Linnhe

Hydrographic Data Report: Deployment ID282

27th August to 27th September 2019

December 2021
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QUALITY ASSURANCE

Mowi 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

Mowi Scotland Ltd. is preparing an application to the Scottish Environmental Protection Agency (SEPA) for a technical variation of CAR/L/1009970 to increase the Azamethiphos (Salmosan) consent at the existing salmon farm located in Loch Linnhe, Linnhe (Figure 1. Site layout of the salmon farm Linnhe. The current meter deployment locations are marked by the black triangles., following a change in equipment to 10 x 120m circumference pens.

Mowi Scotland Ltd have carried out hydrographic surveys at the site in 2019. Hydrographic data at Linnhe was gathered during this time in two deployments:

i. 23rd May to 16th August 2019 (ID277)
ii. 27th August to 27th September 2019 (ID282)

This report describes the data from the 27th August to 27th September deployment at Linnhe. The purpose of this report is to assess the suitability of the collected hydrographic data for input into a hydrodynamic model of the Loch Linnhe region.

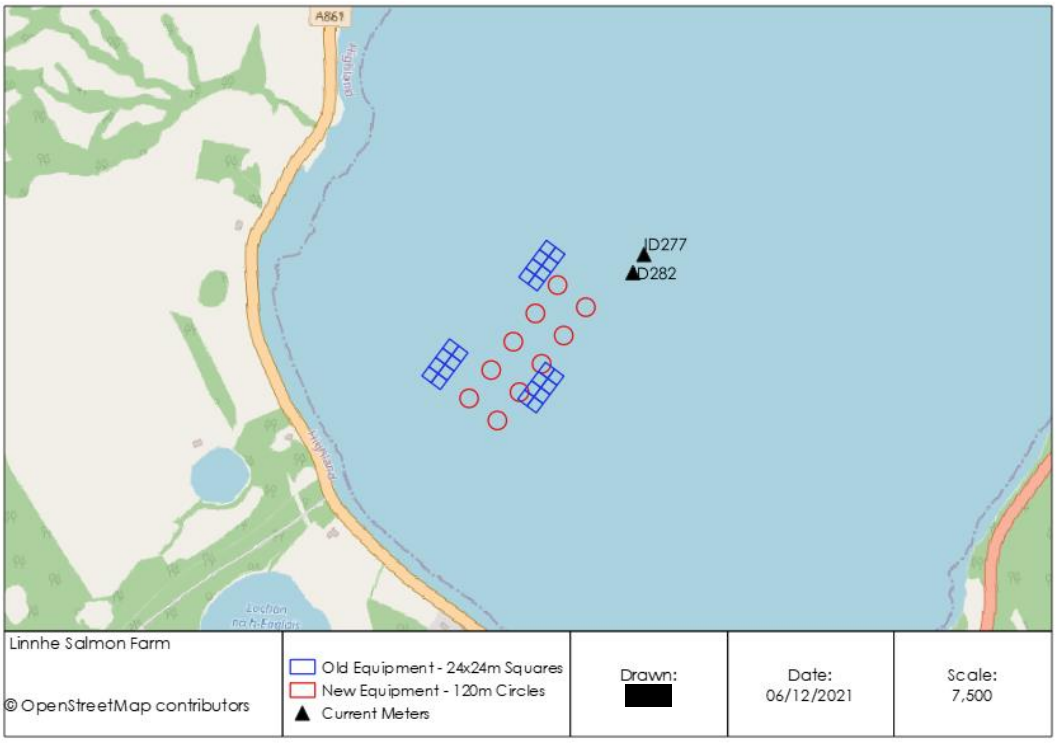


Figure 1. Site layout of the salmon farm Linnhe. The current meter deployment locations are marked by the black triangles.

2. Materials & Methods

2.1 Bathymetry

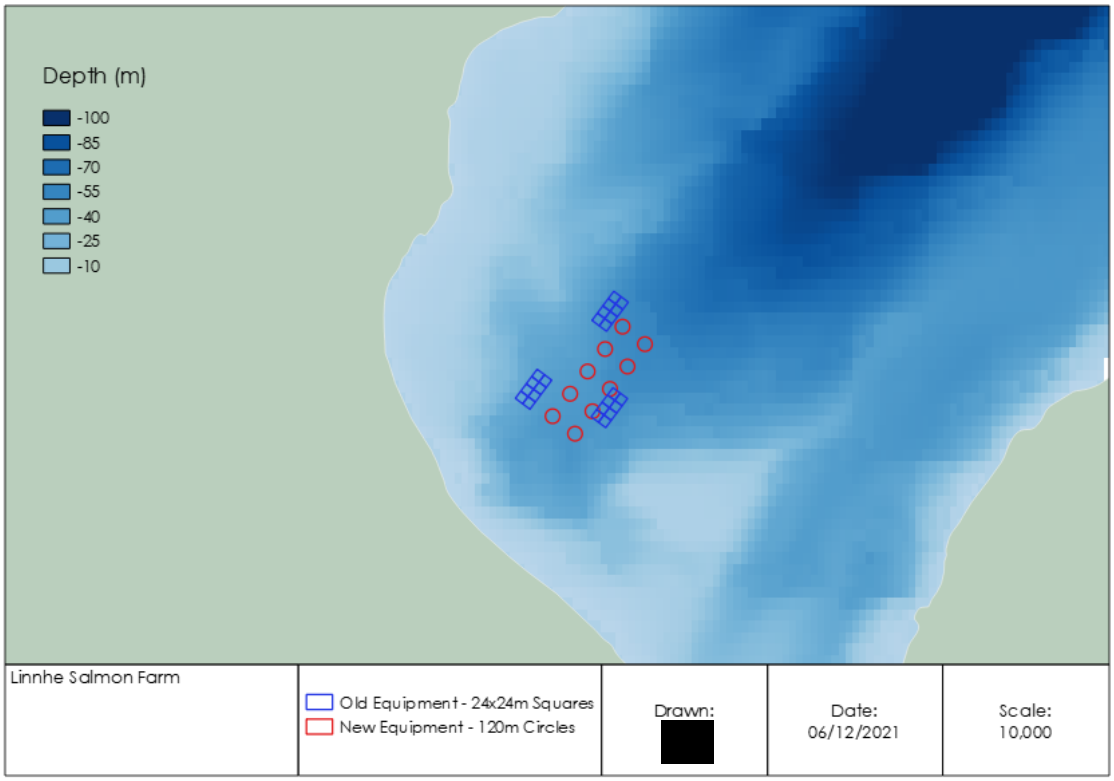


Figure 2. Bathymetry in the region around Linnhe salmon farm.

2.2 Current Data

Mowi staff carried out hydrographic surveys at the site during 2019. The purpose of this hydrographic report is to assess the suitability of the collected hydrographic data for use with a Hydrodynamic model. The data contained in this report were recorded at the site from 27th August to 27th September (30 days and 18 hours 20 minutes of data; deployment ID282). The data from an earlier deployment (ID277) are presented in a separate hydrographic report.

