



# **ADCP Deployment Report**

## **Cumbrae,**

## **Firth of Clyde**

**Data Collected Across 3 Deployments**

**Deployment 1 - 04/10/2017 to 19/11/2017**

**Deployment 2 - 19/11/2017 to 07/12/2017**

**Deployment 3 - 09/01/2018 to 22/02/2018**

**Report Drafted 06/06/2018**

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## 1. Introduction

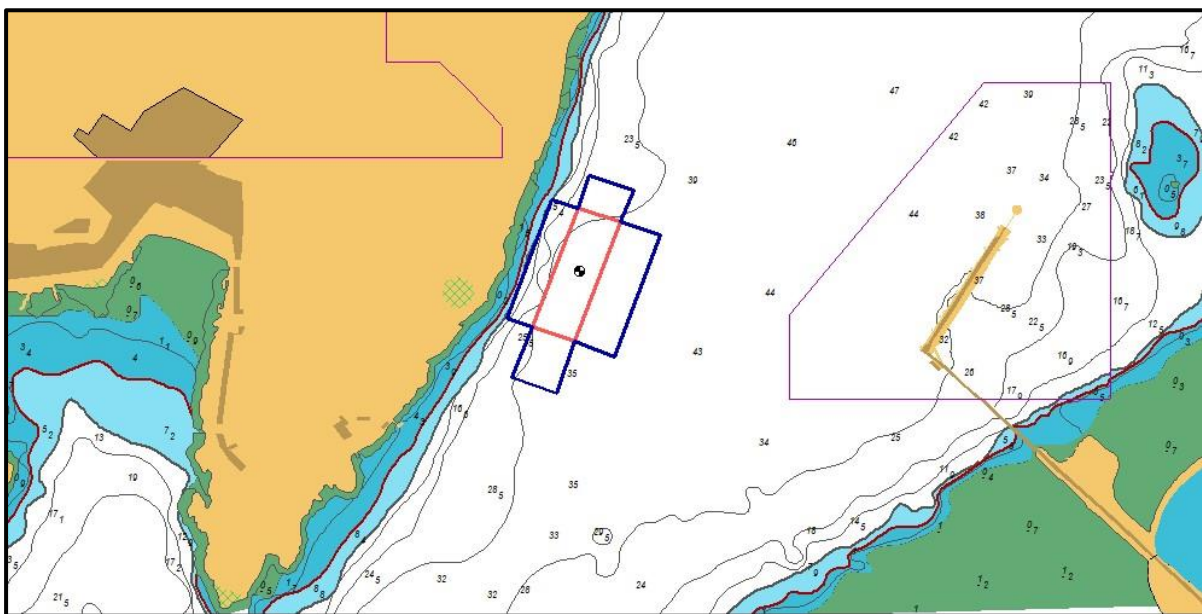
Dawnfresh Farming Ltd. is preparing this report in order to present the findings of the recent hydrographic survey carried out at Cumbrae. The report will consider the method of collection of hydrographic data in order to ascertain whether it is suitably robust for use in autoDepomod modelling.

## 2. Site Description

The proposed site lies off the east coast of the Island of Cumbrae, north east from the village of Millport and opposite the Hunterston Deep Water Port, the current meter was positioned within 150m of the centre of the proposed cage group. On recovery data was downloaded and the meter redeployed with all effort made to return the meter to the same location. The proposed Cumbrae fish farm site will consist of 10 x 120m circumference pens arranged in a 5 x 2, 75m x 65m grid matrix. The biomass being applied for is 2,500T at a Stocking Density of 13.6kg/m<sup>3</sup>.

## 3. Survey Details

Dawnfresh Farming engaged the environmental consultant AMS Ltd. to deploy a current meter at the Cumbrae site in order to gather 90 days of current data. After 46 days deployment the current meter was recovered, data was downloaded and the meter was redeployed in the same location. 18 days after the meter was redeployed something caused the meter to move off station undermining the validity of all subsequent data. The meter was recovered and replaced to the original location on the 9<sup>th</sup> January 2018 to complete the 90 days data collection. Data was collected between 4<sup>th</sup> October 2017 and 22<sup>nd</sup> February 2018 but due to the disruption with the meter, data presented in this report covers the period from 4<sup>th</sup> October to 19<sup>th</sup> November 2017, from 19<sup>th</sup> November 2017 to 7<sup>th</sup> December and from the 9<sup>th</sup> January 2018 to the 22<sup>nd</sup> February 2018. This Hydrographic report considers the full data set as collected and identifies a single 15 days data set between 29<sup>th</sup> October



2017 and the 13<sup>th</sup> November 2017 which is representative of median conditions at the site.

Figure 3.1: Location map of the Cumbrae current meter deployment location and proposed site (Red)

## 4. Materials and Methods

Dawnfresh Farming Ltd. used an RD instruments Sentinel V 100 ADCP which is a 300kHz acoustic Doppler current profiler. Due to the prediction of strong currents at this location, in discussion with our consultant it was decided the most appropriate method of anchoring the meter to the seabed would be using an inline frame. The frame was used with a J mooring consisting of a 10kg anchor to 8m of 19mm chain then 40m ground rope to a 25kg clump weight below the frame. The frame is then suspended 0.5m above the seabed supported by 2 trawl floats. Prior to deployment Dawnfresh Farming Ltd. applied for an exemption to deploy a current meter and navigation was a key consideration, this resulted in a deployment position being agreed and this position was maintained throughout the deployment period. The mooring was marked by a surface marker buoy of 0.5m diameter at the request of the, Northern Lighthouse Board, to aid navigation. Further information can be found on the Sentinel V 100 ADCP at:


<http://www.teledynemarine.com/sentinel-v-adcp?ProductLineID=12>

The Sentinel V 100 ADCP was positioned at 55 45.223°N, 004 53.842°W [218270.163E, 654952.937N] which was within 150m of the proposed cage group centre. The meter was programmed prior to deployment based on chart depth at the proposed deployment location. The cell size was set to 1m and the number of cells was 59. Using the mooring configuration outlined above the transducer head was positioned 0.5m above the seabed. Due to the blanking distance and cell size chosen the bottom cell was automatically set at 2.4m which gave a total distance from the seabed of 2.9m which is within the SEPA requirements. Data was automatically stored to the internal memory and downloaded via Bluetooth on recovery.

### TECHNICAL SPECIFICATIONS

# Sentinel V

20 m, 50 m, 100 m Profiling ADCP



Depth Cell Size <sup>1</sup>	V20 (1000 kHz)		V50 (500 kHz)		V100 (300 kHz)	
	Range (m) <sup>2,3</sup> Wide/Narrow	Std Dev (cm/s) <sup>4</sup> Wide/Narrow	Range (m) <sup>2,3</sup> Wide/Narrow	Std Dev (cm/s) <sup>4</sup> Wide/Narrow	Range (m) <sup>2,3</sup> Wide/Narrow	Std Dev (cm/s) <sup>4</sup> Wide/Narrow
0.25 m	18.0/22.6	19.2/36.5				
0.3 m	19.3/24.0	11.1/20.8				
0.5 m	20.2/24.9	7.1/13.4	44.1/57.6	19.2/36.5		
1.0 m	22.1/26.9	3.6/6.7	50.5/64.6	7.1/13.5	94.5/120.6	10.9/20.6
2.0 m	24.5/29.4	1.7/3.2	56.0/70.6	3.6/6.7	103.5/130.4	5.5/10.3
4.0 m	26.9/32.0	0.8/1.6	63.1/78.2	1.7/3.2	114.6/142.3	2.7/5.2
6.0 m			67.4/82.8	1.1/2.1	121.7/151.5	1.8/3.3
<b>Self-Contained (SC) Communications and Recording</b>	Wireless/Ethernet Internal memory		802.11 b/g/n / TCP/IP One 16 GB Micro SD Card included			
<b>Real-Time (RT) Communications</b>	Serial/Ethernet		RS232 and RS422 / TCP/IP (setup) UDP (output)			
<b>Profile Parameters</b>	Velocity accuracy		V20/V50: 0.3% of the water velocity relative to the ADCP ± 0.3 cm/s			
	Velocity resolution		V100: 0.5% of the water velocity relative to the ADCP ± 0.5 cm/s			
	Velocity range		0.1 cm/s			
	Ping rate		± 5m/s (default); ± 20m/s (maximum)			
			Up to 4 Hz (SC); Up to 16 Hz (RT)			
<b>Echo Intensity Profile</b>	Vertical resolution		Depth cell size			
	Dynamic range		80 dB			
	Precision		±1.5 dB			
<b>Transducer and Hardware</b>	Beam angle		25°			
	Configuration		4-beam, convex; 5th beam vertical			
	Depth rating		200 m			

	<b>Materials</b>	Transducer, housing, and end cap: plastic Connector: metal shell
<b>Standard Sensors</b>	Temperature (mounted on transducer) Compass (magneto-inductive sensor) Tilt (MEMS accelerometers)  Pressure sensor (mounted on transducer) Recorder	Range -5° to 45°C, precision ± 0.4°C, resolution 0.1° Accuracy 2° RMS, resolution 0.1°, max. dip angle 85° Pitch range ± 90°, roll range ± 180°, accuracy 2° RMS, precision 0.05° RMS, resolution 0.1° Range 300m, accuracy 0.1% FS 16GB Micro SD Card
<b>Power</b>	External DC input Internal battery voltage Battery capacity; over-the-counter @ 0°C Battery pack @ 5°C	12–20 VDC 18 VDC new 100 watt hours (typical) 510 watt hours
<b>Software</b>	Included Teledyne RDI Software  Optional Teledyne RDI Software (recommended)	ReadyV (SC)—Pre-deployment (testing, planning, and data recovery) <sup>5</sup> PLAN (RT)—Pre-deployment (testing and planning) <sup>6</sup> VMDAS (RT)—Real-Time (deploy and data processing) <sup>6</sup> Velocity (SC/RT)—Post-processing (data handling, display, and export) <sup>6</sup>
<b>Environmental</b>	Standard depth rating Operating temperature Storage temperature (without batteries)	200 m -5° to 45°C -30° to 60°C
<b>Available Options—Hardware</b> <b>Available Options—Firmware/Software</b>	Straight or right-angle metal shell connector • AC/DC power converter and cable • External battery case Waves (SC) / Bottom Track (RT)	
<b>Dimensions and Weights</b>	Special configuration drawing available upon request	
<p>1. User's choice of depth cell not limited to the typical values specified. 2. Ranges specified are typical at temperature of 5°C and salinity of 35 psu; longer ranges are possible. 3. User selects the bandwidth mode; wide = 25% or narrow = 6%.</p> <p>4. Standard deviations (Std Dev) are typical values for single ping data 5. Resident in ADCP accessed via a web browser. 6. Windows™ based software program.</p>		

Figure 4.1: Specification sheet for Sentinel V 100 ADCP

Table 4.1: Deployment 1 ADCP Settings

<b>Site Name</b>	Cumbrae 1	
<b>Deployment Position</b>	55 45.223, 004 53.842 218270.163, 654952.937	Meter was deployed on the spot where a Marine Licence Exemption had been granted, the coordinate was put into the GPS and meter deployed once the position had been reached. +/- 5m error on GPS
<b>Deployment Date + Time</b>	4th October 2017 @ 13:20	
<b>Current Meter Recovered</b>	19th November 2017 @ 11:47	
<b>Deployment Depth</b>	39.41m @ 13:25	Depth taken immediately before deployment
<b>Correction</b>	2.98m	<a href="https://www.tidetimes.org.uk/millport-tide-times-20171119">https://www.tidetimes.org.uk/millport-tide-times-20171119</a>
<b>Chart Datum</b>	36.43m	
<b>ADCP Type</b>	Sentinel V 100	
<b>Serial Number</b>	20451	
<b>Frequency</b>	307	
<b>Number of Cells</b>	59	
<b>Cell Size</b>	1	
<b>First Cell Range</b>	2.4	

