Macleans Nose North

HYDROGRAPHIC DATA REPORT
22ND MARCH 2017 – 3RD JULY 2017

[redacted]

CONTENTS

LIST OF FIGURES

LIST OF TABLES

QUALITY ASSURANCE

Marine Harvest (Scotland) Ltd is ISO9001 and ISO14001 accredited and all project management follows policies designed to ensure that the collection, collation and reporting of information produced in the course of our operations is done to a consistently high standard meeting the requirements of the end user.

1. Introduction

Marine Harvest (Scotland) Ltd is preparing an application to the planning authority and the Scottish Environmental Protection Agency (SEPA) to increase production at Macleans Nose salmon farming site. Marine Harvest (Scotland) Ltd proposes to install 16 pens, with 16m deep nets, which will be held in 75m grid, at an orientation of 160° (Figure 1). The maximum standing biomass likely to be applied for is 3,500 tonnes.

Marine Harvest (Scotland) Ltd staff carried out a hydrographic survey at the site during 2017. Hydrographic data at two sites ("Macleans Nose North" and "Macleans Nose South") were gathered during the period between 22nd March 2017 and the 3rd July 2017 in two deployments:

(i) 22nd March – 4th May 2017
(ii) 5th May – 3rd July 2017

This report describes the data from both deployments at Maclean Nose North. The purpose of the report is to assess the suitability of the collected hydrographic data for input into a hydrodynamic model of the Macleans Nose region and also into the NewDepomod model.

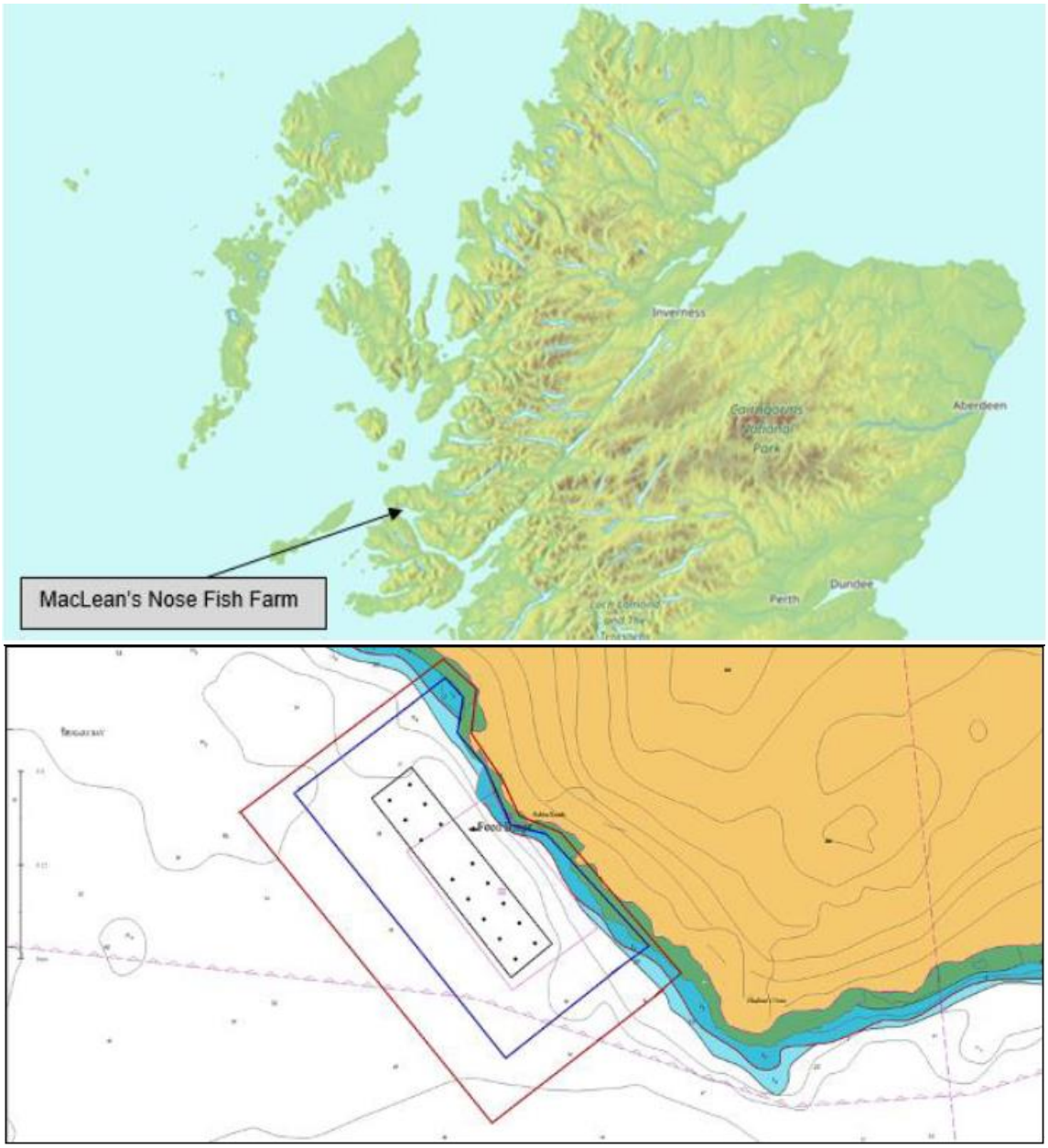

Figure 1. Site location (top) and proposed pen setup (bottom).

2. Materials & Methods

2.1 Depth Survey

Bathymetry data for the study area was obtained by combining regional bathymetry with a local depth survey. Regional scale bathymetry was extracted from numerical models of the Scottish shelf, which utilised a variety of sources (e.g. digital bathymetry datasets, Admiralty charts and multibeam surveys). The regional scale bathymetry was supplemented by a local depth survey conducted by Anderson Marine Surveys Ltd in March 2017 (Figure 2). The local survey covered an area of *ca.* 2 km^2.

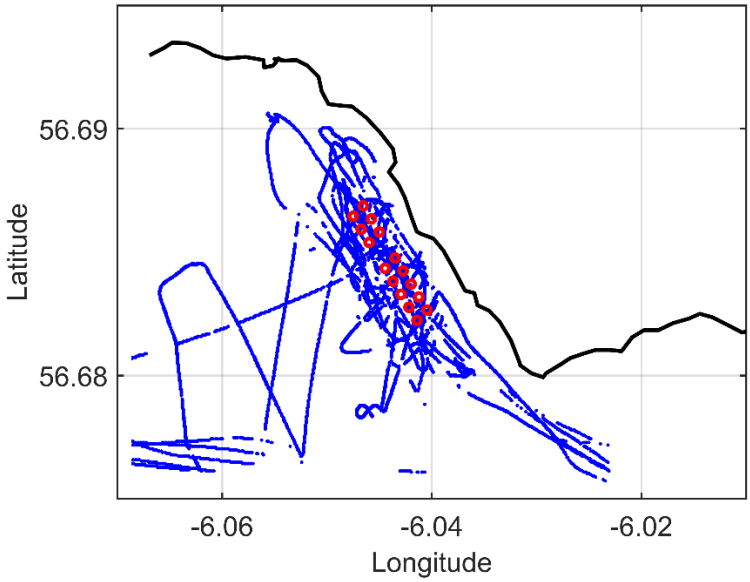

Figure 2. Bathymetry survey – spot depth locations collected by Anderson Marine Surveys Ltd on behalf of Marine Harvest. Proposed cage locations are indicated (**o**).

Measured depths ranged from -2.7 m in the inshore area to 100 m north-east of the cage group (Figure 3). These local data were merged with the regional scale bathymetry to generate a bathymetry map of the site area (Figure 4), which was consistent with expected values according to UK Admiralty data.

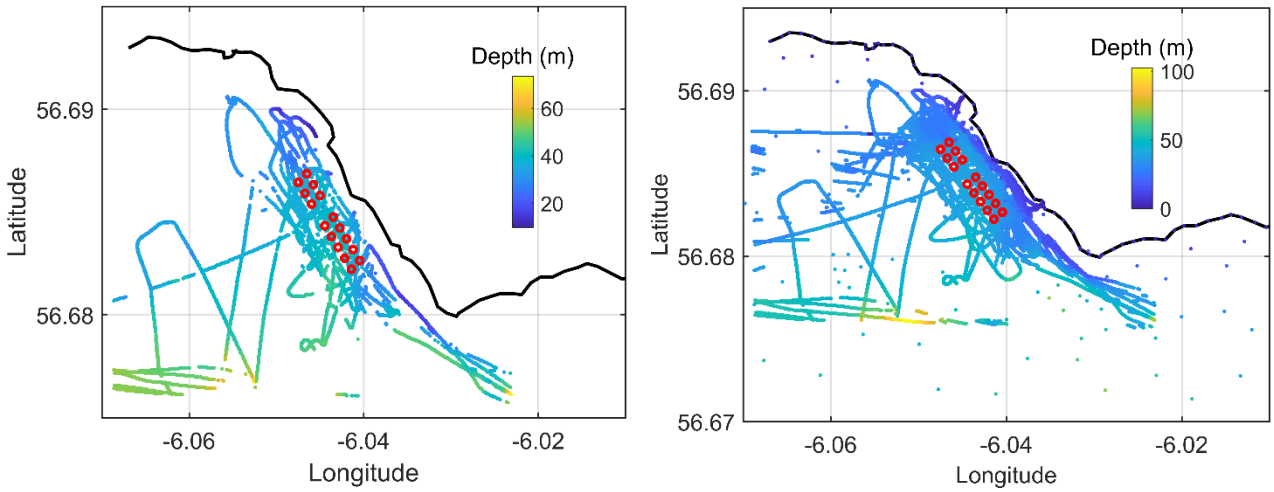

Figure 3. Spot depths collected by Marine Harvest (left) combined with additional depth data (right). Proposed cage locations are indicated (**o**).

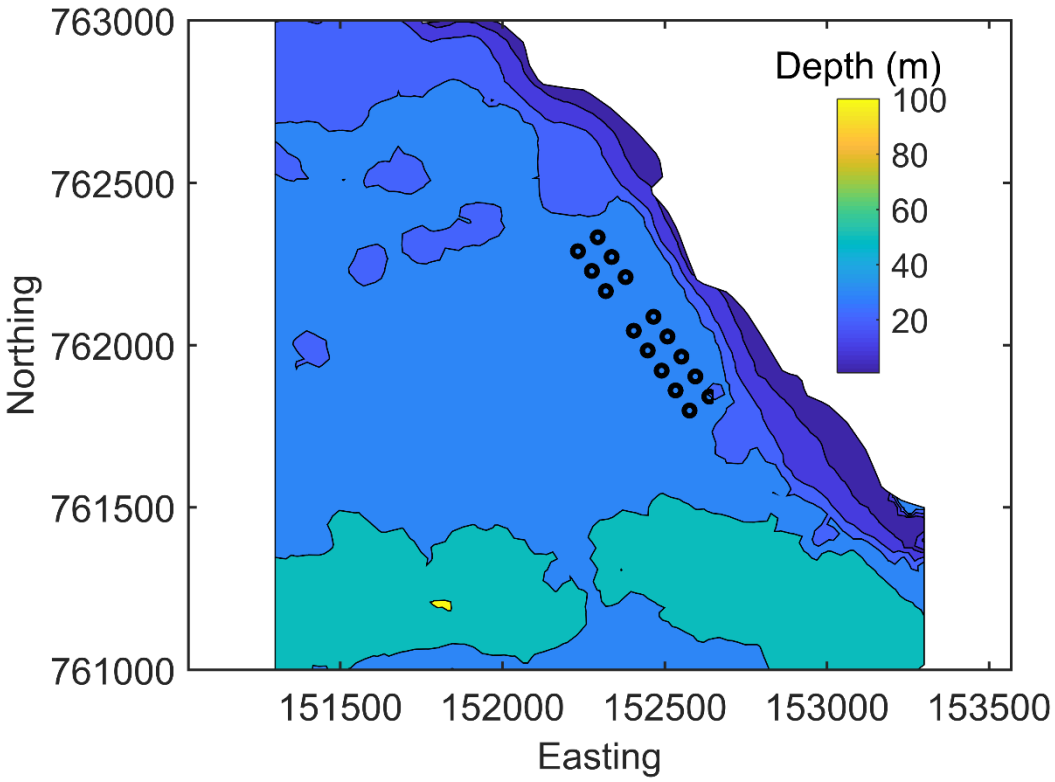

Figure 4. Model bathymetry in the region of the Macleans Nose site, as used with NewDepomod.

2.2 Current Data

A Teledyne RDI Acoustic Doppler Current Profiler (Workhorse Sentinel ADCP) was used to record current data at Macleans Nose salmon farm. The Workhorse Sentinel ADCP was installed in a mooring frame with 20° free gimbal movement that automatically levels the instrument when deployed on the seabed. The Workhorse ADCP was a 300kHz medium range self-recording acoustic Doppler profiler which allows multiple simultaneous sampling strategies with site specific cell size. This allows measurement of current through the entire water column referenced to the instrument. Further details of the Workhorse ADCP can be found at:-

www.rdinstruments.com

The Workhorse Sentinel ADCP, within its mooring frame, was positioned at 56° 41.096N 006° 02.816W (NM 52255 62121), which was 185m from the nearest shoreline and less than 150m from the centre of the proposed cage group (Figure 5). The transducer head was 70cm from the base of the mooring frame. The depth at the Sentinel ADCP position was 38.2m at the time of deployment, giving a corrected depth of 35.1m with respect to the Tobermory tide table.

Initial soundings were taken to establish the possible depth the Sentinel ADCP would be situated at during high tide and in order for the most appropriate cell size to be determined. The instrument was then configured on site immediately before deployment by means of communication using a laptop computer. The cell size was set at 1.0m and the number of cells 44.

Data was automatically written and stored to the internal memory within the Sentinel ADCP main body and then downloaded to computer after completion of the deployment period.

The distance to the near bed cell is automatically calculated based on the configuration settings of the instrument, using the following equation:

Distance to centre of first cell = ½ cell size+blanking distance+(Transmit+lag)/2

This is the distance from the transducer head to the centre of the first cell which equated to 2.72m. For this deployment the blanking distance was 0.6m, the cell size was 1.0m, the lag was 0.46m and the Transmit was 1.36m. This figure is added to the height of the transducer head to give the actual height of the centre of the first cell which gives a height of 2.72m and this is within the SEPA criteria of 3m.