The Sentinel V100 (Wide) ADCP (Table 1), within its mooring frame, was positioned at 56.73188'N, 5.24365'W (201672E 764724N), which was approximately 690m from the nearest shoreline and approximately 280m from the centre of the new cage group (Figure 1). The transducer head was 70 cm from the base of the mooring frame. The mean depth (derived from the pressure sensor) at the Sentinel V100 ADCP position was 67.64 m.

Initial soundings were taken to establish the possible depth the Sentinel V100 ADCP would be situated at during high tide and so that the most appropriate cell size could be determined. The cell size was set at 1.0 m and the number of cells to 79.

Data was automatically written and stored to the internal memory within the Sentinel V100 ADCP main body and then downloaded to computer after completion of the deployment period via WiFi.

2.3 Magnetic Variation

No magnetic variation correction was made to the Sentinel V100 ADCP during deployment, this was undertaken to the data after the instrument was recovered and data downloaded. The magnetic variation used was -2.94°; 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 V100 ADCP current meter, all data was downloaded to a computer for analysis. The raw data file was opened in Teledyne's "Velocity" software and Matlab. Deployment diagnostic data (beam intensity, correlation, pitch and roll) were analysed to confirm that the deployment was successful with the instrument orientated upright. The heading data were also examined to identify any movement of the Sentinel V100 ADCP mooring frame during the deployment.

The diagnostic data suggested that velocities from the first 55 bins were valid (Figure 3). Calculations were undertaken to identify the cells to be used for surface and middle currents. Surface data was taken at an average depth (derived from the pressure sensor) of 9.92 m (cell 55), and cage-bottom data at 16.92 m (cell 48). Surface and middle cell heights were 57.72 m and 50.72 m from the seabed respectively. The bottom cell (cell 1) was at an average depth of 63.92 m and 3.72 m above the seabed.

The 'first cell range' is automatically calculated by the instrument, which is the distance from the transducer head to the first cell. For this deployment, the first cell range was calculated as 3.02 m. This value is then added to the height of the instrument frame (0.7 m) to get the first cell height above the seabed, which equated to 3.72 m

The average StdDev values for the surface middle and bottom cells was 0.64cm/s, 0.63cm/s and 0.63cm/s respectively which are all within the SEPA criteria of 2cm/s.

Depth Cell Size[1]		**V20 (1000kHz)**		**V50 (500kHz)**		**V100 (300kHz)**	
	Depth Cell Size[1]	Range (m)[2,3] Wide/Narrow	Std Dev (cm/s)[3,4] Wide/Narrow	Range (m)[2,3] Wide/Narrow	Std Dev (cm/s)[3,4] Wide/Narrow	Range (m)[2,3] Wide/Narrow	Std Dev (cm/s)[3,4] Wide/Narrow
	0.25m	18.0/22.6	19.2/36.5				
	0.3m	19.3/24.0	11.1/20.8				
	0.5m	20.2/24.9	7.1/13.4	44.1/57.6	19.2/36.5		
	1.0m	22.1/26.9	3.6/6.7	50.5/64.6	7.1/13.5	94.5/120.6	10.9/20.6
	2.0m	24.5/29.4	1.7/3.2	56.0/70.6	3.6/6.7	103.5/130.4	5.5/10.3
	4.0m	26.9/32.0	0.8/1.6	63.1/78.2	1.7/3.2	114.6/142.3	2.7/5.2
	6.0m			67.4/82.8	1.1/2.1	121.7/151.5	1.8/3.3
Communications and Recording	Wireless	802.11b/g/n					
	Internal memory	One 16GB Micro SD Card included					
Profile Parameters	Velocity accuracy	V20/V50: 0.3% of the water velocity relative to the ADCP ±0.3cm/s V100: 0.5% of the water velocity relative to the ADCP ±0.5cm/s					
	Velocity resolution	0.1cm/s					
	Velocity range	±5m/s (default); ±20m/s (maximum)					
	Ping rate	Up to 4Hz					
Echo Intensity Profile	Vertical resolution	Depth cell size					
	Dynamic range	80dB					
	Precision	±1.5dB					
Transducer and Hardware	Beam angle	25°					
	Configuration	4-beam, convex; 5th beam vertical					
	Depth rating	200m					
	Materials	Transducer, housing, and end cap: plastic Connector: metal shell					
Standard Sensors	Temperature (mounted on transducer)	Range -5° to 45°C, precision ±0.4°C, resolution 0.1°					
	Compass (magneto-inductive sensor)	Accuracy 2° RMS, resolution 0.1°, max. dip angle 85°					
	Tilt (MEMS accelerometers)	Pitch range ±90°, roll range ±180°, accuracy 2° RMS, precision 0.05° RMS, resolution 0.1°					
	Pressure sensor (mounted on transducer)	Range 300m, accuracy 0.1%FS					
Power	External DC input	12–20VDC					
	Internal battery voltage	18VDC new					
	Battery capacity; over-the-counter @0°C	100 watt hours (typical)					
	Battery pack @5°C	510 watt hours					
Software	Teledyne RDI's new software included	ReadyV—Pre-deployment (testing, planning, and data recovery)[5] Velocity—Post-processing (data handling, display, and export)[6]					
Environmental	Standard depth rating	200m					
	Operating temperature	-5° to 45°C					
	Storage temperature (without batteries)	-30° to 60°C					
	Weight in air	7.5kg – 16.0kg					
	Weight in water	1.6kg – 6.0kg					
Available Options	External battery case • AC/DC power converter • 5th beam (at time of order only) • Waves processing • Straight or right-angle metal shell connector						
Dimensions	Special configuration drawing available upon request						

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 35psu; longer ranges are possible.
3 User selects the bandwidth mode; wide = 25% or narrow = 6%.
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.

Specifications subject to change without

Table 1: Sentinel V100 ADCP Specifications.

