

H13575

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

DESCRIPTIVE REPORT

Type of Survey: Navigable Area

Registry Number: H13575

LOCALITY

State(s): Northern Mariana Islands

General Locality: Western Pacific Ocean

Sub-locality: Saipan Harbor

2022

CHIEF OF PARTY
Héctor Casanova CPT/NOAA

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Date:

HYDROGRAPHIC TITLE SHEET

H13575

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s): **Northern Mariana Islands**

General Locality: **Western Pacific Ocean**

Sub-Locality: **Saipan Harbor**

Scale: **10000**

Dates of Survey: **04/23/2022 to 05/28/2022**

Instructions Dated: **01/07/2022**

Project Number: **OPR-T381-RA-22**

Field Unit: **NOAA Ship *Rainier***

Chief of Party: **Héctor Casanova CPT/NOAA**

Soundings by: **Multibeam Echo Sounder**

Imagery by: **Multibeam Echo Sounder Backscatter**

Verification by: **Pacific Hydrographic Branch**

Soundings Acquired in: **meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via <https://www.ncei.noaa.gov/>. Products created during office processing were generated in NAD83 UTM 55N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13575

Project: OPR-T381-RA-22

Locality: Western Pacific Ocean

Sublocality: Saipan Harbor

Scale: 1:10000

April 2022 - May 2022

NOAA Ship *Rainier*

Chief of Party: Héctor Casanova CPT/NOAA

A. Area Surveyed

The survey area is referred to as H13575, "Saipan Harbor" (Sheet 5) in the project instructions. The survey area is approximately 1.9 square nautical miles and is located in the Commonwealth of the Northern Marianas Islands.

A.1 Survey Limits

Data were acquired within the following survey limits:

| Northwest Limit | Southeast Limit |
|---------------------------------------|--------------------------------------|
| 15° 14' 11.47" N 145° 40' 21.76" E | 15° 11' 1.97" N 145° 44' 18.99" E |

Table 1: Survey Limits

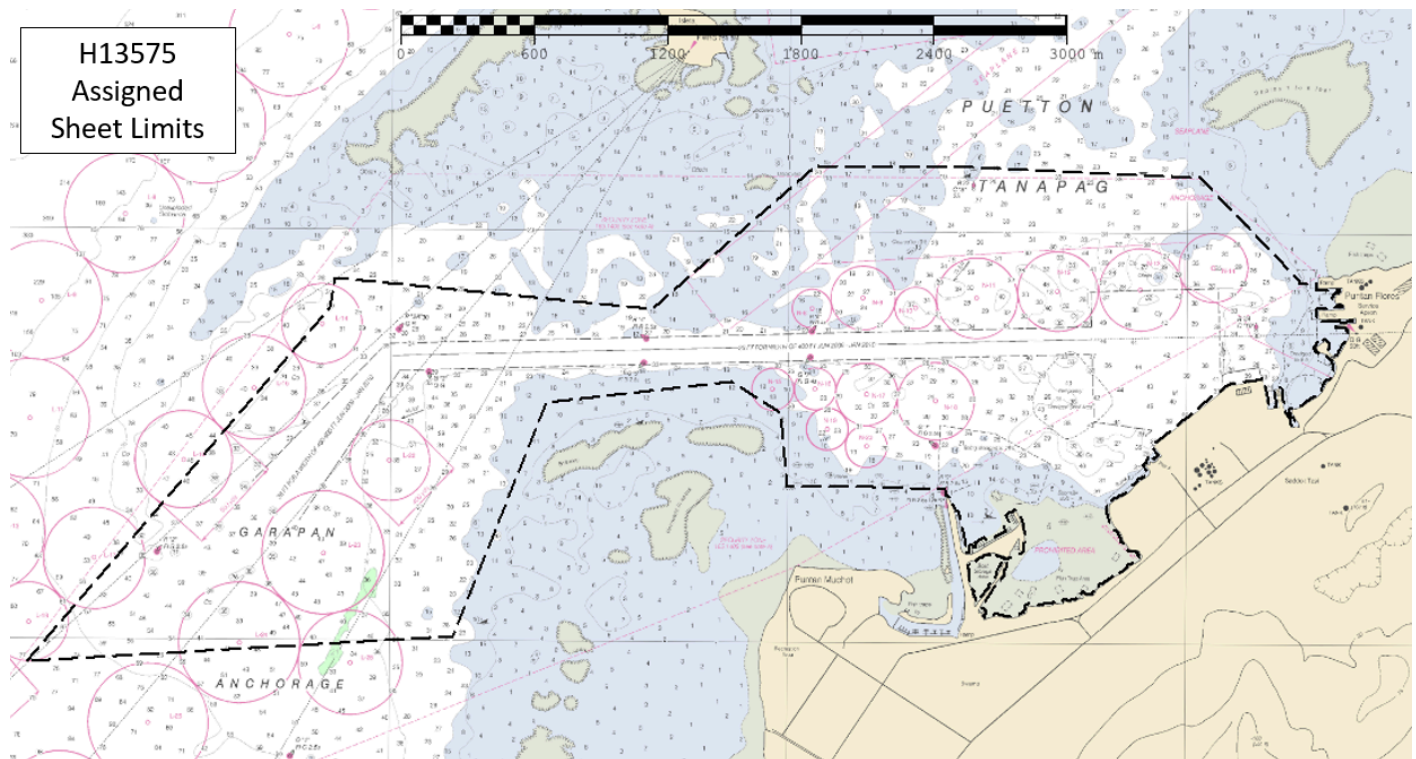


Figure 1: H13575 assigned survey area (Chart 81076_1).

Survey limits were acquired in accordance with the requirements in the Project Instructions and the HSSD.

A.2 Survey Purpose

The ecosystem surrounding the U.S. Territories of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and Wake Island are experiencing stress imposed by climate change and other environmental factors. For this project, NOAA Ship Rainier will be operating around Guam, CNMI, and Wake Island to conduct an extensive hydrographic survey to map bathymetry and habitat around the islands, pinnacles, and reefs in support of nautical charting and habitat mapping.

With the collaboration and partnership of the National Centers for Coastal and Ocean Science (NCCOS), the National Coral Reef Monitoring Program (NCRMP), and the National Marine Fisheries Service (NMFS), this project will also study the health of coral reef systems, ocean chemistry, and fisheries habitat. This team has developed a strategy to map the waters from nearshore to depths greater than 1000 meters. Within the project area, the ship's crew will collect bathymetric data to update charts and backscatter data to characterize habitat, while visiting scientists from NCRMP will perform coral reef assessment dives and other oceanographic observations.

Data collected during this mission are pivotal to long-term biological and oceanographic monitoring of coral reef ecosystems around Guam Island and the CNMI. This 2022 expedition will add to information

collected during monitoring and mapping surveys conducted in 2005, 2007, 2009, 2011, 2014 and 2017. Oceanographic and ecological time series data will allow scientists to evaluate potential changes in environmental conditions and coral reef health in the Mariana Archipelago. This will enable federal and state resource managers to more effectively conserve coral reef ecosystems of Guam and the CNMI, and manage ecosystem services. Data collected during this project also supports monitoring components of the NCRMP Coral Reef Ecosystem Integrated Observing System. This modern hydrographic survey will address gaps in the Seabed 2030 project, provide critical data to update National Ocean Service (NOS) nautical charting products, identify hazards, and improve maritime safety. Survey data from this project are intended to supersede all prior survey data in the common area.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

A.4 Survey Coverage

The following table lists the coverage requirements for this survey as assigned in the project instructions:

| Water Depth | Coverage Required |
|------------------------------|---|
| All waters in survey sheet 5 | Object Detection Coverage (Refer to HSSD Section 5.2.2.2) |

Table 2: Survey Coverage

The entire extents of the assigned sheet limits were not surveyed for H13575. Multibeam echosounder coverage was acquired to the inshore limit of hydrography, the Navigable Area Limit Line (NALL), within a majority of the assigned sheet limits. The NALL is defined as the most seaward of the following: the surveyed 3.5 meter depth contour, the line defined by the distance seaward from the observed MHW line which is equivalent to 0.8 millimeters at chart scale (the assigned sheet limits closely reflect this), or the inshore limit of safe navigation. Areas where H13575 survey coverage reached neither 3.5 meters water depth, nor the assigned sheet limits, were due to losing bottom in silty areas, heavy boat traffic, unsafe navigation due to coral. The figure below illustrate the areas in which MBES data was collected.

During survey acquisition, NOAA Ship RAINIER received a request to survey the anchorage area south of Saipan Harbor. Please see project correspondence for more information.

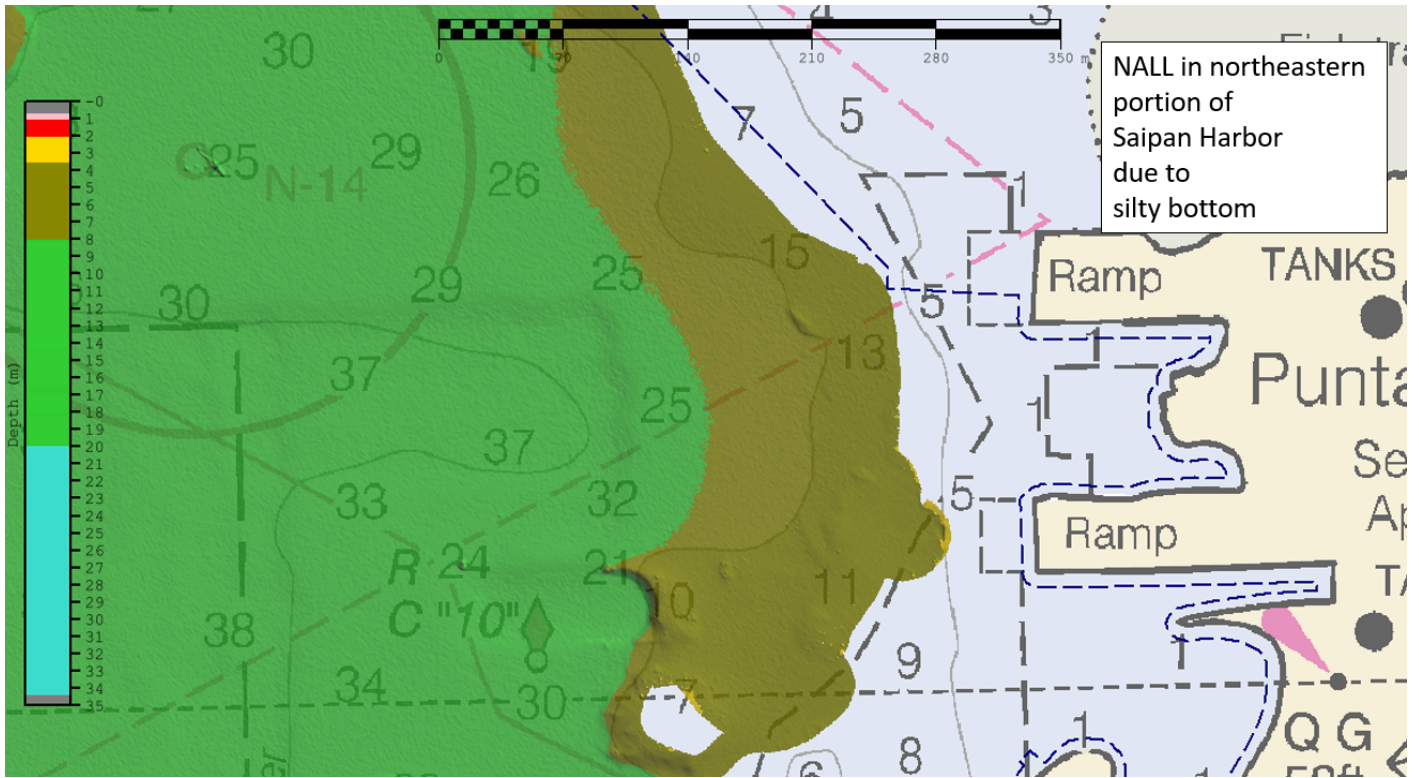


Figure 2: Assigned area of coverage with silty bottom (Chart 81076_1).

