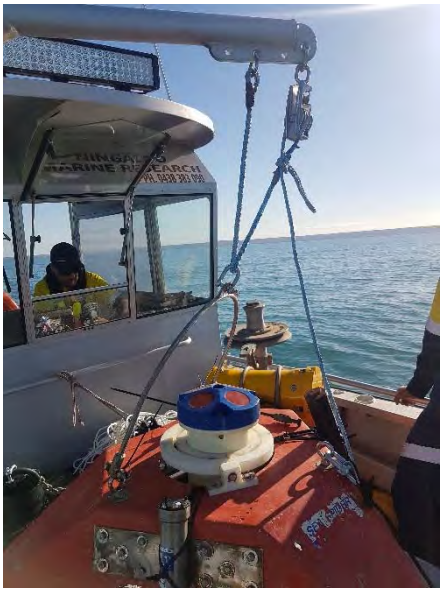

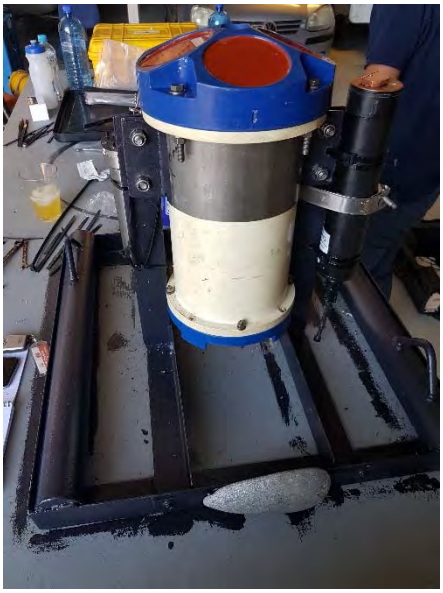

Subsea 7

Exmouth Gulf Current Monitoring

Field Report

August 2018

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1. Introduction

This GHD Pty Ltd (GHD) field report summarises the Exmouth Gulf Current Monitoring campaign carried out from May – June 2018 for Subsea 7 (SS7). This project involved the supply of equipment, deployment/retrieval of equipment, and provision of QA/QC current speed and direction data at two prescribed SS7 sites within Exmouth Gulf over two tidal cycles. Additionally, photosynthetic available radiation (PAR) and turbidity measurements were made near the seabed from loggers attached to the seabed mounted current measurement instruments.

This report outlines in the following sections:

- **Introduction**: An overview of the scope of works completed and report contents;
- **Field methods and equipment**: An overview of the tasks, personnel, equipment and methods used to acquire the data; and
- **Results**: Brief description and/or plots of the QA/QC data in accordance with the Scope of Works (SoW) document (SS7 Doc No. BU-16-0430-SOW-09-04-2018);

Appendices with supporting documentation are attached to this report.

2. Field methods and equipment

2.1 Survey Location

The monitoring instruments were deployed at two (2) deployment locations, Launchway and Parking (refer to Table 2-1 and Figure 1), as specified by SS7 in the Exmouth Gulf of Western Australia.

Table 2-1 Deployment locations and dates of deployment and retrieval

Location	Marker	Depth (m)	Latitude	Longitude	Deployment	Retrieval
Launchway	Surface Buoy	~14	-22.2061	114.1700	22 May 18 16:00	21 Jun 18 15:50
Parking	Surface Buoy	~20	-21.9798	114.3090	22 May 18 17:10	21 Jun 18 13:40

2.2 Survey Period

The monitoring period occurred over approximately two (2) full tidal cycles between 22 May 2018 to 21 June 2018, a total of 31 days.

Figure 1 ADCP deployment locations, Exmouth Gulf

2.3 Field Equipment

2.3.1 Acoustic Doppler Current Profiler

Acoustic Doppler Current Profilers (ADCPs) measure current speeds and directions at various depths throughout the water column. The Workhorse Sentinel Acoustic Doppler Current Profiler 600 kHz and Workhorse Sentinel Acoustic Doppler Current Profiler 1200 kHz are designed for long-term deployments equipped with batteries and sufficient storage for data (see Figure 2, device with blue top). The instruments can be surface mounted (facing down) or bottom mounted (attached to a frame at the seabed, facing up as adopted for this survey). The ADCP units were configured to measure:

- Speed and direction of water currents at 0.5 m interval depth bins;
- Pressure (depth);
- Temperature (near seabed); and
- Wave heights and period (configured only for the 1200 kHz unit deployed at Launchway).

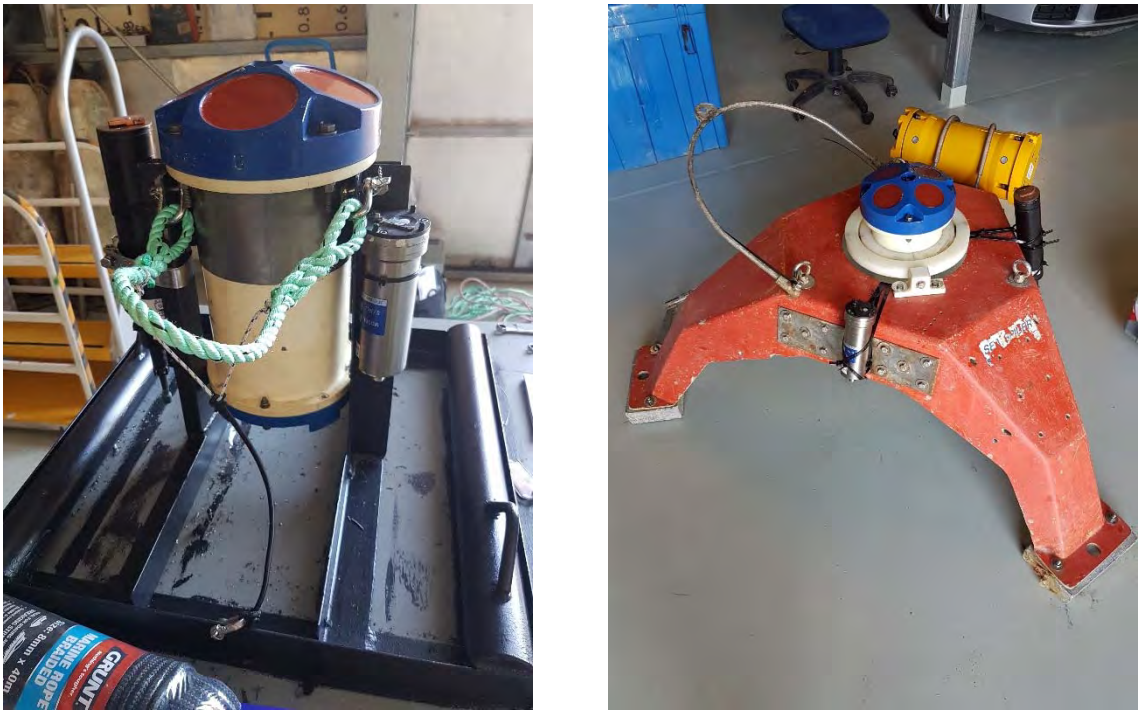


Figure 2 Loggers and ADCP setup pre-deployment for Parking (left) and Launchway (right)

2.3.2 Loggers (Turbidity, PAR-Light)

Additional instruments deployed at both sites included the following two types of loggers:

- WETLabs NTU – Turbidity Logger (Figure 2, black cylinder) and;
- JFE Advantech (Kobe, Japan), Photosynthetically Available Radiation (PAR) Logger (Figure 2, silver cylinder).

