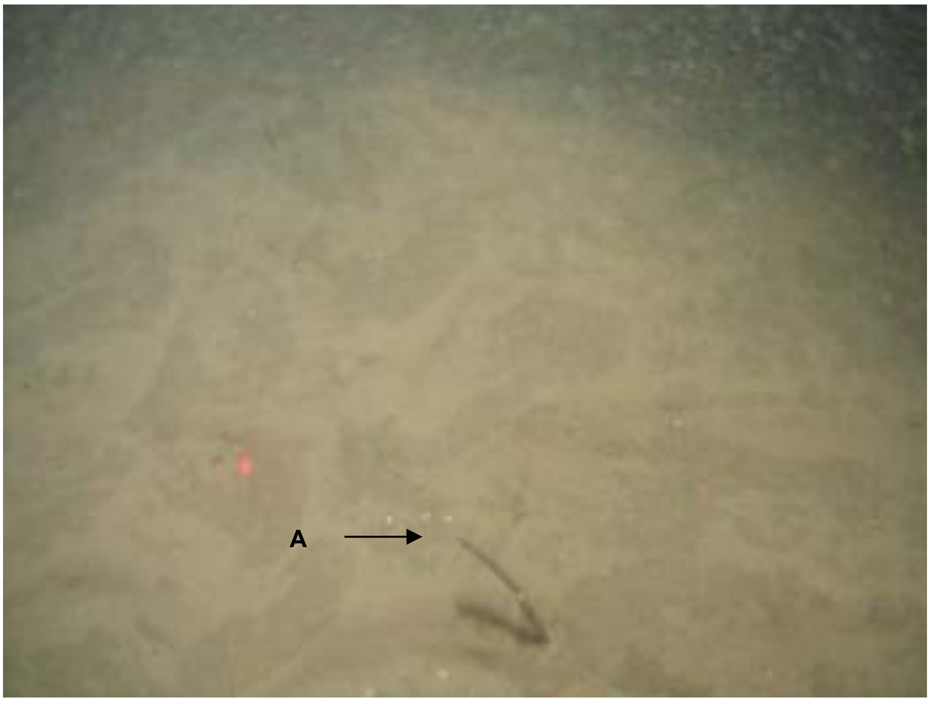
Photograph:
181275_LS_ST03_02

Easting: 303 870.6 mE
Northing: 5 938 724.0 mN
Depth: 35 m BSL

Sediment Type:
Rippled muddy sand with shell fragments

Fauna:
No observed fauna

STATION LS_ST04



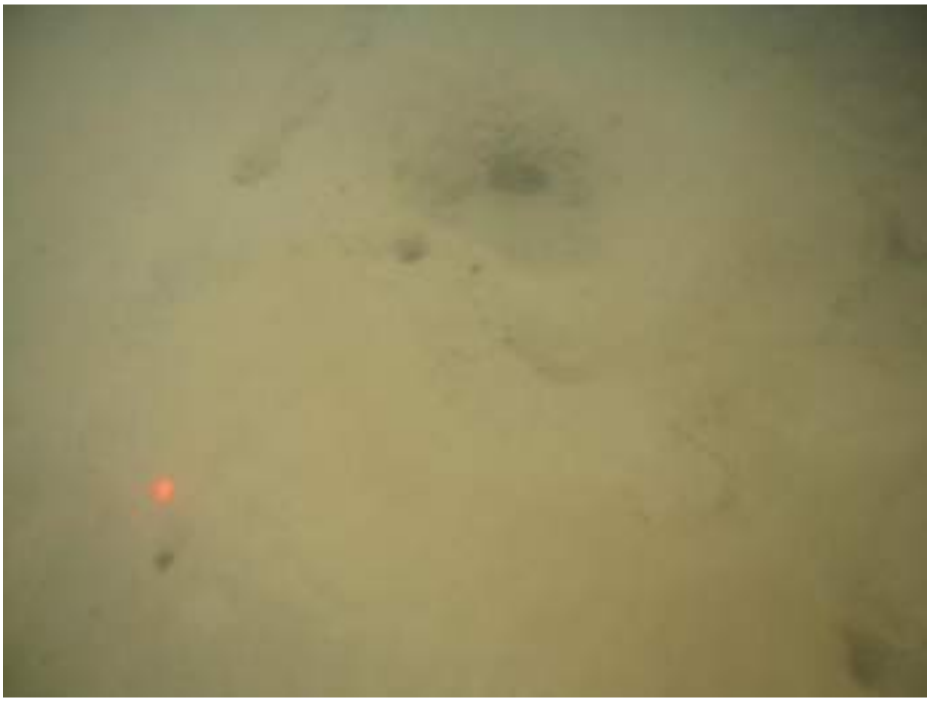
Photograph:
181275_LS_ST04_04

Easting: 307 143.0 mE
Northing: 5 939 807.5 mN
Depth: 41 m BSL

Sediment Type:
Muddy sand

Fauna:
A: Polychaete tubes (Sabellidae)

STATION LS_ST05



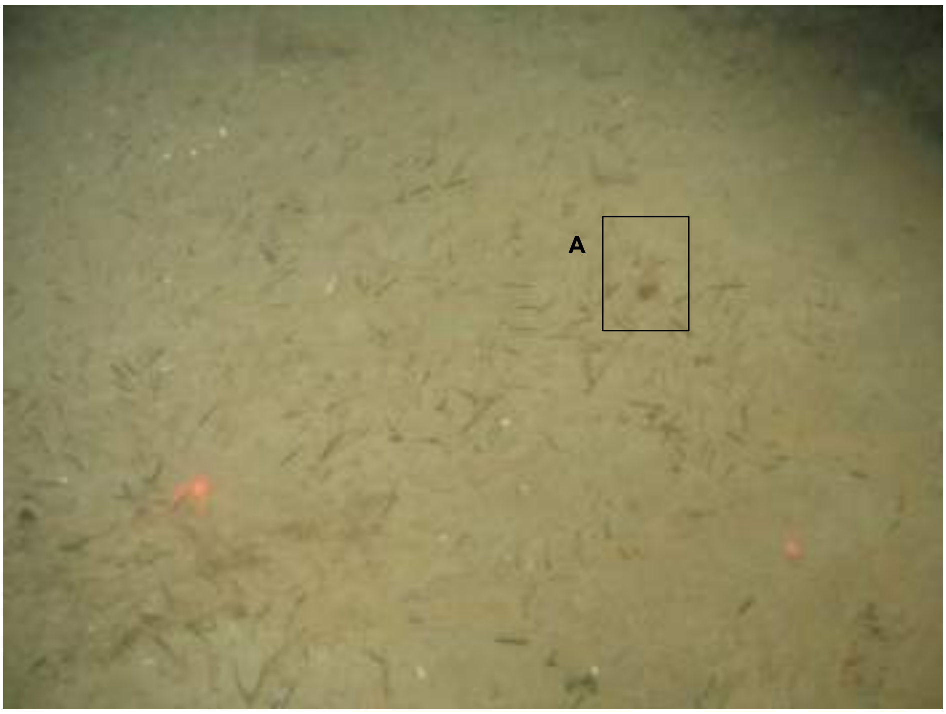
Photograph:
181275_LS_ST05_11

Easting: 314 902.7 mE
Northing: 5 943 531.5 mN
Depth: 66 m BSL

Sediment Type:
Muddy sand

Fauna:
Faunal burrows

TRANSECT CC05_TR01A



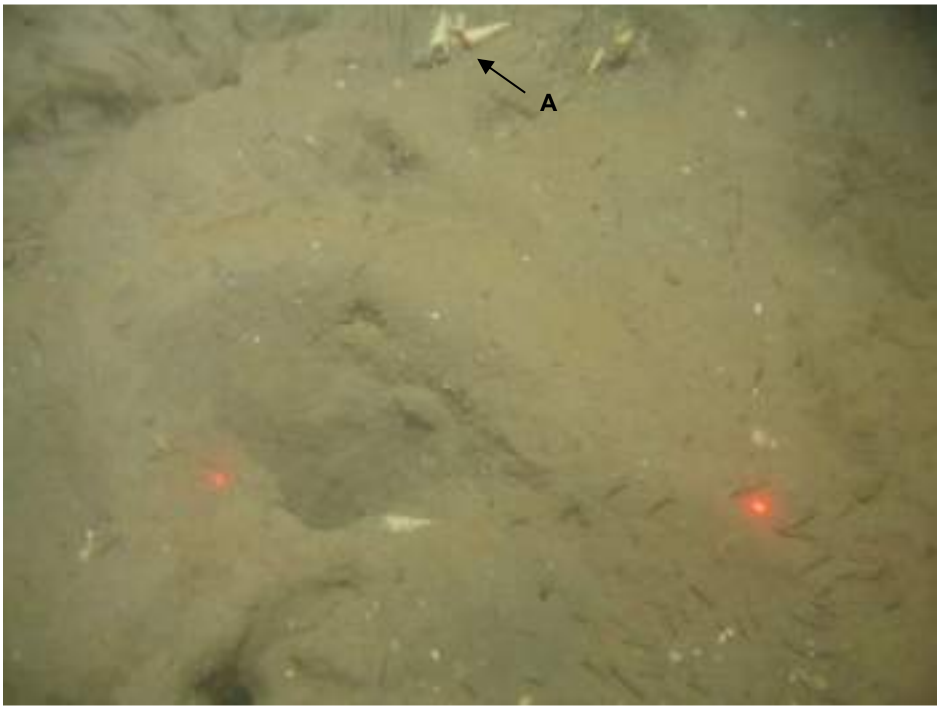
Photograph:
CC05_TR01A_30

Easting: 346 963.1 mE
Northing: 5 957 252.5 mN
Depth: 83.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
A. Sea pen
(*Virgularia mirabilis*)
Faunal turf and faunal tubes (Sabellidae)

TRANSECT CC05_TR02



Photograph:
CC05_TR02_22

Easting: 346 550.0 mE
Northing: 5 957 509.7 mN
Depth: 82.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
A. Hermit crab (Paguridae)
Faunal turf and faunal burrow

STATION CC05_ST01

Photograph:
CC05_ST01_07

Easting: 346 274.3 mE
Northing: 5 957 560.0 mN
Depth: 82.0 m BSL

Sediment Type:
Mud with shell fragments

Fauna:
Faunal turf and faunal tubes (Polychaeta)

H. SENSITIVE HABITAT ASSESSMENT

H.1 STONY REEF ASSESSMENT

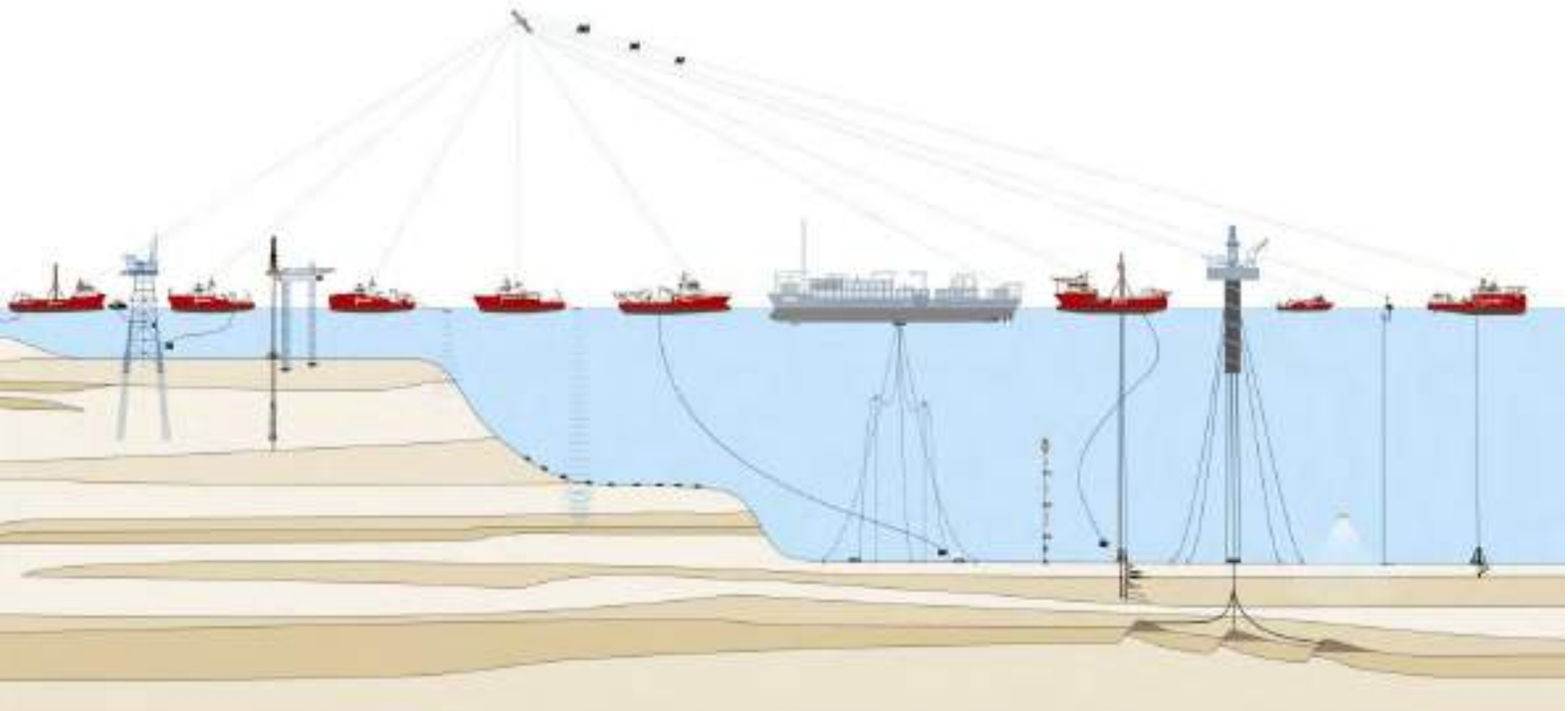
Station/ Transect	Geogenic Classification				Substrate Description and Associated Species	Representative Photograph
	% Cobbles/ Boulders	Elevation	% Epibiota Cover	Overall Geogenic Reef Classification		
LS_ST01A Habitat 2	10 - 20	64 mm – 5 m	20 - 30	Low	**Substrate:** Predominantly bedrock, with areas of cobbles and boulders interspersed with areas of rippled sand **Cobble/Boulder Component:** Cobbles and boulders embedded in sediment **Epibiota Community:** Encrusting fauna and sparse faunal turf covered hard substrate **Typical Taxa:** Red seaweed (Rhodophyceae) Faunal turf (Hydrozoa/Bryozoa) Encrusting polychaete tubes (Serpulidae)	
LS_ST01A Habitat 4	20 – 30	64 mm – 5 m	20 - 30	Low	**Substrate:** Predominantly bedrock, with areas of cobbles and boulders interspersed with areas of rippled sand **Cobble/Boulder Component:** Cobbles and boulders embedded in sediment **Epibiota Community:** Encrusting fauna and sparse faunal turf covered hard substrate **Typical Taxa:** Red seaweed (Rhodophyceae) Faunal turf (Hydrozoa/Bryozoa) Encrusting polychaete tubes (Serpulidae)	

Intertidal Habitat Report
Havingsten Cable Route Survey
Loughshinny, Ireland

Fugro Document No.: 181275-R-016(01)
10 May 2019

Alcatel Submarine Networks UK Limited

Draft report



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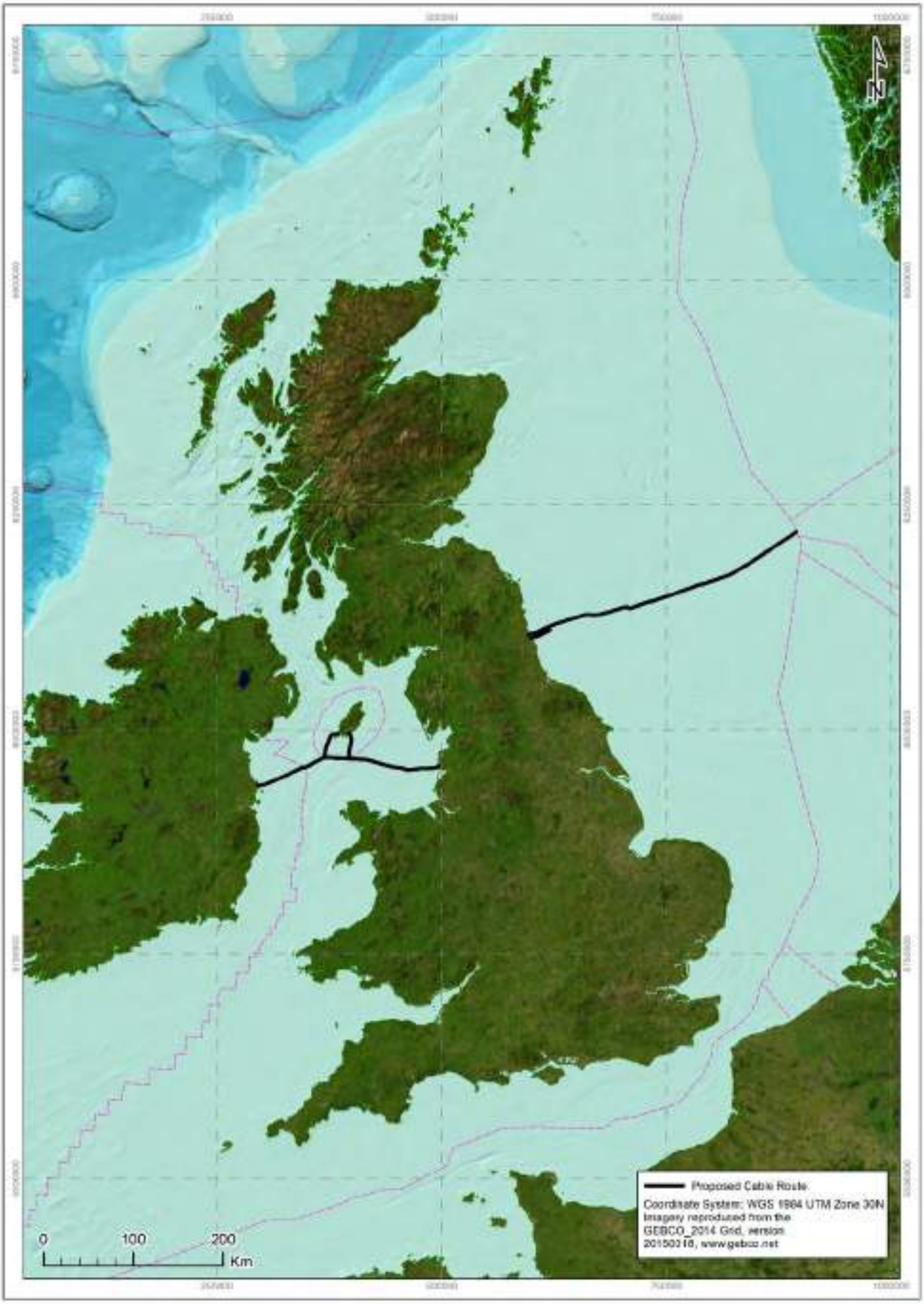

FRONTISPIECE

EXECUTIVE SUMMARY

Introduction

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed intertidal surveys at six proposed cable landings. These were located at Seaton Sluice and Whitley Bay (UK east coast), Squires Gate Lane (UK west coast), Port Erin and Port Grenaugh (Isle of Man) and Loughshinny (Ireland).

The surveys were conducted on spring tide occasions between 18 and 22 February 2019. All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) Projection Zone 29 N Central Meridian.

Survey Strategy

An intertidal habitat survey was required to record the distribution of intertidal sediments and associated conspicuous species. Further objectives were to conduct a fauna and flora survey of key intertidal species, to assist with the classification and mapping of intertidal biotopes within the survey area.

The modified Phase I walkover biotope mapping survey was conducted to record conspicuous intertidal fauna and flora and habitats within the survey area (500 m wide cable corridor).

The entire vertical profile of the shore was investigated, from the supralittoral zone to the low water spring tide level (where safe access allowed), as identified by standard Admiralty tidal predictions.

Intertidal Habitats

Within the Loughshinny survey area, numerous biotopes were identified. Those on hard substrates were mainly classified by the macrofaunal and floral community, whereas biotopes of soft substrates were mainly classified by physical structure. Additionally, several small areas (< 25 m^2) were identified and recorded as target notes. Biotopes recorded were typical of variably exposed shores from this region of the Irish coastline.

Potentially Sensitive Habitats or Species

Four intertidal habitats of potential nature conservation interest were recorded during the survey of Loughshinny. Several areas of bedrock were potential stoney reef, protected as Annex I habitat under ‘Bedrock reef’ or ‘Stony reef’, with the latter listed as a priority habitat on the UK Biodiversity Action Plan (UKBAP) as ‘Intertidal underboulder communities’. Additionally, the coastal sand dunes observed along the upper shore were potentially the Annex I habitat ‘Shifting dunes along the shoreline with *Ammophila arenaria*’, also referred to as ‘white dunes’, whilst soft boulders in the low shore to the east of the survey area were potentially a subsection of the UKBAP listed priority habitat ‘Peat and clay exposures with piddocks’.

The herring gull (*Larus argentatus*), kittiwake (*Rissa* sp.) and fulmar (*Fulmarus glacialis*), observed within the survey area, are listed in ‘the EC Birds Directive’.

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ABBREVIATIONS

CM	Central Meridian
EC	European Commission
EUNIS	European Nature Information System
GIS	Geographical Information System
JNCC	Joint Nature Conservation Committee
OSPAR	Oslo and Paris convention
UKBAP	United Kingdom Biodiversity Action Plan
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

1. INTRODUCTION

1.1 Background

On the instruction of Alcatel Submarine Networks UK Limited, Fugro performed intertidal surveys at six proposed cable landings. These were located at Seaton Sluice and Whitley Bay (UK east coast), Squires Gate Lane (UK west coast), Port Erin and Port Grenaugh (Isle of Man) and Loughshinny (Ireland).

The Havhingsten cable system is a planned subsea telecommunication network and the design spans nearly 920 km with initial landing points in four markets, including Denmark, England, Isle of Man and Ireland.

The intertidal surveys were required to obtain environmental data at the landfall locations to support the Permit in Principle applications. The surveys were conducted to establish whether any sensitive habitats are present within the cable route corridor, specifically habitats listed under Annex I of the European Commission (EC) Habitats Directive and habitats listed by the Oslo-Paris convention (OSPAR) as threatened and/or declining habitats (OSPAR, 2008).

This report presents the results of the intertidal survey conducted at Loughshinny, County Dublin, Ireland.

Appendix A outlines the guidelines for use of this report.

1.2 Scope of Work

An intertidal habitat survey was required to record the distribution of intertidal sediments and associated conspicuous species. Further objectives were to conduct a fauna and flora survey of key intertidal species, to assist with the classification and mapping of intertidal biotopes within the survey area.

1.3 Coordinate Reference System

All coordinates detailed in this report are referenced to World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) Projection Zone 29 N Central Meridian. Table 1.1 provides the detailed geodetics and projection parameters.

Table 1.1: Project Geodetic Parameters, Havingsten Cable Route, Loughshinny

Global Positioning System Geodetics Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	6378137.0
Inverse flattening:	298.257223563
Project Projection Parameters	
Grid Projection:	Universal Transverse Mercator (UTM), Northern Hemisphere
UTM Zone	29 N
Central Meridian:	-9.0
Latitude of Origin:	0.0
False Easting:	500000.0
False Northing:	0.0
Scale factor:	0.9996
Units:	Meter (1.0)

2. METHODS

2.1 Survey Methods

The intertidal habitat mapping survey was undertaken broadly following the Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook Procedural Guideline 3.1: In situ intertidal biotope recording (Wyn et al., 2001). The resolution of intertidal mapping using this method is between Phase 1 terrestrial mapping (JNCC, 2010) and the Marine Nature Conservation Review Phase 2 methods (Hiscock, 1996).

The modified Phase I walkover biotope mapping survey was conducted to record conspicuous intertidal fauna and flora and habitats within the survey area (500 m cable corridor).

The entire vertical profile of the shore was investigated, from the supralittoral zone to the low water spring tide level (where safe access allowed), as identified by standard Admiralty tidal predictions.

Colour aerial photographs covering the survey area were produced as field maps. Habitat boundaries were established and manually mapped onto field maps and any associated faunal and floral assemblages recorded. Photographs were captured within each biotope to facilitate detailed ground-truthing.

Target notes were used to record further information including features that were too small (< 5 m^2) to be portrayed accurately on a map, features on vertical faces and fine scale biotopes that existed as mosaics. Target notes were also used to describe human activities, such as coastal protection measures, shore access and large items of anthropogenic debris. Additional photography stations were recorded at which still photographs were captured of the shore.

In-field determination of the substrate composition was undertaken to assist with biotope assessment and subsequent biotope code allocation. Descriptions are based on the Folk classification (Long, 2006), as presented within Table 2.1, which uses the descriptive terms 'mud', 'sand' and 'gravel' in combinations depending on the estimated proportions of each component. For example, a description of 'muddy sand' defines sediment that has sand as the principle component and a mud proportion of between > 10 % and < 50 %. Further descriptive terms have also been used to better describe the observations where necessary, for example terms such as 'shell fragments'. In addition, to describe the larger sediment fractions, pebbles, cobbles and boulders were defined using the Wentworth classification. Any anthropogenic features evident were also recorded.

Table 2.1: Sediment Particle Sizes and Classification Terms

Particle Size	Corresponding Folk Class Used in Long (2006) Classification	Wentworth (1922) Classification
> 256 mm	NA	Boulder
> 64 to 256 mm		Cobble
> 2 to 64 mm	Gravel	Gravel/pebble
> 62.5 µm to 2 mm	Sand	Sand
> 4 to 62.5 µm	Mud	Silt
> 1 to 4 µm		Clay

Garmin GPSmap 78 hand held Global Positioning System units, accurate to 10 m but often achieving < 5 m accuracy, were used to geo-reference biotope boundaries, photographs and target notes.

2.2 Interpretation Methods

2.2.1 Habitats/Biotopes Classification

Following on shore assessment of the sediments and species present within the survey area, biotopes were classified and assigned to each distinct sediment/species association. To facilitate biotope identification, field maps, target notes and shore photographs were considered.

Habitats within the survey area have been classified in accordance with both the European Nature Information System (EUNIS) habitat classification and 'the Marine Habitat Classification for Britain and Ireland – Version 15.03' (JNCC, 2015). The EUNIS habitat classification has compiled habitat information from across Europe into a single database, whilst the JNCC classification categorises UK habitats. Both classifications systems are based around hierarchical analysis, where abiotic habitats are initially defined (upper levels) and biological communities are then linked to these (lower levels) to produce a biotope classification.

Table 2.2 summarises the EUNIS hierarchy, whilst Table 2.3 summarises the JNCC hierarchy, including an example of the coding system for an equivalent intertidal habitat.

The classification systems are designed to incorporate small-scale temporal variations (e.g. seasonal) into the biotope/habitat categories. However, biological communities and marine environments can be highly dynamic and temporally variable. Therefore, the biotopes and habitats identified by the current assessment are representative of the survey area at the time of sampling only.

Table 2.2: EUNIS (2012) Biotope Classification Hierarchy Example

Level	Example Classification Name	Example Classification Code
1. Environment	Marine habitats	A
2. Broad habitat types	Littoral rock and other hard substrata	A1
3. Habitat complexes	High energy littoral rock	A1.1
4. Biotope complexes	Mussel and/or barnacle communities	A1.11
5 & 6. Biotopes and sub-biotopes	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock	A1.113

Table 2.3: JNCC (2015) Biotope Classification Hierarchy Example

Level	Example Classification Name	Example Classification Code
1.	Littoral rock	LR
2.	High energy littoral rock	LR.HLR
3.	Mussel and/or barnacle communities	LR.HLR.MusB
4.	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock	LR.HLR.MusB.Sem

2.2.2 Biotope Mapping

For the biotope map, the basemap was a geo-referenced ESRI colour aerial photograph. This appears to have been taken during an intermediate tide state, in which the shore within the footprint of the proposed Loughshinny area was not completely exposed (Figure 3.1). During the survey, the tide was lower than depicted, as expected on a spring tide.The boundaries of each biotope, as indicated on each of the field maps, were subsequently digitized and incorporated within a geographical information system (GIS), generated using QGIS and ArcView, and overlaid onto the basemap as a series of polygons. Each polygon was attributed with the relevant biotope classification.

