Report on

Oceanographic & Bathymetric Data Collection for

Assessment of Shoreline Changes

Pre-Monsoon Period (February 2015 – May 2015)

For Vizhinjam International Seaport Ltd.

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Revision Details

Section	Page	Amendments
Cover page		Renamed 'Technical Partner & Advisor' to Advisor
1	12	More details about the project added
Figure 1	14	The survey boundary demarcated
Figure 2	15	The cross shore profiling/LEO/beach sampling locations included
3.2	16-17	Water depths at all the locations added, table numbers added, Reference level of AWS mentioned
5.2	22	DGPS consistency check sheet included
5.3	23	Gyro Calibration details included
5.4	25	Schematic representation of ADCP deployment provided
5.5.3	26	Schematic representation of WRB mooring provided
5.9	30	Calibration details of bathymetric system included
5.10	35	Specifications of water analysis included
5.11	35	Inclusion of Inception Report mentioned
6.3	44-62	Current Measurements; All units changed from knots to cm/s, PVD replaced
6.4	63-71	Wave Measurements; Colour scale of rose plots changed to rainbow colour; scale of Tp changed
6.5	72-85	Unit changed from knots to m/s; estimated wind speed at 10m above ground included
6.6	83	Unit of LEO changed from knots to cm/s
6.9	84	Bathymetric Survey area included
6.10	85	River Crossing survey mentioned
6.11	85	Submission date of Soil analysis report mentioned
9	88	WMO manual mentioned

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DEFINITIONS

Project Owner	Vizhinjam International Seaport Ltd.
Advisor to VISL	National Institute of Ocean Technology, Chennai
Survey Contractor	Ocean Science & Surveying Pvt. Ltd., Navi Mumbai, India (OSaS)
Survey Requirement	Oceanographic & Bathymetric Survey for Shoreline Monitoring
Chart Datum	Chart datum is the level to which soundings on a published charts are reduced, and above which tidal predictions and tidal levels are given in the Tide Table. All depths on charts are referred to this datum.
Current Speed	The speed at which the water body moves in the ocean. The speed is denoted in cm/s
Current Direction	The direction towards which the currents are flowing. A westerly current implies that the currents are flowing from east to west
LEO	Littoral Environmental Observations
Wave Peak period (Tp)	The peak period gives the characteristic frequency of the arriving wave energy. This gives the period at which the spectrum has its highest value.
Significant Wave Height (Hs)	Significant wave height is the average peak-to-peak amplitude of the largest one third of the waves in a given field.
Wave direction	The direction from which the waves are coming. A westerly wave implies that the waves are moving from west to east.
Wind Speed	The speed at which the air moves with respect to the surface of earth. The speed is denoted m/s
Wind Direction	Wind direction is an indicator of the direction that the wind is coming from. A northerly wind is coming from the north and blowing towards the south
Atmospheric pressure	It is defined as the force per unit area exerted against a surface by the weight of the air above that surface. Atmospheric pressure is expressed in millibars (mb)
Relative Humidity	Relative humidity is defined as the ratio of the water vapor density (mass per unit volume) to the saturation water vapor density, usually expressed in percent

ABBREVIATIONS

C.M.	Central Meridian
CD	Chart Datum
cm	Centimetre
dd mm.mmm	Degrees minutes. decimal minutes
DGPS	Differential Global Positioning System
DTM	Digital Terrain Model
EEZ	Exclusive Economic Zone
GcGPS	Globally Corrected Global Positioning System
GPS	Global Positioning System
HSE	Health, Safety & Environment
HWM	High Water Mark
IHO	International Hydrographic Organization
kHz	Kilohertz
Km	Kilometre
kPa	Kilo Pascal
LAT	Lowest Astronomical Tide
Lat	Latitude
LEO	Littoral environmental observation
Long	Longitude
m	Metre
MBES	Multibeam Echo Sounder
MSL	Mean Sea Level
MV	Motor Vessel
NA	Not Applicable
NHO	Naval Hydrographic Organization
NIOT	National Institute of Ocean Technology
nm	Nautical mile
PEP	Project Execution Plan
PVD	Progressive vector diagram
RTK	Real Time Kinematics
SBES	Single Beam Echo Sounder
SOW	Scope of Work
UNCLOS	United Nations Convention of the Law of the Sea
UTM	Universal Transverse Mercator projection
VISL	Vizhinjam International Seaport Ltd.
w.d.	Water depth
WGS84	World Geodetic System 1984
WMO	World Meteorological Organisation

1. EXECUTIVE SUMMARY

Vizhinjam International Seaport Limited (VISL) is a special purpose government company (fully owned by Government of Kerala) that would act as an implementing agency for the development of a green field port - Vizhinjam International Deepwater Multipurpose Seaport at Vizhinjam in Thiruvananthapuram, capital city of Kerala.

With its numerous natural advantages and potential, the port will contribute greatly to economic development and will be an asset in terms of infrastructure development in the country.

① The project obtained Environmental & CRZ Clearance ("EC") from the Ministry of Environment & Forests (MoEF), Government of India (GoI) on 3rd January 2014, wherein it has been specified to carry out intense monitoring and regulatory reporting of the shoreline changes in the project area. Accordingly VISL has entered into a memorandum of understanding (MoU) with the National Institute of Ocean Technology (NIOT), Chennai under the Ministry of Earth Sciences, Government of India for a long term shoreline monitoring programme including the seasonal bathymetry mapping.

To that end, Ocean Science & Surveying Pvt. Ltd, (**www.oceanscience.in**), hereinafter referred to as Ocean Science, has been awarded the contract to carry out Shoreline Monitoring – Oceanographic & Bathymetric Data Collection in the vicinity of the proposed site for the development of the Vizhinjam International Deepwater Multipurpose Seaport, vide the letter of award; VISL/2014-15/EE&EI-1/96 dated 28th January 2015.

As part of the study, NIOT provided a wave rider buoy to be deployed off Mulloor and the data is to be monitored by Ocean Science. Accordingly, a resort (Sea Park) at Mulloor was hired where the receiver of wave rider buoy was setup to monitor the waves.

This report provides the results of the data collected during the first season, i.e. pre monsoon period from 7th February to 31st May 2015. The automatic tide gauge was installed on 7th February 2015 adjacent to the NIOT's tidal station. The Wave Rider Buoy was deployed on 10th February 2015 at the designated location. The ADCPs were deployed on 10th / 11th February 2015 and were recovered after 30 days of observations. The Automatic Weather Station was installed on 18th February 2015.

The cross shore profiling and bathymetric survey, photographic documentation of the area commenced on 22nd February 2015.

All the co-ordinates in the reports and charts are referenced to WGS-84, UTM Projection, CM 75° East, Zone 43, Northern Hemisphere.

2. INTRODUCTION

Vizhinjam, (Malayalam: വിഴിഞ്ഞം) is located near the capital city Thiruvananthapuram (Trivandrum) of the state of Kerala, India. It is located at approximately 08°22′45″N, 76°59′29″E, and 14 km south of the capital city. The city is historically known for being an important port, dating back to the 8th Century AD.

The port is proposed to be developed in a landlord model having a PPP development component. The investment for land, external infrastructure (rail, water and power) and breakwater will be borne by the landlord (VISL/GoK). The investments for other port infrastructure (dredging & reclamation, berths, terminals, superstructure & equipments) will be shared on Public Private Partnership (PPP) basis availing Viability Gap Funding (VGF) from Government of India. The PPP concessionaire so selected will be given the right to operate the Phase I development of the port (800 m berth length) for a specified concession period of 40 years. Traffic linked stage wise future development of the project with an ultimate berth length of 2000m is also envisaged.

The proposed site is endowed with a natural depth of 23 to 25m (which is by far the best compared to other ports in the world) as close as 2 km from the coast. This will enable berthing of mother vessels of 18000 TEU and higher. Since the port site located at the southern tip of India with hardly 10 nautical miles from the international sea route (Suez – Far East route & Far East - Middle East route), the port has the potential to become the future transhipment hub of the country.

The present study is to document the existing shoreline change pattern in different seasons of the year, with the aim of understanding future changes in pattern, if any, during or after the implementation of the port project.

The study comprises carrying out wave, wind and tide observations at one location for one year, as well as current for 30 days each, at four locations, during 3 different seasons; summer (Jan-May), monsoon (June-Sept), and post monsoon (Oct-Dec), bathymetric survey of about 600 sq km, cross shore profiling from 10m CD to 100m from high water line, water & grab sampling, littoral environmental observation etc.

A Google Earth image showing the locations of the observations, including the wave/current measurement location is given in **Figure 1**. The location showing cross shore profile lines which also indicated the LEO, photographic documentation points and beach sampling locations are shown in **Figure 2**.

The mobilisation/inception report (OSaS/P18115/VISL/Mob Rev 0) was submitted on 26th February 2015, which is included in this report as Annexure I.



Figure 1 – General survey location

P1, P2 and P3 corresponds to ADCP location which is denoted as C and P4 corresponds to both ADCP and wave location which is denoted as W The tide gauge location is denoted as T

The cross shore profiling lines, LEO, photographic documentation points and beach sampling locations are indicated in the image below: The cross shore profiles are named as CSP-01 to CSP-81. CSP-01 corresponds to first location which lies south of the existing Vizhinjam Harbour.

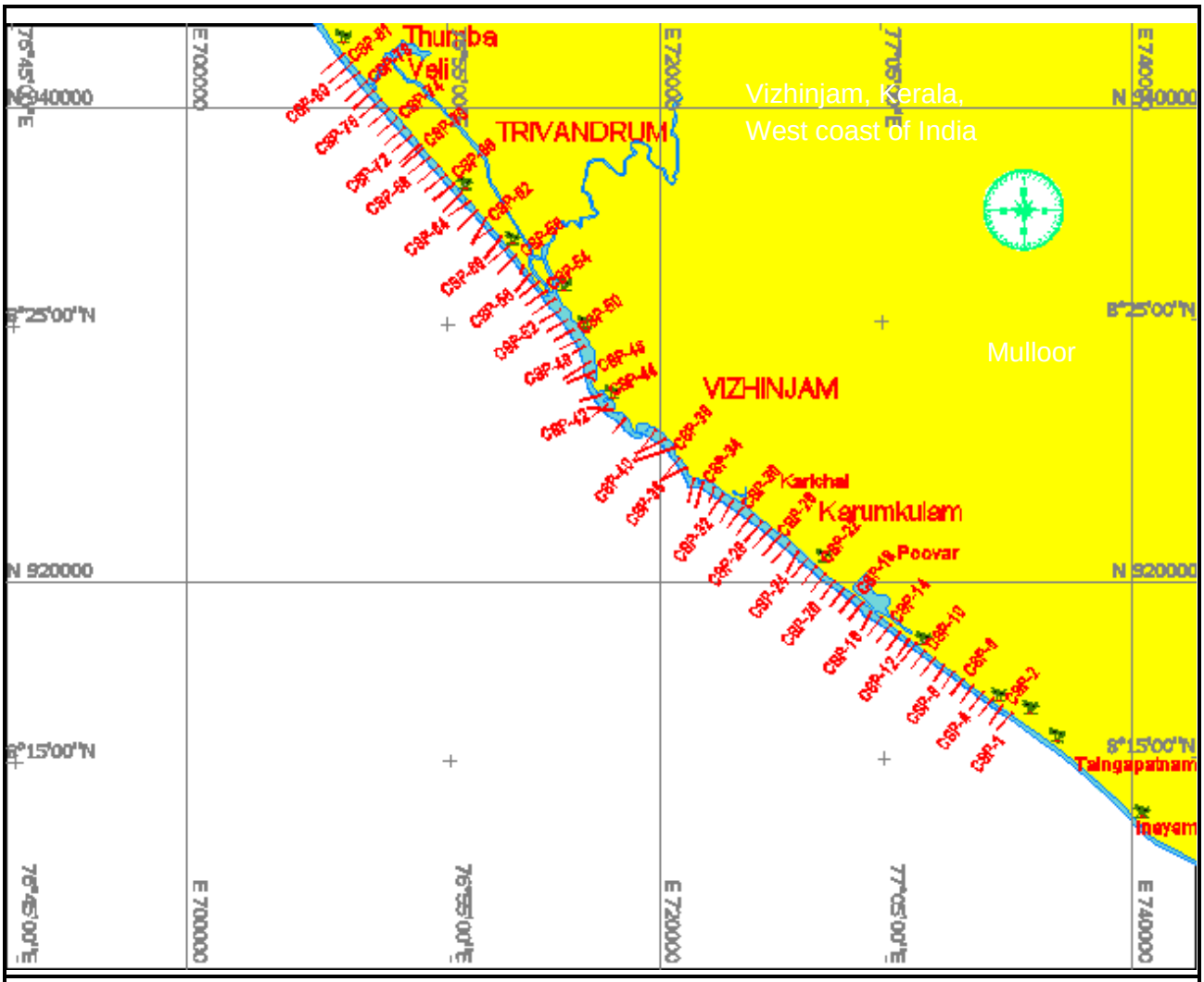


Figure 2 – Cross Shore Profile/LEO/Beach Sampling Locations

3. SCOPE OF WORK

The survey scope of work as provided in the RFQ and as per the contract included the following:

- To mobilise suitable marine spread and a survey boat at site for carrying out the operations.
- To provide requisite personnel and equipment for undertaking of oceanographic measurements.
- Study of shore line.
- Monthly cross shore beach profiling perpendicular to the shoreline for 30 km stretch at an interval of 500m, using RTK or total station for land side up to 100m from HTL or +2m of HTL and using shallow draft boats, sled or any other suitable techniques for sea side up to 10m CD.
- Monthly monitoring of littoral zone (at the cross shore beach profiling locations) to observe the littoral transport direction and alongshore current speed by means of appropriate drogue observations and visual observations.
- Monthly photographic documentation of geomorphological changes (at the cross shore beach profiling locations).
- Seasonal beach sediment sampling and analysis (at the cross shore beach profiling locations).

- Bathymetry survey in an area of 600 sq km (40 km x 15 km) twice in a year i.e. just after the monsoon season and just prior to the commencement of monsoon to generate 0.5m contours (with bathymetric survey lines spaced at 25 m interval) in areas with depth up to 20m CD using multi beam echo sounder and 1 m contour (with bathymetric survey lines spaced at 300 m interval) in areas with depth greater than 20m CD at a spacing of 300m using single beam echo sounder.
- Bathymetry / cross section survey for 500m length of rivers debouching in 40 km stretch of the sea.
- Seabed sediment sampling and analysis in 600 sq km with one sample per sq km.
- Collection and analysis of water samples at specified periods (seasonal) for TSS and turbidity from four specified locations.
- Current measurements (both magnitude and direction) using Acoustic Doppler Current Profiler (ADCP) at three locations, as marked in Figure 1, for the duration of full tidal cycle/30 days each during monsoon (June-Oct), post-monsoon (Nov-Feb) and summer months (Mar-May).
- Wave observations using WRB Datawell DWG-G shall be carried out at one location as marked in the location map.
- Tide measurements using an automatic tide gauge close to the survey area to observe the tidal variations round the clock at 6 minute intervals or as specified to cover one full year. The tide gauge shall be connected to the nearest Survey of India Benchmark. The data shall be used to derive the harmonic constituents.
- Collection of wind speed & direction, atmospheric pressure, humidity and temperature at one location specified by the client/EIC by establishing an automatic weather station to cover one full year.
- Analysis and processing of the data and submission of periodic reports in soft & hard copies.

3.1 Additional Scope of Work

In addition to the above scope, VISL extended the shoreline monitoring to 40 Km from 30 Km via the work order VISL/2014-15/EE&EI-1/381 dated 21st April 2014. Accordingly additional activities were carried out as per the list below:

1. Fixing up of ten more reference stations
2. Beach sampling of additional 10 samples
3. Cross shore profiling, LEO and photographic documentation of another 10 Km

3.2 Location Co-ordinates

① The location co-ordinates of current and wave observations are provided below:

Location Co-ordinates			
WGS-84 Spheroid, UTM Projection, CM 75 East, Zone 43, North			
Name	**Latitude**	**Longitude**	**Depth w.r.t CD (m)**
ADCP - P1 (Vizhinjam)	08° 22' 06.42"N	76° 58' 58.70"E	21.1
ADCP- P2 (Poovar)	08° 18' 00.35"N	77° 03' 55.54"E	22.3
ADCP- P3 (Pachalloor)	08° 25' 01.20"N	76° 56' 28.57"E	21.2
ADCP/Wave - P4 (Mulloor)	08° 21' 43.12"N	76° 59' 25.84"E	27.6

Table 1: Current/Wave Locations

The location co-ordinates of tide station are provided below:

①

Location Co-ordinates			
WGS-84 Spheroid, UTM Projection, CM 75 East, Zone 43, North			
Name	**Latitude**	**Longitude**	**Height above CD (m)**
Tide station	08° 22' 33.68"N	76° 59' 16.65"E	3.251

Table 2: Tide Location Co-ordinates

The location co-ordinates of weather station are provided below:

①

Location Co-ordinates			
WGS-84 Spheroid, UTM Projection, CM 75 East, Zone 43, North			
Name	**Latitude**	**Longitude**	**Height above CD (m)**
Weather station (on top of Ayur Bay Resort)	08° 22' 13.53"N	77° 00' 08.78"E	28.456

Table 3: Weather Station Location Co-ordinates

Since the system is installed 28.456m above CD, a correction factor was applied in the speed to reduce the data to 10m above MSL. The corrections were obtained from WMO manual supplied by NIOT. As per section 5.2.2 in the manual, 20% of the speed was deducted to derive the current speeds at 10m above MSL. The data provided is thus referenced to both the levels.

4. SURVEY CONTROL

4.1 Geodesy

The survey operations were conducted in the WGS 84 Spheroid, Universal Transverse Mercator Projection based on the geodetic parameters presented below. All co-ordinates quoted within this document are with reference to it.

GEODETIC PARAMETERS	
Satellite Datum	
Spheroid	WGS-84
Datum	WGS 84
Semi-Major Axis	6378137.000 m
Semi Minor Axis	6356752.314 m
Inverse Flattening	298.2572
Projection Parameters	
Grid Projection	Universal Transverse Mercator
Latitude of Origin of Projection	0° (Equator)
Longitude of Origin of Projection	75° E, Zone 43
Hemisphere	North
False Easting (metres)	500000
False Northing (metres)	0
Scale Factor on CM	0.9996
Units	Metres

Table 4: Geodetic Parameters

4.2 Vessel

The following vessels were utilised for the survey operations.



Figure 3 – Survey Vessel MFB Samuel



Figure 4 – Survey Vessel MFB Bethel



Figure 5 – Survey/Transit Vessel MFB Sindhu Yatra Matha

4.3 Personnel

The following survey personnel from OSaS/VISL were assigned to the project in the capacities listed in the table below.

Ocean Science & Surveying		
Name	**Designation**	**Period**
S PHILIP	Project Manager / Oceanographer	Duration of Project
HEBIN C	Oceanographer / Party chief	Duration of Project
AMITESH MISHRA	Electronics Engineer	5th Feb to 8th Mar 2015
ABHILASH L	Hydrographic Surveyor	5th Feb to 20th May 2015
JAI PRAKASH PANDEY	Hydrographic Surveyor	5th Feb to 1st Mar; 16th Mar to 25th Mar; 21st Apr to 28th May 2015
MANOJ SINGH	Electronics Engineer	22nd Feb to 7th Mar 2015
SATYAWAN SINGH	Electronics Engineer	5th Mar to 28th May 2015
SAMSON CHACKO	Data Processor / CAD	16th Mar to 13th May 2015
DALEEP UPPAL	Hydrographic Surveyor	21st Mar to 28th Mar 2015
VIKRAM SINGH CHOUHAN	Electronics Engineer	21st Apr to 20th May 2015

SUNDARA SRINIVASAN	Electronics Engineer	11th May to 5th June 2015
M.I. MANSURI	Data Processor / CAD	11th May to 5th June 2015
UNNIKRISHNAN KU	Hydrographic Surveyor	18th May – continuing
SANGRAMGEET BEHERA	Electronics Engineer	25th May – continuing
Vizhinjam International Seaport Ltd.		
Name	**Designation**	**Period**
AJIT SURENDRAN	Chief Project Co-ordinator & Head (EHS & CSR)	Duration of Project
PRADEEP A.S	Engineer (EI)	Duration of Project
SIRIL DAS	Technical Assistant	Duration of Project

Table 5: Survey Personnel

5. SURVEY EQUIPMENT DETAILS

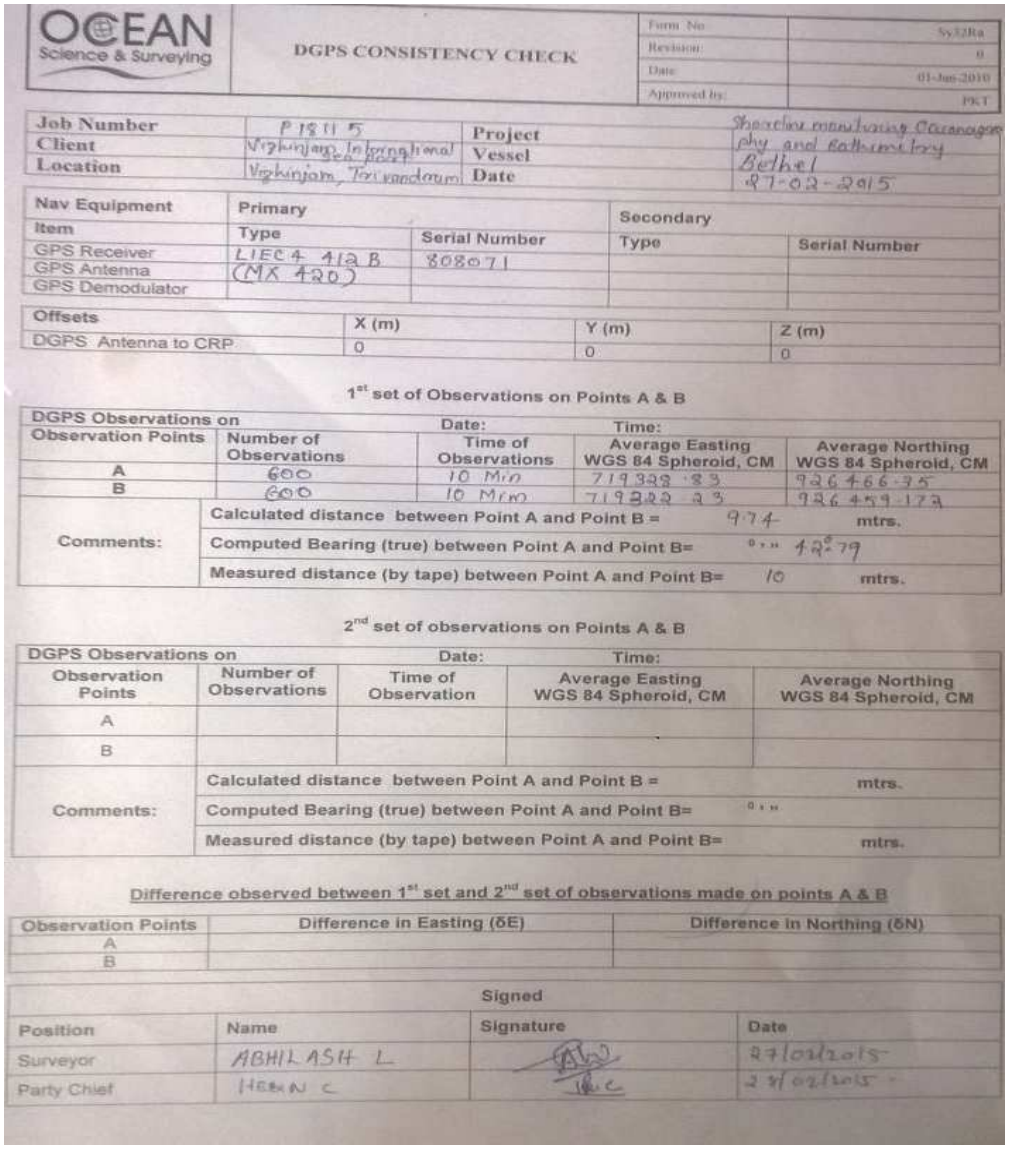
5.1 General

The Wave Rider Buoy was deployed from the vessel MFB Samuel. ADCP's were deployed on a downward looking mode from four different boats for the 30 day period. The Multibeam survey up to 20m contour was carried out from the boat MFB Bethel. Single beam survey for the larger area was carried out using the boat Samuel.

The equipment used for the project is described below:

5.2 DGPS Positioning System

① Vessel positioning was carried out by the Metric Accuracy MX 420 DGPS system using MF based correction signals. Vessel track and offset positions were recorded digitally using QINSy survey data acquisition software. The system is installed permanently on board the survey vessel. The DGPS consistency checks carried out during the course of survey is provided below:



OCEAN Science & Surveying

DGPS CONSISTENCY CHECK

Form No:	Sy32Ra		
Revision:	0		
Date:	01-Jan-2010		
Approved by:	PKT		

Job Number	P 18115	Project	Shoreline monitoring Oceanographic and Bathymetry
Client	Vizhinjam International Seaport	Vessel	Bethel
Location	Vizhinjam, Trivandrum	Date	27-02-2015

Nav Equipment	Primary		Secondary	
Item	Type	Serial Number	Type	Serial Number
GPS Receiver	LIEC4 412 B	808071		
GPS Antenna	(MX 420)			
GPS Demodulator				

Offsets	X (m)	Y (m)	Z (m)
DGPS Antenna to CRP	0	0	0

1st set of Observations on Points A & B

DGPS Observations on Date: Time:

Observation Points	Number of Observations	Time of Observations	Average Easting WGS 84 Spheroid, CM	Average Northing WGS 84 Spheroid, CM
A	600	10 Min	719328.83	926466.35
B	600	10 Min	719322.93	926459.173

Comments:	Calculated distance between Point A and Point B =	9.74	mtrs.
	Computed Bearing (true) between Point A and Point B=	° ' "	42°79
	Measured distance (by tape) between Point A and Point B=	10	mtrs.

2nd set of observations on Points A & B

DGPS Observations on Date: Time:

Observation Points	Number of Observations	Time of Observation	Average Easting WGS 84 Spheroid, CM	Average Northing WGS 84 Spheroid, CM
A				
B				

Comments:	Calculated distance between Point A and Point B =		mtrs.
	Computed Bearing (true) between Point A and Point B=	° ' "	
	Measured distance (by tape) between Point A and Point B=		mtrs.

Difference observed between 1st set and 2nd set of observations made on points A & B

Observation Points	Difference in Easting (δE)	Difference in Northing (δN)
A		
B		

Signed

Position	Name	Signature	Date
Surveyor	ABHILASH L		27/02/2015
Party Chief	HEBIN C		27/02/2015

Figure 6 – DGPS Consistency Check

5.3 Navigation & Heading System

① The navigation computer running QINSy (Quality Integrated Navigation System) navigation software received the corrected GPS latitude and longitude from the DGPS system. The antenna position was converted into local UTM co-ordinates by the QINSy software.

The vessel's centre of gravity (COG) was defined as the central reference point (CRP) for the entire survey and deployment operations. Positioning data was logged at 1-second updates in the QINSy software.

A Standard Meridian Gyro was used to obtain the accurate heading of the survey boat. The calibration detail of the Gyro is given below:

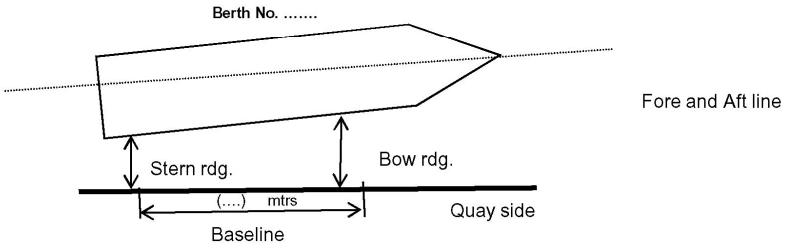
GYRO CALIBRATION
(Quay/Tape off set Method)

Form No.:	Sy37R
Revision:	0
Date:	1-Jan-2010
Approved By:	PKT

Job No	P18115	**Project**	
Client	VISL	**Vessel**	**Bethel**
Location	Vizhinjam	**Date**	**27/02/2015**
Gyro S/N	Meridian Surveyor - 5265		

Quay heading (true)	Baseline length(m)		Quayside on:
42.79	**5.3**		**Starboard**

Observations				Calculations			
Time	Gyro (true)	Bow	Stern	Calc. angle	Calculated Heading	True Quay Hdg	C-O
08:11:56	39.3	0.66	0.6	0.65	39.95	42.79	2.84
08:12:04	38.7	0.68	0.62	0.65	39.35	42.79	3.44
08:12:14	39.5	0.6	0.58	0.22	39.72	42.79	3.07
08:12:22	38.9	0.6	0.57	0.32	39.22	42.79	3.57
08:12:33	39	0.67	0.64	0.32	39.32	42.79	3.47
08:12:43	38.8	0.72	0.67	0.54	39.34	42.79	3.45
08:12:52	39	0.65	0.63	0.22	39.22	42.79	3.57
08:13:02	39	0.72	0.69	0.32	39.32	42.79	3.47
08:13:13	39.1	0.67	0.61	0.65	39.75	42.79	3.04
08:13:22	38.4	0.7	0.62	0.86	39.26	42.79	3.53
08:13:29	39.1	0.64	0.59	0.54	39.64	42.79	3.15
Average	39.03	0.66	0.62	0.48	39.46	C-O	3.33



Note: Drawing not on scale only procedure adopted showing

Gyro SN:

Signed			
Designation	**Name**	**Signature**	**Date**
Surveyor	ABHILASH L		27/02/2015
Party Chief	HEBIN C		27/02/2015

Figure 7 – Gyro Calibration Details

5.4 Current meter

Teledyne RDI Workhorse Sentinel 600 KHz ADCP currentmeter were deployed at the 4 locations. The ADCPs were programmed to record the currents at intervals of 10 minutes. A typical ADCP deployment setup is given below:



Figure 8 – ADCP installed on a downward looking mode

① A schematic representation of ADCP deployed to measure the current profile is given below:

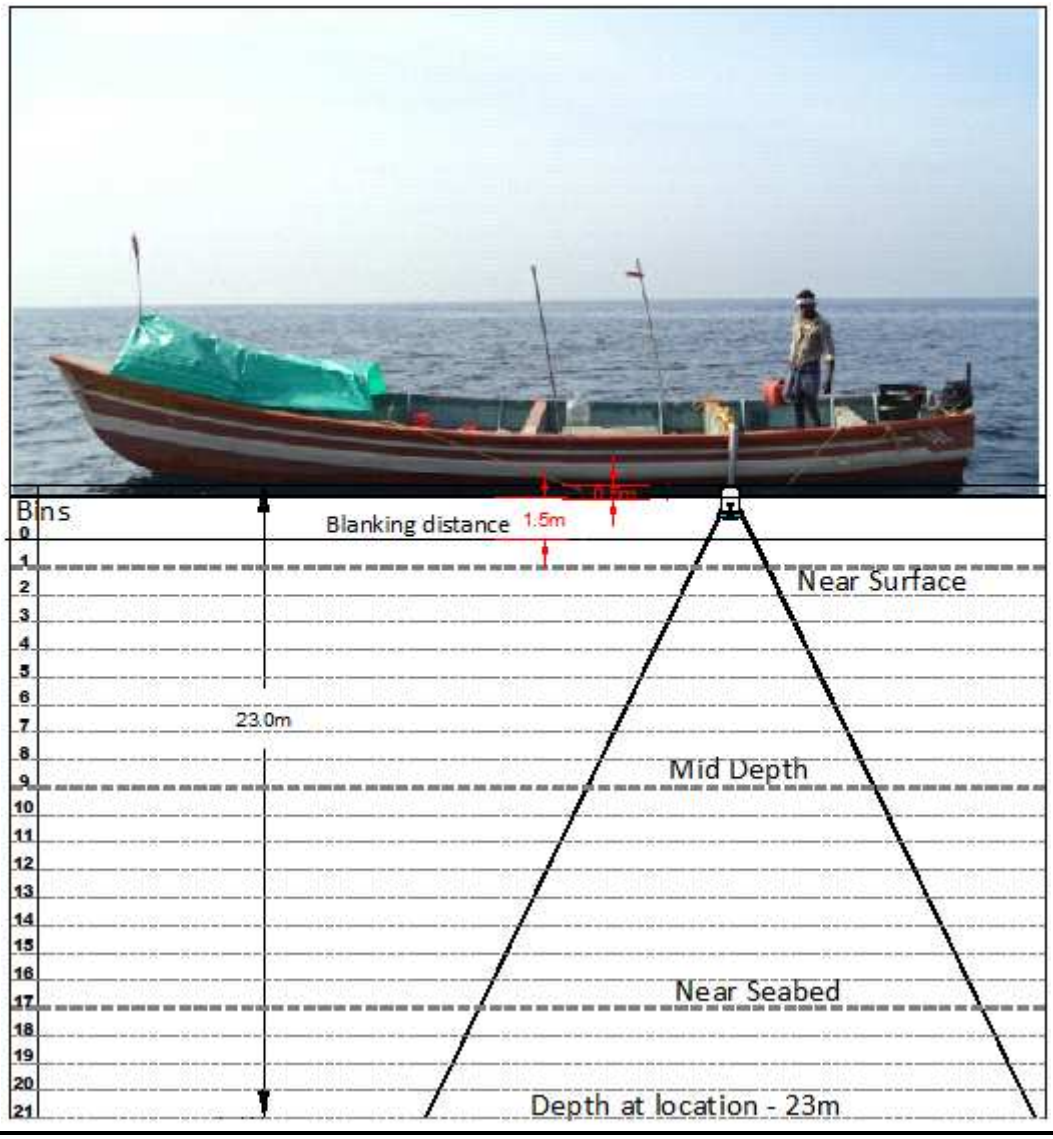


Figure 9 – Schematic diagram of Surface, Mid depth and Near bottom measurement of ADCP

5.5 Wave Rider Buoy

① NIOT deployed the wave rider buoy in collaboration with VISL and is monitored by Ocean Science. A Datawell DWR (G) was supplied and installed for the project. The WRB was programmed to measure all the wave parameters at half-hourly interval. The data is transmitted on a real time basis via the HF antenna to the receiver setup at the Seapark Beach Resort, where the OSaS personnel stays.

The system consists of wave rider buoy (DWR G make) with HF whip/LED flasher, GPS antennae, internal data logger, RX-D receiver with HF antenna and acquisition and post processing software w@ves21. The system has a GPS receiver mounted on a buoy along with HF radio for data transmission in real time. The system has an accuracy of 1 cm + 0.5% of vertical motion; resolution of 1cm and range of ± 30 m at the sampling rate of 1.28 Hz. The directional accuracy and resolution is 1.5° within the range of 0° to 360°.

5.5.1 Calibration of the equipment

The wave rider buoy is factory-calibrated and Datawell does not recommend recalibration of the buoy.

5.5.2 Principles of Wave measurement

GPS wave buoy measurement principle bears a strong anomaly with the Doppler-shift phenomenon of a nearly passing car blowing its horn. The GPS system calculates the velocity of the buoy from changes in the frequency of GPS signals. The velocities are integrated with time to determine buoy displacement. In practice the GPS system uses signals from multiple satellites to determine three-dimensional buoy motion. Accelerometer buoy measures wave height by means of vertical acceleration of the accelerometer mounted on the gravity sensitive platform of the buoy.

5.5.3 Mooring of the instrument

Mooring incorporates between the sea bottom and the mooring eye underneath the buoy. This includes sinker or anchor weight, polypropylene rope, nylon covered galvanized steel cable (combination rope) and associated terminals, floats, rubber cords with associated terminals, swivels, ballast chain, anodes and shackles and cotter pins.

A schematic of the mooring of WRB is given below:

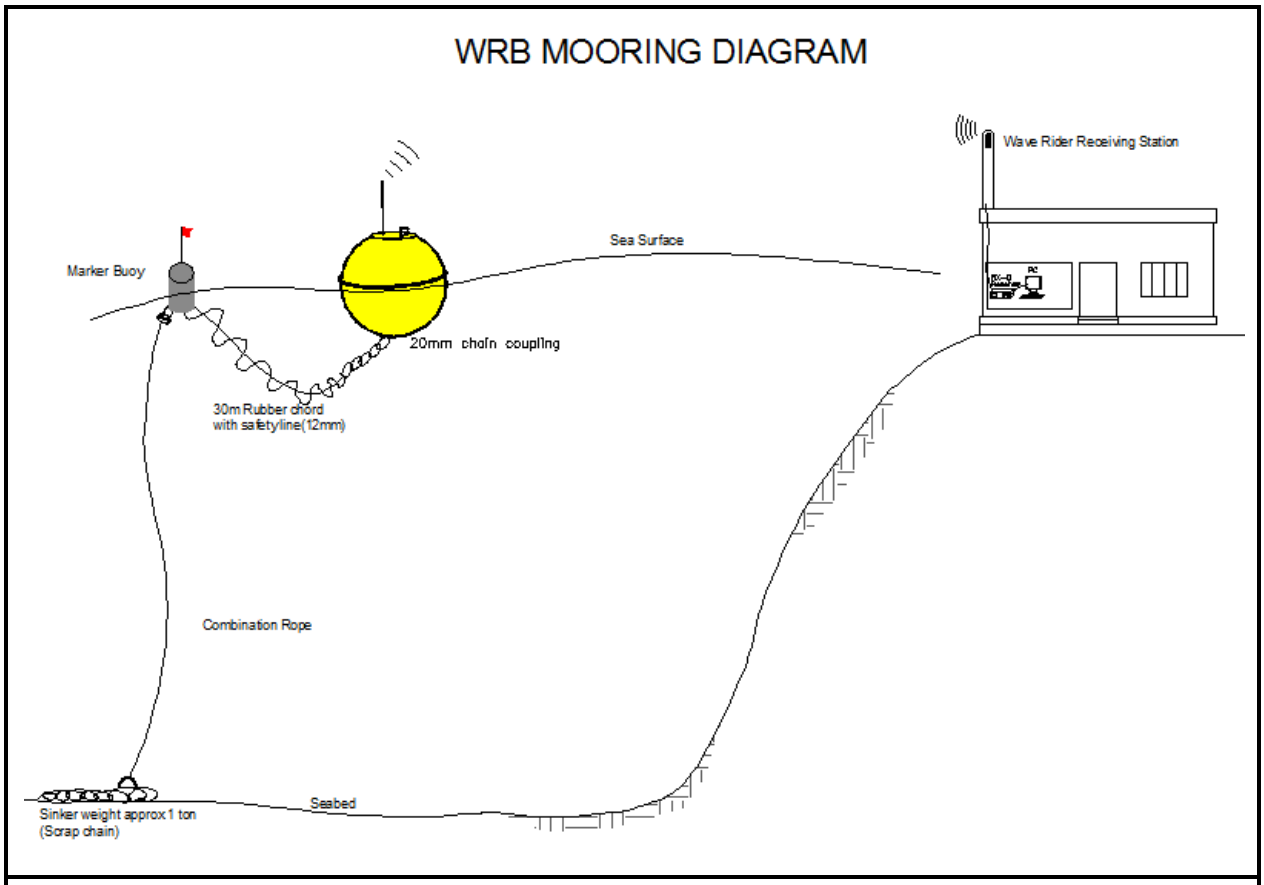


Figure 10 – WRB Mooring Diagram

A photograph of WRB deployed at site is provided below:

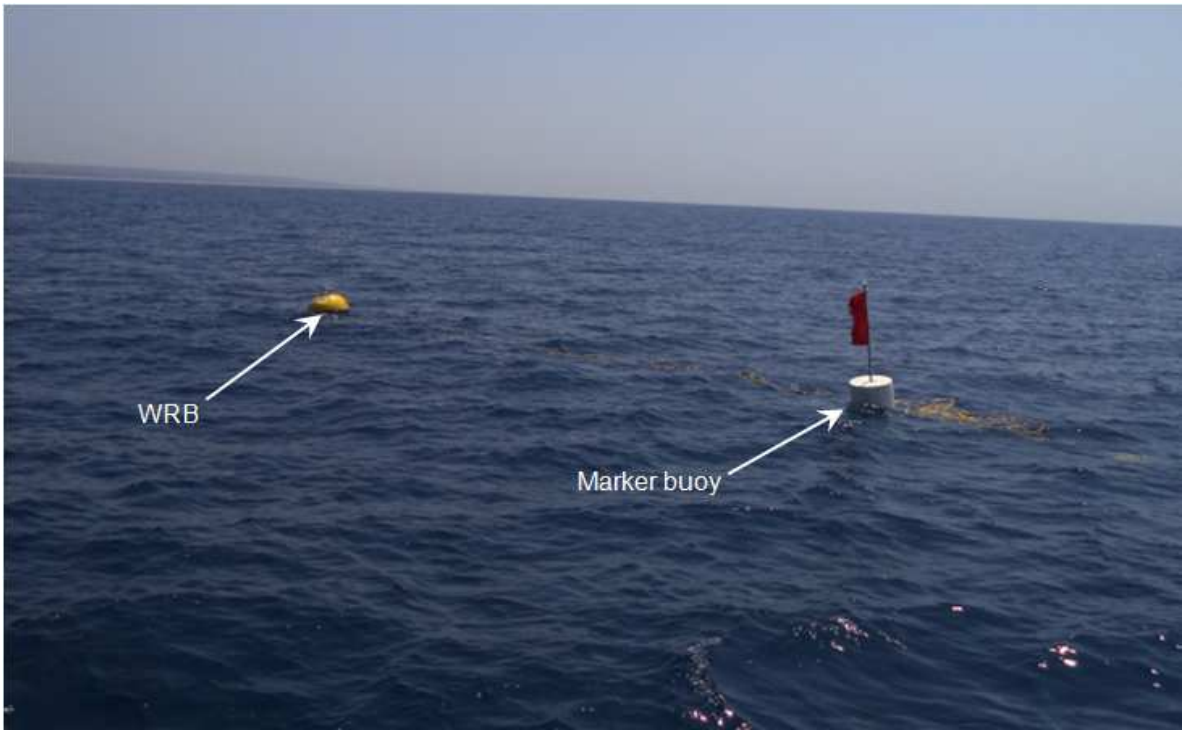


Figure 11 – WRB deployed at location P4 (Mulloor)

A highly elastic rubber cord is essential for high quality wave measurements. It allows the buoy to follow the wave motion, thus guaranteeing that the measured motion of the buoy is indeed the same as the desired motion. The buoy was deployed using single point mooring with free-floating method. The mooring design was configured as per the site condition followed by the mooring suggestion provided by the supplier. A boat was anchored near the wave rider buoy without hindering the wave data measurements along with sufficient crew on board for round the clock watch keeping. Another fiber boat was kept for movement of the watch keepers to caution any boats passing nearby.

5.6 Automatic Tide Gauge

A Valeport 740 Tidemaster automatic tide gauge was installed near the Coast Guard jetty, inside the fishing harbour for measuring the tides. The location is close to the existing tide gauges installed by NIOT. The sensor was installed on a 5m long pipe, fixed in such a way that the sensor was always in water. This was levelled to the local bench mark, situated on top of the jetty. The tide station was programmed to measure the tide at 6-minute intervals throughout the duration of the project.

A photograph of tide gauge location is provided below:



Figure 12 – Location of Tide Gauge

5.7 Automatic Weather Station

An automatic weather station was installed atop Ayur Bay resort at Nellikunnu. The system measures wind speed/direction, atmospheric pressure, temperature, relative humidity and rainfall.

The system consists of the following:

- Gill sonic anemometer
- Microstep pressure sensor
- Microstep relative humidity & temperature sensor
- Meteoservis Rain gauge
- Microstep datalogger

The data is logged on a PC installed at the resort at intervals of 10 minutes. The data is transmitted through a UHF link.

An image of automatic weather station is provided below:



Figure 13 – Automatic Weather Station on top of Ayur Bay Resort, Nellikunnu (Mulloor)

5.8 Real Time Kinematic (RTK) Survey

RTK system was mobilised at site to carry out cross shore profiling on the landward side. The system comprises the following:

- Hemisphere GPS R320 GNSS base station
- Hemisphere GPS R 320 rover

A photograph of the system is provided below:



Figure 14 – RTK System fixed at BM-1

5.9 Bathymetric Survey

The bathymetric survey was carried out using the following systems:

- Knudsen 320M for the singlebeam area
- Geoswath GS+ 250 KHz wide swath bathymetric system for the Multibeam area

The calibration details of the bathymetric system are given below:

5.9.1 Single Beam Echo Sounder

① The single beam echo sounder was calibrated on a daily basis using the 'bar check' method. Actual sound velocity measured using the SVP probe was used in the system. An image of the bar check carried out during the survey is appended below:

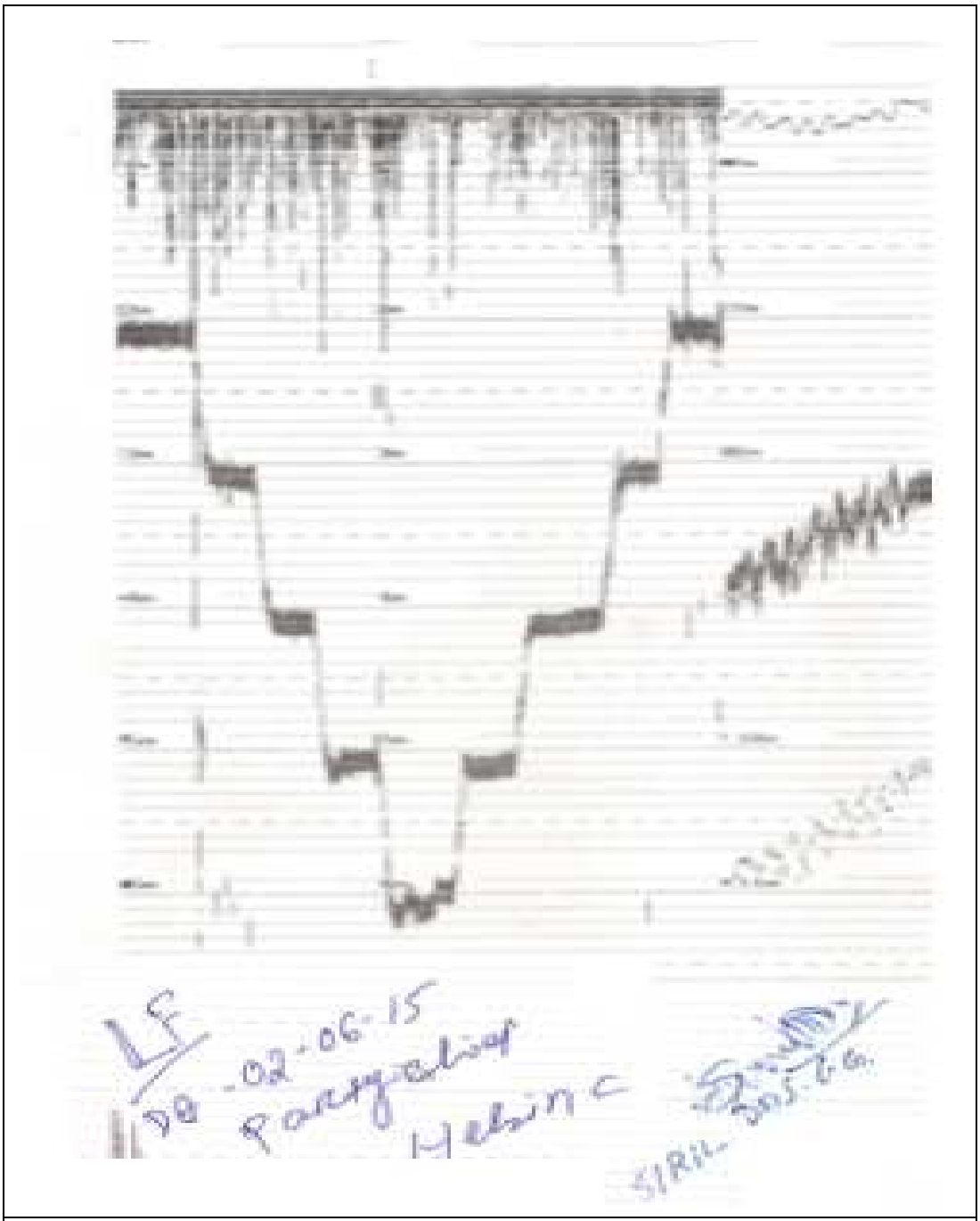


Figure 15 – Bar Check Record

5.9.2 Multi Beam Echo Sounder

The calibration (or patch test) of the Geoswath Plus (GS+) MBES was used to fix the time and angle offsets between the various positioning systems and the transducer head. This was done after mobilisation.

The system offsets were entered in the acquisition software prior to surveying and raw data acquisition. Some of these were easily measured and entered and others were corrected through the calibration procedure.

Entering Offsets

The directly measured system offsets are:

- Transducer Sensor Offsets measured as the distance from the COG to the transducer point (X= 0.3m, Y= 1.15m, Z= -1.05m)
- Antenna Offsets measured as the distance from the COG to the Antenna (X= 3.3m,Y= 0.0m and Z= 4m from water line).
- Heave Offset measured as the vertical distance from the centre of the transducer to the water surface (Z= 4.0 m).
- Time offset (latency) introduced by DGPS computer/ navigation computers or during the serial data transfers.

A Seatex motion reference unit provided compensation for vessel motion.

The sound velocity profile (SVP) file and observed tide files were used to get an accurate calibration from a patch test.

Antenna and Sensor Offsets

The antenna and the sensor offsets, measured with the aid of a measuring tape were entered in the Geoswath Plus data acquisition module along with the vessel dimensions. The **Figure 16** and **Figure 17** provides the measured antenna and sensor offsets.

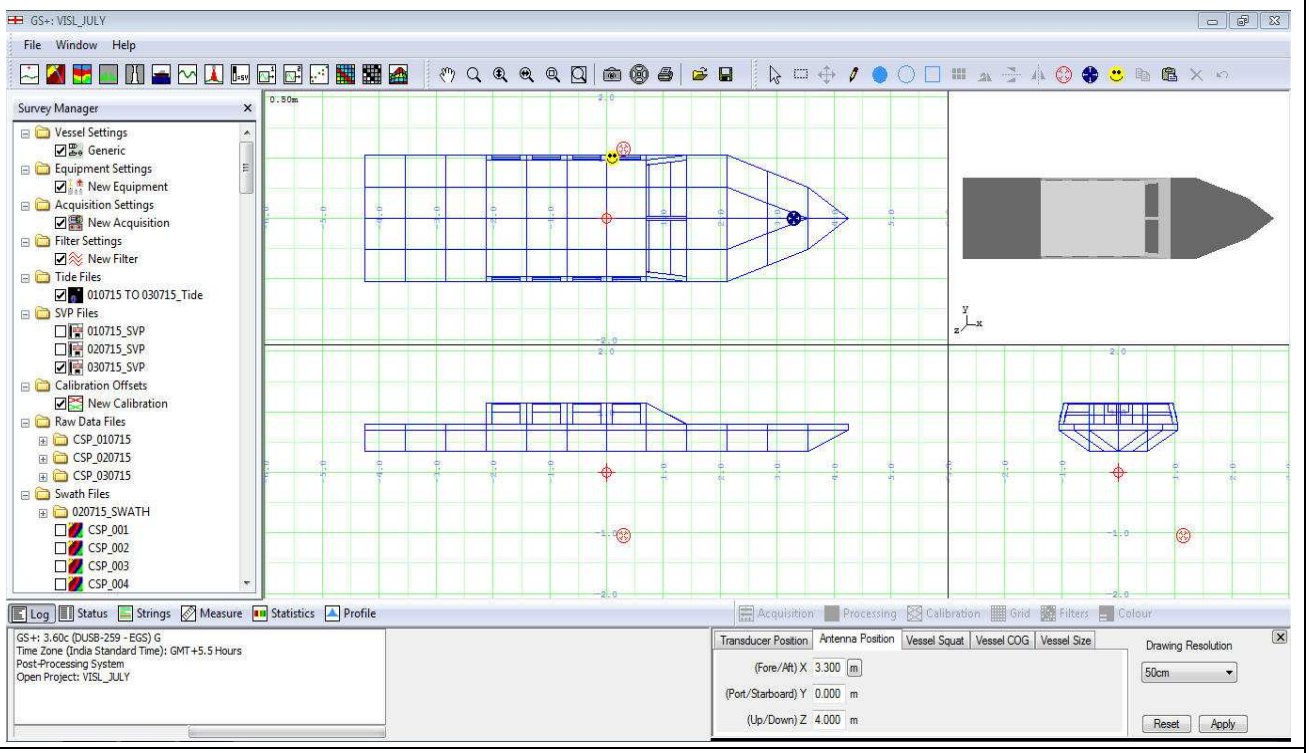


Figure 16: MBES Antenna offsets of MFB Bethel

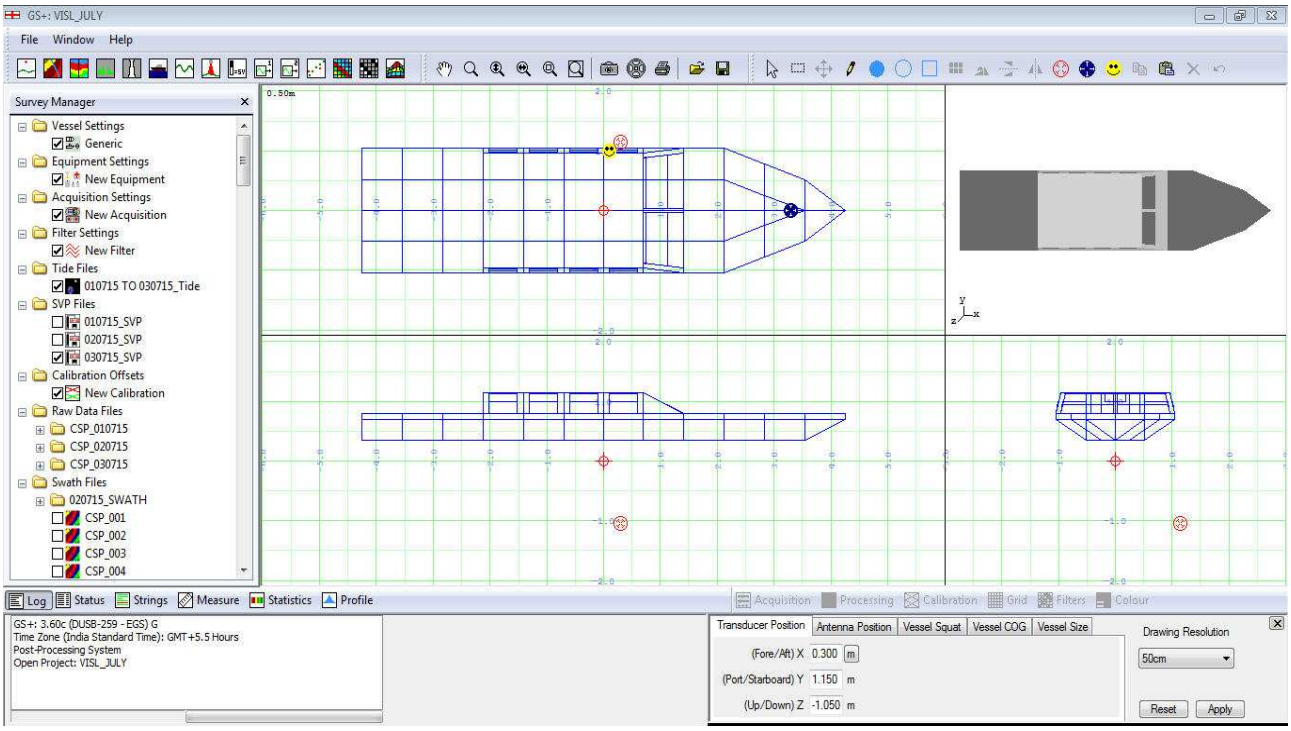


Figure 17: MBES Sensor offsets of MFB Bethel

The corrections for these parameters, obtained from the MBES calibration results, are given below:

Parameter	Values	Description
Latency	1.53	Leica Positioning System
Port Roll	0.39º	Seatex MRU accuracy 0.05º in roll (~3.5cm at 40m)
Starboard Roll	-0.43º	Seatex MRU accuracy 0.05º in roll (~3.5cm at 40m)
Pitch	0.00º	
Yaw(Port)	-1.4°	Accuracy better than 0.2°
Yaw(Stbd)	-1.4°	Accuracy better than 0.2°

Table 6: MBES Calibration Results

The **Figure 18** provides the calibration offsets in the software editor.

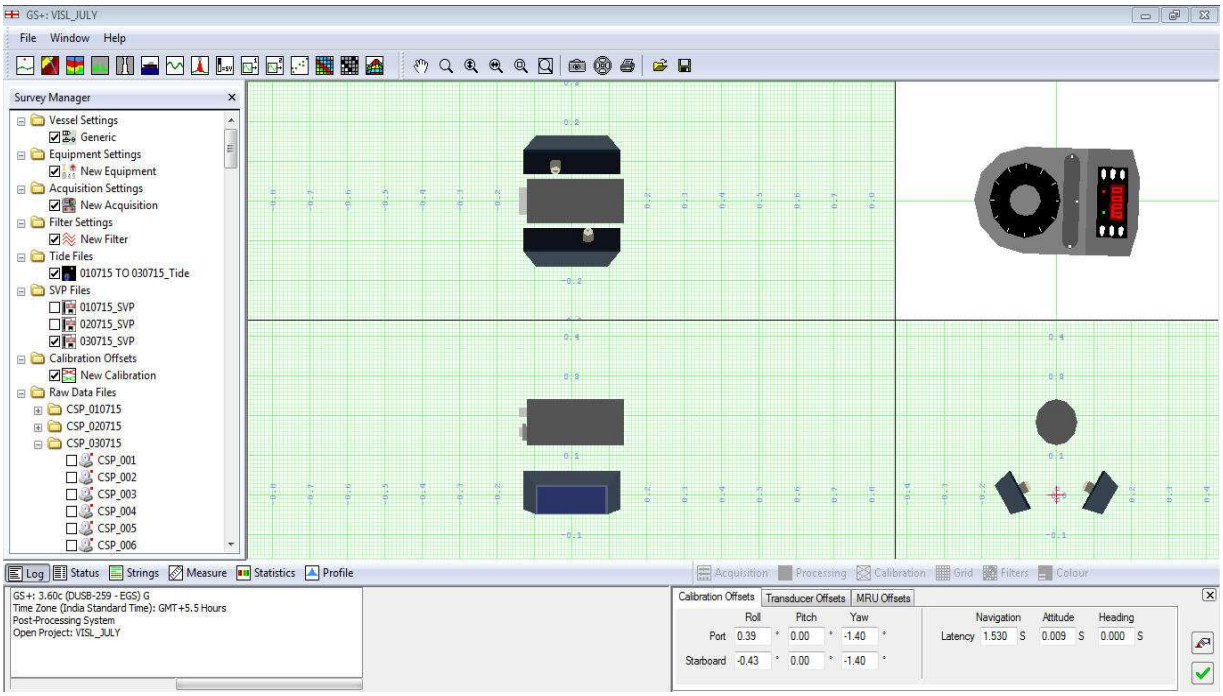


Figure 18: Calibration offsets shown in editor

The **Figure 19** provides the comparison grid before and after applying the calibration co-efficient.

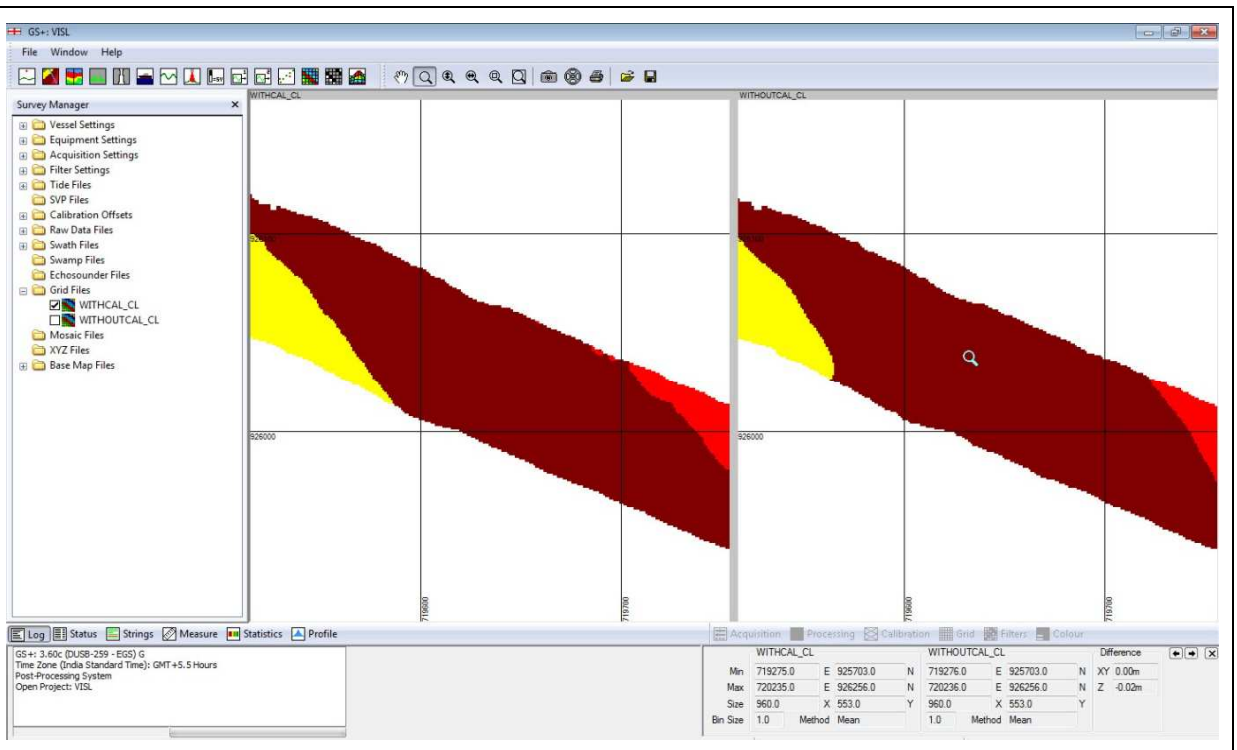


Figure 19: Calibration results with cross profiles (Left-without calibration, right-with calibration)

5.10 Grab and Water Sampling

A Van Veen grab was used for collecting the grab samples and a Niskin 5 litre bottle was used to collect the water samples.

① The water samples were analysed for TSS as per IS 3025, Part 17:1984 (reaffirmed 2012); Turbidity was analysed as per IS 3025, Part 10:1984 (reaffirmed 2012) technical specifications. The salinity was analysed as per American Public Health Association (APHA) guidelines.

5.11 Data Processing and Interpretation

Navigation data was processed using QINSy software. The single beam data was logged in QINSy and after applying tide; the data was processed and plotted using AutoCAD.

The Multibeam data was processed in the GS+ software. After applying the calibration values, sound velocity and the tide the processed data was QC-ed in the in-house software C-View.

ADCP data was processed using WinADCP® / WinSC® and the data was plotted in MS Excel®. The processed wave data from the buoy was plotted in MS Excel.

Grab samples were analysed at Geo Foundations & Structures Pvt. Ltd., Kochi and the water samples were analysed at Standard^{s} Environmental & Analytical Laboratories, Kochi.

① The inception report submitted on 26th February 2015, which details the equipment used, the calibration details etc. is enclosed at Annexure I.

6. SURVEY RESULTS

The results obtained for the first season are presented in this section.

6.1 Control Points

As per the contract, 31 reference stations were fixed along the 30 Km survey boundary using RTK DGPS system. As per the additional work ten more reference stations were also fixed. This was apart from the three reference stations; BM-1, BM-2 and BM-3 which was fixed for all future references.

The co-ordinates of BM-1 and BM-2 were provided by VISL (Detailed Project Report on Rail Connectivity to Vizhinjam International Seaport: Kerala, 2011) prior to start of survey. BM-1 lies next to the Sri Nagar Bhagavathy Temple, Mulloor and BM-2 lies adjacent to the Kollamkodu Sahib Dargah Sharif at Vizhinjam. The Survey of India benchmark which lies on a rock adjoining the basement on the western side of Vizhinjam mosque was also provided. This point is 6.945m above chart datum.

The image below depicts all the locations:



Figure 20 – Benchmark locations

The location BM-2 consists of a chiselled square on the rock adjacent to the compound wall of the Kollamkodu Sahib Dargah at Vizhinjam. This point was cross checked with the RTK GPS system and it was found that the provided and observed co-ordinates did not tally with each other. The 'z' value too did not match with the SOI benchmark. Due to masking of satellites at the SOI benchmark, there was no possibility to fix the co-ordinates of that point. Moreover due to the wall adjacent to it, a tripod cannot be setup at that point.

It was therefore decided to mobilise a VERIPOS globally corrected DGPS to fix the point near the Dargah and to transfer the 'Z' value from the SOI benchmark. VERIPOS Apex² service is a global, high accuracy GNSS positioning service using both the GPS and GLONASS constellations.

It is designed to meet all positioning and navigation applications, delivering decimetre level accuracy while providing a solution that is more resilient to the problems caused by satellite masking and ionospheric scintillation.

Apex² uses PPP which is an absolute positioning technique that corrects or models all GNSS error sources such as satellite orbit, satellite clock, troposphere and ionosphere. It is an extension of the VERIPOS Apex service using both GPS and GLONASS high precision dual-frequency observations to provide accurate positioning. (**www.veripos.com**)

This exercise was carried out on 16/17 February 2015 and the results obtained are provided in the table below:

Station Description	Co-ordinates in WGS 84		Height above Chart Datum
	Geographical	UTM	
BM-2	08° 22' 33".5100 N 76° 59' 12".1368 E	718770.2408 mE 926415.5205 mN	11.209 m

Table 7: Details of station BM2

The existing BM-1 station is in a dilapidated condition and the structure can collapse at any time. Accordingly a new BM-1 was established next to the existing one on the rock. This point was also established by observing co-ordinates using the VERIPOS DGPS system.

Another point BM-3 (which is also shown in Figure 10) was also set up on the roof top of VISL Project office at Panavilakode, Mulloor.

The details are provided below:

Station Description	Co-ordinates in WGS 84		Height above Chart Datum (metre)
	Geographical	UTM	
BM-1 (Near Mulloor temple)	08° 21' 55".7808 N 77° 00' 13".6084 E	720657.1797 mE 925265.7437 mN	11.5576
BM-3 (On the roof of VISL Project office)	8° 22' 21".7313 N 77° 00' 03".3253 E	720338.4535 mE 926061.5341 mE	44.0577

Table 8: Details of station BM1 & BM3

Photographs of the three stations are provided below:



Figure 21 – BM-2 adjacent to Dargah, Vizhinjam

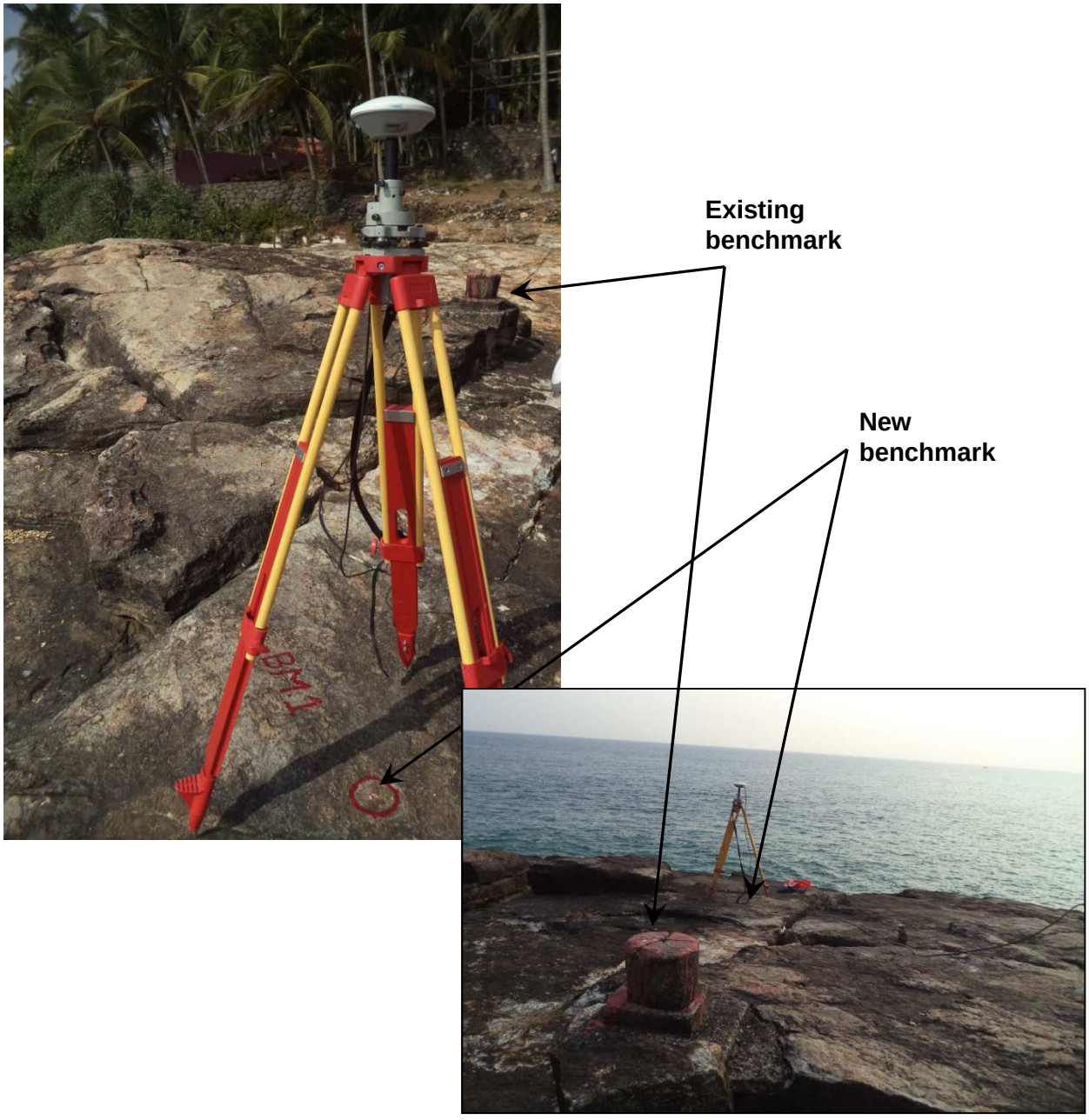


Figure 22 – BM-1 near to Sri Nagar Bhagavathy temple, Mulloor



Figure 23 – BM-3 roof top of VISL Project Office

The image below shows the SOI benchmark which is behind the Dargah at Vizhinjam.



Figure 24 – SOI Bench Mark

Based on the above bench mark co-ordinates, 41 reference points were fixed along the shore. Most of the points were fixed on existing rocks, concrete structures and few of them were also fixed on the existing CES marking stones. Considering BM-1 as centre, the points were named NIOT-CP-1 to NIOT-CP-19 to the south (Poovar) and NIOT-CP-A to NIOT-CP-V to the north (Shankumugham).

The station description of BM-2 which is used as the main reference station is provided below:

STATION DESCRIPTION – VISL BM2 (ADJACENT TO DARGAH)

Station Number:	BM2 VISL	**Latitude:**	08°22'33".5100 N
Locality:	Vizhinjam, Trivandrum	**Longitude:**	76°59'12".1368 E
Geodetic Datum:	WGS84	**Northing:**	926415.5205 M.
Zone:	43 N	**Easting:**	718770.2408 M.
Date:	17 Feb 2015	**Elevation:**	11.209 M. (CD)
Station Description:	The station consists of chisel mark on the rock; corner of the compound wall adjacent to Kollamkodu Sahib Dargah Sharif, Vizhinjam.		
Access:	The road to Kovalam light house further extends to the Dargah and the Mosque at Vizhinjam.		

Sketch: **Map:**



Photographs:



for Ocean Science & Surveying

Cdr. P.K. Tyagi, NM IN (retd.)
Charge Hydrographic Surveyor

OCEAN SCIENCE & SURVEYING PVT. LTD. INDIA NAVI MUMBAI

Station Description of BM2 VISL
Job No. P18115

Ocean Science & Surveying Pvt. Ltd.

Figure 25 – Description of BM-2

The following table provides the details of the reference stations:

Sl No.	Reference Points	Easting	Northing	Latitude	Longitude	Height above CD (m)
1	NIOT_CP-19	734936.867	914404.7342	8° 15'59".91325 N	77° 7'58".30588 E	4.9448
2	NIOT_CP-18	734116.42	915024.1573	8° 16'20".21262 N	77° 7'31".61235 E	5.86
3	NIOT_CP-17	733244.0129	915625.4904	8° 16'39".93202 N	77° 7'3".21742 E	5.2926
4	NIOT_CP-16	732485.4329	916183.7851	8° 16'58".23085 N	77° 6'38".53276 E	5.0749
5	NIOT_CP-15	731570.272	916840.7065	8° 17'19".76585 N	77° 6'8".74908 E	5.658
6	NIOT_CP-14	730843.3861	917407.4855	8° 17'38".33474 N	77° 5'45".09983 E	7.7322
7	NIOT_CP-13	730390.4197	917721.6701	8° 17'48".63657 N	77° 5'30".35551 E	7.7694
8	NIOT_CP-12	729654.9678	918329.1176	8° 18'8".52996 N	77° 5'6".43234 E	4.4221
9	NIOT_CP-11	728738.3202	919038.8737	8° 18'31".78333 N	77° 4'36".60606 E	3.9544
10	NIOT_CP-10	727993.7027	919569.1662	8° 18'49".16695 N	77° 4'12".36870 E	3.7986
11	NIOT_CP-9	729397.4389	920046.5818	8° 19'4".46345 N	77° 4'58".31359 E	4.3316
12	NIOT_CP-8	726454.8538	920766.0091	8° 19'28".37591 N	77° 3'22".29415 E	3.9366
13	NIOT_CP-7	725656.2954	921415.6312	8° 19'49".65109 N	77° 2'56".31253 E	4.2844
14	NIOT_CP-6	724768.7938	922157.4539	8° 20'13".94139 N	77° 2'27".43947 E	4.2148
15	NIOT_CP-5	724159.7014	922734.6909	8° 20'32.82857 N	77° 2'7".634777 E	3.8251
16	NIOT_CP-4	723270.1977	923410.6967	8° 20'54".97675 N	77° 1'38".68346 E	3.0972
17	NIOT_CP-3	722465.6274	923988.1456	8° 21'13".90304 N	77° 1'12".49001 E	3.1602
18	NIOT_CP-2	721481.8683	924273.9063	8° 21'23".36632 N	77° 0'40".39178 E	11.4171
19	NIOT_CP-1	721226.3295	924486.3499	8° 21'30".32234 N	77° 0'32".07696 E	14.6213
20	NIOT_CP-A	720194.5904	926065.8282	8° 22'21".89482 N	76° 59'58".62481 E	11.6288
21	NIOT_CP-B	717970.883	927172.091	8° 22'58".26291 N	76° 58'46".13906 E	22.9947
22	NIOT_CP-C	717565.394	927637.0357	8° 23'13".46045 N	76° 58'32".96422 E	4.4694
23	NIOT_CP-D	717237.5958	928806.139	8° 23'51".56131 N	76° 58'22".44381 E	3.3282
24	NIOT_CP-E	716979.2207	929552.9440.	8° 24'15".90758 N	76° 58'14".12252 E	4.7432
25	NIOT_CP-F	716489.6905	930413.2052	8° 24'43".98399 N	76° 57'58".26496 E	5.5908
26	NIOT_CP-G	715943.5657	931284.6071	8° 25'12".43215 N	76° 57'40".55899 E	5.2857
27	NIOT_CP-H	715560.9067	931799.8978	8° 25'29".26425 N	76° 57'28".13678 E	3.1777
28	NIOT_CP-I	714782.8648	932861.9655	8° 26'3".95510 N	76° 57'2".88080 E	4.5228
29	NIOT_CP-J	714171.7189	933470.9072	8° 26'23".87197 N	76° 56'43".00490 E	7.8878
30	NIOT_CP-K	713749.7645	933992.4272	8° 26'40".91294 N	76° 56'29".29807 E	7.6638
31	NIOT_CP-L	713118.6205	934741.1346	8° 27'5".38141 N	76° 56'8".79020 E	4.2566
32	NIOT_CP-M	712542.8348	935407.128	8° 27'27".14889 N	76° 55'50".07774 E	4.0076
33	NIOT_CP-N	711773.0753	935995.2397	8° 27'46".41283 N	76° 55'25".01160 E	6.3616
34	NIOT_CP-O	711328.4672	936796.413	8° 28'12".55834 N	76° 55'10".60768 E	7.6976
35	NIOT_CP-P	710540.4298	937692.2264	8° 28'41".83894 N	76° 54'44".99218 E	5.7295
36	NIOT_CP-Q	709869.231	938480.1943	8° 29'7".59078 N	76° 54'23".17776 E	5.4124
37	NIOT_CP-R	709080.5573	939351.7461	8° 29'36".08144 N	76° 53'57".53564 E	4.3292

Sl No.	Reference Points	Easting	Northing	Latitude	Longitude	Height above CD (m)
38	NIOT_CP-S	708512.7295	940019.1963	8° 29'57".89418 N	76° 53'39".07962 E	5.08
39	NIOT_CP-T	707885.2999	940760.5905	8° 30'22".12280 N	76° 53'18".68634 E	6.2363
40	NIOT_CP-U	707297.3093	941476.2951	8° 30'45".50894 N	76° 52'59".57765 E	4.7072
41	NIOT_CP-V	706563.5161	942438.4132	8° 31'16".93766 N	76° 52'35".74070 E	4.814
42	NIOT_BM-1	720657.1797	925265.7437	8° 21'55".78077 N	77° 0'13".60836 E	11.5576
43	NIOT_BM-3 (VISL Office)	720338.4535	926061.5341	8° 22'21".73127 N	77° 0'3".32532 E	44.0577
44	NIOT_BM-2	718770.2408	926415.5205	8° 22'33".51000 N	76° 59'12".13680 E	11.209

Table 9: Control Point Co-ordinates

All the points were engraved as per their respective names. If during the course of survey any control point gets damaged, a new point shall be fixed on a clear area as per the availability at site.

6.2 Tidal Measurements

The tides were observed near the Coast Guard jetty for the first season. The tide is referenced to the chart datum, the value of which was provided by VISL. The temporary bench mark is marked on the wharf and is 3.261 above chart datum. An image of the TBM is provided below:

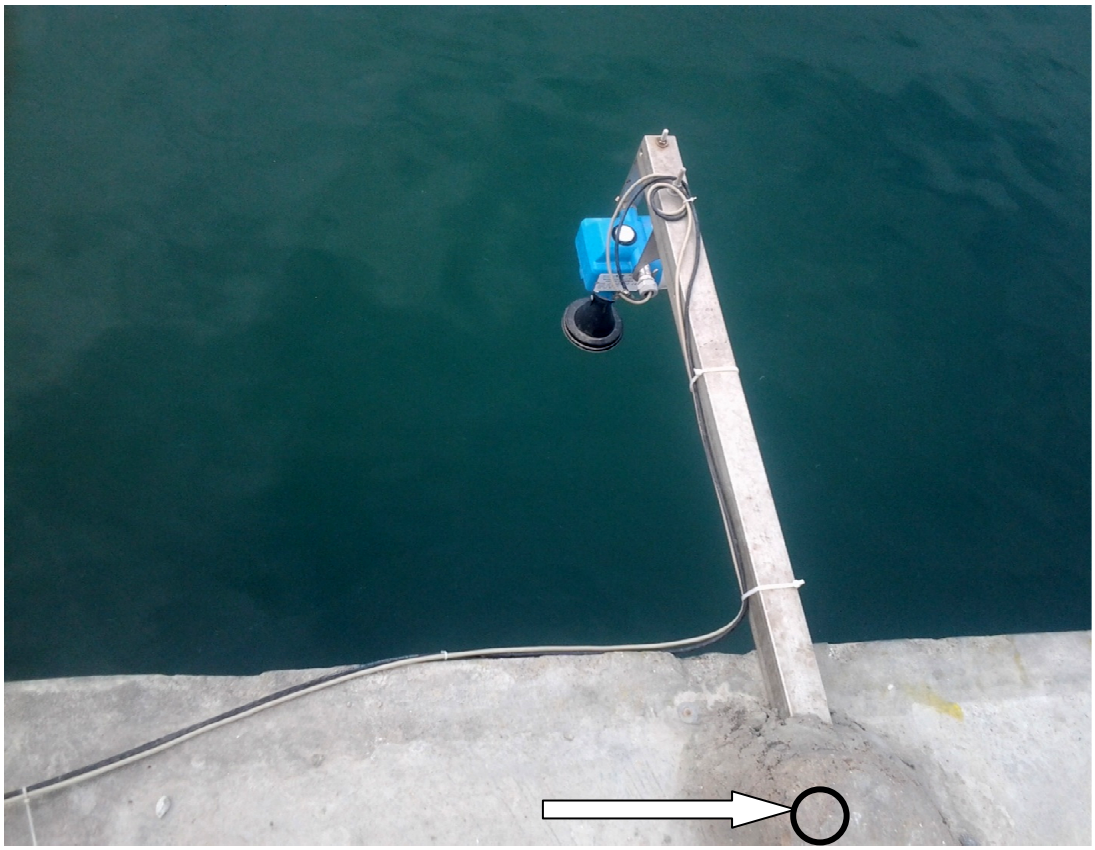


Figure 26 – Location of TBM

The observed tides are mixed semi diurnal in nature. The maximum range was observed during the springs.

The tidal data collected for the period is placed at Annexure II.

6.3 Current Measurements

Acoustic Doppler Current Profilers (ADCP) were mobilised for mapping the current in the survey area. One 600 kHz Rio Grande and three 600 KHz Sentinel ADCPs were deployed at the locations for measuring currents.

The following table gives the deployment details of the ADCPs in the survey area:

ADCP MOORING LOCATIONS WGS-84, UTM Projection, CM 75° East, Zone 43, North					
Location	**Water Depth (m)**	**Period of Observation**	**Easting**	**Northing**	**Frequency**
P1 (Vizhinjam)	21.1	11th Feb to 14th Mar 2015	08° 22' 06.42"N	76° 58' 58.70"E	600 KHz
P2 (Poovar)	22.3	11th Feb to 14th Mar 2015	08° 18' 00.35"N	77° 03' 55.54"E	600 KHz
P3 (Pachalloor)	21.2	11th Feb to 14th Mar 2015	08° 25' 01.20"N	76° 56' 28.57"E	600 KHz
P4 (Mulloor)	27.6	11th Feb to 14th Mar 2015	08° 21' 43.12"N	76° 59' 25.84"E	600 KHz

Table 10: ADCP Mooring Locations

The results of the data obtained by the ADCPs at the four locations are documented below, location-wise.

6.3.1 LOCATION P1 (Vizhinjam)

The ADCP was deployed for a period of 30 days to cover one lunar cycle. It was deployed on an 'L' frame installed on a boat, in a downward looking mode and was used to measure the speed and direction of the current.

The data was recovered after 30 days of observation and after quality checks, spurious data were filtered out.

① A maximum current of 59.8 cm/s was measured at the water surface on 1st March 2015.

Refer to the following compass plots for speed and direction of the currents, where the speed data is plotted in cm/s:

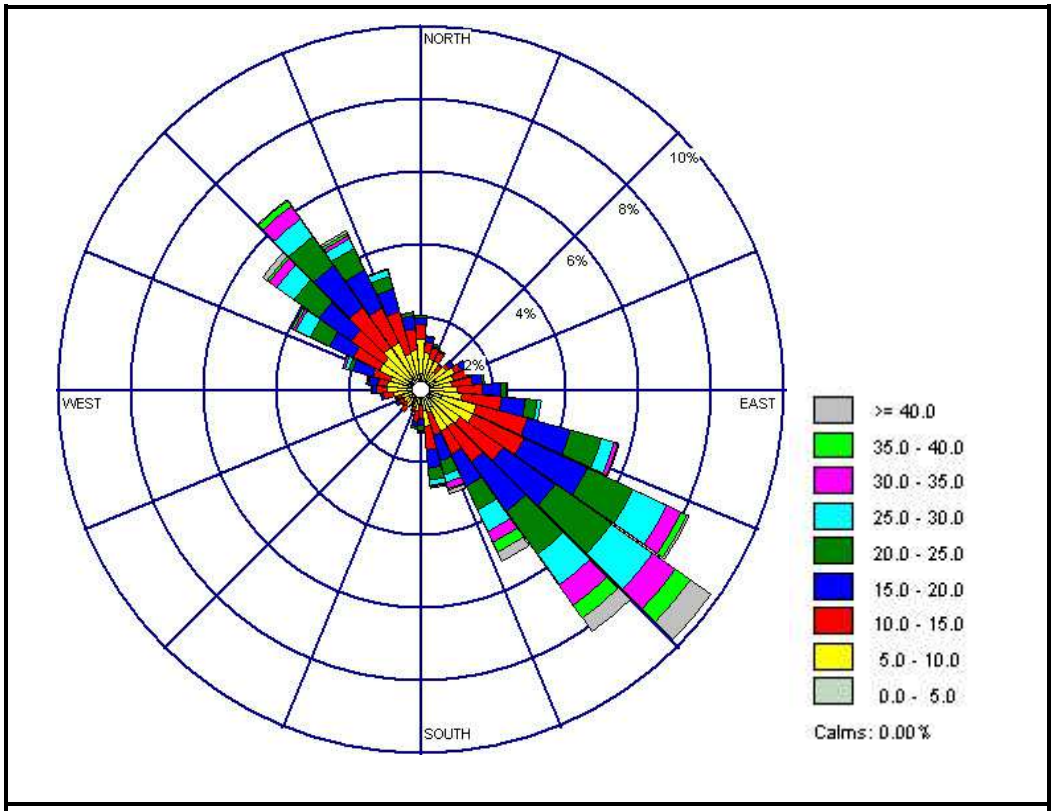


Figure 27 – Compass plot (Surface speed in Cm/s) – P1

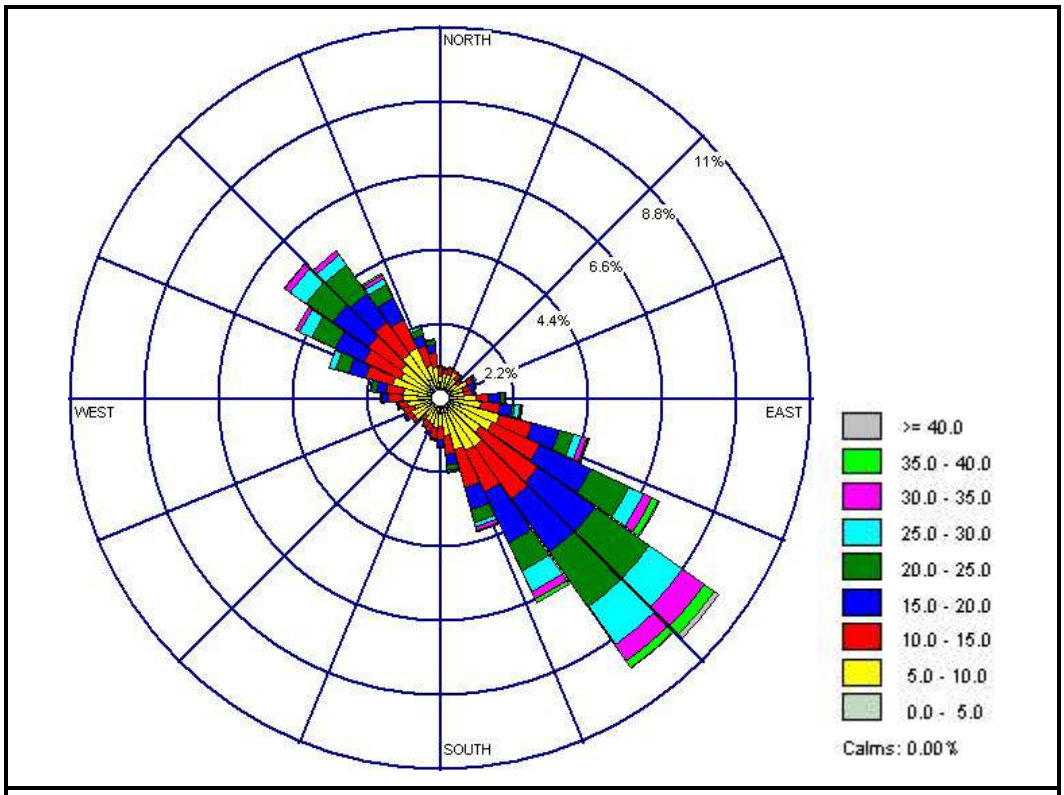


Figure 28 – Compass plot (Mid Depth speed in Cm/s) – P1

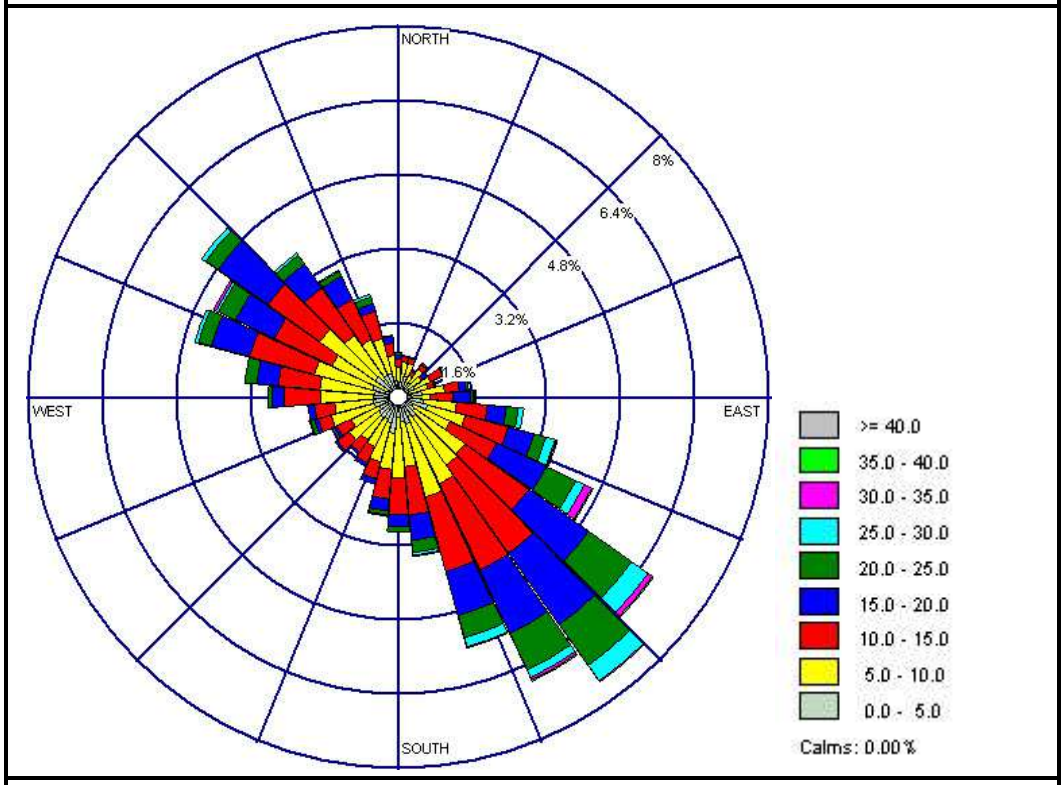


Figure 29 – Compass plot (Near Bottom speed in Cm/s) – P1

The data reveals that the current flow was parallel to the coast. The surface currents are mostly wind driven.

The following table and figures give the histogram of frequency distribution & percentage exceedance curve of current speed:

Frequency Distribution			
Speed (Cm/s)	**Surface**	**Mid**	**Bottom**
0 – 10	1553	1766	2128
10 – 20	1717	1687	1837
20 – 30	833	784	431
30 – 40	70	13	2
>50	14	0	0
Total	**4426**	**4426**	**4426**

Table 11: Frequency Distribution of current speed - P1

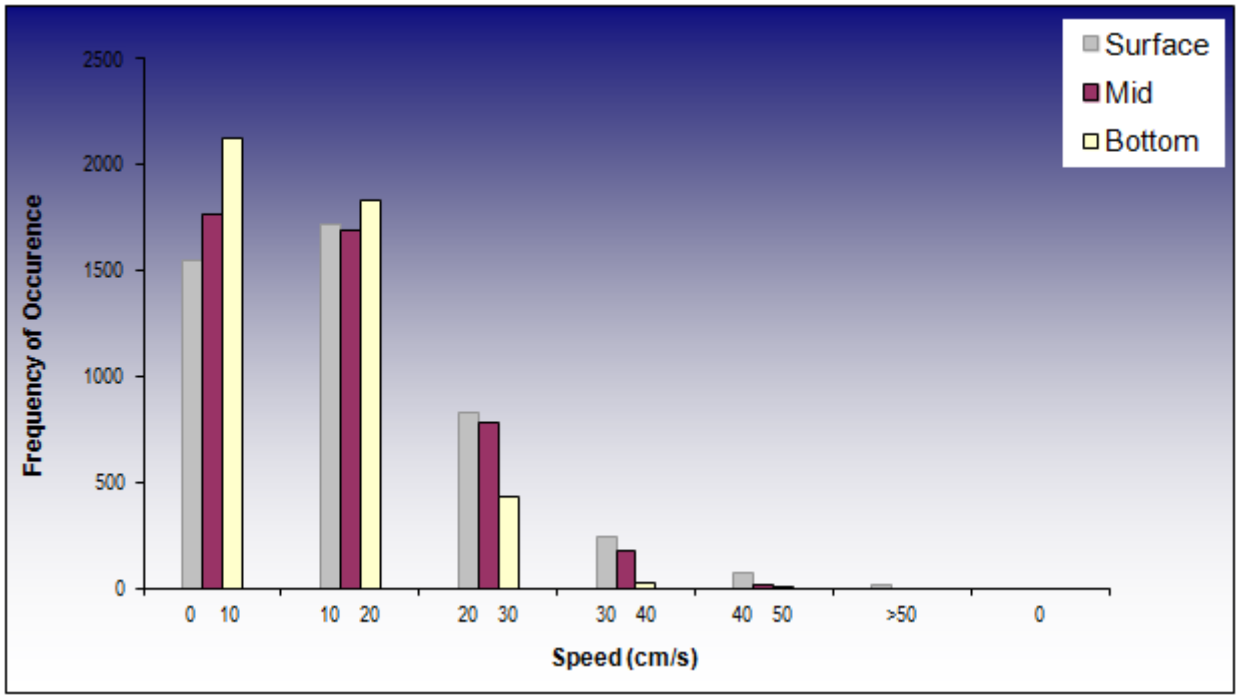


Figure 30 – Frequency Distribution of current speed – P1

Frequency Distribution			
Speed (Cm/s)	**% of Surface**	**% of Mid**	**% of Bottom**
0	100	100	100
10	64.91	60.1	51.92
20	26.12	21.98	10.42
30	7.3	4.27	0.68
40	1.9	0.29	0.05
50	0.32	0	0

Table 12: Percentage of Exceedance of current speed – P1

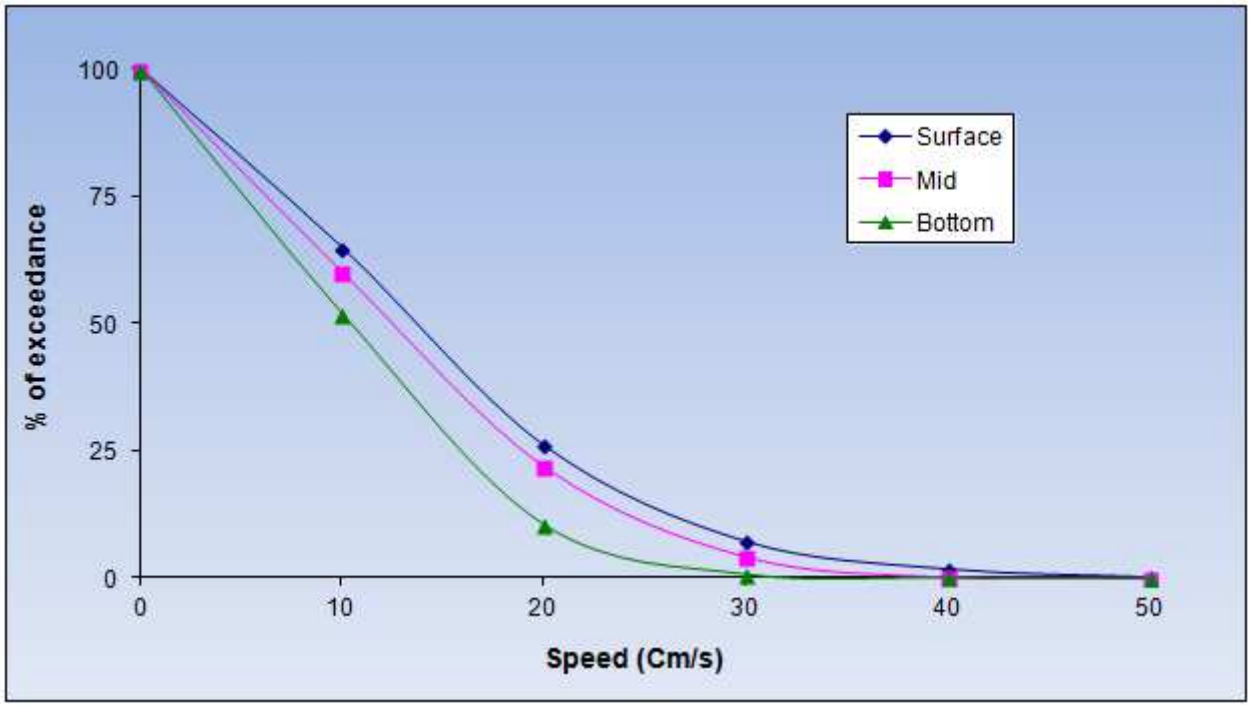


Figure 31 – Exceedance Curve of current speed – P1

The exceedance curve reveals that the current speed was mainly in the range of 0 to 40 cm/s during the period of observation.

The exceedance curves are given only for 3 levels (near surface, mid depth and near bottom obtained from the bin number 1, 7 and 19 respectively).

The time series curves are placed at Annexure III.

Progressive vector diagram for the full observation period is given below:

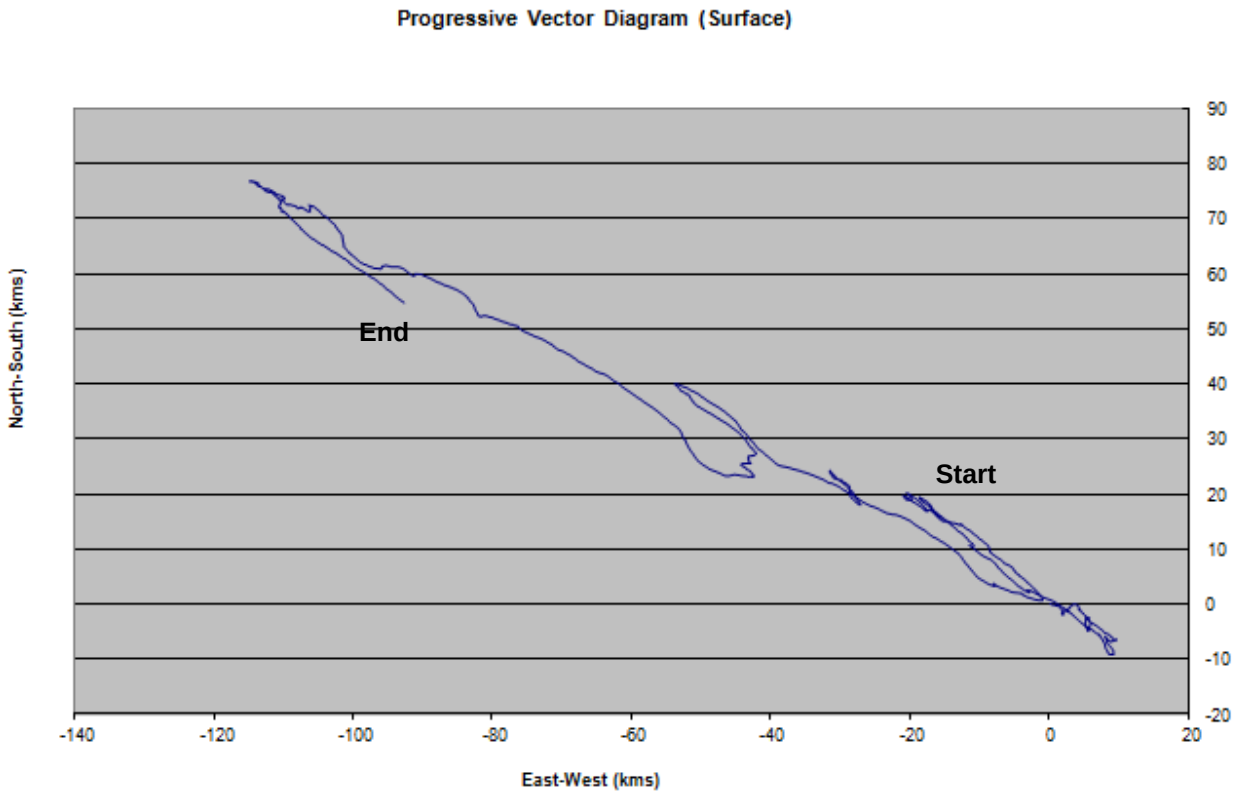


Figure 32 – Progressive Vector Diagram – P1

The progressive vector diagram is used to simulate a Lagrangian display from Eulerian measurements (a moored currentmeter). The progressive vector diagram is constructed by drawing the first current vector in a Cartesian co-ordinate grid. The second vector is then added to the first vector, its tail sitting on the head of the first vector, and so on, as shown in the above figure. The x- and y-axis, which are in velocity units (cm/s), are converted to space units (Km) by noting that a water parcel travelling at 1 cm/s for 1 hour will have covered a distance of 1 cm/s times 3600 seconds, or 0.36 Km. The above figure reveals that a parcel of water would have travelled about 90 Km towards northwest during the one lunar cycle.

6.3.2 LOCATION P2 (Poovar)

The ADCP was deployed for a period of 30 days to cover one lunar cycle. It was deployed on an 'L' frame installed on a boat, in a downward looking mode and was used to measure the speed and direction of the current.

The data was recovered after 30 days of observation and after quality checks, spurious data were filtered out.

A maximum current of 164.3 cm/s was measured at the water surface on 5th March 2015.