These loggers were attached to each ADCP frame as shown in Figure 2. The turbidity and PAR loggers were set to 'burst' measurements with the following configuration:

- Burst interval = 10 minutes;
- Burst duration = 10 seconds;

- Number of samples during burst = 10.

Both the JFE Advantech PAR and WETLabs Turbidity loggers have automatic sensor wipers. The blades activate to wipe the sensor surface prior to each burst, thereby reducing biofouling effects that can compromise measurements. The 10-minute sampling period ensures a high temporal resolution of data and a high frequency of sensor wiping (and thereby reduction in biofouling).

2.3.3 Vessel

Equipment deployment and retrieval was undertaken with the *FD3* vessel operated by TerraFirma Offshore. The *FD3* is a 7.8 m surveyed vessel fully equipped with a winch and 300 kg Davit (refer to Appendix B for full specs). The vessel provided ample desk space for transport of the instrument deployment packages and their safe deployment/retrieval.

2.4 Survey Tasks and Equipment Deployment

After mobilisation of equipment and personnel to Exmouth, the ADCPs were assembled and the internal compass bearings recalibrated. This process was completed as close as practicable to deployment locations to account for any local magnetic anomalies. The overall design of the deployment infrastructure is shown in Appendix A that included a surface buoy with solar-powered navigation light. The instruments were deployed/retrieved with a winch and davit and tethered to a ground weight attached to a surface buoy (Figure 3). Ample distance (~20-30 m) was established between the instrument frame and the surface buoy weight to reduce the probability of light and acoustic 'shadowing' by the buoy.

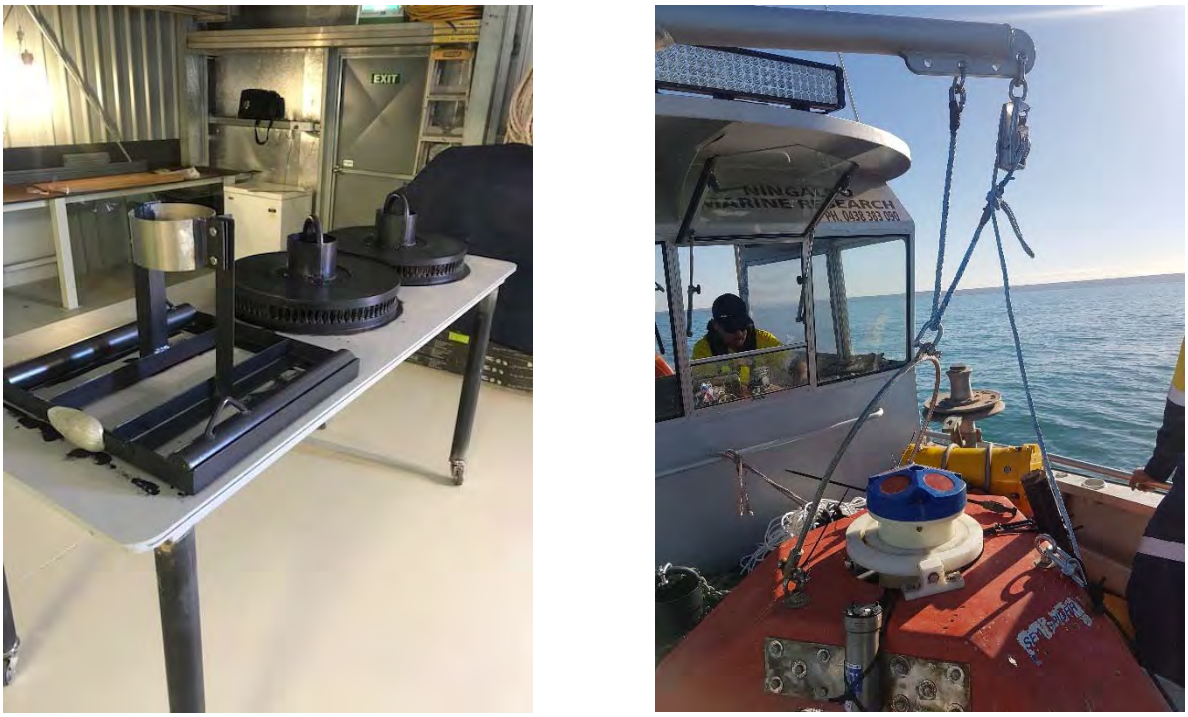


Figure 3 Photos showing ground anchors and ADCP frame (left), and davit and winch deployment (right)

2.5 Equipment Retrieval

Field equipment was retrieved through use of the vessel's davit crane and winch. The following recovery observations were noted in the field:

- All equipment was successfully recovered;

- Some minor biofouling (algal growth) was observed on the equipment frames;
- The logger sensors were clean upon retrieval, with the exception of the PAR logger at the Parking site. Biofouling was observed on the sensor indicating the wiper had stopped working prior to retrieval. Upon data download, no data was saved to the unit's memory, despite field notes indicating a successful unit setup. Field staff hypothesise the unit had a faulty connection to the battery power tjat resulted in a data wipe and discontinuation of logging.

2.6 Data Analysis

Analysis of ADCP and logger data was carried out upon retrieval of equipment. This process ensured adequate QA/QC by:

- Comparison of water levels recorded with astronomical (predicted) tides over the deployment period;
- Checking recorded current speeds and directions with tidal forcing as reported by the Bureau of Meteorology (BoM); and
- Removal and identification of outliers (i.e. data logged during deployment/retrieval, current readings from above the water surface, etc).

GHD provided QA/QC datasets of the monitoring to SS7 shortly after retrieval.

