LONDON ARRAY WINDFARM

EXPORT CABLE ROUTE POST-CONSTRUCTION SURVEY (AUGUST/SEPTEMBER 2013)

INTERPRETIVE REPORT

FINAL – REV2

MARCH 2014

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ISSUE AND APPROVAL CONTROL SHEET

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CHARTS

Chart Name	Chart Contents	Chart Type	Scale	Number of Charts
5149_NU_BATHY	Multibeam Bathymetry image and contours – export cable routes overlaid	North-up	1:5000	13
5149_NU_BACKSCATTER	Multibeam Backscatter image and contours – export cable routes overlaid	North-up	1:5000	13
5149_NU_DIFF	Multibeam Bathymetry Difference image between EGS 2013 and EMU 2010 datasets – export cable routes overlaid	North-up	1:5000	13
5149_ROUTE01	Export Cable 1 – 4 panel chart showing bathymetric, backscatter, bathymetric difference images and seabed profiles.	Alignment	1:5000	11
5149_ROUTE02	Export Cable 2 – 4 panel chart showing bathymetric, backscatter, bathymetric difference images and seabed profiles.	Alignment	1:5000	11
5149_ROUTE03	Export Cable 3 – 4 panel chart showing bathymetric, backscatter, bathymetric difference images and seabed profiles.	Alignment	1:5000	11
5149_ROUTE04	Export Cable 4 – 4 panel chart showing bathymetric, backscatter, bathymetric difference images and seabed profiles.	Alignment	1:5000	11

ABBREVIATIONS

Abbreviation	Definition
AL	Alignment Chart
DGPS	Differential Global Positioning System
ETRS89	European Terrestrial Reference System 1989
FMGT	Fledermaus Geocoder Toolbox
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hz	Hertz
MBES	Multibeam Echo Sounder
MRU	Motion Reference Unit
m/s	Metres per Second
MSL	Mean Sea Level
N/A	Not Applicable
NU	North-up Chart
OS	Ordnance Survey
OSGB	Ordnance Survey of Great Britain
QC	Quality Control
Rev.	Revision
RPL	Route Position List
RTK	Real Time Kinematic
SVP	Sound Velocity Profile
SVS	Sound Velocity system
THU	Total Horizontal Uncertainty
TPU	Total Propagated Uncertainty
TVU	Total Vertical Uncertainty
UKHO	United Kingdom Hydrographic Office
UTM	Universal Transverse Mercator
Ver.	Version
VORF	Vertical Offshore Reference Frame
WD	Water Depth
WGS84	World Geodetic System 1984

EXECUTIVE SUMMARY

In August 2013 EGS International were commissioned to carry out bathymetric surveys of the London Array Export cable routes. The Bathymetric surveys were to cover the 4 export cables corridor as laid and with a buffer of 25m either side of the outermost cable

The vessel mobilisation was carried out in Ramsgate between 27th and 30th August 2013. The bathymetric survey work was carried out onboard the Wessex Explorer between 27th August and 09th September 2013. The survey equipment was demobilised from the vessel on 9th September 2013 in Ramsgate.

Data were collected in ETRS89 Datum with RTK corrections supplied from LAL (Dong London Array) /Dansurvey setup. The VORF model was utilised to reduce data to LAT and for comparative purposes a surface with a fixed offset of 42.1 was also created in order to compare the 2010 and 2013 datasets.

Data comparison between the 2010 and 2013 datasets show general movement of sediment in certain areas along the route with the majority of sandwave migration occurring in the outer cable route east of the Kentish flats.

In the areas of rock dumping scour is experienced, with the deepest levels of scour occurring at the BritNed crossing where scour of 9m is noticed between HV2 and HV3.
Scour is also noticed at each of the substations with scour depths of 1.5m below the previous dataset around the monopile rock dumping area

Remnant trenching is evident at the intertidal landfall with trench depths of up to 2m found. Trenching is also evident at each end of the Rock dump area at the Kentish crossing.

There is evidence of a slight disparity between the datasets in the inshore zone with a difference of 0.2m noticed. Towards the eastern end of the cable route the datasets compare well outside of the shifting sandwave areas.
Exposed cables are noticed in the backscatter imagery at both substations but believed to be the interarray cables.

After completion of survey operations, DONG provided EGS with 2 locations where local fisherman have “snagged” and lost fishing gear (i.e. Fishing Fasteners). One of these locations was plotted to be outside of the survey corridor, therefore it is not possible to comment whether a feature exists on the seabed. The other location was within the survey corridor, the bathymetric and backscatter datasets were inspected in this area, no distinctive sea bed feature was observed.

1. PROJECT OVERVIEW

1.1. PROJECT INFORMATION

Client:	Dong Energy (London Array Limited)
Project:	LAL Post Construction Survey 2013
Contractor:	EGS International Ltd (EGSi)
Contractor Reference:	5149
Survey Area:	Thames Estuary, UK
Survey Type:	Bathymetric
Survey Period:	August 2013- September 2013
Survey Vessels:	Wessex Explorer
Horizontal Datum:	ETRS89 UTM 31 North
Vertical Datum:	LAT (VORF)
Scope of Work Document:	1517022
Client Project Manager:	Willem Knoops (WILKN@dongenergy.co.uk)
Contractor Project Manager:	Ross Taylor (rtaylor@egssurvey.co.uk)

1.2. PROJECT DESCRIPTION

The 4 London Array export cable routes are approximately 50Km in length, is orientated in a northeast direction from the landfall at Seasalter in the Swale towards the London array Wind farm site. Approximately half of the cable route is along a shallow shelf with water depths shallower than 5m LAT.

The export cable route has three main areas of interest the Kentish crossing, the BritNed crossing and the Princess channel. The project aim is the acquisition of bathymetric and backscatter data and to provide a comparison with the 2010 dataset to evaluate any changes to seabed morphology along the export cable route.

1.3. SURVEY ROUTE CORRIDOR

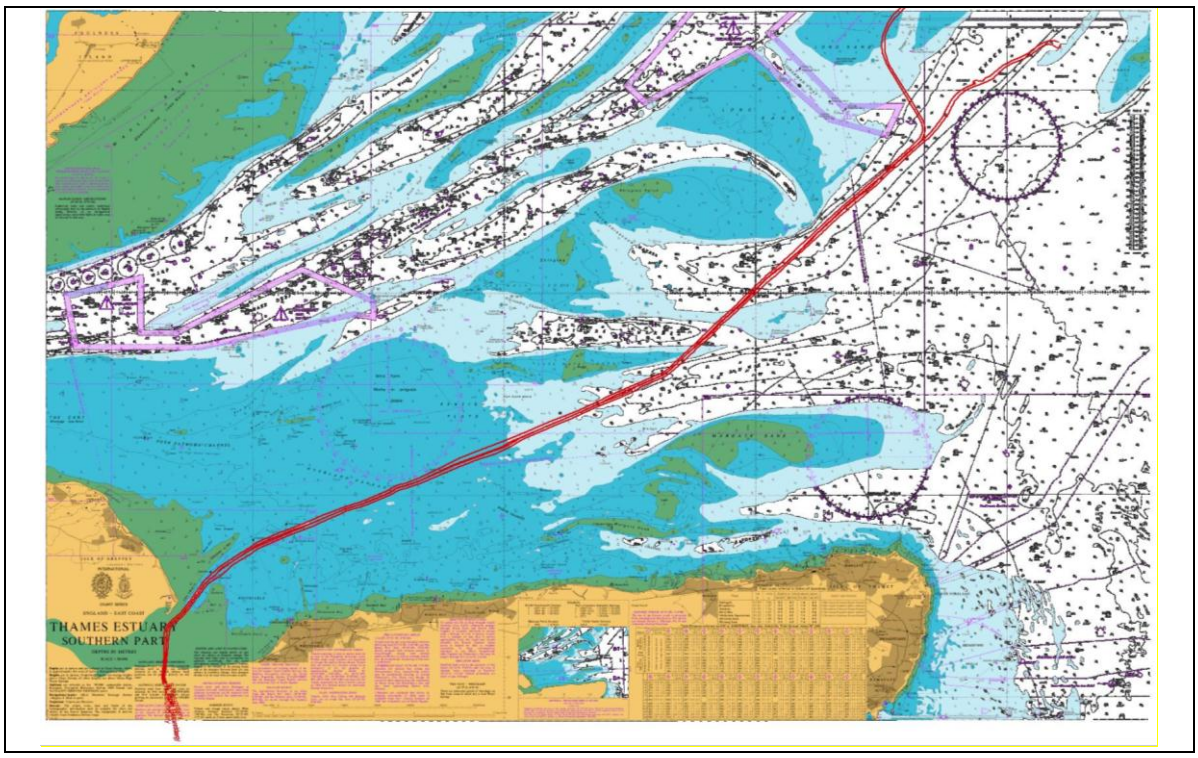

FIGURE 1: SURVEY AREA

1.4. SCOPE OF WORK

The contract for the cable route survey required the following to be carried out:

- The bathymetric surveys are to cover the 4 export cables (HV1- HV4) corridor as laid and with a buffer of 25m either side of the outermost cables H1 and H4. Where the export cable route splits into tow, 25m either side of the outermost cable is required.
- It is requested to survey as near shore as possible without compromising safety but at least to the limit of the pre-construction survey.
- Where the export cable route crosses the Princes channel, the survey should increase to 50m either side of the outermost cables. At the cable crossings with the BritNed and Kentish flats, a 100m buffer either side of the corridor is requested.

2. OPERATIONS

Sections below present a brief summary of the survey operations onboard the Wessex Explorer. Please see the "5149 London Array- Post Construction – Operations and Mobilisation Report" for further information regarding operations.

2.1. BATHYMETRIC SURVEY

The Bathymetric survey work was carried out onboard the Wessex Explorer between 27th August and 09th September 2013.

The vessel mobilisation was carried out in Ramsgate between 27th and 30th August 2013. Survey equipment was demobilised from the vessel on 9th September 2013 in Ramsgate.

For the duration of the bathymetric survey the vessel operated out of Ramsgate Marina keeping in close contact with LAL Marine coordinators throughout the survey.

Full details of the survey operations are detailed in the "5149 London Array- Post Construction – Operations and Mobilisation Report". The Operations Report includes, but is not limited to, the following information:

- Vessel dimensional control
- Equipment calibration and verification
- Daily survey operations
- Health and Safety
- Vessel details
- Equipment details
- Horizontal positioning
- Vertical positioning

3. VESSEL AND EQUIPMENT

3.1. WESSEX EXPLORER

The MV Wessex Explorer is permanently mobilised with a suite of hydrographic survey equipment. The vessel is owned by Hayes Marine and regularly operated by EGSi.

FIGURE 2: WESSEX EXPLORER

Wessex Explorer	
Type	Nearshore Survey/Research Vessel
Length	15.2m
Draught	1.4m
Beam	4.6m
Gross weight	30 tons
Speed Cruising	10 kts
Speed Maximum	12.5 kts
Vessel Coding	60Nm from safe Haven

TABLE 1 WESSEX EXPLORER VESSEL DETAILS.

3.2. EQUIPMENT LIST

EGS Wessex Explorer – EQUIPMENT LIST	
SURVEY EQUIPMENT	**NO., MAKE & MODEL**
Positioning System (Primary) Positioning System (Secondary)	1 x RTK POS MV 320E 1 x C&C Technologies C-Nav 2050 DGPS
Heading Sensor	1 x RTK POS MV 320E
Multibeam Echo Sounder	1 x Kongsberg EM3002 Dual Head Multibeam System (Hull Mounted)
Motion Reference Unit	1 x RTK POS MV 320E
Sound Velocity Profiler	1 x Valeport Soundbar 2 SVP 1 x Valeport Mini SVS
DATA ACQUISITION & PROCESSING SOFTWARE:	**MAKE & MODEL VERSION**
Navigation Acquisition	QPS QINSy v8.1
MBES Acquisition	Kongsberg SIS v3.6.4/QINSy 8.1
MBES Processing	Caris HIPS and SIPS v7.1/QINSy 8.1
Backscatter Processing	Fledermaus FMGT

TABLE 2: WESSEX EXPLORER, EQUIPMENT LIST

3.3. CALIBRATIONS

EGS Wessex Explorer- Calibration Summary		
Calibration:	**Location**	**Date**
Navigation Verification	Sandwich Kent,	27/08/2013
Heading Verification	Ramsgate Marine	30/08/2013
MBES Verification/Calibration	Kentish flats	02/09/2013
Sound Velocity Comparison	Ramsgate Marina	02/09/2013
Lead Line Check	Ramsgate Marina	02/09/2013

TABLE 3: CALIBRATION SUMMARY

4. PERSONNEL

4.1. PROJECT MANAGEMENT

The table below presents a list of the EGSi personnel involved in the project management:

Name	Position
Stephen Hayes	Project Director
Ross Taylor	Project Manager

TABLE 4: PROJECT MANAGEMENT PERSONNEL

4.2. SURVEY OPERATIONS AND REPORTING

Table 5 presents a list of all personnel involved in the survey operations, data processing, interpretation and reporting for this project:

Name	Position
Damien Wall	Party Chief/Data Processer
Matt Hayes	CAD/Charting

TABLE 5: SURVEY OPERATIONS AND REPORTING PERSONNEL

5. SURVEY REFERENCE SYSTEM

5.1. HORIZONTAL POSITIONING

All marine survey operations and subsequent reporting were based on the ETRS89 Datum and UTM Grid, Zone 31N. Full geodetic parameters are given below.