Refer to the following compass plots for speed and direction of the currents, where the speed data is plotted in cm/s:

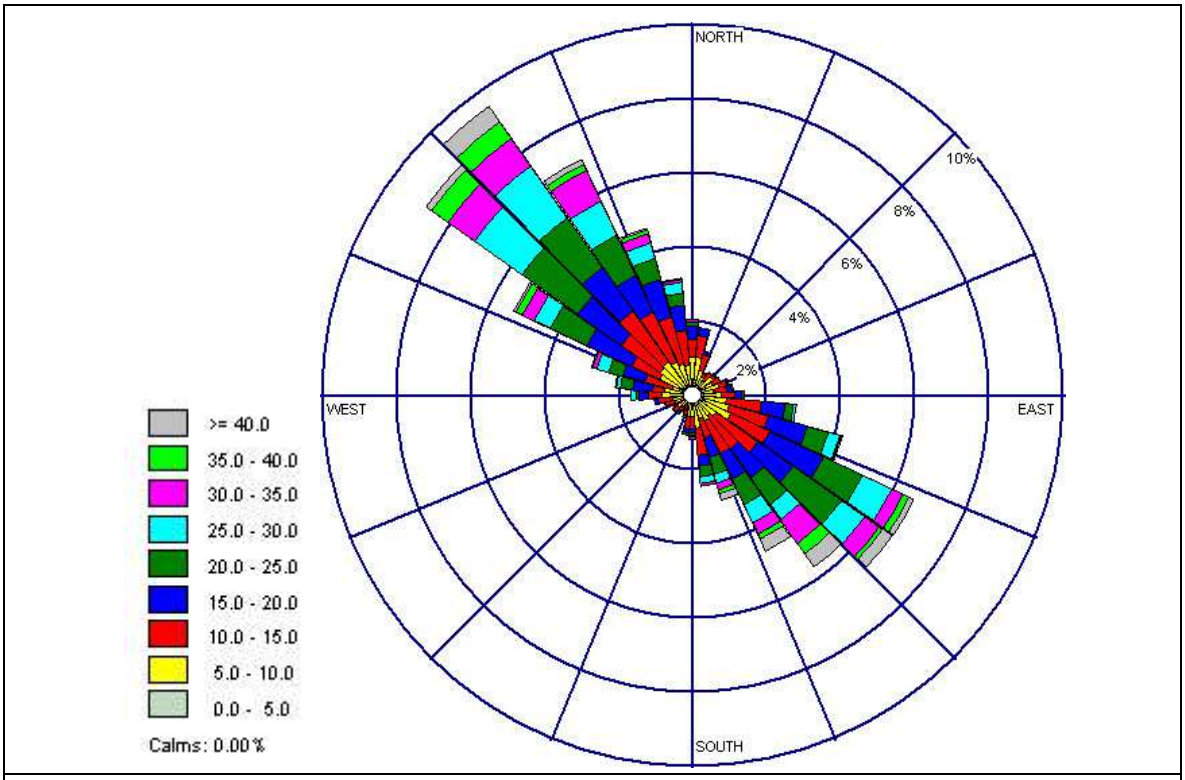


Figure 33 – Compass plot (Surface speed in Cm/s) – P2

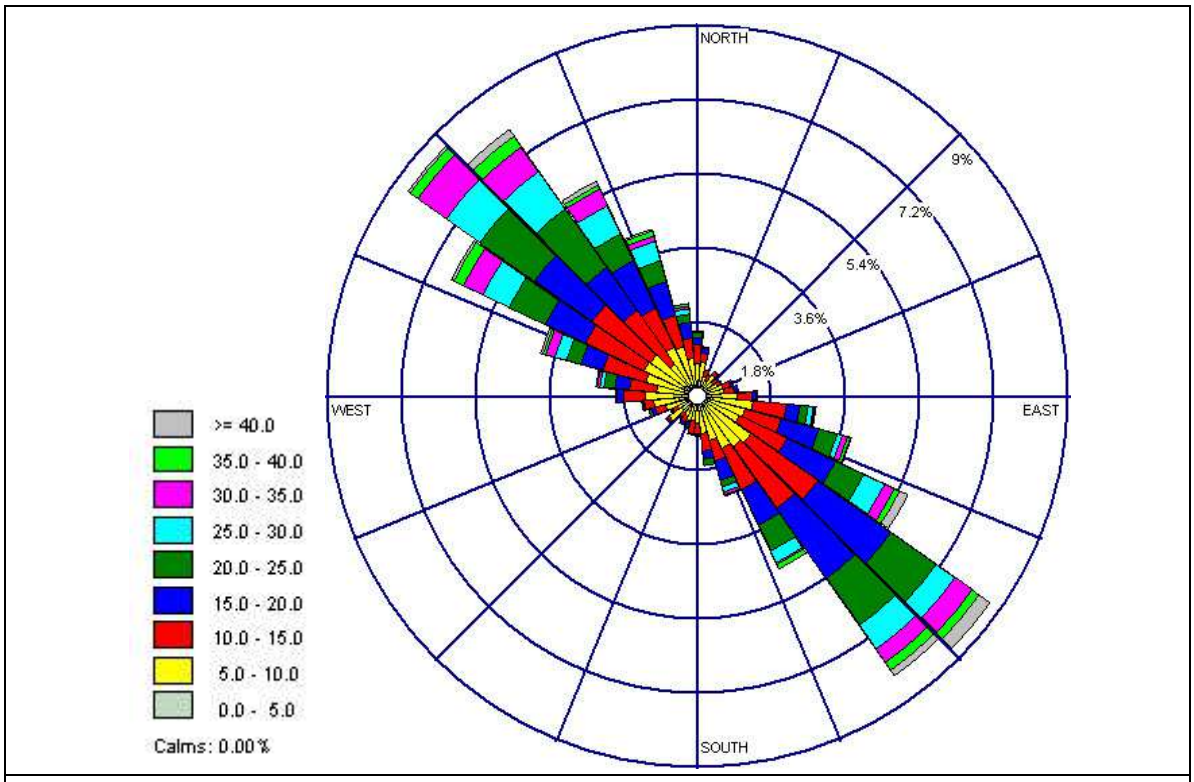


Figure 34 – Compass plot (Mid Depth speed in Cm/s) – P2

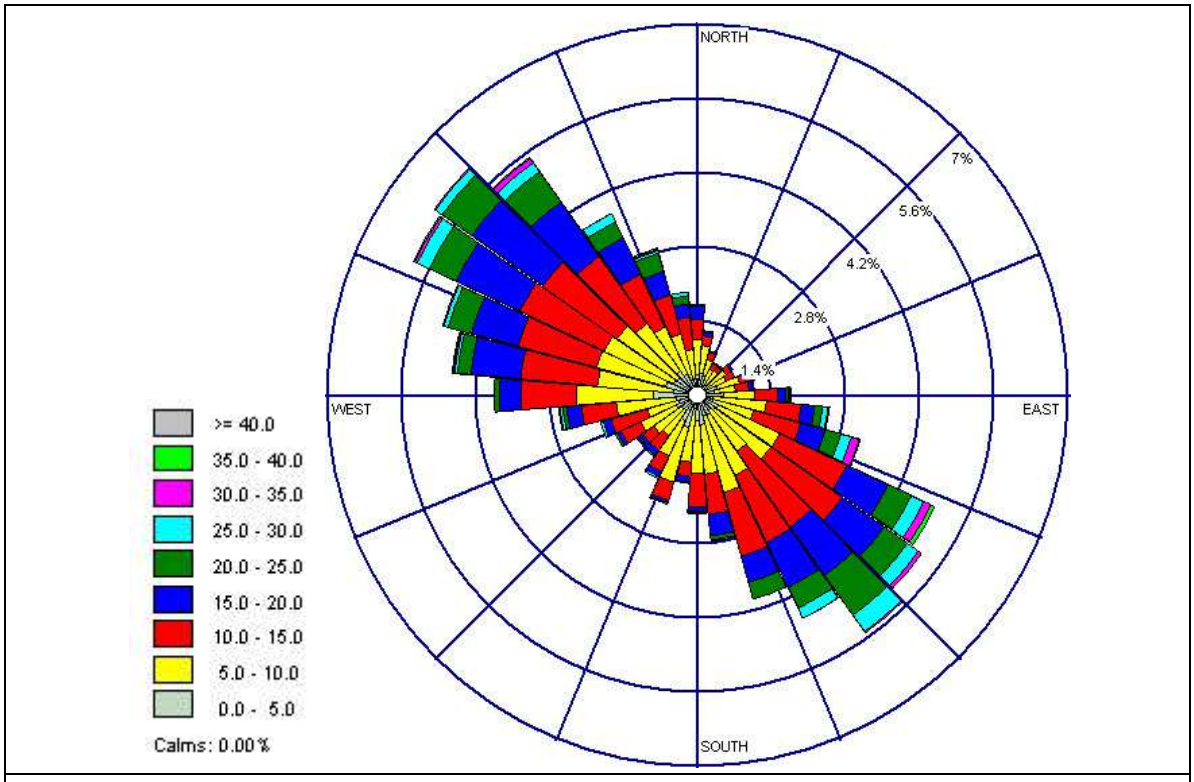


Figure 35 – Compass plot (Near Bottom speed in Cm/s) – P2

The data from this location follows a similar pattern as at P1. The currents are slightly stronger in this location.

The following table and figures give the histogram of frequency distribution & percentage exceedance curve:

Frequency Distribution			
Speed (Cm/s)	**Surface**	**Mid**	**Bottom**
0 – 10	1194	1523	2090
10 – 20	1730	1732	1861
20 – 30	1027	835	431
30 – 40	373	282	43
40 – 50	82	48	1
>50	20	6	0
Total	**4426**	**4426**	**4426**

Table 13: Frequency Distribution of current speed – P2

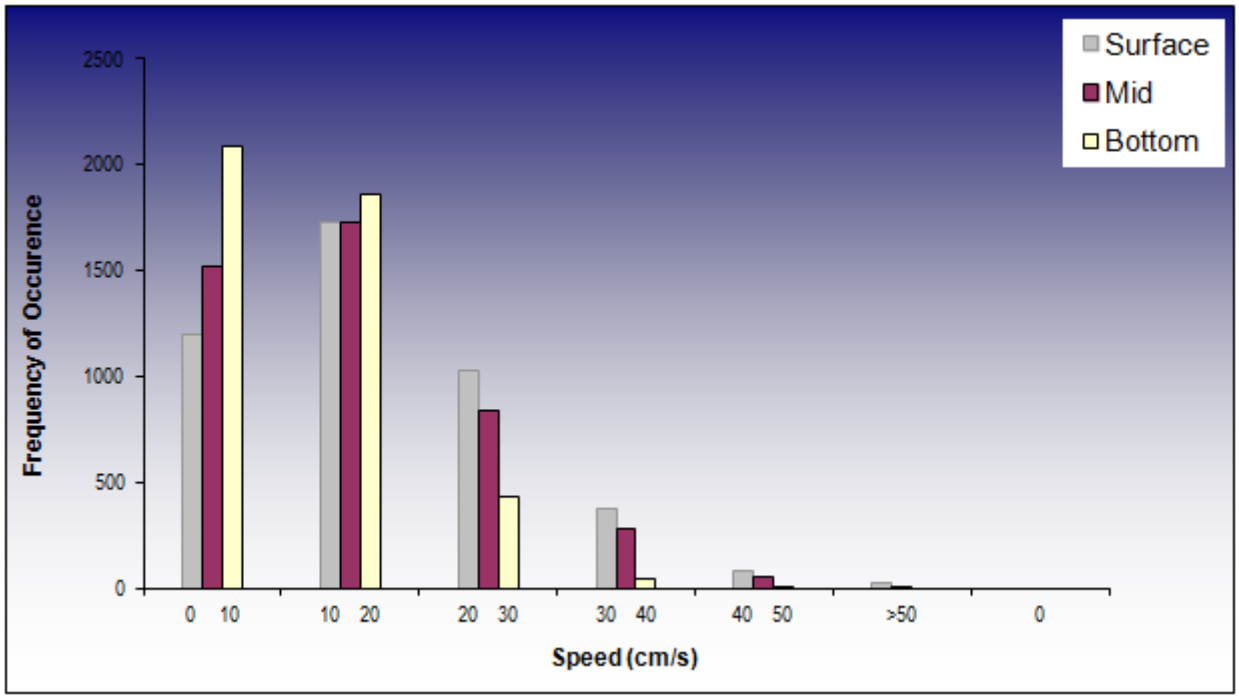


Figure 36 – Frequency Distribution of current speed – P2

Frequency Distribution			
Speed (Cm/s)	**% of Surface**	**% of Mid**	**% of Bottom**
0	100	100	100
10	73.02	65.59	52.78
20	33.94	26.46	10.73
30	10.73	7.59	0.99
40	2.3	1.22	0.02
50	0.45	0.14	0

Table 14: Percentage of Exceedance of current speed – P2

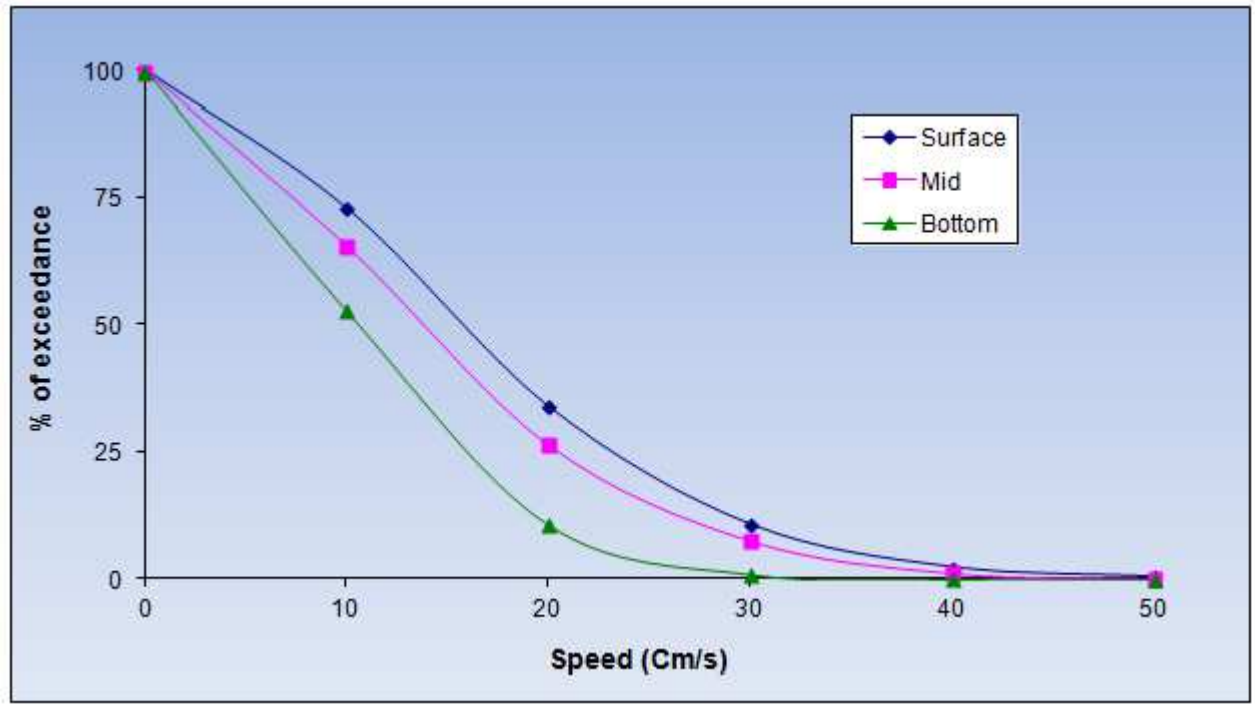


Figure 37 – Exceedance Curve of current speed – P2

The exceedance curve reveals that the speed exceeded 40 cm/s about 2.7% of the observation period.

The time series curves are placed at Annexure III.

The progressive vector diagram for the complete lunar cycle is provided below:

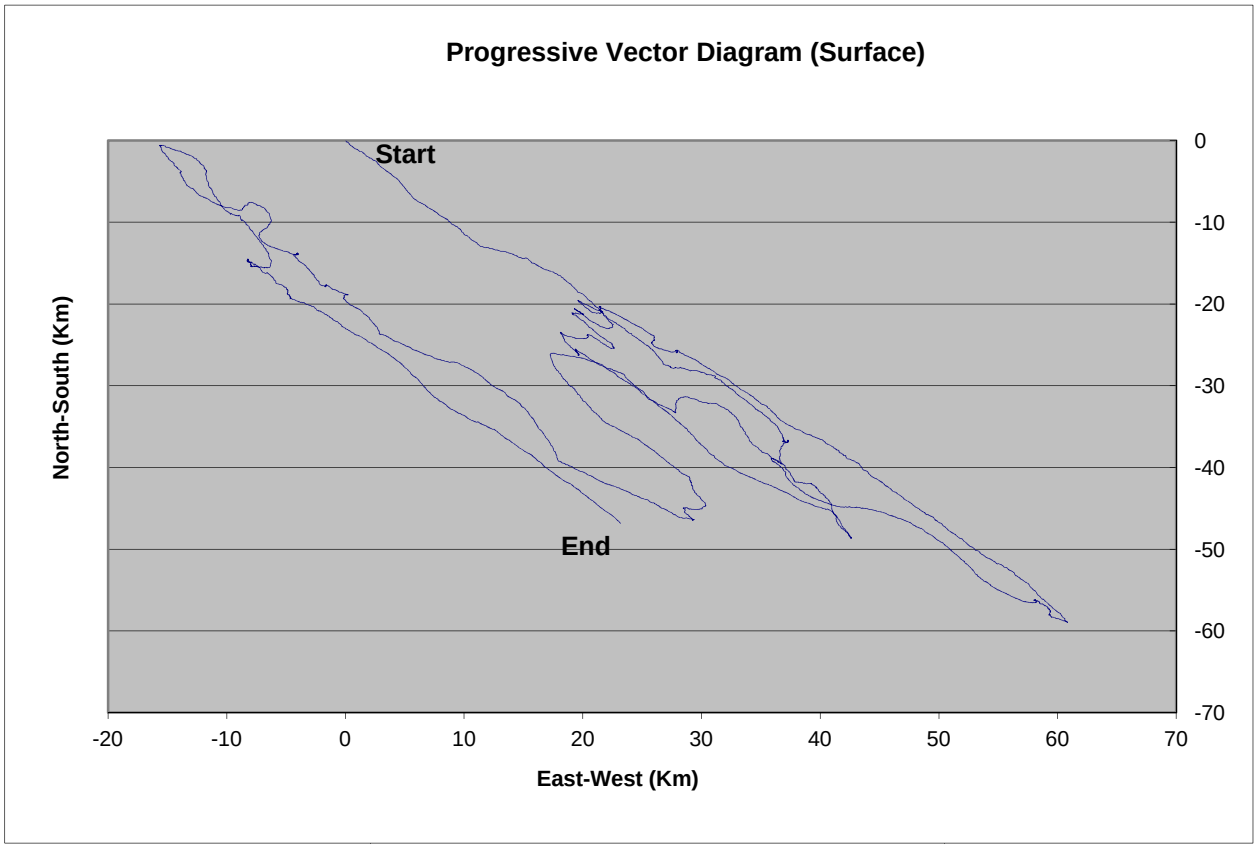


Figure 38 – Progressive Vector Diagram – P2

The above figure reveals that a parcel of water would have travelled about 60 km towards southeast and followed a rotary flow, then travelling 40 km towards northwest and further flowing back to south east. The rotary flow could be due to the closer proximity to Poovar river.

6.3.3 LOCATION P3 (Pachalloor)

The ADCP was deployed for a period of 30 days to cover one lunar cycle. It was deployed on an 'L' frame on a downward looking mode to measure the speed and direction.

After recovery, the data was properly QC-ed for removing spurious data.

A maximum speed of 48.1 Cm/s was observed on 5th March 2015 at 20:00 hours.

The time series curves are placed at Annexure III.

Refer to the following compass plots for speed and direction of the currents:

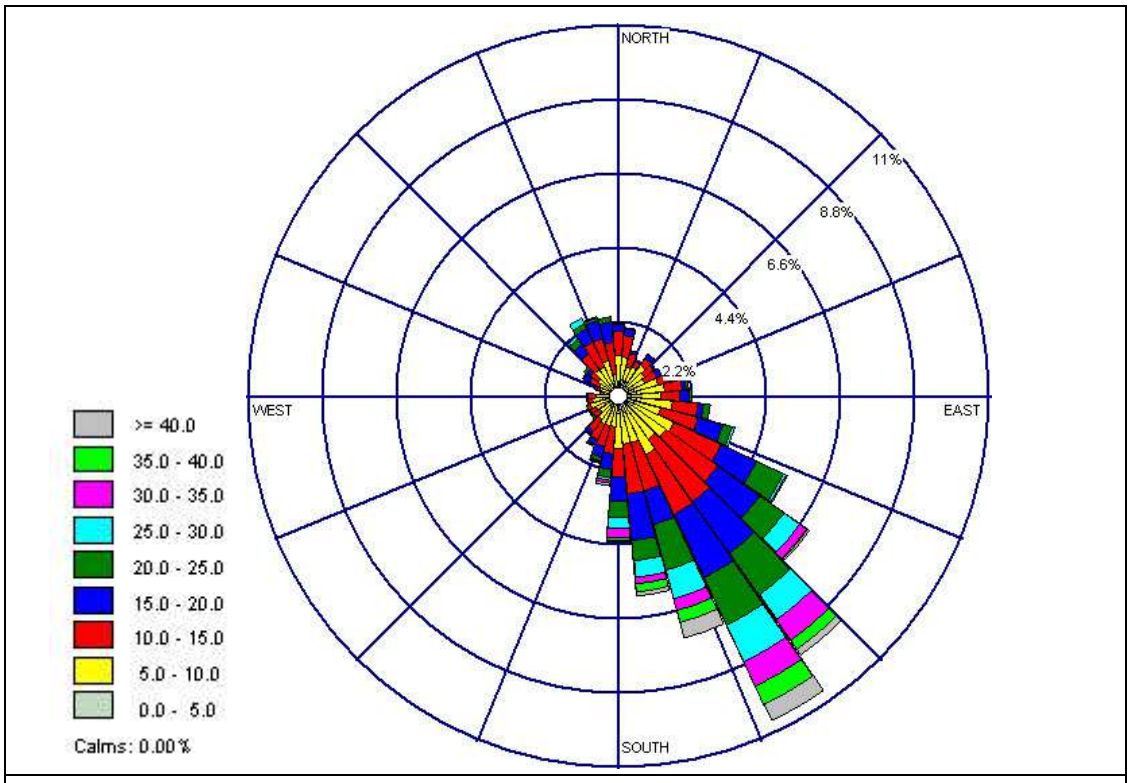


Figure 39 – Compass plot (Surface speed in Cm/s) – P3

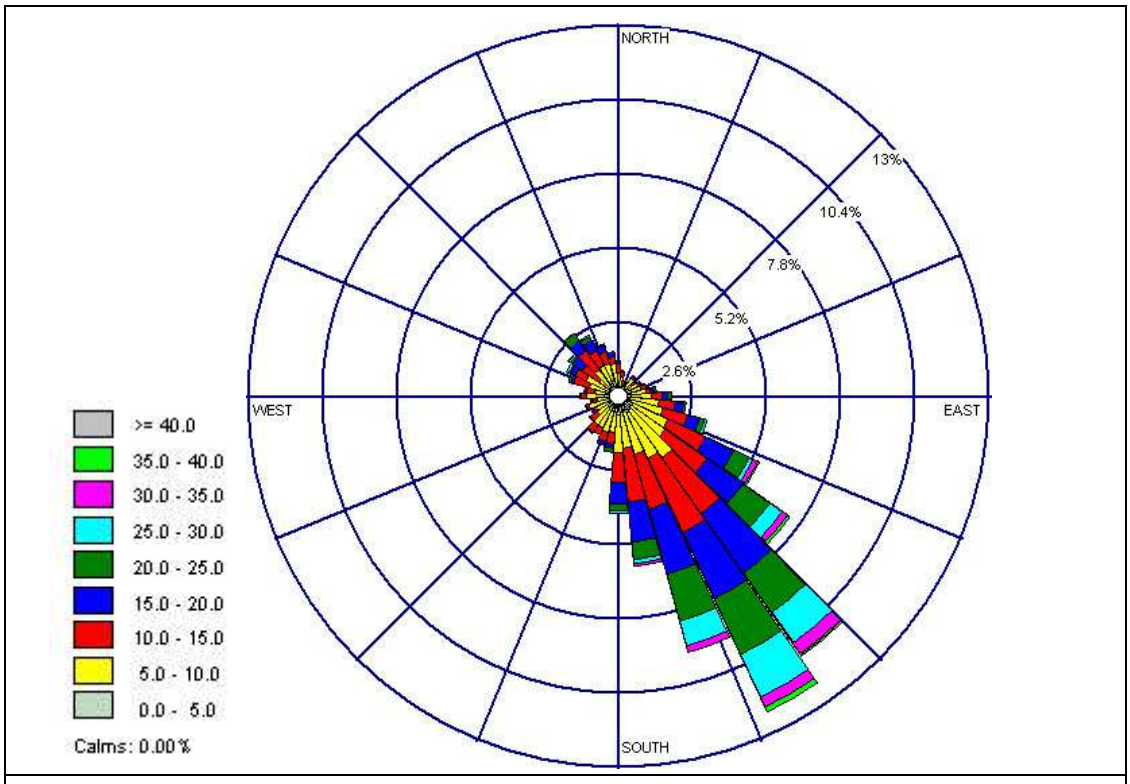


Figure 40 – Compass plot (Mid Depth speed in Cm/s) – P3

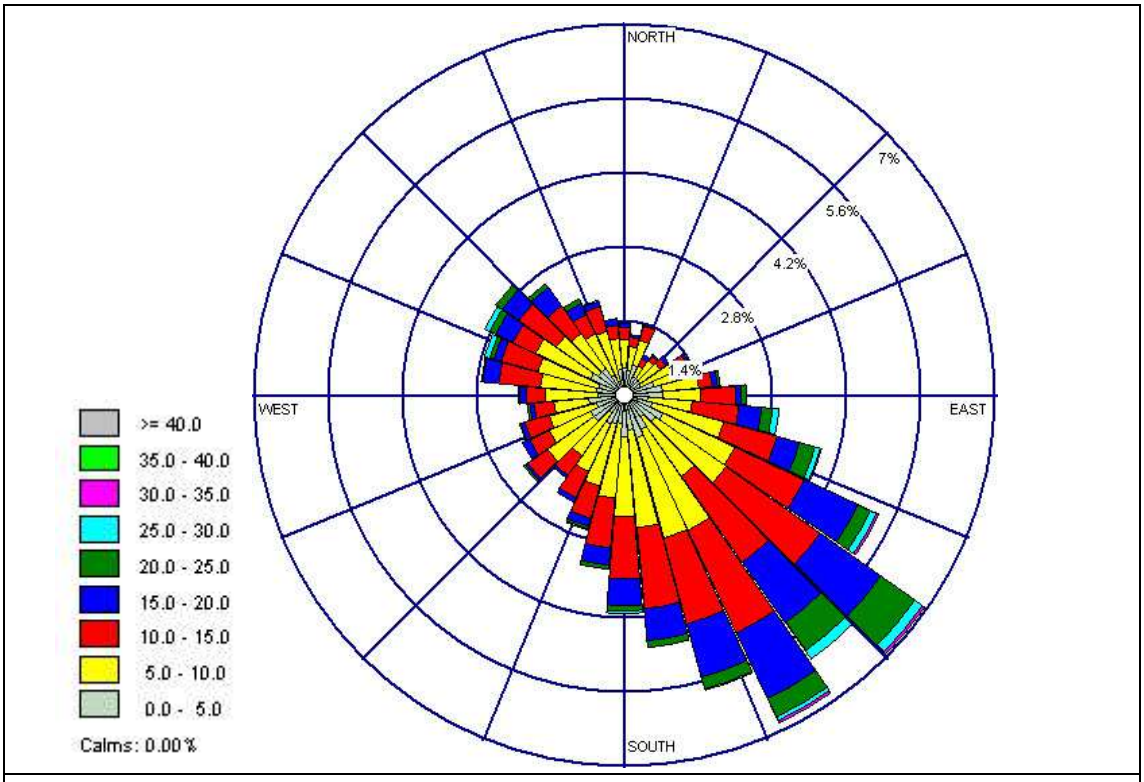


Figure 41 – Compass plot (Near Bottom speed in Cm/s) – P3

The following table and figures give the histogram of frequency distribution & percentage exceedance curve:

Frequency Distribution			
Speed (Cm/s)	**Surface**	**Mid**	**Bottom**
0 – 10	1761	1999	2543
10 – 20	1779	1711	1652
20 – 30	624	631	224
30 – 40	199	84	7
>40	0	0	0
Total	**4426**	**4426**	**4426**

Table 15: Frequency Distribution of current speed - P3

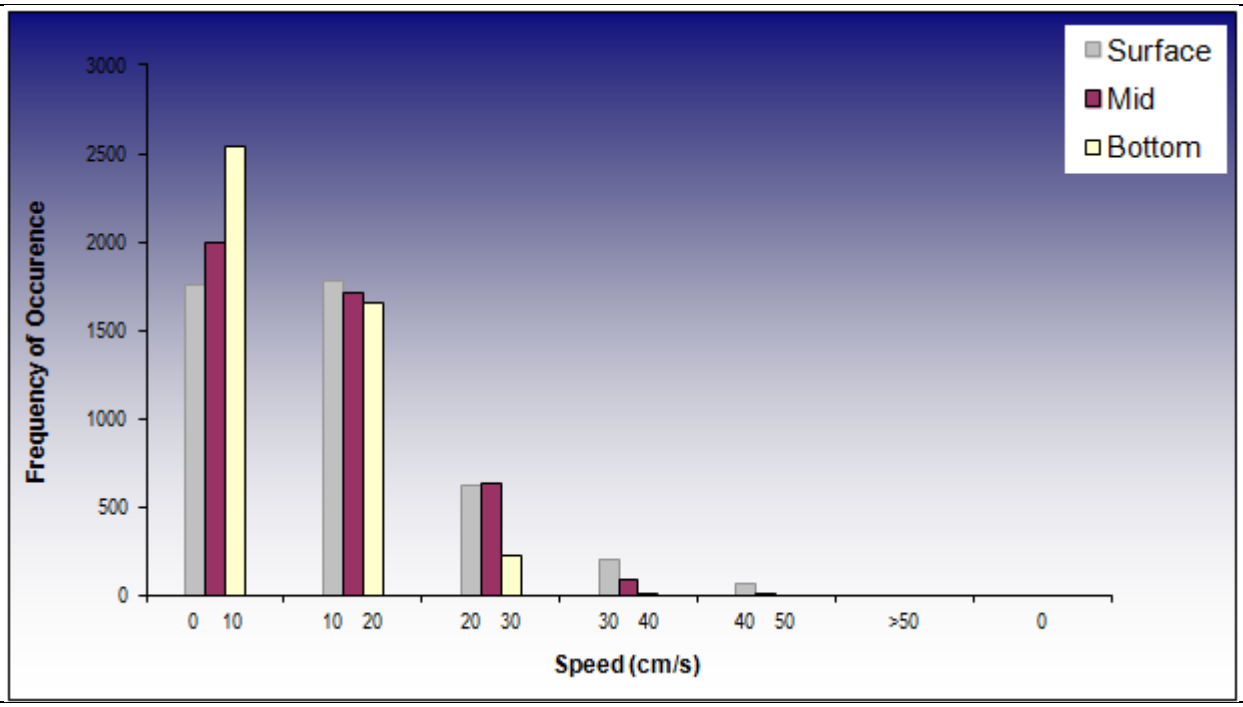


Figure 42 – Histogram of current speed – P3

Frequency Distribution			
Speed (Cm/s)	**% of Surface**	**% of Mid**	**% of Bottom**
0	100	100	100
10	60.21	24.84	42.54
20	20.02	16.18	5.22
30	592	192	016
40	1.42	0.02	0

Table 16: Percentage of Exceedance – P3

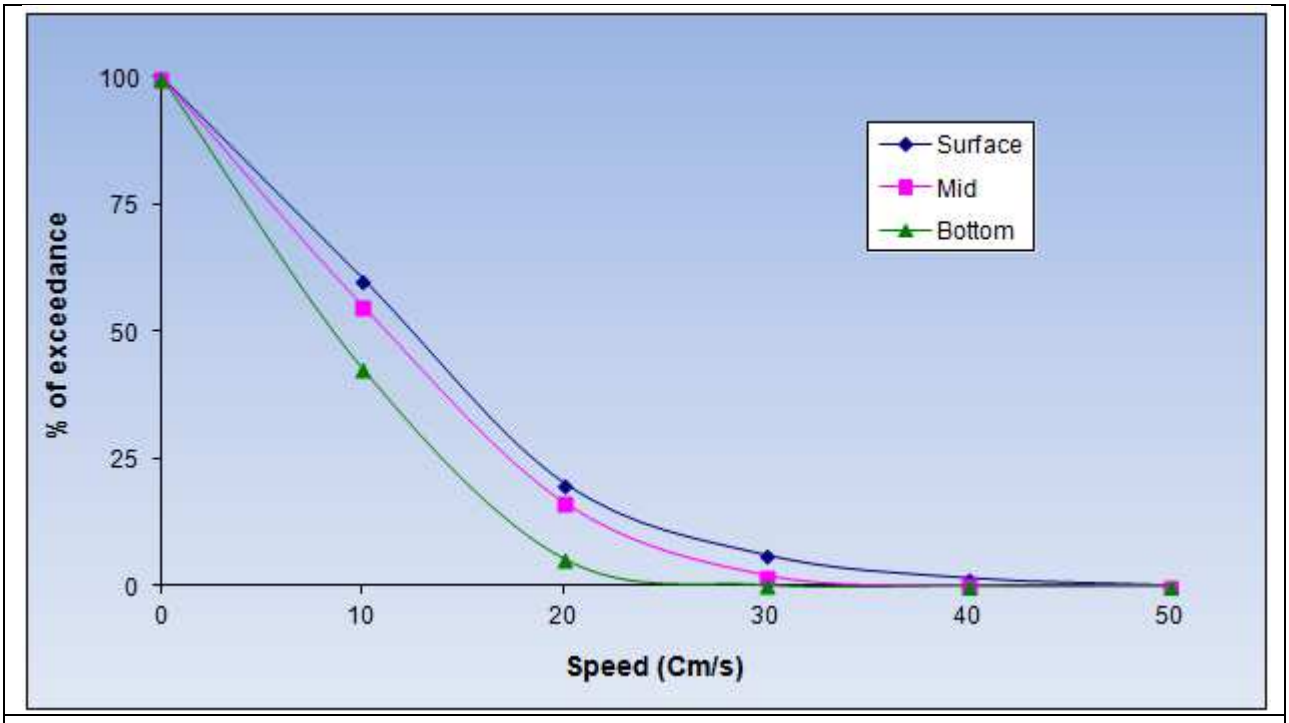


Figure 43 – Exceedance Curve in April – P3

The progressive vector diagram for the lunar cycle is given in the following figure:

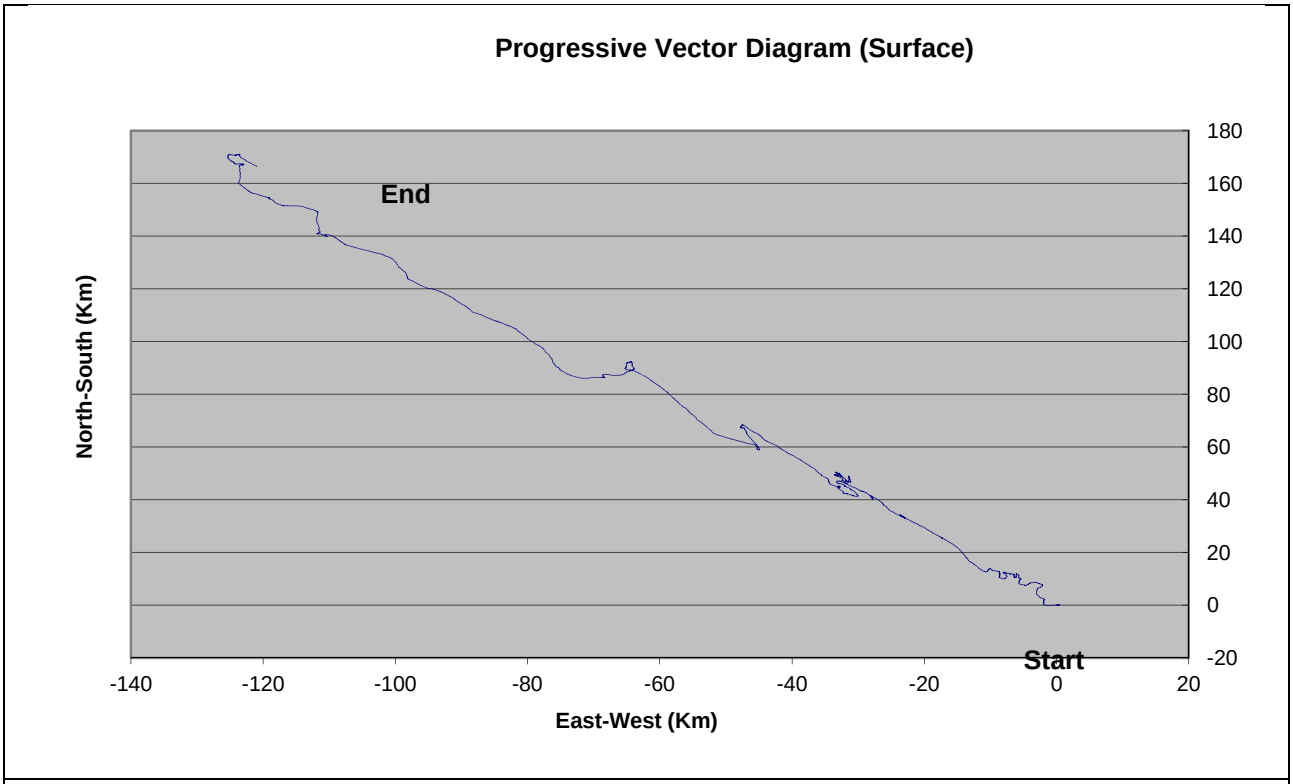


Figure 44 – Progressive Vector Diagram – P3

The above pvd shows the parcel moving about 120 Km towards northwest during the one lunar cycle.

6.3.4 LOCATION P4 (Mulloor)

The ADCP was deployed for a period of 30 days to cover one lunar cycle. It was deployed on an 'L' frame on a downward looking mode to measure the speed and direction.

After recovery, the data was properly QC-ed for removing spurious data.

A maximum speed of 54.6 Cm/s was observed on 1st March 2015 at 15:30 hours.

The time series curves are placed at Annexure III.

Refer to the following compass plots for speed and direction of the currents:

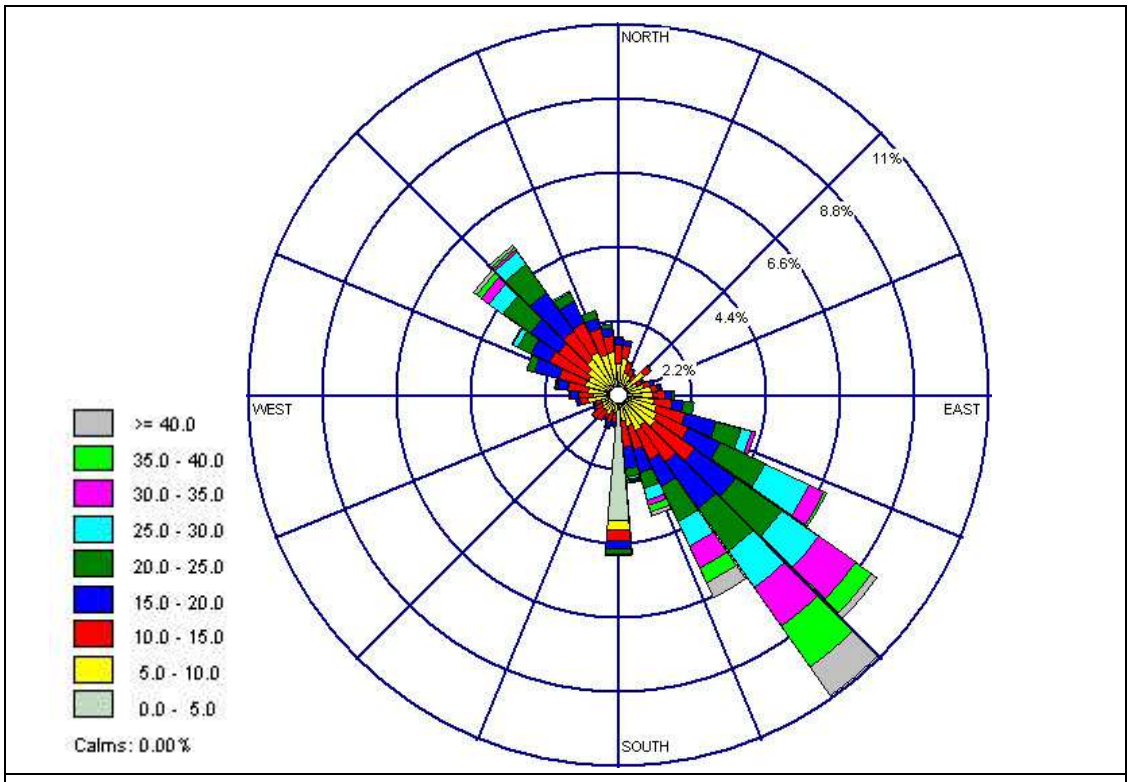


Figure 45 – Compass plot (Surface speed in Cm/s) – P4

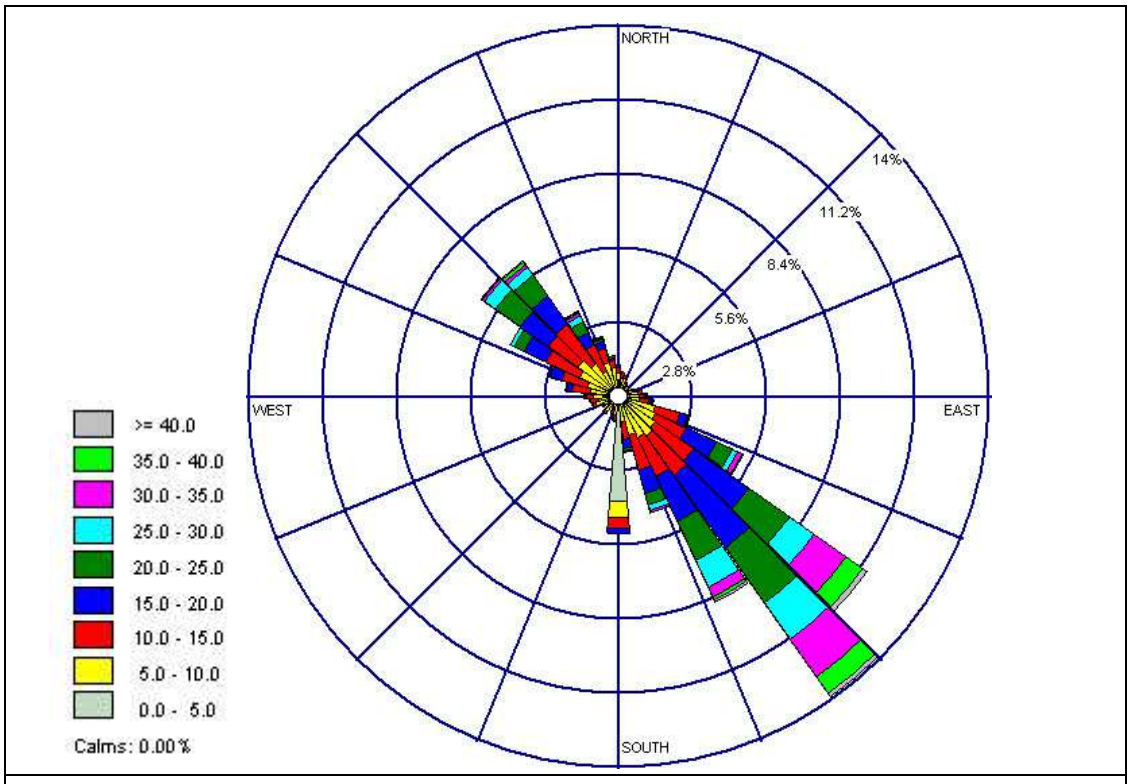


Figure 46 – Compass plot (Mid Depth speed in Cm/s) – P4

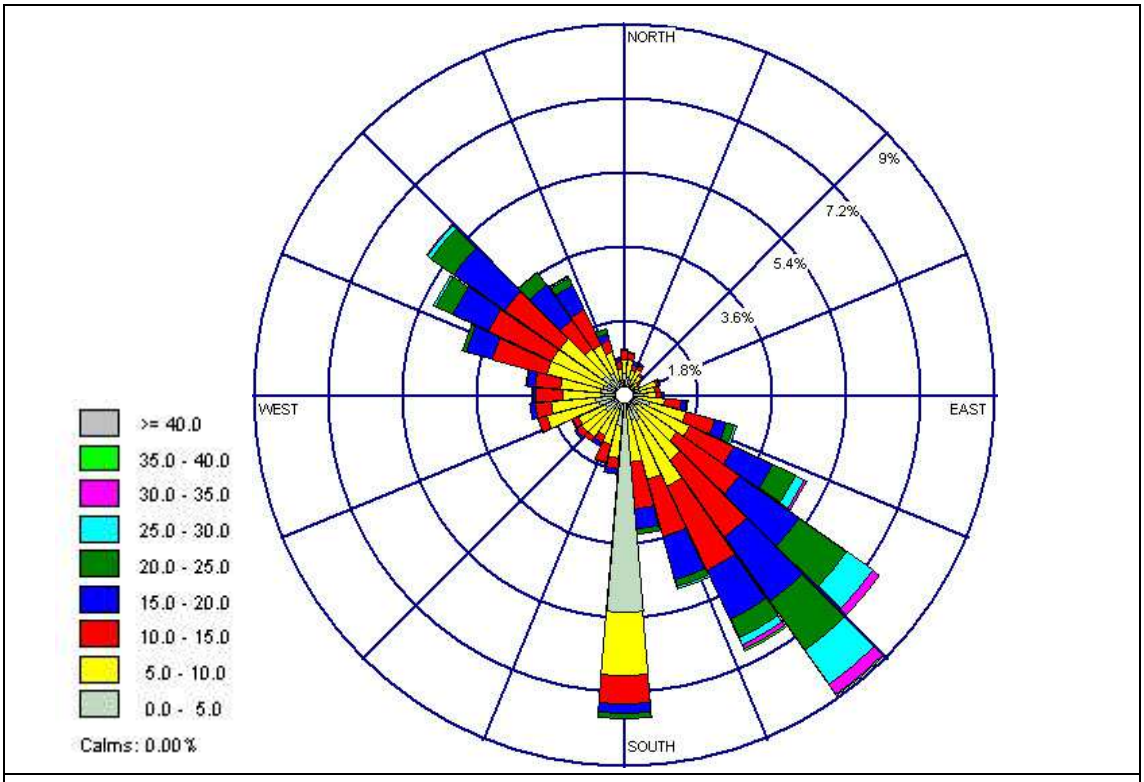


Figure 47 – Compass plot (Near Bottom speed in Cm/s) – P4

The following table and figures give the histogram of frequency distribution & percentage exceedance curve:

Frequency Distribution			
Speed (Cm/s)	**Surface**	**Mid**	**Bottom**
0 – 10	1607	1761	2323
10 – 20	1532	1606	1616
20 – 30	800	711	393
30 – 40	340	263	35
40 – 50	82	26	0
>50	6	0	0
Total	**4367**	**4367**	**4367**

Table 17: Frequency Distribution of current speed – P4

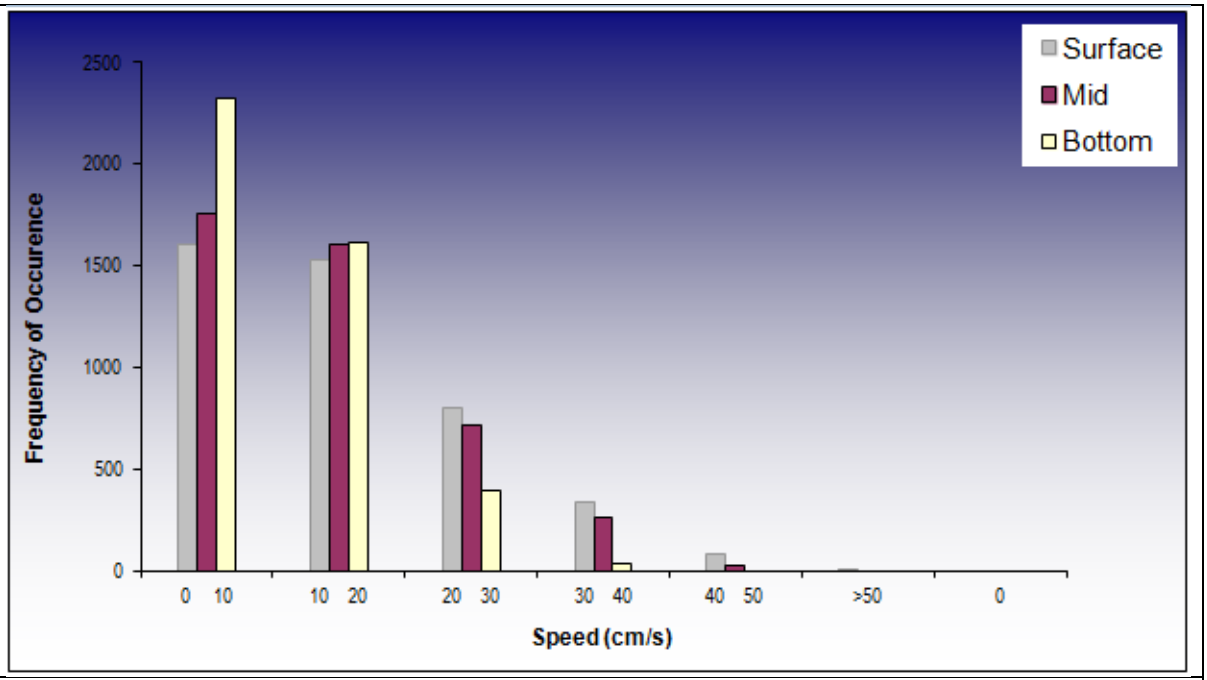


Figure 48 – Histogram of current speed – P4

Frequency Distribution			
Speed (Cm/s)	**% of Surface**	**% of Mid**	**% of Bottom**
0	100	100	100
10	63.20	59.67	46.81
20	28.12	22.90	9080
30	9.80	6.62	0.80
40	2.02	0.60	0.00
50	0.14	0.00	0.00

Table 18: Percentage of Exceedance – P4

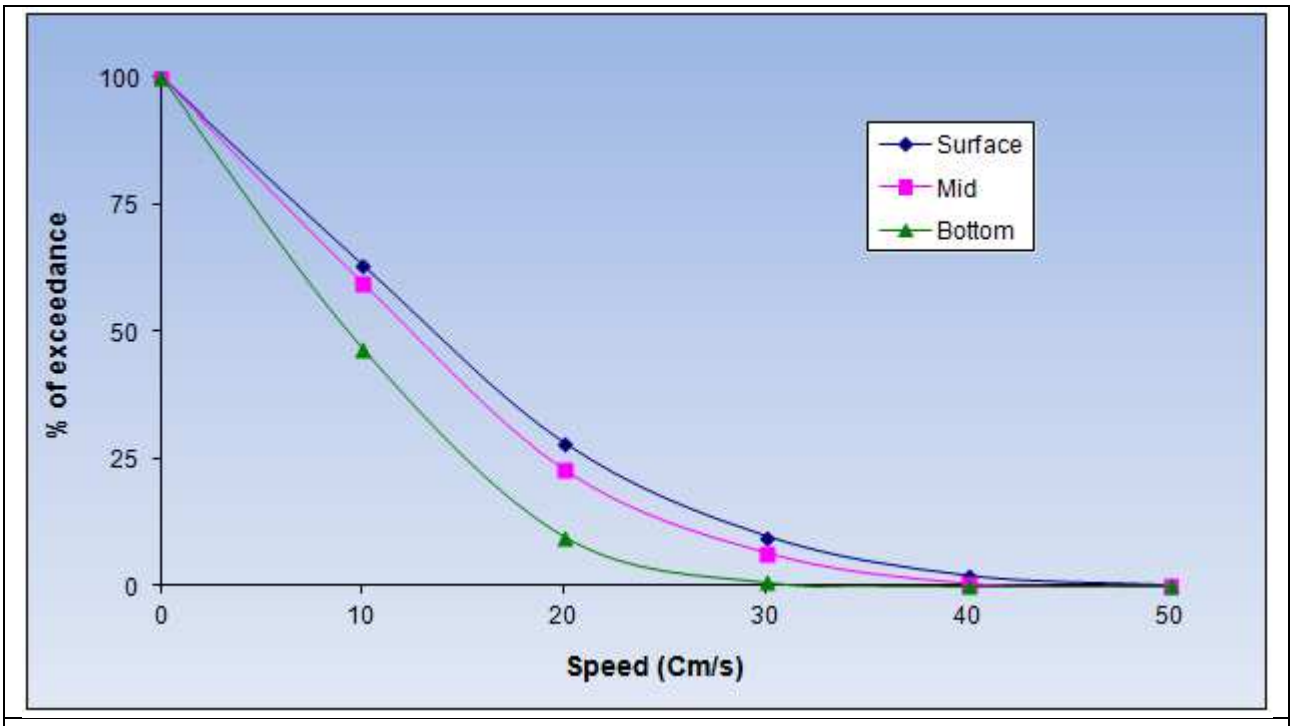


Figure 49 – Exceedance Curve in April – P4

The progressive vector diagram for the lunar cycle is given in the following figure:

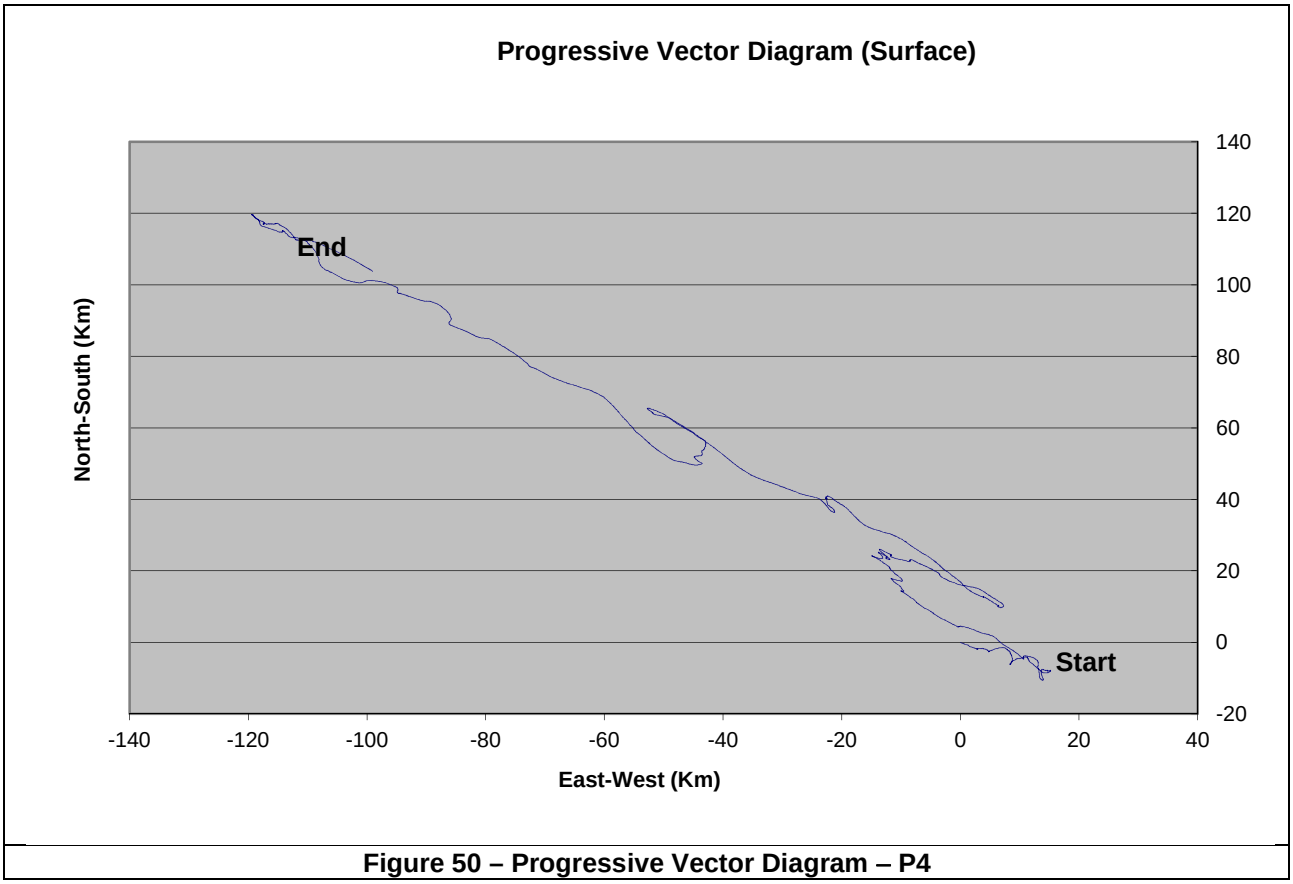


Figure 50 – Progressive Vector Diagram – P4

The above pvd shows the parcel moving about 100 Km towards northwest during the one lunar cycle.

6.4 Wave Measurements

① The WRB supplied by NIOT was deployed at the required location on 10th February 2015. The receiver was set up at the resort where OSaS personnel are staying. The processed data received, was then plotted for time series and rose diagram which are provided below:

Refer to the following rose plot of Hs v/s direction:

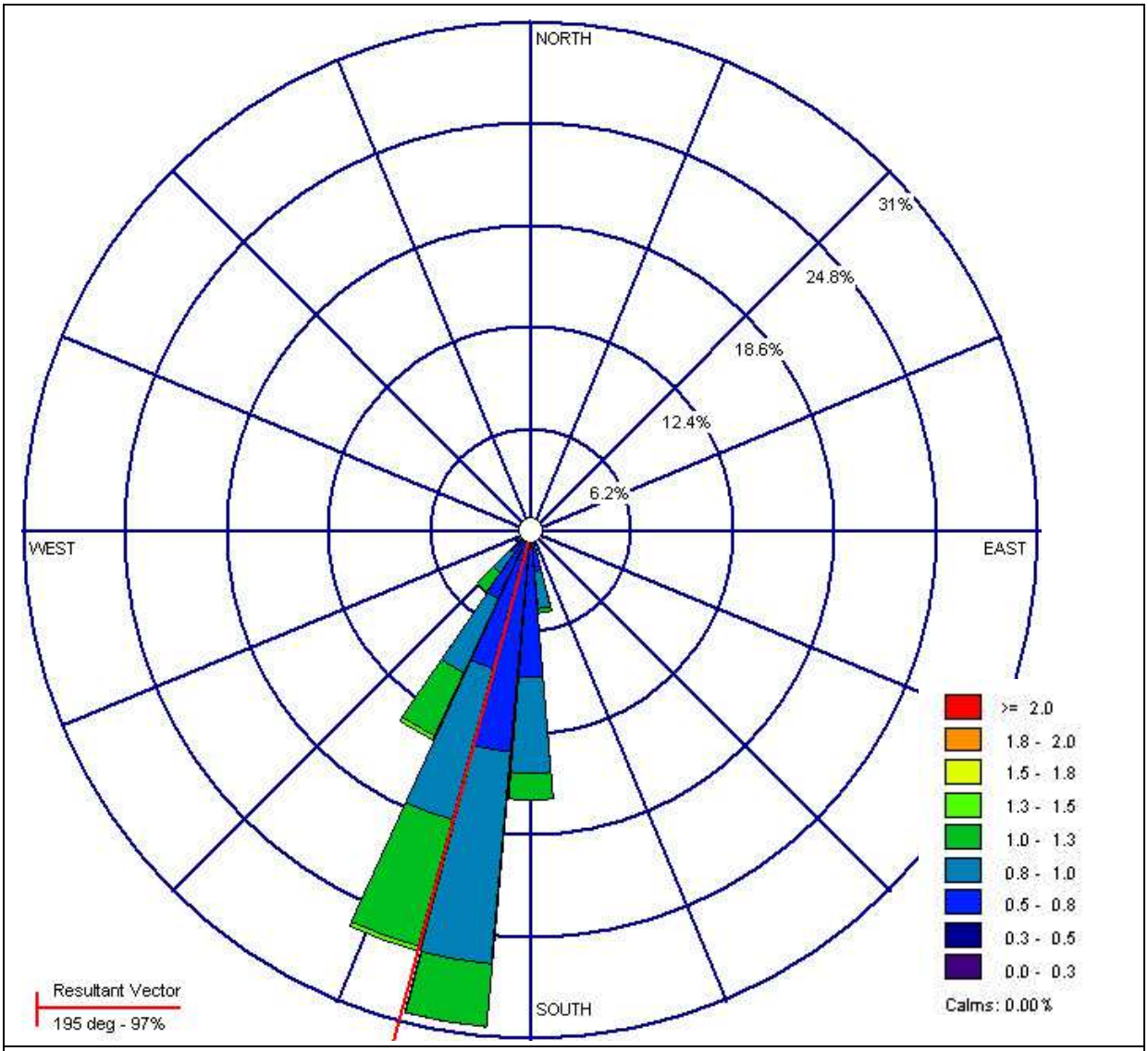


Figure 51 – Wave Rose (Hs in metre v/s Direction) during Feb-Mar 2015

The frequency distribution table and histogram for the month is provided below:

FREQUENCY DISTRIBUTION				
Significant Wave Height (m)	H_s		H_{max}	
	No. of Observations	Percentage of Occurrence	No. of Observations	Percentage of Occurrence
0.0 - 0.25	0	0.0	0.0	0.0
0.25 - 0.5	76	3.2	0.0	0.0
0.5 - 0.75	885	37.8	83.0	3.5
0.75 – 1.0	1019	43.6	555.0	23.6
1.0 - 1.25	339	14.5	608.0	25.9
1.25 - 1.5	20	0.9	640.0	27.2
1.5 – 2.0	0	0.0	443.0	18.9
>2.0	0	0.0	21.0	0.9
Total	**2339**	**100**	**2350**	**100**

Table 19: Frequency Distribution of wave heights (Feb-Mar 15)

The histogram of significant wave height during observation period of Feb-Mar is given below:

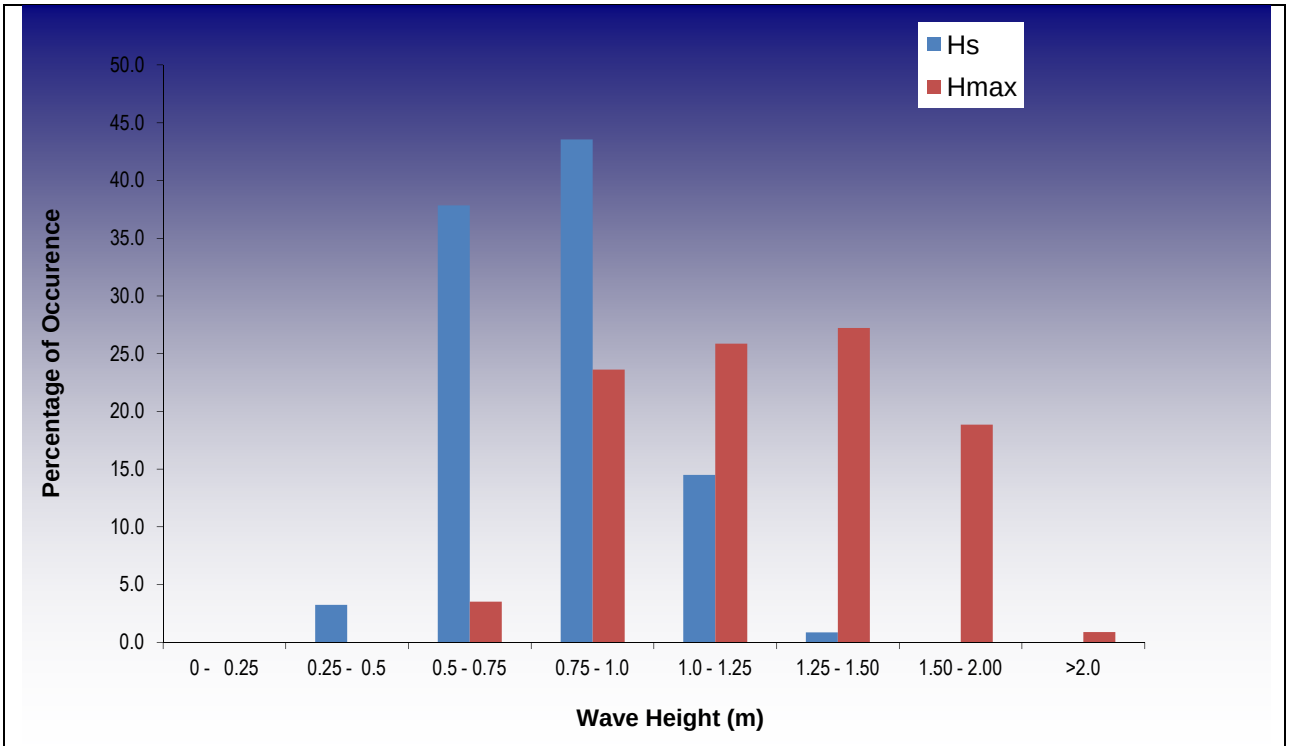


Figure 52 – Histogram of wave heights (Feb-Mar 15)

As can be observed above, about 80% of the observations the maximum wave height was above 0.75m. The significant wave height was above 0.5m, during 95% of the observations.

The following image shows the wave rose drawn with respect to wave period V/s direction:

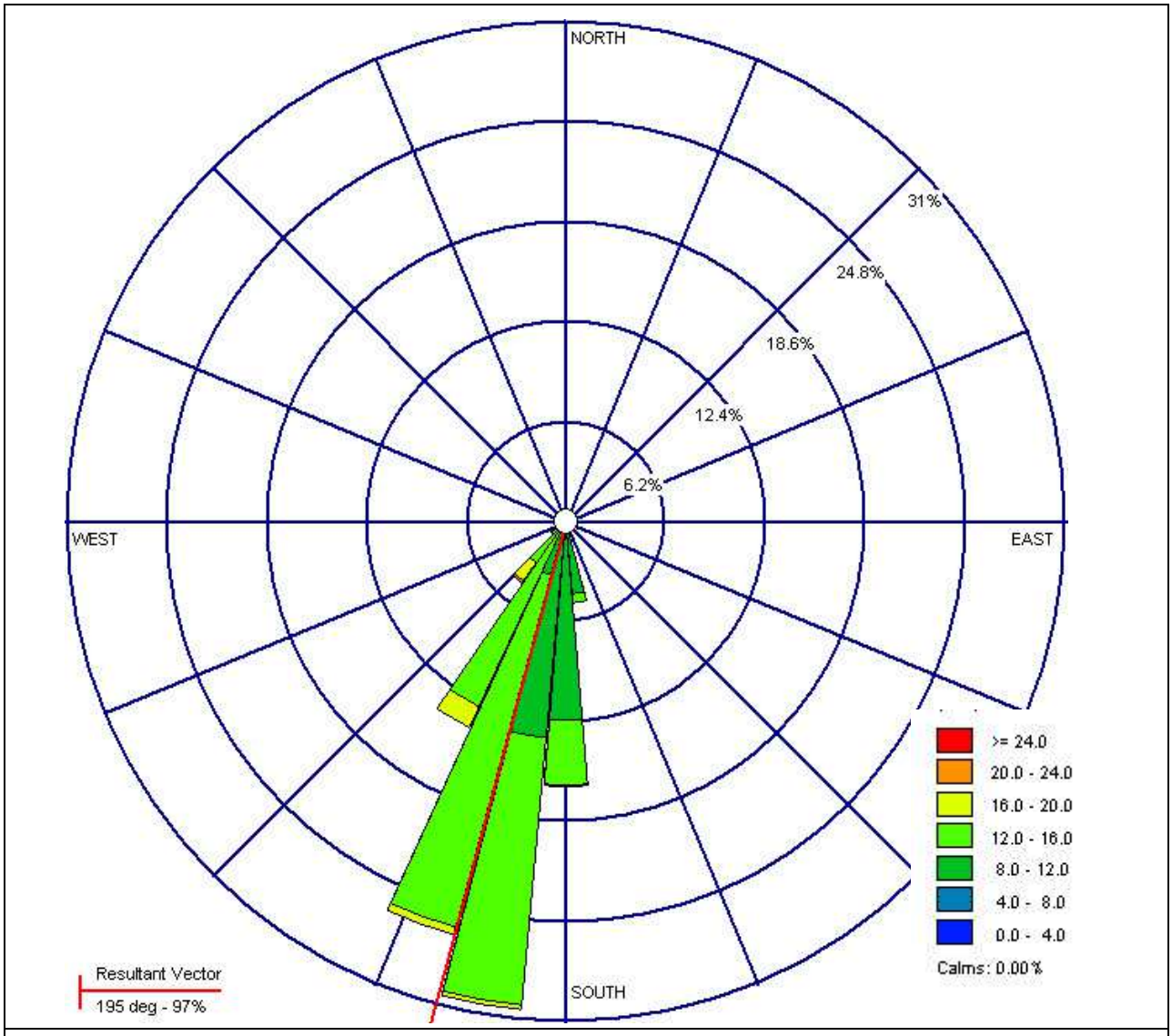


Figure 53 – Wave Rose (Tp in seconds v/s Direction) during Feb-March 2015

The above image indicates that during the Feb-March period, the wave period was in the range of 8 to 17 seconds, with bulk of wave period in the range of 12 to 16 seconds.

The following wave rose is presented for the month of April 2015:

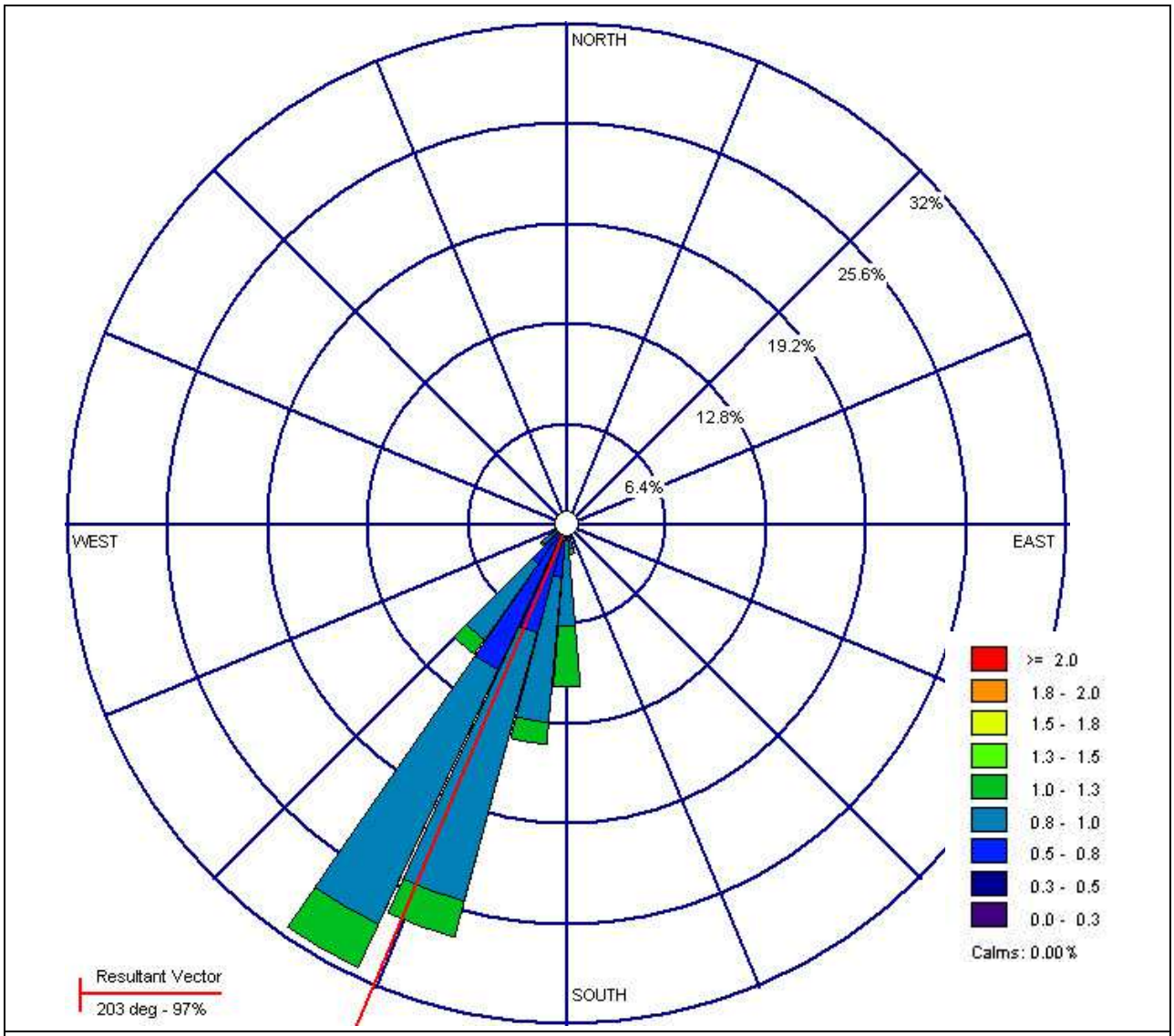


Figure 54 – Wave Rose (Hs in metre v/s Direction) during April 2015

The frequency distribution table and histogram for the month is provided below:

FREQUENCY DISTRIBUTION				
Significant Wave Height (m)	H_s		H_{max}	
	No. of Observations	Percentage of Occurrence	No. of Observations	Percentage of Occurrence
0.0 - 0.25	0	0.0	0.0	0.0
0.25 - 0.5	0	0.0	0.0	0.0
0.5 - 0.75	362	26.4	1.0	0.1
0.75 – 1.0	906	65.9	102.0	7.4
1.0 - 1.25	106	7.7	626.0	45.2
1.25 - 1.5	0	0.0	481.0	34.8
1.5 – 2.0	0	0.0	172.0	12.4
>2.0	0	0.0	2.0	0.1
Total	**1374**	**100**	**1384**	**100**

Table 20: Frequency Distribution of wave heights (April 15)

The histogram of significant wave height during observation period of April 2015 is given below:

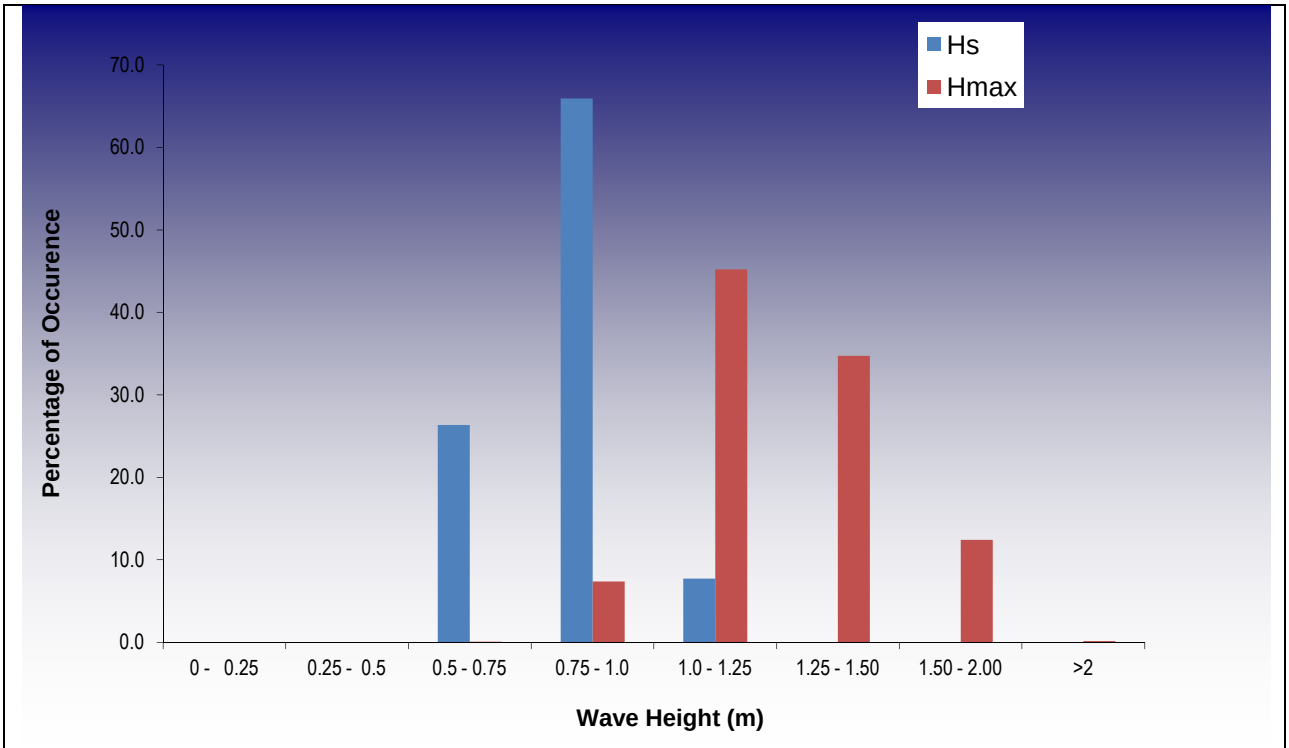


Figure 55 – Histogram of wave heights (April 15)

As can be observed above, about 80% of the observations the maximum wave height was above 1m.

The following image shows the wave rose drawn with respect to wave period V/s direction:

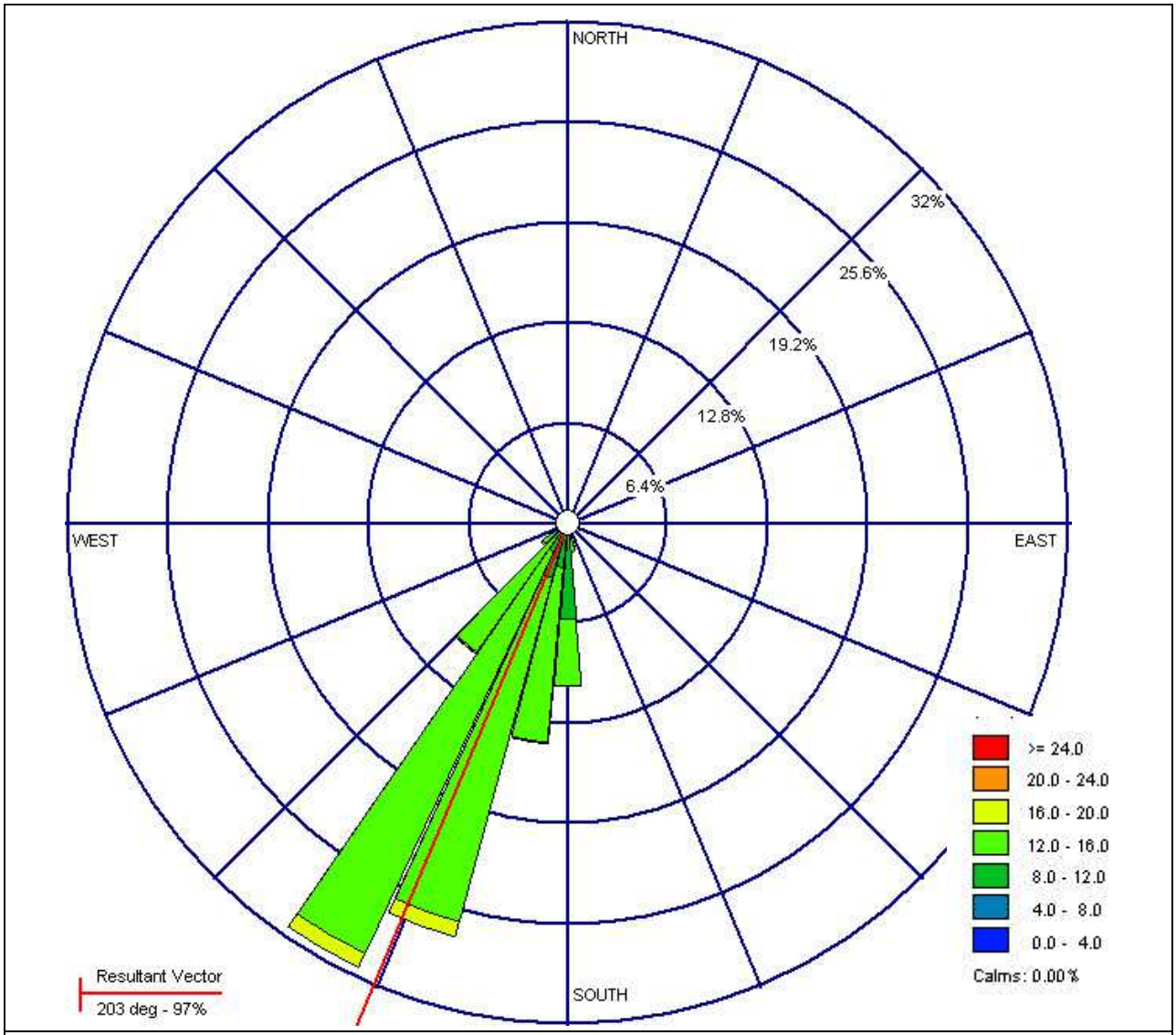


Figure 56 – Wave Rose (Tp in seconds v/s Direction) during April 2015

The above image indicates that during the month of April 2015, the wave period was in the range of 10 to 17 seconds, with bulk of wave period in the range of 12 to 16 seconds.

The wave rose plot for the month of May 2015 is given below:

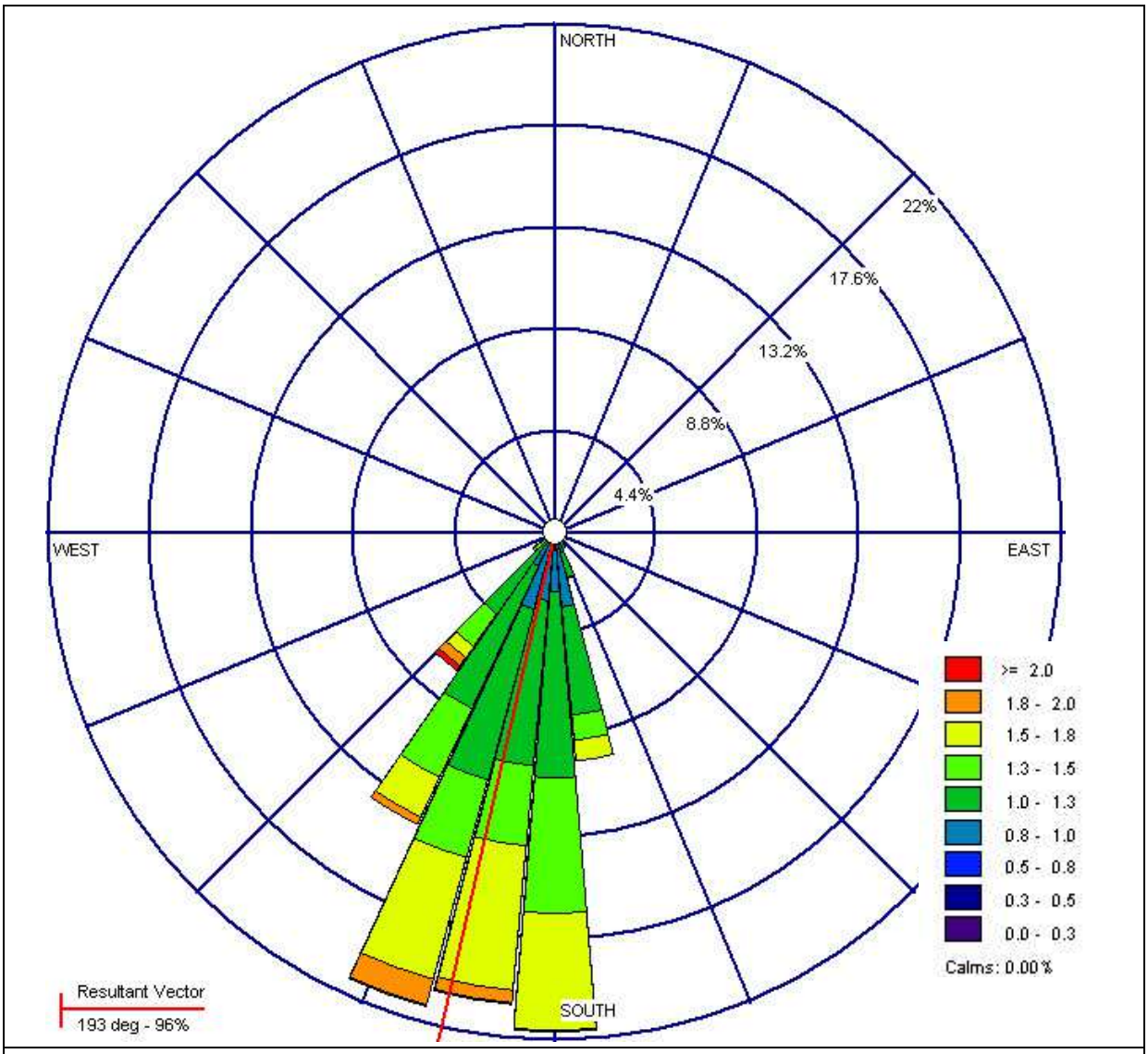


Figure 57 – Wave Rose (Hs in metre v/s Direction) in May 2015

The frequency distribution table and histogram for the month is provided below:

FREQUENCY DISTRIBUTION				
Significant Wave Height (m)	H_s		H_{max}	
	No. of Observations	Percentage of Occurrence	No. of Observations	Percentage of Occurrence
0.0 - 0.25	0	0.0	0.0	0.0
0.25 - 0.5	0	0.0	0.0	0.0
0.5 - 0.75	7	0.5	0.0	0.5
0.75 – 1.0	266	19.3	1.0	19.3
1.0 - 1.25	506	36.8	40.0	36.8
1.25 - 1.5	323	23.5	251.0	23.5
1.5 – 2.0	271	19.7	598.0	19.7
2.0 – 2.50	2	0.1	385.0	0.1
2.50 – 3.00	0	0.0	108.0	0.0
>3.00	0	0.0	16.0	0.0
Total	**1375**	**100**	**1399**	**100**

Table 21: Frequency Distribution of wave heights (May 15)

The histogram of significant wave height during observation period of April 2015 is given below:

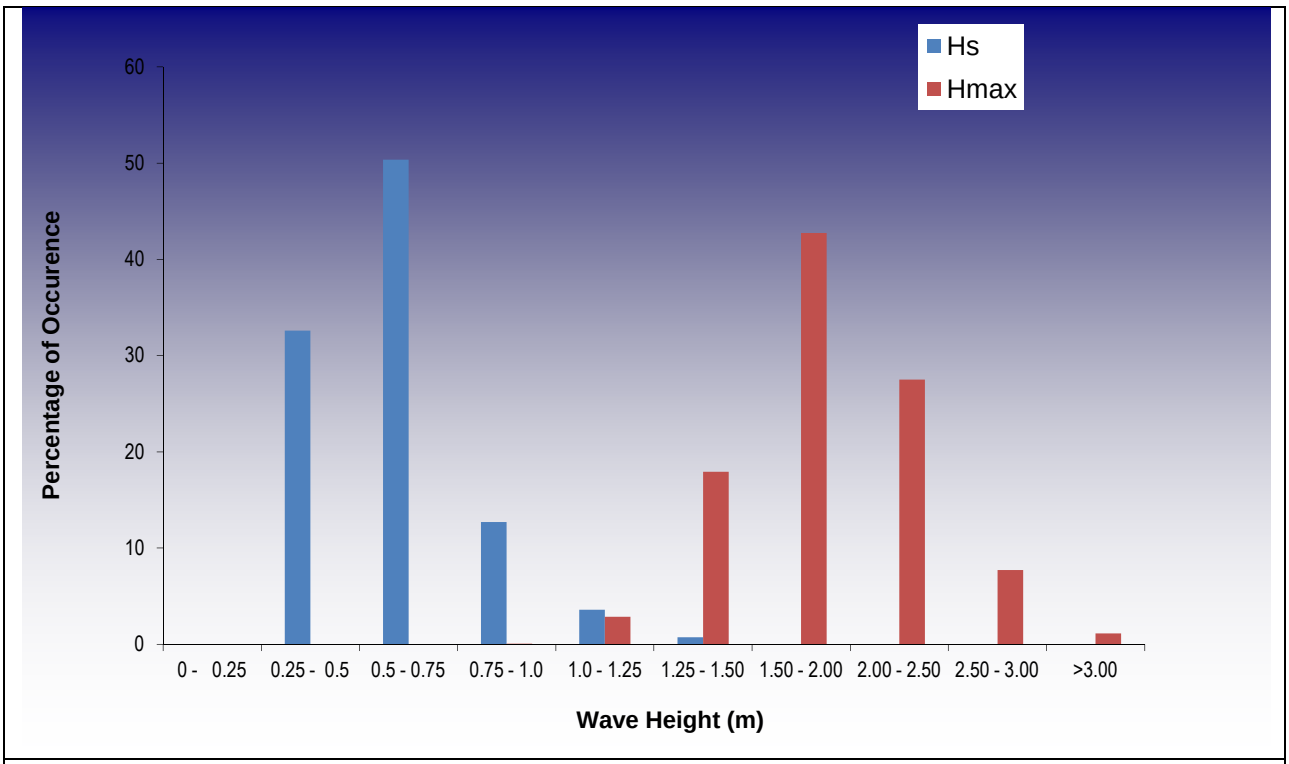


Figure 58 – Histogram of wave heights (May 15)

As can be observed above, the Occurrence of significant wave height was maximum in the range of 0.75 to 1m. The recorded maximum wave height shows 43% Occurrence in the 1.5 to 2m region.

The data during the month of May shows the pre-monsoon effect.

The following image shows the wave rose drawn with respect to wave period V/s direction:

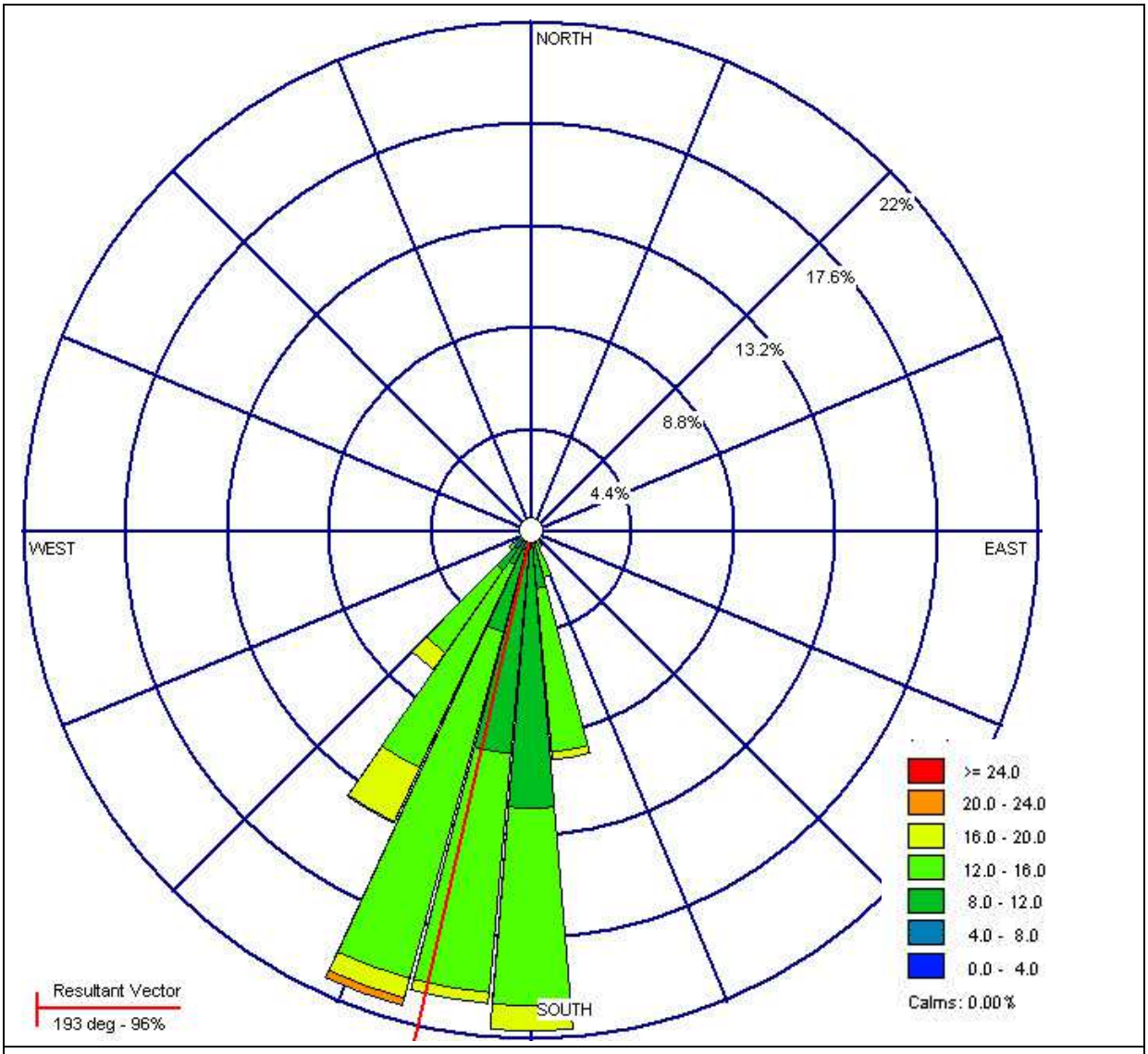


Figure 59 – Wave Rose (Tp in seconds v/s Direction) during May 2015

The above image indicates that during the month of May 2015, the wave period was in the range of 10 to 17 seconds, with bulk of wave period in the range of 12 to 16 seconds.

The time series graphs for the full period are placed at Annexure IV.

6.5 Measurement of Meteorological Parameters

The automatic weather station was installed on the roof of Ayur Bay resort. The data for the months are compiled in the successive paragraphs

The wind rose for the month of Feb-March 2015 is provided below:

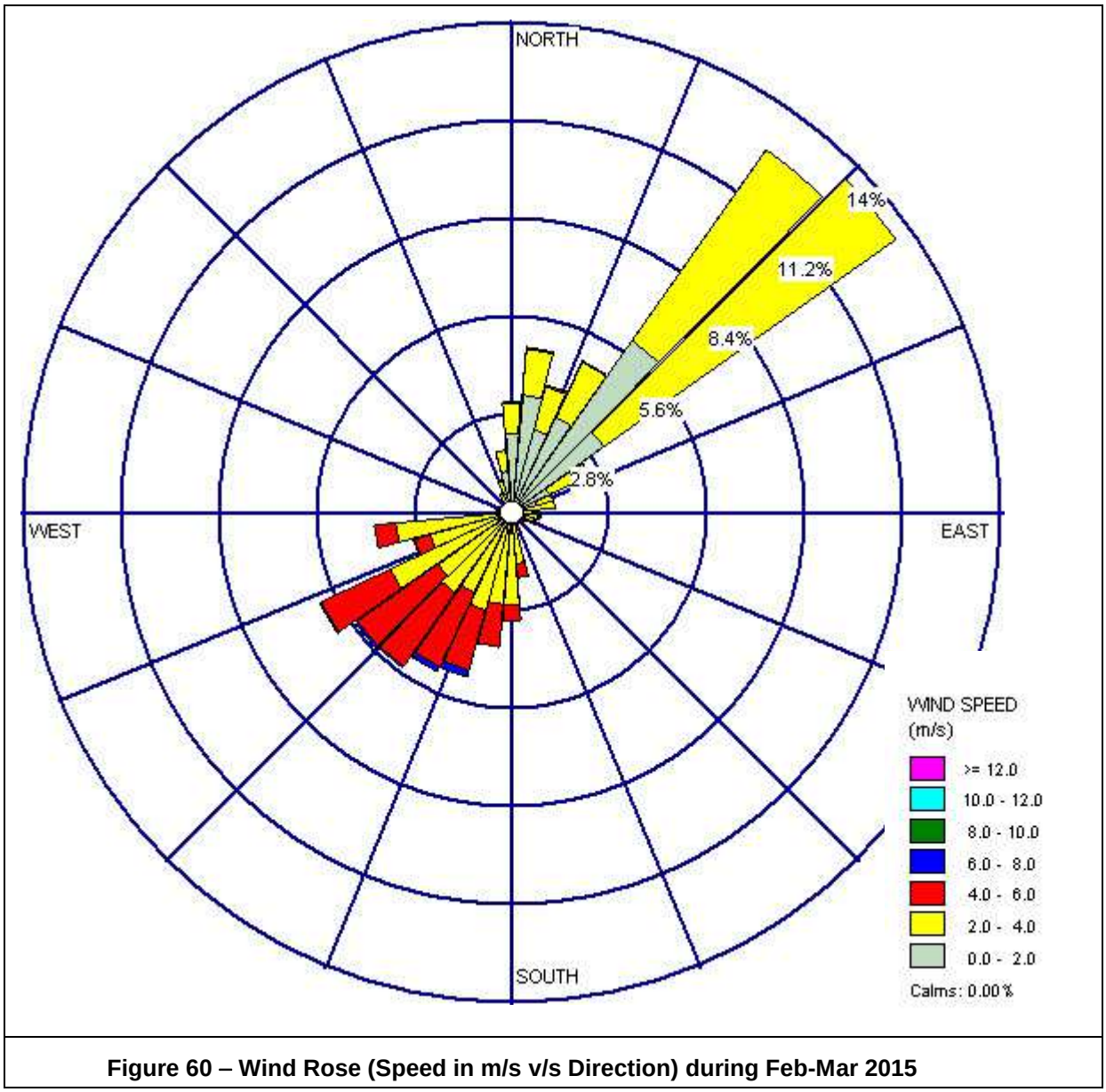


Figure 60 – Wind Rose (Speed in m/s v/s Direction) during Feb-Mar 2015

① The frequency distribution table for the month of Feb-Mar 2015 drawn for the reduced level (10m above MSL) is given below:

Frequency Distribution		
Wind Speed (m/s)	**No. of observations**	**Percentage of Occurrence**
0 -2	1922	35.3
2 - 4	2678	49.1
4 - 6	822	15.1
6 - 8	28	0.5
8 - 10	0	0.0
10 - 12	0	0.0
>12	0	0.0
Total	**5450**	**100**

Table 22: Frequency Distribution of wind speed (Feb-Mar 15)

The histogram of wind speed for the month of Feb-Mar 2015 is given below:

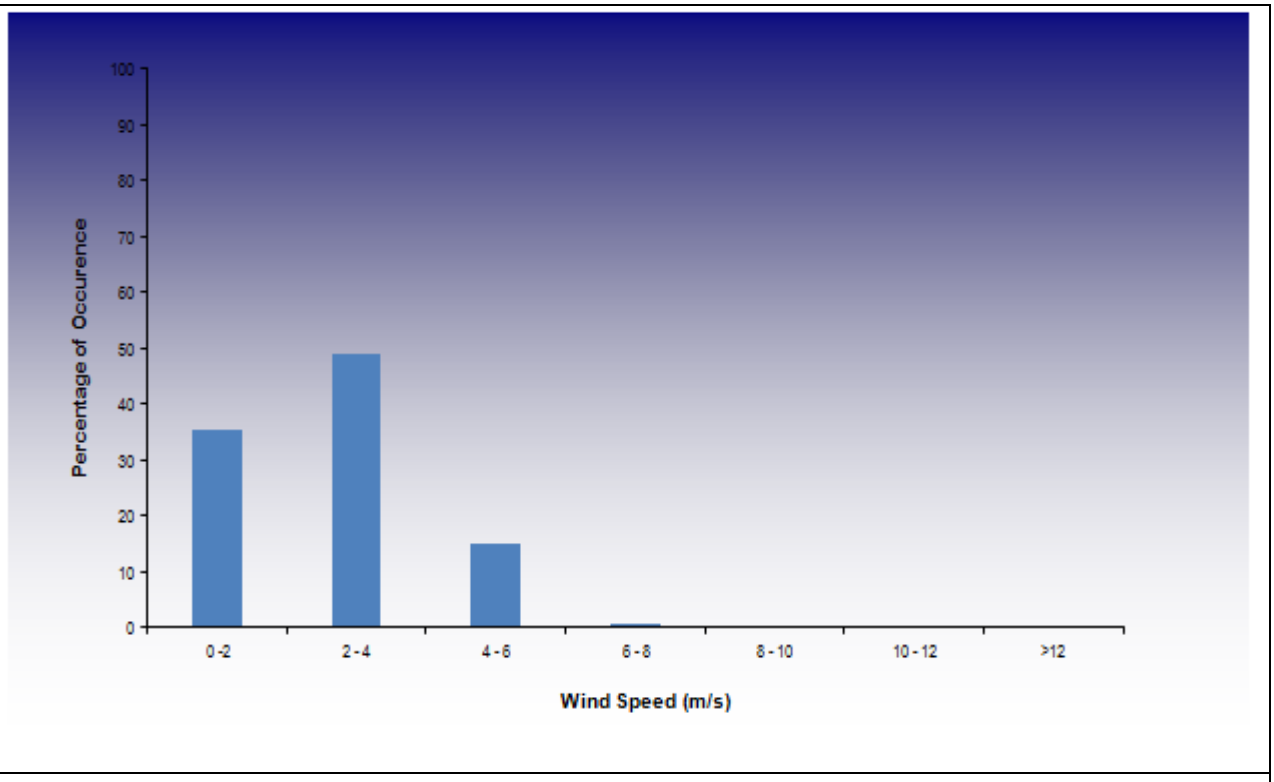


Figure 61 – Histogram of wind speed (Feb-Mar 15)

As can be seen from the above images, about 50% of the observation period the wind speed was from 0 to 4 m/s. The winds blowing from the sea has shown a greater magnitude than that blowing from land. The maximum wind speed attained during the Feb-Mar 2015 period (estimated speed 10m above ground) was 7.4 m/s on 29th March 2015.

The percentage Occurrence table drawn for atmospheric pressure, temperature and relative humidity is presented below:

Frequency Distribution		
Atm Pressure	**No. of observations**	**Percentage of Occurrence**
<1008	2226	40.8
1008-1010	2147	39.4
1010-1012	1023	18.8
> 1012	57	1.0
Total	**5453**	**100**
Temperature	**No. of observations**	**Percentage of Occurrence**
20-24	176	3.2
24-28	2597	47.6
28-32	2679	49.1
>32	1	0.0
Total	**5453**	**100**
RH	**No. of observations**	**Percentage of Occurrence**
50-60	39	0.7
60-70	396	7.3
70-80	1831	33.6
>80	**3187**	**58.4**
Total	**5453**	**100**
Rainfall (mm)	**No. of observations**	**Percentage of Occurrence**
<2	936	99.6
2-5	0	0.0
5-10	1	0.1
>10	3	0.3
Total	**940**	**100**

Table 23: Frequency Distribution of met parameters (Feb-Mar 15)

The histogram drawn for the above for the period Feb-Mar 2015 is shown below:

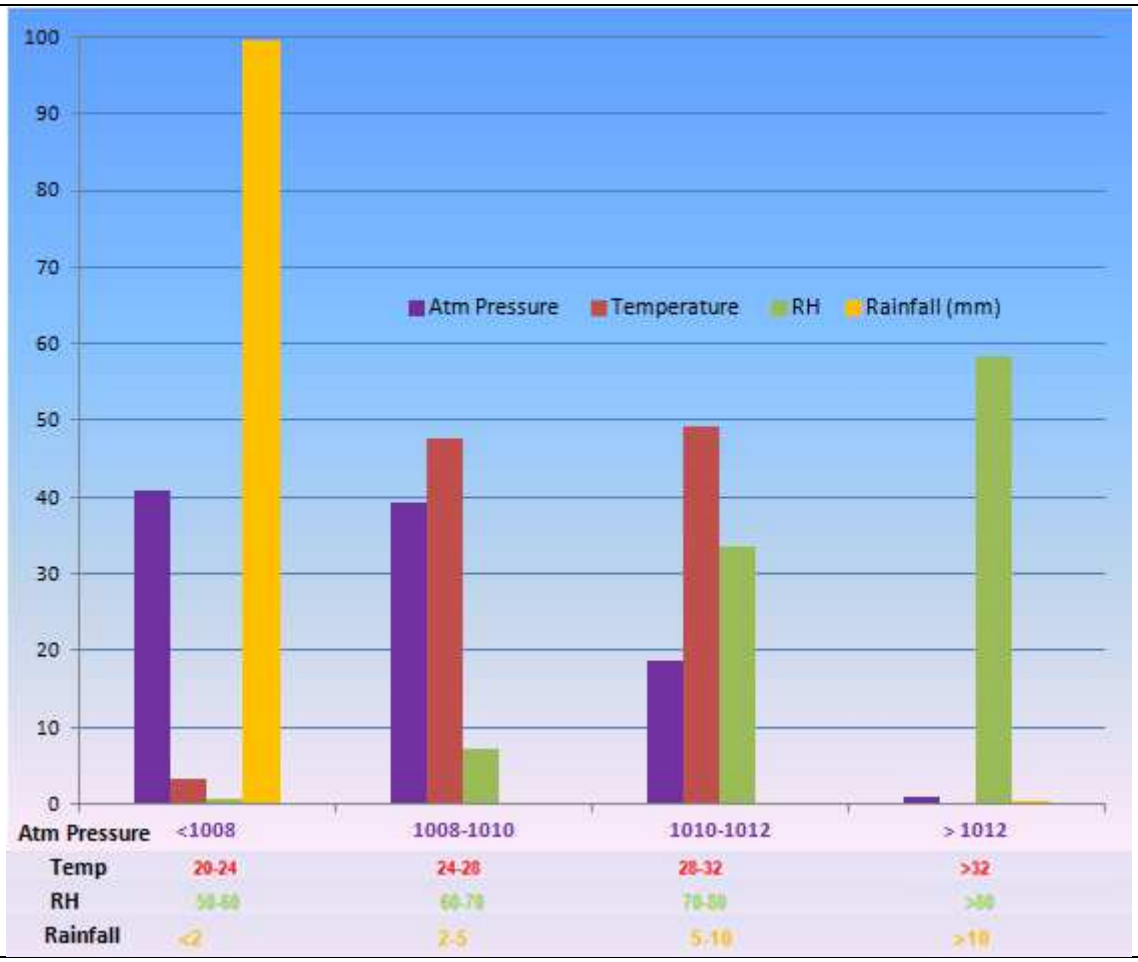


Figure 62 – Histogram of met parameters (Feb-Mar 15)

The data represented above reveals that about 80% of the observations, the atmospheric pressure was below 1010 mb. The temperature hovered around 20 to 32°C and the relative humidity was more than 80% during bulk of the observations. There was minimum rainfall during the period.