Standard deviation has been assessed throughout the deployment to identify accurate and reliable data for near bed, middle (net depth) and surface cells using the following equation:

Cell StdDev = Instrument StdDev √ Percentage Valid Pings/100 x 300

The Instrument StdDev in the above equation is determined using the deployment settings when the meter is programmed, examples of the Standard Deviation values for different configurations are shown in

Table 1. This deployment had a cell size of 1.0m which equates to an Instrument single point StdDev of *ca.* 14.0cm/s (Table 1).

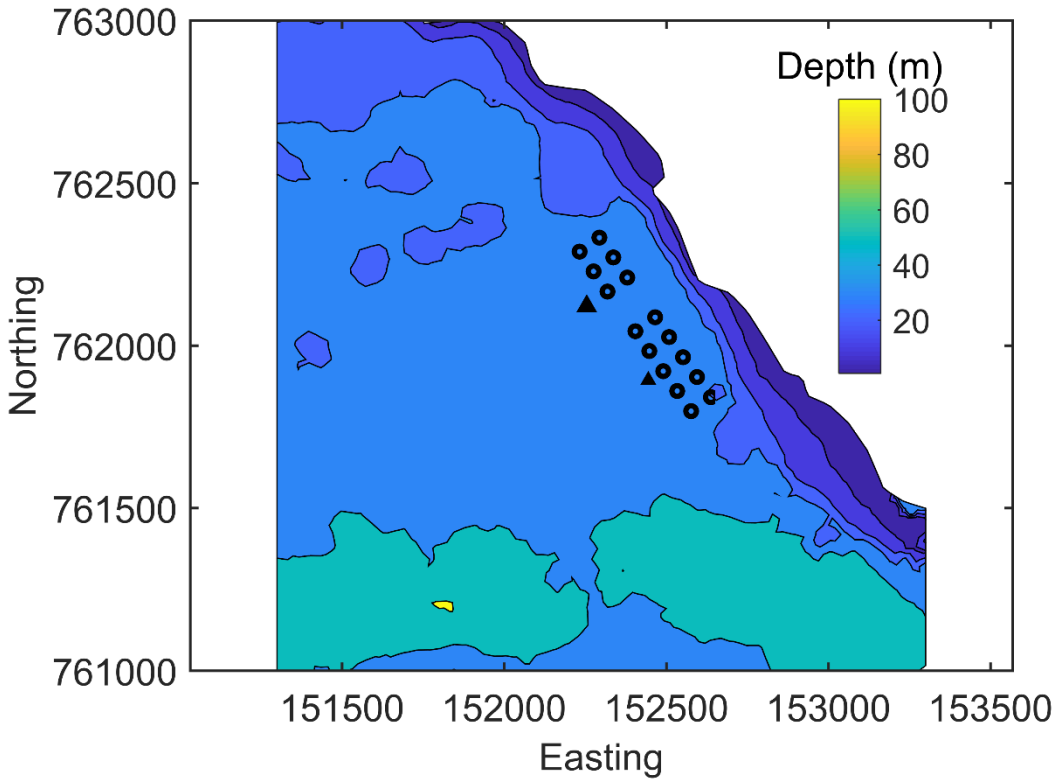

Figure 5. Positions of ADCP deployments in 2017 (▲). This report refers to the most northerly deployment location.

The Percentage of valid pings used to calculate Cell StdDev is derived using "Percentage Good" data which allows us to relate the Standard Deviation to the actual data gathered. The percent good data is available for 1,2,3 and 4 which represent the following:

Percent good 1 = % of good data computed from 3 Beams
Percent good 2 = % of bad data due to more than 2 Beam bad
Percent good 3 = % of bad data due to error velocity exceeded
Percent good 4 = % of good data computed from 4 Beams

The data from Percent good 1 and 4, for the relevant cells, is exported from Velocity and added together, this gives the total percentage of valid pings. The total percentage of valid pings is then used to calculate how many of the 300 pings were used to determine the current speed which is in turn used to calculate Standard Deviation for those individual cells.

The method described has been used to calculate the Standard deviation throughout the deployment for the surface, middle and bottom cells; the average StdDev values for the surface middle and bottom was 0.63cm/s, 0.63cm/s and 0.63cm/s respectively which are all within the SEPA criteria of 2cm/s.

2.3 Magnetic Variation

No magnetic variation correction was made to the Sentinel ADCP during deployment, this was undertaken to the data after the instrument was recovered and data downloaded. The magnetic variation used was 3.51W; this was determined using the World Magnetic Model, produced jointly with the US National Oceanographic and Atmospheric Administration's National Geophysical Data center. Further details can be found at http://www.geomag.bgs.ac.uk/navigation.html

2.4 Data Processing

Upon retrieval of the Sentinel ADCP current meter, all data was downloaded to a computer for analysis. All raw data was opened in "Velocity" software and exported to Microsoft Excel. Pitch and roll data were analysed to identify that the deployment was successful. Once achieved the heading data was then observed to identify any movement of the Sentinel ADCP mooring frame during the deployment. Pitch and Roll were both less than 5° throughout the combined deployment period. Some transient disturbance to the instrument was evident on 19th June but this was short-lived and the pitch and roll values remained less than 2.5°. The heading did not exhibit any unexpected variation, with variations over the deployment period being less than 2°. On this basis, it was concluded that pitch, roll and heading were within a suitable range with variations throughout most of the deployment.

Depth data were then assessed and found to be valid when comparing against soundings taken at the time of current meter deployment.

Calculations were then undertaken to identify each cell to be used for surface and middle currents. Beam signal strength (intensity) was checked for interference but no interference was found (Figure 6 and Figure 7). Data from Bins 1 – 30 were good for both deployments, corresponding to data below 5.4m depth for the first deployment and 5.6m depth for the second. Above Bin 30, signal reflections off the surface began to interfere and contaminate the data. Surface data were taken at -5.4m (cell 30), and cage-bottom data at 16.4m (cell 19). Surface and middle cell heights were 31.7m and 20.7m from the seabed respectively. The bottom cell (Cell 1) was 2.7 m above the seabed at a depth of 34.4m. Cell depths chosen from the second deployment were similar (Table 2) but the middle cell used was 20 which had a depth closer to the net depth of 16 m.

Table 1. Workhorse Sentinel ADCP Specifications

Workhorse Sentinel

Self-Contained 1200, 600, 300 kHz ADCP

TECHNICAL SPECIFICATIONS

Water Profiling	Depth Cell Size[1]	Typical Range[2] 12m **1200kHz**		Typical Range[2] 50m **600kHz**		Typical Range[2] 110m **300kHz**	
	Vertical Resolution	Range[3]	Std. Dev.[4]	Range[3]	Std. Dev.[4]	Range[3]	Std. Dev.[4]
	0.25m	11m	14.0cm/s				
	0.5m	12m	7.0cm/s	38m	14.0cm/s	see note 1	
	1m	13m	3.6cm/s	42m	7.0cm/s	83m	14.0cm/s
	2m	15m[5]	1.8cm/s	46m	3.6cm/s	93m	7.0cm/s
	4m	see note [1]		51m[5]	1.8cm/s	103m	3.6cm/s
	8m					116m[5]	1.8cm/s
Long Range Mode	2m	19m	3.4m/s				
	4m			66m	3.6cm/s		
	8m					154m	3.7cm/s
Profile Parameters	Velocity accuracy	0.3% of the water velocity relative to ADCP ±0.3cm/s		0.3% of the water velocity relative to ADCP ±0.3cm/s		0.5% of the water velocity relative to ADCP ±0.5cm/s	
	Velocity resolution	0.1cm/s		0.1cm/s		0.1cm/s	
	Velocity range:	±5m/s (default) ±20m/s (max)		±5m/s (default) ±20m/s (max)		±5m/s (default) ±20m/s (max)	
	Number of depth cells	1–255		1–255		1–255	
	Ping rate	Up to 10Hz		Up to 10Hz		Up to 10Hz	
Echo Intensity Profile	Vertical resolution	Depth cell size, user configurable					
	Dynamic range	80dB					
	Precision	±1.5dB					
Transducer and Hardware	Beam angle	20°					
	Configuration	4-beam, convex					
	Internal memory	Two PCMCIA card slots; one memory card included					
	Communications	RS-232 or RS-422; ASCII or binary output at 1200-115,200 baud					
Power	DC input	20–50VDC					
	Number of batteries	1 internal battery pack					
	Internal battery voltage	42VDC (new) 28VDC (depleted)					
	Battery capacity @ 0°C	450 watt hrs					
Standard Sensors	Temperature (mounted on transducer)	Range -5° to 45°C, Precision ±0.4°C, Resolution 0.01°					
	Tilt	Range ±15°, Accuracy ±0.5°, Precision ±0.5°, Resolution 0.01°					
	Compass (fluxgate type, includes built-in field calibration feature)	Accuracy ±2°[5], Precision ±0.5°[5], Resolution 0.01°, Maximum tilt ±15°					
Environmental	Standard depth rating	200m; optional to 500m, 1000m, 6000m					
	Operating temperature	-5° to 45°C					
	Storage temperature (without batteries)	-30° to 60°C					
	Weight in air	13.0kg					
	Weight in water	4.5kg					
Software	TRDI's Windows™-based software included: **WinSC**– Data Acquisition System; **WinADCP**– Data Display and Export						
Available Options	• Memory: 2 PCMCIA slots, total 4GB • Pressure sensor • External battery case • High-resolution water-profiling modes • Bottom tracking or surface referencing track • AC/DC power converter, 48VDC output • Pressure cases for depths up to 6000m • Directional Wave Array • Acoustic Modem • Inductive Modem • **Velocity** for advanced post processing						
Dimensions	228.0mm wide x 405.5mm long *(line drawings available upon request)*						

1 User's choice of depth cell size is not limited to the typical values specified.
2 Longer ranges available.
3 Profiling range based on temperature values at 5°C and 20°C, salinity = 35ppt.
4 Broadband mode single ping standard deviation (Std. Dev.).
5 ±1.0° is commonly achieved after calibration.

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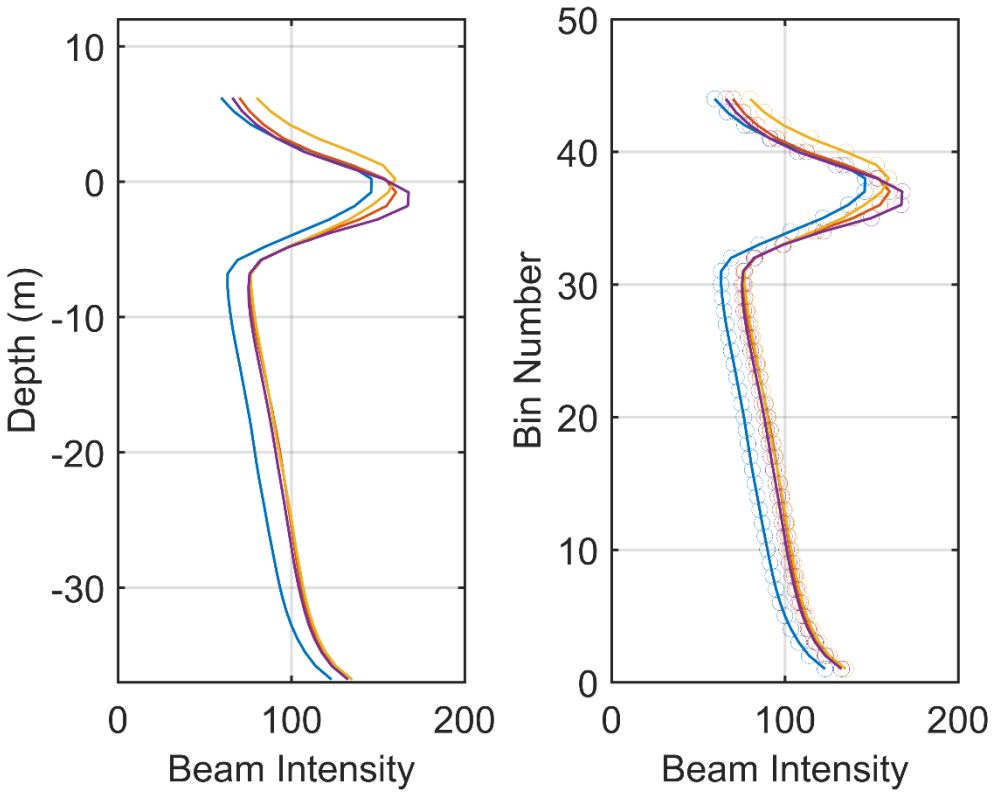


Figure 6. Mean beam intensity of the ADCP signal collected from 22nd March – 4th May 2017 plotted by depth (left) and cell (bin) number (right).

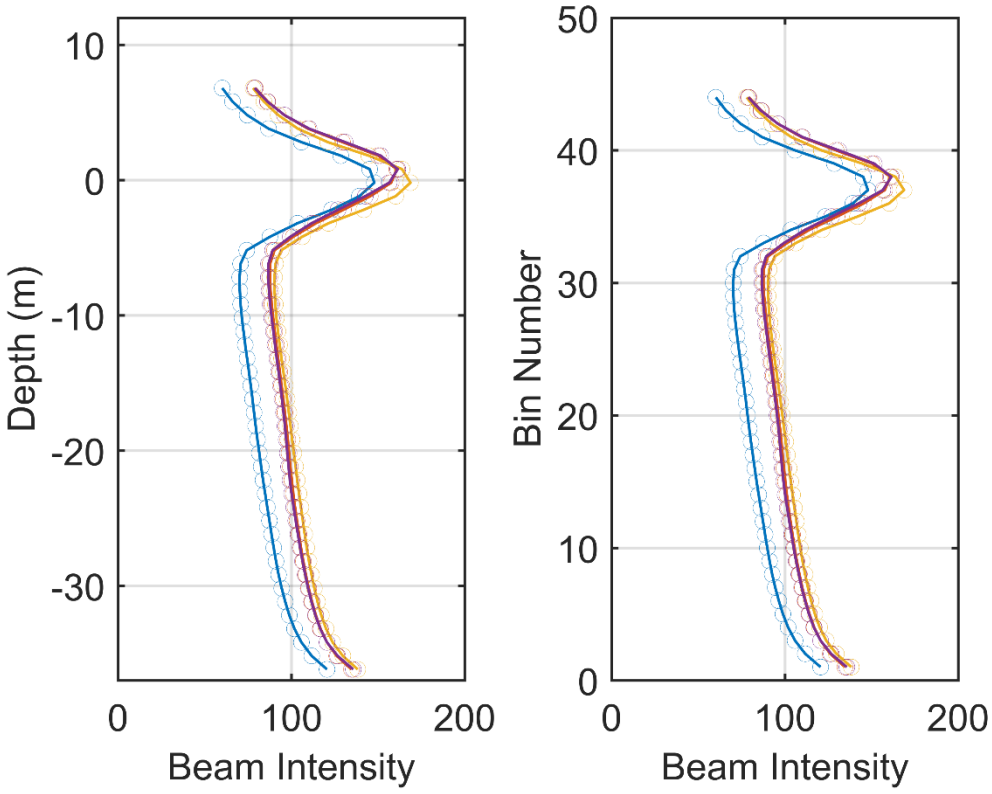


Figure 7. Mean beam intensity of the ADCP signal collected from 5th May – 3rd July 2017 plotted by depth (left) and cell (bin) number (right).