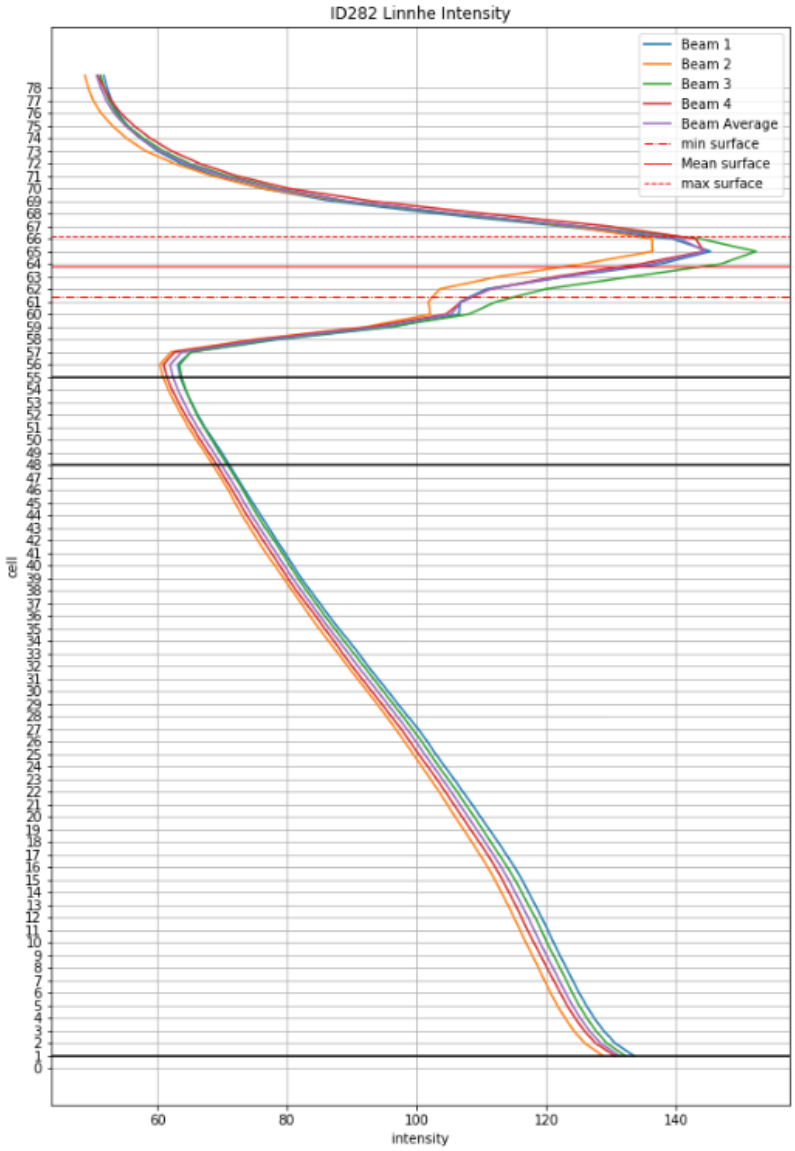


Figure 3. Mean intensity of the ADCP signal for the ID282 dataset plotted by bin number

2.5 Meteorological Data

The collection of meteorological data is no longer required to support the assessment process and consequently has not been undertaken. The current data used is collected using mulitple deployments and over a longer period and thus provides a more realistic representation of site conditions than short deployments, thus allowing an assessment of the influence of meterological conditions.

3. Results and Discussion

A summary of the current data is shown in Figure 4 to Figure 12 and in Table 2 to Table 5. Over the period analysed for this report, the near-surface, middle and bottom cells had current speed averages of 11.68 cm/s, 8.93 cm/s and 5.15 cm/s respectively. This gave an overall average of 8.59 cm/s. The orientation of the tidal velocities was NorthEast – SouthWest in the near bed cell and SouthWest for the pen bottom and near surface cells.

Residual currents at the surface and mid-depth were toward the south-east (157°G and 136°G respectively); near the seabed, the residual flows during the deployment period were to the west (075°G, Figure 9). The magnitude of the residual currents for the surface, middle and bottom cells were moderate, with mean values of 0.075 m/s, 0.045 m/s and 0.007 m/s respectively.

4. Hydrographic Data Summary Sheets

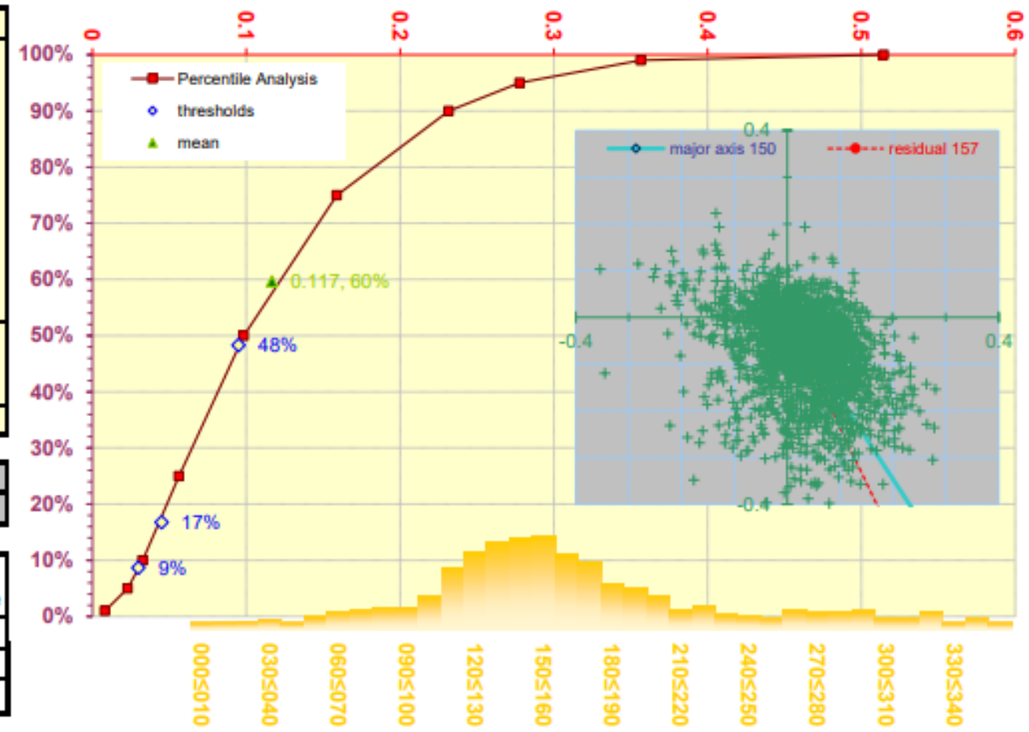
Current meter ID :	Linnhe_57.7m_subs_bin55			201674mE	764722mN
declination:	-2.940	convergence:	-2.711	GMA:	-0.22944 (Deg-M)
Period of measurement :	27/8/19 15:00	to	27/9/19 09:00	30 days	18 hrs	0 mins

Depth/ Pressure		
	Max:	12.19
	Mean:	9.92
	Min:	7.43

Percentiles	Current Speed	
1%	0.008 m/s	percentile analysis
5%	0.023 m/s	
10%	0.033 m/s	
25%	0.056 m/s	
50%	0.099 m/s	
75%	0.159 m/s	
90%	0.232 m/s	
95%	0.278 m/s	
99%	0.357 m/s	
100%	0.515 m/s	
9%	0.030 m/s	threshold values
17%	0.045 m/s	
48%	0.095 m/s	
60%	0.117 m/s	mean

Major axis :	150 (Deg-M)		0.139 m/s
Residual current :	0.075 m/s	at	157 (Deg-M)

	Residual	Tidal amplitude
Longitudinal (U) :	0.075 m/s	0.139 m/s
Lateral (V) :	0.009 m/s	0.095 m/s
Anisotropy (long'l/lat'l) :	8.04	1.46