The wind rose for the month of April 2015 is provided below:

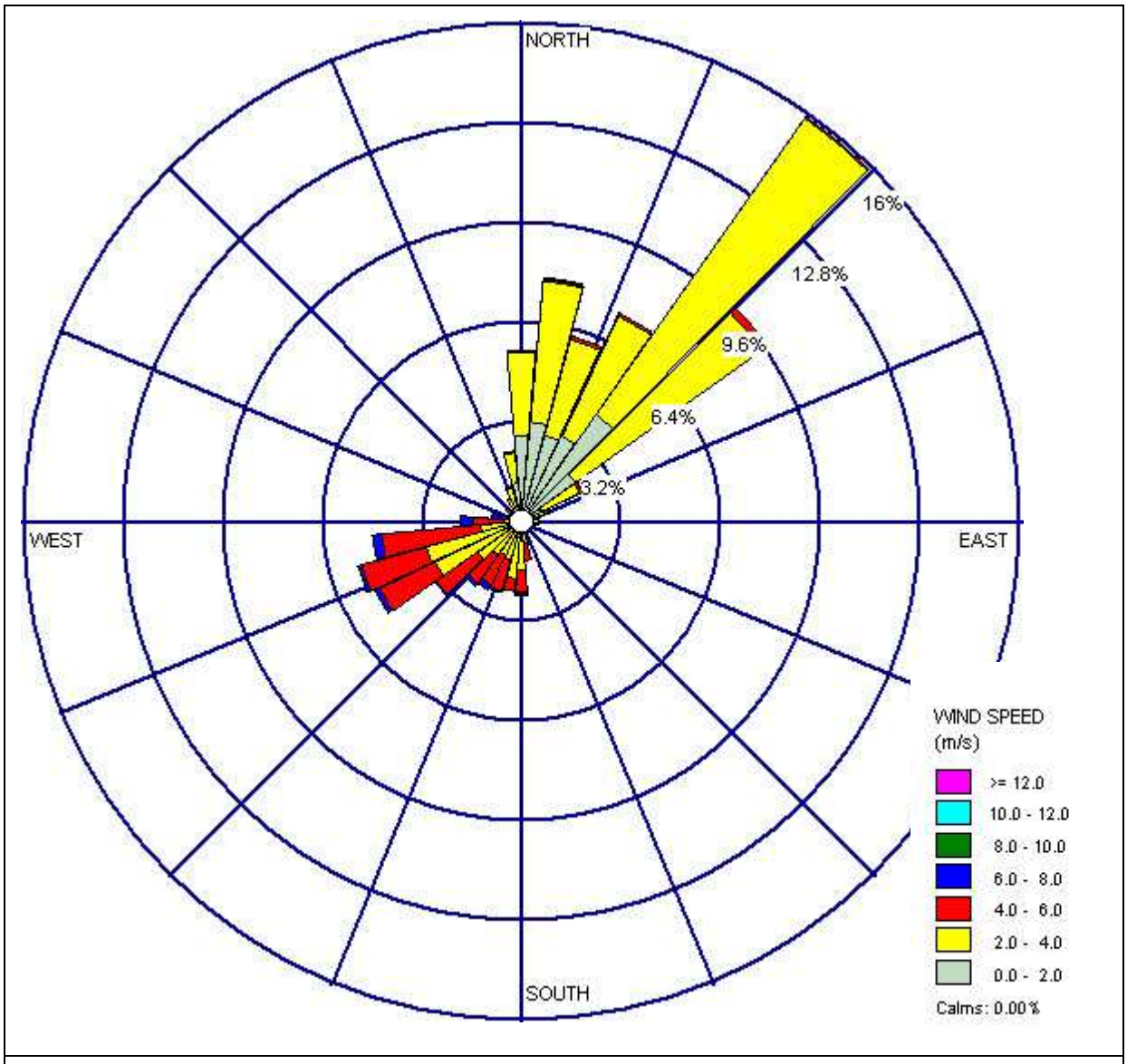


Figure 63 – Wind Rose (Speed in m/s v/s Direction) during April 2015

The frequency distribution table for the month of April 2015 is given below:

Frequency Distribution		
Wind Speed (m/s)	**No. of observations**	**Percentage of Occurrence**
0 -2	1247	32.4
2 - 4	1921	49.9
4 - 6	606	15.7
6 - 8	74	1.9
8 - 10	1	0.0
10 - 12	1	0.0
>12	0	0.0
Total	**3850**	**100**

Table 24: Frequency Distribution of wind speed (April 15)

The histogram of wind speed for the month of April 2015 is given below:

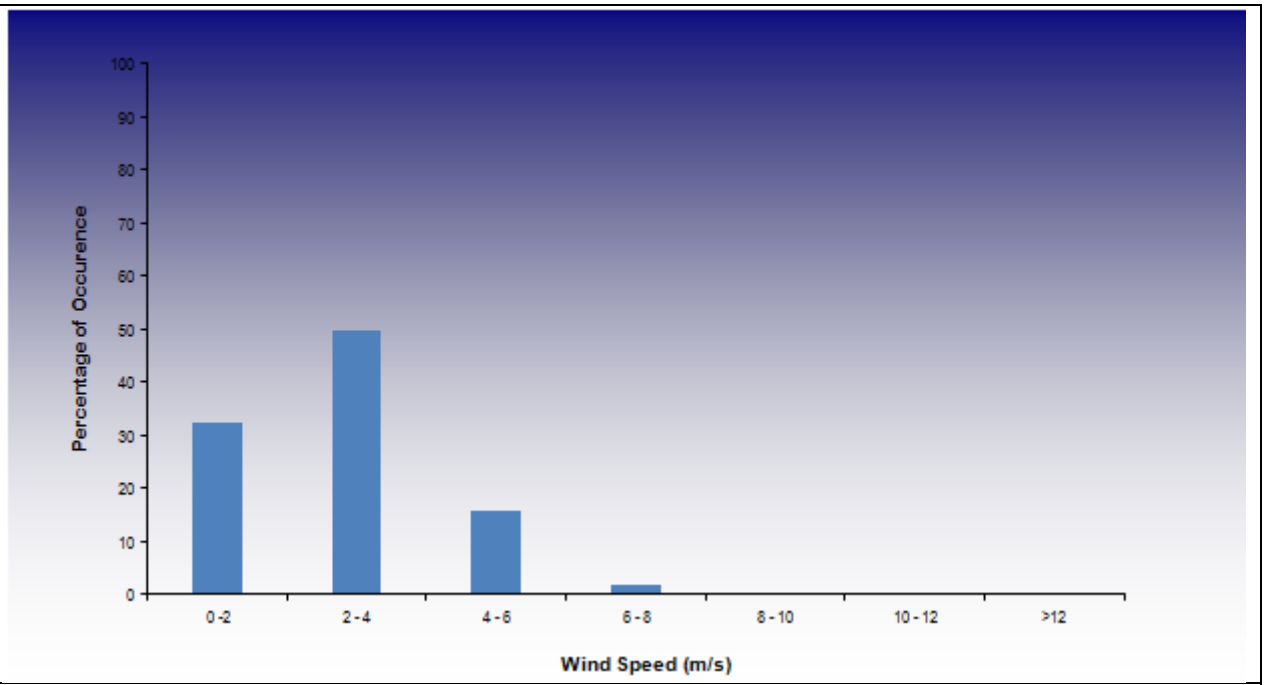


Figure 64 – Histogram of wind speed (April 15)

As can be seen from the above images, about 50% of the observation period the wind speed was from 1 to 4 m/s. The winds blowing from the sea has shown a greater magnitude than that blowing from land. The maximum wind speed attained during April 2015 period was 13 m/s on 21st April 2015. This could be due to the local meteorological disturbance generated off Lakshadweep.

The percentage Occurrence table drawn for atmospheric pressure, temperature and relative humidity is presented below:

Frequency Distribution		
Atm Pressure	**No. of observations**	**Percentage of Occurrence**
<1008	2627	68.3
1008-1010	1085	28.2
1010-1012	137	3.6
> 1012	0	0
Total	**3849**	**100**
Temperature	**No. of observations**	**Percentage of Occurrence**
20-24	22	0.6
24-28	2.59	53.5
28-32	1769	46.0
>32	0	0.0
Total	**3850**	**100**
RH	**No. of observations**	**Percentage of Occurrence**
50-60	15	0.4
60-70	41	1.1
70-80	1169	30.4
>80	2625	68.25
Total	**3850**	**100**
Rainfall (mm)	**No. of observations**	**Percentage of Occurrence**
<2	612	99.0
2-5	1	0.2
5-10	2	0.3
>10	3	0.5
Total	**618**	**100**

Table 25: Frequency Distribution of met parameters (April 15)

The histogram drawn for the above for the month of April 2015 is shown below:

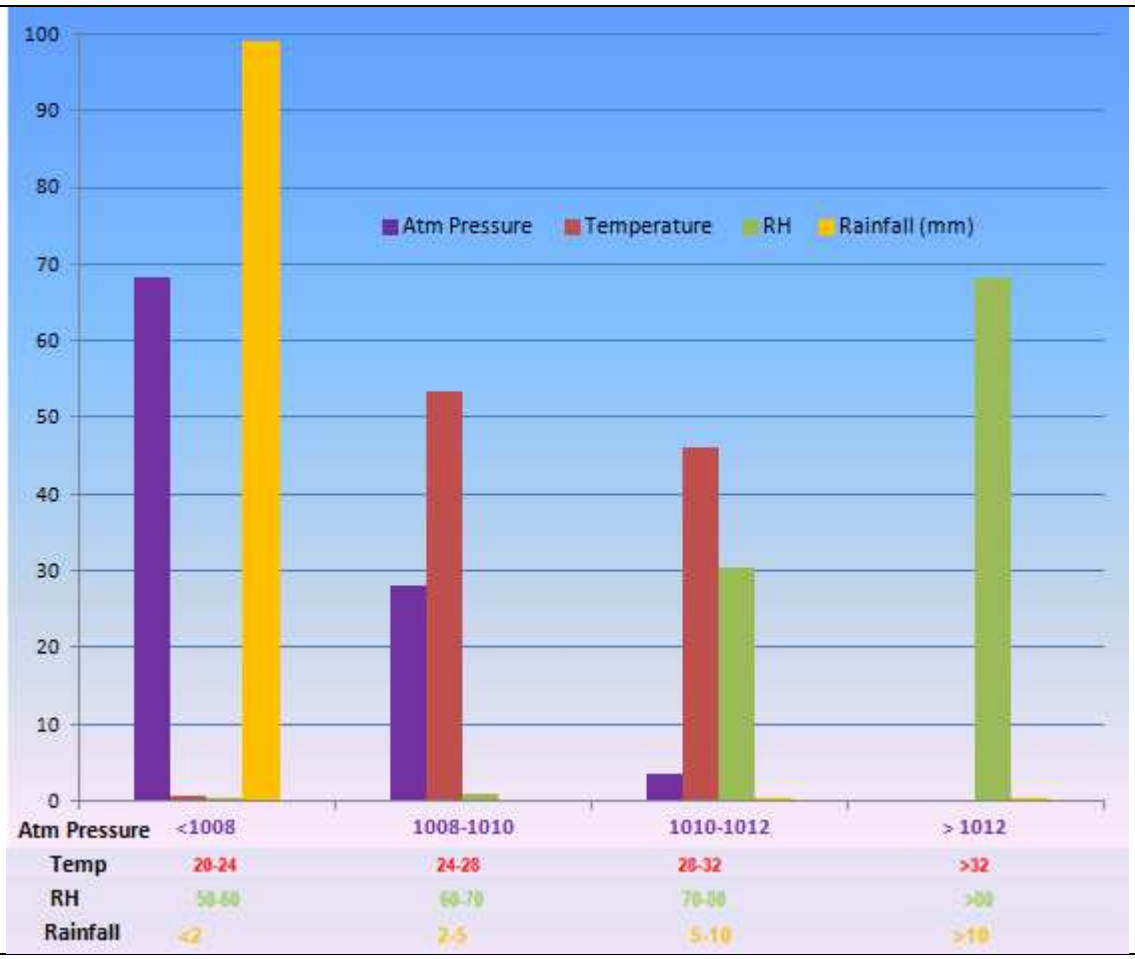


Figure 65 – Histogram of met parameters (April 15)

The data represented above reveals that about 68% of the observations, the atmospheric pressure was below 1010 mb. The temperature hovered around 20 to 32°C and the relative humidity was more than 80% during bulk of the observations. There was minimum rainfall during the period.

The wind rose for the month of April 2015 is provided below:

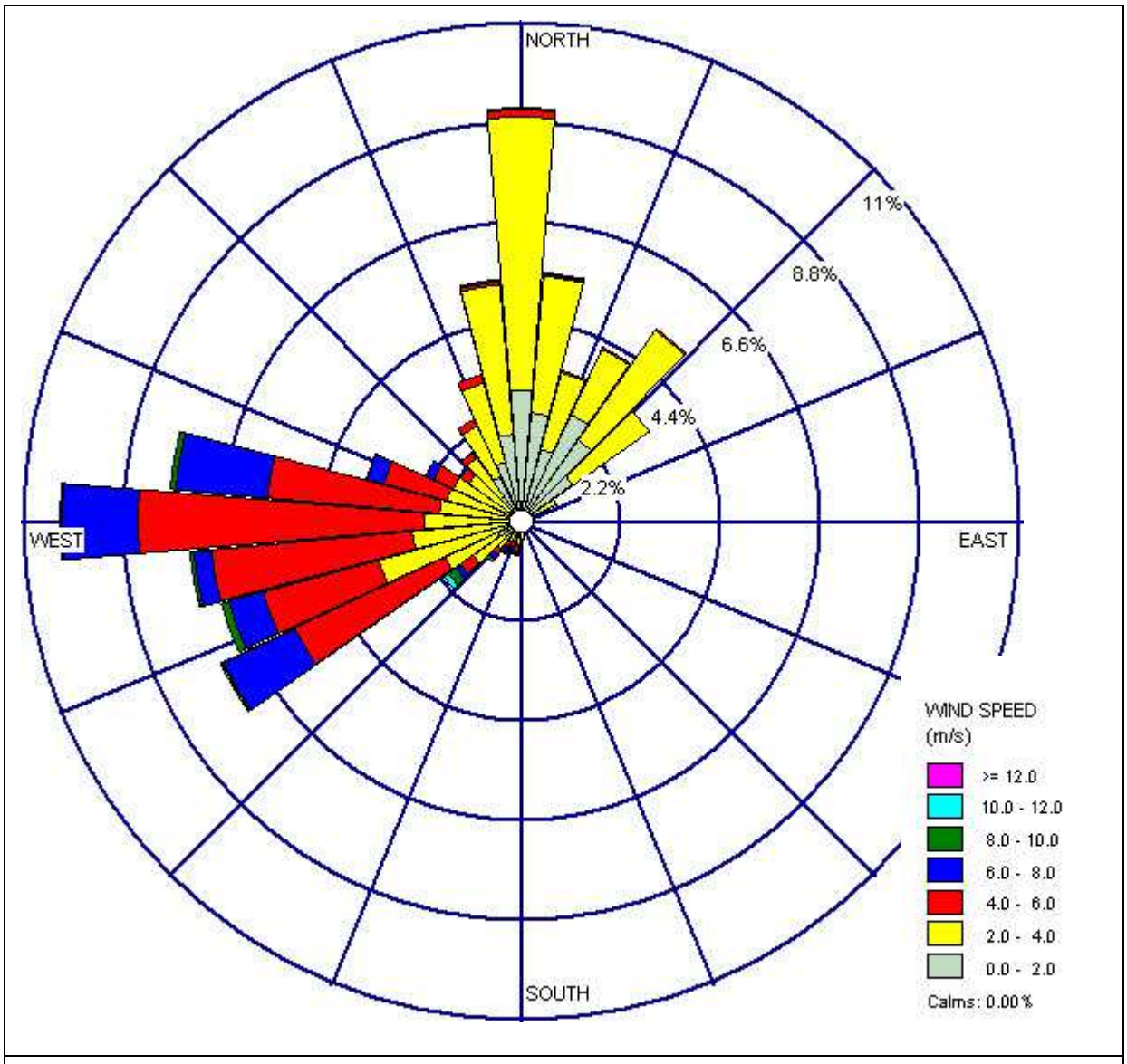


Figure 66 – Wind Rose (Speed in m/s v/s Direction) during May 2015

The frequency distribution table for the month of May 2015 is given below:

Frequency Distribution		
Wind Speed (m/s)	**No. of observations**	**Percentage of Occurrence**
0 -2	1131	27.8
2 - 4	1606	39.4
4 - 6	1008	24.7
6 - 8	280	6.9
8 - 10	41	1.0
10 - 12	8	0.2
>12	0	0.0
Total	**4074**	**100**

Table 26: Frequency Distribution of wind speed (May 15)

The histogram of wind speed for the month of May 2015 is given below:

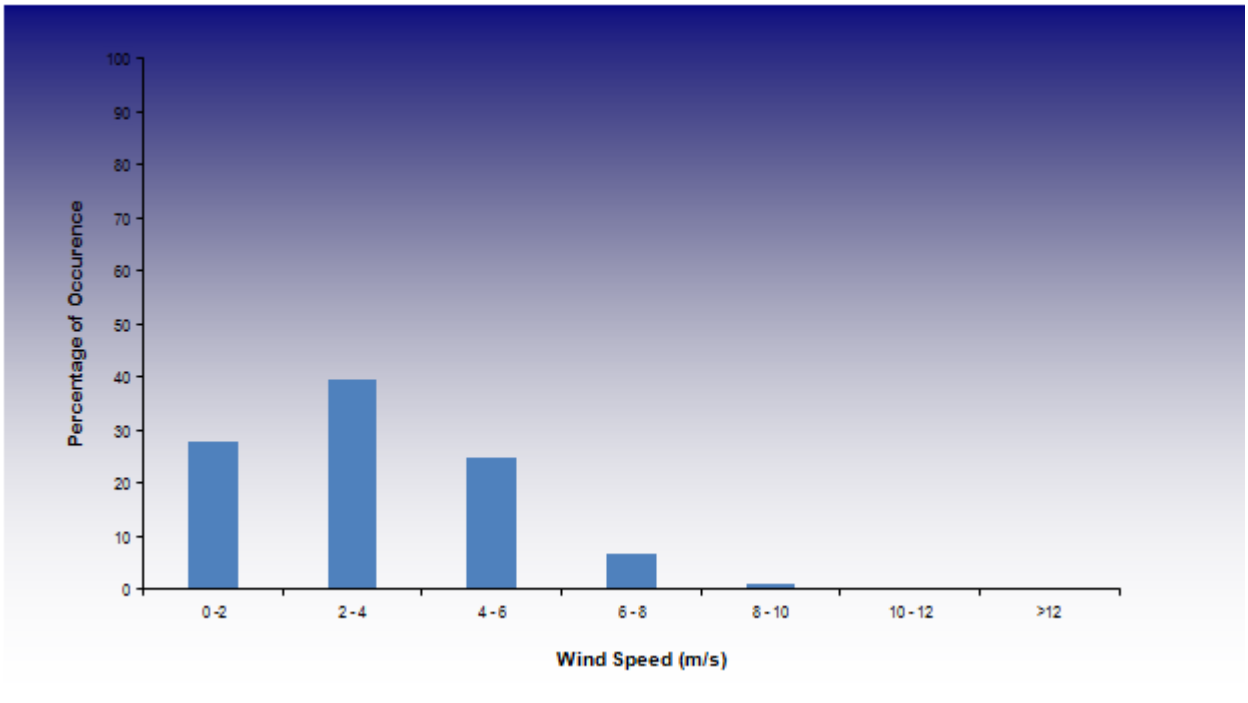


Figure 67 – Histogram of wind speed (May 15)

As can be seen from the above images, about 90% of the observation period the wind speed was from 1 to 8 m/s. The winds blowing from the sea has shown a greater magnitude than that blowing from land. The maximum wind speed attained during the period was 14.4 m/s on 19th May April 2015.

The percentage Occurrence table drawn for atmospheric pressure, temperature and relative humidity is presented below:

Frequency Distribution		
Atm Pressure	**No. of observations**	**Percentage of Occurrence**
<1008	3743	91.9
1008-1010	331	8.1
1010-1012	0	0.0
> 1012	0	0.0
Total	**4074**	**100**
Temperature	**No. of observations**	**Percentage of Occurrence**
20-24	1	0.02
24-28	1749	42.9
28-32	2324	57.0
>32	0	0.0
Total	**4074**	**100**
RH	**No. of observations**	**Percentage of Occurrence**
50-60	2	0.1
60-70	3	0.1
70-80	710	17.4
>80	3358	82.4
Total	**4073**	**100**
Rainfall (mm)	**No. of observations**	**Percentage of Occurrence**
<2	647	96.1
2-5	10	1.5
5-10	11	1.6
>10	5	0.7
Total	**673**	**100**

Table 27: Frequency Distribution of met parameters (May 15)

The histogram drawn for the above for the month of May 2015 is shown below:

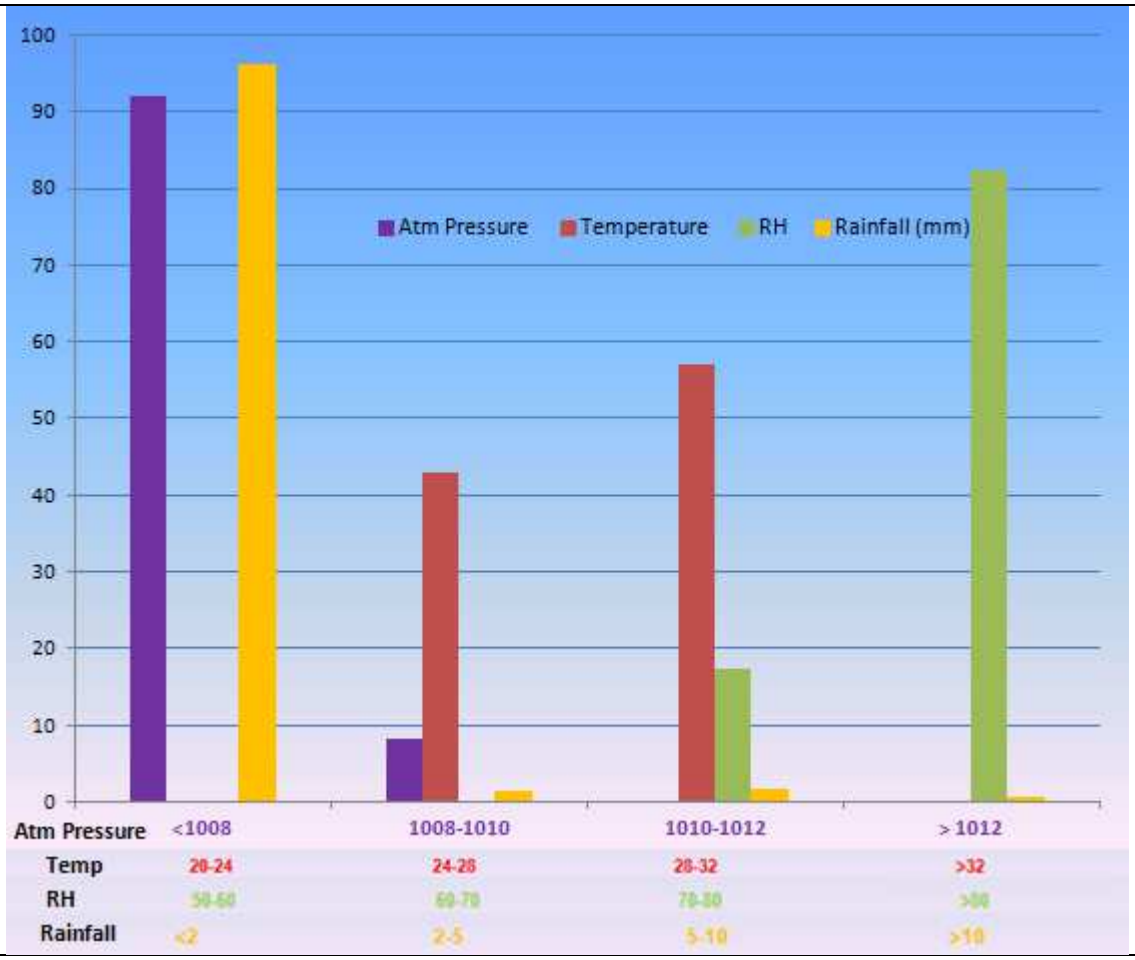


Figure 68 – Histogram of met parameters (May 15)

The data represented above reveals that about 92% of the observations, the atmospheric pressure was below 1010 mb. The temperature hovered around 20 to 32°C and the relative humidity was more than 80% during bulk of the observations. The rainfall was less than 2mm during most of the month.

The time series graphs for the full period are placed at Annexure V.

6.6 Littoral Environmental Observations

The LEO commenced in the month of March 2015, after the LEO plates and the GPS drogue were handed over by NIOT personnel. The LEO plate was deployed at the desired locations and the same was tracked for about ten minutes. The initial and final GPS positions were then used to calculate the SOG and COG. The estimated wave height, angle of wave, period and the stretch of breakers were also noted down in the log. The data sheets for all the months are placed at Annexure VI.

① The along shore current always followed a north trend, with a speed of up to 50cm/s.

6.7 Photographic Documentation

The photographic documentation commenced in the month of March 2015 coinciding with the LEO. The photographs for the period are placed at Annexure VII. As a common reference point, a red flag was fixed at each of the cross shore profiling area while taking the photograph. Using the RTK system, this point was staked during the photography.

Towards the end of April and May 2015, the beach has shown changes in the gradient due to wave action.

The photographs taken during these months are placed at Annexure VII.

6.8 Cross Shore Profiling

The cross shore profiling for the period was carried out using a combination of wide swath bathymetric system offshore and RTK onshore. In the breaker area, no data could be acquired and hence that area is shown in 'dashed line', in the enclosed AutoCAD charts.

It can be seen that the data towards the onset of monsoon has shown changes in the depth pattern.

The charts for the full period are placed in Annexure VIII.

6.9 Bathymetric Survey

① The bathymetric survey was carried out as per the specifications; using Multibeam echo sounder up to 20m contour and using a single beam for the rest of the area at a spacing of 300m. An area of 40 Km X 15 Km was covered during the pre-monsoon campaign.

The charts are drawn on a scale of 1:10,000 and one chart comprising all the bathy is drawn on a scale of 1:50,000.

Minimum water depths of less than 2m were observed inside the Vizhinjam harbour and along the coast. A maximum water depth of 20.9m was recorded in the centre part of the multibeam survey area. The overall trend of the seabed is from northeast to southwest. In the north-western part of the survey area, the water depth increases from 2m contour to 20m contour with an average gradient of 1 in 42. The same trend is continuous in the survey area up to harbour entrance. Near to the port premises, the seabed is irregular with change in water depth from 0m to 9m. Off the harbour area, the water depth increases from 5m contour to 20m contour with an average gradient of 1 in 48. From the harbour area to southeast of the survey area, the seabed slopes from northeast to southwest with an average gradient of 1 in 64.

From 20m depth to 50m, the slope is very gentle. The maximum depth in the area recorded was 59m which is about 14.5 km @ 234° from the existing harbour mouth.

The single and Multibeam survey area is given below:

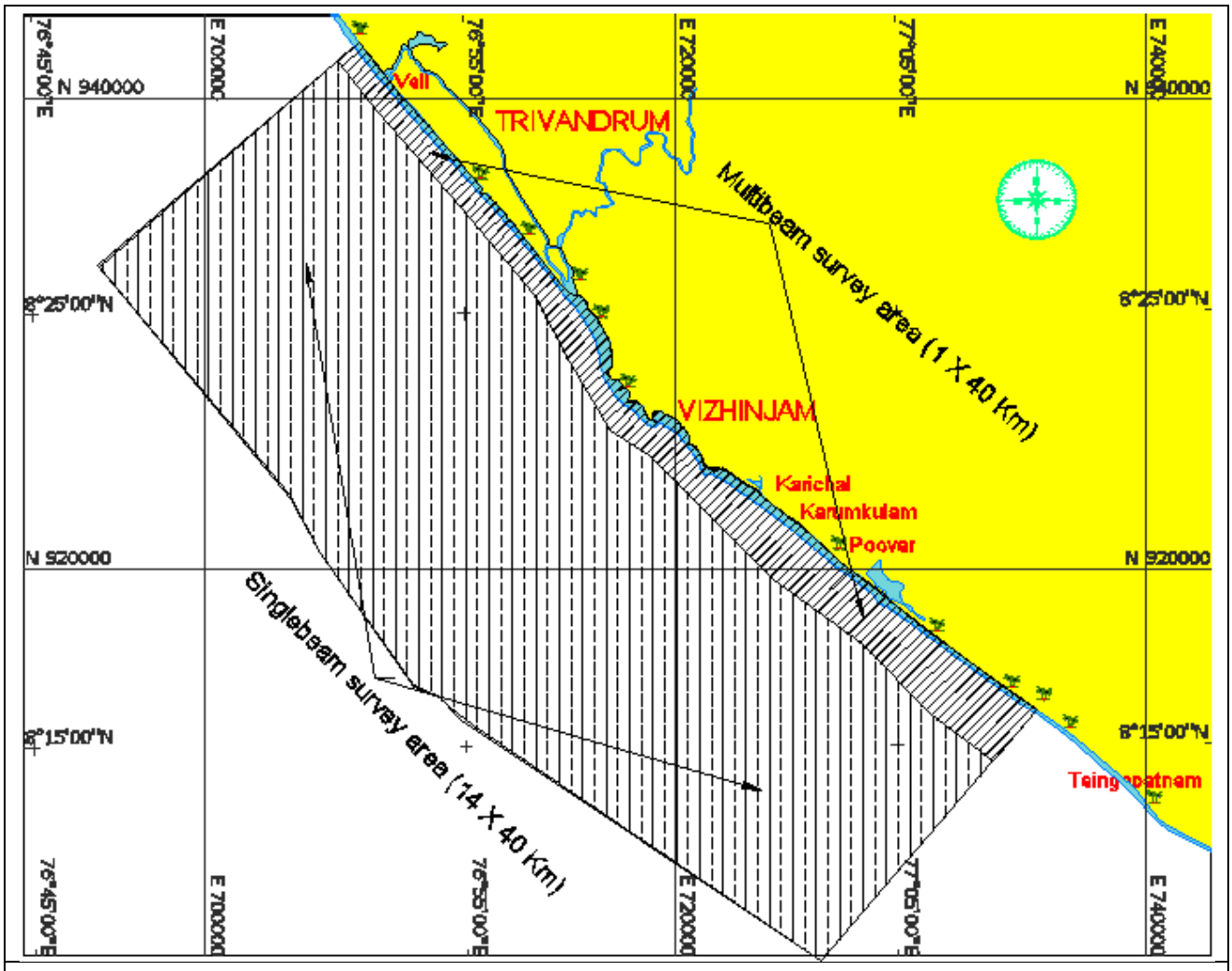


Figure 69 – Bathymetric Survey Area

The bathymetric charts are placed at Annexure IX.

6.10 River Crossing Survey

① The results of the bathymetric data collected in the river crossings shall be included in the Monsoon Report.

6.11 Water & Soil Sampling

① The collected water and soil samples were tested at approved laboratory in Kochi. The water results are placed at Annexure X. Soil sampling report shall be submitted once all the samples are collected and tested, along with the Monsoon Report.

6.12 Progress Report till May 31, 2015

The following image shows the progress report of the project carried out till the month of May 31, 2015.

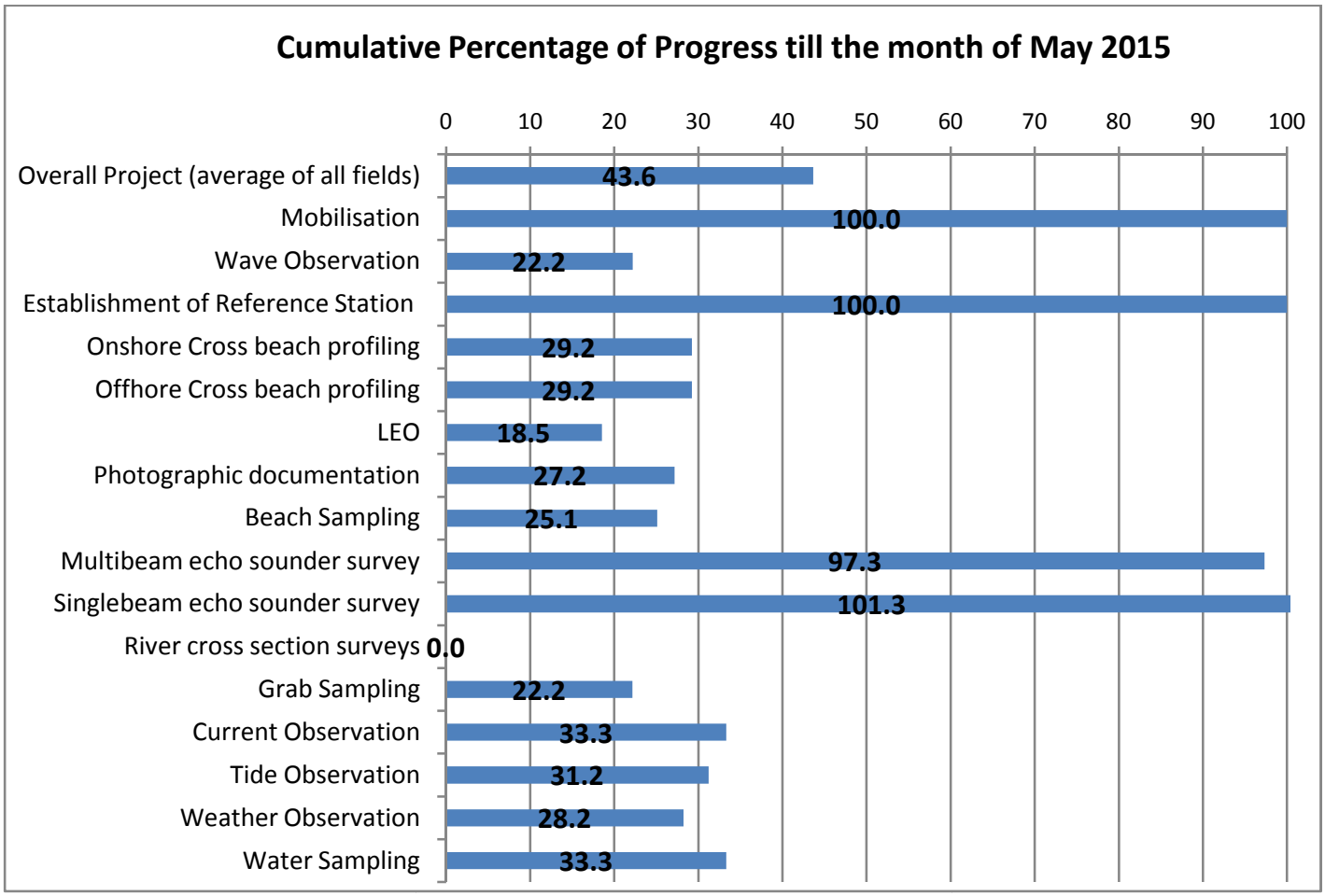


Table 28: Progress Chart till May 31, 2015

7. WEATHER

The weather was conducive for deployment of WRB and ADCP in February 2015. During the bathymetric survey phase, the weather downtime was minimal. On 21st April 2015 a local meteorological disturbance from the Lakshadweep area created high winds and waves associated with rains. The effect of this system is evident in the data recorded in the AWS on 21st April 2015.

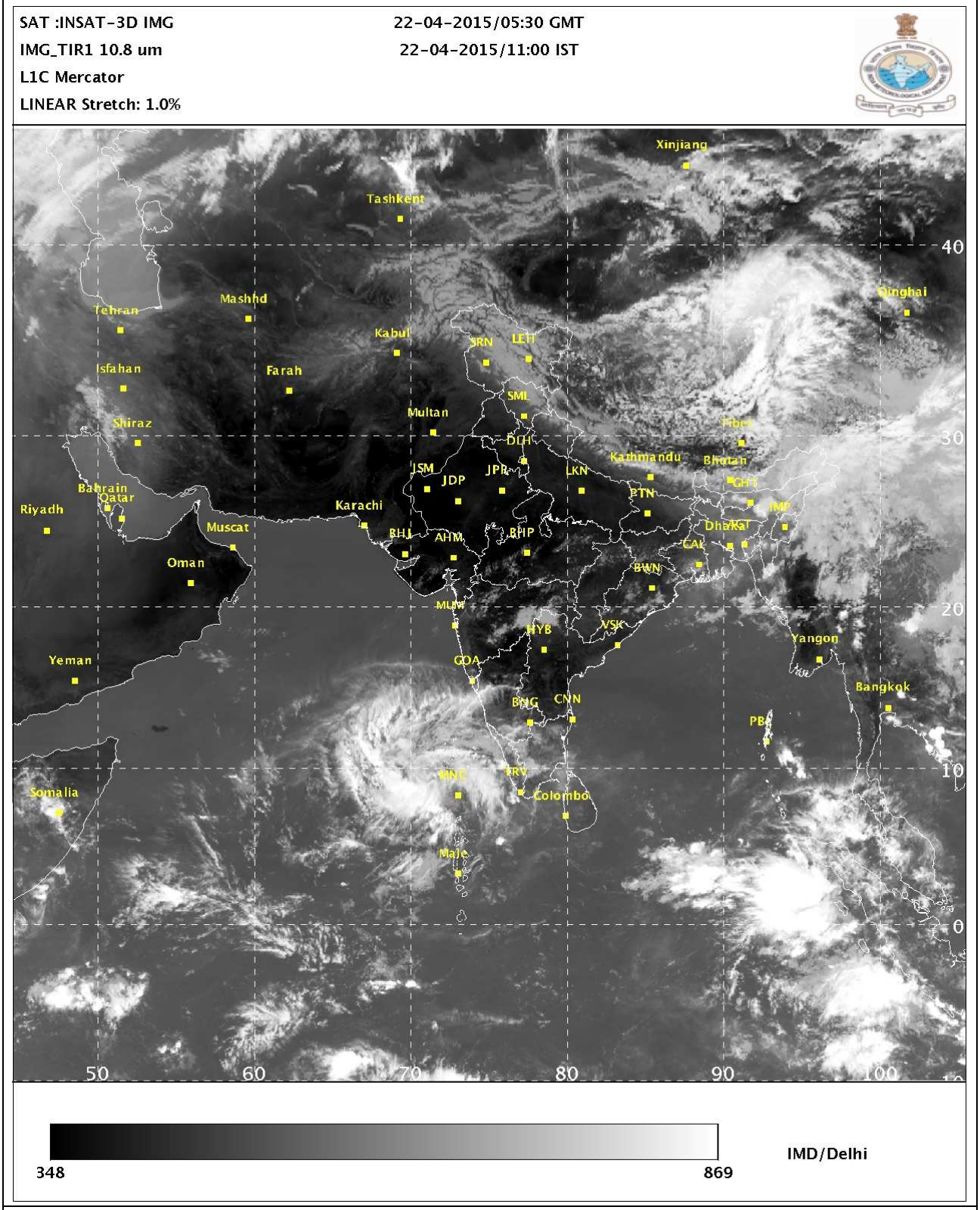


Figure 70 – Local Disturbance experienced at Vizhinjam on 21st / 22nd April

8. CONCLUSIONS

The following observations were identified during the first phase of the project.

1. The observed currents were of the order of 50 cm/s in the deeper area and were seen to generally follow the local topography, except during high winds.
2. Tide was mixed semi diurnal with a maximum range of 0.7m during spring tide.
3. The wave height increased considerably towards end of May indicating the onset of monsoon
4. The wind speed increased towards end of May indicating the onset of monsoon.
5. The maximum water depth observed was 59m, which is 14.5 km from the mouth of harbour.
6. The analysis of water samples reveals a constant salinity of about 35‰. The total suspended solids were comparatively more at bottom than at surface.

9. REFERENCES

① References were made to the following in the preparation of this report.

1. OSaS Inception Report, OSaS/P18115/VISL/Mob Rev 0 dated 26th February 2015
2. www.vizhinjamport.in
3. Images of the survey area from Google Earth®
4. India Meteorological Department
5. Wikipedia
6. WMO manual, Chapter 5 for reducing wind speed to 10m above ground (provided by NIOT)
7. IS 3025; Part 10 & 17
8. APHA Standard Methods for the Examination of Water and Wastewater 20th Edition. (Method 2540 C and 2540 D)

10. ACKNOWLEDGEMENTS

OSaS is pleased to acknowledge the support and co-operation received from the personnel of VISL, throughout the course of the survey.

The scientists/technicians from NIOT are also acknowledged for their support and guidance during the deployment of WRB and during the littoral environmental observations.

The crew of the boat and all local support obtained during the observation is also acknowledged.

Weather forecast during the period was regularly observed at INCOIS and India Meteorological Department's web site.

Photographic Documentation – May 2015



Figure 01:- May_CSP 01



Figure 02:- May_CSP 02



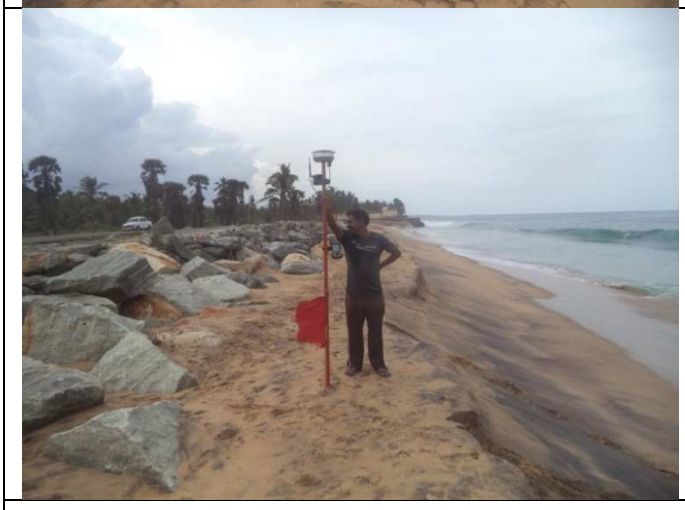



Figure 03:- May_CSP 03



Figure 04:- May_CSP 04



Figure 05:- May_CSP 05






Figure 06:- May_CSP 06

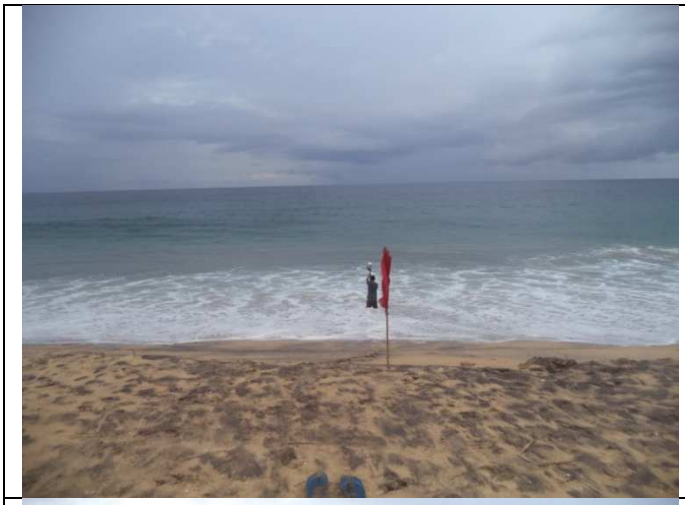
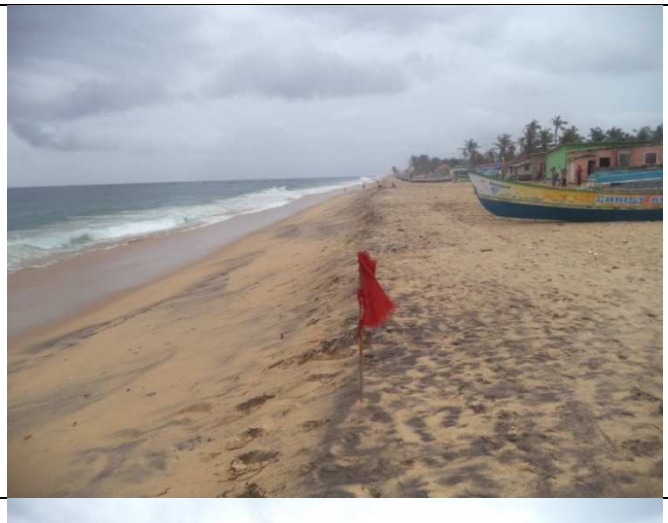
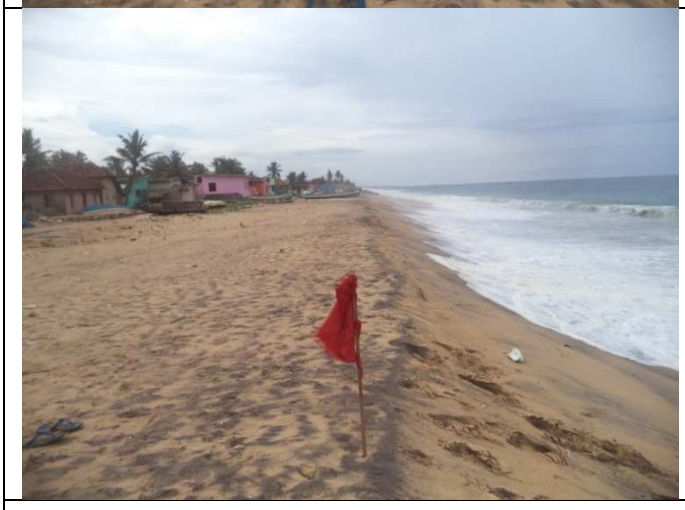





Figure 07:- May_CSP 07



Figure 08:- May_CSP 08

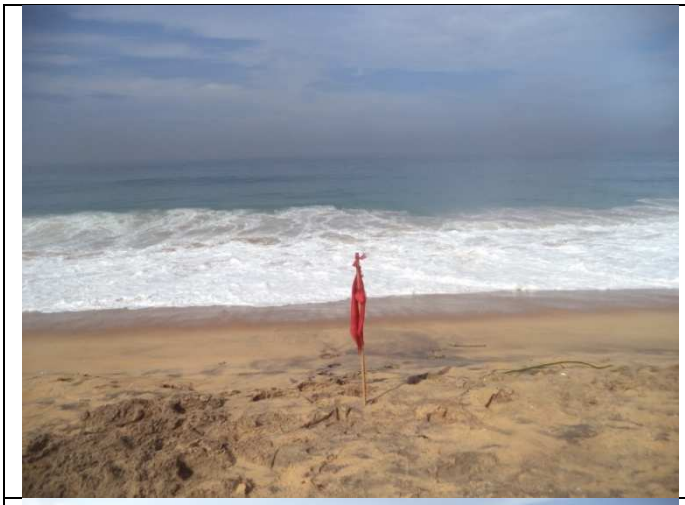
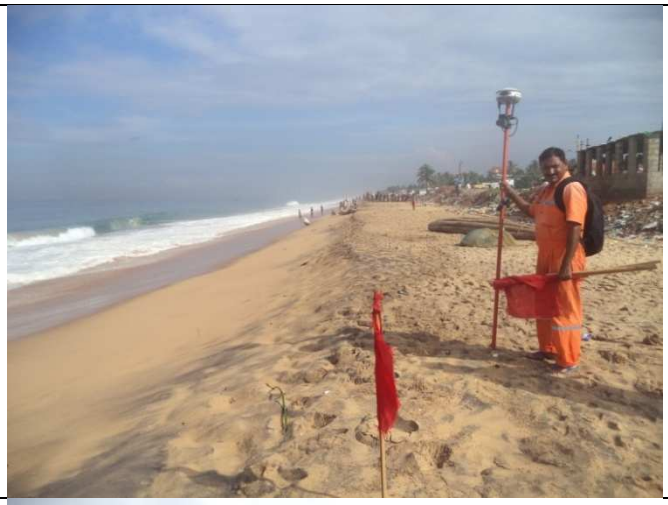





Figure 09:- May_CSP 09

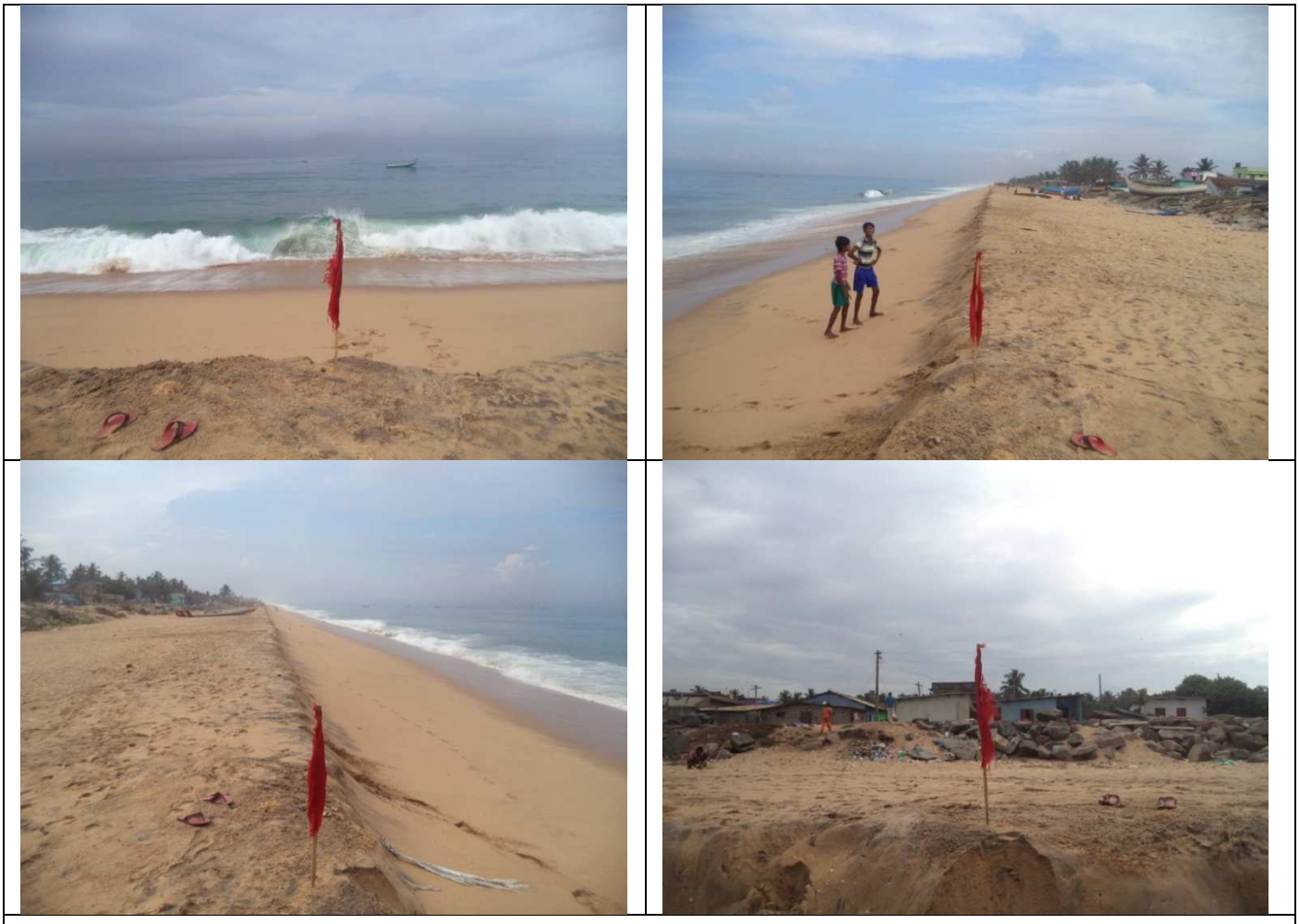


Figure 10:- May_CSP 10



Figure 11:- May_CSP 11



Figure 12:- May_CSP 12

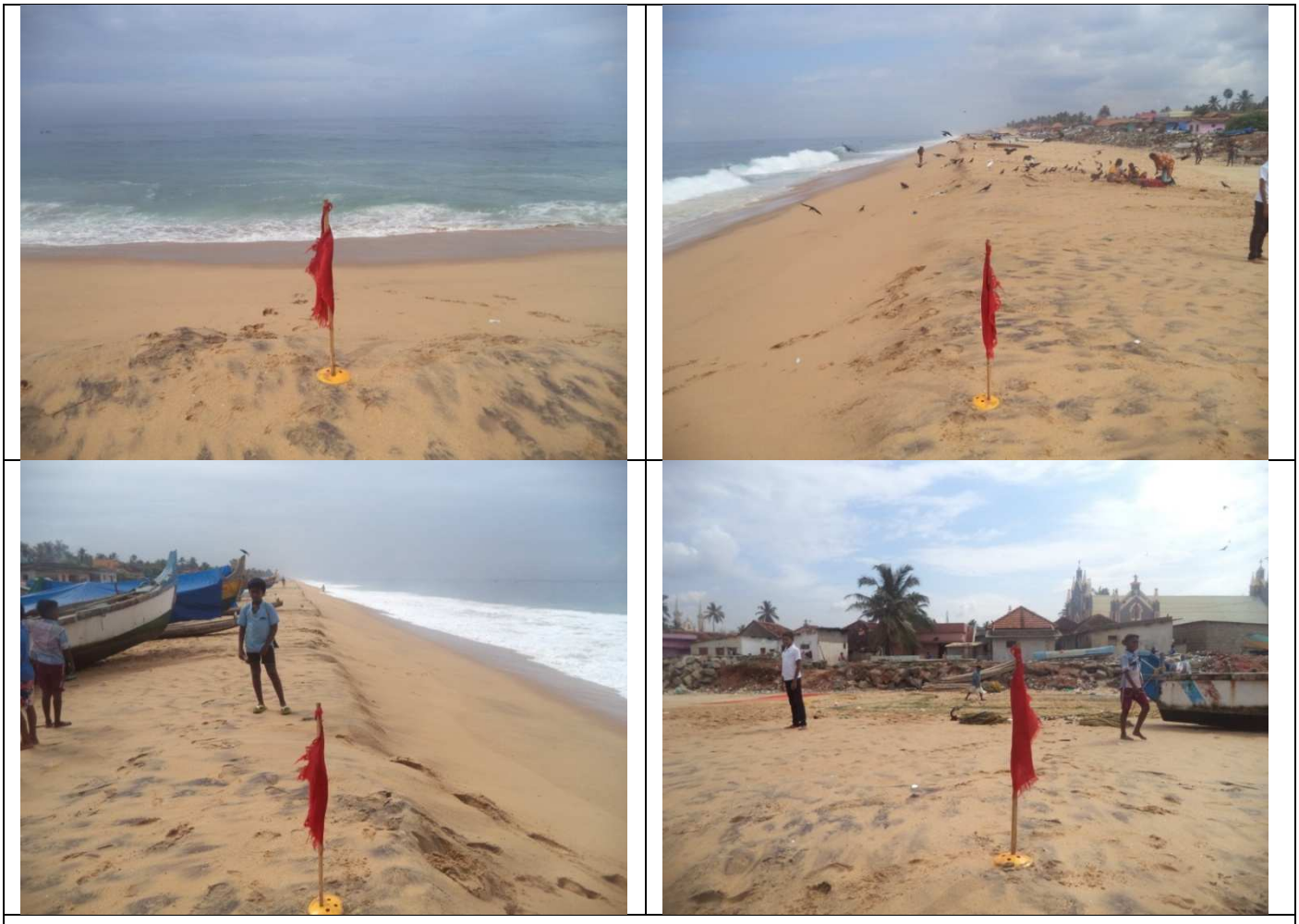


Figure 13:- May_CSP 13

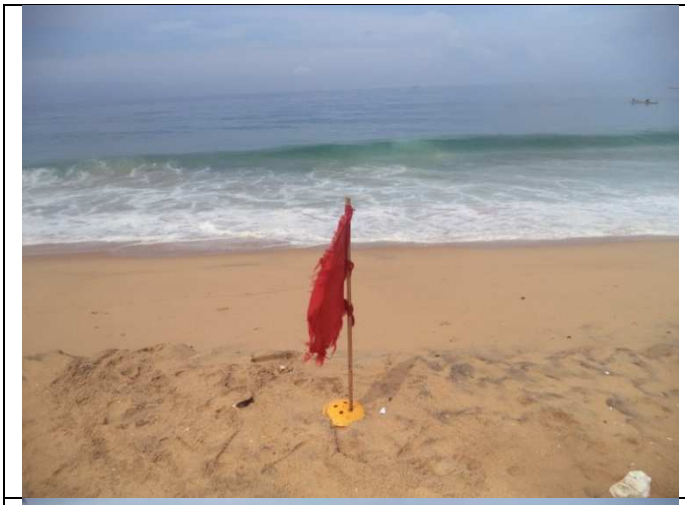





Figure 14:- May_CSP 14






Figure 15:- May_CSP 15



Figure 16:- May_CSP 16

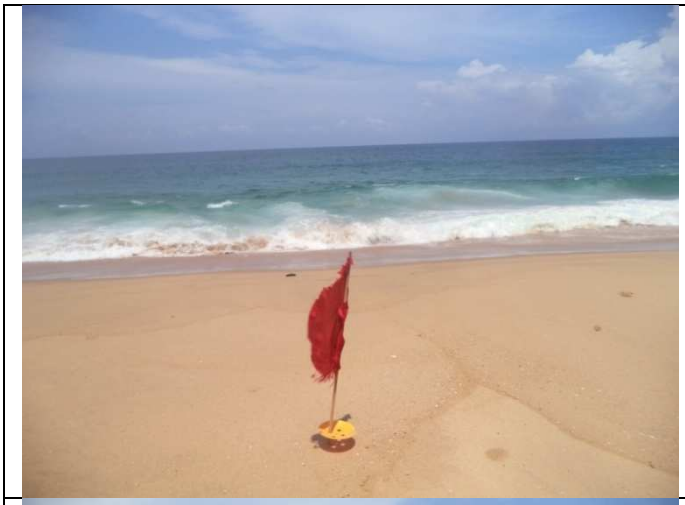
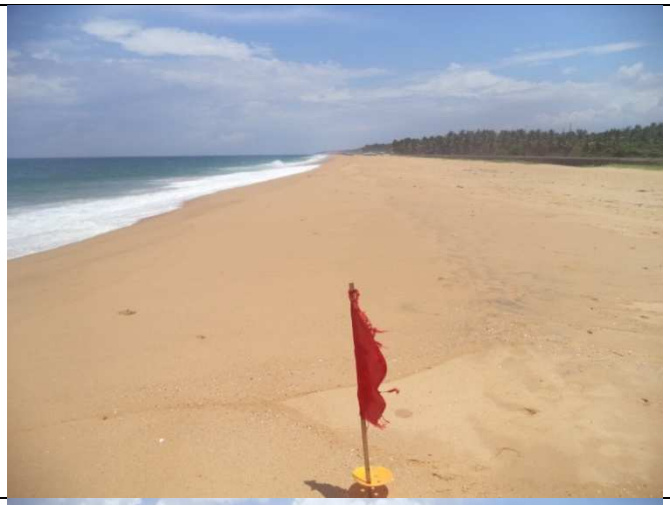
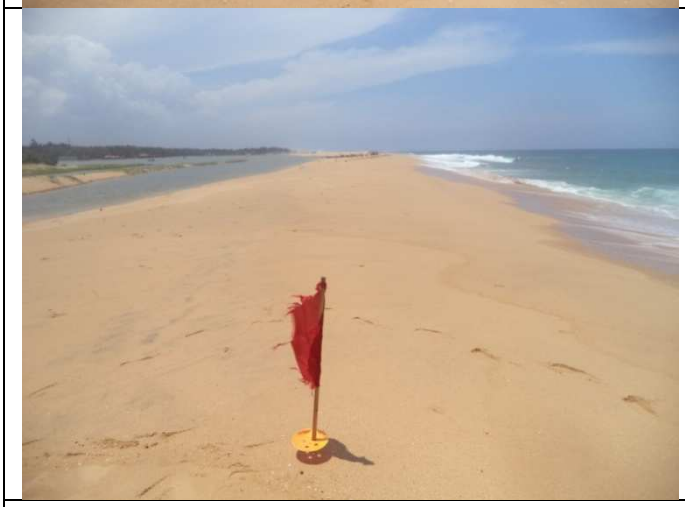





Figure 17:- May_CSP 17



Figure 18:- May_CSP 18






Figure 19:- May_CSP 19



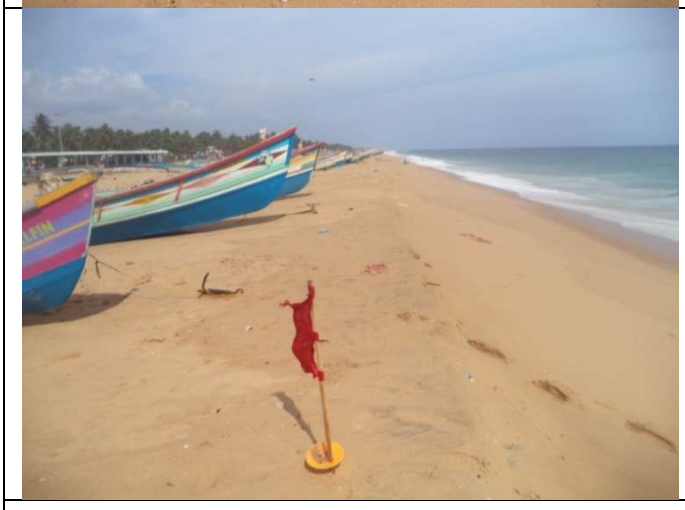



Figure 20:- May_CSP 20






Figure 21:- May_CSP 21

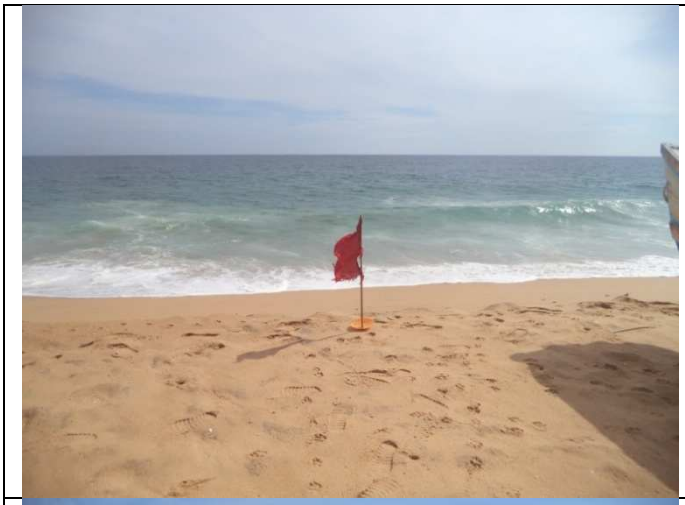
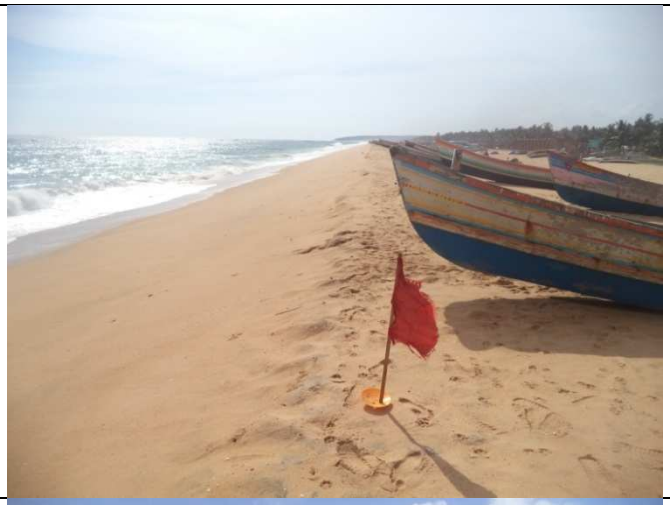





Figure 22:- May_CSP 22



Figure 23:- May_CSP 23



Figure 24:- May_CSP 24



Figure 25:- May_CSP 25






Figure 26:- May_CSP 26



Figure 27:- May_CSP 27

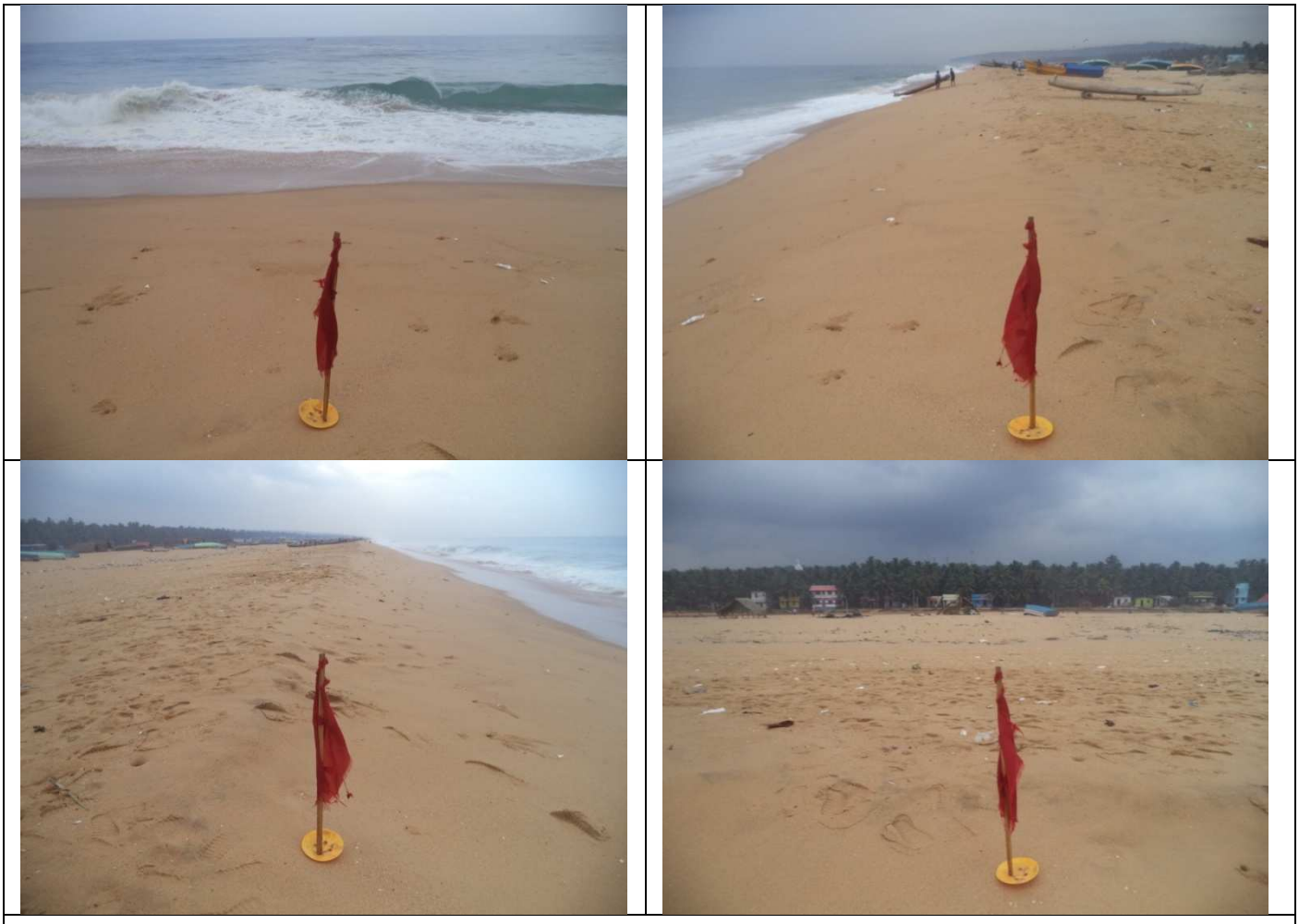


Figure 28:- May_CSP 28



Figure 29:- May_CSP 29



Figure 30:- May_CSP 30

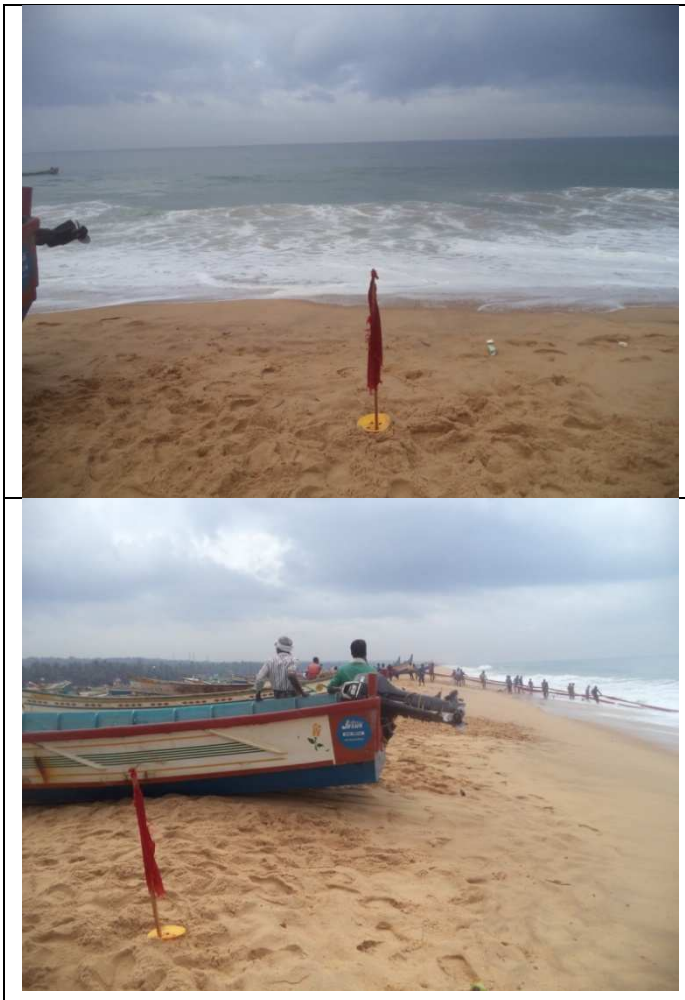


Figure 31:- May_CSP 31

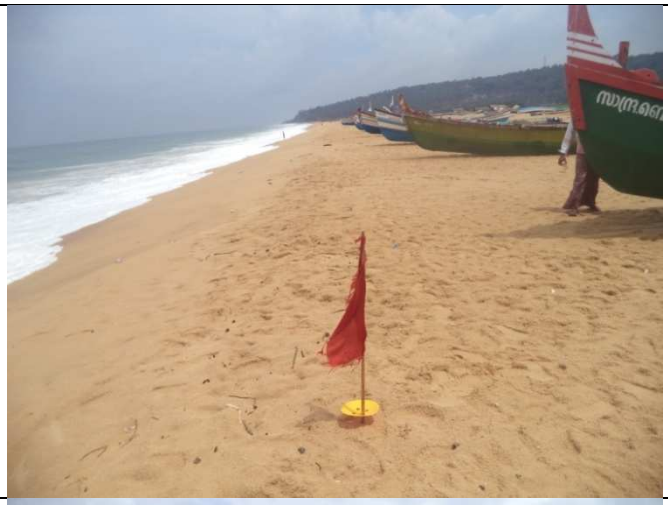





Figure 32:- May_CSP 32



Figure 33:- May_CSP 33



Figure 34:- May_CSP 34

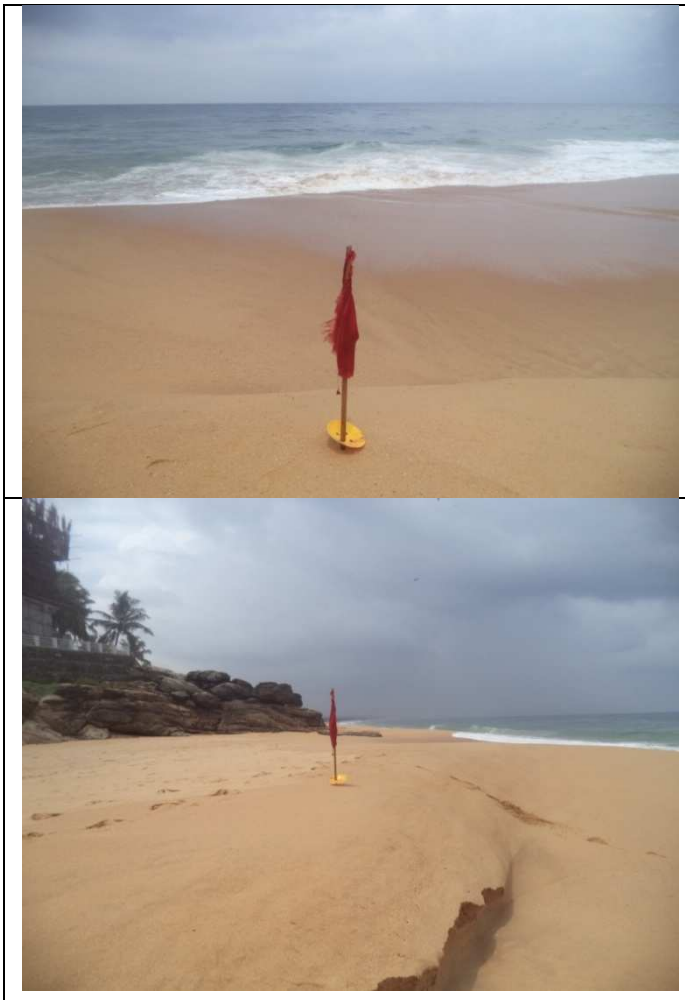


Figure 35:- May_CSP 35






Figure 36:- May_CSP 36

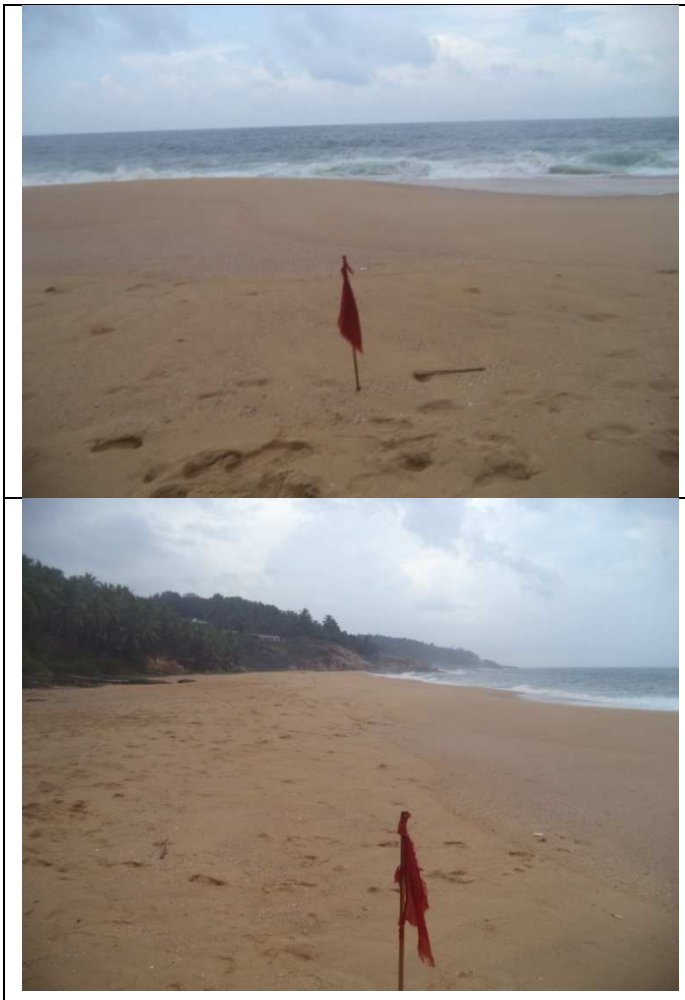


Figure 37:- May_CSP 37



Figure 38:- May_CSP 38

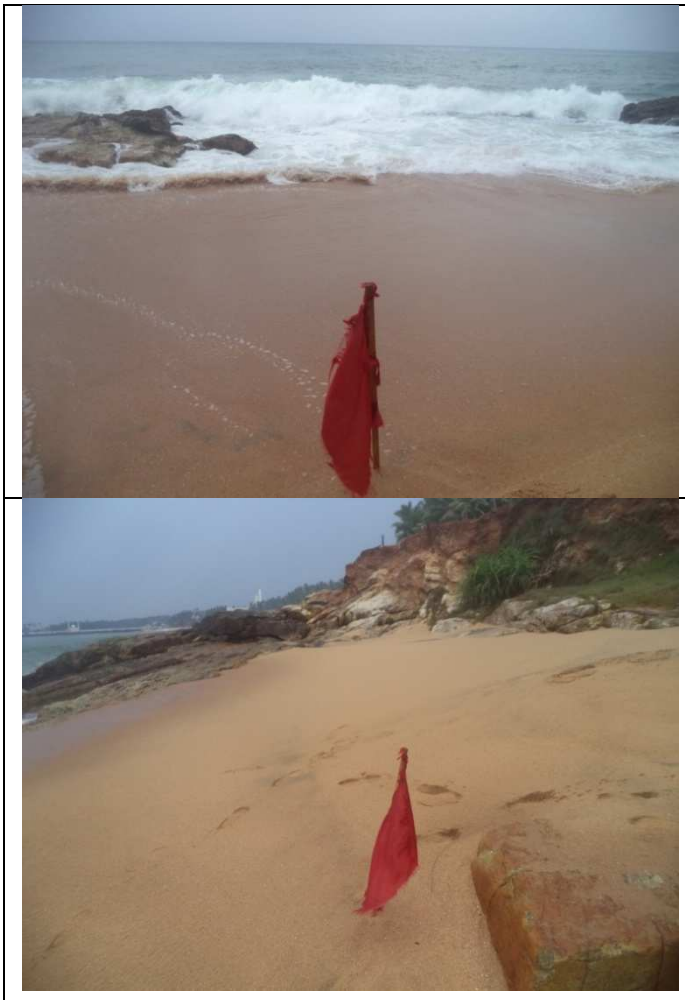


Figure 39:- May_CSP 39



Figure 40:- May_CSP 40



Figure 41:- May_CSP 41



Figure 42:- May_CSP 42



Figure 43:- May_CSP 43






Figure 44:- May_CSP 44

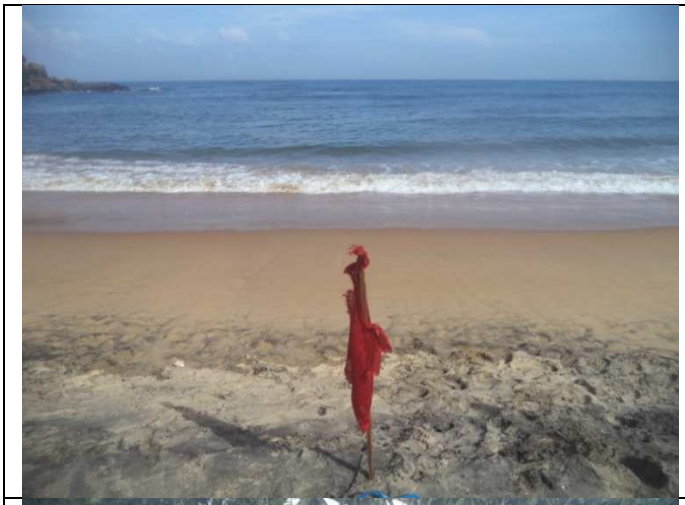





Figure 45:- May_CSP 45



Figure 46:- May_CSP 46



Figure 47:- May_CSP 47



Figure 48:- May_CSP 48



Figure 49:- May_CSP 49



Figure 50:- May_CSP 50

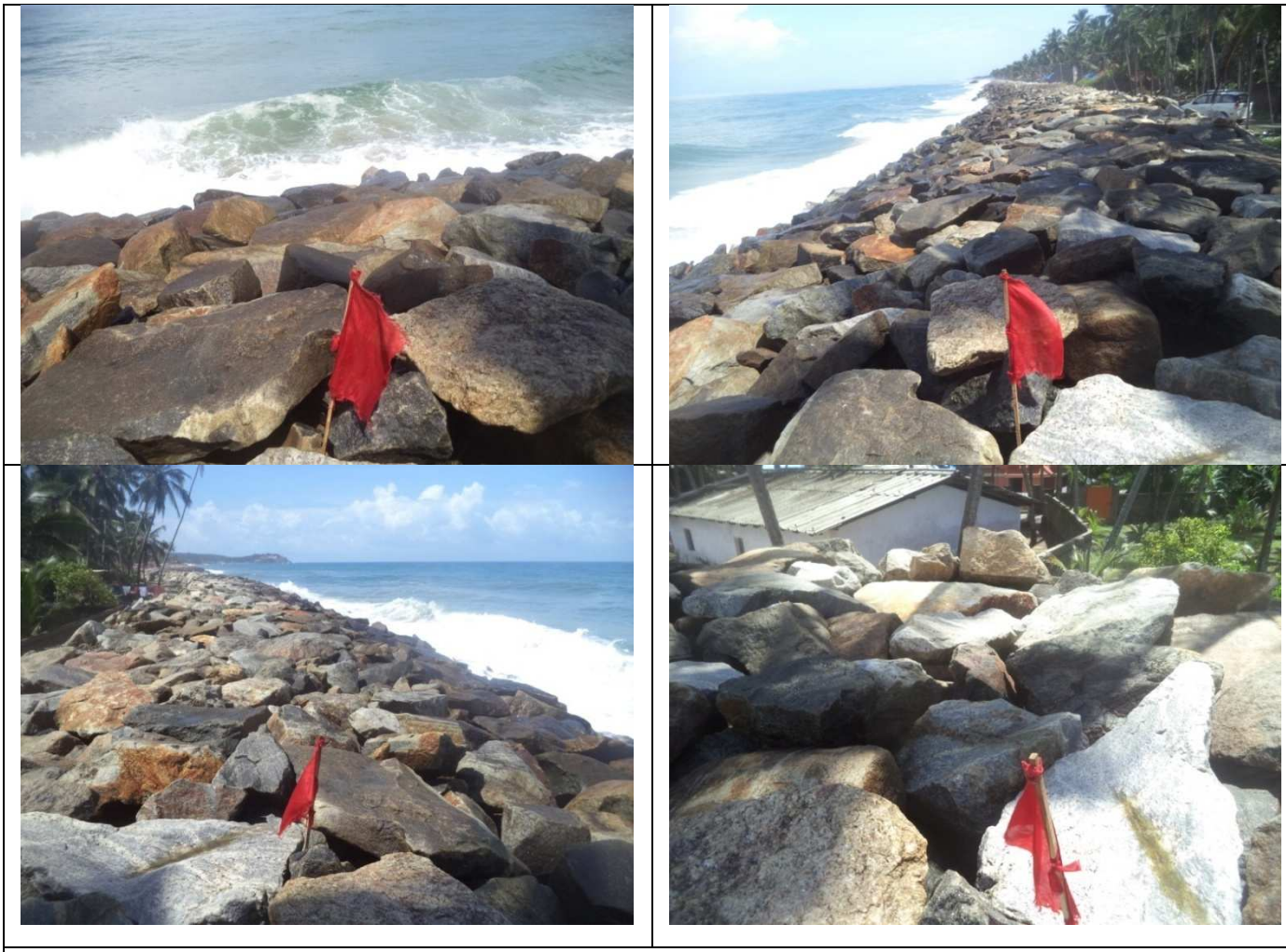


Figure 51:- May_CSP 51



Figure 52:- May_CSP 52



Figure 53:- May_CSP 53

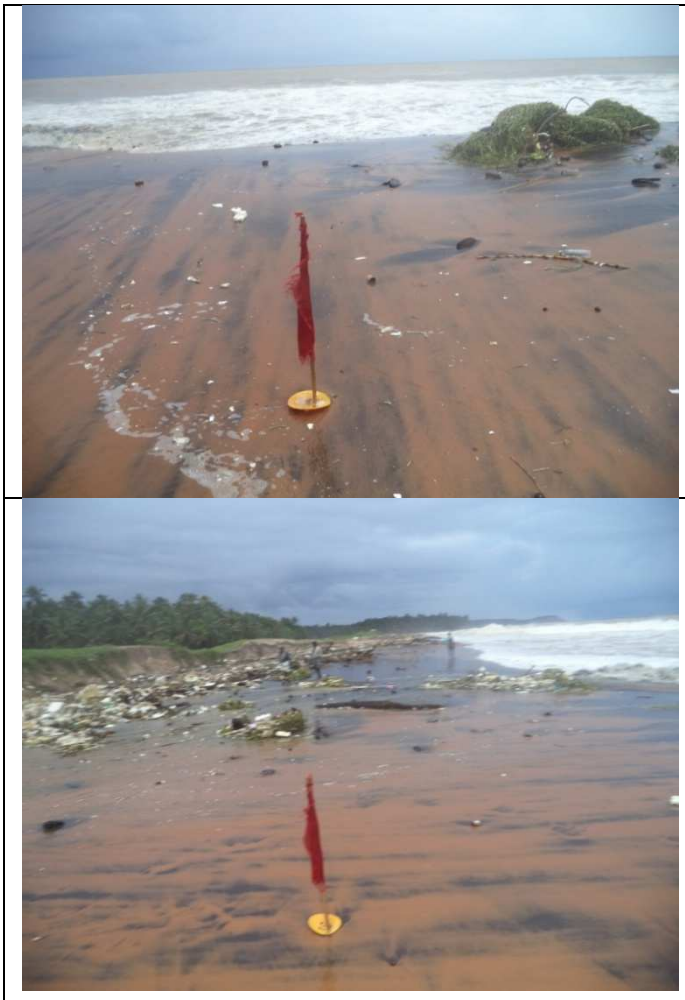


Figure 54:- May_CSP 54



Figure 55:- May_CSP 55

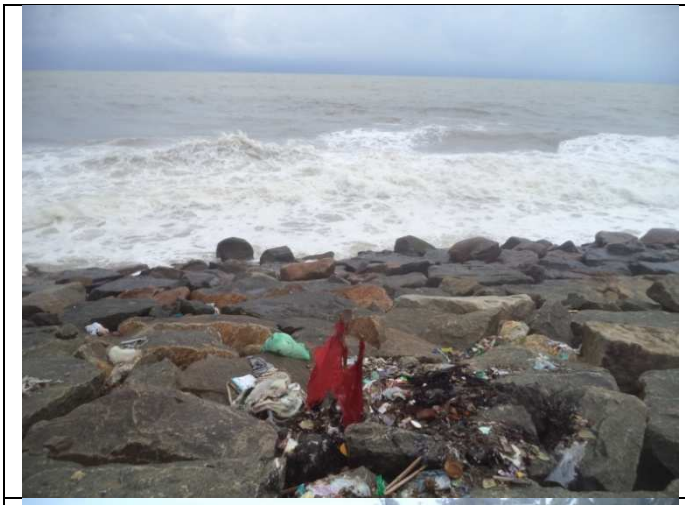





Figure 56:- May_CSP 56






Figure 57:- May_CSP 57






Figure 58:- May_CSP 58



Figure 59:- May_CSP 59






Figure 60:- May_CSP 60






Figure 61:- May_CSP 61



Figure 62:- May_CSP 62






Figure 63:- May_CSP 63






Figure 64:- May_CSP 64



Figure 65:- May_CSP 65






Figure 66:- May_CSP 66



Figure 67:- May_CSP 67



Figure 68:- May_CSP 68



Figure 69:- May_CSP 69



Figure 70:- May_CSP 70



Figure 71:- May_CSP 71



Figure 72:- May_CSP 72






Figure 73:- May_CSP 73



Figure 74:- May_CSP 74



Figure 75:- May_CSP 75






Figure 76:- May_CSP 76



Figure 77:- May_CSP 77



Figure 78:- May_CSP 78



Figure 79:- May_CSP 79



Figure 80:- May_CSP 80






Figure 81:- May_CSP 81

Annexure VII

Photographic Documentation (March 2015)





Figure 02:- March_CSP 11





Figure 01:- March_CSP 12



Figure 03:- March_CSP 13



Figure 04:- March_CSP 14





Figure 05:- March_CSP 15

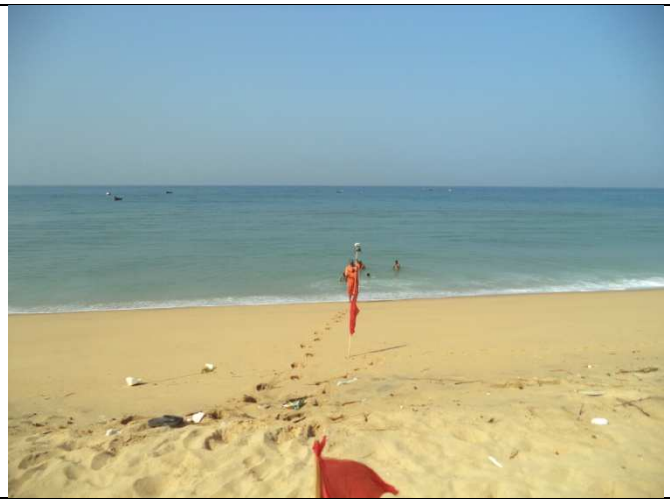




Figure 06:- March_CSP 16



Figure 07:- March_CSP 17



Figure 08:- March_CSP 18





Figure 09:- March_CSP 19





Figure 10:- March_CSP 20





Figure 12:- March_CSP 21





Figure 11:- March_CSP 22





Figure 13:- March_CSP 23





Figure 14:- March_CSP 24



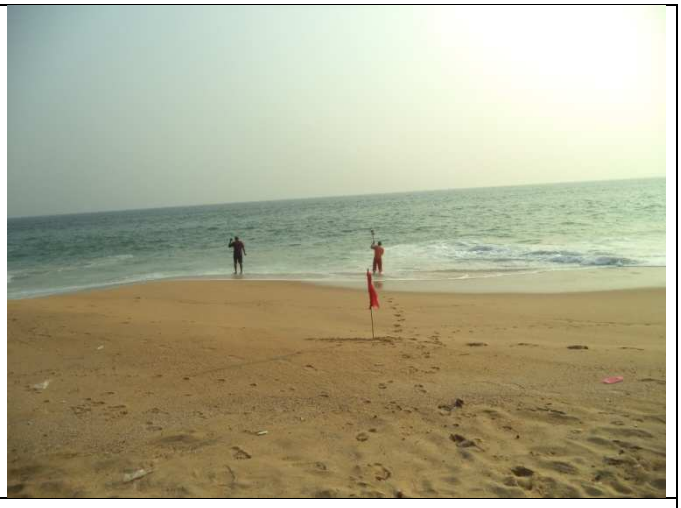


Figure 15:- March_CSP 25





Figure 16:- March_CSP 26





Figure 17:- March_CSP 27





Figure 18:- March_CSP 28





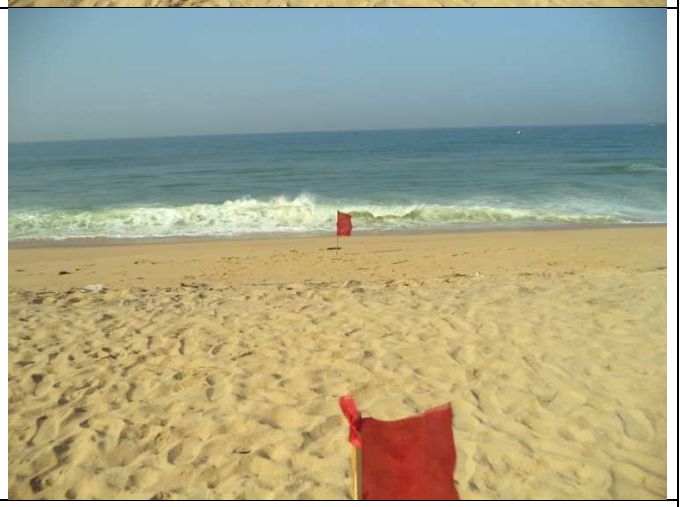


Figure 19:- March_CSP 29






Figure 20:- March_CSP 30

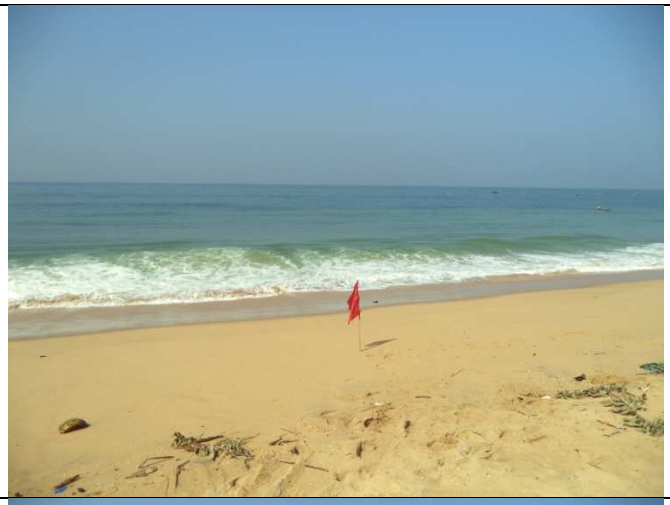





Figure 21:- March_CSP 31



Figure 22:- March_CSP 32







Figure 23:- March_CSP 33





Figure 24:- March_CSP 34







Figure 25:- March_CSP 35



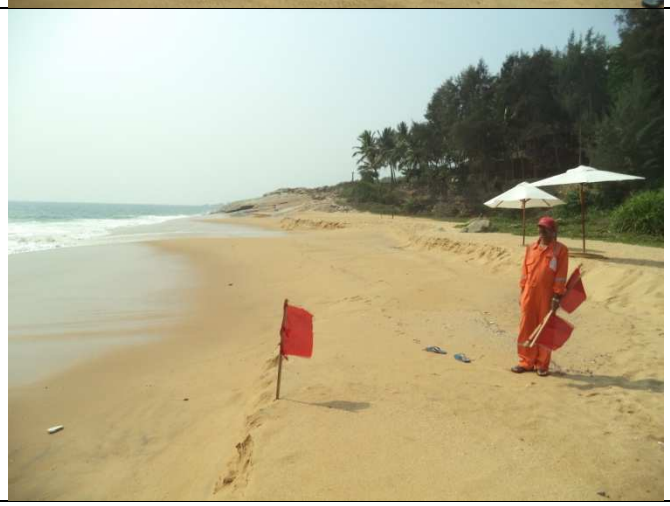



Figure 26:- March_CSP 36



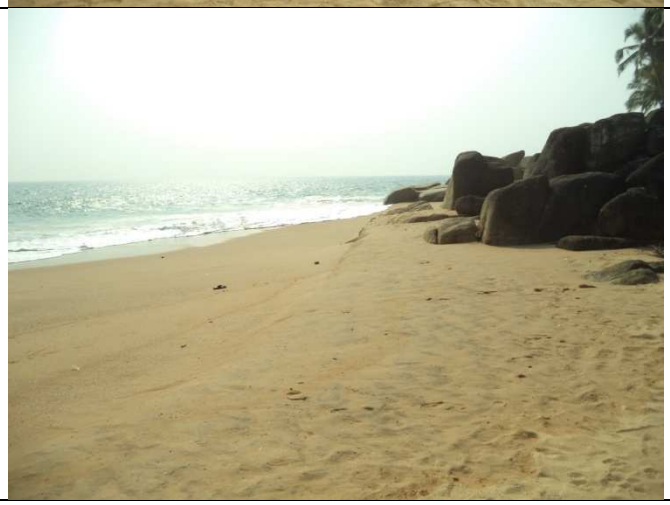



Figure 27:- March_CSP 37

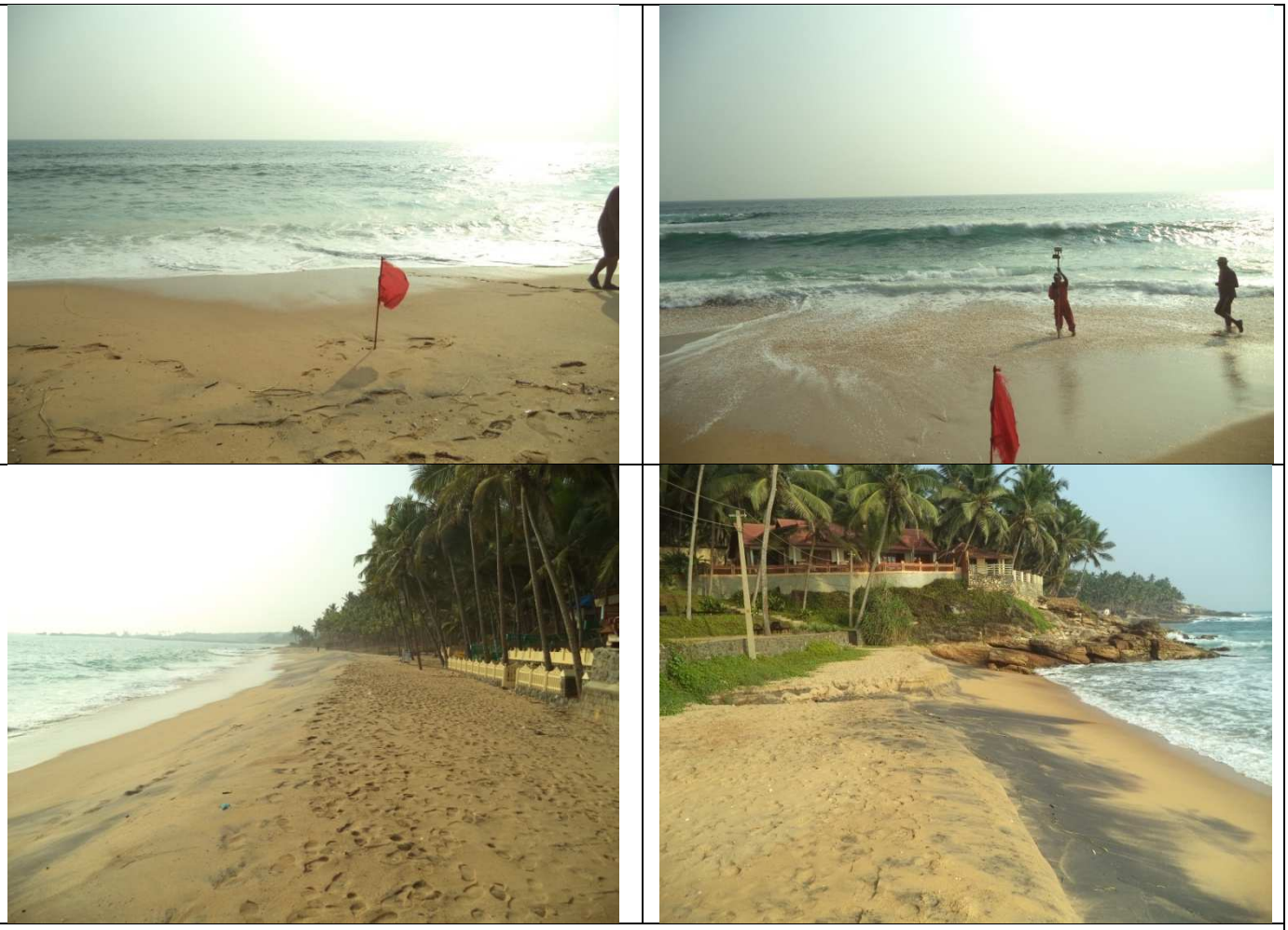


Figure 28:- March_CSP 38





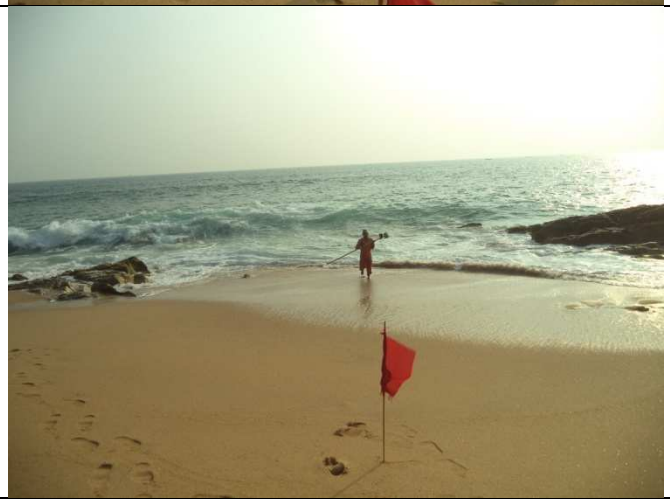


Figure 29:- March_CSP 39



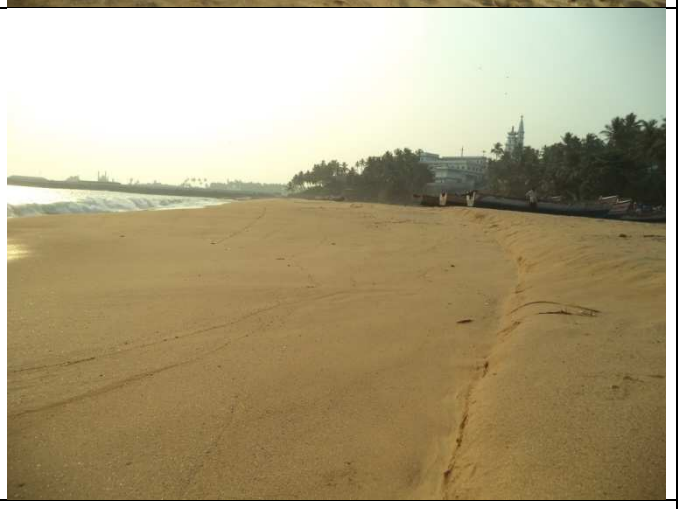



Figure 30:- March_CSP 40






Figure 31:- March_CSP 41






Figure 32:- March_CSP 42



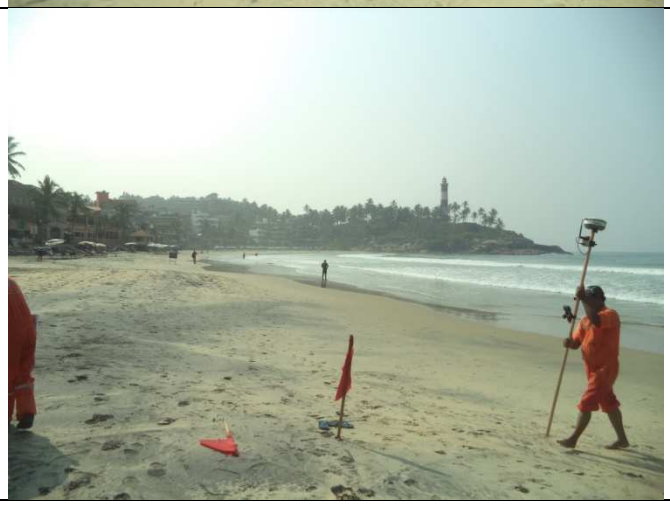



Figure 33:- March_CSP 43

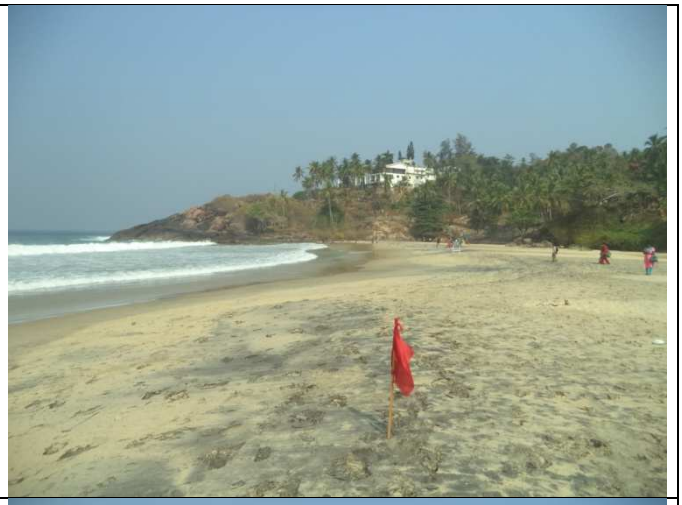





Figure 34:- March_CSP 44



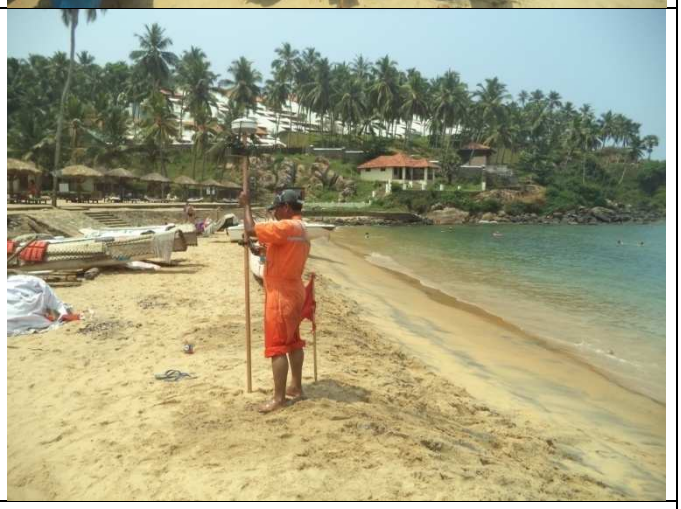



Figure 35:- March_CSP 45






Figure 36:- March_CSP 46

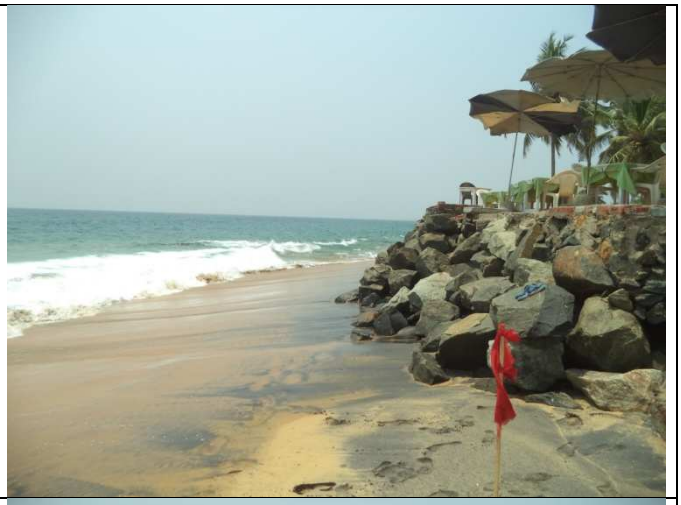
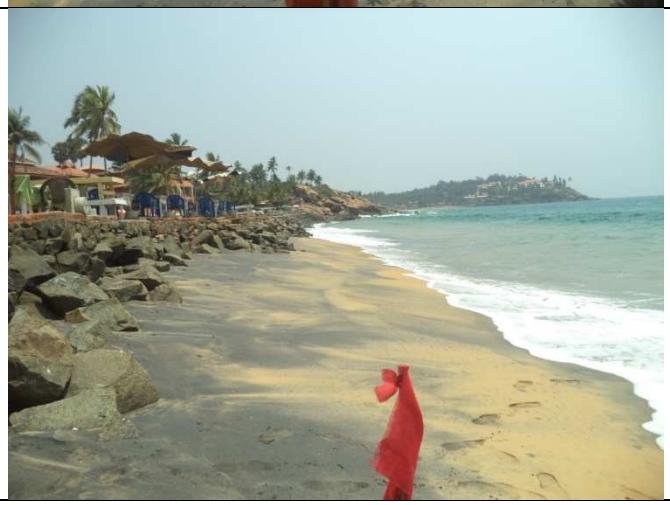