<b>Number of Pings</b>	200	
<b>Ping Interval</b>	1	
<b>Start Date + Time</b>	04/10/2017 @ 08:07	
<b>Valid Data From</b>	04/10/2017 @ 13:47	
<b>Valid Data Ends</b>	19/11/2017 @ 11:47	
<b>Recovery Date + Time</b>	19/11/2017 @ 12:07	
<b>Minimum Depth Recorded</b>	37.07m	+ 0.5m from profiler head to seabed
<b>Bottom Cell Depth</b>	34.65 @ 2.42m from profiler	
<b>Surface Cell Depth</b>	4.65m @ 32.42m from profiler	
<b>Middle Cell Depth</b>	15.65m @ 21.42m from profiler	
<b>Net Depth</b>	16m	

Table 4.2: Deployment 2 ADCP Settings

Site Name	Cumbrae 2	
Deployment Position	55 45.223, 004 53.842 218270.163, 654952.937	Meter was recovered and redeployed on the same day, the coordinate was put into the GPS and meter deployed once the position had been reached. +/- 5m error on GPS
Deployment Date + Time	19th November 2017 @ 12:49	
Current Meter Recovered	9th January 2018 @ 11:00	
Meter Dragged	7th December 2018 @ 16:00	
Deployment Depth	38.9m @ 13:09	Depth taken immediately before deployment
Correction	3:34m	<a href="https://www.tidetimes.org.uk/millport-tide-times-20171119">https://www.tidetimes.org.uk/millport-tide-times-20171119</a>
Chart Datum	35.56m	
ADCP Type	Semtinel V 100	
Serial Number	20451	
Frequency	307	
Number of Cells	59	

Cell Size		1
First Cell Range		2.4
Number of Pings		200
Ping Interval		1
Start Date + Time	19/11/2017 @ 12:49	
Valid Data From	19/11/2017 @ 13:09	
Valid Data Ends	07/12/2017 @ 15:49	
Recovery Date + Time	09/01/2018 @11:09	
Minimum Depth Recorded	35.71m	+ 0.5m from profiler head to seabed
Bottom Cell Depth	33.29m @ 2.41m from profiler	
Surface Cell Depth	5.3m @ 30.41m from profiler	
Middle Cell Depth	16.3m @ 19.41m from profiler	
Net Depth	16m	

Table 4.3: Deployment 3 ADCP Settings

Site Name	Cumbræ 3	
Deployment Position	55 45.223, 004 53.842 218270.163, 654952.937	Meter was recovered and redeployed on the same day, the coordinate was put into the GPS and meter deployed once the position had been reached. +/- 5m error on GPS
Deployment Date + Time	9th January 2018 @ 16:50	
Current Meter Recovered	22nd February 2018 @ 10:50	
Deployment Depth	37.64m @ 16:58	Depth taken immediately before deployment
Correction	3:30m	<a href="https://www.tidetimes.org.uk/millport-tide-times-20171119">https://www.tidetimes.org.uk/millport-tide-times-20171119</a>
Chart Datum	34.34m	
ADCP Type	Sentinel V 100	
Serial Number	20451	

Frequency	307	
Number of Cells	49	
Cell Size	1	
First Cell Range	2.4	
Number of Pings	100	
Ping Interval	1	
Start Date + Time	09/01/2018 @ 16:18	
Valid Data From	09/01/2018 @ 17:18	
Valid Data Ends	22/02/2018 @ 10:38	
Recovery Date + Time	22/02/2018 @ 11:18	
Minimum Depth Recorded	33.54m	
Bottom Cell Depth	31.13m @ 2.41m from profiler	
Surface Cell Depth	5.13m @ 28.41m from profiler	
Middle Cell Depth	16.13m @ 17.41m from profiler	
Net Depth	16m	

## 5. Magnetic Variation

No magnetic variation correction was applied to the ADCP during the deployment. The magnetic variation was applied to the downloaded data during post processing. The magnetic variation for this deployment was 2.96°W which has been calculated using the World Magnetic Calculator: - [http://www.geomag.bgs.ac.uk/data\\_service/models\\_compass/wmm\\_calc.html](http://www.geomag.bgs.ac.uk/data_service/models_compass/wmm_calc.html)

## 6. Depth Survey

In order to map the bathymetry of the site depths were collected close to the time of deployment. A Simrad NSS7 evo2 echo sounder was used which logs depth, position and time directly to the laptop at 1 second intervals. Transducer depth was set at 0.4m below the surface and automatically corrected into depth data output. Prior to beginning the survey the system was manually checked against a Plastimo II hand held echo sounder and found to be accurate over three readings. There is no GPS offset required as the echo sounder transducer and gps antennae were positioned close together. The Belfield Software Tide Plotter ( <http://www.chartsandtides.co.uk/tideplotter> ) was used

to correct raw depth soundings to Chart Datum and the depth offset was given as 3.18m at 12:08 GMT on the 4<sup>th</sup> October 2017 for the Millport tidal port.

Following the collection and correction of soundings the results were used as bathymetry files in autoDepomod. The process involves converting the depth readings to Eastings and Northings and creating a CSV file which generates a contour map.

## 7. Meteorological Data

### Weather History Graph

October 29, 2017 - November 5, 2017

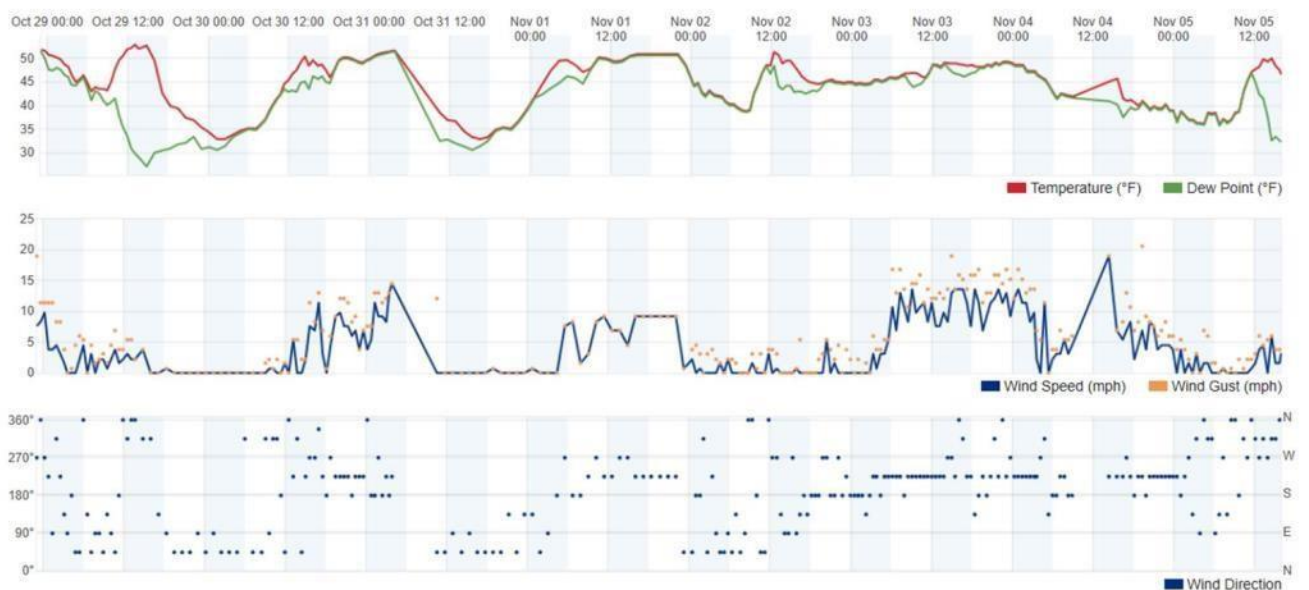


Figure 7.1: Weather data 29/10/17 to 05/11/17



### Weather History Graph

November 6, 2017 - November 13, 2017

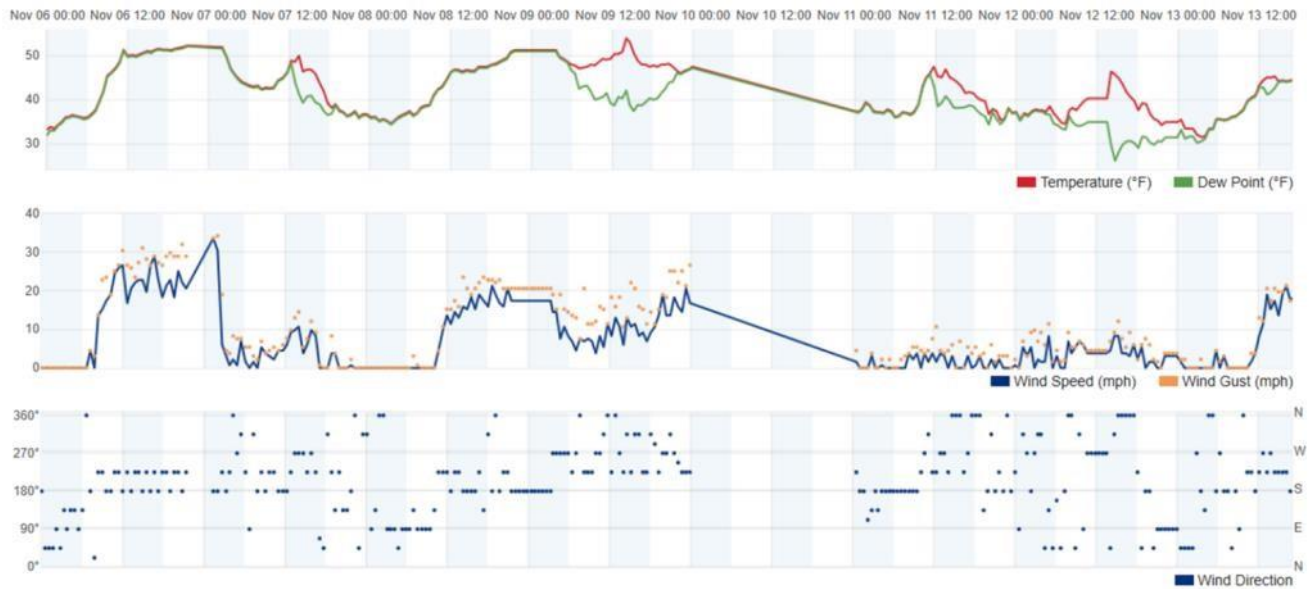


Figure 7.2: Weather Data 06/11/17 to 13/11/17

Weather data was recovered from the Wunderground website, data was taken from a weather station situated in the nearby coastal town of Inverkip at the position: 55 54.000'N, -004 52.140'W, 220724.671E, 671152.413N, Figure 7.3 shows the location in relation to the proposed Cumbrae farm. The data showed that there was at least 3 days of consecutive wind speed below 22 mph which equates to just under 10 m/s, the data is therefore considered to be suitable to allow the current data of this period to be used for modelling. Full data can be viewed at the link below:

<https://www.wunderground.com/personal-weatherstation/dashboard?ID=IINVERCL2#history/s20171106/e20171113/mweek>