Table 2. Selected cells and depths for the two deployments at Macleans Nose North

Deployment Date	Water Depth (m)		Cell Number	Cell Depth (m)
22nd March – 4th May 2017	37.1	Surface	30	5.4
		Middle	19	16.4
		Bottom	1	34.3
5th May – 3rd July 2017	37.3	Surface	30	5.6
		Middle	20	15.6
		Bottom	1	34.6

2.5 Meteorological Survey

Meteorological data were not collected during this survey.

3. Results and Discussion

3.1 Deployment 1: 22nd March – 4th May 2017

A summary of the current data is shown in Figure 8 – Figure 15 and in Table 3 – Table 5. Over the 43 days analysed for this report, the surface, middle and bottom cells had averages of 6.0cm/s, 4.8cm/s and 5.3cm/s respectively. This gave an overall average of 5.4 cm/s. The orientation of the tidal velocities was north-northwest to south-southeast, consistent with a flow parallel to the shoreline.

The residual currents for the bottom, middle and surface cells are similar, with mean values of 0.7 cm/s, 1.8cm/s and 2.7cm/s respectively. The direction of the residual current at the surface was to the northwest. The weak residual at the seabed was to the northeast.

The depth records shown by the current meter pressure sensor exhibited a very clear spring-neap tidal cycle, with a spring range of about 4.5 m and a neap range of about 1.0 – 1.5 m.

3.2 Deployment 2: 5th May – 3rd July 2017

A summary of the current data is shown in Figure 16 – Figure 23 and in Table 6 – Table 8. Over the 59 days analysed for this report, the surface, middle and bottom cells had averages of 5.8 cm/s, 4.3 cm/s and 4.6 cm/s respectively. This gave an overall average of 4.9 cm/s. The orientation of the tidal velocities was northwest to southeast, consistent with a flow parallel to the shoreline.

The residual currents for the bottom, middle and surface cells were similar, with mean values of 0.5 cm/s, 2.0 cm/s and 3.2 cm/s. The direction of the residual current was west-northwest at the surface and middle depths and west-southwest at the bottom.

The depth records shown by the current meter pressure sensor exhibited a very clear spring-neap tidal cycle, with a spring range of about 4 m and a neap range of about 1.5 m.

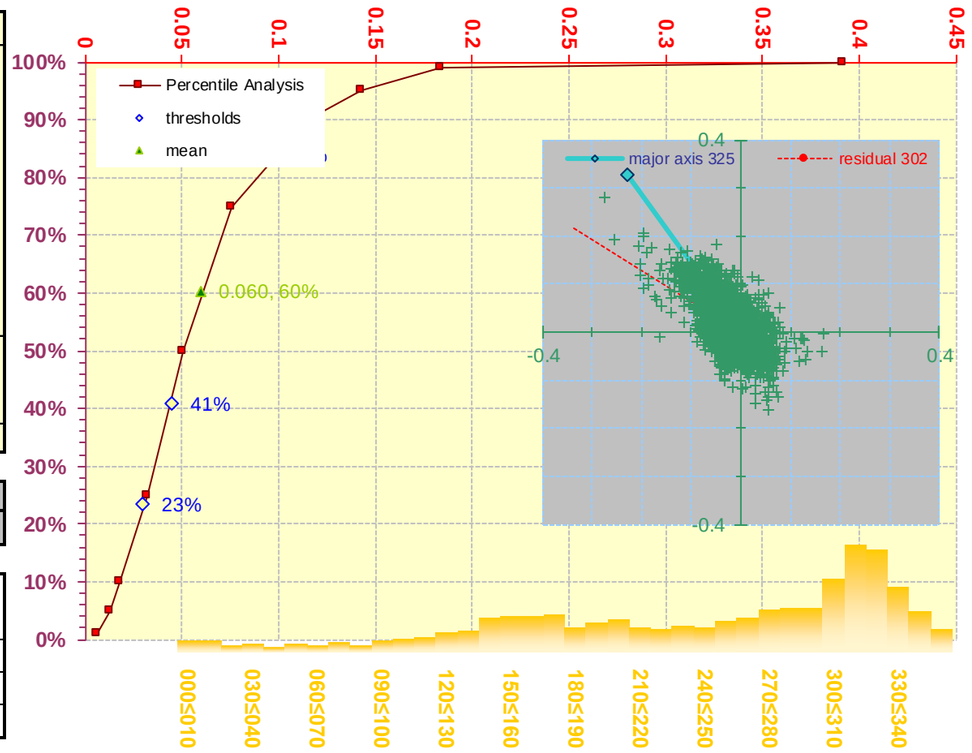
Current meter ID :	MacLeans-Nose-N_subs_31.7m_bin30			152255mE	762121mN
declination:	-3.513		convergence: -3.380	GMA:	-0.133 (Deg-M)
Period of measurement :	22/3/17 13:00	to	4/5/17 15:40	43 days	2 hrs 40 mins

Depth/ Pressure		
	Max:	9.74
	Mean:	7.43
	Min:	5.00

Percentiles	Current Speed	
1%	0.006 m/s	percentile analysis
5%	0.013 m/s	
10%	0.018 m/s	
25%	0.032 m/s	
50%	0.051 m/s	
75%	0.076 m/s	
90%	0.116 m/s	
95%	0.143 m/s	
99%	0.184 m/s	
100%	0.392 m/s	
23%	0.030 m/s	threshold values
41%	0.045 m/s	
84%	0.095 m/s	
60%	0.060 m/s	mean

Major axis :	325 (Deg-M)		0.086 m/s
Residual current :	0.027 m/s	at	302 (Deg-M)

	Residual	Tidal amplitude
Longitudinal (U) :	0.025 m/s	0.086 m/s
Lateral (V) :	-0.010 m/s	0.038 m/s
Anisotropy (long'l/lat'l) :	2.41	2.30



x	y
major axis 325	
-0.229	0.3277
-0.05	0.0708
0	0
#######	#######
residual 302	
0	0
-0.023	0.0146
-0.338	0.2146

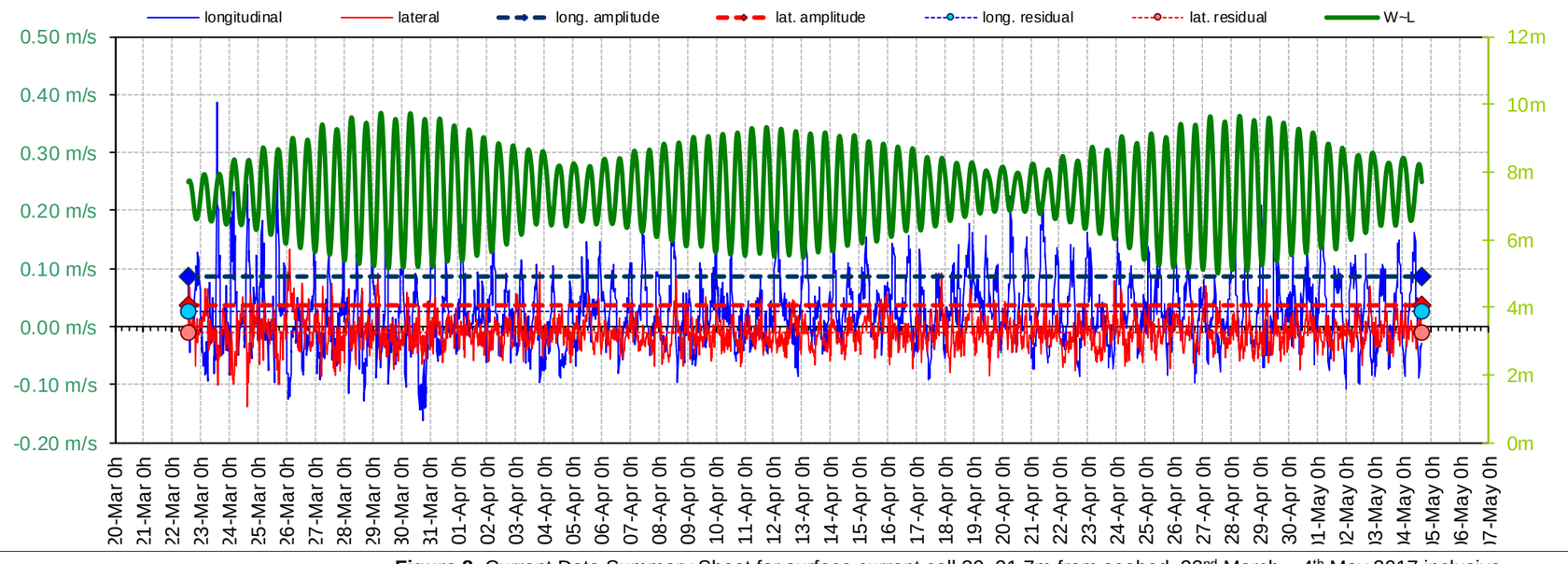


Figure 8. Current Data Summary Sheet for surface current cell 30, 31.7m from seabed, 22nd March – 4th May 2017 inclusive.

Current meter ID :	Macleans-Nose-N_cbot_21.1m_bin19				152255mE	762121mN
declination:	-3.513		convergence:	-3.380	GMA:	-0.133
Period of measurement :	22/3/17 13:00	to	4/5/17 15:40	43 days	2 hrs	40 mins

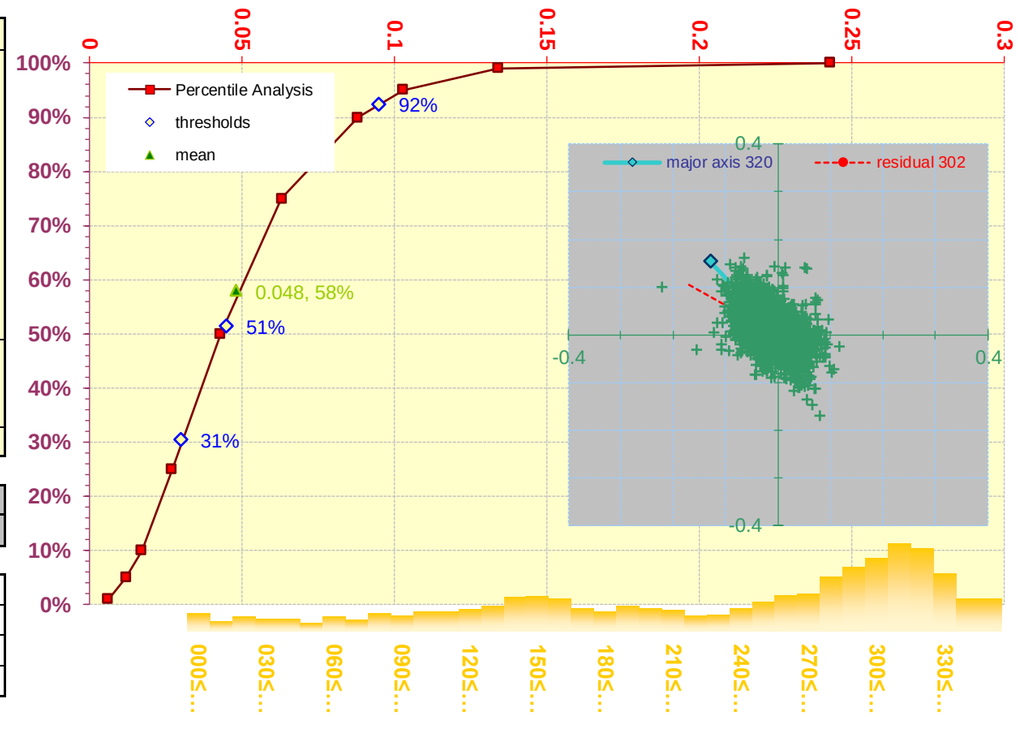
(Deg-M)

Depth/ Pressure	Max:	20.74
	Mean:	18.43
	Min:	16.00

Percentiles	Current Speed	
1%	0.006 m/s	percentile analysis
5%	0.012 m/s	
10%	0.017 m/s	
25%	0.027 m/s	
50%	0.043 m/s	
75%	0.063 m/s	
90%	0.088 m/s	
95%	0.103 m/s	
99%	0.134 m/s	
100%	0.243 m/s	
31%	0.030 m/s	threshold values
51%	0.045 m/s	
92%	0.095 m/s	
58%	0.048 m/s	mean

Major axis :	320 (Deg-M)		0.065 m/s
Residual current :	0.018 m/s	at	302 (Deg-M)

	Residual	Tidal amplitude
Longitudinal (U) :	0.017 m/s	0.065 m/s
Lateral (V) :	-0.006 m/s	0.037 m/s
Anisotropy (long'l/lat'l) :	3.02	1.77



x	y
major axis 320	
-0.129	0.1532
-0.042	0.0501
0	0
######	######
residual 302	
0	0
-0.015	0.0094
-0.17	0.1051

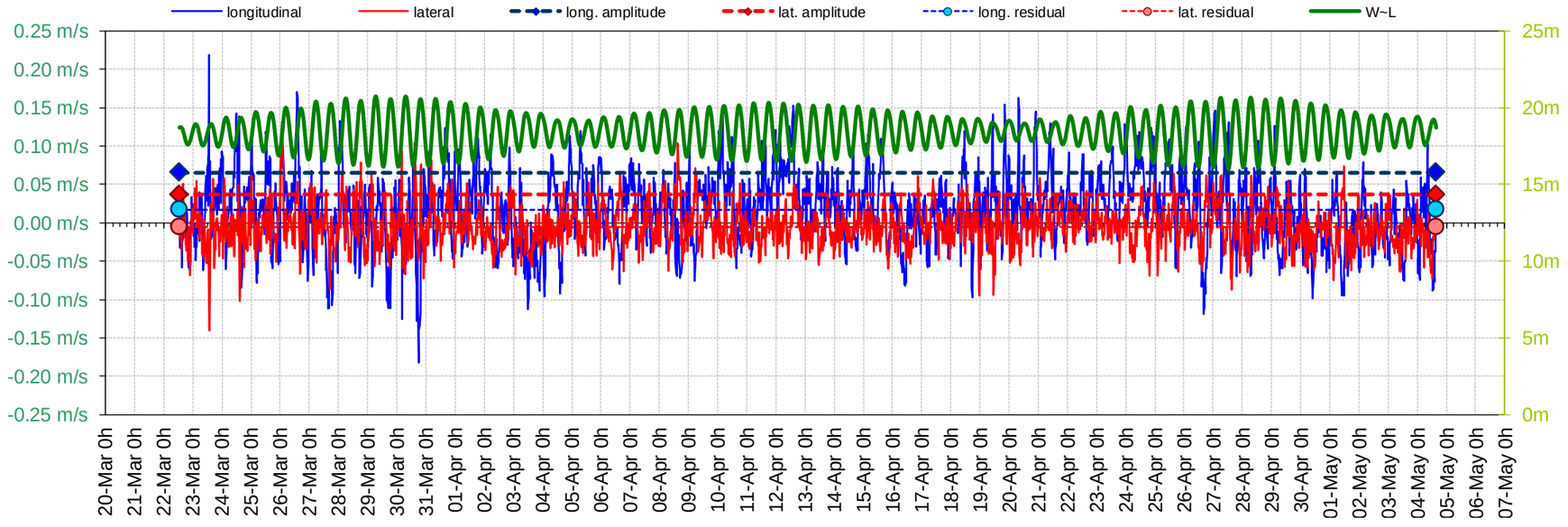


Figure 9. Current Data Summary Sheet for cage bottom current cell 19, 20.7m from seabed, 22nd March – 4th May 2017 inclusive.