Datum Parameters	
Datum	ETRS89
Ellipsoid	GRS80
Semi-Major Axis (a)	6,378,137.000m
Inverse Flattening (1/f)	298.2572221010
Projection Parameters QINSy	
System Name	Universal Transverse Mercator
Projection Method	Transverse Mercator
UTM Zone	31N
Latitude of Origin of Projection	0° (Equator)
Longitude of Origin of Projection	3° E
False Easting (metres)	500,000
False Northing (metres)	0
Scale Factor	0.9996 at Central Meridian

TABLE 6: GEODETIC PARAMETERS FOR CHARTING AND MAPPING

5.2. VERTICAL POSITIONING

The depth soundings provided within this report are in metres below Admiralty LAT as defined by the UKHO VORF model.

5.2.1. TIDE (RTK GPS)

The POS MV 320E system was used as the primary means of determining tidal elevations during survey operations. The RTCM 3 RTK corrections were interfaced to the POS MV to give real time ellipsoid heights.

Prior to the survey a Vertical check was conducted by comparing the POS MV 320 with London Array RTK corrections against a Leica 1200 RTK system with OS Smartnet corrections. This Leica 1200 unit was also checked against Ordnance survey passive station C1TR3557A at Royal St Georges, Sandwich, Kent. The results of this can be found in the Operation and mobilisation report.

A lead line was also used to verify that the absolute depth achieved was correct; the results of the verification have been presented in Table 7.

Lead line Depth 2m Stbd of Head 2	4.44m
Acquired Depth to WL in QINSy	4.45m

TABLE 7: LEAD LINE RESULTS

A tidal plot of reduced RTK data against Herne bay predicted can be seen below.

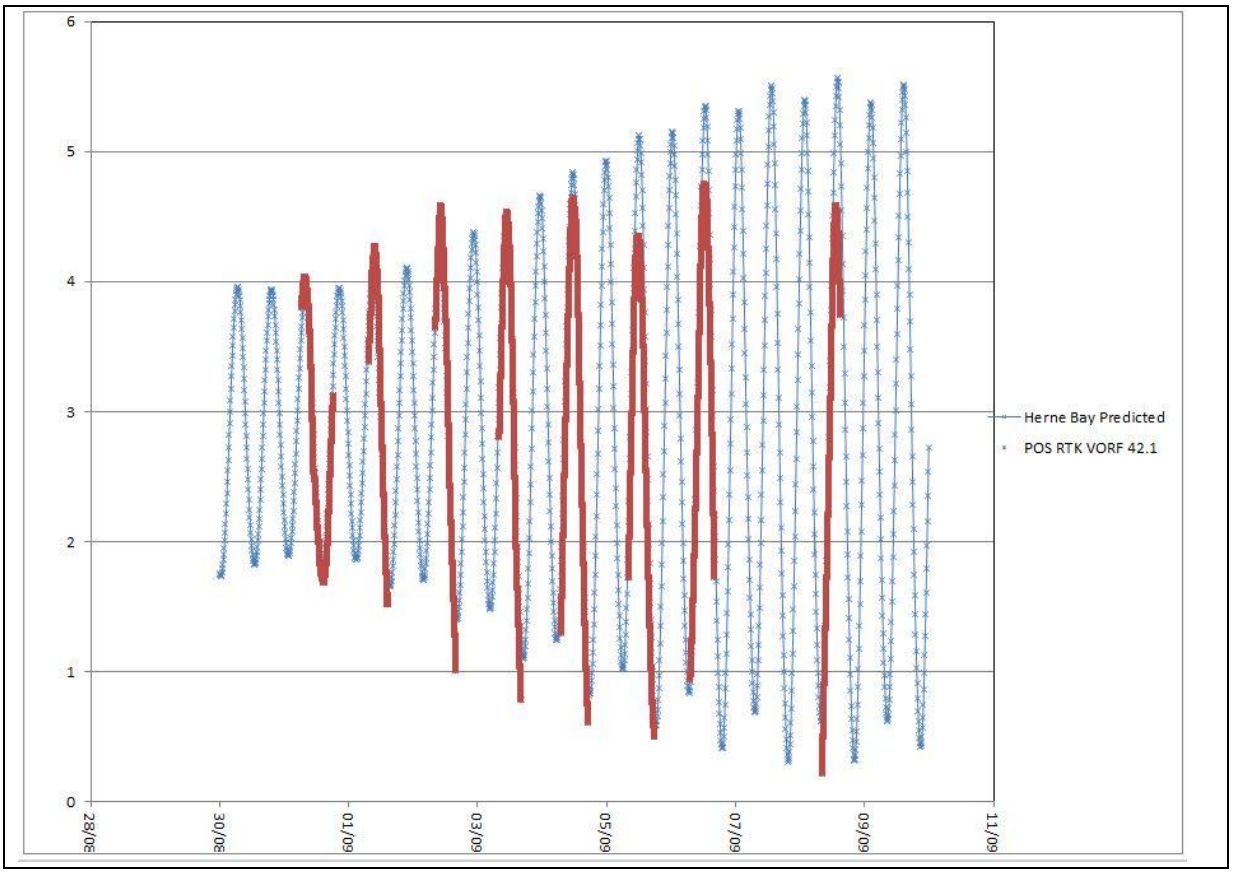

FIGURE 3: SMOOTHED RTK TIDAL PLOT

6. DATA PROCESSING

6.1. DATA PROCESSING OVERVIEW

6.1.1. BATHYMETRY

Raw Kongsberg 3002D Dual head MBES data were acquired in the software package QINSy 8.1, which is a comprehensive bathymetric processing system supporting Survey acquisition, as well as MBES data editing. Kongsberg .all files were also recorded in Kongsberg SIS as a backup and also for backscatter processing.

The EM3002D is a high-resolution system working nominally at 300 kHz and capable of a ping rate of 40 pings per second, providing 508 soundings per ping in high density mode. The high-density mode was utilised for this survey.

Additional lines were also run at certain key areas including Intertidal trenching, Kentish Crossing, BritNed crossing to ensure full insonification in areas of trenching and scour areas.

RTK positioning was utilised as provided by LAL from the base station at Margate Tower and the RTCM3 correction received via VHF. The RTK correction signal (ETRS89) was used in real time for horizontal and vertical positioning

The reduced Bathymetric data was then processed in the processing manager utility of QINSy 8.1. A gridded QINSy navigation surface was produced which is based on average depth values of soundings.

Difference data were viewed at 95% confidence SD grid and any areas of concern can were highlighted. Any outliers were removed from the data set using QPS QLOUD which is QPS's area based multibeam cleaning tool. Sound velocity corrections were applied based on the velocity profiles acquired on the vessel. A PFM surface of the data were created in QPS Fledermaus and the data filtered off a 1m cube surface. Once despiked the data were then re-imported into QINSy processing manager for gridding and exporting.

6.1.2. COMPARISON WITH PREVIOUS DATA

A VORF LAT model was applied to this data set which accurately reduces the data to LAT along the entire route. In order to compare 2013 data with the 2010 survey a bathymetric surface with a fixed 42.1m LAT offset was also created and used in order to generate a difference surface. This was for comparison purposes only and used in the difference plots 2010-2013. A disparity of approximately 20cm is noticed between the datasets from the Kentish flats area into the intertidal landfall. Outside of these areas the data sets show good correlation outside of the changing sandwave areas.

6.1.3. BACKSCATTER DATA PROCESSING WORKFLOW

Following creation of the bathymetry, a backscatter mosaic was created within Fledermaus FMGT module. The backscatter mosaic was created at a mosaic bin size of 0.15m.

Settings	Value/Use
Processing Software	Fledermaus FMGT
Source Data Type	Kongsberg .all
Gain Correction	Auto
TVG Correction	Auto
Beam Pattern Correction	Yes

TABLE 8: MBES BACKSCATTER PROCESSING SETTINGS

The backscatter imagery was investigated for signs of any cable exposures. Cable exposures were noted on the Substations but these were believed to be the interarray cables entering the substation. See figures 17 & 18.

6.2. DATA QUALITY

6.2.1. TOTAL PROPAGATED UNCERTAINTY (TPU)

The TPU of all soundings was calculated within QINSy project. TPU is an estimate of the uncertainty of any individual sounding. The degree of uncertainty to which seabed levels can be derived is dependent upon various factors including:

- Depth of water
- Sea state at time of survey
- Uniformity of velocity of sound in water
- Uncertainty of seabed bottom detection
- Uncertainty of tidal measurements
- Suitability of tidal data to survey area

The International Hydrographic Organisation (IHO) has issued standards for Hydrographic surveys since 1957. Special Publication No 44, 5th Edition outlines four orders of surveys and indicates a minimum standard with which a particular order is expected to meet. The most rigorous of these orders is the Special Order, which is intended only for areas where a vessel's under-keel clearance is critical e.g. berthing areas, harbours and critical areas of shipping channels. The requirement for this survey is that a custom standard which has tighter specifications that IHO special order.

The Special Order uncertainties were calculated using the formula below. The formula is used to compute the TVU (total vertical uncertainty), a component of TPU, at a 95% confidence level, which is the maximum allowed for TVU:

$$\pm\sqrt{a^2 + (bd)^2}$$

a = Portion of uncertainty that does not vary with depth
b = Coefficient which represents the portion of uncertainty that varies with depth.
d = Depth
bd = Portion of uncertainty that varies with depth

For a special order survey the following values are utilised, a=0.25 and b= 0.0075.

For this survey custom parameters were utilised as specified by DONG for the cable route survey. Dong specific parameters, where a = 0.20m and b= 0.0075.

The TPU also takes into account the uncertainty estimates of the component measurements (draft, attitude, vessel offsets etc.). Following TPU computation, a 1m CUBE base surface (Combined Uncertainty and Bathymetry Estimator) was created in Fledermaus to remove any obvious spikes in the dataset. The TPU was then used to apply filters to the dataset in order to remove soundings that did not meet the Dong minimum standards, at 95% confidence level.
SD plots at 95% show that all overlapping data is within 0.2m at 2 sigma level were used throughout the processing stage.

Depth (M)	Custom Order Limit TVU (2 Sigma)
1	0.20
5	0.20
10	0.21
15	0.23
25	0.27

TABLE 9: EXAMPLE OF CUSTOM ORDER MAXIMUM ALLOWED VERTICAL UNCERTAINTY FOR A GIVEN DEPTH

7. RESULTS

7.1. DATA PRESENTATION

7.1.1. CHARTING

Survey results are primarily presented as two sets of charts, totalling 83 charts – see table included in Contents page for breakdown of charts. The two chart sets are:

1. Set of North-Up Charts (39)
2. Set of Alignment Charts (44)

The North-Up charts are split into three types, consisting of 13 charts each. The three types are:

1. Multibeam Bathymetry image and contours, with export routes overlaid
2. Multibeam Backscatter image, with export routes overlaid
3. Multibeam Bathymetry Difference image between EGS 2013 and EMU 2010 datasets – export cable routes overlaid

The alignment charts consist of 4 panels and are split into 4 types; one for each export cable route. Each alignment chart shows bathymetric, backscatter, bathymetric difference images and seabed profiles.

7.1.2. DATA DELIVERABLES

A table summarising the digital deliverables is presented below:

Data Deliverables				
Instrument	Raw Data		Processed Data	
	File Type	File Extension	File Type	File Extension
MBES	Multibeam Echosounder Data	Kongsberg *.all Qinsy QPD	MBES XYZ	*.xyz *.pts
			MBES Image	*.tif *.tfw
			MBES Contours	*.ctr
			Ungridded Soundings	*.pts
			Difference Grids	*.xyz
			ESRI ARC ASCII grids	*.asc
			Backscatter	*.tif
			Seabed Contacts Shape File	*.shp
			Rock Dump Shape Files	*.shp

TABLE 10: DIGITAL DELIVERABLES

7.2. BATHYMETRY

7.2.1. BATHYMETRY COMPARISON

High-resolution bathymetric data were acquired on all survey lines and over 110% MBES coverage was achieved in the survey area.

The water depth limits of surveyed bathymetric data, within the survey area, range from approximately 0.7m above LAT in the shallow inshore end of the survey area, to a maximum of approximately 24.8m below LAT in the deeper offshore section.

Data quality was considered good throughout the survey. When the 2013 dataset is reduced with a fixed VORF value 0f 42.1m, as was used for the 2010 dataset, good comparison (of approximately 0.1m) is observed between the 2013 and 2010 surveys. Although a disparity of up to 0.2m in seabed level is noted in the inshore/Intertidal area.

The fixed VORF value of 42.1m was supplied by DONG. Only the bathymetric comparison plots were processed with a fixed offset of 42.1. All of the supplied *.xyz, *.asc, Full density data and bathymetric charts have been processed using the UKHO VORF model. The full bathymetry comparison can be viewed in the supplied charts.

Localised migration of sandwaves is evident along the outer cable route when the two datasets are compared. See figures 14, 15 &16

Remnant trenching is still evident in the intertidal area, trenching is also evident at the edges of the rock dump protection at the Kentish Crossing.

At the BritNed crossing, significant scour can be observed between Export cables HV2 and HV3 with over 9m difference between the pre and post construction data.

Interarray cables are evident leaving both sub stations in the backscatter mosaic.

7.3. AREAS OF INTEREST

7.3.1. BRITNED CROSSING

Seabed levels at the BritNed crossing vary from approximately 3.9m below LAT to 14.5m below LAT. Scouring is evident around all rock dumps compared to the preconstruction data with the deepest scouring occurring between HV2 and HV3 at the SW of the rock dump area (scour of 9m). Here depths of 14.5m LAT are encountered.