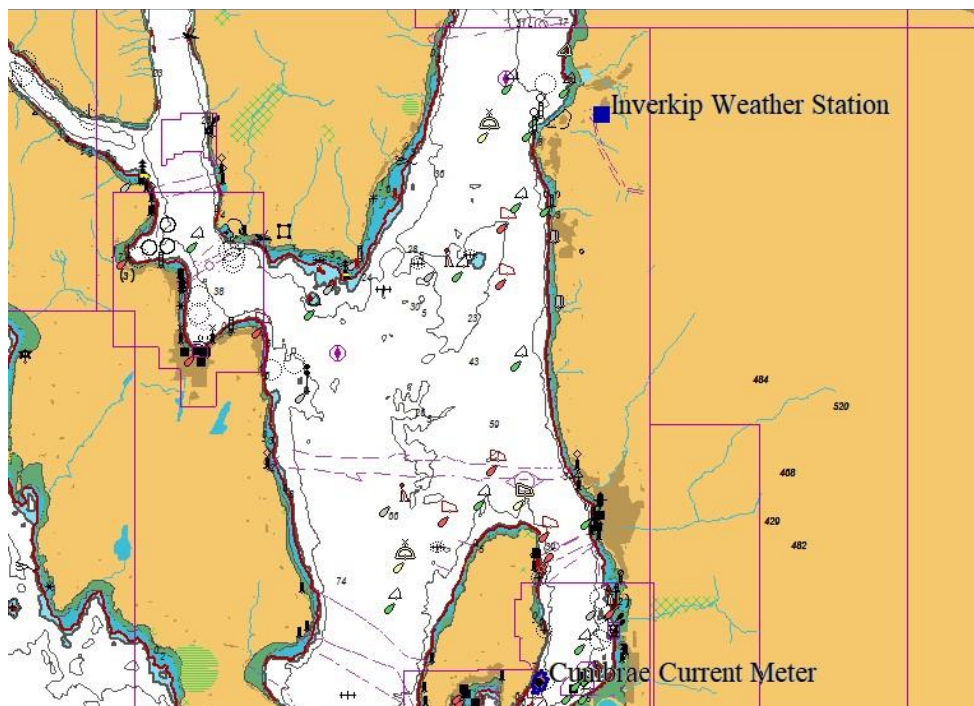


Figure 7.3: Location of Inverkip weather station in relation to proposed Cumbrae farm

## 8. Results and Discussion

All data was inputted to the HG analysis spreadsheets to allow consideration of the full deployments. Once the full range of data were identified a median data set was extracted and processed as a 15 day data set for use in autoDepomod modelling. Figures 8.1 – 8.21 and tables 8.1 – 8.15 show the analysis of the full deployment periods of the two deployments. Figures 8.22 – 8.28 and tables 8.16 – 8.18 show the analysis of the 15 days data for use in autoDepomod modelling.

\*note depths in figures 8.1 – 8.21 have not been corrected for transducer depth (0.5m) but Tables 8.1 – 8.15 have been

