The Association of Surveyors of Papua New Guinea inc.

PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

NAVIGATIONAL DEPTH ASSESSMENT AND BATHYMETRIC CHARACTERIZATION OF VANIMO AND WEWAK HARBORS, PNG.

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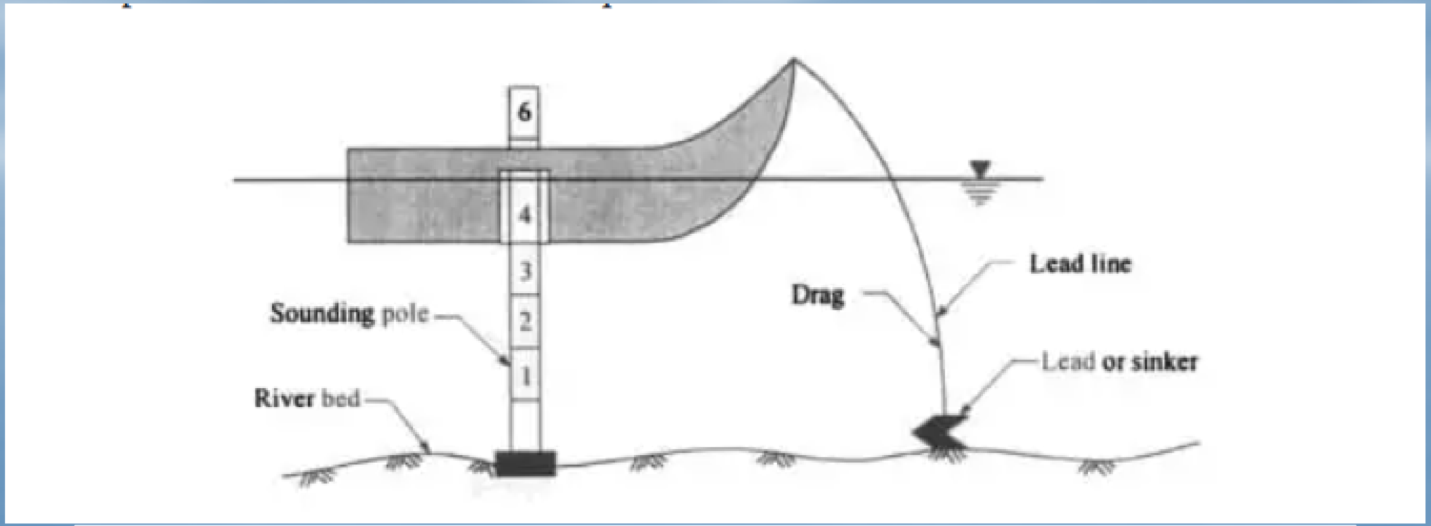
EVOLUTION OF HYDROGRAPHIC SURVEYING

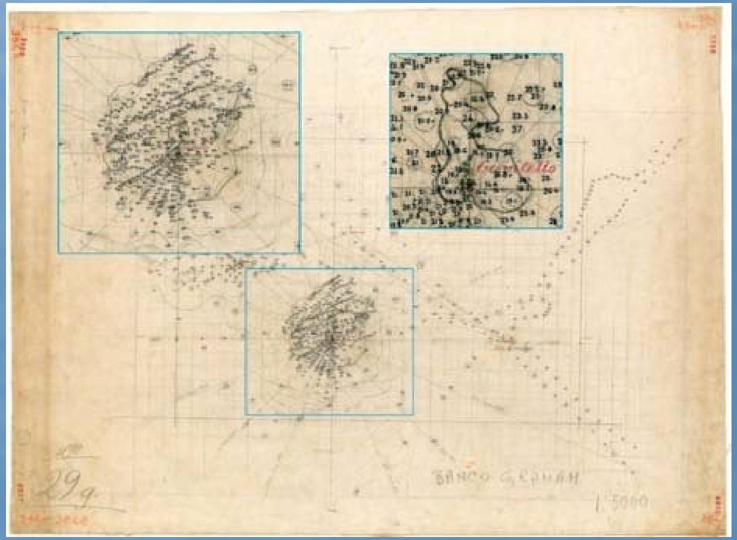
- Historical Baseline- Manual Lead Lines
  - The Established Standard- Single Beam Echo Sounder (SBES)
    - The High-Density Standard-Multi Beam Echo Sounder (MBES)
      - The Modern Frontier-Airborne Bathymetric Lidar (ABL)

HISTORICAL BASELINE-MANUAL LEAD LINES

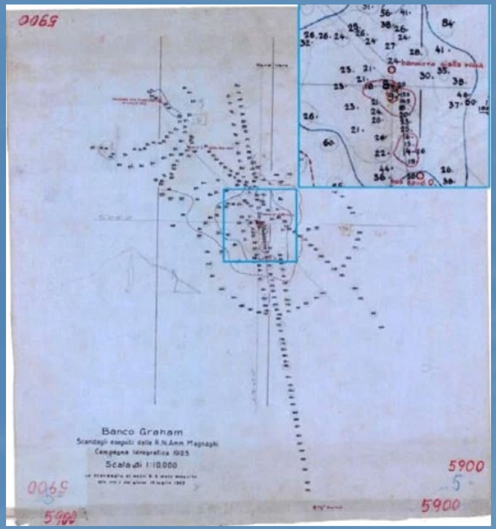
- 1. Method: Physically dropping weighted ropes to the seafloor.
- 2. Result: Discrete, sparse data points; highly labor-intensive and prone to human error.



Source: https://theconstructor.org/surveying/hydrographic-surveying-methods-uses/13838



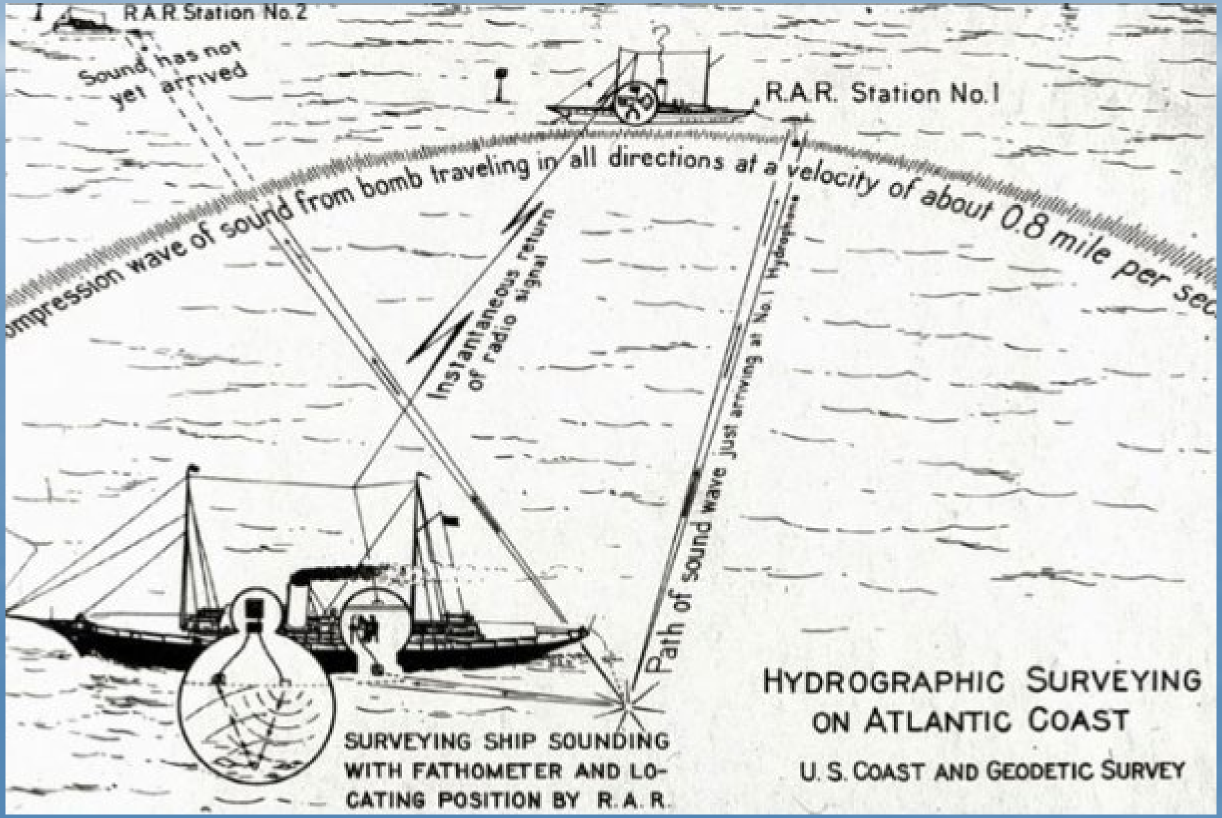
https://www.researchgate.net/figure/Sounding-line-bathymetric-survey-IIM-5900-1925



THE ESTABLISHED STANDARD- SINGLE BEAM ECHO SOUNDER (SBES)-1920

- Single-Beam Echo Sounders (SBES) – introduces to the field becoming the standard hydrographic surveying tool.