Target notes were plotted where appropriate (e.g. features that were too small (< 5 m^2) to be portrayed accurately on a map or those on vertical faces) and overlaid onto the base map. Photograph stations were considered spatially to ground-truth biotopes.

Numerous other map resources were consulted prior to the survey and during data analysis. These included Ordnance Survey maps and both Google and Bing maps. These latter resources indicated that a degree of variation in beach levels has occurred within the survey area as some of the rock habitats evident on available aerial imagery were buried by varying thicknesses of soft sediment at the time of survey, indicating a degree of mobility and transience in intertidal biotopes at this location.

3. RESULTS

3.1 Field Operations

The intertidal habitat survey was carried out over one day on 19 February 2019, during the low spring tide occasion, to allow access to the lowest reaches of the shore and to maximise the surveying time during the field visit. The temperature was approximately 7 °C, with cloudy skies of more than 20 % cloud cover. Winds were moderate, and the wind direction was approximately easterly. As identified by standard Admiralty tidal predictions, the lowest tide level was 0.44 m.

3.2 Intertidal Habitats and Fauna

The Loughshinny survey area comprised a predominantly sandy shore enclosed to the west by layered limestone and shale bedrock extending directly from coastal cliffs, and to the east by a concrete pier used by creel fishermen. The folded sedimentary cliffs and bedrock present to the west of the survey area are reported to be of carboniferous age (Turner, 1951). An extended area of bedrock was emergent to the east of the pier. The lower shore to the east of the bay was comprised of mixed sediment (sand, pebbles, cobbles and boulders), while to the west, the lower shore was comprised of sandy sediments.

The flora observed comprised common rocky shore seaweed species in well recognised zonation patterns. Limited epifauna was observed, likely due to the season and sand scour. However, both epifauna and seaweed diversity and abundance were elevated on the layered limestone and shale bedrock and associated rockpools in the west of the survey area and on the mixed sediment and boulders on the lower shore to the east. A thin veneer of *Sabellaria spinulosa* tubes was observed on mixed sediments on the lower shore to the east of the survey area.

Piddock holes were observed in boulders in the lower shore from the centre to the east side of the bay. Seaweeds included several green and red ephemeral seaweeds, red turf forming seaweeds and several wracks. Coralline and several green and red seaweeds were present in rockpools. Kelp (*Laminaria digitata* and *Saccharina latissima*) was present on mixed sediments on the lower shore to the east of the survey area. Additionally, lug worm (*Arenicola marina*) casts and sand mason worm (*Lanice conchilega*) tubes were observed, the latter in high abundance in sandy sediments in the low shore.

The upper shore featured boulder sea defences upon which small white sand dunes have formed. A small area of gabion sea defence was present in the north-west of the bay. Several outflows were observed along the upper shore, through the boulder sea defences. To the north-east of the bay, a small area of bedrock was emergent, with cobbles and boulders to the west adjacent to the entry slip and boulder sea defences to the north.

Table 3.1 presents the habitat classification hierarchy for the habitats observed within the survey area, both those mapped as distinct habitats and those denoted as target notes. Figure 3.1 spatially presents the habitats observed across the survey area, with those < 25 m^2 or on vertical faces marked as target notes. Appendix B.1 presents that photographic log and Appendix B.2 presents specifics of each target note.

Table 3.1: Habitat Classifications, Havingsten Cable Route Survey, Loughshinny

EUNIS (2012) Habitat Classification						Equivalent JNCC (2015) Classification
Environment Level 1	**Broad Habitat Level 2**	**Habitat Level 3**	**Biotope Complex Level 4**	**Biotope Level 5**	**Sub-biotope Level 6**	
A Marine	A1 Littoral rock and other hard substrata	A1.1 Littoral rock and other hard substrata	-	-	-	LR Littoral rock
			A1.11* Mussel and/or barnacle communities	A1.113* *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock	-	LR.HLR.MusB.Sem* *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
		A1.2 Moderate energy littoral rock	A1.21* Barnacles and fucoids on moderately exposed shores	-	-	LR.MLR.BF* Barnacles and fucoids on moderately exposed shores
				A1.211* *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock	-	LR.MLR.BF.PelB* *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
				A1.213 *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock	-	LR.MLR.BF.FvesB *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
				A1.214* *Fucus serratus* on moderately exposed lower eulittoral rock	-	LR.MLR.BF.Fser* *Fucus serratus* on moderately exposed lower eulittoral rock
					A1.2143 *Fucus serratus* and piddocks on lower eulittoral soft rock	LR.MLR.BF.Fser.Pid *Fucus serratus* and piddocks on lower eulittoral soft rock

EUNIS (2012) Habitat Classification						Equivalent JNCC (2015) Classification
Environment Level 1	**Broad Habitat Level 2**	**Habitat Level 3**	**Biotope Complex Level 4**	**Biotope Level 5**	**Sub-biotope Level 6**	
A Marine continued	A1 Littoral rock and other hard substrata continued	A1.3 Low energy littoral rock	A1.31 Fucoids on sheltered marine shores	A1.311 *Pelvetia canaliculata* on sheltered littoral fringe rock	-	LR.LLR.F.Pel *Pelvetia canaliculata* on sheltered littoral fringe rock
				A1.312 *Fucus spiralis* on sheltered upper eulittoral rock	-	LR.LLR.F.Fspi *Fucus spiralis* on sheltered upper eulittoral rock
				A1.313 *Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock	A1.3131 *Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock	LR.LLR.F.Fves.FS *Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock
					A1.3132 *Fucus vesiculosus* on mid eulittoral mixed substrata	LR.LLR.F.Fves.X *Fucus vesiculosus* on mid eulittoral mixed substrata
				A1.314* *Ascophyllum nodosum* on very sheltered mid eulittoral rock	A1.3141* *Ascophyllum nodosum* on full salinity mid eulittoral rock	LR.LLR.F.Asc.FS* *Ascophyllum nodosum* on full salinity mid eulittoral rock
				A1.315 *Fucus serratus* on sheltered lower eulittoral rock	A1.3152 *Fucus serratus* on full salinity lower eulittoral mixed substrata	LR.LLR.F.Fserr.X *Fucus serratus* on full salinity lower eulittoral mixed substrata

EUNIS (2012) Habitat Classification						Equivalent JNCC (2015) Classification
Environment Level 1	**Broad Habitat Level 2**	**Habitat Level 3**	**Biotope Complex Level 4**	**Biotope Level 5**	**Sub-biotope Level 6**	
A Marine continued	A1 Littoral rock and other hard substrata continued	A1.4 Features of littoral rock	A1.41 Rockpools	A1.413 Seaweeds in sediment-floored eulittoral rockpools	-	LR.FLR.Rkp.SwSed Seaweeds in sediment-floored eulittoral rockpools
				1.421* Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools	-	LR.FLR.Rkp.G* Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools
			A1.44* Communities of littoral caves and overhangs	A1.444* *Audouinella purpurea* and *Cladophora rupestris* on upper to mid-shore cave walls	-	LR.FLR.Cvov.AudCla* *Audouinella purpurea* and *Cladophora rupestris* on upper to mid shore cave walls
			A1.45 Ephemeral green or red seaweed communities (freshwater or sand-influenced) on non-mobile substrata	-	-	LR.FLR.Eph Ephemeral green or red seaweed communities (freshwater or sand-influenced)
	A2 Littoral sediment	A2.2 Littoral sand and muddy sand	A2.21 Strandline	-	-	LS.LSa.St Strandline
				A2.211* Talitrids on the upper shore and strand-line	-	LS.LSa.St.Tal* Talitrids on the upper shore and strand-line
			A2.22 Barren or amphipod-dominated mobile sand shores	-		LS.LSa.MoSa Barren or amphipod-dominated mobile sand shores

EUNIS (2012) Habitat Classification						**Equivalent JNCC (2015) Classification**
Environment Level 1	**Broad Habitat Level 2**	**Habitat Level 3**	**Biotope Complex Level 4**	**Biotope Level 5**	**Sub-biotope Level 6**	
A Marine continued	A2 Littoral sediment continued	A2.2 Littoral sand and muddy sand continued	A2.24 Polychaete/bivalve dominated muddy sand shores	A2.245 *Lanice conchilega* in littoral sand	-	LS.LSa.MuSa.Lan *Lanice conchilega* in littoral sand
		A2.4 Littoral mixed sediments	-	-	-	Ls.LMx Littoral mixed sediments
	A3 Infralittoral rock (and other hard substrata)	A3.3 Low energy infralittoral rock	A3.31 Silted kelp communities (sheltered infralittoral rock)	A3.313 *Laminaria saccharina* on very sheltered infralittoral rock	A3.3131 *Laminaria saccharina* and *Laminaria digitata* on sheltered sublittoral fringe rock	IR.LIR.K.Lsac.Ldig *Laminaria saccharina* and *Laminaria digitata* on sheltered sublittoral fringe rock
B Coastal habitats	B1 Sand dunes	B1.3	B1.32	B1.321 Atlantic white dunes	-	-
	B3 Rock cliffs, ledges and shores, including the supralittoral	B3.1 Supralittoral rock (lichen or splash zone)	B3.11 Lichens or small green seaweeds on supralittoral and littoral fringe rock	-	-	LR.FLR.Lic* Lichens or small green algae on supralittoral and littoral fringe rock
				B3.111 Yellow and grey lichens on supralittoral rock	-	LR.FLR.Lic.YG Yellow and grey lichens on supra-littoral rock surfaces
				B3.112 *Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock	-	LR.FLR.Lic.Pra *Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock
				B3.113* *Verrucaria maura* and sparse barnacles on exposed littoral fringe rock	-	LR.FLR.Lic.Ver.B* *Verrucaria maura* and sparse barnacles on exposed littoral fringe rock

Notes:
EUNIS = European Nature Information System
JNCC = Joint Nature Conservation Committee
* = Biotopes recorded exclusively as target notes (< 25 m^2)

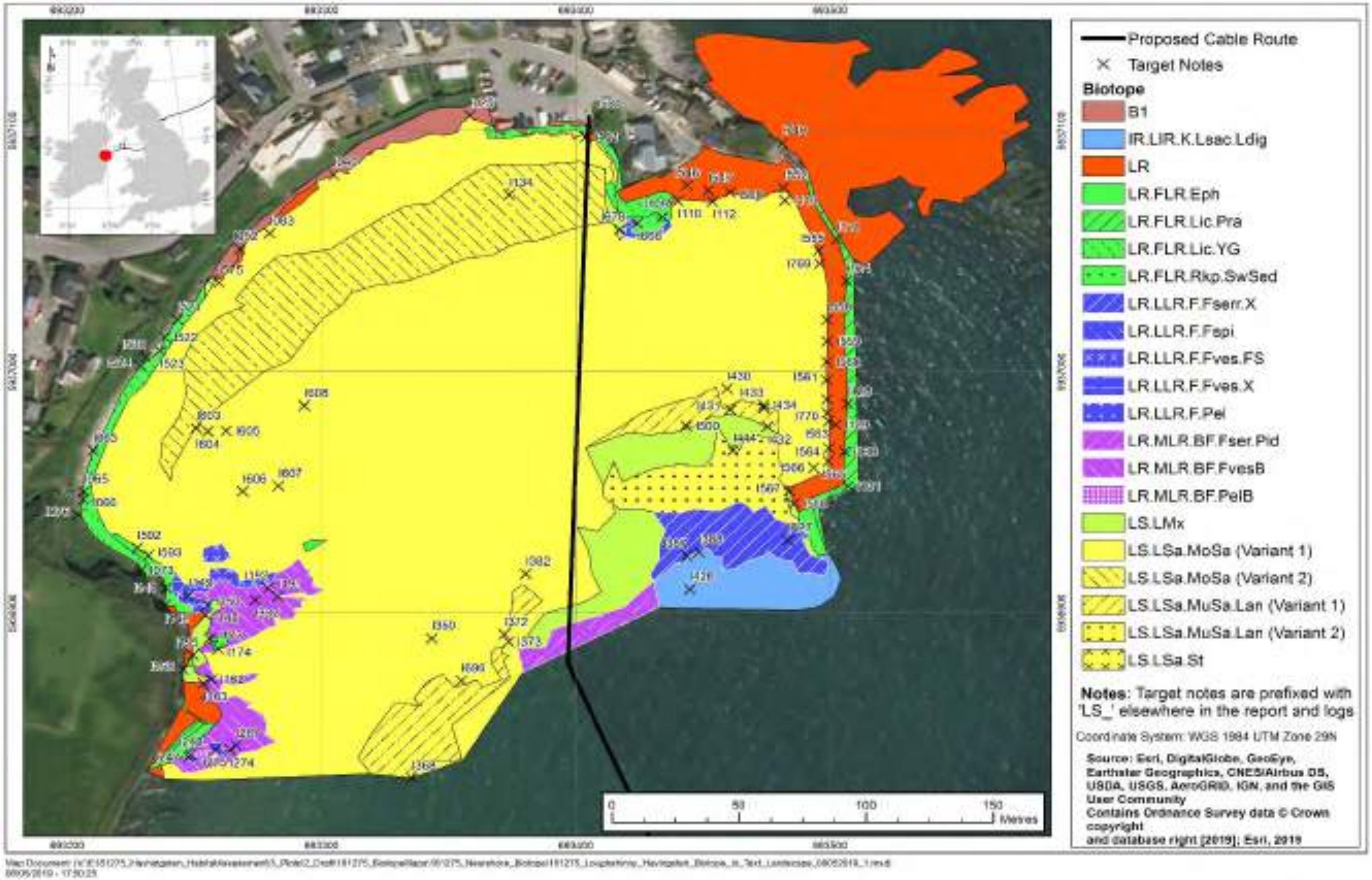


Figure 3.1: Biotope map, Havingsten cable route, Loughshinny

3.2.1 Littoral Rock (and Other Hard Substrata) (A1/LR)

The broad habitat 'Littoral rock' includes rock habitats (e.g. bedrock, boulders and cobbles) that occur in both the intertidal and the splash zone (JNCC, 2015).

Within the Loughshinny survey area, several areas of upper shore bare rock and artificial surfaces (e.g. seawalls, groynes) and a large area observed to the east outwith Loughshinny Bay, were designated as the broad habitat 'Littoral rock' (A1/LR). Hard substrata that was designated as 'Littoral rock' featured a lack of epifauna or flora. Small areas (< 25 m^2), that could not be classified further than 'Littoral rock', were recorded as target notes (Appendix B.2).

Figure 3.2 presents example photographs of this habitat, within the Loughshinny survey area.

Within the Loughshinny survey area, some areas of this broad habitat were characteristic of more fine scale classification. For example, areas of solitary boulders (< 25 m^2) to the west of the survey area was classified further as the biotope complex 'Barnacles and fucoids on moderately exposed shores' (A1.21/LR.MLR.BF) or as the biotope '*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock' (A1.113/LR.HLR.MusB.Sem). Areas were classified as the former due to the presence of a mosaic of fucoids and barnacles, with associated limpets (*Patella vulgata*), whilst areas were classified as the latter due to a dominance of the barnacle *S. balanoides*, with associated limpets (*P. vulgata*) and mussels (*Mytilus* juv.). Additionally, areas of solitary boulders (< 25 m^2), in the central part of the sandy shore, and faces of upper shore bedrock were classified as the biotope '*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock' (A1.211/LR.MLR.BF.PelB), due to an abundant canopy of channelled wrack (*Pelvetia canaliculata*), and undercanopy flora and fauna typical of this biotope (the red seaweed *Catenella caespitosa*, barnacle *S. balanoides*, limpets *P. vulgata*, winkles *Littorina saxatilis* and black tar lichen *Verrucaria maura*). These were recorded as target notes (Appendix B.2). Figure 3.3 presents example photographs of the biotope '*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock', within the Loughshinny survey area.

Several other littoral rock habitats and biotopes have been further categorised, dependent on their physical structure, degree of wave exposure and biological community and are discussed further in the following sections.

3.2.1.1 <u>*Fucus vesiculosus* and Barnacle Mosaics on Moderately Exposed Mid Eulittoral Rock (A1.213/LR.MLR.BF.FvesB)</u>

The biotope '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' occurs on exposed to moderately exposed mid eulittoral bedrock and boulders. This biotope is usually dominated by a mosaic of the barnacle *S. balanoides* and bladder wrack *F. vesiculosus*. The limpet *P. vulgata* and the dog whelk *Nucella lapillus* are often present. The anemone *Actinia equina* and small individuals of the mussel *Mytilus edulis* may occur in crevices. The undercanopy flora and fauna includes red seaweeds (e.g. *Corallina officinalis*, *Mastocarpus stellatus* and *Osmundea pinnatifida*) and winkles (e.g. *Littorina* spp., including *Littorina littorea*) (JNCC, 2015).

To the west of the survey area, on layered limestone and shale bedrock extending from coastal cliffs to sand, this biotope was observed on middle shore bedrock (Figure 3.1) with a relatively sparse canopy of *F. vesiculosus* (Figure 3.4). The undercanopy flora and fauna was sparse but included red seaweeds (e.g. *Chondrus crispus*, *Rhodothamniella floridula*, *Osmundea* sp.) and pink encrusting (Corallinales), green seaweeds (*Ulva* spp. including *Ulva lactuca*), limpets (*Patella* spp. including *P. vulgata*), dog whelks (*N. lapillus*), barnacles (*S. balanoides* and *Austrominius modestus*), winkles (*Littorina* sp.), mussels (*Mytilus* sp. including *M. edulis*).

Figure 3.4 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.2 *Fucus serratus* and Piddocks on Lower Eulittoral Soft Rock (A1.2143/LR.MLR.BF.Fser.Pid)

The sub-biotope '*Fucus serratus* and piddocks on lower eulittoral soft rock' occurs on the lower eulittoral zone, on soft rock shores (e.g. chalk or limestone). This sub-biotope is characterised by the wrack *Fucus serratus* and rock-boring fauna including the piddocks *Barnea* spp., *Pholas dactylus* and *Hiatella arctica*, the latter of which can occur in dense aggregations. Burrowing polychaetes (e.g. *Polydora* spp.) can also occur in high abundance. The undercanopy fauna includes red seaweeds, such as *Gelidium pusillum*, *O. pinnatifida*, *Palmaria palmata*, *Lomentaria articulata* and *R. floridula*, but also calcareous seaweeds such as *C. officinalis* and coralline crusts including *Phymatolithion lenormandii*. The anemone *A. equina* and the mussel *M. edulis* can occupy empty piddock holes. The barnacle *S. balanoides* and the limpet *P. vulgata* often colonise rock surfaces. The dog whelk *N. lapillus*, the winkles *L. littorea* and *Littorina obtusata/mariae* and the top shell *Steromphala cineraria* may also occur (JNCC, 2015).

Within the Loughshinny survey area, this sub-biotope was observed in the sublittoral fringe on the south of the survey area (Figure 3.1). Some small areas (25 m^2) of this sub-biotope were recorded outwith the mapped area as target notes (Appendix B.2). A sparse canopy of serrated wrack *Fucus serratus* was observed. Boulders were covered by a dense red seaweed turf (*R. floridula*) and were colonised by rock-boring fauna including piddocks. Red seaweeds (*Polysiphonia* sp., *C. crispus* and *P. palmata*), coralline seaweeds (*P. lenormandii*), green seaweeds (*Cladophora rupestris* and *U. lactuca*), fan worms (*Spirobranchus* sp.) and bryozoan (Bryozoa) also occurred. Sparse specimens of ross worms (*Sabellaria spinulosa*) and winkle (*L. ?mariae*) were also observed.

Figure 3.5 presents example photographs of this habitat, within the Loughshinny survey area.

On the bedrock to the west of the survey area, the upper canopy of a small area (< 25 m^2) was dominated by the serrated wrack *F. serratus*, whilst the under canopy featured the barnacle *S. balanoides.* No piddocks were observed and this was classified as the higher-level biotope '*Fucus serratus* on moderately exposed lower eulittoral rock' (A1.214/LR.MLR.BR.Fser).

3.2.1.3 *Pelvetia canaliculata* on Sheltered Littoral Fringe Rock (A1.311/LR.LLR.F.Pel)

The biotope '*Pelvetia canaliculata* on sheltered littoral fringe rock' occurs on lower littoral fringe hard substrate (bedrock, stable boulders and mixed substrata) in sheltered to extremely sheltered conditions dominated by the channelled wrack *P. canaliculata*. The undercanopy flora and fauna include a crust of the black tar lichen *V. maura* or, on very sheltered shores, the non-calcified red seaweeds *Hildenbrandia rubra*. The spiral wrack *Fucus spiralis* can be present in lower parts of the biotope. The red seaweed *Catenella caespitosa* and the green seaweed *Ulva* spp.can be present. A low abundance of barnacles may be present on more exposed shores. The winkle *L. saxatilis* and a variety of amphipods may also occur (JNCC, 2015).

Within the Loughshinny survey area, this biotope was observed on small patches of upper shore on bedrock to the east and at the base of the cliff to the west (Figure 3.1). The channelled wrack (*P. canaliculata*) composed the upper canopy. The undercanopy flora included green seaweed turf (*Ulva* sp.), red seaweeds (*Porphyra* sp.) and spiral wrack (*F. spiralis*).

Figure 3.3 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.4 *Fucus spiralis* on Sheltered Upper Eulittoral Rock (A1.312/ LR.LLR.F.Fspi)

The biotope '*Fucus spiralis* on sheltered upper eulittoral rock' occurs on sheltered upper eulittoral bedrock. This biotope is typically dominated by the spiral wrack *F. spiralis*, usually overlying the black tar lichen *V. maura*. Occasionally, channelled wrack *P. canaliculata* and the encrusting red seaweed *H. rubra* are also present. The undercanopy flora includes the limpet *P. vulgata*, the winkles *L. saxatilis* and *L. littorea* and the barnacle *S. balanoides*. The ephemeral green seaweed *Ulva intestinalis* may be present (JNCC, 2015).

Within the Loughshinny survey area, this biotope was observed in bands below the channelled wrack (*P. canaliculata*) and on upper bedrock to the west and east of the bay (Figure 3.1). The upper canopy was comprised of the spiral wrack *F. spiralis.* The undercanopy flora included the green seaweed *Ulva* sp. and the red seaweed *C. caespitosa.* The fauna observed included barnacles (*S. balanoides*).

Figure 3.6 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.5 *Fucus vesiculosus* on Full Salinity Moderately Exposed to Sheltered Mid Eulittoral Rock (A1.3131/LR.LLR.F.Fves.FS)

The sub-biotope '*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock' occurs on moderately exposed to sheltered mid eulittoral bedrock and large boulders. This sub-biotope is dominated by a dense canopy of the bladder wrack *F. vesiculosus*. In localised shelter, the knotted wrack *Ascophyllum nodosum* may be present in low abundance. The red seaweed *M. stellatus* and the serrated wrack *F. serratus* may be present in damp crevices. The crab *Carcinus maenas* may be present in pools, crevices or under boulders. The undercanopy fauna includes a sparse covering of the barnacle *S. balanoides* and the limpet *P. vulgata*, with the mussel *M. edulis* present in crevices. The winkles *L. littorea* and *L. saxatilis* and the dog whelk *N. lapillus* are present on hard substrate, whilst the winkle *L. obtusata/mariae* can be present on the canopy fronds. The calcareous tube-forming polychaete *Spirorbis spirorbis* can occur epiphytically on the fronds (JNCC, 2015).

Within the Loughshinny survey area, this sub-biotope was observed on sheltered to mid eulittoral moderately exposed rock to the west of the survey area (Figure 3.1) and on the vertical surface of the pier. Some small areas (< 25 m^2) were recorded outwith the mapped area as target notes (Appendix B.2). This sub-biotope was dominated by the bladder wrack *F. vesiculosus*. The flora observed included the green seaweeds *Ulva* sp. and the red seaweeds *Porphyra* sp. The fauna observed included barnacles *S. balanoides.* Figure 3.7 presents example photographs of this habitat, within the Loughshinny survey area

To the west of the survey area, the knotted wrack *A. nodosum* dominated the midshore bedrock in a small area (< 25 m^2). Due to the dominance of *A. nodosum*, this small area was characteristic of the sub-biotope '*Ascophyllum nodosum* on full salinity mid eulittoral rock' (A1.3141/LR.LLR.F.Asc.FS). This was recorded as a target note (Appendix B.2).

3.2.1.6 *Fucus vesiculosus* on Mid Eulittoral Mixed Substrata (A.1.3132/LR.LLR.F.Fves.X)

The sub-biotope '*Fucus vesiculosus* on mid eulittoral mixed substrata' occurs on very sheltered to very sheltered mid eulittoral mixed sediment (pebbles, cobbles and boulders) overlaying sediment in fully marine conditions. This sub-biotope is dominated by the bladder wrack *F. vesiculosus*. The knotted wrack *A. nodosum* may occasionally be present on larger boulders. Ephemeral seaweeds such as *U. intestinalis* may be present. The barnacle *S. balanoides*, the limpet *P. vulgata*, the dog whelk *N. lapillus,* the mussel *M. edulis* and the winkles *L. saxatilis* may be present on the hard substrata. Winkles, particularly *L. littorea* and *L. obtusata/mariae*, occur on seaweeds. The polychaetes *A. marina* and *L. conchilega* may be present in sediment, while a variety of gastropods and the crab *C. maenas* occur on and under cobbles (JNCC, 2015).

Within the Loughshinny survey area, this sub-biotope was observed on mid eulittoral mixed sediment adjacent to sand to the west of the survey area (Figure 3.1). This sub-biotope supported a canopy of the bladder wrack *F. vesiculosus*. The flora and fauna were sparse but included green seaweed (*Ulva* spp.) and the knotted wrack *A. nodosum*, with the polychaete *L. conchilega* in sand between the rocks.

Figure 3.7 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.7 *Fucus serratus* on Full Salinity Lower Eulittoral Mixed Substrata (A1.3152/LR.LLR.F.Fser.X)

The sub-biotope '*Fucus serratus* on full salinity lower eulittoral mixed substrata' occurs on sheltered to extremely sheltered full salinity lower eulittoral mixed sediment (pebbles, cobbles, boulders overlaying sediment). This sub-biotope is dominated by a dense canopy of the serrated wrack *F. serratus*. The red seaweed *M. stellatus*, the knotted wrack *A. nodosum* and the green seaweeds *Ulva* spp. and *Cladophora* spp. can be present. Coralline crusts (e.g. *Lithothamnion* spp.) can occur on cobbles and boulders. The crab *C. maenas* and winkles such as *L. littorea* and *L. obtusata/mariae* may occur amongst the pebbles and cobbles. The mussel *M. edulis* may also be present. The barnacle *S. balanoides*, the limpet *P. vulgata* and the tube-forming polychaetes *Spirobranchus triqueter* and *Spirorbis* spp. can colonise hard substrates. *Spirorbis* spp. can also occur on the *F. serratus* fronds. Sediment between the loose substrata may support infauna including the polychaete *A. marina* (JNCC, 2015).

Within the Loughshinny survey area, this sub-biotope was observed on lower shore mixed sediment (pebbles, cobbles and boulders) with a moderate canopy of *F. serratus* (Figure 3.1). The undercanopy flora and fauna were sparse, but included green seaweeds (*Ulva* spp., including *U. lactuca*), pink encrusting seaweeds (Corallinaceae including *P. lenormandii*), red seaweeds (Rhodophyta including *C. crispus, Rhodothamniella* sp. and *Polysiphonia* sp.), sponges (Porifera including *Halichondria* sp.), fan worms (*Spirobranchus* sp.), ross worms (*S. spinulosa*), barnacles (*S. balanoides*) and dog whelks (*N. lapillus*).

Figure 3.8 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.8 Rockpools (A1.41/LR.FLR.Rkp)

The biotope complex 'Rockpools' occurs within depressions in the bedrock producing 'pools' on the retreat of the tide, which are permanently submerged and not directly affected by height on the shore. This biotope complex encompasses four main rockpool biotopes, although it is accepted that an enormous variety of rockpool communities exist (JNCC, 2015).

Within the Loughshinny survey area, rockpools were present on the bedrock to the west of the survey area (Figure 3.1). Rockpools that could not be classified further than the biotope complex 'Rockpools' were less than 25 m^2 and therefore denoted as target notes (Appendix B.2).

