W00005

NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

# DESCRIPTIVE REPORT

*Type of Survey* Hydrographic

*Field No.*

*Registry No.* W00005

## LOCALITY

*State* Micronesia - Northern Marianas Islands

*General Locality* Guam

*Sublocality* Apra Outer Harbor and Agat Bay

**2001**

**CHIEF OF PARTY**
**Scott Ebrite**

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U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# HYDROGRAPHIC TITLE SHEET

REGISTER NO.

**W00005**

FIELD NO.

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 **Micronesia - Northern Marianas Islands**

General Locality **Guam**

Sublocality **Apra Outer Harbor and Agat Bay**

Scale **1:10,000** Date of Survey **01/08 - 03/20/2001**

Instructions Dated _____ Project No. _____

Vessel **LIDAR (SHOALS), USNS SUMNER and Fleet Survey Team**

Chief of Party **Scott Ebrite**

Surveyed by **US Naval Hydrographic Office**

Soundings taken by echo sounder, hand lead, pole **Lidar,SWMB, VBES, and SSS**

Graphic record scaled by **Fleet Survey Team**

Graphic record checked by **Fleet Survey Team**

Evaluation by **Sean C. Rooney** Automated plot by **HP DesignJet 1050C**

Verification by **Sean C. Rooney, Cartographer: Leo Deodato**

Soundings in **Meters and tenths** at **MLLW**

REMARKS: **Office revisions appearing as endnotes were generated by the cartographer during office processing.**

**All depths listed in this report are referenced to mean lower low water unless otherwise noted.**

# Outside Source Data Evaluation
# Survey W00005

Naval Oceanographic Office
Micronesia- Northern Marianas Islands- Guam
Apra Outer Harbor
Scale 1:10,000
January 8 – March 20, 2001

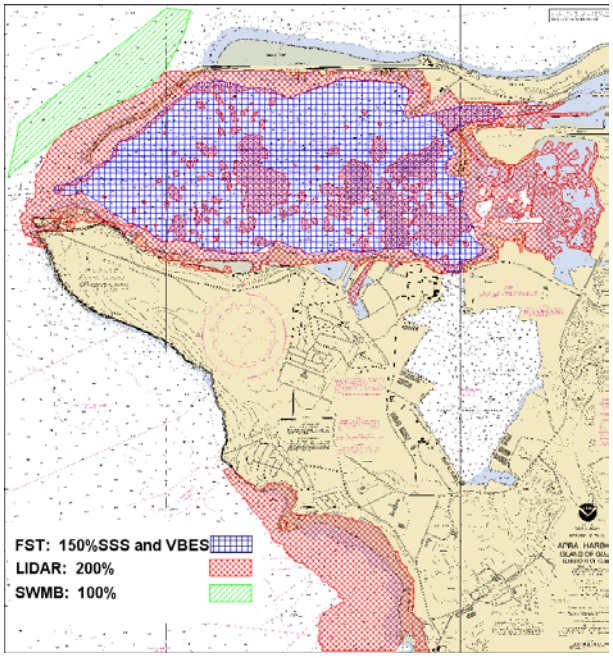
## A. GENERAL INFORMATION

### A.1 Background

This hydrographic survey was conducted by the U.S. Naval Oceanographic Office (NAVO or NAVOCEANO) to, according to the *Guam ROS*, support a "*Navy initiative to increase naval activity and usage of Naval Station Guam as a safe haven for major surface and sub-surface fleet units.*" The survey area is located at Apra Outer Harbor, and Agat Bay, Guam. This survey was conducted using a combination of the Scanning Hydrographic Operational Airborne LIDAR Survey system ("SHOALS"), the NAVO Fleet Survey Team (FST) utilizing side-scan sonar, single beam sonar and post-processed kinematic GPS for detached positions, and multibeam aboard the U.S. Naval Ship (USNS) SUMNER.

Data acquisition was conducted by the FST from January 13 - February 7, 2001 (DN 13 to 38), by SHOALS from January 8 - March 20, 2001 (DN 8 to 79) and by the USNS SUMNER on January 24, 2001 (DN 24).

### A.2 Area Surveyed




This survey was conducted in Apra Outer Harbor, Guam, including Agat Bay along the outer coast of Guam south of Apra Harbor, and offshore of the Glass Breakwater north of the entrance to Apra Harbor. The approximate extents of the survey are:[1]

Northeast corner:
13°28'17.88" N, 144°40'59.06" E

Southwest corner:
13°23'58.59" N, 144°36'54.5" E

## A.3 Data and Reports

The following data and documentation were received from the Naval Oceanographic Office:

| Data: | Description | Format |
|---|---|---|
| Aprafinal_00.asc | Full density XYZ soundings | ASCII |
| Agatfinal.asc | Full density XYZ soundings | ASCII |
| Guam_smoothsheet.dgn | Smooth Sheet | MicroStation DGN |
| Plots: | | |
| Apra Harbor, 00601/01US02 | Smooth Sheet | Hard Copy |
| Reports: | | |
| hss003 | Hydrographic Survey Specifications | Word |
| Guam Report of Survey (ROS) | Descriptive Report | Word |
| WESTPAC LIDAR ROS | LIDAR Descriptive Report | Word |
| Geodetic Survey Report Guam | Horizontal Control Report | Word |
| Cruise Report, SURVEYOPS 6103-01 | USNS SUMNER Cruise Report | Word |
| APNDX A: SURV AREAS | Guam ROS appendix | Word |
| APNDX B: TIDE ZONES | Guam ROS appendix | Word |
| APNDX C: TIDE STATIONS | Guam ROS appendix | Word |
| APNDX D: COVERAGE | Guam ROS appendix | Word |
| APNDX E: NAVAIDS | Guam ROS appendix | Word |
| Supporting Data: | | |
| Offset diagram for COMNAVMAR DIVE BOAT | | Word |
| NIMA Guam targets | Side-scan sonar contacts | Excel |
| CTD, Digibar, Secchi disk locations | | Excel |
| Final_Navaids | Detached positions | Excel |
| Bottom samples | | Excel |
| Digital photos | | JPEG |
| Lessons Learned in Multi-Platform Hydrographic Surveys | | PDF |

# B. DATA ACQUISTION AND PROCESSING

A complete description of data acquisition and processing systems, quality control procedures and data processing methods can be found in the *Guam ROS, WESTPAC LIDAR ROS and Cruise Report, SURVEYOPS 6103-01* for the Fleet Survey Team LIDAR, and Sumner multibeam operations, respectively.[2] The Evaluator's summary and discussions of methods follows.

## B1. Data Acquisition

This project was intended to be conducted and directed primarily by LIDAR (SHOALS), but water depth and water clarity severely restricted the use of LIDAR in portions of the survey area. In order to ensure one hundred percent coverage of the survey area, assistance was obtained from

the NAVO Fleet Survey Team (FST) and USNS SUMNER. See the following appropriate sections for a summary of each system used.[3]

**Fleet Survey Team**

*Vessel*:
A re-configured landing craft mechanized (LCM), was used by the FST as the primary survey platform for the operation. The vessel was 20 meters long, and with a draft of approximately 1.2 meters.

*LCM8-6.jpg: LCM used by the FST*

*Vertical-beam echo sounder (VBES):*
An Odom Hydrotrac Single Beam Echosounder and a 200Khz transducer with a 9 degree beam angle were used for this survey. The transducer was pole-mounted and secured to the starboard side of the LCM, roughly amidships. HYPACK MAX version 00.5A was the data collection software used. Raw sounding data was ingested by HYPACK MAX from the Odom Hydrotrac echosounder. The Hydrotrac was operated with no offsets and a standard 1500m/s assumed sound speed. HYPACK was configured to append draft to the raw data collected.

Vertical-beam echo sounder (VBES) data were acquired by the FST in depths from 2 to 180 feet. In general main scheme line spacing was 40 meters for the Inner Harbor and 50 meters in Outer Harbor. Additional lines were run to develop shoals and other side-scan sonar contacts.

*Side-scan Sonar:*
An EdgeTech 272T digital dual frequency side-scan sonar (SSS) system was used during this survey. Side-scan sonar data were collected using Triton-Elics Isis software. The side-scan sonar towfish was towed from the stern of the FST vessel at speeds not in excess of 6 knots. Bottom contacts were regularly identified and compared on consecutive side-scan sonar passes.

According to the *Guam ROS,* side-scan sonar was collected by the FST within the navigational constraints of the vessel. With the exception of areas of very shallow reefs, close to shallows, or in very navigationally constrained waters, 150% coverage was achieved within the limits of survey. Within Apra Outer Harbor the sonar was operated at 100 and 400 KHz on the 75 meter range scale and line spacing at 133% of the range scale in use. In Cabras Island Channel the

sonar was operated on the 75 meter range scale with lines at 50 meter line spacing, which provided greater than 200% SSS coverage. Refer to section 4.0 of the *Guam ROS* for complete information on side scan sonar operations. No side-scan sonar imagery or side-scan sonar mosaic was provided by the Navy, so the Evaluator was unable to independently review for coverage or data quality.

*Velocity:*
A Sea-Bird Electronics (SBE) Model 19 conductivity, temperature and depth (CTD) profiler or ODOM Digibar were used to collect all sound velocity readings. CTD casts were processed using SEASOFT version 4.235.

CTD or Digibar casts were performed on a daily basis. Digibar readings were compared to CTD values during the first two occasions on which bathymetric data was collected. The comparison proved accurate (within +/- 0.3m/s) for the purpose of the survey. The Digibar was used thereafter when general depths were 20 meters or less. Little or no diurnal variation was apparent during the survey. On days when the Digibar was used, corrections were applied at 1541m/s for the entire survey period. This value was a mean value, and due to the great stability of the temperature and salinity gradient noted during the survey, the Evaluator agrees that this is an acceptable practice.

*GPS:*
Survey vessel positions were obtained using a Trimble 4700 GPS receiver. The receiver was set up in the DGPS mode and correctors were received via VHF radio modem from station EOD Tower (refer to section C.1 for horizontal control information). No formal calibrations of the receivers operating in the DGPS mode were conducted during this survey however, internal precision of the system was monitored by the HYPACK-MAX system (HDOP, PDOP, SNR data).

Positions of navigational features were positioned using post-processed kinematic (PPK) GPS. Refer to the *Geodetic Survey Report Guam* for further information.

*Bottom Samples:*
A total of 51 samples were obtained, approximately 500 meters apart. The bottom samples were obtained throughout the survey area in depths ranging from 10–55 meters, and they are depicted on the Navy's smooth sheet.

**LIDAR:**
The LIDAR portion of the survey was conducted using the SHOALS Airborne system mounted on a DeHaviland Twin Otter aircraft. The LIDAR system was calibrated prior to survey operations and whenever major system components effecting data accuracy were changed or adjusted.