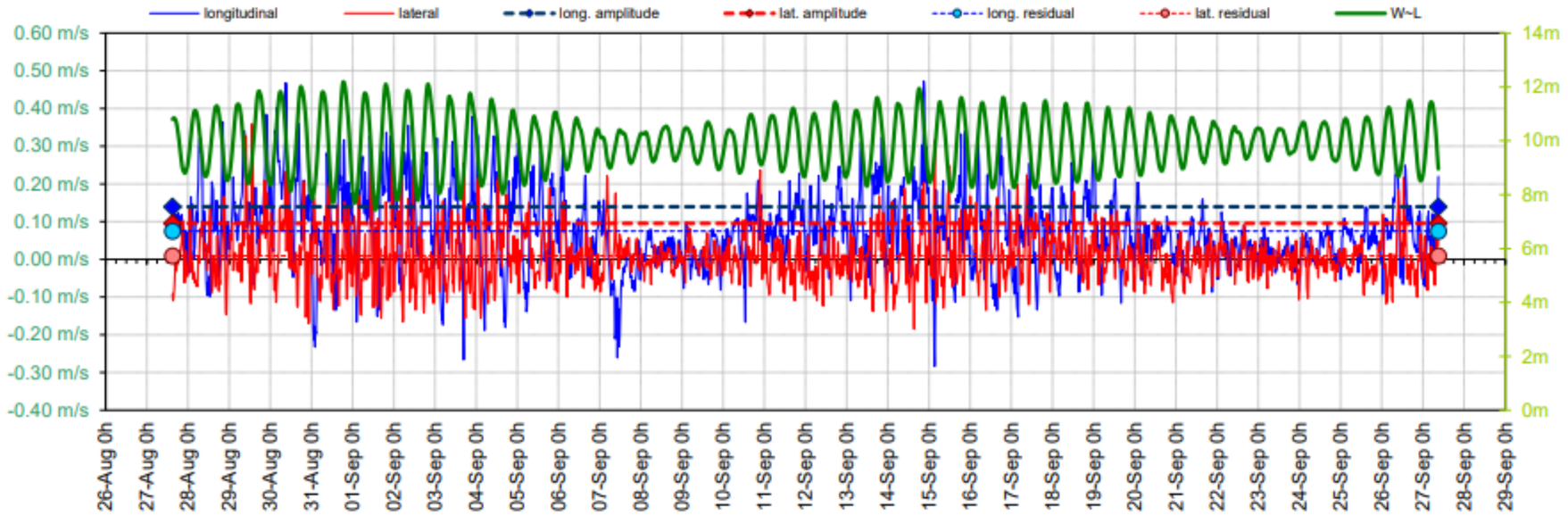


Figure 4. Current Data Summary Sheet for the surface current cell 55, 57.72m from seabed, 27th August to 27th September 2019 inclusive (ID282).

Current meter ID :	Linnhe_50.7m_cbot_bin48				201674mE	764722mN
declination:	-2.940		convergence:	-2.711	GMA:	-0.22944 (Deg-M)
Period of measurement :	27/8/19 15:00	to	27/9/19 09:00	30 days	18 hrs	0 mins

Depth/ Pressure		
	Max:	19.19
	Mean:	16.92
	Min:	14.43

Percentiles	Current Speed	
1%	0.009 m/s	percentile analysis
5%	0.017 m/s	
10%	0.026 m/s	
25%	0.044 m/s	
50%	0.077 m/s	
75%	0.121 m/s	
90%	0.173 m/s	
95%	0.207 m/s	
99%	0.275 m/s	
100%	0.370 m/s	
14%	0.030 m/s	threshold values
25%	0.045 m/s	
63%	0.095 m/s	
59%	0.089 m/s	mean

Major axis :	160 (Deg-M)		0.110 m/s
Residual current :	0.045 m/s	at	136 (Deg-M)

	Residual	Tidal amplitude
Longitudinal (U) :	0.041 m/s	0.110 m/s
Lateral (V) :	-0.018 m/s	0.084 m/s
Anisotropy (long'l/lat'l) :	2.29	1.32

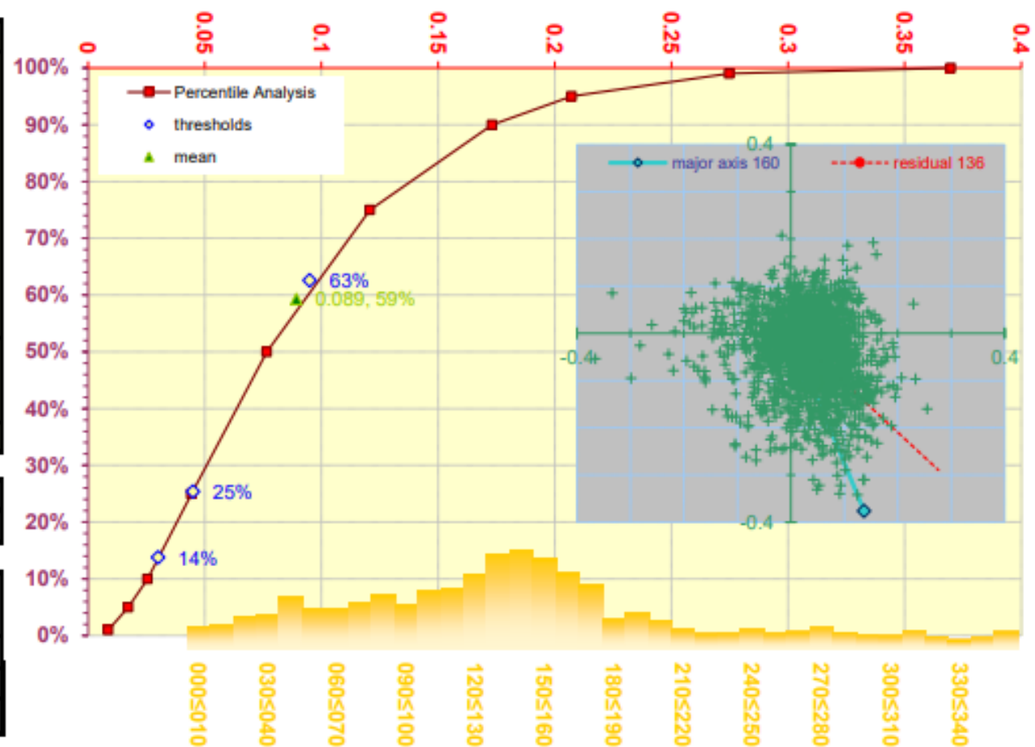


Figure 5. Current Data Summary Sheet for the cage bottom current cell 48, 50.72m from seabed, 27th August to 27th September 2019 inclusive (ID282).

