



**INSTITUT PENYELIDIKAN AIR KEBANGSAAN MALAYSIA
(NAHRIM)**

**PENCERAPAN DAN PERSAMPELAN DATA MARIN UNTUK
KAJIAN PERUBAHAN MORFOLOGI PELABUHAN TERPILIH
DI SEMENANJUNG MALAYSIA**

NO. KONTRAK: QT240000000005424

LAPORAN AKHIR

Prepared by,

Ir. Ts. Muhammad Rizal Razali

05 September 2024

Project Description

Contract No. : LA240000000019123
Contract Period : 19 June – 18 December 2024
Contract Value : RM223,300.00
Bon Value : RM5,582.50 (Maybank)

Contract Breakdown Cost;

Bil	Perkara	Bayaran Pertama (RM)	Bayaran Kedua (RM)	Bayaran Ketiga (RM)
1	Perkhidmatan ukur batimetri untuk kawasan pesisiran pantai Pelabuhan yang dipilih meliputi jarak liputan data sepanjang 20 km sepanjang pesisir pantai dan 3 km ke laut dalam kawasan pelabuhan dan pesisir pantai berhampiran Pelabuhan Kemaman, terengganu Survey setup: i. Ares of survey covered: 20km x 3km approximately 60 km ² ii. Average water depth: 6-12m iii. Interval transect lines: 50m / 100m / 200m iv. Total survey lines: (80+50+40) lines	49,000.00	22,400.00	-
2	Perkhidmatan sokongan logistik kerja-kerja pengendalian, pemasangan, pemantauan dan aktiviti pengambilan semula 2 unit peralatan Acoustic Wave and Current Profiler (AWAC) dimiliki NAHRIM di Seri Kembangan untuk tempoh pemasangan selama 30 hari di dasar laut pesisir pantai Pelabuhan Kemaman.	-	-	33,000.00
3	Perkhidmatan mencerap data parameter kualiti air di Pesisir pantai Pelabuhan Kemaman secara insitu. - Cerapan Data Kemasinan, pH dan Jumlah Pepejal Terampai (TSS) pada setiap 2 kedalaman berbeza (top & bottom) pada setiap stesen untuk 20 stesen di sepanjang 20km pesisir pantai pelabuhan Kemaman.	-	-	29,400.00
4	Perkhidmatan mengambil sampel sedimen dasar laut bagi 20 stesen seperti yang dinyatakan pada item 3 di pesisir Pantai Pelabuhan Kemaman. a) 20 Sampel sedimen dasar laut pada kedalaman antara 6-12m	-	-	12,500.00
5	Perkhidmatan analisis makmal bagi sampel sedimen dasar laut (Grab Sample) seperti yang dinyatakan pada item 4. Sampel dihantar ke makmal (makmal yang telah diakreditasi/mempunyai pensijilan bagi perkhidmatan analisis makmal) untuk dianalisis dan keputusan analisis sampel dikemukakan kepada NAHRIM	-	-	5,200.00
6	Perkhidmatan pemetaan permukaan dasar laut dengan kaedah imbasan (Side-scan sonar) bagi mendapatkan morfologi dasar laut termasuk mengesan dan mengenalpasti objek di dasar laut dan mengenalpasti ciri-ciri batimetri di kawasan pelabuhan Kemaman.	40,950.00	17,550.00	-
7	Perkhidmatan memproses data mentah (raw data) - (data processing and filtration); i. Acoustic Wave and Current Profiler (AWAC), ii. Data United Kingdom Meteorological Office (UKMO), Data Royal Malaysian Navy (RMN)/JUPEM termasuk data CMAP	-	-	8,800.00
8	Penyediaan laporan data dalam bentuk softcopy dan hardcopy (3 salinan) dalam format yang diluluskan NAHRIM	-	-	4,500.00
	Jumlah bayaran berperingkat (RM)	89,950.00	39,950.00	93,400.00

Contract Breakdown Cost;

Bil.	Fasa Pembayaran	Tempoh	Jadual Pembayaran	Jumlah (RM)
1	Bayaran Pertama	19 Jun 2024 - 15 Julai 2024	Julai 2024	89,950.00
2	Bayaran Kedua	16 Julai 2024 - 05 Ogos 2024	Ogos 2024	39,950.00
3	Bayaran Ketiga	06 Ogos 2024 - 30 Ogos 2024	September 2024	93,400.00
Jumlah Keseluruhan				223,300.00

1. Introduction

The marine data collection activities were carried out by CNH S/B at Kemaman Port, Terengganu, and the nearshore regions both in the southern and northern parts of the port. The primary purpose of this data collection was to support the development of numerical models for sediment budget and sediment movement analysis. Accurate bathymetric and seabed data are critical for understanding sediment transport dynamics, predicting sediment deposition and erosion patterns, and planning effective sediment management strategies for the port.

2. Scope of Work

The scope of work for the marine data collection activities included:

- Conducting bathymetry surveys using the single beam method.
- Performing side-scan sonar surveys.
- Covering designated areas within Kemaman Port and its nearshore regions.
- Providing comprehensive data for analysis and interpretation to support port development and maintenance.

3. Survey Methodology

3.1 Bathymetry Survey

Date : 11th July – 15th August 2024
Method : Single Beam
Location : Kemaman Port and nearshore areas (southern and northern regions)

Description: The bathymetry survey aimed to map the underwater topography of Kemaman Port and its adjacent nearshore regions. The single beam method was used to measure water depths and identify underwater features to ensure safe navigation and port operation.

Single Beam Bathymetry for Coastal Bed Profiling

Single beam bathymetry is an essential technique used for coastal bed profiling, involving the use of a Single Beam Echo Sounder (SBES) to measure water depths and map the underwater topography. The SBES operates by emitting a sound pulse directly downwards and measuring the time it takes for the pulse to travel to the seabed and back to the receiver. This time measurement is then converted into a depth reading. The main components involved in single beam bathymetry include the echo sounder, transducer, GPS, motion sensor, data logger, and processing software. The echo sounder generates and receives acoustic signals, while the transducer converts these signals to and from acoustic waves. The GPS provides precise location data for each depth measurement, and the motion sensor accounts for the vessel's pitch, roll, and heave. The data logger records depth and positional data, and the software processes and visualizes the collected data.

The methodology of single beam bathymetry begins with preparation, including equipment calibration, pre-survey planning to define survey lines and coverage areas, and verification of GPS accuracy as shown in Figure 1. During data acquisition, the vessel follows predefined survey lines while the echo sounder continuously emits sound pulses. Depth data is collected along with GPS coordinates as shown in Figure 2 to Figure 5, and motion sensors adjust for vessel movement to ensure accurate readings. Data processing involves correcting raw data for sound speed variations in water, filtering noise, and cleaning the data, followed by integrating depth data with positional information. Finally, data analysis and mapping generate bathymetric charts, identify underwater features and hazards, and analyse seabed morphology. All the activities in this survey works as shown in Figure 6.



Figure 1. Survey areas covering in Port area, south and northern side of Kemaman Port