Positioning was provided by Ashtech Z-12 receivers. At the start of the survey problems with the DGPS-UHF system beacon at EOD Tower made it necessary to utilize VHF broadcast beacons (US Coast Guard Hawaii DGPS beacons) with the SHOALS system utilizing them in Kinematic-OTF mode. Near the end of the survey, correctors received utilizing DGPS-UHF

beacons, for station EOD Tower. No formal calibrations of the receivers were conducted during this survey. Internal precision of the system was monitored by the SHOALS system utilizing standard positional quality control (HDOP, PDOP, SNR data) techniques.

NAVOCEANO accessed that the Navy areas were surveyed at 4x4 meter spot density (110-meter swath) and with greater than 200% coverage to ensure a very high confidence of target detection. See the *WESTPAC LIDAR ROS* for additional information. The Evaluator was unable to independently confirm LIDAR coverage. However, the Evaluator believes that the use of side-scan sonar provides an independent check to LIDAR object detection in areas of overlap. See section D.2 of this report for further analysis of LIDAR data quality.

**USNS SUMNER:**

The approaches to the outer harbor outside the Glass Breakwater were surveyed by USNS SUMNER. The SUMNER is a 329-foot T-AGS 60 class vessel. The SUMNER was equipped with the Science Applications International Corporation (SAIC) Integrated Survey System (ISS-60) for data collection. The motion sensor was a POS/MV. The vessel was also equipped with a SIMRAD EM 121 and a 1002 multibeam sonar system for survey operations. One hundred percent shallow-water multibeam (SWMB) coverage was obtained in the survey area in waters 30 meters and deeper or where the ship's safety would permit. Positioning was obtained using Fugro Starfix Wide area GPS Service. A CTD, XBT and SST/SV were used to sample for sound velocity.

## B2. Corrections to Echo Soundings

*Vertical Beam Echosounder:*

<u>Draft Correction - (Draft settings, Squat and Settlement)</u>
The squat and settlement values for the Dive Boat LCM were not measured or applied for this survey. However, due to the combination of boat design (wide, flat bottom), least depth and slow speed, it was opined by the FST that squat and settlement did not significantly affect survey accuracy. The Evaluator agrees with the above assessment. See section **D.2** of this report for further discussion of this topic, and its impact on the quality of this survey. Static draft for the transducer was determined by measuring the physical distance from the transducer head along the pole. The water level was measured against the pole markings daily prior to sailing and this setting was applied to the raw soundings in HYPACK (and independently in CARIS). See digital photographs (*Xducer-3.JPG* and *Xducer-4.JPG*) for details of the transducer mount.

<u>Sound Velocity Correction</u>
Daily sound speed observations were made using the SEABIRD ELECTRONICS Model 19-03 conductivity, temperature and depth (CTD) instrument or Digibar. On days when the general operating depths were less than 20 meters the Odom Digibar instrument was used to calculate sound velocity. Raw sounding data was ingested by HYPACK MAX from the Odom Hydrotrac echosounder. The Hydrotrac was operated with a standard 1500m/s assumed sound speed. In post-processing CARIS used an (uncorrected) raw dataset to which correct sound velocity was applied.

Heave Corrections
Soundings were not corrected for heave, pitch and roll on the survey platform. The Evaluator feels that this would have a minimal impact on the survey, given the protected nature of the survey area and the size and stability of the survey platform.

Tide corrections
Tides were obtained from the NOAA tide gauge, 1630000 (GUAM, Apra Harbor). Six-minute tides were obtained via direct-dial from the gauge. Email communications with Steve Farr of NAVOCEANO stated that NOAA-derived tidal zoning was applied.

Offsets
All sounding positions were corrected for the antenna offsets (see *OFFSET DIAGRAM FOR COMNAVMAR DIVE BOAT)*. However, due to the lack of a gyro input to the navigation solution, heading was calculated using the most recent positional events in HYPACK (i.e. course made good). Further discussion of this can be found in the *Guam ROS* section 15.1. The Evaluator feels that this is an acceptable practice for single-beam soundings and should have a minimal impact on the data accuracy.

**Side-scan Sonar:**

Offsets
All sounding positions were corrected for the antenna offset (refer to *OFFSET DIAGRAM FOR COMNAVMAR DIVE BOAT*). However, due to the lack of a gyro, azimuth was derived from the most recent positional events in HYPACK (i.e. course made good). Further discussion of this can be found in the *Guam ROS* section 15.1. The Evaluator believes that this is an acceptable procedure, and should have a minimal impact on the data. In the past this practice has been considered adequate on NOAA platforms, although it does degrade the positional accuracy of side-scan sonar contacts possibly by several meters.

Layback was taken into account using "standard NAVOCEANO procedures." No additional documentation was provided on these procedures. The Evaluator was unable to determine if offsets were applied when computing side-scan sonar contact positions. However, the Evaluator feels that it is of minimal impact on data quality, since positions for least depths on features are based on single beam positions, and not side-scan sonar.

**USNS SUMNER: SWMB system**

Draft Correction: No information was provided regarding draft corrections to the USNS Sumner data.

Sound Velocity Correction Sound velocity casts were conducted at least on a daily basis. In addition XBT's were preformed as needed to maintain stability of sound velocity profile. No sound velocity information was provided for this survey. The Evaluator was unable to independently confirm the number or location of sound velocity casts conducted during this portion of the survey. Sound velocity correctors were applied in CARIS, during post processing.

Heave, Roll, and Pitch Corrections A POS/MV provided motion correctors including; attitude, heading and heave to the Simrad EM 1002. In addition the Integrated Survey System (ISS-60) was configured to have the POS/MV apply the motion sensor offsets. According to the paper *Lessons Learned in Multi-Platform Hydrographic* Surveys, this lead to motion sensor offsets being applied twice, and the error could not be corrected.

Additionally, no patch test was conducted as part of this survey. No calibrations were conducted during this survey, aside from calibration of new software for the EM 1002. Email communications with Steve Farr of NAVO stated that the survey was run using previously obtained patch test and system calibrations. These calibrations were not available for review.

Tide corrections
Tides were obtained via direct-dial from the NOAA tide gauge, 1630000 (GUAM, Apra Harbor). Email communications with Steve Farr of NAVOCEANO stated that NOAA derived tidal zoning was applied.

Offsets: No information was provided regarding vessel offset measurements applied to USNS Sumner multibeam data.

**LIDAR**

Draft Correction
Not applicable for LIDAR

Heave Corrections
The aircraft platform motion was compensated for by an aircraft-mounted inertial navigation system. This resolved undulations in the flight path. Aircraft movement outside of normal parameters resulted in "jerk" flags and rejected data.

Tide corrections
Tides were obtained via direct-dial from the NOAA tide gauge, 1630000 (GUAM, Apra Harbor). Email communications with Steve Farr of NAVOCEANO stated that NOAA derived tidal zoning was applied.

Offsets No offsets were apparently applied to the LIDAR data; however. The Evaluator was unable to determine if any offsets existed for the system configuration however, the Evaluator feels all appropriate correctors have been applied to the data.

See *WESTPAC LIDAR ROS* for specific information on LIDAR.

## B3. Data Processing and Quality Control

### Hydrographer

*VBES*
Acquired data was processed using CARIS HIPS (version unknown). Sound velocity, draft settings and tides were applied. The paper Hydrotrac record was compared to the digital record. When necessary features not digitized were manually inserted into the appropriate location on the digital file.

*SSS*
NAVO personnel used the following criteria were used in picking contacts: all man-made features identified were investigated and the least depth found by close sounding; all natural features which protruded from the seabed by approximately 10% of the surrounding general depth were also investigated. Since no side-scan sonar imagery was provided, the Evaluator was unable to determine if all significant contacts were picked for investigation. The Evaluator believes the described practice described seems adequate, and follows NOAA standard procedures.

*SWMB*
Limited documentation on SWMB processing was provided. Email conversations with Steve Farr of NAVOCEANO stated that the data was edited and cleaned by in-house data processors using the NAVO Bathy-Hydro Post-Processing suite (BHPP). Data processing using BHPP included the use of Area-Based Editor (ABE). No evaluation of the data quality was provided. NAVO did not provide full density multibeam sounding data to PHB, so it is not possible to gauge the quality control methods used.

*LIDAR*

The SHOALS proprietary data processing suite was used for processing LIDAR data. Time-tagged position and depth and laser waveform files were then transferred to the NAVOCEANO system Bathy-Hydro Post-Processing suite (BHPP). Data quality control and validation was carried out using the NAVOCEANO Area Based Editor (ABE).

According to the paper *Lessons Learned in Multi-Platform Hydrographic Surveys*, a comparison between LIDAR data collected using the Kinematic-OTF mode, a test LIDAR data set collected using the DGPS mode, and 200 leadline observations was conducted during post processing. All three data sets were processed and validated using the BHPP suite of software tools and then statistically compared, individually and to each other, in areas of overlap. NAVOCEANO personnel found good agreement between adjacent LIDAR lines, as well as between crosslines and main scheme lines. Sounding measurements collected using LIDAR were also noted as being statistically consistent with sounding measurements from the FST, as well as with LIDAR data collected using Kinematic-OTF. The Evaluator was unable to determine which sounding were acquired using Kinematic-OTF mode verses DGPS mode. Through visual examination of

crosslines, overlapping coverage of other system, and with charted soundings, the Evaluator is confident that the LIDAR coverage is of adequate positional and depth accuracy for charting purposes, except where noted in this report. See section D.2 of this report for specific charting recommendations.

## Evaluator

The Naval Oceanographic Office provided PHB with an excessed data set in XYZ format. See section **B.4** of this report for specific data decimation specifications. The Evaluator was unable to independently confirm that tides and sound velocity correctors was loaded to each line and that all lines were merged. As per verbal and email communications with Steve Farr of NAVOCEANO all data was corrected for sound velocity (except LIDAR data) and reduced to MLLW. All soundings for all platforms were corrected for offsets, and tides. The Evaluator imported the XYZ data into MapInfo and compared it to the largest scale chart in the area. In general agreement was good. See section **D.3** of this report for specific chart comparison findings and recommendations. Comparison between the full density and reduced data sets did not reveal any least depths more shoal that the reduced data set. Because no raw data or full density data sets were provided to NOAA, it was difficult to more fully assess the quality of the data; however, documentation provided to NOAA was thorough and leads the Evaluator to believe that the Navy's methods of data quality assurance are sound.

## Internal Data Consistency

**VBES**
Single beam sonar cross lines were run in all areas where possible. Cross line comparison was conducted by the Naval Oceanographic Office. They reported good agreement between the main scheme and crosslines. The overall majority of crossline deviations were noted as being well within IHO Order 1 standards. The Evaluator through visual comparison of the main scheme and crossing line found differences to be generally less than one foot, which meets IHO standards.