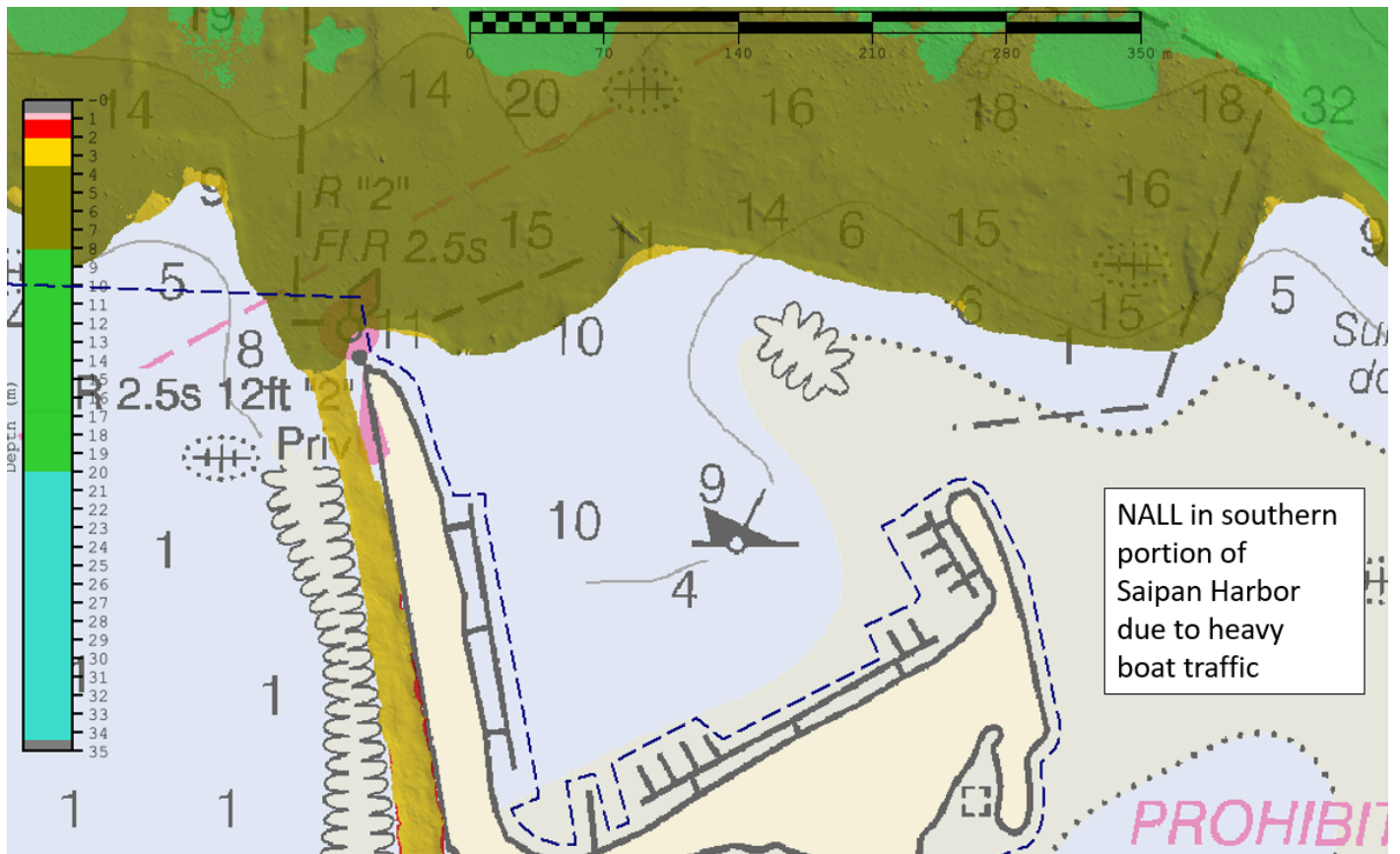


Figure 3: Assigned areas with heavy boat traffic (Chart 81076_1).

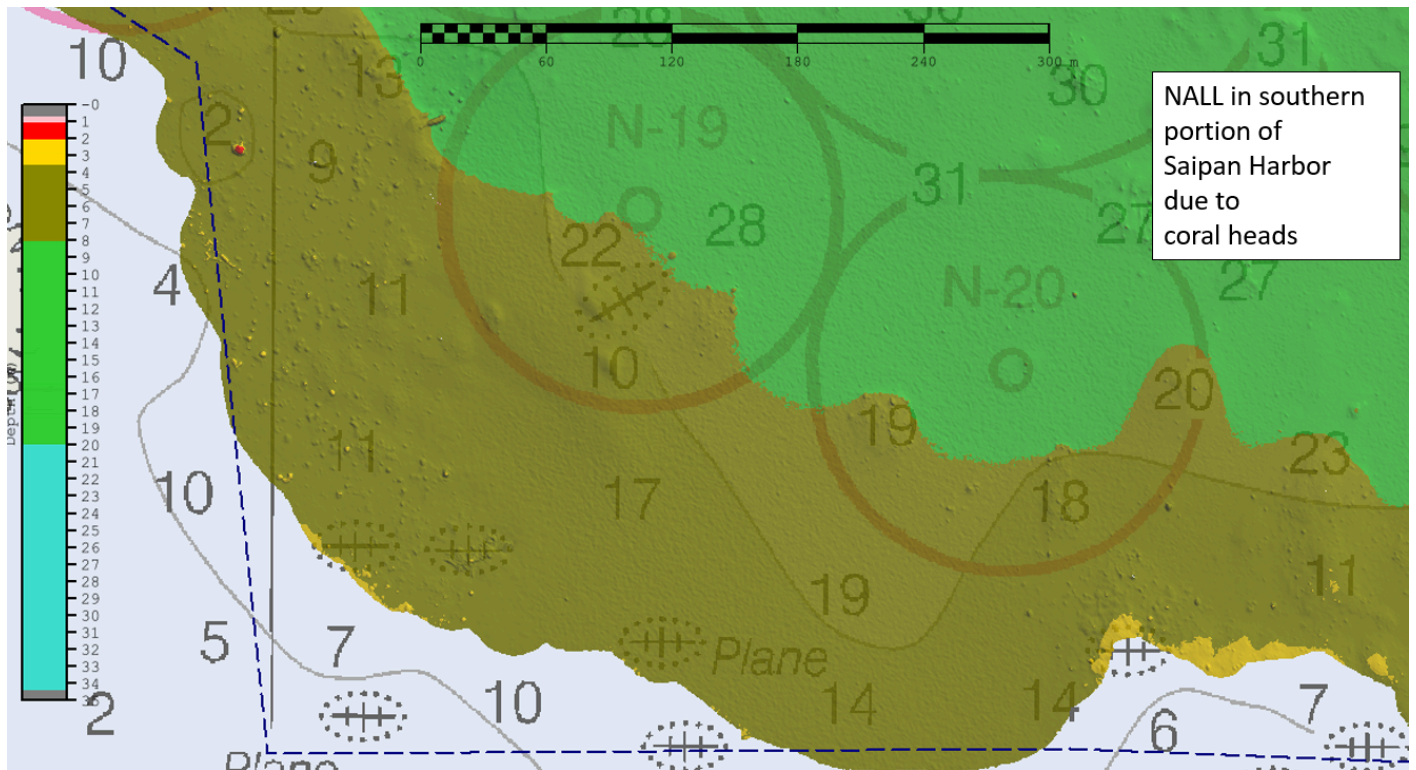


Figure 4: Assigned area with high density of coral heads (Chart 81076_1).