Figure 3.9 presents example photographs of this habitat, within the Loughshinny survey area.

Several rockpools were characteristic of more fine scale classification. For example, a small pool (< 5 m^2) on upper shore bedrock to the west of the survey area was dominated by the green seaweed *Ulva* sp., with the green seaweed *Chaetomorpha melagnoium* also present. This was representative of the biotope 'Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools' (A1.421/LR.FLR.Rkp.G) and was denoted as a target note (Appendix B.2). Figure 3.9c presents example photographs of this habitat, within the Loughshinny survey area.

Only one rockpool biotope was of sufficient size to map and is discussed further in the following subsection.

Seaweeds in Sediment-Floored Eulittoral Rockpools (A1.413/LR.FLR.Rkp.Swsed)

The biotope 'Seaweeds in sediment-floored eulittoral rockpools' occurs in rockpools with sedimentary (mud, sand, gravel) bottoms, which support scour-tolerant seaweeds. Rockpools communities vary with depth of pool and sediment composition. In pools with large areas of sand, infaunal species such as *A. marina* and *L. conchilega* often occur. The seagrass *Zostera* spp. may occur in some pools where stable sand is present. Shallow rockpools with cobble and pebble floors and an underlaying layer of sediment, support red seaweeds communities of *C. crispus*, *M. stellatus*, *Ceramium* spp., *C. officinalis* with green seaweeds such as *Cladophora* spp. and *Ulva* spp. often present (JNCC, 2015).

Within the Loughshinny survey area, this biotope was observed in the upper shore to the west of the survey area, on bedrock adjacent to sand (Figure 3.1). Some small areas of this biotope (< 25 m^2) were reported elsewhere within the survey area and were recorded as target notes (Appendix B.2). The flora observed included red seaweeds *Dumontia* sp. and *C. crispus*, the green seaweed *Cladophora* sp. and the coralline crust *Phymatolithon lenormandii*. The tube building polychaete *L. conchilega* was also observed.

Figure 3.9d presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.9 *Audouinella purpurea* and *Cladophora rupestris* on Upper to Mid Shore Cave Walls (A1.444/LR.FLR.Cvov.AudCla)

The biotope '*Audouinella purpurea* and *Cladophora rupestris* on upper to mid shore cave walls' occurs on steeply sloping or vertical faces of upper to mid shore caves, which are partially sheltered from direct wave action. This biotope is characterised by a dense mat of the turf forming red seaweed *Rhodochorton purpurea* (previously *Audouinella purpurea*). Patches of the green seaweed *C. rupestris* may occur. Epifaunal is generally sparse, comprised of a low abundance of the limpet *Patella* spp., the winkle *L. saxatilis* and the barnacles *S. balanoides* (JNCC, 2015).

Within the Loughshinny survey area, the biotope '*Audouinella purpurea* and *Cladophora rupestris* on upper to mid shore cave walls' was observed at the base of the cliffs to the west of the survey area, within a shallow cave (Figure 3.1). Within the Loughshinny survey area, a small area (25 m^2) of this biotope was recorded as a target note (Appendix B.2). This was characterised by a dense turf of *R. purpurea* with sparse associated fauna, including the barnacle *S. balanoides*, the limpets *P. vulgata* and the winkles *L. saxatilis.*

Figure 3.10 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.1.10 Ephemeral Green or Red Seaweeds (Freshwater or Sand-Influenced) on Non-Mobile Substrata (A1.45/LR.FLR.Eph)

The biotope complex 'Ephemeral green or red seaweed communities (freshwater or sand-influenced) on non-mobile substrata' occurs on disturbed littoral bedrock and mixed sediments throughout the intertidal zone. *Ulva* spp. is generally the dominant green seaweed, whilst *Porphyra purpurea.* and *R. floridula* are generally the dominant red seaweeds. The winkle *Littorina* spp., the limpet *P. vulgata* and the barnacle *S. balanoides* may also occur in low abundance (JNCC, 2015).

Within the Loughshinny survey area, this biotope complex was observed on the bedrock and mixed sediment (pebbles, cobbles and boulders) at the base of the cliff to the west of the survey area, on the emergent bedrock to the east of the survey area adjacent to the pier, at the end of the pier and on vertical surfaces of the pier (Figure 3.1). Some small areas of this biotope complex (< 25 m^2) were observed outwith the mapped areas and were recorded as target notes (Appendix B.2). The flora was dominated by green seaweeds (*Ulva* spp.) and red seaweeds (*Porphyra* spp.), with some small patches of *F. vesiculosus* and *P. canaliculata* reported on boulders and cobbles.

Figure 3.11 presents example photographs of this habitat, within the Loughshinny survey area.

A B C D

A: Photograph LS_I0072

Concrete (slip)

No flora and fauna observed

B: Photograph LS_I0087

Concrete (Promenade verge)

No flora and fauna observed

C: Photograph LS_I0433

Concrete (Sea defence step)

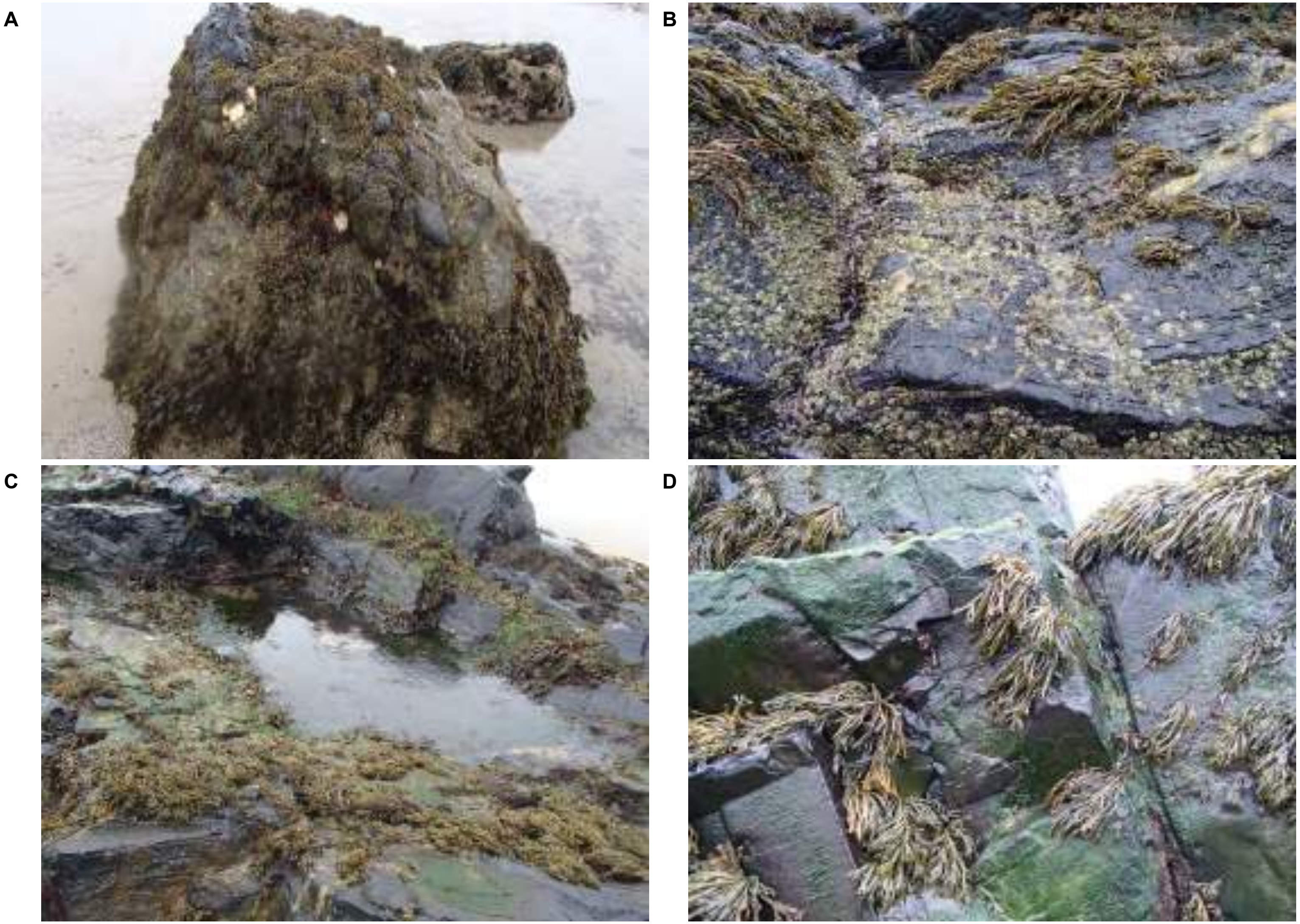
No flora and fauna observed

D: Photograph LS_I0440

Concrete (Sea defence, promenade and slip)

No flora and fauna observed

Figure 3.2: Example photographs of 'littoral rock (and other hard substrata)' (A1/LR), Havingsten cable route, Loughshinny



'*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock' (LR.MLR.BF.PelB)

A: Photograph LS_I0496

Boulder
Channelled wrack (*Pelvetia canaliculata*),
Spiral wrack (*Fucus spiralis*),
Barnacles (*Semibalanus balanoides*),
Limpets (*Patella vulgata*),
Red seaweeds (?*Gelidium* sp.),
Dog whelk (?*Nucella lapillus*.)

B: Photograph LS_I0543

Bedrock
Channelled wrack (*P. canaliculata*),
Green seaweeds (*Ulva* sp.)

'*Pelvetia canaliculata* on sheltered littoral fringe rock' (LR.LLR.F.Pel)

C: Photograph LS_I0222

Bedrock
Channelled wrack (*P. canaliculata*),
Green seaweeds (*Ulva* sp.)

D: Photograph LS_I0251

Bedrock
Channelled wrack (*P. canaliculata*),
Red seaweeds (Rhodophyta including *Porphyra* sp.)

Figure 3.3: Example photographs of '*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock' (A1.211/LR.MLR.BF.PelB) and '*Pelvetia canaliculata* on sheltered littoral fringe rock' (A1.311/LR.LLR.F.Pel), Havingsten cable route, Loughshinny

A

B

C

D

A: Photograph LS_I0231

Bedrock
A: Folded sedimentary rocks of carboniferous age

Bladder wrack (*Fucus vesiculosus*),
Dog whelk (*Nucella lapillus*),
Limpets (*Patella* sp.),
Coralline seaweeds (Corallinales)

B: Photograph LS_I0236

Bedrock
Bladder wrack (*F. vesiculosus*),
Barnacles (Sessilia)

C: Photograph LS_I0238
Bedrock
Bladder wrack (*F. vesiculosus*),
Barnacles (*S. balanoides*),
Limpets (*Patella vulgata*),
Pink encrusting seaweeds (Corallinales)

D: Photograph LS_I0243

Bedrock
Bladder wrack (*F. vesiculosus*),
Barnacles (*S. balanoides*),
Mussels (*Mytilus edulis*),
Limpets (*P. vulgata*),
Winkle (*Littorina littorea*)

Figure 3.4: Example photographs of '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' (A1.213/LR.MLR.BF.FvesB), Havingsten cable route, Loughshinny

A

B

C

D

A: Photograph LS_I0285

Boulder with piddocks (Bivalvia) (piddock bores)
Ross worms (*Sabellaria spinulosa*)

B: Photograph LS_I0291

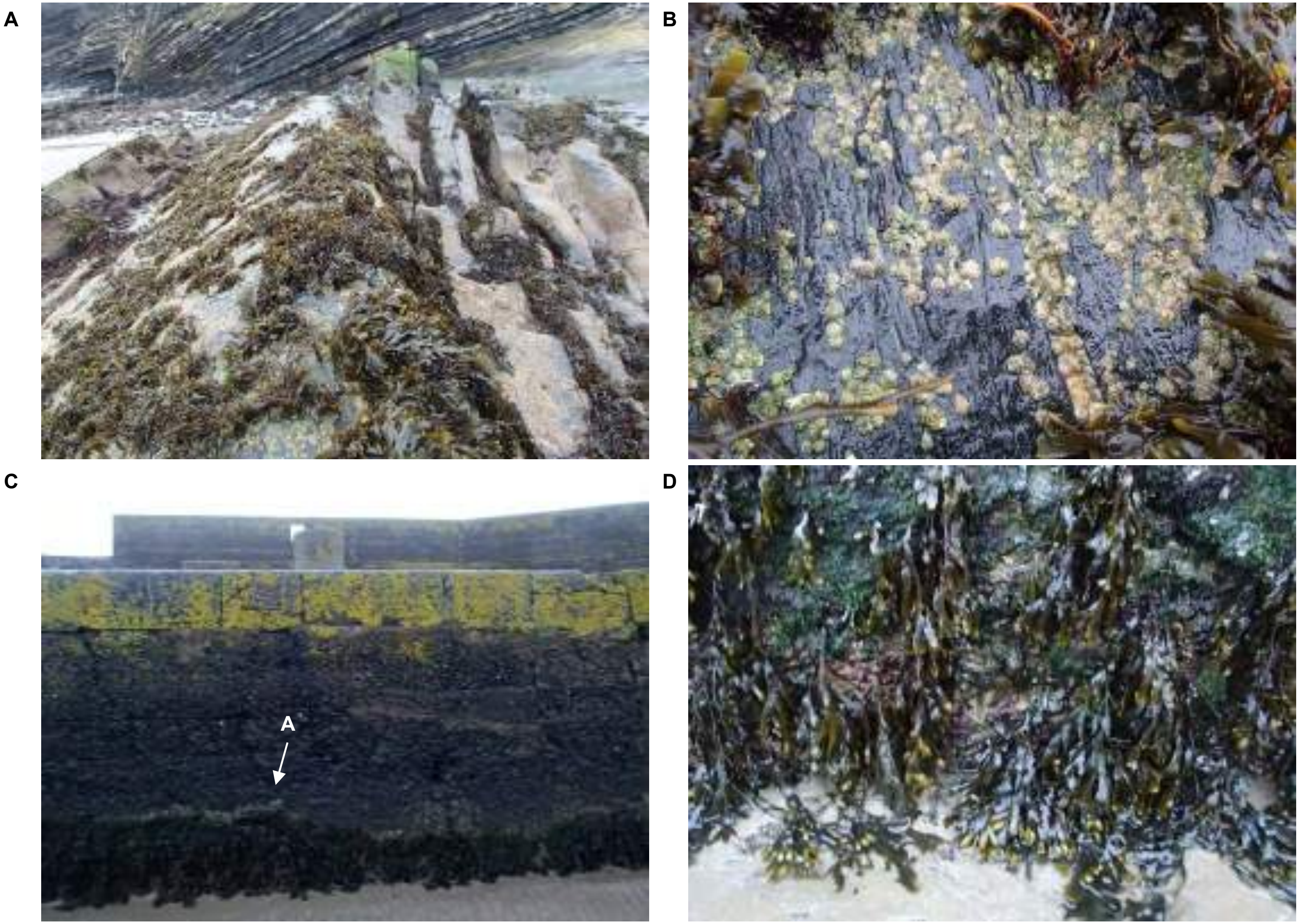
Boulder with piddocks (Bivalvia) (piddock bores)
Fan worms (Serpulidae),
Red seaweed turf (*Rhodothamniella floridula*)

C: Photograph LS_I0296
Boulder with piddocks (Bivalvia) (piddock bores),
Red seaweed turf (*R. floridula*),
Green seaweeds (*Ulva lactuca*)

D: Photograph LS_I0298

Boulder with piddocks (Bivalvia) (piddock bores)
Fan worms (*Spirobranchus* sp.),
Red seaweed turf (*R. floridula*),
Red seaweeds (*Polysiphonia* sp. and *Chondrus crispus*),
Serrated wrack (*Fucus serratus*)

Figure 3.5: Example photographs of '*Fucus serratus* and piddocks on lower eulittoral soft rock' (A1.2143/LR.MLR.BF.Fser.Pid), Havingsten cable route, Loughshinny



A: Photograph LS_I0224

Bedrock
Spiral wrack (*Fucus spiralis*)

B: Photograph LS_I0291

Bedrock
Barnacles (*Semibalanus balanoides*),
Spiral wrack (*F. spiralis*)

C: Photograph LS_I0
Pier wall
A: spiral wrack belt (*F. spiralis*)

D: Photograph LS_I0

Pier wall
Spiral wrack (*F. spiralis*)

Figure 3.6: Example photographs of '*Fucus spiralis* on sheltered upper eulittoral rock' (A1.312/ LR.LLR.F.Fspi), Havingsten cable route, Loughshinny

'*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock' (LR.LLR.F.Fves.FS)

A: Photograph LS_I0254
Bedrock with patches of mixed sediment
Bladder wrack (*F. vesiculosus*),
Green seaweed turf (*Ulva* sp.)

B: Photograph LS_I0261
Bedrock outcrop surrounded by
Bladder wrack (*F. vesiculosus*),
Green seaweed turf (*Ulva* sp.)

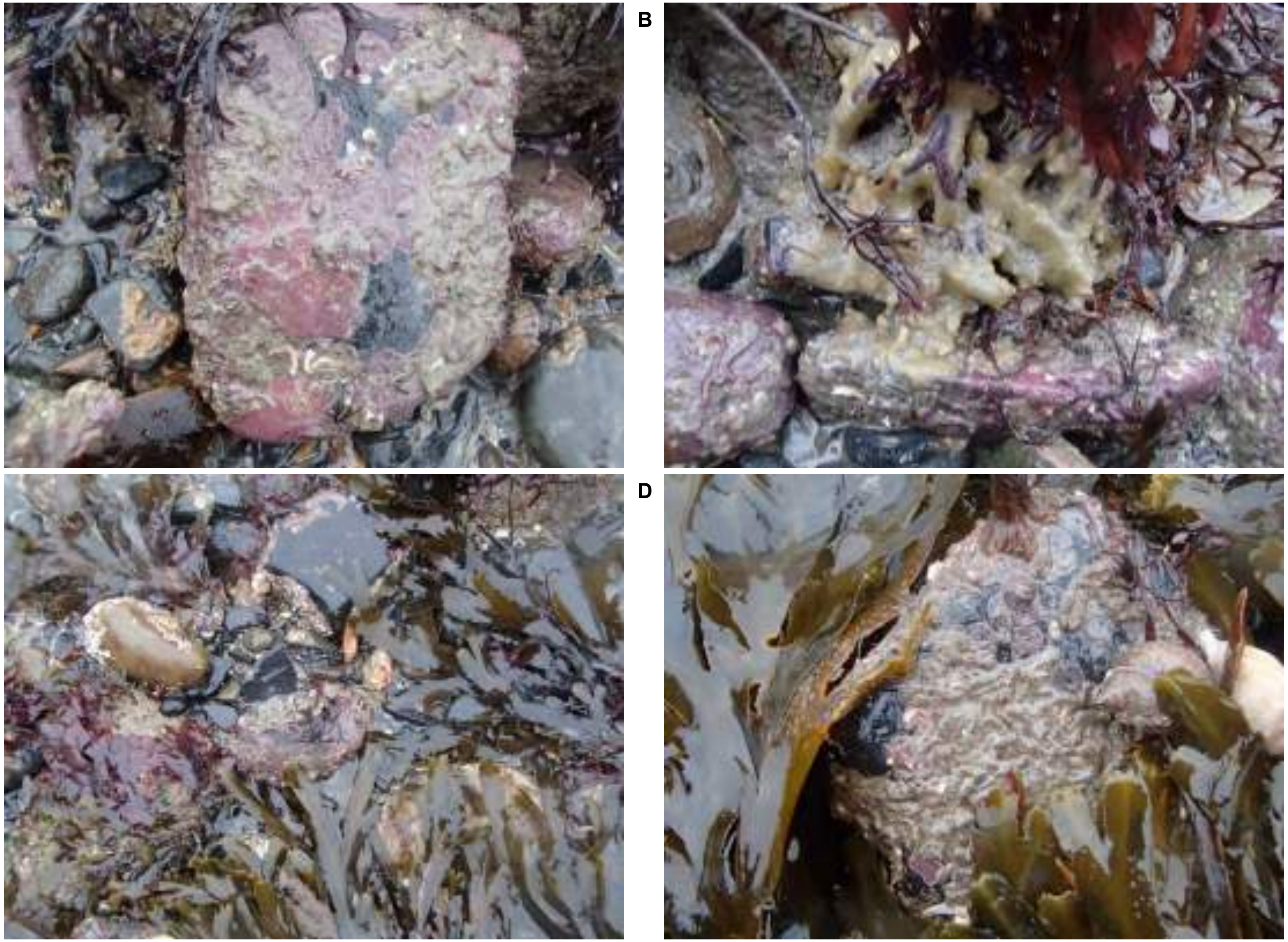
'*Fucus vesiculosus* on mid eulittoral mixed substrata' (LR.LLR.F.Fves.X)

C: Photograph LS_I0118
Mixed sediment
Bladder wrack (*F. vesiculosus*),
Green seaweed turf (*Ulva* sp.)

D: Photograph LS_I0258
Mixed sediment
Bladder wrack (*F. vesiculosus*),
Green Seaweeds (*Ulva* sp.)

Figure 3.7: Example photographs of '*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock' (A1.3131/LR.LLR.F.Fves.FS) and '*Fucus vesiculosus* on mid eulittoral mixed substrata' (A.1.3132/LR.LLR.F.Fves.X), Havingsten cable route, Loughshinny

A B C D



A: Photograph LS_I0325
Mixed sediment (sand, pebbles and cobbles)
Pink encrusting seaweed (*Phymatolithion lenormandii*), carrageen (*Chondrus crispus*), sand mason worm (*Lanice conchilega*), fan worm (*Spirobranchus* sp.), ross worm (*Sabellaria spinulosa*)

B: Photograph LS_I0334
Mixed sediment (sand and cobbles)
Red seaweeds (*Palmaria palmata, C. crispus*), fan worm (*Spirobranchus* sp.), sponge (?*Halichondria* sp.), coralline seaweed (Corallinales), bryozoan (Bryozoa)

C: Photograph LS_I0335
Mixed sediment (sand, pebbles and cobbles)
Red seaweed (*P. palmata*), serrated wrack (*Fucus serratus*), green seaweed (Ulva *lactuca*), carrageen (*C. crispus*), coralline seaweed (*Corallinales*), fan worm (*Spirobranchus* sp.), dog whelk (*Nucella lapillus*), bryozoan (Bryozoa), ross worm (*S. spinulosa*)

D: Photograph LS_I0338
Mixed sediment (sand and cobbles)
Serrated wrack (*F. serratus*), carrageen (*C. crispus*), pink encrusting seaweed (*P. lenormandii*), fan worms (*Spirobranchus* sp.), dog whelk (*N. lapillus*), bryozoan (Bryozoa), ross worm (*S. spinulosa*)

Figure 3.8: Example photographs of '*Fucus serratus* on full salinity lower eulittoral mixed substrata' (A1.3152/LR.LLR.F.Fser.X), Havingsten cable route, Loughshinny

A B C D

'Rockpools' (LR.FLR.Rkp)

A: Photograph LS_I0136
Rockpools

B: Photograph LS_I0138
Rockpool
Coralline seaweed
(*Corallina officinalis*),
Carrageen (*Chondrus crispus*)

Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools (LR.FLR.Rkp.G)

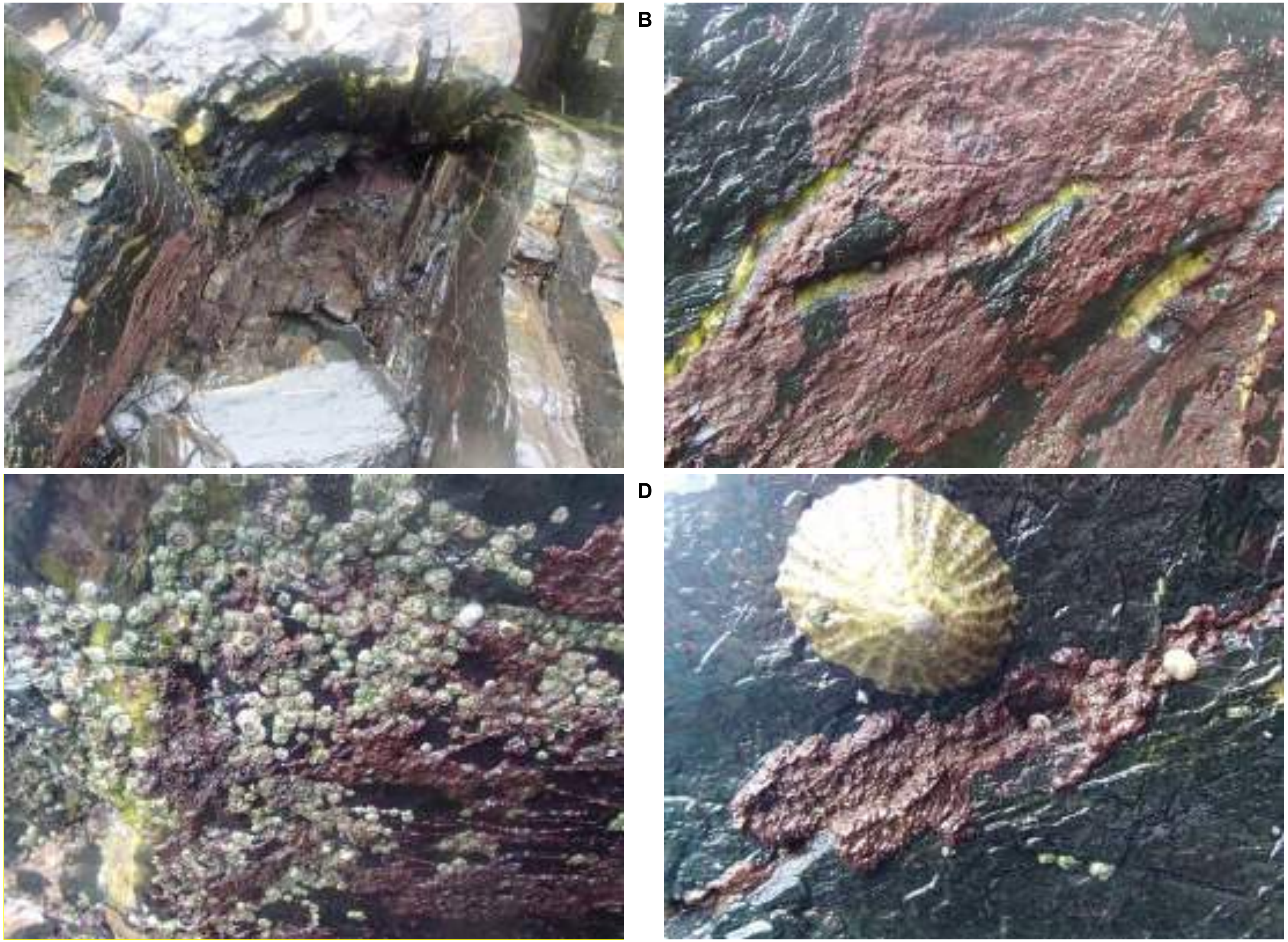
C: Photograph LS_I0215
Pool on upper shore bedrock
Green seaweed (*Ulva* sp. and
Chaetomorpha melagnoium)

Seaweeds in sediment-floored eulittoral rockpools (LR.FLR.Rkp.SwSed)

D: Photograph LS_I0177
Rockpool with sandy bottom
Red seaweeds (*Dumontia* sp. and
C. crispus),
Green seaweed (*C. melagnoium* and
Cladophora sp.),
Pink encrusting seaweed
(*Phymatolithion lenormandii*)

Figure 3.9: Example photographs of 'rockpools' (A1.41/LR.FLR.Rkp), Havingsten cable route, Loughshinny

A B C D



A: Photograph LS_I0144

Gully in the bedrock
Red seaweed turf (*Rhodochorton purpurea*),
Limpet (*Patella vulgata*)

B: Photograph LS_I0145

Bedrock
Red seaweed turf (*R. purpurea*)

C: Photograph LS_I0146

Bedrock

Red seaweed turf (*R. purpurea*),
Barnacles (*Semibalanus balanoides*),
Winkles (*Littorina saxatilis*)

D: Photograph LS_I0148

Bedrock

Red seaweed turf (*R. purpurea*),
Limpet (*P. vulgata*),
Barnacles (*S. balanoides*),
Winkles (*L. saxatilis*)

Figure 3.10: Example photographs of 'littoral caves and overhangs' (A1.44/LR.FLR.Cvov), Havingsten cable route, Loughshinny

A

B

C

D

A: Photograph LS_I0125

Bedrock at the base of cliff
Green seaweed (*Ulva* spp.),
Channelled wrack
(*Pelvetia canaliculata*),
Wrack (*Fucus* sp.)