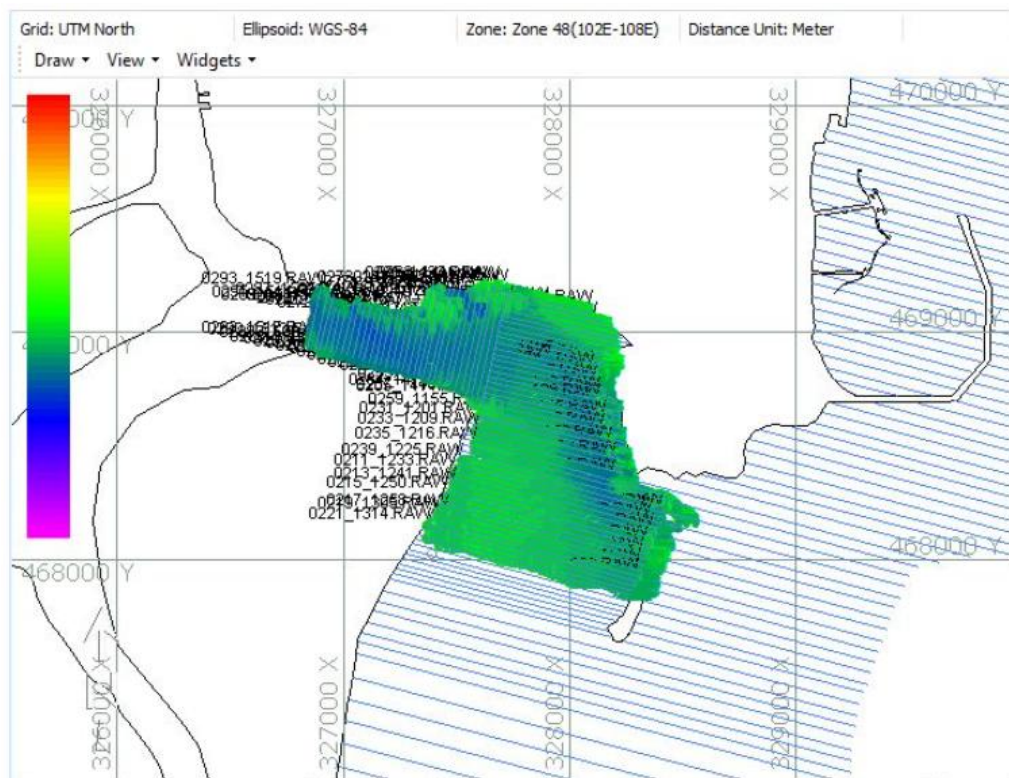


Figure 2. Bathymetry part 1

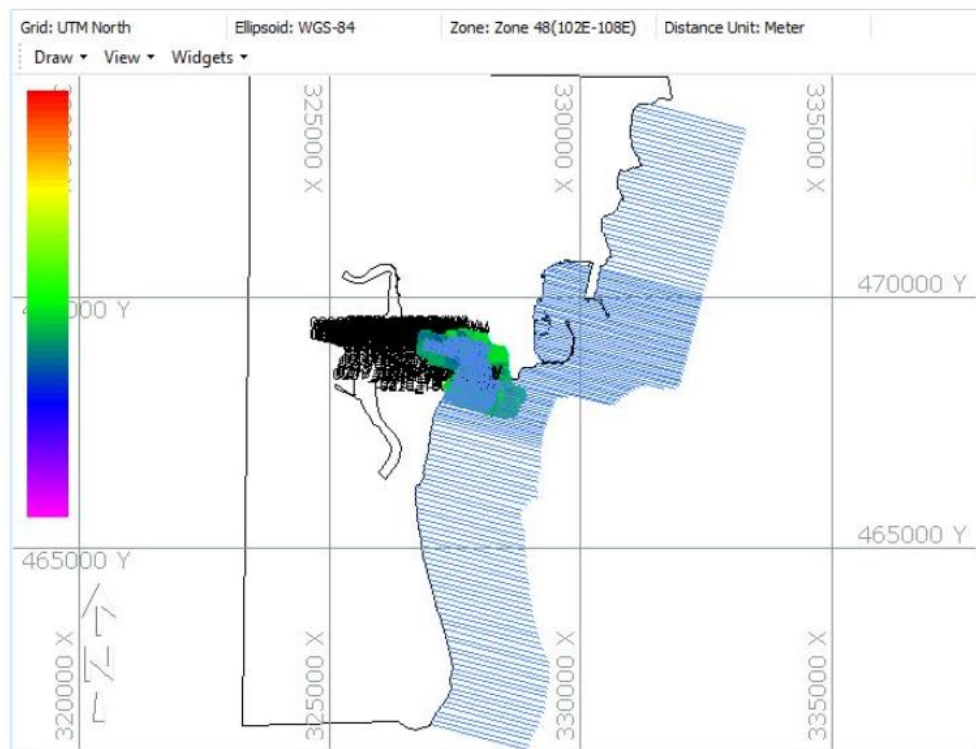


Figure 3. Bathymetry part 1 zoom out

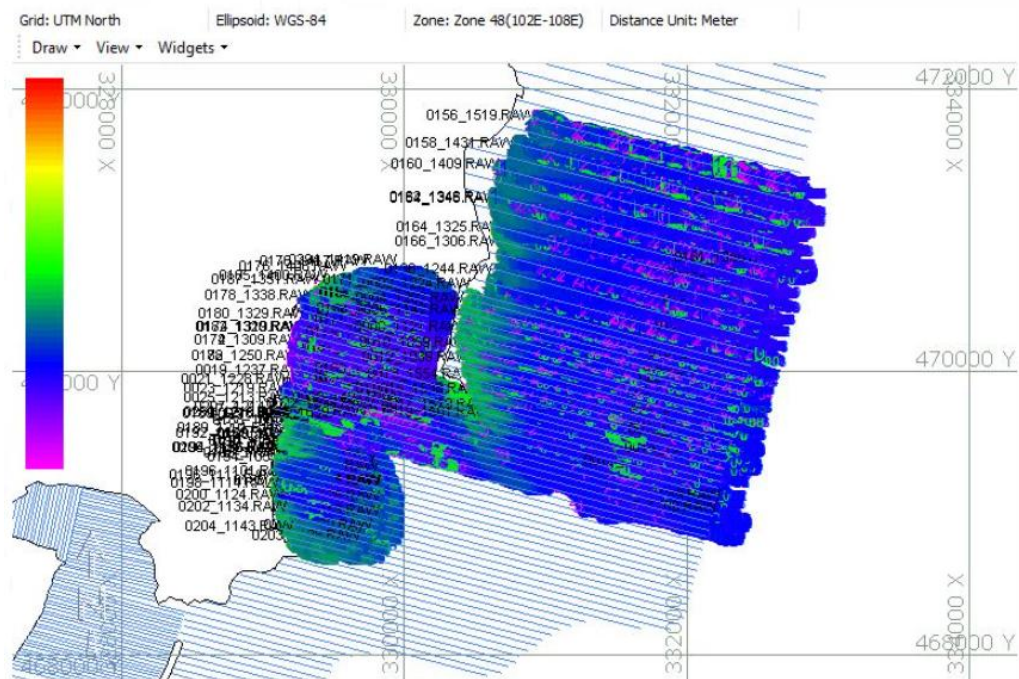


Figure 4. Bathymetry part 2

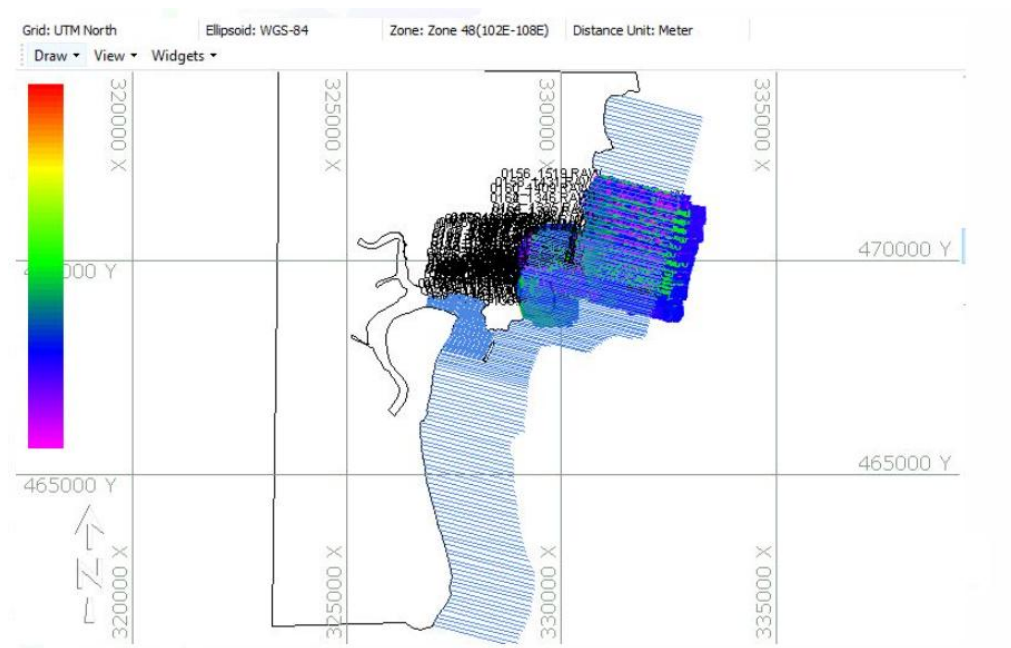


Figure 5. Bathymetry part 2 zoom out



Figure 6. Bathymetry survey setup

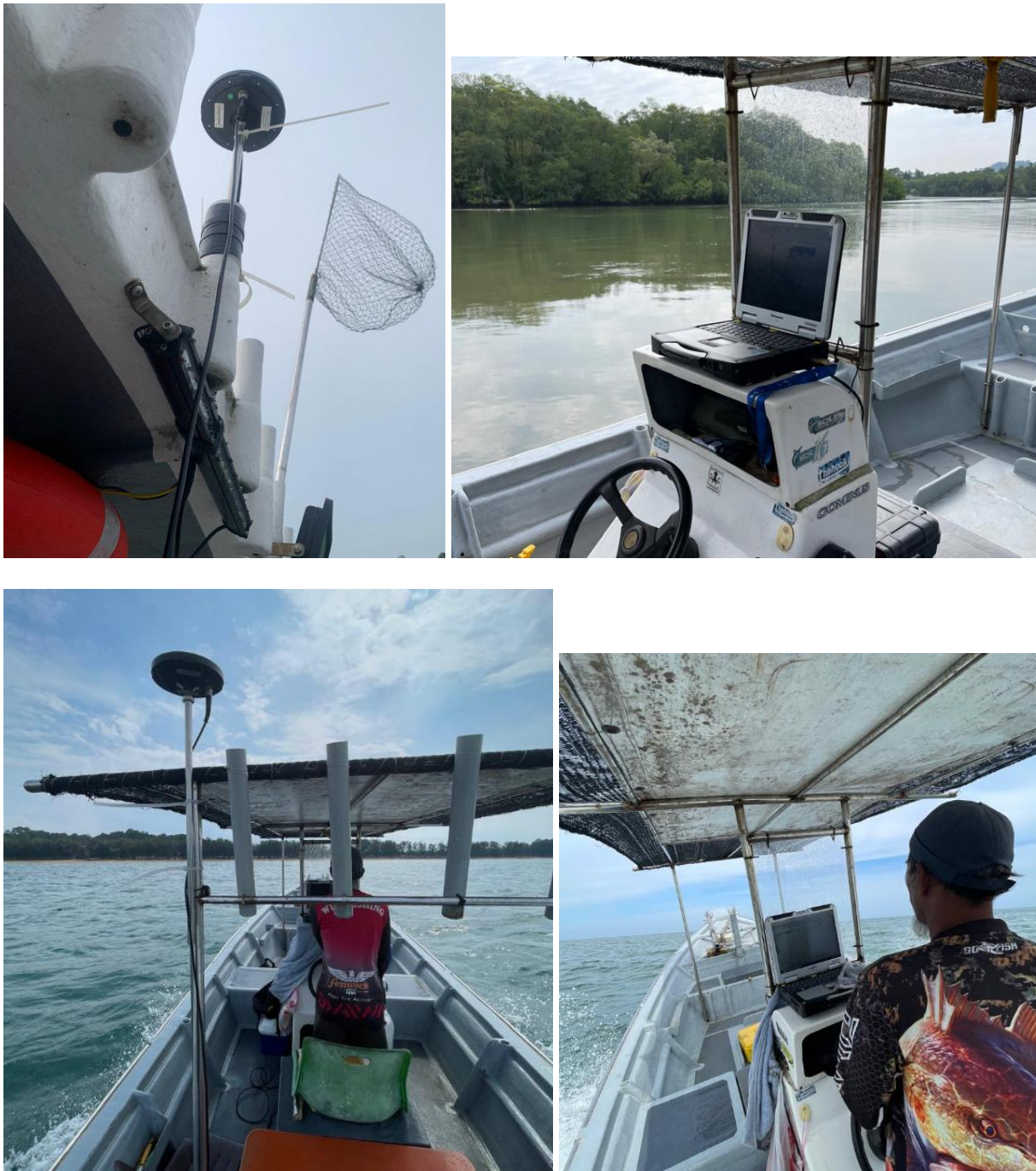


Figure 7. Bathymetry survey

Significance in Coastal Hydraulic Studies and Numerical Modelling

Bathymetry works are significant for safe navigation, port operations, coastal hydraulic studies, numerical modelling on sediment budget, and dredging activities. Accurate bathymetric data aids in hazard identification, preventing groundings and assisting in route planning for safe and efficient navigation. For port operations, it ensures sufficient depth at berths for docking vessels and guides the construction and maintenance of port structures. In coastal hydraulic studies,

bathymetric data is crucial for simulating water movement, wave propagation, and tidal flows, understanding sediment dynamics and deposition patterns, and assessing flood risk from storm surges and sea level rise.

Numerical modelling on sediment budget relies on bathymetric data to identify areas of erosion and accretion, determine dredging requirements, and assess the environmental impact of sediment distribution. Accurate depth data helps plan and execute dredging operations effectively, estimate the volume of material to be removed, and ensure compliance with environmental regulations. In conclusion, single beam bathymetry is a vital technique in coastal bed profiling, providing essential data for safe navigation, port operations, and coastal management. The information gathered supports hydraulic studies, numerical modelling, and dredging activities, contributing to the sustainable development and maintenance of coastal and port environments.

3.2 Side-Scan Sonar Survey

Date : 5th July – 15th August 2024
Method : Side-Scan Sonar
Location : Kemaman Port and nearshore areas (southern and northern regions)

Description: The side-scan sonar survey was conducted to capture detailed images of the seafloor. This method provides high-resolution images of underwater objects, seabed textures, and potential obstructions, which are crucial for navigation safety and port maintenance.

From the 5th July to the 15th of August 2024, a side-scan sonar survey was conducted at Kemaman Port and its nearshore areas, including both the southern and northern regions. The primary objective of this survey was to capture detailed images of the seafloor to support navigation safety and port maintenance. Side-scan sonar is an advanced imaging technique that uses acoustic pulses emitted from a transducer mounted on either a tow fish or the hull of a vessel. These pulses reflect off the seabed and underwater objects, and the returning echoes are processed to create high-resolution images of the seafloor. The key components involved in this survey included the tow fish or hull-mounted transducer, sonar processor, GPS, motion sensor, data logger, and imaging software. The survey process involved careful preparation, including equipment calibration and planning of survey lines. During data acquisition, the vessel followed predetermined lines while the transducer emitted acoustic pulses, capturing continuous seafloor images. Positional and motion data were recorded to ensure image clarity and accuracy. The raw data was then processed to remove noise, correct for sound speed variations, and geo-reference the images. These images were analysed to identify underwater objects, seabed textures, and potential obstructions.

The study area as approved in the proposal is divided into 2 areas as shown in Figure 1 (Areas A) and Figure 8 (Areas B). Areas A (Figure 8) is in the Kemaman Port area, the survey area covers 1.37 square kilometres and Area B (Figure 9) covers a line of 12 km. The technique of survey, data collection, post processing, accuracy of positioning and sounding adopted in this survey was in accordance with survey standard, and the equipment and software were used on this study as shown in Table 1. This survey takes about 4 days in which equipment setup takes half a day. Boat Noor 2 has been used as a survey boat throughout this camp.



Figure 8. Survey Areas 1 (inside of Kemaman Port Areas)

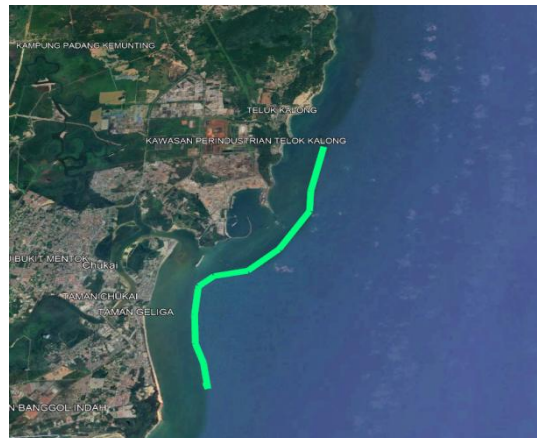


Figure 9. Survey Areas 2 (Long the costal line about approximately 12 km)

Table 1. Equipment and software

Equipment	Model	Description	Quantity
Dual Frequency Side Scan Sonar	Klein, 3900	Klein 3900, Side Scan Sonar (low and High Frequency)	1
Differential Global Positioning System	Trimble Sps351	Navigation and Positioning System Real Time SeaStar DGPS System, World Wide Differential GPS	1
Data Acquisitions Software	Klein TouchBook Panasonic	Data collection	1

HypacMax Survey Software	HypacMax	Navigation	
SonarWiz Map	SonarWitz	Processing and Mosaicking	

Geodetic Information

GPS Satellite Detum: WGS_1984_UTM_Zone_48N & WKID: 32648 Authority: EPSG

Origin of Meridian of reference;

- (i) Projection : Transverse Mercator
- (ii) False Easting : 500000.0
- (iii) False Northing : 0.0
- (iv) Central Meridian : 105.0
- (v) Scale Factor : 0.9996
- (vi) Latitude of Origin: 0.0
- (vii) Linear Unit : Meter (1.0)
- (viii) Geographic Coordinate System: GCS_WGS_1984
- (ix) Angular Unit : Degree (0.0174532925199433)
- (x) Prime Meridian : Greenwich (0.0)
- (xi) Datum : D_WGS_1984
- (xii) Spheroid : WGS_1984
- (xiii) Semimajor Axis: 6378137.0
- (xiv) Semiminor Axis: 6356752.314245179
- (xv) Inverse Flattening: 298.257223563

Material and Method

Determination of Survey Sites using Differential Positioning System (DGPS) and HypacMax Survey Software

In marine survey work, obtaining the best positions is a prerequisite. as DGPS system as shown in Figure 9 was used to plot the survey lines and thus providing better accuracy. SeaSTAR Real-Time Differential Global Positioning System (D-GPS) was used as the positioning and navigation system for the positioning of survey boat as shown in Figure 2. In this project a Trimble Sps 351 system as receiver to track satellite vehicles. D-GPS requires a GPS receiver (called a Reference or Base station) for data collecting from satellites at a precisely surveyed point and at the same time GPS data is observed by the field GPS receiver. Any error in the measurement of each satellite can be calculated at the Reference site and these errors applied as corrections to the field receiver measurements. Services provided like FUGRO has set up a worldwide system of GPS Reference stations. At Malaysia as same as others countries like Australia, Indonesia, a differential correction

is transmitted every second from all Reference stations to the Network Control Centre (NCC) at Perth which operates 24 hours a day, 365 days a year. The corrections are then uploaded to a communication satellite which transmits the correction to users via a demodulating device. Therefore, any GPS receiver able to receiving the standard differential correction format (called RTCM) by simply attaching an Inter-face cable to the SeaSTAR demodulator.

The survey sites, routes and survey area were plotted on digital chart before the survey began. Specialized software “HypacMax” was used to generate transect lines which were superimposed on the nautical chart covering Terengganu coastal waters. The five transect lines generated would effectively covers an area of) when the length of transect lines was set at 50 meter. The survey would then be performed along the transect lines when data were continuously being recorded by the system computer. The data consist of reflection echoes of seabed (covering the area being scanned), the water depth, the track co-ordinates data and other attributes associated with the objects and seabed detected.



Figure 9. Trimble Sps 351 DGPS used in survey

Mapping and Scanning of ARs Using Side Scan Sonar (SSS)

The SSS system, which can process the seabed data in real time, would then display the seabed images of the area surveyed as shown in Figure 10. These data were recorded for playback and for detail analysis at later date. A DGPS unit was interfaced to the computer to provide the position co-ordinates when the side and bottom looking transducer is towed at a certain speed behind a boat at a specified depth. In this survey, the speed of tow varied between 3- 5 knots. The depth of transducer was varied between 3-10 meters below the water surface depending on the depth of seabed/artificial and range of swath data. The basic principal of SSS operation as shown in Figure 4.



Figure 10. Klein 3900 model used in survey

In this survey, range of sonar was used at high frequency 500Khz and swath range 50meter port and starboard side. SSS operates on the principle that sound impulses transmitted underwater produce echoes or reflections from objects and materials on the bottom of the sea, which vary in intensity based, in large part, on the density of the material. This varying of intensity produces light and dark areas on the record called backscatter. The side scan system produces a continuous acoustic backscatter record of the sea bottom along the survey track line. The side scan data were collected with navigation using a Klein Acquisition software as a data acquisition system.



Figure 11. Side scan sonar route survey

The SonarWiz.map was used as a post-processing software to analyst geo-reference, corrected the distortion and assembled side-by-side to produce a mosaic images. A survey software employed on a laptop received the DGPS signals and calculated the offset and layback distances between the side scan transducer and the DGPS antenna. Additional computer monitor was provided to the skipper to show the vessel's position, speed and the transect lines to be followed during the survey. The vessels' track lines were also recorded by the computer.