Figure 37:- March_CSP 47



Figure 38:- March_CSP 48



Figure 39:- March_CSP 49







Figure 40:- March_CSP 50

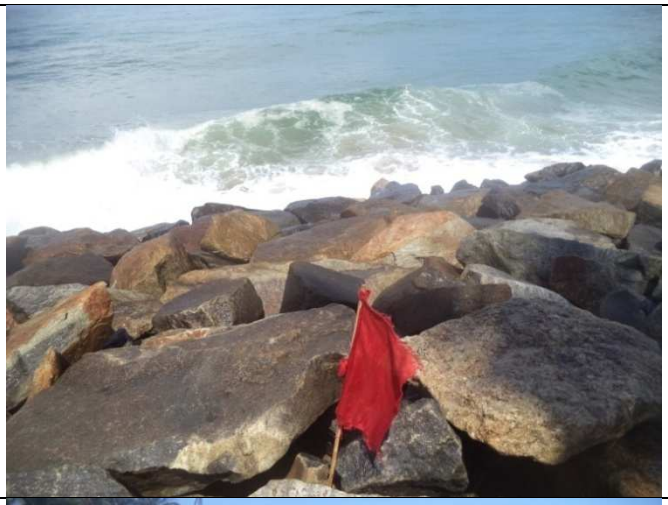






Figure 41:- March_CSP 51



Figure 42:- March_CSP 52



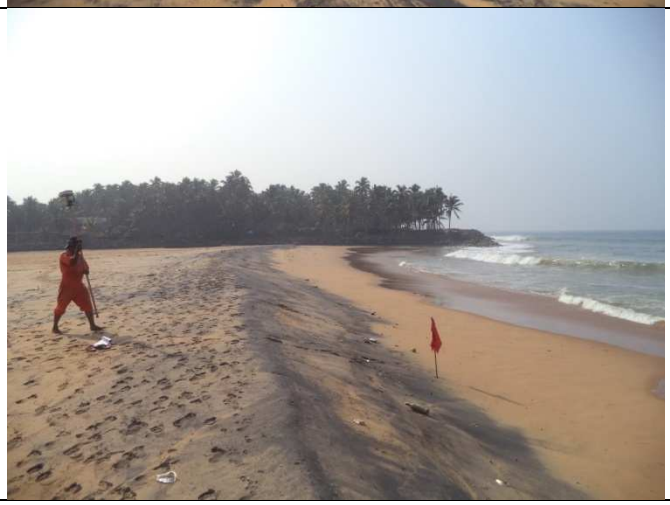



Figure 43:- March_CSP 53






Figure 44:- March_CSP 54






Figure 45:- March_CSP 55







Figure 46:- March_CSP 56






Figure 47:- March_CSP 57






Figure 48:- March_CSP 58






Figure 49:- March_CSP 59






Figure 50:- March_CSP 60






Figure 51:- March_CSP 61



Figure 52:- March_CSP 62






Figure 53:- March_CSP 63






Figure 54:- March_CSP 64





Figure 55:- March_CSP 65






Figure 56:- March_CSP 66

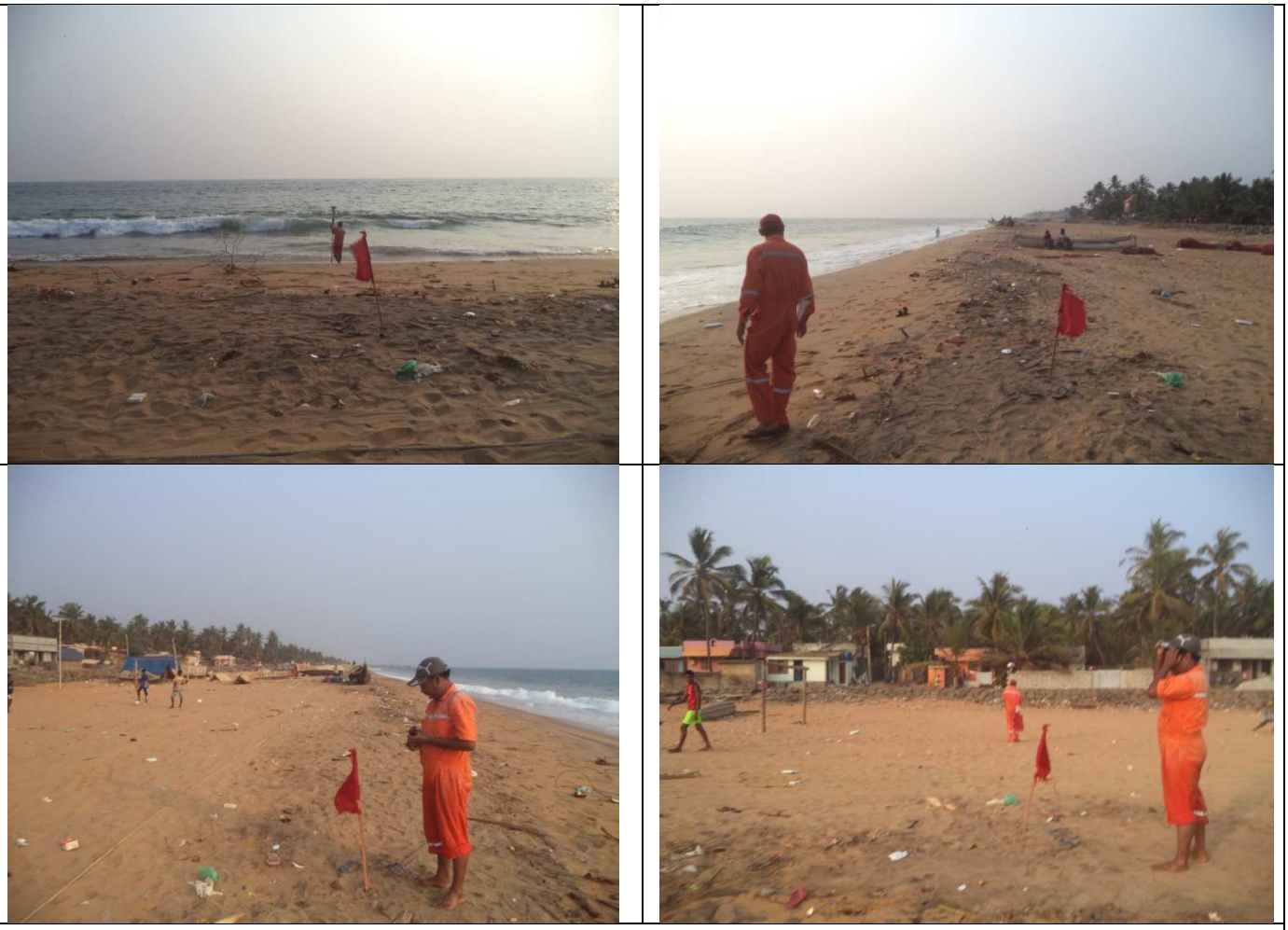


Figure 57:- March_CSP 67

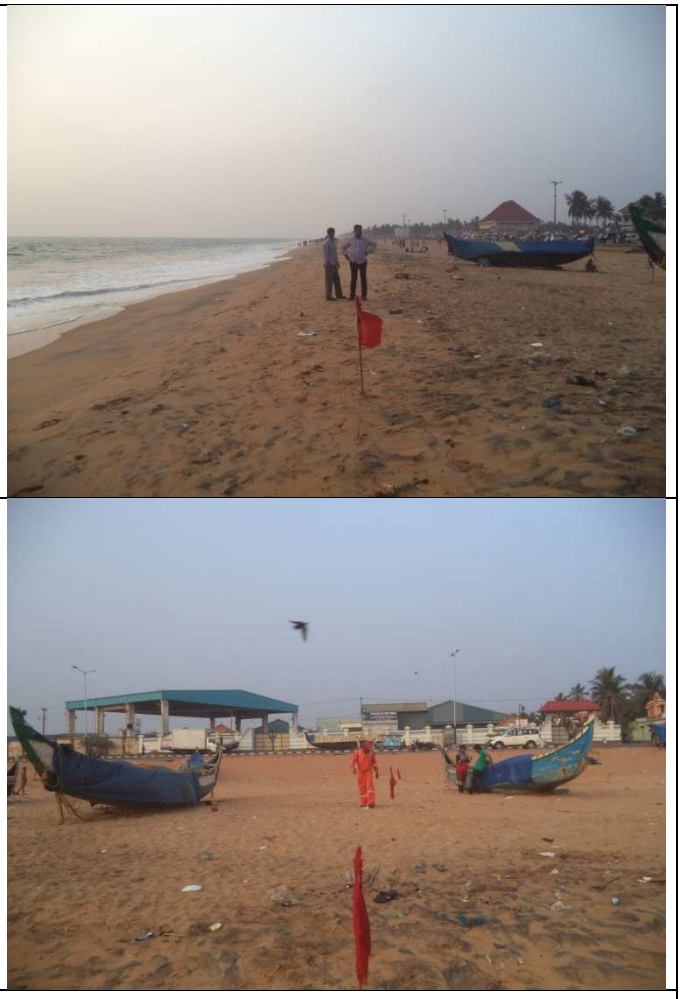



Figure 58:- March_CSP 68






Figure 59:- March_CSP 69






Figure 60:- March_CSP 70







Figure 61:- March_CSP 71

Photographic Documentation (April 2015)






Figure 01:- April_CSP 01






Figure 02:- April_CSP 02






Figure 03:- April_CSP 03









Figure 04:- April_CSP 04









Figure 05:- April_CSP 05



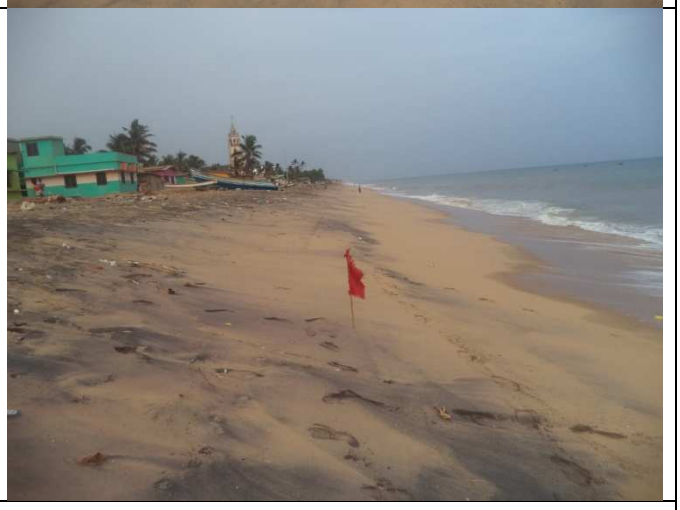



Figure 06:- April_CSP 06

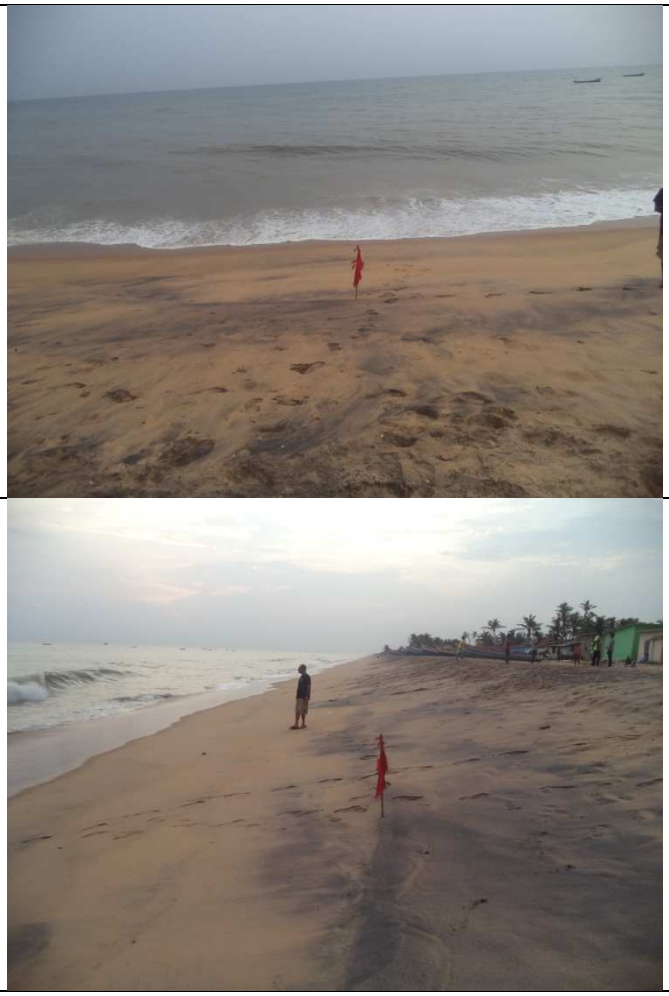


Figure 07:- April_CSP 07



Figure 08:- April_CSP 08



Figure 09:- April_CSP 09



Figure 10:- April_CSP 10



Figure 11:- April_CSP 11

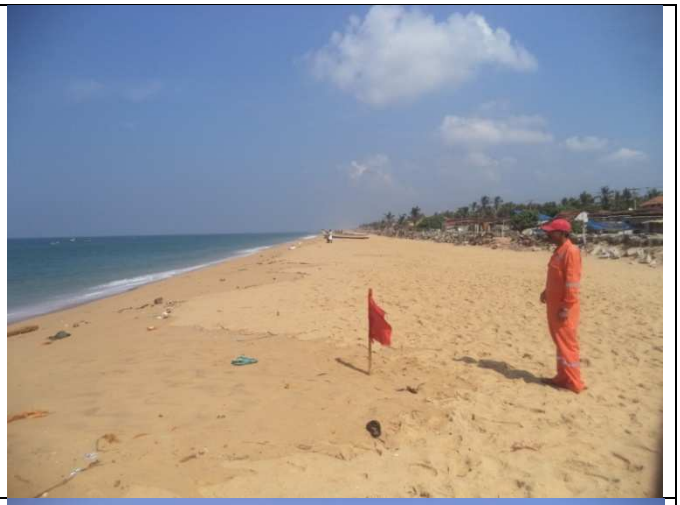





Figure 12:- April_CSP 12





6





Figure 13:- April_CSP 13

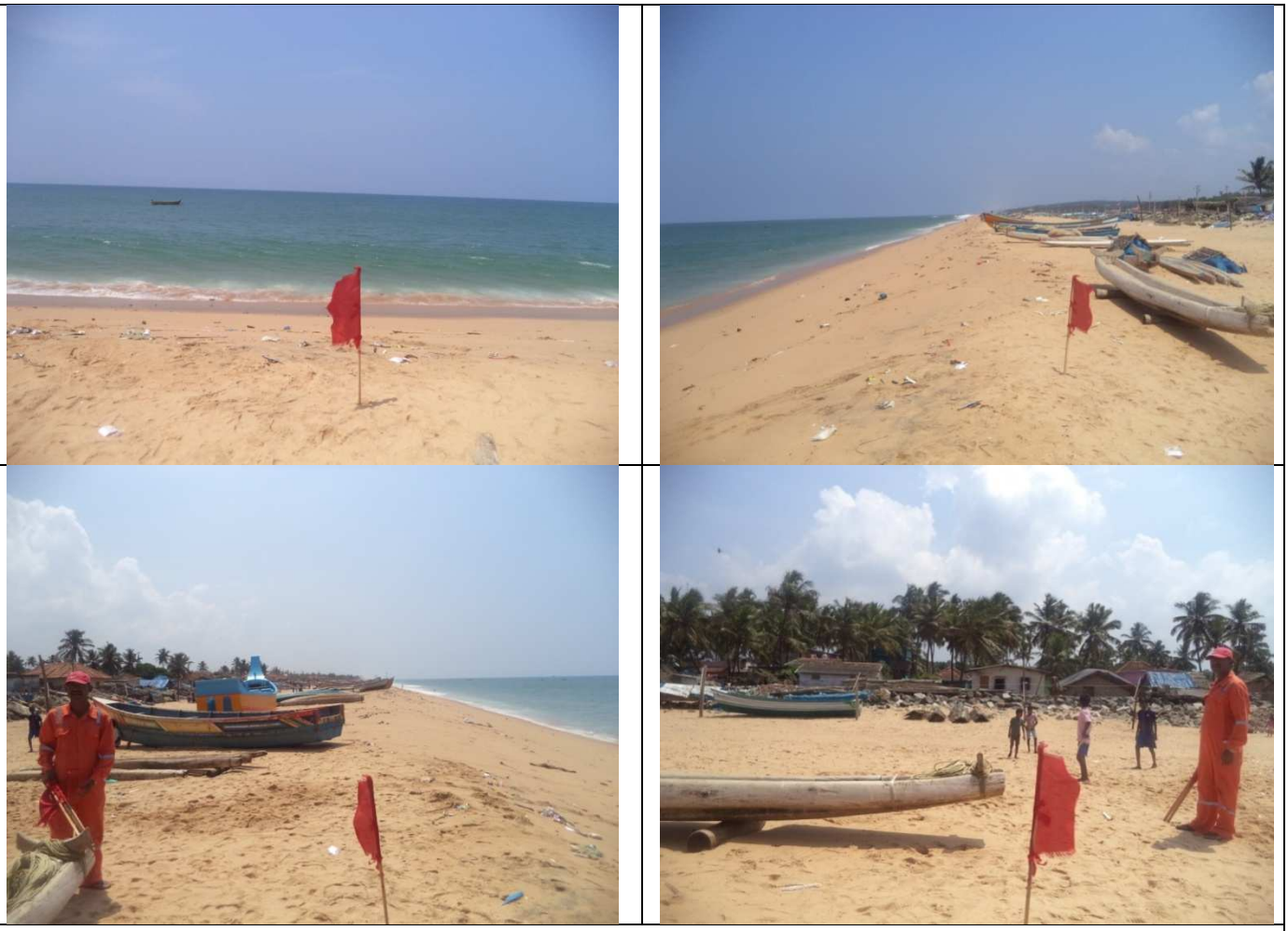


Figure 14:- April_CSP 14






Figure 15:- April_CSP 15




Figure 16:- April_CSP 16



Figure 17:- April_CSP 17






Figure 18:- April_CSP 18






Figure 19:- April_CSP 19



Figure 20:- April_CSP 20

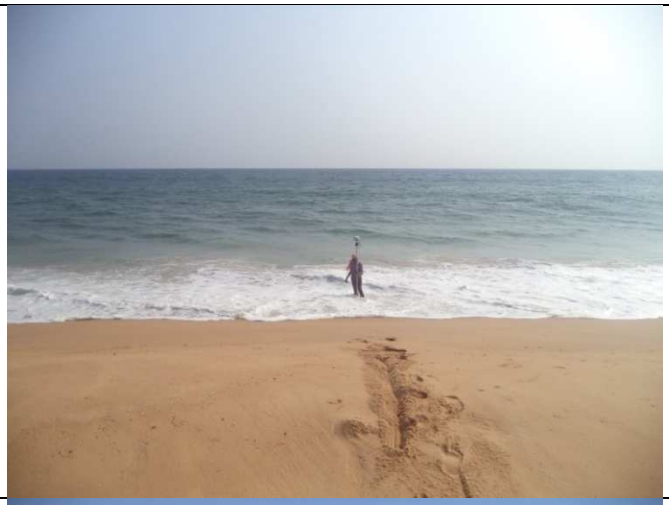





Figure 21:- April_CSP 21

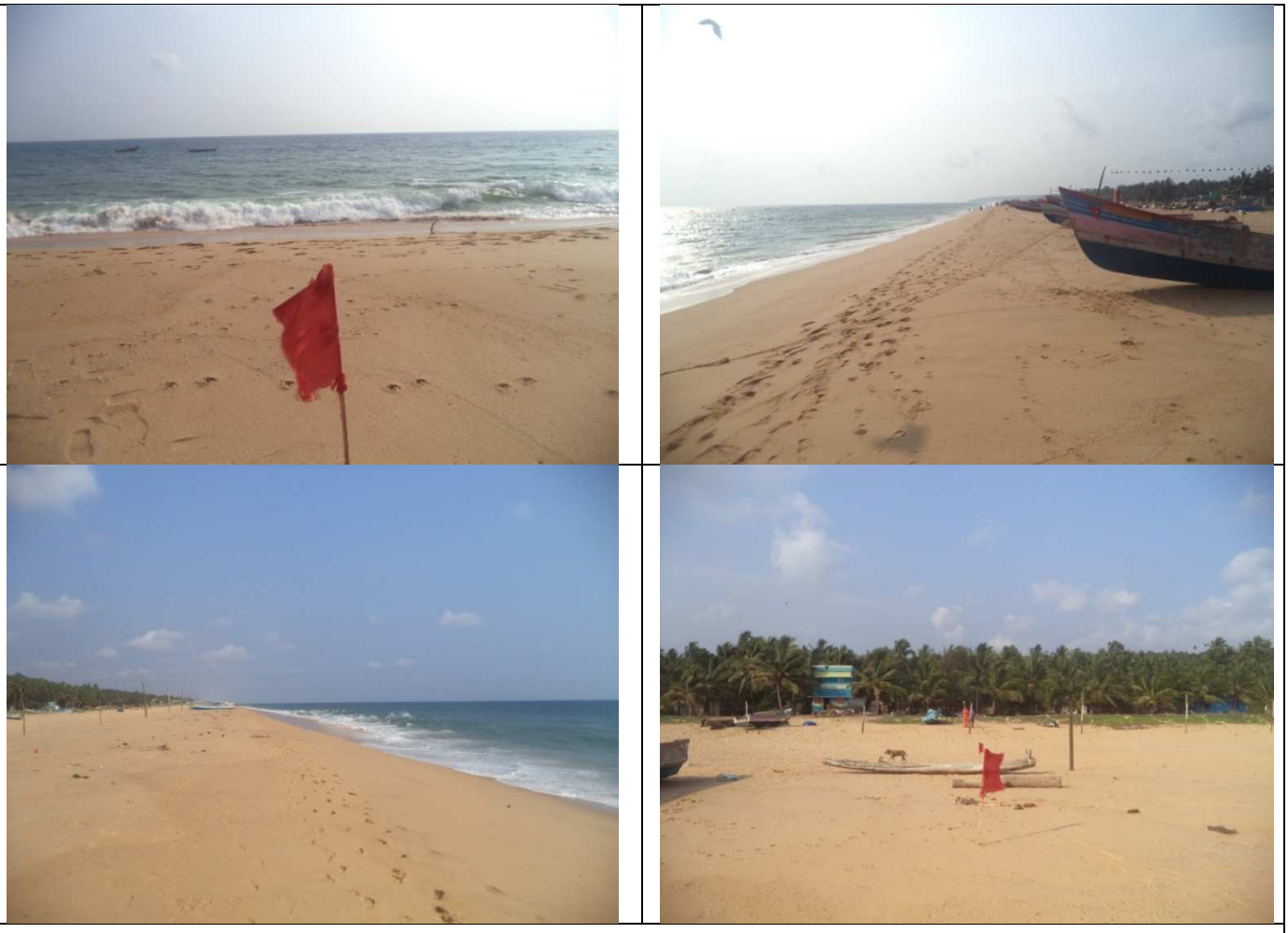


Figure 22:- April_CSP 22

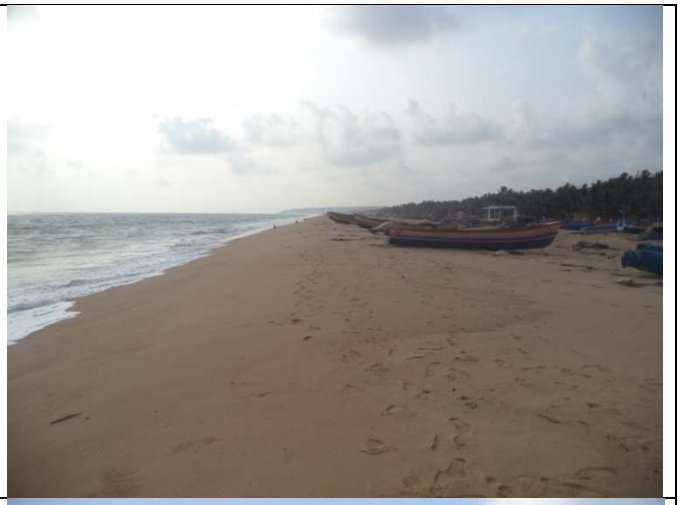





Figure 23:- April_CSP 23






Figure 24:- April_CSP 24






Figure 25:- April_CSP 25

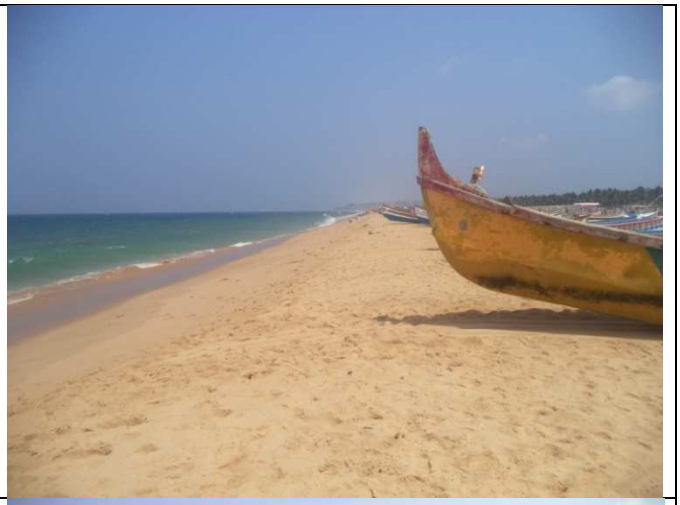





Figure 26:- April_CSP 26



Figure 27:- April_CSP 27



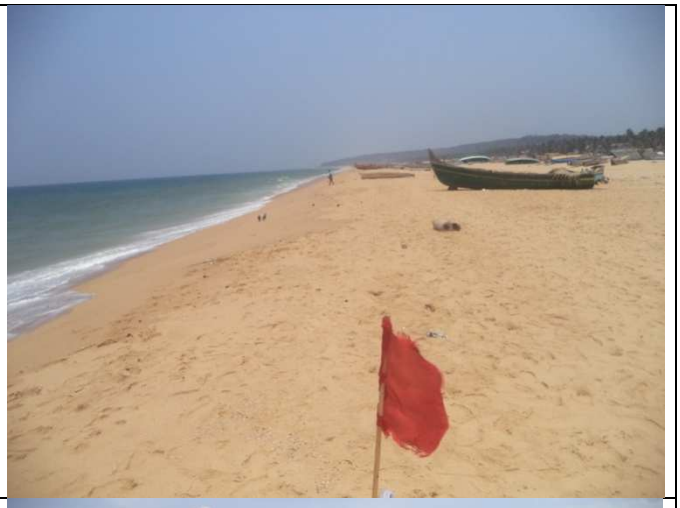




Figure 28:- April_CSP 28

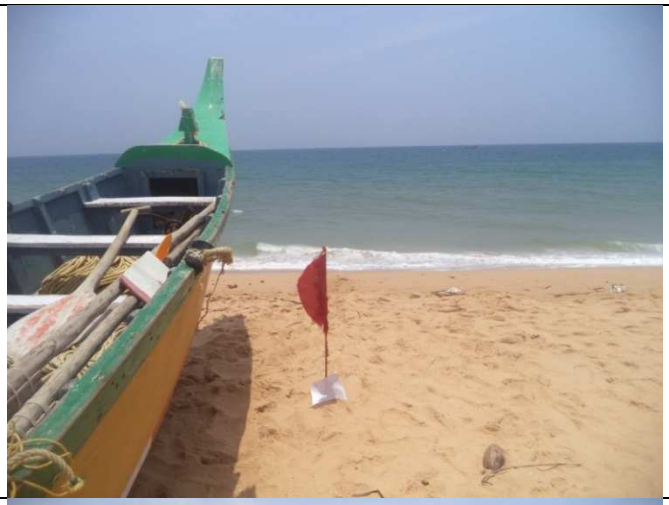
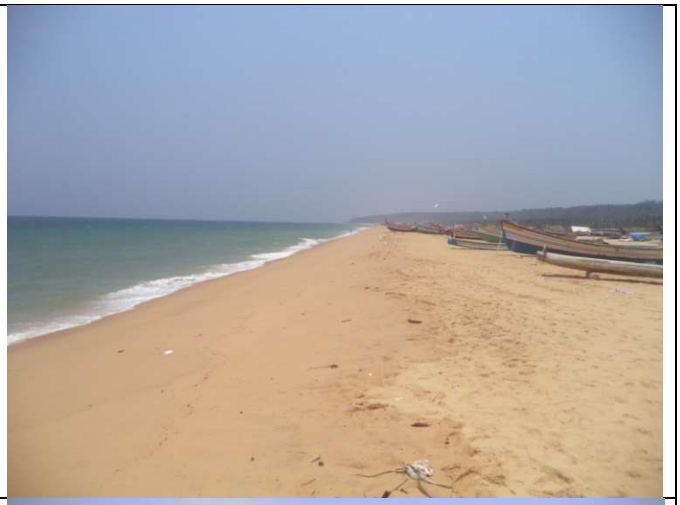






Figure 29:- April_CSP 29



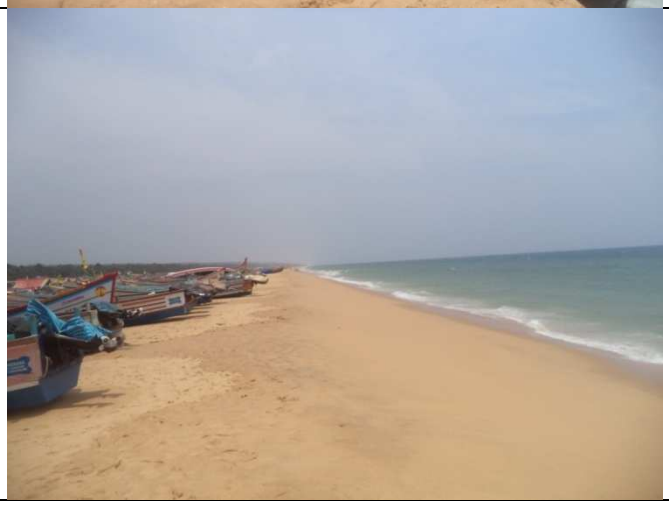



Figure 30:- April_CSP 30

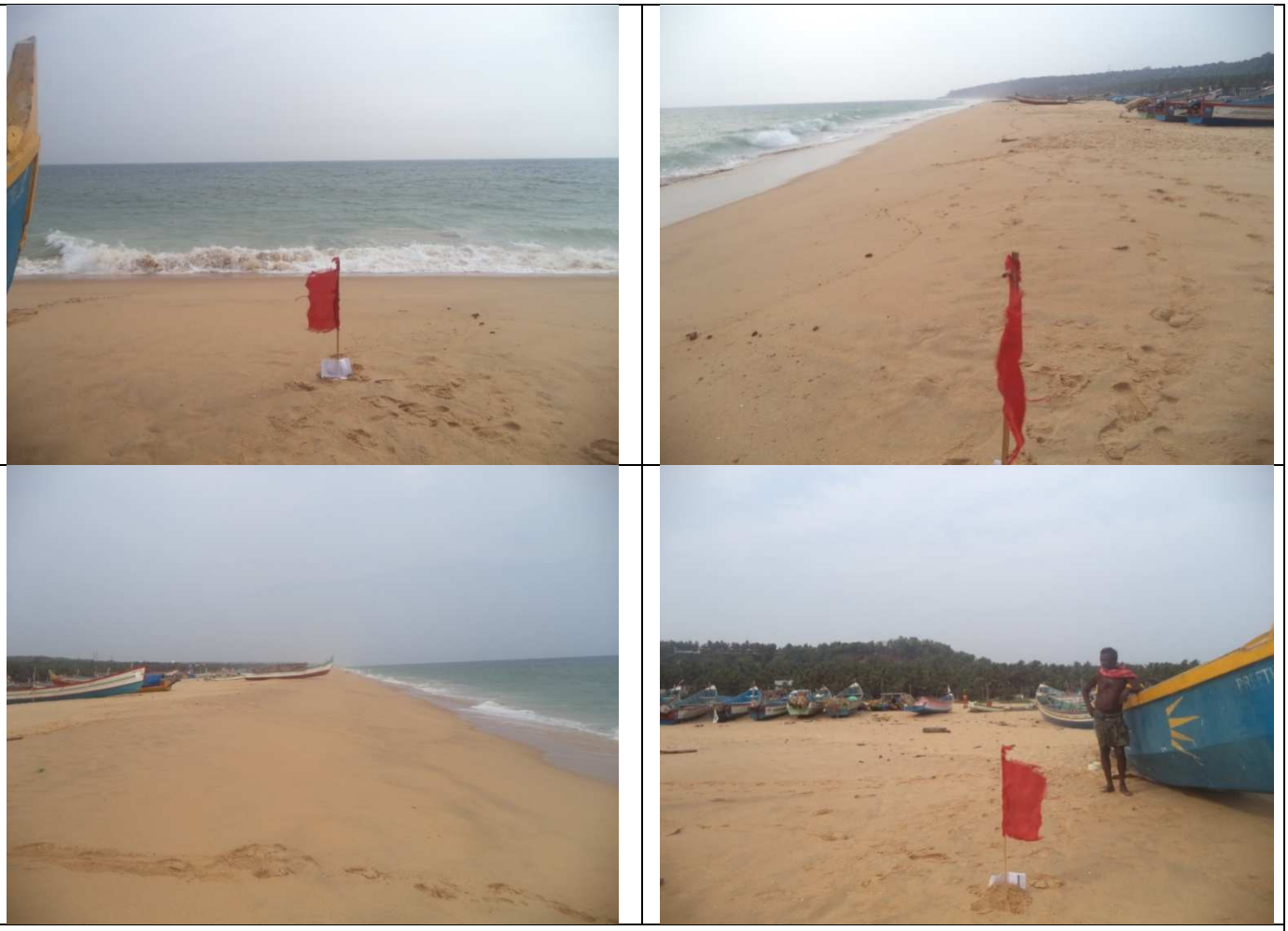


Figure 31:- April_CSP 31



Figure 32:- April_CSP 32



Figure 33:- April_CSP 33



Figure 34:- April_CSP 34

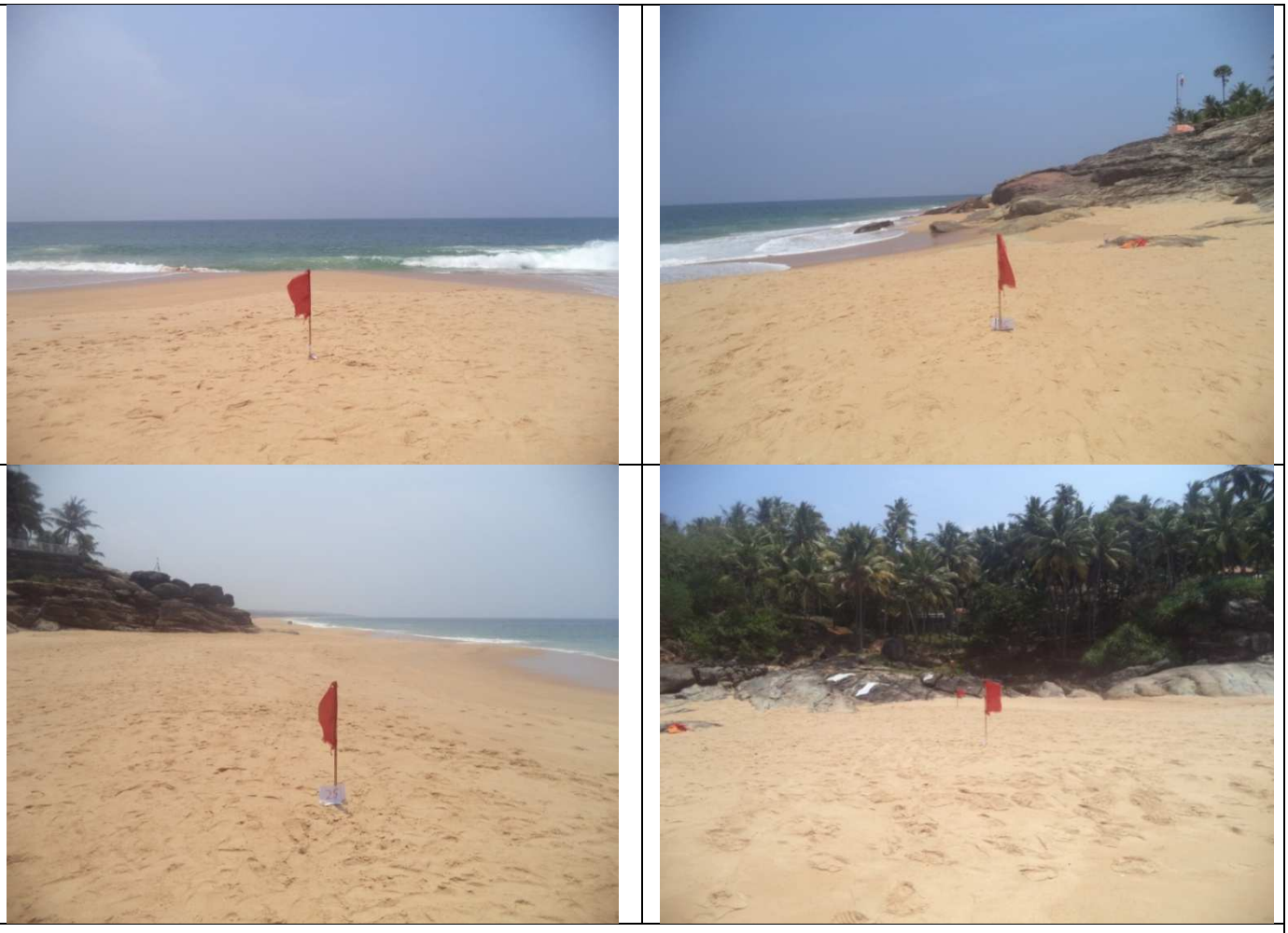


Figure 35:- April_CSP 35

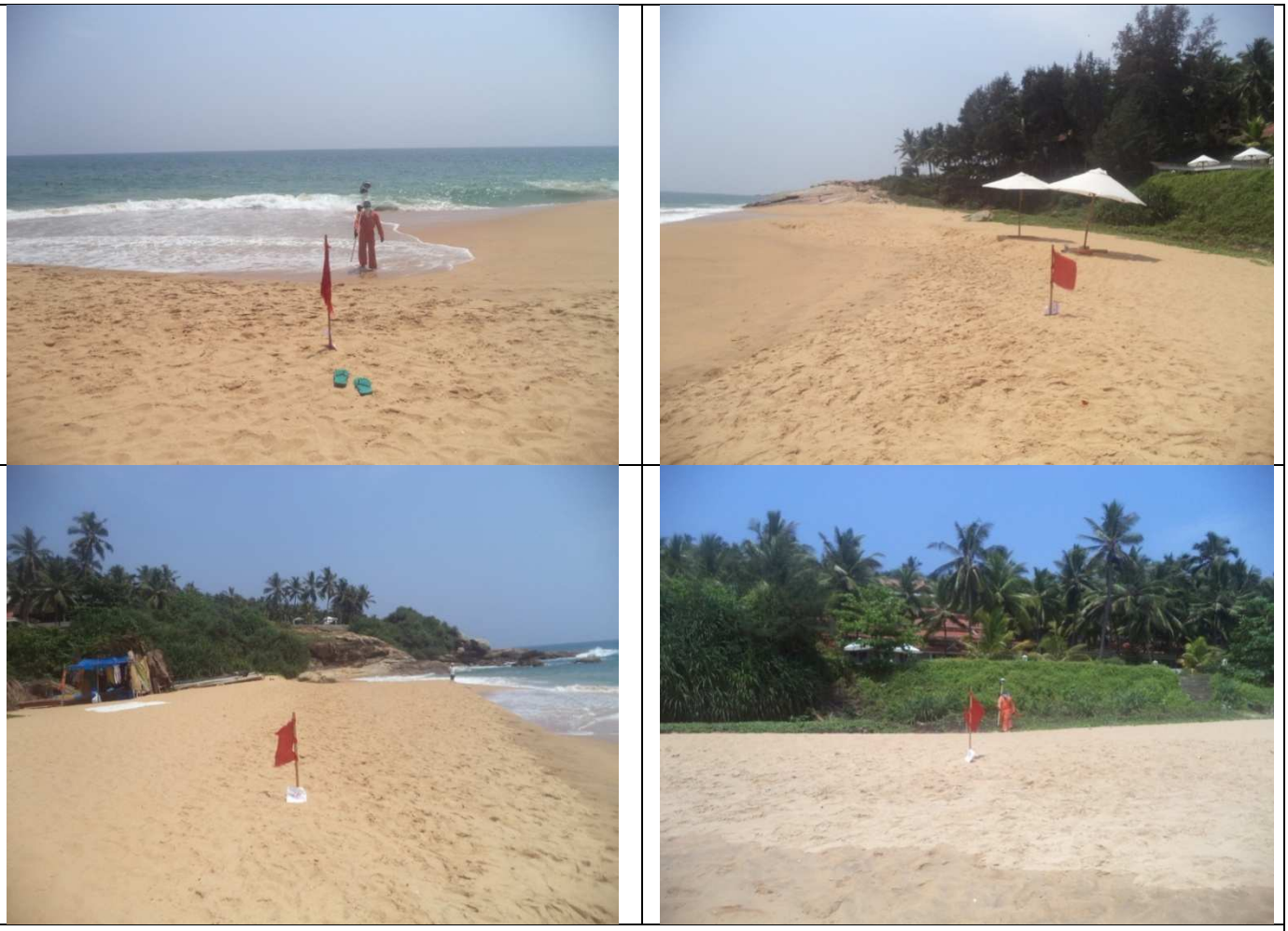


Figure 36:- April_CSP 36

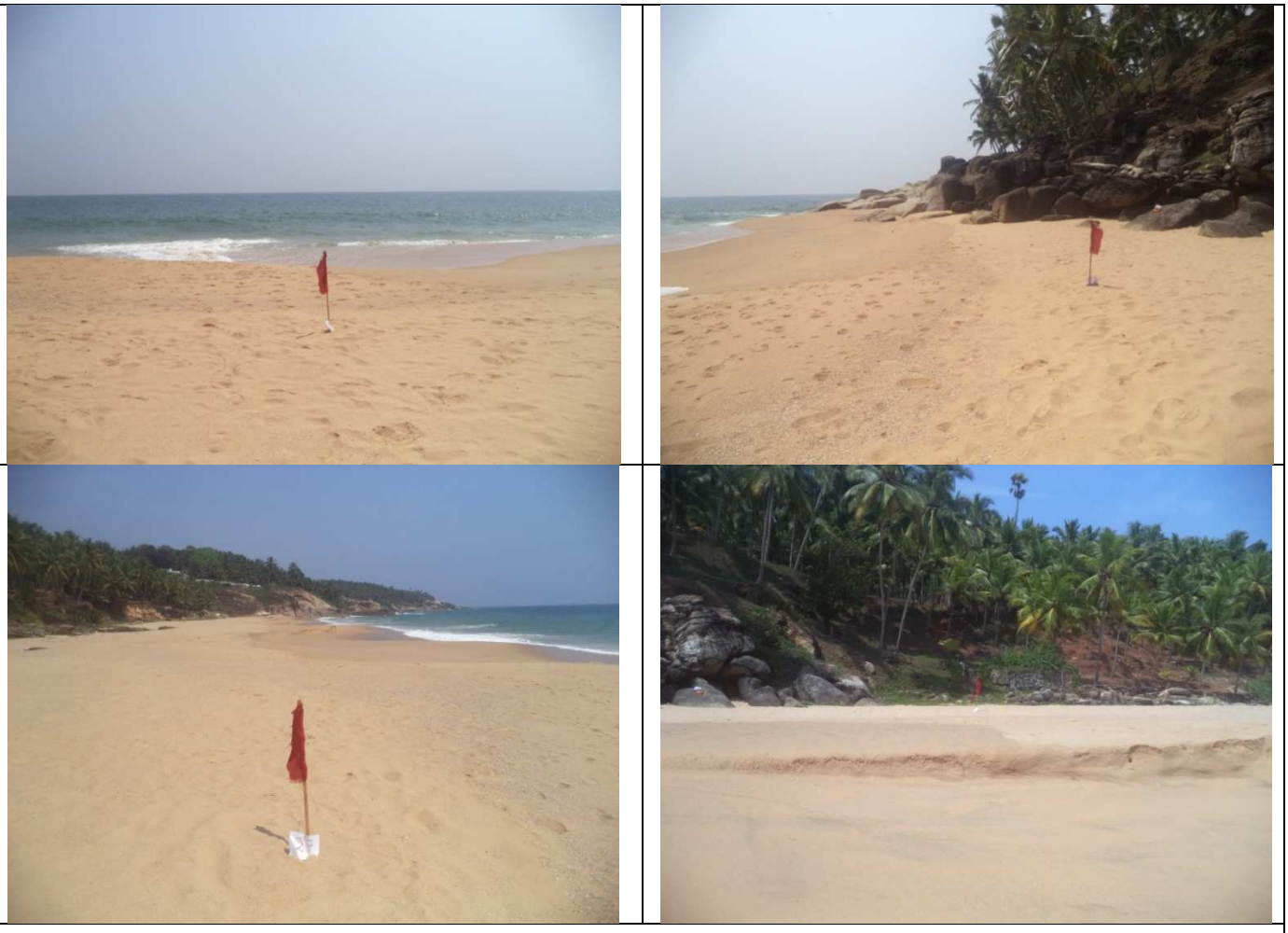


Figure 37:- April_CSP 37



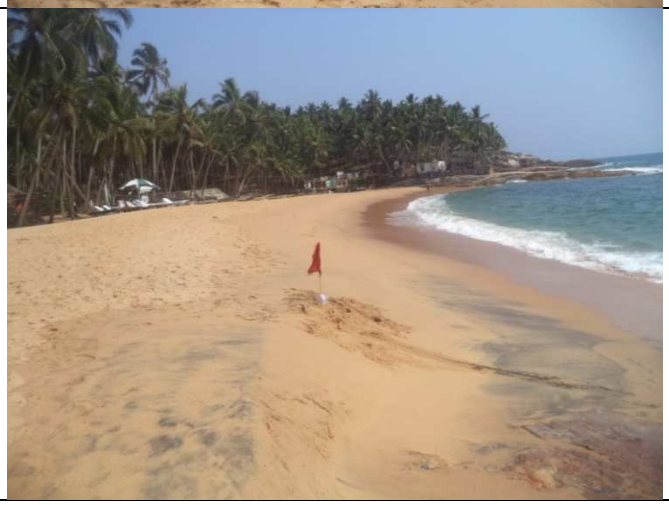



Figure 38:- April_CSP 38

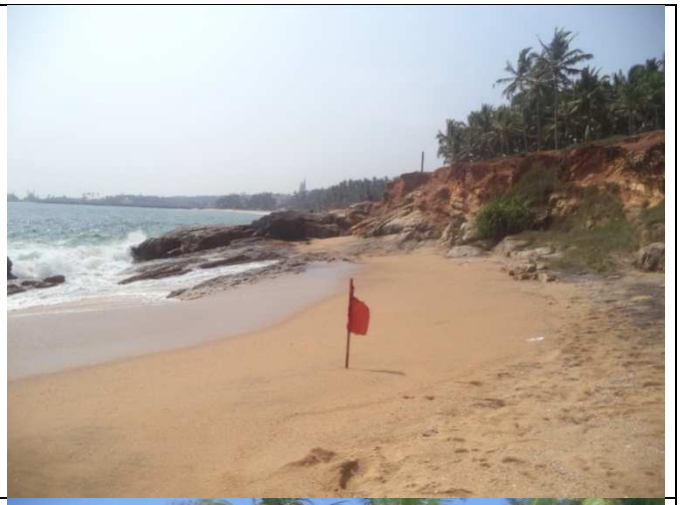





Figure 39:- April_CSP 39

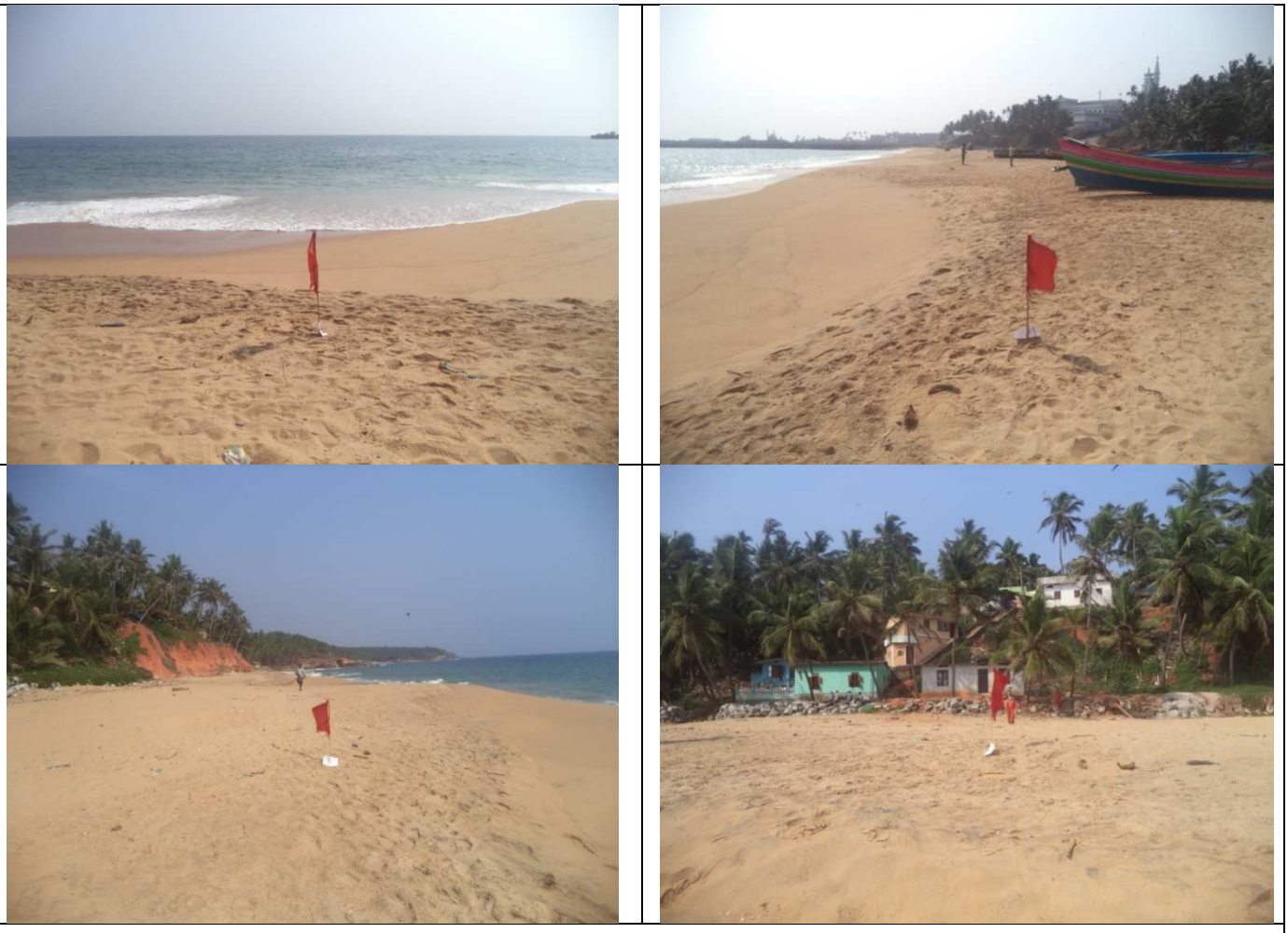


Figure 40:- April_CSP 40



Figure 41:- April_CSP 41

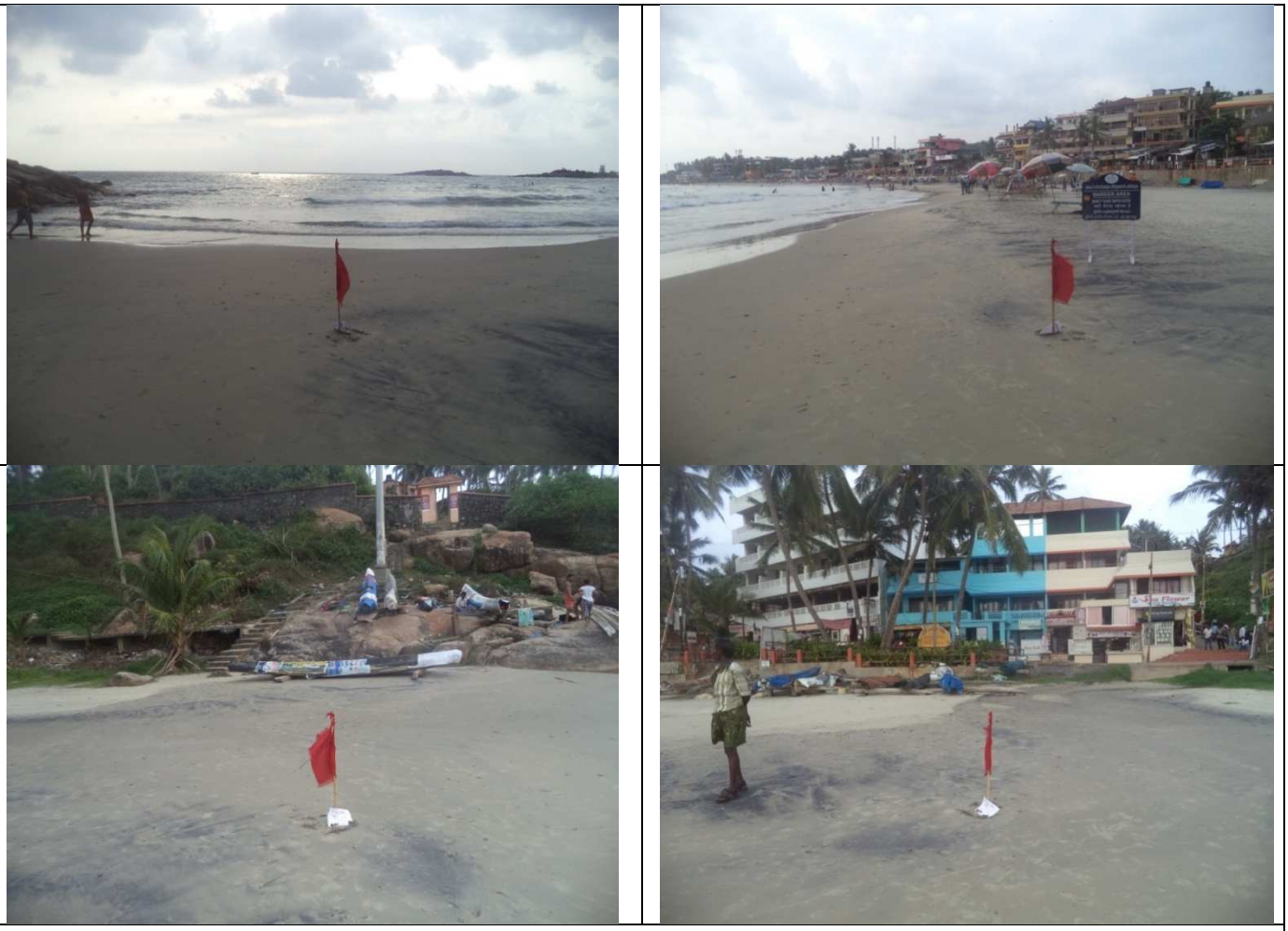


Figure 42:- April_CSP 42

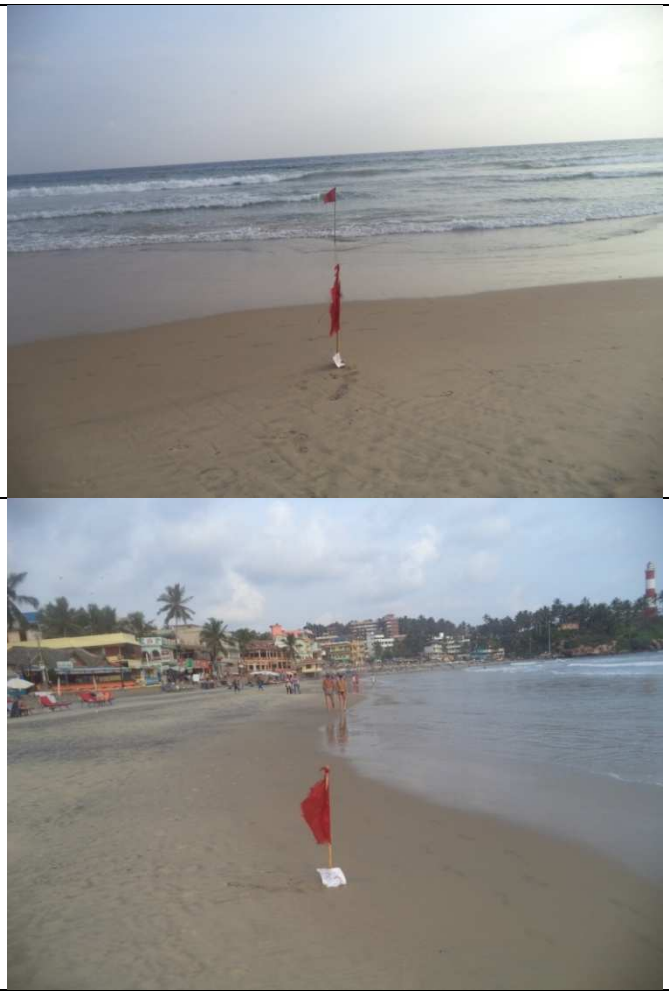



Figure 43:- April_CSP 43



Figure 44:- April_CSP 44

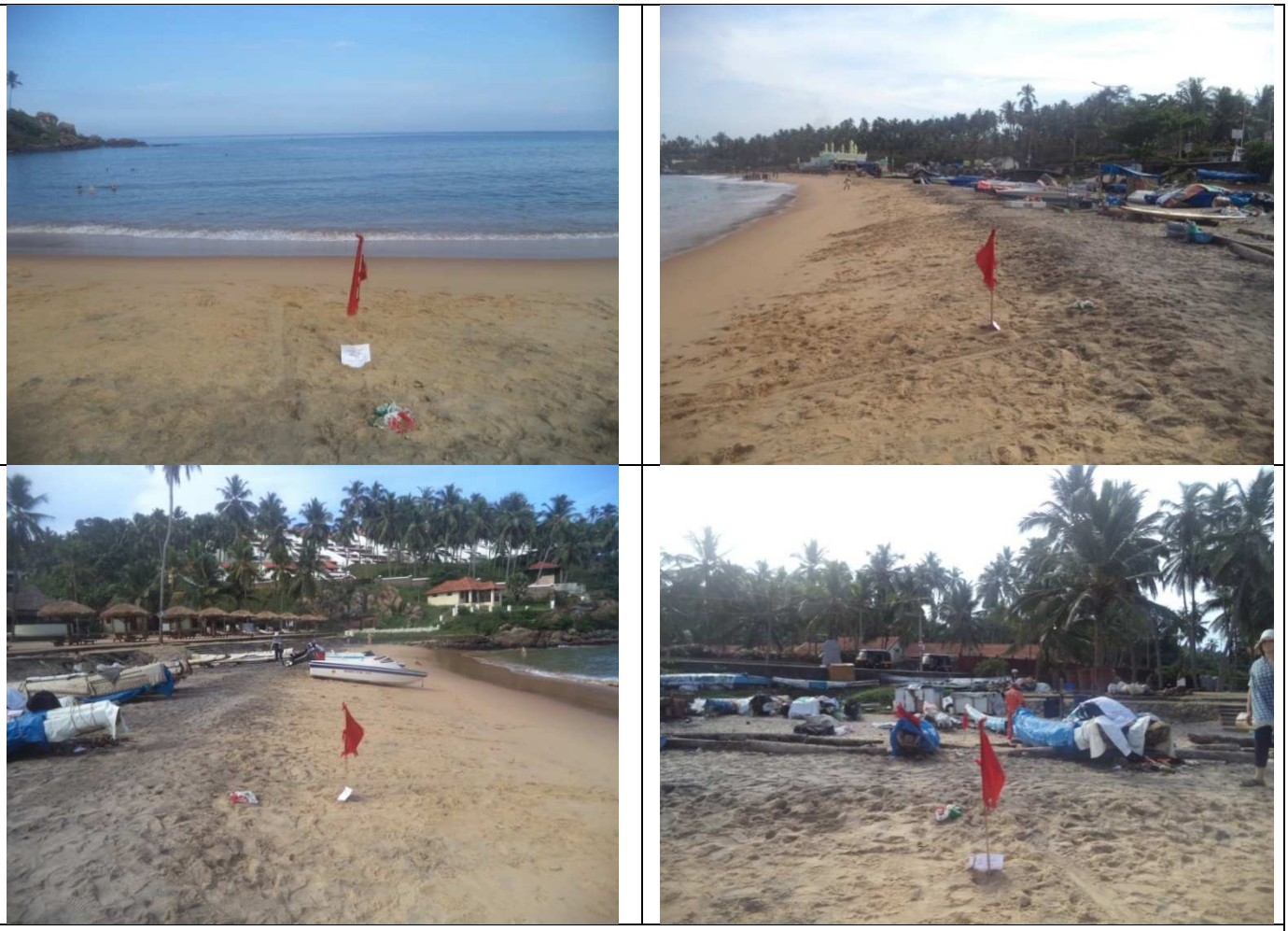


Figure 45:- April_CSP 45

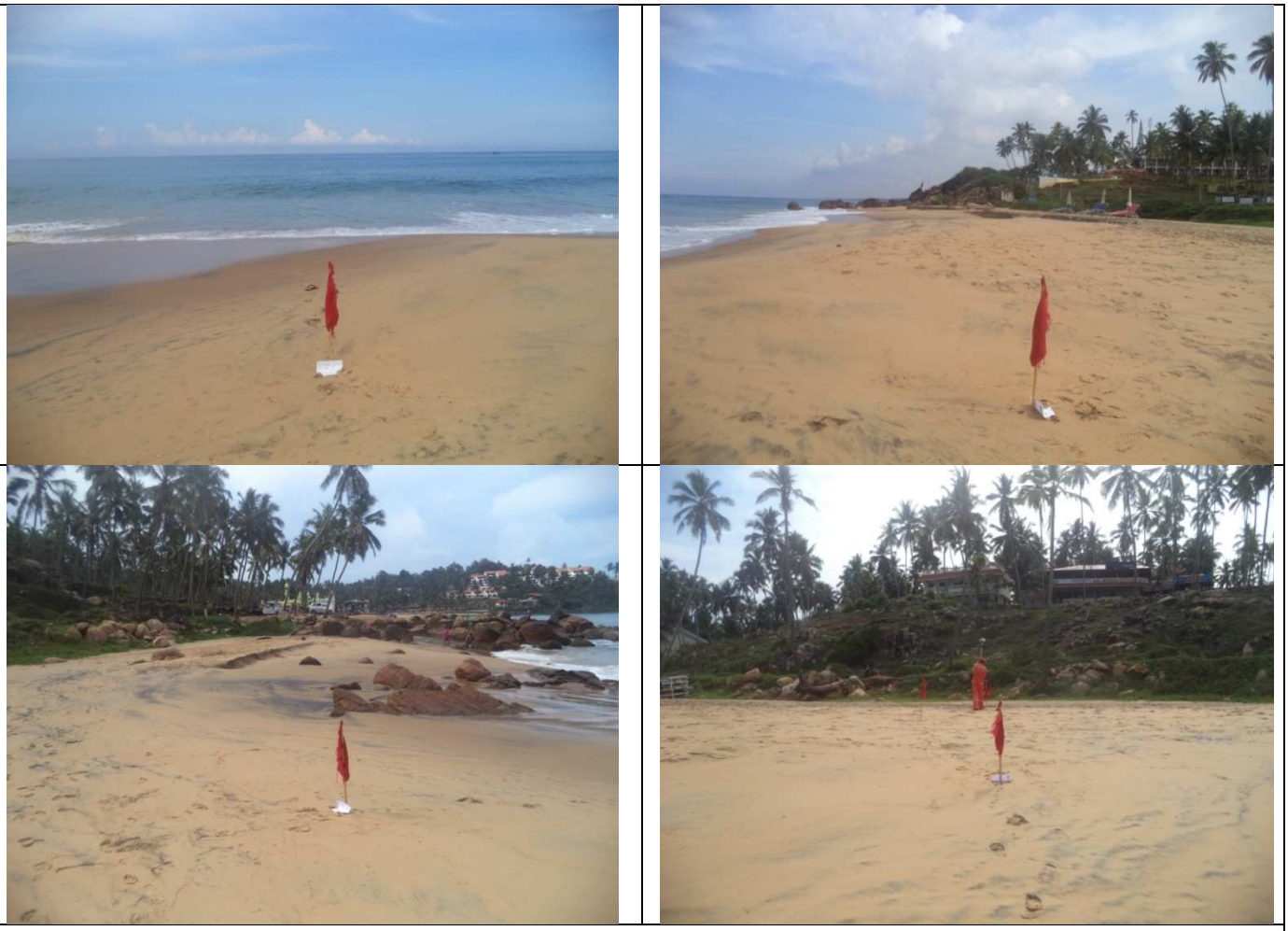


Figure 46:- April_CSP 46

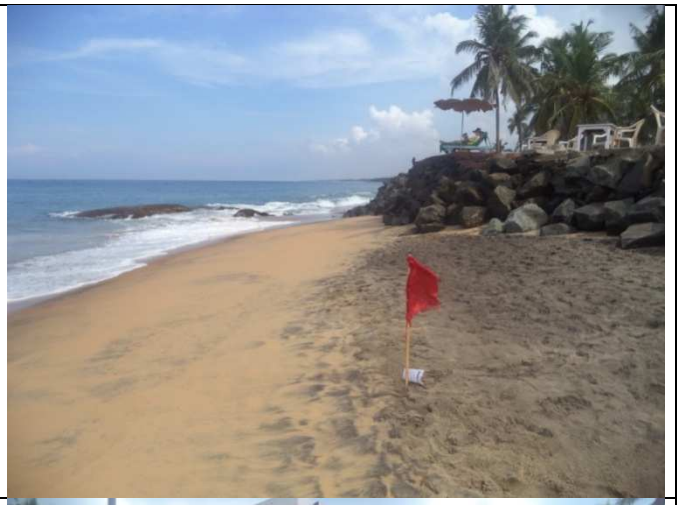
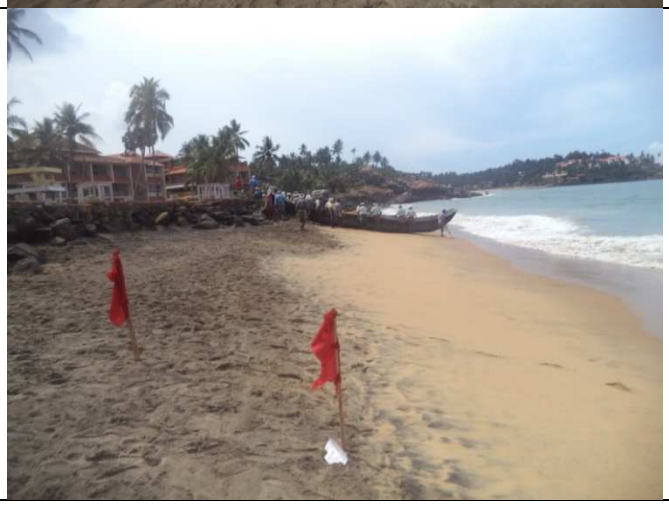





Figure 47:- April_CSP 47



Figure 48:- April_CSP 48



Figure 49:- April_CSP 49






Figure 50:- April_CSP 50

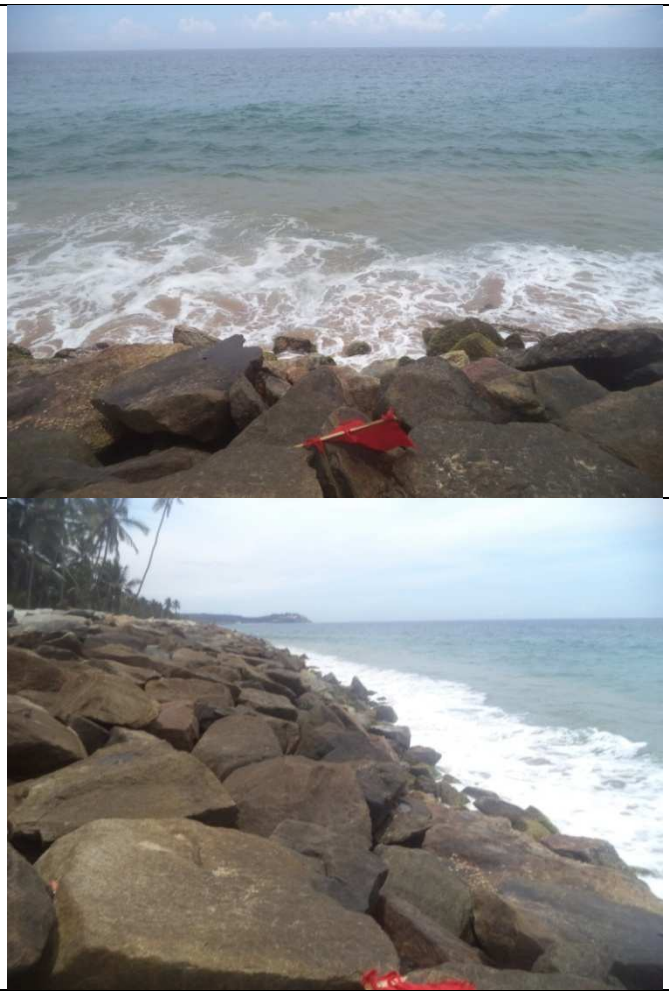



Figure 51:- April_CSP 51






Figure 52:- April_CSP 52



Figure 53:- April_CSP 53




Figure 54:- April_CSP 54

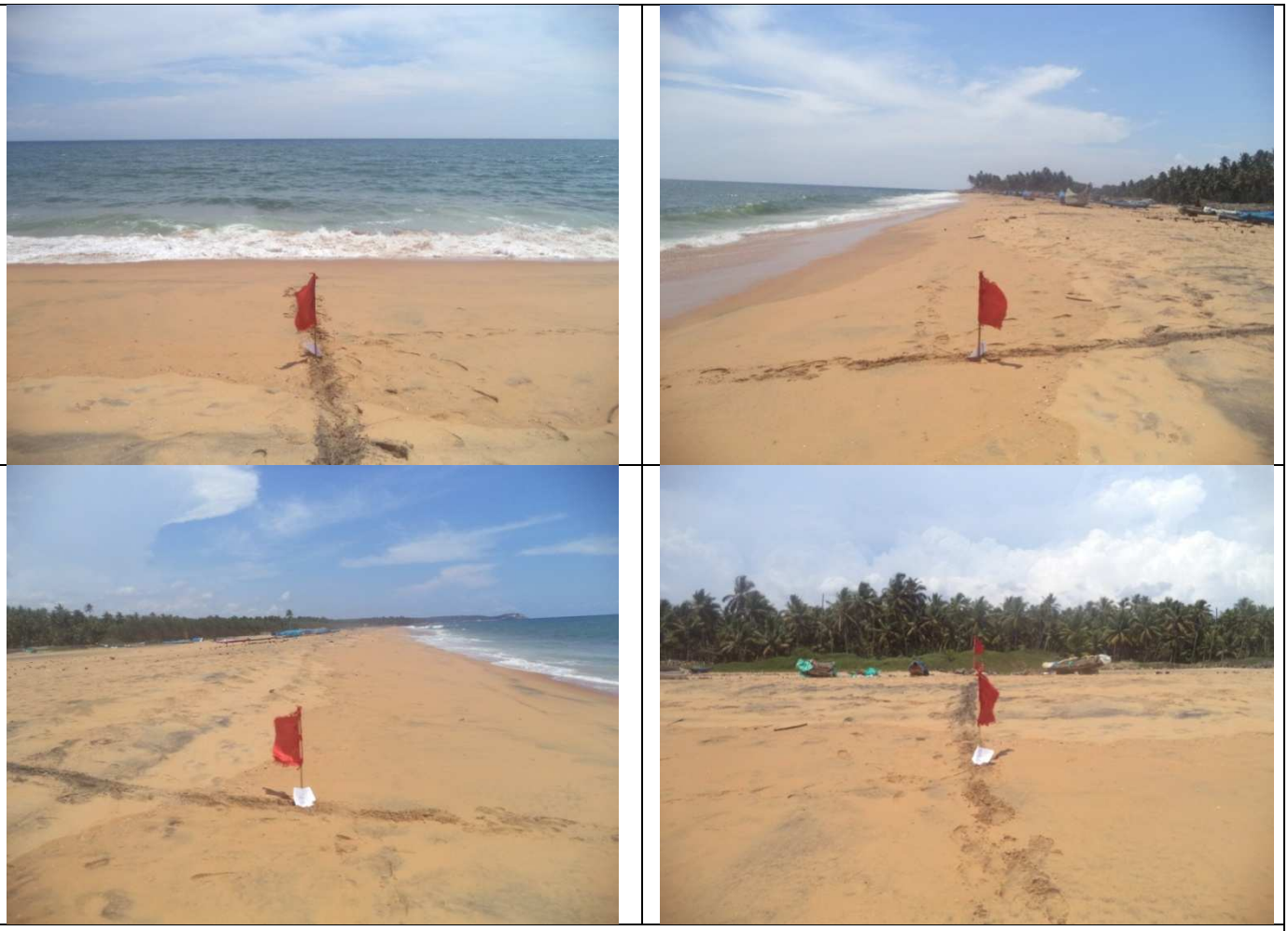


Figure 55:- April_CSP 55

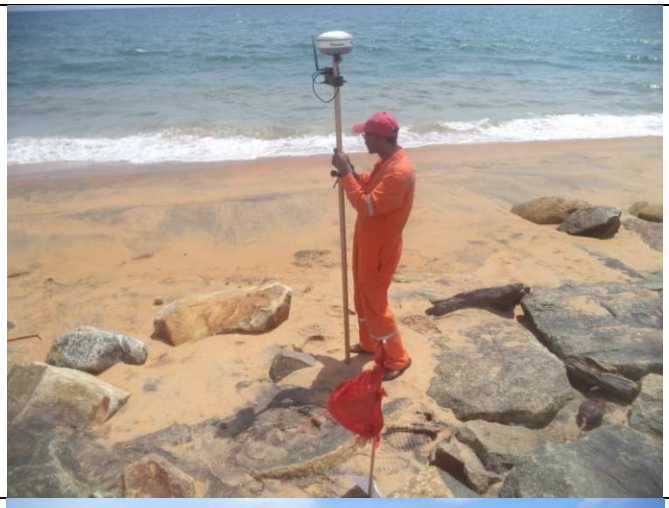





Figure 56:- April_CSP 56






Figure 57:- April_CSP 57




Figure 58:- April_CSP 58






Figure 59:- April_CSP 59




Figure 60:- April_CSP 60



Figure 61:- April_CSP 61

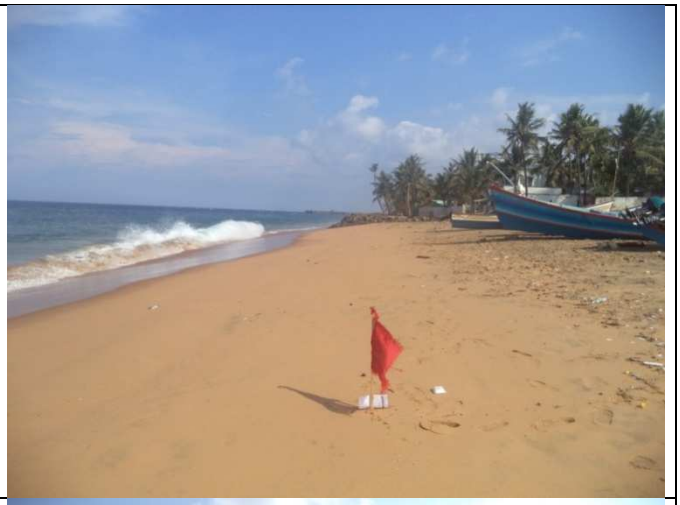





Figure 62:- April_CSP 62




Figure 63:- April_CSP 63



Figure 64:- April_CSP 64

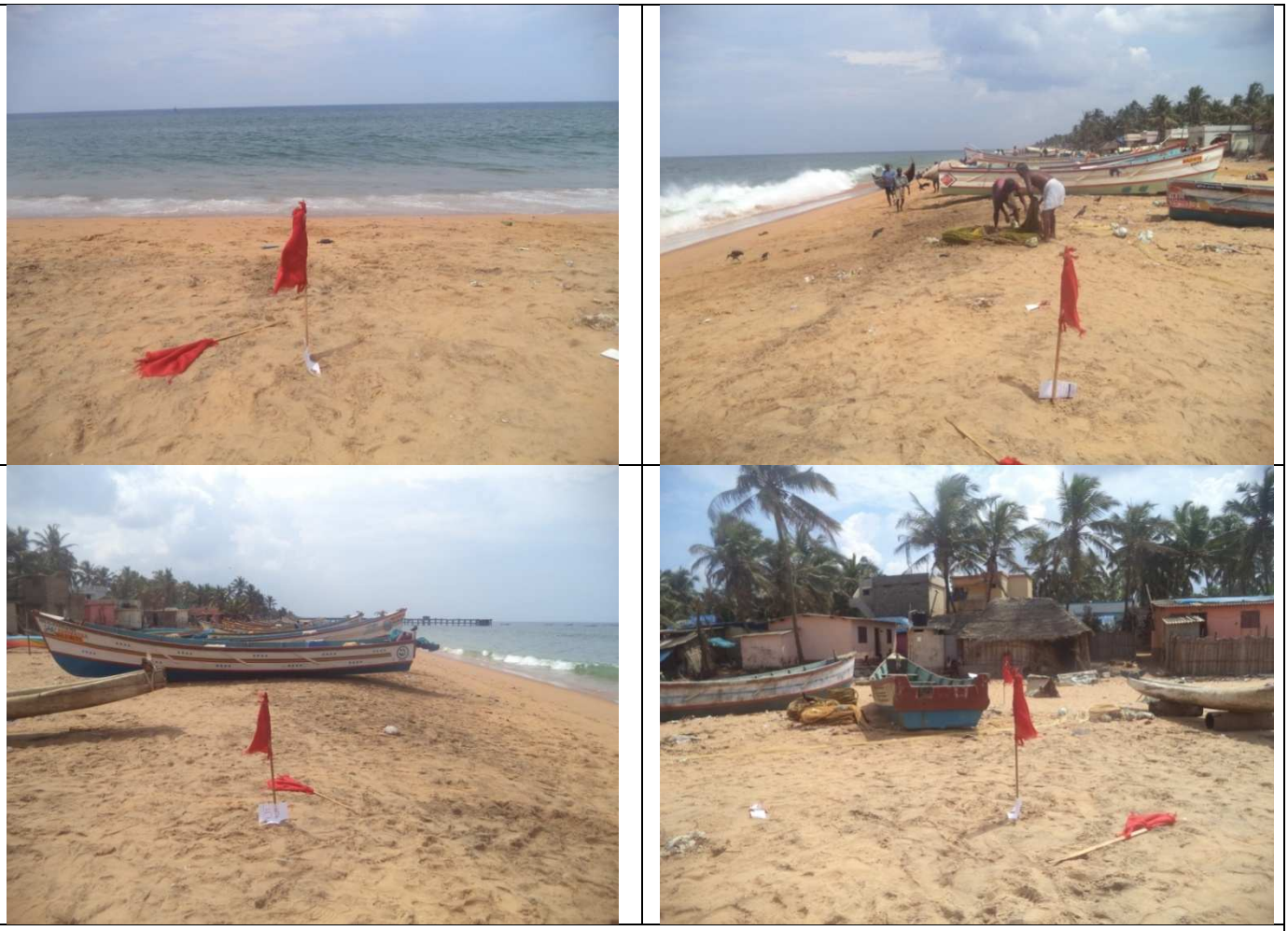


Figure 65:- April_CSP 65

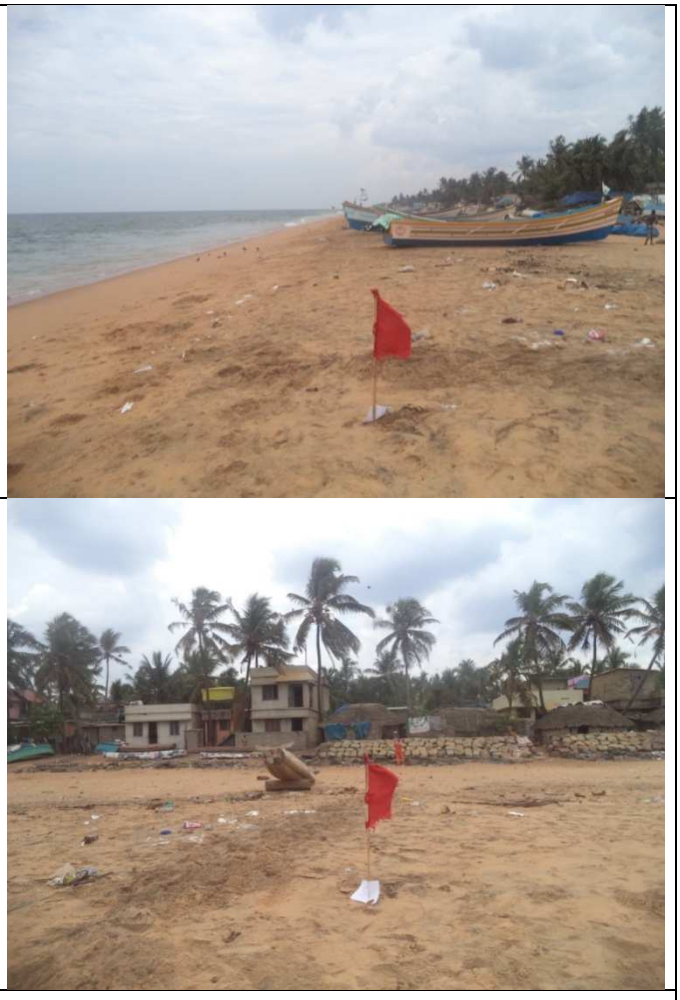



Figure 66:- April_CSP 66






Figure 67:- April_CSP 67

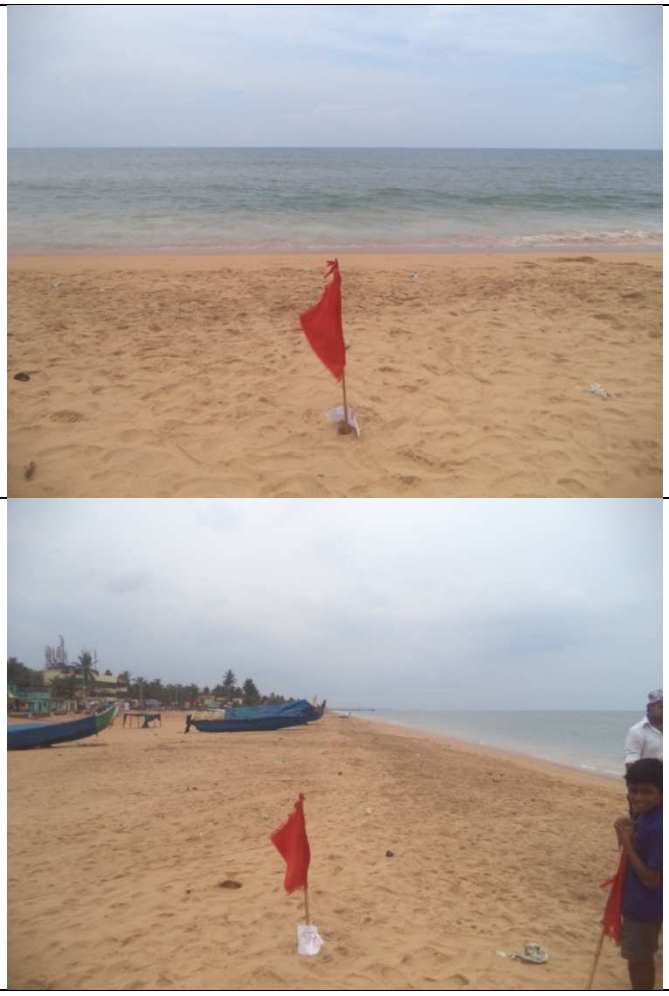


Figure 68:- April_CSP 68






Figure 69:- April_CSP 69

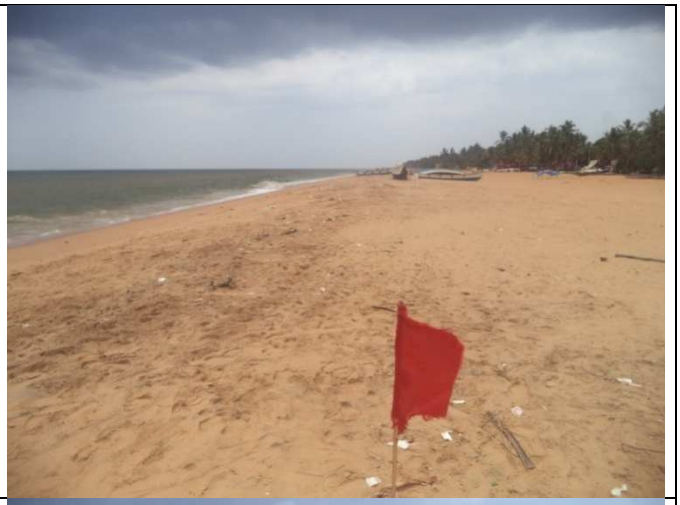





Figure 70:- April_CSP 70

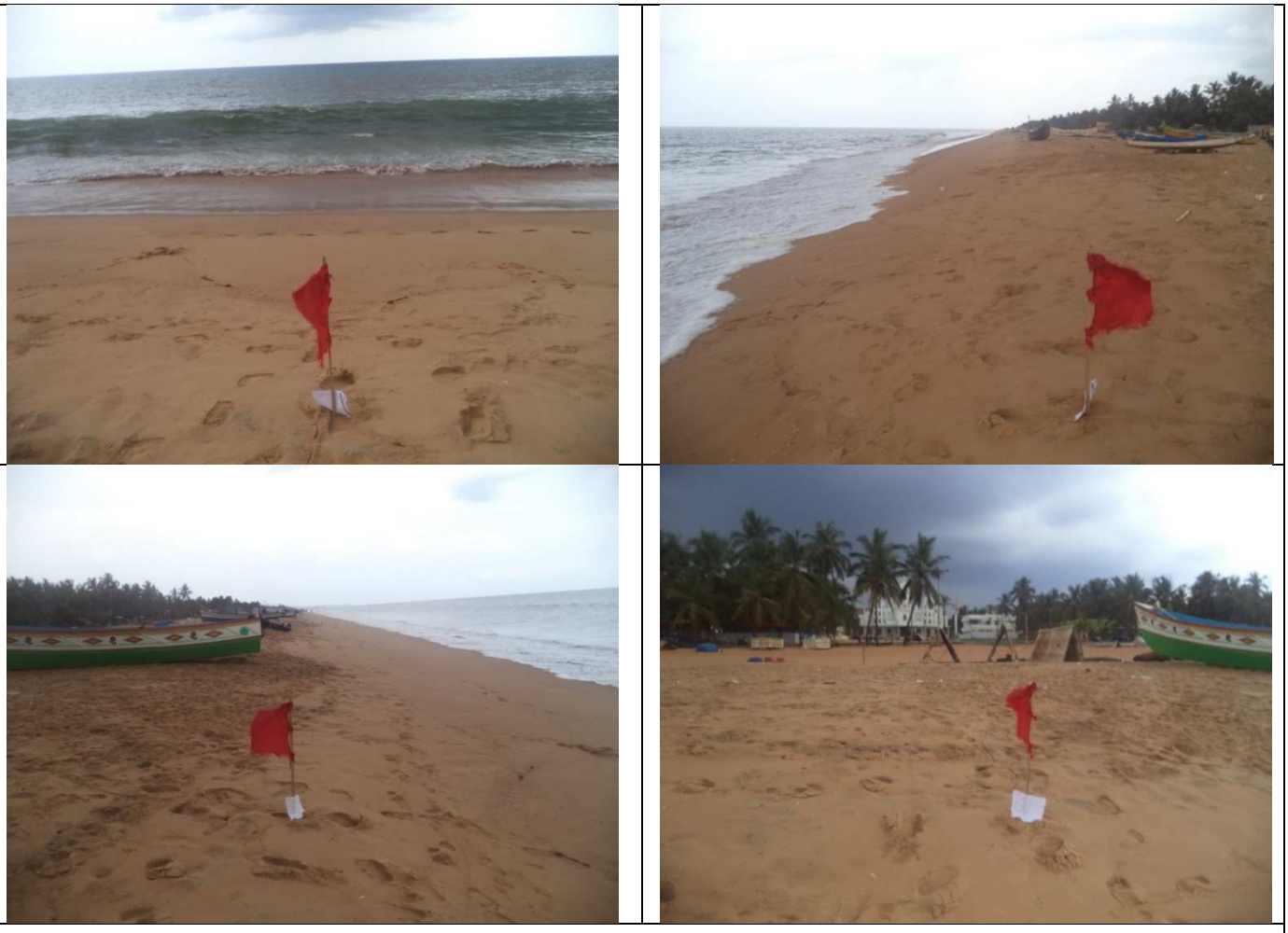


Figure 71:- April_CSP 71



Figure 72:- April_CSP 72

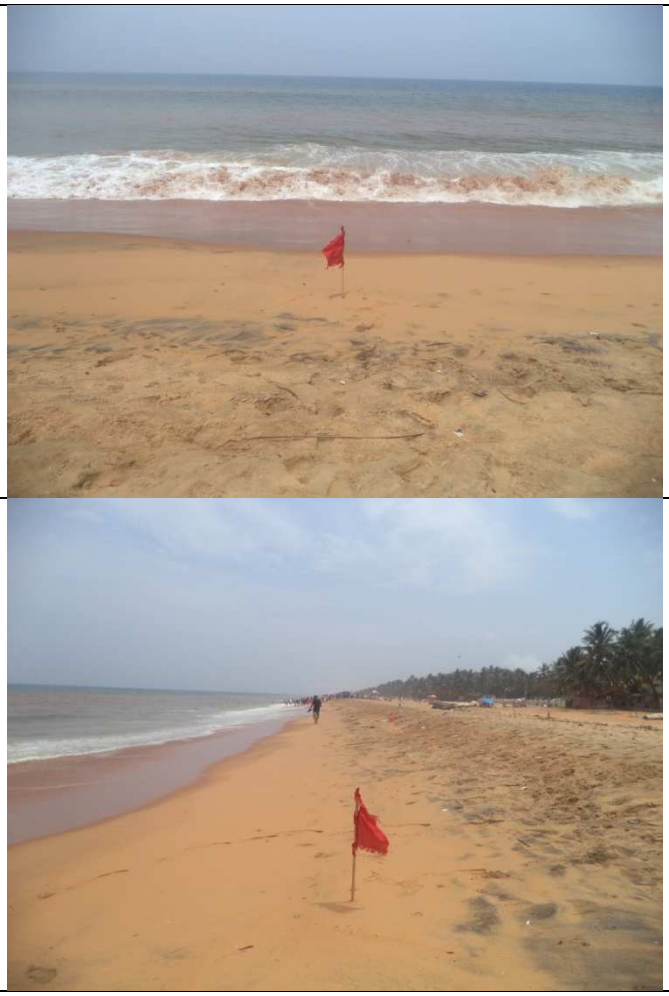



Figure 73:- April_CSP 73




Figure 74:- April_CSP 74



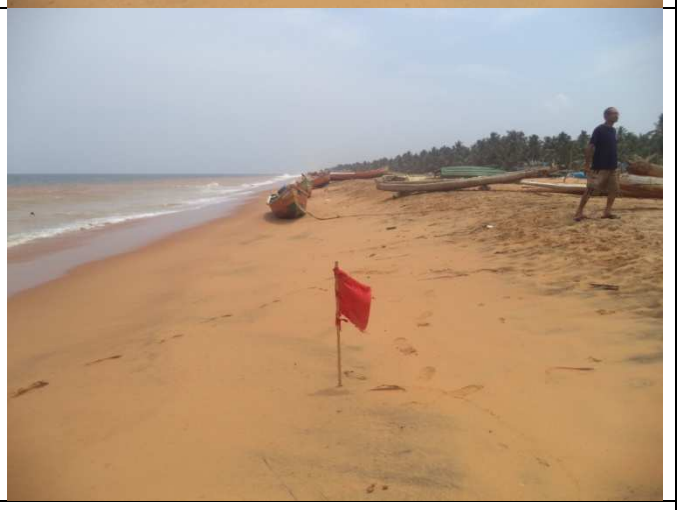



Figure 75:- April_CSP 75



Figure 76:- April_CSP 76






Figure 77:- April_CSP 77

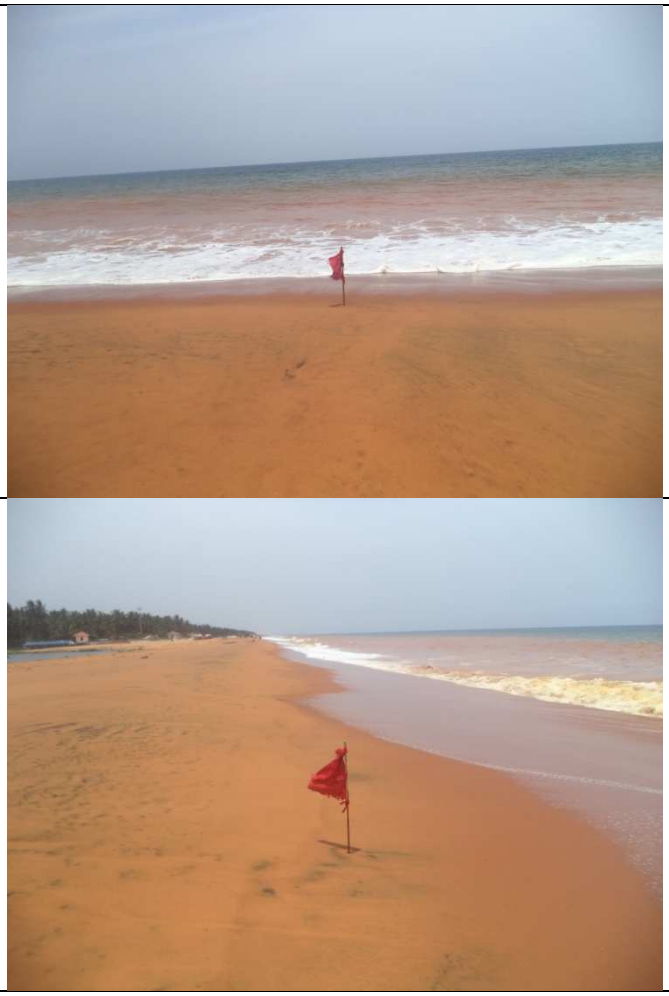



Figure 78:- April_CSP 78




Figure 79:- April_CSP 79






Figure 80:- April_CSP 80



Figure 81:- April_CSP 81

Annexure VI

LEO (March 2015)

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
18/03/2015	CSP 11	08:43	08:55	730817	917373	730657	917473	0.26	302	R	85	1.1	12	15	
18/03/2015	CSP 12	09:16	09:28	730549	917568	730336	917711	0.36	304	R	89	1.2	10	15	
18/03/2015	CSP 13	09:39	09:51	730149	917865	729961	917997	0.32	305	R	90	1.2	12	20	
18/03/2015	CSP 14	10:07	10:19	729746	918163	729545	918301	0.34	304	R	90	0.8	12	20	
18/03/2015	CSP 15	10:20	10:32	729345	918462	729130	918595	0.35	302	R	89	1.2	15	20	
18/03/2015	CSP 16	10:53	11:04	728939	918733	728807	918801	0.23	297	R	90	1.2	15	20	
18/03/2015	CSP 17	12:46	12:58	728556	919075	728346	919227	0.36	306	R	85	1.3	10	20	
18/03/2015	CSP 18	13:12	13:22	728164	919388	727953	919534	0.43	305	R	87	1.3	10	20	
18/03/2015	CSP 19	13:43	13:55	727765	919687	727492	919881	0.47	305	R	85	0.5	10	15	
18/03/2015	CSP 20	14:08	14:20	727370	919983	727187	920109	0.31	305	R	86	0.8	10	15	
18/03/2015	CSP 21	14:38	14:50	726964	920286	726728	920437	0.39	303	R	88	1.5	10	15	
18/03/2015	CSP 22	15:00	15:12	726572	920599	726388	920730	0.31	305	R	87	1.1	10	20	
18/03/2015	CSP 23	16:37	16:49	726188	920918	725985	921072	0.35	307	R	83	1.1	10	25	
18/03/2015	CSP 24	17:05	17:17	725805	921238	725607	921396	0.35	309	R	78	1.2	7.5	20	
18/03/2015	CSP 25	17:27	17:39	725418	921561	725184	921739	0.41	307	R	79	1.1	7.5	20	
20/03/2015	CSP 26	09:25	09:37	725030	921877	724793	922033	0.39	303	R	75	1.8	15	20	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
20/03/2015	CSP 27	09:43	09:55	724634	922188	724479	922288	0.26	303	R	78	1.8	12	15	
20/03/2015	CSP 28	10:25	10:37	724241	922489	724049	922605	0.31	301	R	75	1.8	12	20	
20/03/2015	CSP 29	11:00	11:12	723849	922783	723627	922930	0.37	303	R	76	1.8	12	15	
20/03/2015	CSP 30	11:30	11:42	723456	923060	723252	923198	0.34	304	R	80	1.8	10	15	
20/03/2015	CSP 31	12:08	12:20	723052	923364	722837	923501	0.35	302	R	78	1.8	10	15	
20/03/2015	CSP 32	12:23	12:35	722635	923661	722404	923779	0.36	297	R	82	1.8	10	20	
20/03/2015	CSP 33	13:04	13:16	722253	923898	722027	923979	0.33	290	R	79	1.8	10	20	
20/03/2015	CSP 34	13:19	13:28	721805	924149	721650	924154	0.29	272	R	80	2.0	10	20	
20/03/2015	CSP 35	13:31	13:42	721439	924231	721368	924267	0.12	297	R	82	2.2	10	20	
20/03/2015	CSP 36	15:10	15:22	721129	924813	721060	924835	0.10	288	R	85	1.8	12	20	
20/03/2015	CSP 37	15:33	15:45	720788	925175	720740	925174	0.07	269	R	78	1.8	10	20	
20/03/2015	CSP 38	16:31	16:43	720597	925648	720571	925654	0.04	284	R	75	1.8	10	10	
20/03/2015	CSP 39	16:58	17:10	720215	926027	720172	926053	0.07	301	R	75	1.8	12	15	
20/03/2015	CSP 40	17:19	17:31	719811	926391	719650	926432	0.23	284	R	77	1.8	10	10	
21/03/2015	CSP 41	08:25	08:37	718538	926895	718469	926901	0.10	275	R	78	0.2	10	15	
21/03/2015	CSP 42	08:58	09:10	718021	927278	717962	927385	0.17	331	R	80	0.3	12.5	20	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
21/03/2015	CSP 43	09:15	09:27	717797	927544	717684	927545	0.16	270	R	80	0.3	10	20	
21/03/2015	CSP 44	09:33	09:45	717500	927907	717394	927953	0.16	294	R	80	0.3	10	20	
21/03/2015	CSP 45	11:16	11:28	717239	928523	717241	928624	0.14	1	R	85	0.3	10	15	
21/03/2015	CSP 46	11:30	11:42	717248	928877	717204	928920	0.09	314	R	80	0.3	10	15	
21/03/2015	CSP 47	13:20	13:32	717065	929305	717022	929341	0.08	310	R	83	0.3	12.5	10	
21/03/2015	CSP 48	13:40	13:52	716792	929947	716741	929980	0.08	303	R	80	0.8	12.5	10	
21/03/2015	CSP 49	14:00	14:12	716604	930232						85	0.8	15	10	Seawall
21/03/2015	CSP 50	14:23	14:35	716345	930660	716256	930778	0.21	323	R	78	0.3	10	15	
21/03/2015	CSP 51	14:45	14:57	716075	931083	716040	931113	0.06	311	R	76	0.3	10	15	
21/03/2015	CSP 52	14:57	15:09	715782	931490	715746	931501	0.05	287	R	75	0.3	12.5	15	
23/03/2015	CSP 53	08:57	09:09	715511	931926	715388	932012	0.21	305	R	80	0.3	10	15	
23/03/2015	CSP 54	09:18	09:30	715191	932290	715075	932405	0.23	315	R	78	0.3	12.5	15	
23/03/2015	CSP 55	09:48	10:04	714872	932675	714756	932769	0.15	309	R	75	0.3	12.5	15	
23/03/2015	CSP 56	10:13	10:18	714523	933017	714449	933054	0.27	297	R	75	0.3	12.5	15	
23/03/2015	CSP 57	11:43	11:55	714201	933387	714136	933397	0.09	279	R	78	0.3	12.5	15	
23/03/2015	CSP 58	12:07	12:19	713896	933794	713848	933797	0.07	274	R	75	0.3	12.5	15	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
23/03/2015	CSP 59	12:31	12:43	713259	934569	713219	934596	0.07	304	R	78	0.3	12.5	10	Seawall
23/03/2015	CSP 60	12:52	12:54	713269	934575						80	0.8	10	10	Seawall
23/03/2015	CSP 61	13:12	13:40	712938	934950						75	1.1	10	15	Seawall
23/03/2015	CSP 62	13:42	13:49	712257	935701	712148	935820	0.38	317	R	75	1.1	10	15	Seawall
23/03/2015	CSP 63	14:33	14:39	711917	936054	711801	936170	0.46	315	R	77	0.8	10	15	
23/03/2015	CSP 64	14:51	15:07	711586	936435	711469	936557	0.18	316	R	76	1.2	7.5	15	
23/03/2015	CSP 65	15:24	15:36	711255	936800	711144	936928	0.24	319	R	78	1.2	7.5	20	
23/03/2015	CSP 66	16:53	17:05	710926	937169	710845	937260	0.17	318	R	76	1.2	7.5	20	
23/03/2015	CSP 67	17:14	17:26	710593	937544	710526	937616	0.14	317	R	80	1.2	7.5	20	Between Sea wall
23/03/2015	CSP 68	17:26	17:38	710260	937923	710166	938020	0.19	316	R	83	1.2	7.5	20	Between Sea wall
23/03/2015	CSP 69	17:46	17:58	710272	937933	709875	938350	0.80	316	R	73	1.2	7.5	20	Between Sea wall
23/03/2015	CSP 70	17:59	18:16	709941	938305	709854	938379	0.11	310	R	70	1.2	7.5	20	Between Sea wall
23/03/2015	CSP 71	13:33	13:45	709807	938438	709739	938510	0.14	317	R	85	0.8	10	15	Between Sea wall