- Advanced Positioning & International Standards – introduction to radio acoustic and electronic position systems that improves survey accuracy with the establishment of IHO.



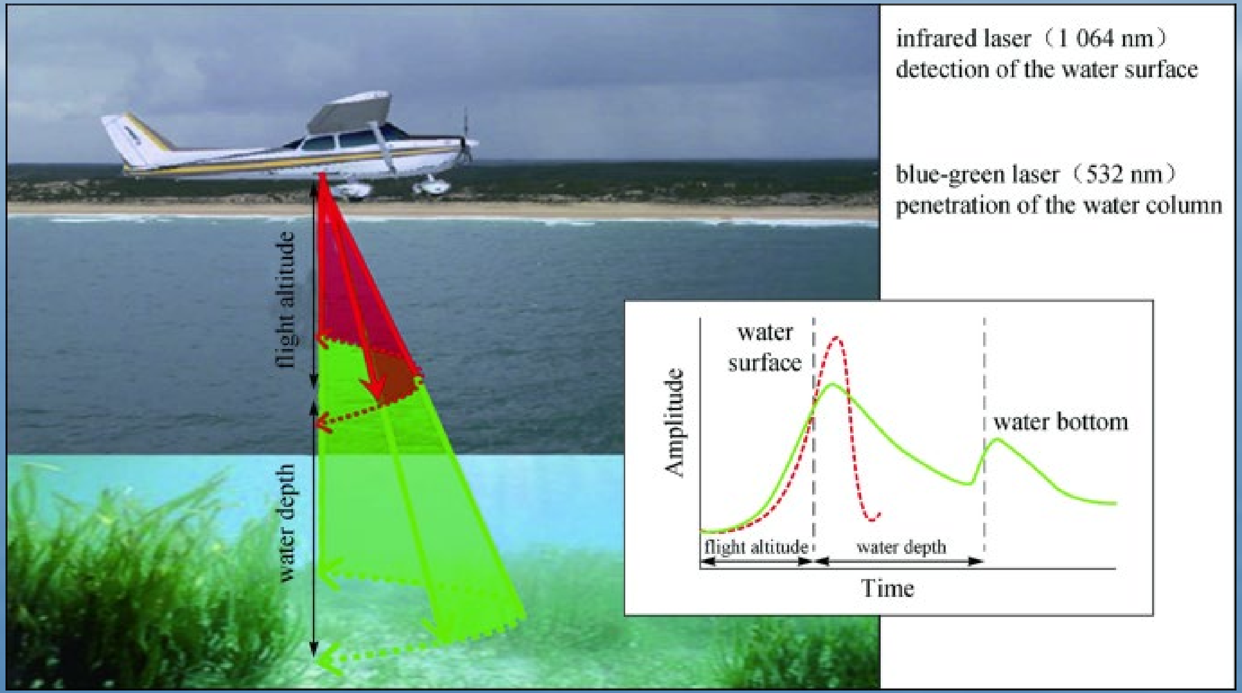
- *Radio acoustic ranging principle. (Image courtesy: NOAA)*

THE HIGH-DENSITY STANDARD-MULTI BEAM ECHO SOUNDER (MBES)-1970'S

- Introduction of Multibeam Technology – revolutionized hydrographic surveying by providing much wider sea bed coverage.
- Improved Sefloor Mapping Accuracy – enable the creation of detailed and accurate seabed maps.
- Advances in Computing and Data Processing - increased computing power and specialized software allowed large volumes of multibeam data to be processed efficiently

THE MODERN FRONTIER-AIRBORNE BATHYMETRIC LIDAR (ABL)

- Advanced Remote & Autonomous Surveying - Airborne Bathymetric LiDAR, UAVs, and autonomous survey vessels for efficient hydrographic data collection.
- Enhanced Data Acquisition & Processing
- AI-Driven Data Integration - Machine learning and automated processing streamline data analysis, database management, and integration with other geospatial datasets.