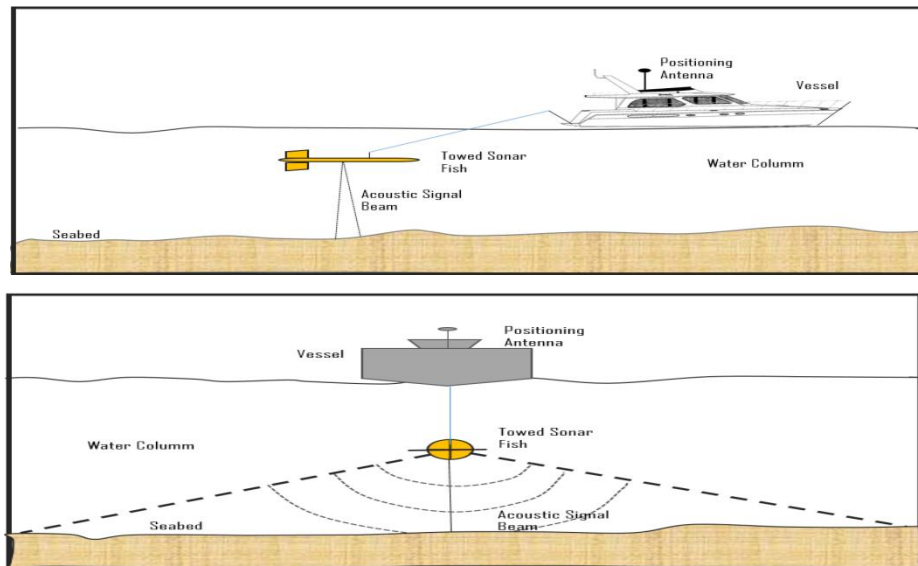


Figure 12. Basic principal of Side Scan Sonar Operation

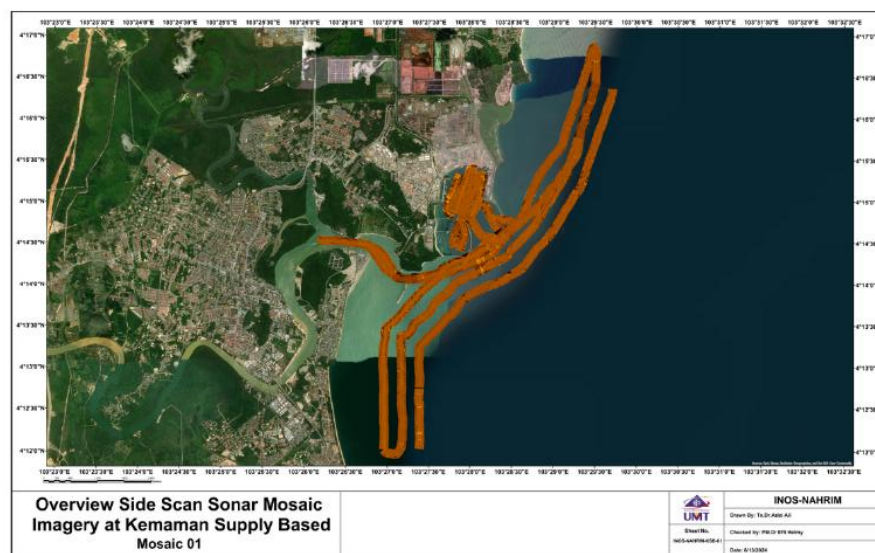


Figure 13. Overview side scan sonar mosaic imagery

Side Scan Sonar Survey Results

Mapping of the seabed in the Kemaman area has been successfully carried out in Areas B. Image sonargraphy shows (Figure 14) the image and surface shape of the seabed obtained from sonar imagery. It involves analysis of classification object on sonargraphy data which has a high percentage of the various objects that need to be verification and correction their position. In general, the image of the seabed in this area is coarse sand and flat areas. Image A, B and C are enlarged images of the seabed in the study area Figure 8.

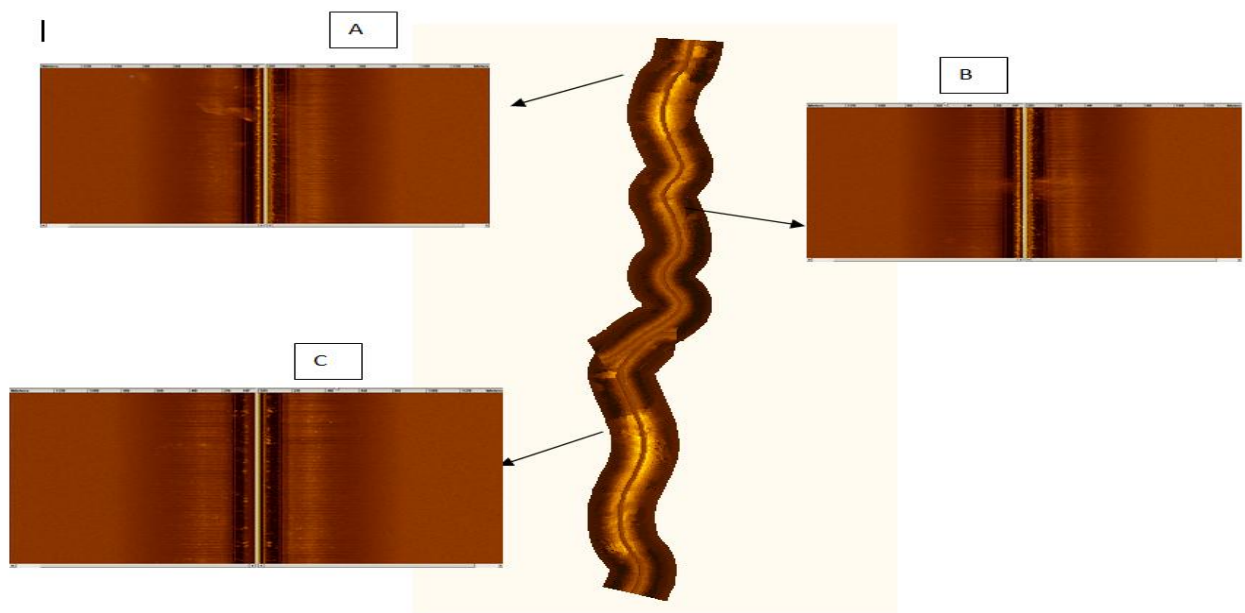


Figure 14. Result of seabed imagery at location (Areas B) from sonargraphy

The significance of the side-scan sonar survey lies in its ability to enhance navigation safety by identifying underwater hazards and aiding in route planning. For port maintenance, it provides detailed images of underwater port structures, aiding in their inspection and repair, and supports dredging operations by identifying areas requiring attention and monitoring compliance with depth requirements. Furthermore, side-scan sonar assists in environmental monitoring by mapping marine habitats and analysing sediment types and distributions, which contribute to sediment management plans.



Figure 15. Seabed imagery data processing at Kemaman River Estuary

In coastal management, the data supports erosion and deposition studies and informs the design of coastal engineering projects. In conclusion, the side-scan sonar survey at Kemaman Port provided essential high-resolution seafloor images that are crucial for ensuring safe navigation, effective port maintenance, and informed coastal and environmental management. Data collected from both surveys were processed and analysed to create detailed maps and reports. The bathymetry data were used to produce depth charts, while the side-scan sonar images were analysed to identify and classify underwater features.

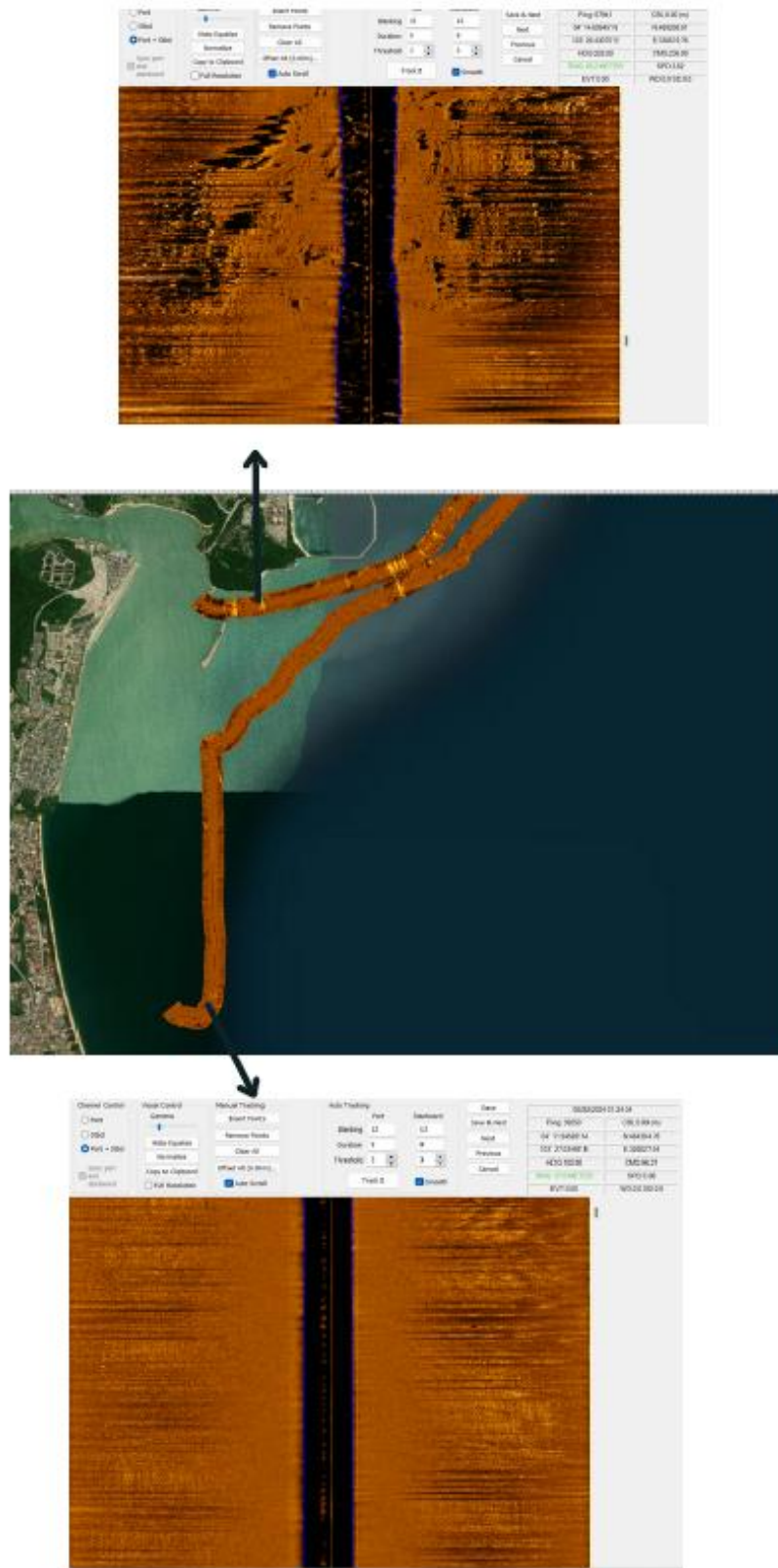


Figure 16. Seabed imagery data processing front of Kemaman estuary and Port area

3.3 Current speed and wave measurement

Date Deployment: AWAC STN1 (near Pantai Telok Kalong) (13th July – 26th August 2024)
AWAC STN2 (near Pantai Telok Mak Nik) (13th July – 26th August 2024)

The Acoustic Wave and Current Profiler (AWAC) model was used to measure current and wave parameter at the study area. The AWAC is a small and lightweight profiler that used in the coastal area and river to retrieve the current profiles at each layer of water depth and also the wave parameter at the surface. The AWAC has several variants but the main function is almost same for all models. The main component of the AWAC include the sensor head and other components such as electronic module, compass, internal batter, power and communication cable. The sensor head contains three acoustic transducers which are tilt sensor, temperature sensor and pressure sensor. The type of AWAC used during data collection program was shown in Figure 17.



Figure 17. Model of AWAC by Nortek AS

The AWAC is one of the variant of ADCP current profilers. The main function of ADCP itself is almost same for all models. The main component of the ADCP included the sensor head and other components such as electronic module, compass, internal battery and power & communication cable. The sensor head contains three acoustic transducers which are tilt sensor, temperature sensor and pressure sensor. The main part of the ADCP was shown in Figure 18.

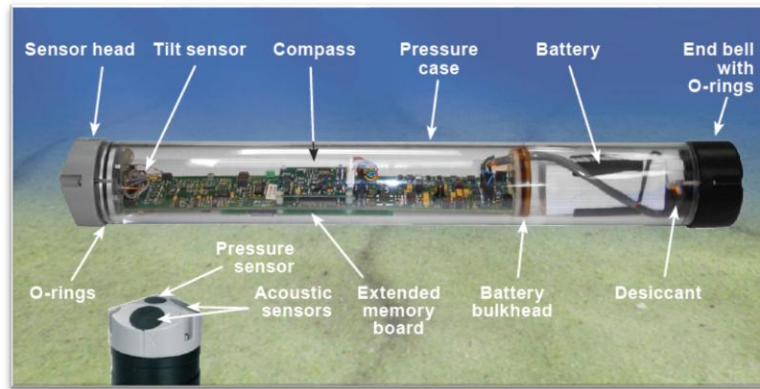


Figure 18. Main Part of ADCP

Before the deployment stage, AWAC were mounted separately to a customized dome frame before being lowered into the seabed. The dome frame act as an anti-throttle to ensure the stability and safety of AWAC from the strong current at the seabed. To ensure AWAC was lowered down properly, it was roped at each side of the frame before the deployment process. NAHRIM's divers used to check the placement of AWAC in the water to ensure that it was properly deployed on the seabed. GPS positions and water depth were taken at each deployment location for AWAC marking and retrieval exercised. The current measurement was performed by two AWACs from 13th July to 26th August 2024. The AWAC were deployed for 45 days covering both neap and spring tide phase (2 cycle) and fulfilled as required by DID's guideline. The detail position and interval data for each AWACs is shown in Table 2.