B: Photograph LS_I0485

Boulders, cobbles and sand
Green seaweed (*Ulva* spp.),
Wrack (*Fucus* sp.)

C: Photograph

Boulder
Green seaweed (*Ulva* sp.),
Red seaweed (*Porphyra* sp.)

D: Photograph LS_I0535

Bedrock at the base of cliff
Green seaweed turf (*Ulva* sp.),
Yellow lichen

Figure 3.11: Example photographs of 'ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata' (A1.45/LR.FLR.Eph), Havingsten cable route, Loughshinny

3.2.2 Littoral Sediment (A2/LS)

The broad habitat 'Littoral sediment' includes habitats of mud, sand, pebbles and cobbles and any combination of these that occur within the intertidal zone. Littoral sediments support infaunal communities tolerant to some degree of drainage as the tide retreats. Littoral sediment is further defined based on particle size descriptions, with the soft sediment biotopes present within the Loughshinny survey area outlined in the subsequent sections of this report.

3.2.2.1 Strandline (A2.21/LS.LSa.St)

The biotope complex 'Strandline' comprises shifting line of decomposing seaweed and debris, typically deposited at the upper extreme of sedimentary and (some rocky) shores at high tide. Ephemeral bands of seaweed can shelter communities of sand hoppers (JNCC, 2015).

Within the Loughshinny survey area, this biotope complex was observed on the upper shore at the base of the boulder sea defences, adjacent to the two main entrances to the beach (Figure 3.1). Within the majority of the strandline no fauna was observed.

Figure 3.12a to 3.12c present example photographs of this habitat, within the Loughshinny survey area.

Within the 'Strandline' biotope complex, immediately west of the carpark slip, a small area (< 25 m^2) featured a community of sandhoppers (talitrid amphipods) underneath decaying drift seaweed. This small area was characteristic of more fine scale classification, and was representative of the biotope 'Talitrids on the upper shore and strand-line' (A2.211/LS.LSa.St.Tal).

Figure 3.12d presents an example photograph of this habitat, within the Loughshinny survey area.

3.2.2.2 Barren or Amphipod-Dominated Mobile Sand Shores (A.22/LS.LSa.MoSa)

The biotope complex 'Barren or amphipod-dominated mobile sand shores' consists of clean mobile sands (fine to coarse gravel sand), with little very fine sand and no mud. Shell fragments, pebbles and cobbles may occasionally occur on the surface. The sands have low water retention and are subject to drying out between tides, particularly on steep upper shores. This biotope complex generally supports a limited range of species, ranging from barren, highly mobile sands to more stable clean sands supporting infaunal communities of isopods, amphipods and a limited range of polychaetes (JNCC, 2015).

Within the Loughshinny survey area, this biotope complex was separated into two distinct variations. Variant 1 comprised of sandy sediments, while variant 2 consisted of coarse sand with pebbles and cobbles. The majority of the upper and lower shore were comprised of variant 1, whilst a coarser band of sediment in the upper mid shore was comprised of variant 2 (Figure 3.1). Within the Loughshinny area, a small area of variant 2 was less than 25 m^2 and recorded as a target note (Appendix B.2). A few solitary boulders were present in the mid shore to the west of the shore, within variant 1. No fauna was observed in either variant of this biotope complex.

Figure 3.13 presents example photographs of both variants of this habitat, within the Loughshinny survey area.

3.2.2.3 *Lanice conchilega* in Littoral Sand (A2.245/LS.LSa.MuSa.Lan)

The biotope '*Lanice conchilega* in littoral sand' (A2.245/LS.LSa.MuSa.Lan) occurs on flats of medium fine to muddy sand flats, generally on the lower shore but also on waterlogged mid shores. The sand may contain a proportion of shell fragments and gravel. The sand mason worm *L. conchilega* can also occur on the lower part of predominantly rocky shores, where patches of sand or muddy sand occur between scattered boulders, cobbles and pebbles. The sediment supports dense populations of the sand mason *L. conchilega* and other polychaetes that are tolerant of sand scour or sediment surface mobility, (e.g. the polychaetes *Anaitides mucosa*, *Aricidea minuta*, *Eumida sanguinea*, *Nephtys hombergii*, *Pygospio elegans*, *Scoloplos armiger* and *Tharyx* spp.) (JNCC, 2015).

Within the Loughshinny survey area, this biotope was further separated into two distinct variations. Variant 1 comprised of sandy sediments, while variant 2 consisted of mixed sediment with pebbles, cobbles and shell fragments. Variant 1 was observed in the low shore to the west of the bay and in the mid shore to the east of the bay, above a region of mixed sediments, while variant 2 was observed in the lower shore to the east of the bay, adjacent to the pier (Figure 3.1). Within this biotope (variants 1 and 2), a high abundance of the sand mason worm *L. conchilega* was observed. No other fauna was recorded.

Figure 3.14 presents example photographs of both variants of this habitat, within the Loughshinny survey area.

3.2.2.4 Littoral Mixed Sediment (A2.4/LS.LMx)

The biotope complex 'Littoral mixed sediment' comprises shores of mixed sediments ranging from muds with gravel and sand to gravels, sands and mud in more even proportions. Mixed sediments are generally poorly sorted. Stable large cobbles or boulders may occur. Large rocks support epibiota such as fucoids with green seaweeds more commonly present on rocky and boulder shores. Mixed sediments that are predominantly muddy tend to support infaunal communities, similar to those of muddy shores (JNCC, 2015).

Within the Loughshinny survey area, this biotope complex was observed on the upper bedrock to the west of the survey area, and in the lower shore to the south of the survey area adjacent to the pier (Figure 3.1). Some small areas (25 m^2) of this biotope complex were recorded outwith the mapped area as target notes (Appendix B.2). Flora and fauna were generally very sparse and varied with position on the shore. On the upper shore, the occasional green seaweed (*Ulva* spp.) was observed. On the lower shore, pink encrusting seaweeds (Corallinales), red seaweeds (Chlorophyta) and fan worms (*Spirobranchus* spp.) were observed.

Figure 3.15 presents example photographs of this habitat, within the Loughshinny survey area.

Strandline (LS.LSa.St)
A: Photograph LS_I0548

A: Pebbles and cobbles patch
No fauna observed

B: Photograph LS_I0080
Pebbles and cobbles strip overlaying sand
Decomposing seaweed and debris
No fauna observed

C: Photograph LS_I0070
Pebbles and cobbles overlaying sand
Decomposing seaweed
No fauna observed

Talitrids on upper shore and strand-line (LS.Sa.St.Tal)

D: Photograph LS_I0079
Pebbles and cobbles strip overlaying sand
Decomposing seaweed and debris
Talitrids (Talitridae)

Figure 3.12: Example photographs of 'Strandline' (A2.21/LS.LSa.St) and 'Talitrids on upper shore and strand-line' (A2.211/LS.Sa.St.Tal), Havingsten cable route, Loughshinny

A

B

C

D

‘Barren or amphipod-dominated mobile sand shores’ (LS.LSa.MoSa) variant 1

A: Photograph LS_I0363

Sand
No fauna observed

B: Photograph LS_I0365

Sand
No fauna observed

‘Barren or amphipod-dominated mobile sand shores’ (LS.LSa.MoSa) variant 2

C: Photograph LS_I0101
Sand with pebbles
No fauna observed

D: Photograph LS_I0105

Coarse sand with pebbles
No fauna observed

Figure 3.13: Example photographs of ‘barren or amphipod-dominated mobile sand shores’ (A.22/LS.LSa.MoSa), Havingsten cable route, Loughshinny

A B C D

‘*Lanice conchilega* in littoral sand’ (LS.LSa.MuSa.Lan) variant 1

A: Photograph LS_I0282
Sand
Sand mason worm (*L. conchilega*)

B: Photograph LS_I0352
Sand
Sand mason worm (*L. conchilega*)

‘*Lanice conchilega* in littoral sand’ (LS.LSa.MuSa.Lan) variant 2

C: Photograph LS_I0343
Mixed sediments (sand, pebbles and cobbles) with shell fragments
Sand mason worm (*L. conchilega*)

D: Photograph LS_I0341
Mixed sediments (sand, pebbles and cobbles) with shell fragments
Sand mason worm (*L. conchilega*)

Figure 3.14: Example photographs of ‘*Lanice conchilega* in littoral sand’ (A2.245/LS.LSa.MuSa.Lan), Havingsten cable route, Loughshinny

A: Photograph LS_I0347

A: Mixed sediment
No fauna visible

B: Photograph LS_I0348

A: Mixed sediment
No fauna visible

C: Photograph LS_I0245
Mixed sediments (pebbles and cobbles)
Drift seaweed
No fauna visible

D: Photograph LS_I0246
Mixed sediments (pebbles and cobbles)
Drift seaweed
No fauna visible

Figure 3.15: Example photographs of 'littoral mixed sediment' (A2.4/LS.LMx), Havingsten cable route, Loughshinny

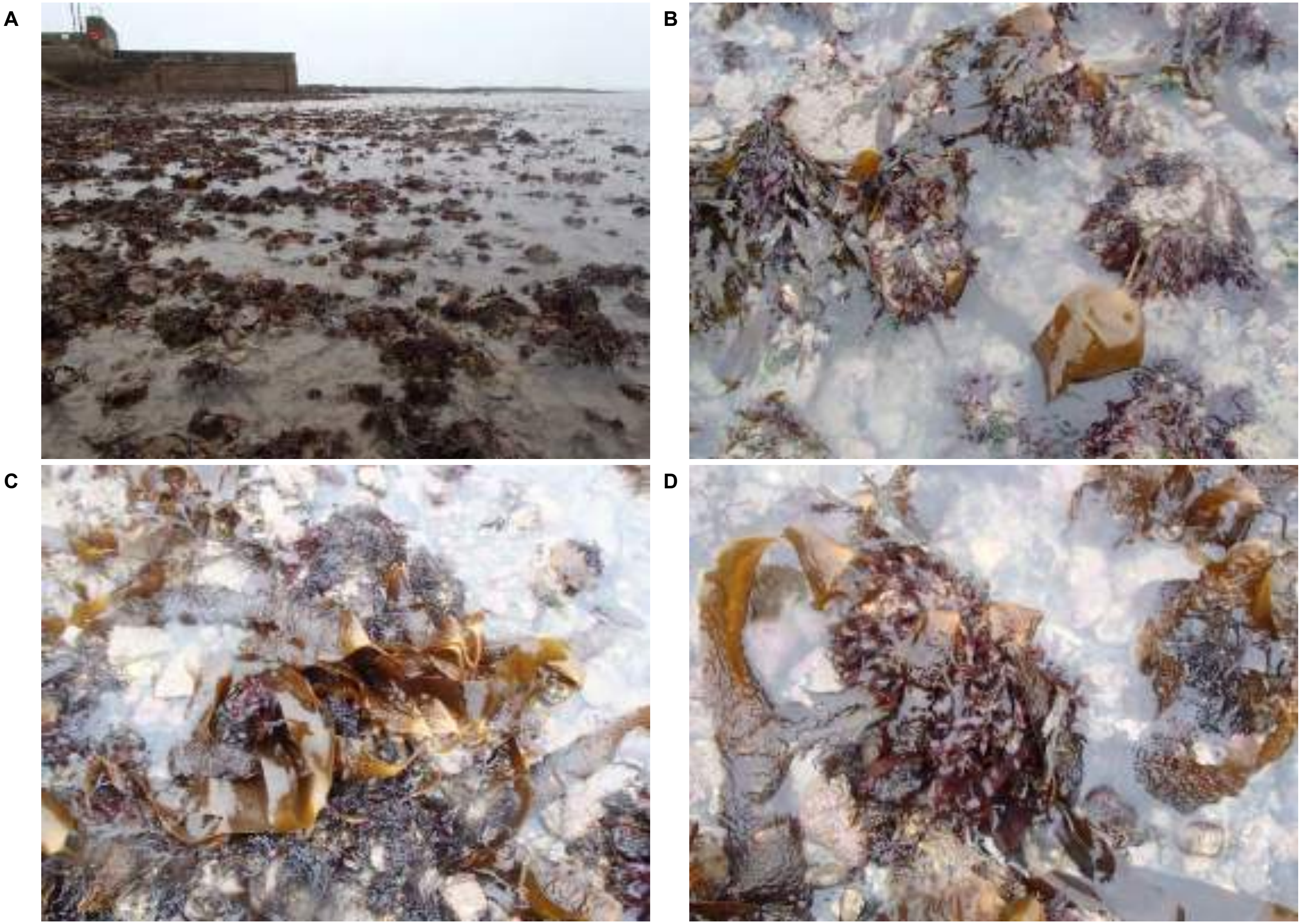
3.2.3 Infralittoral Rock (and Other Hard Substrata) (A3/IR)

3.2.3.1 *Laminaria saccharina* and *Laminaria digitata* on Sheltered Sublittoral Fringe Rock (A3.3131/IR.LIR.K.Lsac.Ldig)

The sub-biotope '*Laminaria saccharina* and *Laminaria digitata* on sheltered sublittoral fringe rock' occurs on sheltered bedrock and boulders in the sublittoral fringe. This sub-biotope is characterised by a mixed canopy of the kelps *L. digitata* and *S. latissima* (previously *Laminaria saccharina*). Red undercanopy seaweeds include *C. crispus*, *Dumontia contorta*, *Bonnemaisonia hamifera* and *Plocamium cartilagineum*, in addition to encrusting coralline seaweeds and non-calcified red crusts. The brown seaweeds *Chorda filum*, Ectocarpaceae and *F. serratus* and green seaweeds *Ulva* spp. may be present. The tube-building polychaete *Spirobranchus triqueter* may be present. The sponge *Halichondria panicea* may be present in cracks and crevices, with a variety of mobile crustaceans (e.g. *C. maenas*), the gastropod *S. cineraria* and the starfish *Asterias rubens* common under boulders (JNCC, 2015).

Within the Loughshinny survey area, this sub-biotope was observed on lower shore mixed sediment (pebbles, cobbles and boulders) to the east of the survey area (Figure 3.1). A moderate canopy of *L. digitata* and *S. latissima* was observed. The undercanopy flora and fauna included snakelocks anemones (*Anemonia viridis*), pink encrusting seaweeds (Corallinales), red seaweeds (*C. crispus* and *P. palmata*), serrated wrack (*F. serratus*), green seaweed (*Ulva* sp.), fan worms (*Spirobranchus* sp.) and ross worms (*S. spinulosa*).

Figure 3.16 presents example photographs of this habitat, within the Loughshinny survey area.



A: Photograph LS_I0315
Mixed sediment (sand, pebbles, cobbles and boulders)
Kelp (*Laminaria digitata* and *Saccharina latissima*)

B: Photograph LS_I0318
Mixed sediment (sand, pebbles and cobbles)
Kelp (*S. latissima* and *L. digitata*), serrated wrack (*Fucus serratus*), red seaweeds (*Chondrus crispus, Palmaria palmata*), fan worms (*Spirobranchus* sp.), green seaweed (*Ulva lactuca*)

C: Photograph LS_I0321
Mixed sediment (sand, pebbles and cobbles)
Kelp (*S. latissima*), red seaweeds (*P. palmata* and *C. crispus*), pink encrusting seaweeds (Corallinales), green seaweed (*U. lactuca*), wrack (*F. serratus*)

D: Photograph LS_I0322
Mixed sediment (sand, pebbles and cobbles)
Kelp (*S. latissima*), red seaweeds (*C. crispus* and *P. palmata*), pink encrusting seaweeds (Corallinales), wrack (*F. serratus*), sponge (Porifera), ross worm (*Sabellaria spinulosa*)

Figure 3.16: Example photographs of '*Laminaria digitata* and *Laminaria saccharina* on sheltered sublittoral fringe rock' (A3.3131/IR.LIR.K.Lsac.Ldig), Havingsten cable route, Loughshinny

3.2.4 Coastal Habitats (B)

Coastal habitats are those above the spring high tide limit (or above mean water level in non-tidal waters) occupying coastal features and characterised by their proximity to the sea. This environment includes coastal dunes and wooded coastal dunes, beaches and cliffs, free-draining supralittoral habitats adjacent to marine habitats that are generally exclusively affected by spray or splash, strandlines characterised by terrestrial invertebrates and moist and wet coastal dune slacks and dune-slack pools.

3.2.4.1 Atlantic White Dunes (B1.321)

The biotope 'Atlantic white dunes' comprises sand-covered marine shorelines, formed by wind and wave action. These include gently sloping beaches and beach-ridges, formed by waves, longshore drift and storms, as well as dunes, formed by aeolian deposits and sometimes re-formed by waves. Where vegetation occurs, these are dominated by marram grass (*A. arenaria*). Other vegetation may be present, including the sea holly (*Eryngium maritimum*), sea spurge (*Euphorbia paralias*) and morning glory (*Calystegia soldanella*) (EUNIS, 2012).

Within the Loughshinny survey area, small white sand dunes were present upon boulder sea defences along the upper shore (Figure 3.1). The sand dunes were generally less than 5 m in width and less than 1.5 m in height. Dune formation was restricted to the landward side by anthropogenic activity (e.g. carpark, lawn, path) and stabilised to seaward by boulders, suggesting that this was a poor example of the habitat as it was heavily anthropogenically influenced.

Within the Loughshinny survey area, vegetation characteristic of sand dunes and other coastal habitats were recorded within this biotope. Flora included marram grass (*Ammophila* sp.), morning glory (*C. soldanella*), sea plantain (*Plantago maritima*), ribwort plantain (*Plantago lanceolata*), bucks-horn plantain (*Plantago coronopus*), common mallow (*Malva sylvestris*), sea beet (*Beta vulgaris* spp. *maritima*), chamomile (*Chamaemelum nobile*), dandelion (*Taraxacum officinale*) and clover (?*Trifolium* sp.).

Figure 3.17 presents example photographs of this habitat, within the Loughshinny survey area.

3.2.4.2 Lichens or Small Green Algae on Supralittoral and Littoral Fringe Rock (B3.11/LR.FLR.Lic)

The biotope complex 'Lichens or small green algae on supralittoral and littoral fringe rock' typically forms a distinct zone or band of lichens in the 'splash' zone on the supralittoral and littoral fringe rock. Yellow and grey lichens (e.g. *Xanthoria parietina*, *Caloplaca marina*, *Caloplaca thallincola* or *Ramalina* sp.) dominate the supralittoral rock with a distinctive black band of tar lichen *V. maura* occurring below in the littoral fringe. Small green seaweeds (e. g. *Prasiola stipitata*, *Blidingia minima*, *Ulothrix flacca*, *Urospora penicilliformis* and *Urospora wormskioldii*) can occur within this biotope complex. Fauna includes the winkle *L. saxatilis* (JNCC, 2015).

Within the Loughshinny survey area, the biotope complex 'Lichens or small green algae on supralittoral and littoral fringe rock' was assigned to small areas (< 25 m^2) of filamentous green seaweed (likely *Ulothrix* spp., *Urospora* spp. and *Blidingia* spp.). These were located on the vertical surface of the pier and recorded as target notes (Appendix B.2).

Additionally, some areas of 'Lichens or small green algae on supralittoral and littoral fringe rock' within the Loughshinny survey area were characteristic of more fine scale classification. A small area (< 25 m^2) was classified further as the biotope '*Verrucaria maura* and sparse barnacles on exposed littoral fringe rock' (B3.113/LR.FLR.Lic.Ver.B) due to the complete cover of the black tar lichen *V. maura*. This was recorded as a target note (Appendix B.2).

More fine scale biotopes assigned to larger areas (> 25 m^2) are discussed in the following subsections.

Yellow and Grey Lichens on Supralittoral Rock (B3.111/LR.FLR.Lic.YG)

The biotope 'yellow and grey lichens on supralittoral rock' occurs on vertical to gently sloping hard substrata (e.g. bedrock, boulders) in the supralittoral zone of most rocky shores. This biotope is characterised by a community of yellow and grey lichens, including the orange sea lichen *Caloplaca marina*, the rim lichen *Tephromela atra*, the cartilage lichens *Ramalina* spp. and the common orange lichen *Xanthoria parietina*. The black tar lichen *V. maura* may also occur (JNCC, 2015).

Within the Loughshinny survey area, this biotope was observed on the upper reaches of the boulder sea defences, on upper shore bedrock and on sections of the pier to the east of the survey area, on vertical and upper surfaces (Figure 3.1). Within the Loughshinny survey area, some small areas of this biotope were less than 25 m^2 and therefore recorded as target notes (Appendix B.2). Within this biotope, black tar lichen *V. maura*, orange foliose lichens *Xanthoria* sp., orange crustose lichens *Caloplaca* sp., and grey and brown foliose lichens *Parmelia* sp. were recorded.

Figure 3.18 presents example photographs of this habitat, within the Loughshinny survey area.

***Prasiola stipitata* on Nitrate-Enriched Supralittoral or Littoral Fringe Rock (B3.112/LR.FLR.Lic.Pra)**

The biotope '*Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock' occurs on exposed to moderately exposed hard substrata (e.g. bedrock, boulders) in the supralittoral zone and littoral fringe. This biotope receives nitrate enrichment and is characterised by the ephemeral green seaweed *P. stipitata* or *Prasiola* spp. (JNCC, 2015).

Within the Loughshinny survey area, this biotope was observed on the upper bedrock to the west of the survey area near the cliff base (below nesting bird's area). Nesting fulmars (*Fulmar glacialis*) were observed in holes and ledges in the upper region of this cliff, providing nitrates through their guano. This biotope was also observed on the external edge of Loughshinny Pier, likely associated with nitrate from roosting birds (Figure 3.1). Within the Loughshinny survey area, some small areas of this biotope (< 25 m^2) were recorded as target notes (Appendix B.2). Within this biotope, green seaweeds dominated, particularly characteristic turfs of *Prasiola* spp. including *P. stipitata*.

Figure 3.19: presents example photographs of this habitat, within the Loughshinny survey area.

A

B

C

D

A: Photograph LS_I0023

Sand dune
Marram grass (*Ammophila* sp.)

B: Photograph LS_I0019

Sand dune
Marram grass (*Ammophila* sp.)

C: Photograph LS_I0039

Sand dune
?Morning glory (?*Calystegia soldanella*)

D: Photograph LS_I0402

Sand dunes
Ribwort plantain (*Plantago lanceolata*)

Figure 3.17: Example photographs of 'Atlantic white dunes' (B1.321), Havingsten cable route, Loughshinny

A B C D

A: Photograph LS_I0053

Boulder sea defence
Black tar lichen *Verrucaria maura*,
orange foliose lichen *Xanthoria* sp.,
orange crustose lichen *Caloplaca* sp.,
foliose lichen *Parmelia* sp.

B: Photograph LS_I0448

Pier
Yellow and grey lichens

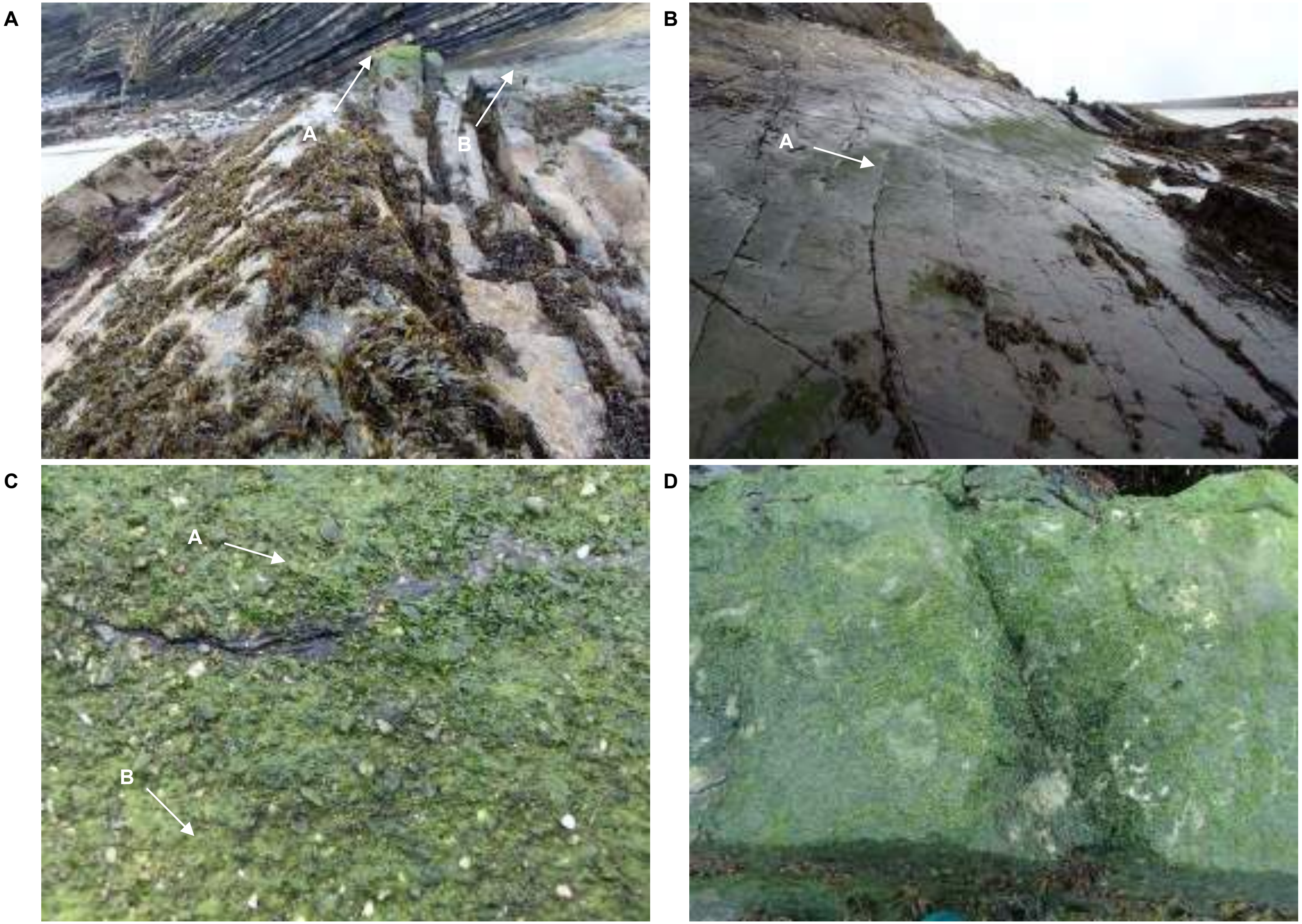
C: Photograph LS_I0078

Bedrock
Black tar lichen *V. maura*,
orange foliose lichen *Xanthoria* sp.,
orange crustose lichen *Caloplaca* sp.,
foliose lichen *Parmelia* sp.

D: Photograph LS_I0449

Pier (upper surface)
Black tar lichen *V. maura*,
orange foliose lichen *Xanthoria* sp.,
orange crustose lichen *Caloplaca* sp.,
foliose lichen *Parmelia* sp.

Figure 3.18: Example photographs of 'yellow and grey lichens on supralittoral rock' (B3.111/LR.FLR.Lic.YG), Havingsten cable route, Loughshinny



A: Photograph LS_I0226

Bedrock
A: *Prasiola* sp. patch
B: *Prasiola* sp. band

B: Photograph LS_I0209

Bedrock
A: *Prasiola* sp. band

C: Photograph LS_I0093

Pier (upper surface)
A: Green algal turf (*Prasiola* sp.),
B: Green filamentous algae (Chlorophyta)

D: Photograph LS_I0230

Bedrock
Green seaweed turf (*Prasiola* sp.)

Figure 3.19: Example photographs of '*Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock' (B3.112/LR.FLR.Lic.Pra), Havingsten cable route, Loughshinny

3.2.5 Potential Sensitive Habitats and Species

Several intertidal habitats of nature conservation interest were potentially recorded during the current survey. Table 3.2 summarises the potentially sensitive habitats within the survey area. These will be discussed in Sections 3.2.5.1 to 3.2.5.4.