2.7 Field Personnel

The field personnel consisted of:

Thomas Sullivan	Project Manager / Environmental Engineer (GHD)
Keam Rawlinson	Marine Scientist (GHD)
Daemon Bass	Vessel Skipper / Master V (Terrafirma Offshore)
George Bass	Deckhand (Terrafirma Offshore)

3. Results

Graphical results are presented in the following sections of the following at the Launchway (Section 3.1) and Parking (Section 3.2) sites:

- Current speed profile time-series, showing the variations of current speeds with depth and time. See Appendix C for larger figures;
- Current direction profile time-series, similar to the above. See Appendix C for larger figures;
- Current speed percentile distribution plots showing the statistical spread of recorded current speeds (readings from all depths accounted for in the curve);
- U (east-west) and V (north-south) velocity component scatter plots (depth-averaged);
- Current rose plots showing the frequency and magnitude of current speeds and directions (depth-averaged) throughout the monitoring period;
- Depth and temperature (at the seabed) time-series plots;
- PAR time-series plots and percentile exceedance graphs (Launchway site only); and
- Turbidity time-series plots and percentile exceedance graphs.

3.1 Launchway

3.1.1 Current Speed

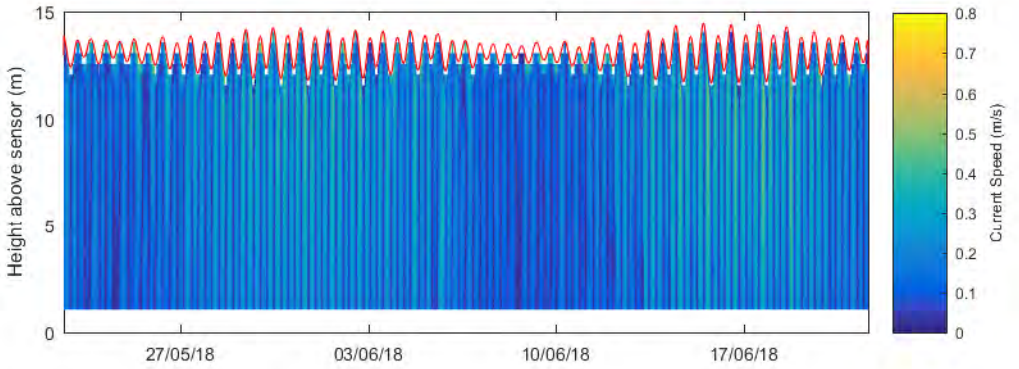


Figure 4 Current speed (m/s) and height above sensor (m), Launchway

3.1.2 Current Direction

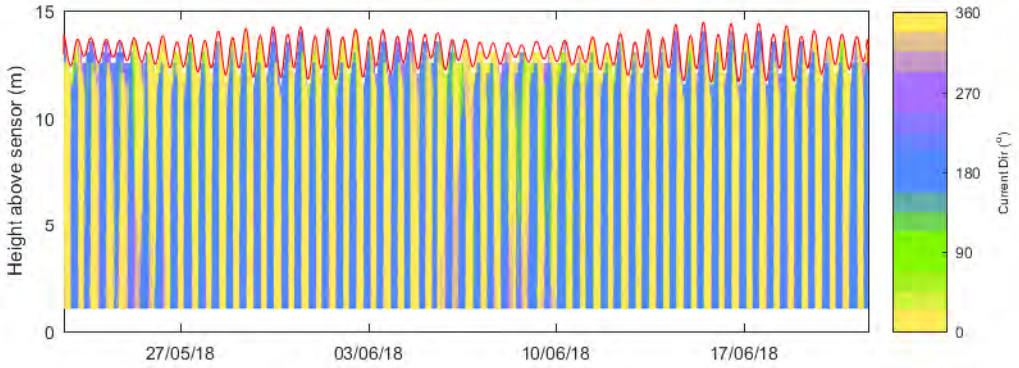


Figure 5 Current direction (0/360° - indicating north) and sea surface height above sensor, Launchway.

3.1.3 Current Speed Percentile Distribution

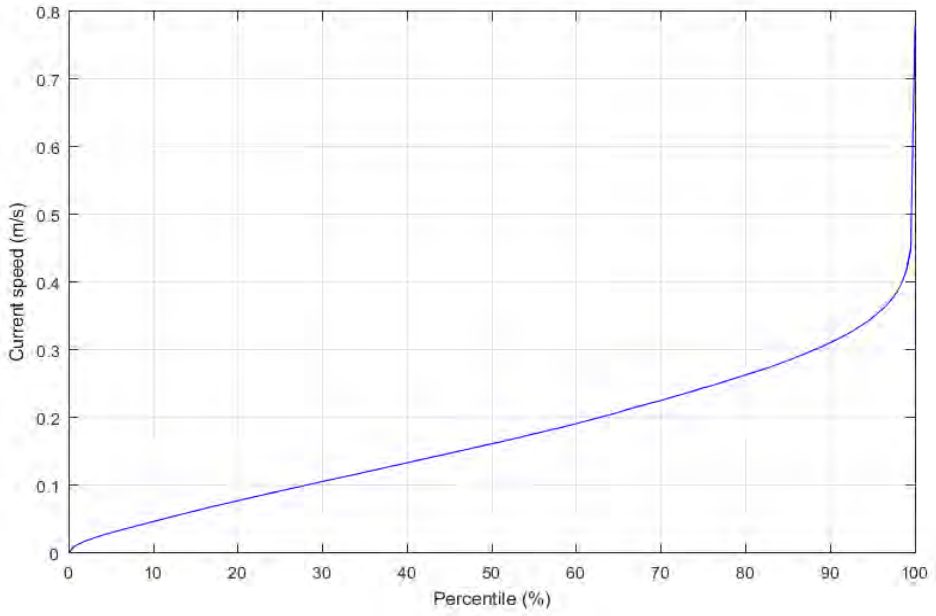


Figure 6 Current speed percentile distribution, Launchway

3.1.4 UV Scatter

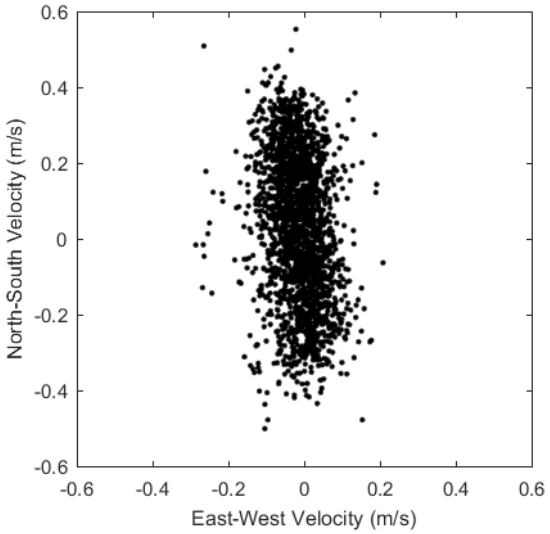


Figure 7 U (east-west) and V (north-south) velocity component scatter plot, Launchway