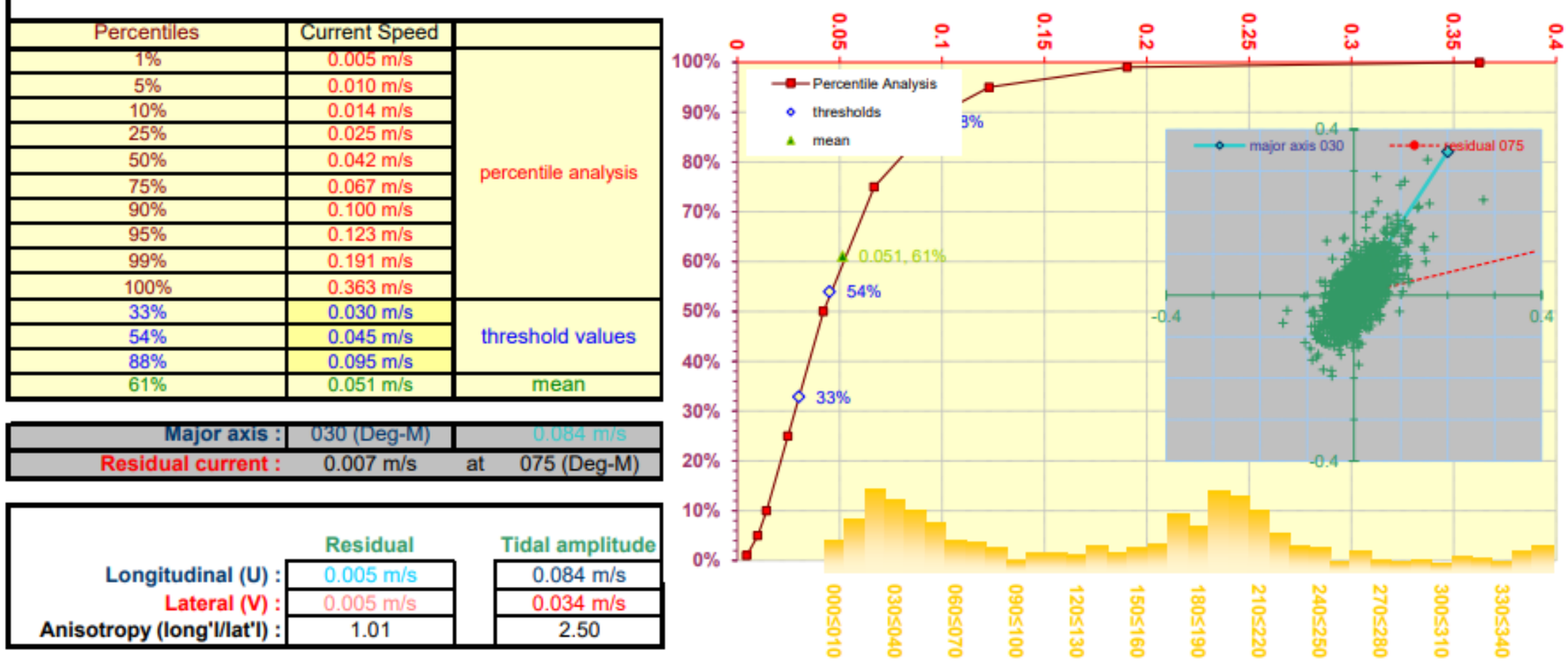
Current meter ID :	Linnhe_3.7m_nrbd_bin01				201674mE	764722mN
declination:	-2.940		convergence:	-2.711	GMA:	-0.22944 (Deg-M)
Period of measurement :	27/8/19 15:00	to	27/9/19 09:00	30 days	18 hrs	0 mins

Depth/ Pressure		
	Max:	66.19
	Mean:	63.92
	Min:	61.43

Percentiles	Current Speed	
1%	0.005 m/s	percentile analysis
5%	0.010 m/s	
10%	0.014 m/s	
25%	0.025 m/s	
50%	0.042 m/s	
75%	0.067 m/s	
90%	0.100 m/s	
95%	0.123 m/s	
99%	0.191 m/s	
100%	0.363 m/s	
33%	0.030 m/s	threshold values
54%	0.045 m/s	
88%	0.095 m/s	
61%	0.051 m/s	mean

Major axis :	030 (Deg-M)		0.084 m/s
Residual current :	0.007 m/s	at	075 (Deg-M)

	Residual	Tidal amplitude
Longitudinal (U) :	0.005 m/s	0.084 m/s
Lateral (V) :	0.005 m/s	0.034 m/s
Anisotropy (long'l/lat'l) :	1.01	2.50



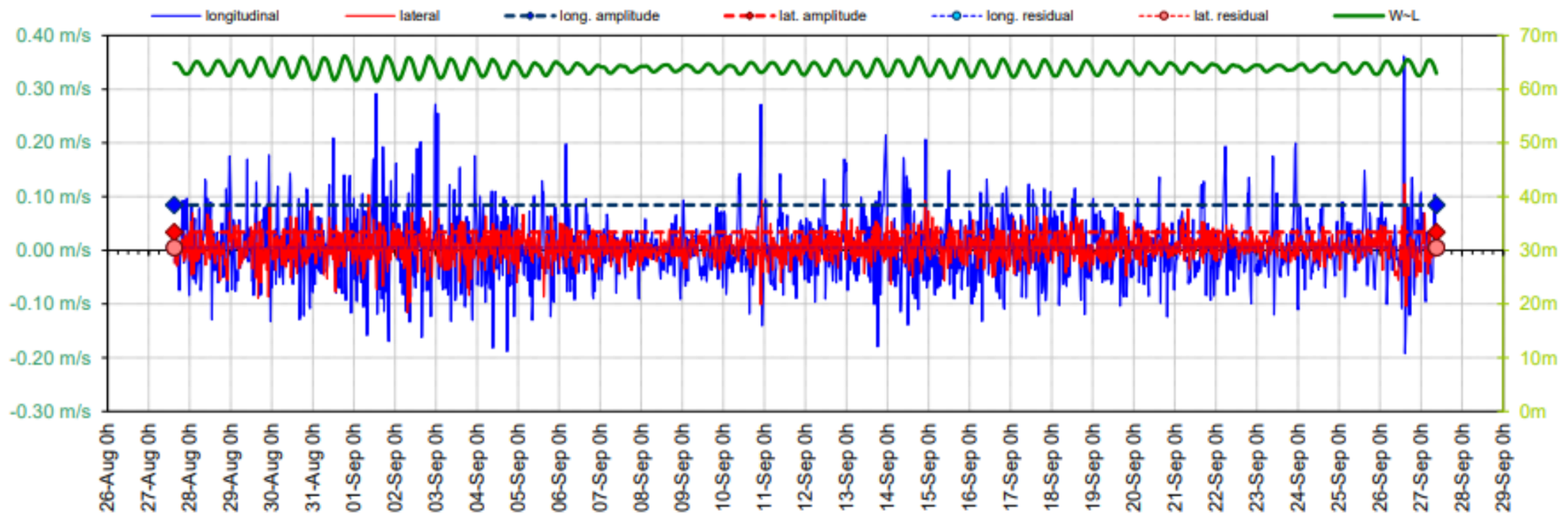


Figure 6. Current Data Summary Sheet for the near bottom current cell 1, 3.72m from seabed, 27th August to 27th September 2019 inclusive (ID282).