Table 2: Detail Location, Interval and Depth for AWAC

Station	Latitude (°N)	Longitude (°E)	First Data	End Data	Days	Interval	Depth (m)
STN 1	4.278389	103.487635	13 th Jul. 2024 11:00 am	26 th Aug. 2024 11:00 am	45	10 mins	14.02m + 0.5m
STN 2	4.196428	103.459415	13 th Jul. 2024 12:00 am	13 th Aug. 2024 10:40 am	32	10 mins	11.8m + 0.5m

Figure 18. Main Part of ADCP

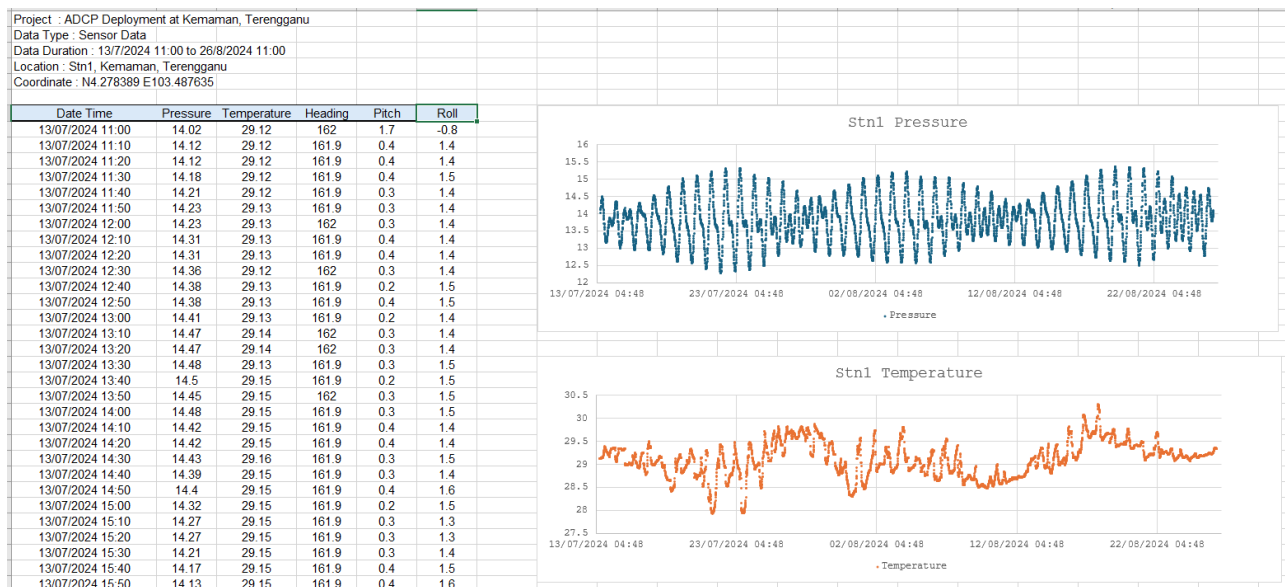


Figure 19. ADCP Sensor Data STN1

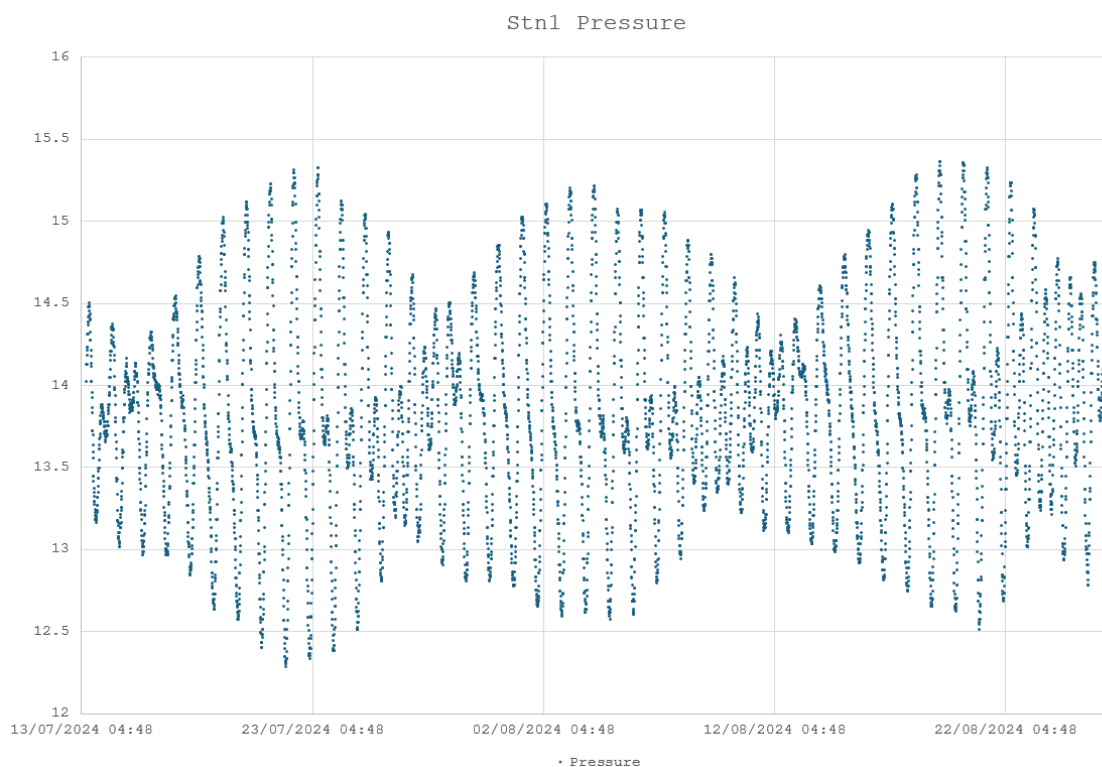


Figure 20. Pressure STN1

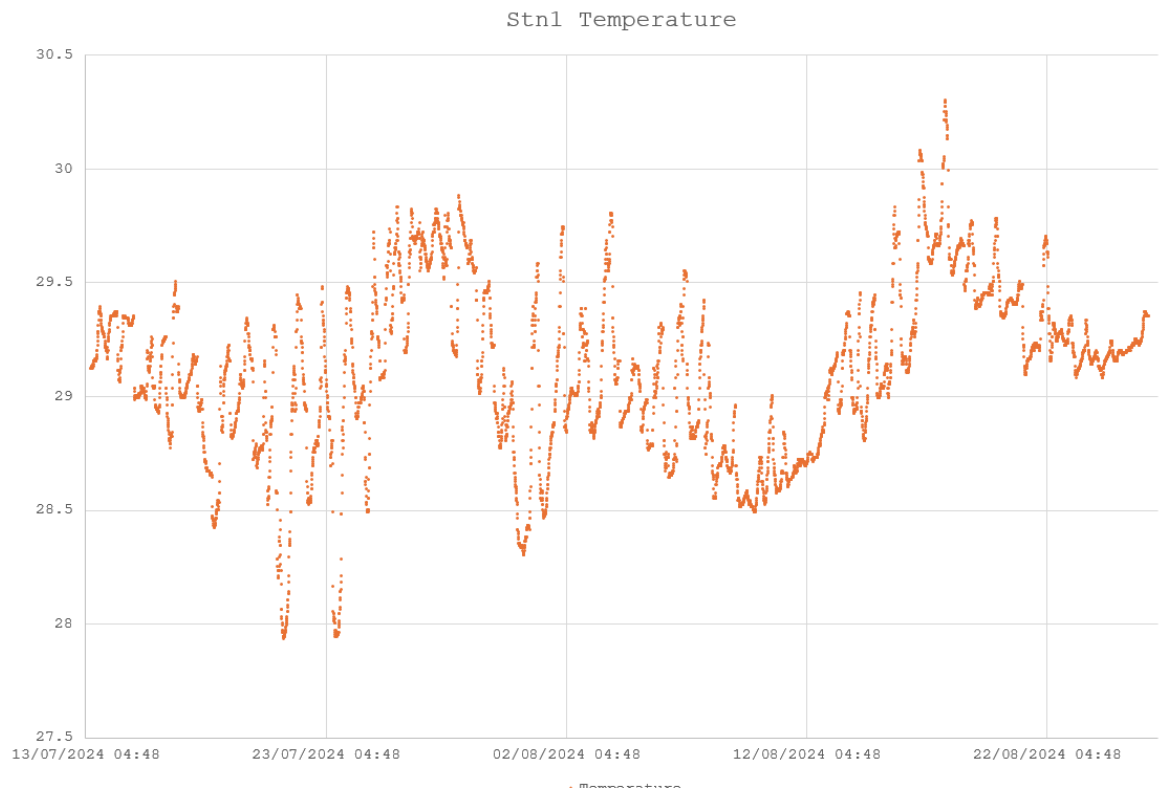


Figure 21. Temperature STN1

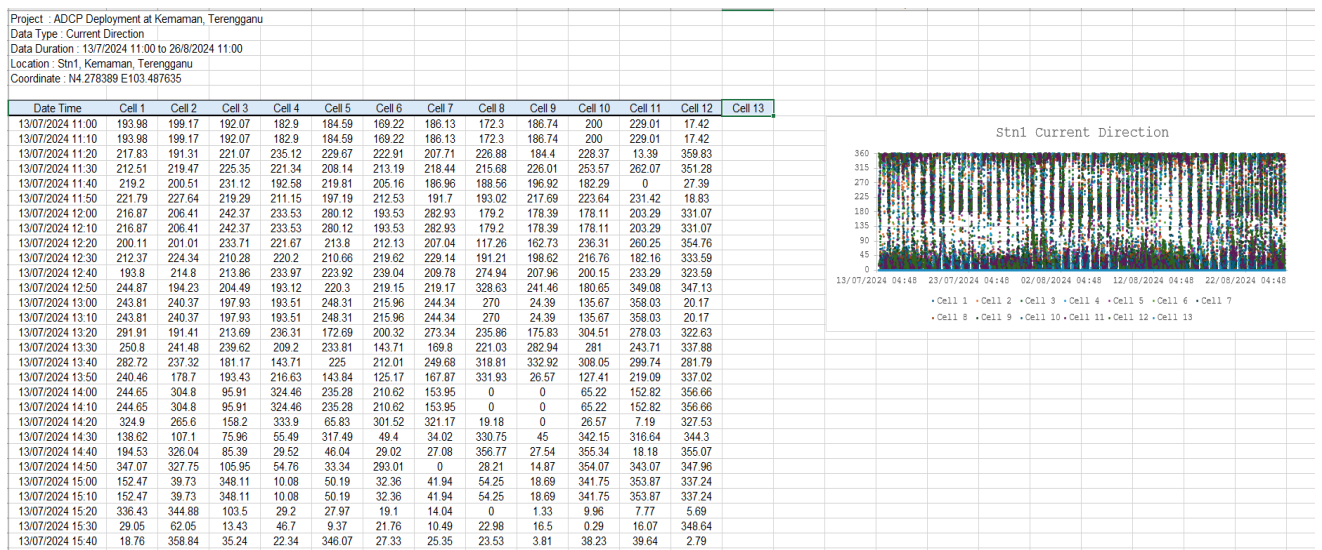


Figure 22. Current Direction Data STN1

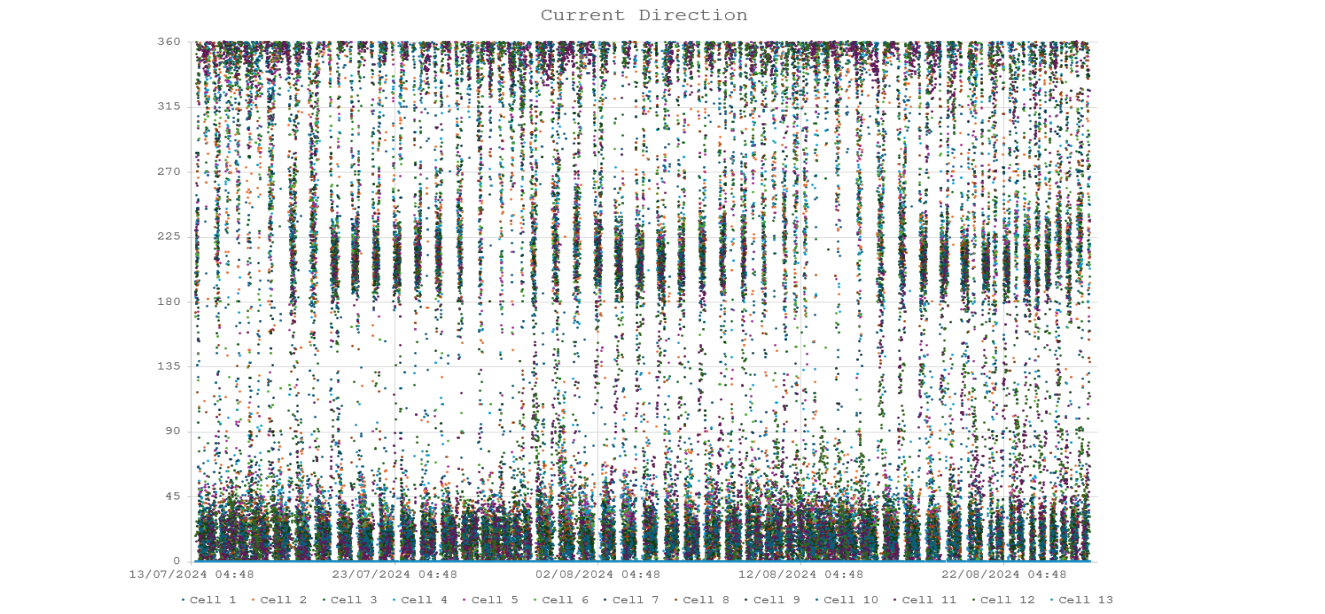


Figure 23. Current Direction STN1

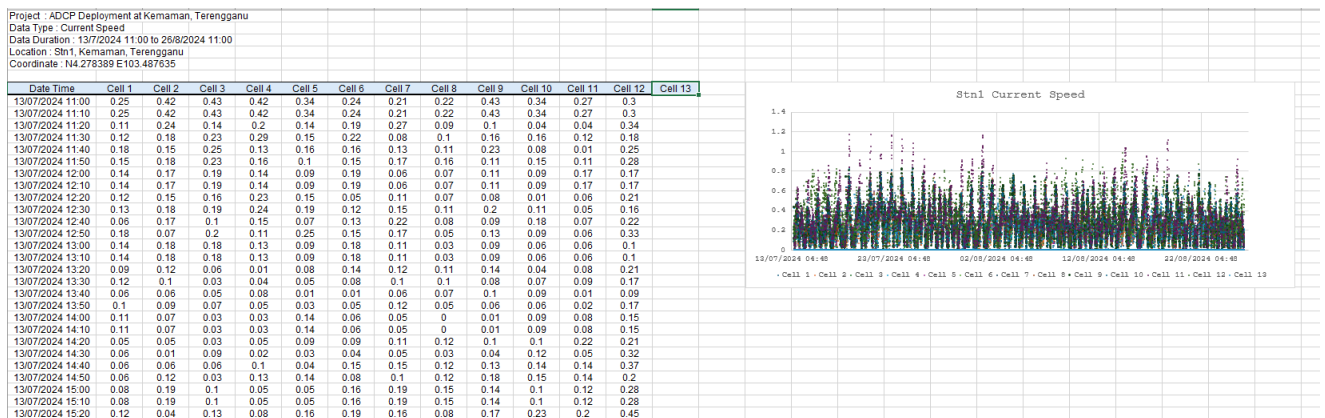


Figure 24. Current Speed Data STN1

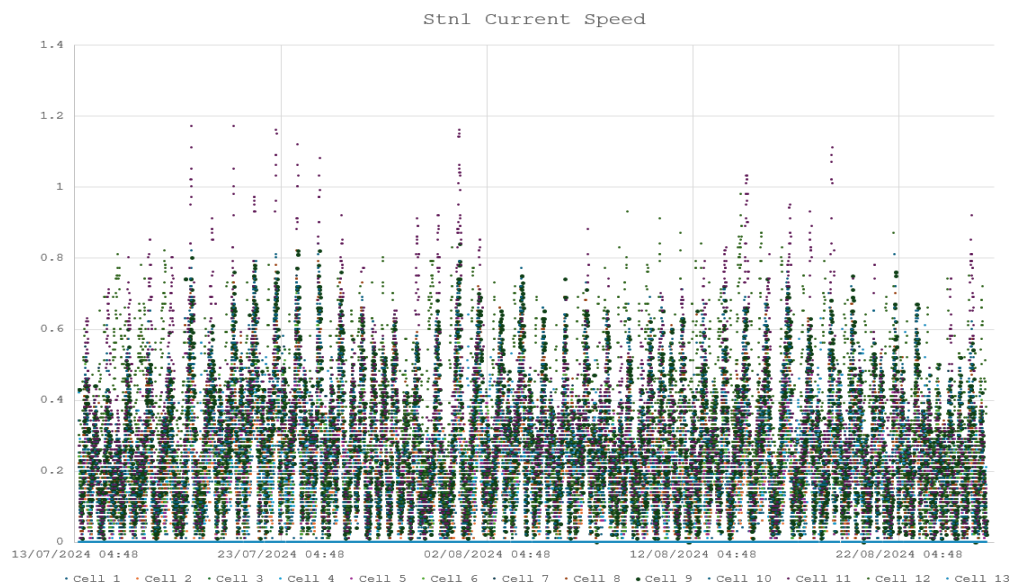


Figure 25. Current Speed STN1

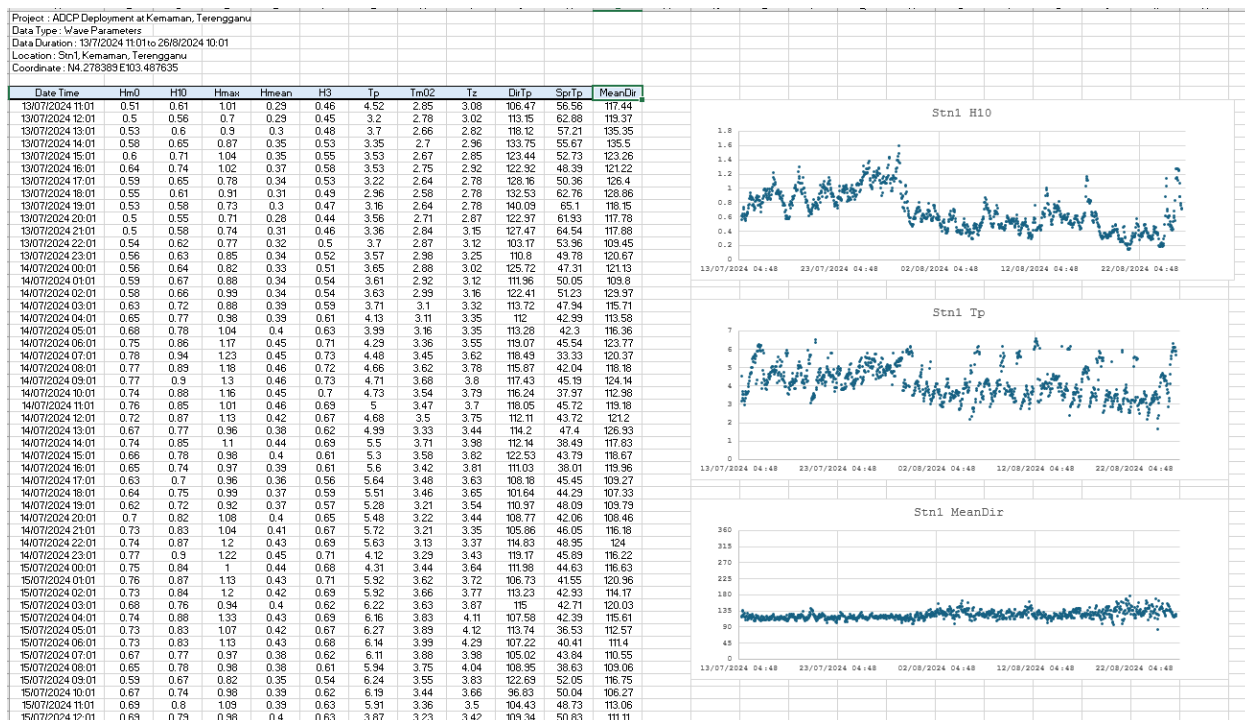


Figure 26. Wave Parameters Data STN1