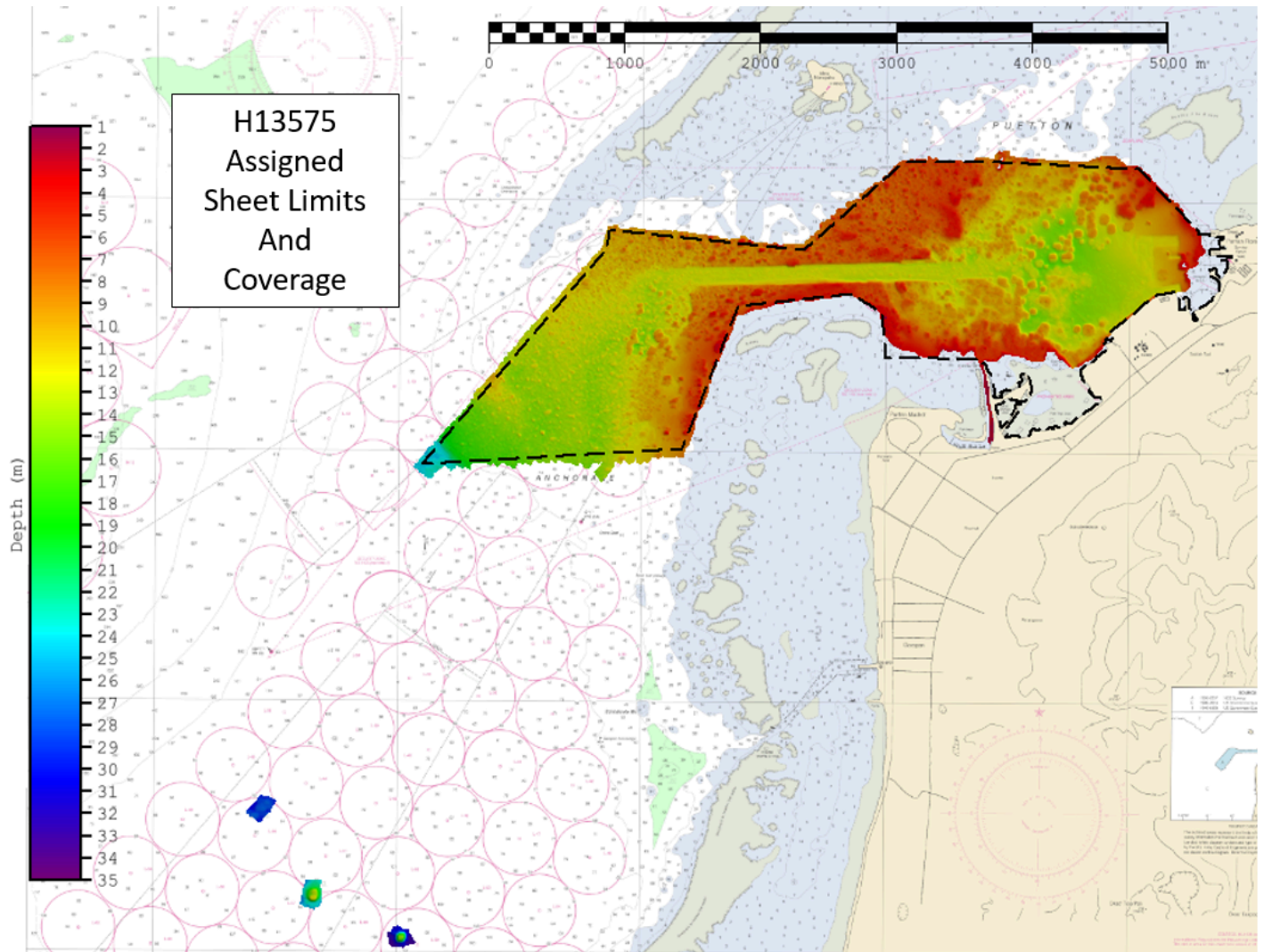


Figure 5: H13575 survey coverage and assigned survey limits for Saipan Harbor (Chart 81076_1).

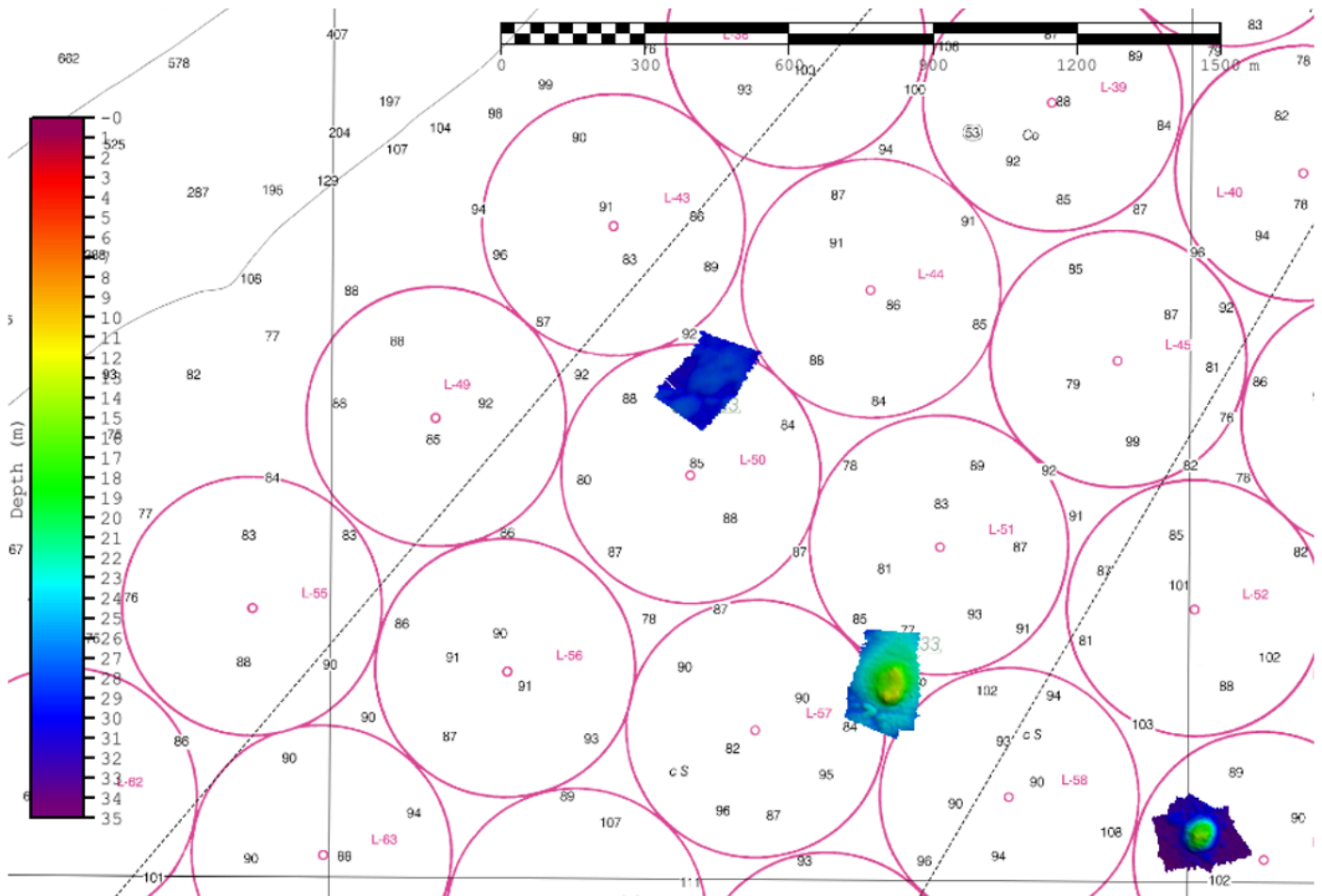


Figure 6: H13575 survey request area (Chart 81076_1).

A.6 Survey Statistics

The following table lists the mainscheme and crossline acquisition mileage for this survey:

| | HULL ID | 2803 | 2804 | Total |
|---|-----------------------------|-------------|-------------|--------------|
| LNM | SBES Mainscheme | 0.0 | 0.0 | 0.0 |
| | MBES Mainscheme | 78.21 | 84.59 | 162.81 |
| | Lidar Mainscheme | 0.0 | 0.0 | 0.0 |
| | SSS Mainscheme | 0.0 | 0.0 | 0.0 |
| | SBES/SSS Mainscheme | 0.0 | 0.0 | 0.0 |
| | MBES/SSS Mainscheme | 0.0 | 0.0 | 0.0 |
| | SBES/MBES Crosslines | 3.32 | 4.53 | 4.82 |
| | Lidar Crosslines | 0.0 | 0.0 | 0.0 |
| Number of Bottom Samples | | | | 0 |
| Number Maritime Boundary Points Investigated | | | | 0 |
| Number of DPs | | | | 0 |
| Number of Items Investigated by Dive Ops | | | | 0 |
| Total SNM | | | | 1.9 |

Table 3: Hydrographic Survey Statistics

The following table lists the specific dates of data acquisition for this survey:

| Survey Dates | Day of the Year |
|---------------------|------------------------|
| 04/23/2022 | 113 |
| 04/24/2022 | 114 |

| Survey Dates | Day of the Year |
|---------------------|------------------------|
| 04/25/2022 | 115 |
| 04/26/2022 | 116 |
| 04/28/2022 | 118 |
| 05/17/2022 | 137 |
| 05/28/2022 | 148 |

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures and data processing methods. Additional information to supplement sounding and survey data, and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

The following vessels were used for data acquisition during this survey:

| Hull ID | 2803 | 2804 |
|----------------|-------------|-------------|
| LOA | 8.8 meters | 8.8 meters |
| Draft | 1.1 meters | 1.1 meters |

Table 5: Vessels Used



Figure 7: NOAA Ship RAINIER survey launch.

All data for survey H13575 was acquired by NOAA Ship RAINIER launches 2803,2804. The vessels acquired MBES bathymetry, backscatter, and sound velocity profiles.

B.1.2 Equipment

The following major systems were used for data acquisition during this survey:

| Manufacturer | Model | Type |
|---------------------|---------------|--|
| Applanix | POS MV 320 v5 | Positioning and Attitude System |
| Kongsberg Maritime | EM 2040 | MBES |
| Sea-Bird Scientific | SBE 19plus V2 | Conductivity, Temperature, and Depth Sensor |
| Teledyne RESON | SVP 70 | Sound Speed System |

Table 6: Major Systems Used

B.2 Quality Control

B.2.1 Crosslines

RAINIER launches collected 5.7 nm (4.8%) of MBES crosslines, across a range of depths in the mainscheme data. The Compare Grids function in Pydro Explorer was used to analyze the finalized (VR) Variable Resolution surfaces of H13575 mainscheme only to crossline only data. Pydro determined that 99.5% of nodes met allowable uncertainties. For additional results, see plots below.