Figures 4 to 8 below show various images of the BritNed crossing

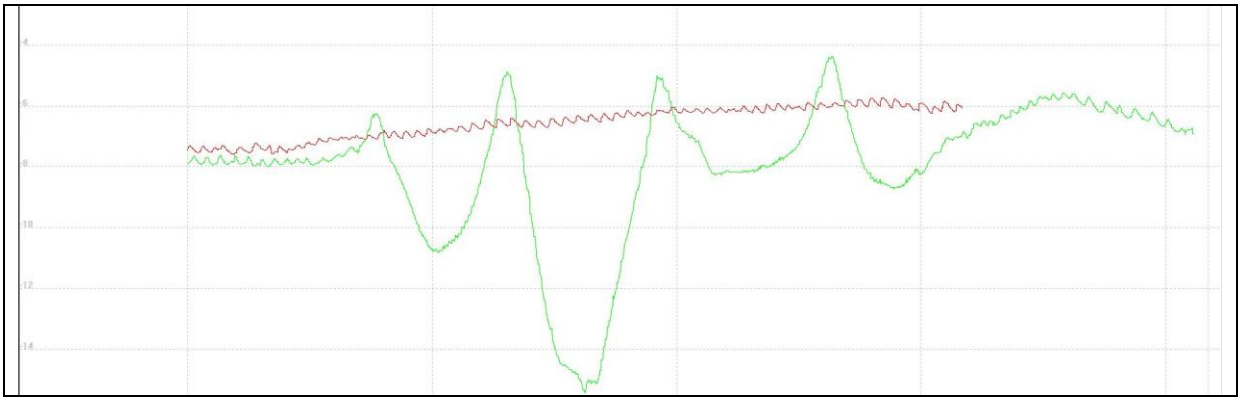

FIGURE 4: POST AND PRE CONSTRUCTION BATHYMETRIC PROFILE COMPARISON AT BRITNED CROSSING. (RED PROFILE 2010)

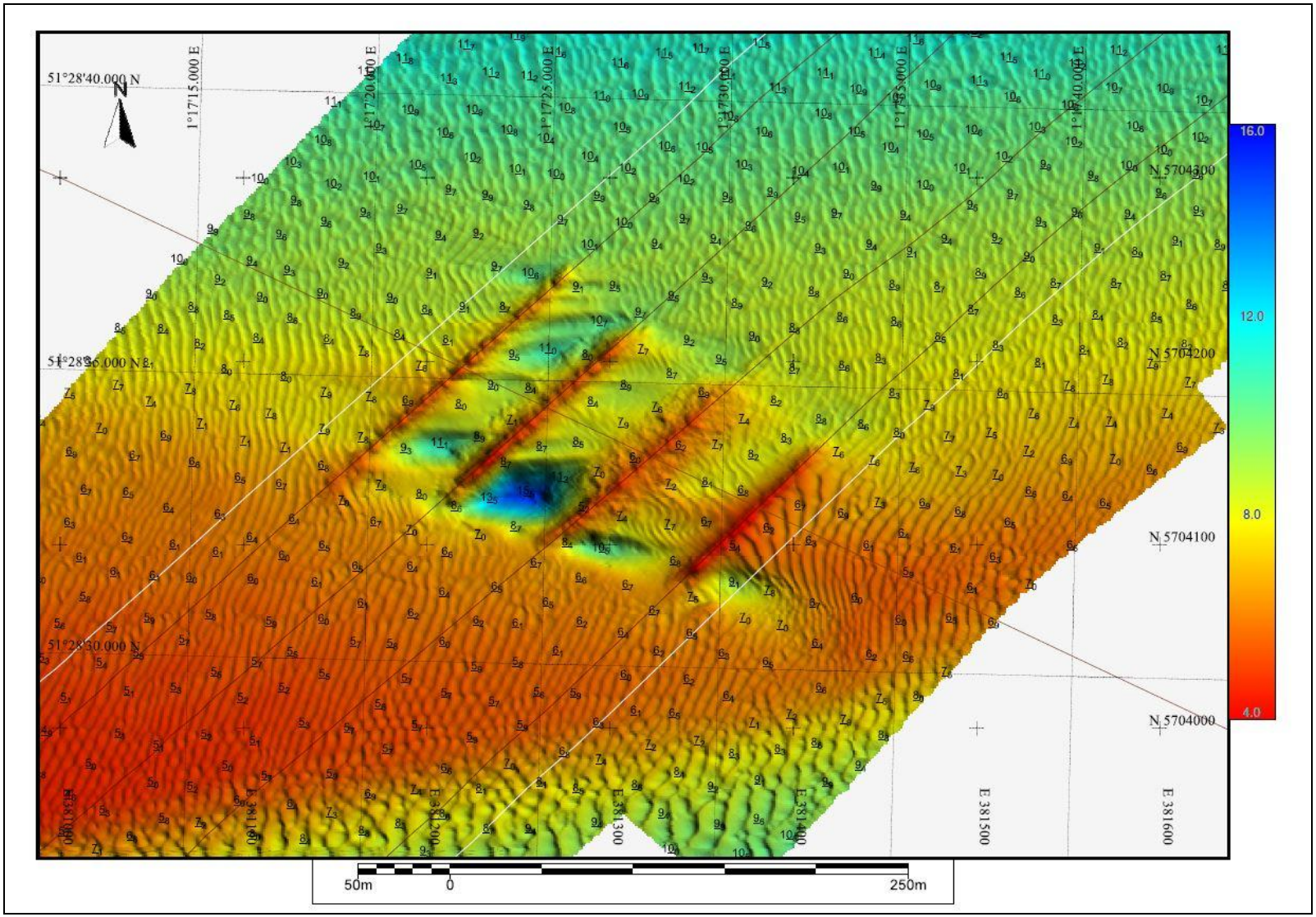

FIGURE 5: BRITNED CROSSING SHADED RELIEF BATHYMETRY (DEPTH BELOW LAT)