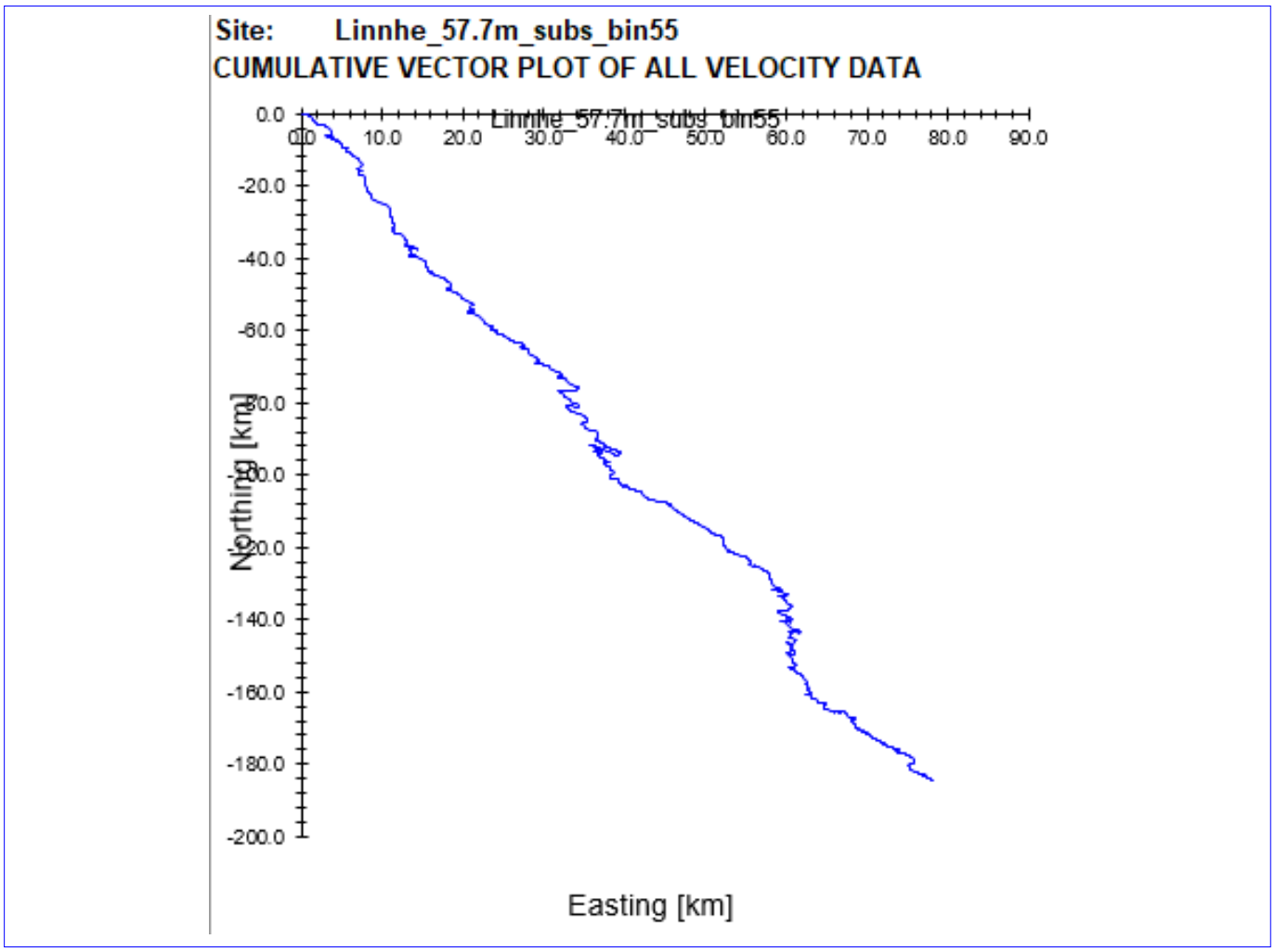


Figure 7. Cumulative Vector Plot of all velocity data from near surface cell for ID282.