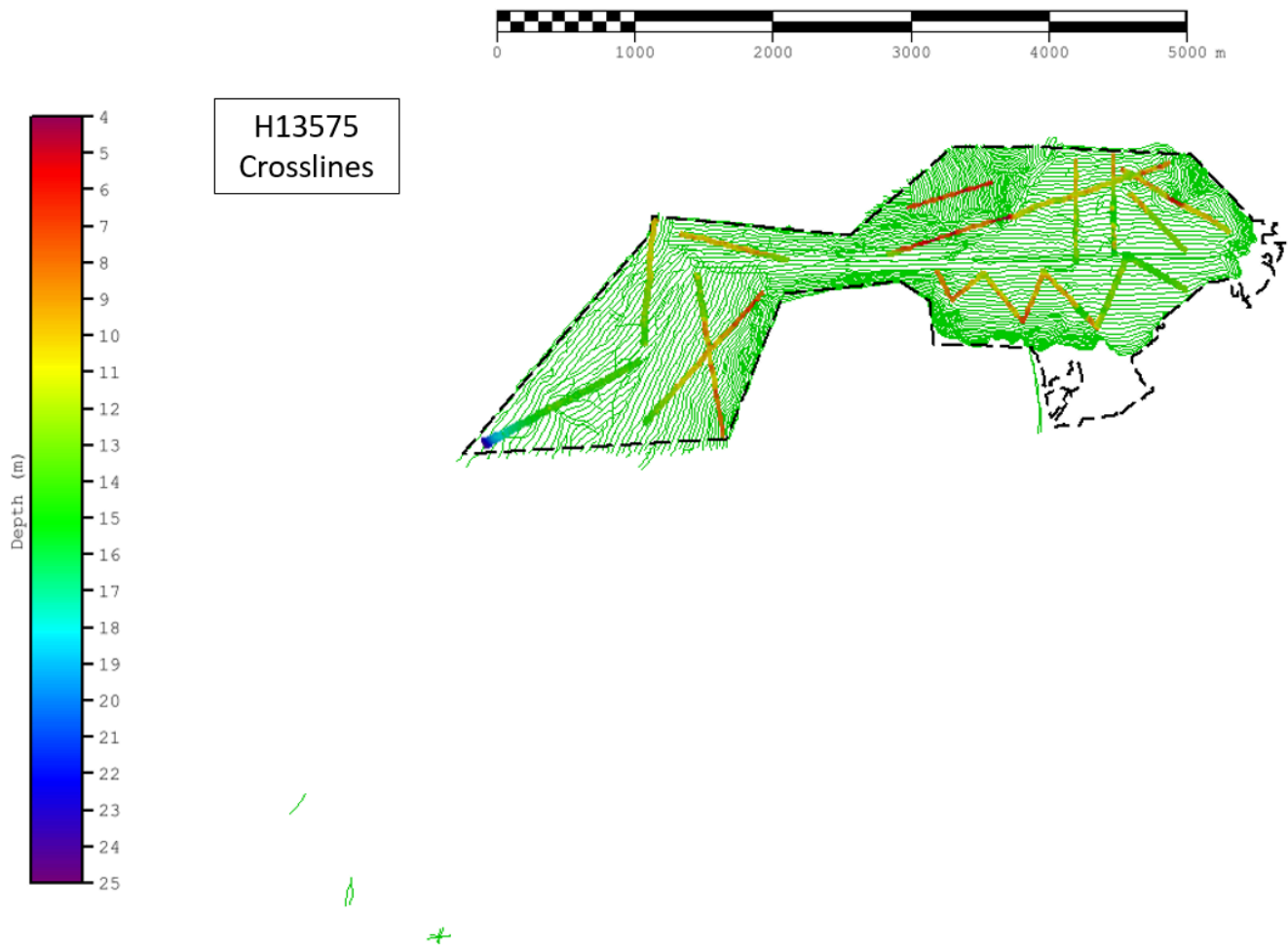


Figure 8: H13575 crossline surface overlaid on mainscheme tracklines.

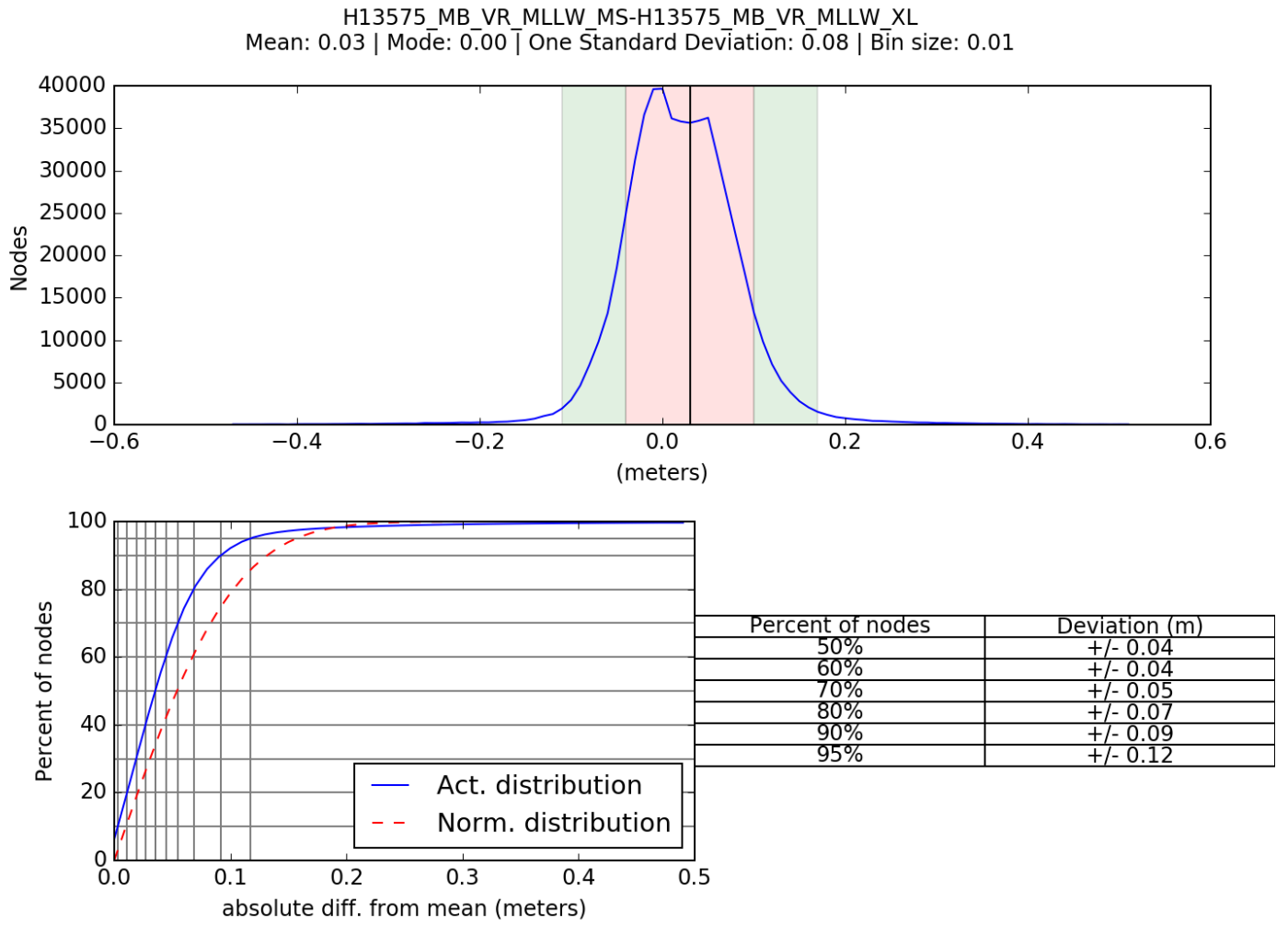


Figure 9: Pydro derived plot showing absolute difference statistics of H13575 mainscheme to crossline data.

Comparison Distribution

Per Grid: H13575_MB_VR_MLLW_MS-H13575_MB_VR_MLLW_XL_fracAllowErr.csar

99.5+% nodes pass (571971), min=0.0, mode=0.1 mean=0.1 max=3.7

Percentiles: 2.5%=0.0, Q1=0.0, median=0.1, Q3=0.1, 97.5%=0.2

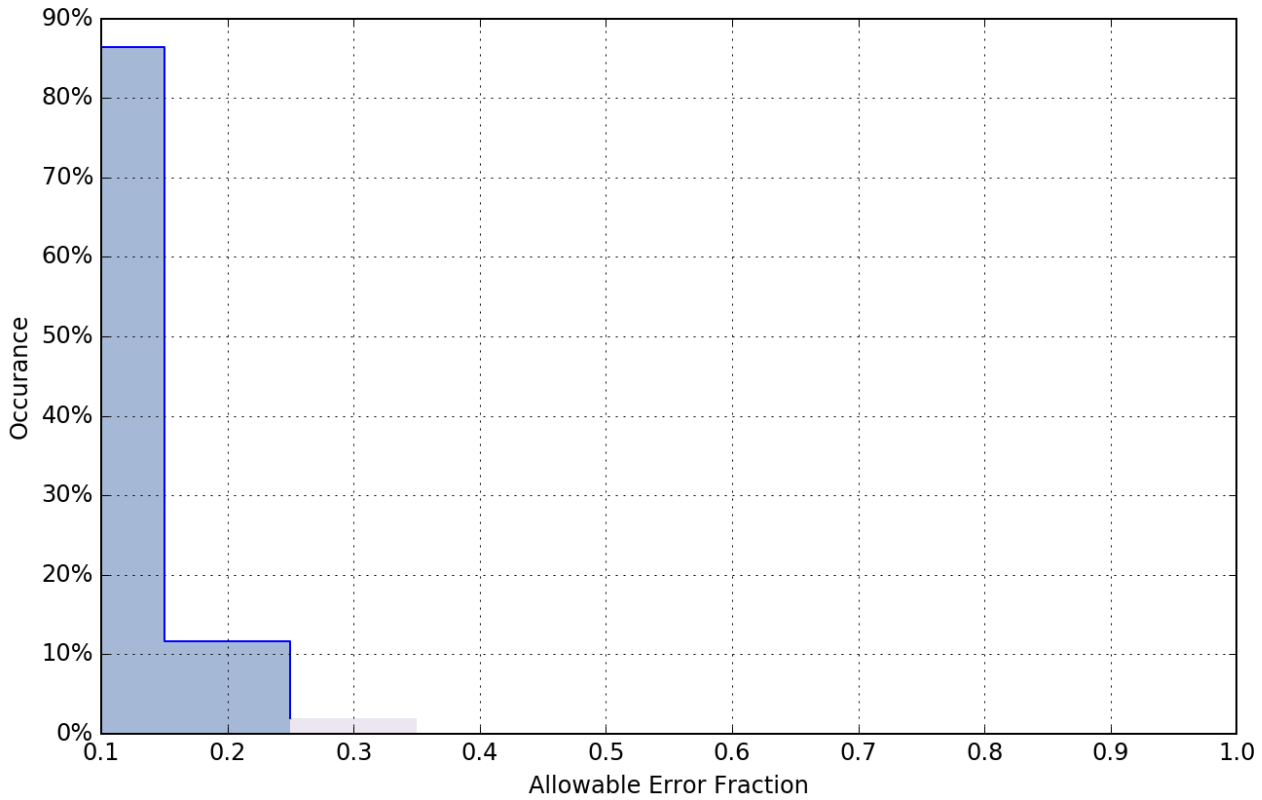


Figure 10: Pydro derived showing percentage-pass value of H13575 mainscheme to crossline data.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

| Method | Measured | Zoning |
|----------------|------------|-------------|
| ERS via VDATUM | 0.0 meters | 0.11 meters |

Table 7: Survey Specific Tide TPU Values.

| Hull ID | Measured - CTD | Measured - MVP | Measured - XBT | Surface |
|------------|-------------------|-------------------|-------------------|--------------------|
| 2803/ 2804 | 3.0 meters/second | N/A meters/second | N/A meters/second | 0.05 meters/second |

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for survey H13575 were derived from a combination of fixed values for equipment and vessel characteristics, as well as from field assigned values for sound speed uncertainties. Tidal uncertainty was provided in the project instructions for the NOAA vertical datum transformation model used for this survey.

In addition to the usual a priori estimates of uncertainty, real-time and post-processed uncertainty sources were also incorporated into the depth estimates of this survey. Real-time uncertainties for position, navigation, attitude, and vessel motion data from Applanix POS MV were applied during acquisition and initially in post-processing. POSpac SBET and RMS files were later applied in CARIS HIPS to supersede POS MV uncertainties associated with GPS height and position.

Uncertainty values of the submitted finalized grids were calculated in Caris using "Greater of the Two" of uncertainty and standard deviation (scaled to 95%). Grid QA v5 within Pydro QC Tools was used to analyze H13575 TVU compliance. H13575 met HSSD requirements in 99.5 percent of grid nodes, which is shown in the histogram plot below.