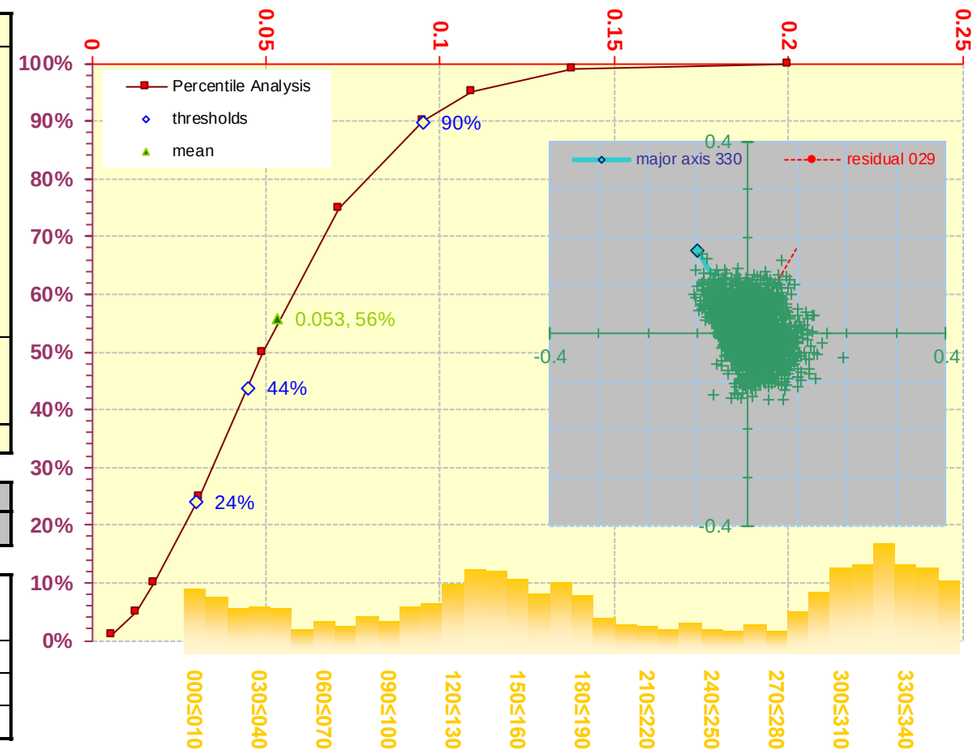
Current meter ID :	MacLeans-Nose-N_nrbd_2.7m_bin01			152255mE	762121mN
declination:	-3.513		convergence:	-3.380	GMA: -0.133 (Deg-G)
Period of measurement :	22/3/17 13:00	to	4/5/17 15:40	43 days	2 hrs 40 mins

Depth/ Pressure	Max:	39.08
	Mean:	36.77
	Min:	34.34

Percentiles	Current Speed	
1%	0.006 m/s	percentile analysis
5%	0.013 m/s	
10%	0.018 m/s	
25%	0.031 m/s	
50%	0.049 m/s	
75%	0.071 m/s	
90%	0.095 m/s	
95%	0.109 m/s	
99%	0.138 m/s	
100%	0.200 m/s	
24%	0.030 m/s	threshold values
44%	0.045 m/s	
90%	0.095 m/s	
56%	0.053 m/s	mean

Major axis :	330 (Deg-G)	0.072 m/s
Residual current :	0.007 m/s	at 029 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.004 m/s	0.072 m/s
Lateral (V) :	0.006 m/s	0.047 m/s
Anisotropy (long'l/lat'l) :	0.60	1.54



x	y
major axis 330	
-0.1	0.1732
-0.036	0.0622
0	0
######	######
residual 029	
0	0
0.0035	0.0063
0.0972	0.1748

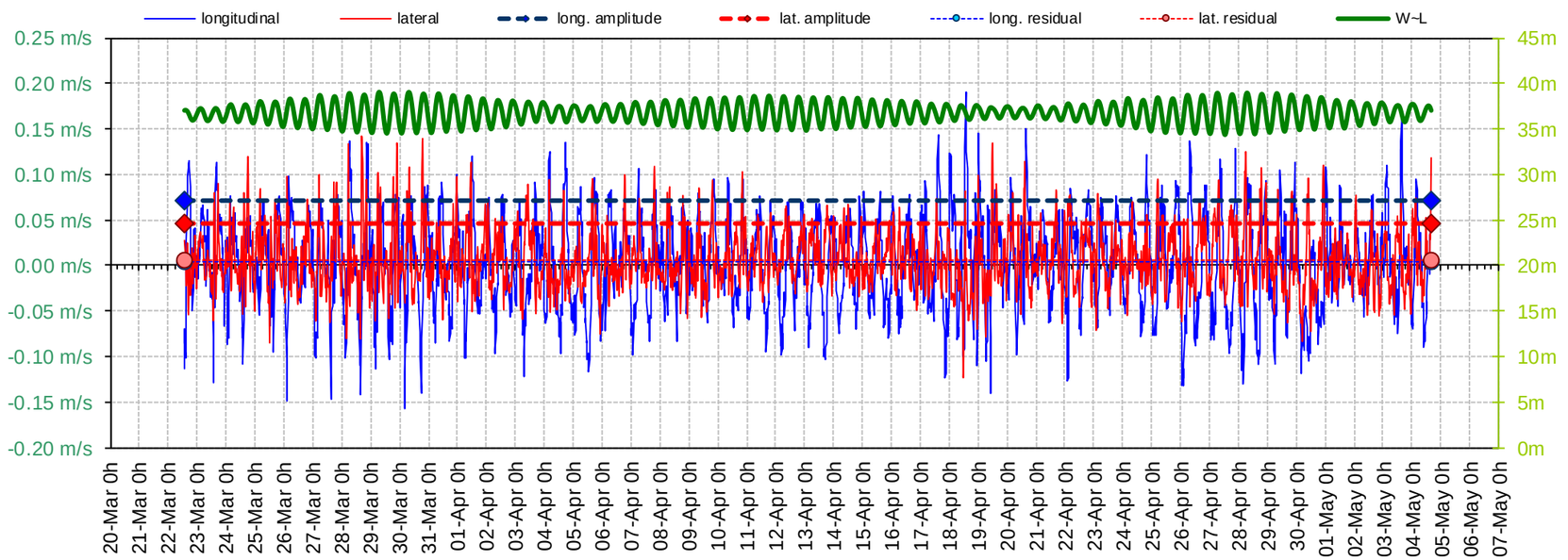


Figure 10. Current Data Summary Sheet for surface current cell 1, 2.7m from seabed, 22nd March – 4th May 2017 inclusive.

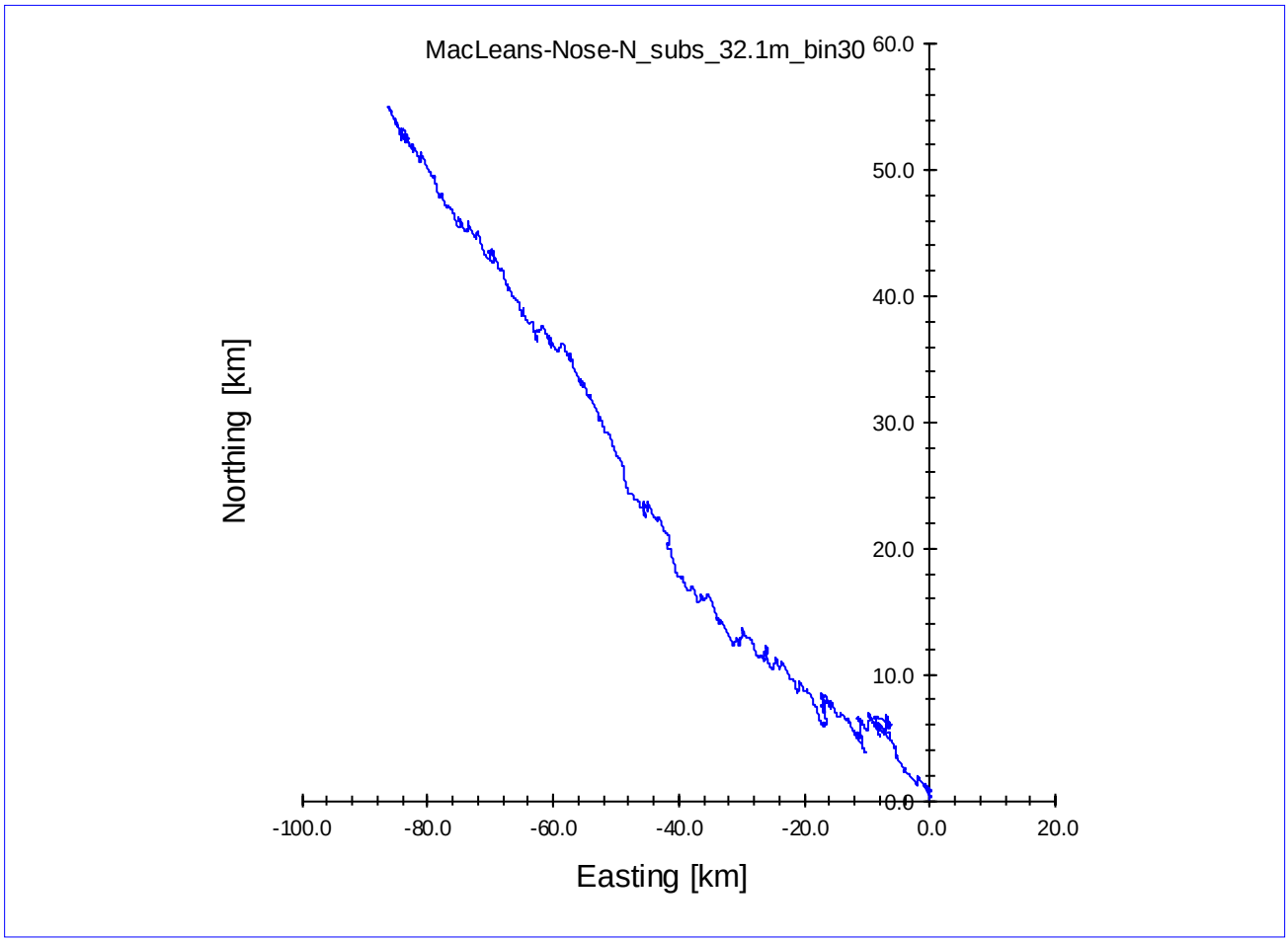


Figure 11. Cumulative Vector Plot of velocity data from surface cell 30

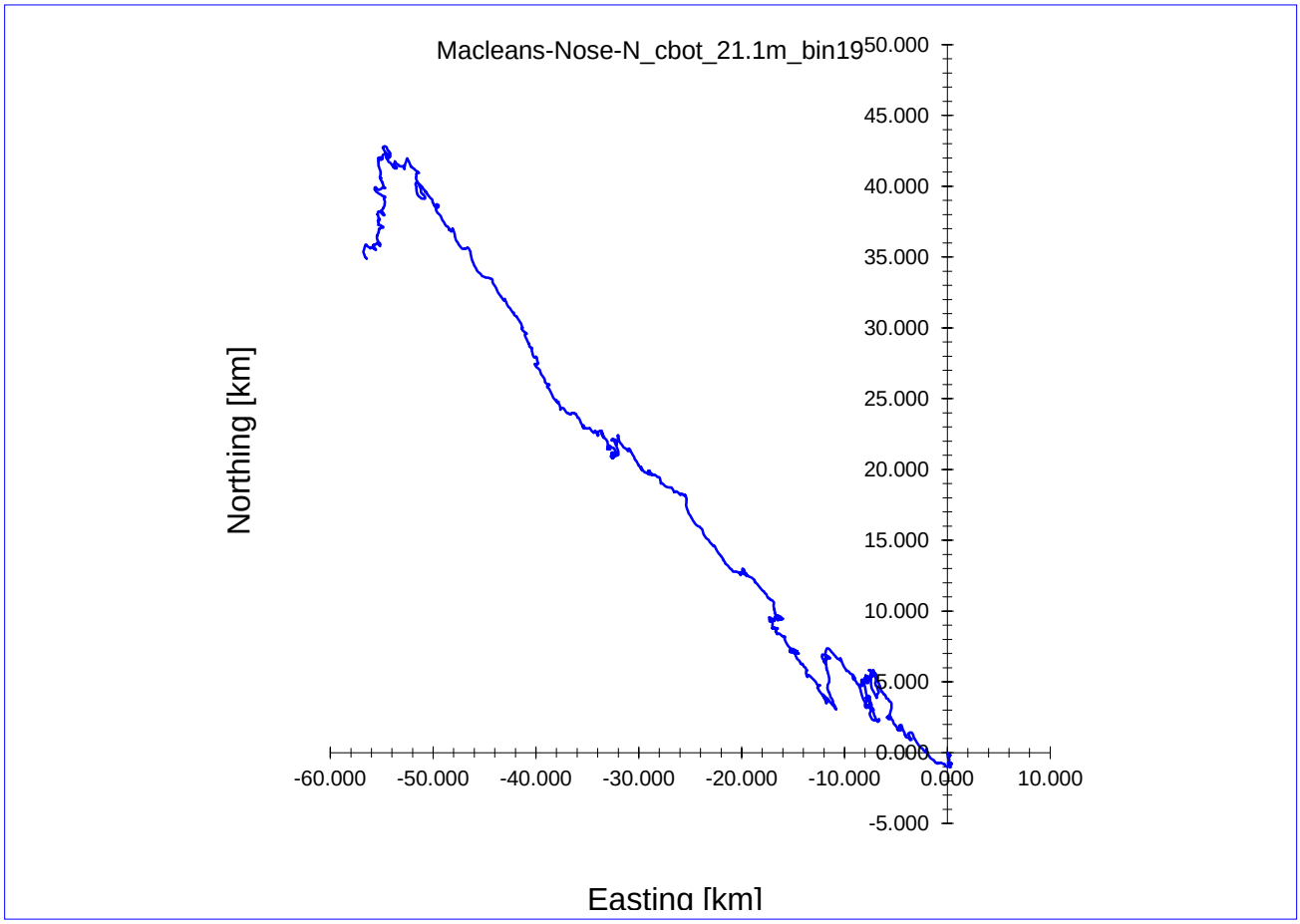


Figure 12. Cumulative Vector Plot of velocity data from middle cell 19.