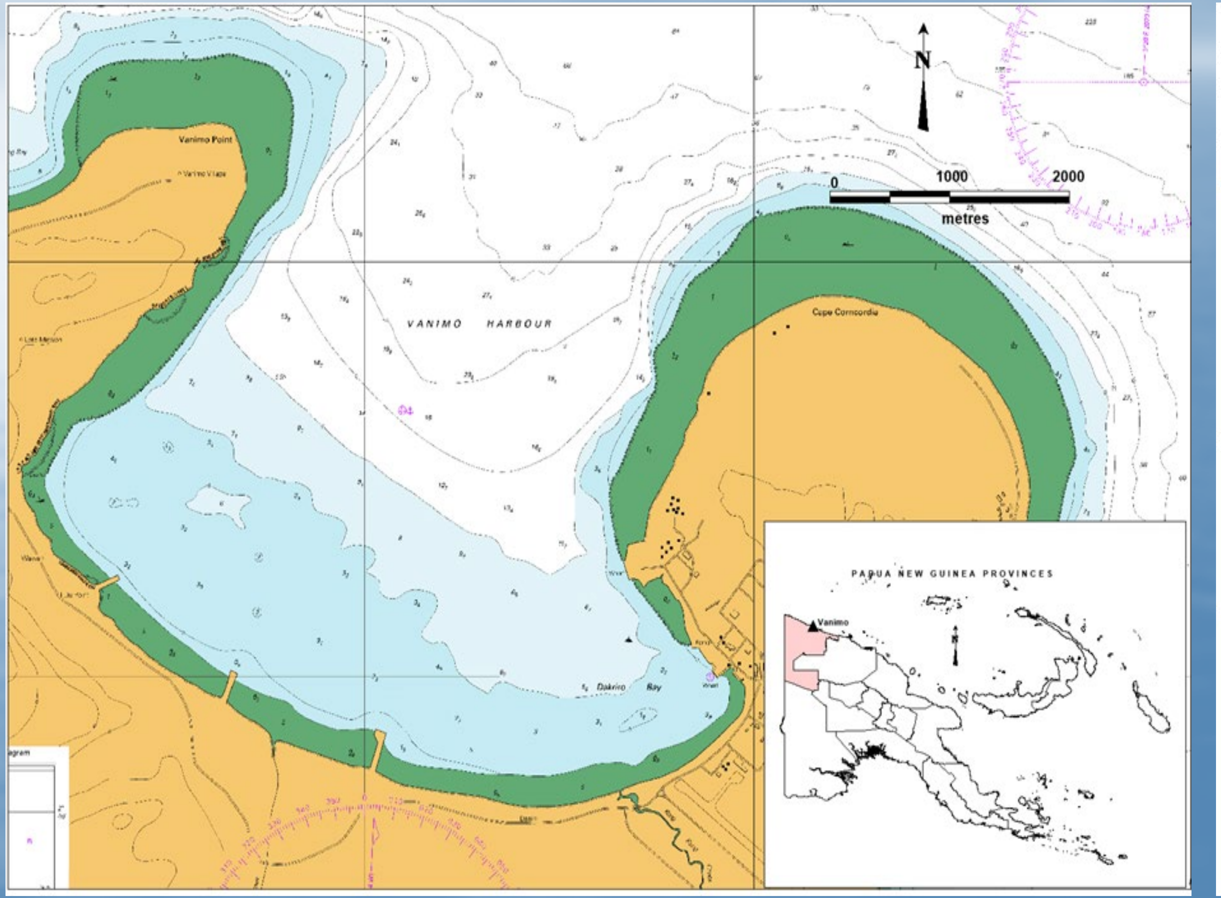


Source: *https://link.springer.com/chapter/10.1007/978-981-15-9750-3_3*

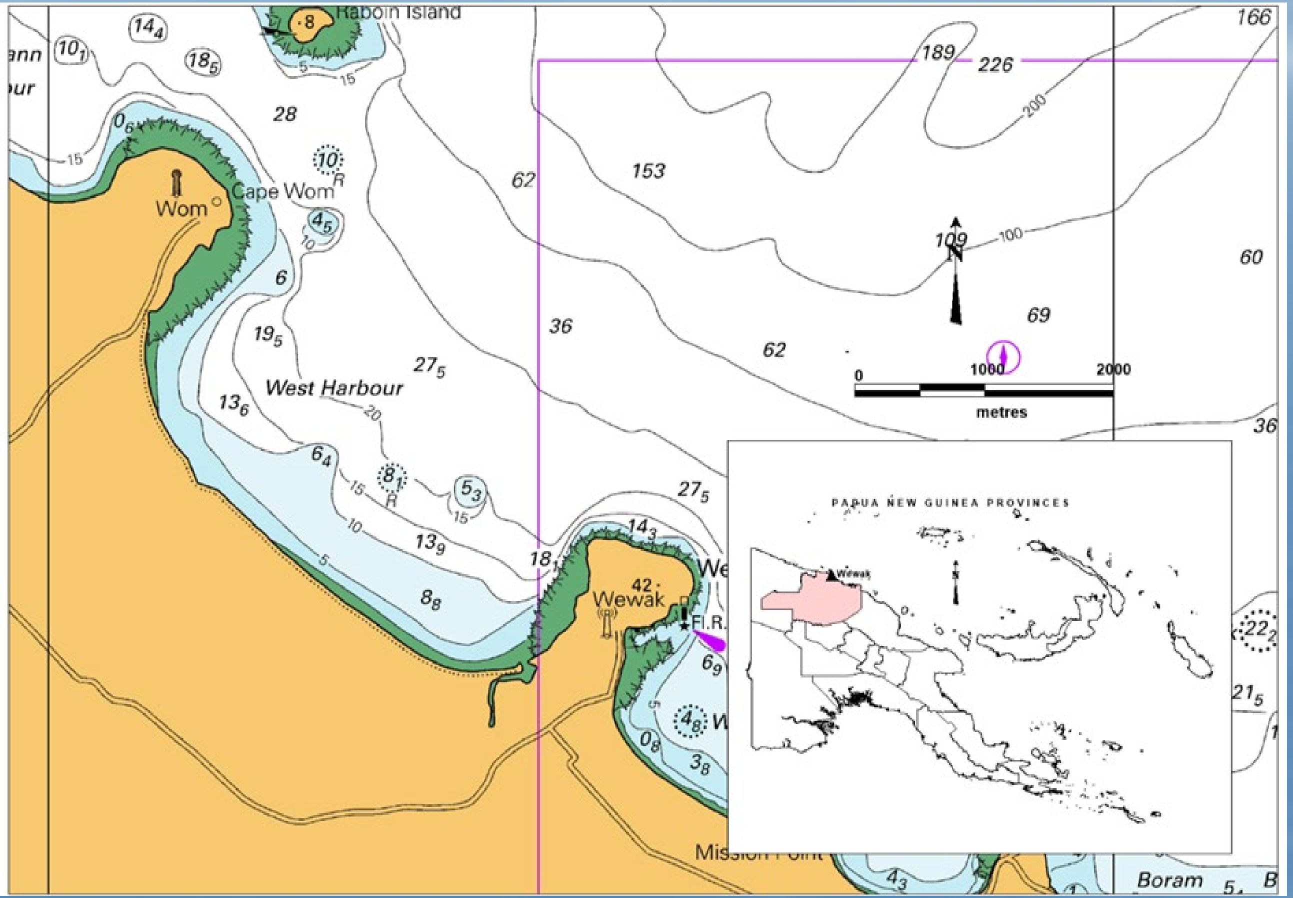
INTRODUCTION

- Hydrographic surveys conducted in Vanimo and Wewak to asses the navigational depths and sea bed characteristics for proposed port development.
- This supports the feasibility studies initiated by the DoT in collaboration with Yooshin Engineering.
- Survey carried out by PNGUOT SSLS, providing critical bathymetry data for port planning and infrustrcutue development