Pydro QC Tools 3.7.0 Grid QA was used to analyze H13575 multibeam echosounder (MBES) data density. The submitted H13575 (VR) Variable Resolution surface met HSSD density requirements shown in the histograms below.

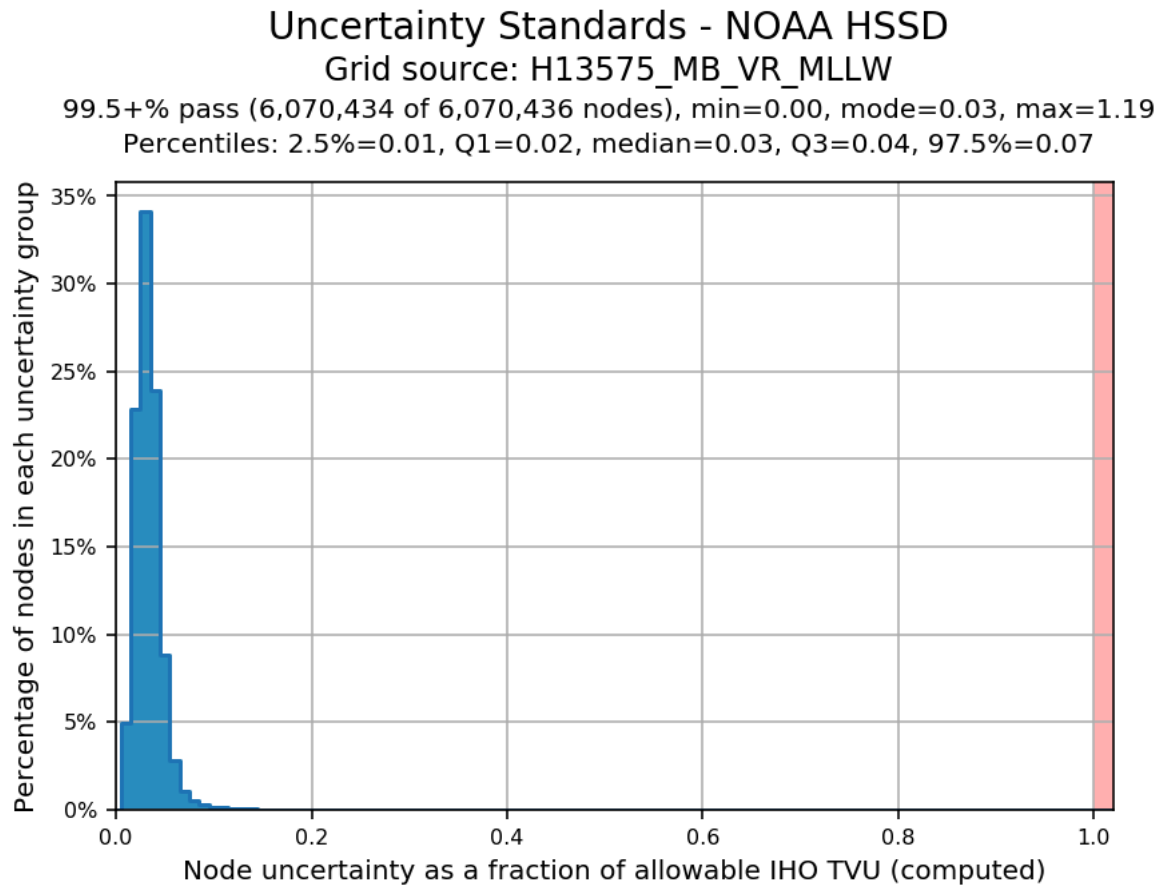


Figure 11: Pydro derived plot showing compliance of H13575 finalized (VR) Variable Resolution MBES data.

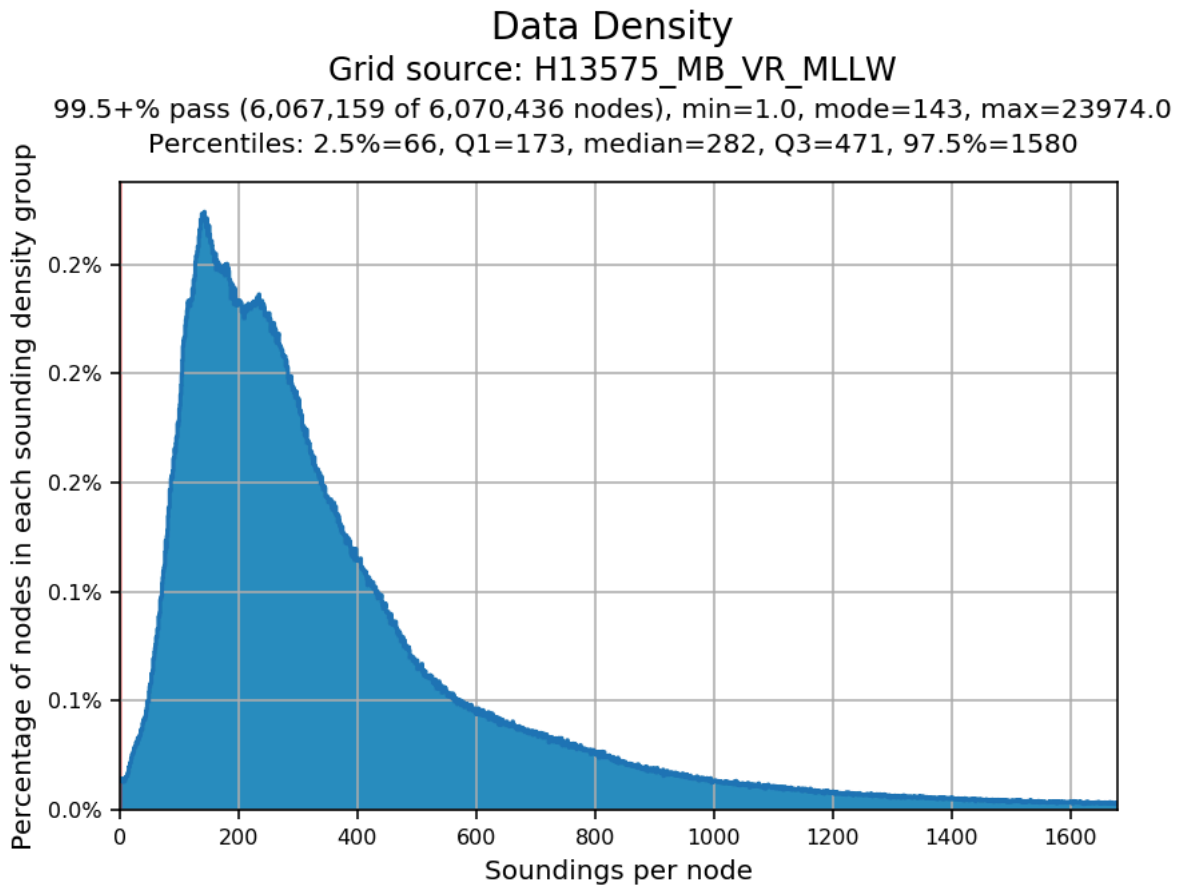


Figure 12: Pydro derived histogram plot showing HSSD density compliance on H13575 finalized (VR) Variable Resolution MBES data.

B.2.3 Junctions

Per the project instructions H13575 should junction to H13572. However, per correspondence with the Project Manager it was determined that survey would only be completed on H13572 to the prior Lidar data provided (goodline). Therefore, data collected on H13575 and H13572 does not overlap and no junction is complete for this sheet.

There are no contemporary surveys that junction with this survey.

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the quality control section of the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

There were no other factors that affected corrections to soundings.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: At least one cast every four hours or as needed.

Thirty sound speed profiles were acquired for this survey at various locations within the survey area at least one every four hours, when significant changes in surface sound speed were observed, or when operating in a new area. Sound speed profiles were obtained using Sea-Bird 19 Plus V2 SEACAT Profilers. All casts were concatenated into a master file and applied to MBES data using the "Nearest distance within time" (4 hours) profile selection method.

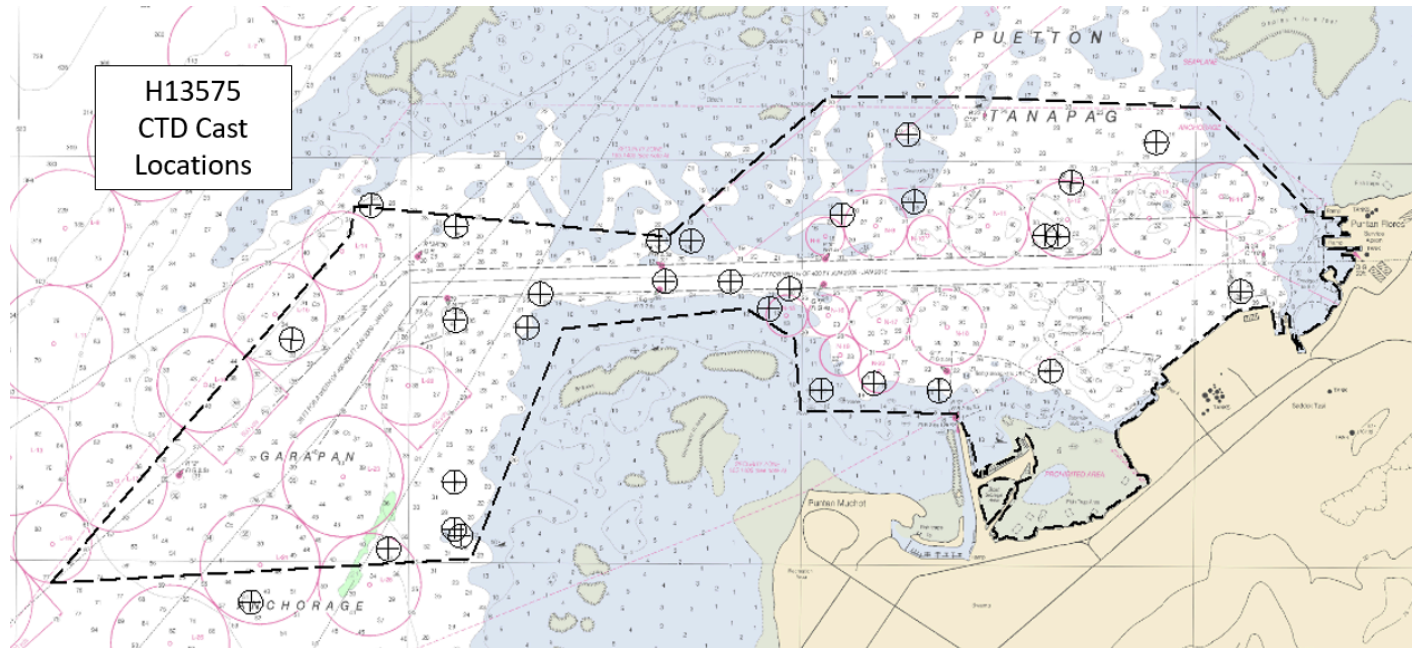


Figure 13: H13575 sound speed cast locations (Chart 81076_1).

