Document:	**Hydrographic Survey Report**
Document no:	**NQ20240118**
Survey Class:	**MSQ Class C**
Area:	**Port Hinchinbrook, North Queensland**
Project name:	**Port Hinchinbrook Pre-Dredge Hydrographic Survey**
Client:	**Cassowary Coast Regional Council**
Contractor:	**SandMap Pty Ltd**
Supervising Hydrographic Surveyor:	**Ted Anderberg** AHSCP Level 1
Hydrographic Surveyor:	**Luiz Schmidt** BSc(Oceanography)

General information

Document date:	18 January 2024
Survey date:	12 January 2024
Purpose of survey:	Pre-Dredge Hydrographic Survey
Survey vessel:	Sandpiper
Survey Areas:	Port Hinchinbrook

Reference documents

Method Statement	NQ20240102
Drawing numbers	SM1028

Contents

1 Introduction

SandMap Pty Ltd was contracted by the Cassowary Coast Regional Council to undertake a pre-dredge hydrographic survey of the main channel of Port Hinchinbrook, also known as One Mile Creek, shown as Priority 1 in Figure 1 below. The project was to be surveyed using one spring high tide period, with other areas to be surveyed if time permitted. The remaining areas were prioritised as shown in Figure 1 below.

Research prior to the survey showed that a significant proportion of the areas required were drying areas above 0m LAT and as such the project would have to be carefully managed to utilise the high tide period to achieve maximum coverage of the survey area. Additionally, the only boat ramp available for launching a survey vessel had restricted access at low tide creating challenging conditions for navigation.

The requirements were to provide a survey to Class C specifications, but with full coverage using swath bathymetry. Full coverage was achieved for the main entrance channel (priority area 1), from the boat ramp to the seaward entrance, and additionally for priority area 2 in the southern marina area. Priority 3 was attempted but not completed as the falling tide and the very shallow water precluded navigation over the small remaining area. Figure 2 below shows the completed survey area.

Weather conditions leading up to the survey were wet with 100mm of rain falling the night prior to the survey and further rainfall in the days preceding. Fortunately, the day of the survey proved reasonable with 10 to 15 knot easterly winds and partly cloudy conditions with a shower or two. These conditions were easily handled by the 5m survey vessel *Sandpiper*.

This report will provide details on the adherence of the survey to the submitted Method Statement NQ20240102, along with information detailing checks and calibrations carried out. Full results of these checks are detailed in the appendices.

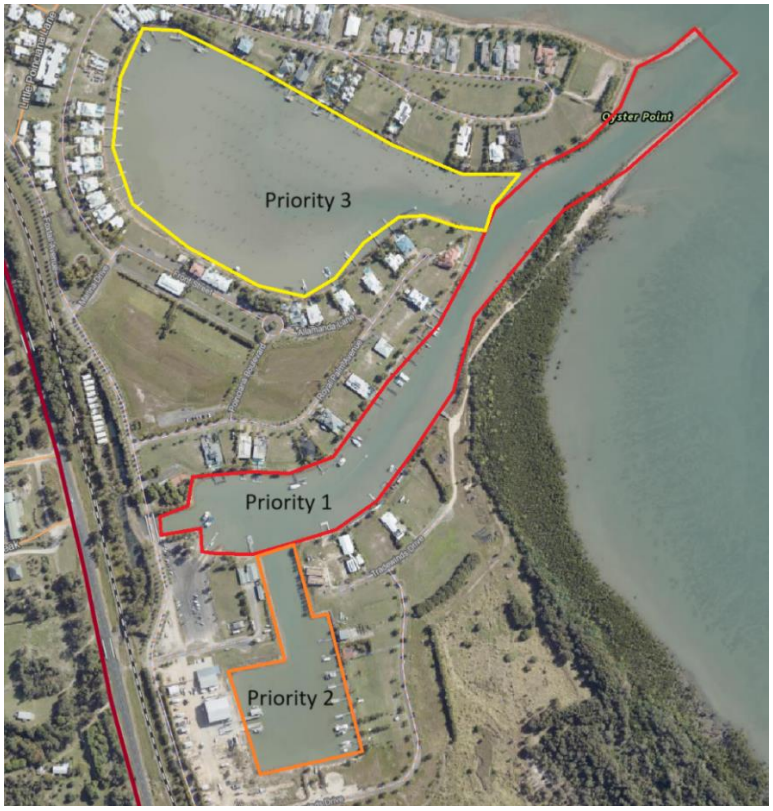


Figure 1: Survey priority areas. Priority 1 area was required while 2 and 3 surveyed if possible.

Figure 2: Site image showing the extent of the captured bathymetry.

2 Personnel

Adheres to Method Statement ☑

The survey was undertaken in the field by one of SandMap's survey team and included hydrographic surveyor Ted Anderberg and hydrographic survey technician Luiz Schmidt. SandMap's hydrographic survey technicians Gene Rippin and Luiz Schmidt assisted with office processing.

Details on the personnel involved in this survey are below:

Hydrographic Survey Team	Qualifications / Experience
Ted Anderberg SandMap Survey Manager	BSurv AHSCP Level 1 Certified Hydrographic Surveyor Coxswain Grade 1 Near Coastal 30 years hydrographic survey experience
Luiz Schmidt Hydrographic Survey Technician	Bachelor of Science (Oceanography) 8 months hydrographic survey experience
Gene Rippin Hydrographic Survey Technician / Coxswain	Bachelor of Science (Marine Biology) Coxswain Grade 1 Near Coastal 1-year Hydrographic survey experience

3 Workplace Health and Safety

Safety on board the vessel *Sandpiper* was managed by the vessel master and SandMap's Survey Manager, Ted Anderberg and hydrographic survey assistant Luiz Schmidt. Ted is an AHSCP Level 1 certified hydrographic surveyor and holds an AMSA Coxswain Grade 1 Near Coastal certification with over 30 years of hydrographic survey experience.

Weather conditions during the survey period were managed such that on water conditions were mild, offering no more than a chop to 0.3m, and did not present a risk to safety. Boating traffic throughout the survey area was also noted as a potential safety issue which was dealt with during the survey. Overall, the traffic level was low.

Crocodiles were reportedly potentially present in the area. The vessel has high sides and all operations onboard were conducted keeping inboard at all times. The trailer was fitted with an automatic boat catch system that allowed for launch and retrieval without any personnel being in or near the water. The boat was driven on and off the trailer by the coxswain while the vehicle operator remained in the vehicle.

The vessel was in commercial 2D survey and operated under an up to date Safety Management System (SMS) as required by the Australian Maritime Safety Authority (AMSA). *Sandpiper* was equipped with appropriate safety equipment including first aid kit, life jackets, flares, radio communication, and EPIRB. Crew members were advised of the proper operation and location of safety gear on embarkation.

4 Horizontal Positioning

4.1 Horizontal Datum

Adheres to Method Statement ☑

The project horizontal datum is the Geocentric Datum of Australia 2020 (GDA2020) with grid coordinates projected onto the Map Grid of Australia 2020 (MGA2020) Zone 55.

4.2 Mapping System

Adheres to Method Statement ☑

Grid coordinates projected onto the Map Grid of Australia 2020 (MGA2020) Zone 55, central meridian of 147° East.