**LIDAR**
Crossline comparison for the LIDAR data was conducted by the Naval Oceanographic Office. LIDAR soundings were compared to single beam sonar cross lines when possible. Additionally, adjacent LIDAR swath overlap provides an excellent data check capability. It was reported by NAVOCEANO (refer to *WESTPAC LIDAR ROS*) that good agreement with the main development lines was generally observed, and the vast majority of crossline deviations were well within IHO Order 1 standards. The Evaluator conducted visual examinations of areas where single beam and LIDAR met. In general soundings compared well, with difference being generally within one foot. However, this comparison can only be considered cursory, because in areas around the edges of LIDAR coverage, the Evaluator lacked the ability to definitively differentiate between soundings obtained from single beam and those from LIDAR. This was due to the high density of LIDAR soundings. No anomalous soundings were noted in these areas, however, which might indicate that one dataset disagreed with the other. The Evaluator does believe that in general LIDAR soundings meets IHO Order 1 standards for positioning and depth accuracy (refer to *WESTPAC LIDAR ROS* for a further assessment of data accuracy).

According to the paper *Lessons Learned in Multi-Platform Hydrographic Surveys*, a comparison between LIDAR data collected using the Kinematic-OTF mode, a test LIDAR data set collected using the DGPS mode, and 200 leadline observations was conducted during post processing. All three data sets were processed and validated using the BHPP suite of software tools and then statistically compared both individually, and to each other, in areas of overlap. NAVOCEANO personnel determined that there was good agreement between adjacent LIDAR lines, as well as between crosslines and main scheme lines. Sounding measurements collected using LIDAR were statistically consistent with sounding measurements from the FST, as well as LIDAR data collected using Kinematic-OTF.

**SWMB**

No documentation was provided by NAVOCEANO discussing SWMB data consistency. However, in a discussion of the survey in *Lessons Learned in Multi-Platform Hydrographic Surveys*, several data quality issues were noted. These included the POS/MV offsets being applied twice, once in the ISS-60 and again by the EM1002 multibeam system. It was determined that this error could not be corrected. In addition it was observed that the outer beams of the EM1002 data were being refracted upward, resulting in the depths from the outer beams being shoaler than the inner beams. It was determined that the outer beams were statistically different from the inner beams as well as different from the LIDAR and FST data. In order to eliminate this error the edited data were restricted to the inner $120^{o}$ swath width. A digital terrain model (DTM) created from the multibeam dataset (XYZ soundings) provided to NOAA did not reveal any noticeable systematic errors.

The Evaluator conducted a comparison of the survey data to the largest scale chart of the area. Significant differences between charted and surveyed data were observed. Differences were observed to be greatest in the furthest offshore portion of the survey. See section D.3 of this report for further discussion on chart differences. In addition comparisons were made to adjoining LIDAR data collected during this survey. While preliminary comparisons showed good general comparison, definitive comparisons could not be made due to the LIDAR sounding being at the edge of detection limits, as well as data gaps of up to 30 meters between the two survey areas.

**<u>Data quality factors:</u>**

According to the *WESTPAC LIDAR ROS* depth and water clarity limitations of the LIDAR system prohibited attaining 100% coverage of the entire survey area. LIDAR coverage in the outer portion of Apra Harbor was limited to the shorelines and reef areas to depths of 20 to 35 meters. In depths deeper than 20 meters signal-to-noise ratio limitations greatly reduce target detection capability, particularly for small objects. Multiple flight coverage will theoretically improve the confidence of target detection capability in the depth range of 2-7 meters, and possibly down to 20 meters. The Evaluator believes that while theoretical detection of objects within this depth range may be possible, it is not sufficient to merit disproval of charted items or to provide definitive least depths on point features without additional supporting data.

No additional documentation on data quality factors was provided by Naval Oceanographic

Office. The Evaluator did not find any additional data quality factors.

## B4. Data Decimation

Sounding Selection: Data was decimated using a NAVOCEANO standard shoal biased sounding selection algorithm. No additional information was provided as to the specifics of this algorithm.

The Naval Oceanographic Office provided PHB with a decimated, shoal-biased dataset and a full-density dataset. The sounding density of the final decimated data set was 1.5 meters at the scale of survey (1:10,000), where supported by acquired sounding coverage. Visual examination of the complete sounding data set at the Pacific Hydrographic Branch did not reveal any least depths more shoal than the excessed data set. PHB did not further decimate the data.

# C. VERTICAL AND HORIZONTAL CONTROL

## C.1 Horizontal Control

The horizontal datum for survey W00005 was North American Datum 1983 (NAD 83). Data were provided in Universal Transverse Mercator, zone 55, based on the WGS 1984 spheroid.

A new base receiver station was established **(**station ID: **EOD TOWER)** for differential correction generation and post-processed kinematic (PPK) positioning. Survey vessel positions were obtained using DGPS. Differential correctors were obtained from station EOD TOWER, unless otherwise noted. No formal calibrations of the Trimble receivers were conducted during the survey. However, internal precision of the system was monitored by the HYPACK-MAX system utilizing standard positional quality control (HDOP, PDOP, SNR data) techniques.

A post-processed kinematic (PPK) GPS survey was run along the secure limits of Naval Station Guam and the Ammunition Pier. This included all shore-based and floating aids-to-navigation in the survey area. Mean solutions were then determined over the occupation interval of each item positioned. Evaluation by the Naval Oceanographic Office (refer to *Geodetic Survey Report Guam*) determined that, "based on 95% probability, centimeter accuracies were achieved during the geodetic survey and features were positioned within the IHO standards for Order 1 surveys (fixed features 2 meters, floating features 10 meters)." Based on the described methodologies the Evaluator believes that positioning standards as set forth in the HSSDM appear to have been met. Observed positions were compared to the largest scale chart (81054) in the area. In general the soundings and positioned features compared well to the chart. This gave the Evaluator a high degree of confidence in the data quality.

LIDAR positions were obtained from an Ashtech Z-12 GPS receiver onboard the survey aircraft. For most of the survey the receiver was set up in the DGPS mode and received correctors via

VHF radio modem (i.e. from the US Coast Guard Hawaii beacons[1]) with the SHOALS system utilizing them in Kinematic-OTF mode. Near the end of the survey correctors were received utilizing DGPS-UHF beacon from station EOD Tower. No calibrations of this receiver were conducted during the survey, but HDOP, PDOP, and SNR were monitored for data quality purposes.

Positioning of USNS SUMNER was obtained using Fugro Starfix Wide area GPS Service. However, system modeling around Guam indicated that the correctors only met IHO second Order requirements (approximately 12 meters).

## C.2 Vertical Control

The Vertical Datum for survey W00005 was Mean Lower-Low Water (MLLW). Tides were obtained via direct-dial from NOAA tide gauge, 1630000 (GUAM, Apra Harbor). The observed tidal data was plotted and compared to the predicted tides for this station, by NAVOCEANO personnel. No significant differences were observed. In addition, a simple non-integrating water level logger, was installed adjacent to the NOAA tide gauge. No additional information was provided regarding the use of this instrument. No tidal data was provided to the Evaluator for this survey. An examination of the verified tides on the NOAA CO-OPS website did not reveal any data gaps during the period of survey, and the data appear to be internally consistent.

NOAA CO-OPS provided zoning to NAVOCEANO (refer to *APNDX B: TIDE ZONES*).[4] Email communications with Steve Farr of NAVOCEANO indicated that NOAA provided zoning was applied to all sounding data.

NAVOCEANO personnel ran vertical levels between the tide station and the closest benchmark to ensure that the gauge was operating properly and collecting data to the MLLW datum. Agreement was noted as being within approximately 5 centimetres; are therefore tide gauge levels were accepted as being accurate for the purposes of the survey. Refer to *Guam ROS*, section 8, for further details.

# D. ANALYSIS AND RECOMMENDATIONS

### D.1 Error Analysis

Please see *Guam ROS* and *WESTPAC LIDAR ROS* for NAVOCEANO's analysis of errors. The Evaluator agrees in general that the NAVOCEANO analysis or errors is complete and accurate, and that the data meet specifications as noted in the NAVOCEANO reports. Specific discussions of data accuracy and error issues are discussed below in section D.2.

### D.2 Discussion of Data Quality and Suitability for Charting

[1] In the NAVOCEANO survey reports, DGPS correctors from U.S. Coast Guard beacons were reported to have been received via VHF. While USCG beacons do not typically transmit on the VHF band, the Evaluator believes that correctors received via "VHF" are actually meant to mean via USCG DGPS beacons.

An evaluation of the data has determined that with the exceptions noted below this survey meets minimum IHO specifications for an Order 1 survey. The data have also been evaluated to determine suitability for use in revising the specified nautical chart(s). With the exceptions noted below these data are considered to be acceptable to supersede the charted information within the common area.

**Single beam**

As discussed in the *Guam ROS* the calculated error for the single beam portion of this survey do not meet the IHO depth accuracy limits for Order 1 surveys. However the Evaluator believes through independent calculation that positional accuracy standards for IHO Order 1 surveys have been met, and that the depth accuracy requirements for IHO Order 1 surveys were miscalculated in the *Guam ROS*. Sound velocity, instrumental accuracy and draft errors were all assessed as having minimal errors. The lack of a heave or motion sensor, combined with the steep seabed slopes, were noted to produce significant error (0.471 meters at 50 meters depths and 0.320 meters in the shallower margins). In addition no corrections for dynamic draft were taken into account. The Evaluator believes that theses errors are acceptable and are within allowable depth accuracy limits for IHO Order 1. The Evaluator believes that despite these errors the survey data is of sufficient quality for charting purposes. The Evaluator also recommends that due to the lack of recent hydrography in the survey area charted soundings be replaced with the survey's soundings, unless the charted soundings are shoaler than surveyed soundings, or in cases specifically addressed by the Evaluator.

**Side-scan Sonar**

The Evaluator agrees with the NAVO assessment that the side-scan sonar portion of this survey meets IHO Order 1 specification for both positional as well as ensonification aspects. However, NOAA standards require 200% side-scan coverage to ensure object detection, and for disproval of items. In areas where merely 150% side-scan coverage was reported to have been obtained along with only single-beam soundings, this should be considered insufficient for item disproval. In areas where greater than 200% side-scan sonar coverage was obtained, or in areas where side-scan sonar coverage was augmented with 200% LIDAR coverage, this should be considered adequate to disprove charted items, unless specifically discussed in this report.