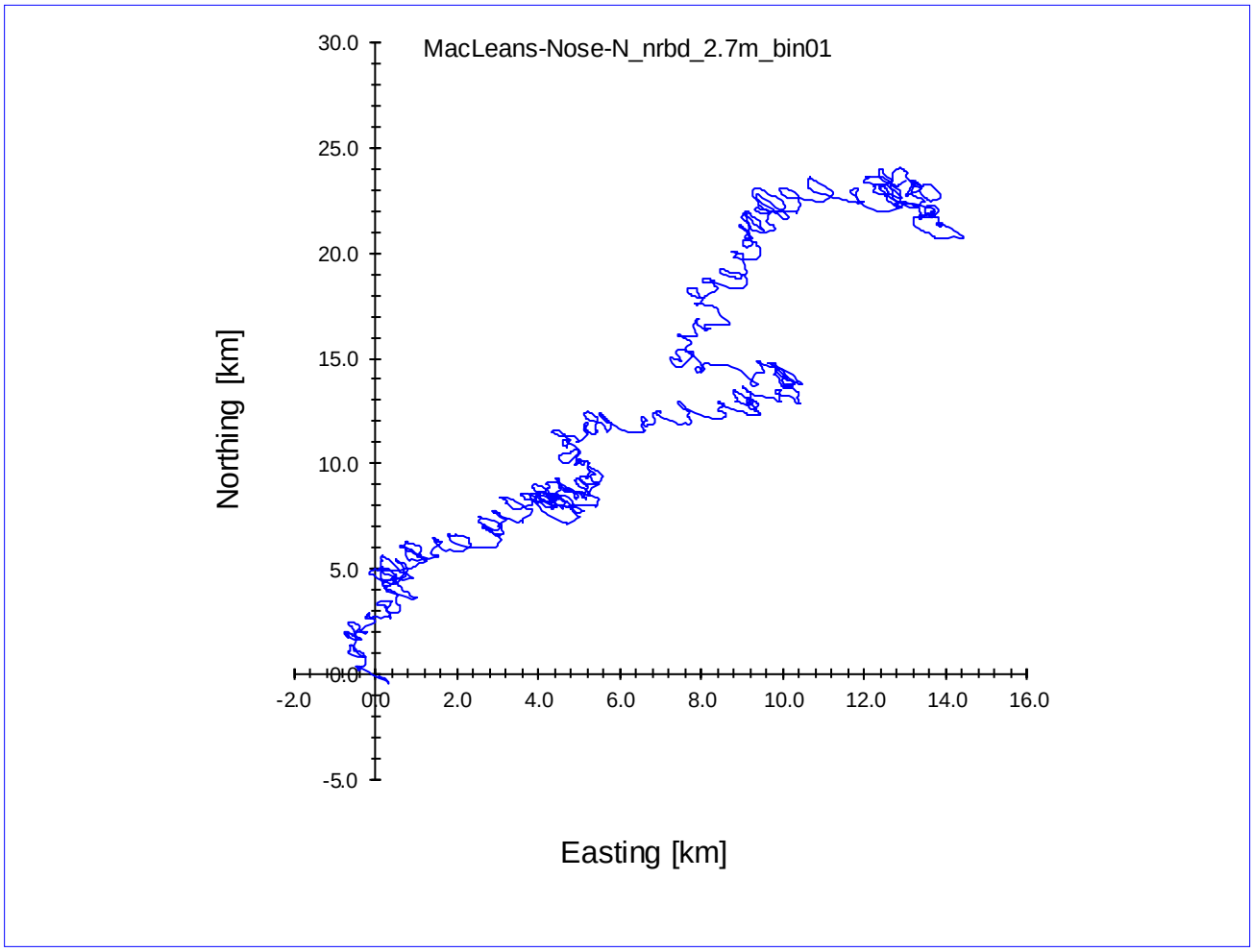


Figure 13. Cumulative Vector Plot of velocity data from bottom cell 1.

5. Summary Of Current Data Part 1

Site Name: Macleans Nose

Data start date: 22nd March 2017 **Data end date:** 4th May 2017

Water Depth (CD): 37.1 m

Table 3 Summary of current meter deployment

Cell	Mean Cell Height from seabed (m)	Mean cell depth below surface (m)	Cell Size (m)	Mean Current Speed (cm/s)	Ranked Percentile (%) for mean speed
Top	31.7	5.4	1	5.98	60
Middle	20.7	16.4	1	4.83	58
Bottom	2.7	34.4	1	5.33	56

Table 4 Ranked percentiles for current speed at all three depths

Cell	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)
Top	23	59	16
Middle	31	49	8
Bottom	24	56	10

Cell	Major Axis (Deg-G)
Top	325
Middle	320
Bottom	330

Table 5 The mean and residual currents recorded

	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	0.060	0.027	0.025	-0.010	0.086	0.038
Middle	0.048	0.018	0.017	-0.006	0.065	0.037
Bottom	0.053	0.007	0.004	0.006	0.072	0.047

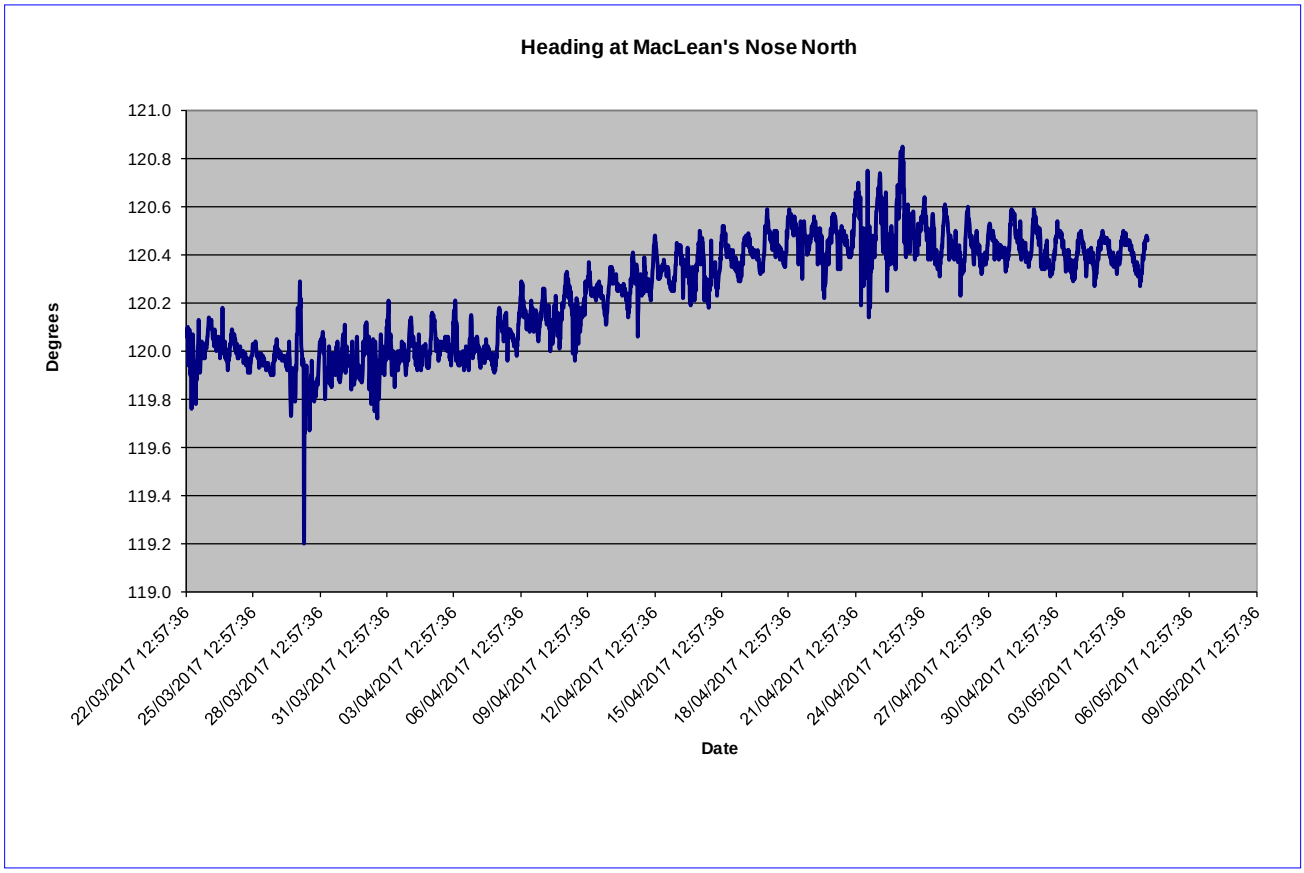


Figure 14. Graph of Heading of Workshorse Sentinel ADCP Current Meter during Deployment 1.

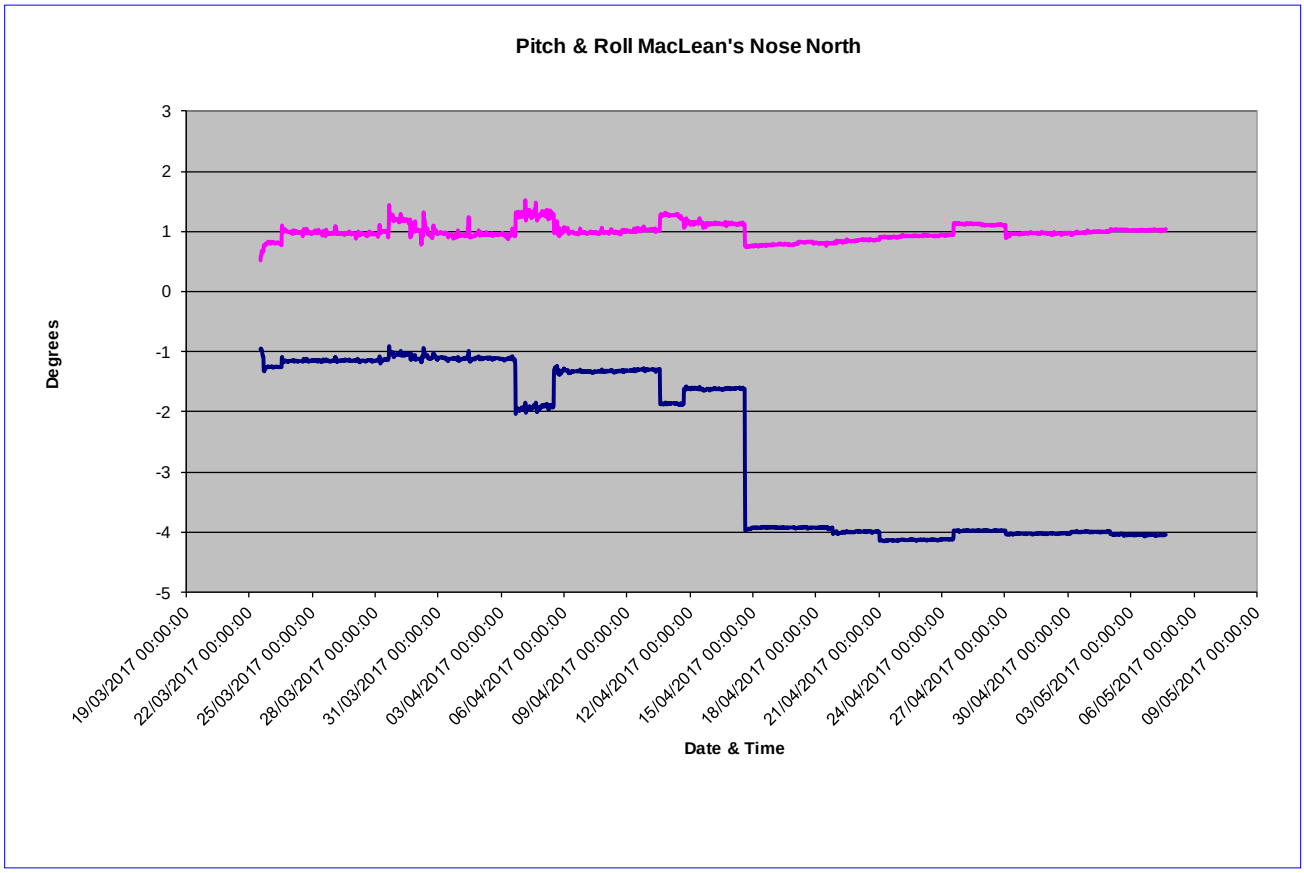


Figure 15. Graph of Pitch & Roll of Workhorse Sentinel ADCP Current Meter during Deployment 1.