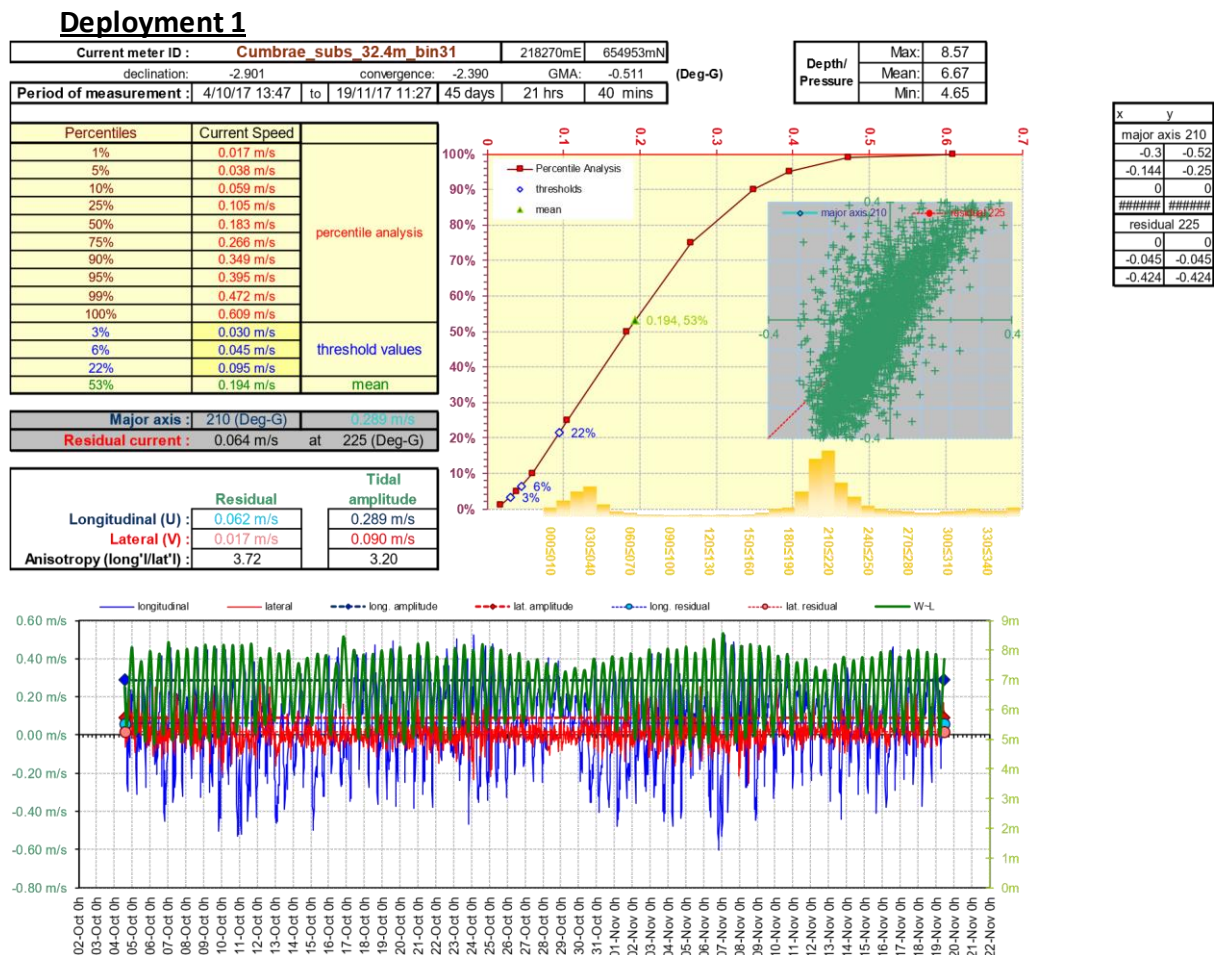


Figure 8.1: HG analysis sheet summary Deployment 1 - Surface

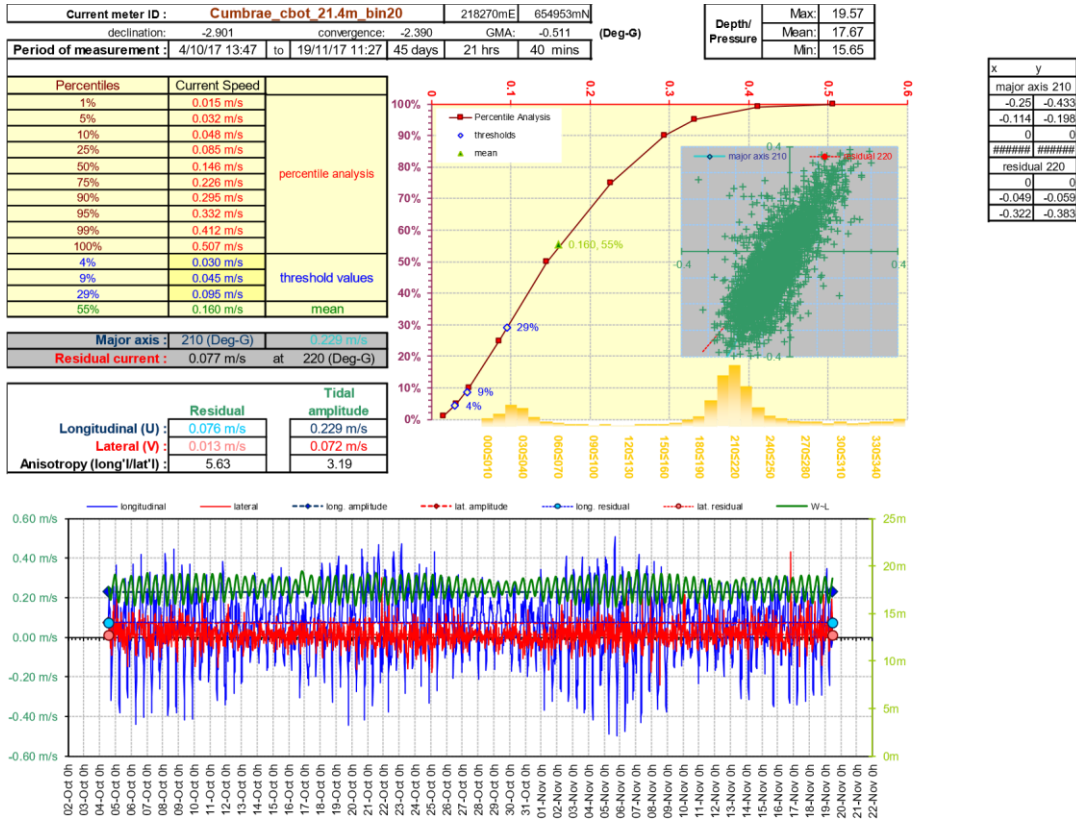


Figure 8.2: HG analysis sheet summary Deployment 1 - Net bottom

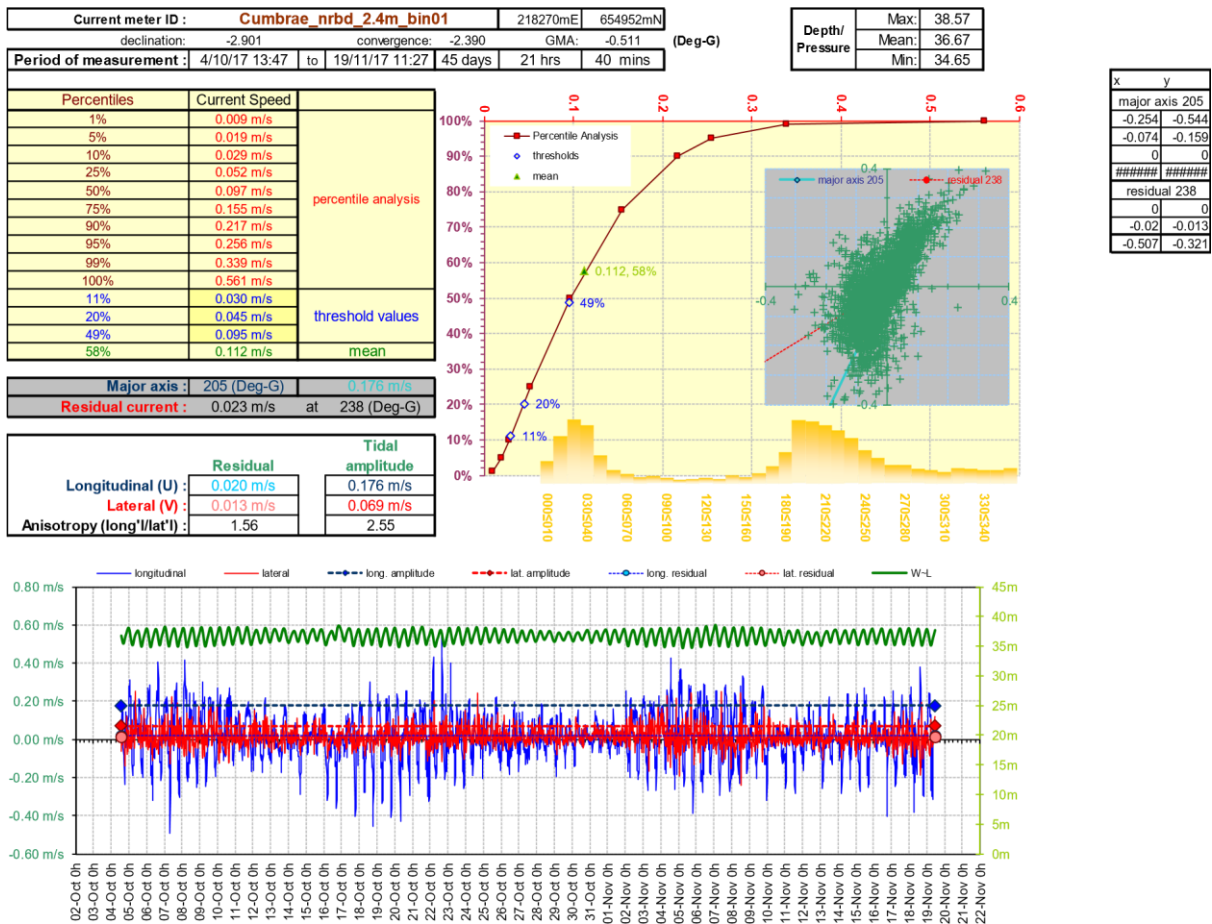


Figure 8.3: HG analysis sheet summary Deployment 1 – Bottom

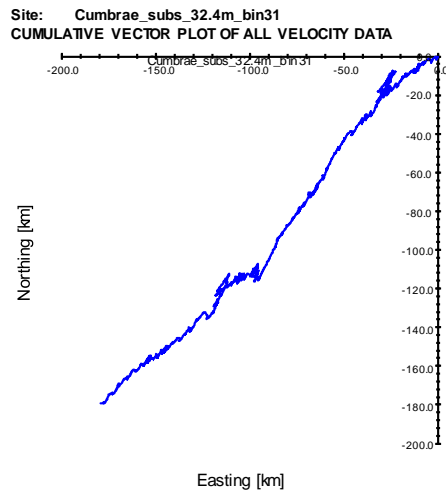


Figure 8.4: Cumulative vector plot Deployment 1 - surface

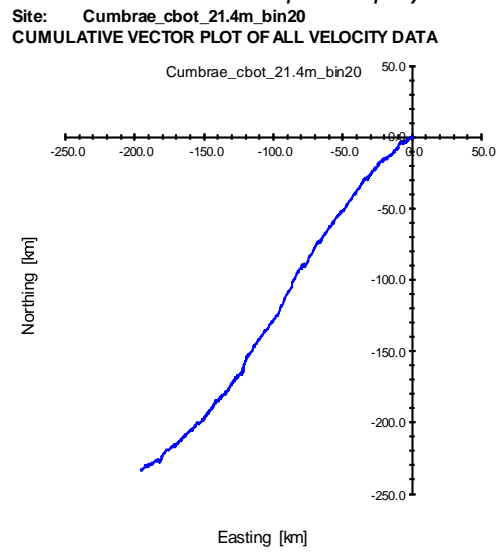


Figure 8.5: Cumulative vector plot Deployment 1 - net bottom

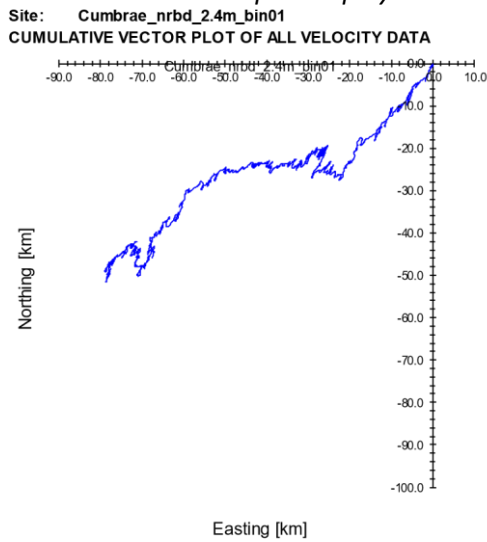


Figure 8.6: Cumulative vector plot bottom

Table 8.1: Recorded depths over deployment period

	Date	Height (m)
<b>Highest Depth Recorded</b>	07/11/2018	40.99
<b>Lowest Depth Recorded</b>	05/11/2017	37.07
<b>Tidal Range Recorded</b>	-	3.92

Table 8.2: Predicted Tidal data at nearest tidal port to monitoring site

Nearest tidal port	Tidal state	High water (GMT)	Height (m)	Low Water (GMT)	Height (m)
Millport	Spring	08/10/2017 02:24	3.57	08/10/2017 07:59	0.18
	Neap	14/10/2017 08:09	2.78	14/10/2017 14:08	1.08

Table 8.3: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
<b>Surface</b>	32.9	4.95	19.4	53
<b>Net bottom</b>	21.9	15.95	16.0	55
<b>Bottom</b>	2.9	34.95	11.2	58

Table 8.4: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
<b>Surface</b>	3	94	78	210
<b>Net bottom</b>	4	91	71	210
<b>Bottom</b>	11	80	51	205

Table 8.5: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
<b>Surface</b>	0.194	0.064	0.062	0.017	0.289	0.090
<b>Net Bottom</b>	0.160	0.077	-	-	-	-

Bottom	0.112	0.023	-	-	-	-
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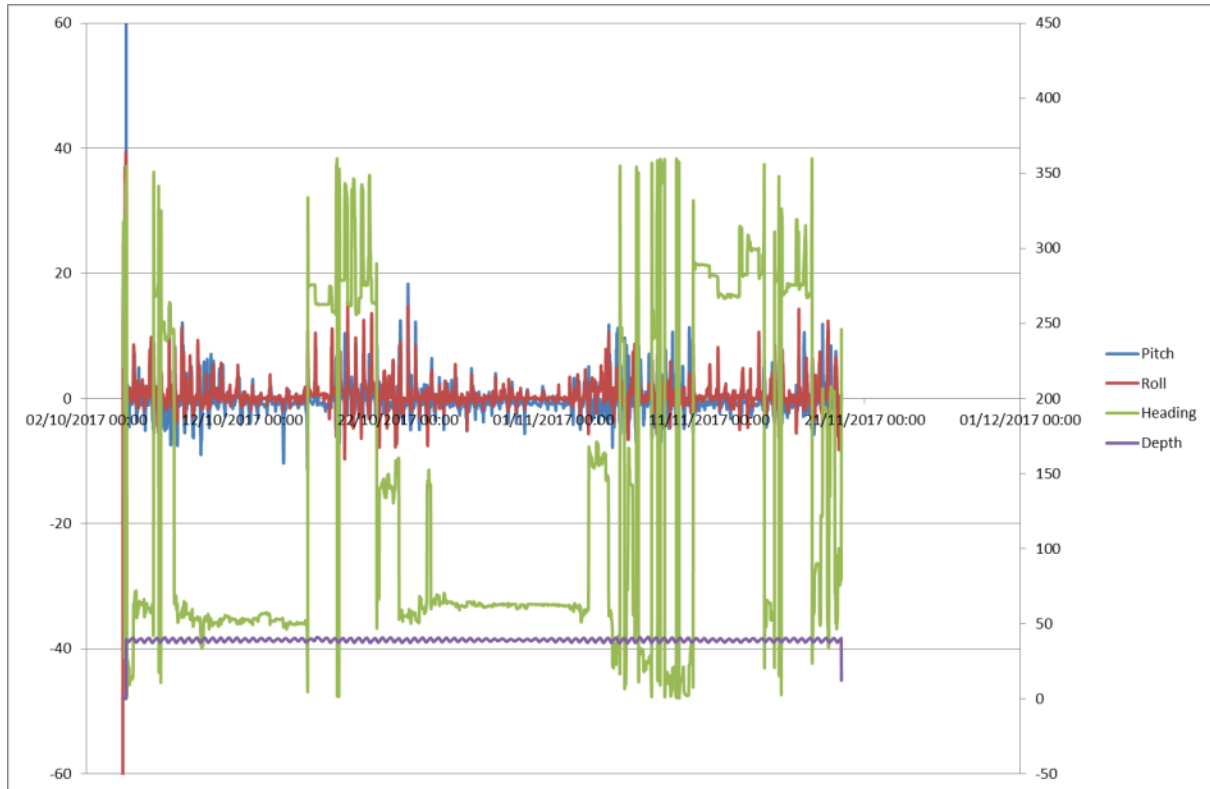