4.3 RTK Post Processing

Adheres to Method Statement ☑

The SBG Ekinox 3 INS integrated with the Edge Tech 6205s2 includes an inbuilt dual antenna GNSS system capable of receiving RTK corrections. Integrated RTK GNSS and inertial solution is utilised within the Discover Bathymetric control software to process swath data before sending a corrected solution to Qinsy acquisition software.

The RTK GNSS data was not post processed as the RTK solution proved to be within horizontal and vertical accuracy tolerances when checked at survey control marks, and when compared to data captured using secondary standalone RTK GNSS equipment.

4.4 Required Precision

Adheres to Method Statement ☑

A total horizontal uncertainty of plus or minus 0.5m at a 95% confidence level was determined for this project. Horizontal accuracy checks as detailed below proved the system was well within this specification during the project.

Details of THU as calculated within Qimera for the Edge Tech 6205s2 hybrid interferometric system are shown below.

Surface Information

Dimensions: 5349 rows x 4809 columns

Cell Size: 0.25 x 0.25 m

Bounds:

X Range: 398857.88 to 400059.88 m

Y Range: 7977951.63 to 7979288.63 m

Z Range: -1 to 0 m

Coordinate System:

GDA2020 / Map Grid of Australia zone 55 + Fixed Height Offset

Total Cells: 25713184

Survey Area: 189464.000 m²

Attribute Statistics

Mean: 0.29

Std Dev: 0.10

Median from Histogram: 0.27

95% Confidence Level (1.96*stdev): 0.196

Data Range: [0.039, 0.792]

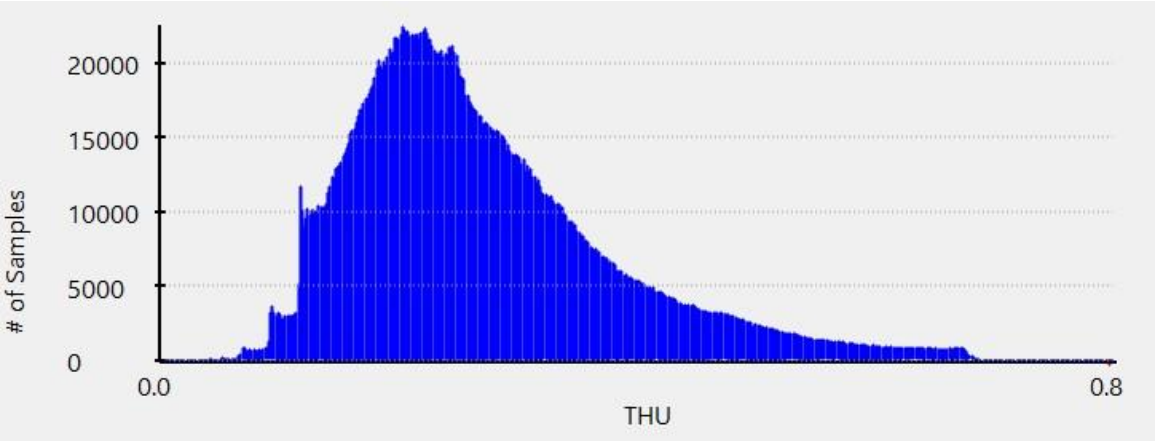


Figure 3: EdgeTech 6025s2 THU

4.5 Rejection Criteria for Position Data

Adheres to Method Statement ☑

Filters were used to ensure minimum satellite count was 6 and a satellite elevation mask of 15° was set. During the project the satellite count was rarely below 20, due to the system using 5 constellations. This ensured the maximum HDOP of 4 and maximum VDOP of 2 was easily met. The maximum age of corrections was 3 seconds.

5 Horizontal Control

Adheres to Method Statement ☒

For this project, a SmartNet Australia iMAX solution was utilised and calculated from GNSS base stations located at Lucinda (MRT4) and Cardwell (CDWL). The Regulation 13 certificates for these base stations can be found at Appendix B: Regulation 13 Certificate.

Initial checks carried out using an Altus NR3 quad constellation RTK GNSS unit against marks PSM10019 and PSM76290 in Cardwell with low horizontal uncertainties, close to the site, produced good results confirming suitable accuracy of the base station solution for use over the survey area.

Check results can be found in Appendix A: Survey Control Checks.

6 Vertical Datums

6.1 Marine Datum

Adheres to Method Statement ☑

All reported depths on plans are referenced to Lowest Astronomical Tide.

Digital data supplied was to LAT.

7 Connection to Vertical Control

Adheres to Method Statement ☒

Recovery marks PSM10019 and PSM76290 from MSQ Tidal Station Number 035012A documentation, located in Cardwell, were used in the setup and checking of the GNSS base station solution, with accuracies within specification for LAT values. To determine this, ellipsoid heights were surveyed, and a single ellipsoid separation value of -57.942m applied. This value was determined by MSQ for the adjacent Cardwell tide gauge.

All control points were also surveyed to AHD using AUSGeoid2020. Resulting values compared favourably with AHD values held in the SCDB.

Results from these checks are tabulated in Appendix A: Survey Control Checks in this report.

7.1 Method Used to Reduce Depths to Datum

Adheres to Method Statement ☑

LAT was derived by capturing ellipsoid heights and then applying a single ellipsoid separation value of -57.942 as recommended by MSQ.

The results of these checks are tabulated in Appendix A: Survey Control Checks in this report.

8 Depth Measurement

8.1 Survey Vessel

Adheres to Method Statement ☑

Survey vessel *Sandpiper* is a mono hull aluminium boat made by Stabicraft, commercially registered through AMSA in 2D survey. It is 5.0m in length with a beam of 2.2m and having a draft of 0.3m. GPS antennae are fixed in position while the sonar is attached to a Universal Sonar Mount (port side amidships) designed and tested to lift out of the water and return to precisely the same position.

Figure 4: Survey Vessel Sandpiper

8.2 Multi-Beam Echo Sounder System (MBES)

Adheres to Method Statement ☑

The EdgeTech 6205s2 used on this project is a fully integrated hybrid Wide Swath Bathymetry and Dual Frequency Side Scan Sonar System using 550/1600 kHz frequency options (Dual Frequency Side Scan with 550 kHz Bathymetry Data).

With the integration of EdgeTech's Full Spectrum® CHIRP technology, the 6205s2 exceeds IHO SP-44, NOAA specifications for Feature Detection and Bathymetric Point Data Uncertainty. It also incorporates a real time sonar head sound velocity sensor.

Specifications for the equipment can be found in Appendix D: Equipment Specifications.

Figure 5: EdgeTech 6205s2

8.3 Method To Compensate for Transducer Motion

Adheres to Method Statement ☑

An integrated SBG Systems Ekinox 3 GNSS/INS with a Septentrio AsteRx4 RTK GNSS Kit is incorporated into the EdgeTech 6205s2 unit fitted to the USM on the vessel and was used for this project for RTK GNSS and inertial information.

The Ekinox is a MEMS-based inertial system that includes an internal measurement unit (IMU) and extended Kalman filter. It incorporates an RTK GNSS system with dual antennae and is mounted within the unit enclosure.

8.4 Limiting Sea Conditions Affecting Survey Quality

Adheres to Method Statement ☑

Conditions for the survey on the day were generally calm with light winds ranging from 10 to 15 knots winds from the east. Channel conditions were essentially smooth experiencing <0.3m chop throughout the survey.

The MRU integrated into the EdgeTech 6205s2 was able to compensate for the conditions encountered.