Table 3.2: Summary of Potential Sensitive Habitat and Species, Havingsten Cable Route, Loughshinny

Species/Habitat	Legislation	Description	Designation/Status
Stony reef	Council Directive 92/43/EEC*	'Bedrock reef'	Annex I habitat
		'Stony reef'	Annex I habitat
	UK Post-2010 Biodiversity Framework†	'Intertidal underboulder communities'	Priority habitat
Peat and clay exposures	UK Post-2010 Biodiversity Framework	'Peat and clay exposures with piddocks'	Priority habitat
			Habitat Features of Conservation Importance (FOCI)
Coastal sand dunes	Council Directive 92/43/EEC*	'Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')'	Annex I habitat

Notes:
* = Council Directive 92/43/EEC is commonly referred to as 'The Habitats Directive'
† = Also listed in Section 41 of the Natural Environmental and Rural Communities (NERC) Act, 2006

It should also be noted that the ross worm *S. spinulosa* was identified within the biotope '*Fucus serratus* on moderately exposed lower eulittoral rock' and sub-biotope '*Laminaria saccharina* and *Laminaria digitata* on sheltered sublittoral fringe rock'. However, they were present a thin veneer or as individual worm tubes and had not accumulated to biogenic reef morphology so are not considered to be of conservation importance in the survey area.

3.2.5.1 Bedrock Reef

Annex I reef is defined by the Habitats Directive (European Commission, 2013) as "*rocky marine habitats or biological concretions that rise from the seabed. They are generally subtidal but may extend as an unbroken transition into the intertidal zone, where they are exposed to the air at low tide. Intertidal areas are only included within this Annex I type where they are connected to subtidal reefs*".

Within the Loughshinny survey area, several areas of emergent bedrock that were topographically distinct from the surrounding substrate were present in the upper to lower shore to the west of the survey area and to the east of the survey area adjacent to the pier. Bedrock to the east of Loughshinny Bay extended from the subtidal zone to the upper shore and may have the potential to be bedrock reef.

Areas of emergent bedrock featured a more diverse community of both seaweeds and epifauna than the surrounding soft or mixed sediments. Numerous biotopes and sub-biotopes were assigned to the bedrock present within the survey area, ranging from 'Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata' (Section 3.2.1.10) in the upper shore to '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' (Section 3.2.1.5) in the mid shore. Bedrock to the east of Loughshinny bay featured a band of kelp on the lower shore.

3.2.5.2 Stony Reef/Intertidal Underboulder Communities

Stony reefs are said to comprise "*hard compact substrata (typically boulders and cobbles), which are generally greater than 64 mm in size. They arise from the seafloor (are topographically distinct from surrounding seafloor)*" (Irving, 2009).

'Intertidal underboulder communities' are listed in Section 41 of the Natural Environment and Rural Communities (NERC) Act, 2006 and are a UK Biodiversity Action Plan (BAP) priority habitat. This feature description relates to underboulder communities, which may feature elevated biodiversity as a result of variable interstitial spaces, micro-niches, shade and moisture conditions as well as the comparative shelter from wave exposure (JNCC 2008, updated 2011). The UK BAP priority habitat descriptions state that "*boulders with a limited underboulder community are not included in this UK BAP habitat, as may occur for example where boulders are embedded in sediment, in low salinity conditions, and where boulders experience high levels of mobility and scour*" (JNCC 2008, updated 2011).

Solitary boulders were occasionally present in the upper and mid shore, within sandy sediment. A distinct area of boulders in mixed sediment was present, near the bedrock to the west of survey area. Several parameters are included in the assessment of stony reef. Percentage cover is one such parameter with a requirement for 10% or more of the seabed substratum to be composed of boulders (Irving, 2009). Boulders comprised less than 10 % of the substrata in the upper and mid shore, where they were not considered representative of the Annex I habitat 'stony reefs' or the priority habitat 'Intertidal underboulder communities'.

Boulders within lower shore mixed sediment occasionally comprised more than 10 % of the substrata, where they may constitute the Annex I 'Stony reefs' as defined by the Habitats Directive (European Commission, 2013). In the lower shore, boulders were included within the sub-biotopes '*Laminaria digitata* and *Laminaria saccharina* on sheltered sublittoral fringe rock' (A3.3131/IR.LIR.K.Lsac.Ldig; Section 3.2.3.1) and '*Fucus serratus* and piddocks on lower eulittoral soft rock' (A1.2143/LR.MLR.BR.Fer.Pid; Section 3.2.1.7). Whilst these sub-biotopes featured an increased richness of fauna and flora in comparison to the surrounding soft and mixed sediments, neither abundance or richness was notably elevated. Consequently, it is not considered to be an excellent example of the Annex I habitat 'stony reefs' or the priority habitat 'Intertidal underboulder communities' and is unlikely to be of conservational value.

Within Loughshinny survey area, the sensitive habitat 'stony reefs' was potentially located adjacent to the area of the proposed cable route.

3.2.5.3 Peat and Clay Exposures

Peat and clay exposures with piddocks are classified as a United Kingdom Biodiversity Action Plan (UKBAP) listed priority habitat ('Peat and clay exposures with piddocks') and a Marine Conservation Zone (MCZ) Habitat Feature of Conservational Interest (FOCI) ('Peat and clay exposures'). Piddocks are elongated burrowing bivalves and include *P. dactylus*, *B. candida* and *B. parva*. These are capable of boring into the soft peat and clay, creating a unique and fragile habitat (UKBAP, 2008). Peat and clay exposures with either existing or historical evidence of piddock activity are unusual communities of limited extent.

Within the Loughshinny survey area, boulders with piddock boreholes were present in the sublittoral fringe in the south of the survey area. These were classified as features of the sub-biotope '*Fucus serratus* and piddocks on lower eulittoral soft rock' (LR.MLR.BF.Fser.Pid/A1.2143).

Within the Loughshinny survey area, the priority habitat 'Peat and clay exposures with piddocks' was potentially located within the area of the proposed cable route.

3.2.5.4 Coastal Sand Dunes

Sand dunes are complex and dynamic habitats, which occur in hostile environmental conditions, such as unstable substrate and exposure to wind and salt spray, and can display unique vegetation communities and specialised plant species (JNCC, 2004).

Coastal dunes are of ecological and economic value, the former associated with provision of habitat for many animals, especially nesting seabirds, the latter associated with tourism and fishing. They also provide shelter of inland areas from intense storms (Delaney et al., 2013). Although dunes include some of the most natural and pristine habitats in Ireland, sand dunes are highly vulnerable to some anthropogenic activities, such as offshore developments and terrestrial land management, which may interfere with sediment dynamics and alter the process of coastal erosion (Delaney et al., 2013).

Within Loughshinny survey area, there is the potential that the upper shore areas of sand dunes may constitute Annex I 'Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')' (2120) as defined by the Habitats Directive (European Commission, 2013). Dune formation was restricted to the landward extent by anthropogenic structures (e.g. carpark, lawn, path) and stabilised to seaward by boulders, suggesting that this was a poor example of the habitat as it was heavily anthropogenically influenced. Due to the limited extension and the species poor flora and fauna, this habitat was unlikely to be of conservation value.

3.2.5.5 Bird Observations

Several species of birds were recorded within the survey area: fulmar (*Fulmarus glacialis*), pale-bellied brent geese (*Branta bernicla hrota*), eurasian oystercatcher (*Haematopus ostralegus*), turnstone (*Arenaria interpres*), great black-backed gulls (*Larus marinus*), kittiwake (*Rissa* sp.) and herring gulls (*Larus argentatus*). A solitary grey heron was also observed (*Ardea cinerea*). Fulmar were nesting in the sedimentary upper reaches of the cliffs to the west of survey area, where several breeding pairs were recorded.

The herring gull (*Larus argentatus*), kittiwake (*Rissa* sp.) and fulmar (*Fulmarus glacialis*) are listed in 'the EC Birds Directive'. Under the Birds of Conservation Concern in Ireland 2014 to 2019 (2014 update), kittiwake (*Rissa* sp.) and herring gull (*Larus argentatus*) are red listed, whilst fulmar (*Fulmar glacialis*), great black backed gull (*Larus marinus*), oystercatcher (*Haematopus ostralegus*), turnstone (*Arenaria interpres*) and brent goose (*Branta bernicla hrota*) are on the amber list.

Table 3.3 summarises the birds observed within the survey area, along with their respective protective status. Figure 3.20 presents example photographs of bird specimens recorded within the Loughshinny survey area.

Table 3.3: Summary of Birds Observed with Protection Status, Havingsten Cable Route, Loughshinny

Species/Habitat	Legislation	Designation/Status
Fulmar (*Fulmar glacialis*)	Directive 2009/147/EC*	Annex II: migratory species
Kittiwake (*Rissa tridactyla*)^	Directive 2009/147/EC*	Annex II: migratory species
Herring gull (*Larus argentatus*)	Directive 2009/147/EC*	Annex II: migratory species

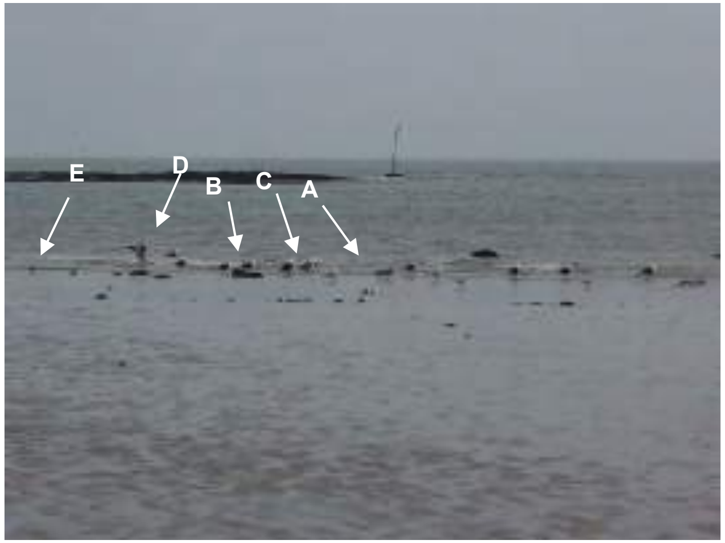
Notes:
* = Directive 2009/147/EC on the conservation of wild birds is commonly referred to as 'the EC Birds Directive'
^ = During the present survey kittiwake (*Rissa* sp.) was identified exclusively at genus level

A

B

C

D



A: Photograph LS_I0115

Nesting fulmar (*Fulmarus glacialis*)

B: Photograph LS_I0188

Pale-bellied Brent geese (*Branta bernicla hrota*)

C: Photograph LS_I0459

Ruddy turnstone birds (*Arenaria interpres*)

D: Photograph LS_I0267

Birds including
A: Eurasian oyster catcher (*Haematopus ostralegus*),
B: Great black-backed gull (*Larus marinus*),
C: Herring gull (*Larus argentatus*),
D: Kittiwake (*Rissa* sp.),
E: ?Dunlin (?*Calidris* sp.)

Figure 3.20: Example photographs of birds recorded, Havingsten cable route, Loughshinny

4. CONCLUSIONS

Within the Loughshinny survey area, numerous biotopes were identified dependent on their substrate type, exposure and biota. Biotopes of hard substrates were largely classified dependent on the macrofaunal and floral community, whilst biotopes of soft substrates were largely classified dependent on physical structure. Biotopes recorded were typical of variably exposed shores from this region of the Irish coastline.

Several sensitive habitats of potential conservation interest were potentially located within the survey area in proximity to the proposed cable route. Sensitive habitats potentially observed within the current survey, included the Annex I habitats 'Shifting dunes along the shoreline with *Ammophila arenaria*', 'bedrock reef' and 'stony reef', and a subsection of the UKBAP listed priority habitat 'Peat and clay exposures with piddocks'. Whilst boulders were present within the survey area, due to lack of notable understorey fauna and flora, the priority habitat 'Intertidal underboulder communities' is unlikely to be of conservational value at this site.

Several areas of emergent bedrock that were topographically distinct from the surrounding substrate were present within the survey area. To the west of the survey area, these did not extend into the subtidal and so are unlikely to represent Annex 1 'bedrock reef'. However, to the east of Loughshinny Bay, bedrock extended into the subtidal and may have conservational value.

Small white sand dunes, present upon boulder sea defences on the upper shore, may represent Annex I 'Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')' under the Habitats Directive. Due to the limited extension as a result of anthropogenic activities and the species poor flora and fauna, this habitat was unlikely to be of conservation value.

The priority habitat 'Peat and clay exposures with piddocks' was potentially observed in the sublittoral fringe to the south of the survey area.

Several species of birds were recorded within the survey area. However, only the herring gull (*Larus argentatus*), kittiwake (*Rissa* sp.) and fulmar (*Fulmarus glacialis*) are listed in 'the EC Birds Directive'.

No other potentially sensitive habitats or species were observed within the current survey.

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APPENDICES

A. GUIDELINES ON USE OF REPORT

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B. PHOTOGRAPHIC LOG

B.1 LOUGHSHINNY PHOTOGRAPHIC LOG

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0001	53.547165	-6.080752	693 401.5	5 937 105.4	-	-	Sand dune/Saltmarsh plant, marram grass (*Ammophila* sp.), sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0002	53.547132	-6.080759	693 401.2	5 937 101.7	270	W	View across small white dune downshore towards cliffs
LS_I0003	53.547132	-6.080759	693 401.2	5 937 101.7	-	-	Sand dune/Saltmarsh plant, marram grass (*Ammophila* sp.), common mallow (*Malva sylvestris*), sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0004	53.547132	-6.080759	693 401.2	5 937 101.7	-	-	Sand dune/Saltmarsh plant and lichen boulder, marram grass (*Ammophila* sp.), sea beet (*Beta vulgaris* subsp. *maritima*) and common mallow (*Malva sylvestris*)
LS_I0005	53.547132	-6.080759	693 401.2	5 937 101.7	-	-	Sand dune/Saltmarsh plant, marram grass (*Ammophila* sp.), sea beet (*Beta vulgaris* subsp. *maritima*) and common mallow (*Malva sylvestris*)
LS_I0006	53.547132	-6.080759	693 401.2	5 937 101.7	-	-	Lichen boulder
LS_I0007	53.547132	-6.080759	693 401.2	5 937 101.7	270	W	View across small white dune across shore with boulders underneath
LS_I0008	53.547176	-6.081379	693 359.9	5 937 104.9	0	N	View up dune
LS_I0009	53.547176	-6.081379	693 359.9	5 937 104.9	180	S	View down shore (high tide)
LS_I0010	53.547176	-6.081379	693 359.9	5 937 104.9	90	E	View across shore down end of sea defence
LS_I0011	53.547176	-6.081379	693 359.9	5 937 104.9	270	W	View across shore from end of sea defence along dunes
LS_I0012	53.547189	-6.081403	693 358.3	5 937 106.3	0	N	View up dune (bottom of path)
LS_I0013	53.547189	-6.081403	693 358.3	5 937 106.3	-	-	Sand dune/Saltmarsh plant, chamomile (*Chamaemelum nobile*)
LS_I0014	53.547189	-6.081403	693 358.3	5 937 106.3	-	-	Sand dune/Saltmarsh plant dandelion (*Taraxacum officinale*), marram grass (*Ammophila* sp.) and chamomile (*Chamaemelum nobile*)
LS_I0015	53.547189	-6.081403	693 358.3	5 937 106.3	315	NW	View up and across dune (plants)
LS_I0016	53.547163	-6.081456	693 354.9	5 937 103.2	-	-	Sand dune/Saltmarsh plant
LS_I0017	53.547163	-6.081456	693 354.9	5 937 103.2	-	-	Sand dune/Saltmarsh plant
LS_I0018	53.547128	-6.0816	693 345.5	5 937 099.0	-	-	Sand dune/Saltmarsh plant
LS_I0019	53.547123	-6.081666	693 341.2	5 937 098.2	315	NW	View up and across dune (dune grass)
LS_I0020	53.547079	-6.081917	693 324.7	5 937 092.6	315	NW	View up and across dune (plant)
LS_I0021	53.547079	-6.081917	693 324.7	5 937 092.6	-	-	Sand dune/Saltmarsh plant

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0022	53.546989	-6.082224	693 304.8	5 937 081.8	315	NW	View up dune (bottom of steps)
LS_I0023	53.546989	-6.082224	693 304.8	5 937 081.8	90	E	View across shore along bottom of dune
LS_I0024	53.546989	-6.082224	693 304.8	5 937 081.8	180	S	View down shore (high tide)
LS_I0025	53.546989	-6.082224	693 304.8	5 937 081.8	270	W	View across shore along bottom of dune
LS_I0026	53.546727	-6.082801	693 267.8	5 937 051.1	315	NW	View up dune (bottom of steps)
LS_I0027	53.546727	-6.082801	693 267.8	5 937 051.1	180	S	View down shore (high tide)
LS_I0028	53.546727	-6.082801	693 267.8	5 937 051.1	45	NE	View across shore along bottom of dune
LS_I0029	53.546727	-6.082801	693 267.8	5 937 051.1	135	SE	View across shore along bottom of dune
LS_I0030	53.546615	-6.082954	693 258.2	5 937 038.2	270	W	Water outflow
LS_I0031	53.546615	-6.082954	693 258.2	5 937 038.2	90	E	Signage above water outflow
LS_I0032	53.546615	-6.082954	693 258.2	5 937 038.2	0	N	View up to outflow
LS_I0033	53.546615	-6.082954	693 258.2	5 937 038.2	180	S	View down shore over sand
LS_I0034	53.546615	-6.082954	693 258.2	5 937 038.2	315	NW	View over dunes and boulders
LS_I0035	53.546615	-6.082954	693 258.2	5 937 038.2	45	NE	View over dunes and boulders
LS_I0036	53.546622	-6.083003	693 254.9	5 937 038.9	135	SE	View across sand below outflow from top
LS_I0037	53.546537	-6.083119	693 247.6	5 937 029.1	45	NE	View over dunes and boulders
LS_I0038	53.546537	-6.083119	693 247.6	5 937 029.1	225	SW	View over grass and boulders
LS_I0039	53.546307	-6.083395	693 230.4	5 937 002.8	-	-	Sand dune/ Saltmarsh plant, morning glory (*Calystegia soldanella*)
LS_I0040	53.546307	-6.083395	693 230.4	5 937 002.8	-	-	Sand dune/Saltmarsh plant, morning glory (*Calystegia soldanella*)
LS_I0041	53.546307	-6.083395	693 230.4	5 937 002.8	-	-	Sand dune/Saltmarsh plant, morning glory (*Calystegia soldanella*)
LS_I0042	53.546307	-6.083395	693 230.4	5 937 002.8	-	-	Sand dune/Saltmarsh plant, sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0043	53.545858	-6.083794	693 206.0	5 936 951.8	180	S	View through fenced area above larger outflow
LS_I0044	53.545847	-6.083787	693 206.5	5 936 950.6	0	N	View up to base of land flow from bottom
LS_I0045	53.545818	-6.083791	693 206.4	5 936 947.3	0	N	View through fenced area above larger outflow
LS_I0046	53.545546	-6.083468	693 229.0	5 936 918.0	225	SW	View of edge of limestone and shale cliff
LS_I0047	53.545546	-6.083468	693 229.0	5 936 918.0	-	-	Close up of black layers in cliff
LS_I0048	53.545546	-6.083468	693 229.0	5 936 918.0	-	-	Close up of black layers in cliff

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [°]	Direction	Comments
LS_I0049	53.545546	-6.083468	693 229.0	5 936 918.0	-	-	Plant on cliff
LS_I0050	53.545546	-6.083468	693 229.0	5 936 918.0	-	-	Plant on cliff
LS_I0051	53.545512	-6.083434	693 231.4	5 936 914.3	-	-	Black, yellow and grey lichen
LS_I0052	53.545512	-6.083434	693 231.4	5 936 914.3	-	-	Black, yellow and grey lichen
LS_I0053	53.545512	-6.083434	693 231.4	5 936 914.3	315	NW	View across lichen zone
LS_I0054	53.545512	-6.083434	693 231.4	5 936 914.3	45	NE	View down lichen zone (high tide)
LS_I0055	53.545668	-6.083775	693 208.1	5 936 930.7	270	W	View to cliffs across grass
LS_I0056	53.545668	-6.083775	693 208.1	5 936 930.7	0	N	View across shore from grass (high tide)
LS_I0057	53.545668	-6.083775	693 208.1	5 936 930.7	90	E	View across bay from grass (high tide)
LS_I0058	53.545668	-6.083775	693 208.1	5 936 930.7	180	S	View to headland cliffs
LS_I0059	53.545668	-6.083775	693 208.1	5 936 930.7	-	-	Close up of grass
LS_I0060	53.545762	-6.083826	693 204.3	5 936 941.0	315	NW	Corner of sea defence (boulders in cages)
LS_I0061	53.545762	-6.083826	693 204.3	5 936 941.0	270	W	View from sea defence (boulders in cages) to cliffs
LS_I0062	53.545762	-6.083826	693 204.3	5 936 941.0	0	N	View from sea defence (boulders in cages) across shore
LS_I0063	53.545891	-6.083733	693 209.9	5 936 955.6	-	-	Yellow lichen on boulders
LS_I0064	53.545891	-6.083733	693 209.9	5 936 955.6	45	NE	View of lichen zone across shore
LS_I0065	53.54674	-6.082574	693 282.8	5 937 053.2	0	N	View to emergent boulders under dunes (3 m × 50 cm)
LS_I0066	53.54684	-6.0825	693 287.2	5 937 064.5	67.5	ENE	View down emergent boulder strip
LS_I0067	53.547058	-6.081997	693 319.5	5 937 090.1	0	N	View of set of emergent boulders (ca. 2 m × 50 cm)
LS_I0068	53.547137	-6.08132	693 364.0	5 937 100.7	202.5	SSW	View of edge of sea defence to sea with a metal structure ca. 3 m due S
LS_I0069	53.547104	-6.081127	693 377.0	5 937 097.6	270	W	Narrow pebble/cobble strip
LS_I0070	53.547104	-6.081127	693 377.0	5 937 097.6	-	-	Pebble/cobbles on sand
LS_I0071	53.547092	-6.080722	693 403.8	5 937 097.3	-	-	View back across cobble strip showing elevated proportion of dead seaweed
LS_I0072	53.547133	-6.080691	693 405.7	5 937 102.0	202.5	SSW	Slip corner
LS_I0073	53.54711	-6.080641	693 409.1	5 937 099.6	-	-	White dune vegetation
LS_I0074	53.546952	-6.080544	693 416.3	5 937 082.3	-	-	Lichen on boulders
LS_I0075	53.546806	-6.08034	693 430.4	5 937 066.6	22.5	NNE	View across fairly barren rock dump

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0076	53.546806	-6.08034	693 430.4	5 937 066.6	247.5	WSW	View across fairly barren rock dump
LS_I0077	53.546806	-6.08034	693 430.4	5 937 066.6	157.5	SSE	View across fairly barren rock dump to lichen covered bedrock
LS_I0078	53.546784	-6.080289	693 433.9	5 937 064.3	-	-	Lichen covered bedrock
LS_I0079	53.546842	-6.080191	693 440.1	5 937 071.0	-	-	Mixed sediment (sand, pebbles, cobbles, boulders) ca. 3 m × 1.5 m wide
LS_I0080	53.546842	-6.080128	693 444.3	5 937 071.2	270	W	View to house over small patch of mixed sediment
LS_I0081	53.546842	-6.080128	693 444.3	5 937 071.2	90	E	View to pier
LS_I0082	53.546828	-6.079555	693 482.3	5 937 071.2	90	E	View to pier from bottom of steps - yellow lichen (0.5 m strip)
LS_I0083	53.54682	-6.079653	693 475.9	5 937 070.0	0	N	View to wall from sand
LS_I0084	53.54682	-6.079653	693 475.9	5 937 070.0	-	-	Lichen on wall
LS_I0085	53.546998	-6.079495	693 485.5	5 937 090.2	67.5	ENE	View down other side of pier at high tide, from top of pier
LS_I0086	53.546998	-6.079495	693 485.5	5 937 090.2	337.5	NNW	View up bank from top of pier
LS_I0087	53.546998	-6.079495	693 485.5	5 937 090.2	270	W	View across lough from top of pier
LS_I0088	53.546998	-6.079495	693 485.5	5 937 090.2	157.5	SSE	View down pier from top of pier
LS_I0089	53.546695	-6.079287	693 500.7	5 937 057.1	180	S	View down pier highlighting lichen
LS_I0090	53.546554	-6.079209	693 506.5	5 937 041.6	180	S	View down pier with yellow lichen on upper surface (followed by green) and green seaweeds on lower
LS_I0091	53.546554	-6.079209	693 506.5	5 937 041.6	-	-	Green seaweeds on lower ledge
LS_I0092	53.546554	-6.079209	693 506.5	5 937 041.6	-	-	Green seaweeds on lower ledge
LS_I0093	53.546554	-6.079209	693 506.5	5 937 041.6	-	-	Green seaweeds upper ledge – *Prasiola* sp. (associated with bird faeces)
LS_I0094	53.546554	-6.079209	693 506.5	5 937 041.6	-	-	Green seaweeds upper ledge – *Blidingia* sp./*Ulothrix* sp. (associated with bird faeces)
LS_I0095	53.546401	-6.079236	693 505.4	5 937 024.5	-	-	Edge of green seaweeds on upper surface - *Prasiola* sp. and *Blidigia* sp./*Ulothrix* sp.
LS_I0096	53.546401	-6.079236	693 505.4	5 937 024.5	-	-	Sea pink
LS_I0097	53.546889	-6.081191	693 373.7	5 937 073.5	270	W	Birds
LS_I0098	53.546889	-6.081191	693 373.7	5 937 073.5	-	-	Sand with rope and pebbles
LS_I0099	53.546889	-6.081191	693 373.7	5 937 073.5	270	W	View across sand
LS_I0100	53.546889	-6.081191	693 373.7	5 937 073.5	0	N	View up beach
LS_I0101	53.546889	-6.081191	693 373.7	5 937 073.5	90	E	View to little house