Figure 8.7: Graph of heading, pitch, roll and depth during Deployment 1

## Deployment 2

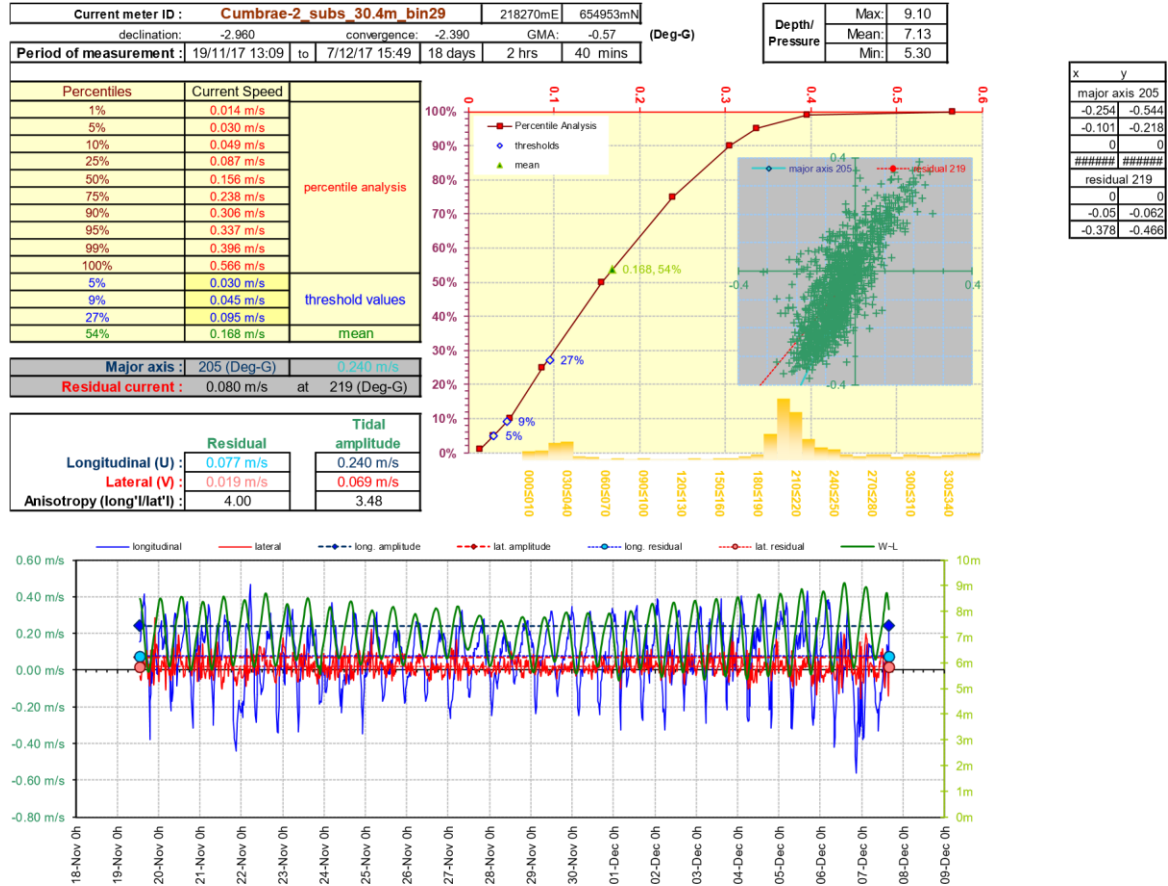


Figure 8.8: HG analysis sheet summary Deployment 2 - Surface

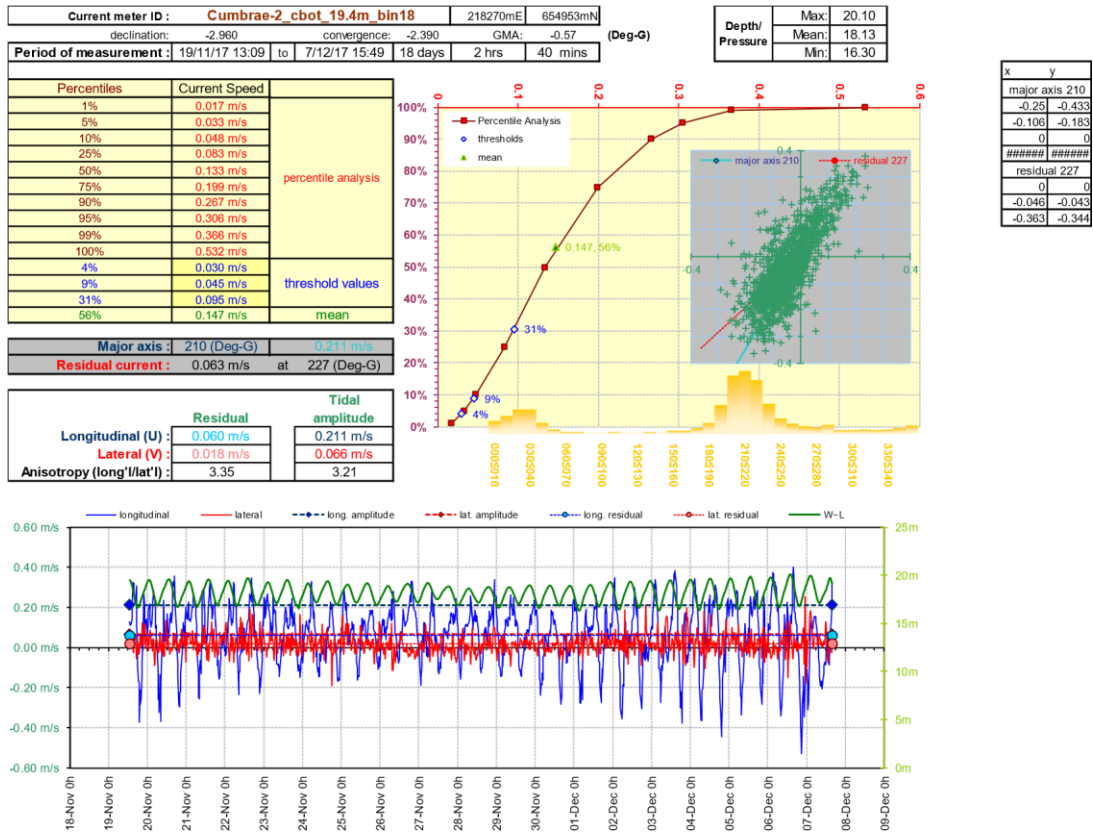


Figure 8.9: HG analysis sheet summary Deployment 2 - Net bottom

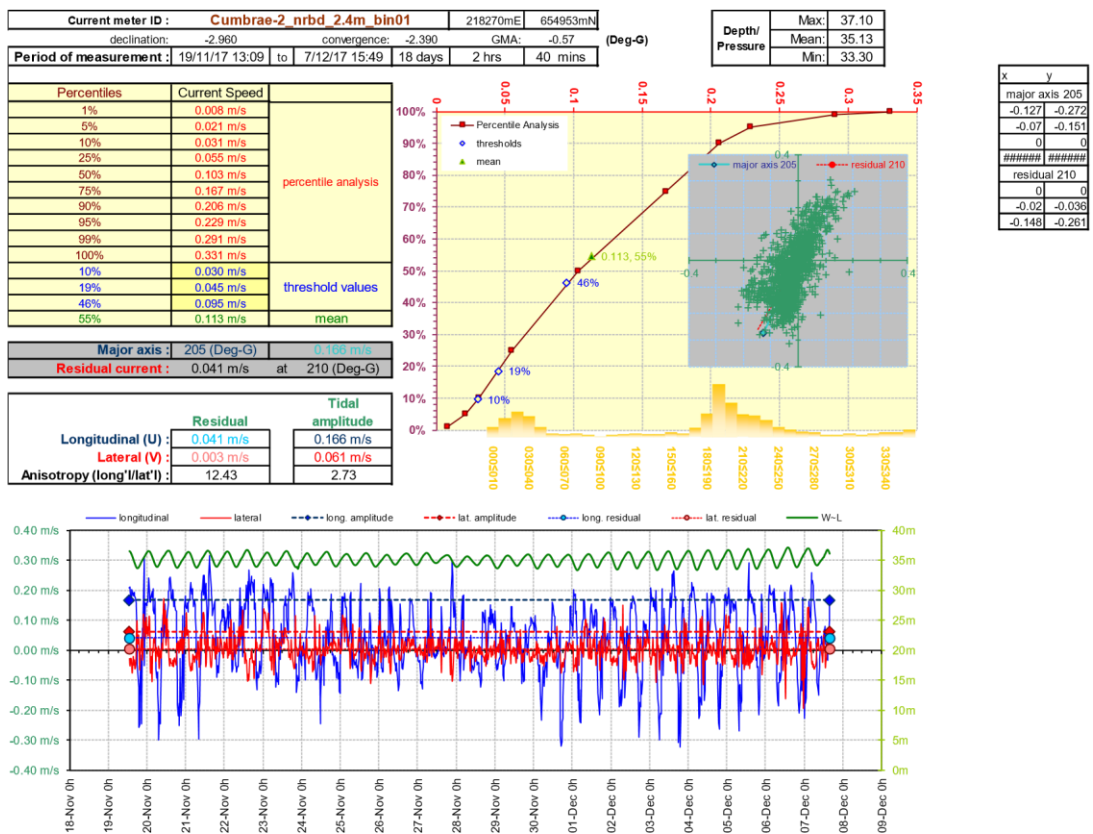
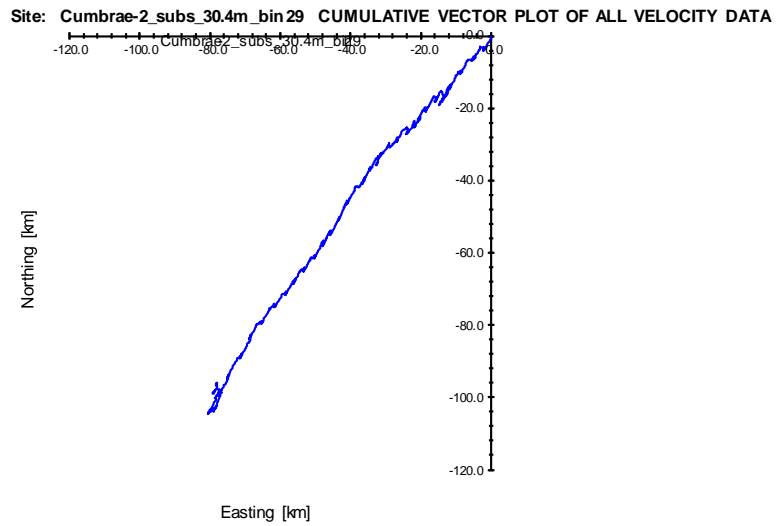


Figure 8.10: HG analysis sheet summary Deployment 2 - Bottom





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Figure 8.11: Cumulative vector plot Deployment 2 - surface

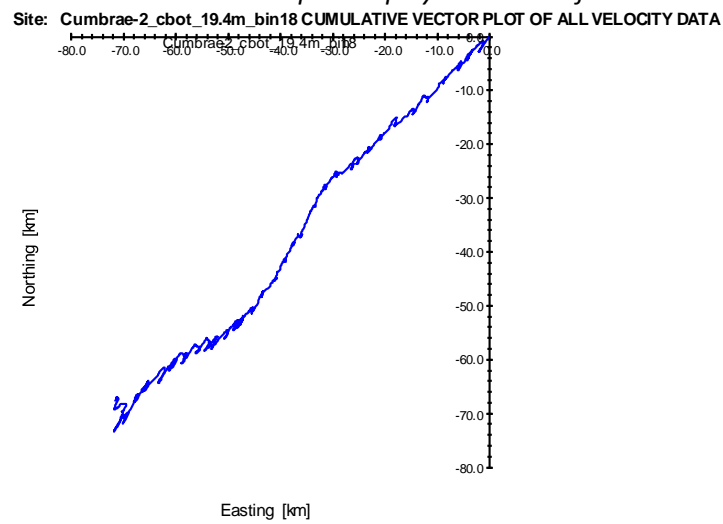


Figure 8.12: Cumulative vector plot Deployment 2 - net bottom

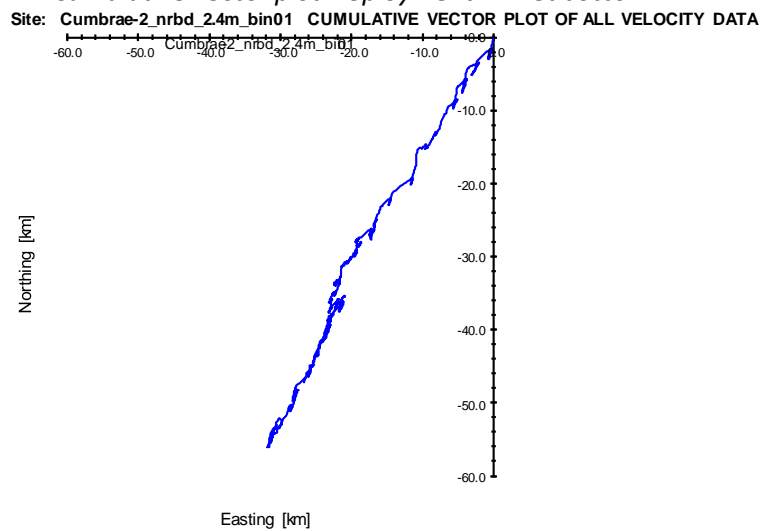


Figure 8.13: Cumulative vector plot Deployment 2 - bottom Table 8.6: Recorded depths over deployment period

	Date	Height (m)
<b>Highest Depth Recorded</b>	06/12/2017	47.56
<b>Lowest Depth Recorded</b>	07/12/2017	43.32
<b>Tidal Range Recorded</b>	-	4.24

Table 8.7: Predicted Tidal data at nearest tidal port to monitoring site - Millport

Nearest tidal port	Tidal state	High water (GMT)	Height (m)	Low Water (GMT)	Height (m)
Millport	Spring	06/12/2017 13:49	3.74	06/12/2017 19:29	0.29
	Neap	12/12/2017 07:43	2.94	12/12/2017 13:15	1.08

Table 8.8: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
<b>Surface</b>	30.9	5.8	16.8	54
<b>Net bottom</b>	19.9	16.8	14.7	56
<b>Bottom</b>	2.9	33.8	11.3	55

Table 8.9: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
<b>Surface</b>	5	91	73	205
<b>Net bottom</b>	4	91	69	210
<b>Bottom</b>	10	81	54	205

Table 8.10: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
<b>Surface</b>	0.168	0.080	0.077	0.019	0.240	0.069
<b>Net Bottom</b>	0.147	0.063	-	-	-	-
<b>Bottom</b>	0.113	0.041	-	-	-	-