SITE; VANIMO & WEWAK PORT HARBOR

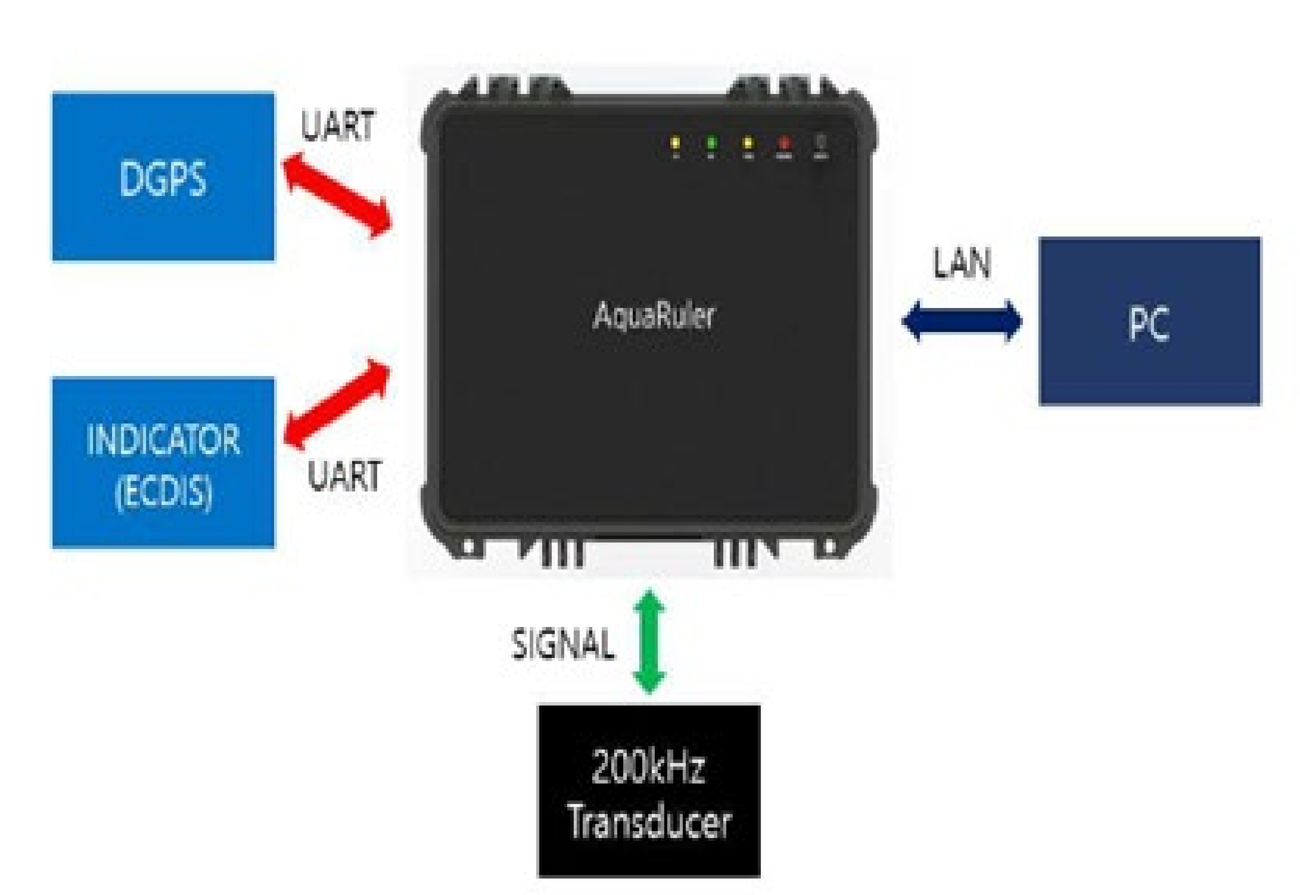


Vanimo Port Site (Vanimo Harbour). Source: NMSA Nautical Chart PNG652, 2016

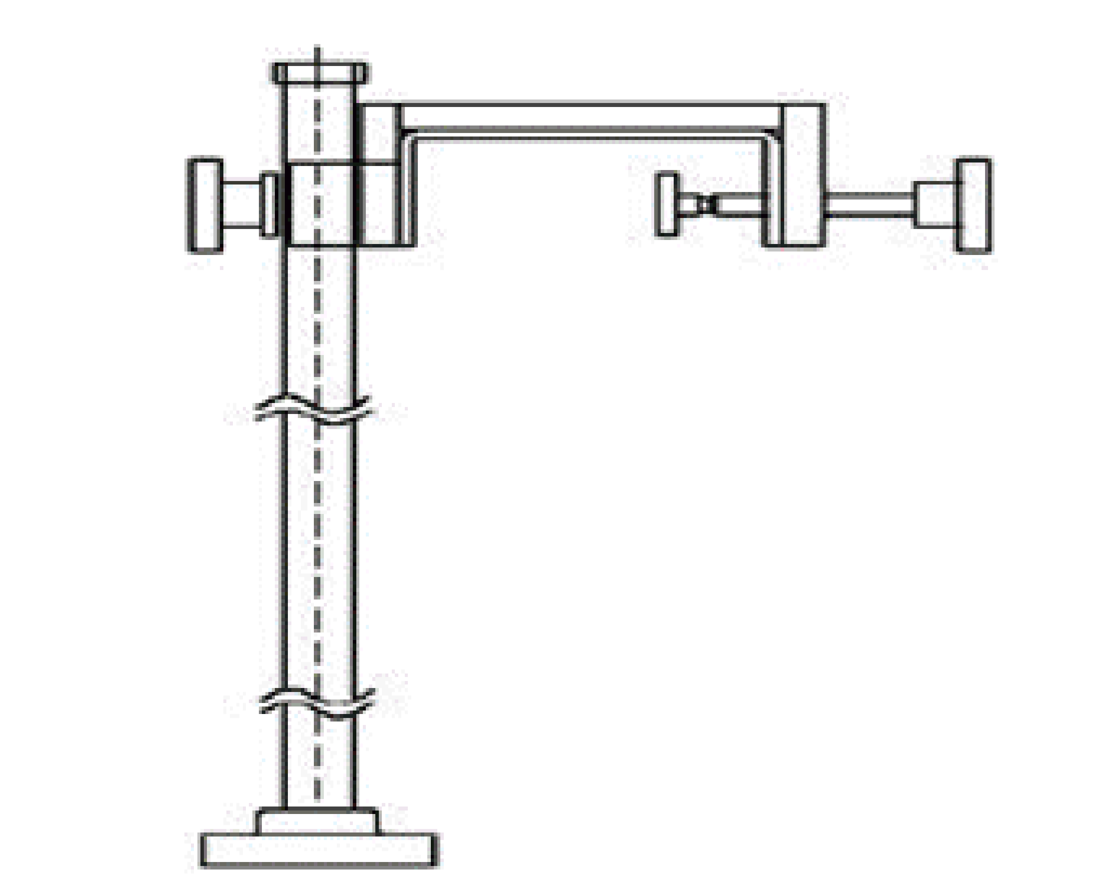


Wewak Port Site (West Harbour). Source: NMSA Nautical Chart PNG651, 2016

ACQUISITION EQUIPMENT



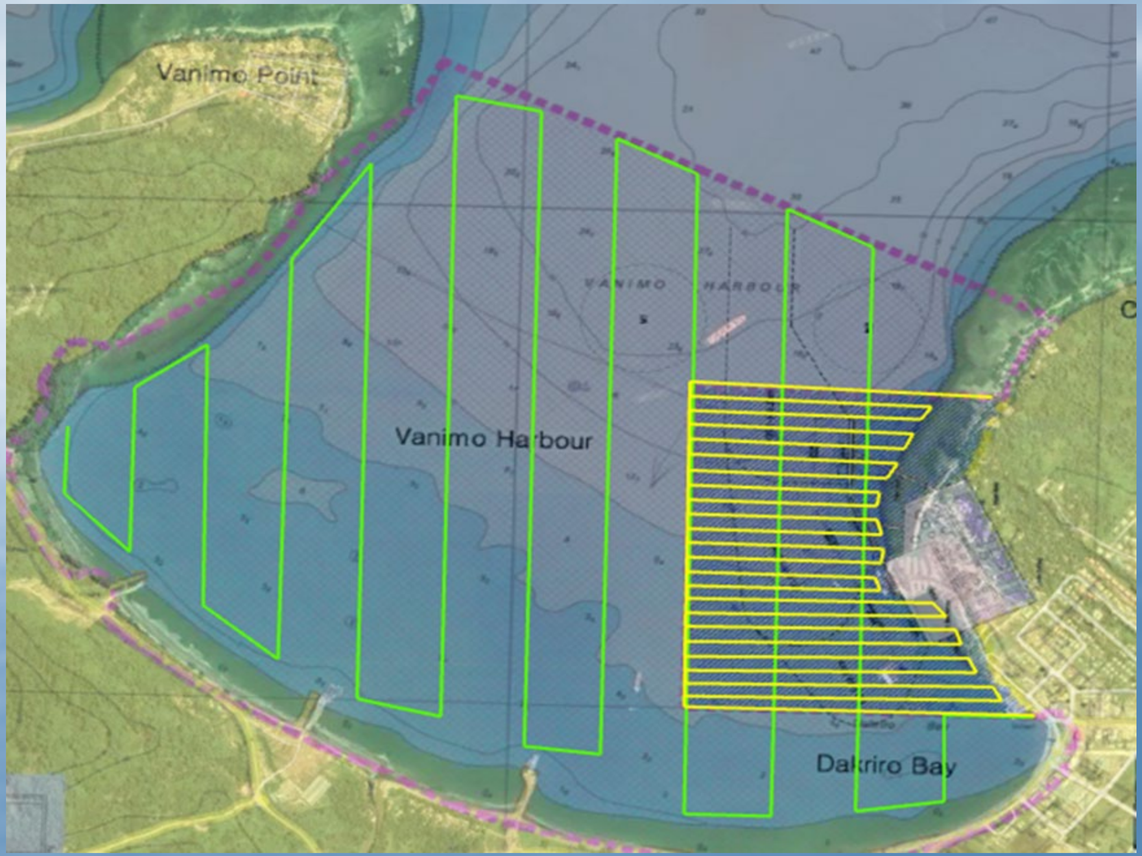
System set up Diagram



Transducer and GPS Frame

- Survey Vessel on site

SURVEY LINES

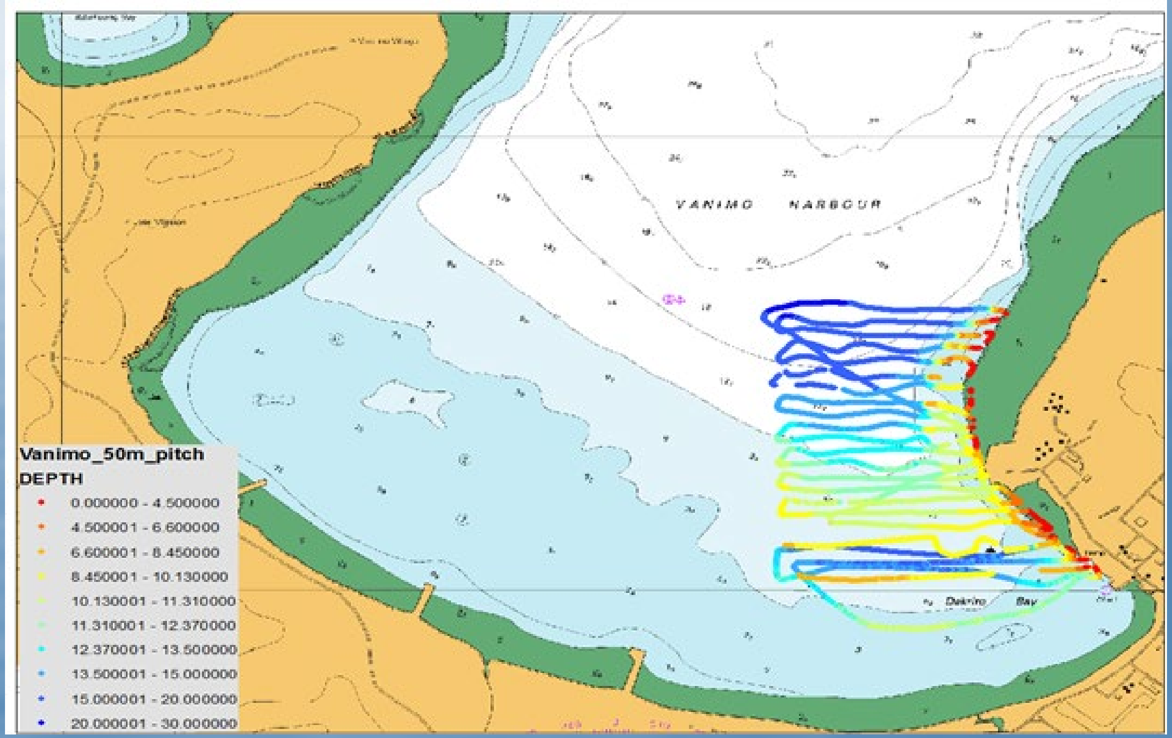


Vanimo Port Pre Survey Lines (50m &300m) designed on the overlaid Scope of Works on Google Earth Imagery

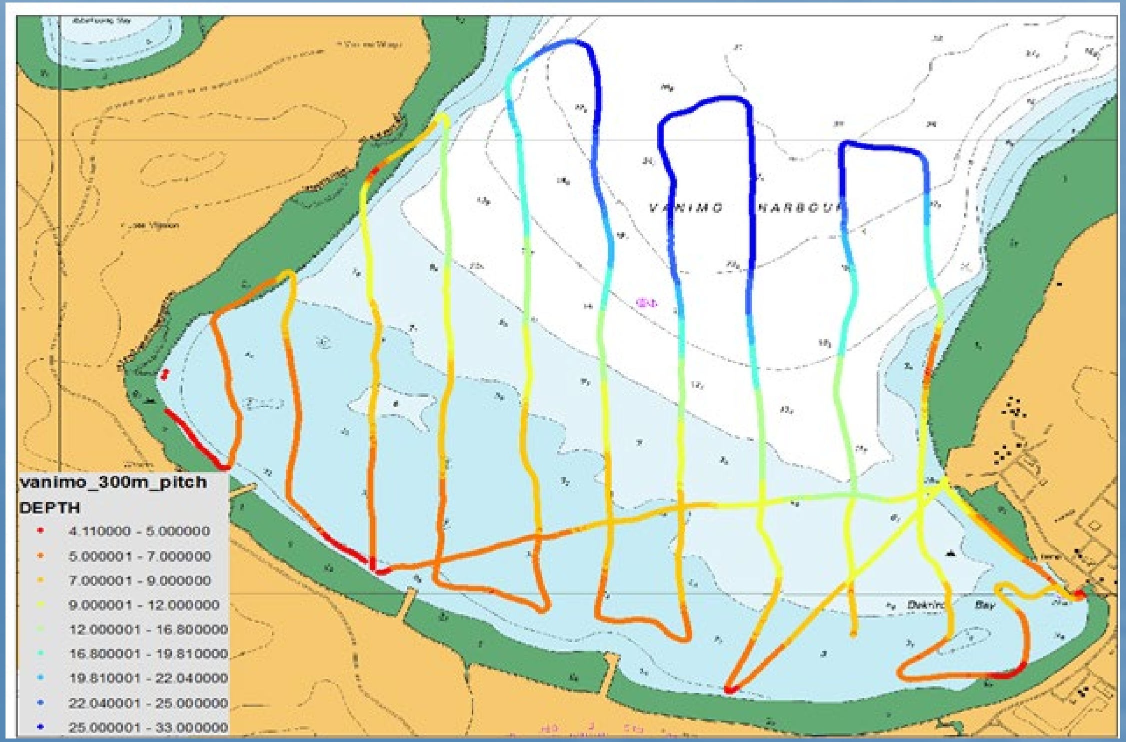
Wewak Proposed Port Site. The 50-meter pitch (red) and the 300-meter pitch (yellow)