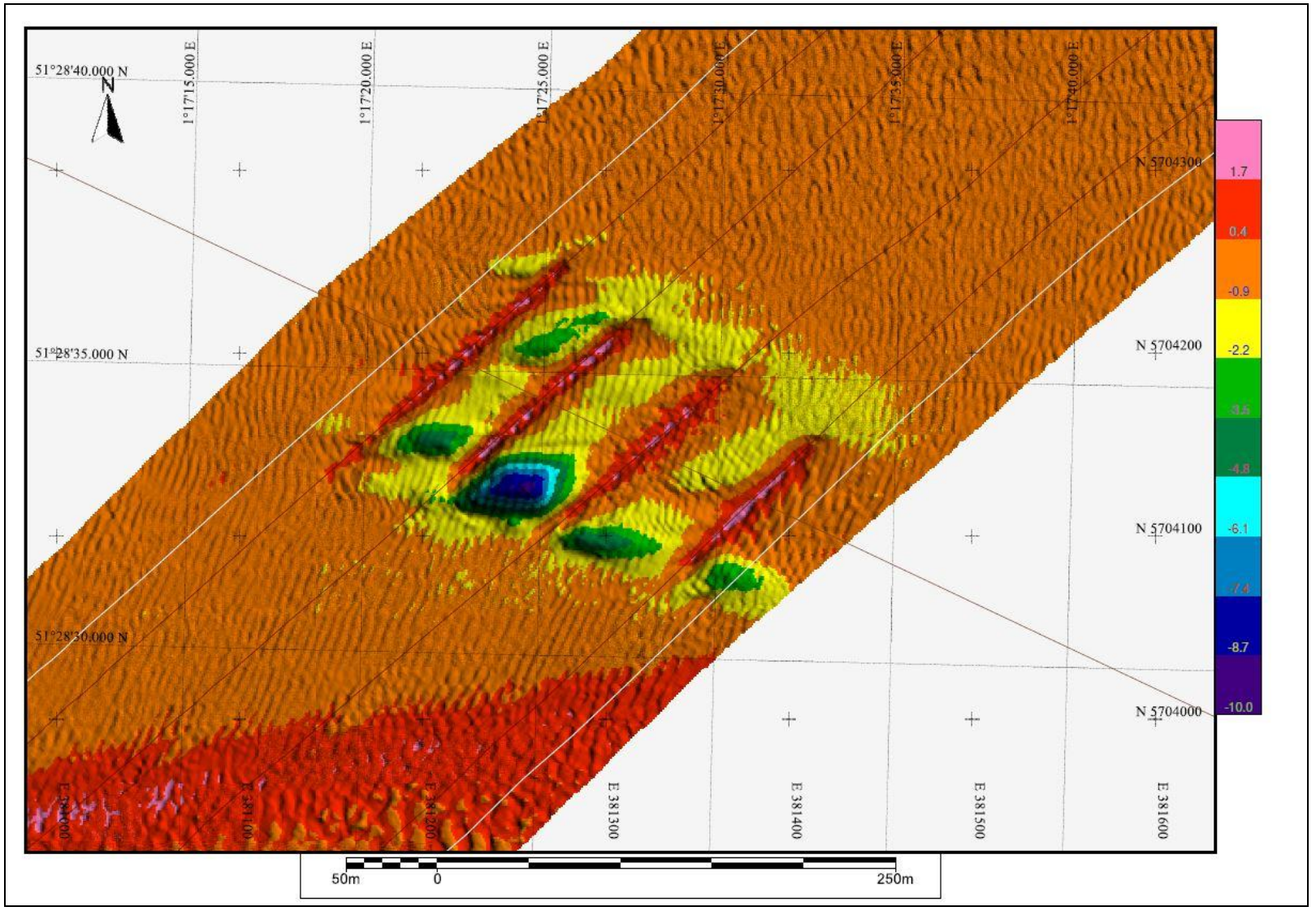

FIGURE 6: BRITNED DATA DIFFERENCE PLOT 2010-2013(DIFFERENCE IN METRES BETWEEN 2010 AND 2013

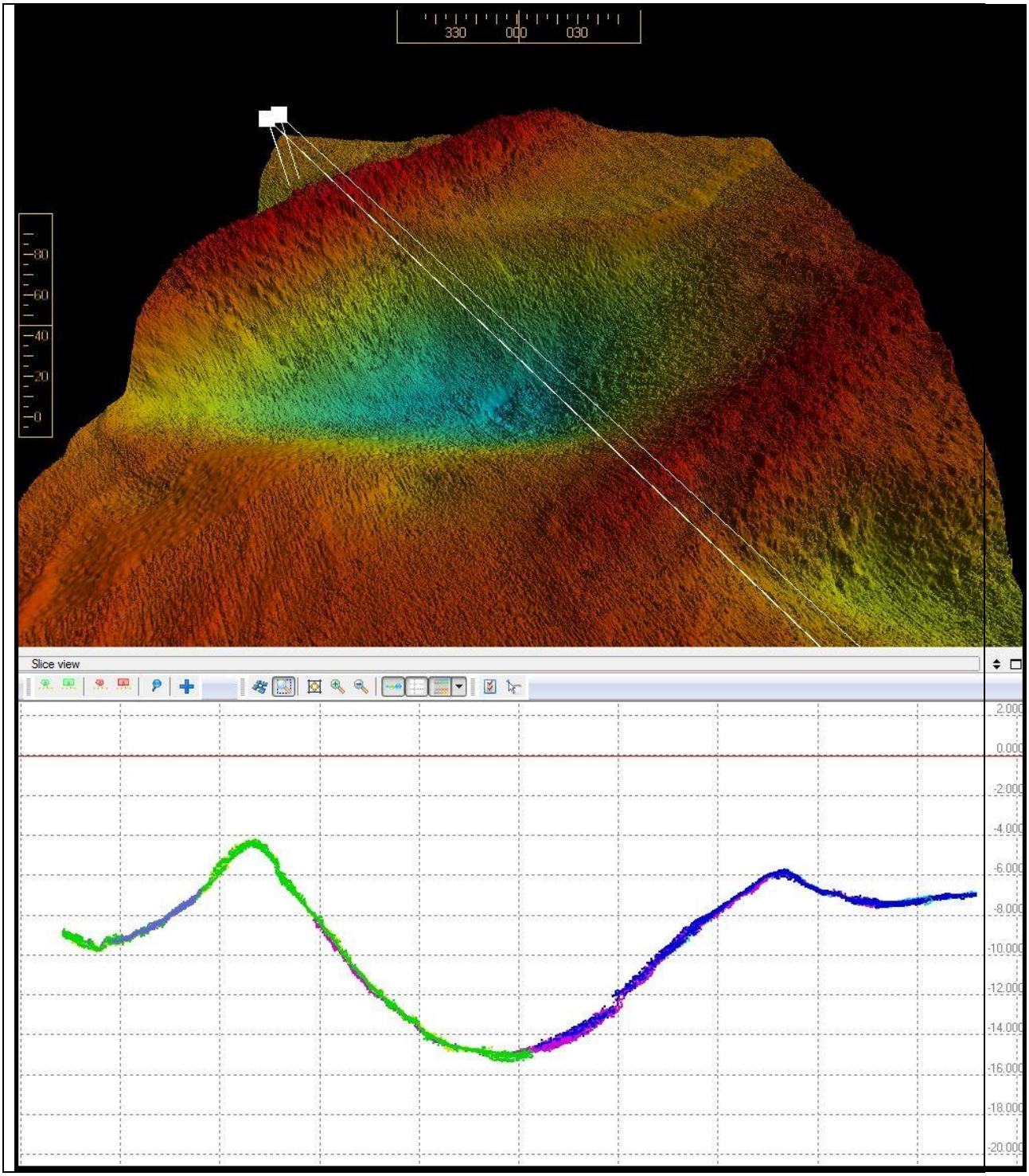

FIGURE 7: 3D IMAGE AND PROFILE OF BRITNED SCOUR

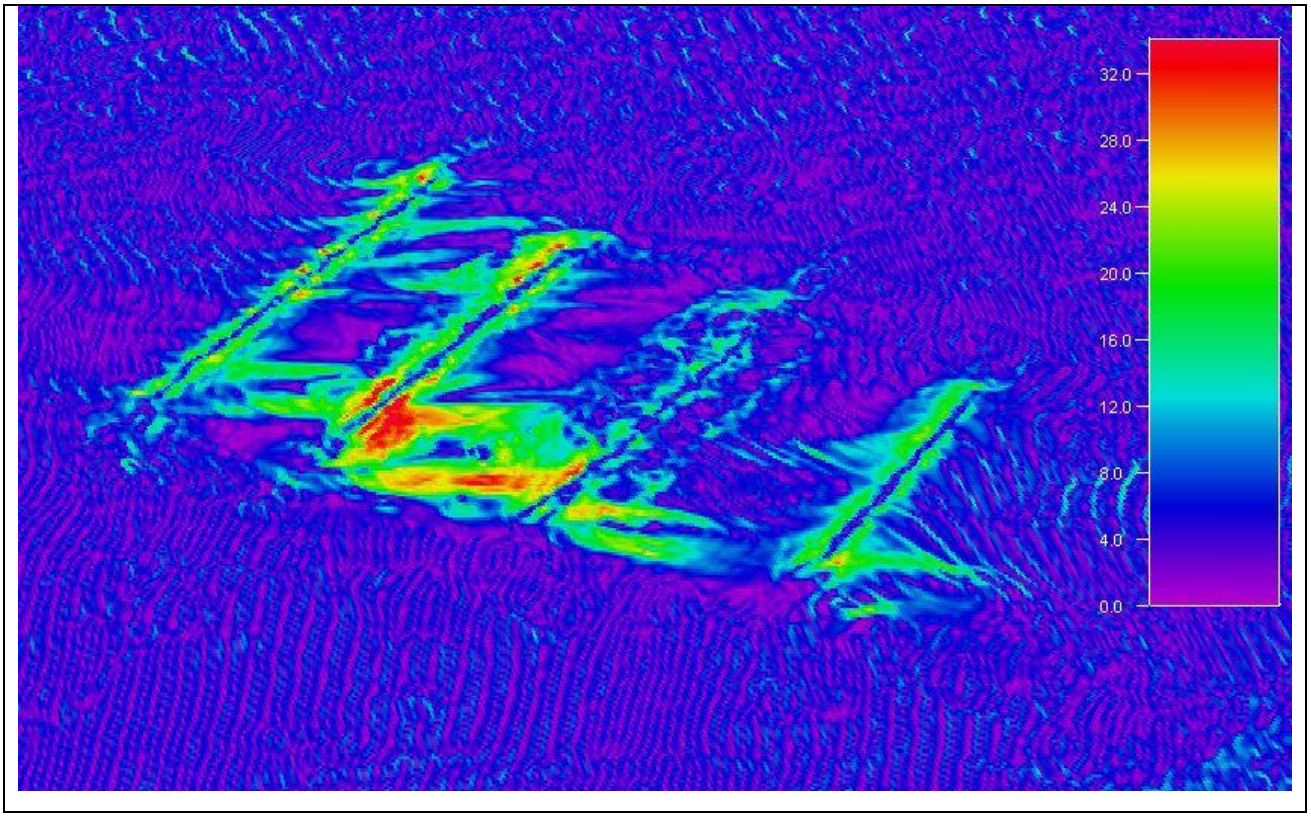

FIGURE 8: SLOPE ANGLE (DEGREES) AT BRITNED CROSSING

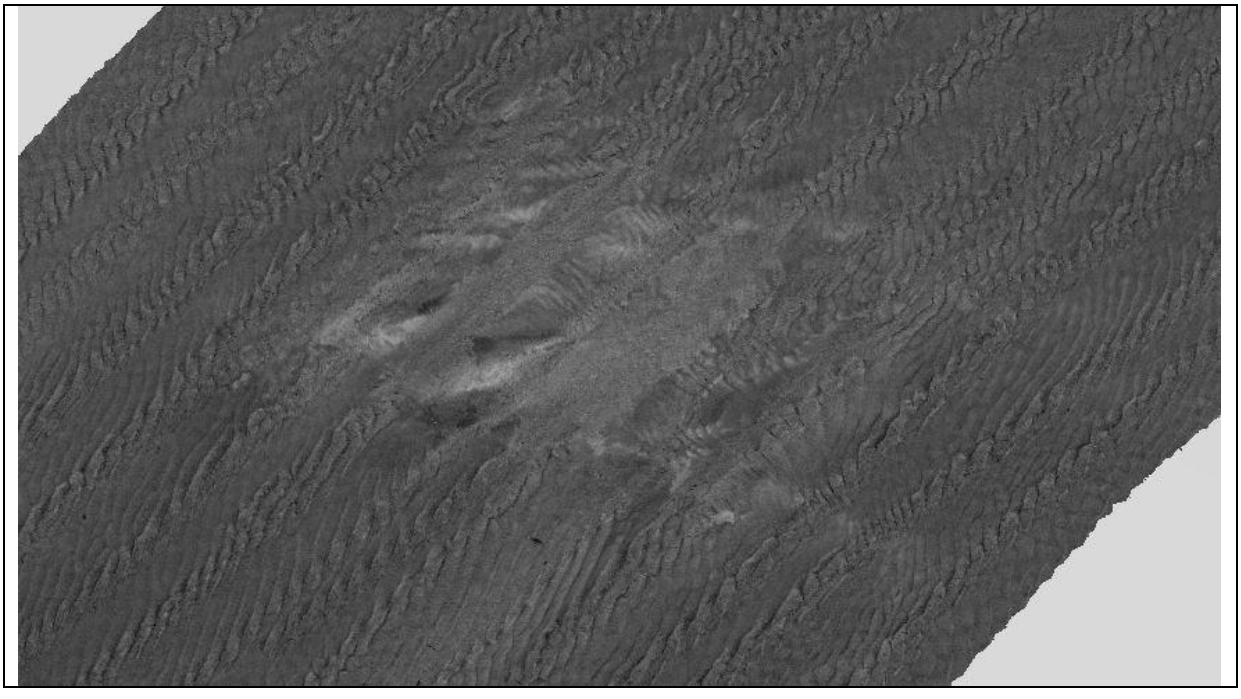

FIGURE 9: BACKSCATTER IMAGE OF BRITNED CROSSING.

7.3.2. KENTISH CROSSING

Rock dump is noted at the Kentish crossing were water depths of 0.8m LAT to 5m LAT are found.

Remnant trenching can be seen at either end of the Rock dump with evidence of sporadic rock dumping along the side of the trench - see figure 10.

7.3.3. INTERTIDAL LANDFALL

A drying height of 0.69 m was reached and data has been collected further inshore than the pre-construction dataset. Remnant trenching is evident from approximately the LAT level into the deeper Swale channel with trench depths of 2m found – see figure 11.

7.3.4. PRINCESS CHANNEL

When the 2010 and 2013 datasets are compared there is a gain of seabed material in the princes channel area in the region of 0.2m to 0.4m.

7.3.5. SUBSTATION 1 NORTH

There is evidence of scouring outside of the central rock dump where the Substation monopile has been placed. Scour in the region of up to 1.5m is experienced here.
Exposed interarray cables are seen entering the substation from the backscatter imagery.

See figure 13 for bathymetric comparison and figure 19 for backscatter imagery.

7.3.6. SUBSTATION 2 EAST

There is evidence of scouring at the east and South West of the Substation monopole. Trenching is evident outside of the central rock dump area along the HV3 and HV4 routes. Exposed interarray cables are seen entering the substation in the backscatter imagery.

See figure 12 for bathymetric comparison and figure 18 for backscatter imagery.