**LIDAR**

As discussed in the *WESTPAC LIDAR ROS* the instrumental accuracy error was accessed as being minimal (0.1 meters). Positional accuracy was stated as meeting IHO Order 1 specifications. The Evaluator agrees with these statements. The *WESTPAC LIDAR ROS* states: "*Theoretically, all navy areas meet IHO Order 1 target/object detection requirements for depths from 7m to 20m with single flight coverage. While at depths deeper than 20m signal-to-noise ratio limitations greatly reduce target detection capability, particularly for small objects.*" While it was noted that multiple flights would improve the confidence in the data, due to NOAA's limited experience with LIDAR and lack of standard specifications and procedures for utilizing LIDAR for item investigations, the Evaluator cannot confidently say that object detection standards were met in areas with merely 200% LIDAR. However, in areas with both 150% or greater SSS coverage and 200% LIDAR coverage, the Evaluator does have confidence that object detection criteria have been met and all significant shoals or objects would have been located in navigationally significant waters.

The LIDAR coverage in the outer portion of Apra Harbor was limited to maximum depths of 20-35 meters due to system limitations and water clarity. The resulting holidays were identified by the Evaluator and are depicted on a supplemental layer to the Navy smooth sheet, called "W00005_coverage." The Evaluator recommends that in these areas that the charted sounding be retained, unless a more shoal depth than the chart was identified during the survey. The remainder of the LIDAR portion of the survey was evaluated by NAVOCEANO personnel as to having meet IHO Order 1 allowable error for depths from 0 to 50 meters. After comparison of charted soundings and neighboring data collected via alternative systems (VBES and SWMB), the Evaluator agrees with this assessment. However, the Evaluator believes that LIDAR soundings should not be considered definitive least depths for point objects. The following areas are notable exceptions to the above recommendation:[5]

In the vicinity of 13°26'52.17"N; 144°40'26.95" E there is a holiday in coverage approximately 540 meters by 490 meters in size. Charted data should not be superseded in this area.

In the vicinity of 13°26'55.68" N 144°40'08.99" E there is a holiday in coverage approximately 540 meters by 490 meters in size. Charted data should not be superseded in this area.

In the vicinity of 13°26'59.2" N 144°40'47.18" E an area of spotty coverage 1,400 by 700 meters long. The charted data should only be superceded by survey soundings where survey soundings are shoaler than charted.

**SWMB**

No *Report of* Survey or other documentation describing data acquisition, processing, and quality control procedures for the SUMNER multibeam data was provided. The paper *Lessons Learned in Multi-Platform Hydrographic Surveys* does provide some general details. According to this paper, the motion sensor offsets were applied twice, and no corrective action was possible. The Evaluator was unable to determine to what extent this would impact the overall quality of the data.

In addition positional information obtained from the Fugro Starfix service was determined to be degraded to IHO Order 2 specifications, with the maximum positioning error was estimated to be approximately 12 meters. The area of the survey was very steep, which would exacerbate any errors due to positioning. Comparison to the largest scale chart of the area showed significant differences to survey data. See section **D.3** of this report for further discussion on chart differences. In addition comparisons were made to adjoining LIDAR data collected during this survey. While preliminary comparisons showed good general agreement, a definitive comparison could not be made due the depths being at the edge of detection limits of LIDAR. In addition a data gap of up to 30 meters exists between the two survey areas, leading to difficulties in making comparison between the two datasets. The Evaluator recommends retaining the charted sounding in the survey area, unless surveyed depths are more shoal.

**Detached Positions**

As discussed in the *Guam ROS* and *Geodetic Survey Report Guam* the differential correction station (**EOD TOWER)** was established for this survey was positioned using PPK-GPS and tied

into to the Continuously Operating Reference Station (CORS). The NAVOCEANO evaluation of the positional accuracy of this site states that it meets IHO Order 1 specifications. The Evaluator agrees with this assessment, based on the described procedures and the high accuracy of this form of surveying. The Evaluator believes that GPS correctors produced from this station are suitable for use during this survey.

All positioned shore-based and floating navigation aids in the survey were positioned using PPK-GPS, and meet IHO Order 1 survey specifications. After reviewing the procedures used during this survey it is the Evaluator's belief that surveyed positions meet IHO Order 1 specifications and recommends that all positioned features be charted based on their surveyed position. [6]

## D.3 Automated Wreck and Obstruction Information System (AWOIS) Items

No AWOIS items were located within the limits of survey W00005. All charted and new items discussed in sections **D.4** and **D.5** of this report should be added to the AWOIS database. [7]

## D.4 Chart Comparison

Survey W00005 was compared with chart 81054 (13th Ed.; Feb. 2003, 1:10,000), the largest scale chart which covered the entire survey area.[8]

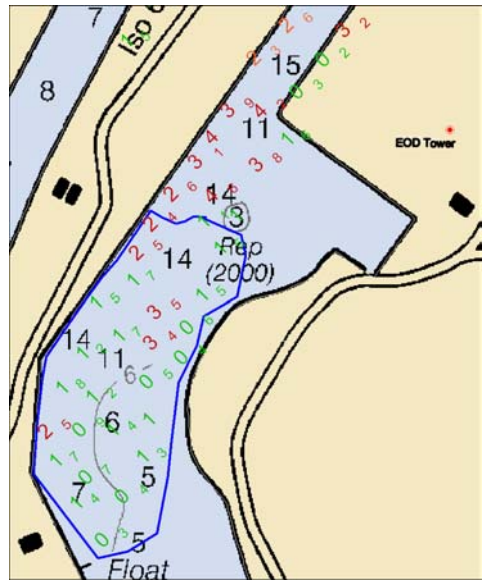
**Chart 81054**
A comparison between surveyed and charted (81054) bathymetry found good general agreement, with most soundings comparing within 3-6 feet. There were some areas of greater differences (10-50 feet), but the Evaluator attributes these to the complex nature of the bottom (large number of coral heads) and the advances in positioning technology (use of DGPS). Several areas did differ significantly from the chart, and are discussed below.

The area offshore of Apra Outer Harbor (13°27'43.91" N 144°37'33.8" E) adjacent to the Glass Breakwater, surveyed by USNS Sumner, showed differences of 10-300 feet deeper than charted soundings. Differences between charted and surveyed data were the greatest in the offshore portion of the survey. It is possible these differences could be attributed to the steep nature of the area and improvements in positional technology since the charted data was collected; however, because of the lack of confidence in the multibeam data from USNS Sumner, the Evaluator does not recommend superseding the chart in this region, apart from critical corrections which may be dangers to navigation. See section **D.2** of this report for further assessment of the USNS Sumner multibeam data.

The second area of discrepancy was the shallow embayment to the southeast of Drydock Point and east of the Special Anchorage area (13°26'55.74" N 144°40'31.28" E). This area has only patchy LIDAR coverage from the survey; and no single-beam, side-scan, or multibeam coverage. It is a highly complex area covered with numerous shoals and coral heads and is not navigationally significant. Comparisons between the survey and charted data showed great variation between the data sets. Both shoal and deep differences ranging from 2-20 feet were observed. The Evaluator attributes the differences in this area to the highly complex nature of

the area and changing nature of the bottom because it is comprised of coral. The chart should only be superseded with shoaler soundings in this region.[9]

Another area of discrepancy was the lagoon to the southwest of the EOD Tower (13°26'23.56" N 144°39'16.8" E). This area has only patchy LIDAR coverage from the survey; and no single-beam, side-scan, or multibeam data were obtained in this area. Comparisons between the survey and charted data showed survey data 2-6 feet more shoal than charted. The Evaluator attributes the differences in this area to the poor water clarity contributing to patchy LIDAR coverage, artificial shoal sounding selection due to large bin size in the restricted basin and possible fliers due to the large number of small craft anchored in the basin. The Evaluator recommends all charted soundings should be retained in this region.




*Charted soundings were retained within the blue region*

Two 33-foot shoals specifically mentioned by the "Fleet Customer" (refer to section 6.4.1.1 of *Guam ROS)* at the entrance to the Inner Harbor (13° 26' 36" N 144° 39' 55" E and 13° 26' 40" N 144° 39' 57" E) were not identified during the survey. The least depths found during this survey for each of the charted soundings were 48 feet and 72 feet respectively. Single-beam coverage over these shoals is extensive and the Evaluator considers these soundings disproved. The Evaluator recommends charting these areas based on this survey.[10]

**Charted Features**

The following charted (81054) mooring buoys were positioned using PPK GPS. Their charted locations were covered by 150% SSS and single beam sonar. The Evaluator believes that these are the same buoys, and that the shift in position can possibly be attributed to the series of typhoons noted in the *Guam ROS* or repositioning by the Navy. The reviewer recommends removal of these charted mooring buoys and charting a new buoy as depicted on the Navy smooth sheet.[11]

| Charted position: | | New position: | | Difference: |
|---|---|---|---|---|
| 13°26'56.35" N | 144°38'22.24" E | 13°26'58.26" N | 144°38'25.04" E. | 100 meters NE |
| 13°26'59.3" N | 144°38'53.26" E | 13°27'00.91" N | 144°38'48.83" E. | 145 meters W |
| 13°26'55.19" N | 144°39'26.34" E | 13°26'52.92" N | 144°39'22.85" E. | 125 meters SW |
| 13°27'06.79" N | 144°39'49.82" E | 13°27'04.36" N | 144°39'50.76" E. | 75 meters N |
| 13°26'48.97" N | 144°40'03.18" E | 13°26'48.88" N | 144°40'01.39" E. | 55 meters W |

The charted (81054) mooring buoy located at 13°27'26.28" N 144°37'59.44" E was not positioned during this survey; however, it was not specifically disproved by the Hydrographer. The Evaluator recommends retaining it as charted.[12]

The charted (81054) mooring buoy located at 13°26'47.23" N 144°38'38.42" E was not observed during the survey; however, it was not specifically disproved by the Hydrographer. The Evaluator recommends retaining as charted.[13]

The charted (81054) 3 foot reported sounding located at 13°26'27.29" N 144°39'19.89" E was investigated using LIDAR. The least depth located during the survey was 3 feet. Adjacent data support a shoal at this position. The Evaluator recommends retaining the sounding and deleting the annotation. The Evaluator believes that this survey was the source of the reported sounding.[14]

The obstruction charted (81054) at 13°27'31.45" N 144°40'02.27" E was investigated using 200% SSS, single beam sonar, and 200% LIDAR. The single beam investigation consisted of several haphazard lines, varying from 2-20 meters apart. A least depth of 46 feet was found at the charted position from all sounding methods, consistent with surrounding depths, and no contact was noted in the side-scan sonar target file at this position. The Evaluator considers this obstruction disproved, and recommends removing it from the chart.[15]