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Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
29/04/2015	CSP 1	16:48	17:06	734845	914431	734674	914560	0.20	307	R	85	1.7	6	10	
29/04/2015	CSP 2	17:09	17:14	734471	914727	734429	914746	0.15	294	R	87	1.7	7	15	
29/04/2015	CSP 3	17:27	17:35	734054	915020	734037	915038	0.05	317	R	90	1.6	6	15	
29/04/2015	CSP 4	17:40	17:49	733656	915311	733619	915324	0.07	289	R	88	1.7	6	15	
29/04/2015	CSP 5	17:53	18:00	733247	915607	733211	915621	0.09	291	R	88	1.2	6	10	
29/04/2015	CSP 6	18:07	18:15	732851	915900	732766	915946	0.20	298	R	85	1.7	6	15	
29/04/2015	CSP 7	18:20	18:26	732442	916198	732411	916204	0.09	281	R	87	1.8	6	15	
29/04/2015	CSP 8	18:33	18:40	732040	916478	732031	916478	0.02	270	R	89	2	7	15	
30/04/2015	CSP 9	09:23	09:29	731625	916782	731559	916819	0.21	299	R	86	2	6	15	
29/04/2015	CSP 10	09:37	09:44	731207	917088	731171	917112	0.10	304	R	86	2	6	15	
03/04/2015	CSP 11	09:25	09:45	730817	917373	730496	917578	0.32	303	R	78	0.3	15	20	
03/04/2015	CSP 12	09:51	10:06	730549	917568	730360	917696	0.25	304	R	75	0.4	15	20	
03/04/2015	CSP 13	10:16	10:32	730149	917865	729902	918027	0.31	303	R	76	0.3	15	15	
03/04/2015	CSP 14	11:00	11:18	729746	918163	729501	918316	0.27	302	R	76	0.5	15	15	
03/04/2015	CSP 15	11:23	11:36	729345	918462	729176	918566	0.25	302	R	77	0.8	12.5	15	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
03/04/2015	CSP 16	11:50	11:58	728939	918733	728831	918777	0.24	292	R	78	1.2	10	20	
03/04/2015	CSP 17	14:12	14:34	728556	919075	728381	919190	0.16	303	R	95	1	10	15	
03/04/2015	CSP 18	14:48	15:03	728164	919388	727972	919510	0.25	303	R	100	1.4	10	20	
03/04/2015	CSP 19	15:11	15:27	727765	919687	727537	919837	0.28	303	R	95	1.5	10	15	
03/04/2015	CSP 20	15:33	15:47	727370	919983	727212	920076	0.22	300	R	95	1.2	10	15	
03/04/2015	CSP 21	15:55	16:07	726964	920286	726776	920404	0.31	302	R	98	1.3	10	15	
03/04/2015	CSP 22	16:13	16:26	726572	920599	726413	920709	0.25	305	R	100	1.2	7.5	15	
03/04/2015	CSP 23	16:39	16:52	726188	920918	726048	921014	0.22	304	R	100	1.2	7.5	15	
04/04/2015	CSP 24	09:18	09:31	725805	921238	725650	921351	0.25	306	R	95	0.4	15	15	
04/04/2015	CSP 25	10:19	10:28	725418	921561	725278	921652	0.31	303	R	95	0.7	12.5	20	
04/04/2015	CSP 26	10:48	10:59	725030	921877	724841	921998	0.34	303	R	97	0.8	12.5	20	
04/04/2015	CSP 27	11:23	11:34	724634	922188	724472	922293	0.29	303	R	98	0.8	12.5	15	
04/04/2015	CSP 28	11:52	12:06	724241	922489	724067	922603	0.25	303	R	100	0.7	12.5	15	
04/04/2015	CSP 29	12:14	12:26	723849	922783	723706	922873	0.23	302	R	110	1.2	12.5	15	
04/04/2015	CSP 30	13:06	13:11	723456	923060	723388	923093	0.25	296	R	115	0.8	10	15	
04/04/2015	CSP 31	15:41	15:58	723052	923364	722821	923513	0.27	303	R	115	1.2	10	15	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
04/04/2015	CSP 32	16:17	16:30	722635	923661	722444	923768	0.28	299	R	120	1.2	7.5	20	
05/04/2015	CSP 33	10:08	10:25	722253	923898	722008	924012	0.27	295	R	95	0.4	15	15	
05/04/2015	CSP 34	10:43	11:01	721805	924149	721589	924200	0.21	283	R	95	0.3	15	15	
05/04/2015	CSP 35	11:19	11:33	721417	924301	721298	924321	0.14	279	R	95	0.4	15	15	
05/04/2015	CSP 36	13:44	13:54	721129	924813	721086	924834	0.08	296	R	94	0.8	15	20	
05/04/2015	CSP 37	14:09	14:18	720788	925175	720690	925190	0.18	279	R	93	0.8	12.5	20	
05/04/2015	CSP 38	14:38	14:49	720597	925648	720548	925674	0.08	298	R	96	0.7	12.5	10	
05/04/2015	CSP 39	15:04	15:12	720215	926027	720163	926048	0.12	292	R	93	0.8	12.5	10	
05/04/2015	CSP 40	15:25	15:39	719811	926391	719715	926418	0.12	286	R	94	0.8	12.5	20	
06/04/2015	CSP 41	03:47	03:52	718538	926895	718431	926938	0.38	292	R	93	0.6	12.5	20	
06/04/2015	CSP 42	04:48	04:53	718021	927278	717983	927352	0.28	333	R	93	0.8	10	20	
06/04/2015	CSP 43	05:00	05:05	717797	927544	717717	927540	0.27	267	R	92	0.8	10	20	
06/04/2015	CSP 44	05:37	05:42	717500	927907	717416	927957	0.33	301	R	93	0.8	12.5	20	
11/04/2015	CSP 45	08:59	09:05	717239	928523	717239	928614	0.25	360	R	87	0.4	20	20	
11/04/2015	CSP 46	09:39	09:45	717248	928877	717193	928921	0.20	309	R	88	0.4	15	20	
11/04/2015	CSP 47	09:50	09:57	717065	929305	717028	929358	0.15	325	R	76	0.4	15	20	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
11/04/2015	CSP 48	10:28	10:40	716792	929947	716663	930124	0.30	324	R	83	0.3	15	15	
11/04/2015	CSP 49										84	0.4	12.5	10	Seawall
11/04/2015	CSP 50										82	0.4	12.5	10	Seawall
11/04/2015	CSP 51										86	0.4	10	10	Seawall
11/04/2015	CSP 52										82	0.4	10	10	Seawall
11/04/2015	CSP 53	04:42	04:55	715511	931926	715382	932038	0.22	311	R	87	1.7	10	15	
11/04/2015	CSP 54	05:02	05:15	715191	932290	715039	932405	0.24	307	R	88	0.8	10	15	
12/04/2015	CSP 55	13:52	14:01	714872	932675	714726	932806	0.36	312	R	94	0.8	10	15	
12/04/2015	CSP 56	14:08	14:22	714523	933017	714384	933132	0.21	310	R	95	0.8	10	15	
12/04/2015	CSP 57	14:32	14:47	714201	933387	714057	933509	0.21	310	R	96	0.4	12.5	15	
12/04/2015	CSP 58	15:19	15:28	713896	933794	713786	933897	0.28	313	R	88	0.8	10	15	
12/04/2015	CSP 59	15:35	15:48	713596	934170	713559	934181	0.05	287	R	93	0.7	10	10	Seawall
12/04/2015	CSP 60	15:54	16:08	713269	934575	713219	934595	0.06	292	R	84	0.8	10	10	Seawall
12/04/2015	CSP 61	16:18	16:30	712938	934950	712889	934978	0.08	300	R	85	0.8	10	10	Seawall
13/04/2015	CSP 62	08:59	09:07	712620	935343	712573	935345	0.10	273	R	85	0.8	10	15	Seawall
13/04/2015	CSP 63	09:32	09:45	712285	935706	712160	935818	0.22	312	R	83	0.8	12.5	20	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
13/04/2015	CSP 64	09:57	10:14	711927	936064	711781	936220	0.21	317	R	82	0.8	10	20	
13/04/2015	CSP 65	10:25	10:37	711604	936436	711473	936562	0.25	314	R	84	0.8	10	20	
13/04/2015	CSP 66	10:58	11:10	711269	936809	711216	936837	0.08	297	R	87	0.8	10	15	
13/04/2015	CSP 67	11:40	11:52	710936	937188	710816	937305	0.23	314	R	93	0.8	10	20	Between Sea wall
13/04/2015	CSP 68	12:12	12:22	710604	937555	710473	937662	0.28	309	R	89	0.8	10	20	Between Sea wall
13/04/2015	CSP 69	12:38	12:48	710272	937933	710164	938054	0.27	318	R	85	0.8	10	20	Between Sea wall
13/04/2015	CSP 70	13:24	13:31	709941	938305	709823	938365	0.31	297	R	86	0.8	10	15	Between Sea wall
13/04/2015	CSP 71	13:38	13:45	709816	938448	709698	938520	0.33	301	R	85	0.8	10	15	Between Sea wall
30/04/2015	CSP 72	11:00	11:07	709483	938821	709413	938889	0.23	314	R	87	1.7	6	15	
30/04/2015	CSP 73	11:10	11:16	709149	939199	709107	939234	0.15	310	R	88	1.4	6	15	
30/04/2015	CSP 74	11:19	11:27	708800	939573	708724	939644	0.22	313	R	86	1.3	6	15	
30/04/2015	CSP 75	11:30	11:41	708471	939953	708398	940046	0.18	322	R	86	1.4	6	15	
30/04/2015	CSP 76	11:44	11:53	708146	940336	708082	940420	0.20	323	R	88	1.4	6	15	
30/04/2015	CSP 77	11:57	12:11	707819	940723	707743	940802	0.13	316	R	87	1.3	6	15	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
30/04/2015	CSP 78	12:30	12:37	707515	941094	707448	941197	0.29	327	R	89	1.3	6	15	
30/04/2015	CSP 79	12:42	12:50	707242	941484	707183	941535	0.16	311	R	90	1.3	7	15	
30/04/2015	CSP 80	12:58	13:08	706912	941886	706869	941948	0.13	325	R	90	1.3	5	10	
30/04/2015	CSP 81	13:15	13:21	706609	942278	706532	942374	0.34	321	R	90	1.3	5	10	

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Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
13/05/2015	CSP 01	10:17	10:26	734893	914466	734804	914532	0.20	307	R	77	0.8	10	10	
13/05/2015	CSP 02	10:44	10:52	734473	914739	734404	914784	0.17	304	R	78	0.8	10	10	
13/05/2015	CSP 03	11:17	11:24	734067	915028	733987	915078	0.22	302	R	78	0.8	10	10	
13/05/2015	CSP 04	11:39	11:46	733658	915317	733612	915350	0.13	306	R	77	0.8	10	10	
13/05/2015	CSP 05	13:10	13:33	733612	915350	733108	915707	0.45	305	R	83	0.8	7.5	15	
13/05/2015	CSP 06	13:40	13:51	732847	915905	732693	916014	0.29	306	R	81	0.8	7.5	15	
13/05/2015	CSP 07	13:55	14:06	732439	916199	732304	916296	0.25	306	R	82	0.8	7.5	15	
13/05/2015	CSP 08	14:04	14:14	732129	916410	731995	916519	0.29	309	R	78	0.8	7.5	15	
14/05/2015	CSP 09	08:42	08:52	731624	916781	731504	916860	0.24	303	R	88	0.4	10	20	
14/05/2015	CSP 10	08:50	09:09	731217	917076	730835	917360	0.42	307	R	76	0.3	10	20	
14/05/2015	CSP 11	09:14	09:20	730811	917372	730748	917422	0.22	308	R	74	0.3	10	20	
14/05/2015	CSP 12	09:24	09:29	730551	917567	730487	917605	0.25	301	R	77	0.3	10	20	
14/05/2015	CSP 13	09:35	09:41	730147	917869	730031	917953	0.40	306	R	78	0.3	10	20	
14/05/2015	CSP 14	09:50	09:56	729749	918165	729662	918227	0.30	306	R	76	0.3	10	20	
14/05/2015	CSP 15	10:03	10:11	729338	918465	729257	918524	0.21	306	R	77	0.3	10	20	
14/05/2015	CSP 16	10:18	10:25	728936	918727	728804	918809	0.37	302	R	79	0.5	10	20	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
14/05/2015	CSP 17	11:46	11:54	728554	919075	728453	919158	0.27	309	R	84	0.8	7.5	20	
14/05/2015	CSP 18	12:07	12:14	728165	919389	728053	919473	0.33	307	R	86	0.4	7.5	20	
14/05/2015	CSP 19	12:22	12:25	727767	919687	727723	919718	0.30	305	R	86	0.4	7.5	20	
14/05/2015	CSP 20	14:54	15:01	727367	919982	727293	920027	0.21	302	R	83	0.3	7.5	20	
14/05/2015	CSP 21	15:12	15:18	726961	920289	726836	920386	0.44	308	R	96	0.2	7.5	20	
14/05/2015	CSP 22	15:20	15:39	726572	920595	726238	920868	0.38	309	R	95	0.8	7.5	20	
14/05/2015	CSP 23	15:41	15:48	726187	920916	726058	921019	0.39	308	R	96	0.5	7.5	20	
14/05/2015	CSP 24	15:49	15:59	725799	921240	725567	921433	0.50	310	R	94	0.4	7.5	20	
14/05/2015	CSP 25	16:10	16:18	725403	921565	725318	921629	0.22	307	R	95	0.4	7.5	20	
15/05/2015	CSP 26	08:46	08:57	725083	921870	724961	921898	0.19	283	R	78	0.3	12.5	20	
15/05/2015	CSP 27	09:00	09:19	724627	922167	724341	922477	0.37	317	R	79	0.3	12.5	20	
15/05/2015	CSP 28	09:20	09:25	724238	922486	724136	922559	0.42	306	R	77	0.3	12.5	20	
15/05/2015	CSP 29	09:32	09:36	723847	922779	723757	922841	0.46	305	R	79	0.4	10	20	
15/05/2015	CSP 30	09:45	09:53	723449	923061	723299	923171	0.39	306	R	77	0.8	10	20	
15/05/2015	CSP 31	09:58	10:05	723036	923367	722898	923456	0.39	303	R	78	0.7	10	20	
15/05/2015	CSP 32	10:55	11:02	722610	923661	722524	923711	0.24	300	R	79	0.7	10	20	

Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
15/05/2015	CSP 33	11:10	11:14	722253	923892	722171	923956	0.43	308	R	78	0.7	10	20	
15/05/2015	CSP 34	11:23	11:27	721737	924158	721674	924195	0.31	300	R	76	0.7	10	20	
15/05/2015	CSP 35	11:33	11:40	721447	924267	721410	924290	0.10	302	R	82	0.0	10	20	
16/05/2015	CSP 36	09:47	09:53	721104	924802	721060	924826	0.14	298	R	82	0.7	10	20	
16/05/2015	CSP 37	10:44	10:53	720777	925155	720748	925176	0.07	306	R	79	0.7	10	20	
16/05/2015	CSP 38	11:18	11:21	720597	925616	720580	925637	0.15	321	R	78	0.7	10	20	
16/05/2015	CSP 39	11:55	12:02	720210	926015	720191	926019	0.05	281	R	83	0.7	10	10	
16/05/2015	CSP 40	12:10	12:15	719809	926381	719772	926394	0.13	289	R	79	0.7	10	20	
16/05/2015	CSP 41	12:45	12:50	718529	926904	718512	926898	0.06	251	R	84	0.7	7.5	20	
16/05/2015	CSP 42	14:49	15:03	718003	927290	717992	927344	0.06	348	R	83	0.7	7.5	20	
16/05/2015	CSP 43	15:05	15:13	717782	927517	717694	927535	0.19	282	R	84	0.7	7.5	20	
16/05/2015	CSP 44	15:19	15:27	717481	927877	717441	927923	0.13	319	R	86	0.7	7.5	20	
18/05/2015	CSP 45	08:47	08:53	717243	928527	717224	928566	0.12	335	R	83	0.2	10	15	
18/05/2015	CSP 46	09:03	09:08	717225	928868	717206	928894	0.11	324	R	74	0.3	10	20	
18/05/2015	CSP 47	09:15	09:20	717075	929314	717055	929317	0.07	280	R	84	0.3	10	15	
18/05/2015	CSP 48	09:36	09:43	716795	929952	716776	929974	0.07	320	R	73	0.3	10	10	

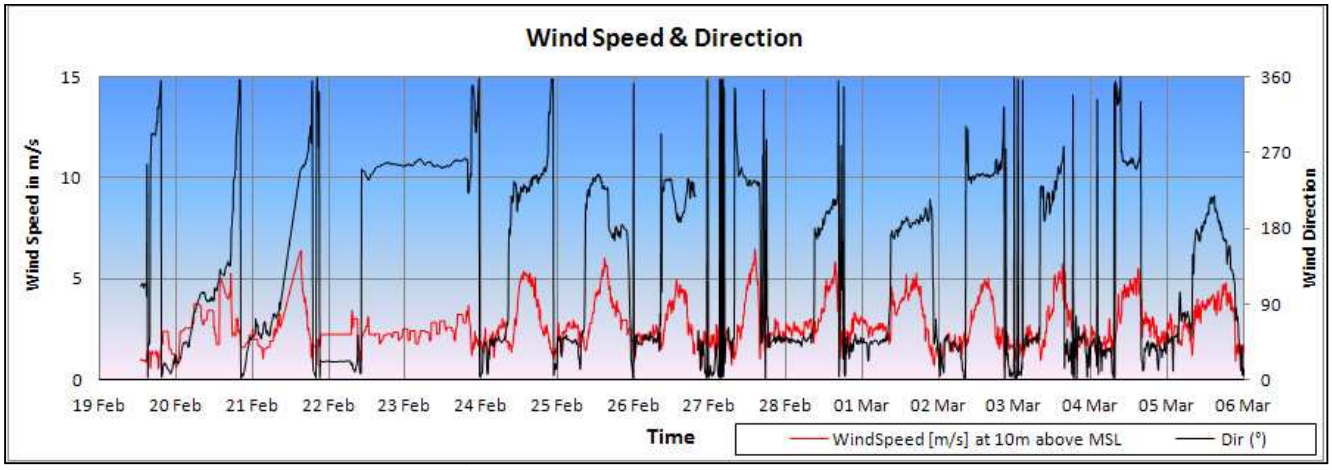
Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
18/05/2015	CSP 49	09:52									74	0.3	10	10	Seawall
18/05/2015	CSP 50	10:03									76	0.3	7.5	10	Seawall
18/05/2015	CSP 51	10:20									78	0.3	7.5	10	Seawall
18/05/2015	CSP 52	10:26									76	0.7	7.5	10	Seawall
18/05/2015	CSP 53	12:15	12:28	715560	931959	715326	932196	0.43	315	R	78	0.7	5	20	
18/05/2015	CSP 54	12:32	12:41	715223	932308	715095	932429	0.33	314	R	82	0.7	5	20	
18/05/2015	CSP 55	12:47	12:56	714876	932678	714809	932741	0.17	313	R	86	0.8	5	20	
18/05/2015	CSP 56	13:09	13:15	714515	933004	714467	933038	0.17	305	R	88	0.8	5	10	
21/05/2015	CSP 57	09:43	09:47	714200	933386	714185	933396	0.07	302	R	79	0.4	10	15	Between Sea wall
21/05/2015	CSP 58	09:55	09:57	713887	933784	713869	933801	0.21	314	R	82	0.3	10	15	Between Sea wall
21/05/2015	CSP 59	10:08	10:15	713588	934161	713550	934189	0.11	307	R	84	0.3	10	10	Between Sea wall
21/05/2015	CSP 60	10:20	10:27	713256	934569	713215	934601	0.12	308	R	85	0.3	10	15	Between Sea wall
21/05/2015	CSP 61	10:40	10:47	712924	934940	712901	934959	0.07	310	R	82	0.3	10	10	Between Sea wall

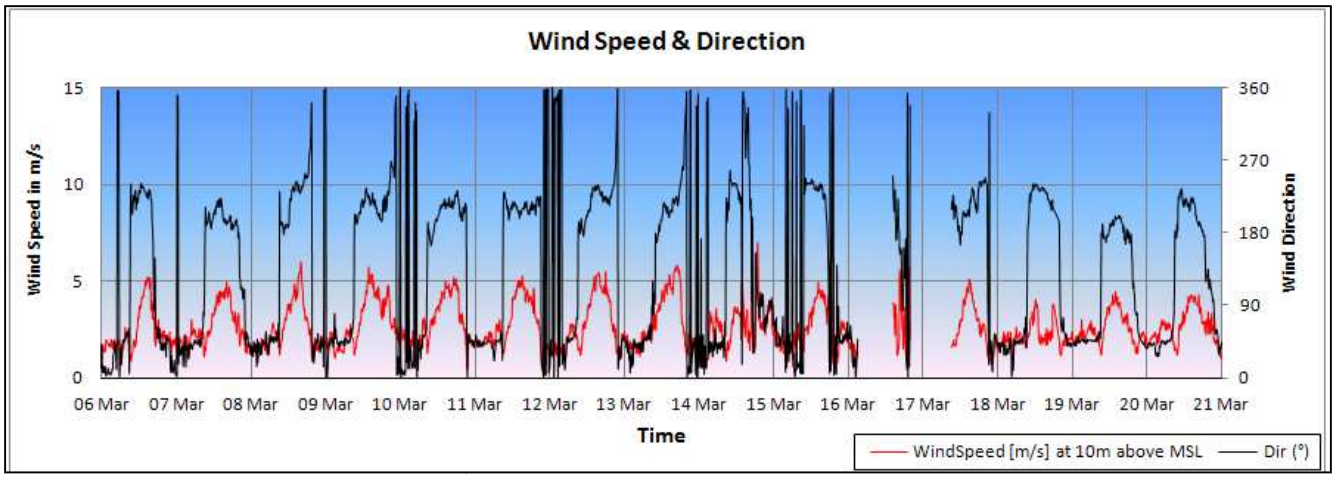
Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
21/05/2015	CSP 62	10:52	10:57	712603	935327	712567	935357	0.15	310	R	78	0.3	10	10	Between Sea wall
21/05/2015	CSP 63	11:00	11:08	712270	935690	712223	935735	0.14	314	R	77	0.7	7.5	10	Between Sea wall
21/05/2015	CSP 64	11:09	11:14	711951	936087	711918	936107	0.13	301	R	80	0.7	7.5	10	
21/05/2015	CSP 65	11:27	11:29	711611	936452	711600	936471	0.18	329	R	82	0.7	7.5	15	
21/05/2015	CSP 66	11:39	11:44	711277	936825	711207	936895	0.33	315	R	83	0.7	7.5	20	
21/05/2015	CSP 67	12:13	12:17	710938	937198	710910	937231	0.18	320	R	86	0.7	7.5	20	
21/05/2015	CSP 68	12:20	12:30	710606	937572	710552	937633	0.13	319	R	87	0.7	7.5	20	
21/05/2015	CSP 69	12:30	12:40	710281	937936	710216	938013	0.17	320	R	82	0.7	7.5	20	
21/05/2015	CSP 70	12:40	12:45	709928	938291	709869	938351	0.28	316	R	84	0.7	7.5	20	
21/05/2015	CSP 71	12:33	12:52	709821	938461	709489	938835	0.44	318	R	83	0.7	7.5	20	
21/05/2015	CSP 72	12:56	13:03	709487	938835	709402	938932	0.31	319	R	82	0.7	7.5	20	
21/05/2015	CSP 73	13:07	13:13	709160	939204	709098	939272	0.26	317	R	85	0.7	7.5	20	
21/05/2015	CSP 74	15:04	15:23	708817	939586	708535	939867	0.35	315	R	78	0.7	7.5	20	
21/05/2015	CSP 75	15:22	15:34	708486	939962	708355	940122	0.29	321	R	82	0.7	7.5	20	
21/05/2015	CSP 76	15:35	15:45	708157	940333	708062	940438	0.24	318	R	83	0.7	7.5	20	

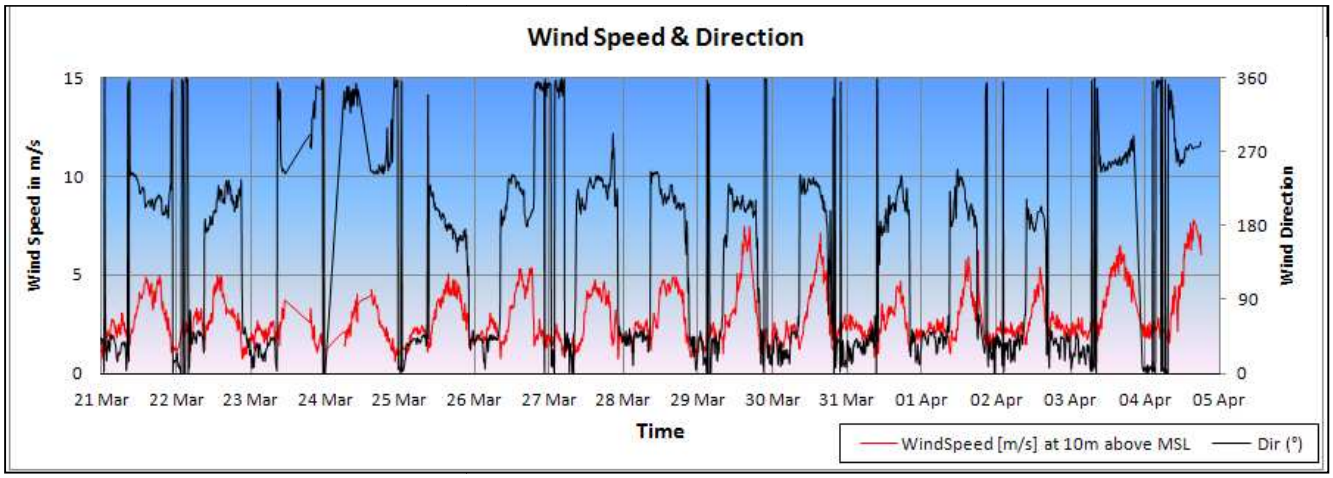
Date	Location No	Start Time	End Time	UTM Co-ordinates				Speed Over Ground (cm/s)	Course over Ground (°)	Current direction (L/R)	Breaker angle (°)	Wave height (m)	Wave period (s)	Surf zone width (m)	Remarks
				Start Point		End point									
				Easting	Northing	Easting	Northing								
21/05/2015	CSP 77	15:45	15:55	707850	940721	707726	940832	0.28	312	R	85	0.7	7.5	20	
21/05/2015	CSP 78	15:58	16:12	707562	941128	707401	941236	0.23	304	R	84	0.7	7.5	20	
21/05/2015	CSP 79	16:06	16:18	707239	941505	707097	941645	0.28	315	R	83	0.7	7.5	20	
21/05/2015	CSP 80	16:23	16:38	706896	941886	706753	942081	0.27	324	R	79	0.7	7.5	20	
21/05/2015	CSP 81	16:35	16:48	706595	942285	706415	942502	0.36	320	R	78	0.7	7.5	20	

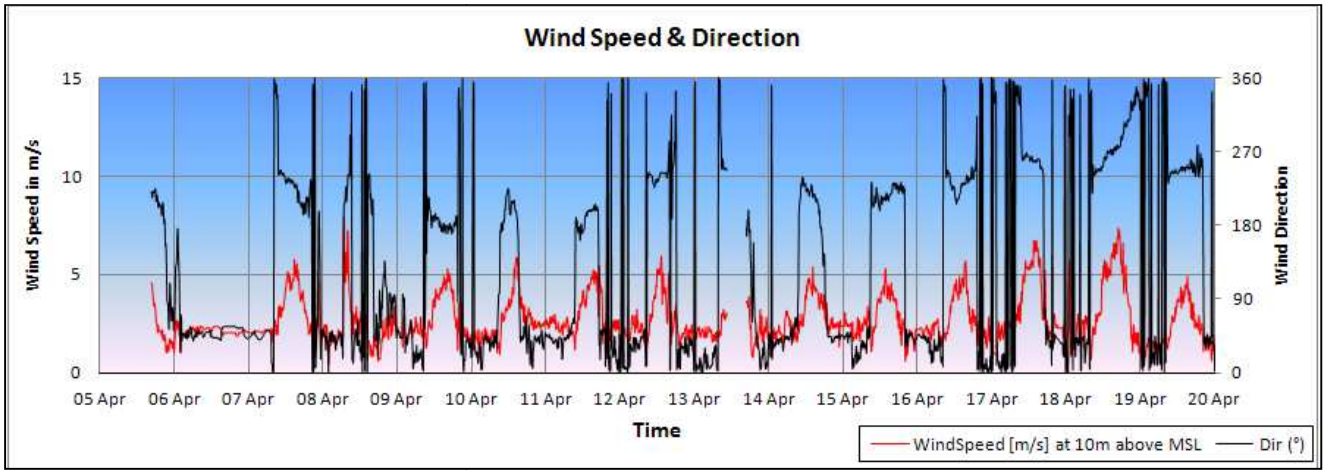
Annexure V

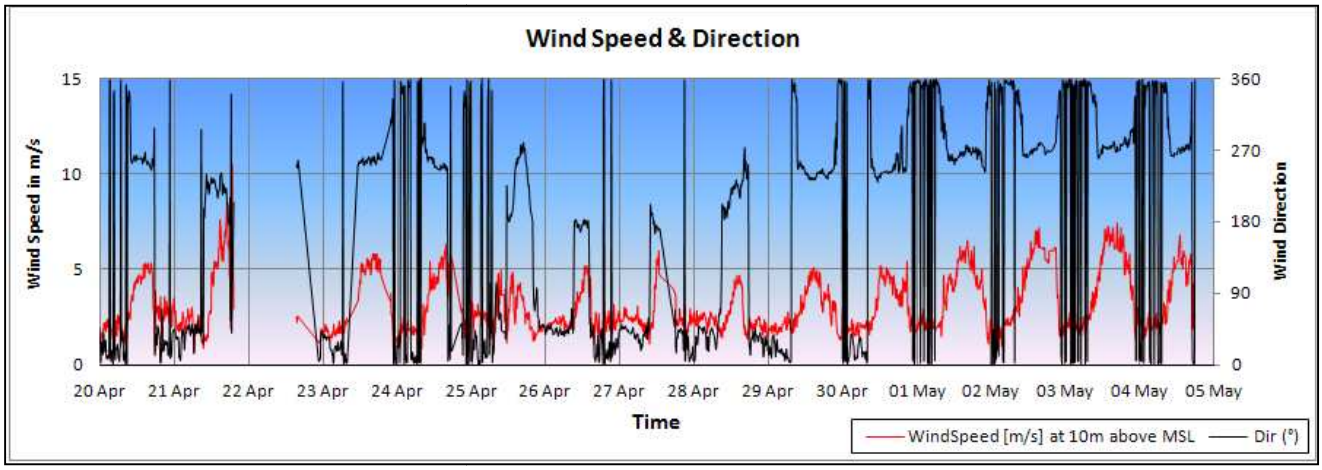
Met Data

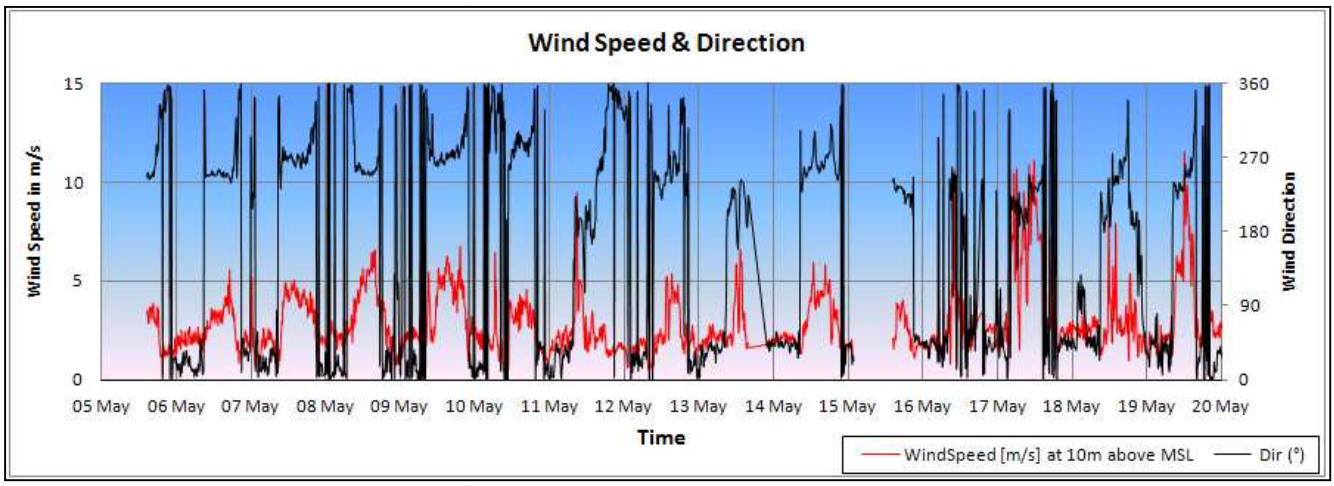

Wind Speed & Direction
Wind Speed in m/s
Wind Direction
15
10
5
0
360
270
180
90
0
19 Feb
20 Feb
21 Feb
22 Feb
23 Feb
24 Feb
25 Feb
26 Feb
27 Feb
28 Feb
01 Mar
02 Mar
03 Mar
04 Mar
05 Mar
06 Mar
Time
WindSpeed [m/s] at 10m above MSL
Dir (°)

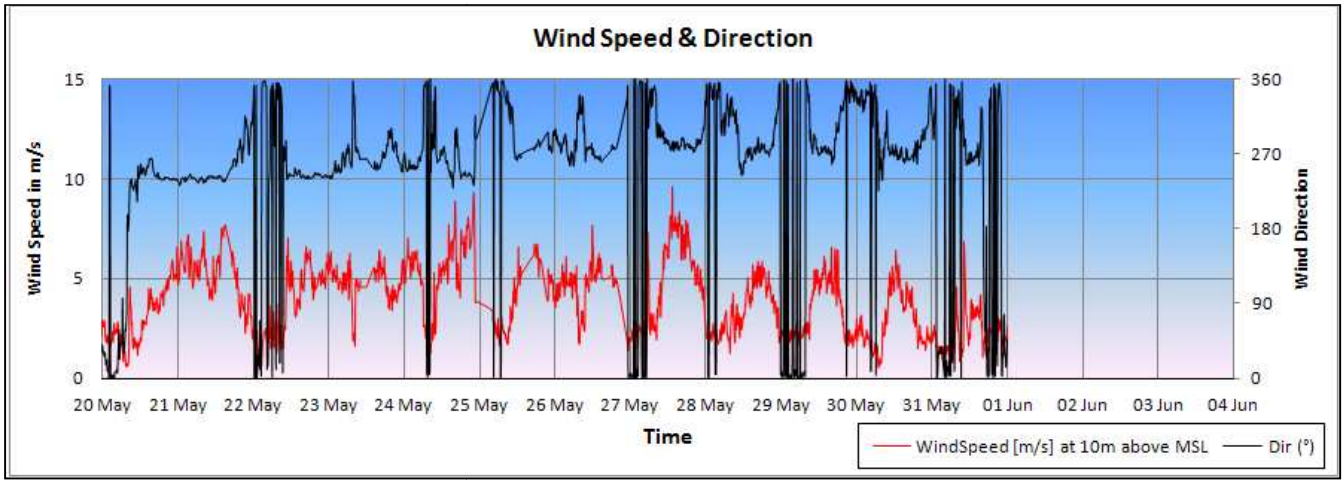

Wind Speed & Direction
Wind Speed in m/s
Wind Direction
15
10
5
0
360
270
180
90
0
06 Mar
07 Mar
08 Mar
09 Mar
10 Mar
11 Mar
12 Mar
13 Mar
14 Mar
15 Mar
16 Mar
17 Mar
18 Mar
19 Mar
20 Mar
21 Mar
Time
WindSpeed [m/s] at 10m above MSL
Dir (°)


Wind Speed & Direction
Wind Speed in m/s
Wind Direction
15
10
5
0
360
270
180
90
0
21 Mar
22 Mar
23 Mar
24 Mar
25 Mar
26 Mar
27 Mar
28 Mar
29 Mar
30 Mar
31 Mar
01 Apr
02 Apr
03 Apr
04 Apr
05 Apr
Time
WindSpeed [m/s] at 10m above MSL
Dir (°)


Wind Speed & Direction
Wind Speed in m/s
Wind Direction
Time
05 Apr 06 Apr 07 Apr 08 Apr 09 Apr 10 Apr 11 Apr 12 Apr 13 Apr 14 Apr 15 Apr 16 Apr 17 Apr 18 Apr 19 Apr 20 Apr
WindSpeed [m/s] at 10m above MSL
Dir (°)

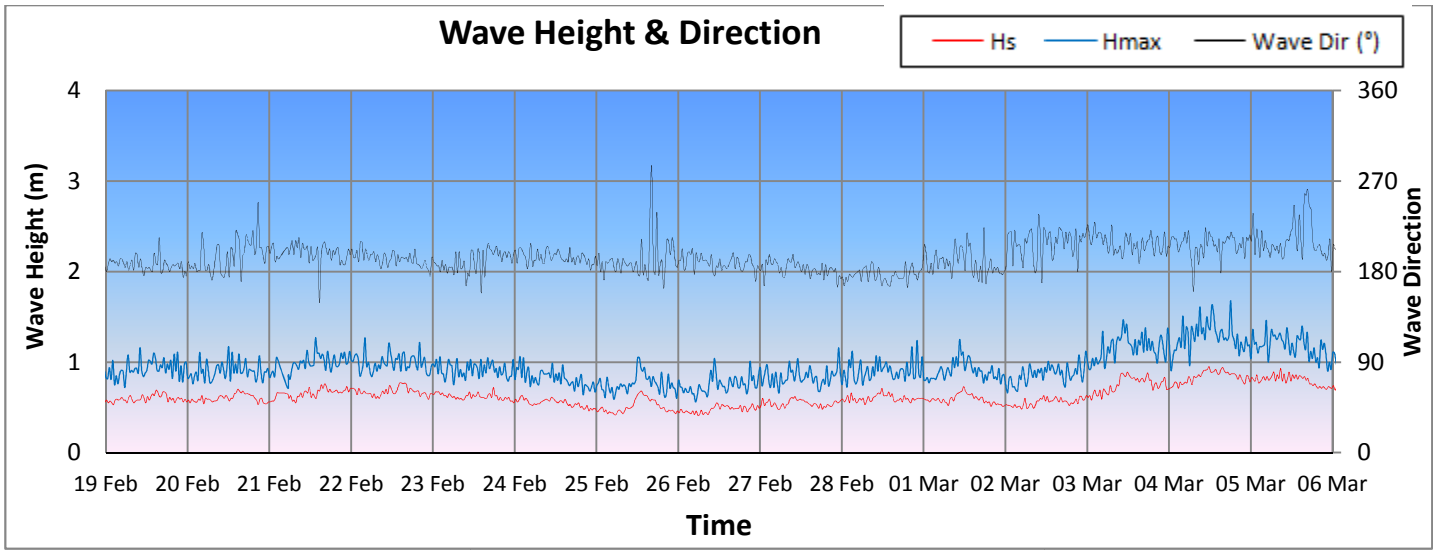

Wind Speed & Direction
Wind Speed in m/s
Wind Direction
Time
20 Apr 21 Apr 22 Apr 23 Apr 24 Apr 25 Apr 26 Apr 27 Apr 28 Apr 29 Apr 30 Apr 01 May 02 May 03 May 04 May 05 May
WindSpeed [m/s] at 10m above MSL
Dir (°)

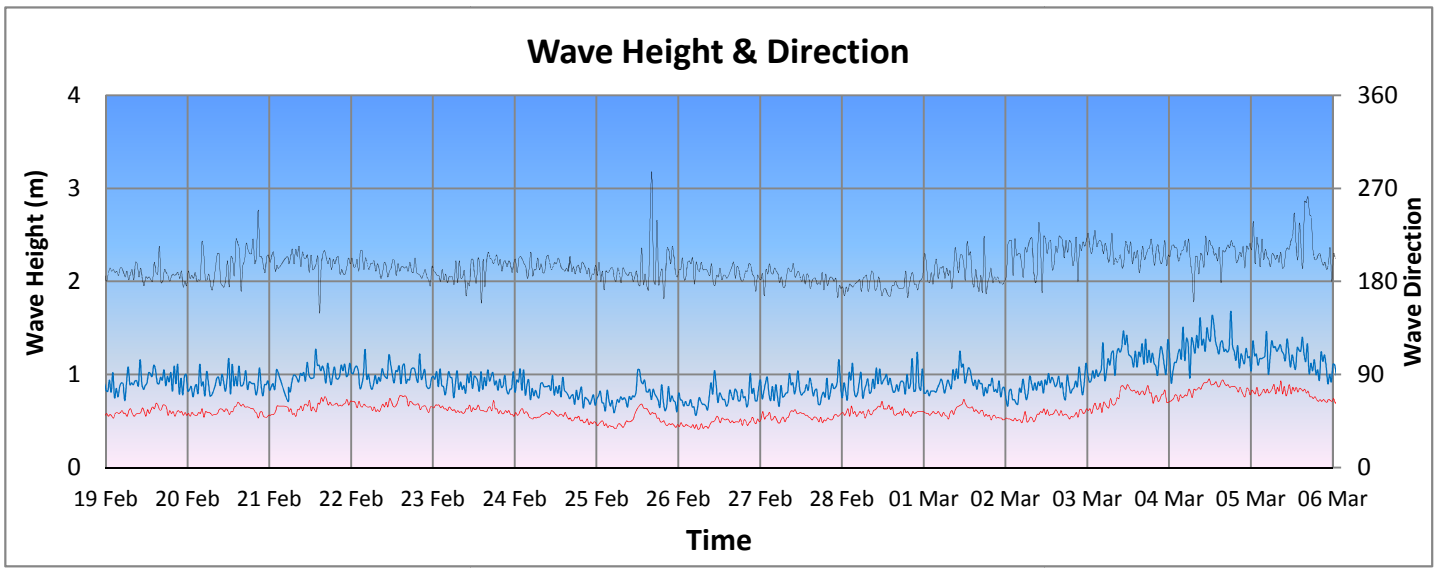

Wind Speed & Direction
Wind Speed in m/s
Wind Direction
Time
05 May 06 May 07 May 08 May 09 May 10 May 11 May 12 May 13 May 14 May 15 May 16 May 17 May 18 May 19 May 20 May
WindSpeed [m/s] at 10m above MSL
Dir (°)

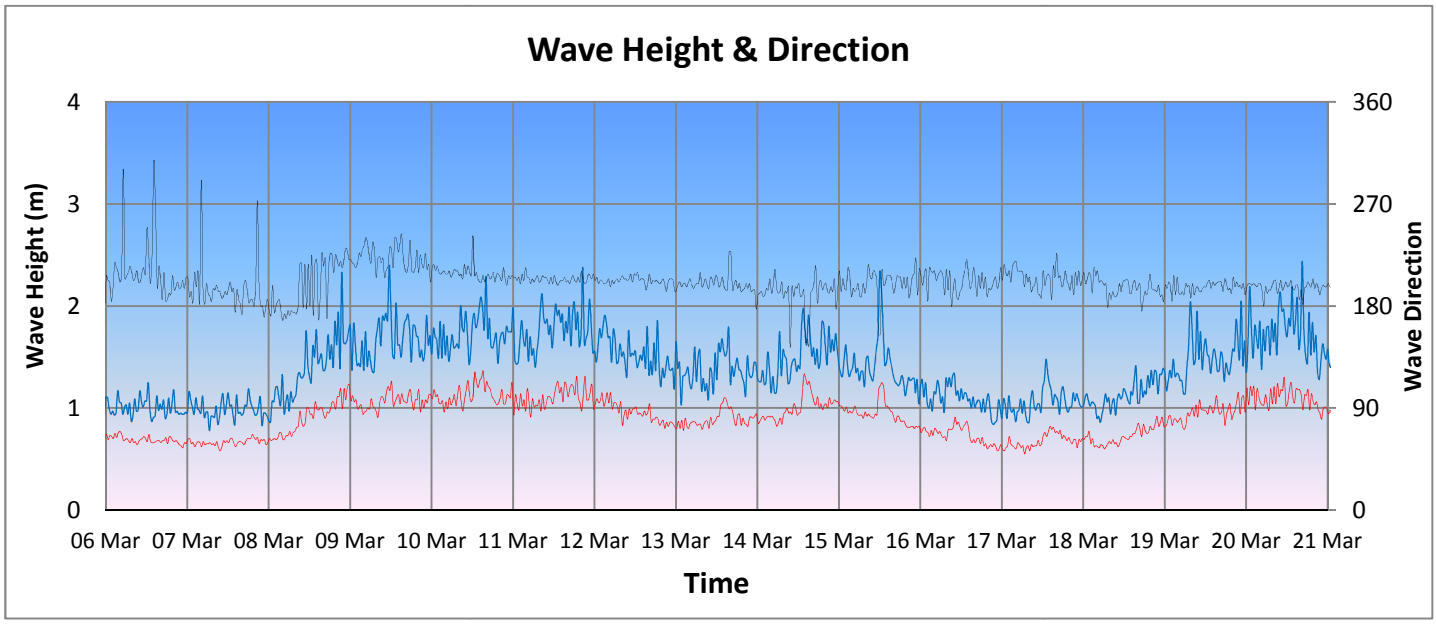

Wind Speed & Direction
Wind Speed in m/s
15
10
5
0
360
270
180
90
0
Wind Direction
20 May
21 May
22 May
23 May
24 May
25 May
26 May
27 May
28 May
29 May
30 May
31 May
01 Jun
02 Jun
03 Jun
04 Jun
Time
WindSpeed [m/s] at 10m above MSL
Dir (°)

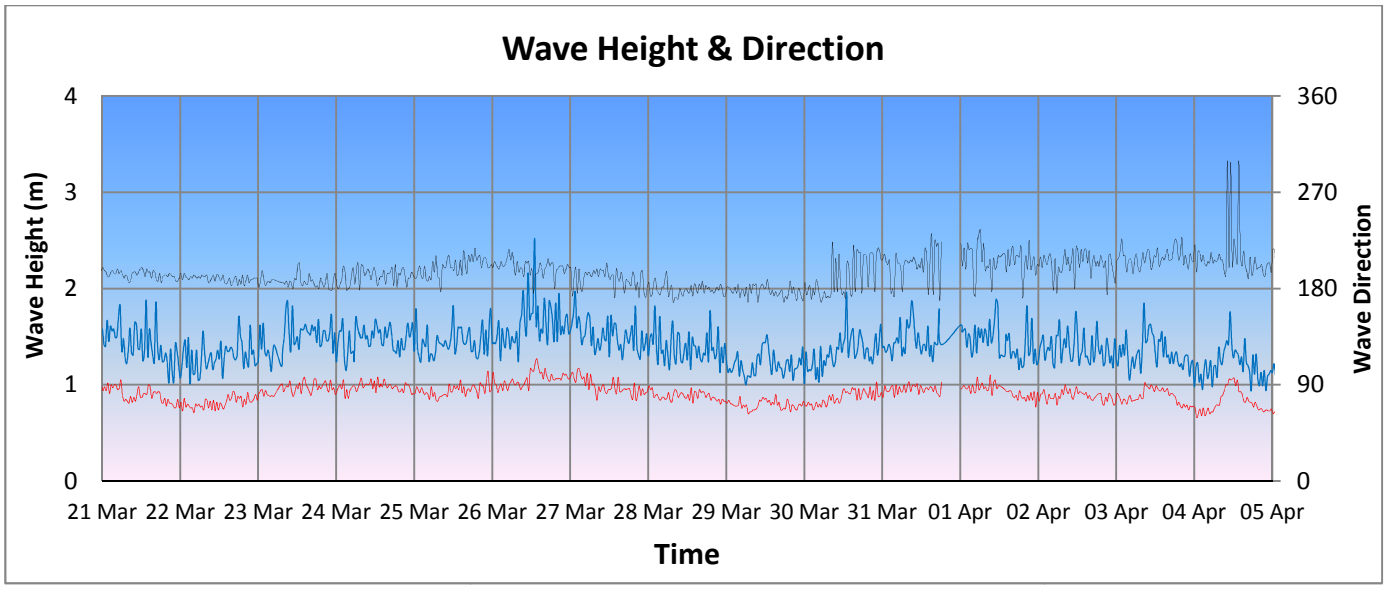
Annexure IV

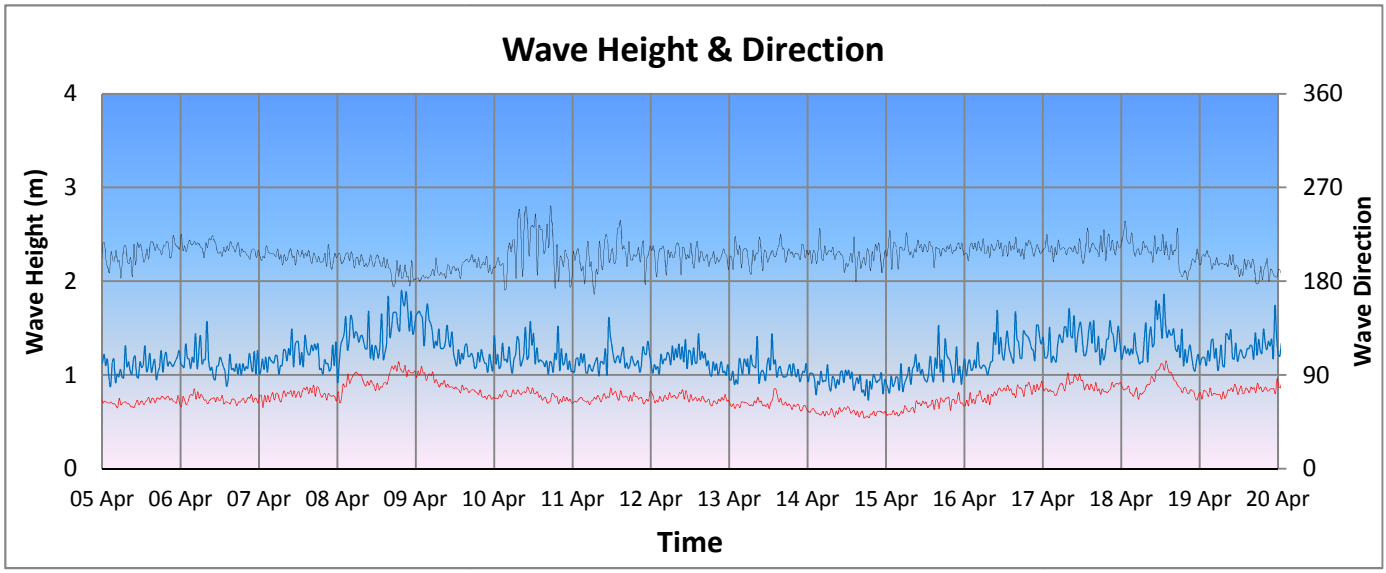
Wave Data

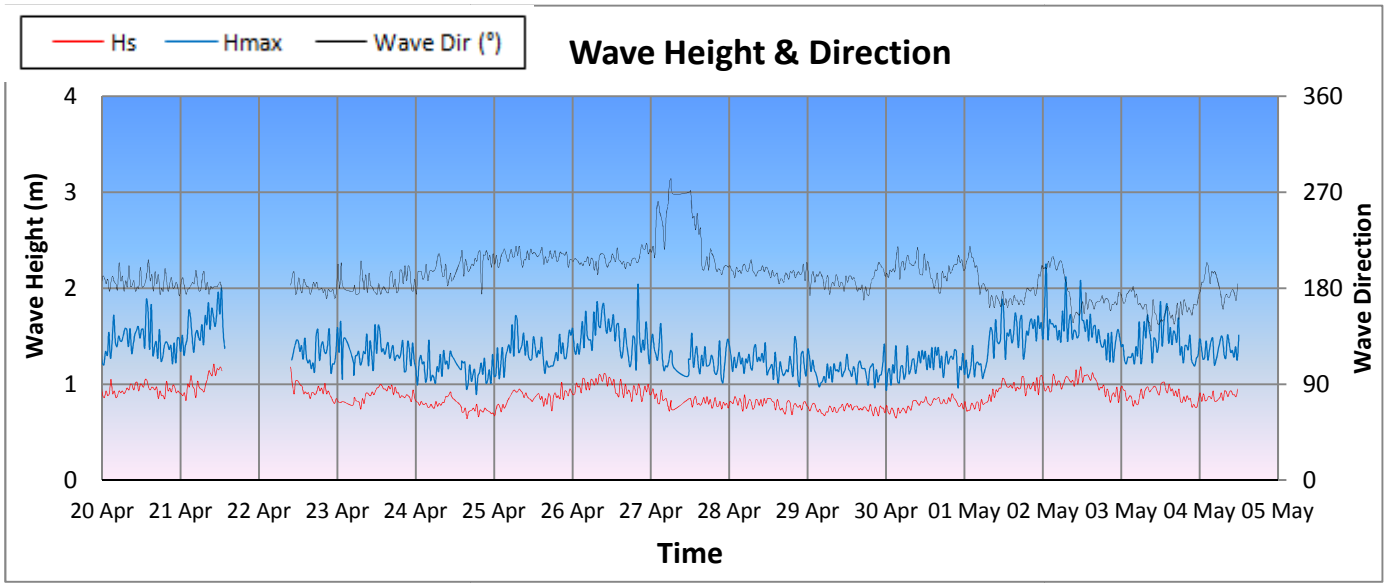

Wave Height & Direction
Hs
Hmax
Wave Dir (°)
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
19 Feb 20 Feb 21 Feb 22 Feb 23 Feb 24 Feb 25 Feb 26 Feb 27 Feb 28 Feb 01 Mar 02 Mar 03 Mar 04 Mar 05 Mar 06 Mar
Time

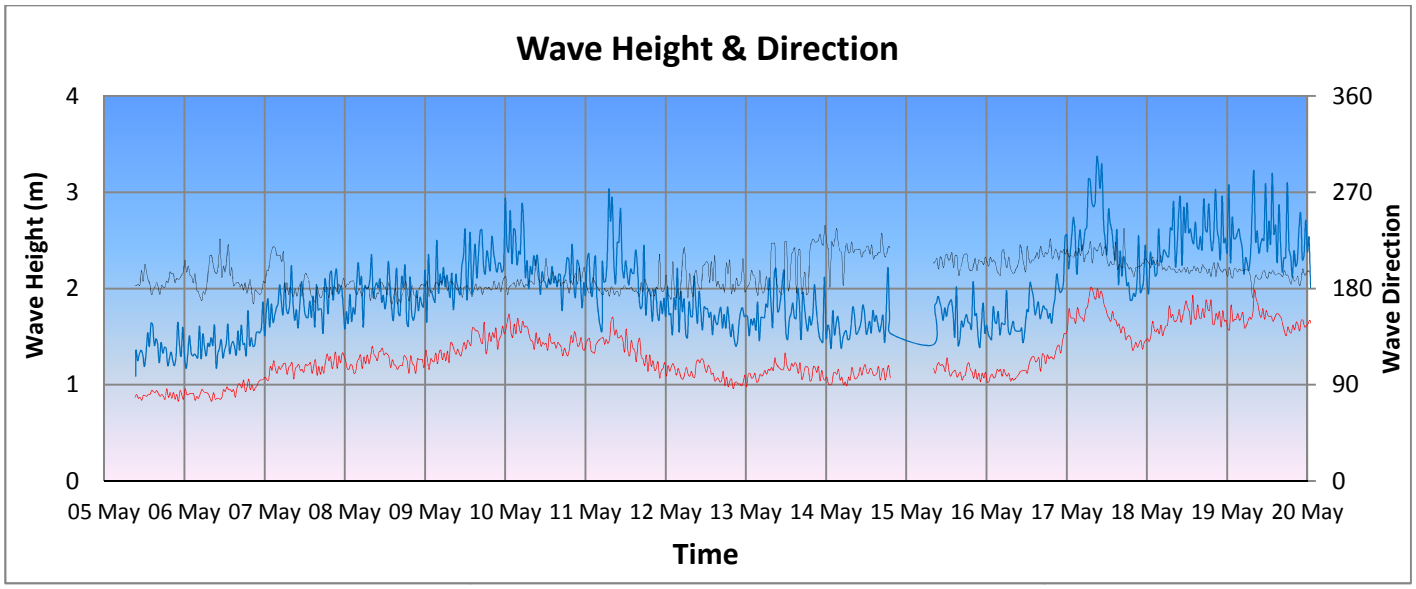

Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
19 Feb 20 Feb 21 Feb 22 Feb 23 Feb 24 Feb 25 Feb 26 Feb 27 Feb 28 Feb 01 Mar 02 Mar 03 Mar 04 Mar 05 Mar 06 Mar
Time

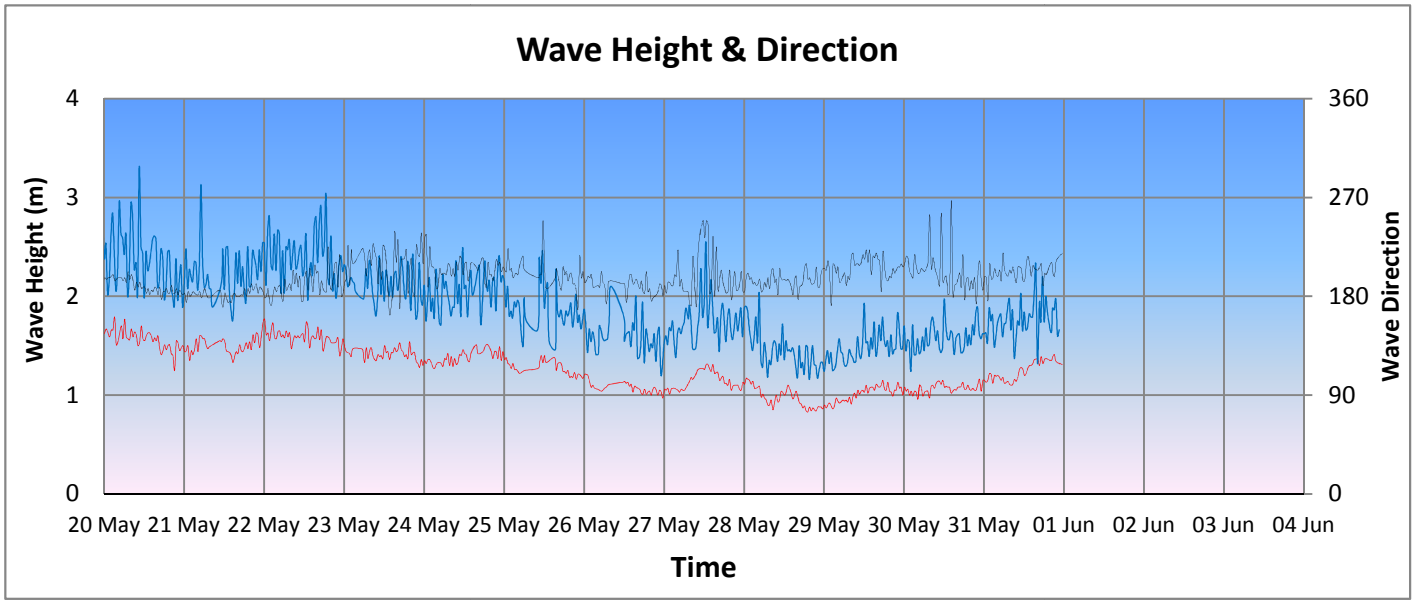

Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
06 Mar 07 Mar 08 Mar 09 Mar 10 Mar 11 Mar 12 Mar 13 Mar 14 Mar 15 Mar 16 Mar 17 Mar 18 Mar 19 Mar 20 Mar 21 Mar
Time

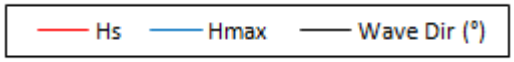

Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
21 Mar 22 Mar 23 Mar 24 Mar 25 Mar 26 Mar 27 Mar 28 Mar 29 Mar 30 Mar 31 Mar 01 Apr 02 Apr 03 Apr 04 Apr 05 Apr
Time


Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
05 Apr 06 Apr 07 Apr 08 Apr 09 Apr 10 Apr 11 Apr 12 Apr 13 Apr 14 Apr 15 Apr 16 Apr 17 Apr 18 Apr 19 Apr 20 Apr
Time


Hs
Hmax
Wave Dir (°)
Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
20 Apr 21 Apr 22 Apr 23 Apr 24 Apr 25 Apr 26 Apr 27 Apr 28 Apr 29 Apr 30 Apr 01 May 02 May 03 May 04 May 05 May
Time


Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
05 May 06 May 07 May 08 May 09 May 10 May 11 May 12 May 13 May 14 May 15 May 16 May 17 May 18 May 19 May 20 May
Time

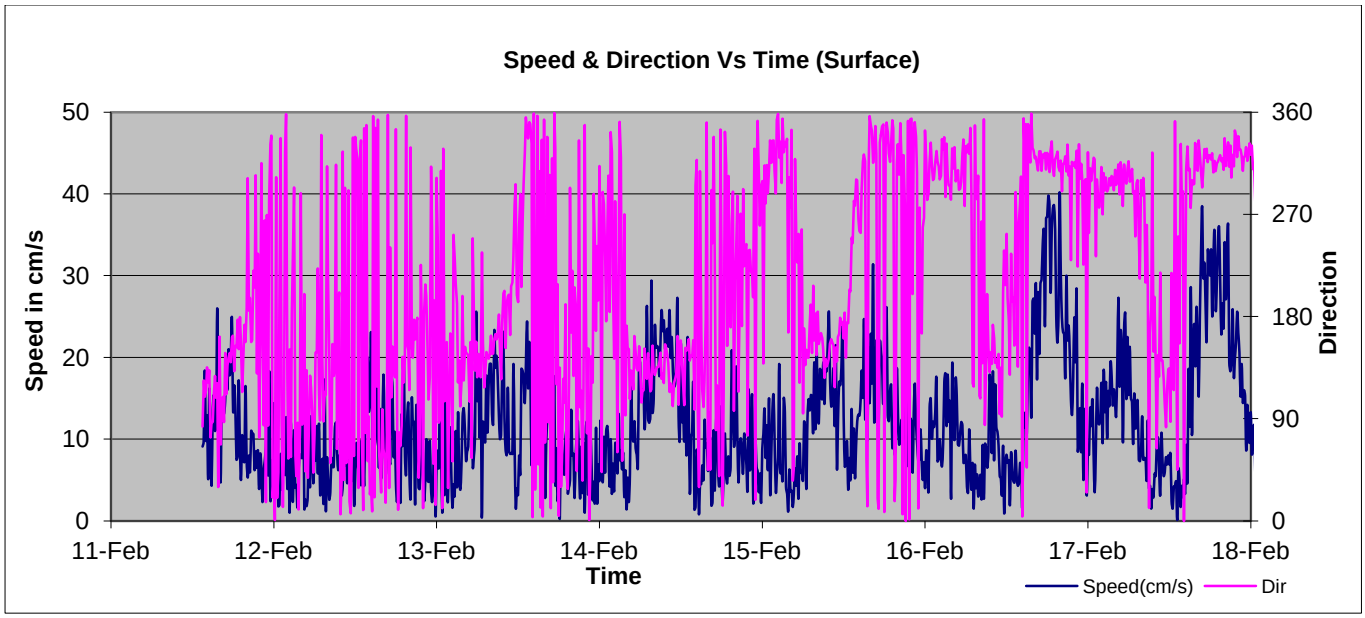

Wave Height & Direction
Wave Height (m)
Wave Direction
0
1
2
3
4
0
90
180
270
360
20 May 21 May 22 May 23 May 24 May 25 May 26 May 27 May 28 May 29 May 30 May 31 May 01 Jun 02 Jun 03 Jun 04 Jun
Time

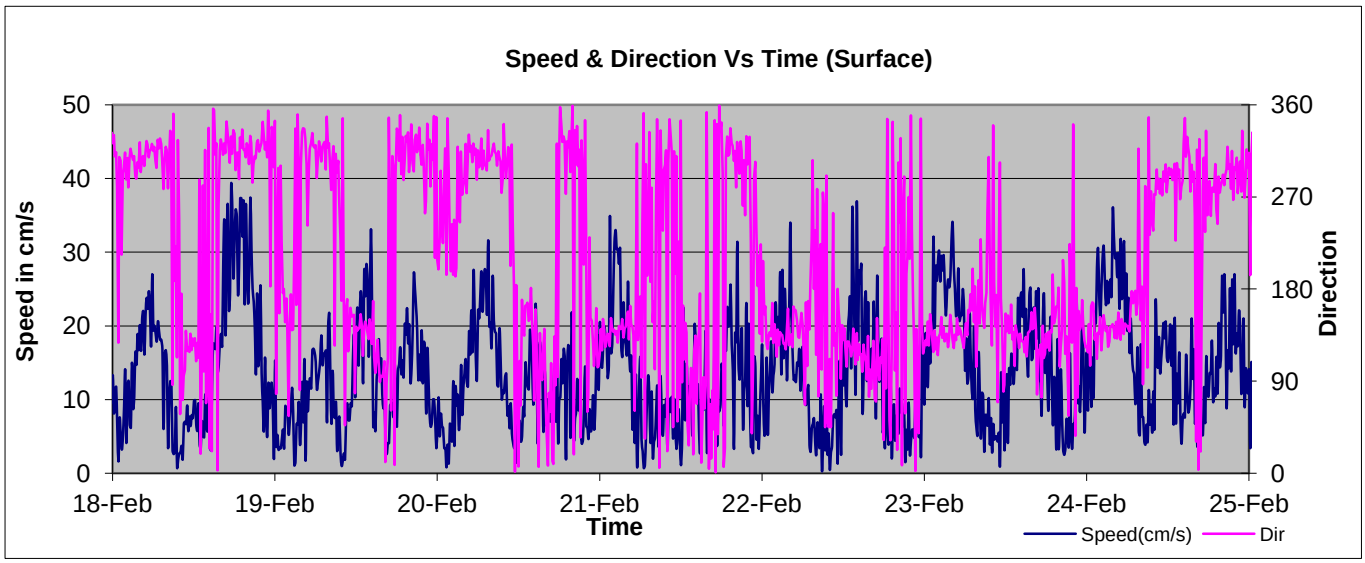

Hs
Hmax
Wave Dir (°)

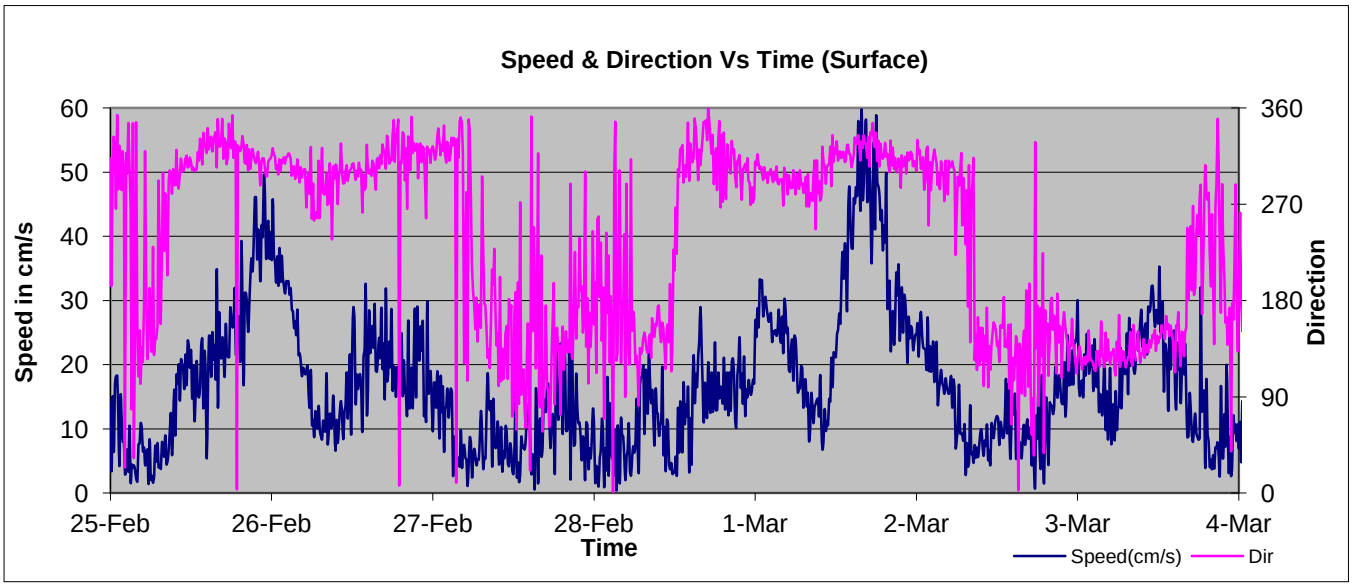
Annexure III

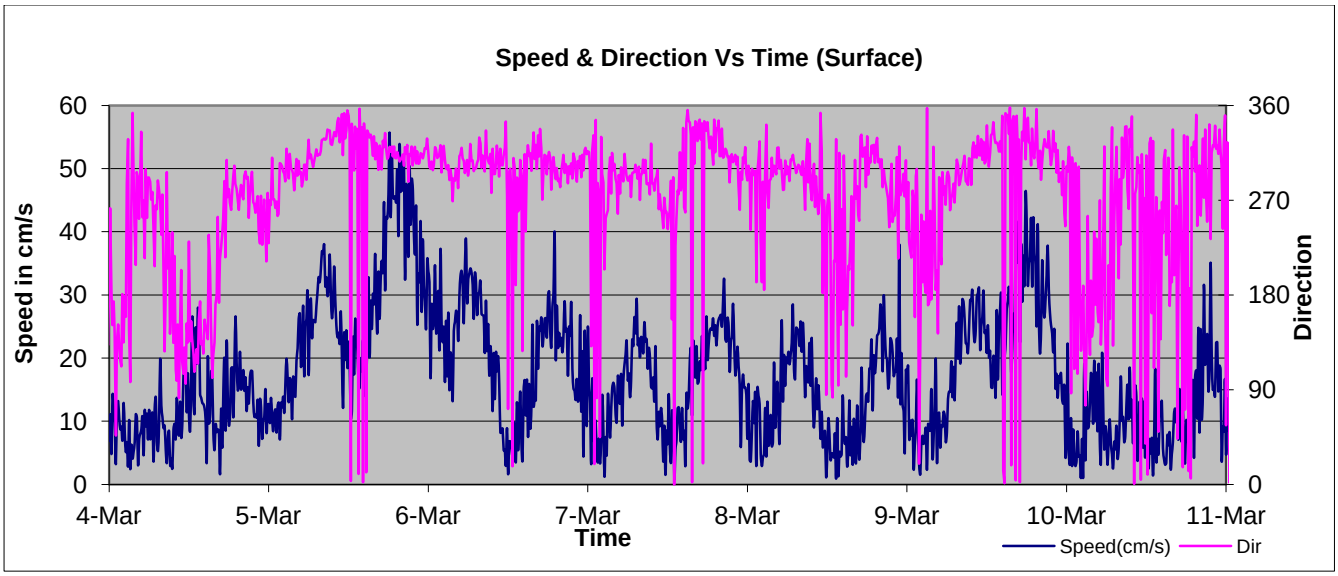
Current Data

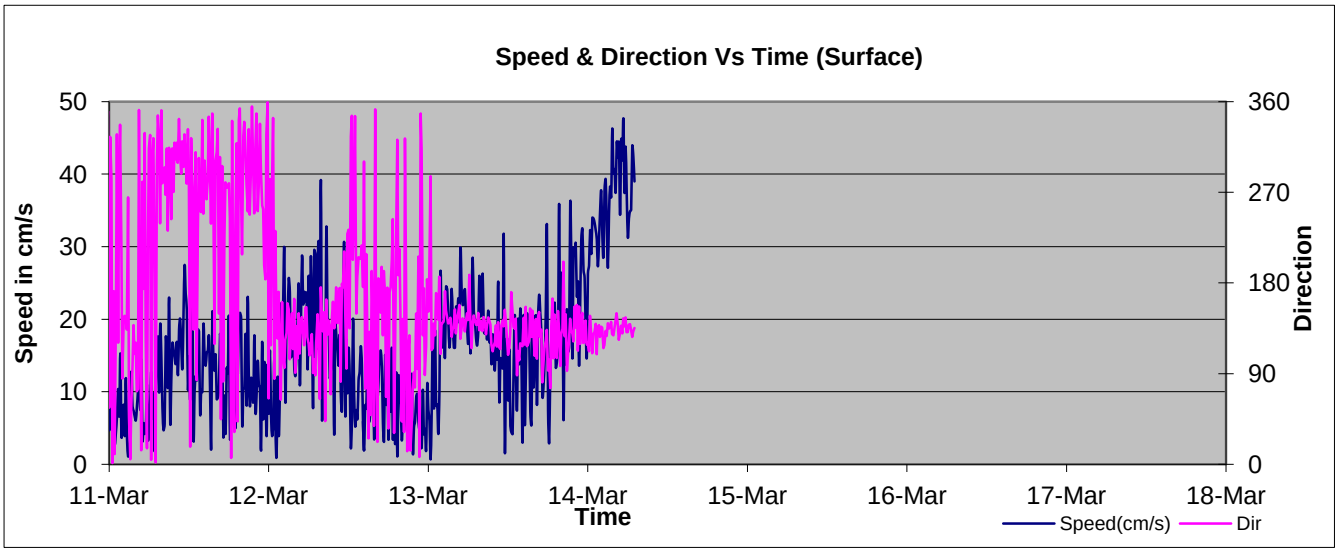
Location P1

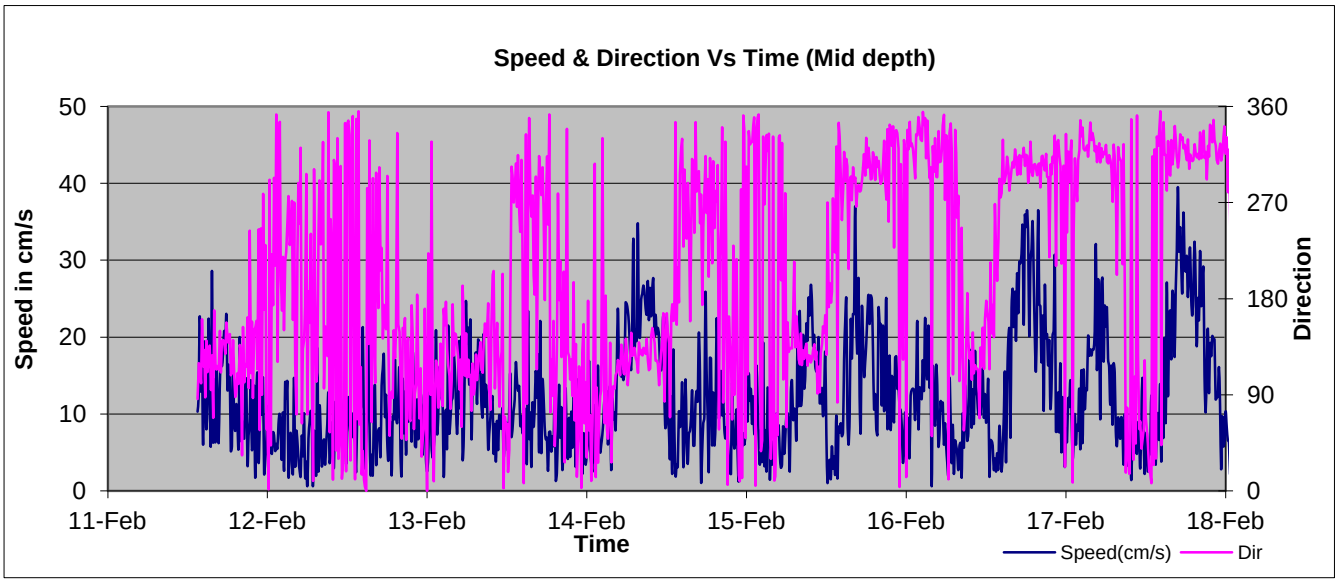

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

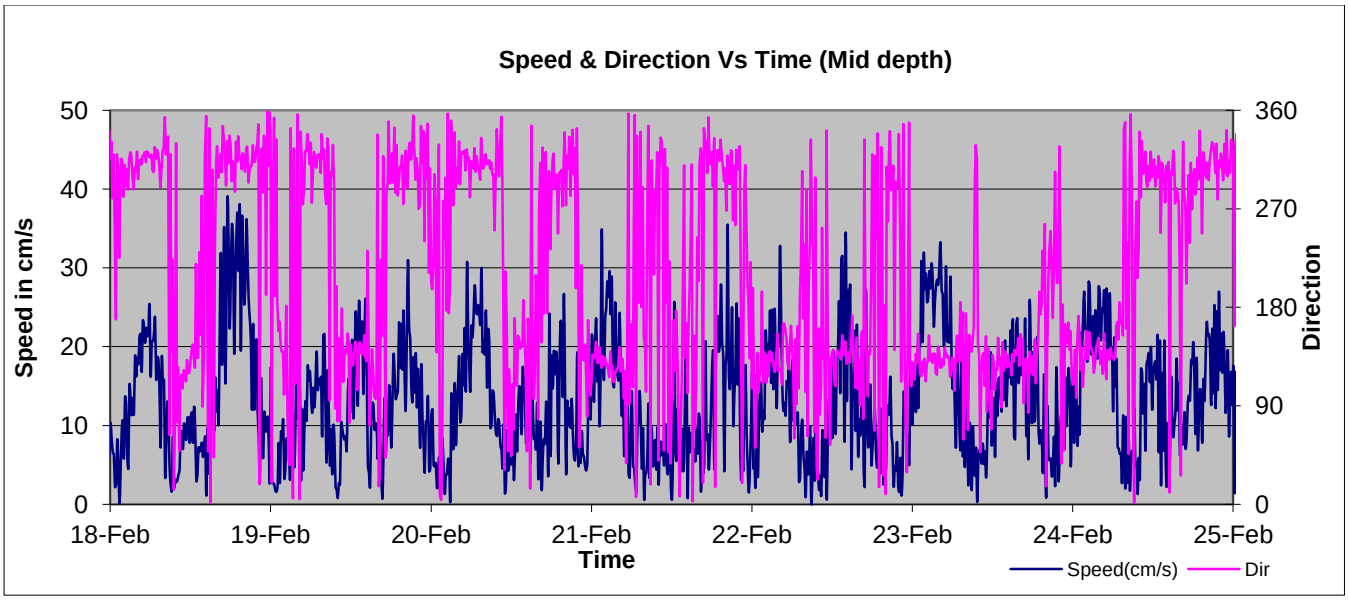

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir

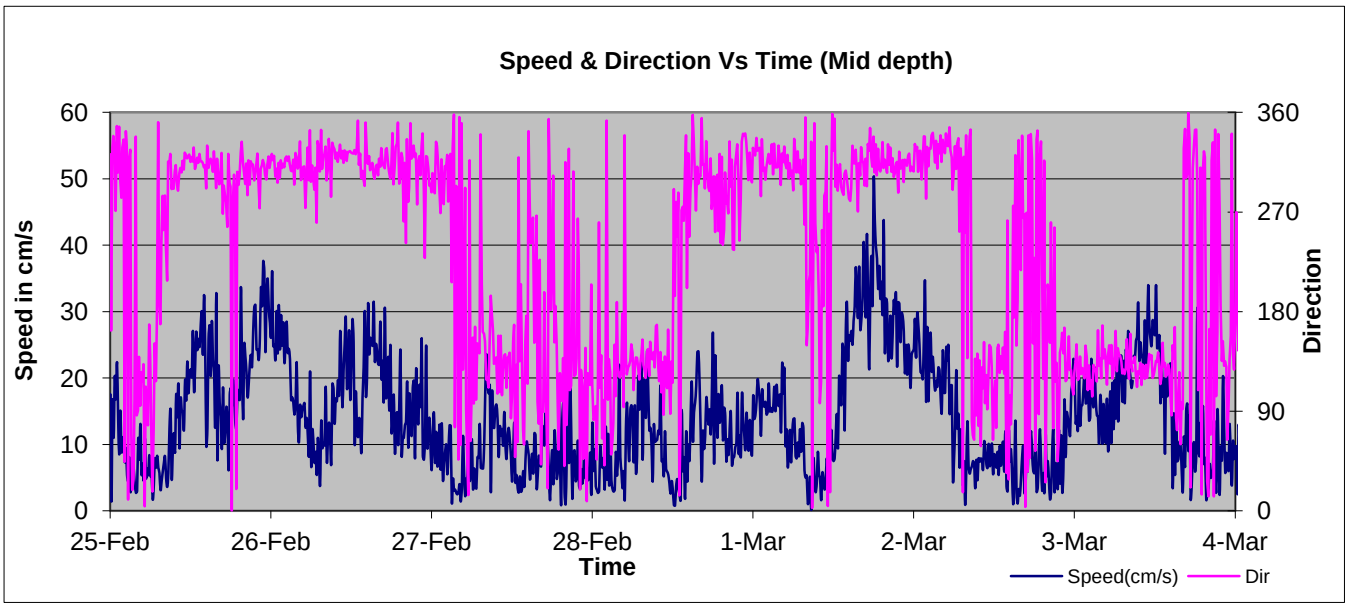

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
60
0
90
180
270
360
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

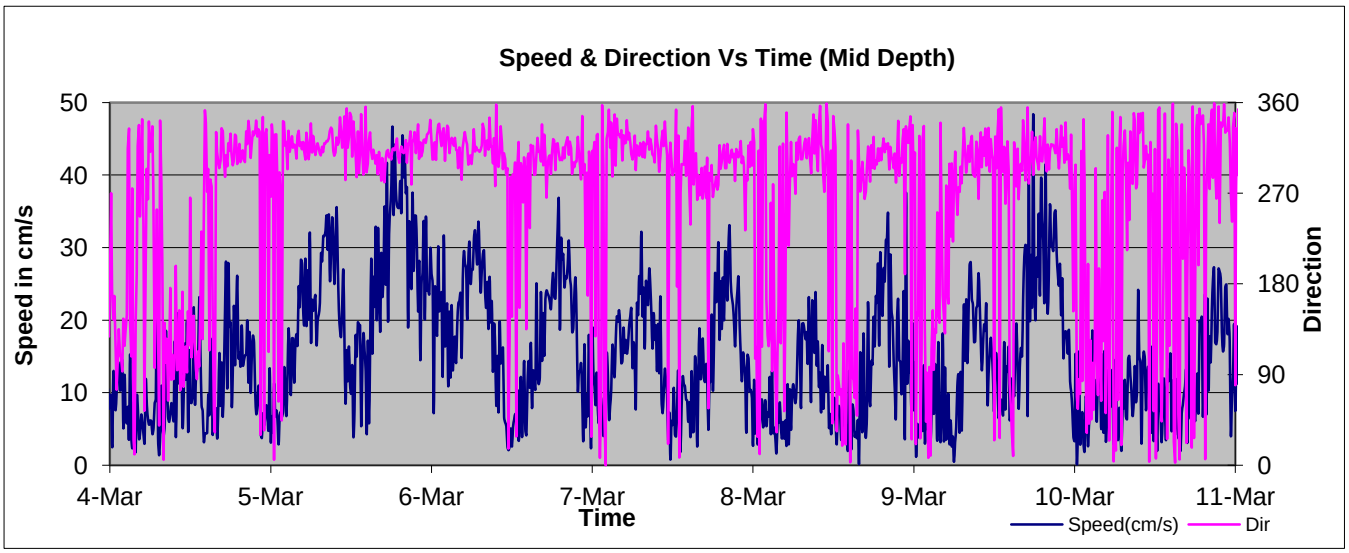

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

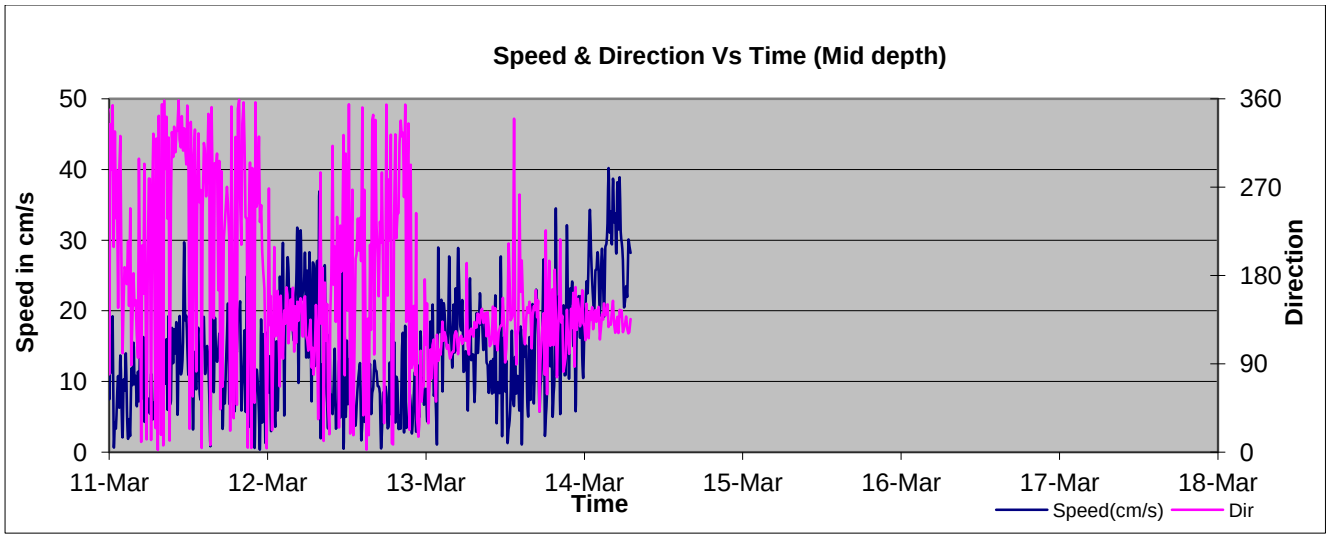

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

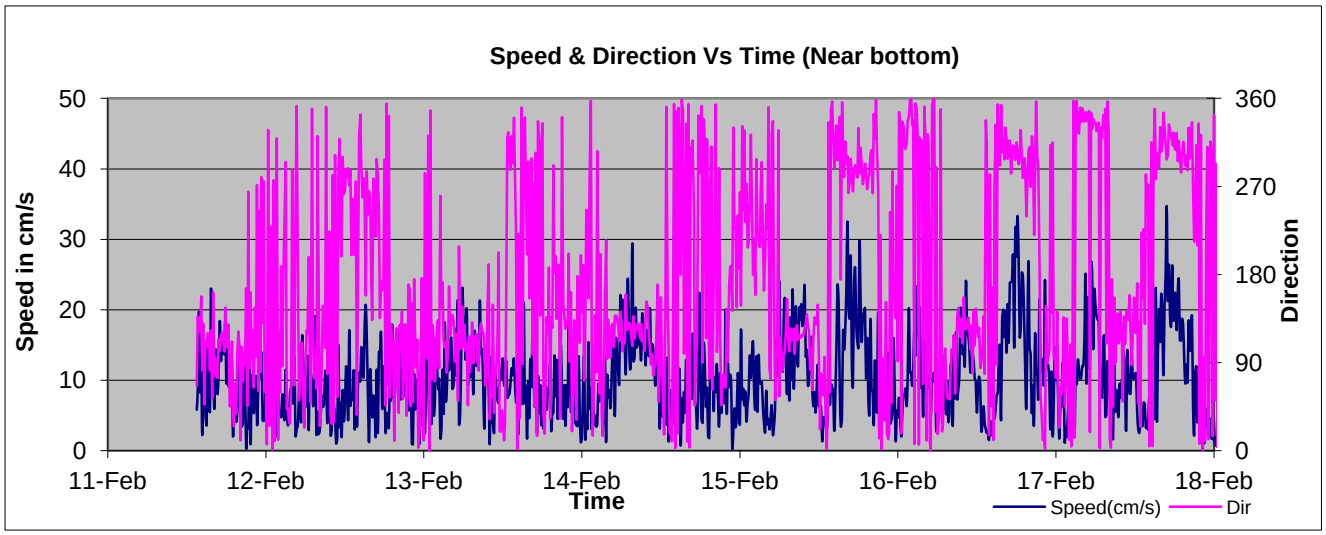

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

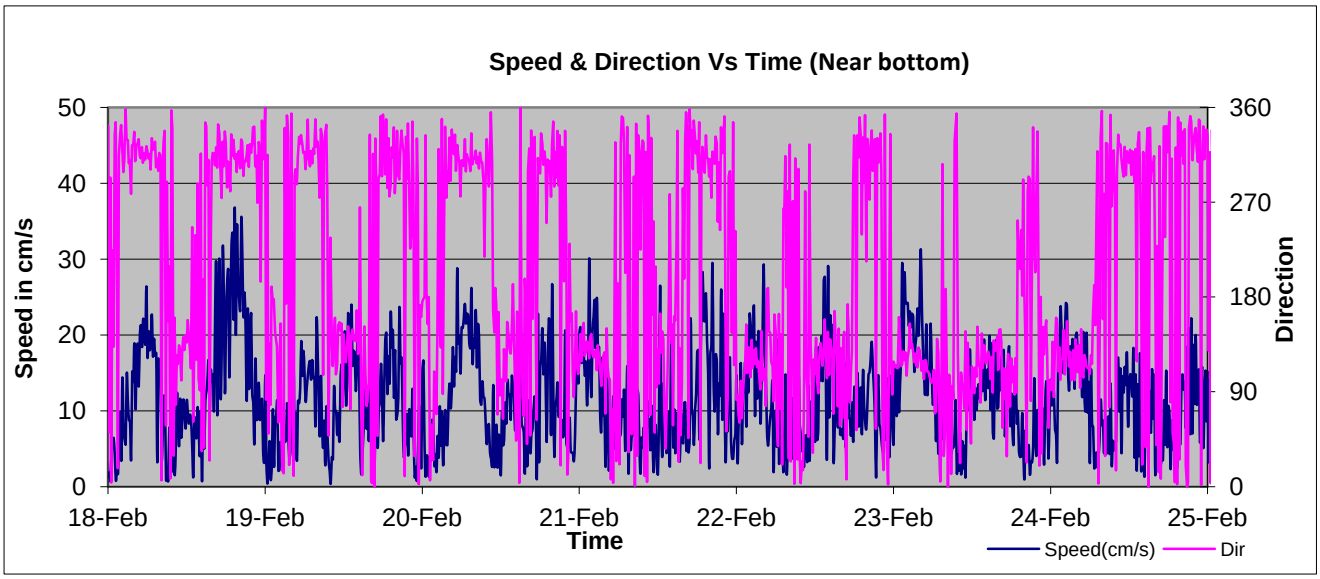

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir

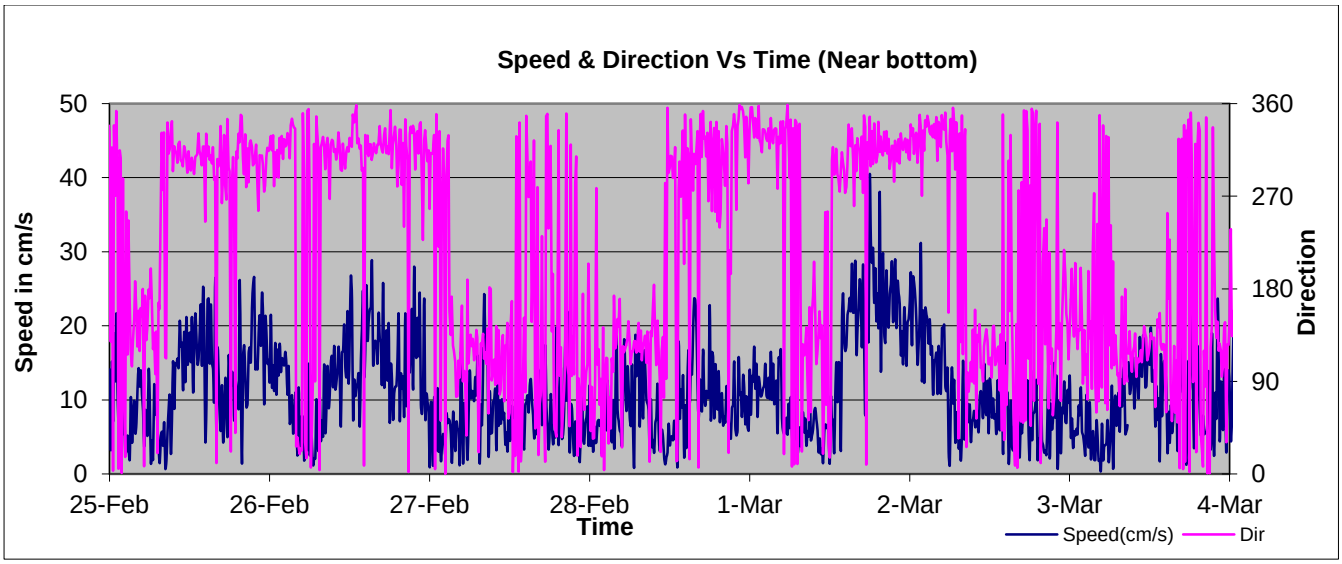

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
60
0
90
180
270
360
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

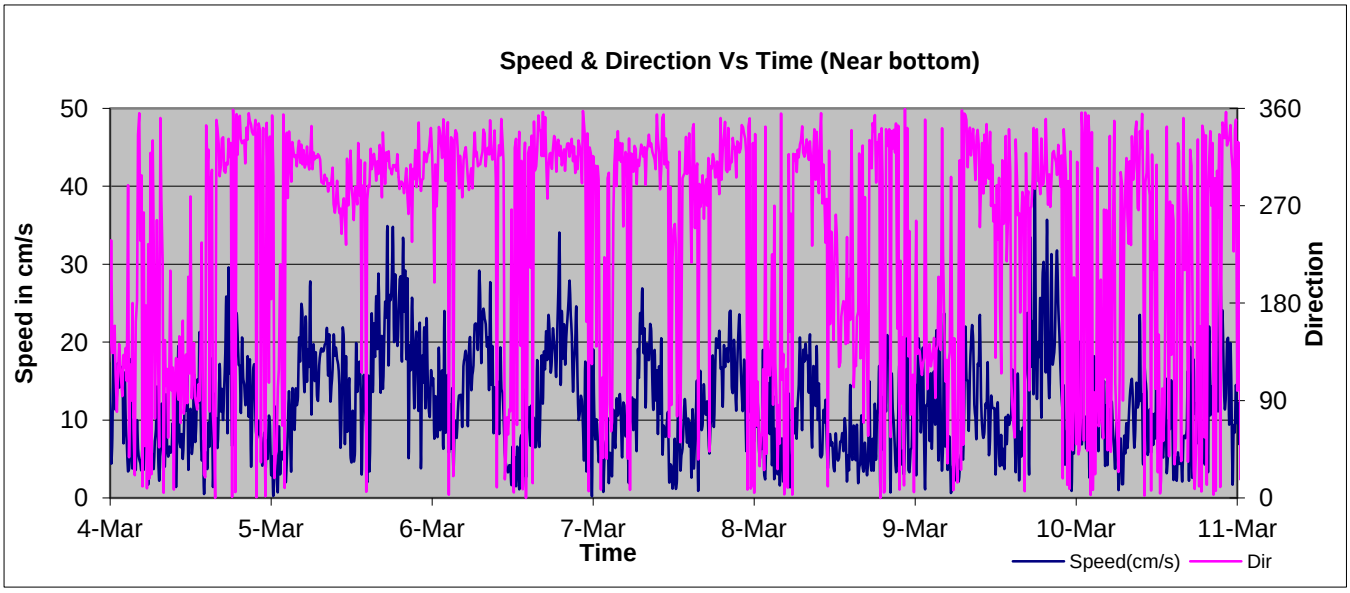

Speed & Direction Vs Time (Mid Depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