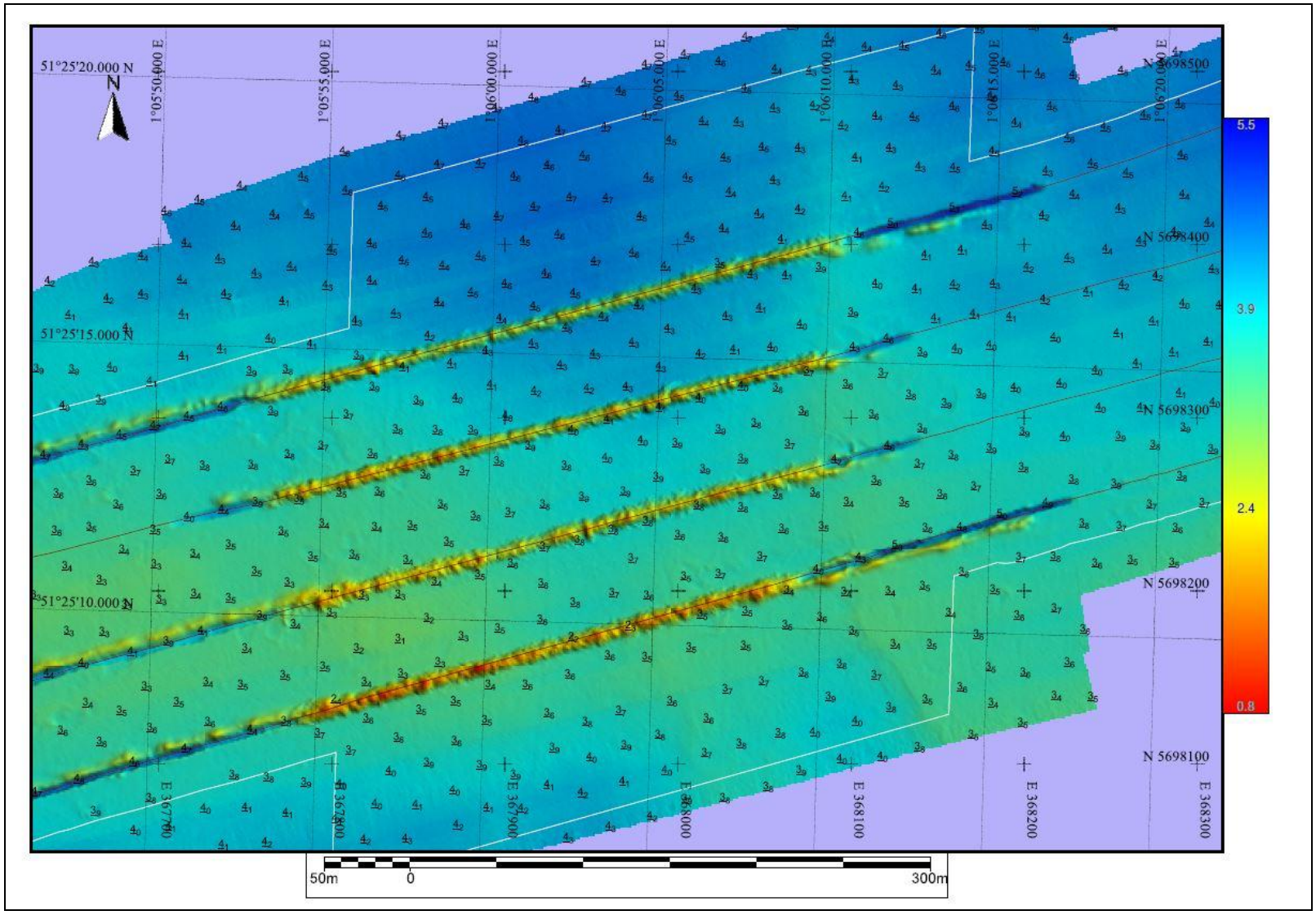

FIGURE 10: KENTISH CROSSING SHADED RELIEF BATHYMETRY

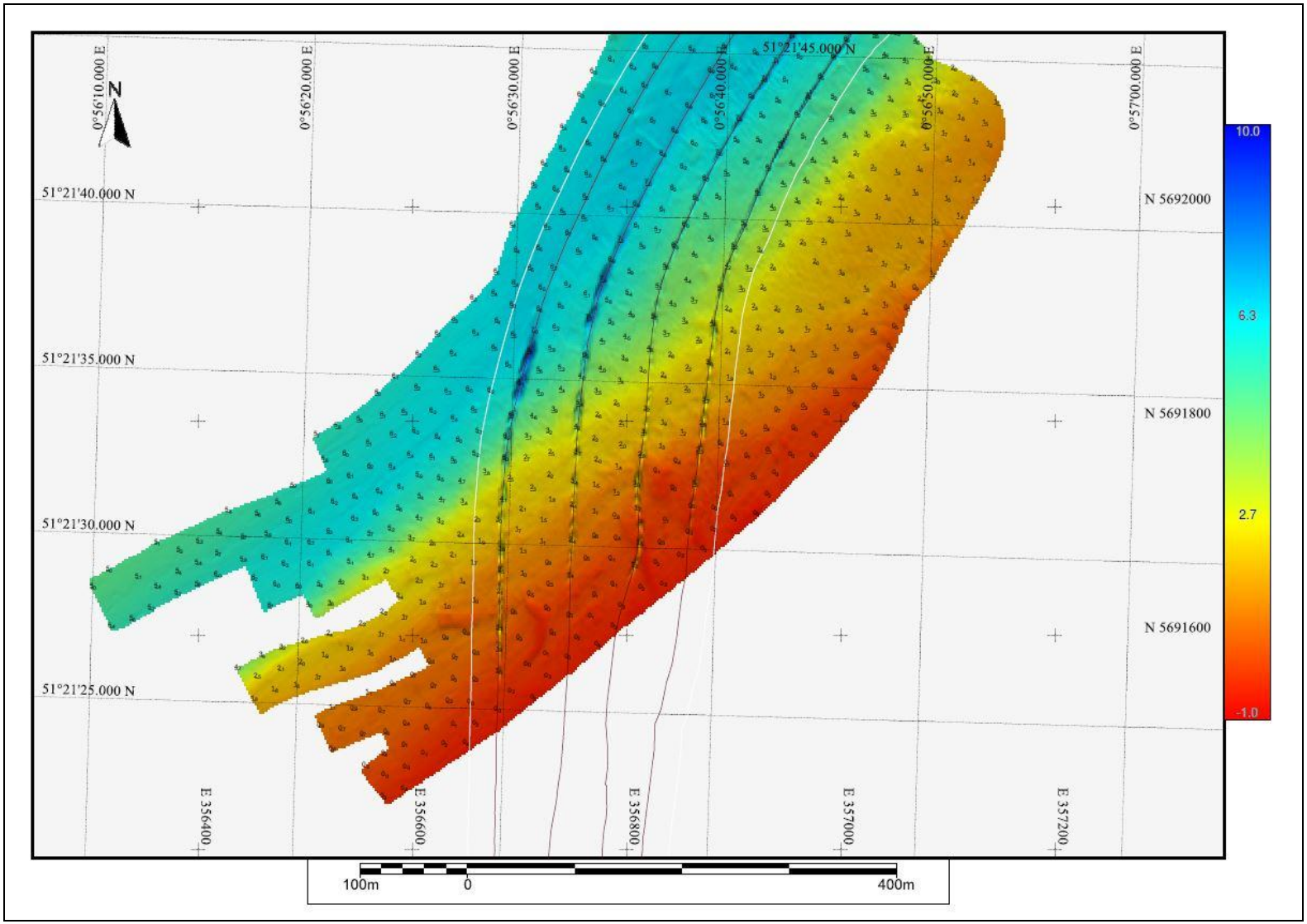

FIGURE 11: INTERTIDAL EXPORT CABLE AREA

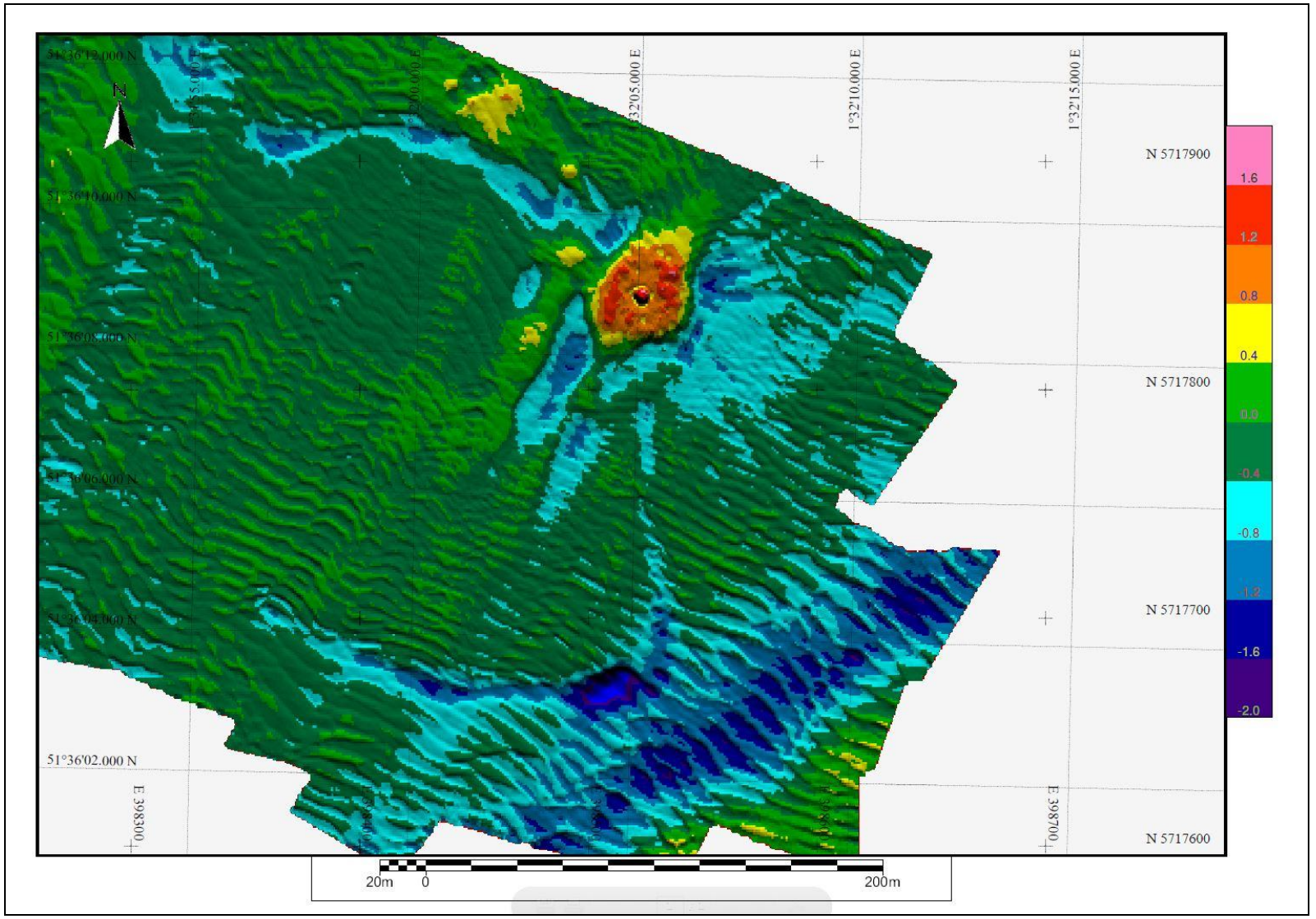

FIGURE 12: EAST SUBSTATION BATHYMETRIC DIFFERENCE PLOT

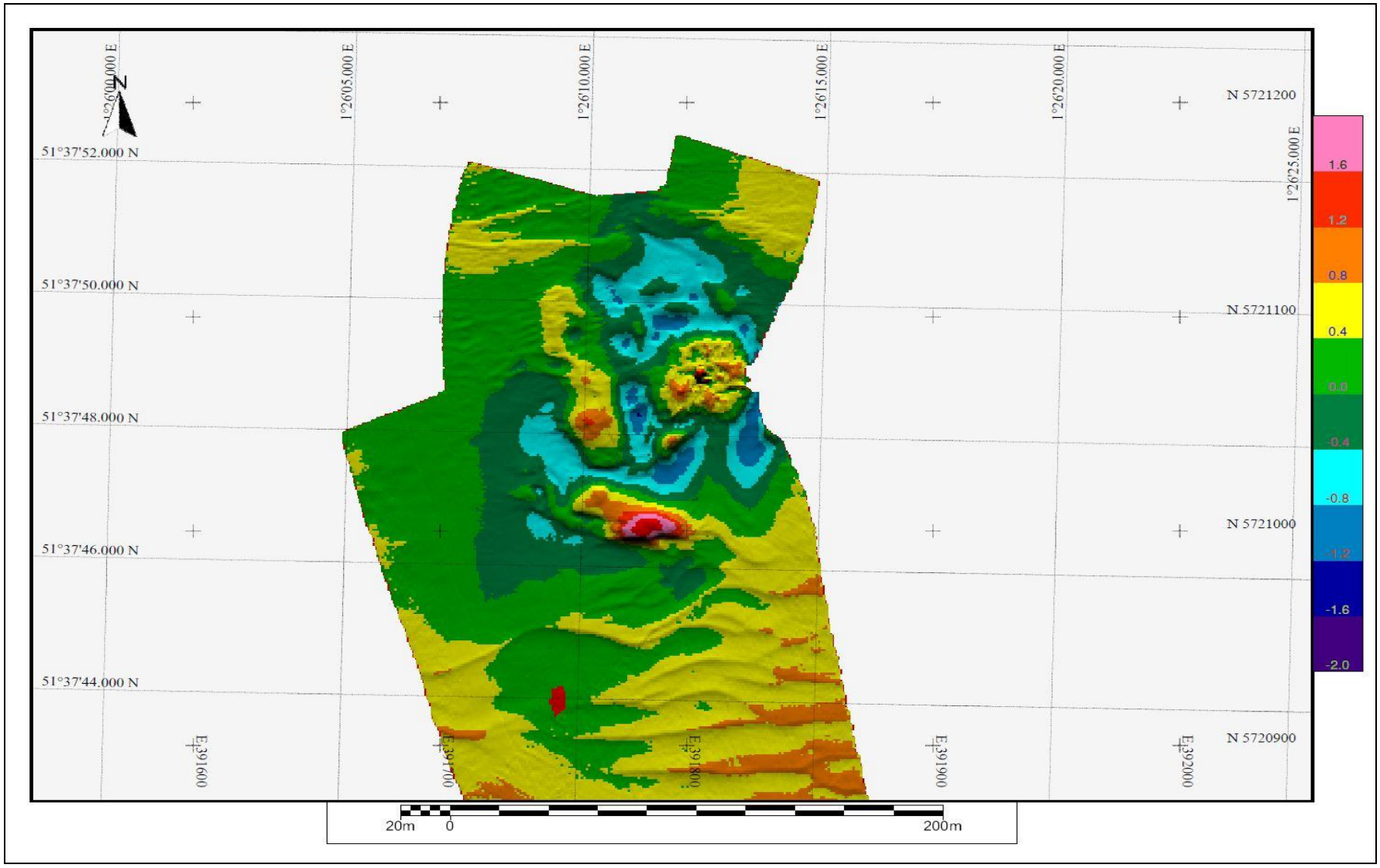

FIGURE 13: NORTH SUBSTATION BATHYMETRIC DIFFERENCE PLOT

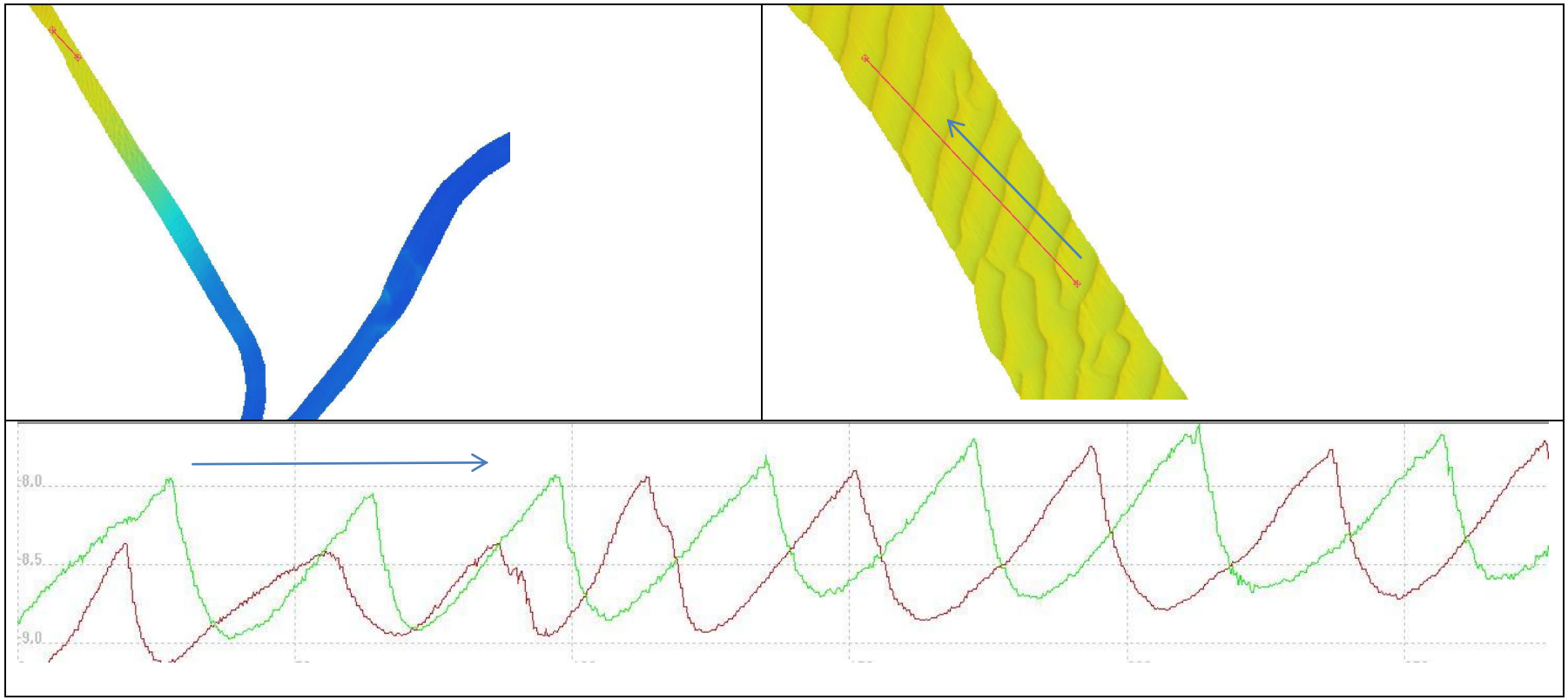

FIGURE 14: EXAMPLE OF SANDWAVE MIGRATION ON NORTH SPUR OF HV1 AND HV2. SANDWAVES MOVING IN A NORTH WESTERLY DIRECTION. RED PROFILE (2010), GREEN PROFILE (2013)