The obstruction charted (81054) at 13°27'32.89" N 144°40'02.96" E was investigated using 150% SSS, single beam sonar and LIDAR. The single beam investigation consisted of several haphazard lines, varying from 20-30 meters apart. A depth of 40 feet was found at the charted location, shoaler than surrounding depths, possibly confirming the existence of the obstruction. The Evaluator believes that the investigation was insufficient to determine the least depth of this feature and recommends retaining the obstruction and adding the remark "40 feet reported 2001."[16]

The 39 foot obstruction charted (81054) at 13°27'32.25" N 144°40'06.23" E was investigated using 200% SSS, limited single beam sonar, and 200% LIDAR. A least depth of 40.0 feet from all sounding methods was found at the charted position, consistent with surrounding depths, and no contact was noted in the side-scan sonar target file at this position. The Evaluator considers this obstruction disproved, and recommends removing it from the chart location.[17]

The 39 foot obstruction charted (81054) at 13°27'30.69" N 144°40'06.98" E was investigated using 150% SSS, single beam echosounder and LIDAR. A least depth of 41 feet from all sounding methods was found at the charted position, consistent with surrounding depths, and no contact was noted in the side-scan sonar target file at this position. The Evaluator considers this obstruction disproved, and recommends removing it from the chart.[18]

The 39 foot obstruction charted (81054) at 13°27'31.35" N 144°40'08.65" E was investigated using 200% SSS, single beam echosounder and LIDAR. Sounding coverage over this obstruction is spotty, and the single beam investigation consisted of several haphazard lines, varying from 5-40 meters apart. A depth of 43 feet was found at the charted location. The Evaluator believes that the investigation was insufficient to determine the least depth of this feature and recommends retaining as charted.[19]

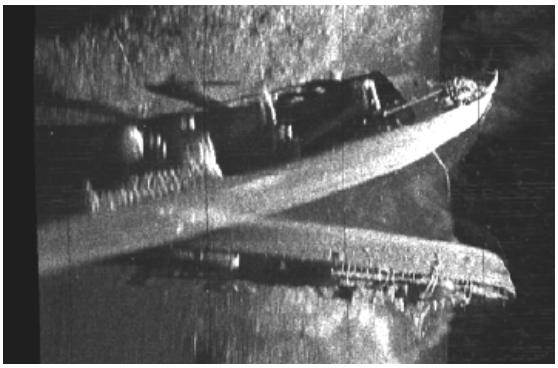
The obstruction charted (81054) at 13°27'33.44" N 144°40'10.37" E was investigated using 200% SSS, single beam echosounder and 200% LIDAR. A depth of 41 feet was found at the

charted location, in general agreement with the surrounding depths. The Evaluator believes that using all three sounding methods that the obstruction was disproved and recommends deleting the charted obstruction.[20]

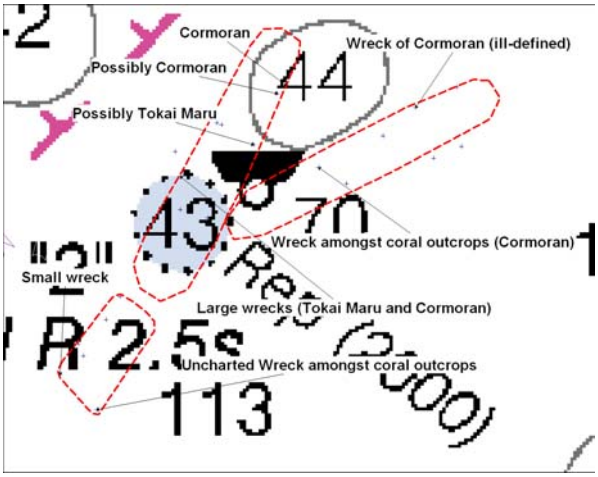
The rock charted (81054) at 13°27'34.21" N 144°40'10.95" E was investigated using 200% SSS, single beam sonar and 200% LIDAR. A depth of 40 feet was found at the charted location. The Evaluator believes that using all three sounding methods that the obstruction was disproved and recommends deleting the charted obstruction.[21]

The chart (81054) depicts the eastern end of Cabras Island Channel reported dredged to 22 feet at 13°27'33.69" N 144°40'20.83" E. This area was investigated using LIDAR. Survey depths were generally shoaler than 22 feet, with a depth of 9 feet located at 13°27'31.85" N 144°40'20.09" E. The Evaluator recommends removing the charted note reported dredged to 22 feet, and charting the surveyed depths.[22]

The *Guam ROS* states: "*The charted (81054) wreck located at 13$^o$ 27' 34.3" N 144$^o$ 39' 20.3" E was investigated using sidescan and close sounded with single beam echo-sounder. This is the wreckage of the MV TOKAI MARU and SS CORMORAN, (contacts ISIS 9 and ISIS 8 respectively), vessels sunk during the Second and First World Wars and which lie atop one another. The definitive shoal depth of 12.88 meters was located in position 13$^o$ 27' 33.452" N 144$^o$ 39' 21.953" E. Recommend: Replace current nomenclature with wreck, (least depth known by sounding only), depth 12$_8$, in position 13$^o$ 27' 33.452" N 144$^o$ 39' 21.953" E. The Charted (81054) wreck (44) located at 13$^o$ 27' 34.2"N 144$^o$ 39' 23.4" E was also investigated using sidescan and close sounded with single beam echo-sounder. This is the wreck of the SS CORMORAN. The shoal depth found over this contact was 14.21 meters (sounding only). Recommend: Replace current nomenclature with wreck, (least depth known by sounding only), depth 14$_2$, in position 13$^o$ 27' 34.138" N 144$^o$ 39' 23.134" E."*



*Side-scan sonar image of the TOKAI MARU and the SS CORMORAN*




*Likely positions of wrecks based on SSS contacts and soundings*

The Evaluator disagrees with the above charting recommendations. The wrecks of the *MV TOKAI MARU* and *SS CORMORAN* do lie in very close proximity, and are well known dives with the recreational dive community. Diagrams and photos of the wreck site are available on

the internet (*Professional Sport Divers of Guam website: psdguam.com*). In addition to these site diagrams the Evaluator overlaid side-scan sonar contact positions from this survey with the chart as well as survey soundings. Based on this information the Evaluator recommends charting the wrecks as follows: The charted 42-foot sounding charted (81054) at 13°27'34.75 N 144°39'20.25 E should be retained as charted.[23] Extensive single beam sonar lines were run over this location, and a 42 foot sounding was found. However, no side-scan contacts were noted at this position and the Evaluator believes this is a shoal, not a wreck.[24]

The Evaluator believes that the least depth for the wreck of the *MV TOKAI MARU* is as reported. The least depth of 42.0 feet was located in position 13° 27' 33".45 N 144° 39' 21.95" E. This correlates well (20 meters to the north) with the charted (81054) 43 foot sounding at 13°27'33.45 N 144°39'21.95" E. The Evaluator recommends charting a wreck at the surveyed location. It is also the Evaluators belief that the charted 44 foot sounding located at 13°27'34.21" N 144°39'23.45" E is actually a part of this extensive wreck. The Evaluator recommends joining this sounding and depiction the entire feature as a dotted outline of the wreck, with least depths of 42 feet and 44 feet.[25]

The wreck of the *SS CORMORAN* has been noted by local sports divers to be lying on her starboard side in 120 feet of water (*Lonely Planet Dive & Snorkel guide- Guam & Yap*, *1999*). Depths on the wreck were noted as being from 70-125 feet. Numerous side-scan sonar hits of the wreck were collected during the survey. By examining the location of the side-scan sonar hits and the soundings obtained during the survey, it is the Evaluator's belief that the surveyed least depth of 43 feet is correlated to the wrong wreck. The depth found via echo sounder within the extents of what the Evaluator believes is the CORMORAN was 72 feet at 13°27'33.32" N 144°39'24.25" E. This agrees much better with information obtained from divers. Because of the sparseness of sounding data in this position, the Evaluator does not have confidence that the least depth was definitely measured; however, the Evaluator recommends charting this extensive wreck as a dotted outline with a least depth of 72 feet, since it is in close proximity to more shoal least depths.[26]

A charted (81054) wreck PA at 13° 26'59.17" N 144° 37'10.6" E was covered using only 200% LIDAR. Depths at the charted location ranged from 51-84 feet. No indication of the wreck was noted. The depths in the area exceed 20 meters, and according to the *WESTPAC LIDAR ROS,* object detection criteria have been met at these depths. No side-scan sonar or single beam sonar data appear to have been collected here. The Evaluator recommends retaining the wreck as charted.[27]

The charted (81054) 48 foot sounding reported 2000 at 13° 26'53.89" N 144° 38'47.62" E was investigated using 200% SSS, single beam sonar and 200% LIDAR. A least depth of 48 feet was obtained at the charted location and this depth is well-supported by other soundings obtained over this shoal. The Evaluator recommends retaining the charted sounding[28], and removing the "reported 2000" notation.[29]

The charted (81054) 57 foot sounding reported in 1970 at 13° 27'30.36" N 144° 39'29.77" E was investigated using 200% SSS and single beam sonar. The charted location was covered by several single-beam lines spaced from 17-25 meters apart. No SSS contacts were noted. Depths

in the general area ranged from 114-118 feet. The reported 57 foot sounding could actually be the charted 60 feet located at 13 º 27'30.0" N 144 º 39'26.85" E, approximately 60 meters to the west. The Evaluator recommends removal of the reported 57 foot sounding, and charting depths from this survey.[30]

The charted (81054) area along "Wharf D" at 13 º 27'27.66" N, 144 º 39'56.70" E has a notation of "41 ft reported 1983." The area adjacent to the wharf face was covered by two single beam sonar lines 25 meters apart. While the surveyed least depth was 45 feet, the investigation was inadequate for determining the least depth along the wharf. The Evaluator recommends retaining the notation as charted.[31]

The charted (81054) (depicted as "foul" on the Navy's smooth sheet) 17 foot sounding at 13°27'44.01" N 144°38'47.69" E was covered by 200% LIDAR and two SSS lines. The survey found a least depth of 37 feet at 13°27'44.11" N 144°38'47.81" E. The surrounding depths ranged from 37-48 feet. The Evaluator recommends removal of the charted 17 foot sounding,[32] and charting an obstruction with a depth of 37 feet.[33]

The charted (81054) 56 foot sounding at 13°27'10.3" N 144°37'23.25" E was covered by 200% LIDAR and 150% SSS. A review of SSS data showed no feature or indication of shoaling. The survey found depths of 93 to 100 feet at the charted location. The Evaluator recommends removal of the charted 56 foot sounding, and charting depths from this survey.[34]

The charted (81054) 112 foot sounding at 13°27'05.75" N 144°37'27.88" E was covered by 150% SSS and several single-beam lines. A review of the SSS data showed no indication of shoaling or feature at this position. The survey found depths of 154 to 167 feet at charted location. The Evaluator recommends removal of the charted 112 foot sounding, and charting depths from this survey.[35]