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0102	53.546889	-6.081191	693 373.7	5 937 073.5	180	S	View to sea - note pebbles
LS_I0103	53.546798	-6.081736	693 338.0	5 937 061.9	-	-	Sand with pebbles and ?cobble
LS_I0104	53.546562	-6.082423	693 293.6	5 937 033.8	-	-	Sand with pebbles
LS_I0105	53.546387	-6.082854	693 265.8	5 937 013.1	-	-	Coarse sand with pebbles
LS_I0106	53.545581	-6.083358	693 236.1	5 936 922.1	0	N	? Turnstone (*Arenaria interpres*)
LS_I0107	53.545581	-6.083358	693 236.1	5 936 922.1	0	N	Gull (*Larus* sp.)
LS_I0108	53.545581	-6.083358	693 236.1	5 936 922.1	0	N	Gull (*Larus* sp.)
LS_I0109	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0110	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0111	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0112	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0113	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0114	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0115	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0116	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0117	53.545581	-6.083358	693 236.1	5 936 922.1	270	W	Nesting Fulmar (*Fulmarus glacialis*)
LS_I0118	53.545581	-6.083358	693 236.1	5 936 922.1	180	S	View across bare/Ulva sp. covered mixed sediment (pebbles to boulders)
LS_I0119	53.545581	-6.083358	693 236.1	5 936 922.1	0	N	Turnstone (*Arenaria interpres*)
LS_I0120	53.545581	-6.083358	693 236.1	5 936 922.1	0	N	Turnstone (*Arenaria interpres*)
LS_I0121	53.545476	-6.083324	693 238.9	5 936 910.6	270	W	View of green area
LS_I0122	53.545476	-6.083324	693 238.9	5 936 910.6	-	-	Green seaweed (*Ulva* spp.)
LS_I0123	53.545476	-6.083324	693 238.9	5 936 910.6	-	-	Yellow-green seaweeds (*Vaucheria* sp.)
LS_I0124	53.545476	-6.083324	693 238.9	5 936 910.6	-	-	Moss
LS_I0125	53.545404	-6.083212	693 246.6	5 936 902.9	-	-	Green seaweed (*Ulva* spp.) on base of cliff, channelled wrack (Pelvetia canaliculata), wrack (*Fucus* sp.)
LS_I0126	53.545378	-6.083182	693 248.7	5 936 900.0	-	-	Red seaweeds *(Porphyra* sp.*)*, green seaweed (*Ulva* spp.), channelled wrack (*Pelvetia canaliculata*), wrack (*Fucus* juv.)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0127	53.545378	-6.083182	693 248.7	5 936 900.0	-	-	Channeled wrack (*Pelvetia canaliculata*), red seaweeds (*Catenella* sp., *Rhodothamniella* sp.), green seaweed (*Ulva* sp.)
LS_I0128	53.545378	-6.083182	693 248.7	5 936 900.0	-	-	Spiral wrack (*Fucus spiralis*), red seaweeds (*Catenella* sp., *Rhodothamniella* sp.), green seaweeds (*Ulva* sp.).
LS_I0129	53.545378	-6.083182	693 248.7	5 936 900.0	-	-	Green seaweeds (*Ulva* sp., *Cladophora ?rupestris*), red seaweeds (*Catenella* sp., *Rhodothamniella floridula*, *Porphyra* sp.), spiral wrack (*F. spiralis*), knotted wrack (*Ascophyllum nodosum*)
LS_I0130	53.545378	-6.083182	693 248.7	5 936 900.0	-	-	Green seaweeds (*Ulva* sp., *Cladophora ?rupestris*), red seaweeds (*Rhodothamniella floridula*, *Porphyra* sp.), spiral wrack (*F. spiralis*), knotted wrack (*Ascophyllum nodosum*)
LS_I0131	53.54537	-6.083098	693 254.3	5 936 899.4	-	-	Small rockpool
LS_I0132	53.54537	-6.083098	693 254.3	5 936 899.4	-	-	Small rockpool
LS_I0133	53.54537	-6.083098	693 254.3	5 936 899.4	-	-	Small rockpool 2
LS_I0134	53.54537	-6.083098	693 254.3	5 936 899.4	-	-	Small rockpool 2
LS_I0135	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	Shallow rockpool - sand influenced
LS_I0136	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	View across shallow rockpool
LS_I0137	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	Shallow rockpool - sand influenced, knotted wrack (*Ascophyllum* sp.) in barnacle zone
LS_I0138	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	Shallow rockpool – Red seaweeds (*Dumontia* sp., *Chondrus crispus*), green seaweed (*Chaetomorpha melagnoium*)
LS_I0139	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	Shallow rockpool - Anemone (*Actinia equina*), green seaweed (*Cladophora* sp.)
LS_I0140	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	Shallow rockpool - Anemone (*Actinia equina*), green seaweed (*Cladophora* sp.)
LS_I0141	53.545445	-6.083193	693 247.7	5 936 907.5	-	-	Brown seaweed (*Scytosiphon* sp.)
LS_I0142	53.545408	-6.083085	693 255.0	5 936 903.6	-	-	Feather duster worm (Sabellida)
LS_I0143	53.545408	-6.083085	693 255.0	5 936 903.6	-	-	Feather duster worm (Sabellida)
LS_I0144	53.545223	-6.083183	693 249.3	5 936 882.8	247.5	WSW	View into gully
LS_I0145	53.545223	-6.083183	693 249.3	5 936 882.8	-	-	Red turf (*Rhodochorton purpurea*)
LS_I0146	53.545223	-6.083183	693 249.3	5 936 882.8	-	-	Barnacles (*Semibalanus balanoides*), winkle (*Littorina saxatilis*) and red seaweeds (*Rhodochorton purpurea*)
LS_I0147	53.545223	-6.083183	693 249.3	5 936 882.8	-	-	Barnacle (*Semibalanus balanoides*), winkle (*Littorina saxatilis*) and red seaweeds (*Rhodochorton purpurea*)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0148	53.545223	-6.083183	693 249.3	5 936 882.8	-	-	Limpets (*Patella vulgata*), winkle (*Littorina saxatilis*), barnacles (*Semibalanus balanoides*), red turf (*Rhodochorton purpurea*)
LS_I0149	53.545223	-6.083183	693 249.3	5 936 882.8	-	-	Winkle (*Littorina saxatilis*), red turf (*Rhodochorton purpurea*)
LS_I0150	53.545223	-6.083183	693 249.3	5 936 882.8	-	-	Winkle (*Melaraphe* sp?)
LS_I0151	53.545172	-6.083245	693 245.5	5 936 877.0	-	-	Green seaweed (*Ulva* sp.) patch (4 m ×1 m) along base of cliff
LS_I0152	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	View across boulders to bedrock and across lough
LS_I0153	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	View down bedrock to sea
LS_I0154	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	View across bedrock
LS_I0155	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	View up bedrock edge to cliff and green areas
LS_I0156	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	Coralline seaweeds (*Corallina officinalis*), pink encruster, red seaweeds (?*Ceramium*, *Chondrus* sp.)
LS_I0157	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	Fan worms (*Spirobranchus* sp.), barnacles (*A. modestus*), coralline seaweeds (*Corallina officinalis*), carrageen (*Chondrus crispus*), green seaweed (*Cladophora* sp.), fucoid (*Fucus* sp.), pink encrusting seaweeds
LS_I0158	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	Red seaweeds (*Osmundea* sp. pool, pits, *Chondrus crispus*), pink encrusting seaweeds, coralline seaweeds (*Corallina officinalis*)
LS_I0159	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	Red seaweeds (*Dumontia* sp., *Chondrus crispus*), coralline seaweeds (*Corallina officinalis*), green (*Chaetomorpha melagonium*), fucoid (*Fucus* sp.)
LS_I0160	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	Red seaweeds (*Dumontia* sp., *Chondrus crispus, Osmundea* sp.), coralline seaweeds (*Corallina officinalis*), green seaweeds (*Chaetomorpha melagonium*), fucoid (*Fucus* sp.),
LS_I0161	53.545116	-6.083129	693 253.4	5 936 871.1	-	-	Brown seaweed (*Halidry siliquosa*)
LS_I0162	53.545242	-6.083032	693 259.3	5 936 885.3	-	-	Bedrock edge and rockpool
LS_I0163	53.545242	-6.083032	693 259.3	5 936 885.3	-	-	Rockpool - sand ingress - limited flora (reds)
LS_I0164	53.545429	-6.082663	693 282.9	5 936 907.1	0	N	View back across sand
LS_I0165	53.545429	-6.082663	693 282.9	5 936 907.1	90	E	View to pier
LS_I0166	53.545429	-6.082663	693 282.9	5 936 907.1	180	S	View out of lough
LS_I0167	53.545429	-6.082663	693 282.9	5 936 907.1	270	W	View to cliffs
LS_I0168	53.545429	-6.082663	693 282.9	5 936 907.1	180	S	View across rockpool
LS_I0169	53.545429	-6.082663	693 282.9	5 936 907.1	180	S	View across rockpool

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	**Latitude**	**Longitude**	**Easting [m]**	**Northing [m]**	**Bearing [◦]**	**Direction**	**Comments**
LS_I0170	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Lots of small pools
LS_I0171	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Lots of small pools
LS_I0172	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Lots of small pools
LS_I0173	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Lots of small pools
LS_I0174	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Brown seaweeds (*Dictyota dichotoma*)
LS_I0175	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Brown seaweeds (*Dictyota dichotoma*)
LS_I0176	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Green seaweeds (*Cladophora* sp.), orange sponge
LS_I0177	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Carrageen (*Chondrus crispus*), coralline seaweeds (*Corallina officinalis*)
LS_I0178	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Carrageen (*Chondrus crispus*), coralline seaweeds (*Corallina officinalis*)
LS_I0179	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Barnacles (*Semibalanus balanoides*)
LS_I0180	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Barnacles (*Semibalanus balanoides*)
LS_I0181	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Barnacles (*Semibalanus balanoides*)
LS_I0182	53.545429	-6.082663	693 282.9	5 936 907.1	-	-	Barnacles (*Semibalanus balanoides*), limpets (*Patella depressa*)
LS_I0183	53.545461	-6.08272	693 278.9	5 936 910.5	-	-	Knotted wrack (*Ascophyllum* sp.) on bedrock (2 m × 2 m)
LS_I0184	53.545461	-6.08272	693 278.9	5 936 910.5	270	W	View across bedrock, over rockpools, to cliffs
LS_I0185	53.545443	-6.082386	693 301.1	5 936 909.4	-	-	View back over bedrock to cliff
LS_I0186	53.545507	-6.082484	693 294.4	5 936 916.3	-	-	Mussels (*Mytilus edulis*)
LS_I0187	53.545507	-6.082484	693 294.4	5 936 916.3	-	-	Area of mussels (*Mytilus edulis*)
LS_I0188	53.545589	-6.082483	693 294.0	5 936 925.4	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0189	53.545589	-6.082483	693 294.0	5 936 925.4	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0190	53.545589	-6.082483	693 294.0	5 936 925.4	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0191	53.545589	-6.082483	693 294.0	5 936 925.4	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0192	53.545589	-6.082483	693 294.0	5 936 925.4	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0193	53.545589	-6.082483	693 294.0	5 936 925.4	90	E	View across area of boulders
LS_I0194	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*), coralline seaweeds (*Phymatolithion lenormandii*)
LS_I0195	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*), coralline seaweeds (*Phymatolithion lenormandii*)
LS_I0196	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*), coralline seaweeds (*Phymatolithion lenormandii*)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0197	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*, *Semibalanus balanoides*), winkle (*Littorina* sp.)
LS_I0198	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*)
LS_I0199	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*)
LS_I0200	53.545143	-6.082885	693 269.5	5 936 874.7	-	-	Barnacles (*Austrominius modestus*)
LS_I0201	53.545119	-6.082832	693 273.1	5 936 872.2	315	NW	Fulmar (*Fulmarus glacialis*)
LS_I0202	53.545119	-6.082832	693 273.1	5 936 872.2	315	NW	Fulmar (*Fulmarus glacialis*)
LS_I0203	53.545119	-6.082832	693 273.1	5 936 872.2	315	NW	View to Fulmar (*Fulmarus glacialis*)
LS_I0204	53.545119	-6.082832	693 273.1	5 936 872.2	225	SW	View across shore - zonation: lichen, black, barnacles
LS_I0205	53.545119	-6.082832	693 273.1	5 936 872.2	225	SW	View across shore - zonation: lichen, black, barnacles
LS_I0206	53.545119	-6.082832	693 273.1	5 936 872.2	270	W	View to Fulmar (*Fulmarus glacialis*)
LS_I0207	53.545119	-6.082832	693 273.1	5 936 872.2	270	W	View to Fulmar (*Fulmarus glacialis*)
LS_I0208	53.545119	-6.082832	693 273.1	5 936 872.2	-	-	Red seaweeds (*Porphyra* sp. (bagged); *Rhodothamniella floridula*), winkle (*Littorina littorea*), barnacles (*A. modestus*), green seaweeds (*U. lactuca*)
LS_I0209	53.544819	-6.083396	693 237.1	5 936 837.3	22.5	NNE	View across green seaweeds (*Prasiola* sp., *Ulva* sp.) strip
LS_I0210	53.544819	-6.083396	693 237.1	5 936 837.3	90	E	View down shore across bedrock and green seaweeds (*Ulva* sp.)/ fucoid (*Fucus* sp.) to barnacles
LS_I0211	53.544845	-6.083233	693 247.8	5 936 840.6	90	E	View across shallow upper shore rockpool zone
LS_I0212	53.544845	-6.083233	693 247.8	5 936 840.6	90	E	Fulmars (*Fulmarus glacialis*)
LS_I0213	53.544845	-6.083233	693 247.8	5 936 840.6	90	E	Fulmars (*Fulmarus glacialis*)
LS_I0214	53.544845	-6.083233	693 247.8	5 936 840.6	90	E	Fulmars (*Fulmarus glacialis*)
LS_I0215	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Shallow upper shore rockpool zone: green seaweeds (*Ulva* sp., *Chateomorpha melagonium*)
LS_I0216	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Shallow upper shore rockpool zone: green seaweeds (*Ulva* sp., *Chateomorpha melagonium*)
LS_I0217	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Shallow upper shore rockpool zone: green seaweeds (*Ulva* sp., *Chateomorpha melagonium*)
LS_I0218	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Shallow upper shore rockpool zone: pink encrusting seaweeds, limpets (*Patella* sp.), winkle (*Littorina* sp.), coralline seaweeds (*Corallina officinalis*)
LS_I0219	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Shallow upper shore rockpool zone: pink encrusting seaweeds, green seaweeds (*Ulva sp.*), red seaweeds (*Gelidium pusillum*), coralline seaweeds (*Phymatolithion lenormandi)*
LS_I0220	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Upper shore fauna: channelled wrack (*Pelvetia canaliculata*), green seaweeds (*Ulva* sp.)

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Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0221	53.544853	-6.08322	693 248.6	5 936 841.6	-	-	Upper shore/sheltered shore fauna: limpets (*Patella* sp.), knotted wrack (*Ascophyllum nodosum*), spiral wrack (*Fucus spiralis*)
LS_I0222	53.544853	-6.08322	693 248.6	5 936 841.6	90	E	View across shallow rockpool
LS_I0223	53.544865	-6.082987	693 264.0	5 936 843.5	-	-	Spiral wrack (*Fucus spiralis*) strip surrounded by bladder wrack (*Fucus vesiculosus*)
LS_I0224	53.544865	-6.082987	693 264.0	5 936 843.5	270	W	View across spiral wrack (*Fucus spiralis*) zone to green seaweeds (*Prasiola* sp.) patch
LS_I0225	53.544865	-6.082987	693 264.0	5 936 843.5	270	W	View across spiral wrack (*Fucus spiralis*) zone to green seaweeds (*Prasiola* sp.) patch
LS_I0226	53.544865	-6.082987	693 264.0	5 936 843.5	270	W	View across spiral wrack (*Fucus spiralis*) zone to green seaweeds (*Prasiola* sp.) patch
LS_I0227	53.544865	-6.082987	693 264.0	5 936 843.5	-	-	Barnacles (*Semibalanus balanoides*)
LS_I0228	53.544865	-6.082987	693 264.0	5 936 843.5	-	-	Barnacles (*Chthalamus stellatus* and *Semibalanus balanoides*)
LS_I0229	53.544865	-6.082987	693 264.0	5 936 843.5	-	-	Barnacles (*Chthalamus stellatus* and *Semibalanus balanoides*)
LS_I0230	53.544868	-6.083077	693 258.0	5 936 843.6	-	-	Green seaweeds (*Prasiola stipitata*)
LS_I0231	53.545176	-6.083152	693 251.6	5 936 877.7	112.5	ESE	View down barnacle and bladder wrack (*Fucus vesiculosus*) zone: dog whelk (*Nucella lapillus*), limpets (*Patella* sp.)
LS_I0232	53.545176	-6.083152	693 251.6	5 936 877.7	180	S	View across zonation: barnacles, lichens
LS_I0233	53.545419	-6.0828	693 273.8	5 936 905.6	0	N	Within barnacle/fucoid (*Fucus* sp.) patch, view across sand
LS_I0234	53.545419	-6.0828	693 273.8	5 936 905.6	112.5	ESE	Within barnacle/fucoid (*Fucus* sp.) patch, view towards pier
LS_I0235	53.545419	-6.0828	693 273.8	5 936 905.6	180	S	Within barnacle/fucoid (*Fucus* sp.) patch, view to outer bay
LS_I0236	53.545419	-6.0828	693 273.8	5 936 905.6	270	W	Within barnacle/fucoid (*Fucus* sp.) patch, view to cliffs
LS_I0237	53.545419	-6.0828	693 273.8	5 936 905.6	180	S	Within barnacle/fucoid (*Fucus* sp.) patch, view to outer bay
LS_I0238	53.545419	-6.0828	693 273.8	5 936 905.6	-	-	Within barnacle/fucoid (*Fucus* sp.) patch – limpets (*Patella vulgata*), bladder wrack (*Fucus vesiculosus*), barnacles (*Semibalanus balanoides*), red turf (*Osmundea sp.*), pink encrusting seaweeds
LS_I0239	53.545419	-6.0828	693 273.8	5 936 905.6	-	-	Within barnacle/fucoid (*Fucus* sp.) patch – limpets (*Patella vulgata*), bladder wrack (*Fucus vesiculosus*), barnacles (*Semibalanus balanoides*), red turf (*Osmundea* sp.), pink encrusting seaweeds
LS_I0240	53.545419	-6.0828	693 273.8	5 936 905.6	-	-	Within barnacle/fucoid (*Fucus* sp.) patch – limpets (*Patella vulgata*), bladder wrack (*Fucus vesiculosus*), barnacles (*Semibalanus balanoides*), red turf (*Osmundea* sp.), pink encrusting seaweeds
LS_I0241	53.545419	-6.0828	693 273.8	5 936 905.6	-	-	Within barnacle/fucoid (*Fucus* sp.) patch – barnacles (*Semibalanus balanoides*)

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Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0242	53.545419	-6.0828	693 273.8	5 936 905.6	-	-	Within barnacle/fucoid (*Fucus* sp.) patch – barnacles (*Semibalanus balanoides*), winkle (*Littorina* sp.)
LS_I0243	53.545419	-6.0828	693 273.8	5 936 905.6	-	-	Within barnacle/ fucoid (*Fucus* sp.) patch – barnacles (*Semibalanus balanoides*), pink encrusting seaweeds, mussels (*Mytilus edulis*)
LS_I0244	53.545245	-6.083154	693 251.2	5 936 885.3	-	-	Bouldery mixed sediment with minimal bladder wrack (*Fucus vesiculosus*) and green seaweeds (*Ulva* sp.)
LS_I0245	53.545245	-6.083154	693 251.2	5 936 885.3	-	-	Bouldery mixed sediment
LS_I0246	53.545245	-6.083154	693 251.2	5 936 885.3	-	-	Bouldery mixed sediment
LS_I0247	53.545245	-6.083154	693 251.2	5 936 885.3	-	-	Bouldery mixed sediment
LS_I0248	53.545379	-6.083144	693 251.2	5 936 900.3	-	-	Channeled wrack (*Pelvetia sp.*) and green seaweeds (*Ulva* sp.)
LS_I0249	53.545379	-6.083144	693 251.2	5 936 900.3	-	-	Channeled wrack (*Pelvetia sp.*) and green seaweeds (*Ulva* sp.)
LS_I0250	53.545379	-6.083144	693 251.2	5 936 900.3	-	-	Channeled wrack (*Pelvetia* sp.) and green seaweeds (*Ulva sp.*), spiral wrack (*Fucus spiralis*), red seaweeds (*Porphyra* sp.)
LS_I0251	53.545379	-6.083144	693 251.2	5 936 900.3	-	-	Channeled wrack *(Pelvetia* sp.) and green seaweeds (*Ulva* sp.*)*
LS_I0252	53.545403	-6.083165	693 249.7	5 936 902.9	90	E	View across *Pelvetia* zone: channelled wrack (*Pelvetia* sp.) and green seaweeds (*Ulva* sp.), spiral wrack (*Fucus spiralis*), red seaweeds (*Porphyra* sp.)
LS_I0253	53.545403	-6.083165	693 249.7	5 936 902.9	180	S	View across bare bouldery mixed sediment area
LS_I0254	53.545403	-6.083165	693 249.7	5 936 902.9	0	N	View across bouldery mixed sediment with bladder wrack (*Fucus vesiculosus*) and some green seaweeds (*Ulva* sp.)
LS_I0255	53.545403	-6.083165	693 249.7	5 936 902.9	270	W	View across bedrock (barnacles) to pier
LS_I0256	53.545475	-6.083139	693 251.1	5 936 911.0	-	-	Bouldery mixed sediment with fucoid (*Fucus* sp.) and green seaweeds (*Ulva* sp.*)*
LS_I0257	53.545475	-6.083139	693 251.1	5 936 911.0	-	-	Bouldery mixed sediment with fucoid (*Fucus* sp.), knotted wrack (*Ascophyllum nodosum*) and green seaweeds (*Ulva* sp.*)*
LS_I0258	53.545475	-6.083139	693 251.1	5 936 911.0	-	-	Bouldery mixed sediment with fucoid (*Fucus* sp.) and green seaweeds (*Ulva* sp.)
LS_I0259	53.545475	-6.083139	693 251.1	5 936 911.0	-	-	Bouldery mixed sediment with fucoid (*Fucus sp.*) and green seaweeds (*Ulva* sp.)
LS_I0260	53.545475	-6.083139	693 251.1	5 936 911.0	-	-	Bouldery mixed sediment with fucoid (*Fucus* sp.) and green seaweeds (*Ulva* sp.)
LS_I0261	53.545566	-6.083103	693 253.1	5 936 921.2	90	E	View across bedrock and sand with fucoid (*Fucus* sp.*)*
LS_I0262	53.545589	-6.083018	693 258.6	5 936 924.0	-	-	Bladder wrack (*Fucus vesiculosus*), red seaweeds (*Rhodothamniella* sp.), barnacles

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0263	53.545589	-6.083018	693 258.6	5 936 924.0	-	-	Bladder wrack (*Fucus vesiculosus*), red seaweeds (*Rhodothamniella* sp.), barnacles, *Ulva lactuca*
LS_I0264	53.545589	-6.083018	693 258.6	5 936 924.0	-	-	Bladder wrack (*Fucus vesiculosus*), red seaweeds (*Rhodothamniella* sp.), barnacles, green seaweeds (*Ulva* sp.), winkle (*Littorina littorea*)
LS_I0265	53.545589	-6.083018	693 258.6	5 936 924.0	-	-	Bladder wrack (*Fucus vesiculosus*), red seaweeds (*Rhodothamniella* sp.), green seaweeds (*Ulva* sp.)
LS_I0266	53.545589	-6.083018	693 258.6	5 936 924.0	90	E	Birds including oystercatcher (*Haematopus ostralegus*), great black-backed gull (*Larus marinus*), herring gull
LS_I0267	53.545589	-6.083018	693 258.6	5 936 924.0	90	E	Birds including oystercatcher (*Haematopus ostralegus*), great black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), kittiwake (*Rissa* sp.), ?dunlin (*Calidris* sp.)
LS_I0268	53.545589	-6.083018	693 258.6	5 936 924.0	90	E	Birds including great black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), kittiwake (*Rissa* sp.)
LS_I0269	53.545251	-6.081764	693 343.2	5 936 889.8		-	Boulder: barnacles (*Semibalanus balanoides*) and limpets (*Patella vulgata*)
LS_I0270	53.545251	-6.081764	693 343.2	5 936 889.8	315	NW	Boulder: barnacles (*Semibalanus balanoides*) and limpets (*Patella vulgata*)
LS_I0271	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*) and dog whelks (*Nucella lapillus*)
LS_I0272	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), winkle (*Littorina* sp.) and limpets (*Patella* sp.)
LS_I0273	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), winkle (*Littorina* sp.) and limpets (*Patella vulgata)*
LS_I0274	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), winkle (*Littorina* sp.) and limpets (*Patella vulgata*)
LS_I0275	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*) and dog whelks (*Nucella lapillus*)
LS_I0276	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*), dog whelks (*Nucella lapillus*) and anemone (*Actinia equina*)
LS_I0277	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*), dog whelks (*Nucella lapillus*), mussels (*Mytilus edulis*) and sand mason worm (*Lanice conchilega*)
LS_I0278	53.545251	-6.081764	693 343.2	5 936 889.8	-	-	Boulder: barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*), rock wrack (*Fucus ?vesiculosus*), green seaweeds (*Ulva* sp./*Blidingia* sp.)
LS_I0279	53.544734	-6.081917	693 335.4	5 936 831.9	225	SW	View across bare sand

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0280	53.544734	-6.081917	693 335.4	5 936 831.9	270	W	View up the shore
LS_I0281	53.544798	-6.081618	693 354.9	5 936 839.8	315	NW	View across sand mason worm (*Lanice conchilega)* patch
LS_I0282	53.544798	-6.081618	693 354.9	5 936 839.8	315	NW	View across sand mason worm (*Lanice conchilega*) patch
LS_I0283	53.545255	-6.081333	693 371.7	5 936 891.4	-	-	Piddock Boulder 1: Piddocks, fan worms (*Spirobranchus sp*.), barnacles
LS_I0284	53.545255	-6.081333	693 371.7	5 936 891.4	-	-	Piddock Boulder 1: Piddocks, fan worms (*Spirobranchus* sp.), barnacles
LS_I0285	53.545255	-6.081333	693 371.7	5 936 891.4	-	-	Piddock Boulder 1: Piddocks, ross worms (*Sabellaria spinulosa*)
LS_I0286	53.545255	-6.081333	693 371.7	5 936 891.4	-	-	Piddock Boulder 1: fan worms (*Spirobranchus* sp.)
LS_I0287	53.545255	-6.081333	693 371.7	5 936 891.4	-	-	Piddock Boulder 1: fan worms (*Spirobranchus* sp.)
LS_I0288	53.545227	-6.081308	693 373.5	5 936 888.3	-	-	Piddock Boulder 1: piddocks and red turf (*Rhodothamniella* sp.), fan worms (*Spirobranchus* sp.) and barnacles (*A. modestus*)
LS_I0289	53.545227	-6.081308	693 373.5	5 936 888.3	-	-	Piddock Boulder 1: piddocks and red turf (*Rhodothamniella* sp.), fan worms (*Spirobranchus* sp.)
LS_I0290	53.545227	-6.081308	693 373.5	5 936 888.3	-	-	Piddock Boulder 1: piddocks and red seaweed turf (*Rhodothamniella* sp.), carrageen (*Chondrus crispus*)
LS_I0291	53.545227	-6.081308	693 373.5	5 936 888.3	-	-	Piddock Boulder 1: piddocks and red seaweed turf (*Rhodothamniella* sp.)
LS_I0292	53.545161	-6.081372	693 369.6	5 936 880.8	-	-	Sand mason worm (*Lanice conchilega*)
LS_I0293	53.545161	-6.081372	693 369.6	5 936 880.8	-	-	Sand mason worm (*Lanice conchilega*)
LS_I0294	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red seaweeds (*Rhodothamniella* sp., *Polysiphonia* sp., *Chondrus crispus*), fan worms (*Spirobranchus* sp.), rock wrack (*Fucus ?vesiculosus*), green seaweeds (*Cladophora rupestris*)
LS_I0295	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red turf (*Rhodothamniella* sp.)
LS_I0296	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red turf (*Rhodothamniella* sp.), barnacles, green seaweeds (*Ulva lactuca)*
LS_I0297	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red seaweeds (*Rhodothamniella* sp., *Chondrus crispus*, *Polysiphonia* sp.), fan worms (*Spirobranchus* sp.), rock wrack (*Fucus ?vesiculosus)*, green seaweeds (*Cladophora rupestris*)
LS_I0298	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red seaweeds (*Rhodothamniella* sp., *Polysiphonia* sp., *Chondrus crispus*), fan worms (*Spirobranchus* sp.), serrated wrack (*Fucus serratus*)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	**Latitude**	**Longitude**	**Easting [m]**	**Northing [m]**	**Bearing [◦]**	**Direction**	**Comments**
LS_I0299	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red seaweeds (*Rhodothamniella* sp., *Polysiphonia* sp., *Chondrus crispus*), fan worms (*Spirobranchus sp.*), fucoids (*Fucus* sp.), bryozoan, green seaweeds (*Ulva lactuca)*, sponge (Porifera), coralline seaweeds (*Phymatolithion lenormandii*)
LS_I0300	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red seaweeds (*Rhodothamniella* sp., *Polysiphonia* sp., *Chondrus crispus*), fan worms (*Spirobranchus sp.*), fucoids (*Fucus* sp.), green seaweeds (*Ulva lactuca*), sponge (Porifera)
LS_I0301	53.545265	-6.081051	693 390.4	5 936 893.3	-	-	Piddock boulder 2: piddocks, red seaweeds (*Rhodothamniella* sp., *Polysiphonia* sp., *Chondrus crispus*), fan worms (*Spirobranchus* sp.), fucoids (*Fucus* sp.), bryozoan (Bryozoa), green seaweeds (*Ulva lactuca*), sponge (Porifera)
LS_I0302	53.545265	-6.081051	693 390.4	5 936 893.3	0	N	View across Piddock boulder 2
LS_I0303	53.545265	-6.081051	693 390.4	5 936 893.3	0	N	View across Piddock boulder 2
LS_I0304	53.545265	-6.081051	693 390.4	5 936 893.3	45	NE	View across Piddock boulder 2
LS_I0305	53.545477	-6.081187	693 380.4	5 936 916.5	0	N	Piddock boulder 3: serrated wrack (*Fucus serratus*), red turf (*Rhodothamniella* sp.), fan worms (*Spirobranchus* sp.)
LS_I0306	53.545477	-6.081187	693 380.4	5 936 916.5	0	N	View across Piddock boulder 3
LS_I0307	53.545477	-6.081187	693 380.4	5 936 916.5	180	S	View across Piddock boulder 3
LS_I0308	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: serrated wrack (*Fucus serratus*), red turf (*Rhodothamniella* sp.)
LS_I0309	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: serrated wrack (*Fucus serratus*), red turf (*Rhodothamniella* sp.)
LS_I0310	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: serrated wrack (*Fucus serratus*), red turf (*Rhodothamniella sp.),* fan worms (*Spirobranchus* sp.)
LS_I0311	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: serrated wrack (*Fucus serratus*), red turf (*Rhodothamniella* sp.), fan worms (*Spirobranchus* sp.)
LS_I0312	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: barnacles, fan worms (*Spirobranchus* sp.)
LS_I0313	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: barnacles, fan worms (*Spirobranchus* sp.)
LS_I0314	53.545477	-6.081187	693 380.4	5 936 916.5	-	-	Piddock boulder 3: serrated wrack (*Fucus serratus*), red seaweed turf (*Rhodothamniella* sp.), carrageen (*Chondrus crispus*)
LS_I0315	53.54543	-6.080435	693 430.4	5 936 913.3	90	E	View across kelp zone towards pier
LS_I0316	53.54543	-6.080435	693 430.4	5 936 913.3	0	N	View from kelp zone up shore across mixed sediment