B.2.8 Coverage Equipment and Methods

All equipment and survey methods were used as detailed in the DAPR.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

All data reduction procedures conform to those detailed in the DAPR.

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Raw backscatter data were acquired as .ALL files logged during MBES operations and subsequently processed by RAINIER personnel. The .GSF files created during processing and backscatter mosaic per

vessel and per frequency are delivered with this report. All equipment and survey methods were used as detailed in the DAPR.

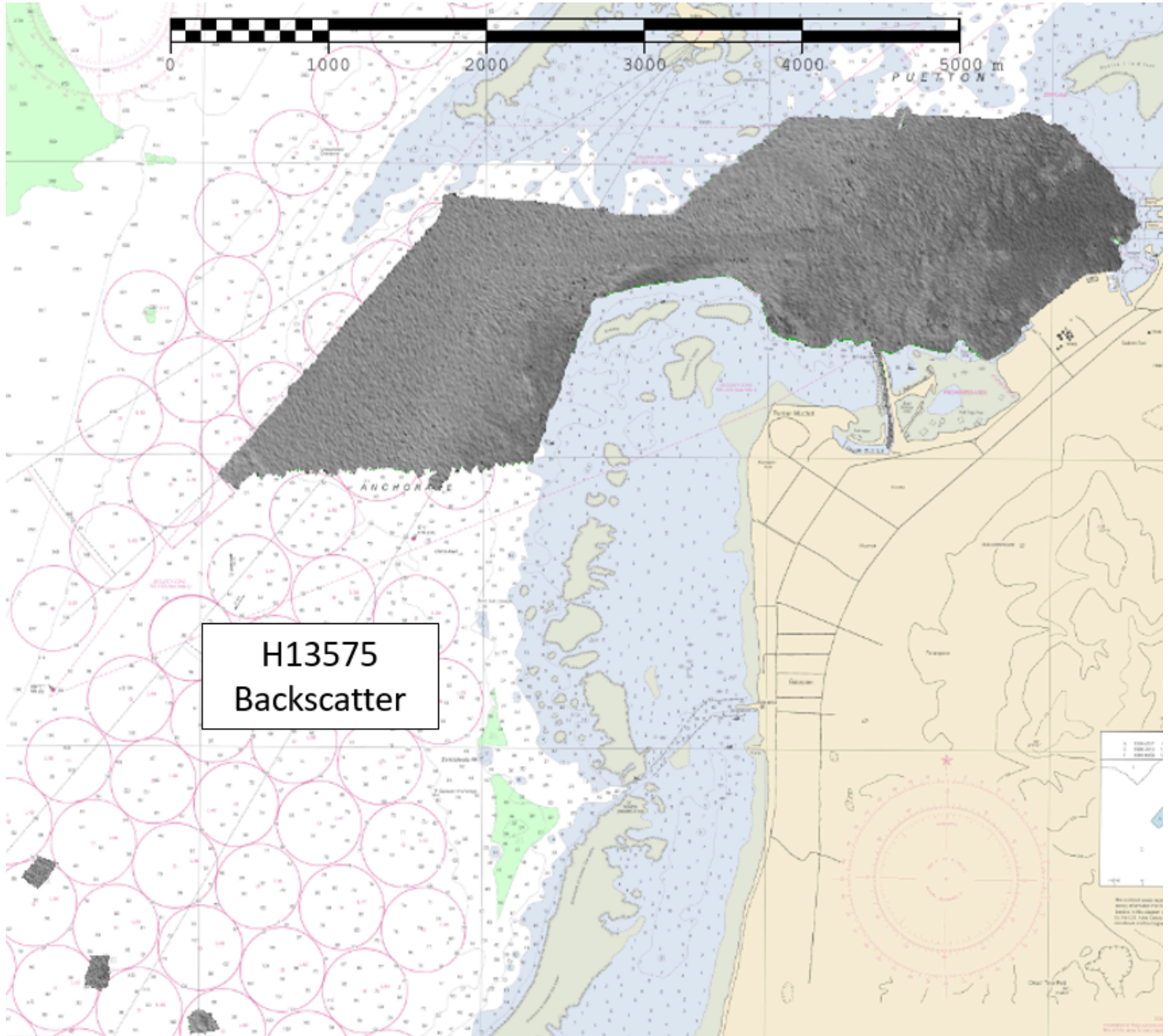


Figure 14: H13575 backscatter mosaic (Chart 81076_1).

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: NOAA Profile Version 2022.

B.5.2 Surfaces

The following surfaces and/or BAGs were submitted to the Processing Branch:

| Surface Name | Surface Type | Resolution | Depth Range | Surface Parameter | Purpose |
|-------------------------|-----------------------------|---------------------|----------------------------|-------------------|---------------|
| H13575_MB_VR_MLLW_Final | CARIS Raster Surface (CUBE) | Variable Resolution | 0.66 meters - 34.44 meters | NOAA_VR | Complete MBES |
| H13575_MB_VR_MLLW | CARIS Raster Surface (CUBE) | Variable Resolution | 1.13 meters - 34.44 meters | NOAA_VR | Complete MBES |

Table 9: Submitted Surfaces

Submitted H13575 surfaces were generated using NOAA recommended parameters for density-based (Ranges) Caris variable-resolution bathymetric grids.

Pydro QC Tools v.3.7.0 Flier Finder, with default settings, was used to identify sounding "fliers" in the finalized H13575 (VR) Variable Resolution surface. Obvious noise was rejected by the hydrographer in Caris Subset Editor. After data cleaning, the Flier Finder tool was run again and found 400 potential fliers in the Object Detection surface. These were investigated and found to be false positives.

Pydro QC Tools v3.7.0 Holiday Finder was used with default settings to find holidays in the finalized H13575 (VR) Variable Resolution surface. Holiday Finder detected 29 holidays in the Object Detection surface. Of the detected holidays, 24 were determined to be acoustic shadows from coral. The remaining 5 detected holidays were confirmed to be gaps in data coverage, but they do not impact the reliability of the data. All acoustic and gap holidays occurred in the deep portion of the bathymetry and have the least depth of shallower sounding in proximity.

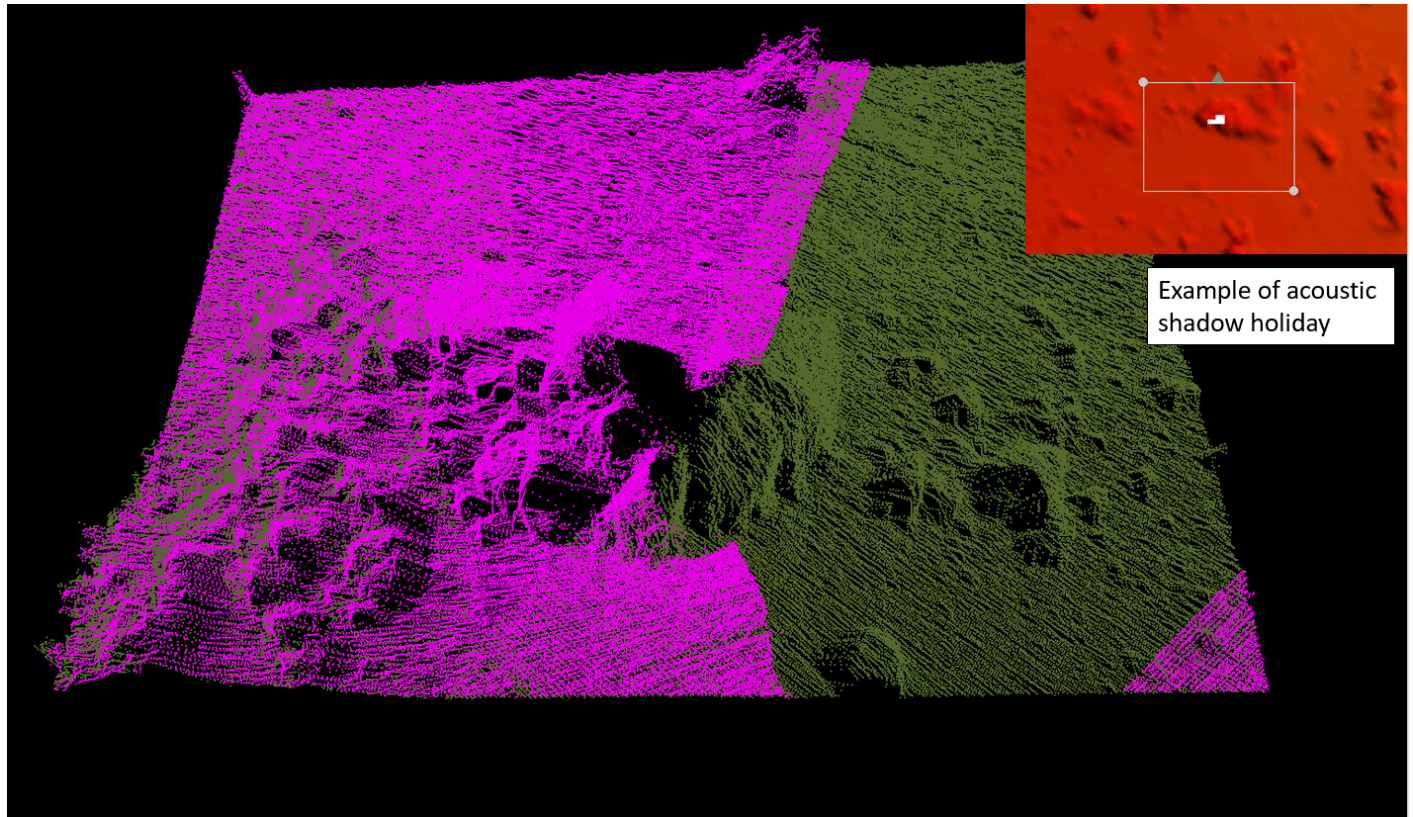


Figure 15: Example of acoustic holiday (Chart 81076_1).