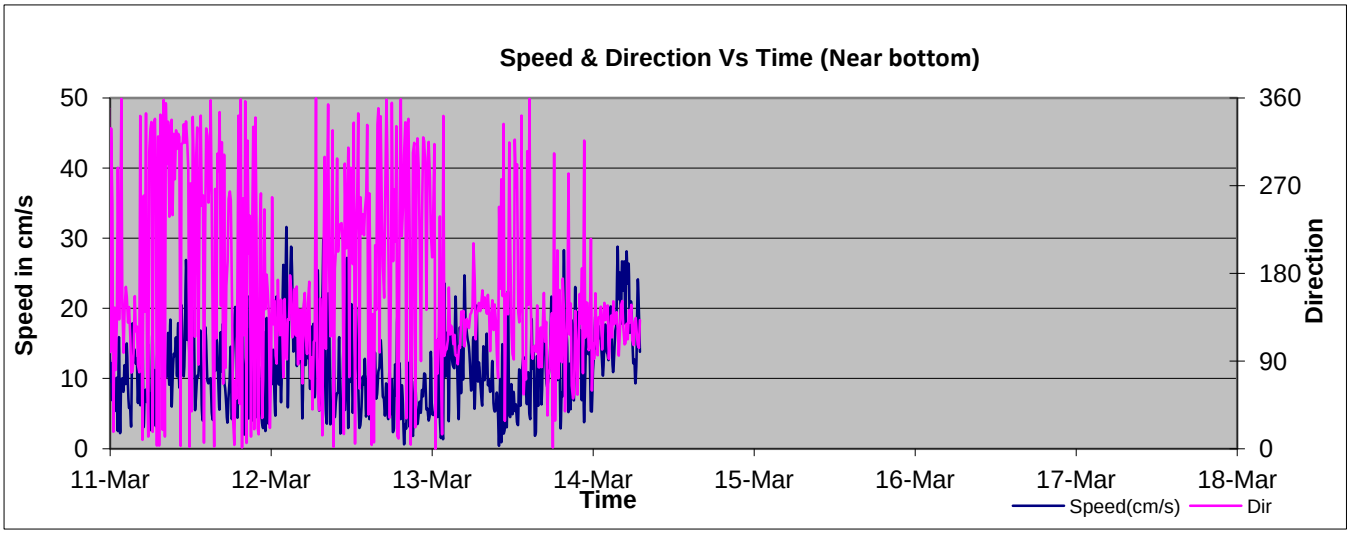

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

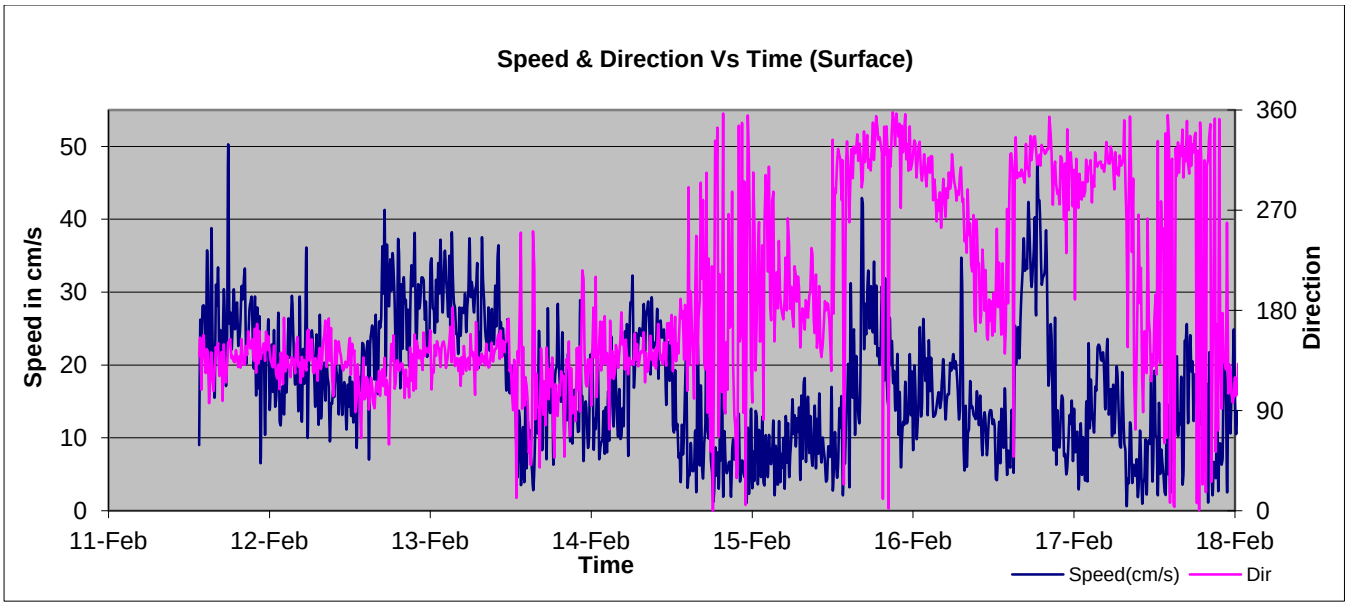

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

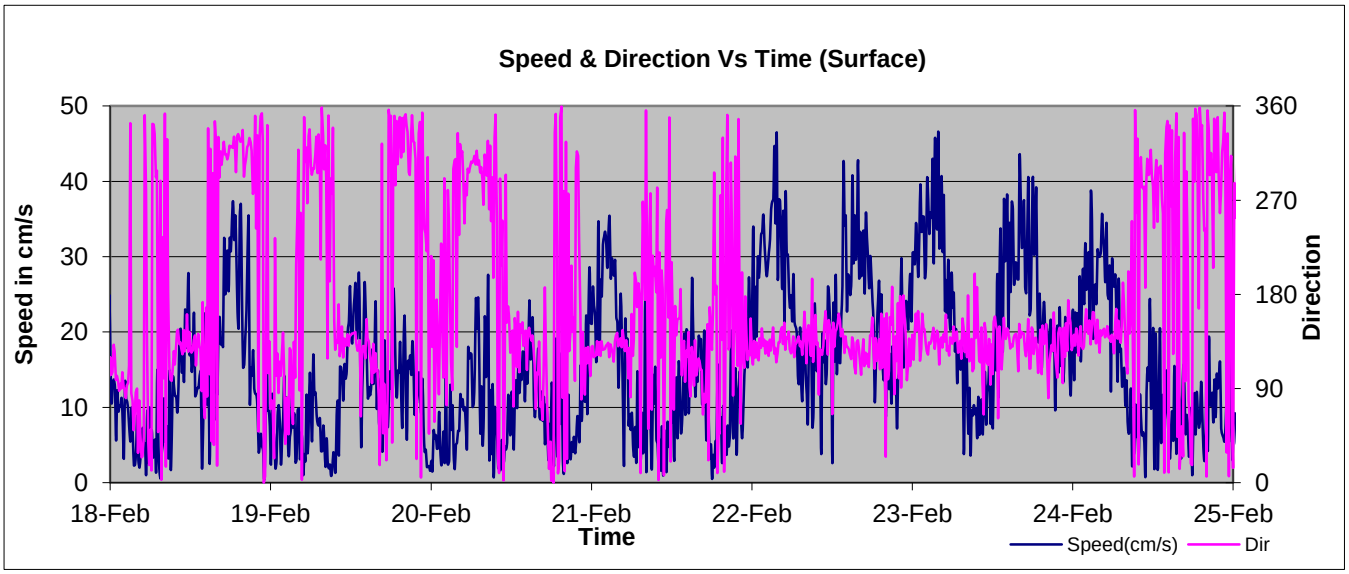

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

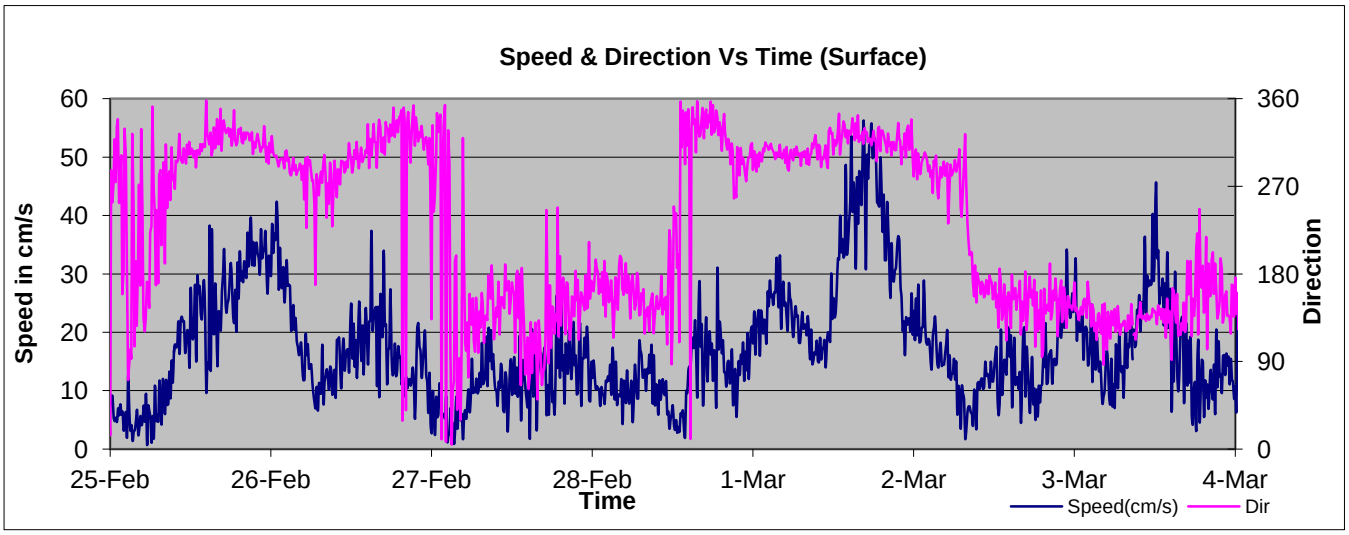
Annexure III

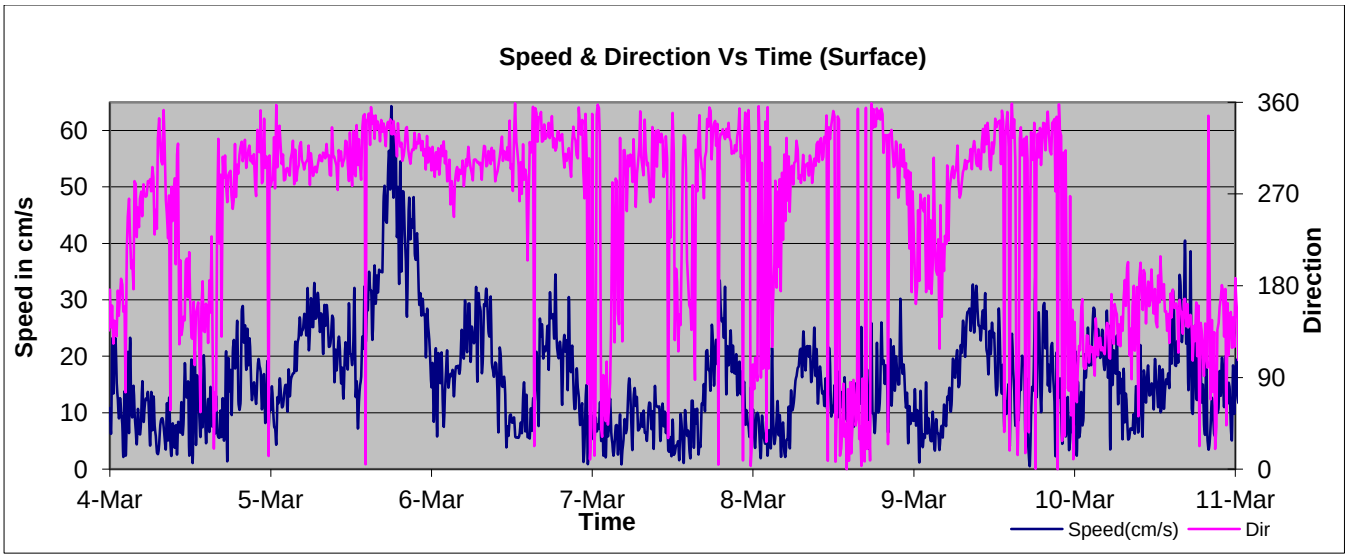
Current Data

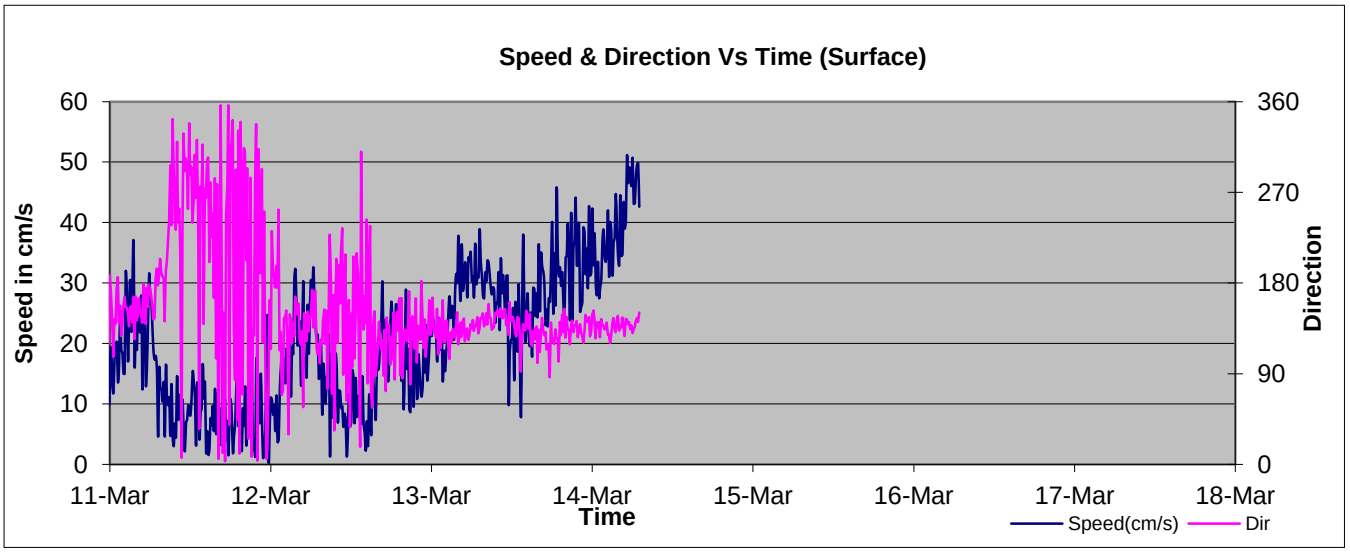
Location P2

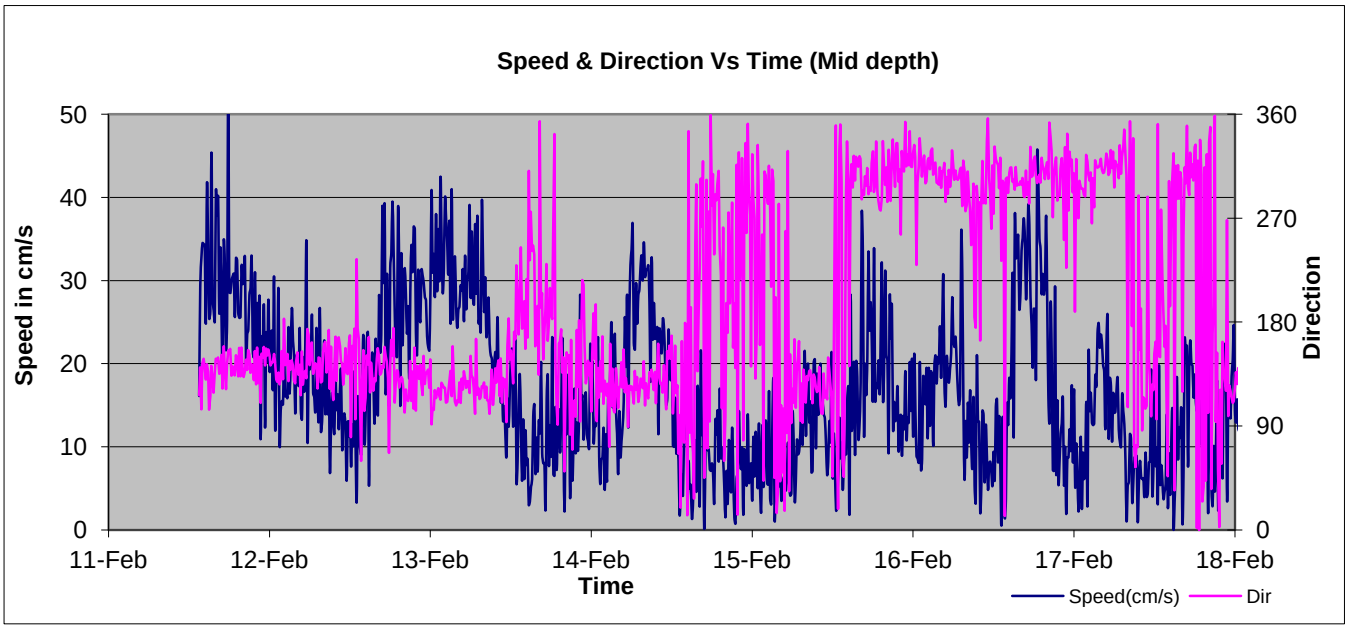

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

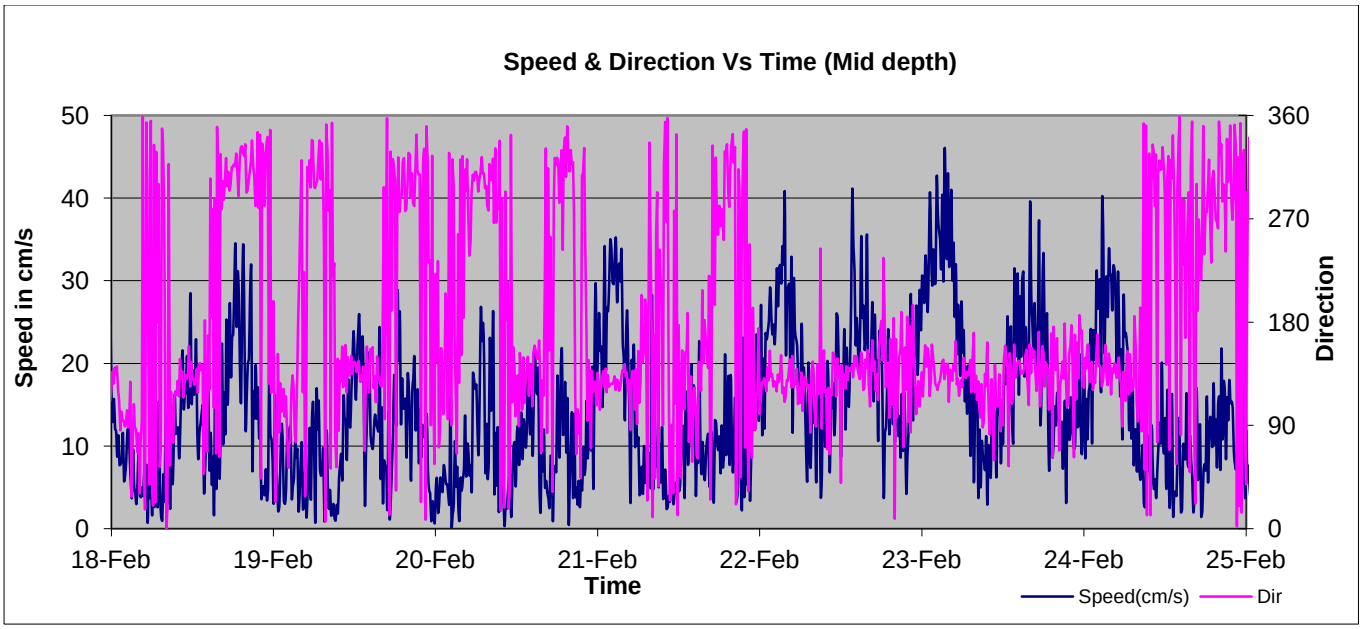

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir

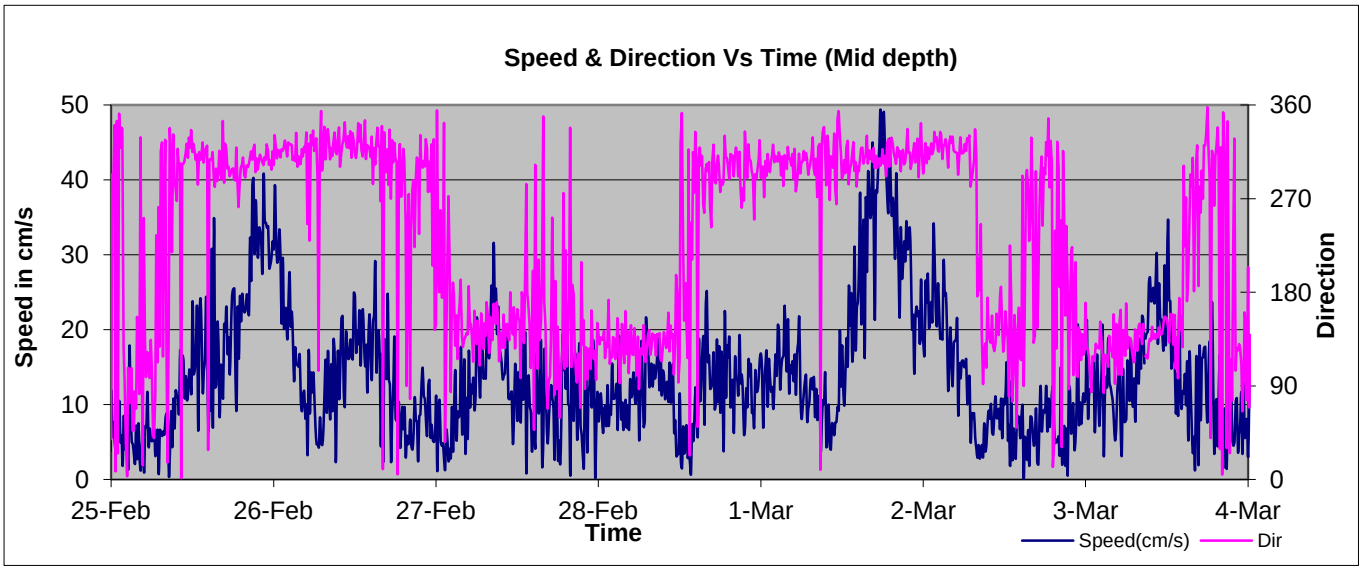

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

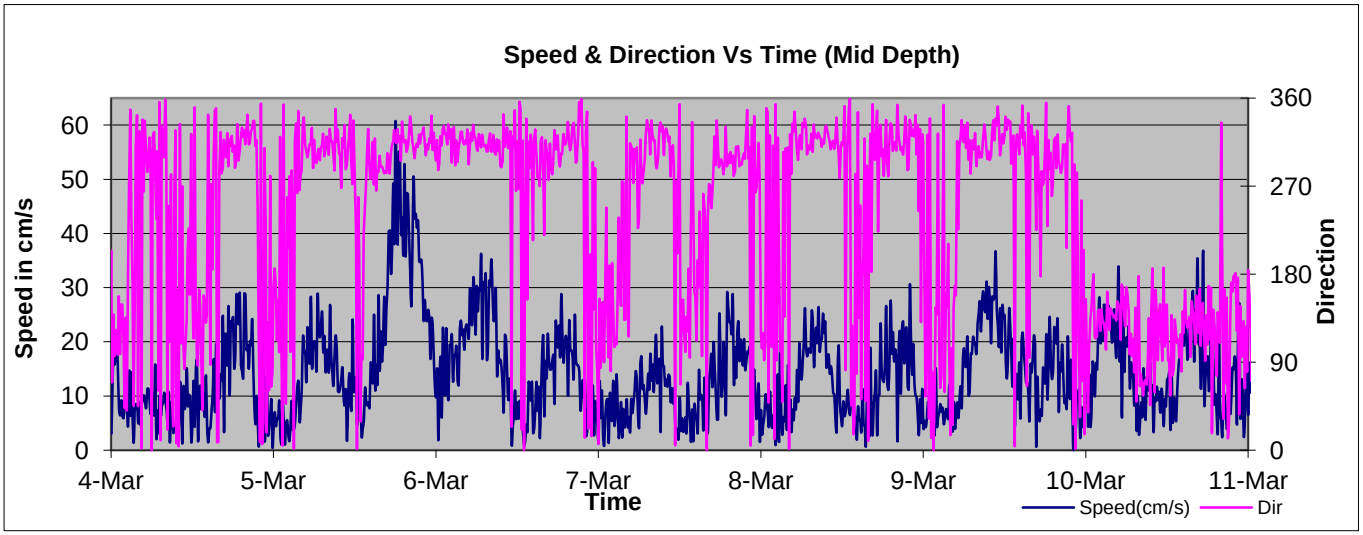

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

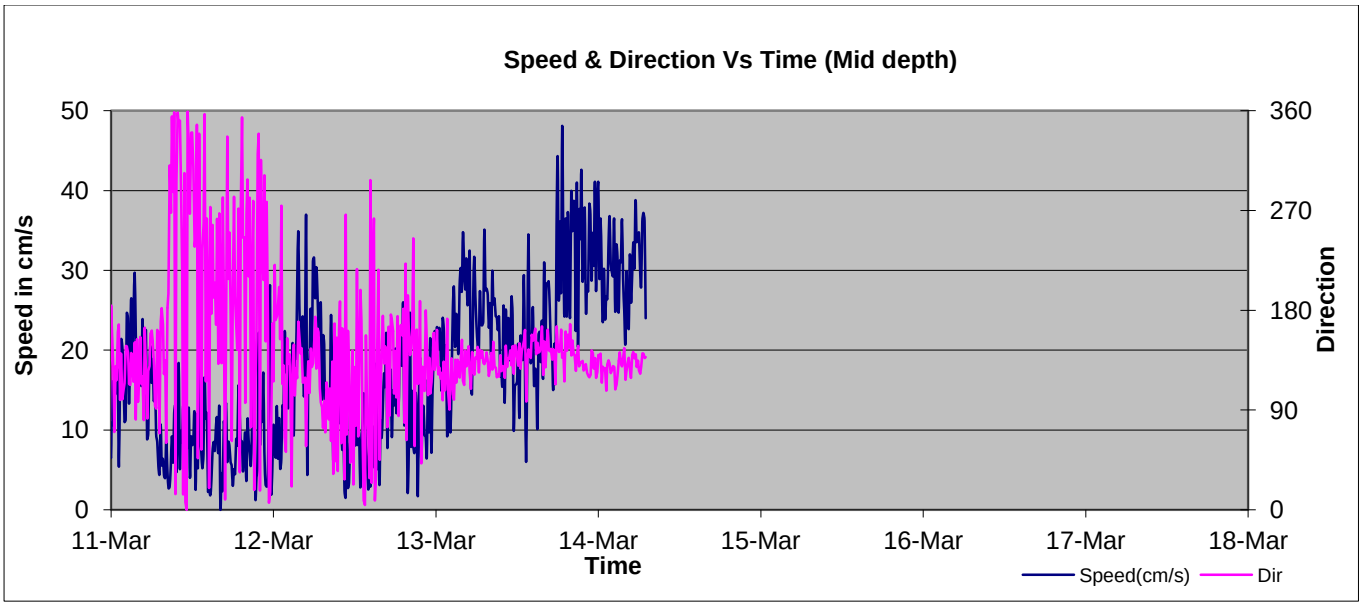

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

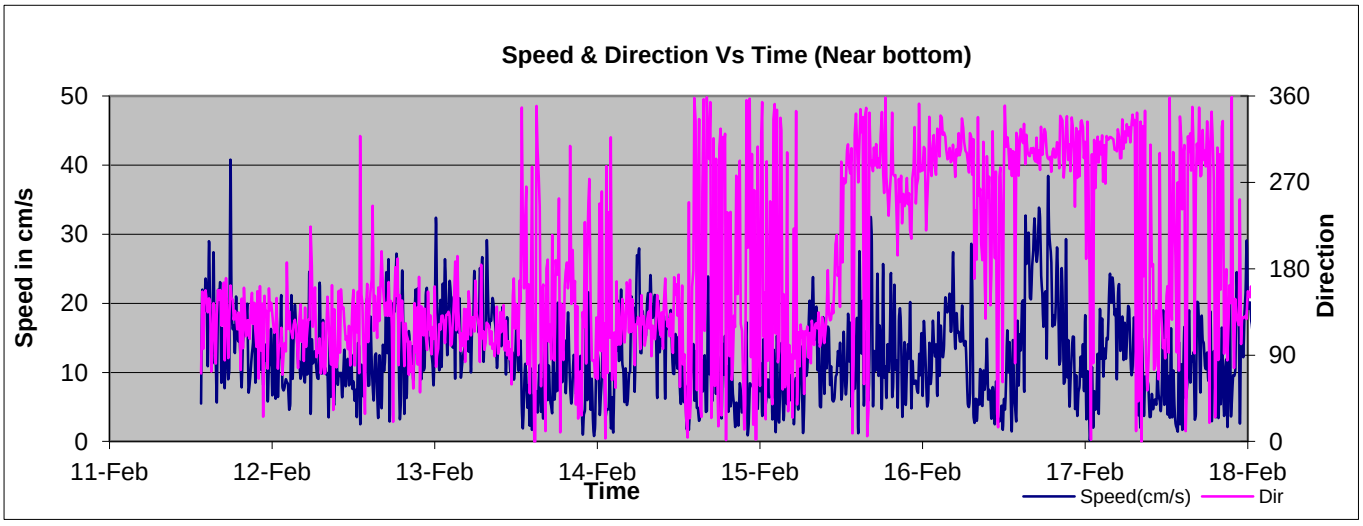

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

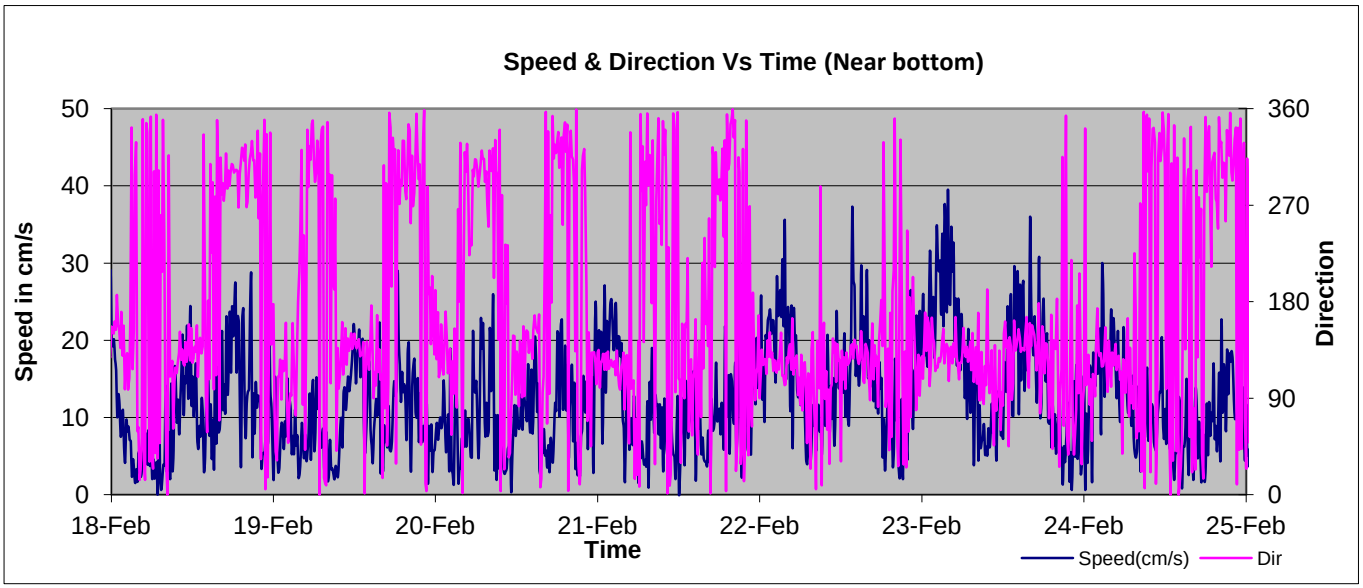

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir

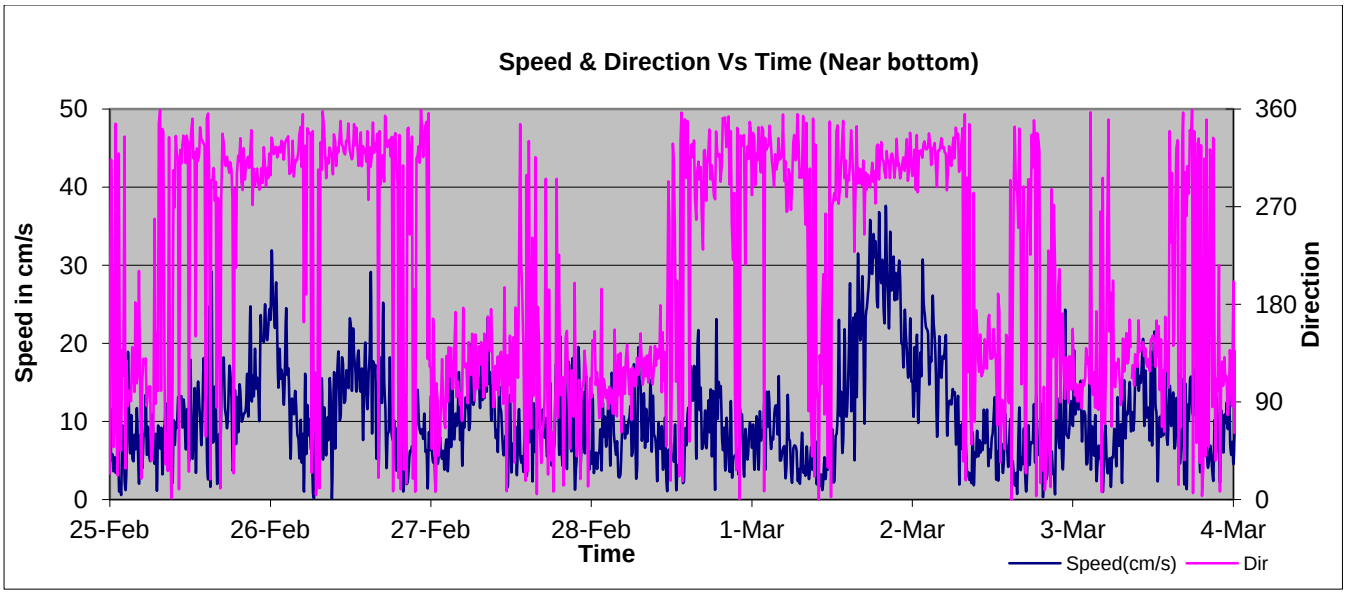

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

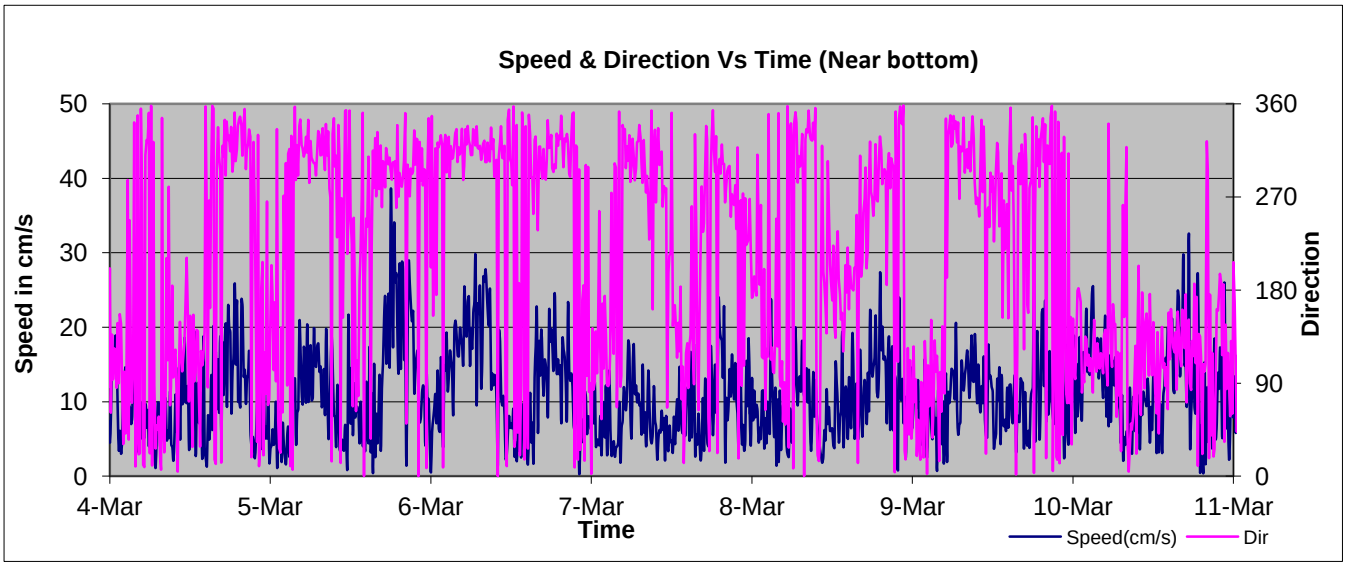

Speed & Direction Vs Time (Mid Depth)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
60
0
90
180
270
360
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

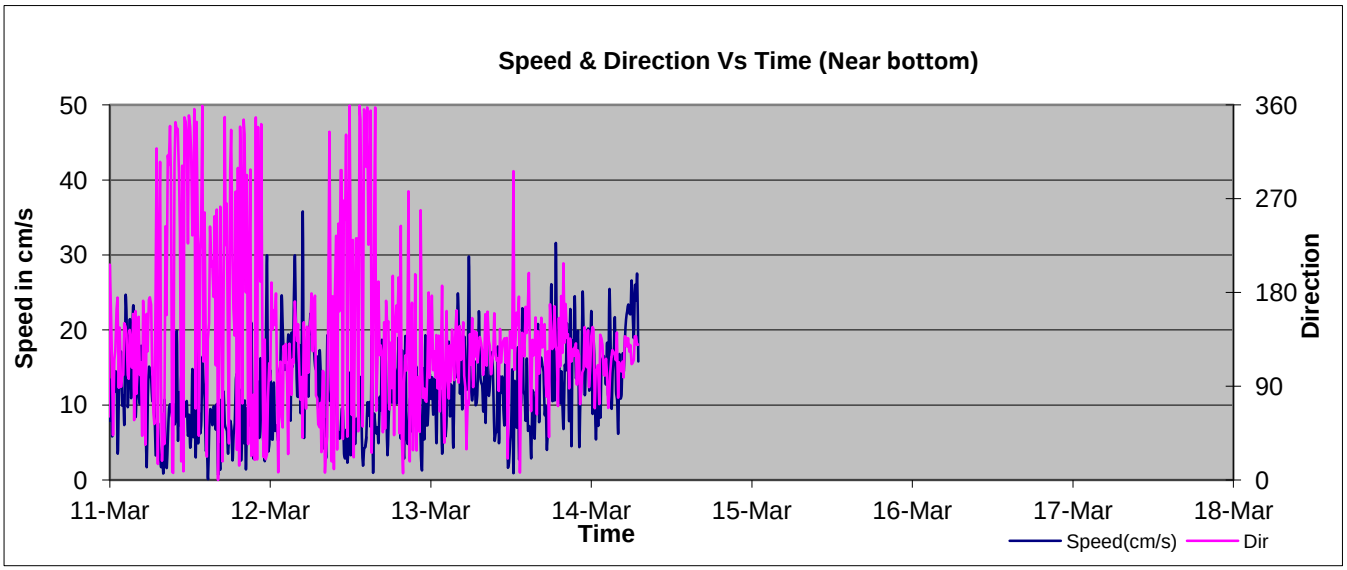

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

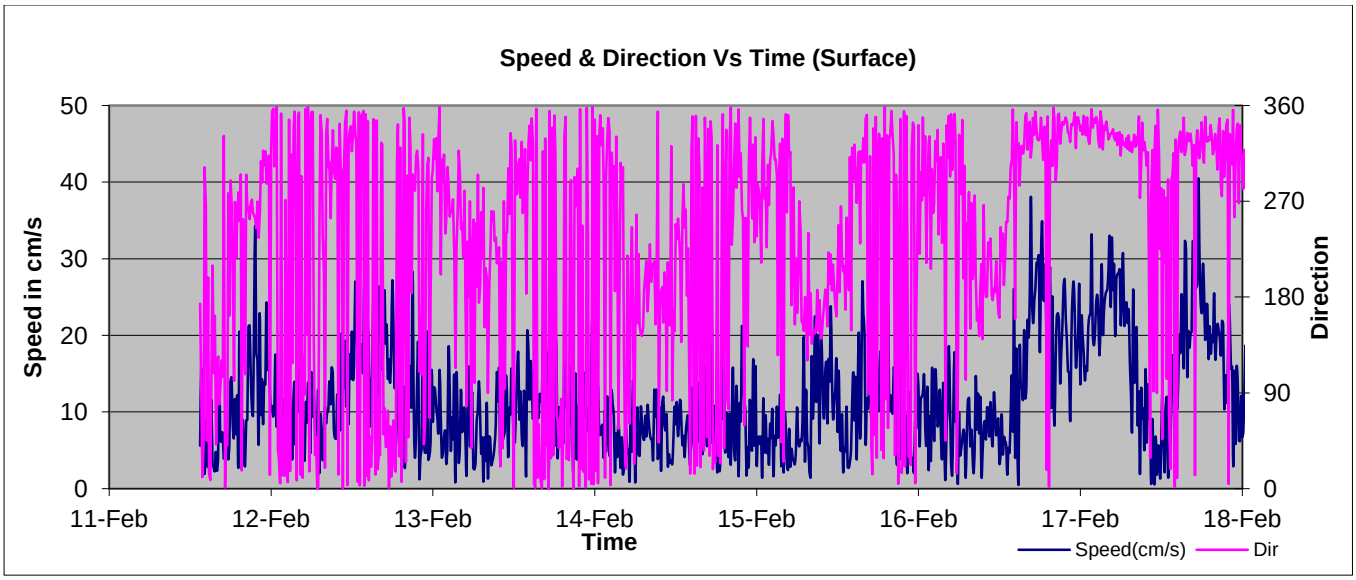

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

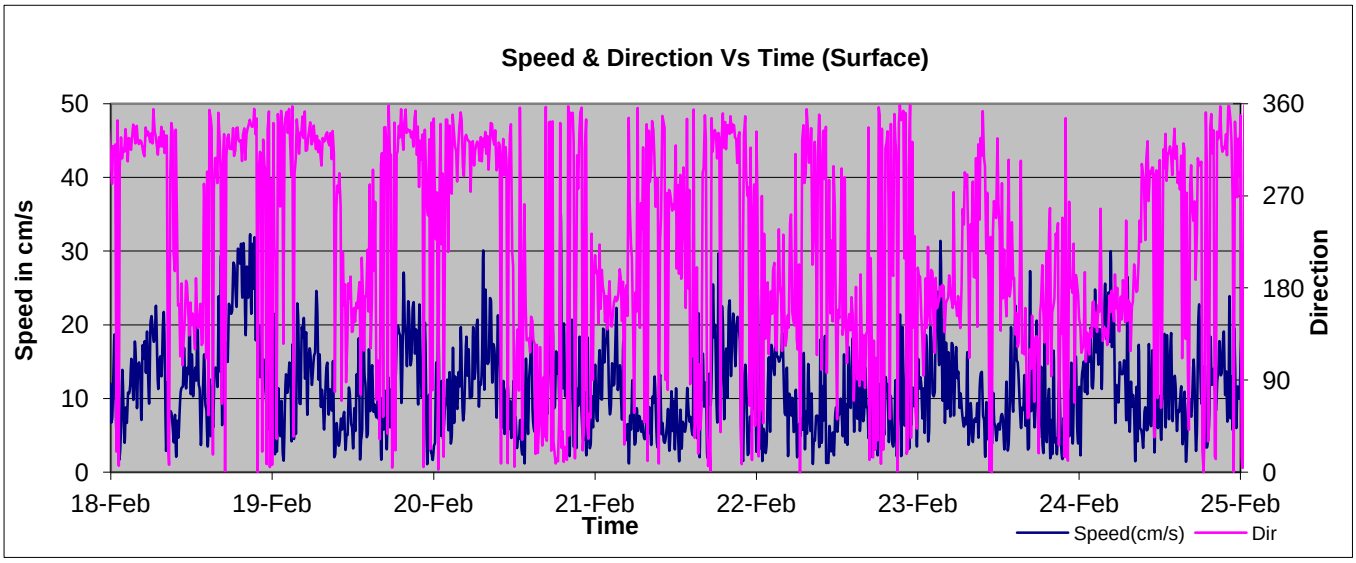

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

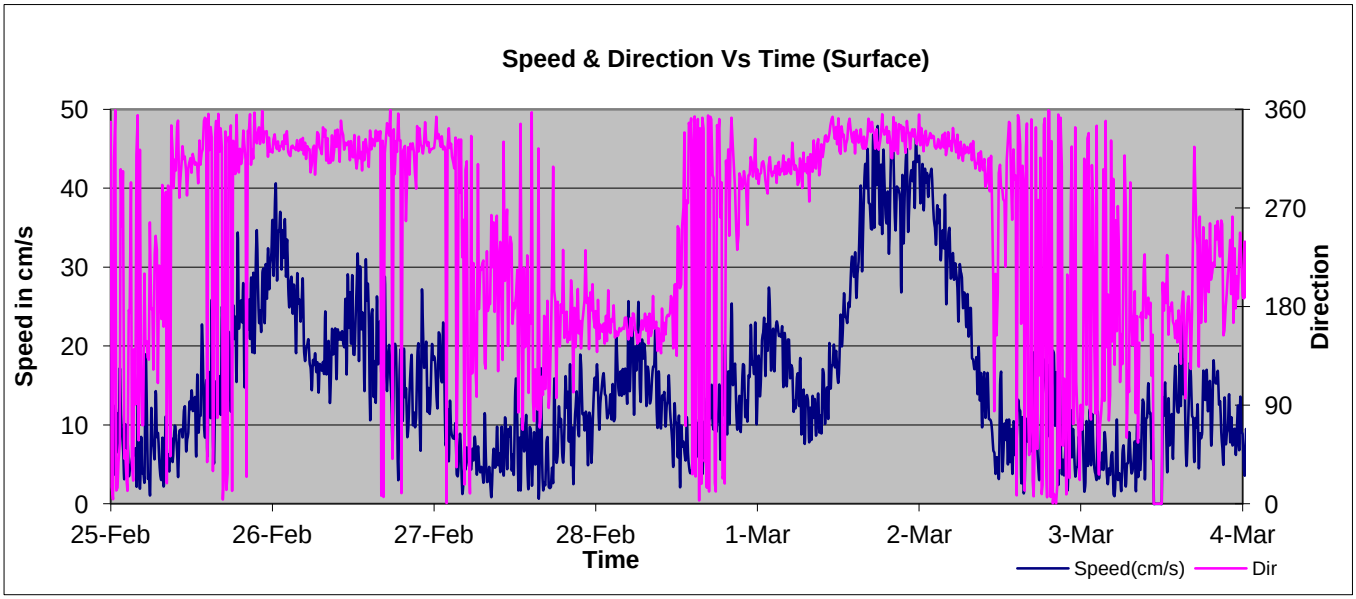
Annexure III

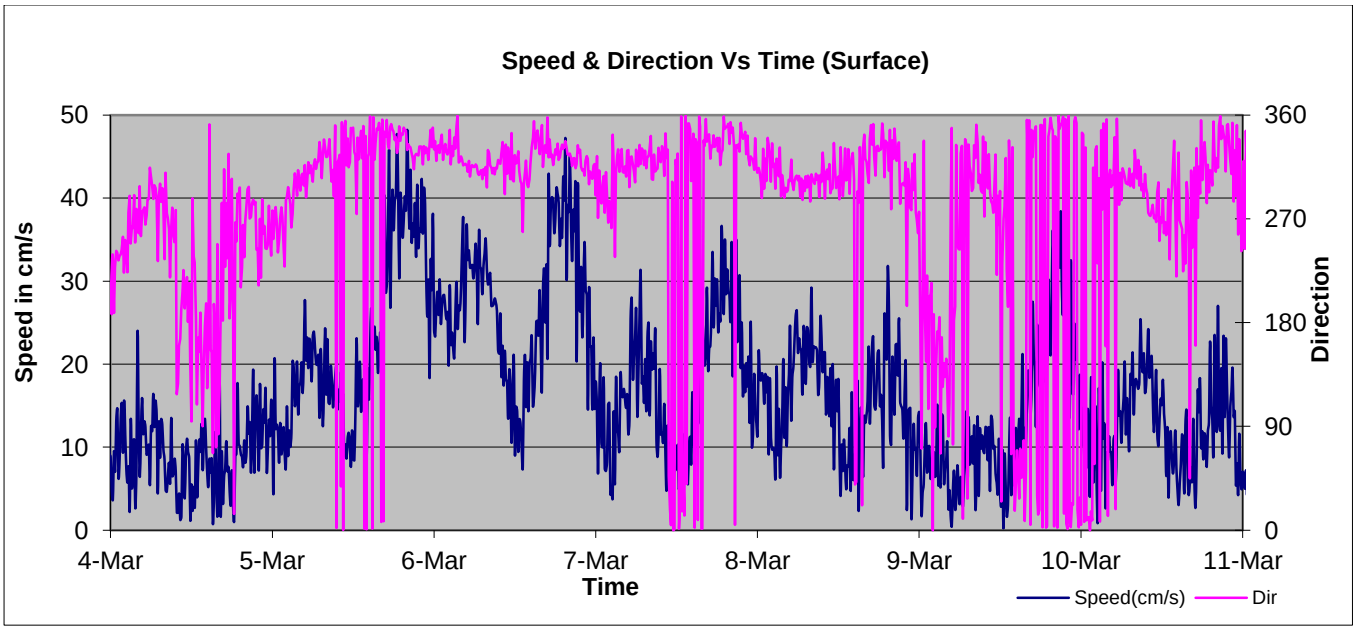
Current Data

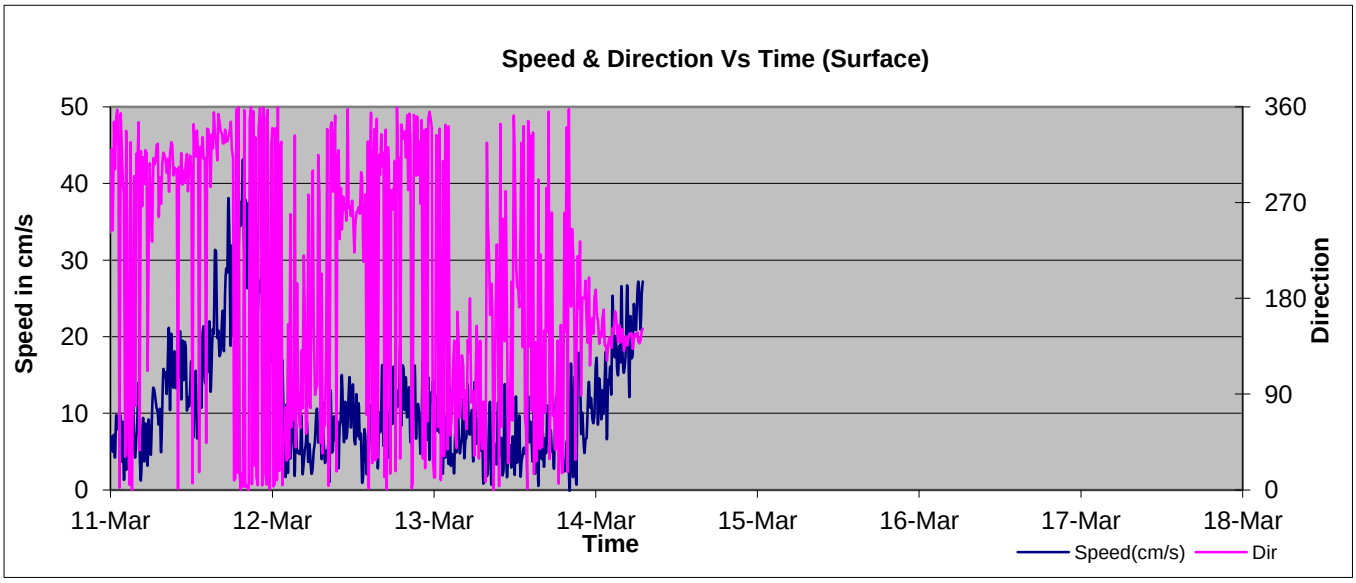
Location P3

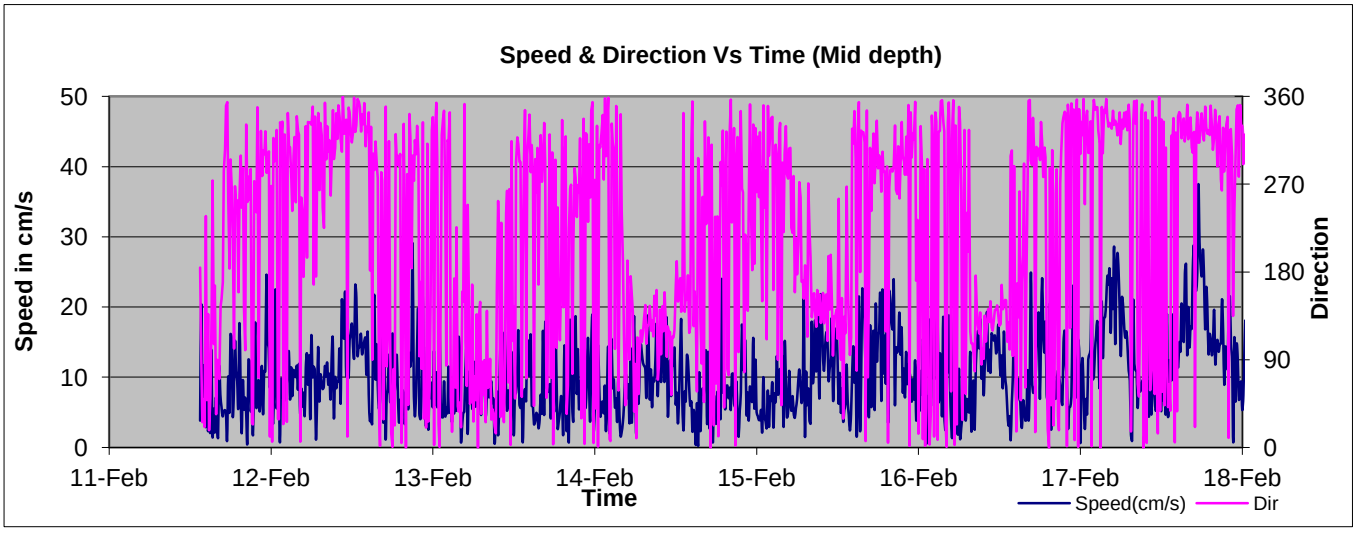

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

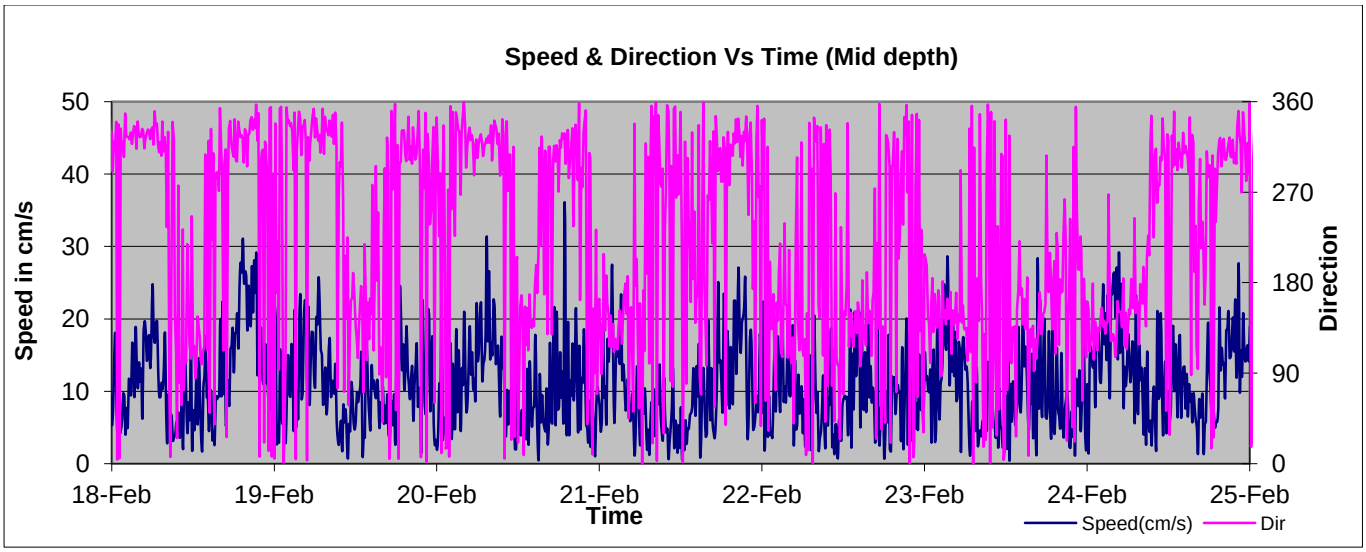

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Speed(cm/s)
Dir

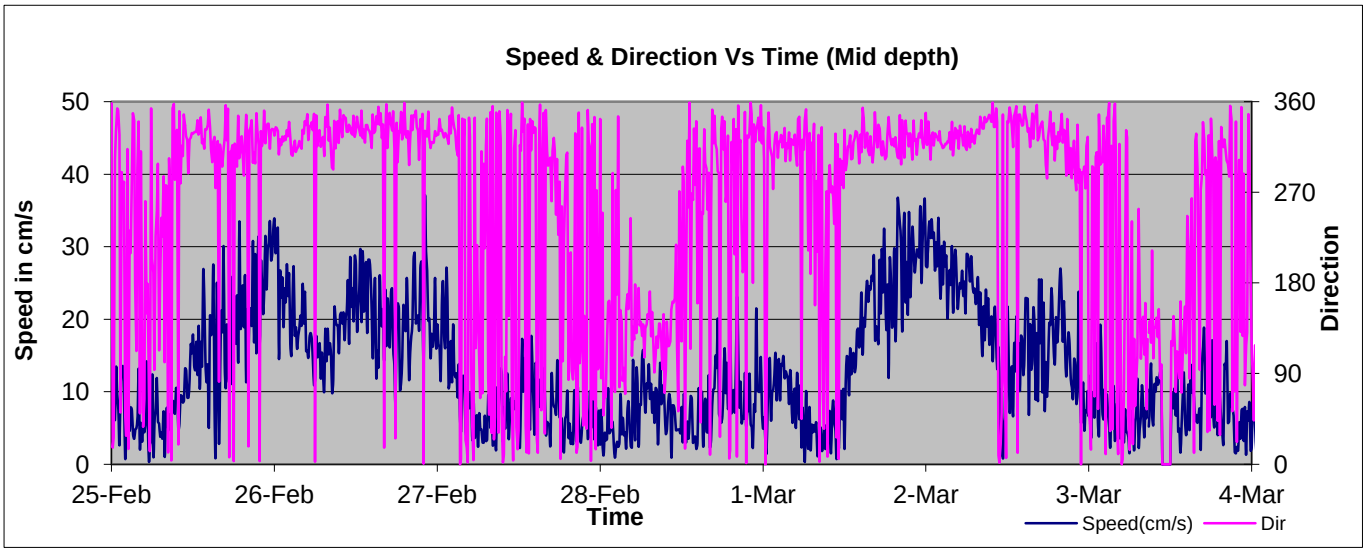

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

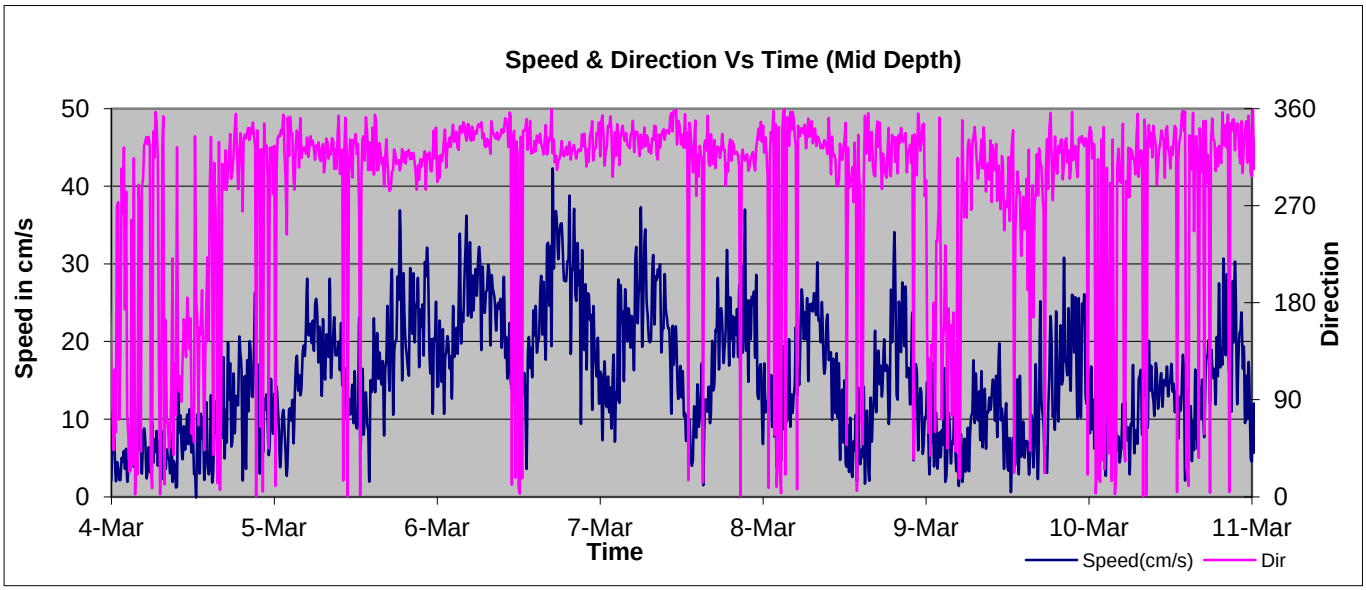

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

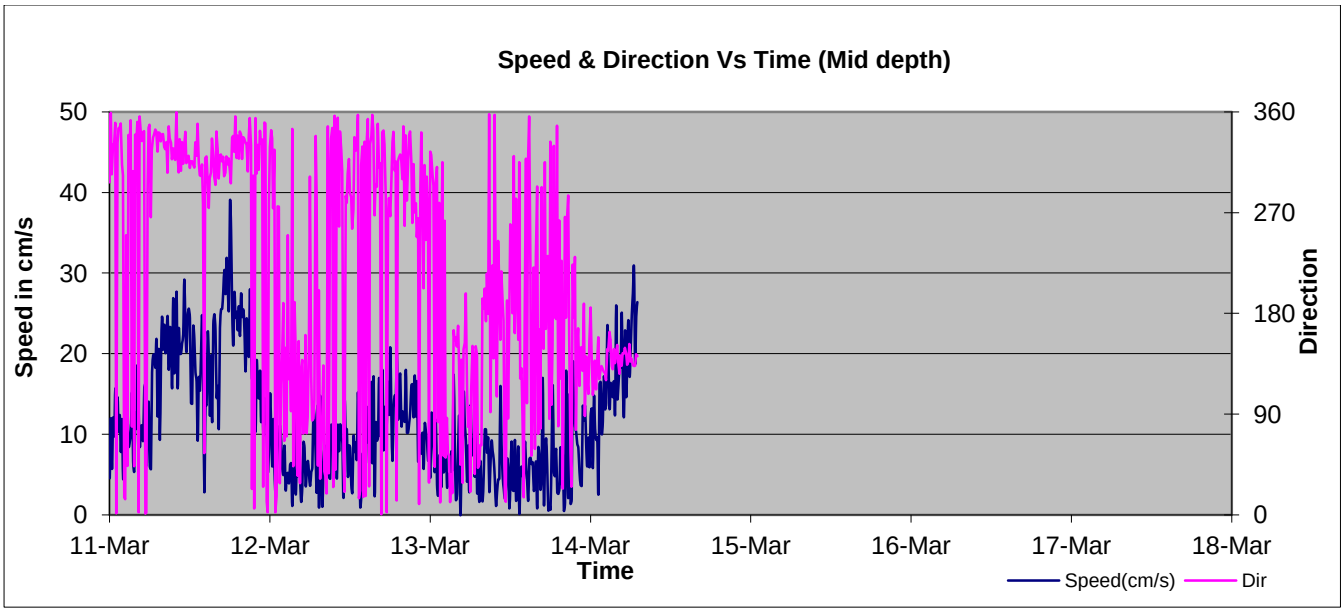

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

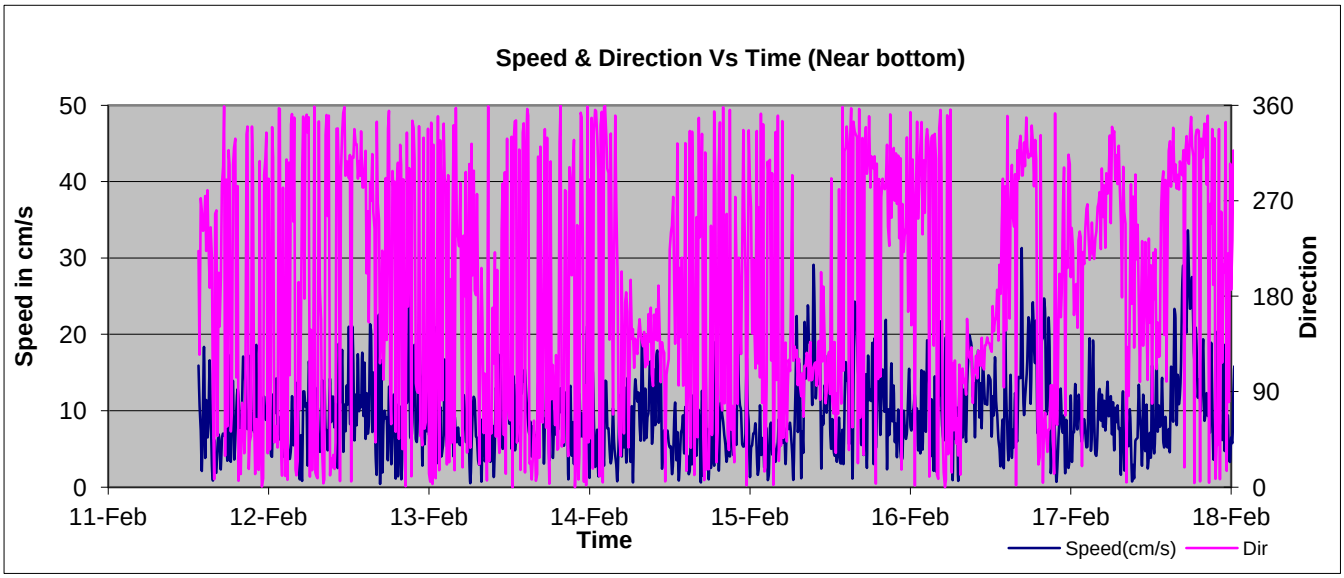

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

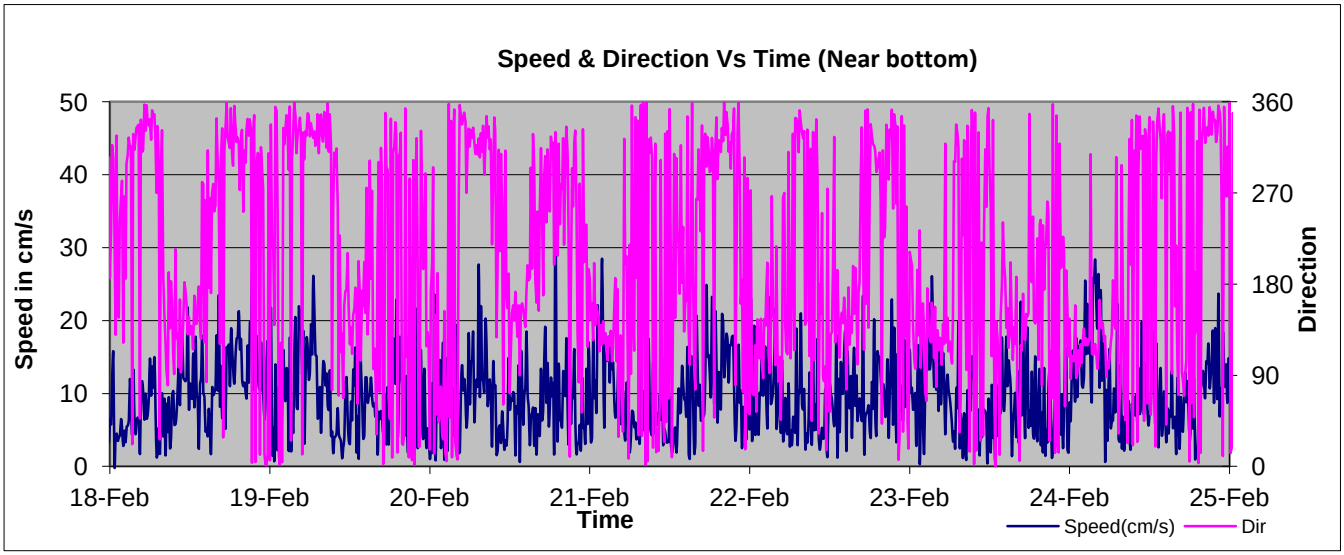

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
0
10
20
30
40
50
0
90
180
270
360
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Time
Speed(cm/s)
Dir

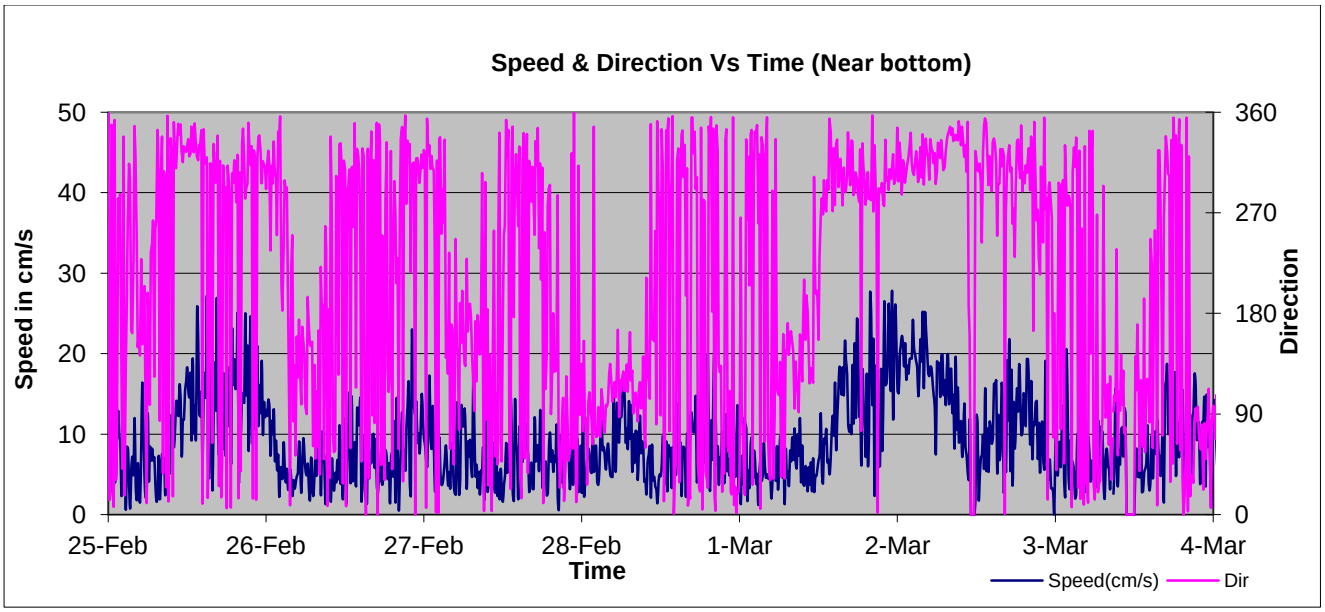

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
0
10
20
30
40
50
0
90
180
270
360
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Time
Speed(cm/s)
Dir

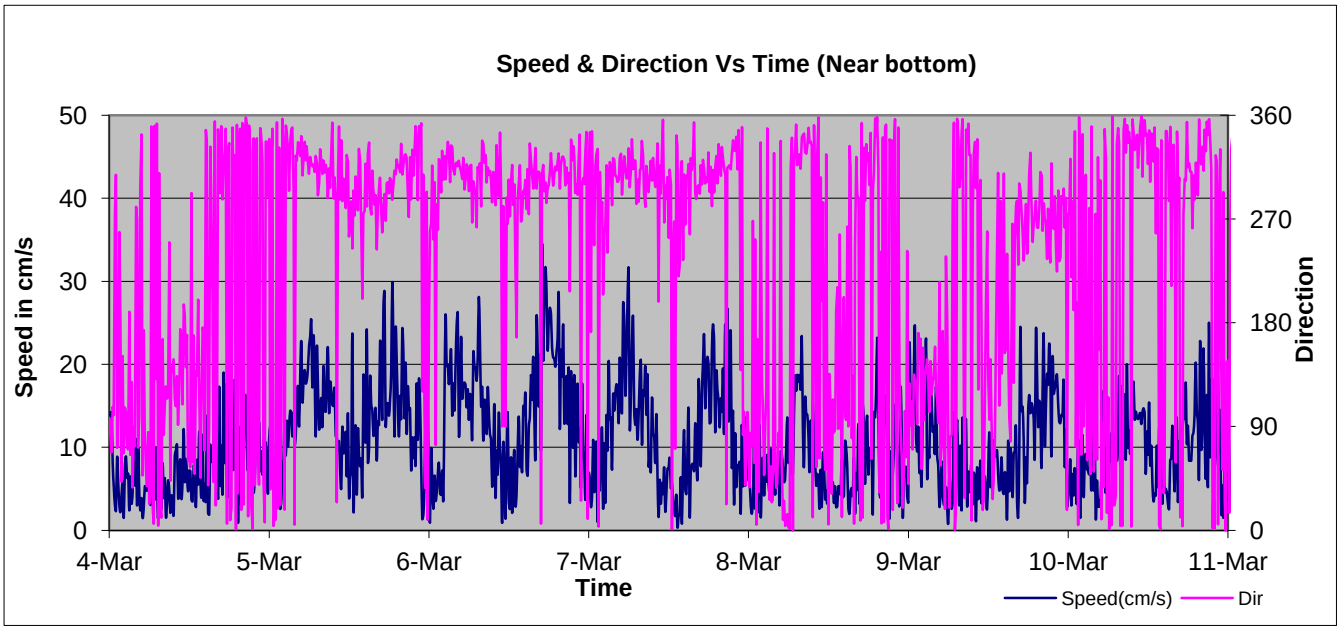

Speed & Direction Vs Time (Mid Depth)
Speed in cm/s
Direction
0
10
20
30
40
50
0
90
180
270
360
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Time
Speed(cm/s)
Dir

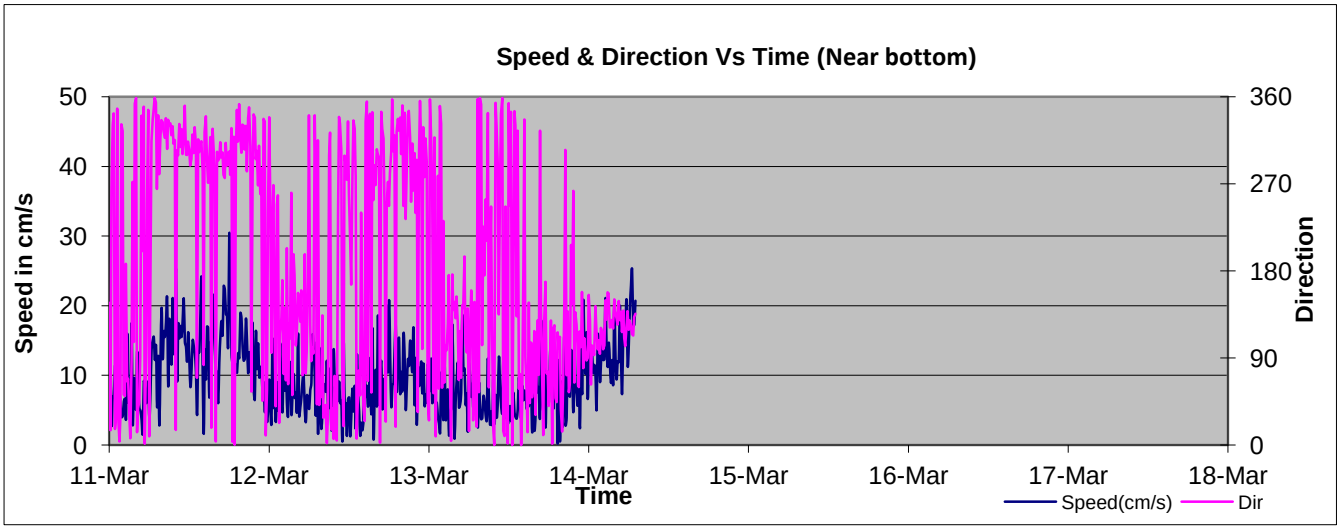

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
50
40
30
20
10
0
360
270
180
90
0
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Time
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
50
40
30
20
10
0
360
270
180
90
0
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Time
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
50
40
30
20
10
0
360
270
180
90
0
18-Feb
19-Feb
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
Time
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

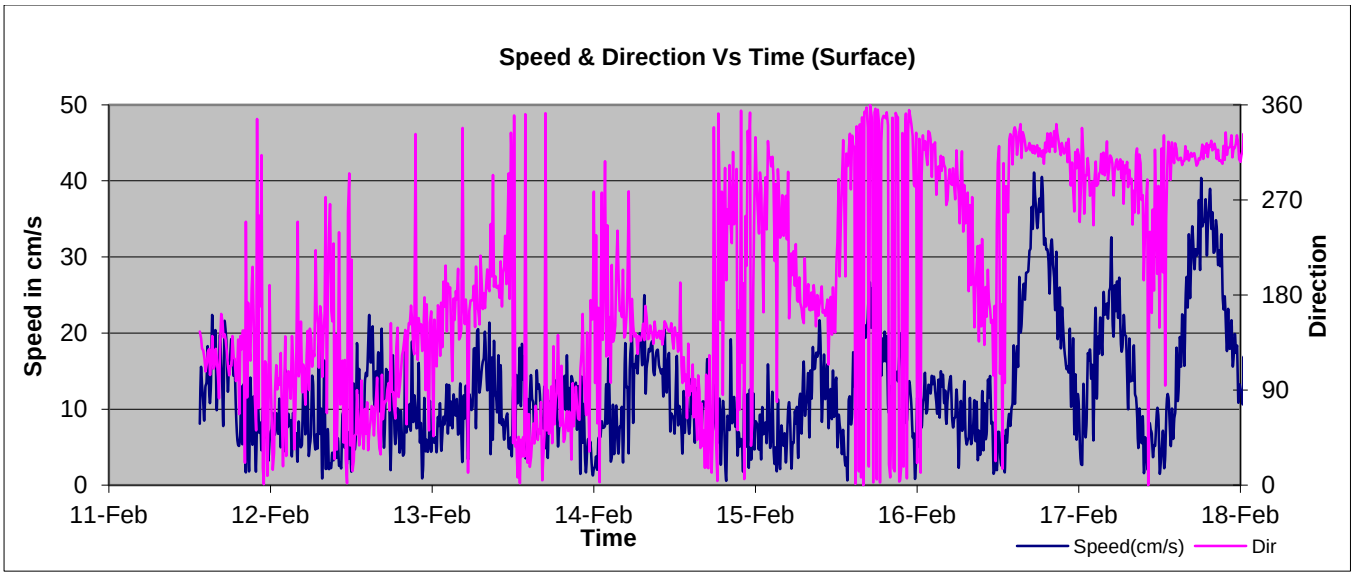

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
4-Mar
5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

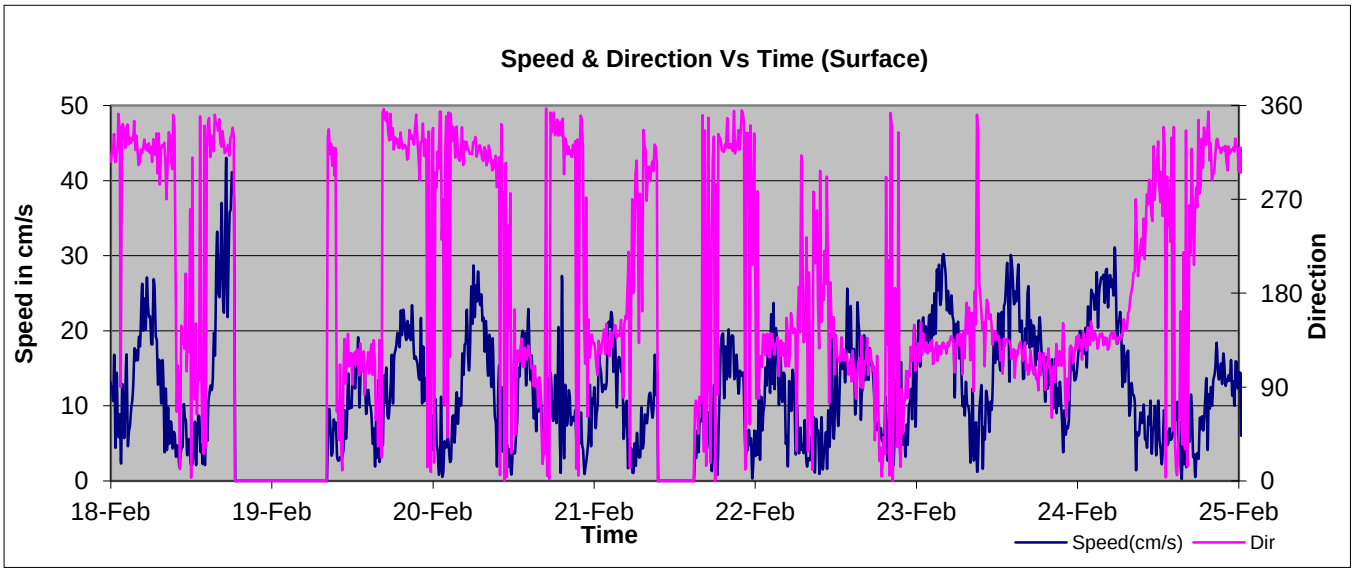

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
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12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

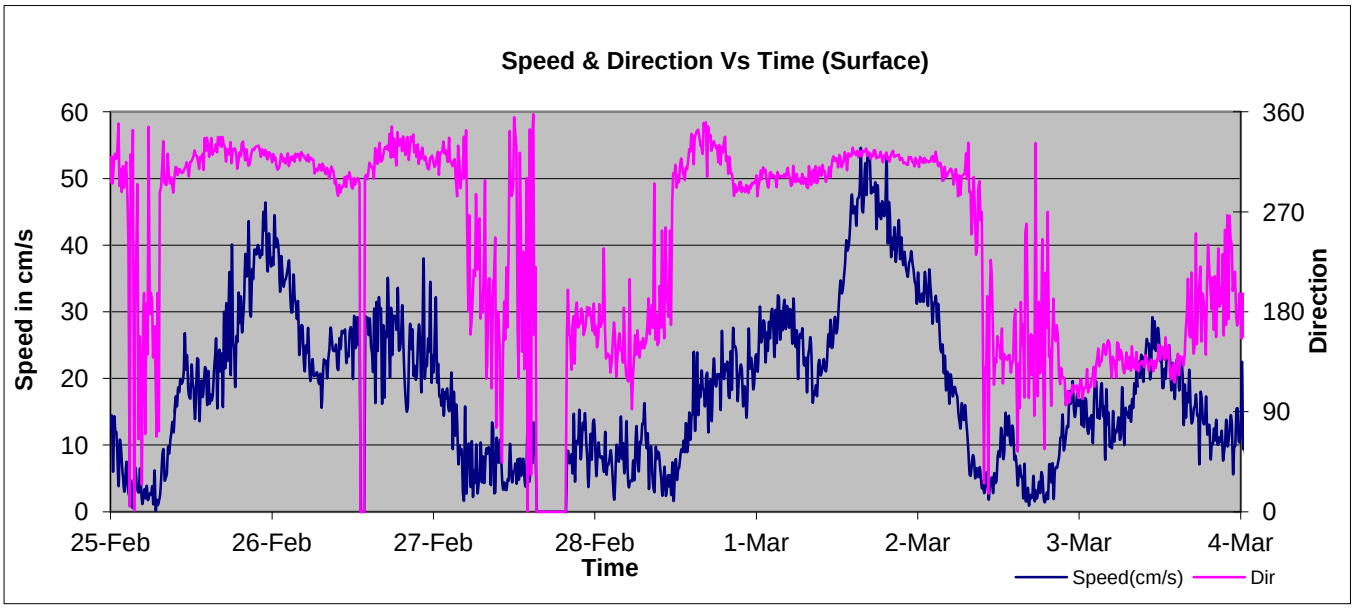
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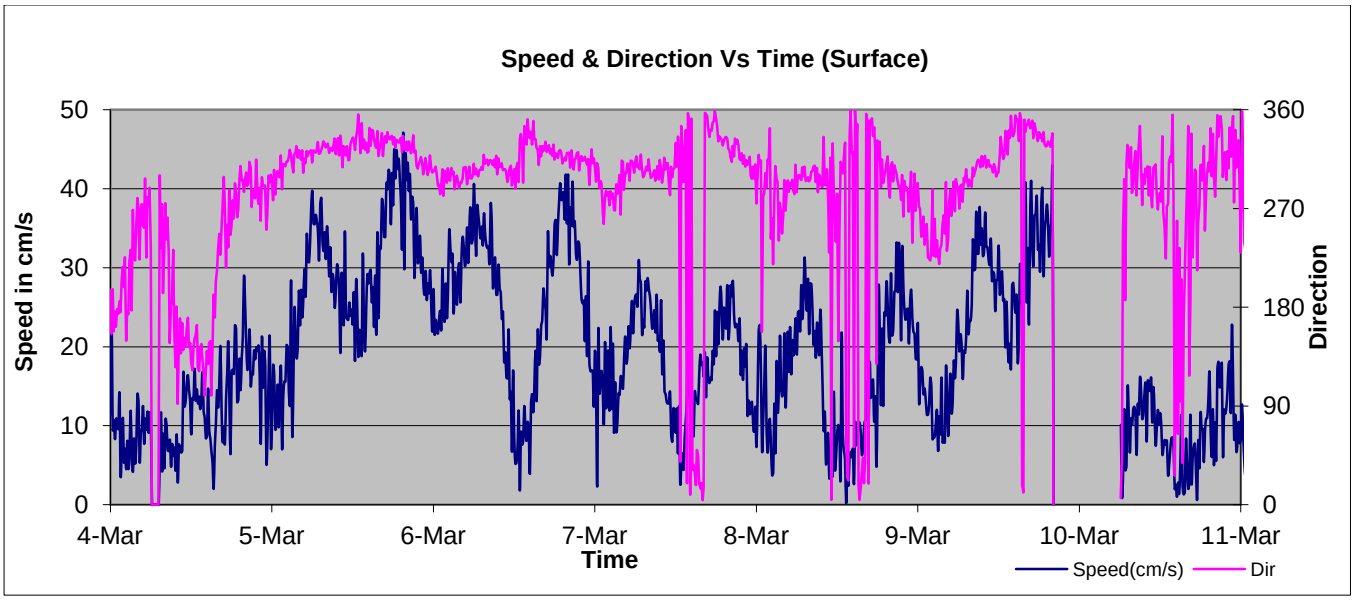
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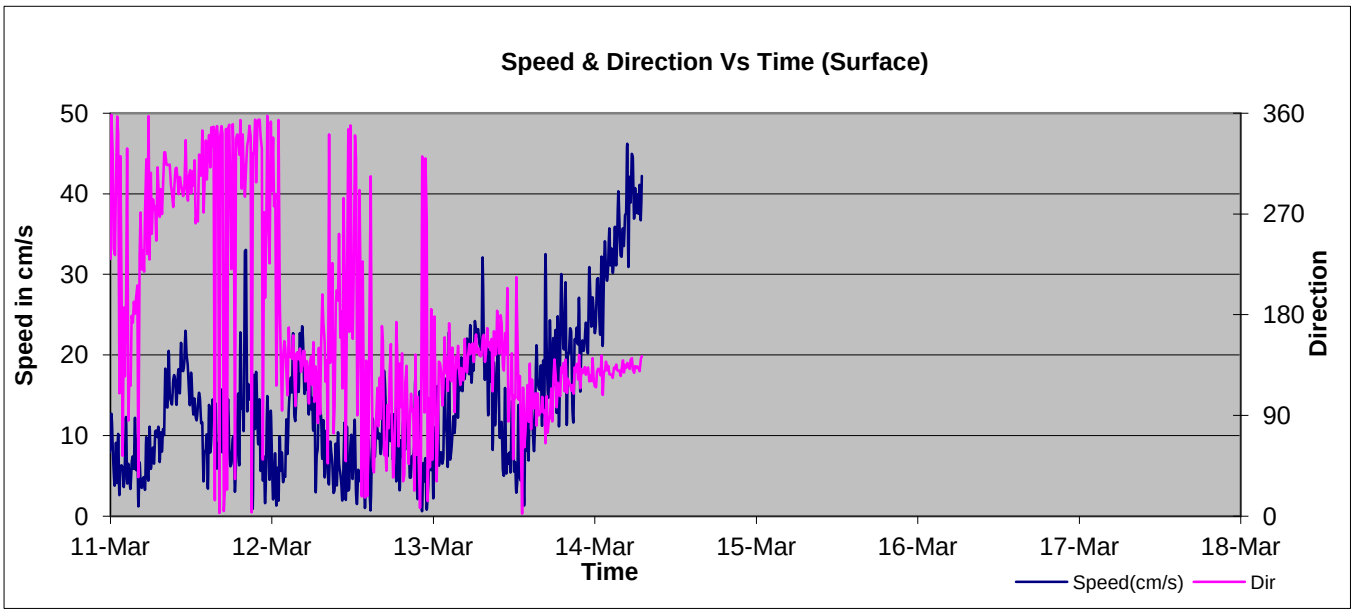
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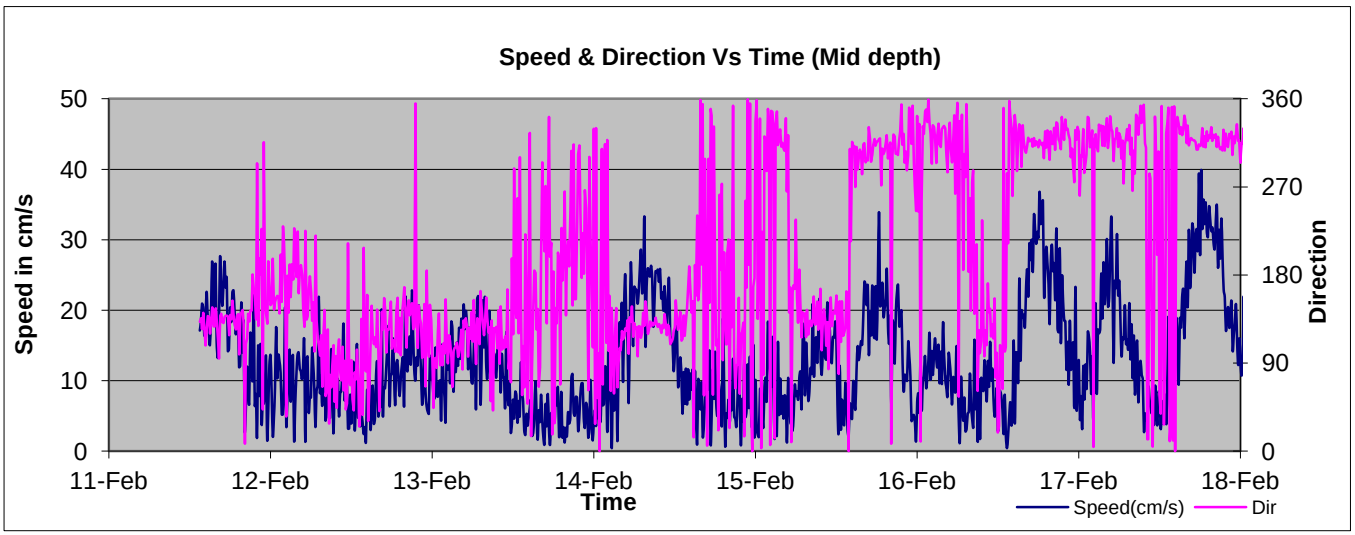

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
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12-Feb
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14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir

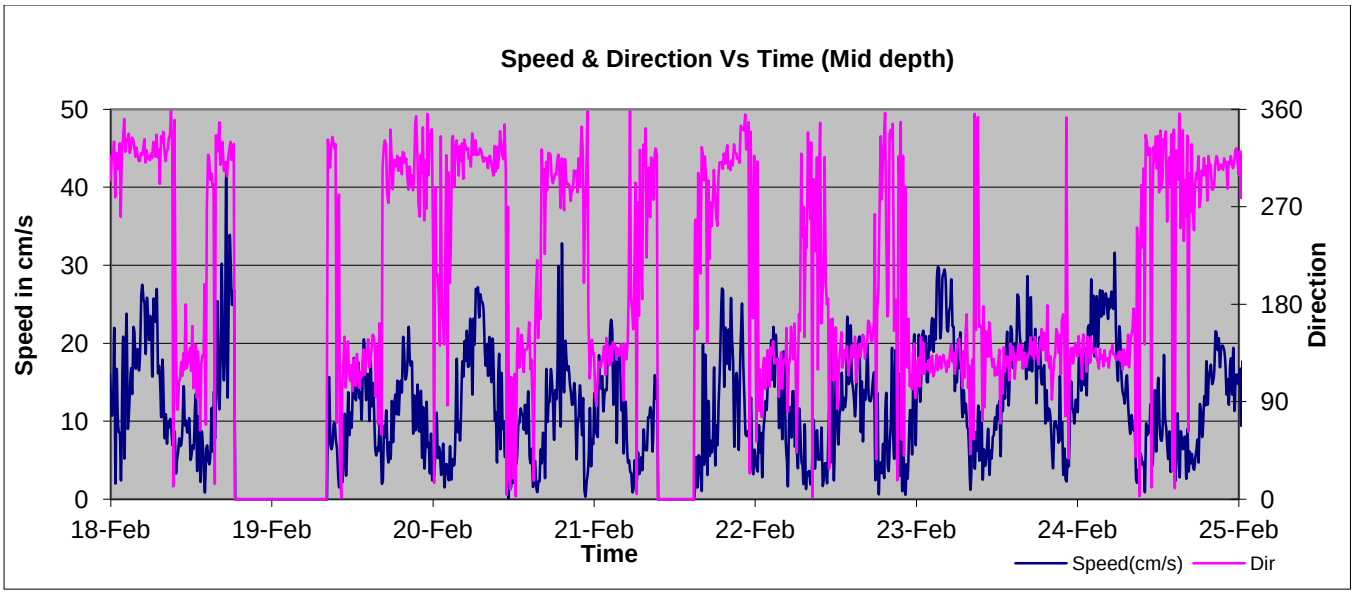

Speed & Direction Vs Time (Surface)
Speed in cm/s
Direction
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23-Feb
24-Feb
25-Feb
Speed(cm/s)
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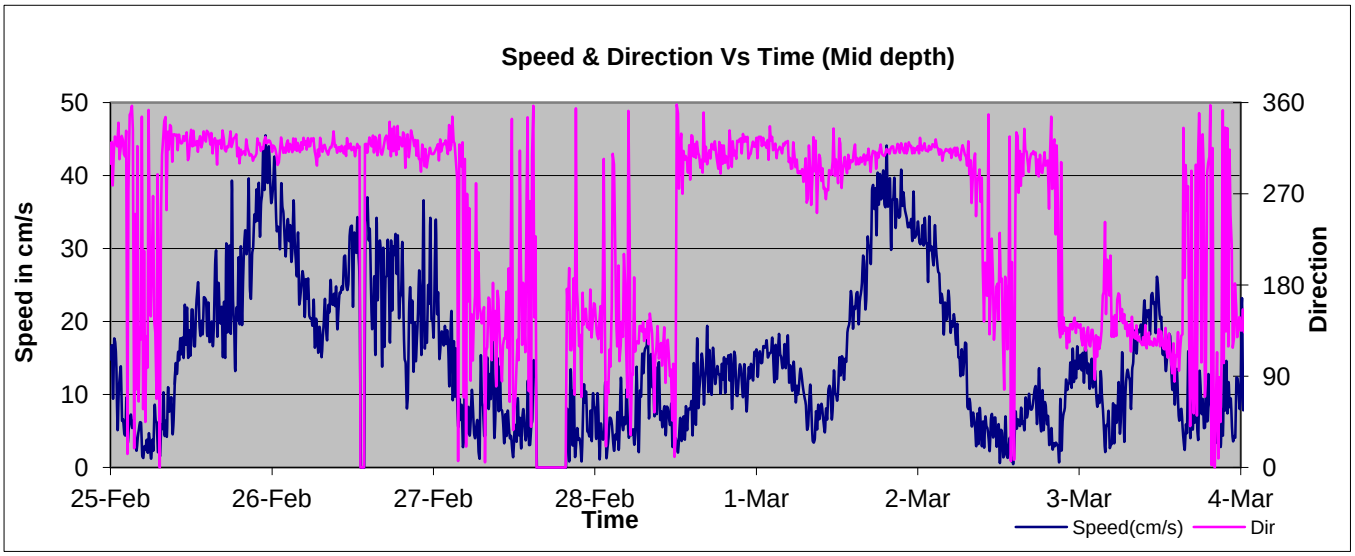

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28-Feb
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2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

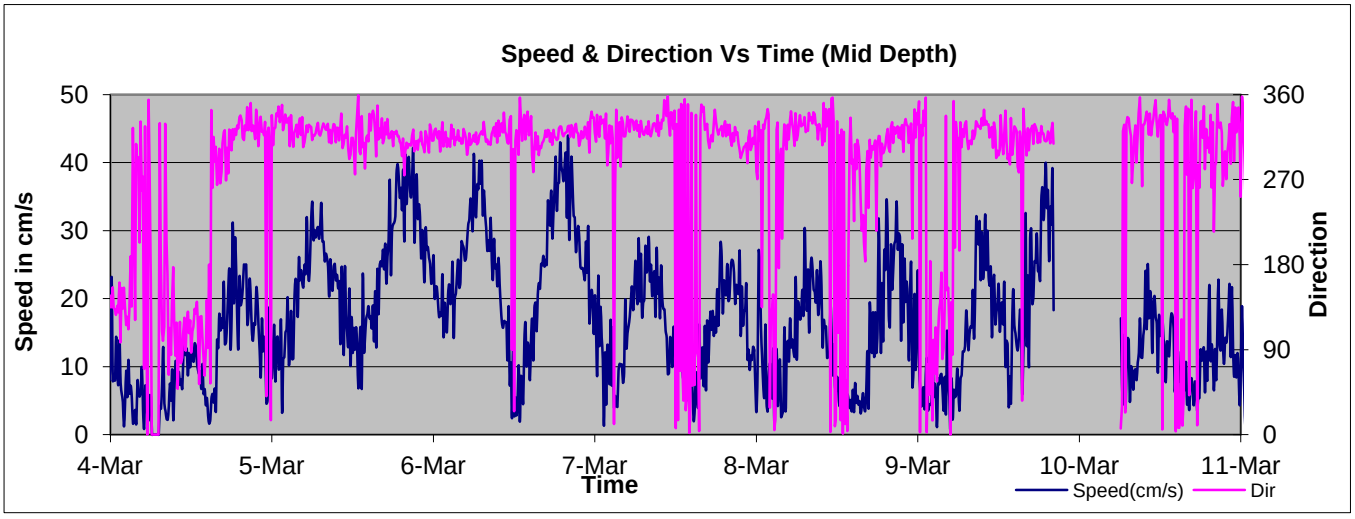

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Speed in cm/s
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Speed(cm/s)
Dir

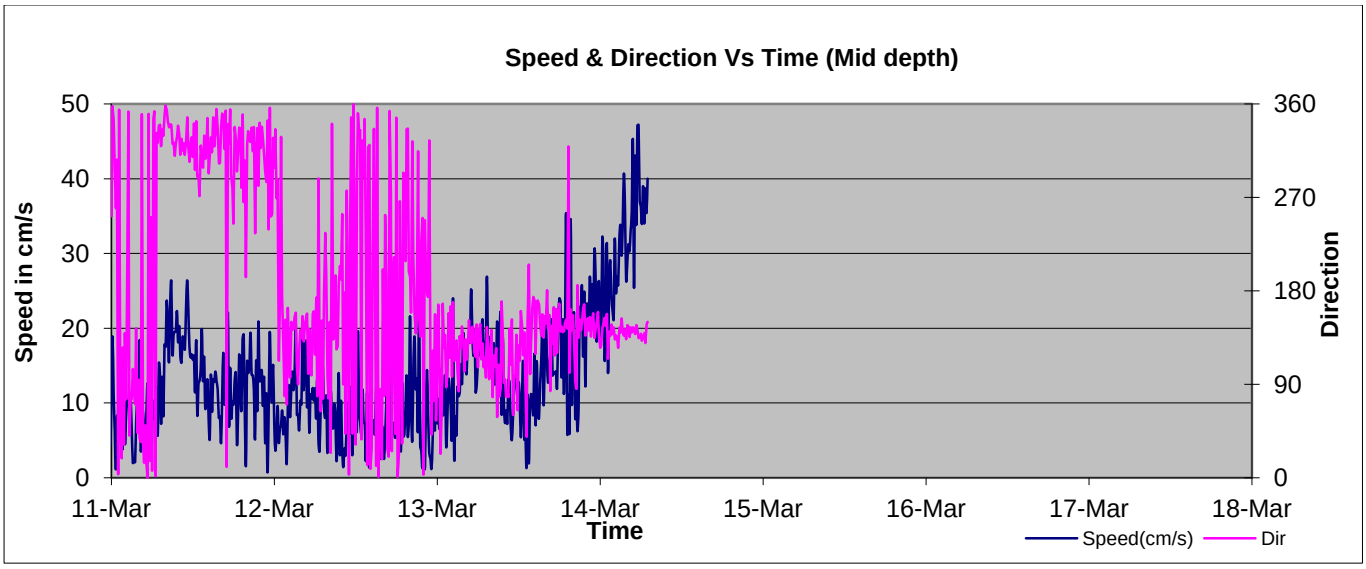

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Speed in cm/s
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Speed(cm/s)
Dir

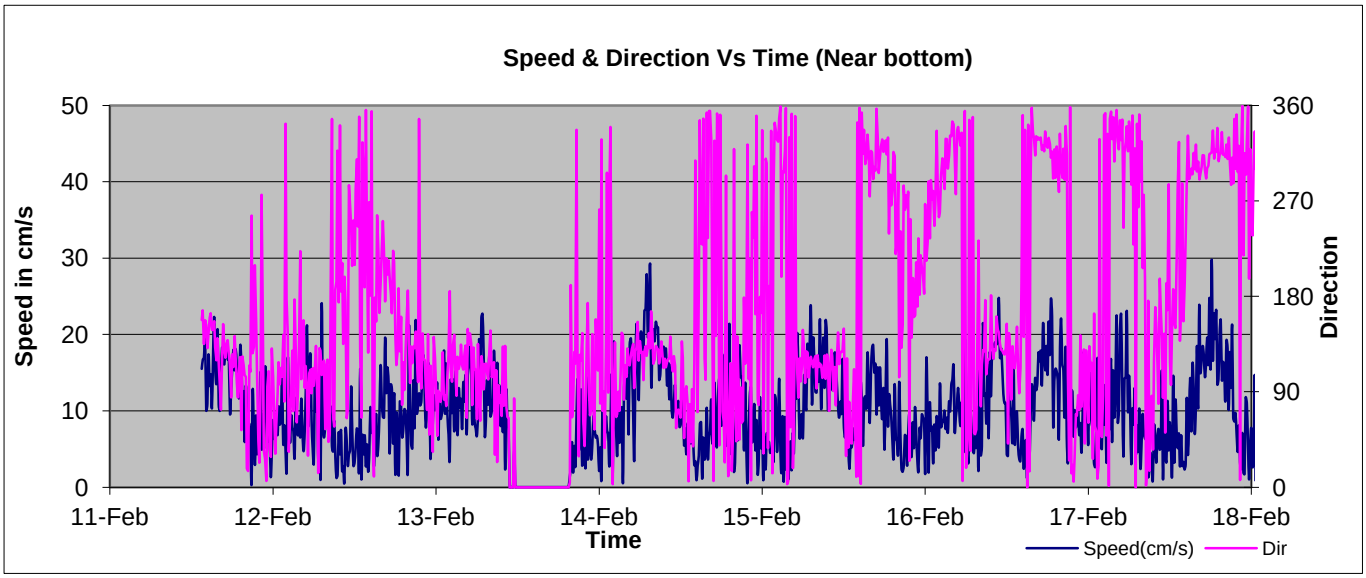

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Speed(cm/s)
Dir

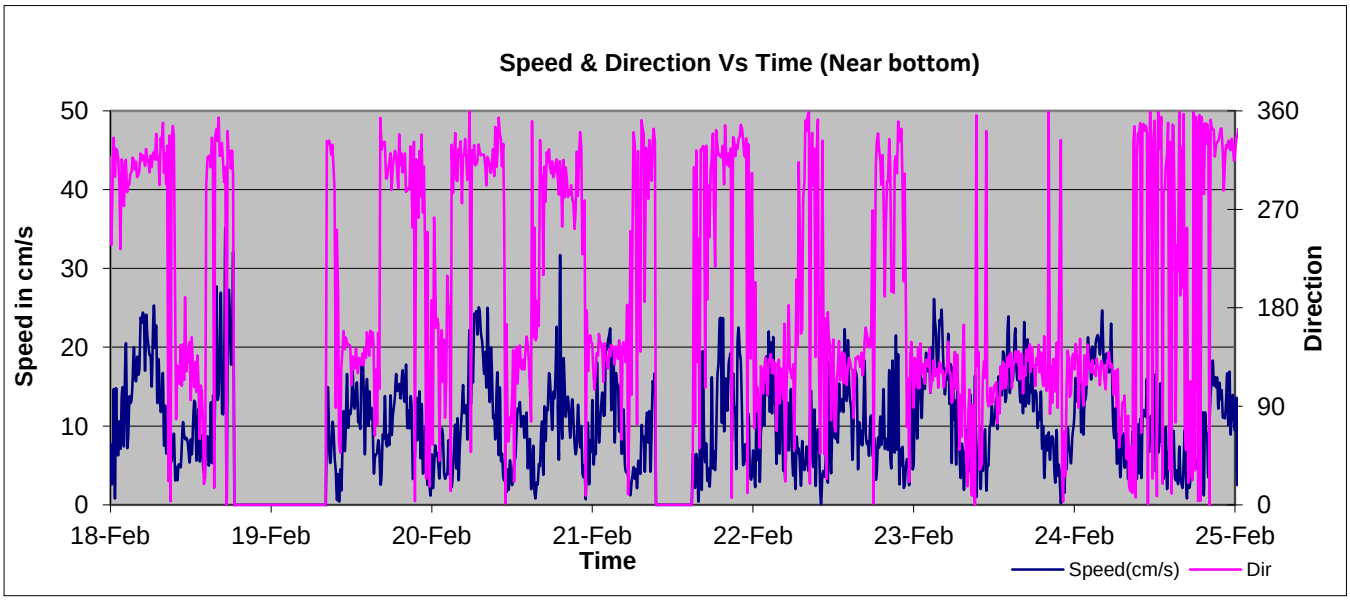

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Speed in cm/s
Direction
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24-Feb
25-Feb
Speed(cm/s)
Dir

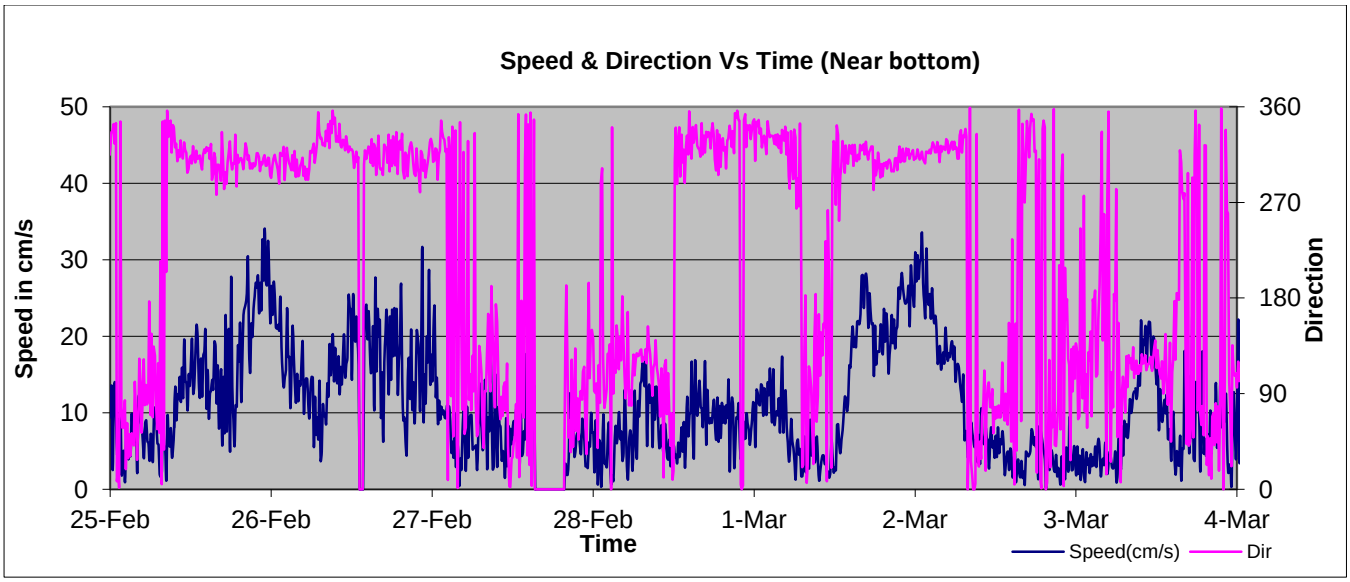

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
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28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

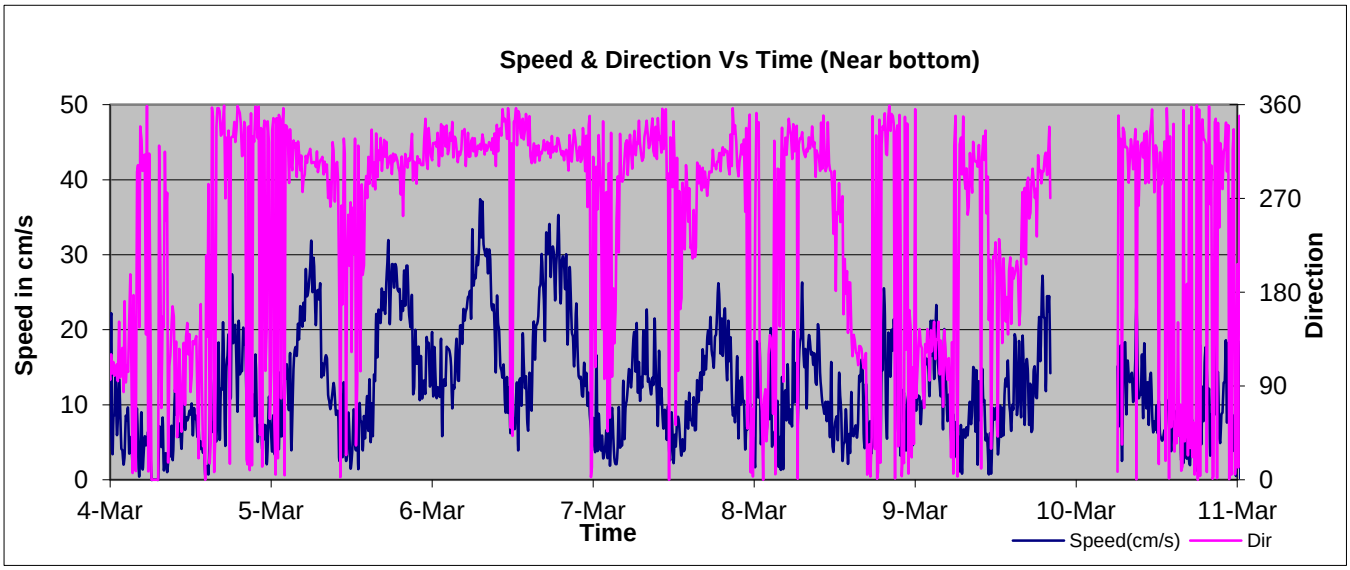

Speed & Direction Vs Time (Mid Depth)
Speed in cm/s
Direction
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8-Mar
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10-Mar
11-Mar
Speed(cm/s)
Dir