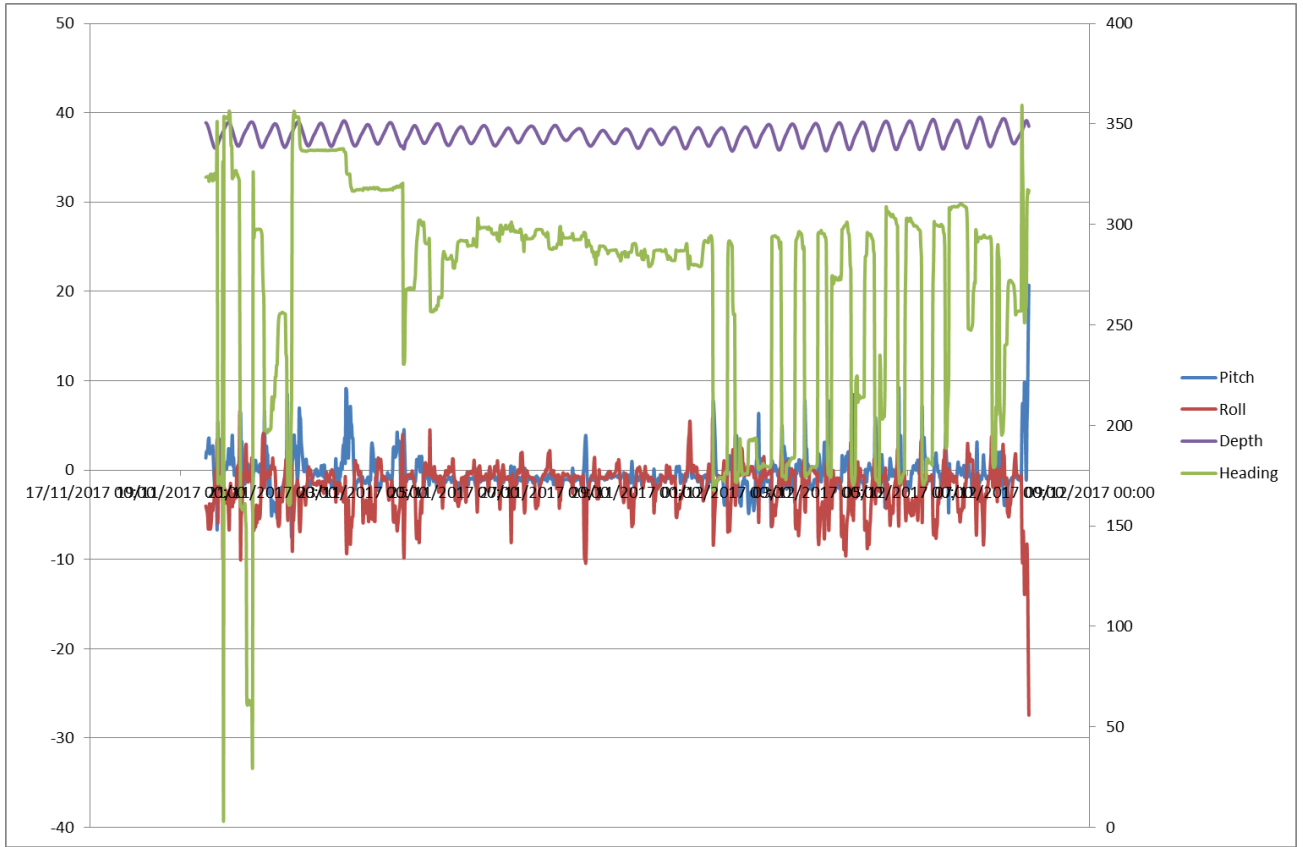


Figure 8.14: Graph of heading, pitch, roll and depth during Deployment 2

### Deployment 3

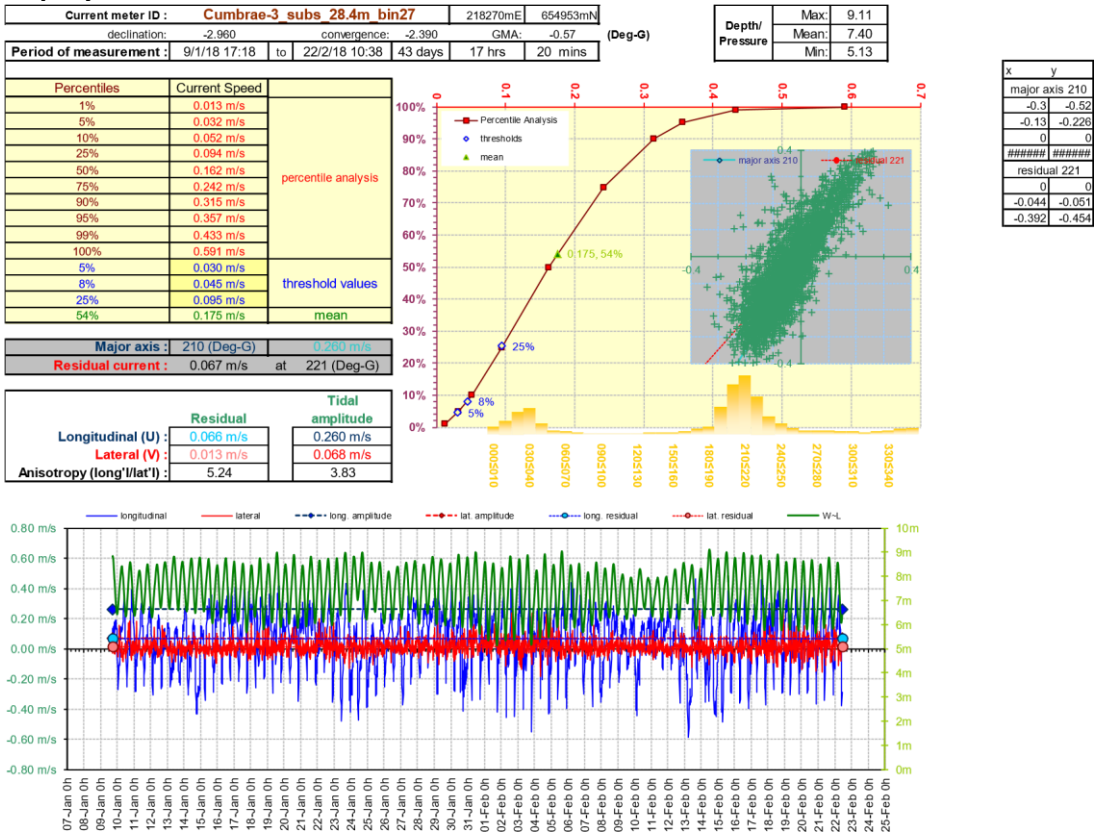


Figure 8.15: HG analysis sheet summary Deployment 3 - Surface

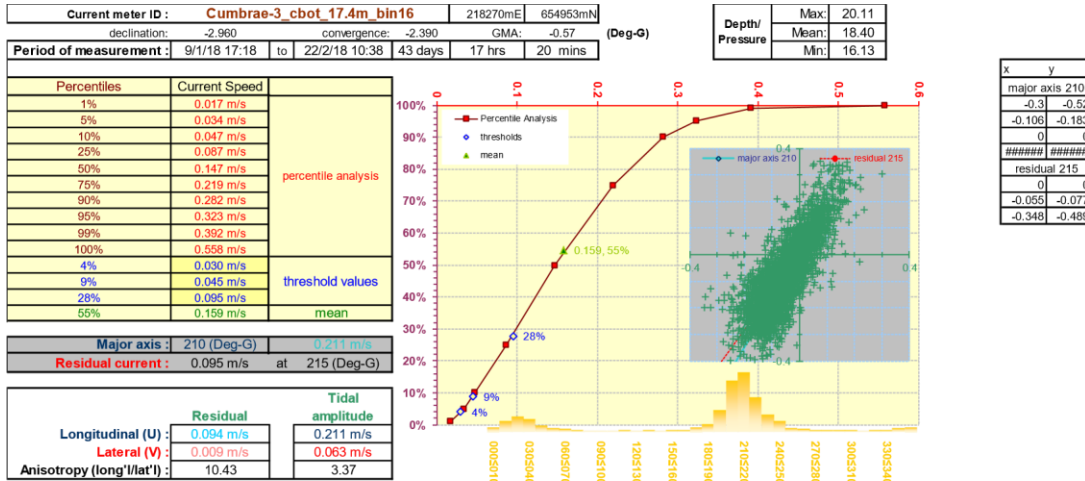


Figure 8.16: HG analysis sheet summary Deployment 3- Net bottom

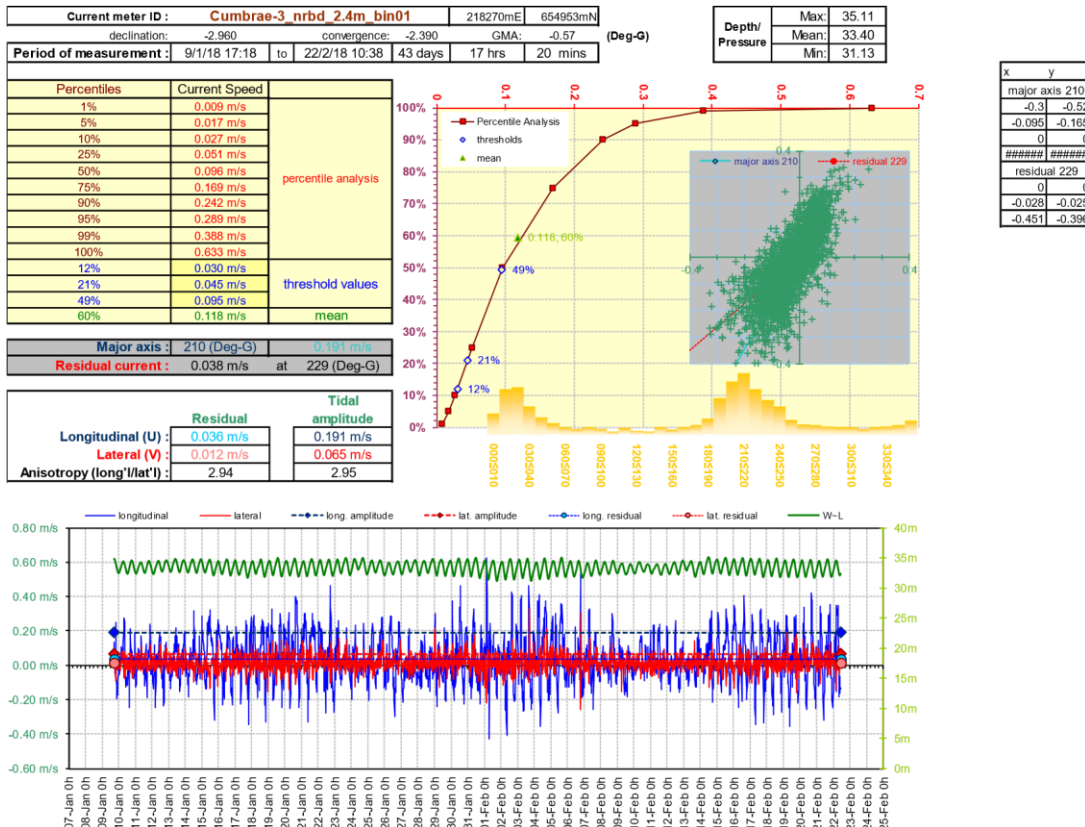


Figure 8.17: HG analysis sheet summary Deployment 3 - Bottom

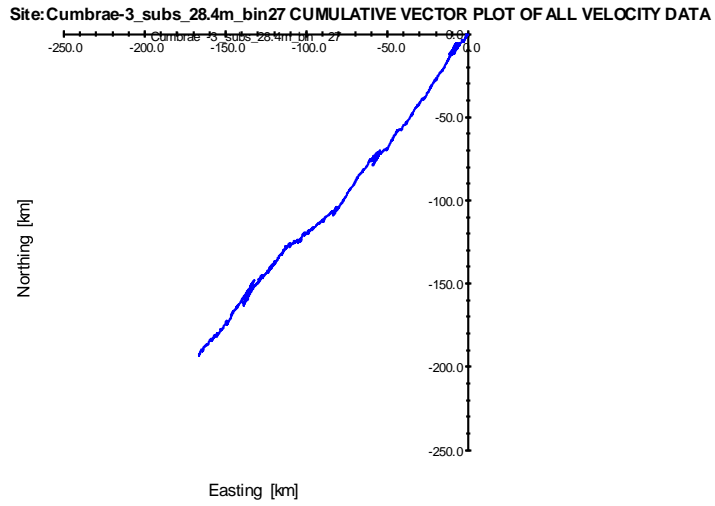


Figure 8.18: Cumulative vector plot Deployment 3 - surface

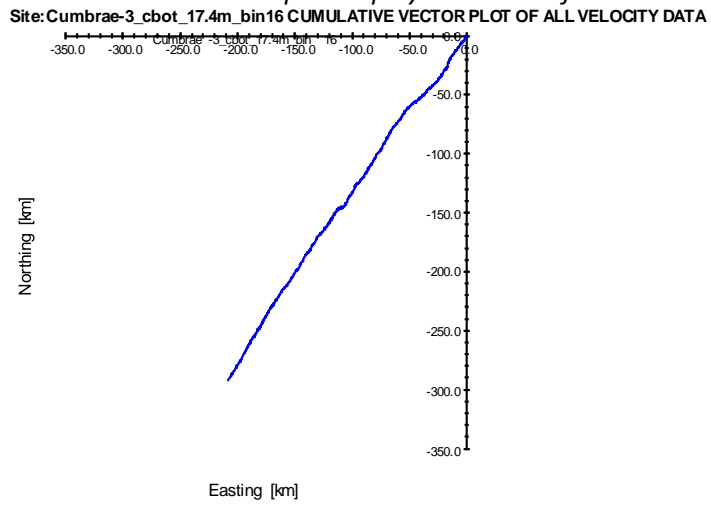


Figure 8.19: Cumulative vector plot Deployment 3 - net bottom

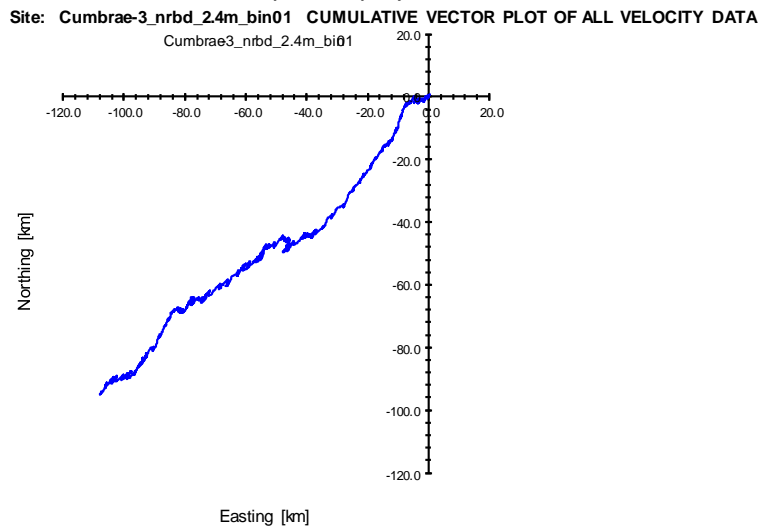


Figure 8.20: Cumulative vector plot Deployment 3 - bottom Table 8.11: Recorded depths over deployment period

	Date	Height (m)

<b>Highest Depth Recorded</b>	14/02/2018	37.52
<b>Lowest Depth Recorded</b>	01/02/2018	33.54
<b>Tidal Range Recorded</b>	-	3.98

Table 8.12: Predicted Tidal data at nearest tidal port to monitoring site

Nearest tidal port	Tidal state	High water (GMT)	Height (m)	Low Water (GMT)	Height (m)
Millport	Spring	02/02/2018 13:25	3.81	02/02/2018 19:03	0.22