Figure 6: Reasonably calm conditions in the survey area

8.5 Method Used to Determine Least Depths

Adheres to Method Statement ☑

Depths were logged to a 0.25m BIN and displayed in Qinsy in real time on a 0.25m x 0.25m grid. After data cleaning, a 0.5m x 0.5m BIN of minimum depths was created. The 0.5m x 0.5m minimum depth BIN was used for depth plotting and contour generation.

9 Seabed Coverage

9.1 Method to Ensure Seabed Coverage Criteria is Met

Adheres to Method Statement ☑

Survey lines were run to best suit the sand and mud banks and to avoid collisions with objects and vessels in the area, focusing on the priority areas in descending order. Survey lines were run along the channel. Line spacings were used that allowed 100% overlap for 200% coverage of the seabed within the survey extents marked.

Zigzag checklines were run in three sections of the survey area at the end of the survey.

9.2 Echo Sounder Pulse Repetition Rate

Adheres to Method Statement ☑

Ping rate was at least 30 pings per second at 15m range.

9.3 Beam Widths Along and Across Track

Adheres to Method Statement ☑

Beamwidth for the EdgeTech system was 0.4°. Swath range was kept to maximum 6 x depth in water over 5m depth and extended up to 10 times in less than 1m depth to cover as much as possible. At all times the swath edge was monitored for quality and swath width reduced if significant deterioration was noted.

9.4 Survey Vessel Speed Over Ground

Adheres to Method Statement ☑

SOG was generally 4 to 5 knots on average to maintain good data density and to ensure safe operation.

9.5 Sounding Line Spacing and Orientation

Adheres to Method Statement ☑

Sounding lines were run at 8m spacings to more than satisfy Class C requirements and to provide 100% overlap and 200% coverage. The main lines were run along the channel with other lines following an opportunistic path as the bank and other conditions allowed. Zigzag checklines across the channel were run at the end of the survey for checking purposes.

9.6 Rejection Criteria for Line Running

Adheres to Method Statement ☑

Lines were run to ensure 100% overlap and hence 200% coverage in line with navigation surveys. QA checks for data density and overlap confidence were carried out real time. Additional lines were run where necessary.

10 Calibration and Quality Assurance

Equipment tests have been run regularly on previous projects and equipment dialled in with offsets known and incorporated within the software prior to the commencement of this survey. All results for the checks detailed below can be found in Appendix C: Calibration Checks.

10.1 Static Calibration Method

Adheres to Method Statement ☑

The Altus NR3 RTK GNSS unit was used to establish local control at the vessel launch site at the Port Hinchinbrook boat ramp pontoon for initial checks and additionally to measure directly to a coordinated layback point on the vessel which could then be compared with the corresponding data produced by the Qinsy data acquisition system. Results detailed at Appendix C: Calibration Checks.

10.2 Dynamic Calibration

Adheres to Method Statement ☑

Pre and post survey system checks undertaken at predetermined marks including heading checks. Patch tests carried out previously. Details and results shown in Appendix C: Calibration Checks.

10.2.1 Dynamic Draft Calibrations

Adheres to Method Statement ☑

RTK GNSS heighting was used for depth reduction to chart datum.

10.2.2 Patch Tests

Patch tests were undertaken recently to determine equipment calibration. Patch tests have been undertaken frequently prior to this project and equipment offsets dialled in correctly. No change to previous values were required in the most recent calibration.

The results are detailed at Appendix C: Calibration Checks.

10.3 Bar Check

Adheres to Method Statement ☑

Bar check equivalent was carried out on this project. The seabed surface around the boat ramp launch site at Port Hinchinbrook was surveyed in a number of locations using a pole mounted RTK GNSS unit to create a small reference surface. Prior to commencement of survey this area was surveyed and known positions compared with the data acquired. Overall, a standard of < 5cm was maintained over the duration of the job.

10.4 Water Column Sound Velocity Profile Calibrations

Adheres to Method Statement ☑

Sound Velocity Profile dips were taken using a Valeport SWiFT SVP instrument at no more than 2 hour intervals or when the surface sound velocity sensor indicated a change.

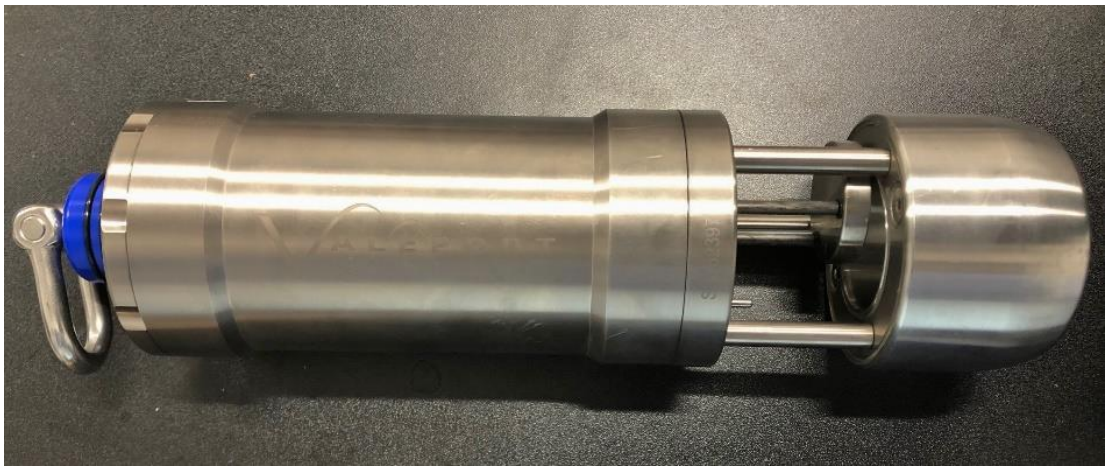


Figure 7: Valeport SWiFT SVP

11 Sounding Reduction and Data Presentation

11.1 Methods to Reduce Raw Data to Sounding Datum

Adheres to Method Statement ☑

Qimera software was used to reduce soundings to LAT by use of a single ellipsoid separation value of -57.942m as recommended by MSQ.

Details and check results can be found in Appendix A: Survey Control Checks.

11.2 Principle and Method Used in Sounding Selection

Adheres to Method Statement ☑

Soundings were shoal biased and selected to avoid overwriting.

11.3 Principle and Process for Rounding of Soundings

Adheres to Method Statement ☑

Soundings were rounded up about the 0.05m for the plans. Values of 0.050m and greater were rounded up while 0.049m and less were rounded down. Values displayed to one decimal point.

11.4 Positioning of Selected Soundings

Adheres to Method Statement ☑

All soundings retained their actual position during the selection and plotting process. The location of each labelled depth is the position of the decimal point.

11.5 Method of Contour Generation

Adheres to Method Statement ☑

Contours were generated from a TIN (Triangulated Irregular Network) of the 0.5 x 0.5cm CUBE surface.

11.6 Scale of Plans

Adheres to Method Statement ☑

The scale of the soundings plot supplied was 1:2000 at A1 size.

11.7 Digital Format of Final Data

Adheres to Method Statement ☑

The data was supplied digitally as ASCII files in MGA2020 datum in LAT height datum. Additionally, a survey plan was produced with a soundings plot with LAT heights. This was supplied in PDF format.