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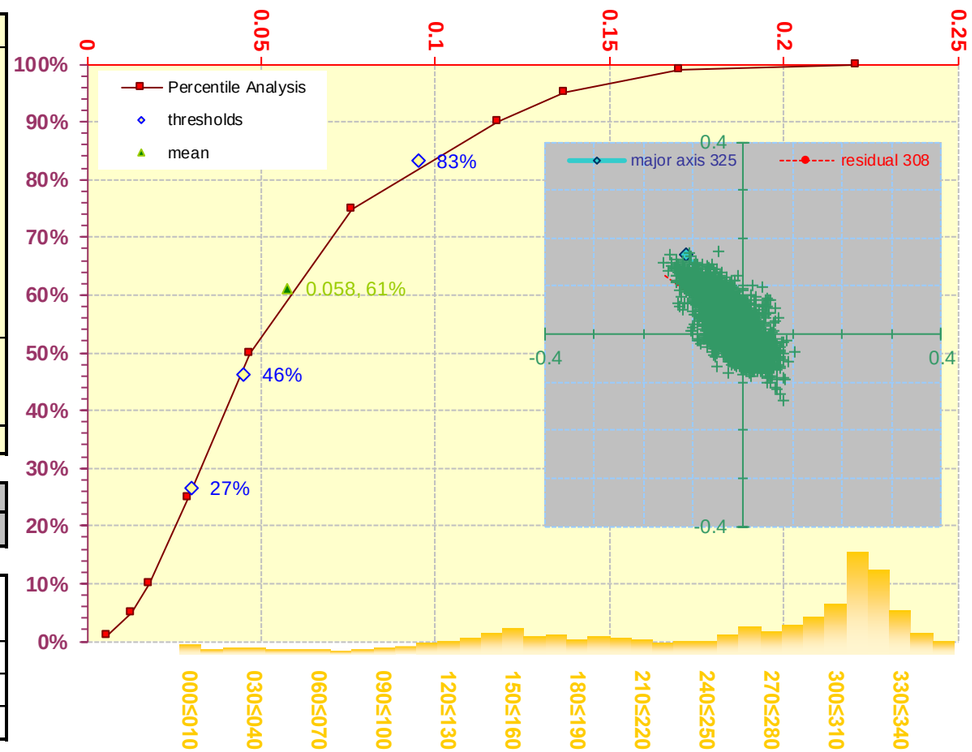
Current meter ID :	MacLeans-Nose-N_subs_31.7m_bin30			152235mE	762123mN
declination:	-3.513		convergence:	-3.380	GMA: -0.133 (Deg-G)
Period of measurement :	5/5/17 08:09	to	3/7/17 10:29	59 days	2 hrs 20 mins

Depth/ Pressure		
	Max:	9.98
	Mean:	7.88
	Min:	5.57

Percentiles	Current Speed	
1%	0.006 m/s	percentile analysis
5%	0.013 m/s	
10%	0.018 m/s	
25%	0.029 m/s	
50%	0.047 m/s	
75%	0.076 m/s	
90%	0.118 m/s	
95%	0.137 m/s	
99%	0.170 m/s	
100%	0.221 m/s	
27%	0.030 m/s	threshold values
46%	0.045 m/s	
83%	0.095 m/s	
61%	0.058 m/s	mean

Major axis :	325 (Deg-G)		0.081 m/s
Residual current :	0.032 m/s	at	308 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.031 m/s	0.081 m/s
Lateral (V) :	-0.010 m/s	0.031 m/s
Anisotropy (long'l/lat'l) :	3.17	2.60



x	y
major axis 325	
-0.115	0.1638
-0.046	0.0664
0	0
######	######
residual 308	
0	0
-0.025	0.0196
-0.159	0.1218

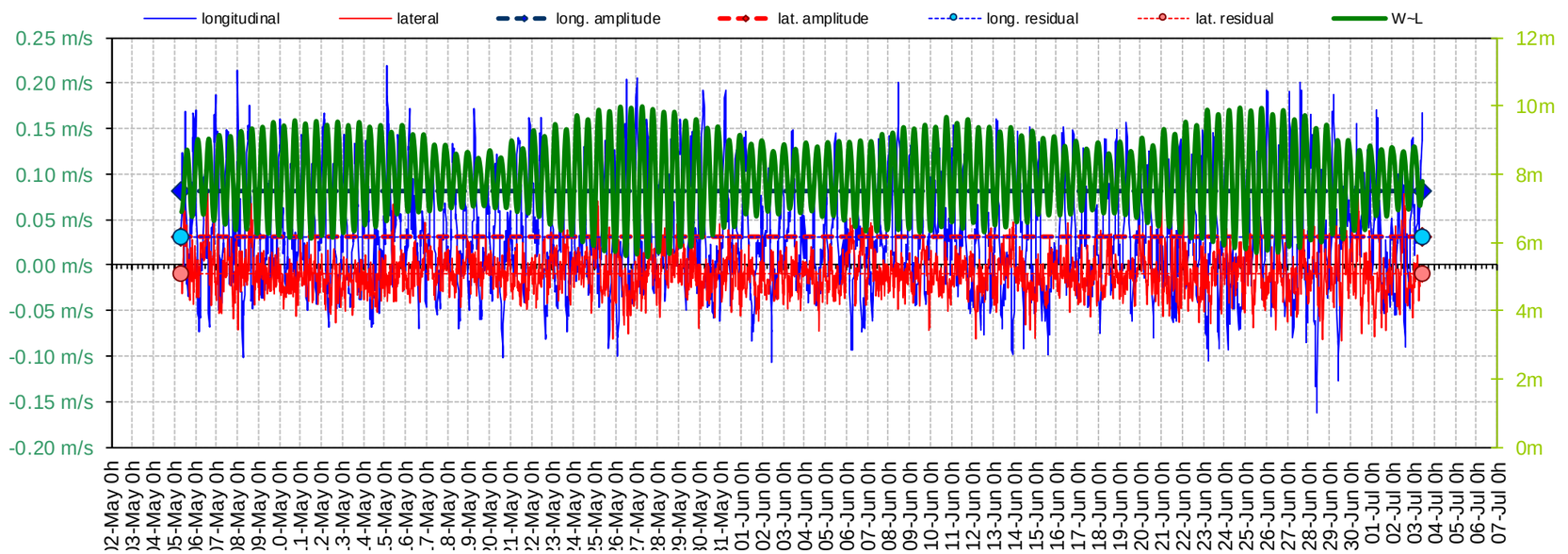


Figure 16. Current Data Summary Sheet for surface current cell 30, 31.7m from seabed 5th May – 3rd July 2017 inclusive.

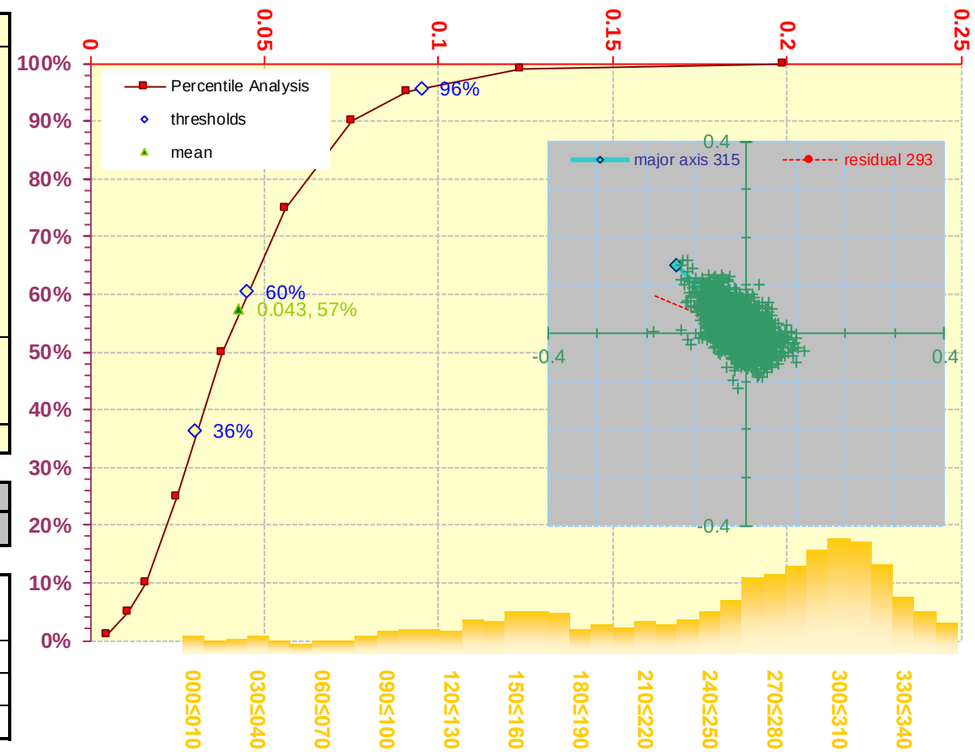
Current meter ID :	MacLeans-Nose-N_cbot_21.7m_bin20				152235mE	762123mN
declination:	-3.513		convergence:	-3.380	GMA:	-0.133 (Deg-G)
Period of measurement :	5/5/17 08:09	to	3/7/17 10:29	59 days	2 hrs	20 mins

Depth/ Pressure		
	Max:	19.98
	Mean:	17.88
	Min:	15.57

Percentiles	Current Speed	
1%	0.005 m/s	percentile analysis
5%	0.011 m/s	
10%	0.016 m/s	
25%	0.025 m/s	
50%	0.038 m/s	
75%	0.056 m/s	
90%	0.075 m/s	
95%	0.091 m/s	
99%	0.123 m/s	
100%	0.199 m/s	
36%	0.030 m/s	threshold values
60%	0.045 m/s	
96%	0.095 m/s	
57%	0.043 m/s	mean

Major axis :	315 (Deg-G)		0.056 m/s
Residual current :	0.020 m/s	at	293 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.018 m/s	0.056 m/s
Lateral (V) :	-0.007 m/s	0.032 m/s
Anisotropy (long'l/lat'l) :	2.49	1.78



x	y
major axis 315	
-0.141	0.1414
-0.04	0.0398
0	0
######	######
residual 293	
0	0
-0.018	0.0077
-0.184	0.0785

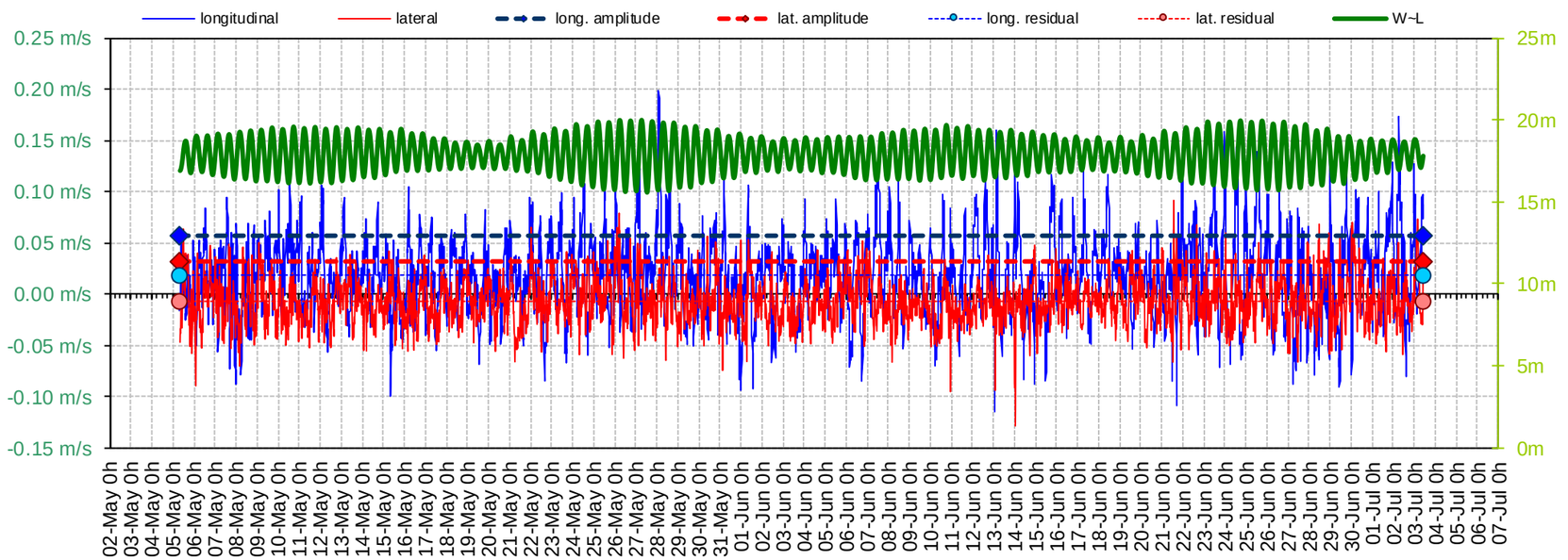


Figure 17. Current Data Summary Sheet for cage bottom current cell 20, 21.7m from seabed, 5th May – 3rd July 2017 inclusive.

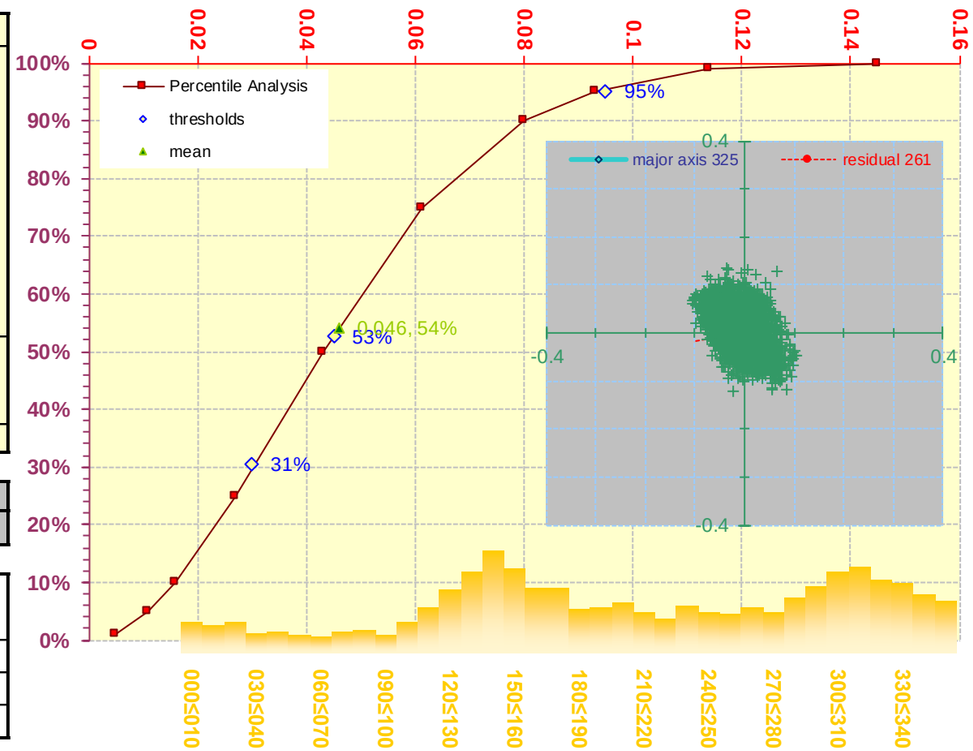
Current meter ID :	MacLeans-Nose-N_nrbd_2.7m_bin01				152235mE	762123mN
declination:	-3.513		convergence:	-3.380	GMA:	-0.133 (Deg-G)
Period of measurement :	5/5/17 08:09	to	3/7/17 10:29	59 days	2 hrs	20 mins