	Neap	27/12/2017 06:10	3.01	27/12/2017 12:00	1.04

Table 8.13: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
Surface	28.9	5.63	17.5	54
Net bottom	17.9	16.63	15.9	55
Bottom	2.9	31.63	11.8	60

Table 8.14: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	5	92	75	210
Net bottom	4	91	72	210
Bottom	12	79	51	210

Table 8.15: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Surface	0.175	0.067	0.066	0.013	0.260	0.068
Net Bottom	0.159	0.095	-	-	-	-
Bottom	0.118	0.038	-	-	-	-

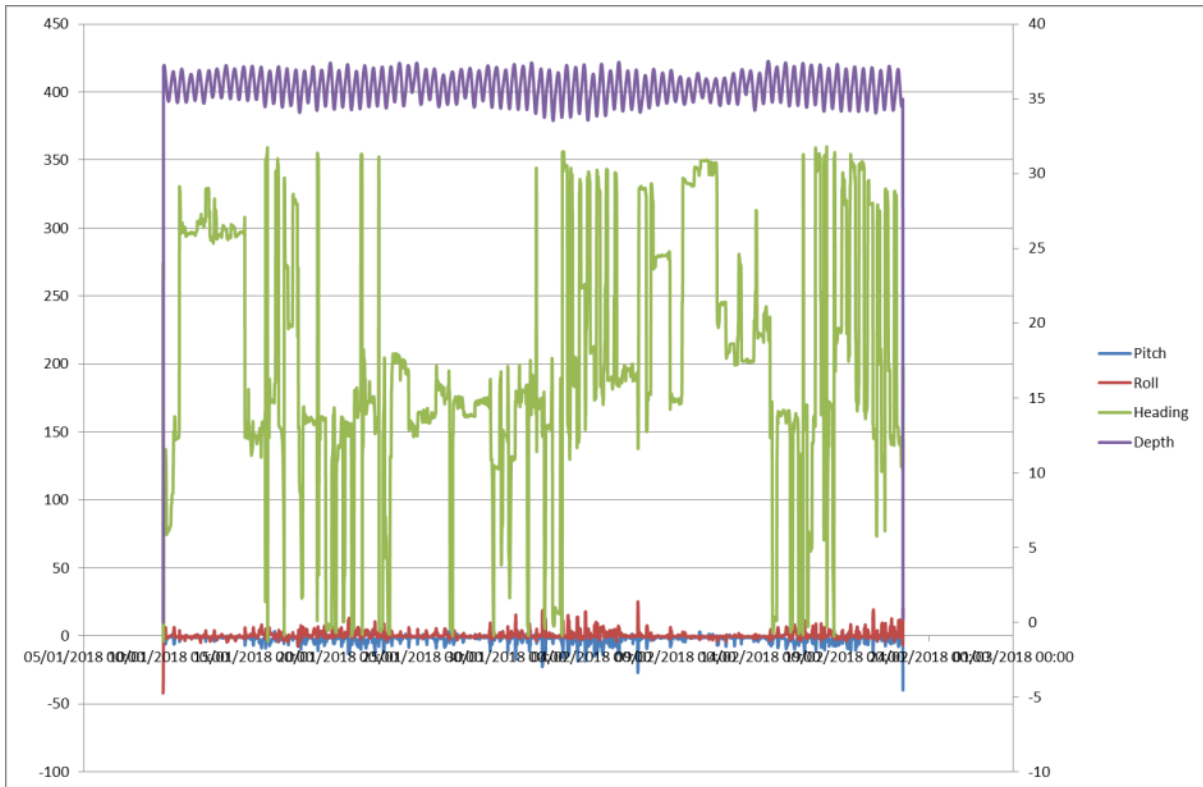


Figure 8.21: Graph of heading, pitch, roll and depth during Deployment 3

### 15 Days Data for Modelling

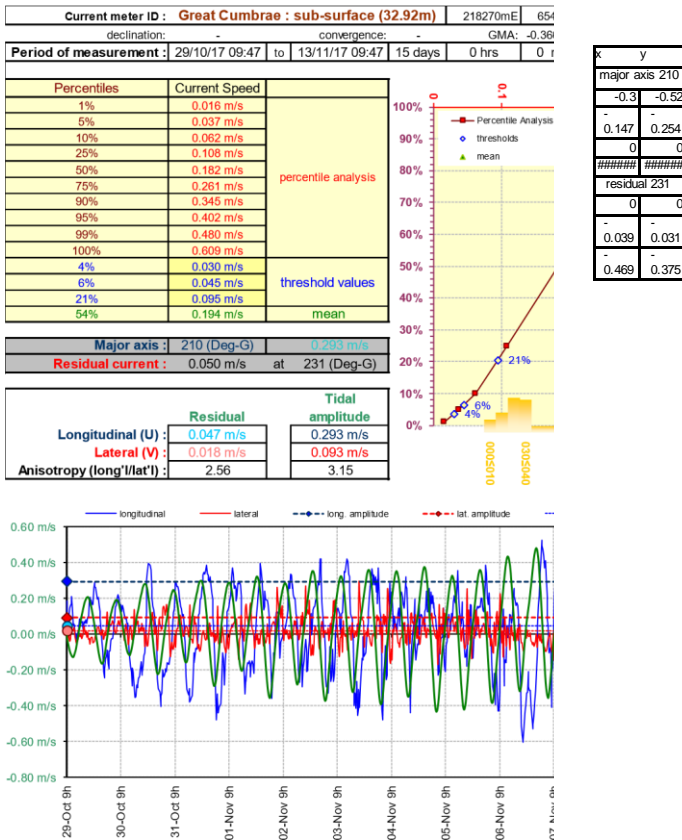
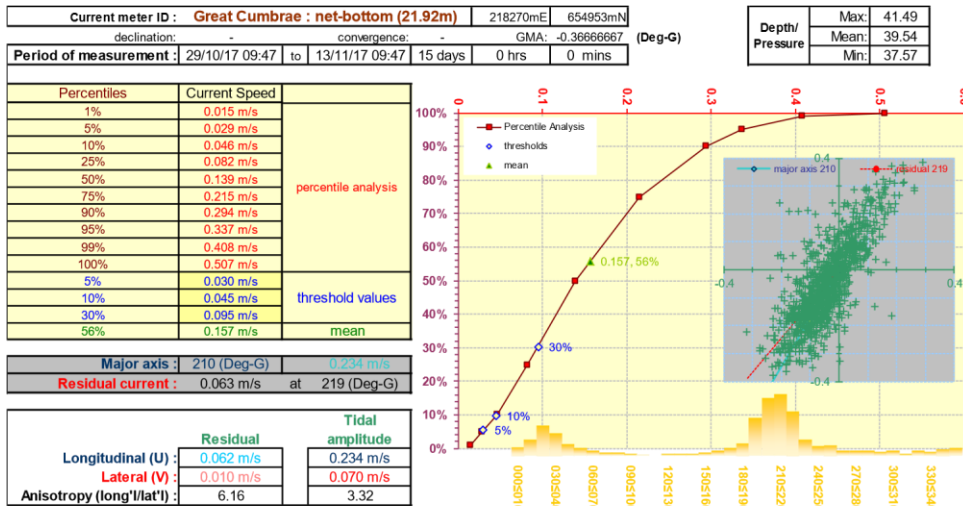
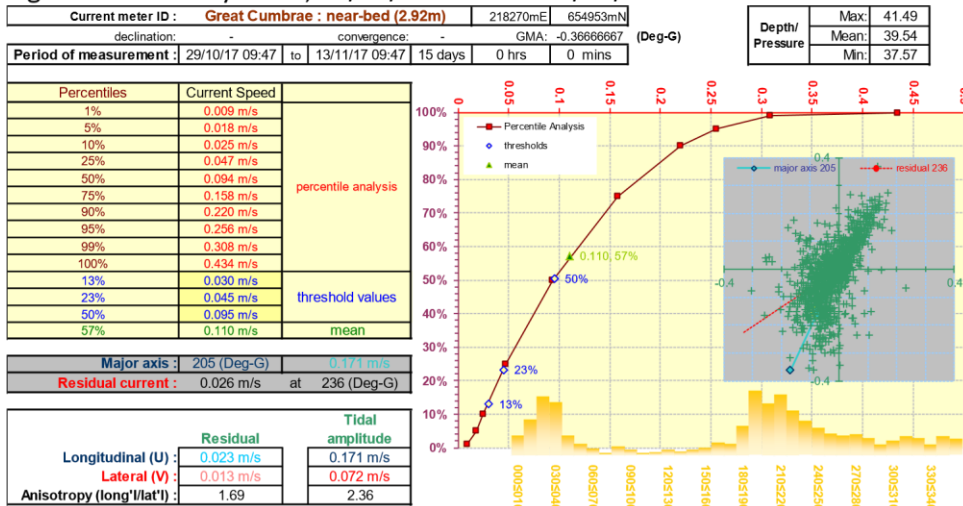


Figure 8.22: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Surface



x	y
major axis 210	
-0.25	-0.433
-0.117	-0.202
0	0
#####	#####
residual 219	
0	0
-0.04	-0.049
-0.316	-0.387

Figure 8.23: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Middle



x	y
major axis 205	
-0.169	-0.363
-0.072	-0.155
0	0
#####	#####
residual 236	
0	0
-0.022	-0.015
-0.33	-0.226