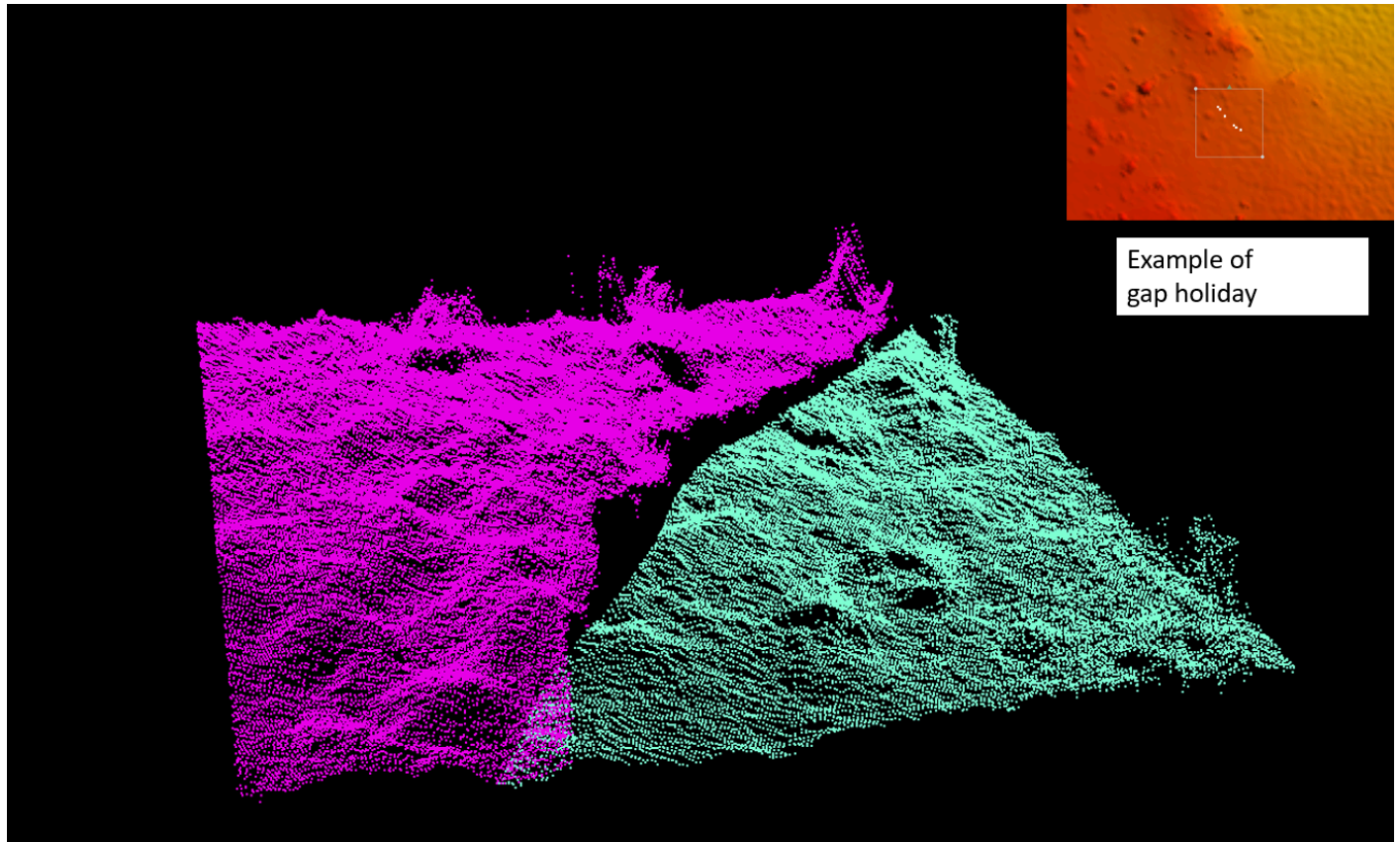


Figure 16: Example of gap holiday (Chart 81076_1).

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying DAPR.

C.1 Vertical Control

The vertical datum for this project is Mean Lower Low Water.

ERS Datum Transformation

The following ellipsoid-to-chart vertical datum transformation was used:

| Method | Ellipsoid to Chart Datum Separation File |
|----------------|--|
| ERS via VDATUM | OPR_T381- RA-22_GuamCNMI_EC_ERTDM2021_NAD83(MA11)- MLLW.csar |

Table 10: ERS method and SEP file

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD 83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 55.

The following PPK methods were used for horizontal control:

- RTX

RTK

Precise Positioning-Real Time Extended (PP-RTX) processing methods were used in Applanix POSPac MMS (v8.5) software during post-processing horizontal correction of submitted H13575 MBES data.

WAAS

The Wide Area Augmentation System (WAAS) was used for real-time horizontal control during data acquisition.

D. Results and Recommendations

D.1 Chart Comparison

D.1.1 Electronic Navigational Charts

The following are the largest scale ENC's, which cover the survey area:

| ENC | Scale | Edition | Update Application Date | Issue Date |
|----------|---------|---------|-------------------------|------------|
| US5SP07M | 1:12000 | 12 | 06/17/2022 | 06/17/2022 |

Table 11: Largest Scale ENC's

D.1.2 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.3 Charted Features

A charted mooring buoy in the northeastern section of Saipan Harbor was not observed during survey acquisition.

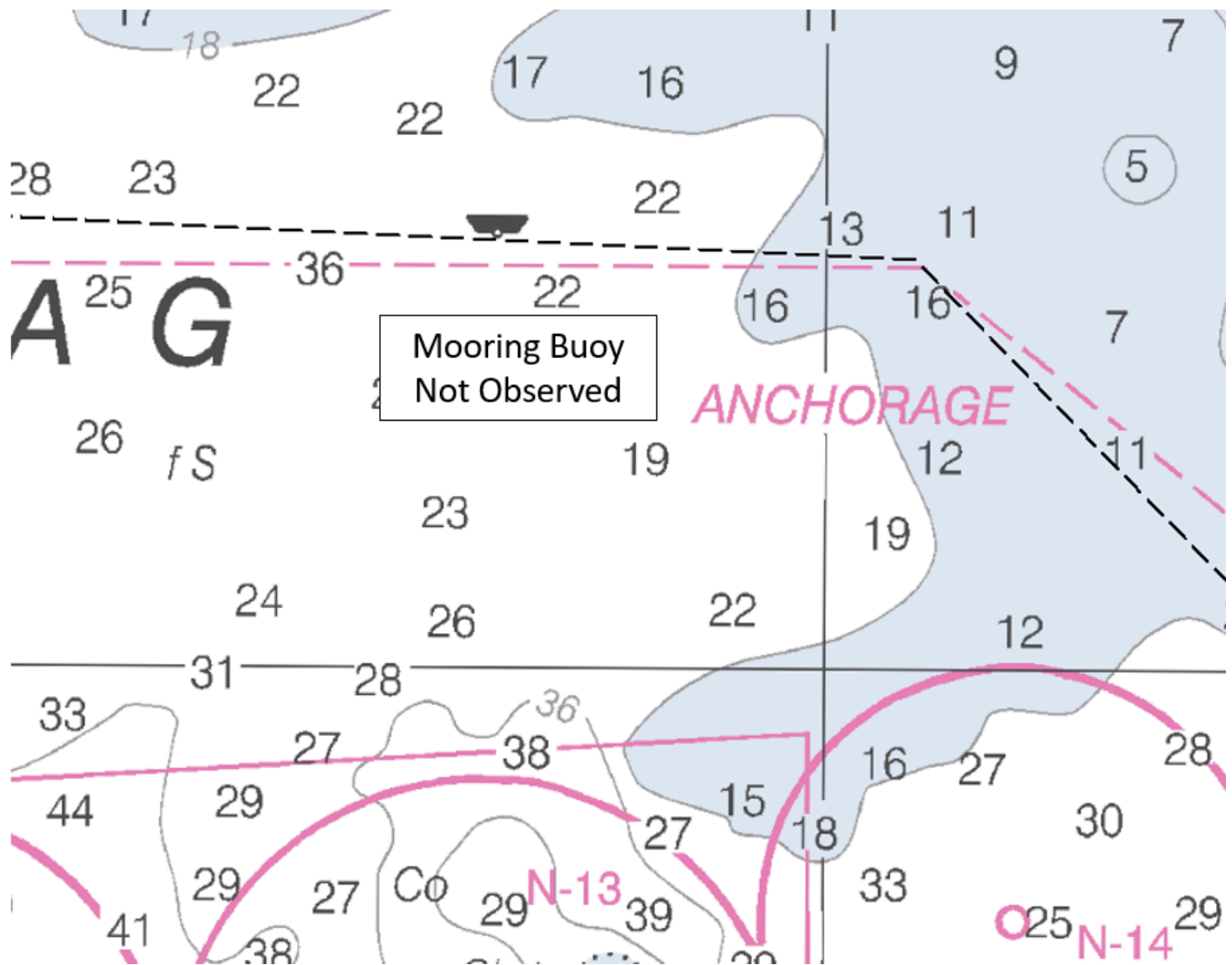


Figure 17: Charted mooring buoy in Saipan Harbor (Chart 81076_1).

D.1.4 Uncharted Features

No uncharted features exist for this survey.

D.1.5 Channels

The channel entering Saipan Harbor is deeper than previously charted.

D.2 Additional Results

D.2.1 Aids to Navigation

Navigational buoy G"1" was not observed during survey acquisition in Saipan Harbor. This was reported to the USCG.

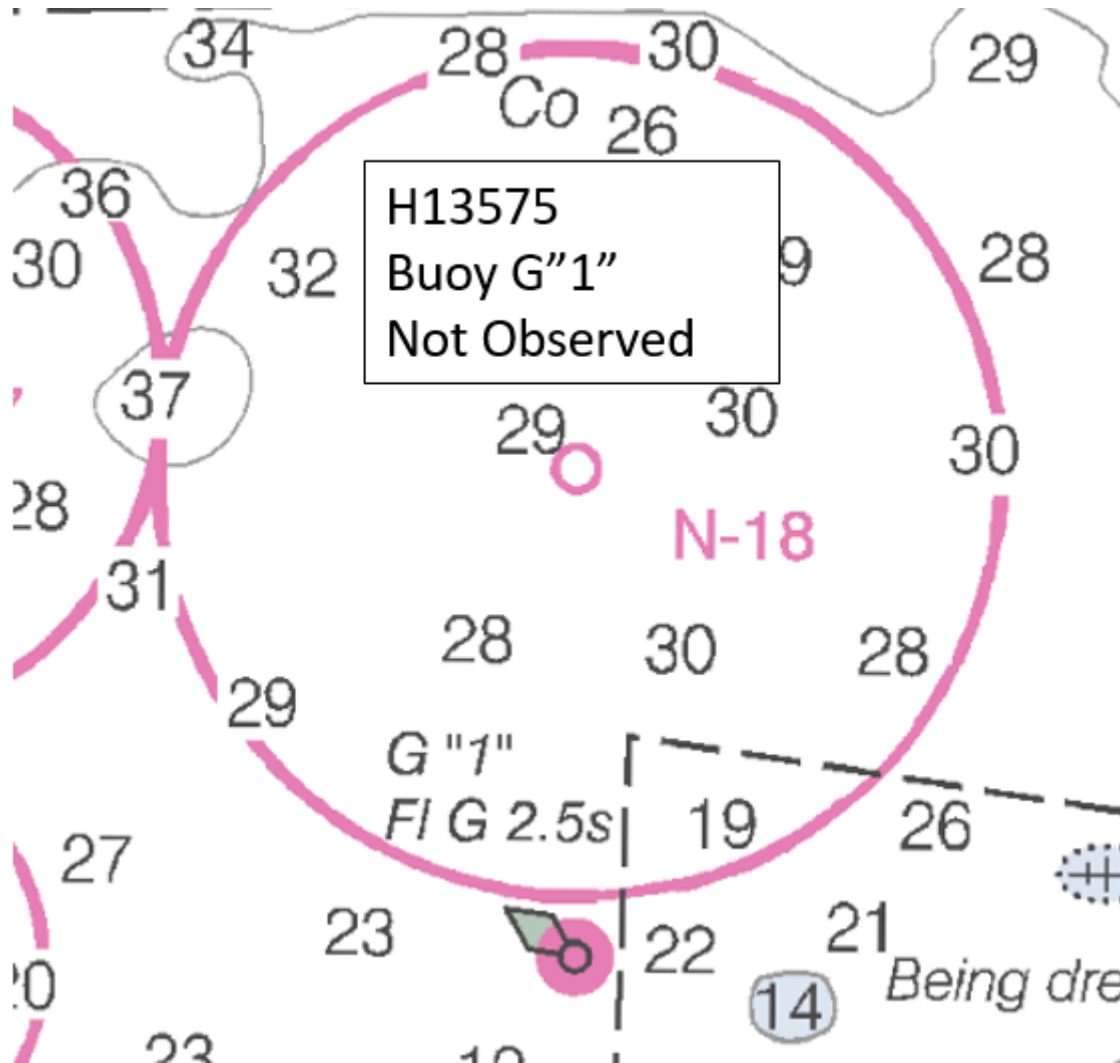


Figure 18: Green buoy one's charted location (Chart 181076_1).