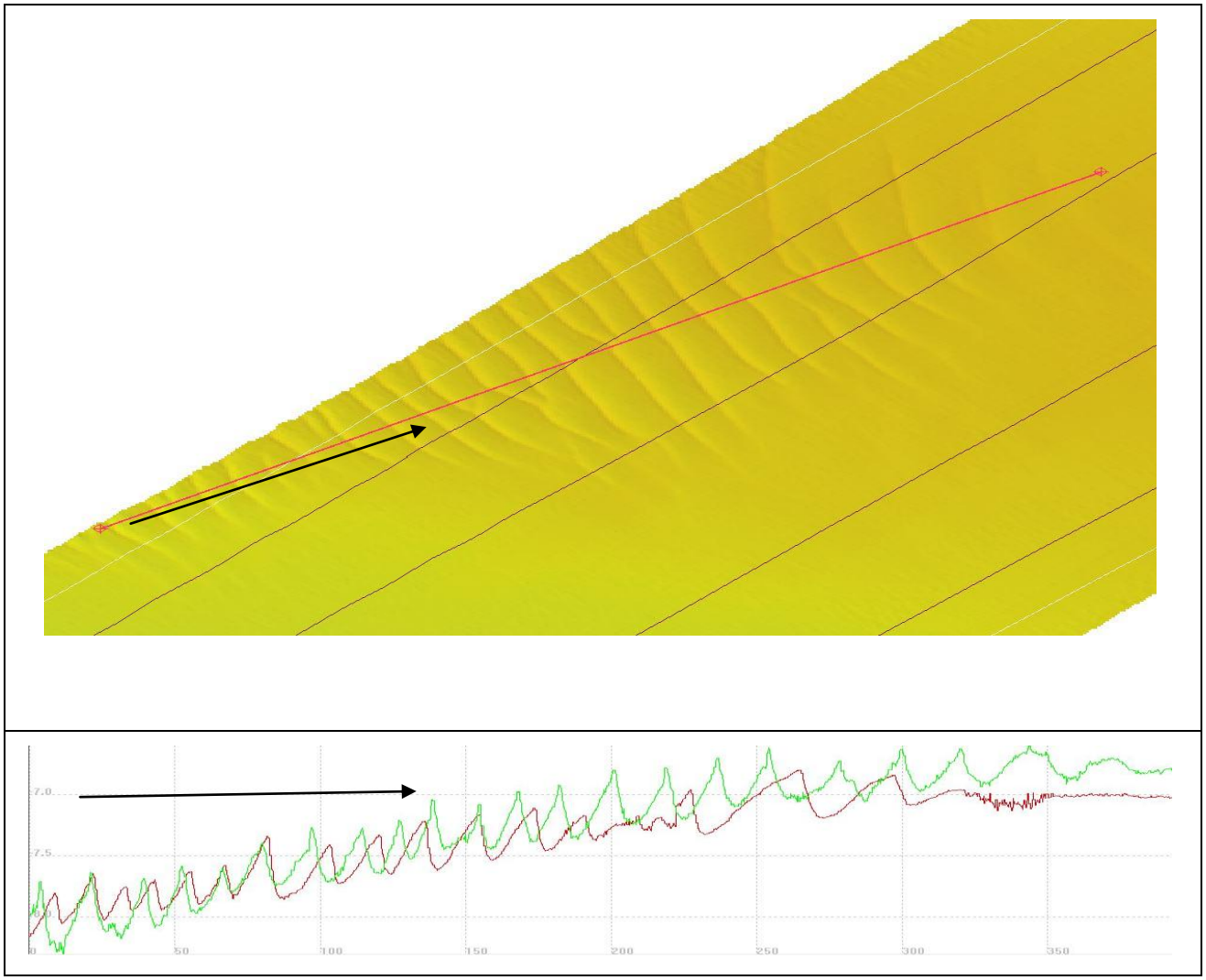

FIGURE 15: EXAMPLE OF SANDWAVE MIGRATION, 400M E OF PRINCES CHANNEL. RED PROFILE (2010), GREEN PROFILE (2013)

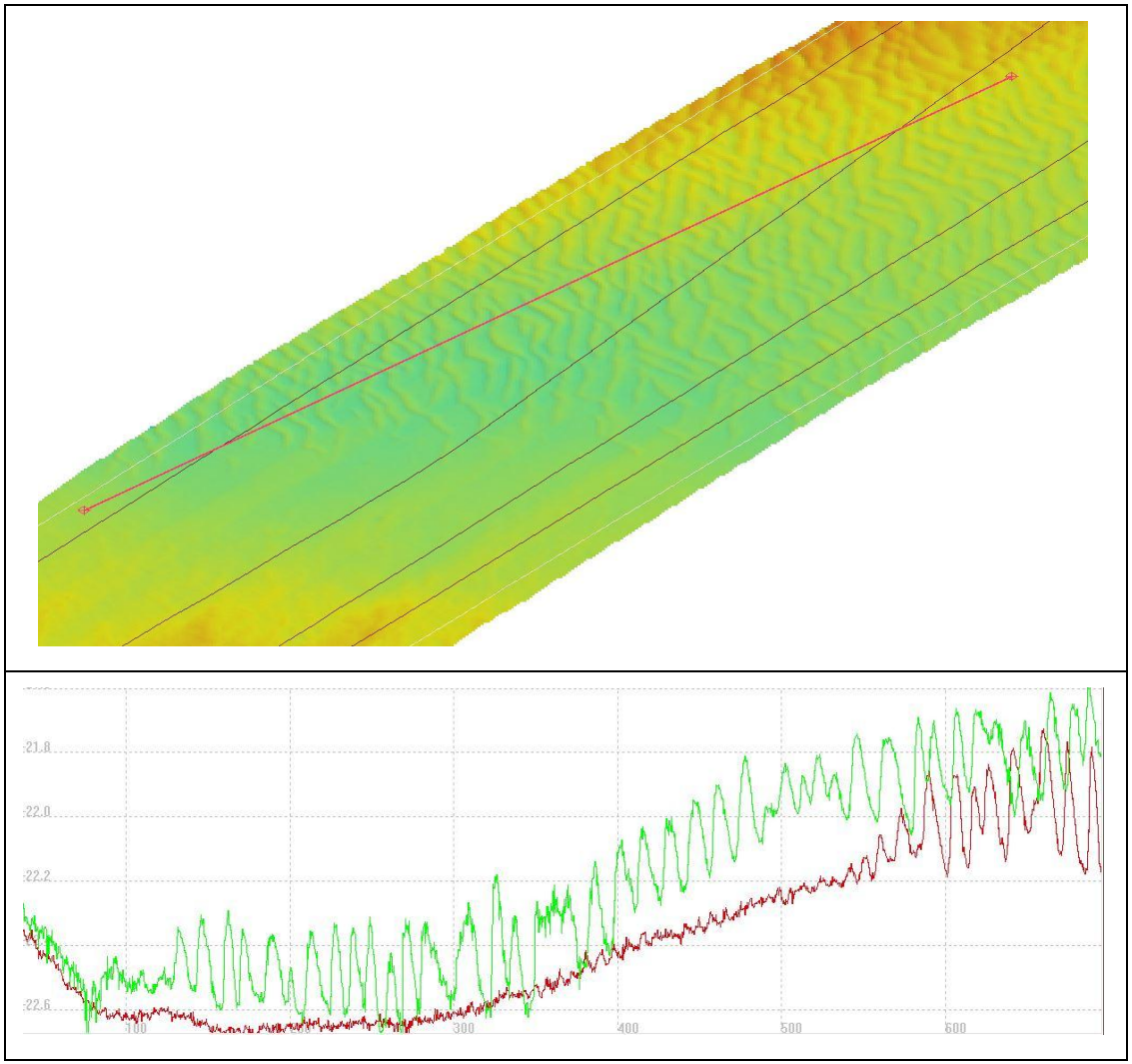

FIGURE 16: NEW SANDWAVE FIELD DEVELOPING, SE OF NORTH EDINBURGH CHANNEL

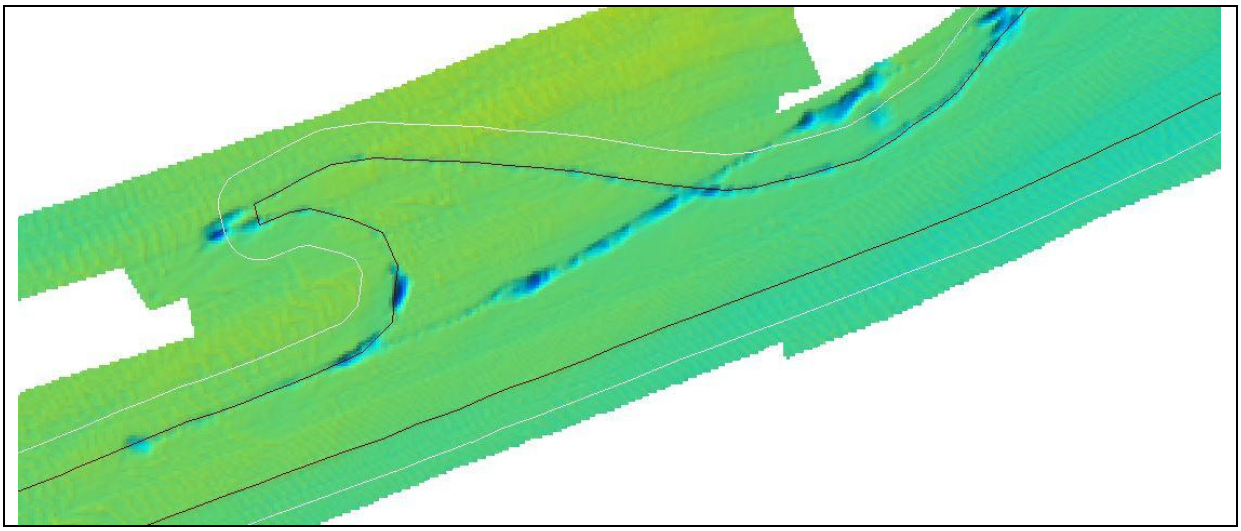

FIGURE 17: LOOP BACK IN HV3 CABLE ROUTE.

A loop back was noted on the HV3 cable route. It is suspected that the cable was retrieved and relayed during the cable lay process.