12 Data Quality and Retention

12.1 The Method(s) Used to Derive the Quality of the Data and Ability to Meet the Depth Tolerance as Required in the Standards

Adheres to Method Statement ☑

Zigzag checklines were run over the main lines run. Processed swath sounding data was statistically compared with these lines and corresponding data from crossing lines. The RMSE of the differences of corresponding data was within 0.2m at the 95% confidence level (where: RMSE (95%) = 1.96 x RMSE (1 sigma)).

The cross line check below indicates data quality for the EdgeTech (hybrid interferometric) system acquired data compared to EdgeTech acquired check lines.

Summary Cross Line Check

Surface Characteristics Information
Name: x line check
Dimensions: 2688 rows x 2432 columns
Cell Size: 0.500000
Bounds:
X Range: 398858.3 to 400073.8
Y Range: 7977953.3 to 7979296.8
Z Range: -0.48 m to 0.33 m
Horizontal Coordinate System:
GDA2020 / Map Grid of Australia zone 55 + Fixed Height Offset

Surface Statistics Information
Name: last x line check
Median: 0.00
Mean: 0.00
Std Dev: 0.06
Height Range: [-0.447, 0.330]
Total 2D Surface Area: 8362.25
Positive (above 0.0) 2D Surface Area: 4311.50
Negative (below 0.0) 2D Surface Area:4050.75
Total Volume: 33.96
Positive (above 0.0) Volume: 204.30
Negative (below 0.0) Volume: 170.34
95% Confidence Level (1.96*stdev): 0.118

Details of TVU as calculated within Qimera for the Edge Tech 6205s2 hybrid interferometric system are shown below.

Calculated TVU

Surface Information
Dimensions: 5349 rows x 4809 columns
Cell Size: 0.25 x 0.25 m
Bounds:
X Range: 398857.88 to 400059.88 m
Y Range: 7977951.63 to 7979288.63 m
Z Range: -1 to 0 m
Coordinate System:
GDA2020 / Map Grid of Australia zone 55 + Fixed Height Offset
Total Cells: 25713184
Survey Area: 189464.000 m²

Attribute Statistics
Mean: 0.07
Std Dev: 0.03
Median from Histogram: 0.06
95% Confidence Level (1.96*stdev): 0.059

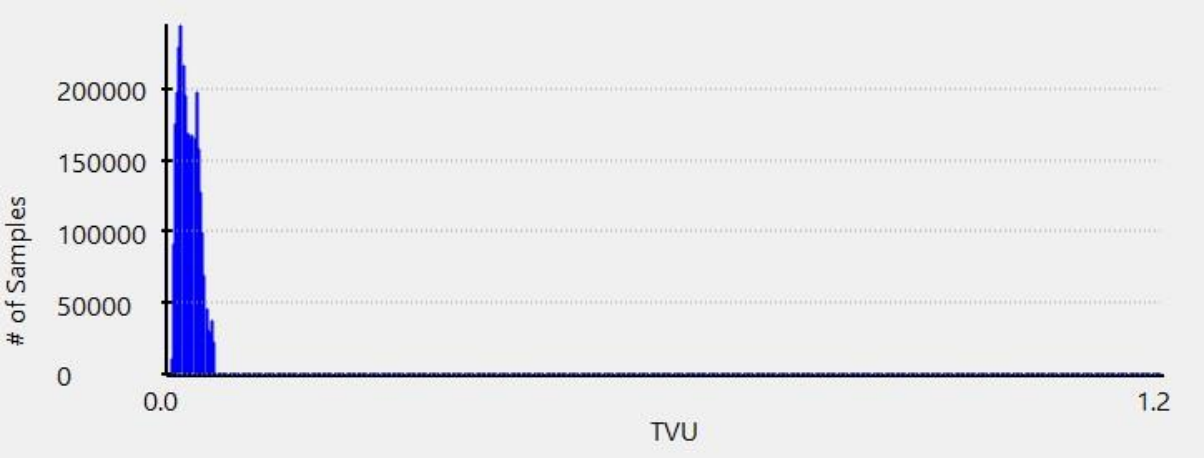


Figure 8: EdgeTech 6025s2 TVU

12.2 The Time Frame(s) and Those Responsible for Retention of Raw Data Gathered During the Survey and the Final Results

Adheres to Method Statement ☑

Raw and processed survey data will be stored for a minimum of 2 years by SandMap.

13 Deliverables

The deliverables consisted of the following:

Port_Hinchinbrook_0.5m_MGA2020_LAT.xyz	Comma separated ASCII file (Easting, Northing, Height) in MGA2020 datum with LAT height datum. 0.5m grid.
Port_Hinchinbrook_0.5m_MGA2020_LAT.tif	Bathymetry Geotiff at 1m resolution in MGA2020 and LAT datum.
Port Hinchinbrook Pre-Dredge Hydrographic Survey - SM1028	PDF document consisting of survey plan with LAT height datum. Plan number: SM1028.
Port Hinchinbrook Pre-Dredge Hydrographic Survey Report – NQ20240118.pdf	Report of Survey.

Signatures

I certify that this Survey Report and the variations described herein conform to the Hydrographic Survey meeting the Survey Class.

Edward (Ted) Anderberg

Certified Practicing Hydrographic Surveyor Level 1
AHSCP Geospatial Council of Australia

Appendix A: Survey Control Checks

Equipment	Septentrio NR3 RTK		**Date**	12/01/2024
Base Station	HxGN SmartNet	iMAX		

Published SCIMS						
Station	**Easting**	**Northing**	**LAT**	**AHD**	**HU**	**VU**
PSM10019	397459.311	7979918.520	7.514	5.649	0.016	Class A/ 1st ORDER
PSM76290	397384.073	7979837.521	8.513	6.667	0.150	Class D/ 4th ORDER

Observed (using Ausgeoid2020) MGA2020 (Zone 55) NR3																			
Station	**Easting**	**Northing**	**LAT**	**AHD**	**dE**	**dN**	**dLAT**	**dAHD**	**HSDV**	**VSDV**	**Status**	**Satellites**	**Age**	**PDOP**	**HDOP**	**VDOP**	**TDOP**	**GDOP**	**Comments**
PSM10019	397459.3306	7979918.541	7.5254	5.669	-0.020	-0.021	-0.011	-0.020	0.009	0.012	FIXED	17	2.0	1.475	0.640	1.270	0.932	1.745	00 point averag
PSM76290	397384.0552	7979837.473	8.5241	6.668	0.018	0.048	-0.011	-0.001	0.009	0.013	FIXED	19	2.0	1.458	0.820	1.250	0.963	1.747	00 point averag

Australian Government
Geoscience Australia

Certificate of Verification of a Reference Standard of a Position-Measurement in Accordance with Regulation 13 of the National Measurement Regulations 1999 and the National Measurement Act 1960

Name of Verifying Authority:

Name: National Positioning Infrastructure Branch
Organisation: Geoscience Australia
Address: Corner Jerrabomberra Ave and Hindmarsh Drive, Symonston ACT 2609 Australia
Telephone: (02) 6249 9111
Email: geodesy@ga.gov.au

Client detail:

Name: David Greaves
Organisation: Department of Transport and Main Roads
Address: 313 Adelaide Street, Brisbane, Qld 4000
Telephone: (07) 3066 8979
Email: David.J.Greaves@tmr.qld.gov.au
Date of request: 07 June 2022

Description and denomination of standard of measurement:

The measurement was undertaken using an antenna `LEIAS10 NONE` (International GNSS Service antenna naming convention) with the serial number 17281043 and refers to a point located 0.0350 m below the antenna reference point. The antenna is attached to a galvanised steel post on a building via a galvanised steel post with seco 2072.30. The station (4 character ID: CDWL) is located at Cardwell, QLD. The certificate was determined using data from 03 July 2022 to 09 July 2022 inclusive. Analysis was undertaken following the procedures detailed in Geoscience Australia's GPS Analysis Manual for the Verification of Position issue 2.2. The reference number of this certificate is CDWL01082022.