VANIMO SURVEY LINES

Pitch	Area	Total Length of survey lines	Length of each line
50 meter (lines spaced 50 m apart)	0.87 km2	18.3 km	22 lines of app 650m each
300 meter (line spaced 300m apart)	5.09 km2	22.6 km	10 lines of 2km each



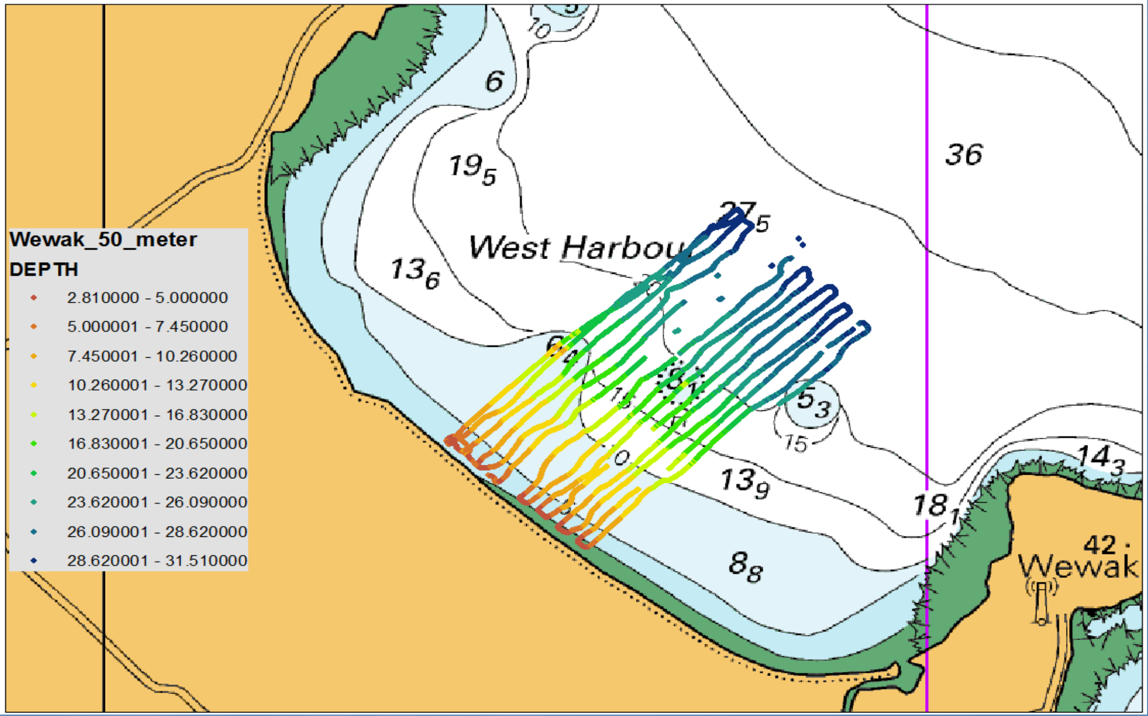
Vanimo 50m coverage



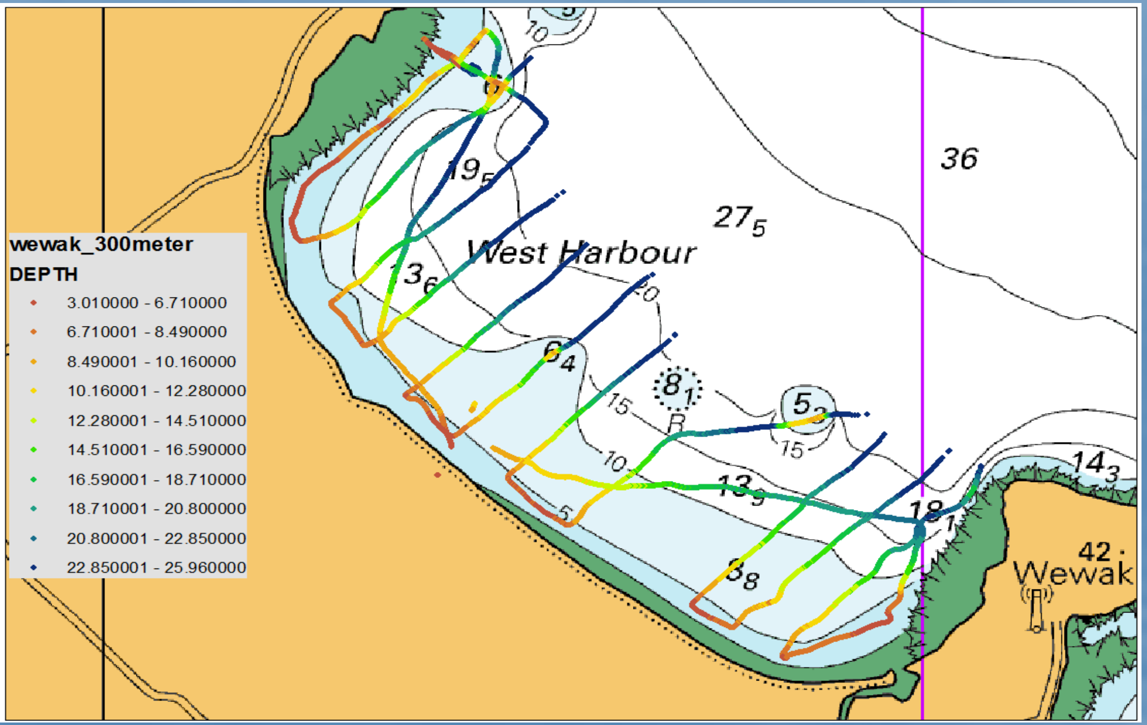
Vanimo 300m coverage

WEWAK SURVEY LINES

Pitch	Area	Total Length of survey lines	Length of each line
50 meter (lines spaced 50 m apart)	2.32 square km	37.1km	17 lines of 2km each
300 meter (line spaced 300m apart)	7.88 square km	17.69km	12 lines of 2km each



Wewak 50m Pitch coverage



Wewak 300m Pitch coverage

SOUND VELOCITY VERIFICATION AND DEPTH CALIBRATION (BAR CHECK METHOD)

- Calibration conducted - a plate suspended 1.0 m below the transducer to verify the assumed sound velocity of 1,500 m/s and correct SBES depth measurements.

Bar check confirmed a sound velocity of 1500 m/s with a depth error of 0.1 m.

Site	Bar Check	Velocity	Variation
Vanimo	N/A	1500ms (average)	N/A
Wewak	Yes	1500ms	0.01

DATA COLLECTION

Site	Varied Depth	Seabed Description	Source
Vanimo	3-33 meters	Sandy and reefs near coast	NMSA Nautical Chart 652
Wewak	4-30 meters	Sandy and reef near the 25m depth	NMSA Nautical Chart 651

Depth Variation

Instrument	Vanimo	Wewak
Transducer	Port side Mounted	Port Side Mounted
Motion Reference Unit	N/A	N/A
Sound Velocity Probe	N/A	N/A
Operating Parameters		
Transducer Frequency	1500m/s	1500m/s
Minimum Water Depth	2m	3m
Maximum Water Depth	31m	33m
Average Boat Speed	5knots(2.5m/s)	10knots (5m/s)
Pulse Length	1m/s (PWD Step8)	1m/s (PWD Step8)

STPDR Settings

* DATA PROCESSING

Depth data extracted from STPDR in CSV (Comma Delimited) format

Data cleaning,coordinate format conversion and tidal corrections applied in using Microsoft Excel.