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0317	53.545494	-6.080301	693 439.0	5 936 920.8	-	-	Kelp (*Saccharina latissima*), red seaweeds (*Chondrus crispus*, *Palmaria palmata*, *Phymatolithion lenormandii*), fan worm (*Spirobranchus* sp.), red seaweeds (*Polysiphonia* sp.), green seaweeds (*Ulva lactuca*), ross worm (?*Sabellaria spinulosa)*
LS_I0318	53.545501	-6.080234	693 443.4	5 936 921.7	-	-	Kelps (*Saccharina latissima*, *Laminaria digitata)*, serrated wrack (*Fucus serratus*), red seaweeds (*Chondrus crispus*, *Palmaria palmata*), fan worm (*Spirobranchus* sp.*)*, green seaweeds (*Ulva lactuca*)
LS_I0319	53.54552	-6.080227	693 443.8	5 936 923.9	-	-	Anthropogenic debris - engine, kelp (*Laminaria digitata*), red seaweeds (*Palmaria palmata, Chondrus crispus*), serrated wrack (*Fucus serratus*), green seaweeds (*Ulva lactuca*), bryozoan (Bryozoa), pink encrusting seaweeds
LS_I0320	53.54552	-6.080227	693 443.8	5 936 923.9	-	-	Anthropogenic debris - engine, kelp (*Laminaria digitata*), red seaweeds (*Palmaria palmata, Chondrus crispus*), serrated wrack (*Fucus serratus*), green seaweeds (*Ulva lactuca*), bryozoan (Bryozoa), pink encrusting seaweeds
LS_I0321	53.545533	-6.080158	693 448.3	5 936 925.5	-	-	Kelp (*Saccharina latissima*), red seaweeds (*Palmaria palmata*, *Chondrus crispus*), pink encrusting seaweeds, green seaweeds (*Ulva lactuca*), serrated wrack (*Fucus serratus*)
LS_I0322	53.545533	-6.080158	693 448.3	5 936 925.5	-	-	Kelp (*Saccharina latissima*), red seaweeds (*Palmaria palmata*, *Chondrus crispus*), pink encrusting seaweeds, serrated wrack (*Fucus serratus)*, ross worms (?*Sabellaria spinulosa*), sponge (Porifera)
LS_I0323	53.545533	-6.080158	693 448.3	5 936 925.5	-	-	Anemone (*Anemonia viridis*)
LS_I0324	53.545533	-6.080158	693 448.3	5 936 925.5	-	-	Anemone (*Anemonia viridis*)
LS_I0325	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Ross worms (*Sabellaria spinulosa)*, coralline seaweeds (*Phymatolithion lenormandii*), fan worms (*Spirobranchus* sp.*),* carrageen (*Chondrus crispus*), sand mason worms (*Lanice conchilega*)
LS_I0326	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Red encrusting seaweeds, snails (*Gibbula cineraria*), coralline seaweeds (*Phymatolithion lenormandi*), carrageen (*Chondrus crispus*), fan worms (*Spirobranchus* sp.*)*, green seaweeds (*Ulva lactuca*)
LS_I0327	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Snails (*Gibbula cineraria*), coralline seaweeds (*Phymatolithion lenormandi*), red seaweeds (*Chondrus crispus, Palmaria palmata)*, fan worms (*Spirobranchus sp.*)
LS_I0328	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Coralline seaweeds (*Phymatolithion lenormandi*), carrageen (*Chondrus crispus*), fan worms (*Spirobranchus* sp.), barnacles
LS_I0329	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Ross worms (*Sabellaria spinulosa*)
LS_I0330	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Ross worms *(Sabellaria spinulosa*) and fan worms (*Spirobranchus* sp.*)*

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0331	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Anemone (*Sagartia* sp.), snails (*Gibbula cineraria*), hydroids (Hydrozoa)
LS_I0332	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Sand mason worms (*Lanice conchilega*), ross worms (*Sabellaria spinulosa*), fan worms (*Spirobranchus* sp.), coralline seaweeds (*Phymatolithion lenormandi*)
LS_I0333	53.545396	-6.08022	693 444.8	5 936 910.1	-	-	Ross worms (*Sabellaria spinulosa*), sponge (Porifera), green seaweeds (*Ulva lactuca*), fan worms (*Spirobranchus* sp.)
LS_I0334	53.545564	-6.079625	693 483.5	5 936 930.4	-	-	Red seaweeds (*Palmaria palmata and Chondrus crispus*), fan worm (*Spirobranchus* sp.), sponge (?*Halicondria* sp.), pink encrusting seaweeds, bryozoan (Bryozoa)
LS_I0335	53.545564	-6.079625	693 483.5	5 936 930.4	-	-	Red seaweeds (*Palmaria palmata* and *Chondrus crispus*), serrated wrack (*Fucus serratus*), green seaweeds (*Ulva lactuca*), fan worms (*Spirobranchus* sp.), dog whelks (*Nucella lapillus*), pink encrusting seaweeds, bryozoan (Bryozoa), ross worms (*Sabellaria spinulosa*)
LS_I0336	53.545564	-6.079625	693 483.5	5 936 930.4	-	-	Red seaweeds (*Palmaria palmata* and *Chondrus crispus*), serrated wrack (*Fucus serratus*), fan worms (*Spirobranchus sp.*), pink encrusting seaweeds, bryozoan (Bryozoa), ross worms (*Sabellaria spinulosa*)
LS_I0337	53.545564	-6.079625	693 483.5	5 936 930.4	-	-	Anemone (*Anemonia viridis*)
LS_I0338	53.545564	-6.079625	693 483.5	5 936 930.4	-	-	Fan worms (*Spirobranchus* sp.), dog whelks (*Nucella lapillus)*, serrated wrack (*Fucus serratus*), carrageen (*Chondrus crispus*), bryozoan (Bryozoa), pink encrusting seaweeds, ross worms (*Sabellaria spinulosa*)
LS_I0339	53.545739	-6.079785	693 472.1	5 936 949.4	-	-	Bare mixed rock with sand mason worms (*Lanice* sp.)
LS_I0340	53.545739	-6.079785	693 472.1	5 936 949.4	-	-	Bare mixed rock with sand mason worms (*Lanice* sp.)
LS_I0341	53.545739	-6.079785	693 472.1	5 936 949.4	-	-	Bare mixed rock with sand mason worms (*Lanice* sp.)
LS_I0342	53.545739	-6.079785	693 472.1	5 936 949.4	270	W	View across bare mixed rock with sand mason worms (*Lanice* sp.) to cliffs
LS_I0343	53.545739	-6.079785	693 472.1	5 936 949.4	270	W	View across bare mixed rock with sand mason worms (*Lanice* sp.) to cliffs
LS_I0344	53.545739	-6.079785	693 472.1	5 936 949.4	0	N	View up beach
LS_I0345	53.545739	-6.079785	693 472.1	5 936 949.4	90	E	View across bare mixed rock to pier
LS_I0346	53.545739	-6.079785	693 472.1	5 936 949.4	180	S	View down shore across fucoids (*Fucus* sp.) and Kelp
LS_I0347	53.545594	-6.079794	693 472.1	5 936 933.3	45	NE	Focus on pier: view up from serrated wrack (*Fucus serratus*)
LS_I0348	53.545594	-6.079794	693 472.1	5 936 933.3	135	SE	Focus on pier: view down from serrated wrack (*Fucus serratus*)
LS_I0349	53.546058	-6.079734	693 474.0	5 936 985.0	225	SW	View across *Lanice* on sand to *Lanice* on coarse sand to *Lanice* on gravel
LS_I0350	53.546058	-6.079734	693 474.0	5 936 985.0	225	SW	View across *Lanice* on sand to Lanice on coarse sand to *Lanice* on gravel

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0351	53.546064	-6.079893	693 463.4	5 936 985.3	-	-	Sand mason worms (*Lanice conchilega*) on sand
LS_I0352	53.546064	-6.079893	693 463.4	5 936 985.3	-	-	Sand mason worms (*Lanice conchilega*) on sand
LS_I0353	53.546064	-6.079893	693 463.4	5 936 985.3	-	-	Sand mason worms (*Lanice conchilega*) on sand
LS_I0354	53.546064	-6.079893	693 463.4	5 936 985.3	-	-	Sand mason worms (*Lanice conchilega*) on sand
LS_I0355	53.545928	-6.079923	693 462.1	5 936 970.1	-	-	Sand mason worms (*Lanice conchilega*) on coarse sand/gravel
LS_I0356	53.545928	-6.079923	693 462.1	5 936 970.1	-	-	Sand mason worms (*Lanice conchilega*) on coarse sand/gravel
LS_I0357	53.545928	-6.079923	693 462.1	5 936 970.1	-	-	Sand mason worms (*Lanice conchilega*) on coarse sand/gravel
LS_I0358	53.545928	-6.079923	693 462.1	5 936 970.1	-	-	Sand mason worms (*Lanice conchilega*) on coarse sand/gravel
LS_I0359	53.545906	-6.079931	693 461.6	5 936 967.6	-	-	Anthropogenic debris
LS_I0360	53.545906	-6.079931	693 461.6	5 936 967.6	-	-	Anthropogenic debris
LS_I0361	53.545906	-6.079931	693 461.6	5 936 967.6	-	-	Anthropogenic debris
LS_I0362	53.546117	-6.080638	693 413.8	5 936 989.1	0	N	View up beach
LS_I0363	53.546117	-6.080638	693 413.8	5 936 989.1	90	E	View to pier
LS_I0364	53.546117	-6.080638	693 413.8	5 936 989.1	180	S	View down shore, across sand to mixed gravel and across outer bay
LS_I0365	53.546117	-6.080638	693 413.8	5 936 989.1	270	W	View to pier
LS_I0366	53.546117	-6.080638	693 413.8	5 936 989.1	-	-	Sand
LS_I0367	53.546908	-6.080634	693 410.5	5 937 077.1	202.5	SSW	View down shore
LS_I0368	53.546908	-6.080634	693 410.5	5 937 077.1	202.5	SSW	View down shore
LS_I0369	53.546608	-6.079366	693 495.9	5 937 047.2	90	E	View to pier
LS_I0370	53.546608	-6.079366	693 495.9	5 937 047.2	90	E	Spiral wrack (*Fucus spiralis*) zone
LS_I0371	53.546608	-6.079366	693 495.9	5 937 047.2	90	E	Red seaweeds (*Catenella* sp.)/ green seaweeds (*Ulva* sp.) zone
LS_I0372	53.546608	-6.079366	693 495.9	5 937 047.2	90	E	Lichen zone
LS_I0373	53.546608	-6.079366	693 495.9	5 937 047.2	90	E	Spiral wrack (*Fucus spiralis*), bladder wrack (*Fucus vesiculosus*) and knotted wrack (*Ascophyllum* sp.)
LS_I0374	53.546462	-6.079395	693 494.6	5 937 030.9	90	E	View to pier with outflow and tunnel
LS_I0375	53.54603	-6.079413	693 495.4	5 936 982.8	90	E	View to pier steps
LS_I0376	53.54603	-6.079413	693 495.4	5 936 982.8	90	E	View to pier steps

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0377	53.54603	-6.079413	693 495.4	5 936 982.8	90	E	Fucoid (*Fucus* sp.), barnacles (*Semibalanus* sp.) and green seaweeds (*Ulva* sp.)
LS_I0378	53.54603	-6.079413	693 495.4	5 936 982.8	90	E	Fucoid (*Fucus* sp.), barnacles (*Semibalanus balanoides*) and green seaweeds (*Ulva* sp.)
LS_I0379	53.54603	-6.079413	693 495.4	5 936 982.8	90	E	Green seaweeds (*Blidingia* sp./*Ulothrix* sp.)
LS_I0380	53.54603	-6.079413	693 495.4	5 936 982.8	90	E	Fucoids (*Fucus* sp.)
LS_I0381	53.545776	-6.083208	693 245.2	5 936 944.2	270	W	View to outflow
LS_I0382	53.545776	-6.083208	693 245.2	5 936 944.2	0	N	Across sand
LS_I0383	53.545776	-6.083208	693 245.2	5 936 944.2	90	E	Down beach
LS_I0384	53.545776	-6.083208	693 245.2	5 936 944.2	180	S	To cliffs
LS_I0385	53.546506	-6.082649	693 278.9	5 937 026.9	0	N	View to outflow
LS_I0386	53.546586	-6.082848	693 265.3	5 937 035.3	0	N	View to small black pipes outflow
LS_I0387	53.547157	-6.080752	693 401.5	5 937 104.5	-	-	Saltmarsh plants, sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0388	53.547157	-6.080752	693 401.5	5 937 104.5	270	W	View to Sand dunes upper edge- Carpark
LS_I0389	53.547164	-6.080998	693 385.2	5 937 104.6	-	-	Saltmarsh plant, sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0390	53.547164	-6.080998	693 385.2	5 937 104.6	-	-	Rock dump- Sand dunes upper edge-Carpark
LS_I0391	53.547132	-6.081252	693 368.5	5 937 100.3	-	-	Saltmarsh plant, sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0392	53.547195	-6.081288	693 365.9	5 937 107.3	-	-	Saltmarsh plant
LS_I0393	53.547272	-6.081318	693 363.5	5 937 115.7	-	-	Saltmarsh plant-rock dump
LS_I0394	53.547222	-6.081421	693 356.9	5 937 109.9	225	SW	Path through sand dunes
LS_I0395	53.547223	-6.081577	693 346.6	5 937 109.6	-	-	Saltmarsh plants
LS_I0396	53.547223	-6.081577	693 346.6	5 937 109.6	180	S	Path through sand dunes
LS_I0397	53.547215	-6.081653	693 341.6	5 937 108.5	225	SW	Path through sand dunes
LS_I0398	53.547189	-6.08173	693 336.6	5 937 105.4	-	-	Saltmarsh plants (?*Ammophila* sp.)
LS_I0399	53.547189	-6.08173	693 336.6	5 937 105.4	-	-	Saltmarsh plants Dandelion (*Taraxacum officinale*)
LS_I0400	53.547141	-6.081914	693 324.7	5 937 099.6	-	-	Sand dunes upper edge - Clover (?*Trifolium* sp.)
LS_I0401	53.547141	-6.081914	693 324.7	5 937 099.6	-	-	Goosetongue plant (*Plantago maritima*)
LS_I0402	53.547107	-6.082053	693 315.6	5 937 095.4	-	-	Ribwort plantain (*Plantago lanceolata*)
LS_I0403	53.547107	-6.082053	693 315.6	5 937 095.4	-	-	Saltmarsh burnt

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0404	53.54701	-6.082276	693 301.3	5 937 084.0	-	-	Ribwort plantain (*Plantago lanceolata*)
LS_I0405	53.54701	-6.082276	693 301.3	5 937 084.0	225	SW	View of the shore - saltmarsh plants
LS_I0406	53.546929	-6.082463	693 289.3	5 937 074.5	-	-	Sand dunes upper edge - Common mallow (*Malva sylvestris*)
LS_I0407	53.546929	-6.082463	693 289.3	5 937 074.5	180	S	Sand dunes upper edge - Common mallow (*Malva sylvestris*)
LS_I0408	53.546814	-6.082706	693 273.7	5 937 061.0	-	-	Dandelion (*Taraxacum officinale*)
LS_I0409	53.546727	-6.082868	693 263.4	5 937 050.9	-	-	Stairs through sand dunes
LS_I0410	53.546651	-6.082961	693 257.5	5 937 042.2	-	-	Sand dunes upper edge- Saltmarsh plants sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0411	53.546587	-6.083044	693 252.3	5 937 034.9	-	-	Sand dunes upper edge (debris tire)
LS_I0412	53.546473	-6.083191	693 243.1	5 937 021.8	0	N	Sand dunes upper edge end - Interruption concrete foundation
LS_I0413	53.546408	-6.083269	693 238.3	5 937 014.4	-	-	Saltmarsh plants sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0414	53.54636	-6.083299	693 236.5	5 937 008.9	-	-	Bucks-horn plantain (*Plantago coronopus*)
LS_I0415	53.54636	-6.083299	693 236.5	5 937 008.9	-	-	Saltmarsh plants, morning glory (*Calystegia soldanella*)
LS_I0416	53.54636	-6.083299	693 236.5	5 937 008.9	-	-	Saltmarsh plant sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0417	53.54636	-6.083299	693 236.5	5 937 008.9	225	SW	View to dumprocks and saltmarsh plants sea beet (*Beta vulgaris* subsp. *maritima*), morning glory (*Calystegia soldanella*)
LS_I0418	53.546308	-6.083421	693 228.6	5 937 002.8	-	-	Saltmarsh plants sea beet (*Beta vulgaris* subsp. *maritima*), morning glory (*Calystegia soldanella*)
LS_I0419	53.546212	-6.083537	693 221.4	5 936 991.8	-	-	Dumprocks and saltmarsh plants sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0420	53.546212	-6.083537	693 221.4	5 936 991.8	-	-	Chamomile (*Chamaemelum nobile*) and sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0421	53.545994	-6.083751	693 208.2	5 936 967.0	-	-	Dreinage pipe
LS_I0422	53.545893	-6.083783	693 206.6	5 936 955.7	-	-	Chamomile (*Chamaemelum nobile*) and sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0423	53.545853	-6.083816	693 204.5	5 936 951.2	270	W	View through fenced area
LS_I0424	53.545849	-6.083895	693 199.3	5 936 950.5	315	NW	View through fenced area, ditch above land flow
LS_I0425	53.545849	-6.083895	693 199.3	5 936 950.5	-	-	Stairs gate
LS_I0426	53.545849	-6.083895	693 199.3	5 936 950.5	-	-	Landflow (end of sand dunes upper edge)
LS_I0427	53.546338	-6.083389	693 230.6	5 937 006.2	315	NW	Saltmarsh plants - Sand dunes beyond the path
LS_I0428	53.547169	-6.080648	693 408.4	5 937 106.1	225	SW	View to the shore in front of carpark
LS_I0429	53.547083	-6.080603	693 411.8	5 937 096.7	225	SW	Saltmarsh plant sea beet (*Beta vulgaris* subsp. *maritima*)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0430	53.547083	-6.080603	693 411.8	5 937 096.7	225	SW	View to saltmarsh plant- Boulders-Sea sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0431	53.547052	-6.080572	693 413.9	5 937 093.3	-	-	Saltmarsh plant sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0432	53.546995	-6.080533	693 416.8	5 937 087.1	-	-	Common mallow (*Malva sylvestris*)
LS_I0433	53.546894	-6.080518	693 418.2	5 937 075.9	-	-	House- Rock dump covered by lichens
LS_I0434	53.547082	-6.080676	693 406.9	5 937 096.4	-	-	Saltmarsh plant sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0435	53.547041	-6.080554	693 415.2	5 937 092.1	-	-	Saltmarsh plant sea beet (*Beta vulgaris* subsp. *maritima*)
LS_I0436	53.546887	-6.080551	693 416.1	5 937 075.0	180	S	House corner- Rock dump covered by lichens
LS_I0437	53.546852	-6.080442	693 423.5	5 937 071.4	45	NE	House corner- Rock dump covered by lichens
LS_I0438	53.546878	-6.080299	693 432.8	5 937 074.7	270	W	House corner- Rock dump
LS_I0439	53.546941	-6.080329	693 430.5	5 937 081.6	270	W	House corner- Rock dump
LS_I0440	53.546898	-6.080132	693 443.8	5 937 077.4	-	-	Wall
LS_I0441	53.546876	-6.080007	693 452.2	5 937 075.3	-	-	Dead seaweeds
LS_I0442	53.546876	-6.080007	693 452.2	5 937 075.3	-	-	Whelk eggs dead seaweeds
LS_I0443	53.546867	-6.079881	693 460.6	5 937 074.6	-	-	Dead seaweeds
LS_I0444	53.546829	-6.079713	693 471.9	5 937 070.8	-	-	Dead seaweeds, tubeworms (*Spirorbis* sp.)
LS_I0445	53.546856	-6.079645	693 476.2	5 937 074.0	-	-	Dead seaweeds, tubeworms (*Spirorbis* sp.)
LS_I0446	53.546862	-6.079622	693 477.7	5 937 074.8	-	-	View to shore-corner with pier
LS_I0447	53.546862	-6.079622	693 477.7	5 937 074.8	-	-	Pier stairs
LS_I0448	53.546877	-6.07956	693 481.8	5 937 076.6	-	-	Pier
LS_I0449	53.546636	-6.07937	693 495.5	5 937 050.3	-	-	Yellow and black lichens
LS_I0450	53.546378	-6.079336	693 498.9	5 937 021.7	-	-	Yellow and black lichens
LS_I0451	53.546001	-6.079353	693 499.5	5 936 979.7	-	-	Pier stairs
LS_I0452	53.5459	-6.079359	693 499.5	5 936 968.5	-	-	Pier- Green lichens
LS_I0453	53.545852	-6.079367	693 499.2	5 936 963.1	-	-	Pier- Green lichens
LS_I0454	53.545831	-6.079455	693 493.5	5 936 960.5	-	-	Pier- Green lichens
LS_I0455	53.545699	-6.07958	693 485.8	5 936 945.5	-	-	Pier- Green lichens
LS_I0456	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Pier

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0457	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Seaweed turf (*Prasiola* sp.) on the wall of the pier
LS_I0458	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Ruddy turnstone birds (*Arenaria interpres*)
LS_I0459	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Ruddy turnstone birds (*Arenaria interpres*)
LS_I0460	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Ruddy turnstone birds (*Arenaria interpres*)
LS_I0461	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Fulmar (*Fulmarus* glacialis)
LS_I0462	53.545656	-6.079466	693 493.6	5 936 941.1	-	-	Fulmar (*Fulmarus* glacialis)
LS_I0463	53.546605	-6.082933	693 259.6	5 937 037.2	-	-	Discharge- Rock dump- End of sand dunes
LS_I0464	53.54655	-6.08302	693 254.1	5 937 030.8			Rock dump - Yellow lichens
LS_I0465	53.546505	-6.083077	693 250.5	5 937 025.7	-	-	Rock dump - Yellow lichens
LS_I0466	53.546441	-6.083167	693 244.9	5 937 018.3	-	-	Rock dump - Yellow and black lichens
LS_I0467	53.546187	-6.083496	693 224.2	5 936 989.2	-	-	Rock dump - Yellow and black lichens
LS_I0468	53.545998	-6.083665	693 213.9	5 936 967.7	-	-	Lower edge of rock dump - Dead seaweeds
LS_I0469	53.54592	-6.083717	693 210.8	5 936 958.9	-	-	Rock dump bored
LS_I0470	53.54592	-6.083717	693 210.8	5 936 958.9	-	-	Rock dump - Lichens
LS_I0471	53.545856	-6.083748	693 209.0	5 936 951.7	-	-	Rock dump - water landflow
LS_I0472	53.545856	-6.083748	693 209.0	5 936 951.7	-	-	Lower edge of rock dump- Lichens and Ulva
LS_I0473	53.545766	-6.083711	693 211.9	5 936 941.8	-	-	Lower edge of rock dump- Lichens and Ulva
LS_I0474	53.545766	-6.083711	693 211.9	5 936 941.8	-	-	Rock dump -Lichens - Small rock pool with sand mason worms (Lanice conchilega) tubes
LS_I0475	53.545706	-6.083673	693 214.7	5 936 935.2	-	-	Rock dump - sand mason worms (*Lanice conchilega*) tubes
LS_I0476	53.545706	-6.083673	693 214.7	5 936 935.2	-	-	Rock dump - sand mason worm tubes (*Lanice conchilega)* tubes
LS_I0477	53.545706	-6.083673	693 214.7	5 936 935.2	-	-	Rock dump - sand mason worm tubes (*Lanice conchilega)*
LS_I0478	53.545706	-6.083673	693 214.7	5 936 935.2	-	-	Rock dump - sand mason worm tubes (*Lanice conchilega)*
LS_I0479	53.545706	-6.083673	693 214.7	5 936 935.2	-	-	Rock dump - sand mason worm tubes (*Lanice conchilega)*
LS_I0480	53.545706	-6.083673	693 214.7	5 936 935.2	-	-	Rock dump - sand mason worm tubes (*Lanice conchilega)*
LS_I0481	53.545686	-6.083605	693 219.3	5 936 933.2	-	-	Boulders covered by green seaweed turf (*Ulva* sp.)
LS_I0482	53.545686	-6.083605	693 219.3	5 936 933.2	-	-	Boulders covered by green seaweed turf (*Ulva* sp.)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0483	53.545686	-6.083605	693 219.3	5 936 933.2	-	-	Lower edge of rock dump- Boulders covered by green seaweed turf (*Ulva* sp.), sand mason worms (*Lanice conchilega*) tubes, carrageen (?*Chondrus crispus*), anthropogenic debris (rope)
LS_I0484	53.545647	-6.083521	693 225.0	5 936 929.0	-	-	Rock covered by green seaweed (*Ulva* sp.), red seaweed (*Porphyra* sp.), snail (*Littorina* sp.?)
LS_I0485	53.545647	-6.083521	693 225.0	5 936 929.0	-	-	Boulders/ Cobbles covered by green seaweed turf (*Ulva* sp.), spiral wrack (*Fucus spiralis*?)
LS_I0486	53.54563	-6.083486	693 227.4	5 936 927.2	-	-	Boulders covered by barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*), spiral wrack (*Fucus spiralis?*)
LS_I0487	53.5456	-6.08342	693 231.9	5 936 924.1	-	-	Boulders covered by channeled wrack (*Pelvetia canaliculata*), red seaweeds (*Gelidium pusillum*), spiral wrack (?*Fucus spiralis*), barnacles (*Semibalanus balanoides*), winkle (*Littorina* sp.)?
LS_I0488	53.5456	-6.08342	693 231.9	5 936 924.1	-	-	Boulders covered by rock wrack (?*Fucus spiralis*), red seaweeds (*Gelidium pusillum*), barnacles (*Balanus balanoides*), winkle (*Littorina* sp.)
LS_I0489	53.545574	-6.08337	693 235.4	5 936 921.3	-	-	Boulders/ Cobbles covered by green seaweeds (*Ulva* sp.) and red seaweeds (*Porphyra* sp.)
LS_I0490	53.545574	-6.08337	693 235.4	5 936 921.3	-	-	Boulders/ Cobbles covered by green seaweeds (*Ulva* sp.) and red seaweeds (*Porphyra* sp.), channeled wrack (*Pelvetia canaliculata*)
LS_I0491	53.545552	-6.083299	693 240.2	5 936 919.1	-	-	Green seaweed turf (*Ulva* sp.)- cliff base
LS_I0492	53.545392	-6.083194	693 247.8	5 936 901.6	-	-	Green seaweed turf (*Ulva* sp.), spiral wrack (?*Fucus spiralis*) - Cliff base- Cobbles stripe at the bottom
LS_I0493	53.545392	-6.083194	693 247.8	5 936 901.6	-	-	Rock pool feather duster worm (Sabellida), sand worms (*Lanice conchilega*), carrageen (*Chondrus crispus*)
LS_I0494	53.545392	-6.083194	693 247.8	5 936 901.6	-	-	Rock pool feather duster worm (Sabellida), sand worms (*Lanice conchilega*), carrageen (*Chondrus crispus*)
LS_I0495	53.545739	-6.08322	693 244.5	5 936 940.1	-	-	View to shoreline- solitary boulders
LS_I0496	53.546066	-6.083104	693 250.7	5 936 976.8	-	-	Solitary boulder covered by rock wrack (?*Fucus spiralis*), channeled wrack (*Pelvetia canaliculata*), barnacles (*Semibalanus balanoides*), limpets (*Patella vulgata*), red seaweeds (Gelidium sp?), dog whelks (*Nucella lapillus*)
LS_I0497	53.546066	-6.083104	693 250.7	5 936 976.8	45	NE	Solitary boulder covered rock wrack (?*Fucus spiralis*), channeled wrack (*Pelvetia canaliculata*)/ red seaweeds (?*Gelidium* sp.)
LS_I0498	53.546066	-6.083104	693 250.7	5 936 976.8	-	-	Solitary boulder covered rock wrack (?*Fucus spiralis*), channeled wrack (*Pelvetia canaliculata*)/ red seaweeds (?*Gelidium* sp.), barnacles, limpets (*Patella vulgata*)
LS_I0499	53.546053	-6.083037	693 255.2	5 936 975.5	-	-	Rock pool- barnacles, sand mason worms (*Lanice conchilega*) tubes