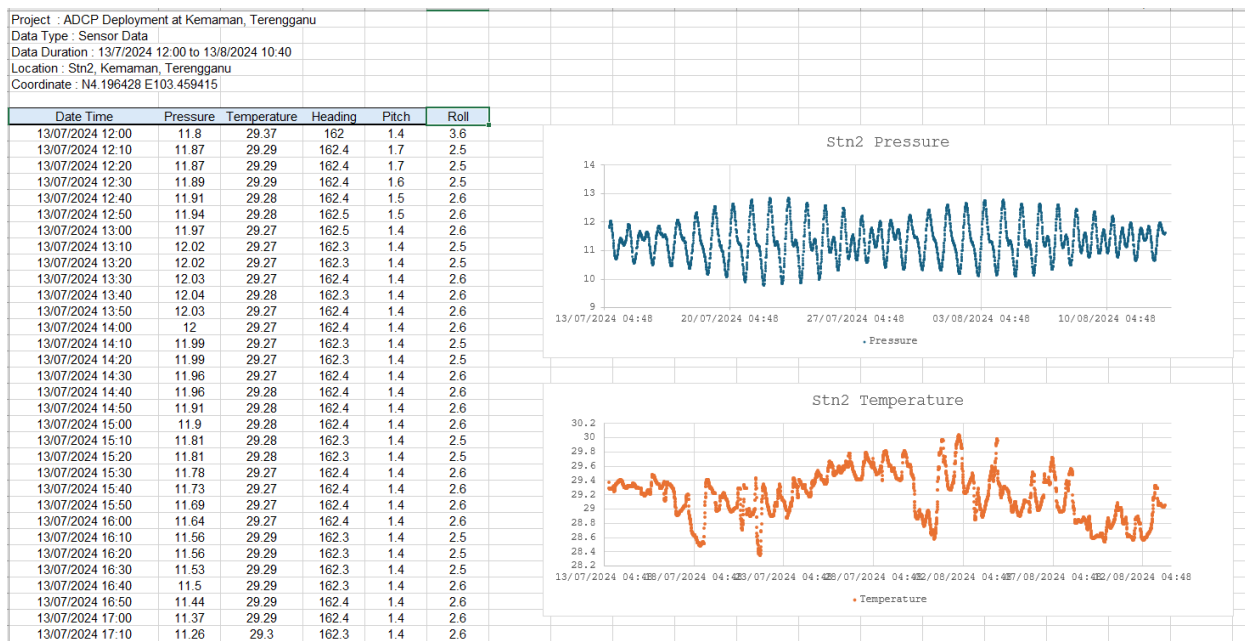


Figure 27. ADCP Sensor Data STN2

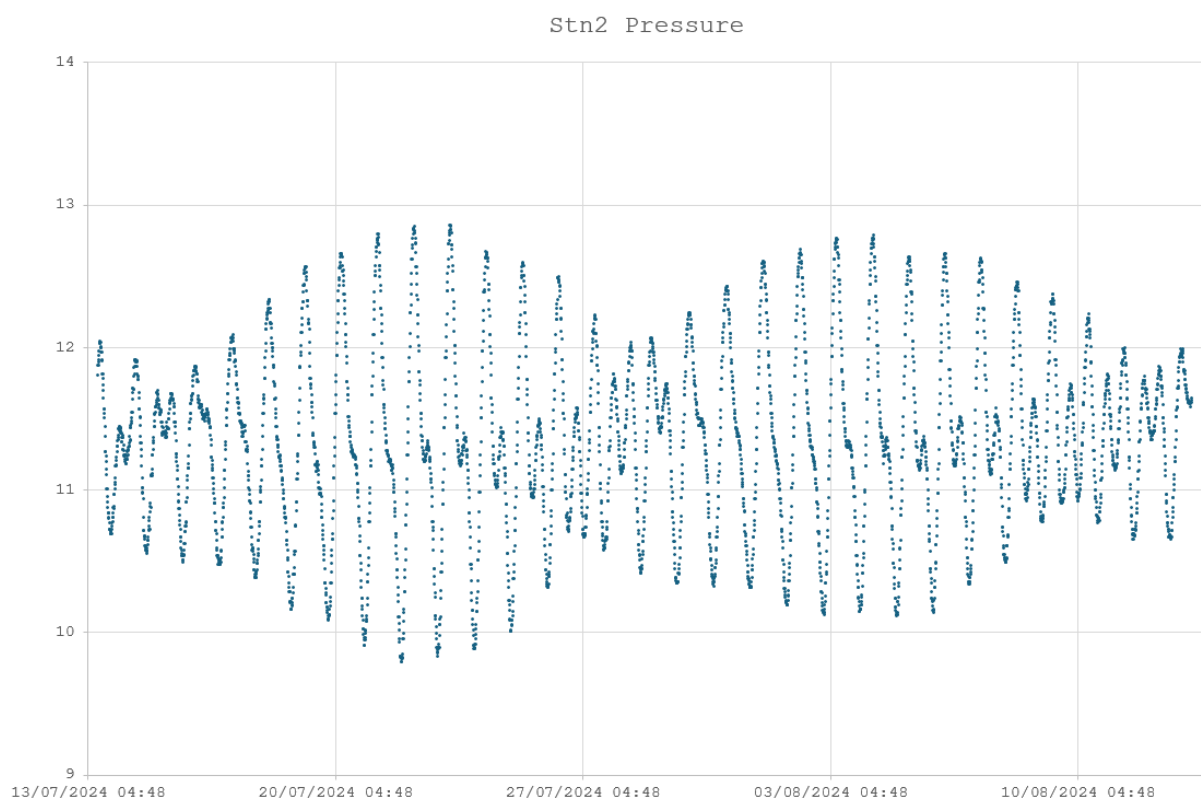


Figure 28. Pressure STN2

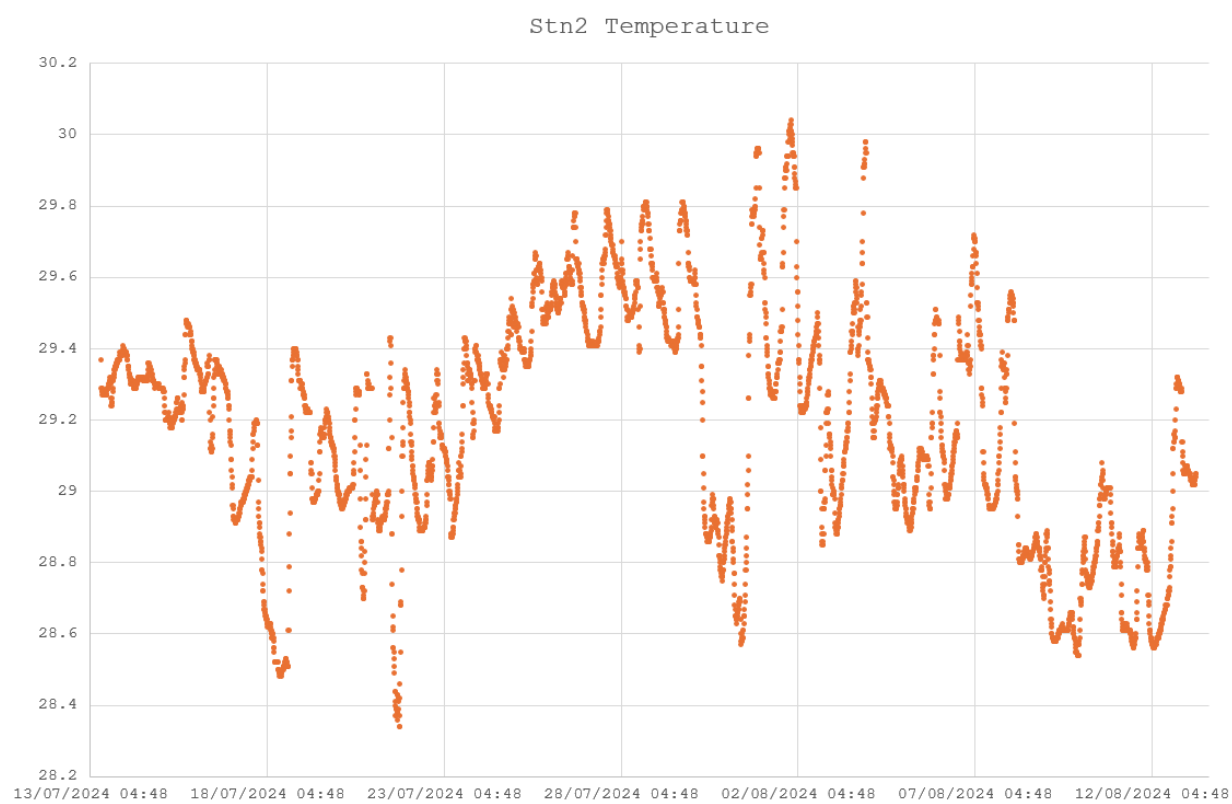


Figure 28. Temperature STN2

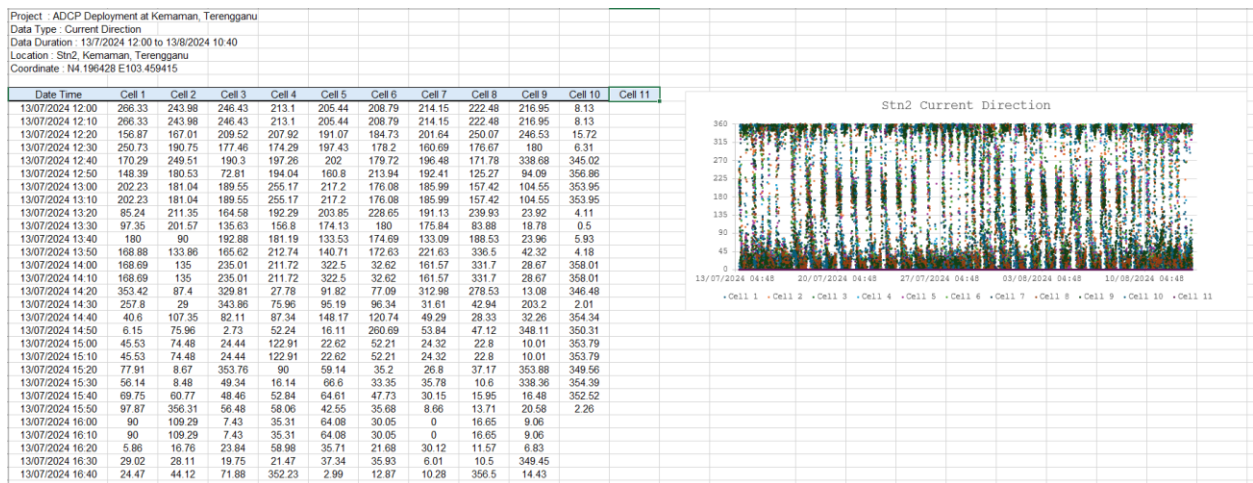


Figure 29. Current Direction Data STN2

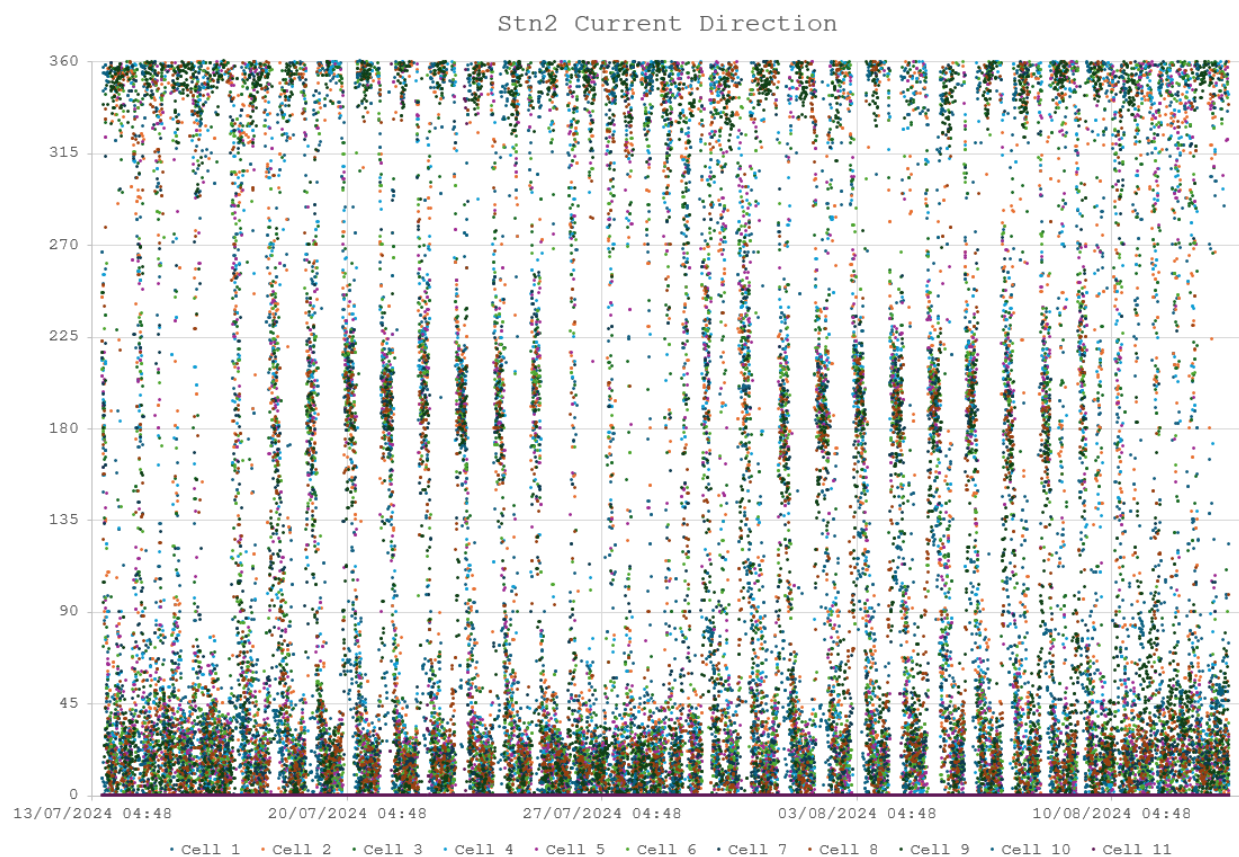


Figure 30. Current Direction STN2

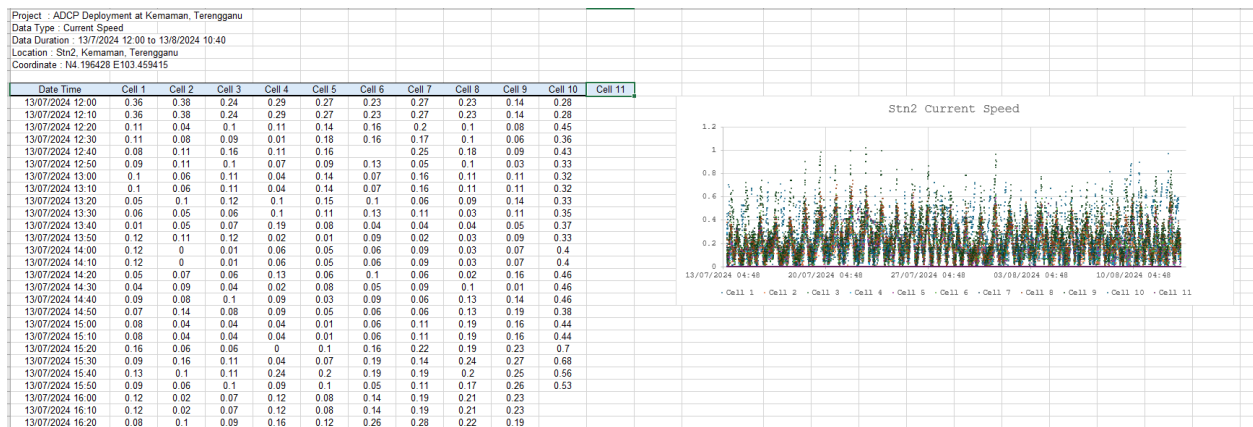


Figure 31. Current Speed Data STN2

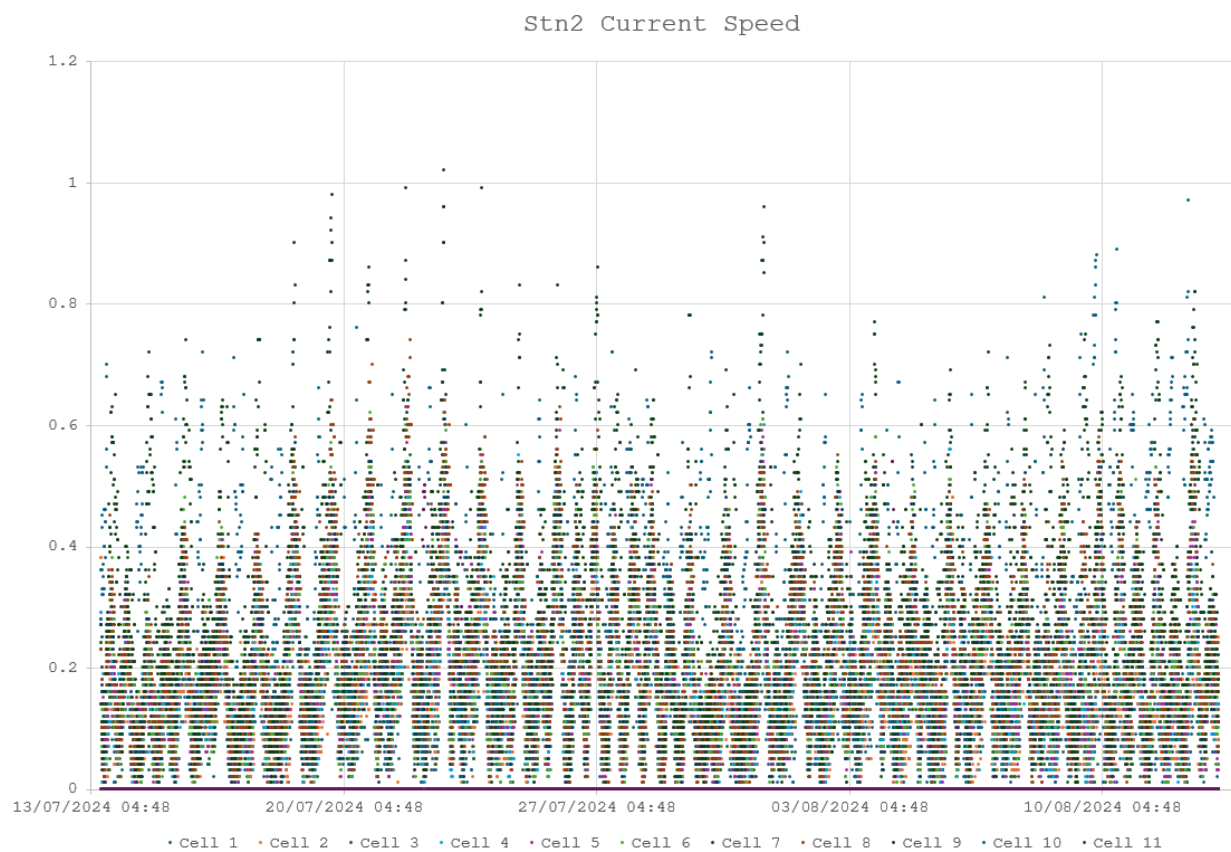


Figure 32. Current Speed STN2

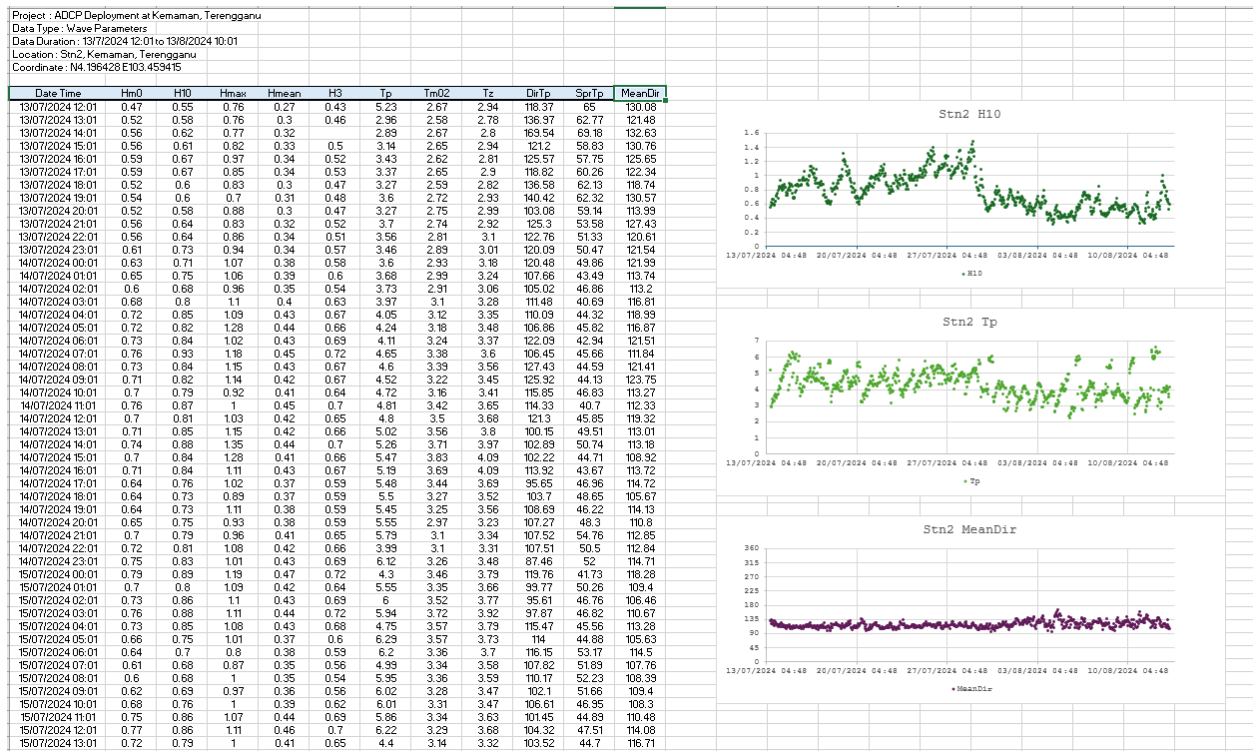


Figure 33. Wave Parameters STN2

3.4 Tidal Elevation

Two units of tide gauge model RBR Solo³ (Figure 34) will be used in this survey and installed at the existing local jetty structure which closed to the proposed study area. This equipment will measure the height of water level covering completed tidal cycle during the deployment period. During the installation, the tide gauge is inserted into a 3 m PVC pipe with the diameter of 1.5 inch before lowered to the bottom water column. The pipe must be placed and tied properly to avoid any disturbance from the wake wave from the boat nearby. It is very important to ensure that the pipes installed will not slide either in horizontal or vertical direction since it can affect the tidal result. The tide gauge then inserted into the pipe column with the head (sensor) facing bottom and the tail is tied upward with the rope. The level of the sensor from the Mean Sea Level (MSL) then measured using Benchmark (BM) as reference. The auto level equipment will be used to fly level from the BM to the sensor. Measurement setting for the tide gauge is set to record at every 10 minutes' interval. The setting up of the tide gauge is necessary to recorded and produce tidal fluctuation occurrence of water level in the unit of pressure which then convert to the depth of water. The recorded tidal data was measured for every 10 minutes for 30 days continuously.