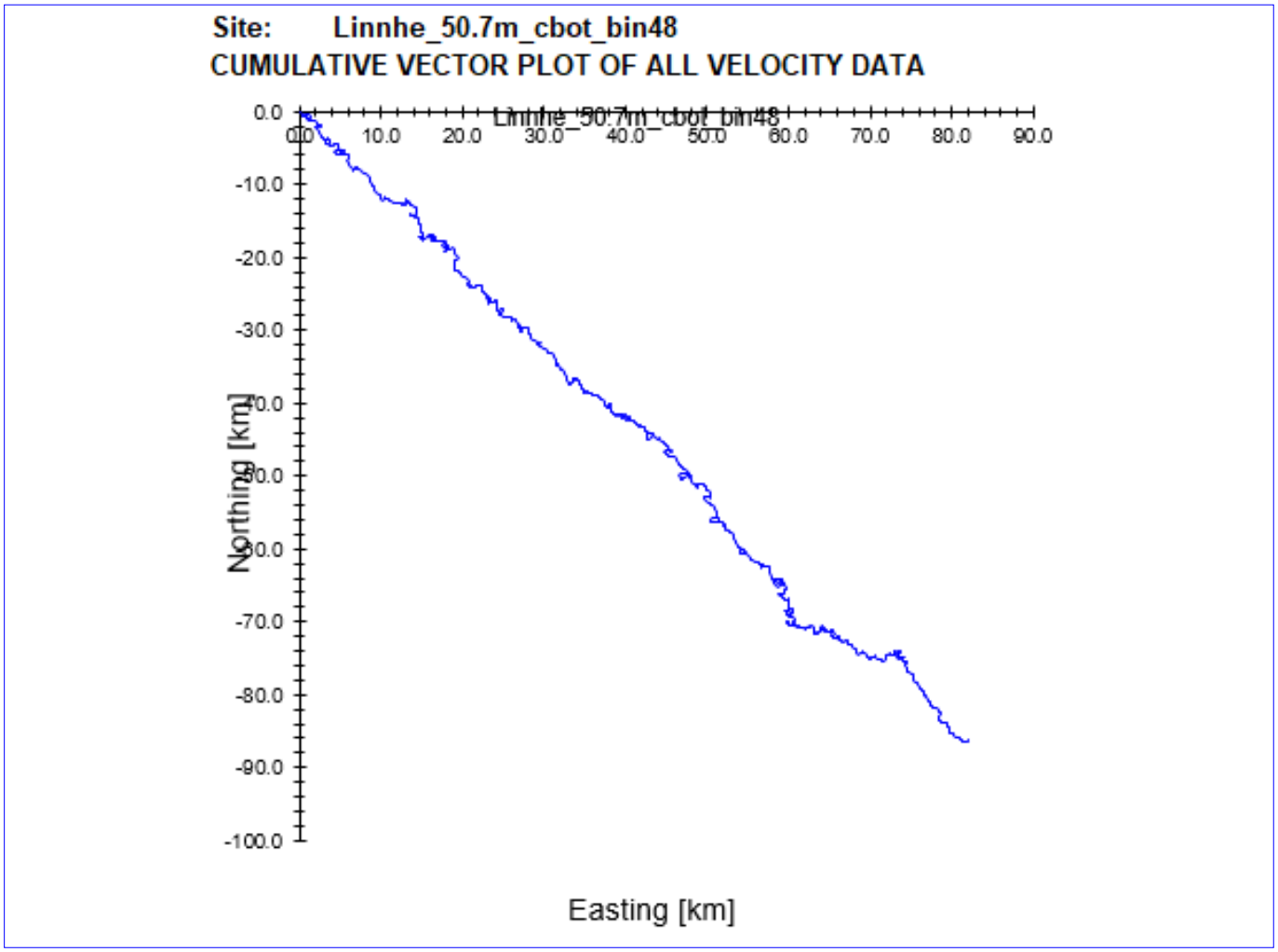


Figure 8. Cumulative Vector Plot of all velocity data from cage bottom cell for ID282.

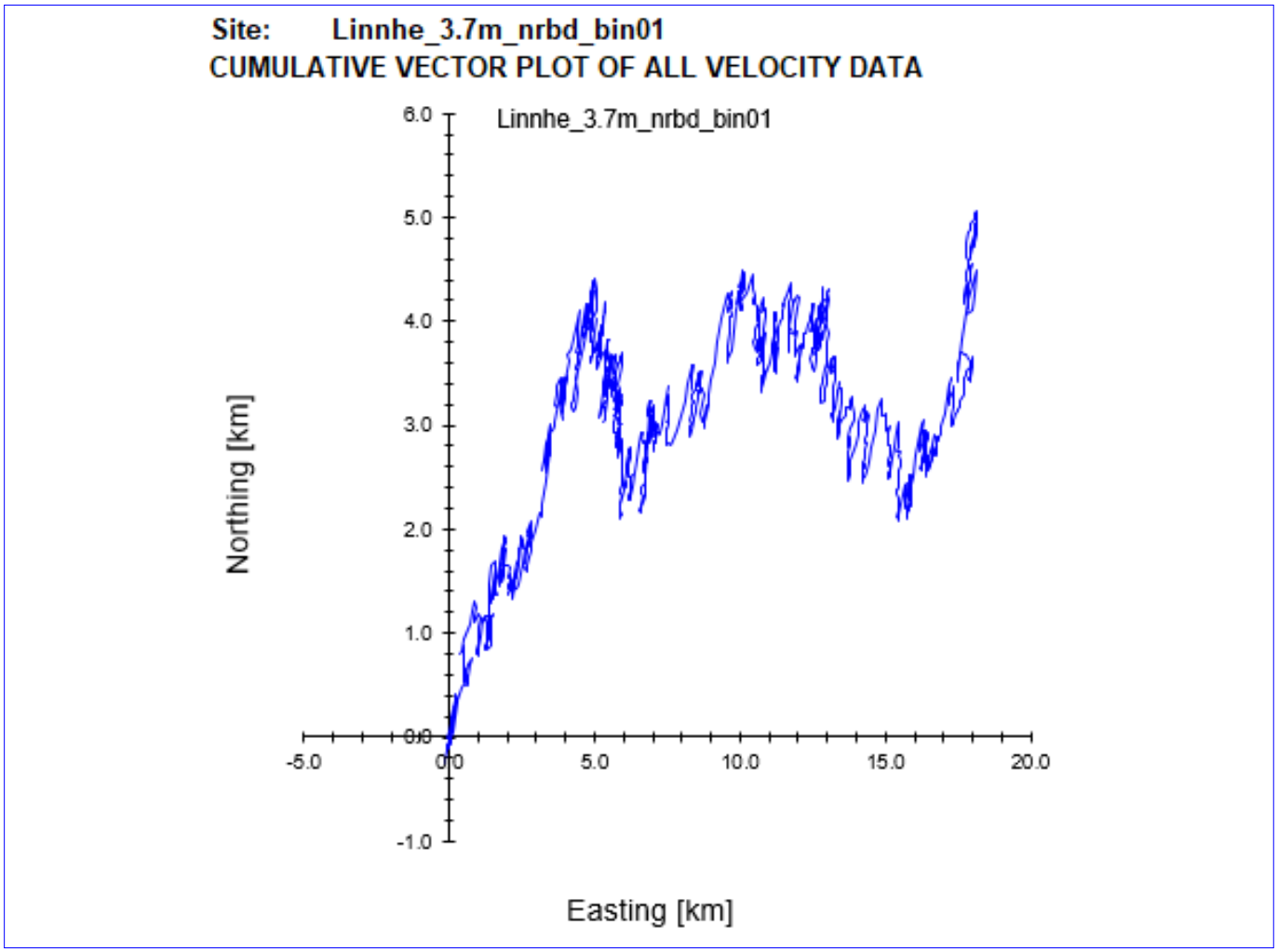


Figure 9. Cumulative Vector Plot of all velocity data from near bottom cell for ID282.

5. Summary of Current Data – ID282

Site Name: Linnhe
Data start date: 27/08/2019
Data end date: 27/09/2019
Mean Water Depth: 67.64m

Table 2. Summary of current meter deployment

	Cell	Depth Below Minimum Surface (m)	Distance from Seabed (m)	Mean current speed (cm/s)
Near surface:	55	7.43	57.72	11.68
Cage bottom:	48	14.43	50.72	8.93
Near bed:	1	61.43	3.72	5.15
			Average current speed:	8.59

Table 3. Ranked percentiles for current speed at all three depths

Cell	Ranked Percentile (%) for mean speed	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)
Near surface:	60	9	83	52
Cage bottom:	59	14	74	37
Near bed:	61	33	46	12

Table 4. Major axis

Cell	Major Axis (Deg-G)
Near surface:	150
Cage Bottom:	160
Near bed:	030

Table 5. Mean and residual currents

Cell	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)
Near Surface:	0.117	0.075	0.075	0.009	0.139	0.095
Cage Bottom:	0.089	0.045	0.041	-0.018	0.110	0.084
Near Bed:	0.051	0.007	0.005	0.005	0.084	0.034