Permanent distinguishing marks:

Exempt under Regulation 16 (4)

Date of verification: 01 August 2022

Date of expiry of certificate: 01 August 2027

NATA Accredited for compliance with ISO/IEC 17025 - Calibration. Accreditation No. 15002.

Value of standard of measurement:

Station (4 character ID): CDWL

South Latitude and its uncertainty of value:

18° 16' 1.67826" ± 0.00029" (0.009 m)

East Longitude and its uncertainty of value:

146° 1' 19.69981" ± 0.00029" (0.009 m)

Elevation above Ellipsoid and its uncertainty of value:

72.246 ± 0.028 m

Geocentric Datum of Australia (GDA2020) coordinates referred to the GRS80 ellipsoid being in the ITRF2014 reference frame at the epoch 2020. The uncertainties are calculated in accordance with the principles of the ISO/IEC 98-3 Uncertainty of Measurement - Part 3: Guide to the Expression of Uncertainty in Measurement (2008), with an interval estimated to have a confidence level of 95% at the time of verification. The combined standard uncertainty was converted to an expanded uncertainty using a coverage factor, k, of 2. Measurement traceability is ensured against the recognised value standard for position of the Australian Fiducial Network.

Details of any relevant environmental or other influence factor(s) at the time of verification:

Uncertainty of the coordinates of the recognized-value standard of measurement of position (i.e. GDA2020); and Uncertainty due to instability of the GPS antenna mounting and modelling of the antenna phase centre variations.

Signature:
01 August 2022
Dr John Dawson
Geoscience Australia approved signatory
National Positioning Infrastructure Branch
Geoscience Australia

Being a person, or a person representing a body, appointed as a verifying authority under Regulations 71 and 73 of the National Measurement Regulations 1999 in accordance with the National Measurement Act 1960, I hereby certify that the above standard is verified as a reference standard of measurement in accordance with the Regulations, by the above-named authority.

Appendix B: Regulation 13 Certificate

Lucinda Base Station (MRT4)

Australian Government
Geoscience Australia

Certificate of Verification of a Reference Standard of a Position-Measurement in Accordance with Regulation 13 of the National Measurement Regulations 1999 and the National Measurement Act 1960

Name of Verifying Authority:

Name: National Positioning Infrastructure Branch
Organisation: Geoscience Australia
Address: Corner Jerrabomberra Ave and Hindmarsh Drive, Symonston ACT 2609 Australia
Telephone: (02) 6249 9111
Email: geodesy@ga.gov.au

Client detail:

Name: Stephen Mallows
Organisation: Department of Transport and Main Roads
Address: Northern District, Floor 6, 445 Flinders Street, QLD 4810
Telephone: (07) 4421 8777
Email: David.A.Dance@tmr.qld.gov.au
Date of request: 02 August 2018

Description and denomination of standard of measurement:

The measurement was undertaken using an antenna `LEIAS10 NONE` (International GNSS Service antenna naming convention) with the serial number 13501072 and refers to a point located 0.0000 m below the antenna reference point. The antenna is attached to a heavy duty steel post on a rag bolt footings via a heavy duty steel post. The station (4 character ID: MRT4) is located at Lucinda, QLD. The certificate was determined using data from 15 July 2018 to 21 July 2018 inclusive. Analysis was undertaken following the procedures detailed in Geoscience Australia's GPS Analysis Manual for the Verification of Position issue 2.2. The reference number of this certificate is MRT422082018.

Permanent distinguishing marks:

Exempt under Regulation 16 (4)

Date of verification: 22 August 2018

Date of expiry of certificate: 22 August 2023

NATA

Accredited for compliance with ISO/IEC 17025 - Calibration. Accreditation No. 15002.

Value of standard of measurement:

Station (4 character ID): MRT4

South Latitude and its uncertainty of value:

$$18^\circ\ 31'\ 39.64734" \pm 0.00023"\ (0.007\ m)$$

East Longitude and its uncertainty of value:

$$146^\circ\ 19'\ 42.15552" \pm 0.00023"\ (0.007\ m)$$

Elevation above Ellipsoid and its uncertainty of value:

$$68.362 \pm 0.015\ m$$

Geocentric Datum of Australia (GDA2020) coordinates referred to the GRS80 ellipsoid being in the ITRF2014 reference frame at the epoch 2020. The uncertainties are calculated in accordance with the principles of the ISO/IEC 98-3 Uncertainty of Measurement - Part 3: Guide to the Expression of Uncertainty in Measurement (2008), with an interval estimated to have a confidence level of 95% at the time of verification. The combined standard uncertainty was converted to an expanded uncertainty using a coverage factor, k, of 2. Measurement traceability is ensured against the recognised value standard for position of the Australian Fiducial Network.

Details of any relevant environmental or other influence factor(s) at the time of verification:

Uncertainty of the coordinates of the recognized-value standard of measurement of position (i.e. GDA2020); and Uncertainty due to instability of the GPS antenna mounting and modelling of the antenna phase centre variations.

Signature:
22 August 2018
Mr Gary Johnston
Geoscience Australia approved signatory

Branch Head
National Positioning Infrastructure Branch
Geoscience Australia

Being a person, or a person representing a body, appointed as a verifying authority under Regulations 71 and 73 of the National Measurement Regulations 1999 in accordance with the National Measurement Act 1960, I hereby certify that the above standard is verified as a reference standard of measurement in accordance with the Regulations, by the above-named authority.

Appendix C: Calibration Checks

C.1 Static Calibration Check of INS System by Direct Measurement

Data below from checks adjacent to boat ramp area. Areas of soft mud encountered.

Date: 12/01/2024

Comparison: Qinsy vs Rover	Qinsy	Rover	Diff
1	1.751	1.7495	-0.002
2	1.331	1.3757	0.045
3	1.025	0.97	-0.055
4	1.095	1.1123	0.017
5	0.811	0.8007	-0.010
6	1.07	1.0777	0.008
7	1.161	1.1607	0.000
8	1.241	1.2415	0.001
9	1.251	1.2507	0.000
10	1.071	1.0754	0.004
11	1.05	1.0181	-0.032
12	0.816	0.8248	0.009
13	0.752	0.7422	-0.010
14	0.761	0.7576	-0.003
15	0.974	0.9853	0.011
16	1.295	1.3202	0.025
17	1.676	1.7292	0.053

MRU Ref Point Easting	529933.46	529933.5	-0.04
MRU Ref point Northing	6854167.2	6854167	-0.070
Heading	33.5	32.99261	0.51