7.4. BACKSCATTER IMAGES

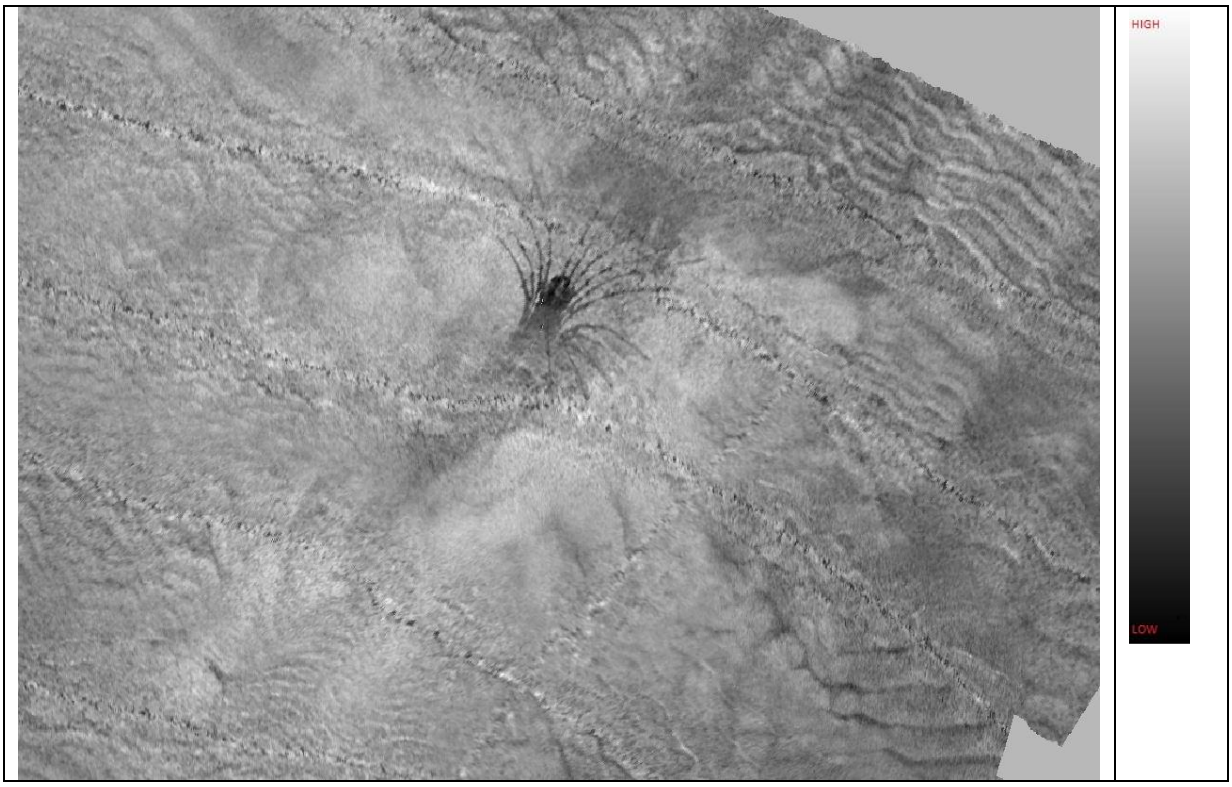

FIGURE 18: BACKSCATTER INTENSITY: SUBSTATION EAST SHOWING EXPOSED INTERARRAY CABLES

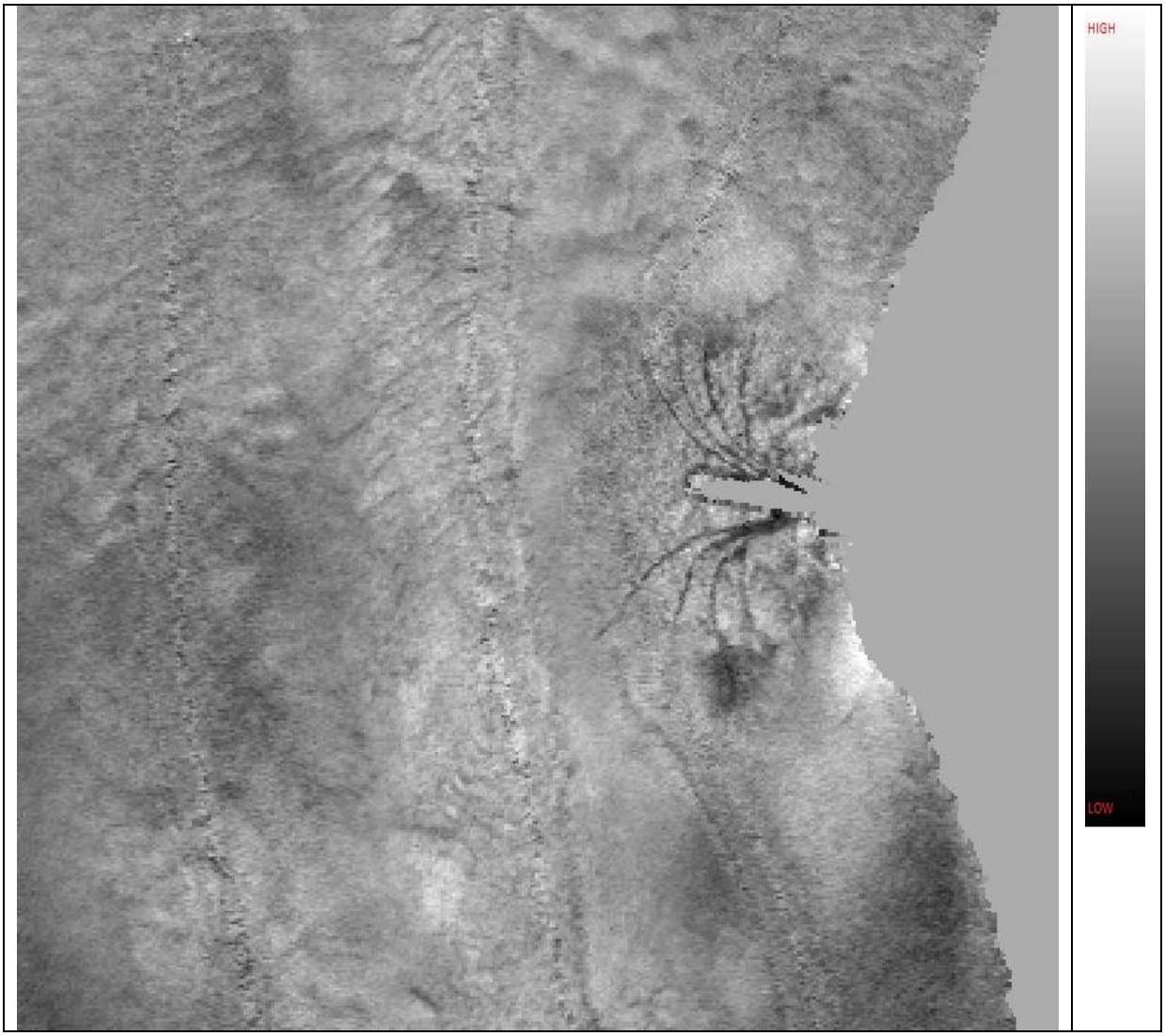

FIGURE 19: BACKSCATTER INTENSITY: SUBSTATION NORTH SHOWING EXPOSED INTERARRAY CABLES

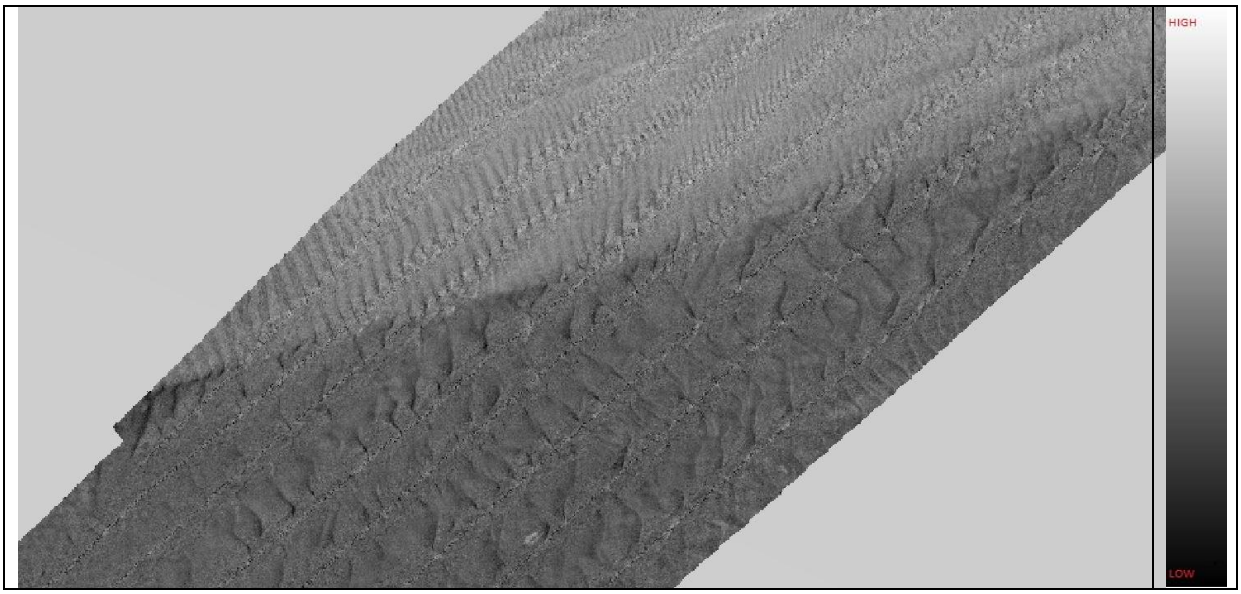

FIGURE 20: BACKSCATTER INTENSITY: SEDIMENT BOUNDARY EXAMPLE EAST OF BRITNED CROSSING

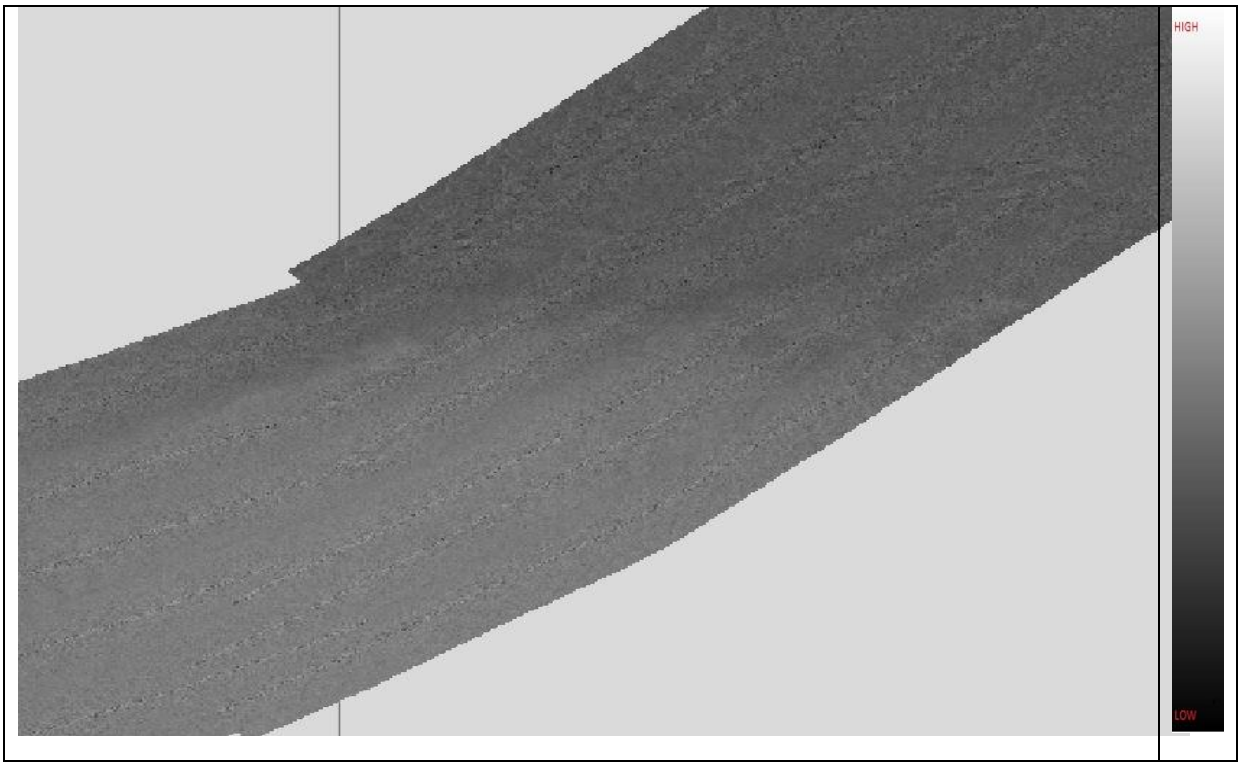

FIGURE 21: BACKSCATTER INTENSITY: SEDIMENT BOUNDARY EXAMPLE WEST OF BRITNED CROSSING

7.5. SEABED FEATURES

A total of 47 seabed features were identified from the bathymetric and backscatter data and are presented in the table below.

Description	Dimensions LxWxH	Easting	Northing
1_Debris with associated scour	3x2x0.8	358159.51	5693507.86
2_Raised Mound with scour	4x4x0.3	360257.33	5695116.16
3_Scour depression	0.25m	361182.57	5695743.31
4_Scour depression on HV4	0.3m	361885.48	5695908.29
5_Trenching on HV4	0.3m depth	362288.72	5696071.20
6_Seabed depression 12m diameter, raised edges	12m diameter	362963.81	5696425.24
7_Debris	1.7x1.5x0.3	363106.89	5696374.18
8_Debris	2x2x0.6	363631.95	5696511.55
9_Depression possible spud leg touchdown		363640.92	5696528.31
10_Disturbance, possible spud leg depression		363747.21	5696580.86
11_Disturbance, possible spud leg depression		365133.16	5697164.03
12_Disturbance, possible spud leg depression		366600.09	5697640.75
13_Disturbance, Possible spud leg depression		366743.69	5697674.87
14_Disturbance, possible spud leg depression		367136.5	5697820.72
15_Start of hv 4 east trench		367377.41	5697952.14
16_Start of hv 4 east rock dump		367780.74	5698125.37

Description	Dimensions LxWxH	Easting	Northing
17_End of hv 4 east rock dump		368070.59	5698208.52
18_End of hv 4 east trench		368225.28	5698252.97
19_Start of hv3 east trench		367564.89	5698126.05
20_Start of hv3 east rock dump		367769.79	5698189.33
21_Start of hv3 west rock dump		368082.61	5698272.85
22_Start of hv3 west trench		368131.32	5698285.75
23_Start of hv2 east trench		367717.01	5698241.61
24_Start of hv2 east rock dump		367763.44	5698252.35
25_Start of hv2 west rock dump		368093.12	5698335.88
26_Start of hv2 west trench		368130.70	5698347.30
27_Start of hv1 east trench		367516.70	5698235.75
28_Start of hv1 east rock dump		367750.32	5698311.12
29_Start of hv1 west rock dump		368095.29	5698402.44
30_Start of hv1 west trench		368207.46	5698432.29
31_Seabed depression, possible spud leg touchdown		370965.87	5699627.45
32_Seabed depression, possible spud leg touchdown		370975.80	5699593.33
33_Possible anchor/clump weight with chain joined with 34		372031.64	5699924.6
34_Possible anchor/clump weight with chain		372072.82	5699915.46
35_Small debris with scour	2x1x0.2	374273.40	5700735.99
36_Start of BritNed hv1 rock dump		381146.25	5704130.69
37_Endof BritNed hv1 rock dump		381278.86	5704249.52
38_Endof BritNed hv2 rock dump		381312.84	5704216.05
39_Endof BritNed hv3 rock dump		381367.71	5704188.08
40_Endof BritNed hv4 rock dump		381415.64	5704153.49
41_Startof BritNed hv2 rock dump		381211.60	5704123.59
42_Startof BritNed hv3 rock dump		381261.81	5704100.90
43_Startof BritNed hv4 rock dump		381339.22	5704079.97
44_CENTRE OF DEEP SCOUR 10m		381251.63	5704127.03
45_Linear feature perpendicular to HV3	11x 2	384518.42	5707020.50
46_Seabed mound	35x35x1.5	384741.80	5707262.42
47_LOOP back IN HV3 cable route, possible repaired cable area		394538.57	5716150.56

TABLE 11: SEABED CONTACTS / FEATURES

8. FISHING FASTENERS

After completion of survey operations, DONG provided EGS with 2 locations where local fisherman have "snagged" and lost fishing gear (i.e. Fishing Fasteners). One of these locations was plotted to be outside of the survey corridor, therefore it is not possible to comment whether a feature exists on the seabed. The other location was within the survey corridor, the bathymetric and backscatter datasets were inspected in this area, no distinctive sea bed feature was observed.