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

No bottom samples were required for this survey.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features exist for this survey.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

Ferry routes and/or terminals exist for this survey, but were not investigated. MSC crew transfer ferries frequently move in and out of the main channel in Saipan Harbor. The ferries dock in the basin between Pier A and C.

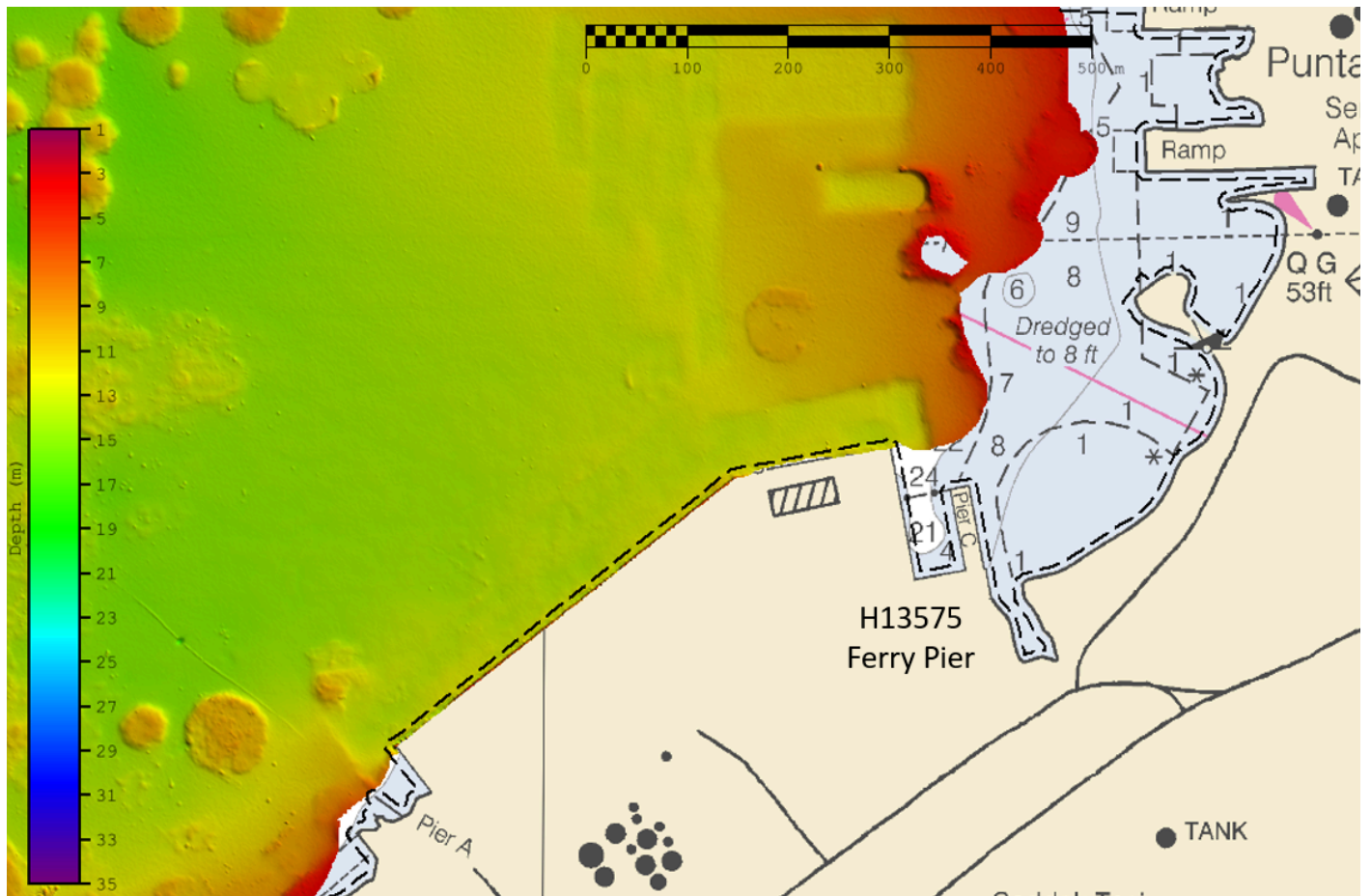


Figure 19: Ferry pier location in Saipan Harbor (Chart 81076_1).

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor or environmental conditions exist for this survey.

D.2.9 Construction and Dredging

No present or planned construction or dredging exist within the survey limits.

D.2.10 New Survey Recommendations

No new surveys or further investigations are recommended for this area.

D.2.11 ENC Scale Recommendations

No new ENC scales are recommended for this area.

E. Approval Sheet

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Field Procedures Manual, Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

| Approver Name | Approver Title | Approval Date | Signature |
|-----------------------------|--------------------------|---------------|--|
| Héctor Casanova CPT/NOAA | Chief of Party | 10/17/2022 |  Digitally signed by CASANOVA.HECTOR.LUIS.1 253816461 Date: 2022.10.27 09:24:27 -07'00' |
| Collin Walker LT/NOAA | Field Operations Officer | 10/17/2022 |  WALKER.COLLIN.HAR RISON.1523758540 2022.10.27 08:42:40 -07'00' |
| James B. Jacobson | Chief Survey Technician | 10/17/2022 |  JACOBSON.JAMES.BRYAN. 1269664017 I have reviewed this document 2022.10.21 12:56:21 -07'00' |
| Christina L. Brooks | Sheet Manager | 10/17/2022 |  Digitally signed by BROOKS.CHRISTINA.LORRAI NE.1553513177 Date: 2022.10.21 08:23:58 -07'00' |

F. Table of Acronyms

| Acronym | Definition |
|----------------|--|
| AHB | Atlantic Hydrographic Branch |
| AST | Assistant Survey Technician |
| ATON | Aid to Navigation |
| AWOIS | Automated Wreck and Obstruction Information System |
| BAG | Bathymetric Attributed Grid |
| BASE | Bathymetry Associated with Statistical Error |
| CO | Commanding Officer |
| CO-OPS | Center for Operational Products and Services |
| CORS | Continuously Operating Reference Station |
| CTD | Conductivity Temperature Depth |
| CEF | Chart Evaluation File |
| CSF | Composite Source File |
| CST | Chief Survey Technician |
| CUBE | Combined Uncertainty and Bathymetry Estimator |
| DAPR | Data Acquisition and Processing Report |
| DGPS | Differential Global Positioning System |
| DP | Detached Position |
| DR | Descriptive Report |
| DTON | Danger to Navigation |
| ENC | Electronic Navigational Chart |
| ERS | Ellipsoidal Referenced Survey |
| ERTDM | Ellipsoidally Referenced Tidal Datum Model |
| ERZT | Ellipsoidally Referenced Zoned Tides |
| FFF | Final Feature File |
| FOO | Field Operations Officer |
| FPM | Field Procedures Manual |
| GAMS | GPS Azimuth Measurement Subsystem |
| GC | Geographic Cell |
| GPS | Global Positioning System |
| HIPS | Hydrographic Information Processing System |
| HSD | Hydrographic Surveys Division |

| Acronym | Definition |
|----------------|---|
| HSSD | Hydrographic Survey Specifications and Deliverables |
| HSTB | Hydrographic Systems Technology Branch |
| HSX | Hypack Hysweep File Format |
| HTD | Hydrographic Surveys Technical Directive |
| HVCR | Horizontal and Vertical Control Report |
| HVF | HIPS Vessel File |
| IHO | International Hydrographic Organization |
| IMU | Inertial Motion Unit |
| ITRF | International Terrestrial Reference Frame |
| LNM | Linear Nautical Miles |
| MBAB | Multibeam Echosounder Acoustic Backscatter |
| MCD | Marine Chart Division |
| MHW | Mean High Water |
| MLLW | Mean Lower Low Water |
| NAD 83 | North American Datum of 1983 |
| NALL | Navigable Area Limit Line |
| NTM | Notice to Mariners |
| NMEA | National Marine Electronics Association |
| NOAA | National Oceanic and Atmospheric Administration |
| NOS | National Ocean Service |
| NRT | Navigation Response Team |
| NSD | Navigation Services Division |
| OCS | Office of Coast Survey |
| OMAO | Office of Marine and Aviation Operations (NOAA) |
| OPS | Operations Branch |
| MBES | Multibeam Echosounder |
| NWLON | National Water Level Observation Network |
| PDBS | Phase Differencing Bathymetric Sonar |
| PHB | Pacific Hydrographic Branch |
| POS/MV | Position and Orientation System for Marine Vessels |
| PPK | Post Processed Kinematic |
| PPP | Precise Point Positioning |
| PPS | Pulse per second |

| Acronym | Definition |
|----------------|--|
| PRF | Project Reference File |
| PS | Physical Scientist |
| RNC | Raster Navigational Chart |
| RTK | Real Time Kinematic |
| RTX | Real Time Extended |
| SBES | Singlebeam Echosounder |
| SBET | Smooth Best Estimate and Trajectory |
| SNM | Square Nautical Miles |
| SSS | Side Scan Sonar |
| SSSAB | Side Scan Sonar Acoustic Backscatter |
| ST | Survey Technician |
| SVP | Sound Velocity Profiler |
| TCARI | Tidal Constituent And Residual Interpolation |
| TPU | Total Propagated Uncertainty |
| USACE | United States Army Corps of Engineers |
| USCG | United States Coast Guard |
| UTM | Universal Transverse Mercator |
| XO | Executive Officer |
| ZDF | Zone Definition File |