Figure 8.24: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Bottom



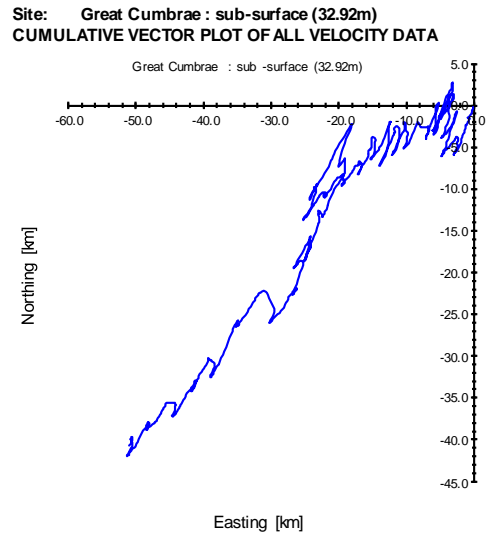


Figure 8.25: 15 days current data Cumulative Vector Plot – Surface

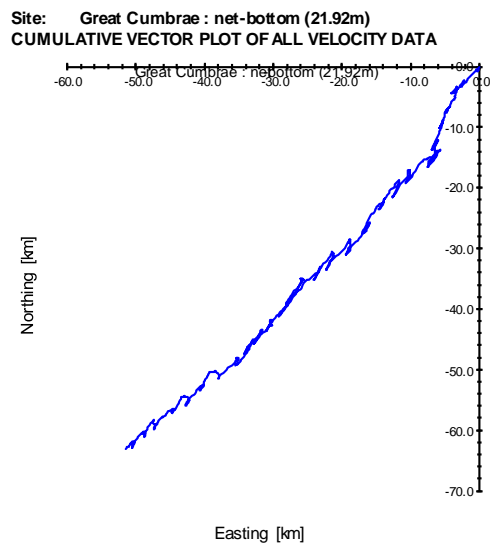


Figure 8.26: 15 days current data Cumulative Vector Plot – Middle

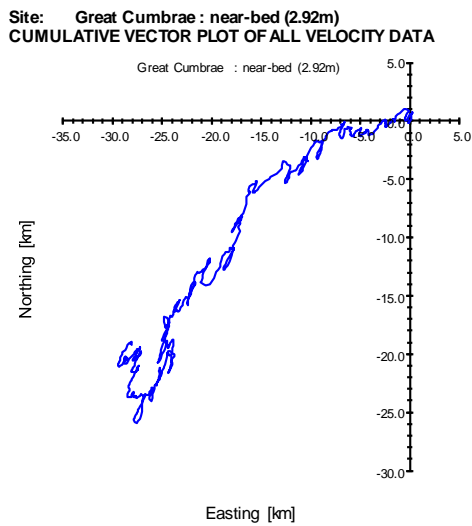


Figure 8.27: 15 days current data Cumulative Vector Plot – Bottom



Figure 8.28: Heading, Depth, Pitch and Roll over the 15 days analysed

Table 8.16: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
Surface	32.92	4.65	19.4	54
Net bottom	21.92	15.65	15.7	56
Bottom	2.92	34.65	11.0	57

Table 8.17: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	4	94	79	210
Net bottom	5	90	70	210
Bottom	13	77	50	205

Table 8.18: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Surface	0.194	0.050	0.047	0.018	0.293	0.093

<b>Net Bottom</b>	0.157	0.063	-	-	-	-
<b>Bottom</b>	0.110	0.026	-	-	-	-

### 9. Depth Survey Results



Figure 9.1: Cumbrae depth survey results plotted on Seapro

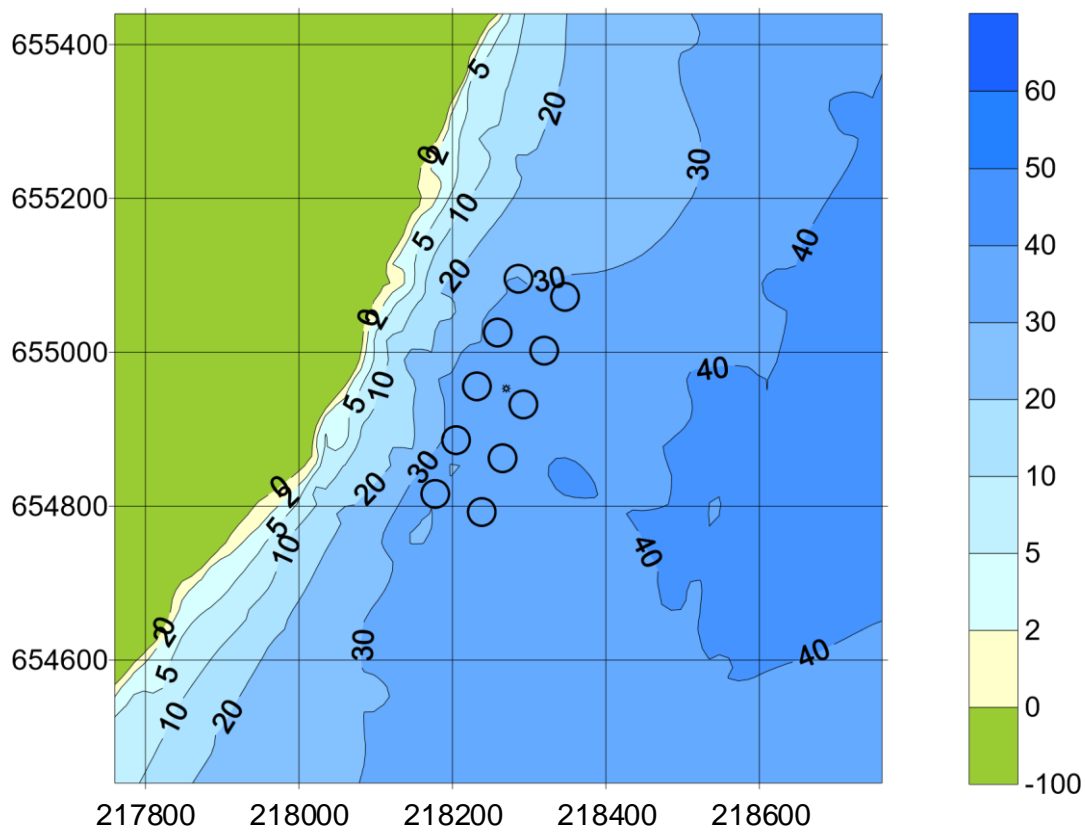


Figure 9.2: Contour map created from depth survey and charted depths

Table 9.1: Extract from full Cumbrae depth survey 4th October 2017

				OSGB E	OSGB N	04-Oct-17	UTC		Measured Depth	Correction	chart datum
55	45.048	4 W	54.116	2179743	6546457		12:08:30		21.6	3.18	18.42
55	45.047	4 W	54.114	2179763	6546438		12:08:31		22.1	3.18	18.92
55	45.046	4 W	54.112	2179783	6546418		12:08:32		22.6	3.18	19.42
55	45.044	4 W	54.109	2179813	654638		12:08:33		22.9	3.18	19.72
55	45.044	4 W	54.107	2179834	6546379		12:08:34		23.3	3.18	20.12
55	45.043	4 W	54.104	2179864	6546359		12:08:35		23.6	3.18	20.42
55	45.042	4 W	54.102	2179885	654634		12:08:36		24	3.18	20.82
55	45.041	4 W	54.100	2179905	654632		12:08:37		24.2	3.18	21.02
55	45.040	4 W	54.098	2179925	6546301		12:08:38		24.6	3.18	21.42
55	45.039	4 W	54.095	2179955	6546281		12:08:39		24.8	3.18	21.62
55	45.038	4 W	54.093	2179976	6546262		12:08:40		25.1	3.18	21.92
55	45.037	4 W	54.091	2179996	6546242		12:08:41		25.3	3.18	22.12
55	45.036	4 W	54.089	2180016	6546223		12:08:42		25.6	3.18	22.42

55	45.035	4 W	54.086	2180046	6546203	12:08:43	25.8	3.18	22.62
55	45.034	4 W	54.084	2180067	6546184	12:08:44	26	3.18	22.82
55	45.033	4 W	54.082	2180087	6546164	12:08:45	26.2	3.18	23.02
55	45.032	4 W	54.079	2180117	6546144	12:08:46	26.4	3.18	23.22
55	45.032	4 W	54.077	2180138	6546143	12:08:47	26.6	3.18	23.42
55	45.031	4 W	54.075	2180158	6546124	12:08:48	26.7	3.18	23.52
55	45.030	4 W	54.072	2180189	6546104	12:08:49	26.9	3.18	23.72
55	45.029	4 W	54.070	2180209	6546085	12:08:50	27	3.18	23.82
55	45.029	4 W	54.068	218023	6546084	12:08:51	27.1	3.18	23.92
55	45.028	4 W	54.066	218025	6546064	12:08:52	27.2	3.18	24.02
55	45.027	4 W	54.063	2180281	6546045	12:08:53	27.4	3.18	24.22
55	45.026	4 W	54.061	2180301	6546025	12:08:54	27.5	3.18	24.32
55	45.026	4 W	54.059	2180322	6546024	12:08:55	27.6	3.18	24.42
55	45.025	4 W	54.056	2180352	6546004	12:08:56	27.6	3.18	24.42
55	45.024	4 W	54.054	2180373	6545985	12:08:57	27.6	3.18	24.42
55	45.023	4 W	54.052	2180393	6545966	12:08:58	27.7	3.18	24.52
55	45.022	4 W	54.050	2180413	6545946	12:08:59	27.7	3.18	24.52
55	45.021	4 W	54.048	2180433	6545927	12:09:00	27.9	3.18	24.72
55	45.020	4 W	54.045	2180464	6545907	12:09:01	27.8	3.18	24.62
55	45.020	4 W	54.043	2180484	6545906	12:09:02	27.9	3.18	24.72
55	45.019	4 W	54.041	2180505	6545887	12:09:03	28	3.18	24.82
55	45.018	4 W	54.038	2180535	6545867	12:09:04	28.1	3.18	24.92
55	45.017	4 W	54.036	2180555	6545847	12:09:05	28.3	3.18	25.12
55	45.017	4 W	54.033	2180587	6545846	12:09:06	28.5	3.18	25.32
55	45.016	4 W	54.030	2180617	6545826	12:09:07	28.7	3.18	25.52
55	45.015	4 W	54.027	2180648	6545806	12:09:08	29	3.18	25.82
55	45.014	4 W	54.025	2180668	6545787	12:09:09	29.2	3.18	26.02
55	45.014	4 W	54.023	2180689	6545786	12:09:10	29.4	3.18	26.22

*\*Full depth survey was comprised of 4,061 readings and will therefore be appended to the final submission*

## **10. Conclusions**

The pitch and roll of the transducer was to a large extent reliant on the state of tide, it was apparent that during spring tides the meter displayed higher readings of pitch and roll. The high energy nature of the site did make data collection challenging although for the majority of the deployment period the meter remained comfortably within the operable tolerances of the instrumentation used with only isolated peaks out with those tolerances. The variations in heading through the 3 deployments were larger but such variations in heading are due to the use of an inline frame which was used as the location was predicted to be a high energy location particularly suited to the use of an inline frame. The Sentinel V 100 corrects the direction of current against the heading reading for each ping therefore the data is largely unaffected by the movement in heading even mid reading. The heading graph was also impacted by the movement between 359 Degrees and 0 degrees which gives a visual representation that unduly highlights the movement in heading.

Measured depths during the depth survey correspond closely to those recorded by the pressure sensor during deployment. A comprehensive depth survey was used to generate the contour map for use with autoDepomod and this was generally consistent with charted depths.

Average daily windspeed was below 10 m/s for a period greater than 3 consecutive days

The 15 days current data is considered to be representative of the likely average conditions at the proposed Cumbrae location. The analysis of the 15 days of data is consistent with the analysis of the full data sets and give confidence that the data is acceptable for autoDepomod modelling. The site and hydrographic survey reported in this document is considered to comply with the requirements of Attachment VIII and the current speed and direction are considered to be representative of the proposed Cumbrae location.