3.1.5 Current Rose

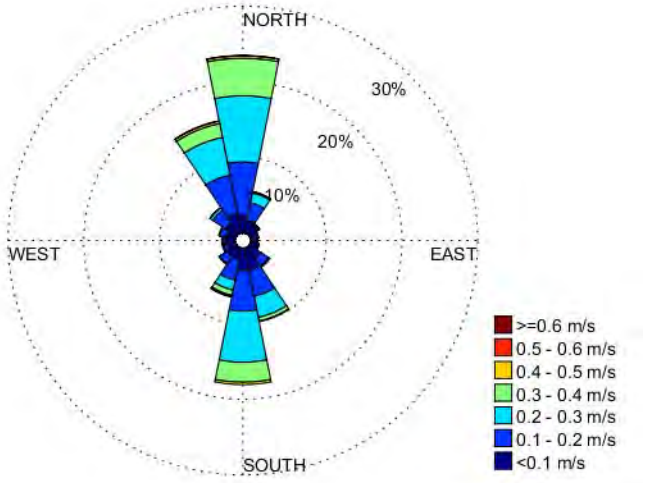


Figure 8 Current speed (velocity m/s) rose. Duration is indicated as % of time occurring throughout monitoring period, Launchway.

3.1.6 Depth and Temperature

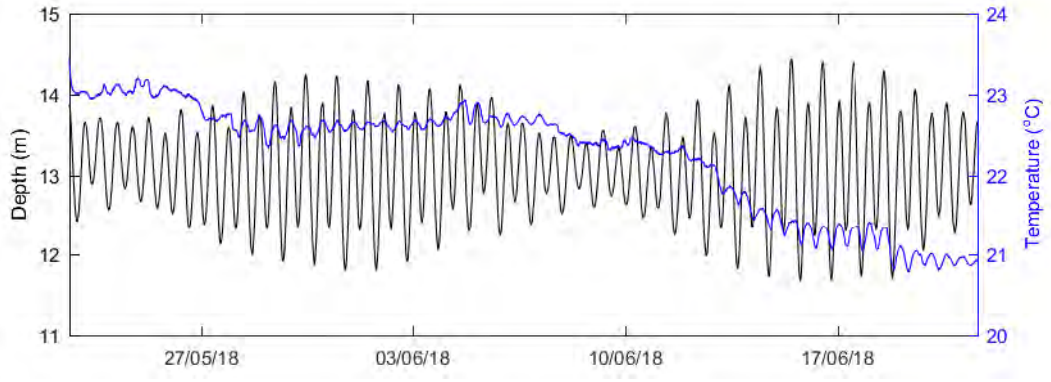


Figure 9 Depth (m) and temperature (°C) profile recorded throughout the monitoring period, Launchway

3.1.7 PAR

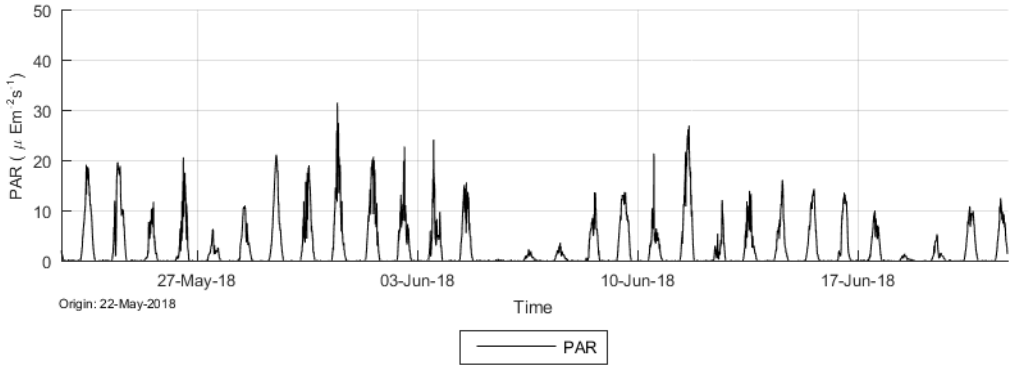


Figure 10 PAR (μ Em^{-2} s^{-1}) recording for Launchway

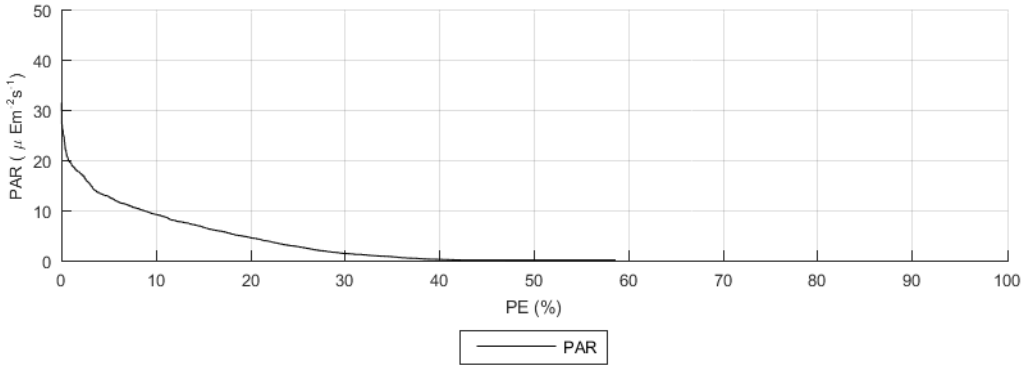


Figure 11 Percentile exceedance plot (μ Em^{-2} s^{-1}), Launchway

3.1.8 Turbidity

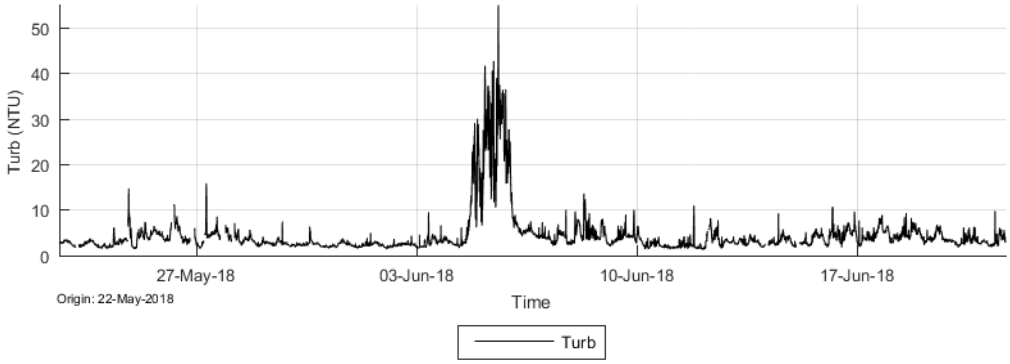


Figure 12 Turbidity recorded throughout monitoring event, note storm event 5th June, Launchway