C.2 Patch Tests

C.2.1 Roll

Port Transducer

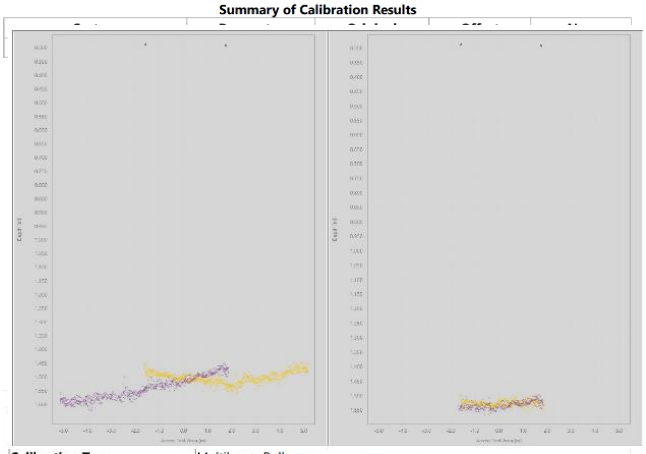
EdgeTech _6205s2

Roll port transducer

Patch Test Information

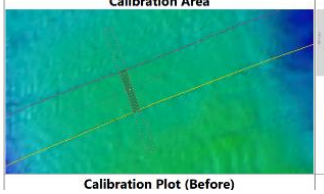
Project:	A:/Projects/Bribie Gardens Survey/Bribie Gardens
Software:	Qimera v2.5.1
Time of Report:	2023-08-30 02:22:58
Username:	Gene
Vessel Name:	Sandpiper
Lines In Patch Test:	01: 20230829_012142 - progress - 0001 (071°, 2.9 kts) 02: 20230829_011846 - progress - 0001 (248°, 2.3 kts)

Summary of Calibration Results



Calibration Type:	Multibeam Roll
Patch Location:	27°04'24.42"S, 153°10'05.36"E
Patch Heading:	71.0°
Patch Width:	10.39 meters
Patch Height:	0.60 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	-0.798°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.000°

Calibration Area



Calibration Plot (Before)

RMS Plot

Calibration Plot (After)

Starboard Transducer

EdgeTech _6205s2

Roll stbd transducer

Patch Test Information

Project:	A:/Projects/Bribie Gardens Survey/Bribie Gardens
Software:	Qimera v2.5.1
Time of Report:	2023-08-30 02:34:07
Username:	Gene
Vessel Name:	Sandpiper
Lines In Patch Test:	01: 20230829_013045 - progress - 0001 (069°, 3.1 kts) 02: 20230829_013809 - progress - 0001 (251°, 1.7 kts)

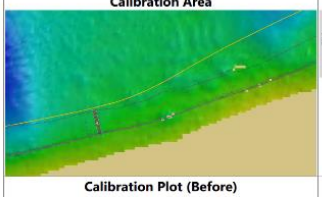
Summary of Calibration Results

System	Parameter	Original	Offset	New

Calibration Step 1

Lines Used:	01: 20230829_013045 - progress - 0001 (069°, 3.1 kts) 02: 20230829_013809 - progress - 0001 (251°, 1.7 kts)
Calibration Type:	Multibeam Roll
Patch Location:	27°04'24.88"S, 153°10'05.32"E
Patch Heading:	-14.0°
Patch Width:	0.36 meters
Patch Height:	2.66 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.000°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.420°

Calibration Area



Calibration Plot (Before)

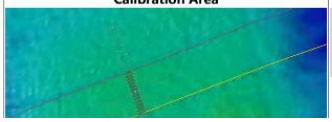
RMS Plot

Calibration Plot (After)

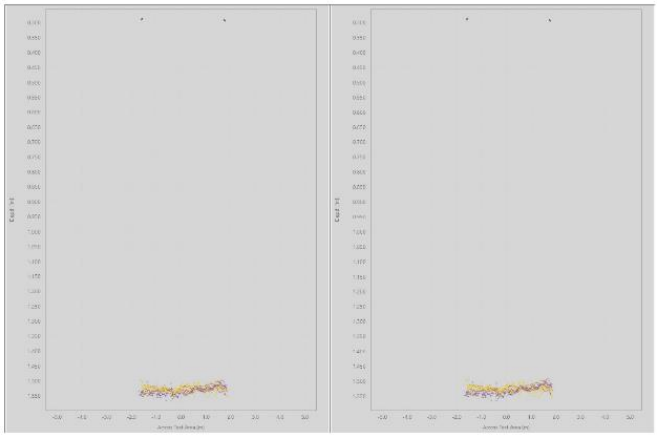
Calibration Step 2

Lines Used:	01: 20230829_012142 - progress - 0001 (071°, 2.9 kts) 02: 20230829_011846 - progress - 0001 (248°, 2.3 kts)
Calibration Type:	Multibeam Roll
Patch Location:	27°04'24.42"S, 153°10'05.36"E
Patch Heading:	71.0°
Patch Width:	10.39 meters
Patch Height:	0.60 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.081°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.000°

Calibration Area



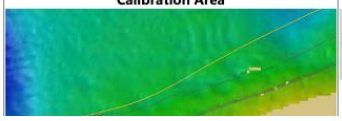
RMS Plot



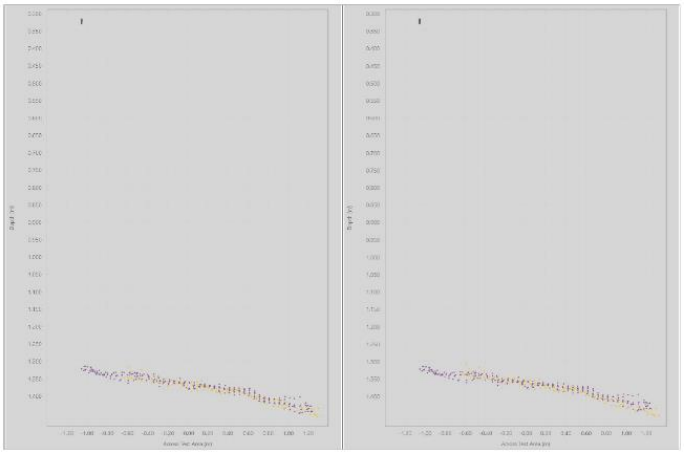
Calibration Step 2

Lines Used:	01: 20230829_013045 - progress - 0001 (069°, 3.1 kts) 02: 20230829_013809 - progress - 0001 (251°, 1.7 kts)
Calibration Type:	Multibeam Roll
Patch Location:	27°04'24.88"S, 153°10'05.32"E
Patch Heading:	-14.0°
Patch Width:	0.36 meters
Patch Height:	2.66 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.000°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	-0.229°

Calibration Area



RMS Plot



C.2.2 Pitch

EdgeTech _6205s2

pitch port transducer

Patch Test Information

Project:	A:/Projects/Bribie Gardens Survey/Bribie Gardens
Software:	Qimera v2.5.1
Time of Report:	2023-08-30 02:48:22
Username:	Gene
Vessel Name:	Sandpiper
Lines In Patch Test:	01: 20230829_012142 - progress - 0001 (071°, 2.9 kts) 02: 20230829_011846 - progress - 0001 (248°, 2.3 kts)