Data imported into MapInfo Software to verify positions

Files translated to ArcGIS shapefiles for averaging and interpolation

Converted to AutoCAD for Deliverables

* SHORELINE DATA

- Five GNSS control stations were established within ±500 m of each project site using ITRF 2014 on WGS 84 coordinates and EGM 2008/MSL vertical datum.
- Ground control point coordinates and levels were used to configure the GNSS-RTK base and rover receivers, ensuring accurate horizontal and vertical positioning during the bathymetric survey.
- Shoreline and depth data were integrated to provide continuous contour mapping; however, some shoreline sections were not surveyed due to security and safety constraints

HORIZONTAL CONTROL

- **Survey positioning was based on WGS 84 projected to UTM Zone 54S**, with GNSS-RTK corrections and 5-hour observations for Base through AUSPOS to achieve accurate and reliable control coordinates.

Vanimo

STATIONS	EASTINGS (m)	NORTHINGS (m)	ELLIPSOID HEIGHT (m)	INSTALLATION DATE	Vertical Uncertainty
Base A	532737.512	9703876.949	80.298	2022/08/26	E=0.011 N=0.008 H=0.036
Base B	533178.058	9703408.362	80.531	2022/08/26	E=0.014 N=0.009 H=0.036

Wewak

STATIONS	EASTINGS (m)	NORTHINGS (m)	ELLIPSOID HEIGHT (m)	INSTALLATION DATE	Vertical Uncertainty
Base A	788987.358	9607419.444	79.896	2022/08/31	E=0.009 N=0.006 H=0.024

VERTICAL CONTROL

- The vertical datum was derived above the mean sea level using the Earth Gravitational Model 2008 (EG2008) for both sites

Vanimo

STATIONS	EASTINGS (m)	NORTHINGS (m)	ELLIPSOID HEIGHT (m)	Mean Sea Level (m)	Geoid Separation (N)
Base A	532737.512	9703876.949	80.298	3.252	77.046
Base B	533178.058	9703408.362	80.531	3.438	77.093

Wewak

STATIONS	EASTINGS (m)	NORTHINGS (m)	ELLIPSOID HEIGHT (m)	Mean Sea Level	Geoid Separation N
Base A	788987.358	9607419.444	79.896	1.859	78.037

* TIDAL CORRECTION

- RTK GPS provides centimeter-level positioning and height accuracy.
- Tidal corrections can be determined directly, reducing the need for conventional tide gauges.
- A land-based RTK station supplies differential corrections to the survey vessel.
- The ellipsoid-to-chart datum separation must be known to apply tidal corrections accurately.
- **Datum Separation (N)** is determined by;

$$N = h_{GPS} - H_{MSL}$$

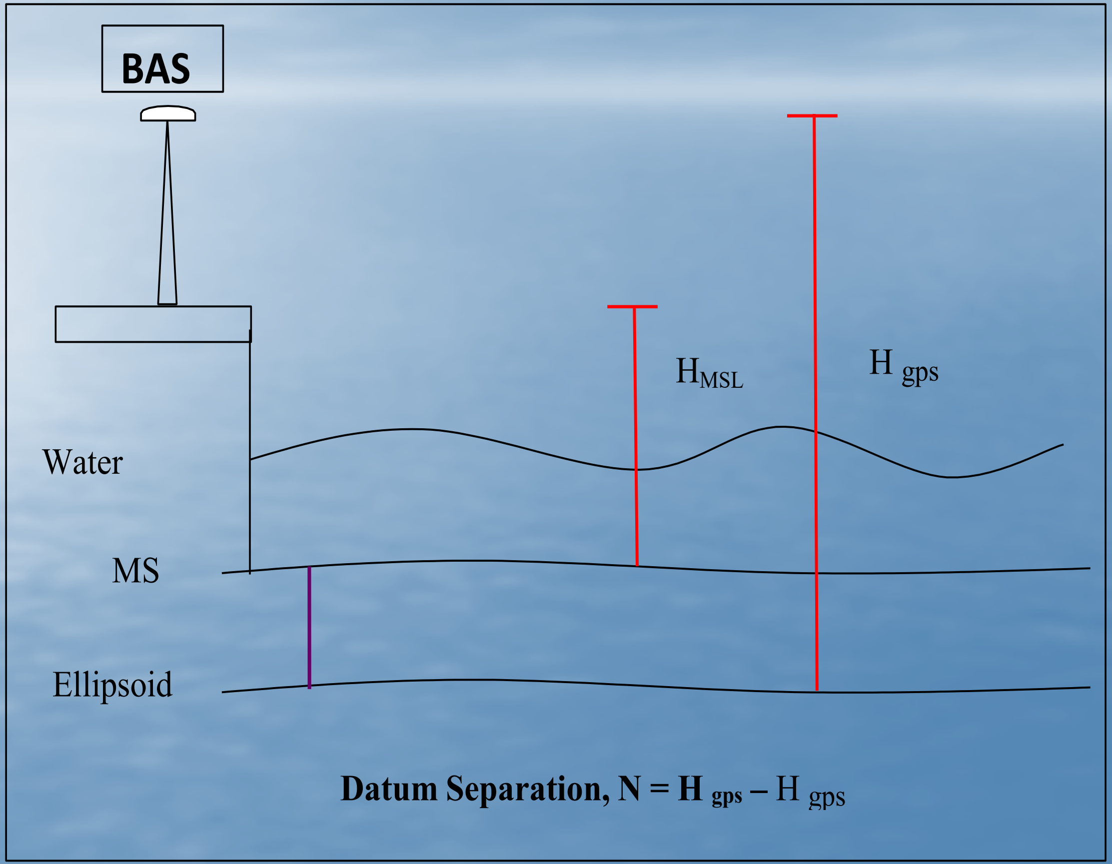
Where; **h_{GPS} is the ellipsoidal height**

H_{MSL} is the Mean Sea Level

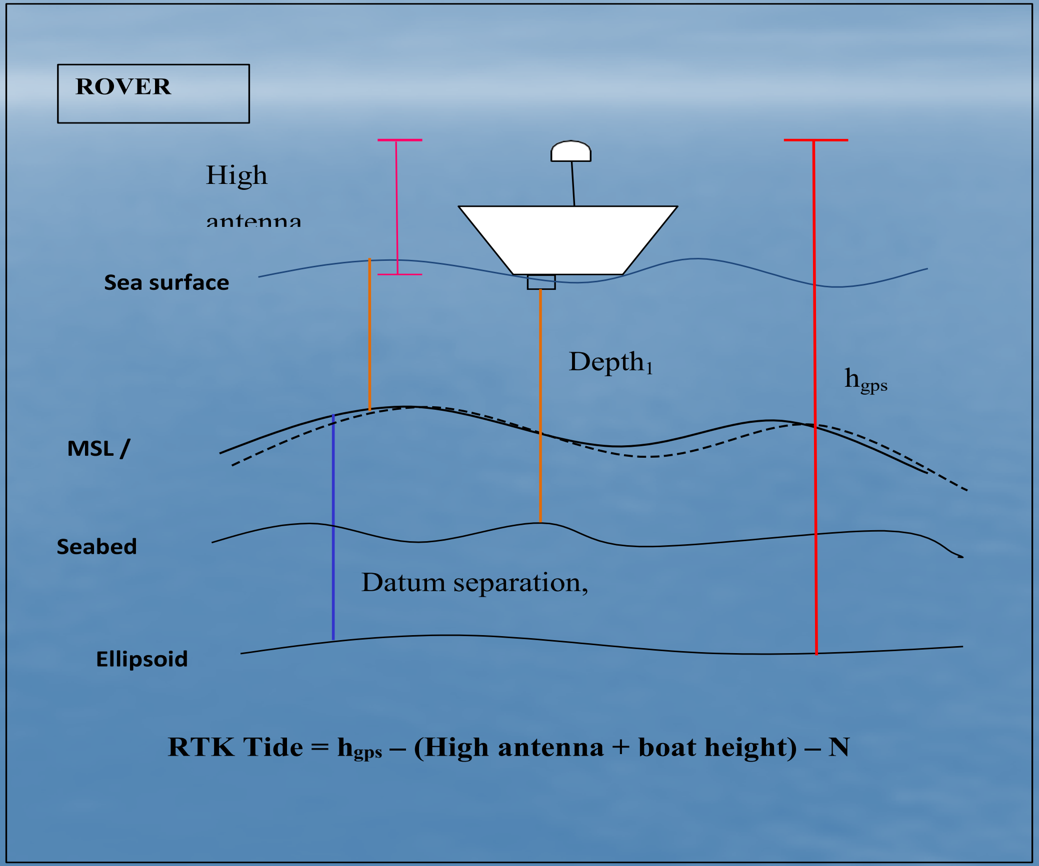
- **RTK Tide = h_{GPS} – (Distance from GPS to Transducer) - N**