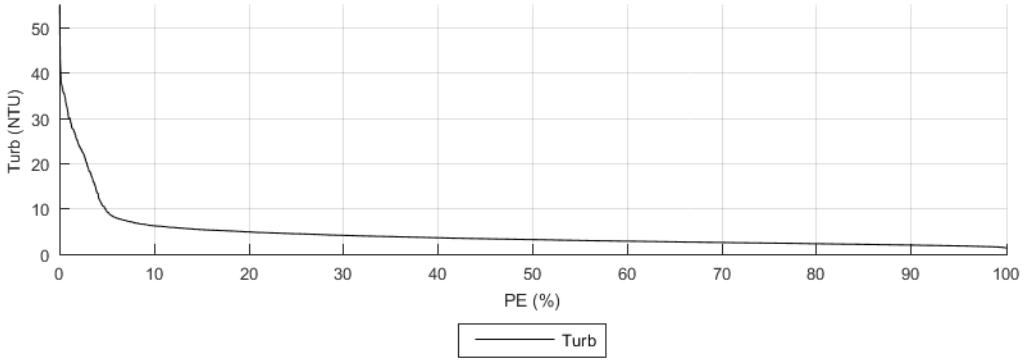


Figure 13 Percentile exceedance plot (turbidity), Launchway

3.2 Parking

3.2.1 Current Speed

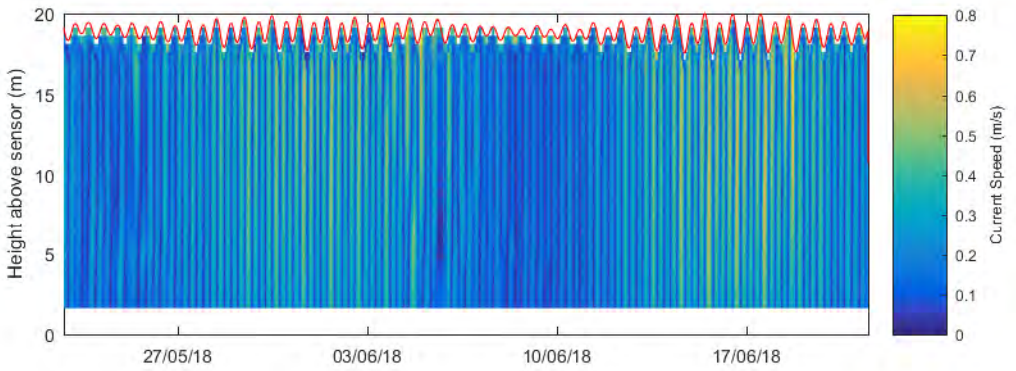


Figure 14 Current speed (m/s) and height above sensor (m) recorded, Parking

3.2.2 Current Direction

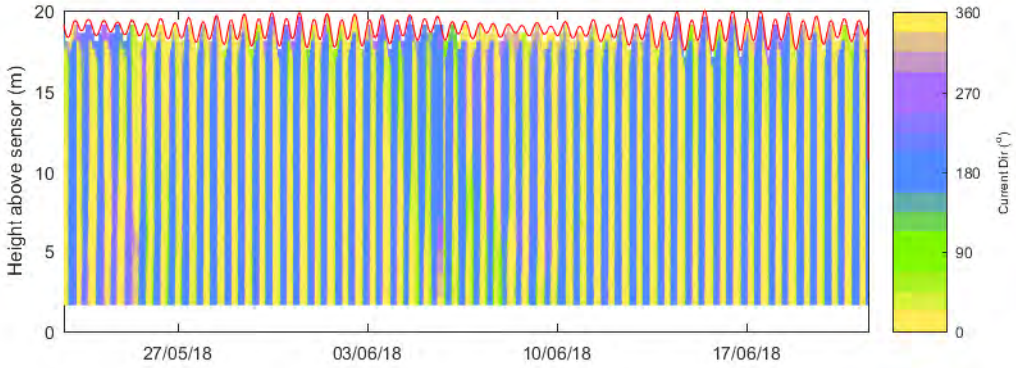


Figure 15 Current direction (0/360° - indicating north) and sea surface height above sensor, Parking