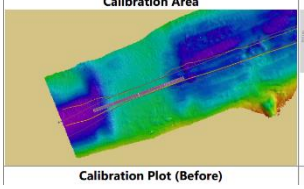
Summary of Calibration Results

System	Parameter	Original	Offset	New
Edgetech MPES Port	Pitch	0.000	0.495	0.495

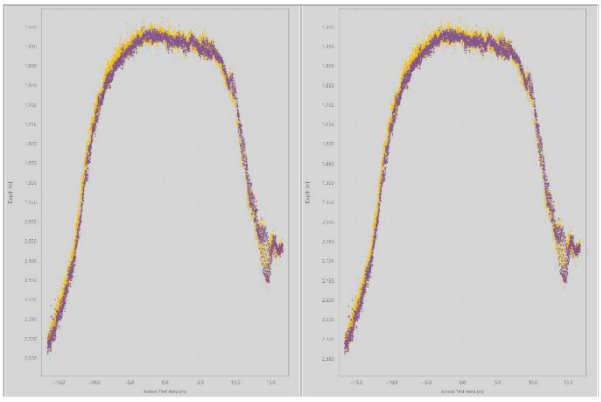
Calibration Step 1

Lines Used:	01: 20230829_012142 - progress - 0001 (071°, 2.9 kts) 02: 20230829_011846 - progress - 0001 (248°, 2.3 kts)
Calibration Type:	Multibeam Pitch
Patch Location:	27°04'24.44"S, 153°10'05.40"E
Patch Heading:	-20.0°
Patch Width:	33.42 meters
Patch Height:	1.00 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.495°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.000°

Calibration Area | **RMS Plot**



Calibration Plot (Before) | **Calibration Plot (After)**



EdgeTech _6205s2

pitch stbd transducer

Patch Test Information

Project:	A:/Projects/Bribie Gardens Survey/Bribie Gardens
Software:	Qimera v2.5.1
Time of Report:	2023-08-30 02:51:51
Username:	Gene
Vessel Name:	Sandpiper
Lines In Patch Test:	01: 20230829_013045 - progress - 0001 (069°, 3.1 kts) 02: 20230829_013809 - progress - 0001 (251°, 1.7 kts)

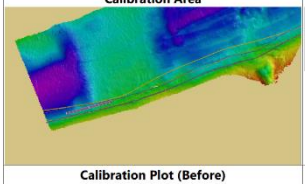
Summary of Calibration Results

System	Parameter	Original	Offset	New
Edgetech MPES Stbd	Pitch	0.000	1.179	1.179

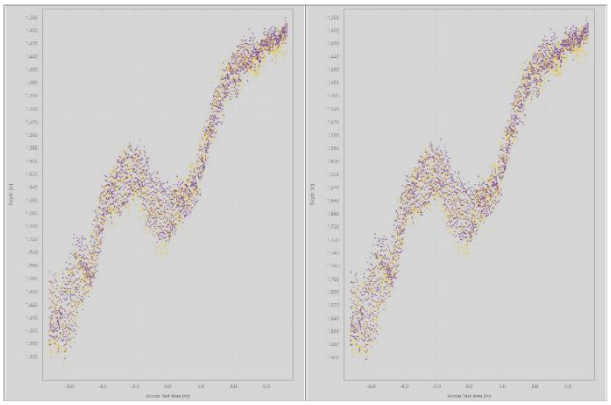
Calibration Step 1

Lines Used:	01: 20230829_013045 - progress - 0001 (069°, 3.1 kts) 02: 20230829_013809 - progress - 0001 (251°, 1.7 kts)
Calibration Type:	Multibeam Pitch
Patch Location:	27°04'24.92"S, 153°10'05.04"E
Patch Heading:	-15.0°
Patch Width:	14.54 meters
Patch Height:	0.62 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.000°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.666°

Calibration Area | **RMS Plot**



Calibration Plot (Before) | **Calibration Plot (After)**



C.2.3 Heading

EdgeTech _6205s2

Port heading patch

Patch Test Information

Project:	A:/Projects/Bribie Gardens Survey/Bribie Gardens
Software:	Qimera v2.5.1
Time of Report:	2023-08-30 03:06:14
Username:	Gene
Vessel Name:	Sandpiper
Lines In Patch Test:	01: 20230829_013257 - progress - 0001 (248°, 2.9 kts) 02: 20230829_012818 - progress - 0001 (249°, 2.9 kts)

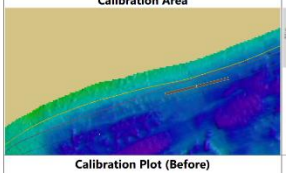
Summary of Calibration Results

System	Parameter	Original	Offset	New
Edgetech MPES Port	Heading	0.000	0.018	0.018

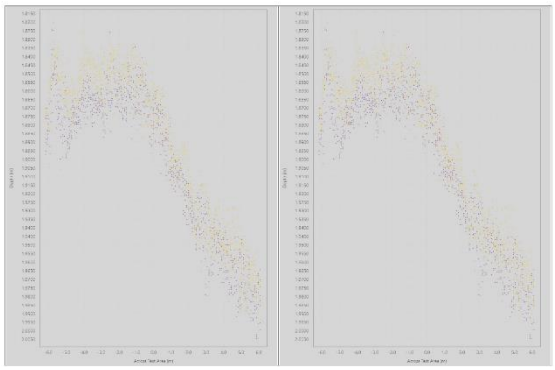
Calibration Step 1

Lines Used:	01: 20230829_013257 - progress - 0001 (248°, 2.9 kts) 02: 20230829_012818 - progress - 0001 (249°, 2.9 kts)
Calibration Type:	Multibeam Heading
Patch Location:	27°04'23.49"S, 153°10'06.85"E
Patch Heading:	-14.0°
Patch Width:	12.36 meters
Patch Height:	0.46 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.018°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.000°

Calibration Area | **RMS Plot**



Calibration Plot (Before) | **Calibration Plot (After)**



EdgeTech _6205s2

stbd heading patch

Patch Test Information

Project:	A:/Projects/Bribie Gardens Survey/Bribie Gardens
Software:	Qimera v2.5.1
Time of Report:	2023-08-30 03:10:55
Username:	Gene
Vessel Name:	Sandpiper
Lines In Patch Test:	01: 20230829_013516 - progress - 0001 (069°, 2.5 kts) 02: 20230829_012619 - progress - 0001 (067°, 3.5 kts)

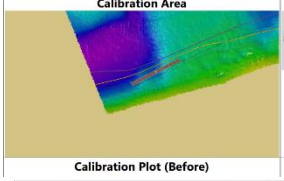
Summary of Calibration Results

System	Parameter	Original	Offset	New
Edgetech MPES Stbd	Heading	0.000	0.166	0.166

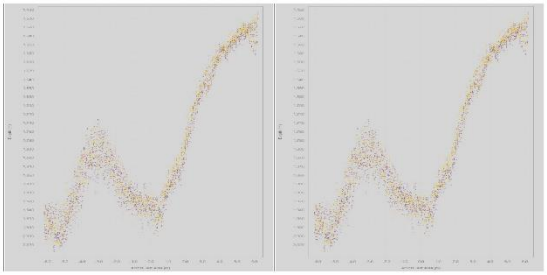
Calibration Step 1

Lines Used:	01: 20230829_013516 - progress - 0001 (069°, 2.5 kts) 02: 20230829_012619 - progress - 0001 (067°, 3.5 kts)
Calibration Type:	Multibeam Heading
Patch Location:	27°04'24.85"S, 153°10'05.02"E
Patch Heading:	-27.0°
Patch Width:	12.37 meters
Patch Height:	0.78 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.000°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.130°

Calibration Area | **RMS Plot**



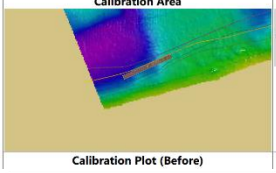
Calibration Plot (Before) | **Calibration Plot (After)**