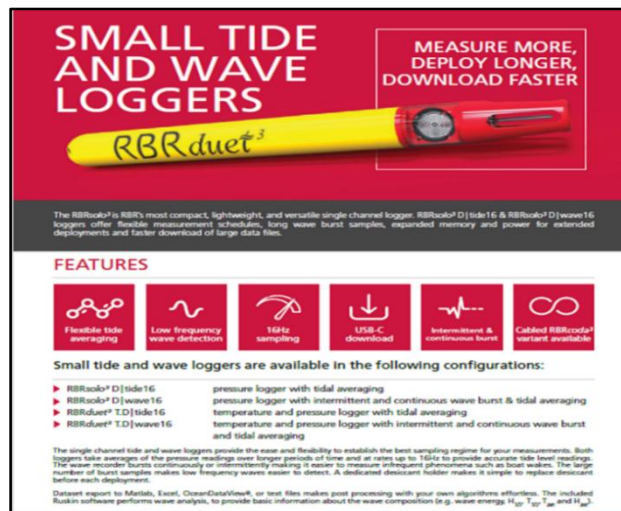


Figure 34. Tide gauge

For tidal data, one unit of tide gauge model RBR Solo³ were used and installed at the existing jetty near to river mouth. This equipment will measure the height of water level covering complete tidal cycle during the deployment period. In addition, NAHRIM was also used tidal elevation measured by both AWACs for the analysis. The AWAC will provide pure tidal data at the offshore and RBR tide gauge will cater the tidal elevation at the river mouth area. Water level data needed for the model calibration as required by DID's guideline and for the bathymetry survey correction. The types of RBR tide gauge used in this survey is shown in figure 35.



Figure 35. RBR Solo3 Used for Measuring Water Level

During the installation process of RBR tide gauge, each tide gauge was inserted into a PVC pipe with the diameter of 1.5 inch before lowered to the water column. The pipe must be placed and tied properly to avoid any disturbance from the wake wave from the boat nearby since the jetty area is active with fishermen boat. It was very important to ensure the stability of the pipes installed since any horizontal or vertical movement of the pipes may defect the water level result. Some small holes created along the pipes to ensure the natural movement of water inside. The tide gauge then inserted into the pipe column with the head (sensor) facing bottom and the tail was tied upward with the rope.

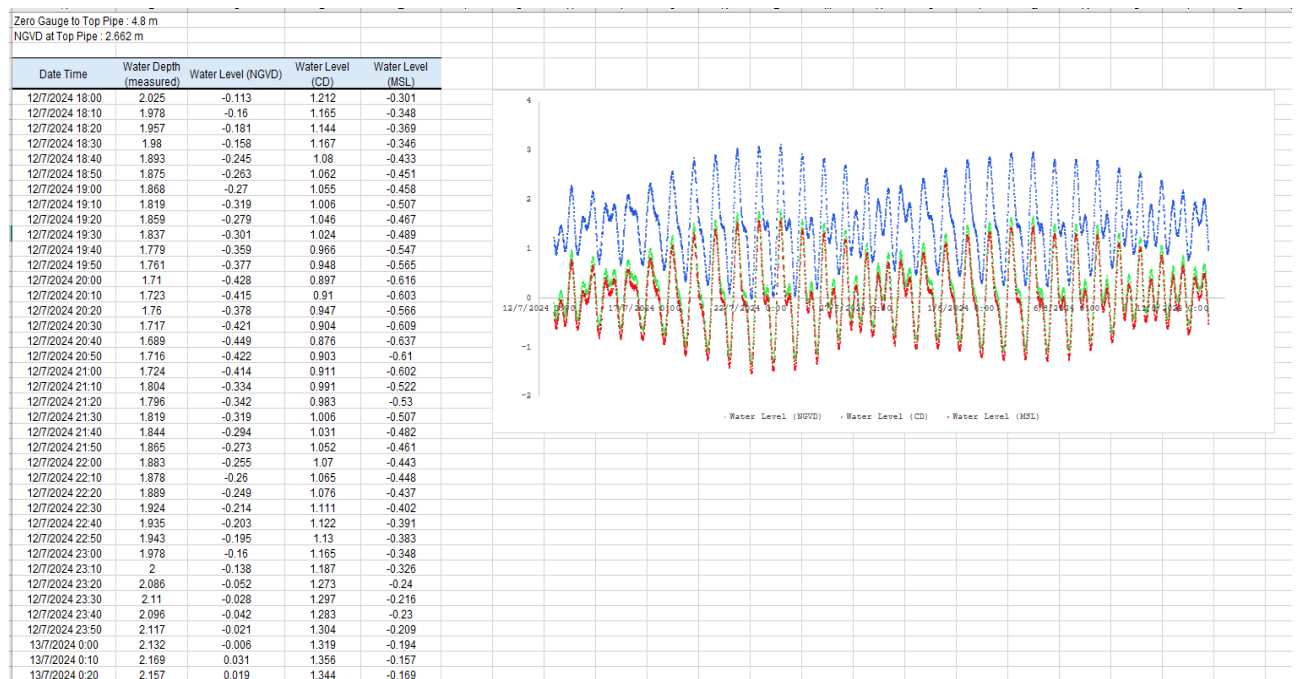


Figure 36. Tidal Elevation data series

3.5 Water Quality

In-situ water quality sampling of temperature, turbidity, salinity, and total suspended solids (TSS) is critical for understanding sediment budgets in nearshore and port areas. Temperature influences water density and circulation, affecting sediment transport patterns. High turbidity and TSS values indicate increased sediment suspension, often linked to dredging, erosion, or riverine inputs, which can influence sediment deposition and movement within the port and nearshore zones. Salinity measurements help distinguish between freshwater and marine sediment sources, which is vital for assessing sediment influx and its impact on the sediment budget. By analysing these parameters, water quality sampling supports the assessment of sediment dynamics, aiding in the management of sediment transport, deposition, and potential accumulation zones in port areas.

2	Location Name = K1						
3	Latitude = N 4.253889						
4	Longitude = E 103.478611						
5	Date & Time	Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (ppt)	pH (pH)	Temperature (°C)	Depth (m)
6	22/8/2024 10:56	0.9764847	0.92766047	31.727182	8.15713	29.571163	10.019356
7	22/8/2024 10:56	0.96152836	0.9134519	31.728733	8.156931	29.56435	10.055255
8	22/8/2024 10:56	1.0942948	1.0395801	31.794136	8.156891	29.74648	1.5473938
9	22/8/2024 10:56	1.094079	1.039375	31.792334	8.15645	29.805904	1.4921232
10							
11							
2	Location Name = K2						
3	Latitude = N 4.248055						
4	Longitude = E 103.479722						
5	Date & Time	Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (ppt)	pH (pH)	Temperature (°C)	Depth (m)
6	22/8/2024 11:00	0.9690094	0.92055887	31.82762	8.1601095	29.376396	10.0991955
7	22/8/2024 11:00	0.9634823	0.9153082	31.826015	8.159898	29.3694	10.191774
8	22/8/2024 11:01	1.1346554	1.0779226	31.899736	8.154408	29.493769	1.5700895
9	22/8/2024 11:01	1.0932796	1.0386156	31.898844	8.157842	29.680344	1.5270388
10							
11							
2	Location Name = K3						
3	Latitude = N 4.244444						
4	Longitude = E 103.475556						
5	Date & Time	Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (ppt)	pH (pH)	Temperature (°C)	Depth (m)
6	22/8/2024 11:05	1.1200018	1.0640017	31.885738	8.157828	29.318466	10.26672
7	22/8/2024 11:05	1.0915439	1.0369724	31.878656	8.15639	29.302713	10.022167
8	22/8/2024 11:06	1.074799	1.021059	31.815763	8.155748	29.587364	1.5787499
9	22/8/2024 11:06	1.0597137	1.006728	31.795523	8.155914	29.601492	1.5700957
10							
11							
2	Location Name = K4						
3	Latitude = N 4.2400000						
4	Longitude = E 103.471944						
5	Date & Time	Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (ppt)	pH (pH)	Temperature (°C)	Depth (m)
6	22/8/2024 11:09	1.6033435	1.5231763	31.911661	8.153053	29.393755	10.105032
7	22/8/2024 11:10	1.3494768	1.2820029	31.914938	8.153888	29.390497	10.0271015
8	22/8/2024 11:10	1.2562705	1.1934569	31.877993	8.145955	29.546972	1.5062758
9	22/8/2024 11:10	1.219285	1.1583208	31.825516	8.149302	29.612303	1.5496385
10							
11							
2	Location Name = K5						
3	Latitude = N 4.235556						
4	Longitude = E 103.467222						
5	Date & Time	Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (ppt)	pH (pH)	Temperature (°C)	Depth (m)
6	22/8/2024 11:25	1.3294319	1.2629603	32.605015	8.185842	29.377043	10.160607
7	22/8/2024 11:25	1.2057377	1.1454507	31.908146	8.162164	29.358686	10.137471
8	22/8/2024 11:26	1.0975051	1.0426298	31.908997	8.157291	29.811327	1.5650933
9	22/8/2024 11:26	1.0484681	0.99604475	31.875708	8.15671	29.871542	1.5322754
10							
11							
2	Location Name = K6						
3	Latitude = N 4.230555						
4	Longitude = E 103.461389						
5	Date & Time	Turbidity (NTU)	Total Suspended Solids (mg/L)	Salinity (ppt)	pH (pH)	Temperature (°C)	Depth (m)
6	22/8/2024 11:32	1.0533011	1.000636	31.895363	8.1625595	29.45739	10.000002
7	22/8/2024 11:32	1.0359987	0.98419875	31.896278	8.162644	29.457232	10.028181
8	22/8/2024 11:32	1.0737674	1.0200791	31.920034	8.159712	29.47901	1.5953058

Figure 37. In-Situ water sampling data

3.6 Sediment size distribution

Sediment samples were collected randomly at different locations within the proposed site and surrounding coastal zone including two samples at AWAC STN1 and AWAC STN2 respectively. This sediment data will be used to determine the properties of the bed layer of the study area which will be used later for the simulation of numerical model. It was also important to determine how much change to the sediment transport by period of time with constructing new structure. Samples were taken by using a Grab Sampler. Surface seabed sampling is the simplest method of collecting topsoil samples within a short period of time; through this method, approximately 10 cm of top sediment was collected using the grabber. The sampling was conducted accordingly to the procedure outlined below;

- a. Log the coordinates of samples stations using a handheld GPS,
- b. Lower the grab vertically to the sea floor from a stationary boat,
- c. Collect and raise the grab above the sea level,
- d. Transfer the samples to airtight bag and sealed,
- e. Send the collected samples to laboratory for grain size distribution analysis (mechanical & hydrometer test), D50, bulk density and dry density, and
- f. The grain size was determined using the BS1377.1900, Part 2 Method 9.2, 9.3 and 9.5 Standard.

Bed sediment samples were collected at 22 different locations within the Pantai Telok Kalong in northern region, Sungai Kemaman estuary area, and Pantai Teluk Mak Nik in southern region. The sampling was done on 22th August 2024 at site by CNH team. These sediment data were used to determine the properties of the bed layer of the study area which later will be used as an input for numerical model simulation. The location of the 22 grab sample locations and its ID were shown in figure 38 (A-C).



Rajah 1: Kawasan mencerap data di perairan bahagian selatan dan hadapan Pelabuhan Kemaman

Label	Koordinat	Label	Koordinat
1	4°15'14"N 103°28'43"E	7	4°13'36"N 103°27'19"E
2	4°14'53"N 103°28'47"E	8	4°13'29"N 103°26'45"E
3	4°14'40"N 103°28'32"E	9	4°13'02"N 103°26'53"E
4	4°14'24"N 103°28'19"E	10	4°12'38"N 103°26'30"E
5	4°14'08"N 103°28'02"E	11	4°12'11"N 103°26'48"E
6	4°13'50"N 103°27'41"E		

Figure 38A. Location of Grab Sediment ID using Google Earth



Rajah 2: Kawasan mencerap data di perairan dalam kawasan Pelabuhan dan bahagian utara Pelabuhan Kemaman

Label	Koordinat	Label	Koordinat
12	4°16'56"N 103°29'03"E	16	4°15'19"N 103°28'52"E
13	4°16'29"N 103°29'02"E	17	4°15'03"N 103°27'54"E
14	4°15'59"N 103°28'51"E	18	4°14'46"N 103°28'11"E
15	4°15'42"N 103°28'40"E		

Figure 38B. Location of Grab Sediment ID using Google Earth



Rajah 3: Kawasan mencerap data di perairan dalam kawasan muara sungai Kemaman

Label	Koordinat	Label	Koordinat
19	4°14'26"N 103°26'51"E	21	4°14'02"N 103°27'21"E
20	4°14'05"N 103°26'58"E	22	4°13'53"N 103°26'52"E

Perincian kerja pensampelan Total Suspended Solid (TSS)



Figure 38C. Location of Grab Sediment ID using Google Earth

The soil sample then tested at certified soil laboratory on 23th August - 4th September 2024. The result for sediment analysis and classification of soil based on the mechanical and hydrometer test is summarized in table 3. The types of the soil then tabulated and analyzed for numerical modelling input later on.

Table 3: Classification of Soil based on Soil Test Laboratory Analysis

Sample ID	Coordinate		Sampling Date	Soil Properties (%)				Dominant Soil Properties
	Latitude °N	Longitude °E		Gravel	Sand	Silt	Clay	
K/1	4°15'14"	103°28'43"	22 Aug 24	0	70	25	5	Sand
K/2	4°14'53"	103°28'47"	22 Aug 24	66	30	2	2	Gravel
K/3	4°14'40"	103°28'32"	22 Aug 24	9	85	3	3	Sand
K/4	4°14'24"	103°28'19"	22 Aug 24	0	43	41	16	Sand
K/5	4°14'08"	103°28'02"	22 Aug 24	0	62	29	9	Sand
K/6	4°13'50"	103°27'41"	22 Aug 24	0	62	26	12	Sand
K/7	4°13'36"	103°27'19"	22 Aug 24	0	62	28	10	Sand
K/8	4°13'29"	103°26'45"	22 Aug 24	0	95	2.5	2.5	Sand
K/9	4°13'02"	103°26'53"	22 Aug 24	0	76	22	2	Sand
K/10	4°12'38"	103°26'30"	22 Aug 24	0	79	19	2	Sand
K/11	4°12'11"	103°26'48"	22 Aug 24	0	73	25	2	Sand
K/12	4°16'56"	103°29'03"	22 Aug 24	2	76	20	2	Sand
K/13	4°16'29"	103°29'02"	22 Aug 24	2	72	23	3	Sand
K/14	4°15'59"	103°28'51"	22 Aug 24	3	64	26	7	Sand
K/15	4°15'42"	103°28'40"	22 Aug 24	0	72	26	2	Sand
K/16	4°15'19"	103°28'52"	22 Aug 24	1	60	32	7	Sand
K/17	4°15'03"	103°27'54"	22 Aug 24	0	26	51	23	Silt
K/18	4°14'46"	103°28'11"	22 Aug 24	0	5	58	37	Silt
K/19	4°14'26"	103°26'51"	22 Aug 24	31	66	1.5	1.5	Sand
K/20	4°14'05"	103°26'58"	22 Aug 24	0	95	2.5	2.5	Sand
K/21	4°14'02"	103°27'21"	22 Aug 24	0	99	0.5	0.5	Sand
K/22	4°13'53"	103°26'52"	22 Aug 24	0	93	3.5	3.5	Sand

The images of NAHRIM's sampling activities for seabed sediment size are shown below.