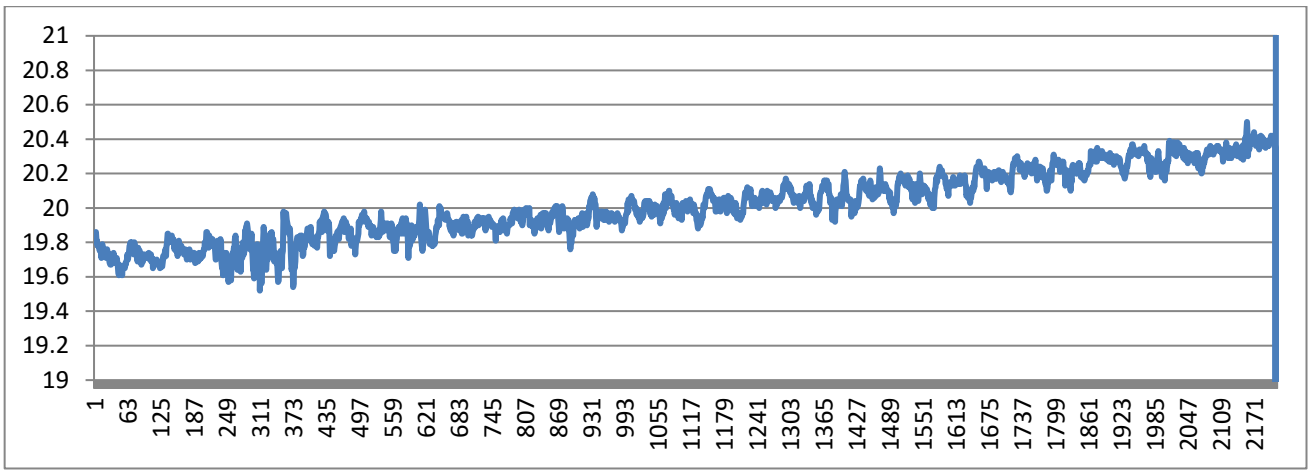


Figure 10. Summary of heading data from deployment ID282.

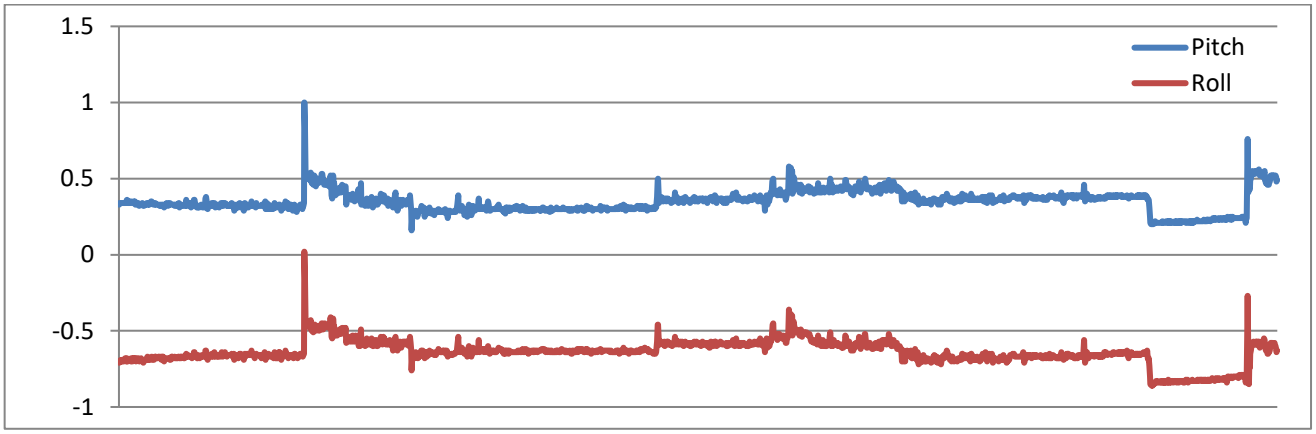


Figure 11. Summary of pitch and roll data from deployment ID282.

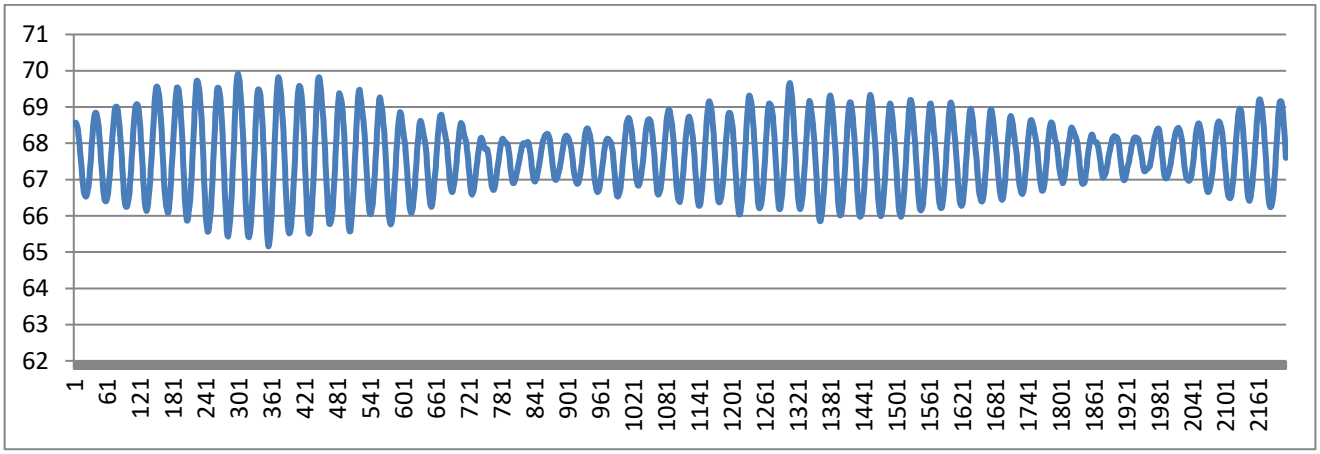


Figure 12. Pressure data from deployment ID282.

6. Conclusion

Mowi Scotland has collected and analysed current data for the proposed increase in Azamethiphos consented at the Linnhe fish farm. The analysed current data for the 30 days and 18 hours 20 minutes period are believed to be reliable and representative of the proposed location. The last two records from the current meter were filtered from the dataset as the recovery impacted the quality of the data.

Annex 1. Survey Equipment Deployment Log

Location:	Linnhe
Nearest tidal port:	Corran
Time zone:	UTC
Meter switched on:	15:00 27/08/2019
Meter switched off:	10:00 27/09/2019
Period used for this report:	15:00 27/08/2019 – 09:20 27/09/2019
ADCP serial number:	24616
Meter position:	56.73188'N 5.24365'W
	201672 E 764724 N
Minimum water depth:	65.15 m (64.45m measured by ADCP + 0.7 m *)
Mean water depth:	67.64 m (66.94 measured by ADCP + 0.7 m *)
Depth of meter from surface:	65.7 m (below mean low water spring to transducer)
Height of meter from seabed:	0.7 m to transducer head
Sounding at deployment:	66 m @ 12:35 on 27/08/2019

Table A1. ADCP meter settings:

Reference:	Transducer
Bin size (m):	1.0
Dist to 1st bin (m):	3.02
Number of bins:	79
Frequency (kHz):	307
Recording interval (mins):	20
No. pings per ensemble:	300
Magnetic correction:	0
Ensemble:	300
Standard Deviation (cm/sec):	0.63
Time/Ping (seconds):	2