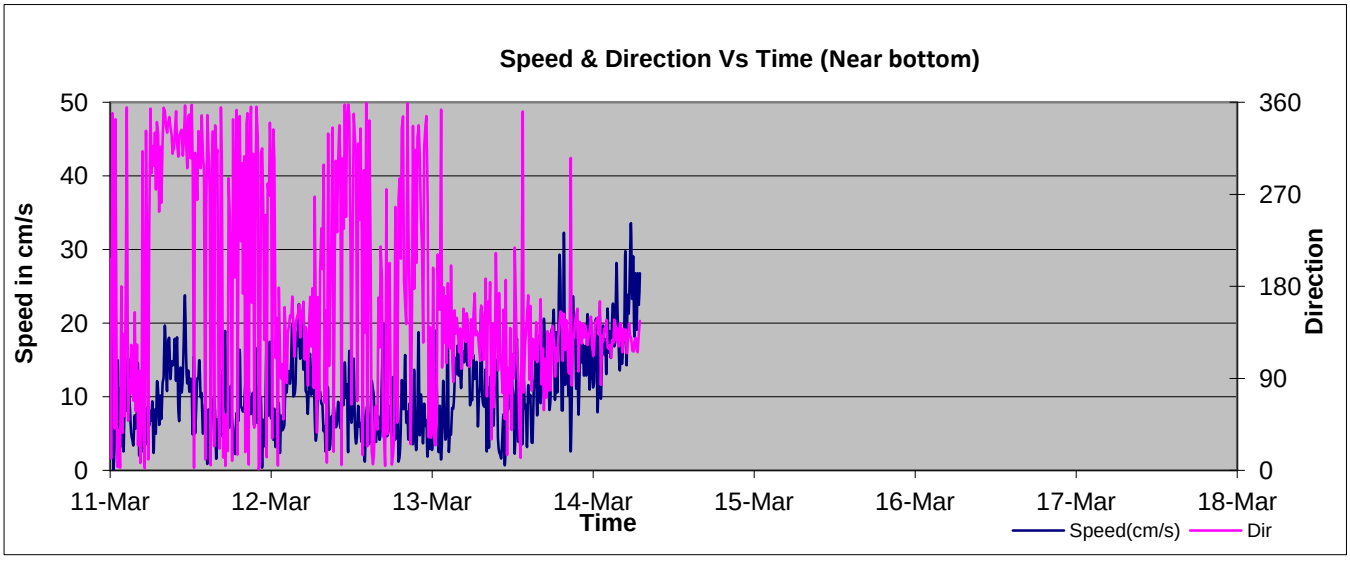

Speed & Direction Vs Time (Mid depth)
Speed in cm/s
Direction
Time
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90
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360
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Speed(cm/s)
Dir


Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
10
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25-Feb
Speed(cm/s)
Dir

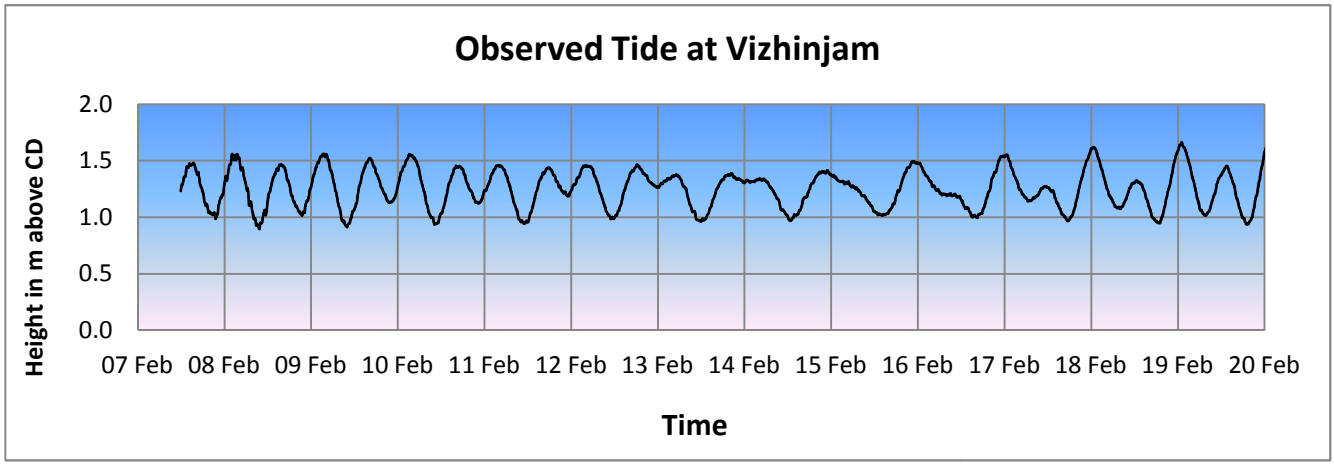

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
10
20
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50
0
90
180
270
360
25-Feb
26-Feb
27-Feb
28-Feb
1-Mar
2-Mar
3-Mar
4-Mar
Speed(cm/s)
Dir

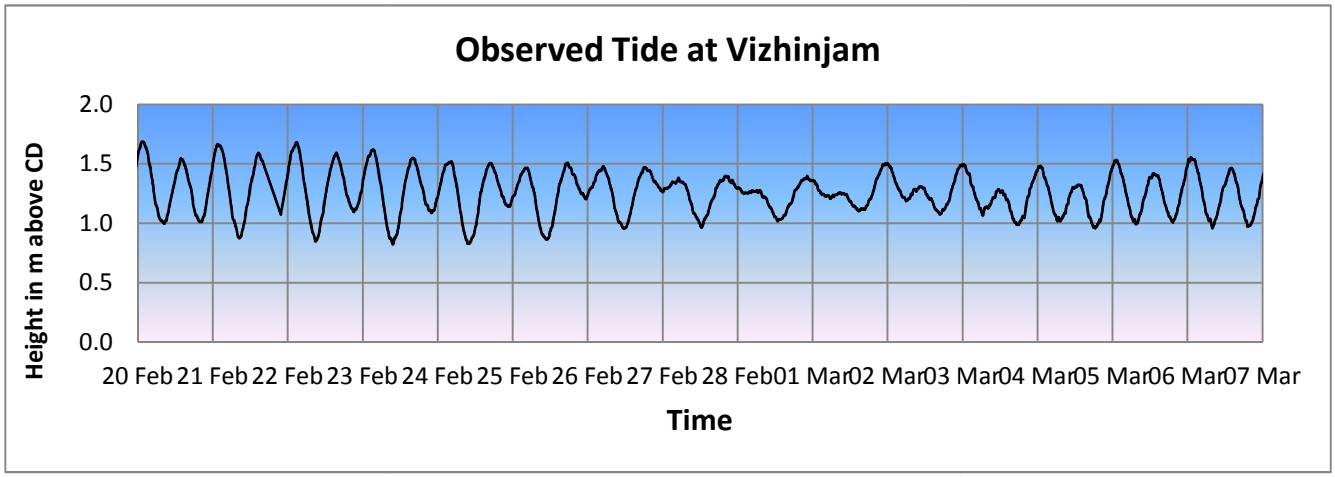

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
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30
40
50
0
90
180
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5-Mar
6-Mar
7-Mar
8-Mar
9-Mar
10-Mar
11-Mar
Speed(cm/s)
Dir

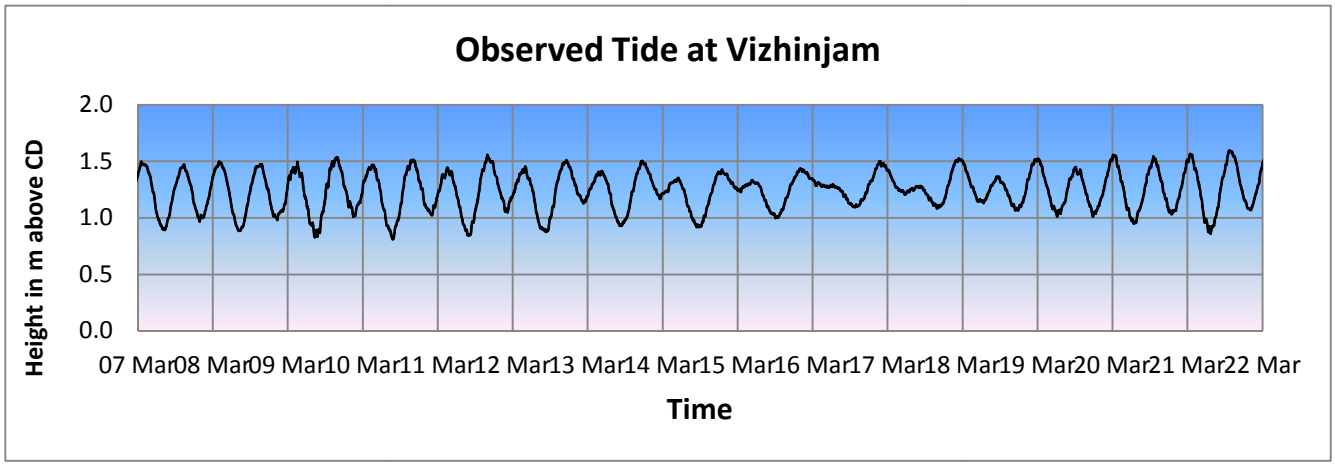

Speed & Direction Vs Time (Near bottom)
Speed in cm/s
Direction
Time
0
10
20
30
40
50
0
90
180
270
360
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
Speed(cm/s)
Dir

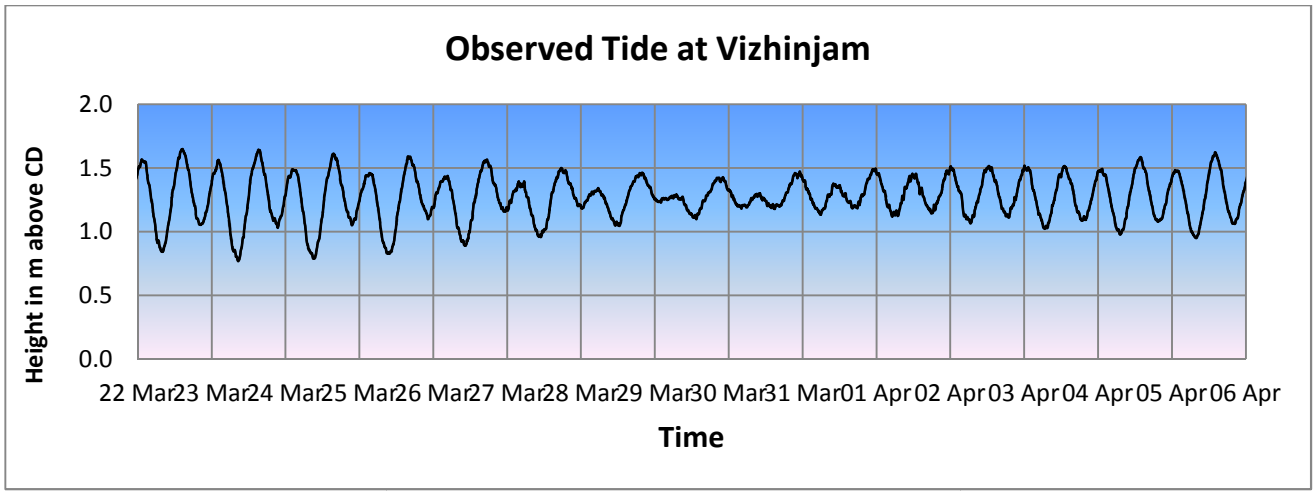
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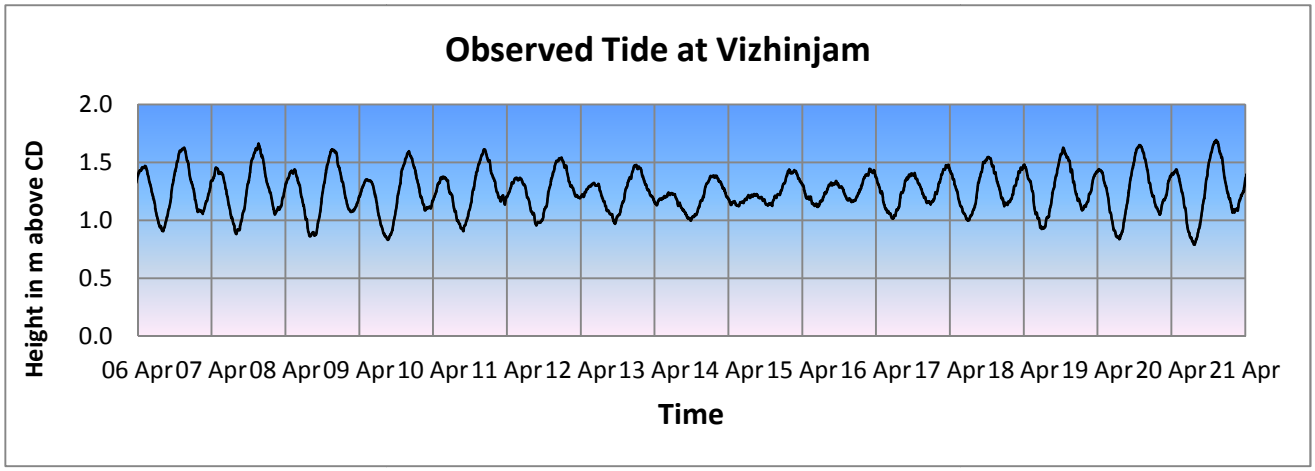
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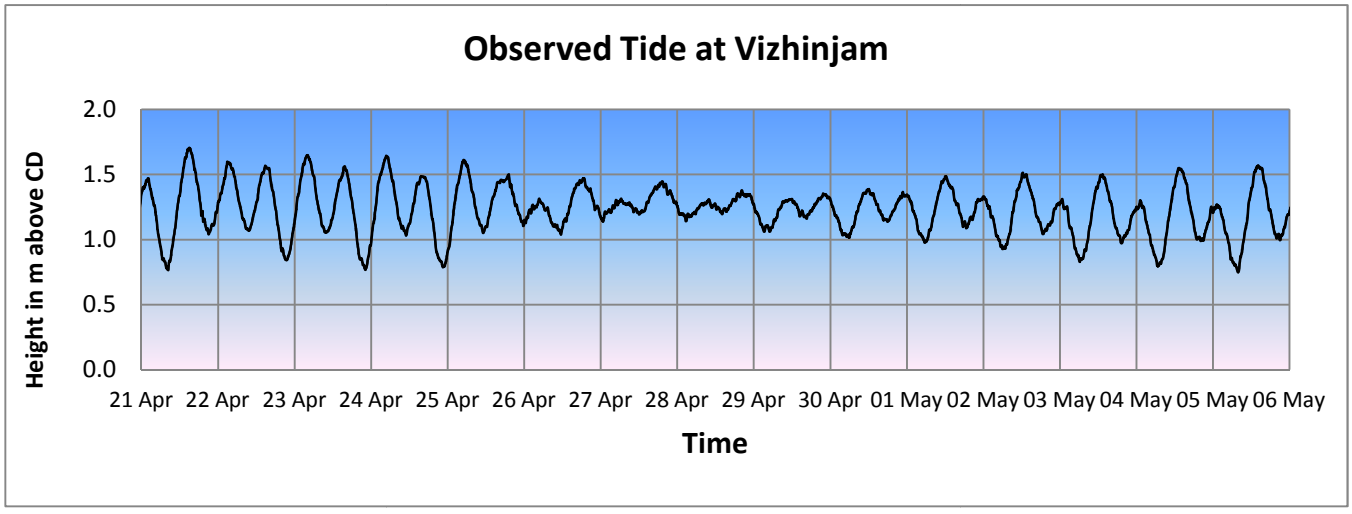

Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
07 Feb 08 Feb 09 Feb 10 Feb 11 Feb 12 Feb 13 Feb 14 Feb 15 Feb 16 Feb 17 Feb 18 Feb 19 Feb 20 Feb
Time

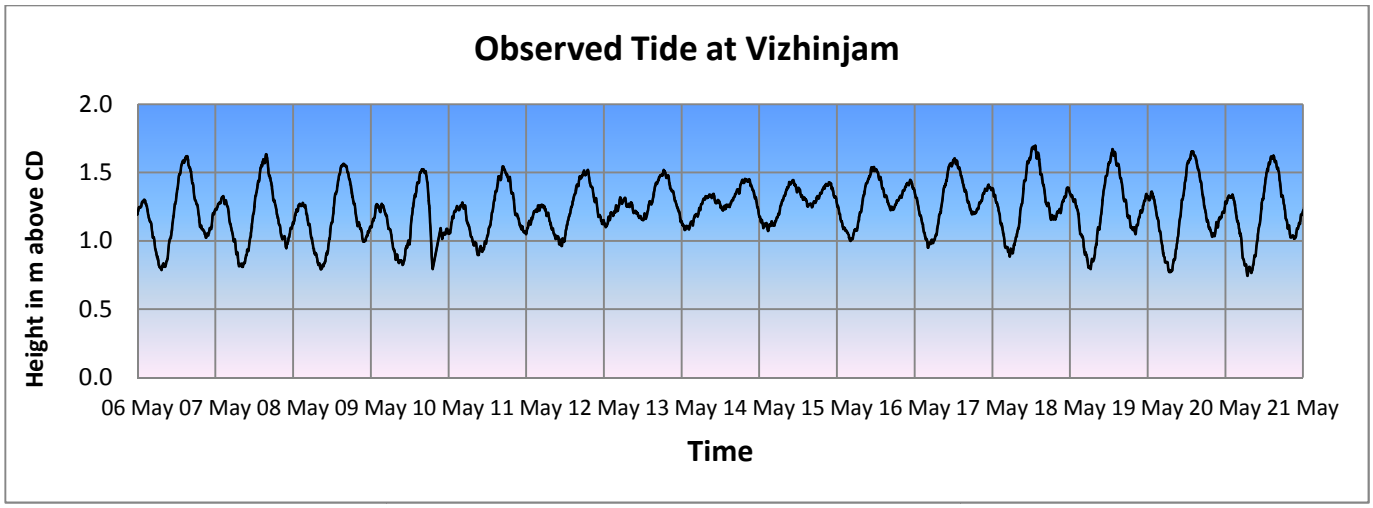

Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
20 Feb 21 Feb 22 Feb 23 Feb 24 Feb 25 Feb 26 Feb 27 Feb 28 Feb 01 Mar 02 Mar 03 Mar 04 Mar 05 Mar 06 Mar 07 Mar
Time

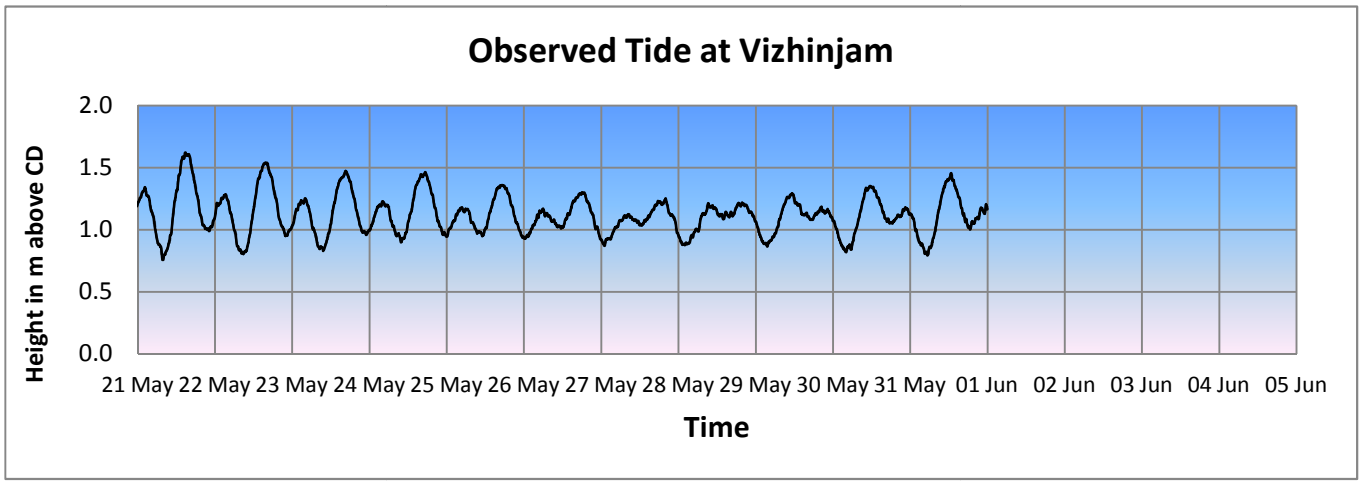

Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
07 Mar 08 Mar 09 Mar 10 Mar 11 Mar 12 Mar 13 Mar 14 Mar 15 Mar 16 Mar 17 Mar 18 Mar 19 Mar 20 Mar 21 Mar 22 Mar
Time


Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
22 Mar 23 Mar 24 Mar 25 Mar 26 Mar 27 Mar 28 Mar 29 Mar 30 Mar 31 Mar 01 Apr 02 Apr 03 Apr 04 Apr 05 Apr 06 Apr
Time


Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
06 Apr 07 Apr 08 Apr 09 Apr 10 Apr 11 Apr 12 Apr 13 Apr 14 Apr 15 Apr 16 Apr 17 Apr 18 Apr 19 Apr 20 Apr 21 Apr
Time


Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
21 Apr 22 Apr 23 Apr 24 Apr 25 Apr 26 Apr 27 Apr 28 Apr 29 Apr 30 Apr 01 May 02 May 03 May 04 May 05 May 06 May
Time


Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
06 May 07 May 08 May 09 May 10 May 11 May 12 May 13 May 14 May 15 May 16 May 17 May 18 May 19 May 20 May 21 May
Time


Observed Tide at Vizhinjam
Height in m above CD
2.0
1.5
1.0
0.5
0.0
21 May 22 May 23 May 24 May 25 May 26 May 27 May 28 May 29 May 30 May 31 May 01 Jun 02 Jun 03 Jun 04 Jun 05 Jun
Time

Annexure I

INCEPTION REPORT

INCEPTION AND MOBILISATION REPORT

for

Oceanographic & Bathymetric Data Collection for

Assessment of Shoreline Changes

for Vizhinjam International Seaport Limited

Client

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Kerala, India
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: **mail@vizhinjamport.in**

Survey Contractor

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Maharashtra, India
Tel. +91 22 27595100
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E-mail: mail@oceanscience.in
Web: http://www.oceanscience.in

OCEAN SCIENCE Document no. OSaS/P18115/VISL/Mob Rev 0
26th February 2015

DOCUMENT ISSUE FORM

Document Type: Procedure /Survey Report	Inception and Mobilisation Report
Type	Final
Document Title	Inception and Mobilisation Report for Oceanographic & Bathymetric Data Collection for Assessment of Shoreline Changes for Vizhinjam International Seaport Limited Ocean Science Doc no. OSaS/P18115/VISL/Mob Rev 0
Prepared by	S Philip
Prepared at	Ocean Science & Survey Pvt. Ltd. Data Processing Centre Navi Mumbai.
Submitted to	Vizhinjam International Seaport Limited
No. of Copies	By email

Revisions

Rev	Date	Prepared by		Approved by	
		Name	Signature	Name	Signature
0	26 Feb '15	S Philip		F.R. Patel	

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Revision Details

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DEFINITIONS

Client	Vizhinjam International Seaport Limited
Survey Contractor	Ocean Science & Surveying Private Ltd., Navi Mumbai, India (Ocean Science)
Survey Requirement	To carry out bathymetric and oceanographic study for the assessment of shore line changes
Chart Datum	Chart datum is the level to which soundings on a published chart are reduced, and above which tidal predictions and tidal levels are given in the Tide Table. All depths on charts are referred to this datum.

ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
BM	Bench mark
C.M.	Central Meridian
CD	Chart Datum
cm	Centimetre
CR	Client Representative
dd mm.mmm	Degrees minutes. decimal minutes
DGPS	Differential Global Positioning System
DTM	Digital Terrain Model
EEZ	Exclusive Economic Zone
GcGPS	Globally Corrected Global Positioning System
GPS	Global Positioning System
HSE	Health, Safety & Environment
HTL	High Tide Line
HWM	High Water Mark
kHz	Kilohertz
km	Kilometre
kPa	Kilo Pascal
LAT	Lowest Astronomical Tide
Lat	Latitude
LEO	Littoral Environment Observation
Long	Longitude
m	Metre
MBES	Multibeam echo sounder
MSL	Mean Sea Level
MV	Motor Vessel
NA	Not Applicable
NU	North Up

PEP	Project Execution Plan
RTK	Real-time Kinematics
SBES	Single Beam Echo Sounder
SOI	Survey of India
SOW	Scope of Work
SVP	Sound Velocity Profile
UNCLOS	United Nations Convention of the Law of the Sea
UTM	Universal Transverse Mercator projection
VISL	Vizhinjam International Seaport Limited
w.d.	Water depth
WGS84	World Geodetic System 1984

1. INTRODUCTION

Vizhinjam International Seaport Limited (VISL) is a special purpose government company (fully owned by Government of Kerala) that would act as an implementing agency for the development of a green field port - Vizhinjam International Deepwater Multipurpose Seaport at Vizhinjam in Thiruvananthapuram, capital city of Kerala.

With its numerous natural advantages and potential, the port will contribute greatly to economic development and will be an asset in terms of infrastructure development in the country.

The project obtained Environmental & CRZ Clearance ("EC") from the Ministry of Environment & Forests (MoEF), Government of India (GoI) on 3rd January 2014, wherein it has been specified to carry out intense monitoring and regulatory reporting of the shoreline changes in the project area. Accordingly VISL has entered into a memorandum of understanding (MoU) with the National Institute of Ocean Technology (NIOT), Chennai under the Ministry of Earth Sciences, Government of India for a long term shoreline monitoring programme including the seasonal bathymetry mapping.

To that end, Ocean Science & Surveying Pvt. Ltd, (www.oceanscience.in), hereinafter referred to as Ocean Science, has been awarded the contract to carry out Shoreline Monitoring – Oceanographic & Bathymetric Data Collection in the vicinity of the proposed site for the development of the Vizhinjam International Deepwater Multipurpose Seaport, vide the letter of award; VISL/2014-15/EE&EI-1/96 dated 28th January 2015.

As part of the study, NIOT shall supply a wave rider buoy to be deployed off Mulloor and the data is to be monitored by Ocean Science. Accordingly, a resort (Sea Park) at Mulloor was hired where the receiver of wave rider buoy was setup to monitor the waves.

2. REFERENCE DOCUMENTS

This Survey Procedure was prepared on the basis of the following documents.

- Request for Proposal for carrying out Oceanographic & Bathymetric Data Collection for Assessment of Shoreline Changes issued by VISL in October 2014
- http://vizhinjamport.in/aboutvisl.php for details about VISL.
- Kick off meeting held at VISL office on 3rd February 2015
- PEP dated OSaS/P18115/VISL/PEP Rev 1 dated 6th February 2015

3. SCOPE OF WORK

3.1 General

The scope of work shall be as follows:

- To mobilise suitable marine spread at site for carrying out the operations.
- To provide requisite personnel and equipment for undertaking of oceanographic measurements.
- Study of shore line.
- Monthly cross shore beach profiling perpendicular to the shoreline for 30 km stretch at an interval of 500m, using RTK or total station for land side up to 100m from HTL or +2m of HTL and using shallow draft boats, sled or any other suitable techniques for sea side up to 10m CD.

- Monthly monitoring of littoral zone (at the cross shore beach profiling locations) to observe the littoral transport direction and alongshore current speed by means of appropriate drogue observations and visual observations.
- Monthly photographic documentation of geomorphological changes (at the cross shore beach profiling locations).
- Seasonal beach sediment sampling and analysis (at the cross shore beach profiling locations).
- Bathymetry survey in an area of 600 sq km (40 km x 15 km) twice in a year i.e. just after the monsoon season and just prior to the commencement of monsoon to generate 0.5m contours (with bathymetric survey lines spaced at 25 m interval) in areas with depth up to 20m CD using multi beam echo sounder and 1 m contour (with bathymetric survey lines spaced at 300 m interval) in areas with depth greater than 20m CD at a spacing of 300m using single beam echo sounder.
- Bathymetry / cross section survey for 500m length of rivers debouching in 40 km stretch of the sea.
- Seabed sediment sampling and analysis in 600 sq km with one sample per sq km.
- Collection and analysis of water samples at specified periods (seasonal) for TSS and turbidity from four specified locations.
- Current measurements (both magnitude and direction) using Acoustic Doppler Current Profiler (ADCP) at three locations, as marked below in Figure 1, for the duration of full tidal cycle/30 days each during monsoon (June-Oct), post-monsoon (Nov-Feb) and summer months (Mar-May).
- Wave observations using WRB Datawell DWG-G shall be carried out at one location as marked in the location map.
- Tide measurements using an automatic tide gauge close to the survey area to observe the tidal variations round the clock at 6 minute intervals or as specified to cover one full year. The tide gauge shall be connected to the nearest Survey of India Benchmark. The data shall be used to derive the harmonic constituents.
- Collection of wind speed & direction, atmospheric pressure, humidity and temperature at one location specified by the client/EIC by establishing an automatic weather station to cover one full year.
- Analysis and processing of the data and submission of periodic reports in soft & hard copies.

All survey work shall be carried out as per detailed Scope of Work and sound professional practices.

The proposed locations, as provided in the RFQ, plotted in a Google Earth image is given below:

3.2 Area of Work

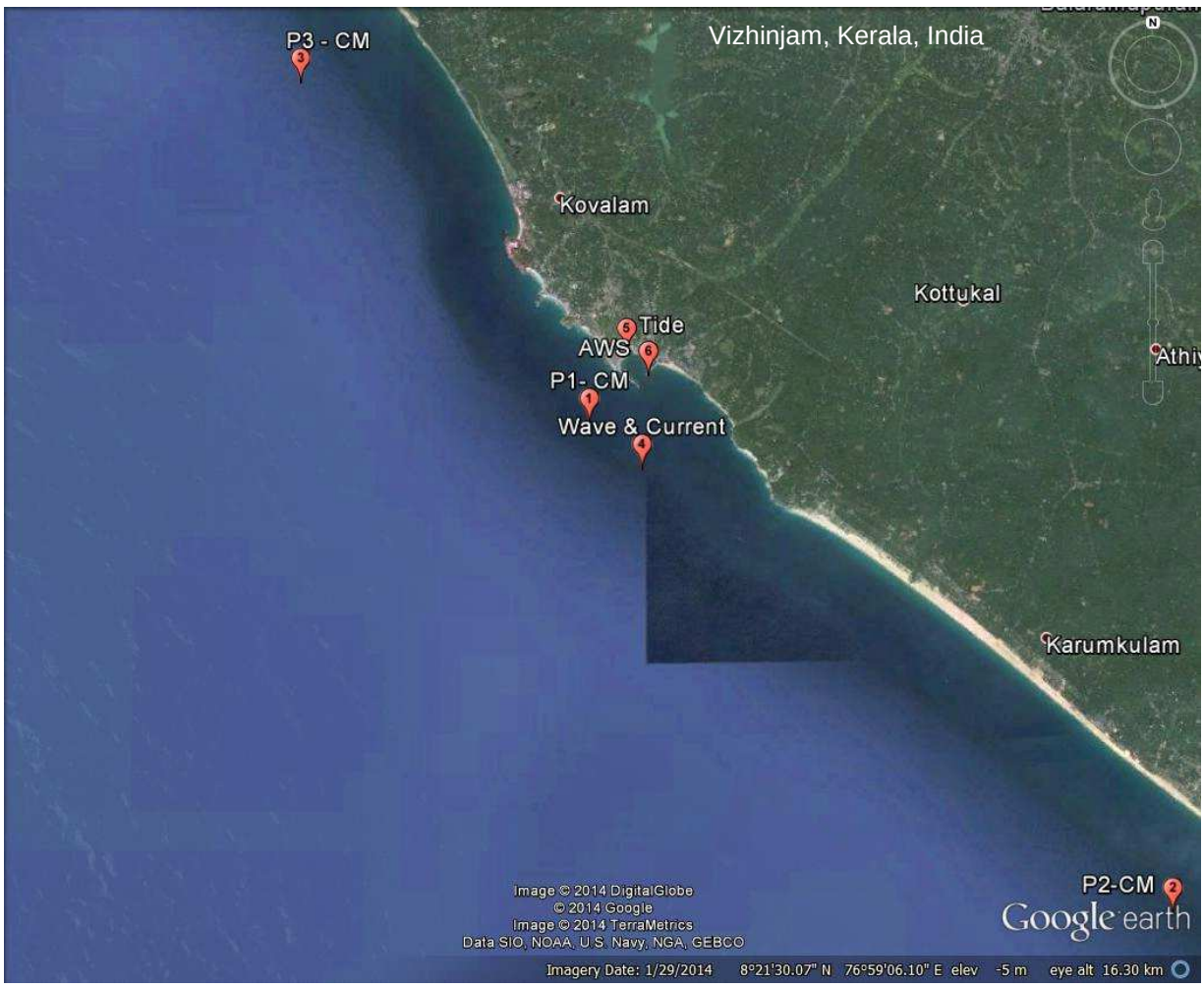


Figure 1 - Survey area showing proposed current/wave/AWS, tide locations

4. HSE CHECKS

A safety induction was given by the party chief prior to the installation of WRB & ADCP and prior to commencement of cross shore profiling.

Safety boots, PPE, hardhats and cover-alls were required for all personnel involved during mooring of WRB and ADCP.

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5. MOBILISATION OF METOCEAN EQUIPMENT

5.1 Current Meter

The following are the details of ADCP location with co-ordinates:

Location	Latitude	Longitude	Deployment Date	Boat Name & Reg No.
P1 (Vizhinjam)	08° 22' 06.42"N	76° 58' 58.70"E	10/02/2015	IND-KL-01-MO-3938&11/12/2014
P2 (Poovar)	08° 18' 00.35"N	77° 03' 55.54"E	11/02/2015	IND-KL-01-MO-6946&27/10/1999
P3 (Pachalloor)	08° 25' 01.20"N	76° 56' 28.57"E	10/02/2015	KLF-01(OM)-3695 & 31/03/2008
P4 (Mulloor)	08° 21' 43.12"N	76° 59' 25.84"E	11/02/2015	IND-K1-04-MM-1259&13/12/2011

The ADCPs were checked for compass error prior to the deployment. All of the ADCPs have been deployed on a downward looking mode and the data is being recorded at intervals of 10 minutes. The deployment log sheet and setup files are provided in Annexure I.

The images given below are of the ADCP deployed from the boat at each location:



Figure 2 - ADCP deployed at location P1 (Vizhinjam Harbour Entrance)



Figure 3 - ADCP deployed at location P2 (Poovar)



Figure 4 - ADCP deployed at location P3 (Pachalloor)



Figure 5 - ADCP deployed at location P4 (Mulloor)

5.2 Wave Rider Buoy

A Datawell wave rider buoy, supplied by NIOT, was deployed at the location as per the details below:

Location	Latitude	Longitude	Deployment Date	Boat Name & Reg No.
P4 (Mulloor)	08° 21' 43.12"N	76° 59' 25.84"E	10/02/2015	IND-K1-04-MM-1259&13/12/2011

The WRB is programmed to measure waves at half-hourly intervals. The data is being received at the resort Sea Park.

The following image shows the WRB at the location:

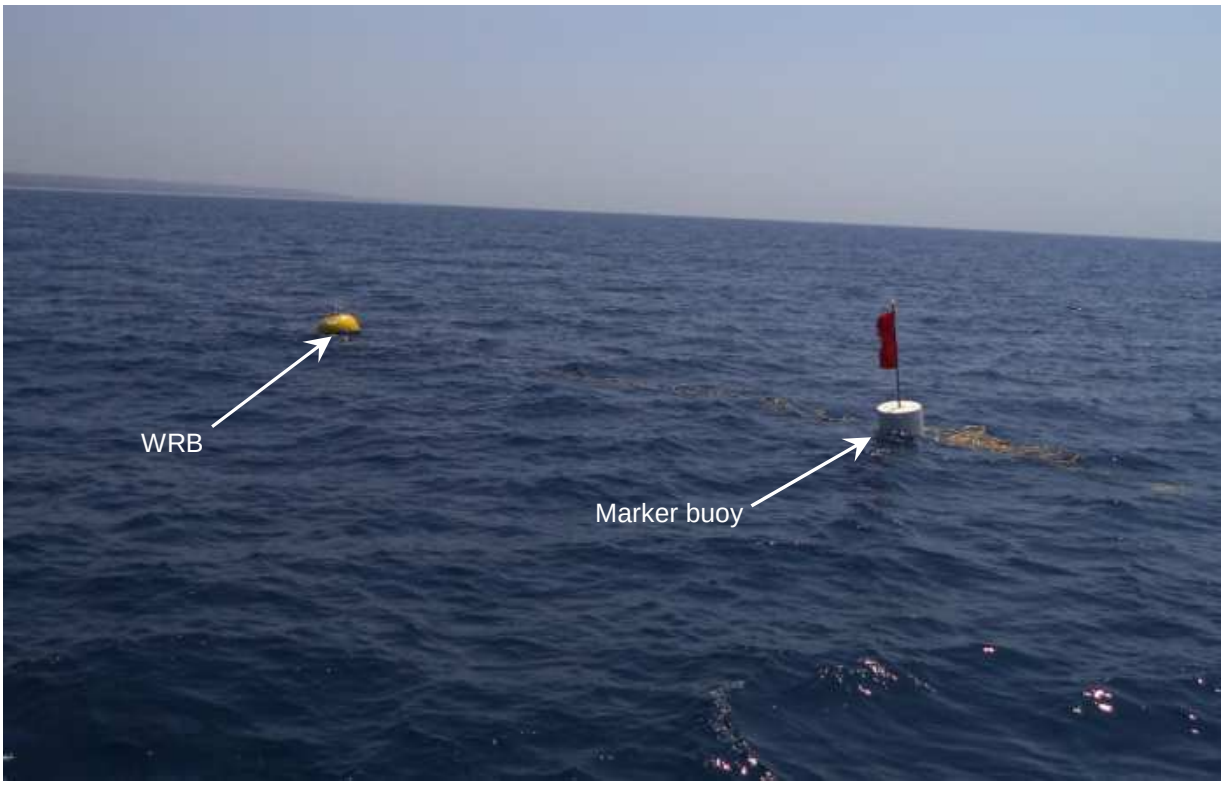


Figure 6 – WRB deployed at location P4 (Mulloor)

The data is received continuously on the receiver installed in the guest house. An image of the receiver and the data is provided below:

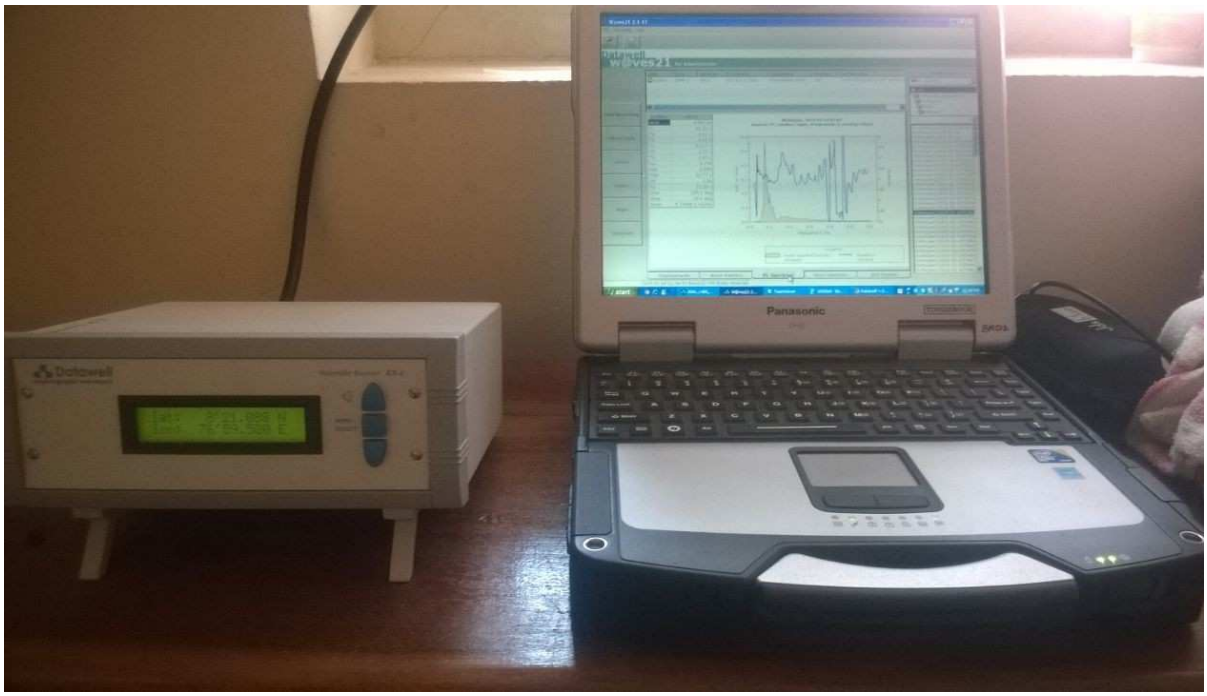


Figure 7 – Wave Data Receiver

5.3 Automatic Tide Gauge

The Valeport Tidemaster tide gauge was installed near the Coast Guard jetty adjacent to the existing NIOT tidal station on 7th February 2015. The benchmark provided by VISL during the first phase of survey was 2.992m above CD. During the present phase, this benchmark value was cross checked from the existing Survey of India (SOI) benchmark situated near the mosque. It was found that the value of 2.992m provided is incorrect and the new value as transferred using auto levelling and RTK system was 3.251m above CD. See Section 6.2 for details.

This value will be used to reduce the tidal readings with respect to the chart datum.

The sampling rate of the tide gauge was configured to 2 Hz with a burst sampling of 1 minute and 6 minute intervals.

The installation and calibration details of the tide gauge are placed at Annexure II.

An image of the tide location is provided below:



Figure 8 – Automatic Tide Gauge next to NIOT radar tide gauge

5.4 Automatic Weather Station

An automatic weather station was installed atop Ayur Bay resort at Nellikunnu on 18th February 2015. The system measures wind speed/direction, atmospheric pressure, temperature, relative humidity and rainfall.

The system consists of the following:

- Gill sonic anemometer
- Microstep pressure sensor
- Microstep relative humidity & temperature sensor
- Meteoservis Rain gauge
- Microstep datalogger

The data is logged on a PC installed at the resort at intervals of 10 minutes. The data is transmitted through a UHF link.

The calibration certificates of the sensors are placed at Annexure III.

An image of automatic weather station is provided below:

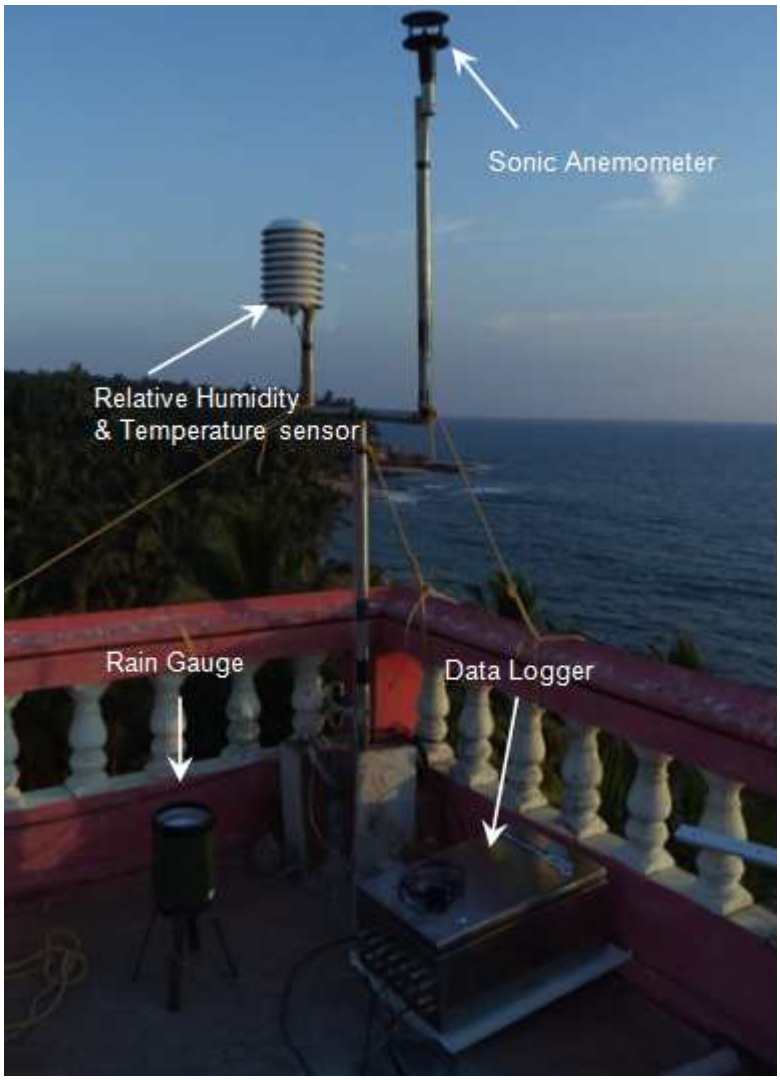


Figure 9 – Automatic Weather Station on top of Ayur Bay Resort, Nellikunnu (Mulloor)

The data is received on a computer installed in the guest house. A typical graphical display is provided below:

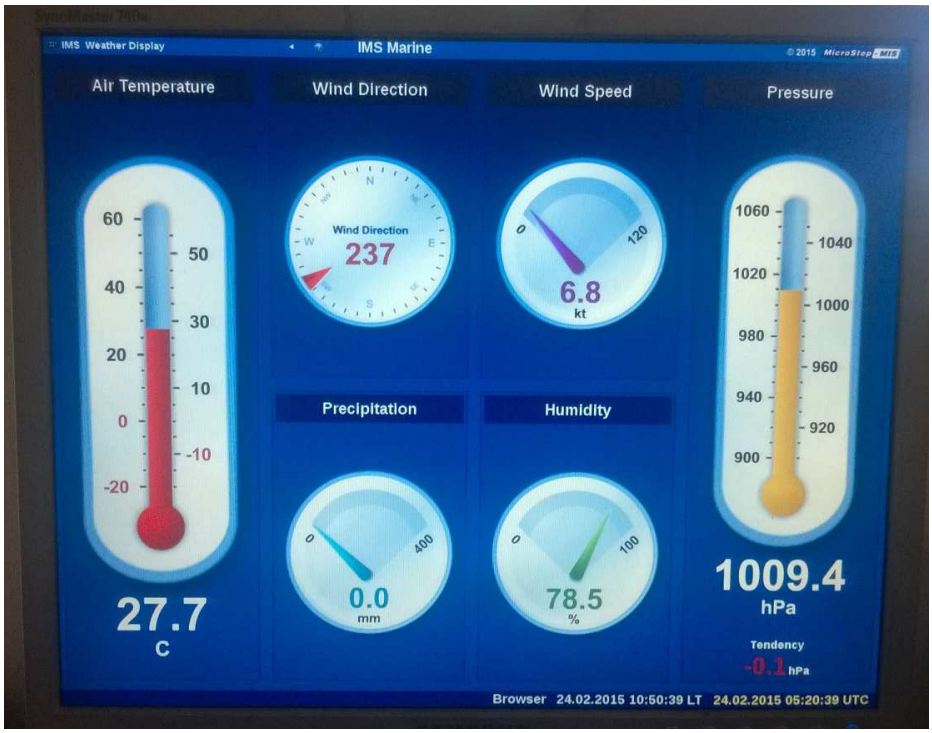


Figure 10 – Automatic Weather Station Display

5.5 Real Time Kinematic (RTK) Survey

RTK system was mobilised at site to carry out cross shore profiling on the landward side. The system comprises the following:

- Hemisphere GPS R320 GNSS base station
- Hemisphere GPS R 320 rover

The system was checked for accuracy by checking the value of the tide gauge benchmark. As per the previous report, the benchmark value near the tide gauge is 2.992m above CD.

The base system was set up near the benchmark next to the Dargah and when the rover was set up at the benchmark near the tide gauge, a value of 2.991m was obtained, thus proving the accuracy of the RTK system.

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6. SURVEY CONTROL

6.1 Geodesy

The Differential Global Positioning System (DGPS), referenced to the WGS-84 spheroid is used as the position fixing system. The table below provides the grid and spheroid parameters to be adopted during the survey.

GEODETIC PARAMETERS	
Spheroid & Datum	WGS-84
Semi-Major Axis	6378137.000 m
Semi Minor Axis	6356752.314 m
Inverse Flattening	298.2572
Projection Parameters	
Grid Projection	Universal Transverse Mercator
Latitude of Origin of Projection	0° (Equator)
Longitude of Origin of Projection	75° E, Zone 43
Hemisphere	North
False Easting (metres)	500000
False Northing (metres)	0
Scale Factor on CM	0.9996
Units	Metres

Table 1: Geodetic Parameters

6.2 Reference Station

The co-ordinates of BM-1 and BM-2 were provided by VISL (Detailed Project Report on Rail Connectivity to Vizhinjam International Seaport: Kerala, 2011) prior to start of survey. BM-1 lies next to the Sri Nagar Bhagavathy Temple, Mulloor and BM-2 lies adjacent to the Kollamkodu Sahib Dargah Sharif at Vizhinjam. The Survey of India benchmark which lies on a rock adjoining the basement on the western side of Vizhinjam mosque was also provided. This point is 6.945m above chart datum.

The image below depicts all the locations:



Figure 11 – Benchmark locations

The location BM-2 consists of a chiselled square on the rock adjacent to the compound wall of the Kollamkodu Sahib Dargah at Vizhinjam. This point was cross checked with the RTK GPS system and it was found that the provided and observed co-ordinates did not tally with each other. The 'z' value too did not match with the SOI benchmark. Due to masking of satellites at the SOI benchmark, there was no possibility to fix the co-ordinates of that point. Moreover due to the wall adjacent to it, a tripod cannot be setup at that point.

It was therefore decided to mobilise a VERIPOS globally corrected DGPS to fix the point near the Dargah and to transfer the 'Z' value from the SOI benchmark. VERIPOS Apex² service is a global, high accuracy GNSS positioning service using both the GPS and GLONASS constellations.

It is designed to meet all positioning and navigation applications, delivering decimetre level accuracy while providing a solution that is more resilient to the problems caused by satellite masking and ionospheric scintillation.

Apex² uses PPP which is an absolute positioning technique that corrects or models all GNSS error sources such as satellite orbit, satellite clock, troposphere and ionosphere. It is an extension of the VERIPOS Apex service using both GPS and GLONASS high precision dual-frequency observations to provide accurate positioning. (**www.veripos.com**)

This exercise was carried out on 16/17 February 2015 and the results obtained are provided in the table below:

Station Description	Co-ordinates in WGS 84		Height above Chart Datum
	Geographical	UTM	
BM-2	08° 22' 33".5100 N 76° 59' 12".1368 E	718770.2408 mE 926415.5205 mN	11.209 m

The existing BM-1 station is in a dilapidated condition and the structure can collapse at any time. Accordingly a new BM-1 was established next to the existing one on the rock. This point was also established by observing co-ordinates using the VERIPOS DGPS system.

Another point BM-3 (which is also shown in the above figure) was also set up on the roof top of VISL Project office at Panavilakode, Mulloor.

The details are provided below:

Station Description	Co-ordinates in WGS 84		Height above Chart Datum (metre)
	Geographical	UTM	
BM-1 (Near Mulloor temple)	08° 21' 55".7808 N 77° 00' 13".6084 E	720657.1797 mE 925265.7437 mN	11.5576
BM-3 (On the roof of VISL Project office)	8° 22' 21".7313 N 77° 00' 03".3253 E	720338.4535 mE 926061.5341 mE	44.0577

Photographs of the three stations are provided below:

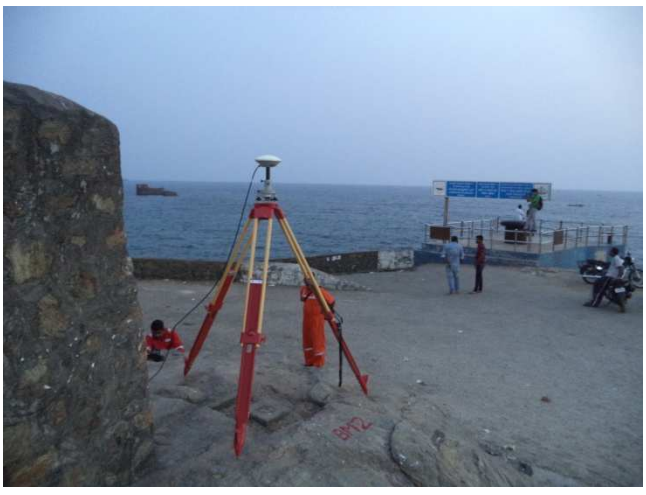




Figure 12 – BM-2 adjacent to Dargah, Vizhinjam

Further description of BM2 VISL is placed at Annexure IV.

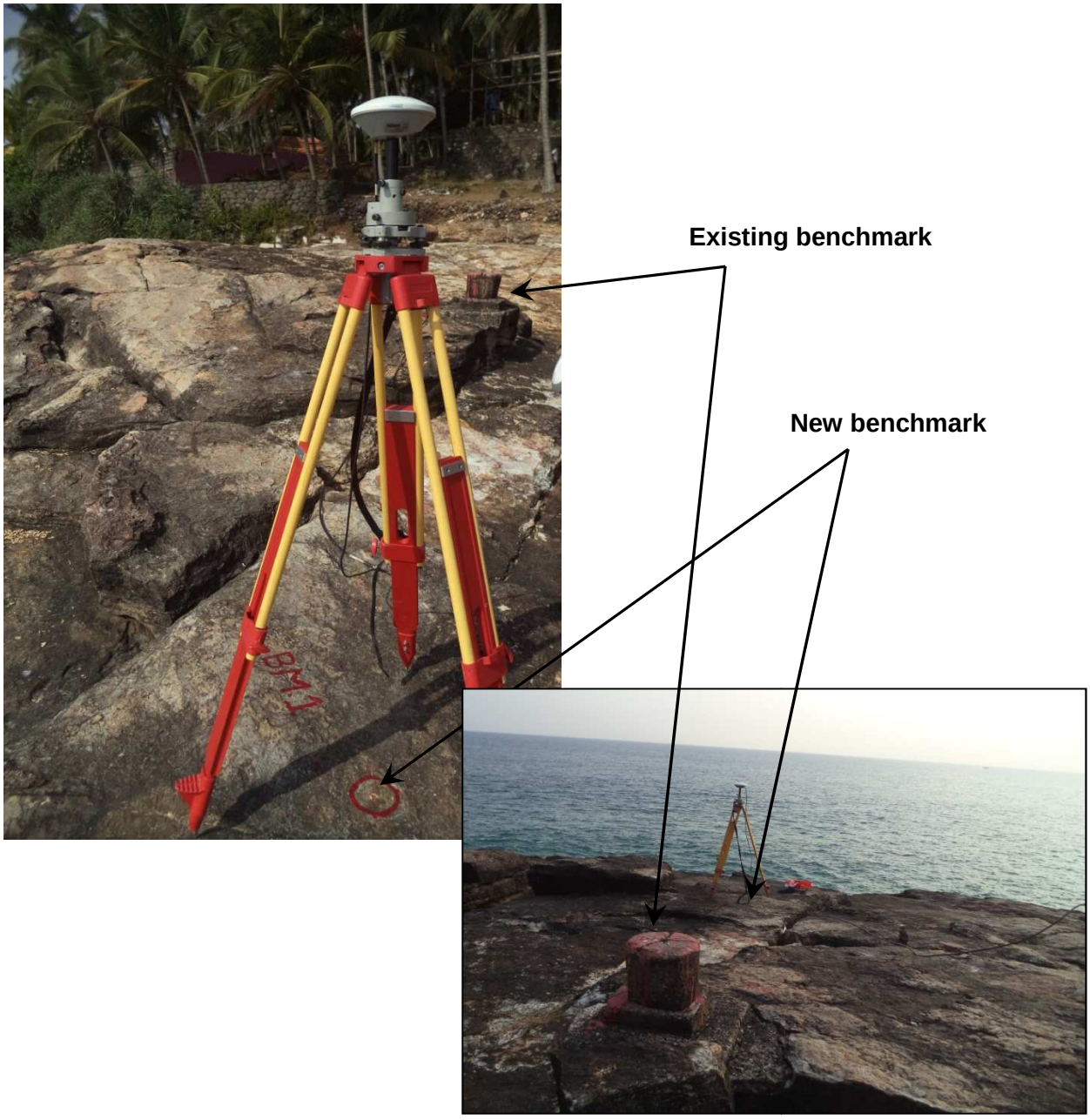


Figure 13 – BM-1 near to Sri Nagar Bhagavathy temple, Mulloor

Note: Presently the BM is painted in red. A permanent marking will be carried out by engraving on the rock.



Figure 14 – BM-3 roof top of VISL Project Office



Figure 15 – SOI Bench Mark

7. CONCLUSIONS

This document describes the equipment calibrations and checks that were completed prior to beginning work. All equipment was deemed to be working within manufacturer's specifications and survey requirements.

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Annexure I (MetOcean Log)

OCEAN Science & Surveying	MetOcean Log	Form No.:	Sy75R
		Revision:	Rev 0
		Date:	01 Jan 2012
		Approved by:	PKT

Ocean Science References:	Job No: P18115	Project Representative : AJIT S.
	Project Title : SHORE LINE MONITORING	
Client Company/Organisation:	VIZHINJAM INTERNATIONAL SEAPORT LTD.	

Location Details

Name	Co-ordinates	
	Geographicals	UTM
P1, VIZHINJAM	08° 22' 06.42" °N 76 58 58.70 °E	mE mN
P2, POOVAR	08° 18' 0.3" °N 77 03 55.5 °E	mE mN
P3, PACHALLOOR	08° 25' 1.2' °N 76° 56' 28.6 °E	mE mN
P4, MULLOOR	08° 21' 43.1" N 76° 59 25.8" E	

Instrumentation

Instruments	Serial Number	Date of deployment (dd/mm/yy hh:mm)	Date of recovery (dd/mm/yy hh:mm)	Battery Voltage
Current meter 1	16657	10/02/15, 16:00		41.7 V
Current meter 2	18569	11/02/15, 10:00		44.1 V
Current meter 3	19810	10/02/15, 18:30		44.2 V
Water Level Recorder	36814	07/02/15 10:00		9V
CTD				
Automatic Weather Station				
CURRENT METER -4	815	11/02/15, 12:00		12 V

Position of current meter	Upward Looking	Downward Looking
Deployment depth		✓
Instrument		RDI ADCP

Depth at location / Height above MSL 23 meters

Parameters measured : CURRENT SPEED & DIRECTION

Measuring interval 10 minutes

REMARKS:

ATG PROGRAMMED TO MEASURE AT 6 MINUTE INTERVAL

SHARON PHILIP

Name & Signature

Date: 11/02/15

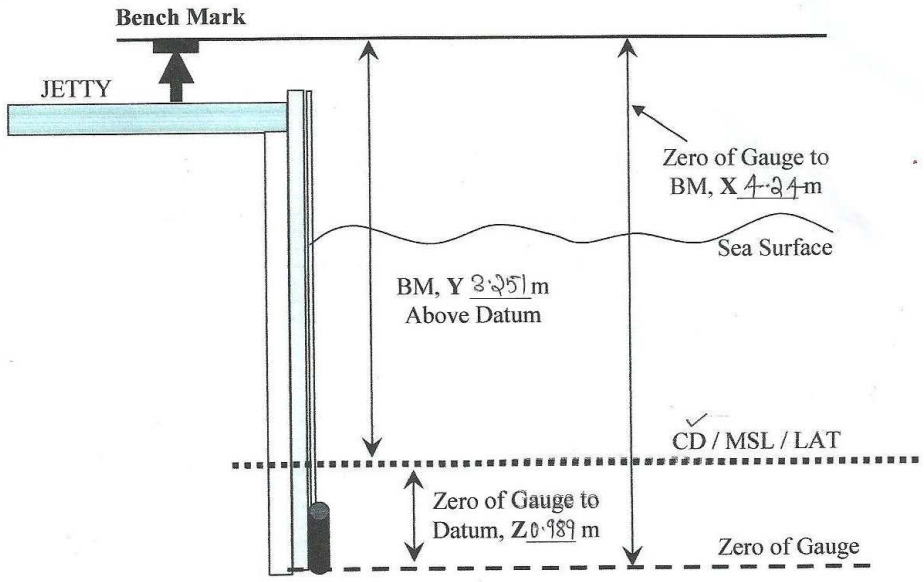
E-mail: mail@oceanscience.in Tel: +91 22 2759 5100, Fax: +91 22 2759 5110

Annexure II (Tide Gauge levelling & Calibration Certificate)

OCEAN Science & Surveying	TIDE GAUGE INSTALLATION	Form No.:	Sy14R
		Revision:	4
		Date:	01-Jan-2010
		Approved by:	PKT

Job Number	P 18115	**Project**	VISL		
Location	Vizhinjam	**Installation Date**	07-02-2015		
Tide Gauge Sr. No.	59618	**Party Chief**	Sharon Philip		
Tide Gauge setup refers to:		**CD**	✓	**MSL**	**LAT**

Diagram



Bench Mark details:

Value of Bench Mark	3·251	**Meters above the datum**
Levelled By	Abhilash L	
Date	14-02-15	

Calculations:

X, Length from Bench Mark to Zero of Tide Gauge	4·24 **m**
Y, Level of Bench Mark above Datum	3·251 **m**
Z, Tide Correction factor, Z=X - Y	0·989 **m**
Tide height in m bove Datum = Raw Tide reading - Z	____ **m**

Signature:

Surveyor / Engineer	Abhilash L
Party Chief	Sharon Philip

Calibration and Instrument build record

Valeport Ltd. Totnes, Devon, UK

Calibration certificate number	36995
Instrument type	VLR 741
Serial number	36814
Communications set up ex-factory	RS232
Baud rate set ex factory	115200
Main micro software version	0741705B2
Memory size	512Mb
PCBs	Part/Issue / Ser No
Micro	07415000 / 59618
Piessure sensor	Type / PDCR 1830
	Tx range dBar / 10
	Set Range dBar / 10
	Serial number / 4025733

Calibration Equipment used		
Instrument	Type	Serial No
Calibrator	Druck DPI 610	166/97/08

Calibration data and Polynomial fit

Counts (mmm)	Applied pressure	Polynomial fit for raw data		Polynomial calculations			Measured pressure	Post Calibration Check: Applied pressure		Error [Reading - Actual]	
		Order >>>>	2	Calc Press from polynomial output	Press Error [Calc - Actual]						
mmmm	dBarG	Parameter	Value	dBarG	dBar	%FS	dBarG	dBarG	dBar	%FS
554.8	0.000	a0	-1.779110E+00	-0.002	-0.002	-0.024	-0.002	0.000	-0.002	-0.020
1182.2	2.000	a1	3.203822E-03	2.005	0.005	0.049	2.004	2.000	0.004	0.040
1806.2	4.000	a2	-2.511890E-09	3.999	-0.001	-0.006	3.999	4.000	-0.001	-0.010
2431.5	6.000			5.996	-0.004	-0.039	5.996	6.000	-0.004	-0.040
3060.2	8.000			8.002	0.002	0.017	8.000	8.000	0.000	0.000
3687.3	10.000			10.000	0.000	0.002	10.000	10.000	0.000	0.000

Enter polynomial fit from graph in cell E32

Set Pressure Units to dBar: #041;0

Clear User Cal: #052;1;0

Password string: #000;RETAW

Read Pressure Continuously at 2Hz: #500

Unit number string: #002;36814

Rejection Rate string: #005;50

Manufacture Date string: #007;25;02;14

Calibration string: #050;-2.511890E-09;3.203822E-03;-1.779110E+00

Name	M.Buckle
Date	25/02/14
Signed	

Calibrated to Valeport's procedures using test equipment with calibrations traceable to UKAS or national standards

36814PRESS_140225.xls

25/02/2014 09:59

Annexure III (Automatic Weather Station & Calibration Certificates)

OCEAN Science & Surveying	MetOcean Log	Form No.:	Sy75R
		Revision:	Rev 0
		Date:	01 Jan 2012
		Approved by:	PKT

Ocean Science References:	Job No: P18115	Project Representative : AJITS
	Project Title : SHORE LINE MONITORING, BATHYMETRIC & OCEANOGRAPHIC SURVEY	
Client Company/Organisation:	VIZHINJAM INTERNATIONAL SEAPORT LTD.	

Location Details

Name	Co-ordinates	
	Geographicals	UTM
AYUR BAY RESORT	08 22' 13.48 °N 77 00 08.39 °E	mE mN
	°N °E	mE mN
	°N °E	mE mN

Instrumentation

Instruments	Serial Number	Date of deployment (dd/mm/yy hh:mm)	Date of recovery (dd/mm/yy hh:mm)	Battery Voltage
Current meter 1				
Current meter 2				
Current meter 3				
Water Level Recorder				
CTD				
Automatic Weather Station	000 34	18/02/15 18:00		12V

Position of current meter	Upward Looking	Downward Looking
Deployment depth		
Instrument		

Depth at location / Height above MSL _____ meters

Parameters measured : WIND SPEED, GUST, DIRECTION, TEMP, RELATIVE HUMIDITY ATM. PRESSURE & PRECIPITATION.

Measuring interval 10 minutes

REMARKS:

SHARON.

Name & Signature

Date: 18/02/15.

E-mail: mail@oceanscience.in Tel: +91 22 2759 5100, Fax: +91 22 2759 5110

MicroStep - MIS

MicroStep-MIS, spol. s r.o.
Čavojského 1
841 04 Bratislava, Slovak Republic

Certificate of Factory Calibration

Object:	RHT75 Relative humidity and temperature probe
Manufacturer:	MicroStep-MIS
Type – No.:	RHT75-AT
Serial – No.:	RHT75-1.1-1409-AT-087
Order – No.:	
Measuring range	
Relative humidity:	0 %RH to 100 %RH
Temperature (SHT75):	-40 °C to + 80 °C
Temperature (pt100):	-60 °C to + 80 °C
Number of pages:	1
Date of calibration:	12.09.2014

We hereby confirm that the above mentioned measuring instrument was manufactured under the supervision of a certified quality assurance system according to EN ISO 9001.

Calibration process:

Relative humidity:	Immediate comparison of the instrument with working standard 60583712, traceable to National standard.
Temperature:	Immediate comparison of the instrument with working standard PT100-1.0-0908-1/5DIN-191 No. 191, traceable to National standard. Resistance of the working standard and the measured instrument was measured using Digital multimeter HP34401A, US36092035 using 4-wire resistance measurement.

Interval sampling calibration for measuring instrument is operated on regularly calibrated instruments traceable to the national standard.

Results of measurement:

	Reference	Instrument		Correction	Uncertainty
Relative humidity [%RH]	51.2	digital:	53.1	-1.9	
		analog:	53.0	-1.8	
Temperature [°C]	25.7	digital:	25.8	-0.1	
		analog:	25.8	-0.1	
		pt100:	25.9	-0.2	

The calibrated value is valid only at the time of measurement and is referenced to the indicated reference of the factory working standard.
PRT calculation to temperature has been done according to STN EN 60751.

Measuring conditions:

Ambient temperature:	(25.0 ± 2) °C
Relative humidity:	(59 ± 5) %
Air pressure:	(993.0 ± 5) hPa

Seal	Date	Person in charge	Responsible person
	12.05.2014	Jaroslav Hutira	Adam Krovina

www.microstep-mis.com
info@microstep-mis.com
Registered at Companies Register of the District Court Bratislava I, in Section Sro, Insert No. 22037/B
Tel: + 421 2 602 00 100
Fax: + 421 2 602 00 180
1/1
F001 eng
ICO: 35 791 489
DIC: 2020223271
IC DPH / VAT: SK2020223271

MicroStep-MIS, spol. s r.o.
Čavojského 1
841 04Bratislava, Slovak Republic

Certificate of Factory Calibration 0072/PR/2014

Object:	Digital Barometer MSB181
Manufacturer:	MicroStep-MIS
Type – No.:	MSB181
Serial – No.:	1410-184
Order – No.:	
Number of pages:	1
Date of calibration:	2014-10-22
Reference used:	CDG020D
Reference sn.:	8136

Measuring range
Pressure: 750 hPa to 1050 hPa

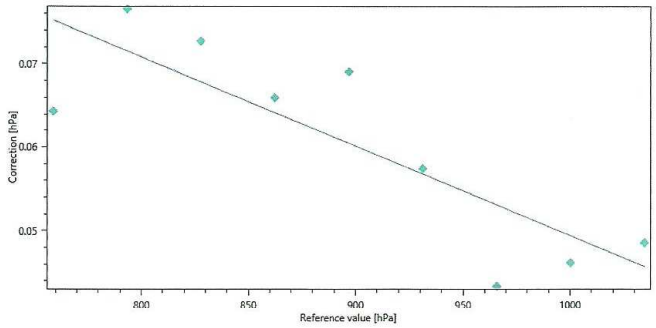
Measuring conditions
Ambient temperature: (23 ± 2) °C
Relative humidity: (60 ± 5) %
Air pressure: (984 ± 5) hPa

Interval sampling calibration for measuring instrument is operated on regularly calibrated instruments traceable to the national standard.

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95 %.

Calibration results:

Reference value [hPa]	Instrument value [hPa]	Correction [hPa]	Uncertainty [hPa]
+758.70	+758.63	+0.07	0.12
+793.19	+793.11	+0.08	0.12
+827.66	+827.59	+0.07	0.12
+862.15	+862.09	+0.06	0.12
+896.62	+896.55	+0.07	0.12
+931.11	+931.05	+0.06	0.12
+965.59	+965.55	+0.04	0.12
+1000.06	+1000.02	+0.04	0.13
+1034.56	+1034.51	+0.05	0.12



The calibrated value is valid only at the time of measurement and is referenced to the indicated reference of the factory working standard.

Seal	Date	Person in charge	Responsible person
	2014-10-22	Jaroslav Hutira	Adam Krovina

www.microstep-mis.com
info@microstep-mis.com
Registered at Companies Register of the District Court Bratislava I, in Section Sro, Insert No. 22037/B
Tel: + 421 2 602 00 100
Fax: + 421 2 602 00 180
1/1
F001 eng
IČO: 35 791 489
DIČ: 2020223271
IČ DPH / VAT: SK2020223271

METEOSERVIS v.o.s.
Smetanova 902/II
389 01 Vodňany
Czech Republic

CALIBRATION CERTIFICATE

Instrument:	**Unheated Rain Gauge with Tipping Bucket Mechanism**
Model:	**MR2**
Serial Number:	**1420**
Calibration date:	**8. 9. 2014**
Manufacturer:	**METEOSERVIS v.o.s. , Czech Republic**

The Rain Gauge has been calibrated on the 0.2 mm of the precipitation per one turnover.
The calibration was performed at 11,7 mm/hour of the simulated precipitation intensity on the METEOSERVIS's calibration device.

For METEOSERVIS v.o.s.

Technician

Tel/fax: +420 383 382 637 *fax: +420 383 385 227* *email: meteoservis@iol.cz*

Annexure IV (Station Fixing Log)

OCEAN Science & Surveying	STATION FIXING USING DGPS	Form No:	Sy36R
		Revision:	0
		Date:	1-Jan-2010
		Approved by:	PKT

Job No	P18115		Project	Shoreline Monitoring
Client	Vizhinjam Intl Seaport Ltd			
Location	Vizhinjam		Date	16/17 February 2015

EQUIPMENT	PRIMARY	
Item	Type	Serial No
GPS Receiver	Veripos GNSS System	31098
GPS Antenna		38202
RTCM Receiver		
RTCM Antenna		

STATION FIXING USING DGPS

No	Time	Observerd E	Observed N	No.	Time	Observerd E	Observed N
1	12:17	718770.2608	926415.5405	15	13:27	718770.2208	926415.5005
2	12:22	718770.2588	926415.5385	16	13:32	718770.2228	926415.5025
3	12:27	718770.2568	926415.5365	17	13:37	718770.2248	926415.5045
4	12:32	718770.2548	926415.5345	18	13:42	718770.2268	926415.5065
5	12:37	718770.2528	926415.5325	19	13:47	718770.2288	926415.5085
6	12:42	718770.2508	926415.5305	20	13:52	718770.2308	926415.5105
7	12:47	718770.2488	926415.5285	21	13:57	718770.2328	926415.5125
8	12:52	718770.2468	926415.5265	22	14:02	718770.2348	926415.5145
9	12:57	718770.2448	926415.5245	23	14:07	718770.2368	926415.5165
10	13:02	718770.2428	926415.5225	24	14:12	718770.2388	926415.5185
11	13:07	718770.3308	926415.6105	25	14:17	718770.1508	926415.4305
12	13:12	718770.2488	926415.5285	26	14:22	718770.2328	926415.5125
13	13:17	718770.2508	926415.5305	27	14:27	718770.2308	926415.5105
14	13:22	718770.2468	926415.5265	28	14:32	718770.2348	926415.5145
Average		718770.3	926415.5	Average		718770.2	926415.5

Mean "Easting"	*718770.2408*
Mean "Northing"	*926415.5205*

SIGNED			
Designation	Name	Signature	Date
Surveyor/Engineer	Jaishankar Pandey		17/02/15
Party Chief	Sharon Philip		17/02/15

STATION DESCRIPTION – VISL BM2 (ADJACENT TO DARGAH)

Station Number:	BM2 VISL	**Latitude:**	08°22'33'.5100 N
Locality:	Vizhinjam, Trivandrum	**Longitude:**	76°59'12'.1368 E
Geodetic Datum:	WGS84	**Northing:**	926415.5205 M.
Zone:	43 N	**Easting:**	718770.2408 M.
Date:	17 Feb 2015	**Elevation:**	11.209 M. (CD)
Station Description:	The station consists of chisel mark on the rock; corner of the compound wall adjacent to Kollamkodu Sahib Dargah Sharif, Vizhinjam.		
Access:	The road to Kovalam light house further extends to the Dargah and the Mosque at Vizhinjam.		

Sketch:



Map:



Photographs:



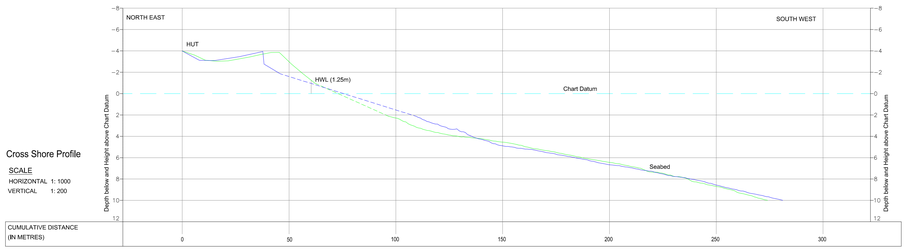


for Ocean Science & Surveying

Cdr. P.K. Tyagi, NM IN (retd.)
Charge Hydrographic Surveyor

OCEAN SCIENCE & SURVEYING PVT. LTD. INDIA NAVI MUMBAI

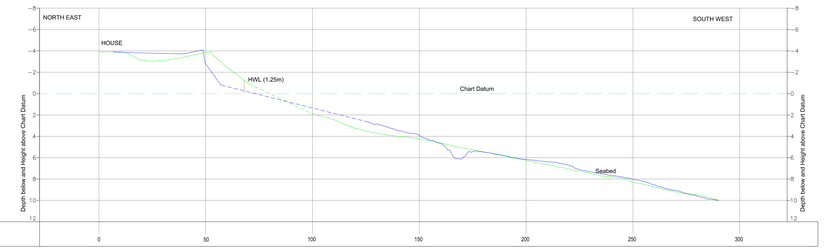
Cross Section Line No.CSP-73



Cross Shore Profile

SCALE
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VERTICAL 1: 200

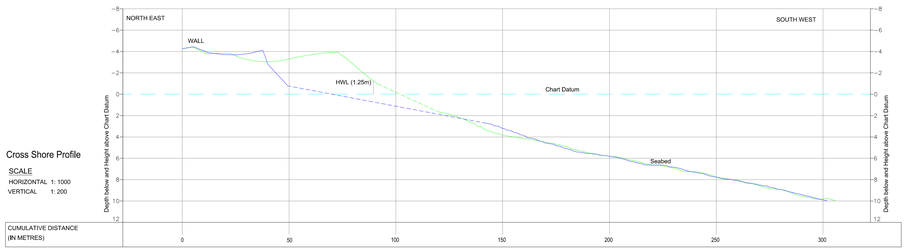
Cross Section Line No.CSP-74



Cross Shore Profile

SCALE
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VERTICAL 1: 200

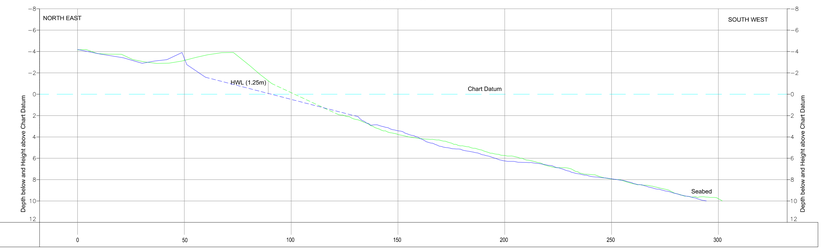
Cross Section Line No.CSP-75



Cross Shore Profile

SCALE
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VERTICAL 1: 200

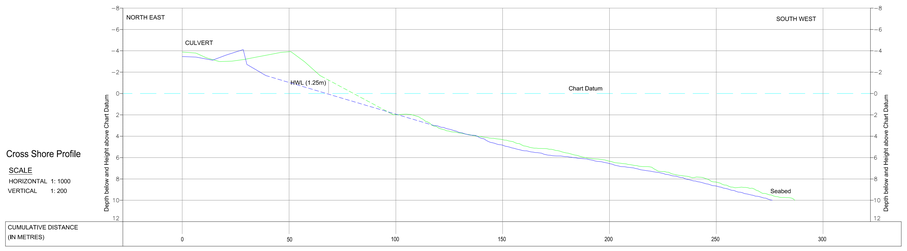
Cross Section Line No.CSP-76



Cross Shore Profile

SCALE
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VERTICAL 1: 200

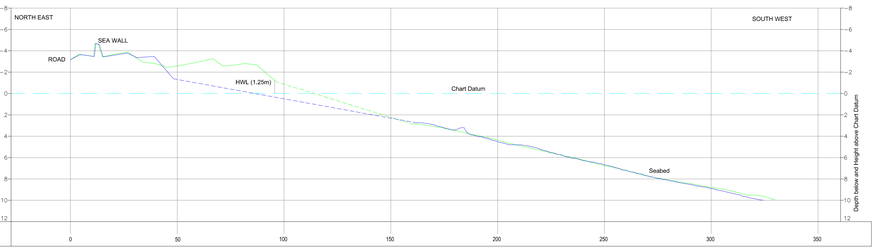
Cross Section Line No.CSP-77



Cross Shore Profile

SCALE
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VERTICAL 1: 200

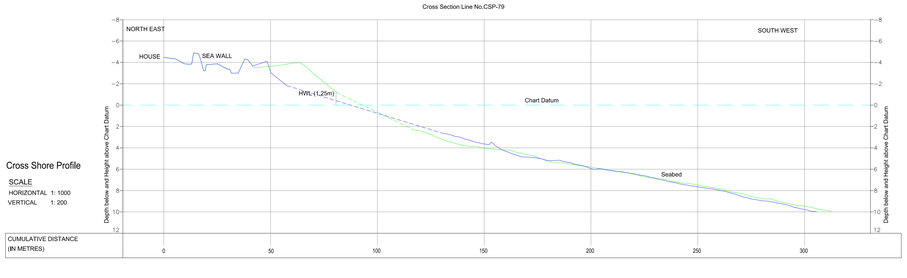
Cross Section Line No.CSP-78



Cross Shore Profile

SCALE
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VERTICAL 1: 200

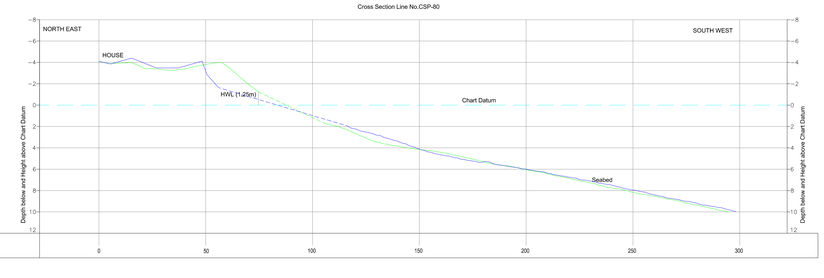
Cross Section Line No.CSP-79



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

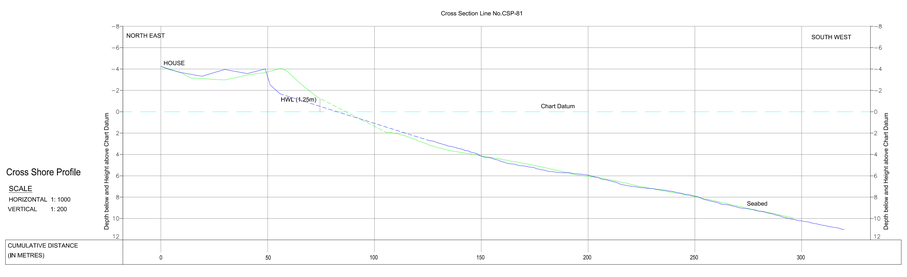
Cross Section Line No.CSP-80



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-81



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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Scale

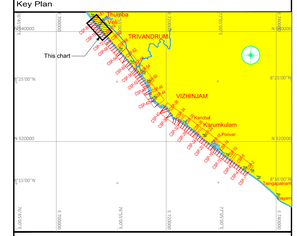
HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres

4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt. Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai - 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
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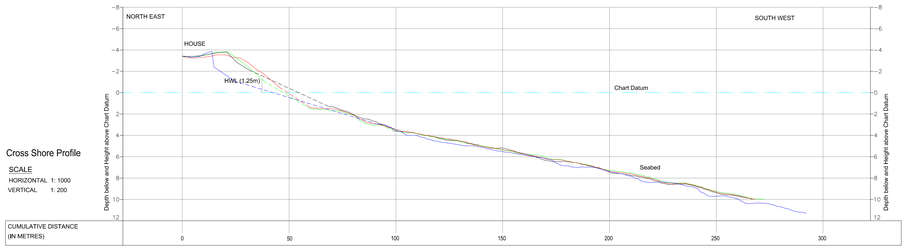
Drawing Title

Cross Shore Profiling at Vizhinjam

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip
Dwg No. : OSaS_P18115_VBL_CSP73-CSP81_10		Sheet No. 10 of 10

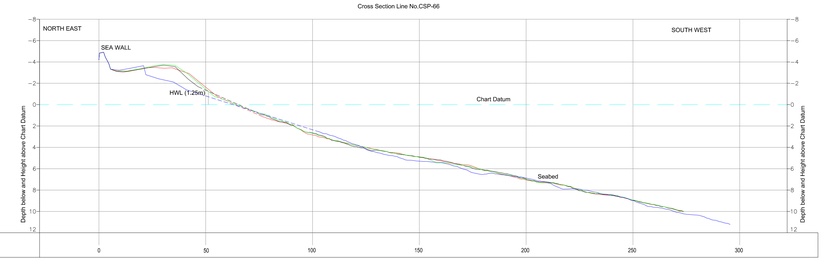
Cross Section Line No.CSP-65



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

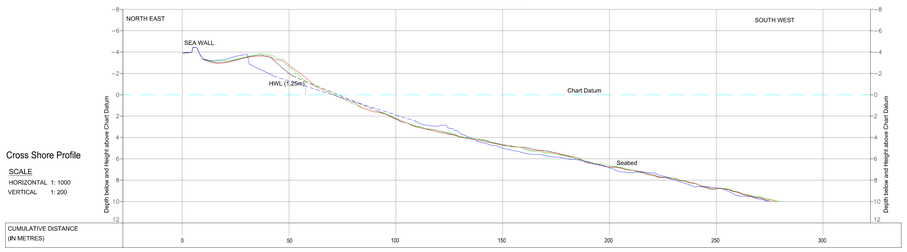
Cross Section Line No.CSP-66



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

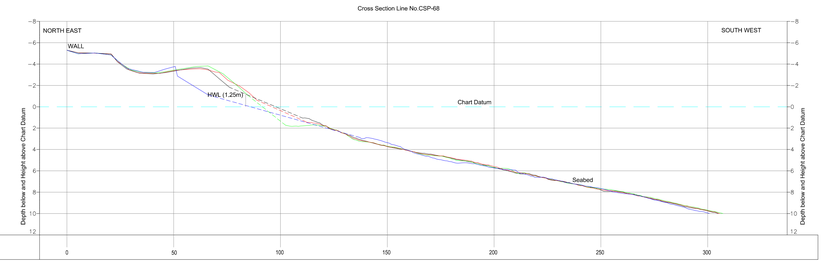
Cross Section Line No.CSP-67



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

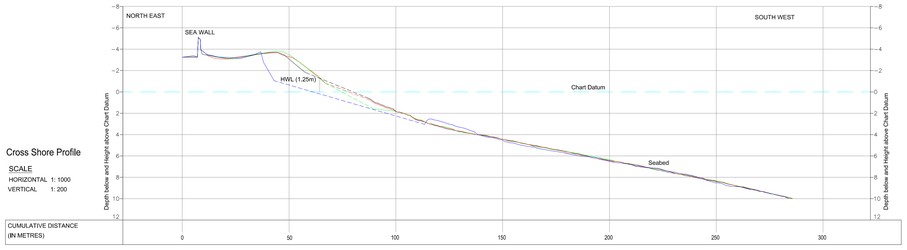
Cross Section Line No.CSP-68



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

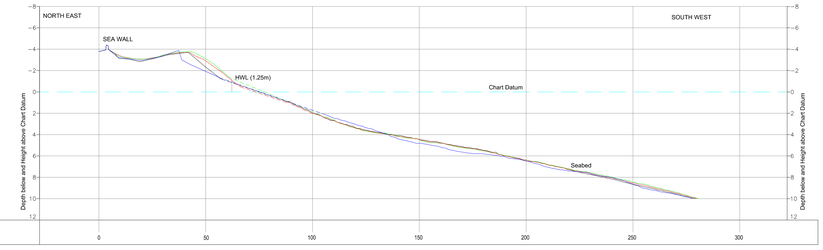
Cross Section Line No.CSP-69



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

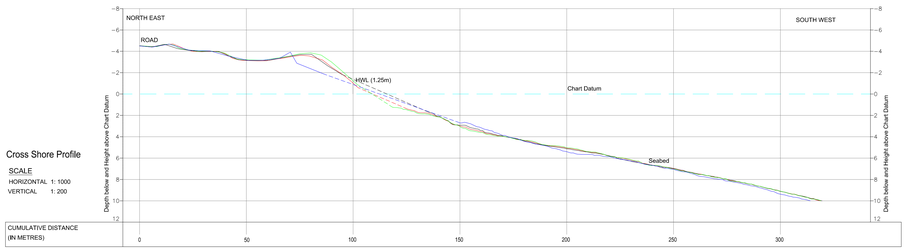
Cross Section Line No.CSP-70



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

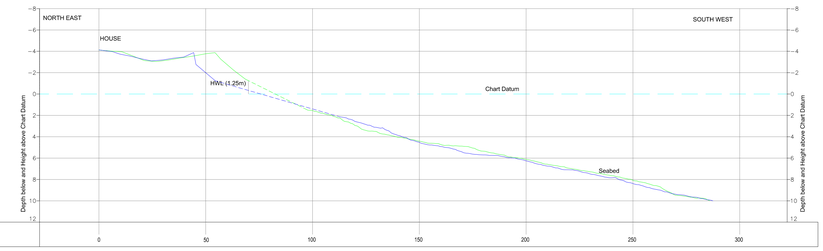
Cross Section Line No.CSP-71



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-72



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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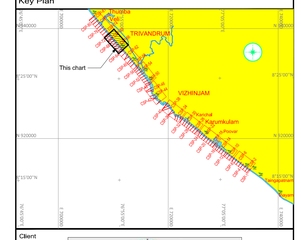
Scale

HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt, Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

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Tower No.8, Railway Station Complex,
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Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
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Drawing Title

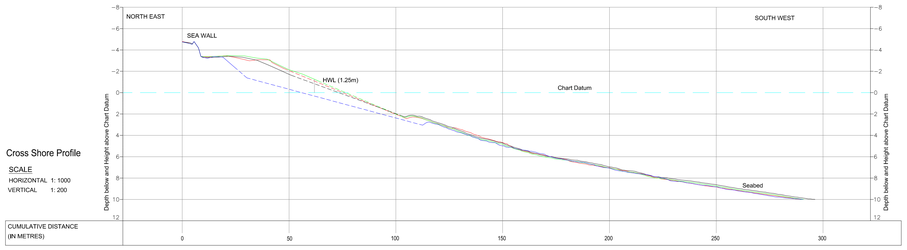
Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip

Dwg No. : OSaS_P18115_VBL_CSP65-CSP72_09 — Sheet No. 9 of 10

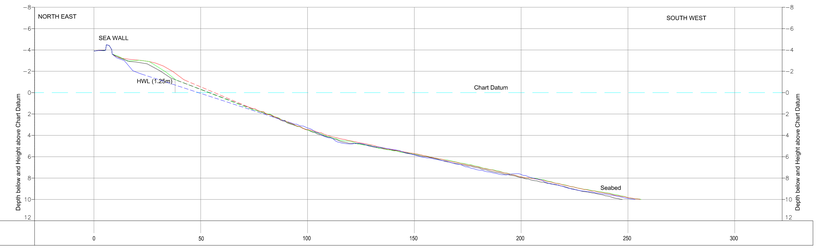
Cross Section Line No.CSP-57



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

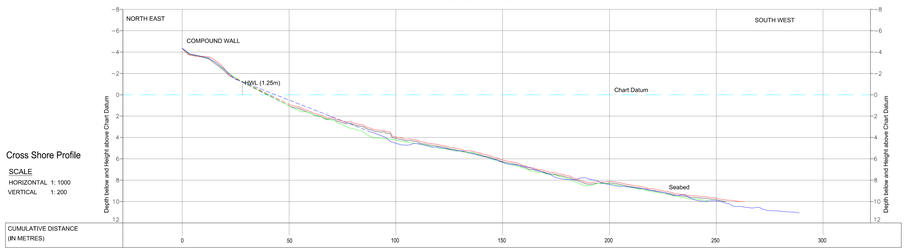
Cross Section Line No.CSP-58



Cross Shore Profile

SCALE
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VERTICAL 1: 200

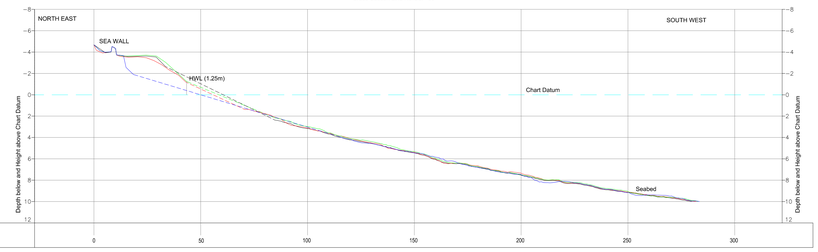
Cross Section Line No.CSP-59



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

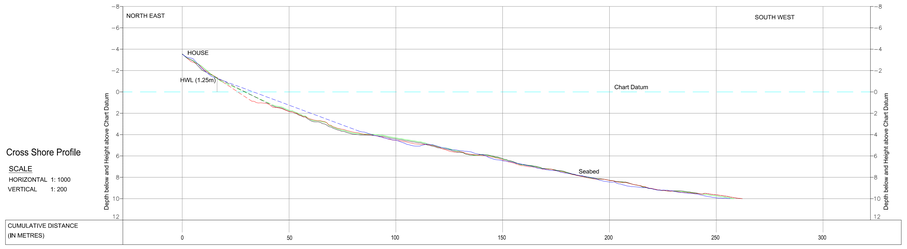
Cross Section Line No.CSP-60



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

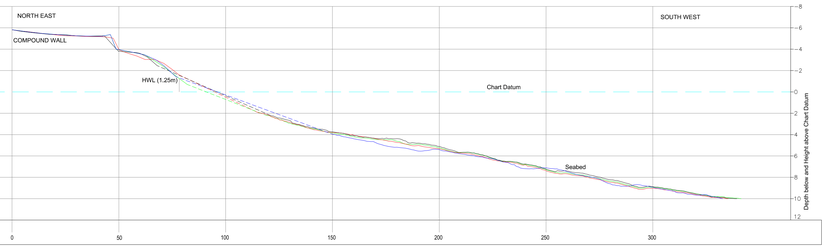
Cross Section Line No.CSP-61



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

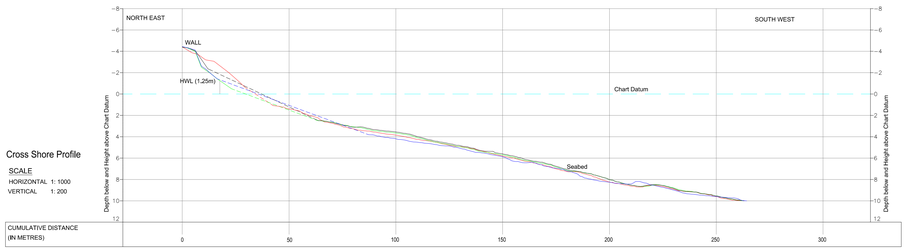
Cross Section Line No.CSP-62



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

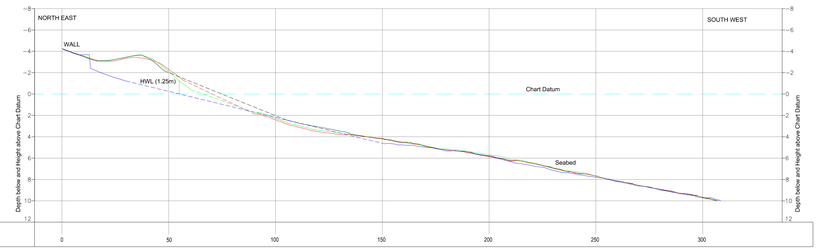
Cross Section Line No.CSP-63



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-64



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

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LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

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Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
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False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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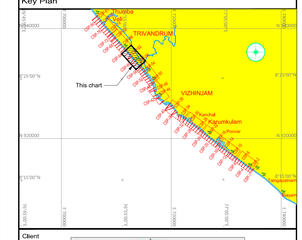
Scale

HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

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Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
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Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

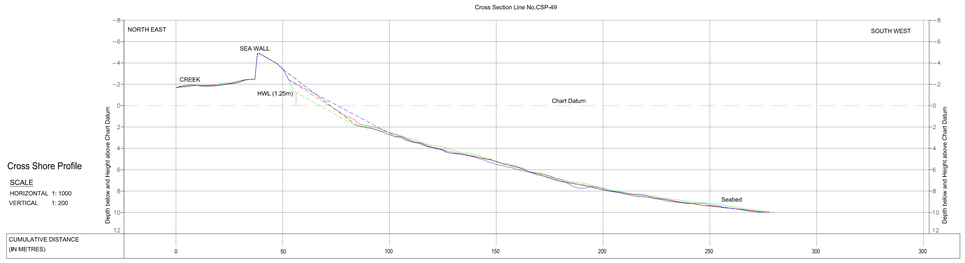
Drawing Title

Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip

Dwg No. : OSaS_P18115_VBL_CSP57-CSP64_08 — Sheet No. 8 of 10

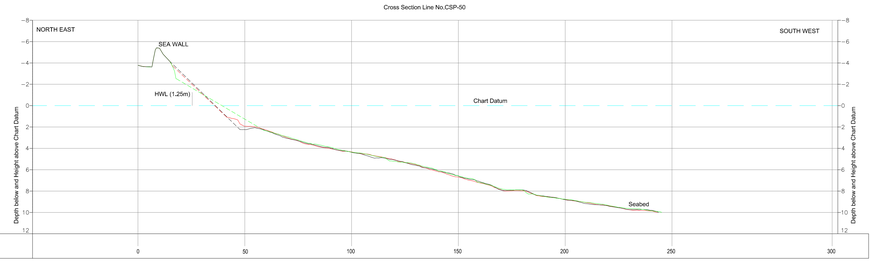


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

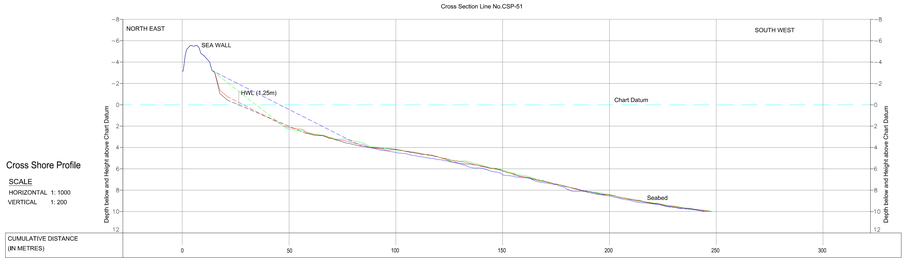


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

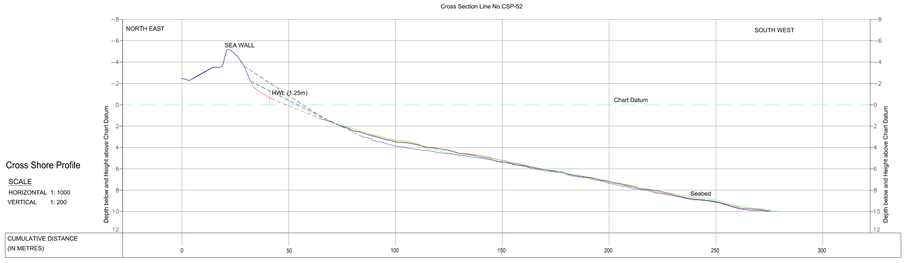


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

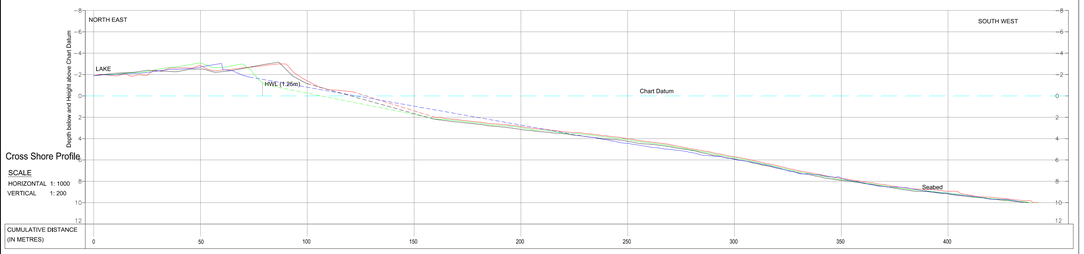


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

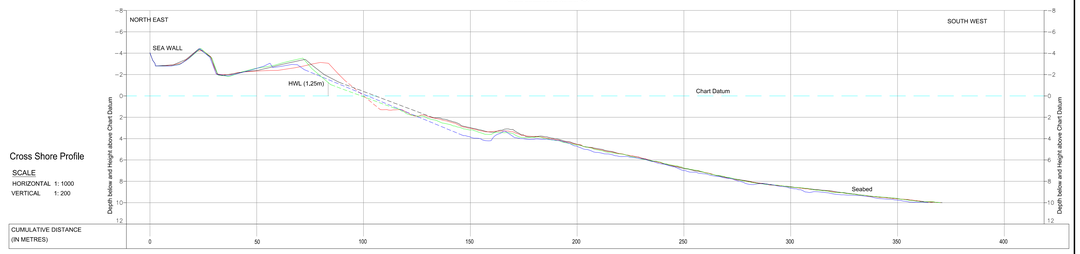


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

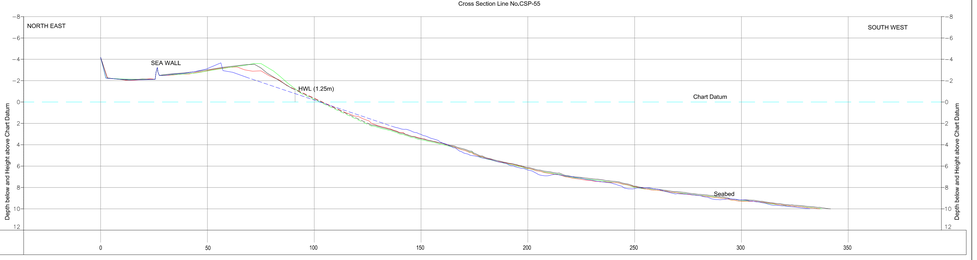


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

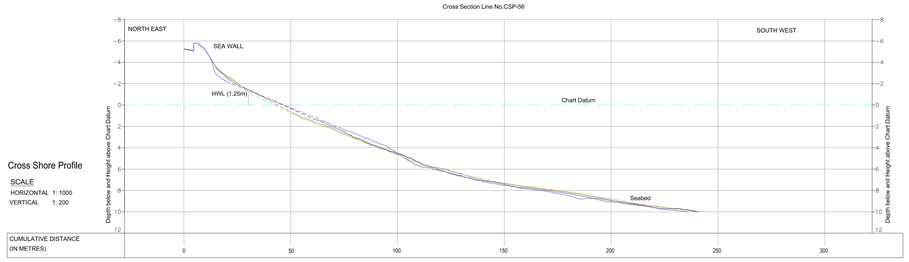


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200



Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.31424S5m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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Scale

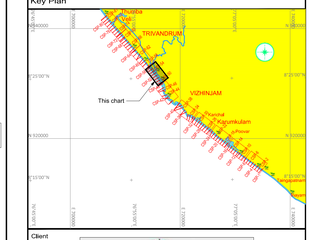
HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres

4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client



1st Floor, Vipanchika Towers,
Near Govt, Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai – 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

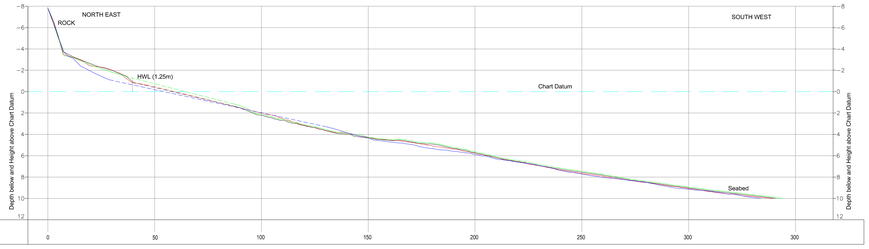
Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko | Interpreted : Satyawan | Approved : S. Philip