3.2.3 Current Speed Percentile Distribution

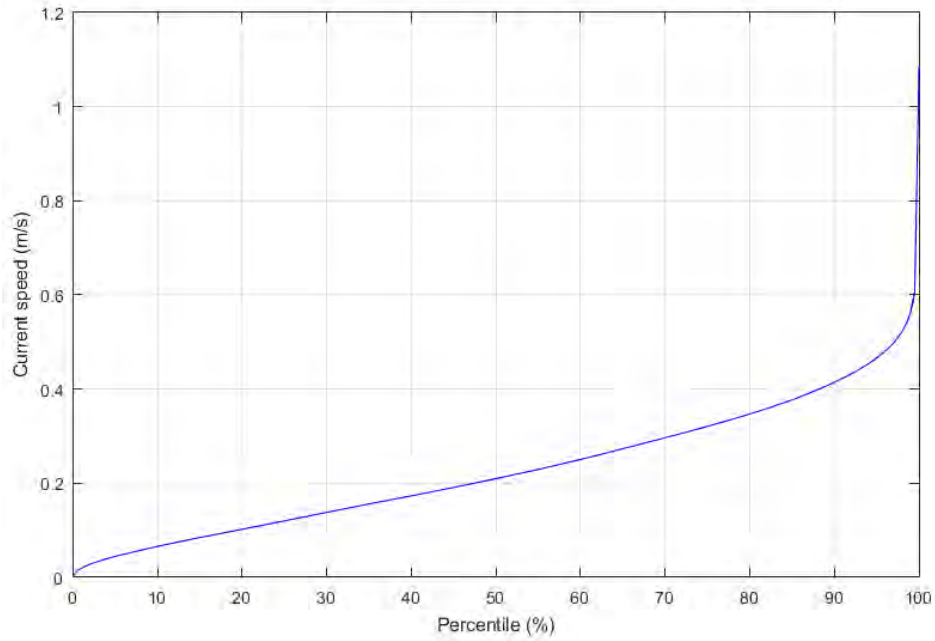


Figure 16 Current speed percentile distribution, Parking

3.2.4 UV Scatter

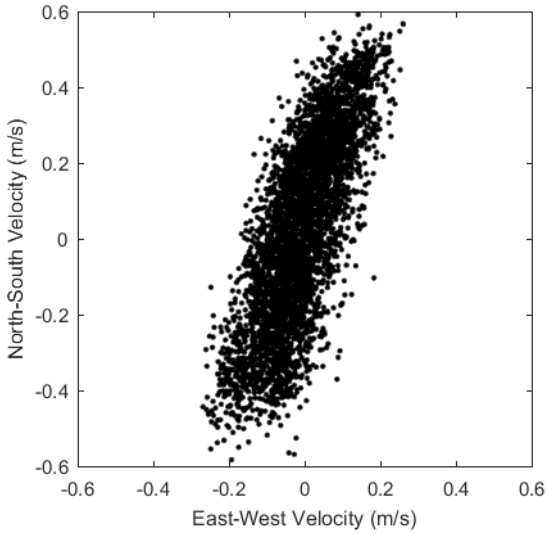


Figure 17 U (east-west) and V (north-south) velocity component scatter plot, Parking

3.2.5 Current Rose

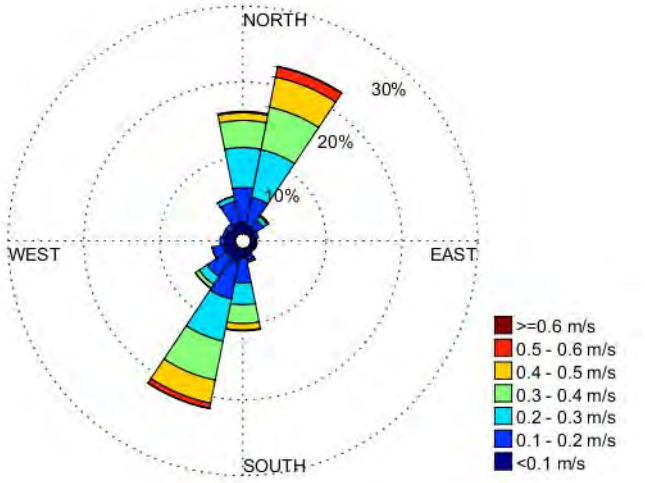


Figure 18 Current speed (velocity m/s) rose. Duration is indicated as % of time occurring throughout monitoring period, Parking

3.2.6 Depth and temperature profile

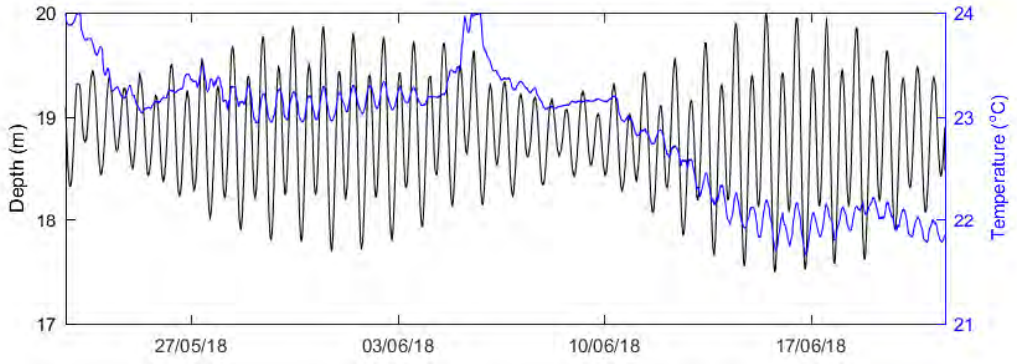


Figure 19 Depth (m) and temperature (°C) profile recorded throughout the monitoring period, Parking

3.2.7 Turbidity

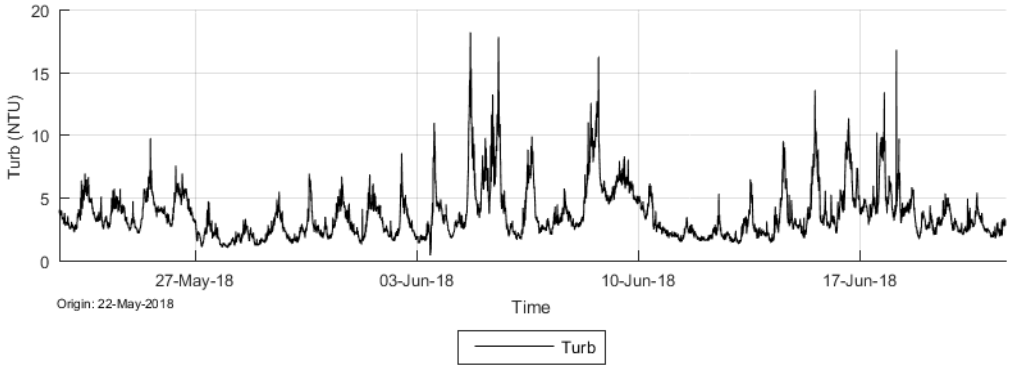


Figure 20 Turbidity recorded throughout monitoring event, note storm event 5th June, Parking