The charted (81054) 106 foot sounding at 13°26'57.81" N 144°37'41.36" E was covered by 150% SSS. Two single-beam lines spaced forty meters apart were run in the vicinity. A review of the SSS data showed no indication of shoaling or features in this area, and the Evaluator believes that a feature with a drastic depth change such as this would appear on side-scan sonar imagery. The survey found depths of 144 to 152 feet at the charted location. The Evaluator recommends removal of the charted 106 foot sounding, and charting depths from this survey.[36]

The charted (81054) 85 foot sounding at 13°26'45.47" N 144°38'46.45" E was covered by 150% SSS and several single-beam lines. A review of the SSS data showed no indication of shoaling or feature in this area. The survey found depths of 128 to 135 feet at the charted location. The Evaluator recommends removal of the charted 85 foot sounding, and charting depths from this survey.[37]

The charted (81054) 51 foot sounding at 13°26'37.81" N 144°39'59.92" E was covered by 150% SSS and several single-beam lines. A review of SSS data showed no indication of shoaling or feature in this area. The survey found depths of 74 to 75 feet at the charted location. The Evaluator recommends removal of the charted 51 foot sounding, and charting depths from this survey.[38]

**New Features**

The coralline nature of the area generated a great many shoals and obstructions which were not charted. According to the *Guam* ROS all shoals identified by sonar were investigated by echosounder; and from the data it does appear that most targets were investigated, albeit with varying levels of thoroughness. A database of these contacts is available in *NIMA Guam targets.xls*. Numerous uncharted small wrecks were found scattered throughout outer Apra Harbor. These small wrecks are the remains of aircraft, LCMs, tracked military and commercial vehicles chiefly from WWII and post-WWII eras. The vast majority of these wrecks were not considered dangerous to surface navigation; nevertheless, the *Guam ROS* recommends that their existence should be annotated on the chart. The Evaluator agrees with this statement for the most part; however very insignificant wrecks and obstructions, found by the Navy yet not depicted on the smooth sheet, should not be added to the chart. The Evaluator has reviewed the smooth sheet and the database of target and specific charting recommendations are made below.

A new wreck was positioned at 13°26'49.07" N 144°40'13.08" E (on the Navy smooth sheet). This is the wreck of a large (65 foot) yacht, see Digital Photo *P0000072.JPG*. The wreck was positioned using PPK GPS alongside the mast (target *Final_Navaids.xls* - GUAM028). The Evaluator recommends charting a new visible wreck at the surveyed position.[39]

*P0000072.jpg: New visible wreck*

A new wreck was positioned at 13°27'28.7" N 144°39'09.66" E (on the Navy smooth sheet). The Evaluator believes the new large wreck is the *Kitsugawa Maru* a WWII freighter, based on descriptions in a dive guide and several dive site maps available on the world-wide web (*Lonely Planet Dive & **Snorkel** guide- Guam & Yap*, *1999* and *Professional Sport Divers of Guam website: psdguam.com*). A prominent mast was reported by the FST. This mast is also mentioned on the *psdguam.com* web site, and the least depth was noted as being at approximately 50 feet. The wreck was 90m long and 20m high, based on side-scan sonar. A least depth of 63 feet was obtained using 150% SSS and a limited single beam sonar investigation; however it appears that this least depth was obtained by scaling the height from the side-scan sonar records. The investigation consisted of several irregularly spaced lines, varying from 5 to more than 20 meters apart and this least depth is not contained in the single-beam data. The Evaluator believes that the investigation was insufficient to determine the least depth of this feature and recommends charting a new wreck with the annotation "63 feet reported 2001[40]."

A new wreck was positioned at 13°27'35.48" N 144°38'00.02" E (on the Navy smooth sheet). The Evaluator believes this new large, extensive wreck is a 300 + ft WWII water barge, based on based on descriptions in a dive guide and several dive site maps available on the web (*Lonely Planet Dive & Snorkel guide- Guam & Yap*, *1999* and *Professional Sport Divers of Guam*

*website: psdguam.com*). A least depth of 38 feet was obtained using 150% SSS and LIDAR; however it does not appear that LIDAR completely covered the extents of the wreck due to its depth. A second side-scan contact located at 13°27'34.08" N 144°37'58.4" E is also believed to be the same wreck. A least depth of 38 feet was scaled from side-scan sonar. A depth of 40 feet was determined by LIDAR at 13°27'34.15" N 144°37'58.26" E. A charted 59 foot sounding located at 13°27'35.9" N 144°38'00.46" E, correlates well with the soundings obtained during the survey, and is believed to be the wreck possibly detected on a prior survey. While the Evaluator believes that LIDAR is insufficient to determine the least depth of this feature in this depth of water, and that the single-beam coverage is not sufficient either, these depths, taken together with the depth scaled from the side-scan sonar record, appear to correlate with one-another. The Evaluator recommends removing the charted 59-foot sounding and charting the entire feature as a dotted outline of the wreck, with a least depth of 38 feet.[41]

A new wreck was positioned at 13°27'32.55" N 144°39'43.64" E (on the Navy smooth sheet), just south of the fuelling jetty F-1. The new wreck was approximately 37 meters long, based on side-scan sonar. The FST noted it as lying on an orientation of 030/210 degrees. The new wreck was investigated using 150% SSS and a single beam echo sounder. The primary side-scan sonar hit (Contact ISIS 174 in *NIMA Guam Targets.xls*) produced a depth of 58 feet. Two additional contacts were identified as the same wreck. The single beam investigation consisted of several lines spaced from 6-17 meters apart and is not alone sufficient to definitively determine the least depth. The shoal depth found by single beam was 58 feet located at 13°27'31.6" N 144°39'43.7" E. The Evaluator recommends charting a dangerous wreck, with the entire feature as a dotted outline. Because this is in a navigationally significant area and the least depth of this feature is not certain, the new wreck should have a remark "58 feet reported 2001.[42]"

A new wreck at was positioned at 13°27'31.45" N 144°39'20.92" E (Contact 24-Jan-12) (on the Navy smooth sheet). This new large wreck was identified by the FST as an unrelated wreck is in close proximity to the wrecks of the TOKAI MARU and CORMORAN. The FST specifically identified it as an independent new wreck. The new wreck was investigated using 150% SSS and single beam echo sounder. The single beam investigation consisted of several lines spaced from 5-12 meters apart. A least depth of 54 feet was scaled from side-scan sonar and is shoaler than the echosounder depths. The Evaluator recommends charting the new wreck with a least depth of 54 feet.[43]

A new wreck was positioned at 13°27'30.61" N 144°39'16.35" E (on the Navy smooth sheet). A depth of 79 feet was obtained on the new small wreck from side-scan sonar. The investigation consisted of single-beam lines spaced from 5-15 meters apart. The Evaluator believes that the investigation was insufficient to determine the least depth of this feature; however, the depth from SSS is much more shoal than any single-beam depth and likely represents a conservative indication of the least depth of the wreck. The Evaluator recommends charting a non-dangerous wreck.[44]

A new wreck was positioned at 13°27'03.38" N 144°37'23.29" E. This was not depicted on the Navy's smooth sheet and was merely noted in *NIMA Guam Targets.xls*. A depth of 135 feet was obtained on the new small wreck from side-scan sonar. The investigation consisted of single-beam lines spaced from 7-18 meters apart. The shoal depth recorded by single beam in the

general area was 145 feet. The Evaluator believes that the investigation was insufficient to determine the least depth of this feature; however, the depth from SSS is much more shoal than any single-beam depth and likely represents a conservative indication of the least depth of the wreck. The Evaluator recommends charting a non-dangerous wreck.[45]

A new "foul" was positioned at 13°27'05.11" N 144°37'21.15" E (on the Navy smooth sheet). A depth of 112 feet was obtained, assumedly based on SSS imagery only. The area was covered with several single-beam lines spaced from 2-37 meters apart. The shoal depth of 144 feet was reported. The Evaluator recommends charting a new non dangerous obstruction at the surveyed position.[46]

A new "foul" was positioned at 13°27'08.22" N 144°37'26.84" E (on the Navy smooth sheet). A depth of 108 feet was obtained based on 150% SSS imagery only. Survey depths LIDAR depths in the general area show depths of approximately 118 feet. The Evaluator recommends charting a non-dangerous obstruction.[47]

A new wreck was positioned at 13°27'10.36" N 144°37'27.91" E (annotated "foul" on the Navy's smooth sheet). The small wreck was 1.5 meters high, based on side-scan sonar. A depth of 95 feet was scaled from side-scan sonar, and the area was covered with single beam sonar, side-scan sonar, and LIDAR. Depths in the general area were approximately 102 feet. The Evaluator recommends charting a new non dangerous wreck.[48]

A new obstruction was positioned at 13°26'56.99" N 144°37'39.67" E (annotated "foul" on the Navy's smooth sheet). The new obstruction was a "vehicle" which was 2.5 meters high, based on side-scan sonar. The evaluator believes that this obstruction could be the same feature which is charted as 106-foot sounding, approximately 55 meters to the northeast. A depth of 131 feet was obtained using 150% SSS and limited single beam sonar investigation. The investigation consisted of three unevenly spaced single beam lines passing from 3 meters to 30 meters of the obtained least depth. The Evaluator recommends charting a new non-dangerous obstruction.[49]

A new obstruction was positioned at 13°26'52.17" N 144°38'06.66" E (annotated "foul" on the Navy's smooth sheet). The new obstruction was a "vehicle with little vertical extent." A depth of 115 feet was scaled from side-scan sonar, and the target is located on a slope with depths from 83 to 128 feet. The Evaluator recommends charting a new non-dangerous obstruction.[50]

A new obstruction was positioned at 13°26'40.86" N 144°38'20.34" E (annotated "foul" on the Navy's smooth sheet). The new obstruction was "wreckage," 42 meters long and 1 meter high, based on side-scan sonar. A least depth of 108 feet was scaled from side-scan sonar, and a limited single beam sonar investigation revealed a least depth of 115 feet. The Evaluator recommends charting a new non-dangerous obstruction.[51]

A new wreck was positioned at 13°27'00.81" N 144°38'28.89" E (on the Navy's smooth sheet). The new small wreck had a depth of 118 feet scaled from SSS and a limited single beam sonar investigation indicated a depth of 121 feet. The Evaluator recommends charting a new non dangerous wreck.[52]

A new wreck was positioned at 13°27'00.95" N 144°38'30.42" E. This was not depicted on the Navy's smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new small wreck had a least depth of 118 feet scaled from SSS and limited single beam sonar investigation indicated a depth of 125 feet. The Evaluator recommends charting a new non dangerous wreck.[53]