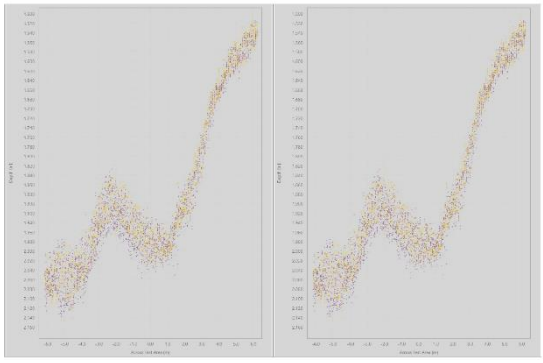
Calibration Step 2

Lines Used:	01: 20230829_013516 - progress - 0001 (069°, 2.5 kts) 02: 20230829_012619 - progress - 0001 (067°, 3.5 kts)
Calibration Type:	Multibeam Heading
Patch Location:	27°04'24.83"S, 153°10'04.99"E
Patch Heading:	-24.0°
Patch Width:	12.37 meters
Patch Height:	0.98 meters
Active Motion System:	SBG MRU
Active Gyro System:	SBG Gyro
Active Position System:	SBG Position
Calibration System:	Edgetech MPES Port
Head Offset Value:	0.000°
Calibration System:	Edgetech MPES Stbd
Head Offset Value:	0.036°

Calibration Area | **RMS Plot**



Calibration Plot (Before) | **Calibration Plot (After)**



Appendix D: Equipment Specifications

EdgeTech
The Leader in Underwater Technology

6205 S2

MULTI PHASE WIDE SWATH BATHYMETRY & SIDE SCAN SONAR

FEATURES & BENEFITS

- Option for integrated OEM Inertial Navigation System
- 4th generation MPES (Multi-Phase) technology
- Co-registered simultaneous dual frequency side scan data
- Bathymetry data which is IHO SP-44 Special Order compliant
- Bathymetry backscatter data
- Motion Tolerant side scan data
- Swath sectors of up to 200° means far shorter time for data collection
- Optimized Bathymetry modes: Equidistant and Equiangular
- EdgeTech's Discover Bathymetric control software
- Integrated sound velocity sensor
- Unrivaled swath coverage and resolution in shallow water when compared to other MBES or PDBS sonar.

APPLICATIONS

- Nautical Charting / Hydrographic Surveys
- Benthic Habitat Mapping
- Military Rapid Environmental Assessments (REA)
- Cable & Pipeline Route Surveys
- Dredging Operations
- Marine Debris Search
- Port & Harbor Security

OPTIONS

The following standard frequency configurations are available:

- 520/850 kHz (dual freq Side Scan and 520 kHz bathymetry)
- 520/850 kHz (dual freq Side Scan with 850 kHz bathymetry)
- 520/1600 kHz (dual freq Side Scan with 520 kHz bathymetry)
- 850/1600 kHz (dual freq Side Scan with 850 kHz bathymetry)

Note: "The following 3rd party OEM Inertial Navigation Units are available::

- APPLANIX AP+18EI, MV (Surfmaster)
- SBG Systems Ekinox 3

For Futher details, please contact EdgeTech.

The EdgeTech 6205 S2 is our 4th generation fully integrated Wide Swath Bathymetry and Dual Frequency Side Scan Sonar System that produces real time, high resolution, side scan imagery and three-dimensional maps of the seafloor. The 6205 S2 overcomes the limitations of Multi Beam Echo Sounders (MBES) and Interferometric (Phase Differencing) systems in shallow water by using EdgeTech's unique Multi-Phase Echo Sounder (MPES) technology. This unique Hybrid approach utilizes multiple receive arrays and combines both Beamforming and Phase Differencing techniques to determine each sounding along the seafloor. With the integration of EdgeTech's Full Spectrum® CHIRP technology, the 6205 S2 exceeds IHO SP-44, NOAA, and USACE specifications for Feature Detection and Bathymetric Point Data Uncertainty.

EdgeTech's MPES technology enables the 6205 S2 to produce wider and cleaner swath (over 200°) than current technologies, resulting in superior coverage enabling faster and safer survey completion. At the same time, the 6205 S2 rejects multipath effects, reverberation, and acoustic noise commonly encountered in wide swath high resolution environments.

Additionally, EdgeTech's latest broadband Electronics and Modular Arrays are utilized in the 6205 S2 resulting in a lightweight design, which is required for wide swath high resolution applications and survey platforms of opportunity. The standard configuration for the 6205 S2 includes an integrated Sound Velocity sensor and optional integrated OEM Inertial Navigation System, and interfaces to all popular 3rd Party acquisition and processing software packages, as well as to standard peripheral position/attitude sensors (if needed).

For more information please visit EdgeTech.com

info@EdgeTech.com | USA 1.508.291.0057

EdgeTech
The Leader in Underwater Technology

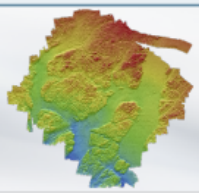
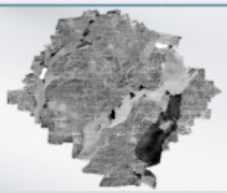
6205 S2

MULTI PHASE WIDE SWATH BATHYMETRY & SIDE SCAN SONAR

KEY SPECIFICATIONS

BATHYMETRY			
Sonar Frequency	520 kHz	850 kHz	
Beamwidths*	1° x 0.5°	1° x 0.4°	
Optimal Operating Water Depth**	< 50 m	< 25 m	
Max Swath Width***	200 m	75 m	
Max Swath Sector	200°		
Max Soundings Per Ping	800		
Sounding Patterns	Equidistant and Equiangular		
SIDE SCAN SONAR IMAGERY			
Frequency	520 kHz	850 kHz	1600 kHz
Horizontal Beamwidth (2-way)	0.36°	0.29°	0.20°
Range Resolution	10 mm	9 mm	6 mm
Max Range**	150 m	75 m	35 m
SYSTEM			
Pulse Modulation	CW & FM CHIRP		
Ping Rate (Range Dependent)	Up to 60 Hz		
Construction	Polycarbonate and Aluminum		
Sonar Unit Dimensions	L: 72.7 x W: 20.2 x H: 13.9 cm (28.6 x 7.9 x 5.5 in)		
Deck Cable Length	20m (Standard), or custom length to suit USV (unmannded surface vehicle)		
Depth Rating	50 m (165 ft)		
Sonar Unit Weight (In Air)	14 kg (32 lbs)		
19" Rack Mount Top Unit	6 kg (12 lbs)		
19" Rack Mount Unit Dimensions	L: 52.1 x W: 48.3 x H: 8.9 cm (20.5 x 19 x 3.5 in)		
Input Voltage	24-36 VDC or 100/240 VAC (auto sensing)		
Power (Typical / Max)	55W / 70W (Current draw 1.4 amp)		
Software	Included, windows based software, EdgeTech's Discover Bathymetric Acquisition and Sonar Control		
Data Products	Bathymetry, Backscatter, Side Scan Imagery, and Real Time Uncertainties		

* Across track resolution expressed as a beamwidth at nadir
** Dependent on environmental conditions (i.e. absorption, reverberation, sea noise, etc.)
*** Assumes a flat seafloor and dependent on environmental conditions


For more information please visit EdgeTech.com

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