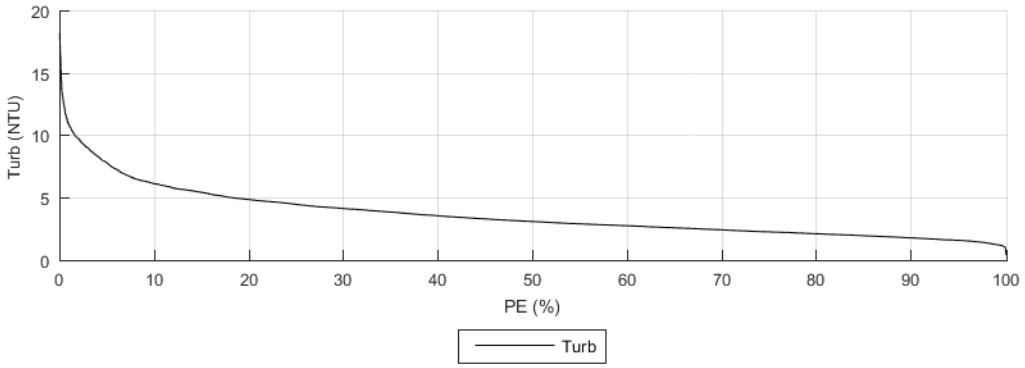
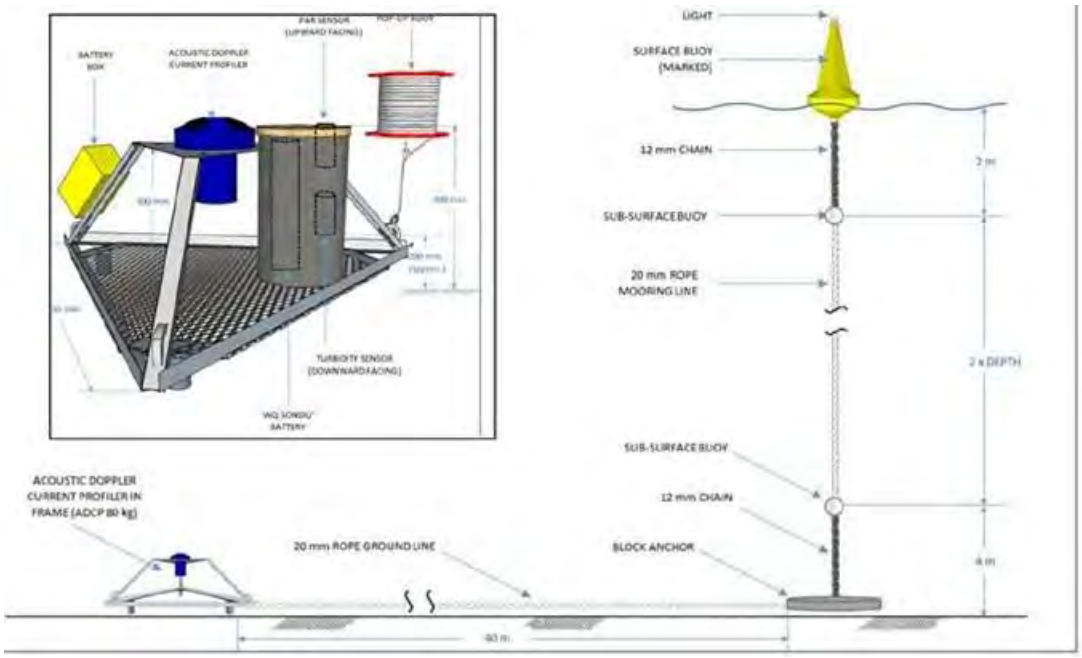


Figure 21 Percentile exceedance plot (turbidity), Parking

Appendices

Appendix A – Deployment design

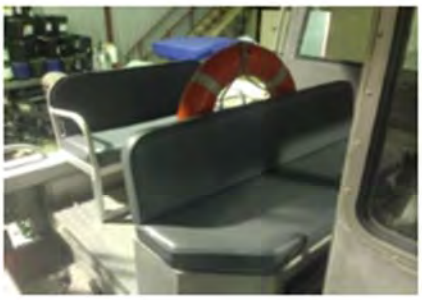


Appendix B – Vessel specifications

FD3

7.8mt Hotshot & Workboat

TERRAFIRMA OFFSHORE , PTY. LTD.
1 Griffiths Way
Exmouth W.A. 6707



TERRAFIRMA OFFSHORE , PTY. LTD.
1 Griffiths Way
Exmouth W.A. 6707

FD3

HULL	**Hampton Boats**
Length over all	**7.8**
Draft	**0.50**
Beam	**2.28**
YANMAR 4C	**140/190** KWP/HP
Gear Survey	**25/02/2018**
Hull Survey	**25/02/2019**
Survey Standard	**2c , 4pax & 1crew**
M&H No:	**3995**
Build Date	**1993. Nov 2014 full refit and upgrade from fisheries Patrol to 2C Workboat and Research Vessel.**

ENGINE

Make	**Yanmar**
Model	**4LHA-STZE**
Hours	**1572**

DRIVE

Make	**Mercruisr**
Model	**Bravo 2X Leg**

ANCILLARY

VHF X2	**ICOM IC-M45**
FIRE SYSTEM	**STAT-X**
HF	**Barret 550**
Sounder X2	**Furuno GP1870F 7" Color Gps/ LowranceX-4**
Plotter	**Furuno GP1870F 7" Color Gps**
GPS	**Furuno GP1870F 7" Color Gps**
Spotlight	**12V**
Life Jackets	**5x SOLAS and 5x PFD**
Winch	**Hamilton**
Davit	**300kg @ 1.8mts**
Trailer	**Streamline 2200 dual axle (Electric Brakes)**

FD3 is located in Exmouth WA she is AMSA/DOT surveyed and fully insured 2C hotshot workboat and Research Vessel owned and operated by Terrafirma Offshore PTY LTD , ideal for Hotshot transfers and Surveys (Dive, baited cam, ROV, MFO ect) She Has a very strong off road trailer with a beach launching wheel and separately powered trailer winch system.

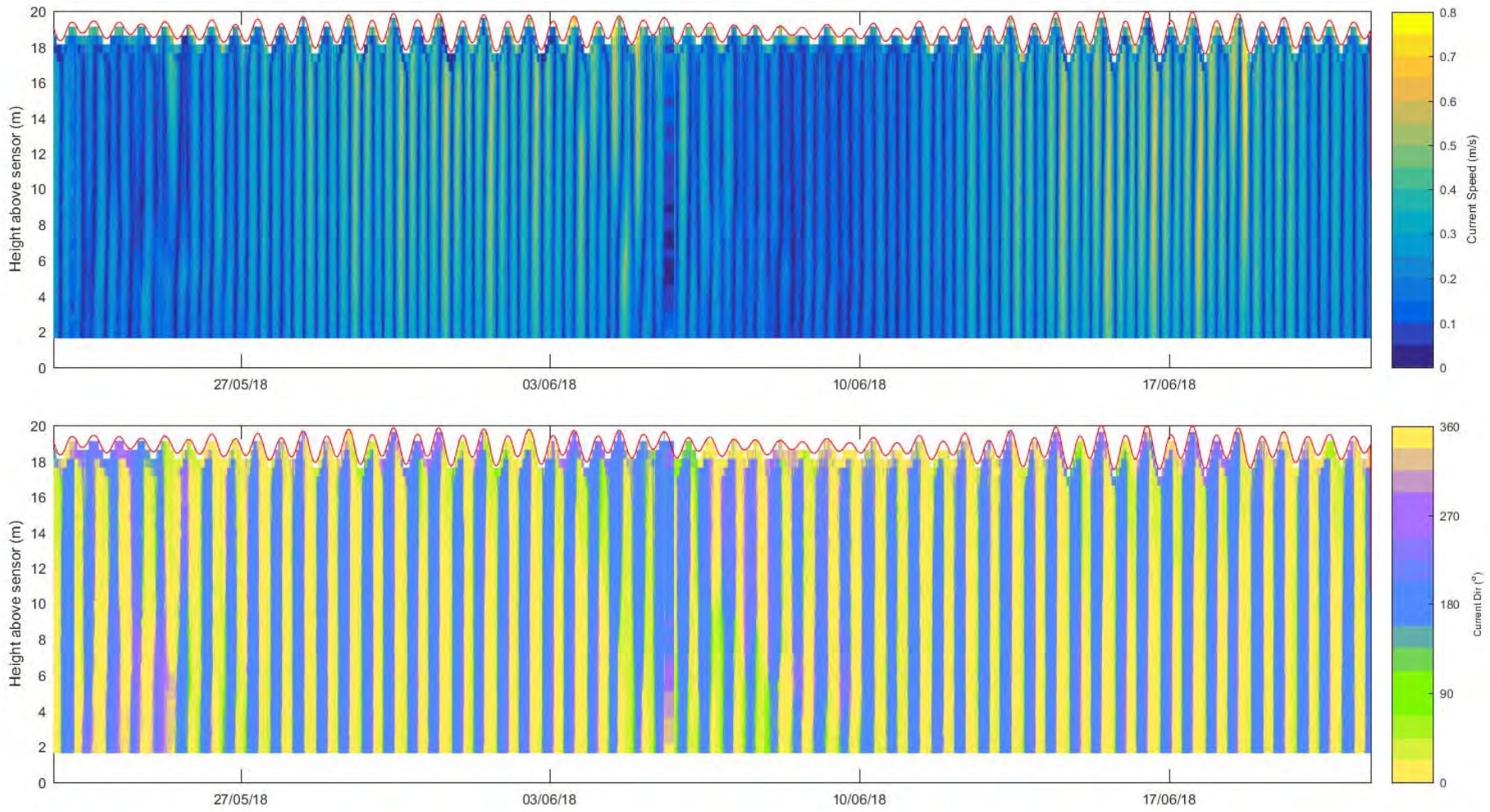
She is available for contract and can be supplied with a vessel master and crew. All safety gear is provided including a Vessel Management System. For more information please contact :