Dwg No. : OSaS_P18115_VBL_CSP49-CSP56_07 | Sheet No. 7 of 10

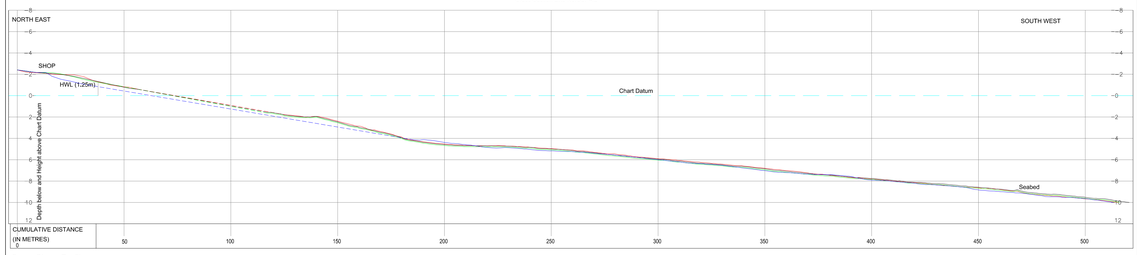
Cross Section Line No.CSP-41



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

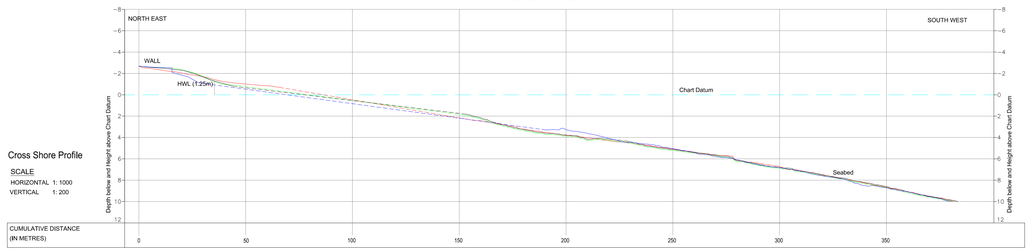
Cross Section Line No.CSP-42



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

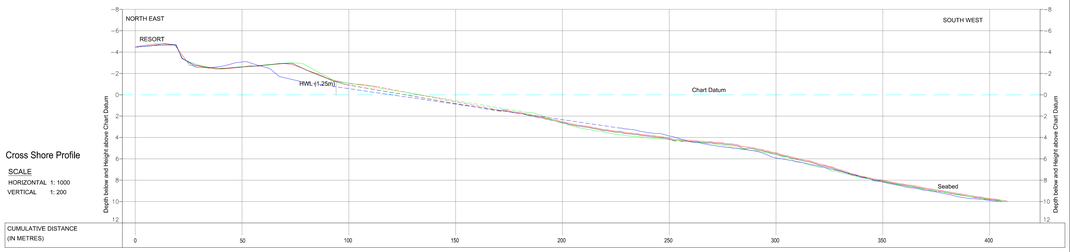
Cross Section Line No.CSP-43



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

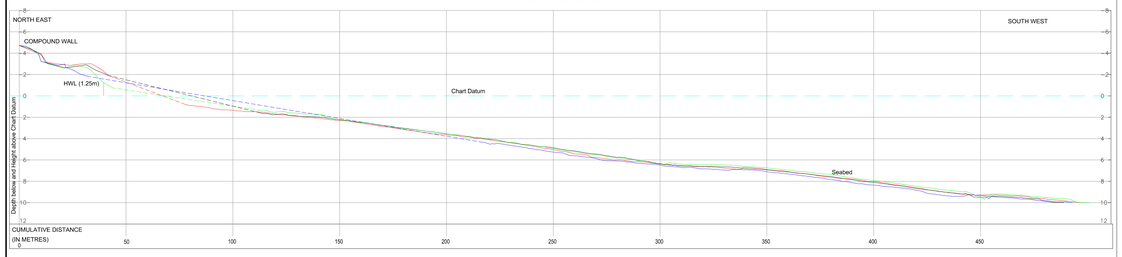
Cross Section Line No.CSP-44



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

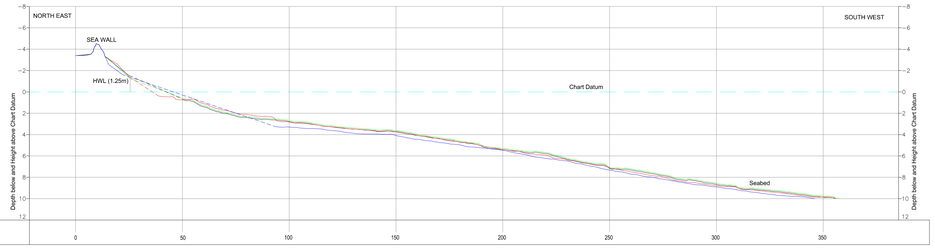
Cross Section Line No.CSP-45



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

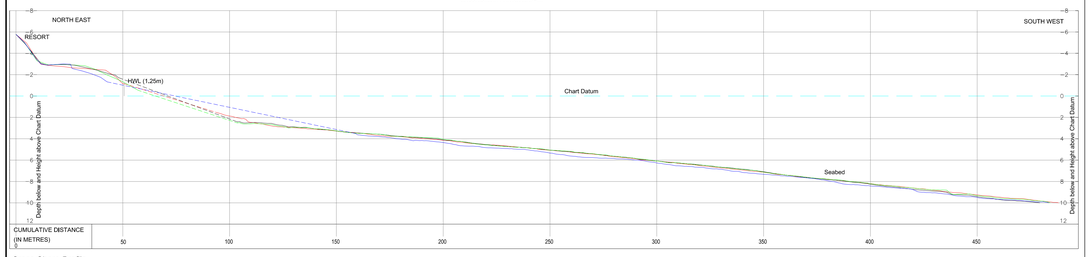
Cross Section Line No.CSP-47



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

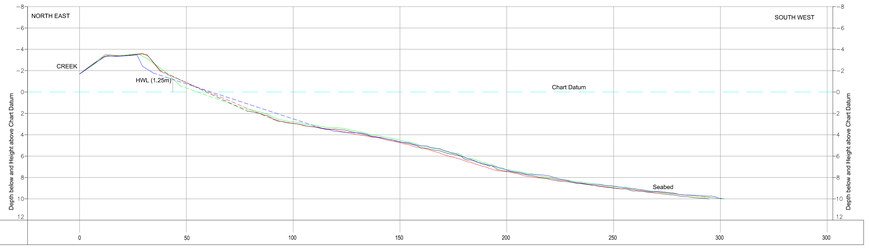
Cross Section Line No.CSP-46



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-48



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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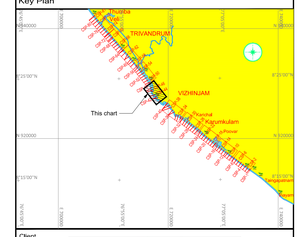
Scale

HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt, Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

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(Formerly known as EGS SURVEY PVT. LTD.)
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CBD Belapur, Navi Mumbai – 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

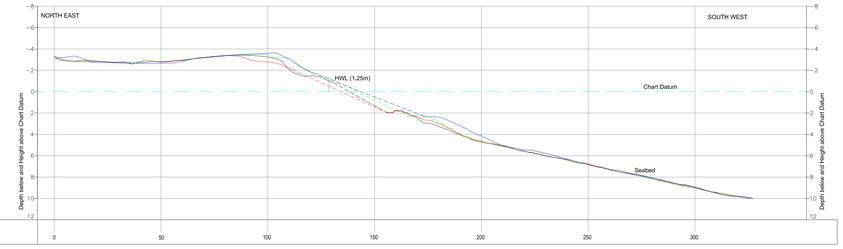
Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip

Dwg No. : OSaS_P18115_VBL_CSP41-CSP48_06 — Sheet No. 6 of 10

Cross Section Line No.CSP-33



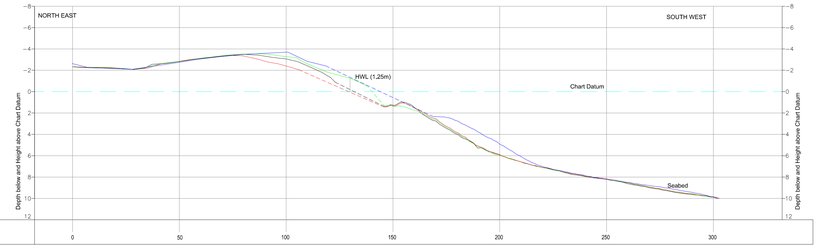
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-34



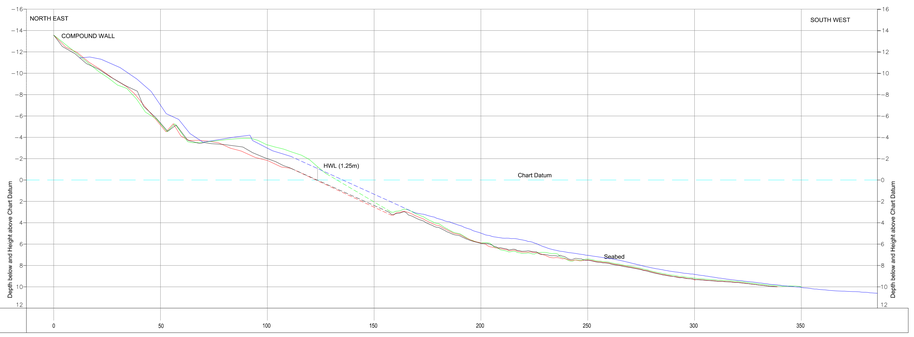
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-35



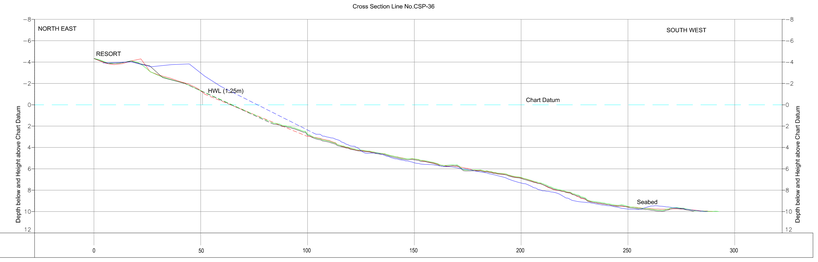
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-36



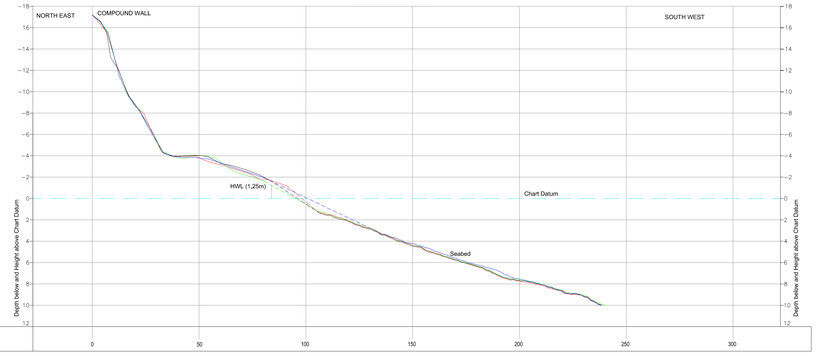
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-37



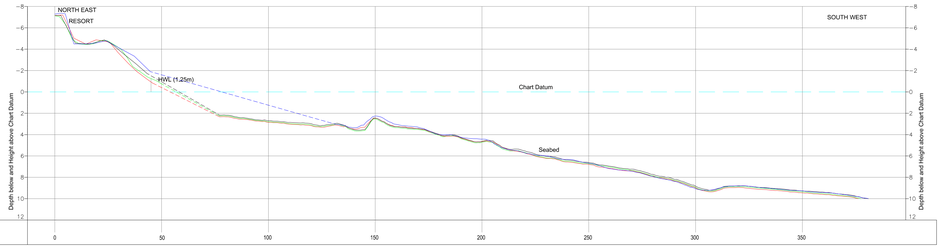
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-38



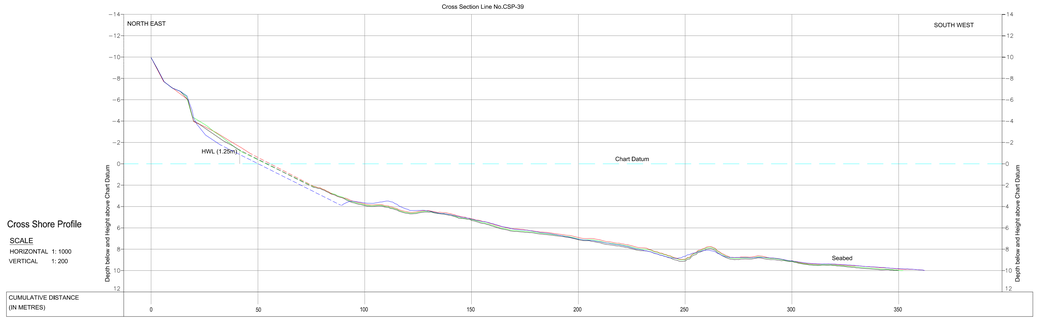
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-39



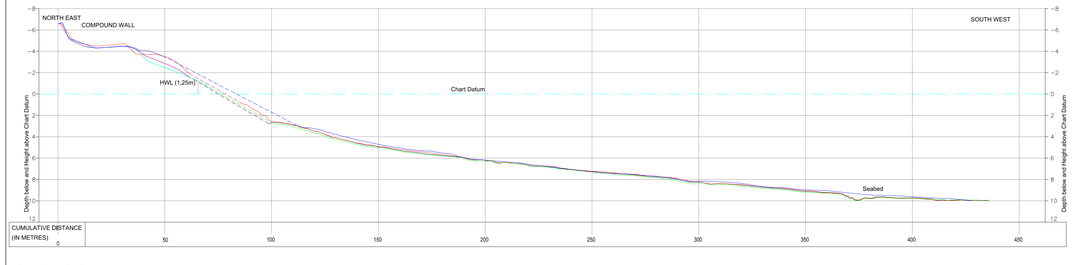
Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Cross Section Line No.CSP-40



Cross Shore Profile

SCALE

HORIZONTAL 1: 1000

VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
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Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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Scale

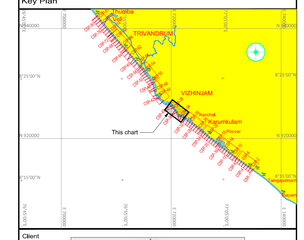
HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres

4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt, Guest House, Thycaud,
Thiruvananthapuram, Kerala, India, 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai - 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

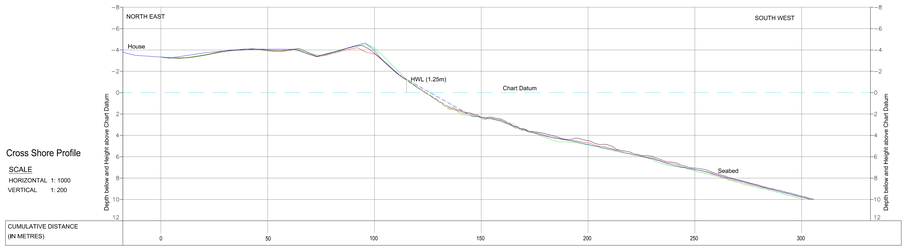
Drawing Title

Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip
Dwg No. : OSaS_P18115_VBL_CSP33-CSP40_05		Sheet No. 5 of 10

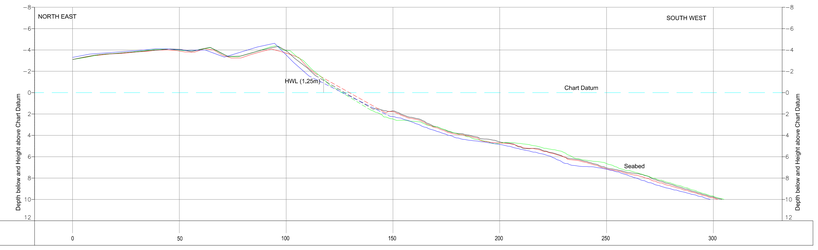
Cross Section Line No.CSP-25



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

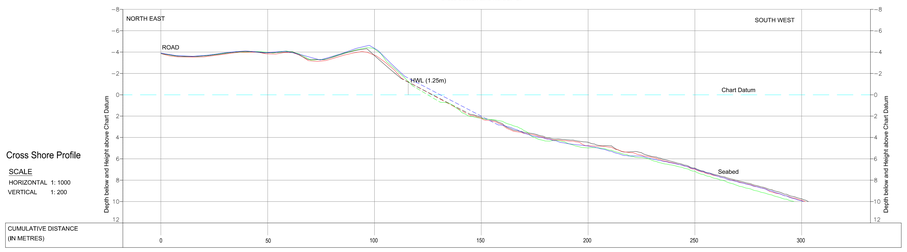
Cross Section Line No.CSP-26



Cross Shore Profile

SCALE
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VERTICAL 1: 200

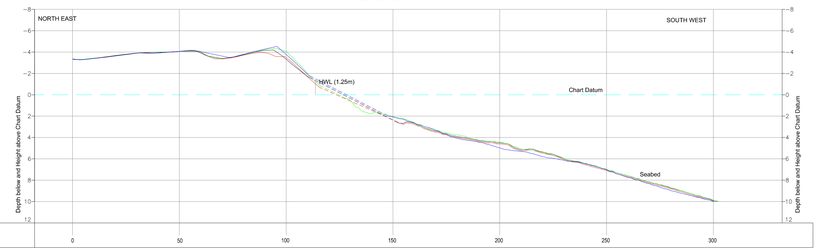
Cross Section Line No.CSP-27



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

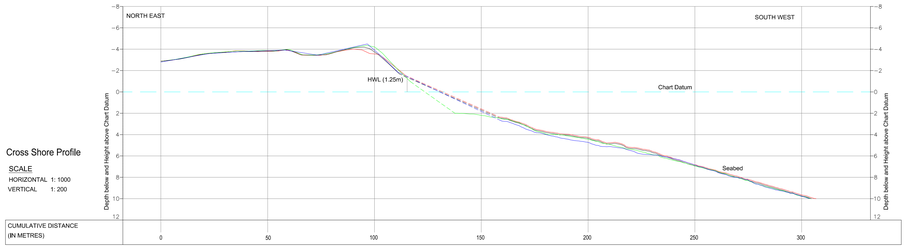
Cross Section Line No.CSP-28



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

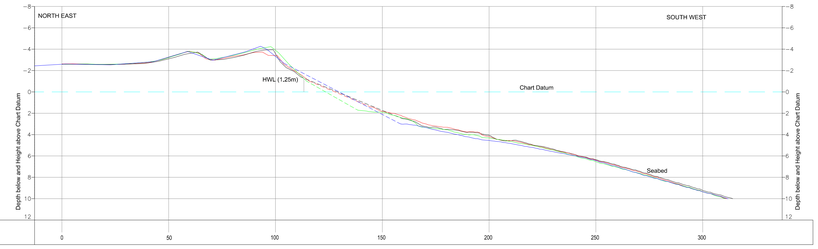
Cross Section Line No.CSP-29



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

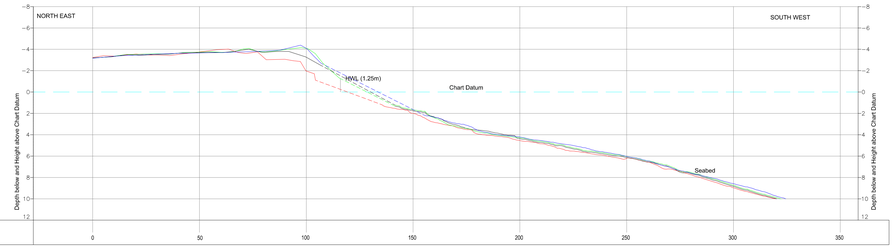
Cross Section Line No.CSP-30



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

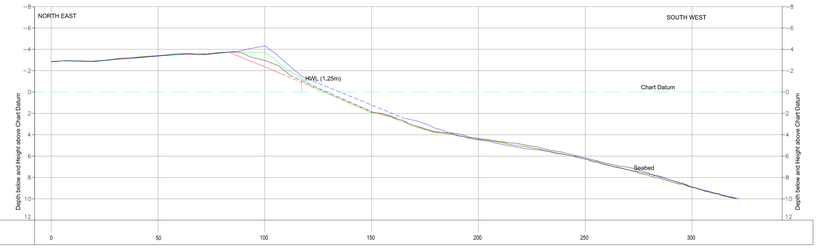
Cross Section Line No.CSP-31



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-32



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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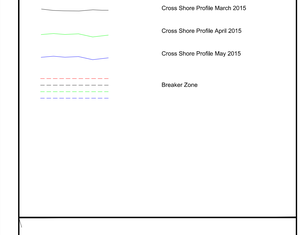
Scale

HORIZONTAL 1 : 1,000

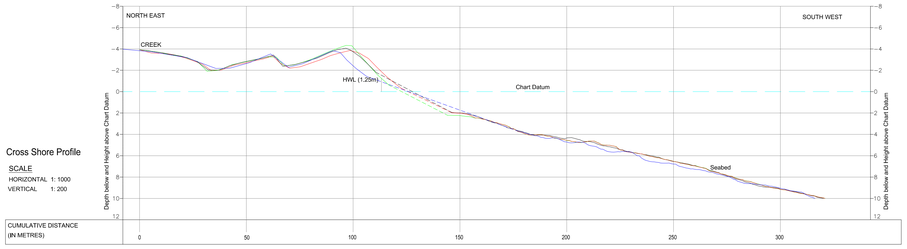
20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan


TRIVANDRUM
VIZHINJAM
Kovalam
Pozhiyoor
Pazhayathura
Kaduvakuzhi
Kaduvakuzhi
Kaduvakuzhi

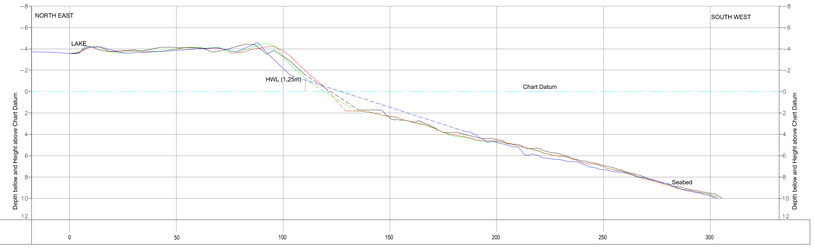
Cross Section Line No.CSP-17



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

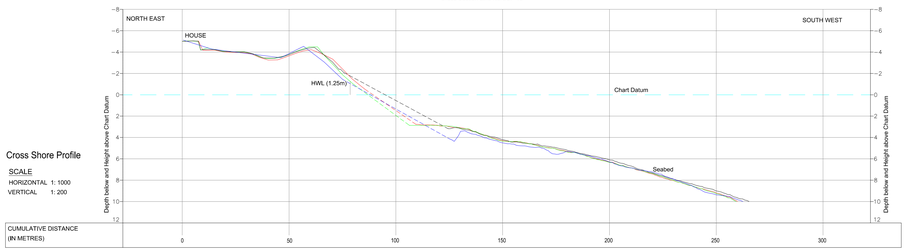
Cross Section Line No.CSP-18



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

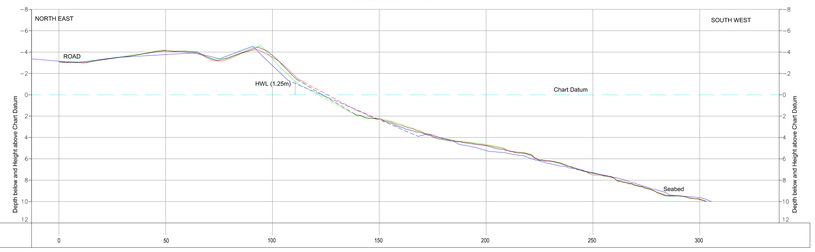
Cross Section Line No.CSP-19



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

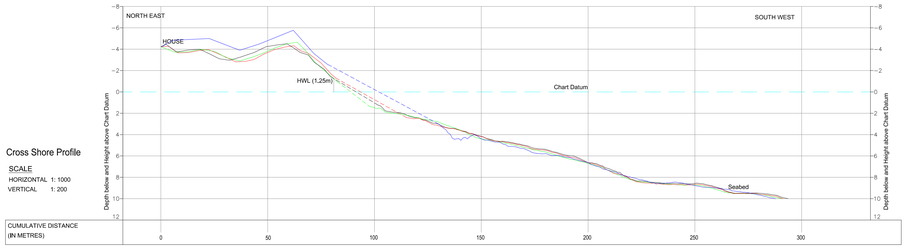
Cross Section Line No.CSP-20



Cross Shore Profile

SCALE
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VERTICAL 1: 200

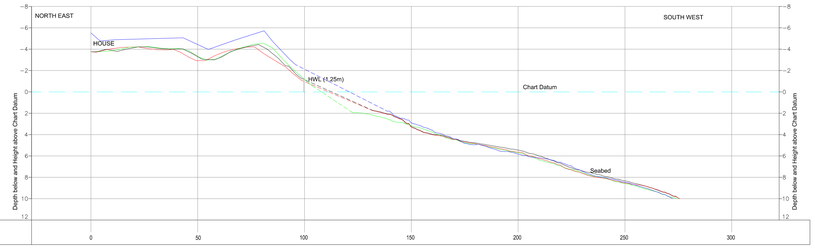
Cross Section Line No.CSP-21



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

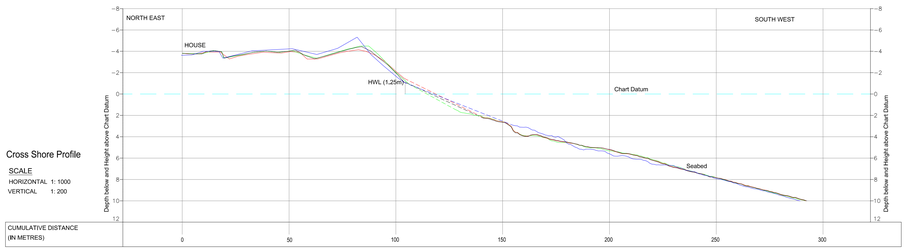
Cross Section Line No.CSP-22



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

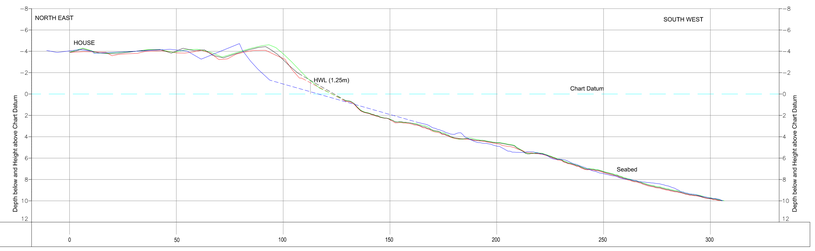
Cross Section Line No.CSP-23



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-24



Cross Shore Profile

SCALE
HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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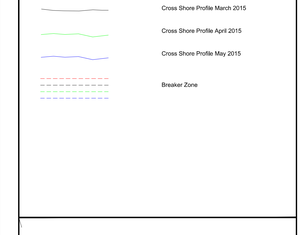
Scale

HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt, Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai – 400 614
Maharashtra, India.

Project

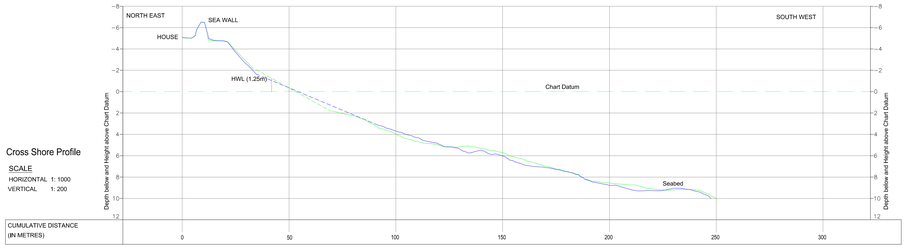
Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

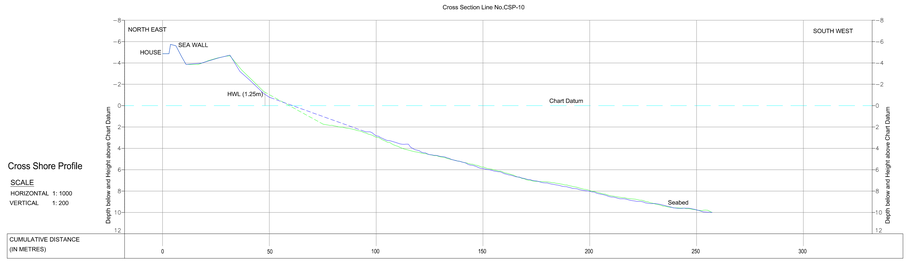
Drawing Title

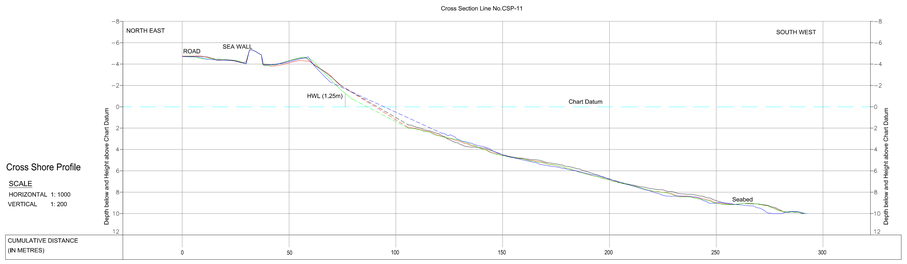
Cross Shore Profiling at Vizhinjam

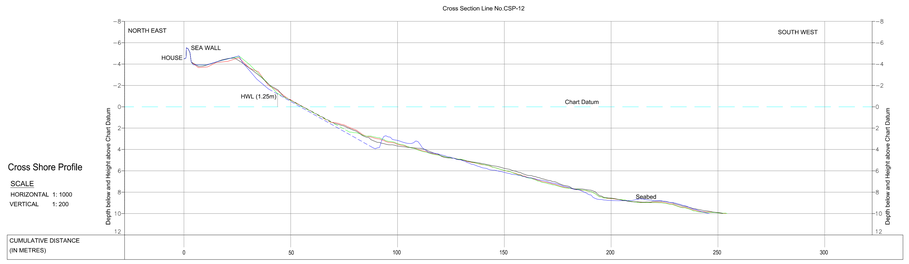
Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

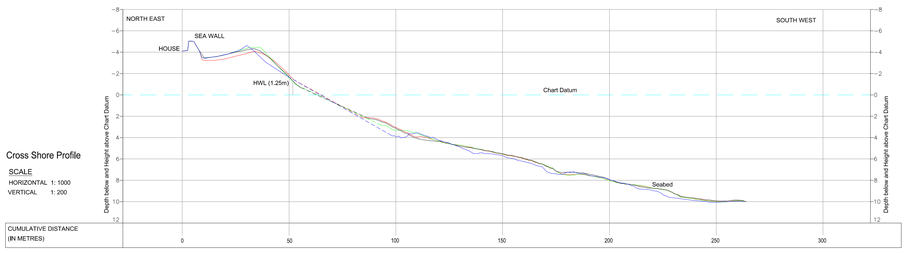
Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip
Dwg No. : OSaS_P18115_VBL_CSP17-CSP24_03		Sheet No. 3 of 10

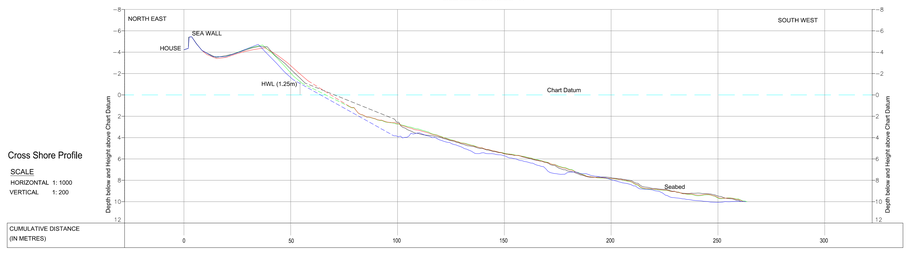


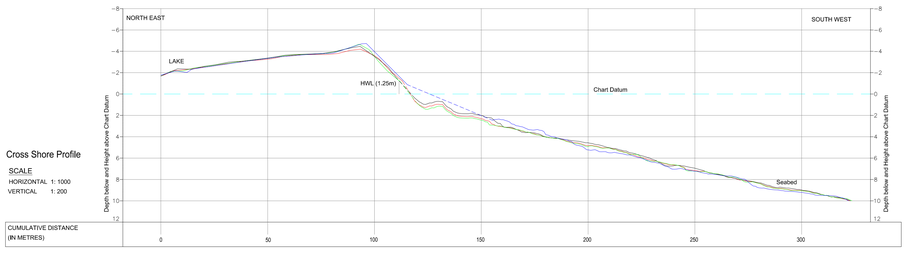


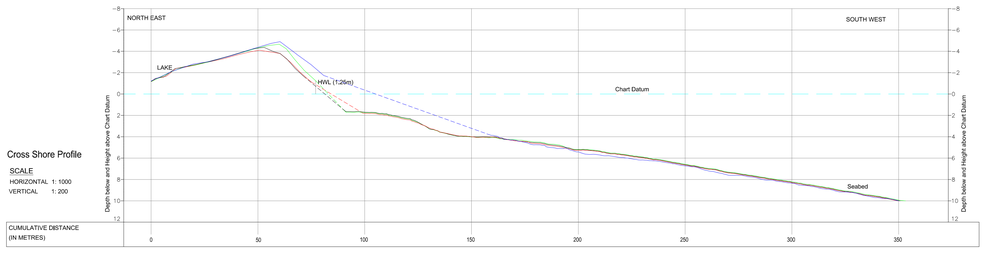












Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

Cross Shore Profile February 2015
Cross Shore Profile March 2015
Cross Shore Profile April 2015
Cross Shore Profile May 2015
Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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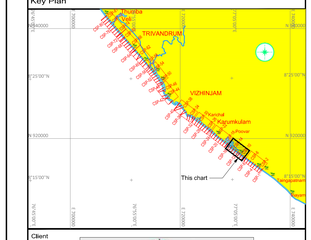
Scale

HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt, Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
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CBD Belapur, Navi Mumbai – 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

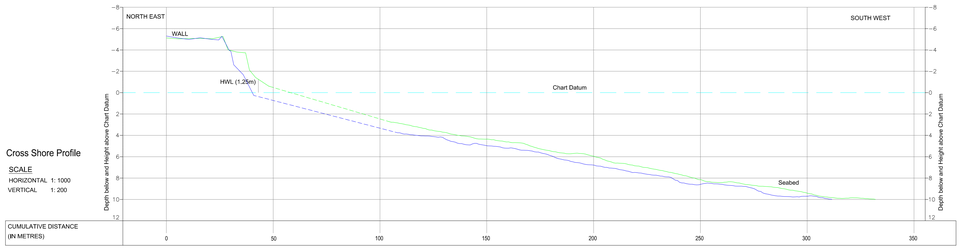
Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip

Dwg No. : OSaS_P18115_VBL_CSP9-CSP16_02 — Sheet No. 2 of 10

Cross Section Line No.CSP-01

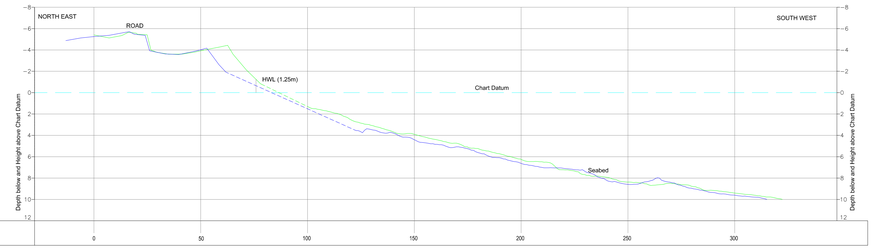


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-02

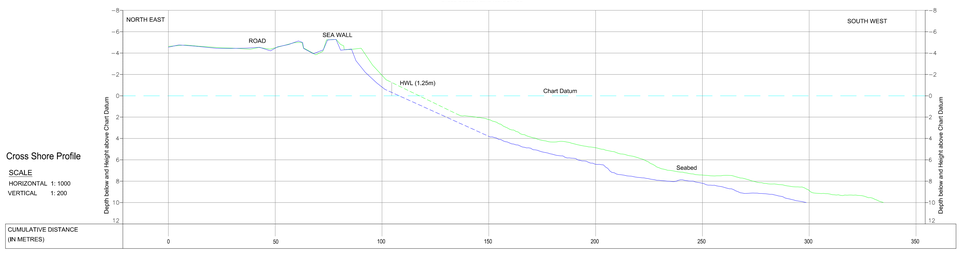


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-03

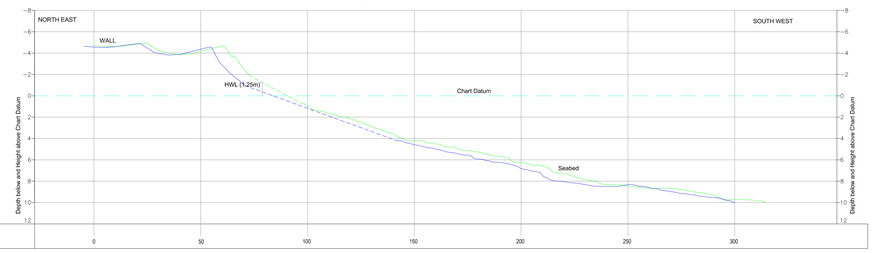


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-04

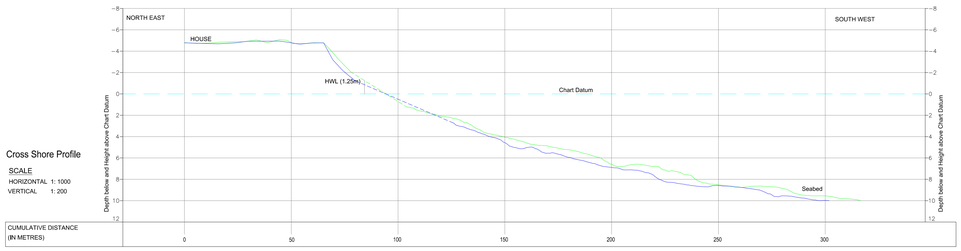


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-05

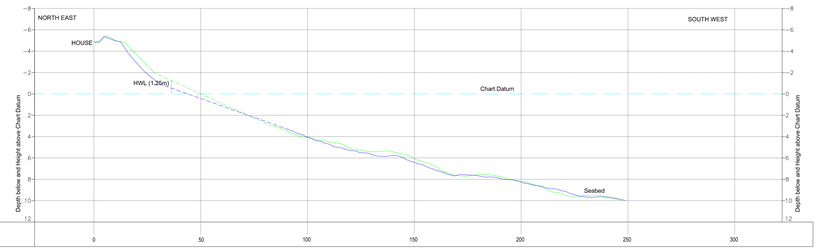


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-06

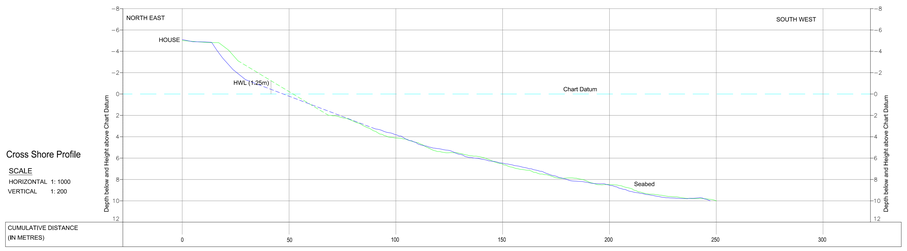


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-07

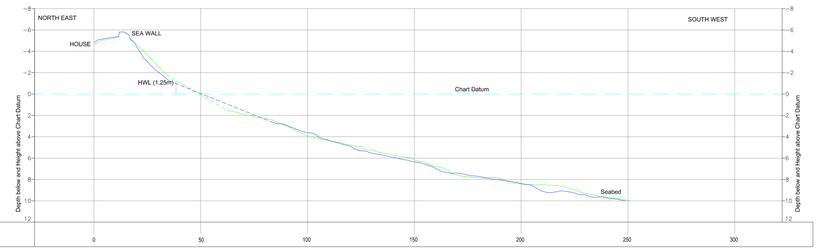


Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Cross Section Line No.CSP-08



Cross Shore Profile

SCALE

HORIZONTAL 1: 1000
VERTICAL 1: 200

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- Cross Shore Profile February 2015
- Cross Shore Profile March 2015
- Cross Shore Profile April 2015
- Cross Shore Profile May 2015
- Breaker Zone

Survey Notes :

Survey dates	:	Feb to May 2015
Survey boats	:	Bethel
Surface positioning	:	Leica MX 420 series DGPS
RTK System	:	Hemisphere GPS R320 GNSS base and rover
Bathymetry acquired using	:	Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
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Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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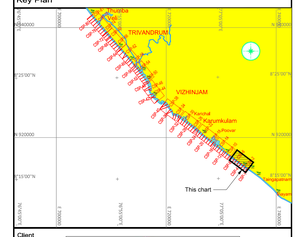
Scale

HORIZONTAL 1 : 1,000

20 0 20 40 60 80 100metres
4 0 4 8 12 16 20

VERTICAL 1 : 200

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

1st Floor, Vipanchika Towers,
Near Govt. Guest House, Thycaud,
Thiruvananthapuram, Kerala, India. 695014
Tel : +91 471 2328614 Tel/Fax: +91 471 2328616
E-mail: mail@vizhinjamport.in

Advisor

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)
NIOT Campus, Velachery - Tambaram Main Road,
Pallikaranai, Chennai - 600 100, INDIA
Phone: 6678 3325 / 3322 ; Fax: 91- 44 - 22460645

Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
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CBD Belapur, Navi Mumbai – 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

Cross Shore Profiling at Vizhinjam

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : S. Chacko	Interpreted : Satyawan	Approved : S. Philip
Dwg No. : OSaS_P18115_VBL_CSP1-CSP8_01		Sheet No. 1 of 10

Thumba
Veli
TRIVANDRUM
P18115_OSaS_VISL_01
P18115_OSaS_VISL_03
P3
P18115_OSaS_VISL_07
P18115_OSaS_VISL_02
P18115_OSaS_VISL_04
VIZHINJAM
P1
P4
Karichal
P18115_OSaS_VISL_05
Karumkulam
Poovar
P18115_OSaS_VISL_08
P2
P18115_OSaS_VISL_09
P18115_OSaS_VISL_10
P18115_OSaS_VISL_06
Taingapatnam
Inayam
P18115_OSaS_VISL_11
P18115_OSaS_VISL_12
P18115_OSaS_VISL_13
N
W
E
S

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

N 2098500 — UTM Grid Line & Text

18°58'00"N — Lat/Long Grid Line & Text

P2 — Water Sample / Current meter Locations

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.3142/5m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

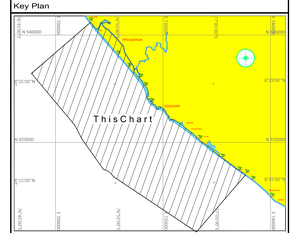
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Scale

HORIZONTAL 1 : 50,000

1000 0 1000 2000 3000 4000 5000metres

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED
1st Floor, Vipanchika Towers, Near Govt. Guest House,
Thycaud, Thiruvananthapuram,Kerala, India. 695014
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Pallikaranai, Chennai - 600 100, INDIA
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Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai - 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

Control Chart

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri | Approved : S. Philip

Dwg. No. OSaS_P18115_VISL_Control Chart_01

Match Line Dwg. No. : OSdS_P18115_VISL_BATHY_11

Match Line Dwg. No. : OSdS_P18115_VISL_BATHY_12

Match Line Dwg. No. : OSdS_P18115_VISL_BATHY_11

Match Line Dwg. No. : OSdS_P18115_VISL_BATHY_12

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

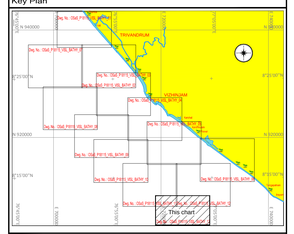
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000 metres

Key Plan



Client

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Near Govt. Guest House, Thycaud,
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Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

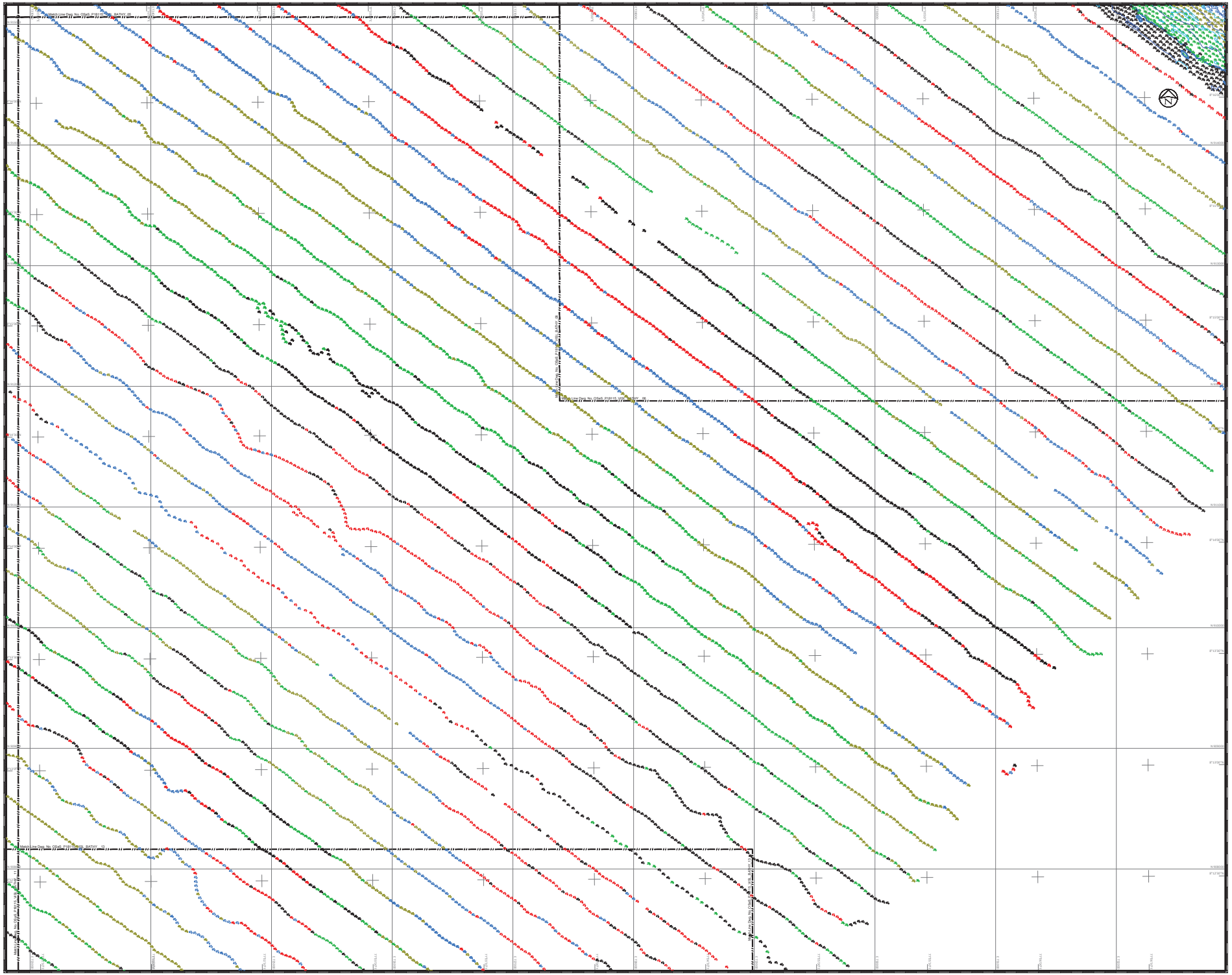
Bathymetric Chart

Sheet No. 13 of 13

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Satyavan | Approved : S. Philip

Dwg. No. : OSdS_P18115_VISL_BATHY_13



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March – May 2015
Survey boats	:	Sothed and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath (Ais MSES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.257223563D
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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Scale

HORIZONTAL 1 : 10,000

Key Plan

Client

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Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

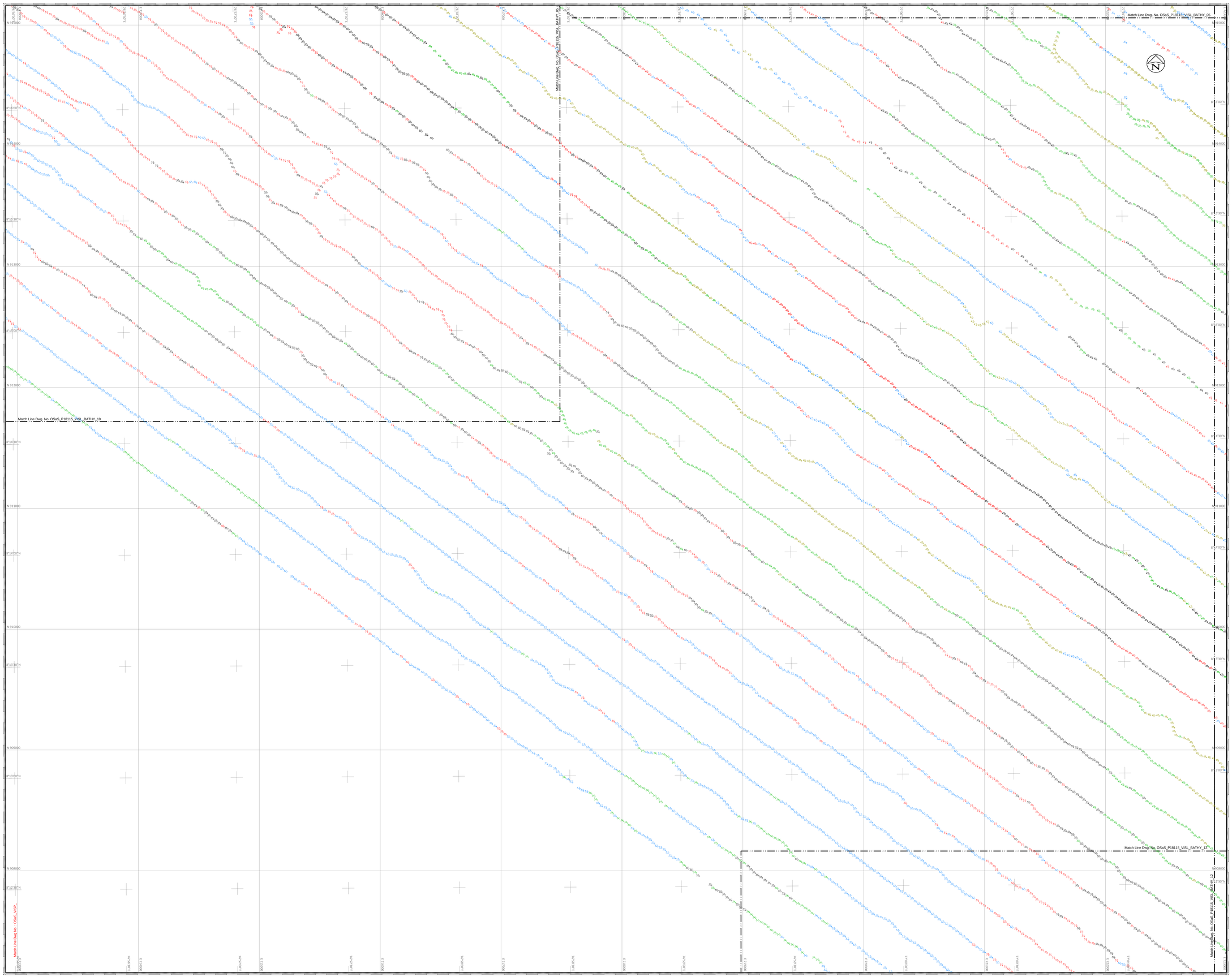
Bathymetric Chart

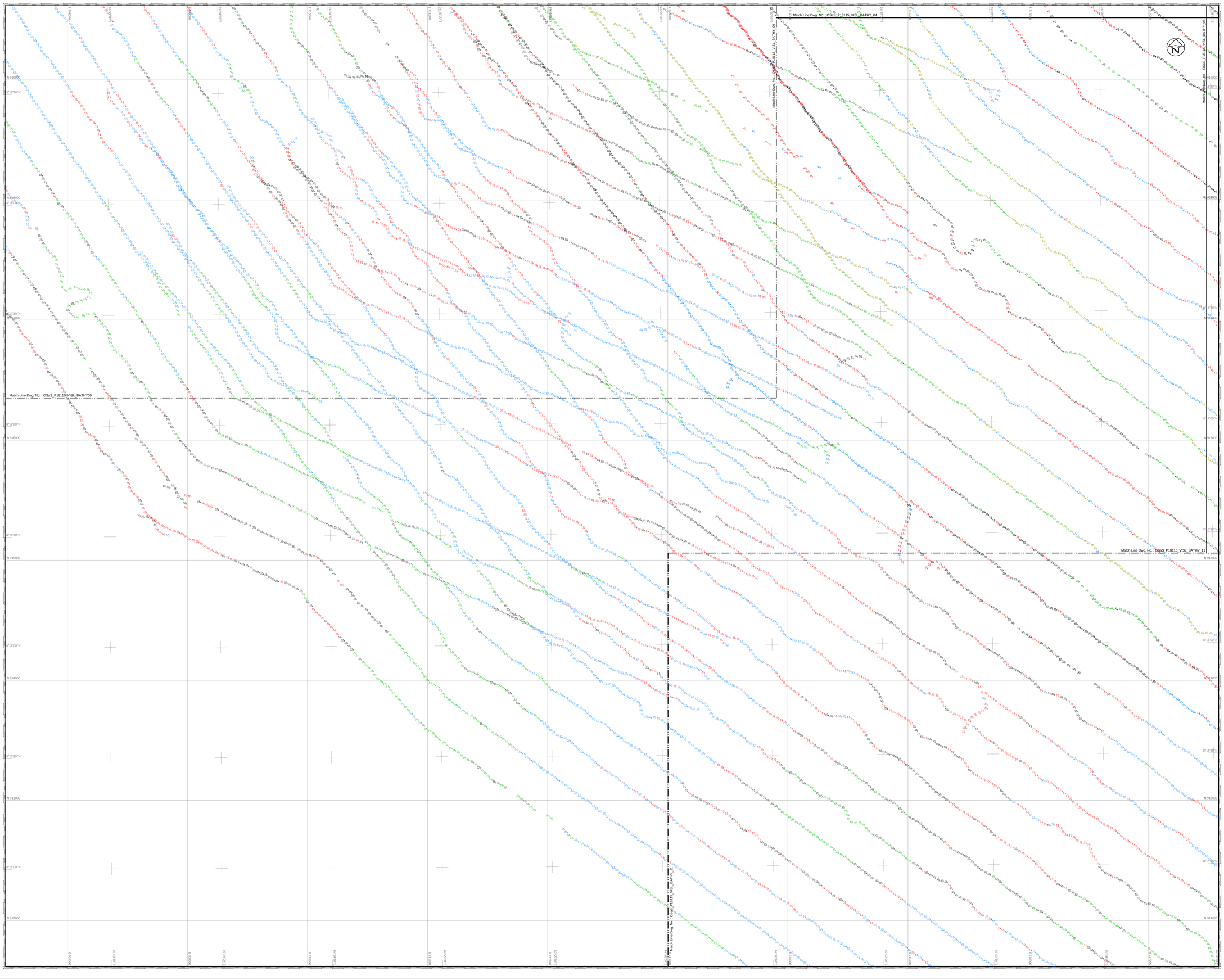
Sheet No. 12 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Sabyasan | Approved : S. Philip

Dwg.No. : OSaS_P18115_VIS_BATHY_12


Match Line Dwg. No. OSoS_P18115_VISL_BATHY_09
Match Line Dwg. No. OSoS_P18115_VISL_BATHY_10
Match Line Dwg. No. OSoS_P18115_VISL_BATHY_11
Match Line Dwg. No. OSoS_P18115_VISL_BATHY_12
Match Line Dwg. No. OSoS_VISP
N 915000
N 914000
N 913000
N 912000
N 911000
N 910000
N 909000
N 908000
E 312000
E 313000
E 314000
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E 329000
E 330000
E 331000
E



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

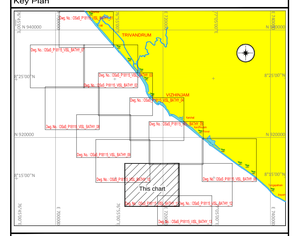
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



Client

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Advisor

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Survey contractor

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Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

Bathymetric Chart

Sheet No. 10 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn - M. I. Mansuri	Interpreted : M. I. Mansuri / Satyavan	Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_10

Match Line Dwg No. : OSdS_P18115_VISL_BATHY_03

Match Line Dwg No. : OSdS_P18115_VISL_BATHY_08

Match Line Dwg No. : OSdS_P18115_VISL_BATHY_04

Match Line Dwg No. : OSdS_P18115_VISL_BATHY_10

Match Line Dwg No. : OSdS_P18115_VISL_BATHY_09

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

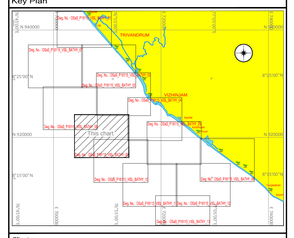
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_07

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_02

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_03

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_09

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_09

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- N 908000 — UTM Grid Line & Text
- 8°12'30"N — Lat/Long Grid Line & Text
- Matchline
- .5, .6, .7, .8, .9 — Water depth in metres & decimetres below chart datum
- 4 — Minor depth contours in metres below chart datum
- 4.5 — Minor depth contours in metres below chart datum
- 5 — Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.257223563D
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

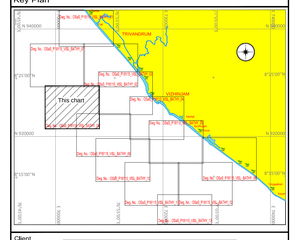
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



Client

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Drawing Title

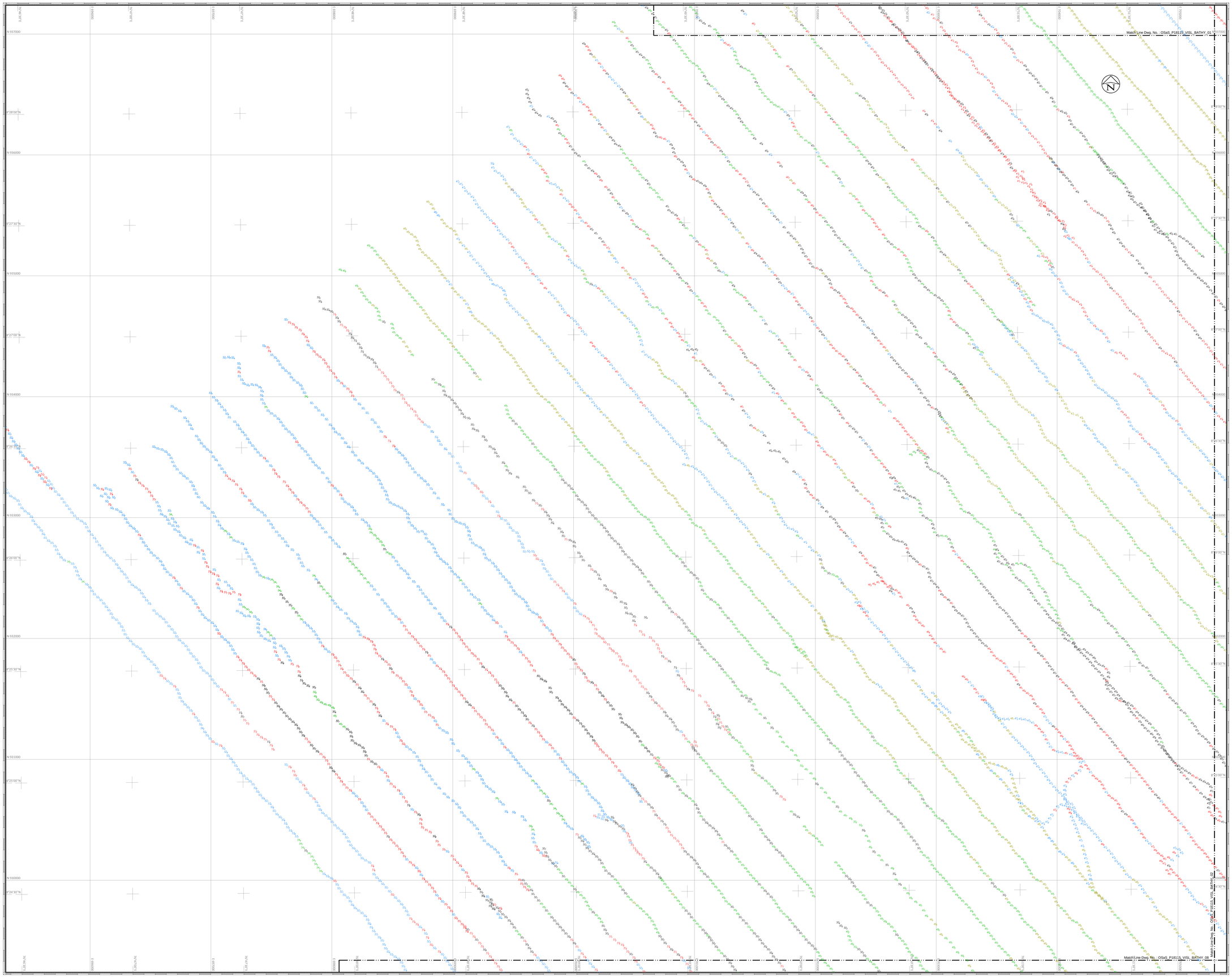
Bathymetric Chart

Sheet No. 08 of 13

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Satyavan | Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_08



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

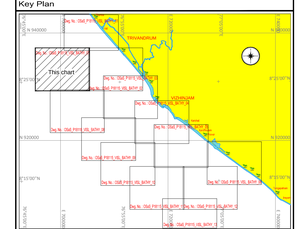
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



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Vizhinjam International Seaport Limited

Drawing Title

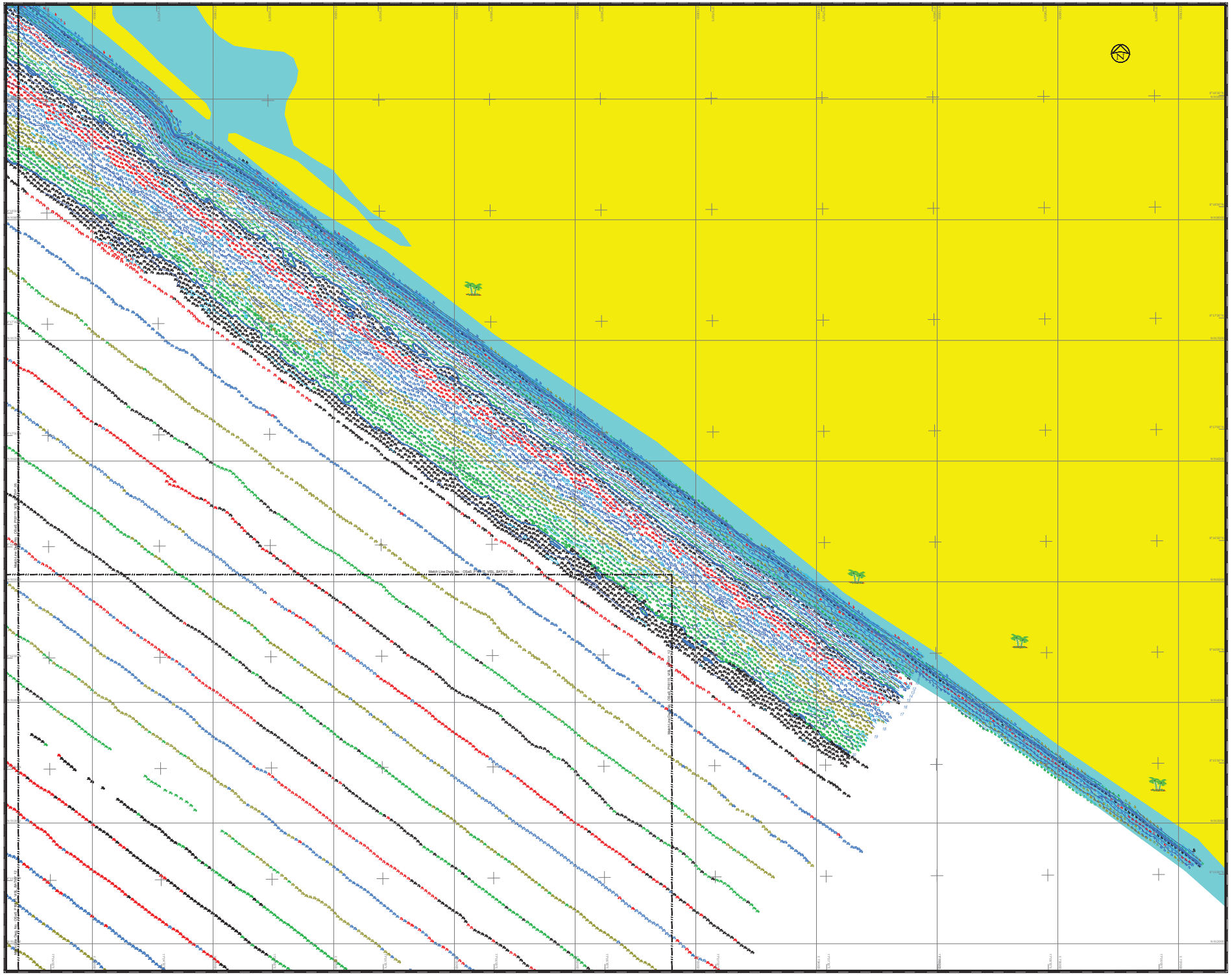
Bathymetric Chart

Sheet No. 07 of 13

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Satyavan | Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_07



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.257223563S
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

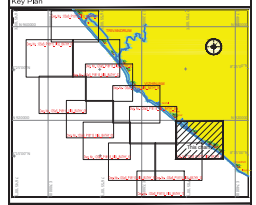
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Scale

HORIZONTAL 1 : 10,000

0 200 400 600 800 1000Metres

Key Plan



Client

Vizhinjam International Seaport Limited

1st Floor, Vipanchika Towers,
Near Govt. Guest House, Thycaud,
Thiruvananthapuram,Kerala, India. 695014
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Survey contractor

OCEAN SCIENCE & SURVEYING PVT LTD
(Formerly known as EGS SURVEY PVT. LTD.)
C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai - 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

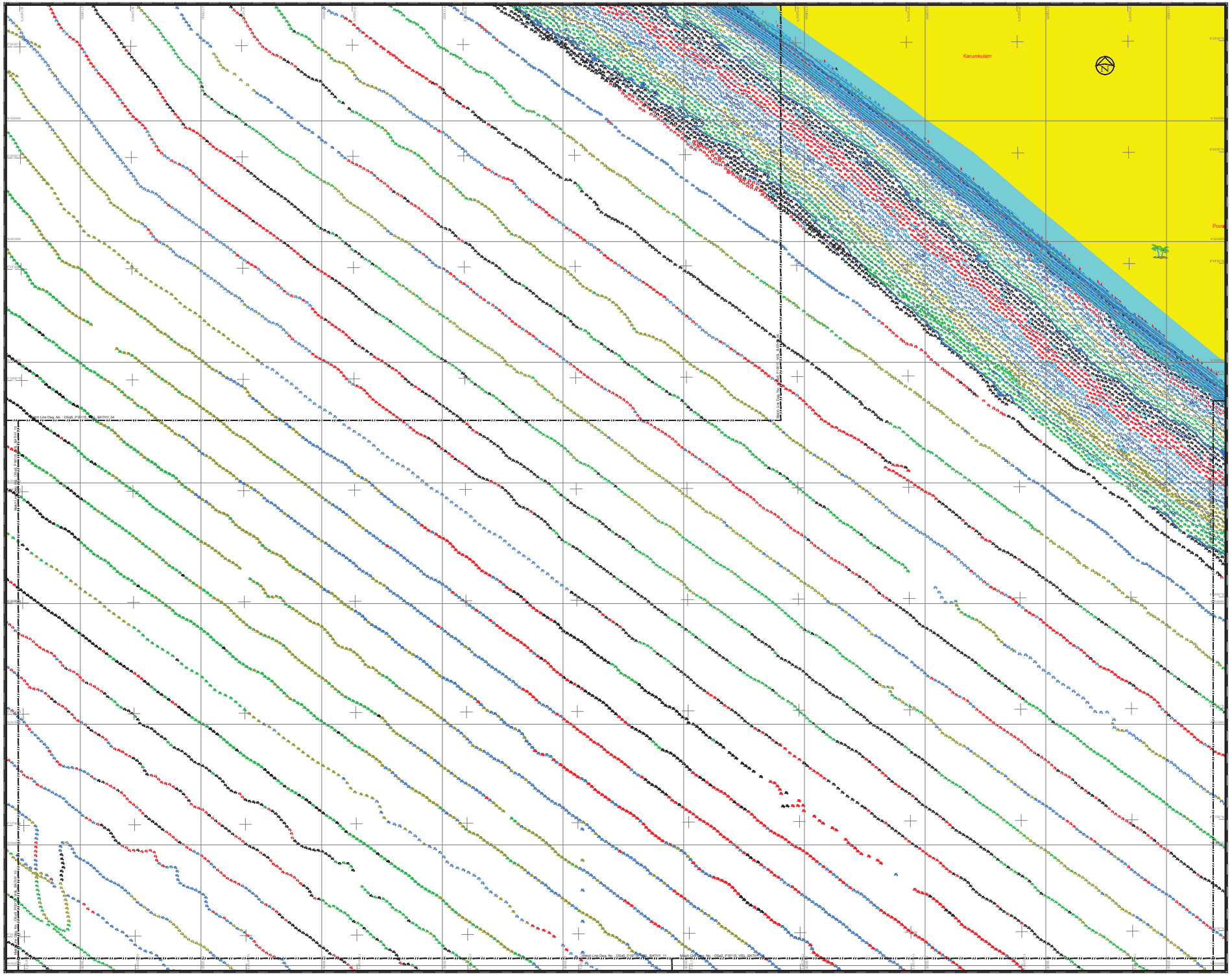
Bathymetric Chart

Sheet No. 06 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M.J. Mansuri | Interpreted : M. I. Mansuri / Sabyasachi | Approved : S. Philip

Dwg.No.: OSeS_P1811S_VIS_BATHY_06



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March – May 2015
Survey Vessels	:	Sailfield and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

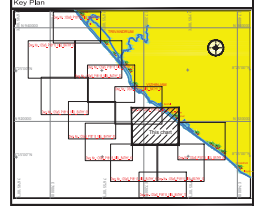
Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.257223563D
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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Scale

HORIZONTAL 1 : 10,000

Key Plan



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Project

Oceanographic & Bathymetric Data Collection
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Drawing Title

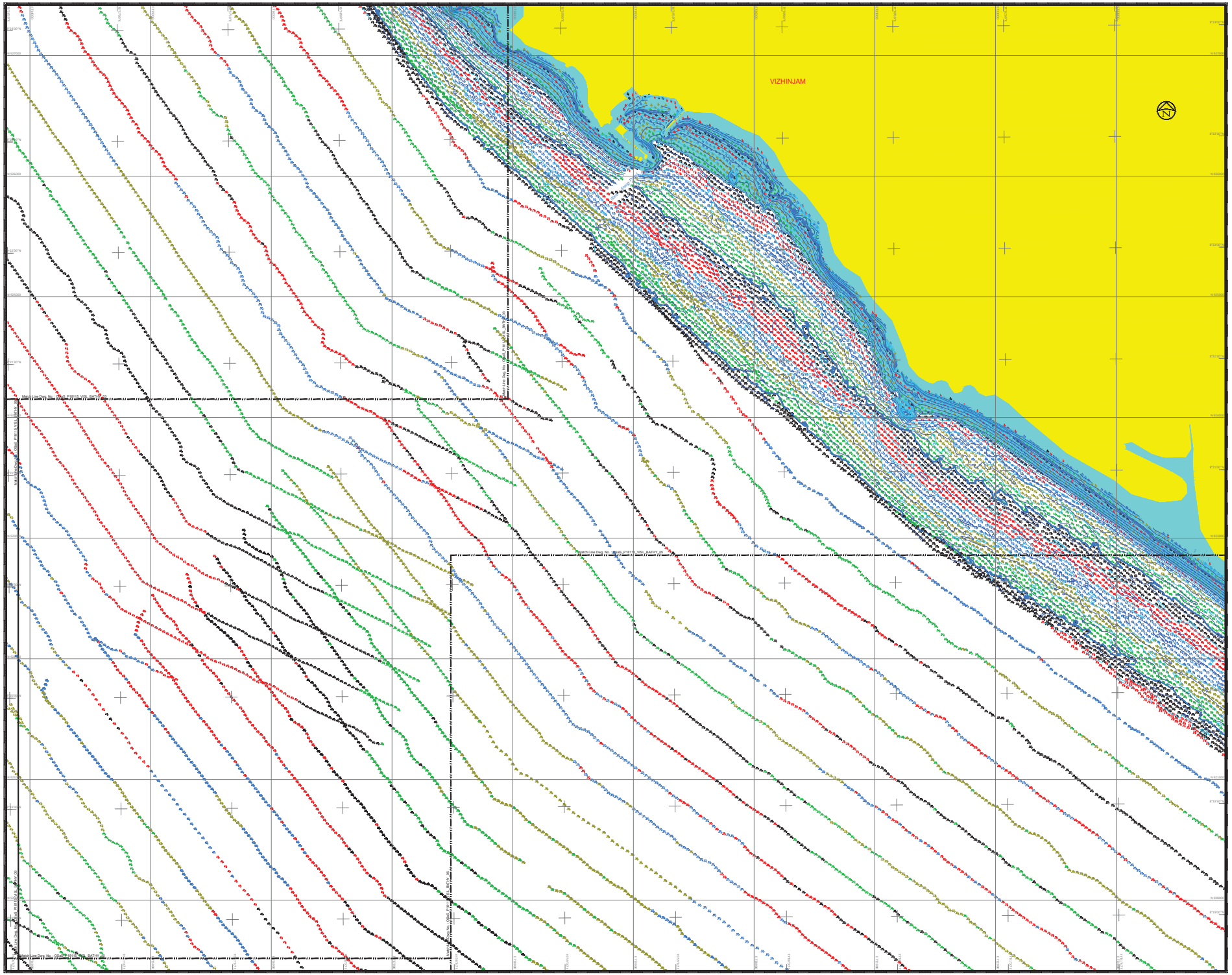
Bathymetric Chart

Sheet No. 05 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. L Menson | Interpreted : M. L Menson / Sabyason | Approved : S. Philip

Dwg.No. : OSaS_P18115_VIS_BATHY_05



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath (Ais MBES

Geodetic parameters :

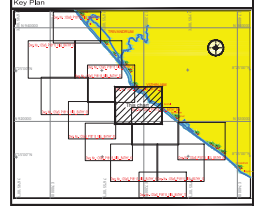
Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.257223563D
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

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Scale

HORIZONTAL 1 : 10,000

Key Plan



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Survey contractor :

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Project :

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title :

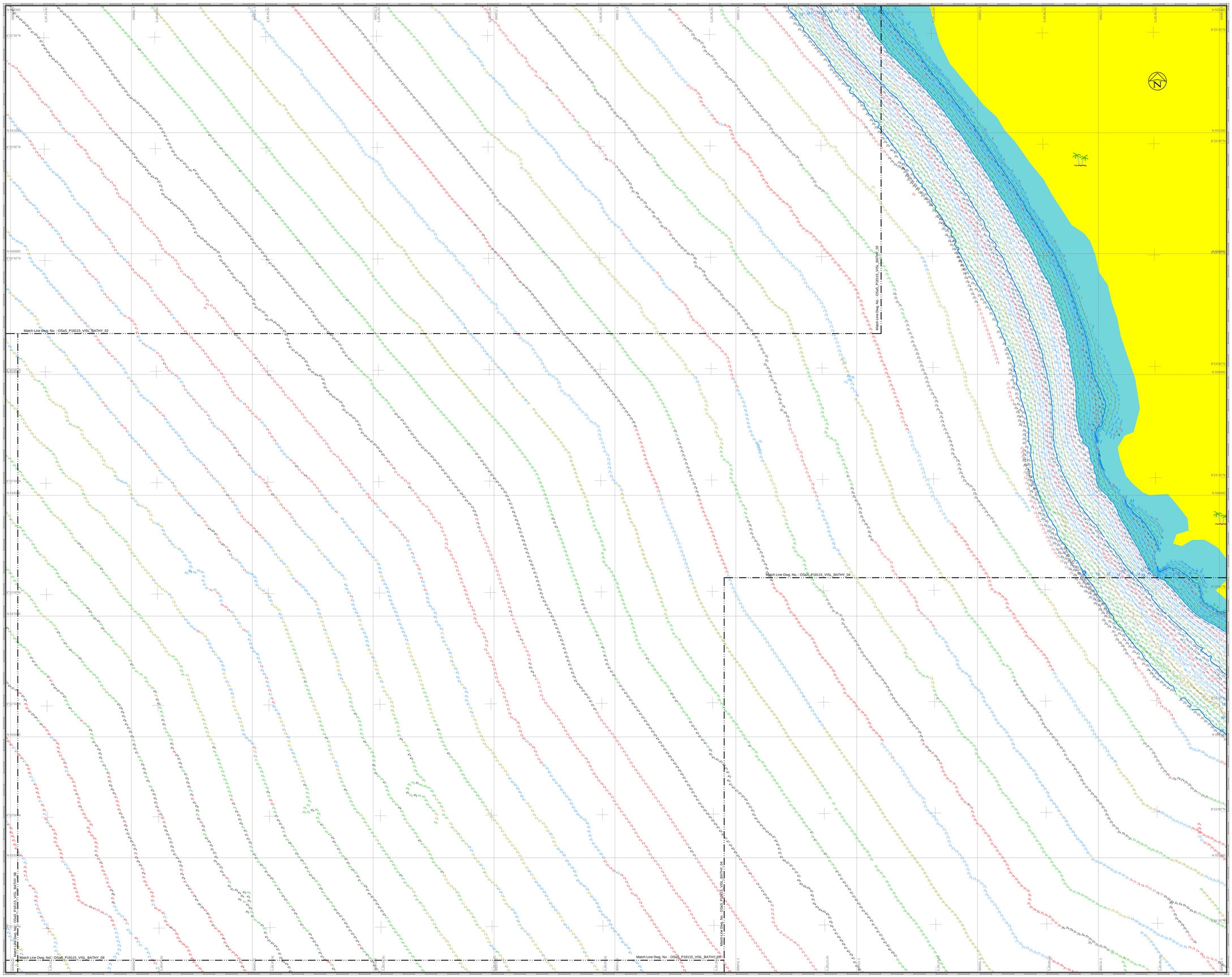
Bathymetric Chart

Sheet No. 04 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Sabyasachi | Approved : S. Philip

Dwg.No. : OSoS_P18115_VBL_BATHY_04



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

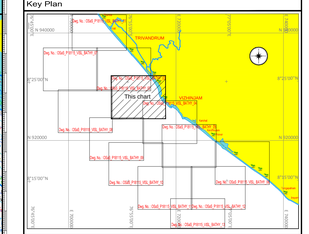
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



Client

Vizhinjam International Seaport Limited

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C005/006, Platform Floor,
Tower No.8, Railway Station Complex,
CBD Belapur, Navi Mumbai – 400 614
Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
For
Assessment of Shoreline Changes
For
Vizhinjam International Seaport Limited

Drawing Title

Bathymetric Chart

Sheet No. 03 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Satyavan | Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_03

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_01

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_08

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_07

Match Line Dwg. No. : OSaS_P18115_VISL_BATHY_09

Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

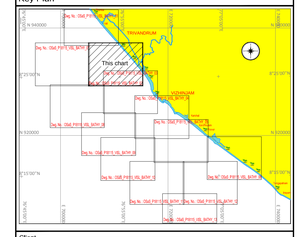
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

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Maharashtra, India.

Project

Oceanographic & Bathymetric Data Collection
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For
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Drawing Title

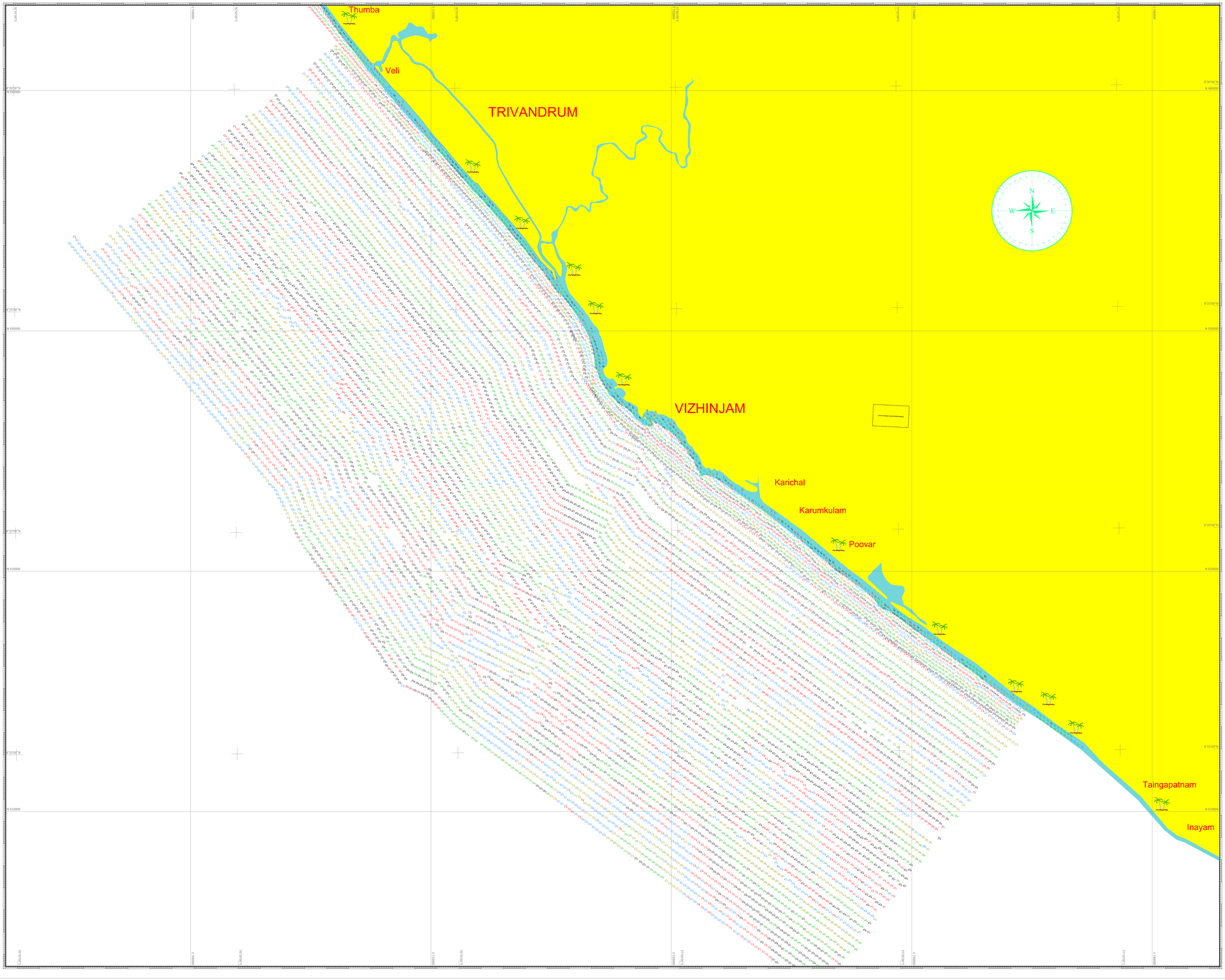
Bathymetric Chart

Sheet No. 02 of 13

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Satyavan | Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_02



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
2. Observed tides at vizhinjam Harbour is used to reduce the raw bathy to chart datum.

LEGEND

- UTM Grid Line & Text
- Lat/Long Grid Line & Text
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
Projection	:	Universal Transverse Mercator
Longitude of Origin (CM)	:	75° E (Zone 43)
Latitude of Origin	:	0° N (Equator)
Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

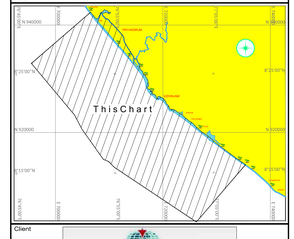
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Scale

HORIZONTAL 1 : 50,000

1000 0 1000 2000 3000 4000 5000metres

Key Plan



Client

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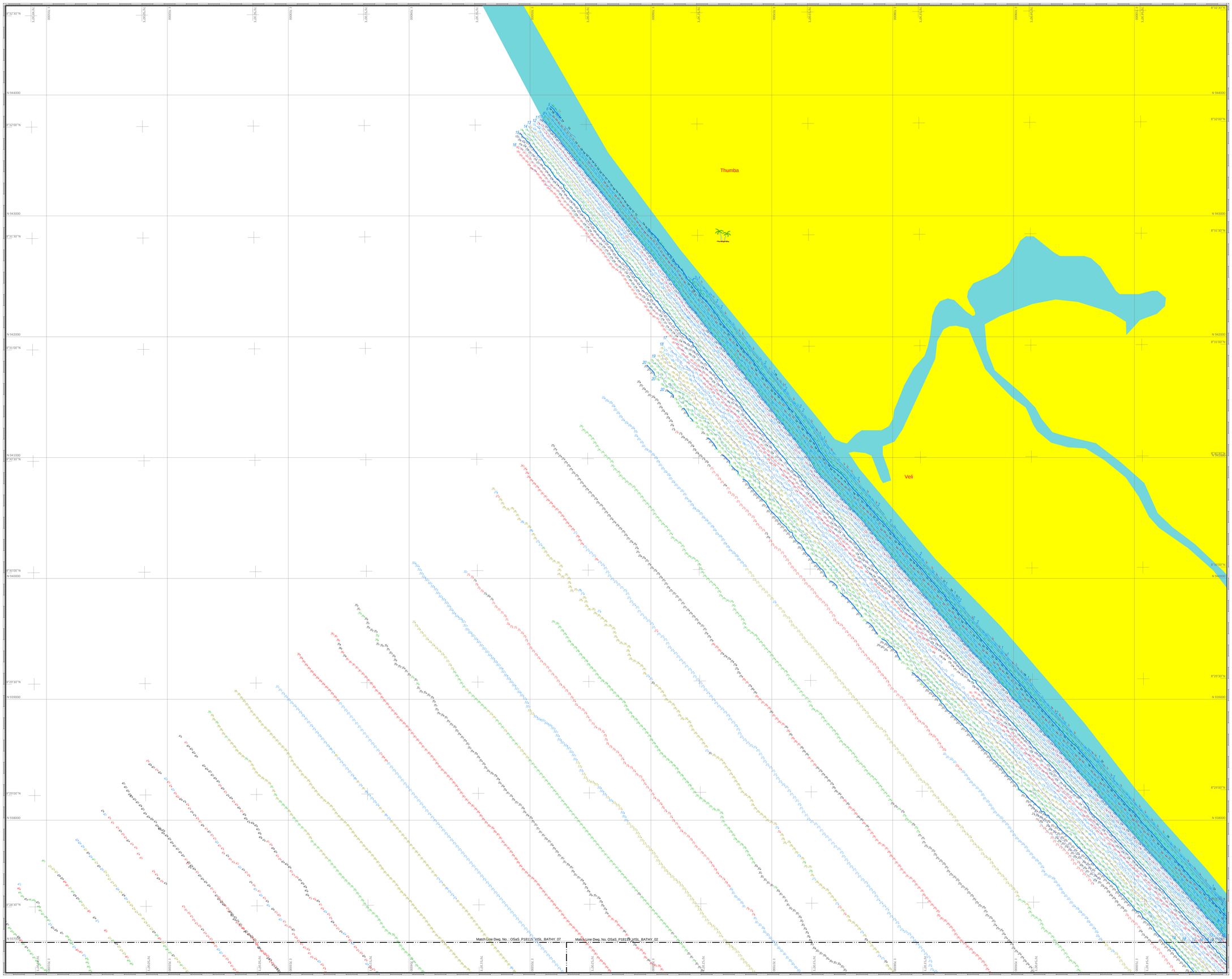
Drawing Title

BATHYMETRIC CHART

Rev.No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri | Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_01_50k



Notes :

1. Background details shown in the charts are extracted from NHO navigation chart No. 222
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LEGEND

- UTM Grid Line & Text
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- Matchline
- Water depth in metres & decimetres below chart datum
- Minor depth contours in metres below chart datum
- Minor depth contours in metres below chart datum
- Major depth contours in metres below chart datum

Survey Notes :

Survey dates	:	March - May 2015
Survey boats	:	Bethel and Samuel
Surface positioning	:	Leica MX 420 series DGPS
Bathymetry acquired using	:	Knudsen 320 M echo sounder & Geo swath plus MBES

Geodetic parameters :

Horizontal Coordinate System	:	WGS84
Geodetic Datum / Spheroid	:	WGS84
Semi-Major Axis (a) (meters)	:	6378137.000m
Semi-Minor Axis	:	6356752.314245m
Inverse Flattening	:	298.2572235630
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Hemisphere	:	North
False Easting	:	500 000 m
False Northing	:	0 m
Scale Factor at CM	:	0.9996
Units	:	Metres

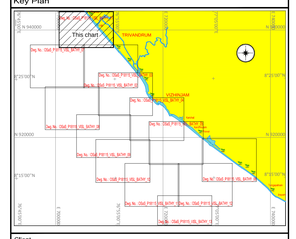
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Scale

HORIZONTAL 1 : 10,000

200 0 200 400 600 800 1000metres

Key Plan



Client

VIZHINJAM INTERNATIONAL SEAPORT LIMITED

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For
Vizhinjam International Seaport Limited

Drawing Title

Bathymetric Chart

Sheet No. 01 of 13

Rev No.	Description	Date
0	First issue	20.06.2015
1	Final Submission	25.07.2015

Drawn : M. I. Mansuri | Interpreted : M. I. Mansuri / Satyavan | Approved : S. Philip

Dwg. No. : OSaS_P18115_VISL_BATHY_01

Annexure X

WATER SAMPLE REPORT

Standard^{S}
Environmental Monitoring

TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R304

Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date & Time		Parameters		
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (^{O}C)
Vizhinjam Harbour (L1)	WS-L1-SUR-001	02.03.2015 07.00 Hrs	1.2	9.1	35.5	28.8
Vizhinjam Harbour (L1)	WS-L1-MID-002	02.03.2015 07.00 Hrs	1.6	7.3	34.6	28.8
Vizhinjam Harbour (L1)	WS-L1-BOT-003	02.03.2015 07.00 Hrs	1.1	8.0	34.9	28.8
Vizhinjam Harbour (L1)	WS-L1-SUR-004	02.03.2015 08.00 Hrs	1.1	6.8	35.1	28.8
Vizhinjam Harbour (L1)	WS-L1-MID-005	02.03.2015 08.00 Hrs	1.8	9.3	35.0	28.8
Vizhinjam Harbour (L1)	WS-L1-BOT-006	02.03.2015 08.00 Hrs	1.1	6.4	35.2	28.8
Vizhinjam Harbour (L1)	WS-L1-SUR-007	02.03.2015 09.00 Hrs	1.6	7.8	35.2	28.8
Vizhinjam Harbour (L1)	WS-L1-MID-008	02.03.2015 09.00 Hrs	2.1	8.6	34.8	28.8
Vizhinjam Harbour (L1)	WS-L1-BOT-009	02.03.2015 09.00 Hrs	2.0	11.3	35.0	28.8
Vizhinjam Harbour (L1)	WS-L1-SUR-010	02.03.2015 10.00 Hrs	1.2	8.4	35.5	28.8
Vizhinjam Harbour (L1)	WS-L1-MID-011	02.03.2015 10.00 Hrs	1.3	9.0	34.3	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-012	02.03.2015 10.00 Hrs	2.5	10.6	34.8	28.7
Vizhinjam Harbour (L1)	WS-L1-SUR-013	02.03.2015 11.00 Hrs	0.9	10.6	35.0	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-014	02.03.2015 11.00 Hrs	1.1	3.9	35.0	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-015	02.03.2015 11.00 Hrs	1.2	5.4	35.1	28.7

For and on behalf of
Standard^{s} Environmental & Analytical Laboratories

Authorized Signatory

End of Report

Standard^{S} Environmental & Analytical Laboratories
'B' Grade Laboratory - Approved by Kerala State Pollution Control Board
K.J. Tower (above SBI Eloor Branch), Kuttikattukara P.O., Udyogamandal, Ernakulam - 683 501
Tel: 0484-2546660, 93 87 27 24 02, E-mail: seaalab@gmail.com

Standard^{S}
Environmental Monitoring

TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R305

Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (^{O}C)
Vizhinjam Harbour (L1)	WS-L1-SUR-016	02.03.2015 12.00 Hrs	1.6	8.2	35.0	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-017	02.03.2015 12.00 Hrs	2.2	12.1	35.5	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-018	02.03.2015 12.00 Hrs	3.8	15.4	35.0	28.7
Vizhinjam Harbour (L1)	WS-L1-SUR-019	02.03.2015 13.00 Hrs	1.5	8.6	35.1	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-020	02.03.2015 13.00 Hrs	1.2	7.9	35.0	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-021	02.03.2015 13.00 Hrs	1.3	10.8	35.5	28.7
Vizhinjam Harbour (L1)	WS-L1-SUR-022	02.03.2015 14.00 Hrs	1.4	9.6	35.3	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-023	02.03.2015 14.00 Hrs	1.6	8.4	34.6	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-024	02.03.2015 14.00 Hrs	2.5	12.6	34.8	28.7
Vizhinjam Harbour (L1)	WS-L1-SUR-025	02.03.2015 15.00 Hrs	1.8	8.8	35.2	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-026	02.03.2015 15.00 Hrs	2.2	11.8	35.2	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-027	02.03.2015 15.00 Hrs	1.9	8.2	35.3	28.7
Vizhinjam Harbour (L1)	WS-L1-SUR-028	02.03.2015 16.00 Hrs	1.4	7.8	35.5	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-029	02.03.2015 16.00 Hrs	2.5	10.0	35.6	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-030	02.03.2015 16.00 Hrs	3.2	14.8	35.9	28.7
Vizhinjam Harbour (L1)	WS-L1-SUR-031	02.03.2015 17.00 Hrs	1.9	7.8	35.4	28.7
Vizhinjam Harbour (L1)	WS-L1-MID-032	02.03.2015 17.00 Hrs	1.4	9.6	35.0	28.7
Vizhinjam Harbour (L1)	WS-L1-BOT-033	02.03.2015 17.00 Hrs	3.2	15.2	35.1	28.7

For and on behalf of
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TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R306

Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (^{O}C)
Pachallor (L2)	WS-L2-SUR-034	03.03.2015 07.00 Hrs	2.7	13.8	35.3	28.0
Pachallor (L2)	WS-L2-MID-035	03.03.2015 07.00 Hrs	3.1	16.0	35.7	28.0
Pachallor (L2)	WS-L2-BOT-036	03.03.2015 07.00 Hrs	1.1	8.6	35.2	28.0
Pachallor (L2)	WS-L2-SUR-037	03.03.2015 08.00 Hrs	1.8	7.4	35.5	28.0
Pachallor (L2)	WS-L2-MID-038	03.03.2015 08.00 Hrs	1.2	6.2	35.7	28.0
Pachallor (L2)	WS-L2-BOT-039	03.03.2015 08.00 Hrs	1.3	8.9	35.7	28.1
Pachallor (L2)	WS-L2-SUR-040	03.03.2015 09.00 Hrs	1.8	11.0	35.7	28.1
Pachallor (L2)	WS-L2-MID-041	03.03.2015 09.00 Hrs	1.6	7.9	35.6	28.1
Pachallor (L2)	WS-L2-BOT-042	03.03.2015 09.00 Hrs	2.2	12.6	35.2	28.1
Pachallor (L2)	WS-L2-SUR-043	03.03.2015 10.00 Hrs	2.9	10.8	35.2	28.1
Pachallor (L2)	WS-L2-MID-044	03.03.2015 10.00 Hrs	2.5	9.7	35.5	28.1
Pachallor (L2)	WS-L2-BOT-045	03.03.2015 10.00 Hrs	2.7	14.6	35.5	28.2
Pachallor (L2)	WS-L2-SUR-046	03.03.2015 11.00 Hrs	2.8	10.9	35.1	28.2
Pachallor (L2)	WS-L2-MID-047	03.03.2015 11.00 Hrs	1.1	7.8	35.6	28.2
Pachallor (L2)	WS-L2-BOT-048	03.03.2015 11.00 Hrs	3.1	14.4	35.5	28.3

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For and on behalf of
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End of Report

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Standard^{S}
Environmental Monitoring

TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R307 Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (^{O}C)
Pachallor (L2)	WS-L2-SUR-049	03.03.2015 12.00 Hrs	1.5	6.8	35.7	28.3
Pachallor (L2)	WS-L2-MID-050	03.03.2015 12.00 Hrs	1.1	5.9	36.1	28.4
Pachallor (L2)	WS-L2-BOT-051	03.03.2015 12.00 Hrs	2.8	7.2	35.6	28.4
Pachallor (L2)	WS-L2-SUR-052	03.03.2015 13.00 Hrs	0.7	2.8	35.4	28.4
Pachallor (L2)	WS-L2-MID-053	03.03.2015 13.00 Hrs	1.2	9.6	35.2	28.4
Pachallor (L2)	WS-L2-BOT-054	03.03.2015 13.00 Hrs	0.7	3.8	35.8	28.4
Pachallor (L2)	WS-L2-SUR-055	03.03.2015 14.00 Hrs	1.8	4.8	35.7	28.4
Pachallor (L2)	WS-L2-MID-056	03.03.2015 14.00 Hrs	1.1	4.0	36.0	28.4
Pachallor (L2)	WS-L2-BOT-057	03.03.2015 14.00 Hrs	0.7	3.0	25.9	28.4
Pachallor (L2)	WS-L2-SUR-058	03.03.2015 15.00 Hrs	1.5	6.8	35.4	28.4
Pachallor (L2)	WS-L2-MID-059	03.03.2015 15.00 Hrs	0.8	5.1	36.2	28.4
Pachallor (L2)	WS-L2-BOT-060	03.03.2015 15.00 Hrs	0.8	4.8	36.3	28.4
Pachallor (L2)	WS-L2-SUR-061	03.03.2015 16.00 Hrs	3.2	6.4	36.0	28.4
Pachallor (L2)	WS-L2-MID-062	03.03.2015 16.00 Hrs	1.4	5.2	36.0	28.4
Pachallor (L2)	WS-L2-BOT-063	03.03.2015 16.00 Hrs	0.7	2.8	35.9	28.4
Pachallor (L2)	WS-L2-SUR-064	03.03.2015 17.00 Hrs	1.4	3.6	35.9	28.4
Pachallor (L2)	WS-L2-MID-065	03.03.2015 17.00 Hrs	0.5	2.9	36.2	28.4
Pachallor (L2)	WS-L2-BOT-066	03.03.2015 17.00 Hrs	2.1	3.6	36.2	28.4

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TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R308 Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (°C)
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-067	08.03.2015 07.00 Hrs	1.1	4.2	36.1	28.0
DrudgeDumping/Kovalam (L3)	WS-L3-MID-068	08.03.2015 07.00 Hrs	3.6	11.2	36.1	28.0
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-069	08.03.2015 07.00 Hrs	0.8	2.2	36.0	28.0
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-070	08.03.2015 08.00 Hrs	0.9	1.8	35.9	28.0
DrudgeDumping/Kovalam (L3)	WS-L3-MID-071	08.03.2015 08.00 Hrs	3.1	12.4	35.3	28.1
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-072	08.03.2015 08.00 Hrs	2.1	7.6	35.6	28.1
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-073	08.03.2015 09.00 Hrs	2.0	7.2	35.6	28.2
DrudgeDumping/Kovalam (L3)	WS-L3-MID-074	08.03.2015 09.00 Hrs	1.8	6.4	35.5	28.1
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-075	08.03.2015 09.00 Hrs	2.3	13.0	35.8	28.1
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-076	08.03.2015 10.00 Hrs	0.9	2.8	35.5	28.1
DrudgeDumping/Kovalam (L3)	WS-L3-MID-077	08.03.2015 10.00 Hrs	1.5	5.2	35.5	28.1
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-078	08.03.2015 10.00 Hrs	1.0	3.6	35.5	28.2
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-079	08.03.2015 11.00 Hrs	0.6	2.0	36.1	28.2
DrudgeDumping/Kovalam (L3)	WS-L3-MID-080	08.03.2015 11.00 Hrs	0.7	2.0	35.7	28.2
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-081	08.03.2015 11.00 Hrs	0.8	1.9	35.5	28.2



For and on behalf of
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End of Report

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Environmental Monitoring

TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R309

Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (^{O}C)
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-082	08.03.2015 12.00 Hrs	1.7	3.1	35.5	28.3
DrudgeDumping/Kovalam (L3)	WS-L3-MID-083	08.03.2015 12.00 Hrs	1.8	2.8	35.4	28.3
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-084	08.03.2015 12.00 Hrs	1.4	2.9	35.6	28.4
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-085	08.03.2015 13.00 Hrs	1.1	2.3	35.6	28.4
DrudgeDumping/Kovalam (L3)	WS-L3-MID-086	08.03.2015 13.00 Hrs	0.8	2.1	35.8	28.4
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-087	08.03.2015 13.00 Hrs	2.1	3.2	35.9	28.5
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-088	08.03.2015 14.00 Hrs	0.9	2.2	35.8	28.5
DrudgeDumping/Kovalam (L3)	WS-L3-MID-089	08.03.2015 14.00 Hrs	1.5	3.5	36.0	28.5
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-090	08.03.2015 14.00 Hrs	0.9	2.1	36.4	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-091	08.03.2015 15.00 Hrs	0.9	2.9	36.0	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-MID-092	08.03.2015 15.00 Hrs	1.8	6.8	36.0	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-093	08.03.2015 15.00 Hrs	1.7	9.7	36.0	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-094	08.03.2015 16.00 Hrs	0.7	4.0	36.0	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-MID-095	08.03.2015 16.00 Hrs	1.3	6.8	36.1	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-096	08.03.2015 16.00 Hrs	1.3	8.2	36.1	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-SUR-097	08.03.2015 17.00 Hrs	3.0	13.6	36.5	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-MID-098	08.03.2015 17.00 Hrs	2.0	10.8	36.5	28.6
DrudgeDumping/Kovalam (L3)	WS-L3-BOT-099	08.03.2015 17.00 Hrs	1.5	9.8	36.5	28.6

For and on behalf of
Standard^{s} Environmental & Analytical Laboratories

Authorized Signatory

End of Report

Standard^{S} Environmental & Analytical Laboratories
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Standards
Environmental Monitoring

TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R310

Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (°C)
Poovar (L4)	WS-L4-SUR-100	11.03.2015 07.00 Hrs	0.7	4.3	36.0	28.2
Poovar (L4)	WS-L4-MID-101	11.03.2015 07.00 Hrs	1.1	7.6	34.3	28.2
Poovar (L4)	WS-L4-BOT-102	11.03.2015 07.00 Hrs	1.9	11.0	34.5	28.1
Poovar (L4)	WS-L4-SUR-103	11.03.2015 08.00 Hrs	1.1	8.0	34.6	28.1
Poovar (L4)	WS-L4-MID-104	11.03.2015 08.00 Hrs	0.9	6.0	34.8	28.2
Poovar (L4)	WS-L4-BOT-105	11.03.2015 08.00 Hrs	1.5	8.0	34.6	28.3
Poovar (L4)	WS-L4-SUR-106	11.03.2015 09.00 Hrs	1.4	7.8	34.7	28.3
Poovar (L4)	WS-L4-MID-107	11.03.2015 09.00 Hrs	0.9	6.4	34.6	28.4
Poovar (L4)	WS-L4-BOT-108	11.03.2015 09.00 Hrs	0.6	4.3	34.6	28.3
Poovar (L4)	WS-L4-SUR-109	11.03.2015 10.00 Hrs	0.7	5.1	34.7	28.3
Poovar (L4)	WS-L4-MID-110	11.03.2015 10.00 Hrs	0.9	6.3	34.5	28.4
Poovar (L4)	WS-L4-BOT-111	11.03.2015 10.00 Hrs	1.5	8.4	35.0	28.4
Poovar (L4)	WS-L4-SUR-112	11.03.2015 11.00 Hrs	1.2	7.8	34.8	28.4
Poovar (L4)	WS-L4-MID-113	11.03.2015 11.00 Hrs	0.9	6.3	34.9	28.4
Poovar (L4)	WS-L4-BOT-114	11.03.2015 11.00 Hrs	1.9	8.0	34.9	28.4

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For and on behalf of
Standards Environmental & Analytical Laboratories

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End of Report

Standard^{S}
Environmental Monitoring

TEST REPORT

TEST CERTIFICATE NO: SEANN/1503/R311

Date: 31.03.2015

Customer Name & Address		M/s Ocean Science & Surveying (P) Ltd Railway Station Complex, CBD Belapur, Navi Mumbai.	
Sampling Site	Proposed Vizhinjam Port	Sample Drawn by	Customer
Description of Sample	Water	Date of Analysis Started	26.03.2015
Date of Sample Received	25.03.2015	Date of Analysis Completed	31.03.2015

Location	Sample Name	Date	Parameters			
			Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (‰)	Temperature (^{O}C)
Poovar (L4)	WS-L4-SUR-115	11.03.2015 12.00 Hrs	0.9	7.1	34.8	28.4
Poovar (L4)	WS-L4-MID-116	11.03.2015 12.00 Hrs	0.8	4.8	35.0	28.4
Poovar (L4)	WS-L4-BOT-117	11.03.2015 12.00 Hrs	1.2	8.6	34.8	28.4
Poovar (L4)	WS-L4-SUR-118	11.03.2015 13.00 Hrs	1.7	9.6	34.6	28.4
Poovar (L4)	WS-L4-MID-119	11.03.2015 13.00 Hrs	1.1	3.9	34.6	28.4
Poovar (L4)	WS-L4-BOT-120	11.03.2015 13.00 Hrs	2.5	12.0	34.6	28.3
Poovar (L4)	WS-L4-SUR-121	11.03.2015 14.00 Hrs	1.1	6.0	34.7	28.3
Poovar (L4)	WS-L4-MID-122	11.03.2015 14.00 Hrs	1.5	7.8	35.0	28.3
Poovar (L4)	WS-L4-BOT-123	11.03.2015 14.00 Hrs	2.6	9.0	35.2	28.3
Poovar (L4)	WS-L4-SUR-124	11.03.2015 15.00 Hrs	1.1	7.6	35.0	28.3
Poovar (L4)	WS-L4-MID-125	11.03.2015 15.00 Hrs	1.4	7.4	35.0	28.3
Poovar (L4)	WS-L4-BOT-126	11.03.2015 15.00 Hrs	3.1	11.8	35.0	28.3
Poovar (L4)	WS-L4-SUR-127	11.03.2015 16.00 Hrs	1.1	3.6	35.0	28.2
Poovar (L4)	WS-L4-MID-128	11.03.2015 16.00 Hrs	0.9	3.2	35.0	28.2
Poovar (L4)	WS-L4-BOT-129	11.03.2015 16.00 Hrs	2.1	8.2	35.0	28.3
Poovar (L4)	WS-L4-SUR-130	11.03.2015 17.00 Hrs	1.8	5.4	35.4	28.3
Poovar (L4)	WS-L4-MID-131	11.03.2015 17.00 Hrs	2.2	6.3	35.4	28.3
Poovar (L4)	WS-L4-BOT-132	11.03.2015 17.00 Hrs	2.6	7.6	35.2	28.3

For and on behalf of
Standard^{s} Environmental & Analytical Laboratories

Authorized Signatory

End of Report

Standard^{S} Environmental & Analytical Laboratories
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