Depth/ Pressure	Max:	9.98
	Mean:	7.88
	Min:	5.57

Percentiles	Current Speed	
1%	0.005 m/s	percentile analysis
5%	0.011 m/s	
10%	0.016 m/s	
25%	0.027 m/s	
50%	0.043 m/s	
75%	0.061 m/s	
90%	0.080 m/s	
95%	0.093 m/s	
99%	0.114 m/s	
100%	0.145 m/s	
31%	0.030 m/s	threshold values
53%	0.045 m/s	
95%	0.095 m/s	
54%	0.046 m/s	mean

Major axis :	325 (Deg-G)		0.064 m/s
Residual current :	0.005 m/s	at	261 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.002 m/s	0.064 m/s
Lateral (V) :	-0.004 m/s	0.037 m/s
Anisotropy (long'l/lat'l) :	0.48	1.75



x	y
major axis 325	
-0.057	0.0819
-0.037	0.0525
0	0
######	######
residual 261	
0	0
-0.005	-8E-04
-0.099	-0.016

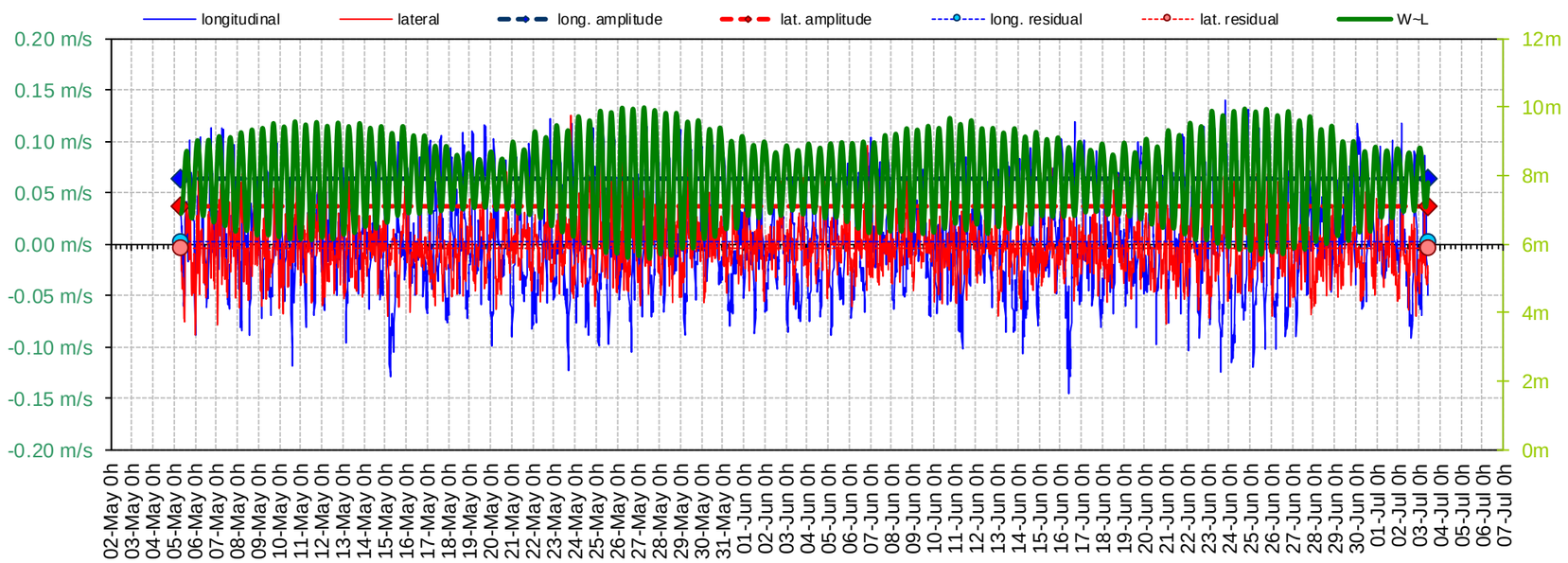


Figure 18. Current Data Summary Sheet for surface current cell 1, 2.7m from seabed, 5th May – 3rd July 2017 inclusive.

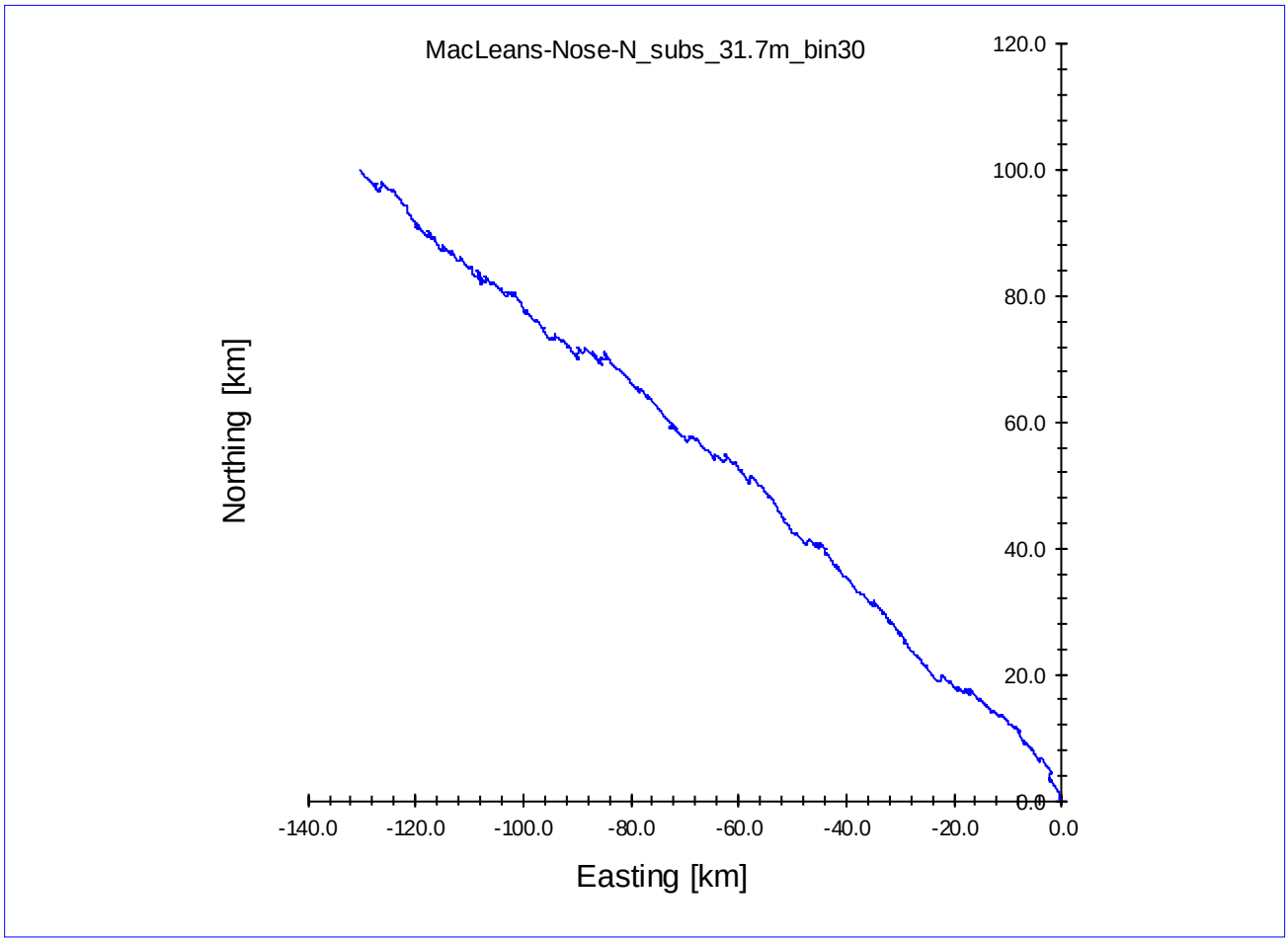


Figure 19. Cumulative Vector Plot of velocity data from surface cell 30

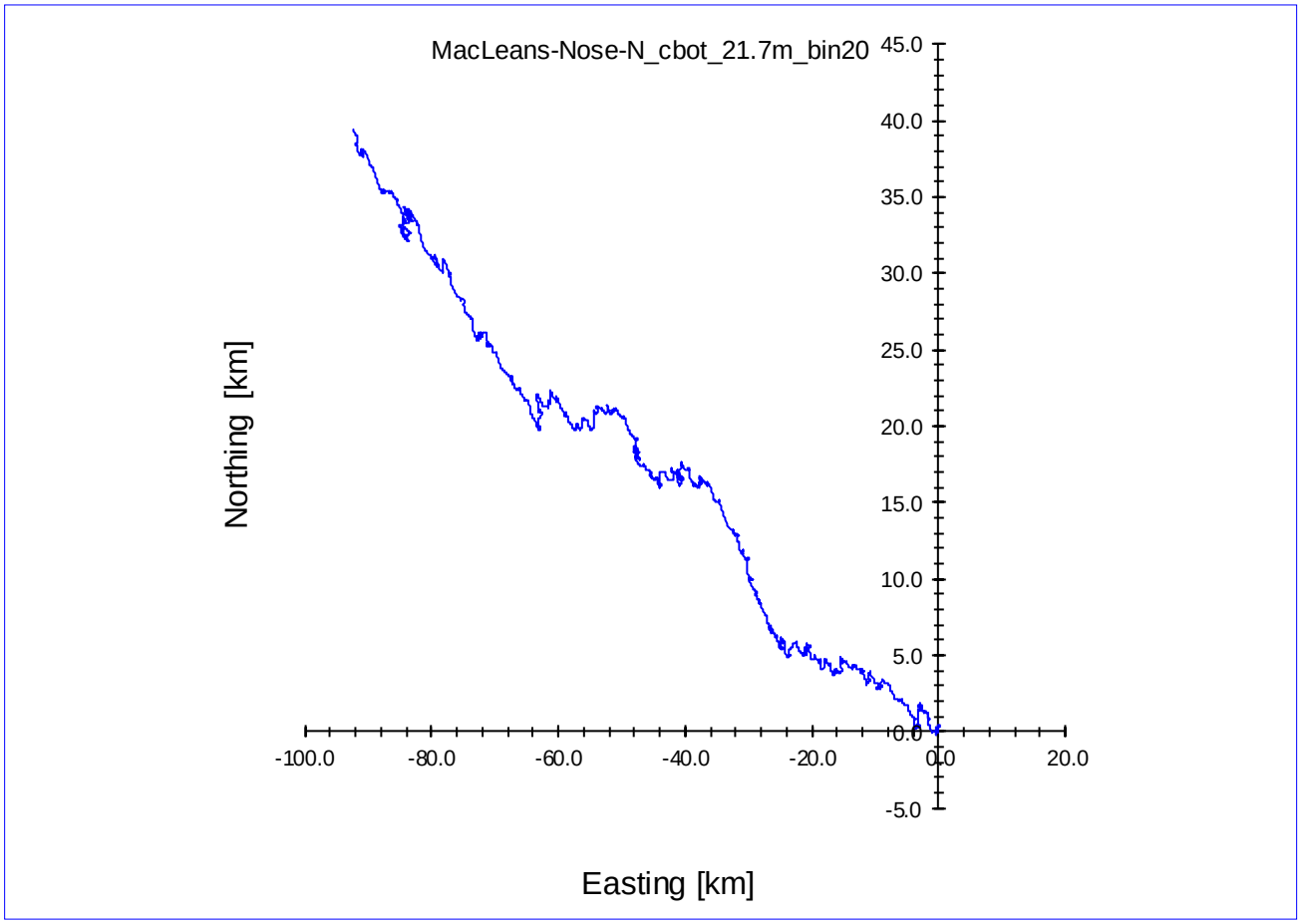


Figure 20. Cumulative Vector Plot of velocity data from middle cell 20.

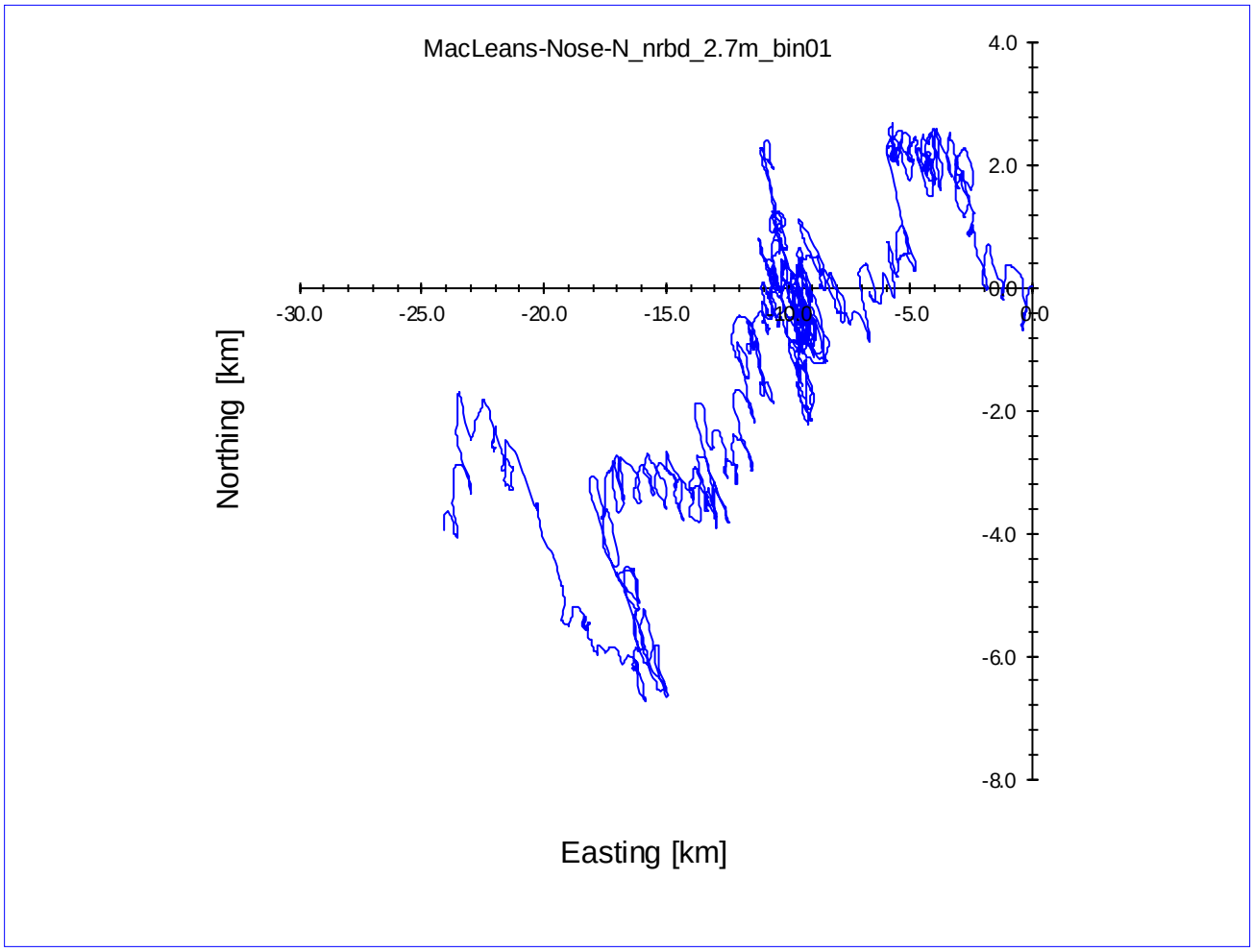


Figure 21. Cumulative Vector Plot of velocity data from bottom cell 1.