Source: www.aspng.org/techinforvert.htm

CONCEPT OF TIDAL CORRECTION



Datum Separation Concept



RTK Tide Concept

Source: www.aspng.org/techinforvert.htm

* TIDAL CORRECTIONS

- Vanimo Tidal Correction

STATIONS	ELLIPSOID HEIGHT (m)	Geoid Separation	Distance from GPS to Transducer (m)	RTK Tide
Base A	80.298	77.046	2.05	1.202
Base B	80.531	77.093	2.05	1.388

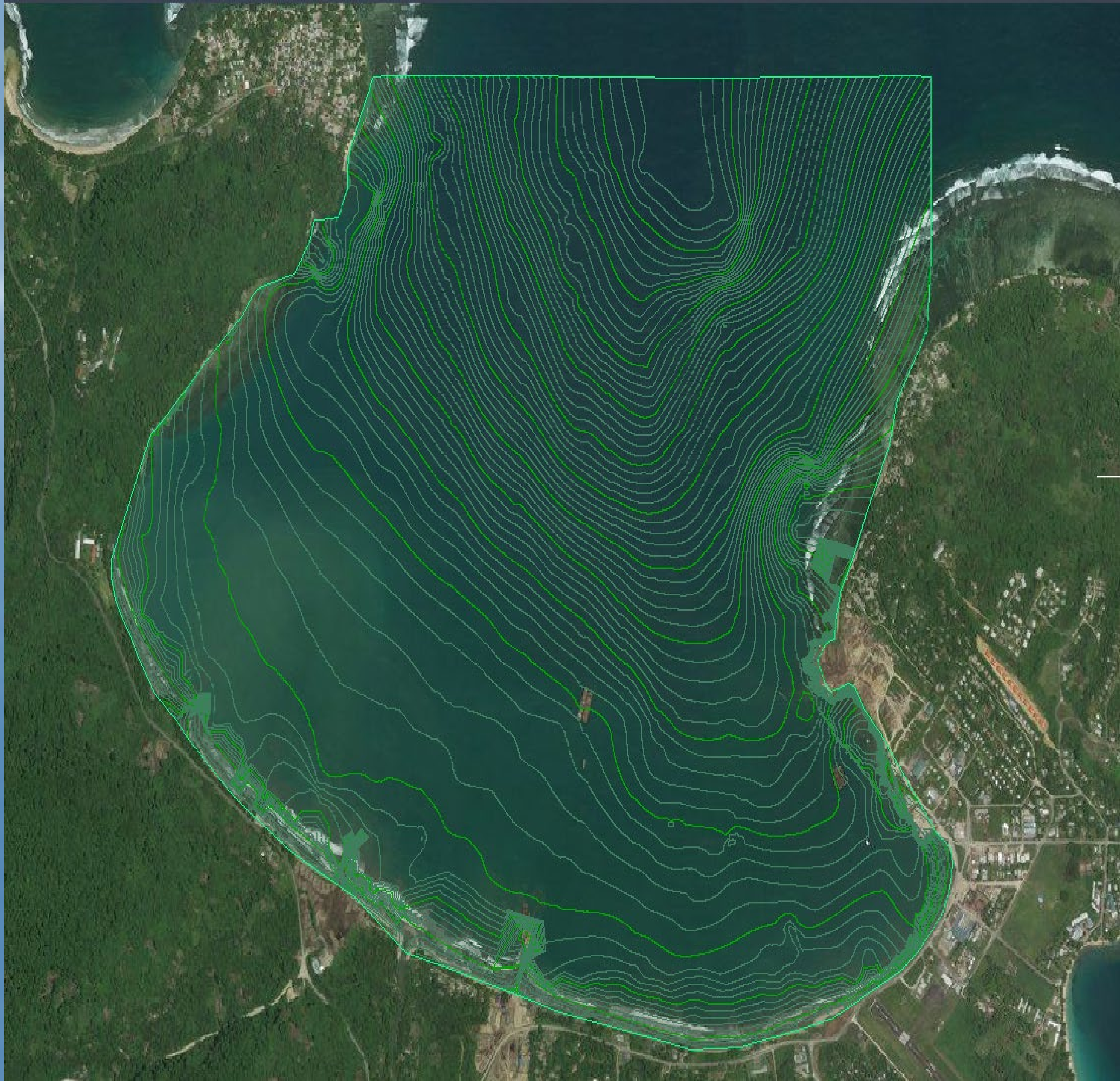
- Wewak Tidal Correction

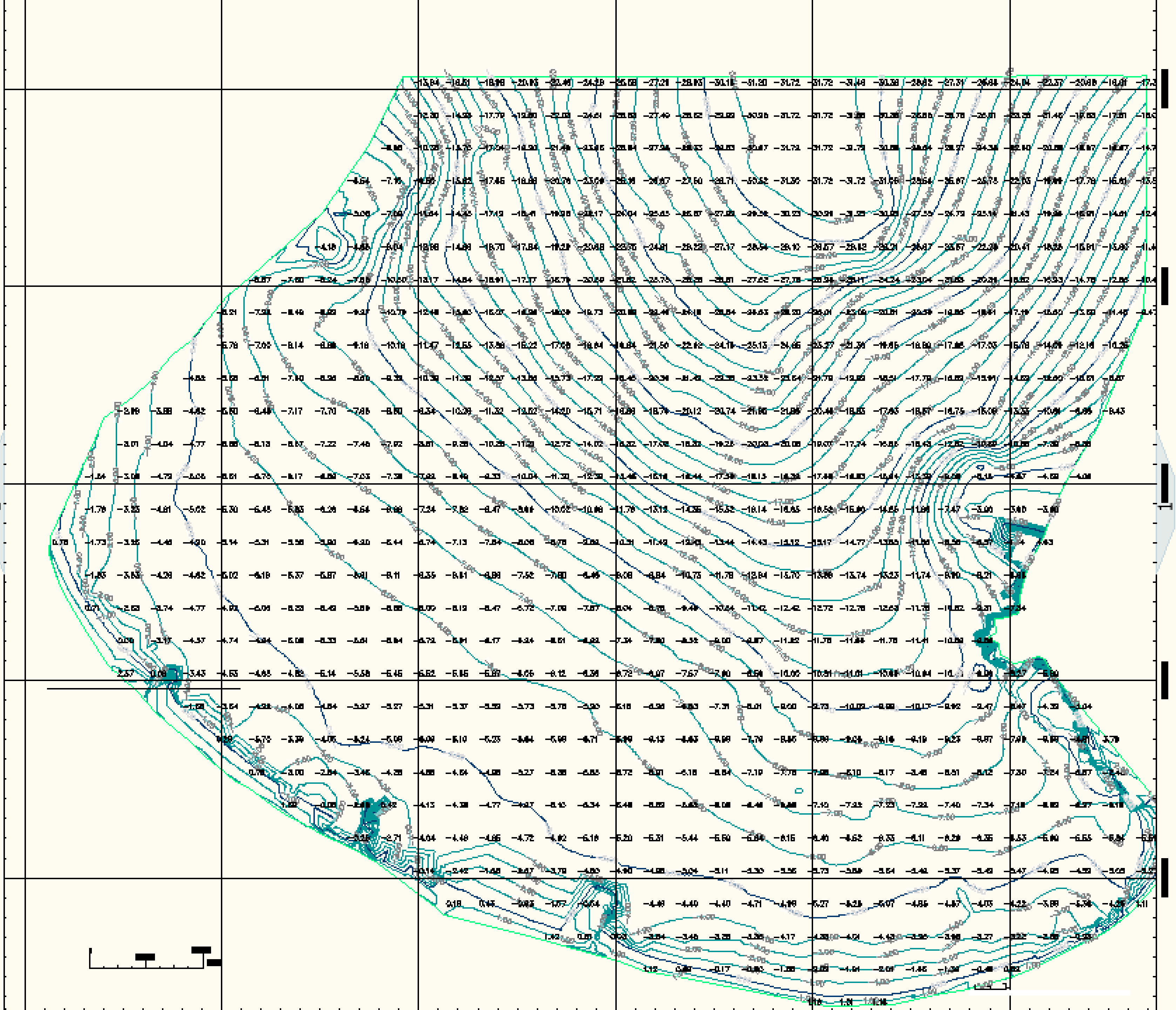
STATIONS	ELLIPSOID HEIGHT (m)	Geoid Separation	Distance from GPS to Transducer (m)	RTK Tide
Base A	80.298	77.046	2.05	1.202

Using RTK Tide value, the Charted Depth was calculated as:

CD = Observed Depth - RTK Tide

VANIMO CONTOUR AFTER APPLYING CORRECTION





LEGEND

KEY MAP

SCALE

1:1000

SHEET NUMBER

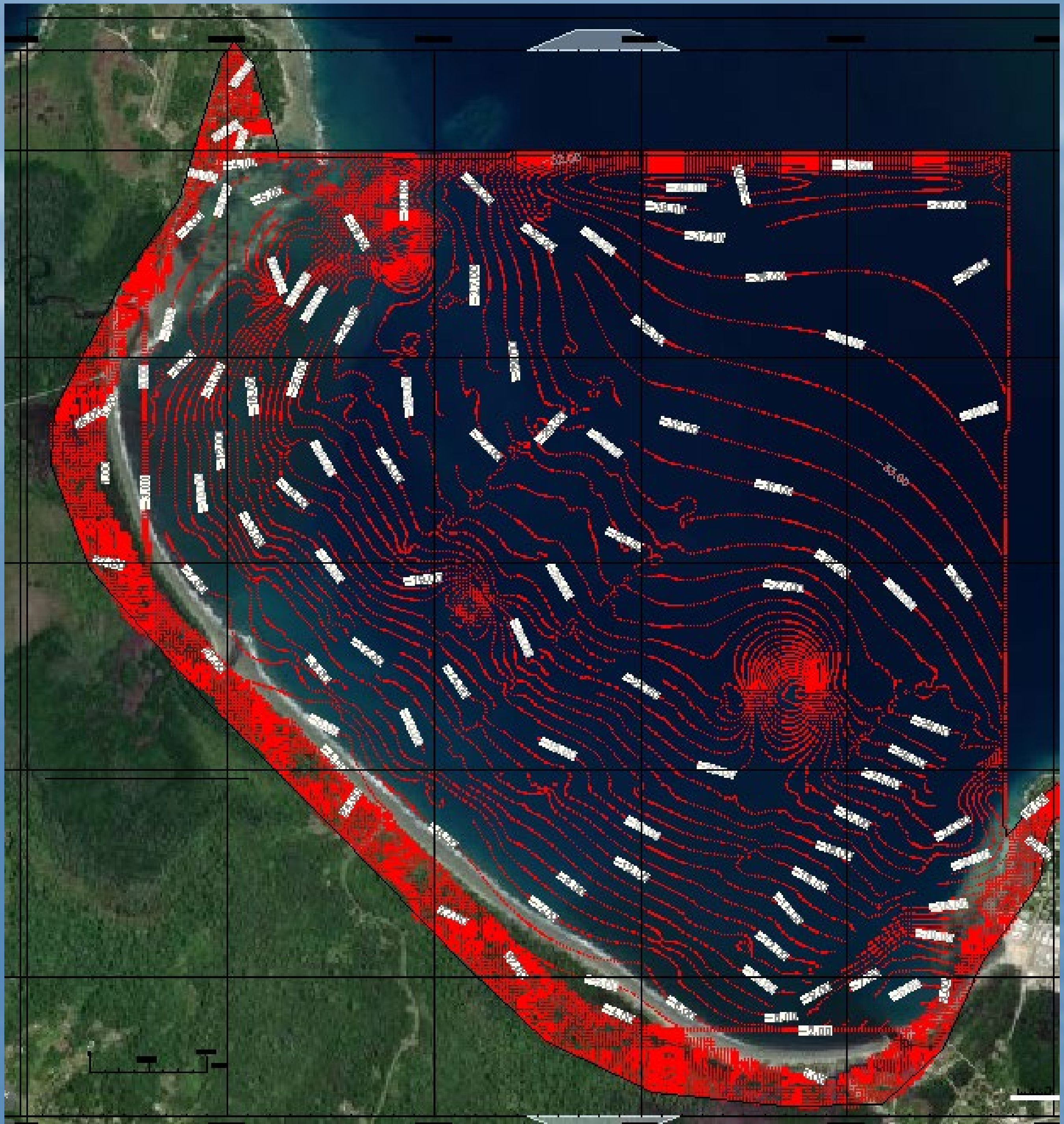
1

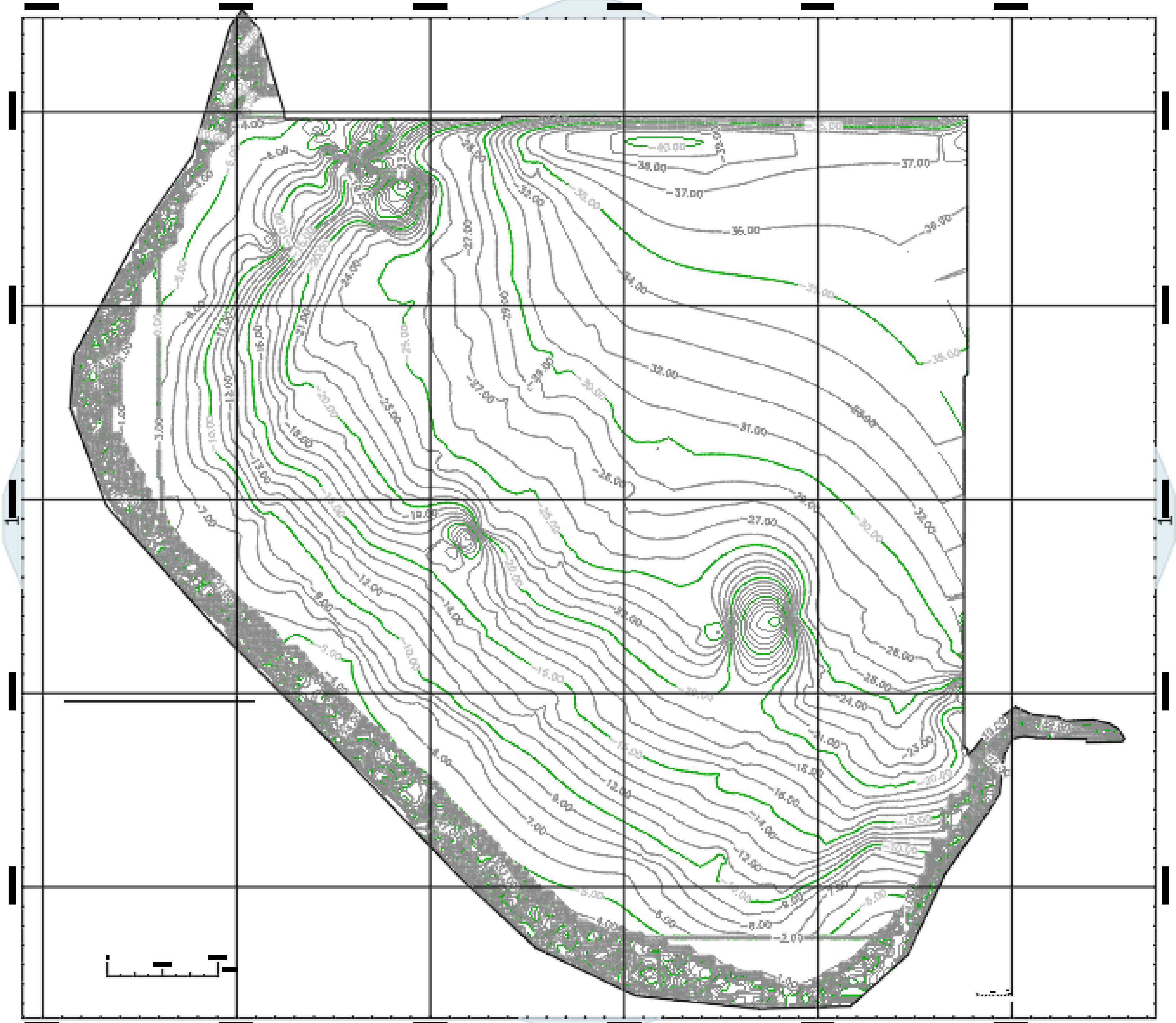
PLOT DATE

11/16/2022

FILE NAME

WEWAK CONTOUR AFTER APPLYING CORRECTION





Department of Surveying & Lands Studies

LEGEND

KEY MAP

SCALE	SHEET NUMBER
1:1000	1
PLOT DATE	
11/16/2022	

FILE NAME

Bathemetry of

CONCLUSION

- Bathymetric surveys at Vanimo and Wewak successfully provided reliable baseline hydrographic data for proposed port development and coastal planning.
- SBES integrated with GNSS-RTK proved to be a cost-effective and method for mapping seabed morphology and navigational depths.
- Seabed depths ranging from approximately **3 m to 35 m** were identified, highlighting important bathymetric features and potential navigation constraints.
- Bathymetric maps and digital terrain models were produced to support harbor design, dredging assessments, and infrastructure planning.
- The study demonstrates the importance of bathymetric surveying in supporting sustainable coastal development and evidence-based decision making in PNG.

RECOMMENDATION

- Conduct detailed follow-up surveys using **Multi-Beam Echo Sounder (MBES)** for complete seabed coverage and higher-resolution mapping.
- Establish permanent tidal monitoring stations to improve vertical datum consistency and long-term hydrographic monitoring.
- Undertake regular bathymetric surveys to monitor seabed changes, sedimentation, and navigational safety within harbor areas.
- Integrate bathymetric datasets with coastal management and land administration systems to support future planning and development.
- Utilize the survey results as a foundation for detailed engineering, environmental impact assessments, and port design studies.

END OF PRESENTATION!!!!!

Thank you!!!