(a) Grab Sampler equipment used during sampling



(b) Water depth was measured using depth sounder at each identified point before sampling activities



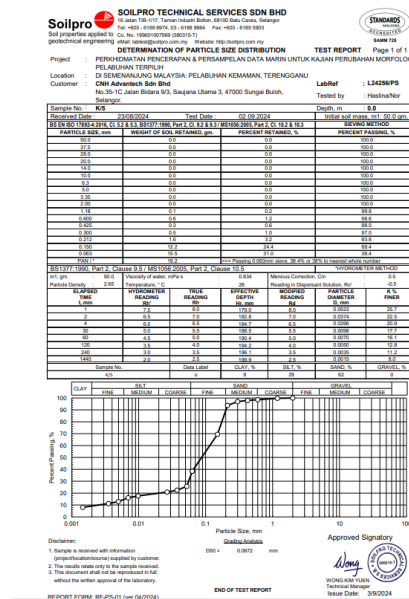
(c) Grabber lower down into water column to grab the top soil of seabed layer



(d) Collected sediment sample from grabber transferred to the air tight plastic bag



(e) All Sediment sample then packed, sealed and labelled for laboratory analysis



(f) Sample of laboratory result for sediment analysis

Figure 39 (a-f). Images of Bed Sediment Sampling Activities

4. Correlation and Significance of Single Beam Bathymetry and Side-Scan Sonar in Port Hydraulic Studies

The integration of single beam bathymetry and side-scan sonar methods plays a pivotal role in port hydraulic studies, particularly in identifying sediment budget and sediment movement within port areas. Both techniques provide complementary data that enhance our understanding of underwater topography and seabed characteristics, which are critical for managing sediment dynamics and maintaining navigable waterways.

Single Beam Bathymetry:

Single beam bathymetry primarily focuses on measuring water depths along predefined survey lines, providing accurate depth profiles of the seabed. This data is crucial for mapping the

underwater topography, identifying depth variations, and detecting submerged features. By generating detailed bathymetric charts, single beam surveys help in understanding the spatial distribution of sediment deposition and erosion. This information is essential for determining the sediment budget, which involves calculating the balance between sediment added to and removed from the port area over time. Accurate depth measurements help in identifying areas with significant sediment accumulation or loss, guiding dredging operations and sediment management strategies.

Side-Scan Sonar:

Side-scan sonar, on the other hand, captures high-resolution images of the seafloor, revealing detailed textures and structures. This method excels in identifying underwater objects, seabed textures, and potential obstructions that are not easily detectable through single beam surveys. The images generated by side-scan sonar provide a comprehensive view of the seabed, highlighting features such as sediment ripples, underwater debris, and variations in sediment composition. By analysing these images, researchers can gain insights into sediment movement patterns, sediment transport pathways, and areas prone to sediment accumulation. Side-scan sonar data complements single beam bathymetry by offering a visual context to the depth measurements, facilitating a more thorough understanding of sediment dynamics.

5. Combined Significance in Sediment Budget and Movement

When combined, single beam bathymetry and side-scan sonar provide a holistic approach to studying sediment budget and movement in port areas. Single beam bathymetry offers precise depth measurements that are essential for quantifying sediment volumes and monitoring changes in seabed elevation. Side-scan sonar adds a layer of detail by visually representing the seafloor's texture and structure, which helps in interpreting the processes driving sediment transport and deposition.

In port hydraulic studies, understanding the sediment budget is crucial for maintaining navigable channels, designing effective dredging plans, and mitigating the impact of sedimentation on port infrastructure. Accurate bathymetric data helps in predicting sedimentation rates and identifying hotspots of sediment accumulation that require intervention. Side-scan sonar images provide additional insights into the sources and sinks of sediment, as well as the physical characteristics of the sediment, which influence its movement and deposition patterns.

By integrating data from both methods, port authorities can develop more informed sediment management strategies that balance the need for dredging with environmental conservation. For example, identifying areas of high sediment transport can inform the placement of sediment traps or the design of breakwaters to control sediment deposition. Additionally, understanding sediment movement patterns can help in predicting the impact of construction projects on sediment dynamics and implementing measures to minimize negative effects.

The combined use of single beam bathymetry and side-scan sonar in port hydraulic studies significantly enhances our ability to manage sediment budget and sediment movement. Single beam bathymetry provides accurate depth profiles essential for quantifying sediment volumes, while side-scan sonar offers detailed images of the seafloor, revealing sediment textures and transport patterns. Together, these methods provide comprehensive data that support effective sediment management, ensuring safe navigation, and sustainable port operations.

6. Results and Findings

The expected survey results are indicated as the following:

- **Bathymetry:** Accurate depth measurements and underwater topography maps were generated. These maps revealed important features and potential hazards that could affect navigation and port operations.
- **Side-Scan Sonar:** High-resolution images of the seafloor were obtained, providing detailed information about the seabed composition and the presence of underwater objects. Seafloor mapping at the Kemaman Supply Based and surrounding areas is essential for a wide range of activities, from ensuring safe navigation and supporting infrastructure development to protecting the environment and advancing scientific knowledge. Regular and accurate mapping of this area helps manage the dynamic and complex interactions between the river, the sea, and human activities, ultimately contributing to the sustainable development and preservation of the region. Mapping in the study area has been successfully carried out, but the weather at the time of the survey was quite bad with a strong south-easterly wind, this caused the sonar data to be slightly unstable and the image obtained was quite disturbed.
- **Water Quality:** In-situ water quality sampling of temperature, turbidity, salinity, and total suspended solids (TSS) is critical for understanding sediment budgets in nearshore and port areas. Temperature influences water density and circulation, affecting sediment transport

patterns. High turbidity and TSS values indicate increased sediment suspension, often linked to dredging, erosion, or riverine inputs, which can influence sediment deposition and movement within the port and nearshore zones. Salinity measurements help distinguish between freshwater and marine sediment sources, which is vital for assessing sediment influx and its impact on the sediment budget. By analyzing these parameters, water quality sampling supports the assessment of sediment dynamics, aiding in the management of sediment transport, deposition, and potential accumulation zones in port areas.

Prepared by : CNH Advantech Sdn. Bhd.

Date : 20 August 2024

.....
Hazamri b. Harith
Pengarah Urusan

Approved/Endorsed by: Pusat Kajian Pantai dan Oseanografi

Date :

.....
Ir. Ts. Muhammad Rizal b. Razali
Pegawai Penyelidik

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SIJIL AKUAN PENDAFTARAN SYARIKAT

NO. SIJIL : K63342131543015051
NO. RUJUKAN PENDAFTARAN : 357-02141164
TEMPOH SAH LAKU : 02/09/2021 - 13/10/2024

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b.p. Ketua Setiausaha Perbendaharaan
Kementerian Kewangan Malaysia

Tarikh Berdaftar Dengan Kementerian Kewangan Malaysia : 02/09/2021

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BIL	TARIKH DAFTAR BIDANG	KOD BIDANG	KETERANGAN	STATUS
1	01/09/2021	010102	PENERBITAN DAN PENYIARAN/ PENERBITAN/ BAHAN BACAAN	Aktif
2	01/09/2021	010501	PENERBITAN DAN PENYIARAN/ FOTOGRAFI DAN FILEM/ KAMERA DAN AKSESORI	Aktif
3	01/09/2021	020101	PERABOT, PERALATAN PEJABAT, HIASAN DALAMAN DAN DOMESTIK/ PERABOT, KELENGKAPAN DAN AKSESORI/ PERABOT,PERABOT MAKMAL DAN KELENGKAPAN BERASASKAN KAYU/ROTAN/FABRIK/LOGAM/PLASTIK	Aktif
4	01/09/2021	020804	PERABOT, PERALATAN PEJABAT, HIASAN DALAMAN DAN DOMESTIK/ PAKAIAN DAN KELENGKAPAN/ PAKAIAN KESELAMATAN, KELENGKAPAN DAN AKSESORI	Aktif
5	01/09/2021	050101	PERALATAN HOSPITAL, PERUBATAN, UBAT-UBATAN DAN FARMASEUTIKAL/ PERALATAN HOSPITAL, BAHAN DAN KELENGKAPAN PERUBATAN/ PERALATAN DAN KELENGKAPAN HOSPITAL	Aktif
6	01/09/2021	050102	PERALATAN HOSPITAL, PERUBATAN, UBAT-UBATAN DAN FARMASEUTIKAL/ PERALATAN HOSPITAL, BAHAN DAN KELENGKAPAN PERUBATAN/ PERALATAN / KELENGKAPAN PERUBATAN	Aktif
7	01/09/2021	060101	KIMIA, BAHAN KIMIA DAN PERALATAN MAKMAL/ KIMIA/ KIMIA MAKMAL	Aktif
8	01/09/2021	060501	KIMIA, BAHAN KIMIA DAN PERALATAN MAKMAL/ PERALATAN MAKMAL/ PERALATAN MAKMAL SERTA AKSESORI	Aktif
9	01/09/2021	060502	KIMIA, BAHAN KIMIA DAN PERALATAN MAKMAL/ PERALATAN MAKMAL/ PERALATAN MAKMAL PENGUKURAN, PENCERAPAN DAN SUKAT	Aktif
10	01/09/2021	070303	PERTANIAN, PERHUTANAN DAN TERNAKAN/ UBAT, MAKANAN TERNAKAN/TUMBUHAN, PERALATAN DAN AKSESORI/ PERALATAN DAN KELENGKAPAN PERTANIAN/TERNAKAN/AKUATIK	Aktif
11	01/09/2021	080101	KEJURUTERAAN AWAM, BINAAN DAN KELENGKAPAN KEMUDAHAN AWAM/ KELENGKAPAN/KEMUDAHAN AWAM/ KELENGKAPAN/KEMUDAHAN AWAM	Aktif
12	01/09/2021	100101	PERALATAN SUKATAN DAN UKURAN/ PERALATAN SUKATAN DAN UKURAN/ SEMUA PERALATAN SUKATAN/UKURAN	Aktif
13	01/09/2021	110601	PENGANGKUTAN, KOMPONEN DAN AKSESORI/ BOT DAN KAPAL/ BOT	Aktif
14	01/09/2021	110701	PENGANGKUTAN, KOMPONEN DAN AKSESORI/ PERALATAN MARIN/ PERALATAN MARIN	Aktif
15	01/09/2021	120401	PERTAHANAN DAN KESELAMATAN/ PERALATAN KESELAMATAN DAN PENGUATKUASAAN/ ALAT KESELAMATAN,PERLINDUNGAN DAN KAWALAN PERLINDUNGAN	Aktif
16	01/09/2021	120502	PERTAHANAN DAN KESELAMATAN/ PENGESANAN, PEMANTAUAN DAN PERLINDUNGAN/ PERALATAN PEMANTAUAN DAN PENGESANAN	Aktif
17	01/09/2021	130101	PERALATAN KEJURUTERAAN DAN MESIN PENGELUARAN/ MESIN, KELENGKAPAN BENGKEL DAN MESIN PENGELUARAN/ MESIN DAN	Aktif

			KELENGKAPAN BENGKEL	
18	01/09/2021	210201	ICT (INFORMATION COMMUNICATION TECHNOLOGY)/ PERALATAN DAN KELENGKAPAN TELEKOMUNIKASI/ ALAT PERHUBUNGAN	Aktif
19	01/09/2021	220601	PERKHIDMATAN/ PENYELENGGARAAN/PEMBAIKAN PERALATAN/KELENGKAPAN PERUBATAN DAN MAKMAL/ ALAT KELENGKAPAN HOSPITAL/MAKMAL	Aktif
20	01/09/2021	220602	PERKHIDMATAN/ PENYELENGGARAAN/PEMBAIKAN PERALATAN/KELENGKAPAN PERUBATAN DAN MAKMAL/ MESIN DAN PERALATAN MAKMAL	Aktif
21	01/09/2021	221101	PERKHIDMATAN/ GUNA TENAGA/ KAKITANGAN IKTISAS (PROFESIONAL)-TIDAK TERMASUK KHIDMAT PERUNDING	Aktif
22	01/09/2021	221102	PERKHIDMATAN/ GUNA TENAGA/ KAKITANGAN SEPARA IKTISAS(SEMI PROFESIONAL)-TIDAK TERMASUK KHIDMAT PERUNDING	Aktif
23	01/09/2021	221110	PERKHIDMATAN/ GUNA TENAGA/ KHIDMAT LATIHAN,TENAGA PENGAJAR DAN MODERATOR/NEGOTIATOR	Aktif
24	01/09/2021	221201	PERKHIDMATAN/ KHIDMAT UDARA/LAUT/DARAT/ TOPOGRAFI/LIDAR	Aktif
25	01/09/2021	221204	PERKHIDMATAN/ KHIDMAT UDARA/LAUT/DARAT/ HIDROGRAFI	Aktif
26	01/09/2021	221206	PERKHIDMATAN/ KHIDMAT UDARA/LAUT/DARAT/ PEMETAAN/PEMETAAN UTILITI BAWAH TANAH	Aktif
27	01/09/2021	221304	PERKHIDMATAN/ KESENIAN, HIBURAN DAN PELANCONGAN/ AUDIO VISUAL	Aktif
28	01/09/2021	221503	PERKHIDMATAN/ PENYEWAAN DAN PENGURUSAN/ KENDERAAN/JENTERA/KENDERAAN REKREASI	Aktif

Tarikh Berdaftar Dengan Kementerian Kewangan Malaysia : 02/09/2021



Maybank Islamic Berhad (787435-M)
15th Floor, Tower A, Dataran Maybank, 1, Jalan Maarof, 50000 Kuala Lumpur.

IBS GIZA, KOTA DAMANSARA

MUKA / 頁 / PAGE : 1
TARIKH PENYATA : 30/04/24
結單日期 :
STATEMENT DATE
NOMBOR AKAUN :
戶號 : 562759110161
ACCOUNT NUMBER

CNH ADVANTECH SDN BHD
D-2-30 JALAN SP 11/2
SERI PRISTANA
47000 SUNGAI BULOH
SELANGOR

PROTECTED BY PIDM UP TO RM250,000 FOR EACH DEPOSITOR

CURRENT ACCOUNT-I

URUSNIAGA AKAUN/ 戶口進支項 /ACCOUNT TRANSACTIONS

TARIKH MASUK 進支日期 ENTRY DATE	TARIKH NILAI 灰過賬日期 VALUE DATE	BUTIR URUSNIAGA 進支項說明 TRANSACTION DESCRIPTION	JUMLAH URUSNIAGA 銀碼 TRANSACTION AMOUNT	BAKI PENYATA 結單存餘 STATEMENT BALANCE