6. Summary Of Current Data Part 2

Site Name: Macleans Nose

Data start date: 5th May 2017 **Data end date:** 3rd July 2017

Water Depth (CD): 37.3 m

Table 6. Summary of current meter deployment.

Cell	Mean Cell Height from seabed (m)	Mean cell depth below surface (m)	Cell Size (m)	Mean Current Speed (cm/s)	Ranked Percentile (%) for mean speed
Top	31.7	5.6	1	5.77	61
Middle	21.7	15.6	1	4.27	57
Bottom	2.7	34.6	1	4.60	54

Table 7. Ranked percentiles for current speed at all three depths

Cell	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)
Top	27	54	17
Middle	36	40	4
Bottom	31	47	5

Cell	Major Axis (Deg-G)
Top	325
Middle	315
Bottom	325

Table 8. The mean and residual currents recorded

	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	0.058	0.032	0.031	-0.010	0.081	0.031
Middle	0.043	0.020	0.018	-0.007	0.056	0.032
Bottom	0.046	0.005	0.002	-0.004	0.064	0.037

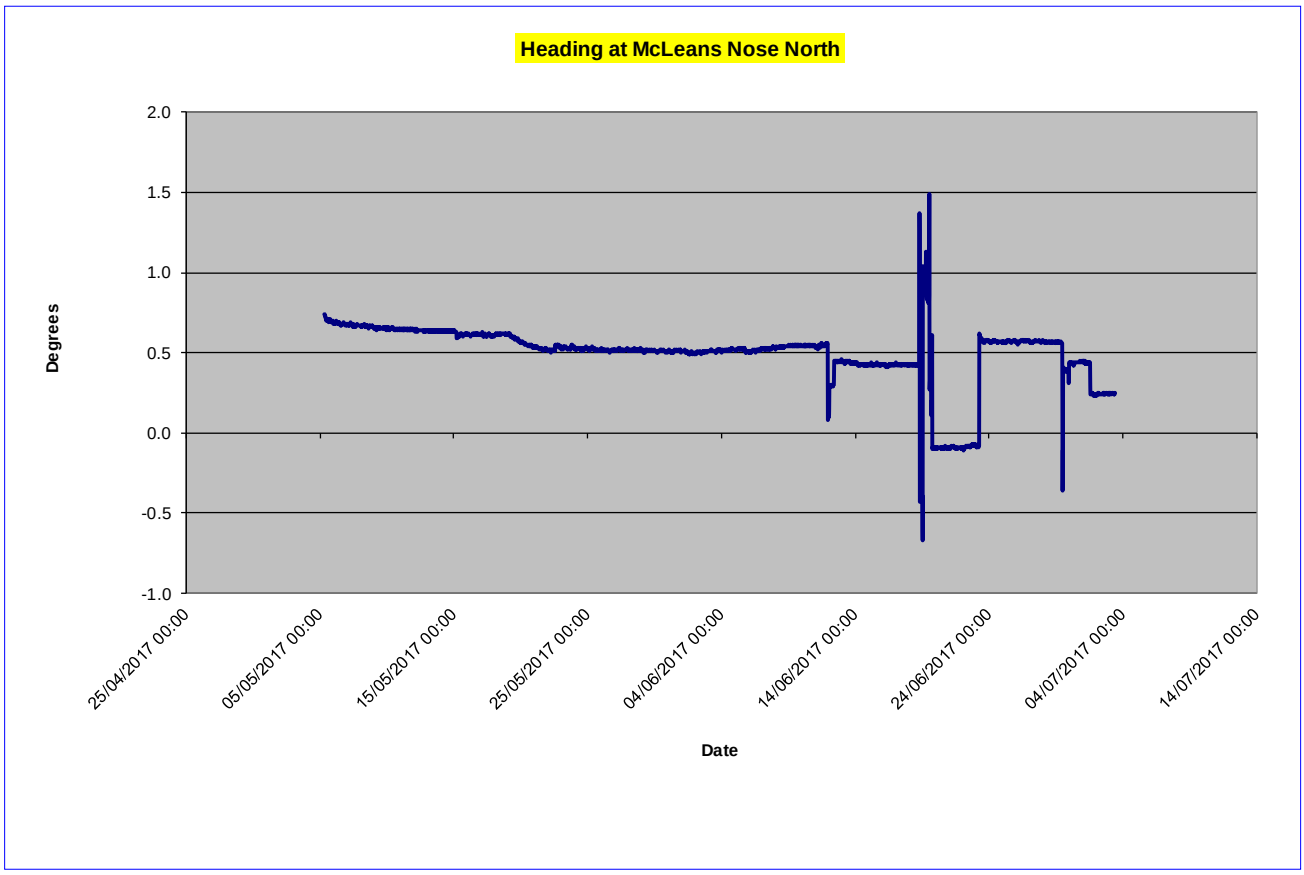


Figure 22. Graph of Heading of Workshorse Sentinel ADCP Current Meter during Deployment 2.

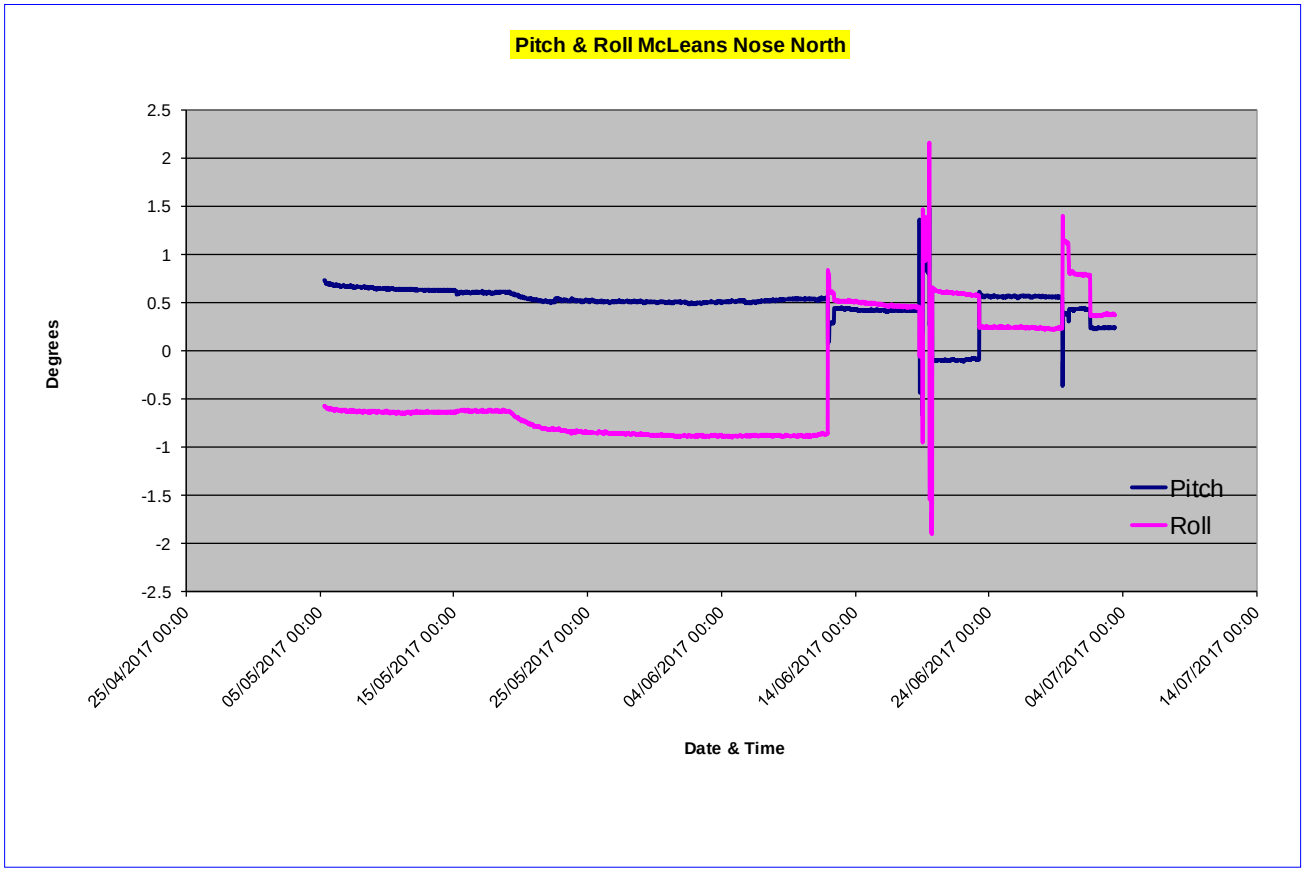


Figure 23. Graph of Pitch & Roll of Workhorse Sentinel ADCP Current Meter during Deployment 2.

7. Summary Of Meteorological Data

No meteorological data were collected.

8. Conclusion

Marine Harvest (Scotland) Ltd has collected and analysed current and bathymetric data for the Macleans Nose salmon farm site. Two deployments were made, totalling 102 days of data.

The analysed current data for the both deployment periods are believed to be reliable and representative of the proposed location.

Meteorological data were not collected.

The bathymetric data gained from surveying the proposed site proved to be representative of chart data for the same location.

It is therefore concluded this complete data set is acceptable for use in calibrating a hydrodynamic model of the area and for use with NewDepomod.

Annex 1 Survey Equipment Deployment Logs

Sentinel V (ADCP) Current Meter Record Log

Location: **MacLean's Nose**
Nearest tidal port: **Tobermory** Time zone: UTC

Max spring / min neap range during deployment:

		Date	Time	Height (m)
Spring tide	HW	28/03/2017	05:59	4.8
	LW	26/04/2017	11:56	0.4
Neap Tide	HW	19/04/2017	10:41	3.2
	LW	19/04/2017	17:29	2.0

Deployment Details

	Time		Date
Meter switched on.	13:00:42		22/03/2017
Meter deployed.	13:00:42		22/03/2017
Meter lifted.	20:40:42		04/05/2017
Meter switched off.	20:40:42		04/05/2017
Period used for this report.	22/03/2017 13:00:42	to	04/05/2017 15:40:42

ADCP serial number: 24616
Meter position: 56° 41.096N 006° 02.816W
152255.37E, 762121.35N
Minimum water depth: 37.1m (36.4m measured by ADCP + 0.7m *)
Water depth (Chart Datum): 36.8m (minimum water depth – 0.3m tide timetable)
Mean water depth: 39.5m (measured by ADCP + 0.7m *)
Depth of meter from surface: 36.4m (below mean low water spring to transducer)
Depth of meter from seabed: * Meter on seabed 0.7m to transducer head
Sounding at deployment: 38.2m @ 12:55 on 22/03/2017
Corrected sounding: 35.1 m (38.2m – 3.1m from Tobermory table)

Data summary:

	Cell number	Depth (m)	Dist from seabed (m)	Mean current speed (cm/s)
Surface	Cell 30	5.4m Below MLWS	31.7m	5.98
Mid depth	Cell 19	16.4m Below MLWS	20.7m	4.83
Bottom	Cell 1	34.4 m Below MLWS	2.7m	5.33
Average current speed:				**5.4**

ADCP meter settings:

Reference	Transducer
Bin size	1.0m
Dist to 1st bin	2.02
Number of bins	44
Frequency	307 kHz
Recording interval	20 min
No. pings per ensemble	300
Magnetic correction	0
Ensemble	300
Standard Deviation	0.63cm/sec
Time/Ping	00:01:00

Sentinel V (ADCP) Current Meter Record Log

Location: **MacLean's Nose**

Nearest tidal port: **Tobermory** Time zone: UTC

Max spring / min neap range during deployment:

		Date	Time	Height (m)
Spring tide	HW	25/05/2017	05:09	4.7
	LW	25/05/2017	11:31	0.5
Neap Tide	HW	19/05/2017	11:41	3.2
	LW	19/05/2017	18:02	1.9

Deployment Details

	Time		Date
Meter switched on.	08:09:24		05/05/2017
Meter deployed.	08:09:24		05/05/2017
Meter lifted.	11:29:24		03/07/2017
Meter switched off.	11:29:24		03/07/2017
Period used for this report.	05/05/2017 08:09:24	to	03/07/2017 10:29:24

ADCP serial number: 24616

Meter position: 56° 41.096N 006° 02.836W

152234.97E, 762122.55N

Minimum water depth: 37.3m (36.6m measured by ADCP + 0.7m *)

Water depth (Chart Datum): 36.9m (minimum water depth – 0.4m tide timetable)

Mean water depth: 39.6m (measured by ADCP + 0.7m *)

Depth of meter from surface: 36.6m (below mean low water spring to transducer)

Depth of meter from seabed: * Meter on seabed 0.7m to transducer head

Sounding at deployment: 36.9m @ 08:37 on 05/05/2017

Corrected sounding: 35.1 m (38.2m – 3.1m from Tobermory table)

Data summary:

	Cell number	Depth (m)	Dist from seabed (m)	Mean current speed (cm/s)
Surface	Cell 30	5.6m Below MLWS	31.7m	5.77
Mid depth	Cell 20	15.6m Below MLWS	21.7m	4.27
Bottom	Cell 1	34.6m Below MLWS	2.7m	4.60
Average current speed:				**4.9**

ADCP meter settings:

Reference	Transducer
Bin size	1.0m
Dist to 1st bin	2.02
Number of bins	44
Frequency	307 kHz
Recording interval	20 min
No. pings per ensemble	300
Magnetic correction	0
Ensemble	300
Standard Deviation	0.63cm/sec
Time/Ping	00:01:00