Daemon Bass (Managing Director) Ph: 0438 383 090 Email:terrafirmaoffshore@outlook.com

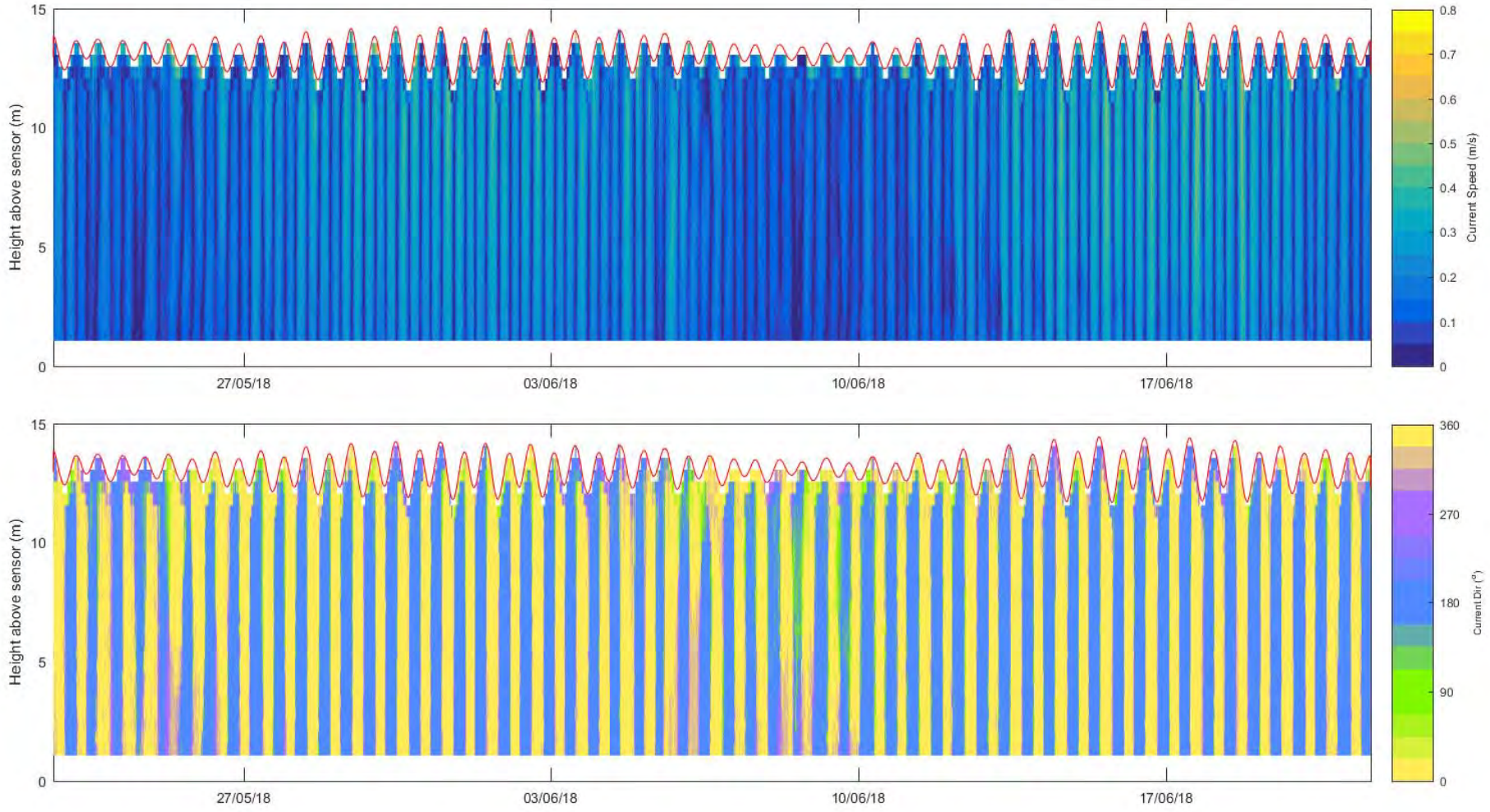
TERRAFIRMA OFFSHORE , PTY. LTD.
1 Griffiths Way
Exmouth W.A. 6707

Appendix C – ADCP Figures

Parking



Launchway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15
10
5
0
27/05/18
03/06/18
10/06/18
17/06/18
Current Speed (m/s)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Height above sensor (m)
15
10
5
0
27/05/18
03/06/18
10/06/18
17/06/18
Current Dir (°)
360
270
180
90
0

GHD

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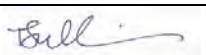
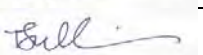
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	K Rawlinson	T Sullivan		J R Romero		10/8/18
1	K Rawlinson	T Sullivan		J R Romero		13/8/18

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