The table below summarises the locations below:

Position As Provided by DONG		Location ID	Status
Longitude *(D.DDDDDD WGS84)*	**Latitude** *(D.DDDDDD WGS84)*		
001,076617°	51,414650°	Matt Barnes June 2013	Outside of Survey Area
001,041467°	51,407617°	Julian Walpole June 2013	No feature observed

TABLE 12: LOCATIONS OF POTENTIAL FISHING FASTENERS

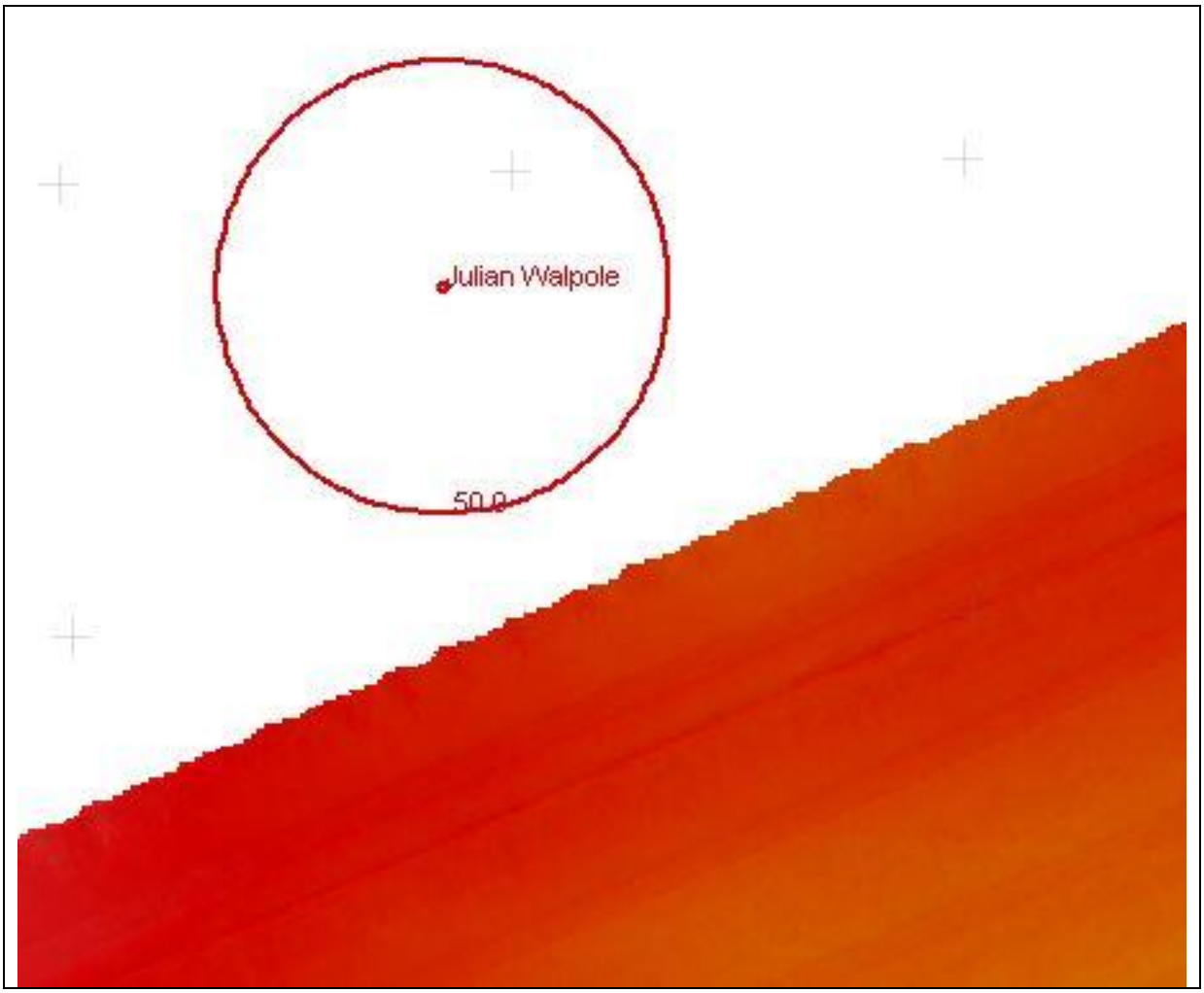

FIGURE 22 BATHYMETRY IMAGE, LOST FISHING GEAR – JULIAN WALPOLE LOCATION

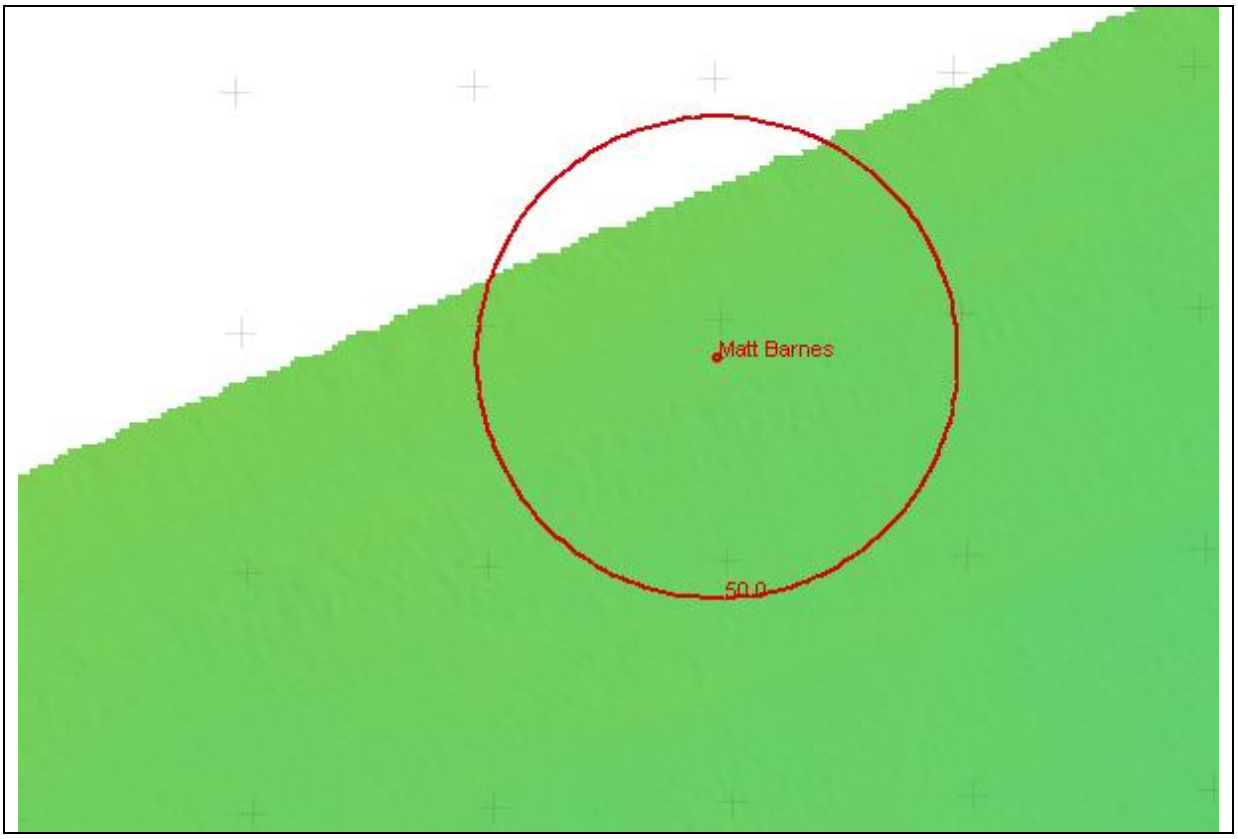

FIGURE 23 BATHYMETRY IMAGE, LOST FISHING GEAR - MATT BARNES LOCATION

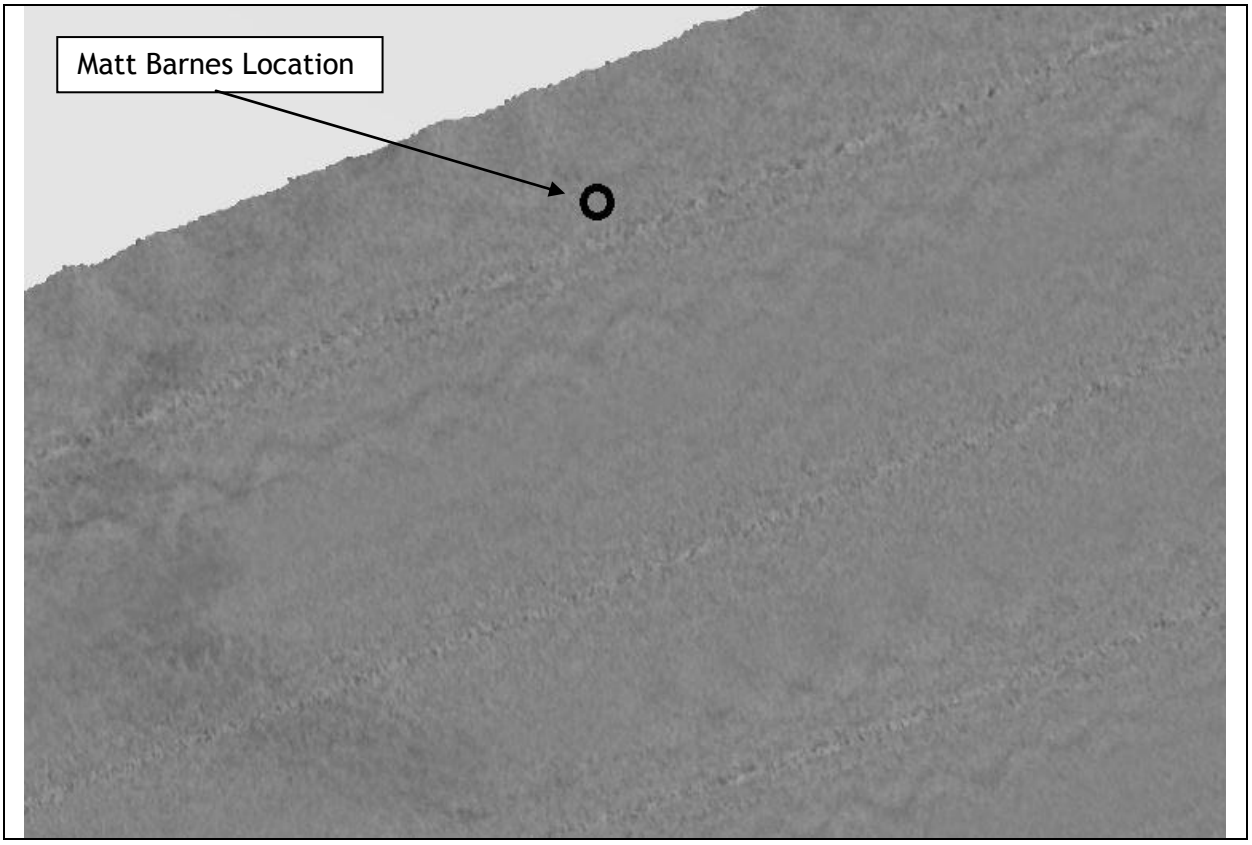

FIGURE 24 BACKSCATTER IMAGE, LOST FISHING GEAR - MATT BARNES LOCATION

9. CONCLUSION

EGS (International) Ltd was contracted to undertake a bathymetric survey, with the primary aim of determining changes to the seabed morphology along the export cable route between the 2010 pre-construction survey and the 2013 post construction survey. Changes were noted along the route with the most significant noted at the BritNed crossing. A disparity of 0.2m between the datasets in the inshore areas was noted when both data sets were normalised for comparison.

Vessel mobilisation and survey operations were conducted in a safe manner with no HSE incidents throughout the project. Tool box talks were conducted before all equipment deployment and recoveries and all personnel were given a vessel safety induction before operations commenced.

The duration of the project was 7 days of acquisition times which was within the planned timescale.

Results for the survey are presented as 4 types of charts. A series of alignment comprising 3 panels, have been produced for the Export cable route corridor comprising of bathymetric data, Bathymetric difference plot, and Backscatter imagery.

Full density sounding data has been provided along with ASCII bathymetric grids and Bathymetric difference data in both ASCII and ARC format.

No cable exposures have been interpreted along either of the 4 export cable routes. Exposed interarray cables are noted at the two substation locations and can be seen clearly in the backscatter imagery.

Significant scour is noted at the BritNed crossing where scouring depths of 9m are found when compared to the 2010 survey. EGS advise that this area should be closely monitored.

Scour is also noted at both substations but to a lesser degree than the BritNed crossing.
At the Kentish crossing trenching is evident at both sides of the rock dump areas. Remnant trenching is also evident at the intertidal zone with trenching visible into the Swale channel.

A total of 47 seabed contacts were noted from small debris items to small depressions possibly caused by a spud leg touchdown. These seabed contacts have been derived using both the bathymetric and backscatter datasets.

On the SE Spur of the outer cable route a loop back is noted along the HV3 cable route possibly when the cable has been retrieved/relayed.

Two lost fishing gear locations were provided by the DONG. One of these locations is outside the survey corridor. No debris or evidence of fishing gear, or seabed feature were observed in the MBES Backscatter or Bathymetry datasets for the second location, which is labelled Matt Barnes June 2013.

10. REFERENCES

1) Scope of work document 1517022
2) EMU 2010 bathymetric dataset (0.5m)
3) EGS Mobilisation and Operations Report