A new wreck was positioned at 13°27'01.95" N 144°38'35.28" E (on the Navy's smooth sheet). The new small wreck had a depth of 108 feet scaled from SSS. The single beam investigation consisted of a star pattern investigation resulting in water depths ranging from 113-120 feet. The Evaluator recommends charting a new non dangerous wreck.[54]

A new obstruction was positioned at 13°26'59.34" N 144°38'40.5" E (annotated "Wrk" on the Navy's smooth sheet). The new obstruction was wreckage, 1 meter high, based on side-scan sonar. A depth of 102 feet was scaled from SSS. A least depth of 112 feet was recorded with single-beam. The Evaluator recommends charting a new non-dangerous obstruction.[55]

A new obstruction was positioned at 13°26'44.99" N 144°38'47.63" E (annotated "foul" on the Navy's smooth sheet). The new obstruction was a container, 18 meters long and 2.5 meters high, based on side-scan sonar. The least depth of 118 feet was scaled from SSS. The single-beam investigation consisted of two single beam lines with 7 meter line spacing and found a least depth of 128 feet. The Evaluator recommends charting a new non-dangerous obstruction.[56]

A new wreck was positioned at 13°27'04.4" N 144°39'55.15" E (on the Navy's smooth sheet). The new small wreck was 13 meters long and 1 meter high, based on side-scan sonar. A least depth of 82 feet was scaled from SSS and a limited single beam sonar investigation revealed a depth of 85 feet. The Evaluator recommends charting a new non dangerous wreck.[57]

A new wreck was positioned at 13°27'14.66" N 144°39'52.3" E (on the Navy's smooth sheet). The new small wreck was 14.5 meters long and 2 meters high, based on side-scan sonar. A depth of 75 feet was scaled from SSS and a limited single beam sonar investigation revealed a depth of 79 feet. The Evaluator recommends charting a new non dangerous wreck.[58]

New "wreckage" was positioned at 13°27'22.72" N 144°39'52.59" E. This was not depicted on the Navy's smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new obstruction had a height of 2 meters, based on side-scan sonar. The least depth of 82 was scaled from SSS and this wreckage is located on a slope with depths from 5 to 100 feet. The Evaluator recommends charting a new non-dangerous obstruction since it is in a major channel.[59]

A new obstruction was positioned at 13°27'23.69" N 144°39'52.3" E. This was not depicted on the Navy's smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new obstruction was rectangular wreckage. The wreckage was 6 meters long and 1.2 meters high, based on side-scan sonar. A depth of 89 feet was scaled from SSS and a single-beam depth in the area showed a least depth of 95 feet. This is possibly the same contact as that mentioned in the paragraph above. The Evaluator recommends charting a new non-dangerous obstruction since it is in a major channel.[60]

A new obstruction (annotated "foul" on the Navy's smooth sheet) was positioned at 13°27'10.08" N 144°38'56.13" E. The new obstruction was a vehicle with a height of 2.5 meters, based on side-scan sonar. A least depth of 118 feet was scaled from SSS and a limited single beam sonar mainscheme lines in the area indicated a least depth of 125 feet. The Evaluator recommends charting a new non-dangerous obstruction.[61]

A new obstruction (annotated "foul" on the Navy's smooth sheet) was positioned at 13°27'16.79" N 144°38'36.81" E. The new obstruction was a vehicle with a height of 2 meters, based on side-scan sonar. A least depth of 105 feet was scaled from side-scan sonar, and the single-beam investigation revealed a least-depth of 112 feet. The Evaluator recommends charting a new non-dangerous obstruction.[62]

A new obstruction (annotated "foul" on the Navy's smooth sheet) was positioned at 13°27'31.52" N 144°39'08.54" E. The new obstruction was covered with SSS and limited single beam sonar main scheme lines. Depths in the area ranged from 131-135 feet. The Evaluator recommends charting a new non-dangerous obstruction.[63]

A new wreck was positioned at 13°27'11.08" N 144°38'17.04" E (depicted on the Navy's smooth sheet). The new small wreck was 2 meters high, based on side-scan sonar. A least depth of 131 feet was scaled from SSS. The investigation consisted of several intersecting single beam lines in a star pattern. This investigation revealed a least depth of 102 feet at 13°27'10.33" N 144°38'18.55" E. The Evaluator recommends charting a new non dangerous wreck, at the position of the least depth and not the obstruction shown on the smooth sheet.[64]

A new wreck was positioned at 13°27'23.63" N 144°38'10.74" E (depicted on the Navy's smooth sheet). The new small oblong wreck was 1 meter high, based on side-scan sonar. A depth of 128 feet was scaled from side-scan sonar, and a limited single-beam investigation revealed a least depth of 135 feet. The Evaluator recommends charting a new non dangerous wreck.[65]

A new wreck was positioned at 13°27'46.02" N 144°38'20.97" E (depicted as "foul" on the Navy's smooth sheet). The new small wreck was 11 meters long and 1 meter high, based on side-scan sonar. A least depth of 95 feet was scaled from side-scan sonar. The least depth from single-beam and LIDAR is 102 feet. The Evaluator recommends charting a new non dangerous wreck.[66]

A new wreck was positioned at 13°27'23.07" N 144°37'44.19" E (depicted on the Navy's smooth sheet). The new wreck was 22 meters long and 1.3 meters high, based on side-scan sonar. A least depth of 118 was scaled from side-scan sonar. The wreck was on the very edge of the LIDAR coverage. The wreck is located on a slope with survey depths ranging from approximately 90 to 140 feet. The Evaluator recommends charting a new non-dangerous wreck.[67]

A new wreck was positioned at 13°27'20.37" N 144°37'41.34" E (depicted on the Navy's smooth sheet). The new small wreck was 14 meters long and 1 meter high, based on side-scan sonar. A least depth of 148 feet was scaled from side-scan sonar. The wreck is located on a

slope with survey depths ranging from approximately 100 to 175 feet. The Evaluator recommends charting a new non dangerous wreck.[68]

A new wreck was positioned at 13°27’09.48” N 144°37’35.83” E. This was not depicted on the Navy’s smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new wreck was 20 meters long and 1 meter high, based on side scan sonar. A depth of 164 feet was scaled from side-scan sonar. The Evaluator recommends charting a new non dangerous wreck.[69]

A new obstruction was positioned at 13°26’53.82” N 144°38’07.89” E (depicted as “foul” on the Navy’s smooth sheet). The new obstruction was a vehicle, 13 meters long and 1 meter high, based on side scan sonar. A least depth of 121 feet was obtained from 150% SSS and a single pass of single beam sonar. The Evaluator recommends charting a new non-dangerous obstruction.[70]

A new obstruction was positioned at 13°27’29.69” N 144°39’41.53” E. This was not depicted on the Navy’s smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new obstruction was wreckage, 6 meters long and 1 meter high, based on side scan sonar. A least depth of 102 feet was scaled from side-scan sonar. The Evaluator recommends charting a new non-dangerous obstruction.[71]

A new wreck was positioned at 13°27’42.21” N 144°39’33.9” E. This was not depicted on the Navy’s smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new small wreck was 23 meters long and 1 meter high, based on side scan sonar. A depth of 102 feet was scaled from side-scan sonar. The Evaluator recommends charting a new non dangerous wreck.[72]

A new wreck was positioned at 13°27’46.06” N 144°39’27.31” E. This was not depicted on the Navy’s smooth sheet and was merely noted in *NIMA Guam Targets.xls*. A least depth of 92 feet was scaled from side-scan sonar. The Evaluator recommends charting a new non dangerous wreck.[73]

A new wreck was positioned at 13°27'22.29" N 144°38'44.09" E. This was not depicted on the Navy’s smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new wreck was 12 meters long, and 1 meter high, based on side scan sonar. A least depth of 128 feet was scaled from side-scan sonar. The Evaluator recommends charting a new non dangerous wreck.[74]

A new obstruction was positioned at 13°27’12.29” N 144°38’43.0” E. This was not depicted on the Navy’s smooth sheet and was merely noted in *NIMA Guam Targets.xls*. The new obstruction was a “vehicle, 1.5 meters high”, based on side scan sonar. The least depth of 102 feet was scaled from side-scan sonar. The Evaluator recommends charting a new non-dangerous obstruction.[75]

A new wreck was positioned at 13°27'25.74" N 144°37'38.28" E (depicted only on the Navy's smooth sheet). The new wreck was covered by LIDAR. Depths at the location ranged from 25-39 feet. The Evaluator recommends charting a new dangerous wreck, depth unknown.[76]

A new wreck was positioned at 13°27'26.08" N 144°37'42.33" E (depicted only on the Navy's smooth sheet). The new wreck was covered by LIDAR. Depths at the location ranged from 32-36 feet. The Evaluator recommends charting a new dangerous wreck, depth unknown.[77]

A new wreck was positioned at 13°27'07.13" N 144°40'01.61" E (depicted only on the Navy's smooth sheet). The new wreck was covered by a single single beam pass. Depths at the location ranged from 58-72 feet. The Evaluator recommends charting a new dangerous wreck, depth unknown.[78]

The Evaluator recommends modifying the existing chart Note A, to add cautionary notes for the newly established safety zones. The note should reflect the latest version of the CFR, including sections: 33CFR165.1401, 33CFR165.1402, and 33CFR165.1404.[79]

See section **D.2** of this report for additional charting recommendations.