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0500	53.546052	-6.082927	693 262.5	5 936 975.7	-	-	Solitary boulder covered by spiral wrack (?*Fucus spiralis*), barnacles, dog whelks (*Nucella lapillus*)
LS_I0501	53.546052	-6.082927	693 262.5	5 936 975.7	-	-	Solitary boulder covered by spiral wrack (?*Fucus spiralis*), barnacles, dog whelks (*Nucella lapillus*)
LS_I0502	53.546052	-6.082927	693 262.5	5 936 975.7	-	-	Solitary boulder covered by spiral wrack (?*Fucus spiralis*), barnacles, dog whelks (*Nucella lapillus*)
LS_I0503	53.546052	-6.082927	693 262.5	5 936 975.7	-	-	Solitary boulder covered by mussels (*Mytilus* juv.) and barnacles (*Semibalanus balanoides*), dog whelks (*Nucella lapillus*)
LS_I0504	53.546052	-6.082927	693 262.5	5 936 975.7	-	-	Solitary boulder covered by mussels (*Mytilus* juv.) and barnacles (*Semibalanus balanoides*), winkle (*Littorina* sp.)
LS_I0505	53.545824	-6.082846	693 268.9	5 936 950.6	-	-	Solitary boulder covered by green seaweeds (*Ulva* sp.), barnacles (*Semibalanus balanoides*)
LS_I0506	53.545824	-6.082846	693 268.9	5 936 950.6	-	-	Solitary boulder covered by barnacles (*Semibalanus balanoides*) and limpets (*Patella vulgata*)
LS_I0507	53.545824	-6.082846	693 268.9	5 936 950.6	-	-	Solitary boulder covered by green seaweeds (*Ulva* sp.), barnacles (*Semibalanus balanoides*), winkle (*Littorina littorea*)
LS_I0508	53.54584	-6.082633	693 283.0	5 936 952.9	-	-	Solitary boulder covered by green seaweeds (*Ulva* sp.) and red seaweed (*Porphyra* sp.)
LS_I0509	53.54584	-6.082633	693 283.0	5 936 952.9	-	-	Solitary boulder covered by green seaweeds (*Ulva* sp.) and red seaweed (*Porphyra* sp.)
LS_I0510	53.546135	-6.082459	693 293.1	5 936 986.2	-	-	Sand mason worm tubes (*Lanice conchilega*)/Gravelly sand- Boulder covered by green seaweeds (*Ulva* sp.)
LS_I0511	53.546135	-6.082459	693 293.1	5 936 986.2	-	-	Sand mason worm tubes (*Lanice conchilega*)/Gravelly sand- Boulder covered by green seaweeds (*Ulva* sp.)
LS_I0512	53.546135	-6.082459	693 293.1	5 936 986.2	-	-	Sand mason worm tubes (*Lanice conchilega*)/Gravelly sand- Boulder covered by green seaweeds (*Ulva* sp.)
LS_I0513	53.545921	-6.08326	693 241.1	5 936 960.2	-	-	Gravel with sand mason tubes (*Lanice conchilega*)
LS_I0514	53.545921	-6.08326	693 241.1	5 936 960.2	-	-	View of shore gravelly sand with pebbles and cobbles
LS_I0515	53.546109	-6.083051	693 254.1	5 936 981.7	-	-	Lower edge gravelly sand with pebbles and cobbles
LS_I0516	53.546263	-6.082689	693 277.3	5 936 999.8	0	N	Lower edge gravelly sand with pebbles and cobbles
LS_I0517	53.546263	-6.082689	693 277.3	5 936 999.8	-	-	Gravelly sand with pebbles and cobbles
LS_I0516	53.546456	-6.082334	693 300.0	5 937 022.2	-	-	Lower edge gravelly sand with pebbles and cobbles
LS_I0517	53.546544	-6.082151	693 311.7	5 937 032.5	315	NW	Lower edge gravelly sand with pebbles and cobbles

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0518	53.546569	-6.082009	693 321.0	5 937 035.7	-	-	Lower edge gravelly sand with pebbles and cobbles
LS_I0519	53.546666	-6.081305	693 367.2	5 937 048.4	-	-	Lower edge gravelly sand with pebbles and cobbles
LS_I0520	53.546948	-6.081471	693 354.9	5 937 079.3	180	S	Upper edge gravelly sand with pebbles and cobbles
LS_I0521	53.546868	-6.081655	693 343.1	5 937 069.9	-	-	Upper edge gravelly sand with pebbles and cobbles
LS_I0522	53.546541	-6.082841	693 266.0	5 937 030.3	315	NW	View shore-water outflow- End of sand dunes
LS_I0523	53.546516	-6.08279	693 269.5	5 937 027.7	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0524	53.546516	-6.08279	693 269.5	5 937 027.7	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0525	53.546516	-6.08279	693 269.5	5 937 027.7	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0526	53.546516	-6.08279	693 269.5	5 937 027.7	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0527	53.546516	-6.08279	693 269.5	5 937 027.7	-	-	Pale-bellied Brent geese (*Branta bernicla hrota*)
LS_I0528	53.544987	-6.083166	693 251.5	5 936 856.6	-	-	Cliff base-Rock covered by yellow lichens
LS_I0529	53.544987	-6.083166	693 251.5	5 936 856.6	-	-	Cliff base-Rock covered by yellow lichens
LS_I0530	53.544987	-6.083166	693 251.5	5 936 856.6	-	-	Cliff base-Rock covered by yellow lichens
LS_I0531	53.544987	-6.083166	693 251.5	5 936 856.6	-	-	Up to the cliff-Nesting fulmars (*Fulmarus glacialis*)
LS_I0532	53.545038	-6.083262	693 245.0	5 936 862.0	-	-	Rock covered by yellow lichens and green seaweeds (*Ulva* sp.)
LS_I0533	53.545022	-6.083259	693 245.2	5 936 860.2	-	-	Rock covered by green seaweeds (*Ulva* sp.)
LS_I0534	53.545022	-6.083259	693 245.2	5 936 860.2	-	-	Rock covered by green seaweeds (*Ulva* sp.) and yellow lichens on the top edge of a rock
LS_I0535	53.545056	-6.083244	693 246.1	5 936 864.1	-	-	Rock covered by green seaweeds (*Ulva* sp.) and yellow lichens on the top edge of a rock
LS_I0536	53.545056	-6.083244	693 246.1	5 936 864.1	-	-	Rock covered by green seaweeds (*Ulva* sp.), plants
LS_I0537	53.545056	-6.083244	693 246.1	5 936 864.1	-	-	Saltmarsh plants
LS_I0538	53.545056	-6.083244	693 246.1	5 936 864.1	-	-	Cliff base - Rock covered by yellow lichens and green seaweeds (*Ulva* sp.), saltmarsh plants
LS_I0539	53.545056	-6.083244	693 246.1	5 936 864.1	-	-	Herring gull (*Larus* sp.), gulls (?)
LS_I0540	53.545056	-6.083244	693 246.1	5 936 864.1	-	-	Herring gull (*Larus* sp.)
LS_I0541	53.546726	-6.080263	693 435.9	5 937 057.9	-	-	Lower edge- Rocks covered by green seaweeds (*Ulva* sp.), channeled wrack (*Pelvetia canaliculata*)
LS_I0542	53.546726	-6.080263	693 435.9	5 937 057.9	-	-	View to Bedrock-Dumprock zonation lower zone green seaweeds (*Ulva* sp.), spiral wrack (*F. spiralis*) and channeled wrack (*Pelvetia canaliculata*), upper zone yellow lichens
LS_I0543	53.546725	-6.080335	693 431.1	5 937 057.6	-	-	Bedrock covered by channeled wrack (*Pelvetia canaliculata*) and green seaweeds (*Ulva* sp.)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0544	53.546824	-6.080552	693 416.3	5 937 068.0	-	-	Patch of Sand with gravel and pebbles in the middle of bedrock
LS_I0545	53.546868	-6.080588	693 413.7	5 937 072.8	135	SE	View to shore rock dump and house
LS_I0546	53.546755	-6.080367	693 428.9	5 937 060.8	225	SW	View to zonation green seaweeds and yellow lichens zones
LS_I0547	53.546768	-6.080371	693 428.6	5 937 062.3	225	SW	Line green seaweeds (*Ulva* sp.) and yellow lichens zones
LS_I0548	53.546744	-6.080545	693 417.1	5 937 059.1	45	NE	Line green seaweeds (*Ulva* sp.) and yellow lichens zones/Small rockpool
LS_I0549	53.546744	-6.080545	693 417.1	5 937 059.1	-	-	Rock covered by green seaweeds (*Ulva* sp.) and channeled wrack (*Pelvetia canaliculata*)/ Small rockpool
LS_I0550	53.545881	-6.08064	693 414.8	5 936 962.9	135	SE	View to Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment sandy gravel/ pebbles and cobbles
LS_I0550	53.545805	-6.080595	693 418.1	5 936 954.6	-	-	View to Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment sandy gravel/ pebbles and cobbles
LS_I0551	53.545805	-6.080595	693 418.1	5 936 954.6	-	-	Mistake
LS_I0553	53.545805	-6.080595	693 418.1	5 936 954.6	-	-	Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment gravelly sand/ pebbles and cobbles
LS_I0554	53.545805	-6.080595	693 418.1	5 936 954.6	-	-	Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment gravelly sand/ pebbles and cobbles
LS_I0555	53.545805	-6.080595	693 418.1	5 936 954.6	-	-	Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment gravelly sand/ pebbles and cobbles
LS_I0556	53.545752	-6.080708	693 410.9	5 936 948.4	-	-	Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment gravelly sand/ pebbles and cobbles
LS_I0557	53.545731	-6.079625	693 482.7	5 936 949.0	-	-	Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment gravelly sand/ pebbles and cobbles
LS_I0558	53.545731	-6.079625	693 482.7	5 936 949.0	-	-	Upper edge - sand mason worms (*Lanice conchilega*) on mixed sediment gravelly sand/ pebbles and cobbles
LS_I0559	53.545089	-6.081598	693 354.9	5 936 872.2	-	-	Boulder covered by barnacles and limpets (*Patella vulgata*)
LS_I0560	53.545025	-6.08154	693 359.1	5 936 865.2	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0561	53.545025	-6.08154	693 359.1	5 936 865.2	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0562	53.545025	-6.08154	693 359.1	5 936 865.2	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0563	53.544925	-6.081667	693 351.1	5 936 853.8	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0564	53.544925	-6.081667	693 351.1	5 936 853.8	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0565	53.544925	-6.081667	693 351.1	5 936 853.8	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0566	53.545028	-6.081885	693 336.2	5 936 864.6	-	-	Mistake
LS_I0567	53.544897	-6.082072	693 324.4	5 936 849.6	-	-	Boulder covered by red seaweed turf (*Rhodothamniella floridula*) and barnacles
LS_I0568	53.544897	-6.082072	693 324.4	5 936 849.6	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0569	53.544897	-6.082072	693 324.4	5 936 849.6	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0570	53.544897	-6.082072	693 324.4	5 936 849.6	-	-	Upper edge of sandy sediments with sand mason worms (*Lanice conchilega*)
LS_I0571	53.545438	-6.081203	693 379.5	5 936 912.1	-	-	Boulder covered by red seaweed turf (*Rhodothamniella floridula*), serrated wrack (*Fucus serratus*), barnacles and limpets (*Patella vulgata*), piddocks
LS_I0572	53.545438	-6.081203	693 379.5	5 936 912.1	-	-	Boulder covered by red seaweed turf (*Rhodothamniella floridula*), serrated wrack (*Fucus serratus*), barnacles and piddocks
LS_I0573	53.545438	-6.081203	693 379.5	5 936 912.1	-	-	Boulder covered by red seaweed turf (*Rhodothamniella floridula*), serrated wrack (*Fucus serratus*), barnacles and piddocks
LS_I0574	53.545381	-6.081272	693 375.2	5 936 905.6	-	-	Boulder bored by piddocks
LS_I0575	53.545381	-6.081272	693 375.2	5 936 905.6	-	-	Boulder bored by piddocks
LS_I0576	53.545181	-6.081326	693 372.5	5 936 883.2	-	-	Boulder bored by piddocks
LS_I0577	53.545131	-6.081234	693 378.9	5 936 877.9	-	-	Boulder bored by piddocks
LS_I0578	53.545131	-6.081234	693 378.9	5 936 877.9	-	-	Boulder bored by piddocks
LS_I0579	53.545202	-6.081094	693 387.8	5 936 886.1	-	-	Boulder bored by piddocks covered by red seaweed turf (*Rhodothamniella floridula*)
LS_I0580	53.545202	-6.081094	693 387.8	5 936 886.1	-	-	Boulder bored by piddocks
LS_I0581	53.545202	-6.081094	693 387.8	5 936 886.1	-	-	Boulder bored by piddocks
LS_I0582	53.545202	-6.081094	693 387.8	5 936 886.1	-	-	Ruddy turnstone bird (*Arenaria interpres*)
LS_I0583	53.545202	-6.081094	693 387.8	5 936 886.1	-	-	Mistake
LS_I0584	53.545555	-6.08081	693 405.0	5 936 926.2	-	-	Boulder bored by piddocks - no alive specimens visible
LS_I0585	53.545555	-6.08081	693 405.0	5 936 926.2	-	-	Boulder bored by piddocks - no alive specimens visible
LS_I0586	53.545625	-6.080749	693 408.7	5 936 934.1	-	-	Cobbles bored by piddocks - no alive specimens visible
LS_I0587	53.545625	-6.080749	693 408.7	5 936 934.1	-	-	Cobbles bored by piddocks - no alive specimens visible, fan worm tubes (*Spirobranchus* sp.)
LS_I0588	53.54584	-6.080255	693 440.5	5 936 959.4	-	-	Cobbles bored by piddocks - no alive specimens - Sand mason worm tube (*Lanice conchilega*)

Geodetic Parameters: WGS84 UTM 29 N							
Photo Number	Latitude	Longitude	Easting [m]	Northing [m]	Bearing [◦]	Direction	Comments
LS_I0589	53.54584	-6.080076	693 452.3	5 936 959.9	-	-	Cobbles bored by piddocks - no alive specimens
LS_I0590	53.54584	-6.080076	693 452.3	5 936 959.9	-	-	Cobbles bored by piddocks - no alive specimens - sand mason worm tubes (*Lanice conchilega*)
LS_I0591	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	Cobbles bored by piddocks - no alive specimens
LS_I0592	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore
LS_I0593	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore
LS_I0594	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore sand
LS_I0595	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore-sand mason worms (*Lanice* sp.)
LS_I0596	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore
LS_I0597	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore from end of the pier- cobbles
LS_I0598	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore from end of the pier- cobbles
LS_I0599	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore from end of the pier- cobbles
LS_I600	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore - cobbles
LS_I601	53.546197	-6.080369	693 431.3	5 936 998.8	-	-	View of the shore - cobbles
LS_I602	53.546831	-6.080673	693 408.3	5 937 068.4	-	-	Cobbles bored by piddocks - no alive specimens
LS_I603	53.546831	-6.080673	693 408.3	5 937 068.4	-	-	Cobbles bored by piddocks - no alive specimens
LS_I604	53.546831	-6.080673	693 491.7	5 936 924.8	-	-	Cobbles bored by piddocks - no alive specimens
LS_I605	53.547042	-6.079556	693 481.3	5 937 094.9	-	-	View to shore beyond the pier
LS_I606	53.547042	-6.079556	693 481.3	5 937 094.9	-	-	View to shore beyond the pier
LS_I607	53.547042	-6.079556	693 481.3	5 937 094.9	-	-	View to shore beyond the pier
LS_I608	53.547042	-6.079556	693 481.3	5 937 094.9	-	-	View to shore beyond the pier
LS_I609	53.547042	-6.079556	693 481.3	5 937 094.9	-	-	View to shore beyond the pier

B.2 LOUGHSHINNY TARGET NOTES

Waypoint	Latitude	Longitude	Notes	Biotope
LS_I025	53.547189	-6.081403	Bottom of path	-
LS_I040	53.546989	-6.082224	Bottom of main steps	-
LS_I052	53.546727	-6.082801	Bottom of steps	-
LS_I063	53.545998	-6.083722	Base of outflow	-
LS_I065	53.545847	-6.083787	Case of outflow	-
LS_I066	53.545818	-6.083791	Western end of fence above larger outflow	-
LS_I073	53.545546	-6.083468	Edge of limestone and shale layered cliff	-
LS_I076	53.545762	-6.083826	Corner of sea defence (boulders in cages)	-
LS_I083	53.54678	-6.08262	Yellow and grey lichens on supralittoral rock (emergent boulders with lichen under dunes – 3 m × 50 cm)	LR.FLR.Lic.YG
LS_I101	53.547092	-6.080722	Talitrids on the upper shore and strandline	LS.LSa.St.Tal
LS_I109	53.546784	-6.080289	Lichens (*Verrucaria maura*) covered bedrock	LR.FLR.Lic.Ver.B
LS_I110	53.546842	-6.080191	Mixed sediment (sand, pebbles, cobbles, boulders) ca. 3 m × 1.5 m wide	LS.LMx
LS_I112	53.546835	-6.079985	Outer edge of bottom slip - covered by mobile sands	-
LS_I113	53.546828	-6.079555	Outer edge of bottom of steps	-
LS_I121	53.546676	-6.079258	Bottom step	-
LS_I124	53.54652	-6.079213	Other edge of green seaweed patch on walkway (now extends up whole wall)	LR.FLR.Eph
LS_I128	53.546063	-6.079239	Vertical distribution - Green seaweed extends down wall	LR.FLR.Eph
LS_I129	53.545987	-6.079313	Vertical distribution - Green seaweed extends down wall	LR.FLR.Eph
LS_I130	53.545885	-6.079269	Vertical distribution - Green seaweed extends down wall	LR.FLR.Eph
LS_I131	53.545757	-6.079257	Vertical distribution - Green seaweed extends down wall	LR.FLR.Eph
LS_I134	53.546889	-6.081191	Anthropogenic debris (rope on sand with pebbles)	-
LS_I141	53.545476	-6.083324	Vertical distribution - Green seaweed on cliff (fresh water influence?)	LR.FLR.Eph
LS_I142	53.545411	-6.083337	Vertical distribution - Green seaweed on cliff (fresh water influence?)	LR.FLR.Eph
LS_I148	53.54537	-6.083098	Small rockpool - Area of small rockpools	LR.FLR.Rkp
LS_I149	53.545445	-6.083193	Shallow rockpool - sev. small totalling ca. 1.5 × 3.0 m - Seaweeds in sediment-floored eulittoral rockpools	LR.FLR.Rkp.SwSed
LS_I150	53.545408	-6.083085	Several small < 1 m^2 rockpools, with Sabellidae - Seaweeds in sediment-floored eulittoral rockpools	LR.FLR.Rkp.SwSed

Waypoint	Latitude	Longitude	Notes	Biotope
LS_I155	53.545223	-6.083183	Gully in base of cliff - Littoral caves and overhangs with features of *Audouinella purpurea* and *Cladophora rupestris* on upper to mid shore cave walls as also barnacles but not *Cladophora*	LR.FLR.CvOv.AudCla
LS_I158	53.545172	-6.083245	Vertical distribution - *Ulva* sp. patch (4 m × 1 m) along base of cliff	LR.FLR.Eph
LS_I162	53.545131	-6.083079	Border of cliff base and bedrock - both littoral rock	LR
LS_I163	53.545116	-6.083129	Area of rockpools	LR.FLR.Rkp
LS_I173	53.545283	-6.08308	Border between bedrock edge, top of sand and boulders with *Ulva* sp. above	LR.FLR.Eph
LS_I174	53.545242	-6.083032	Large shallow rockpool	LR.FLR.Rkp
LS_I191	53.545429	-6.082663	Area of rockpools in barnacles	LR.FLR.Rkp
LS_I192	53.545461	-6.08272	Ascophyllum nodosum on full salinity mid eulittoral rock *Ascophyllum* sp. on bedrock (2 m × 2 m)	LR.LLR.F.Asc.FS
LS_I247	53.544845	-6.083233	Shallow upper shore rockpool zone	LR.FLR.Rkp
LS_I248	53.544853	-6.08322	Rockpools	LR.FLR.Rkp/LR.FLR.Rkp.G
LS_I267	53.54488	-6.082951	Serrated wrack (*Fucus serratus*) (1 m × 1 m patch in gully/crevice) – *Fucus serratus* on moderately exposed lower eulittoral rock	LR.MLR.BF.Fser
LS_I274	53.544865	-6.082987	Zonation: *Prasiola* sp., *Pelvetia* sp., *F. spiralis*, *F. vesiculosus*	LR.FLR.Lic.Pra
LS_I275	53.544868	-6.083077	*Prasiola* sp. surrounded by *Pelvetia* sp. (1 m × 1 m patch)	LR.FLR.Lic.Pra
LS_I332	53.545419	-6.0828	Rockpools	LR.FLR.Rkp
LS_I350	53.545251	-6.081764	Boulder surrounded by sand	LR
LS_I368	53.544734	-6.081917	*Lanice conchilega* patch meets sea	LS.LSa.MuSa.Lan
LS_I372	53.545255	-6.081333	Piddock boulder 1	LR.MLR.BF.Fser.Pid
LS_I373	53.545227	-6.081308	Piddock Boulder 1: Piddocks and *Rhodothamniella floridula*	LR.MLR.BF.Fser.Pid
LS_I382	53.545477	-6.081187	Piddock boulder 3	LR.MLR.BF.Fser.Pid
LS_I387	53.54552	-6.080227	Anthropogenic debris - engine	-
LS_I388	53.545533	-6.080158	Kelp zone variable	-
LS_I426	53.545396	-6.08022	*Sabellaria spinulosa*	-
LS_I427	53.545564	-6.079625	*Sabellaria spinulosa*	-
LS_I430	53.546136	-6.079949	Anchor/Weight/Boat rope 1	-
LS_I431	53.54606	-6.079936	Anchor/Weight/Boat rope 2	-
LS_I432	53.54599	-6.079719	Anchor/Weight/Boat rope 3	-

Waypoint	Latitude	Longitude	Notes	Biotope
LS_I433	53.54607	-6.079735	Anchor/Weight/Boat rope 4	-
LS_I434	53.546058	-6.079734	Anthropogenic debris and *Lanice conchilega* on different substrates	-
LS_I444	53.545906	-6.079931	Anthropogenic debris on coarse sand/gravel with *Lanice conchilega*	-
LS_I500	53.546003	-6.080198	Anchor/Weight/Boat chain	-
LS_I521	53.546473	-6.083191	Concrete foundation stripe	LR
LS_I522	53.546408	-6.083269	Concrete foundation stripe	LR
LS_I523	53.54636	-6.083299	Saltmarsh plants	-
LS_I524	53.546308	-6.083421	Saltmarsh plants	-
LS_I530	53.546338	-6.083389	Saltmarsh plants beyond the path	-
LS_I531	53.547169	-6.080648	Carpark	-
LS_I546	53.546898	-6.080132	Slipway	-
LS_I547	53.546876	-6.080007	Slipway	-
LS_I548	53.546867	-6.079881	Wall	-
LS_I552	53.546877	-6.07956	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I555	53.546636	-6.07937	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I558	53.546378	-6.079336	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I559	53.546298	-6.07934	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I560	53.546222	-6.079348	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I561	53.546154	-6.079355	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I562	53.546082	-6.079356	Vertical distribution - Yellow and black lichens	LR.FLR.Lic.YG
LS_I563	53.546001	-6.079353	Vertical distribution - Green lichens/small green seaweed	LR.FLR.Lic
LS_I564	53.5459	-6.079359	Vertical distribution - Green lichens/small green seaweed	LR.FLR.Lic
LS_I565	53.545852	-6.079367	Vertical distribution - Green lichens/small green seaweed	LR.FLR.Lic
LS_I566	53.545831	-6.079455	Vertical distribution - Green lichens/small green seaweed	LR.FLR.Lic
LS_I567	53.545745	-6.079604	Vertical distribution - Green lichens/small green seaweed	LR.FLR.Lic
LS_I568	53.545699	-6.07958	Vertical distribution -Green lichens/small green seaweed	LR.FLR.Lic
LS_I575	53.546605	-6.082933	Discharge – Rock dump - End of sand dunes	-
LS_I592	53.54563	-6.083486	Boulders covered by barnacles and fucoids	LR.MLR.BF
LS_I593	53.5456	-6.08342	Boulders covered by barnacles and fucoids	LR.MLR.BF

Waypoint	Latitude	Longitude	Notes	Biotope
LS_I603	53.546066	-6.083104	Solitary boulder covered bladder wrack (*Fucus vesiculosus*), channeled wrack (*Pelvetia canaliculata*)	LR.MLR.BF.PelB
LS_I604	53.546053	-6.083037	Solitary boulder covered bladder wrack (*Fucus vesiculosus*), channeled wrack (*Pelvetia canaliculata*)	LR.MLR.BF.PelB
LS_I605	53.546052	-6.082927	Solitary boulder covered by mussels (*Mytilus* juv.) and barnacles (*Semibalanus balanoides*)	LR.HLR.MusB.Sem
LS_I606	53.545824	-6.082846	Solitary boulder covered by barnacles (*Semibalanus balanoides*) and limpets (*Patella vulgata*)	LR.HLR.MusB.Sem
LS_I607	53.54584	-6.082633	Solitary boulder covered by green seaweed (*Ulva* sp.) and red seaweed (*Porphyra* sp.)	LR.FLR.Eph
LS_I608	53.546135	-6.082459	Solitary boulder covered by green seaweed (*Ulva* sp.)	LR.FLR.Eph
LS_I666	53.546765	-6.080436	Patch of sand with gravel and pebbles	LS.Lsa.MoSa variant 2
LS_I676	53.546744	-6.080545	Small rockpool/rock covered by green seaweeds (*Ulva* sp.) and channeled wrack (*Pelvetia canaliculata*)	LR.FLR.Rkp
LS_I696	53.545089	-6.081598	Boulder covered by barnacles and limpets (*Patella vulgata*)	LR.MLR.BF
LS_I740	53.547042	-6.079556	Path down to bedrock area	-
LS_I769	53.546588	-6.079365	Vertical zonation: red seaweeds (*Catenella* sp.), bladder wrack (*Fucus vesiculosus*)/spiral wrack (*Fucus spiralis*), knotted wrack (*Ascophyllum* sp.)	LR.FLR.Lic.YG/LR.FLR.Eph/LR.LLR.F.Fspi
LS_I770	53.546031	-6.079358	Vertical zonation: small green algae, spiral wrack (*Fucus spiralis*), green seaweed (*Ulva* sp.)	LR.FLR.Lic/LR.FLR.Eph/LR.LLR.F.Fspi