**D.5 Shoreline**

The shoreline portrayed on the NAVOCEANO smooth sheet was generated from the vector shoreline used in the DNC of the area. The high resolution shoreline data mentioned in the *Guam ROS* was not applied to the survey data. The Evaluator recommends retaining the shoreline as charted except where specifically addressed below.[80]

**Charted Features**

The charted (81054) electrical power ship located at 13°26'45.64" N 144°40'22.14" E was disproved. A visual search of the area by the FST and review of aerial photography by NAVOCEANO did no reveal any sign of it. The Evaluator recommends removal of the charted electrical power ship.[81]

Three wrecks charted (81054) 13° 27' 40.9" N, 144° 38' 02.0" E; 13° 27' 44.0" N, 144° 38' 05.7" E; 13° 27' 45.4" N, 144° 38' 08.3" E were observed. They were not considered to be hazardous to navigation by virtue of their proximity to the Glass Breakwater. The wrecks were observed to protrude out of the water between approximately 0.9-1.2 meters at MHHW. The Evaluator recommends retaining the wrecks as charted.[82] The drying wreck charted (81054) at 13°27'44.78" N 144°38'07.18" E was not specifically mentioned during the investigation of the above three wrecks. The Evaluator recommends retaining the wreck as charted.[83] Two (non-dangerous) wrecks charted (81054) at 13° 27' 41.8" N 144° 38' 02.8" E and 13° 27' 46.5" N 144° 38' 08.6" E were not investigated due to their proximity to the breakwater; side-scan sonar data was available to further determine their extent. The Evaluator recommends retaining the wrecks as charted.[84]

The HANSEN Company silo Charted (81054) at 13°27'40.38" N 144°39'48.43" E, was positioned 25 meters northeast using kinematic PPS at 13°27'41.1" N 144°39'48.63" E (position from *Final:Navaids.xls*, target GUAM057). The Fleet Survey Team recommends removal of the charted silo, and charting a new silo at the surveyed position. It is also recommended that this silo be marked: ⊙ SILO. It is considered that the term 'conspic by day'

should be used to describe the limitations of the structure as a navigational aid (Digital Photo *P0000088.JPG*). The Evaluator agrees with the above recommendation.[85]

*Hansen Silo P0000088.jpg*

**New Features:**

Three new piles (annotated "stakes" on the Navy's smooth sheet) were positioned at 13°27'10.46" N 144°39'36.52" E. The new piles were positioned using PPK GPS. A charted (81054) pile located 13°27'11.33" N 144°39'36.76" E was not addressed but is likely the same feature. The Evaluator recommends retaining the charted pile and charting the three new piles at the surveyed position.[86]

*P0000135.jpg: Three new piles*

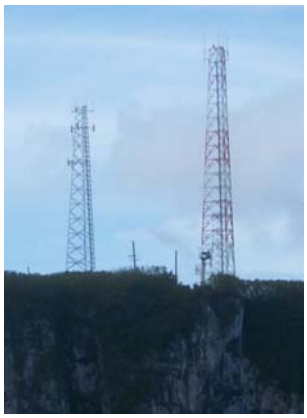
A new communications tower was positioned at 13°26'44.82" N 144°37'10.12" E using PPK GPS (on the Navy's smooth sheet). The positioned Orote Point Communications tower was the taller of two towers. The Evaluator recommends charting towers at the surveyed position [87](see image below).

The following new items were positioned using PPK GPS. The Evaluator recommends charting them at their appropriate positions:[88]

| | | |
|---|---|---|
| New mooring buoy | 13°27'38.04" N | 144°39'30.31" E |
| New mooring buoy | 13°26'50.50" N | 144°40'27.10" E |
| New mooring Buoy | 13°26'44.21" N | 144°39'22.98" E |
| New mooring Buoy[89] | 13°27'37.95" N | 144°39'30.31" E |
| EOD Tower (84.5 ft tall) | 13°26'29.63" N | 144°39'25.68" E |
| Lattice Tower (Red and white, approx 100' tall) | 13°27'48.85" N | 144°40'05.21" E |


*P0000035.jpg: EOD Tower*


*P0000089.jpg: Lattice Tower*



*P0000125.jpg Orote Point Communications towers*

A new obstruction consisting of wreckage was positioned off Apuntua Point at 13°25’15.57” N 144°38’19.28” E (depicted only on the Navy's smooth sheet). While no least depth was provided the site is a former dumping ground and is well known by local divers (*Lonely Planet Dive & Snorkel guide- Guam & Yap*, *1999*). It is reported to contain World War II debris including trucks, tanks, and boats. The Evaluator recommends charting this new obstruction as wreckage, least depth unknown.[90]

A new large mobile dry-dock, appeared to be permanently moored alongside an unnamed jetty at position 13° 26’ 39” N 144° 39’ 33” E (on the Navy's smooth sheet). It was therefore impossible to obtain depths close to this wharf, although the seabed under the platforms was investigated with side-scan sonar. No significant contacts were detected. Positional information for the new dry-dock was obtained using LIDAR data. The Evaluator recommends charting the new dry-dock as it appears on the Navy smooth sheet.[91]

A new coral head was positioned at 13°26’55.36” N 144°37’46.65” E. The coral head appears on the Navy smooth sheet, however no supporting documentation was provided for this feature and the source is not apparent. This area was covered with 150% SSS and limited single beam sonar investigation. A single beam investigation of the feature revealed a least depth of 102 feet, in the same position as a charted 102-foot shoal which is likely the same feature. The Evaluator recommends charting the area based on survey depths, and noting a bottom characteristic of coral on the chart.[92]

A new coral head was positioned at 13°26’38.19” N 144°40’07.98” E. The coral head appears on the Navy smooth sheet, however no supporting documentation was provided for this feature and the source is not apparent. The survey location was covered with 150% SSS and LIDAR. This feature is located on a slope with depths ranging from 35 to 50 feet. The Evaluator recommends charting the area based on survey depths, and noting a bottom characteristic of coral on the chart.[93]

## D.5 Dangers to Navigation

Twenty six[94] Dangers to Navigation were found during the evaluation of survey W00005 and W00006. These dangers to Navigation were forwarded to MCD on September 22, 2003. See copy of submitted letter in this report.

## D.6 Aids to Navigation

According to the *Guam ROS,* all aids to navigation (AtoN's), man-made coastline, and significant features were positioned using post-processed kinematic techniques and photographed. The listing provided by NAVOCEANO (*Final Navaids.xls)* was described as being definitive and was recommended to be used to update the chart. However, because no features were specifically disproved, any AtoN not positioned should be retained as charted.[95] Light characteristics were confirmed for all AtoN's in the harbors on the evening of the 5th February using binoculars, a hand-held compass, a stopwatch and the current chart. It was opined that the existing AtoN's throughout the area were generally in good condition and fit for purpose, but that their geographic positions and characteristics were in need of updating.

Comparisons were made between surveyed positions and the most recent copy of the US Coast Guard Light List. Several lights and buoys were found to be significantly different from their listed position. In addition, some items in the Light List had no position given. The Evaluator recommends that these surveyed positions be passed along to the US Coast Guard to update the Light List.[96] A letter was submitted on September 25, 2003 to Steve Hill N/CS29 with an updated list of ATON positions.[97]

# E. APPROVAL

## Hydrography

All obtained records, reports, and data have been evaluated with regard to survey coverage, survey accuracy, and suitability for nautical charting.

Evaluated by: Sean C. Rooney

Sean C. Rooney
Physical Scientist (Hydrographer)
Pacific Hydrographic Branch

Reviewed by: E. J. Van Den Ameele

Lieutenant Edward J. Van Den Ameele, NOAA
Hydrographic Team Leader
Pacific Hydrographic Branch

## Cartography

The evaluated survey has been inspected with regard to delineation of the depth curves, development of critical depths, cartographic symbolization, comparison with prior surveys and verification or disproval of charted data.

Compiled by: Leo Deodato

Leo Deodato
Cartographer
Pacific Hydrographic Branch

Reviewed by: Bruce A. Olmstead

Bruce A. Olmstead
Cartographer
Pacific Hydrographic Branch

## Approval

I have reviewed the data and reports. Data are suitable for nautical charting except where specifically recommended in this report.

Approved by: E. J. Van Den Ameele

For Commander John E. Lowell, Jr., NOAA
Chief, Pacific Hydrographic Branch

AWORS/SURFV 10/6/03 SSV

**Revisions Compiled by the Cartographer During Office Processing and Certification**

[1] Limits specified below are describing the physical sheet limits. Hydrography was accomplished in two separate areas. These areas include Apra Outer Harbor and the west side of Guam from Apuntua Point to Pelagi Islets. Refer to section A.2, Area Surveyed, for a graphic coverage plot.
[2] Filed with the Hydrographic Data
[3] See area surveyed on page 1 for Lidar, SSS, and echo sounder coverage.
[4] Filed with the Hydrographic Data.
[5] Concur with the recommendations below.
[6] Surveyed positions are attached to this report in a letter dated September 25, 2003.
[7] Concur
[8] Base on the present survey information and the discussions below, W00005 should supersede the charted information within the common area.
[9] Concur
[10] Concur
[11] Concur
[12] Concur
[13] Concur
[14] Do not concur. Chart survey depth of 3ft and delete note *Rep (2000).*
[15] Concur
[16] Concur
[17] Concur
[18] Concur
[19] Concur
[20] Concur
[21] Concur
[22] Concur
[23] Do not concur. Chart survey depth of 42ft.
[24] Concur
[25] Concur
[26] Concur
[27] Concur
[28] Do not concur. Chart survey depth of 48ft.
[29] Concur
[30] Concur
[31] Concur
[32] Concur
[33] Concur
[34] Concur
[35] Concur
[36] Concur
[37] Concur
[38] Concur
[39] Concur with clarification. Chart wreck with visible mast.
[40] Concur with clarification. Chart *63Wk Rep (2001)*

[41] Concur with clarification. Chart 38 *Rep (2001)*
[42] Concur with clarification. Chart 57 *Wk Rep (2001)*
[43] Concur
[44] Concur with clarification. Chart 79 *Wk Rep (2001)*
[45] Concur with clarification. Chart 135 *Wk Rep (2001)*
[46] Concur with clarification. Chart 112 *Obstn Rep (2001)*
[47] Concur with clarification. Chart 108 *Obstn Rep (2001)*
[48] Concur with clarification. Chart 95 *Wk Rep (2001)*
[49] Concur with clarification. Chart 131 *Obstn Rep (2001)*
[50] Concur with clarification. Chart 115 *Obstn PA Rep (2001)*
[51] Concur with clarification. Chart 108 *Obstn Rep (2001)*
[52] Concur with clarification. Chart 118 *Wk Rep (2001)*
[53] Concur with clarification. Chart 118 *Wk Rep (2001)*
[54] Concur with clarification. Chart 108 *Wk Rep (2001)*
[55] Concur with clarification. Chart 102 *Wk Rep (2001)*
[56] Concur with clarification. Chart 118 *Obstn Rep (2001)*
[57] Concur with clarification. Chart 82 *Wk Rep (2001)*
[58] Concur with clarification. Chart 75 *Wk Rep (2001)*
[59] Concur with clarification. Chart 82 *Wk PA Rep (2001)*
[60] Concur with clarification. Chart 89 *Wk Rep (2001)*
[61] Concur with clarification. Chart 118 *Obstn Rep (2001)*
[62] Concur with clarification. Chart 105 *Obstn Rep (2001)*
[63] Concur with clarification. Chart *Obstn Rep (2001)*
[64] Concur
[65] Concur with clarification. Chart 128 *Wk Rep (2001)*
[66] Concur with clarification. Chart 95 *Wk Rep (2001)*
[67] Concur with clarification. Chart 118 *Wk PA Rep (2001)*
[68] Concur with clarification. Chart 148 *Wk Rep (2001)*
[69] Concur with clarification. Chart 164 *Wk PA Rep (2001)*
[70] Concur with clarification. Chart 121 *Obstn Rep (2001)*
[71] Concur with clarification. Chart 102 *Wk PA Rep (2001)*
[72] Concur with clarification. Chart 102 *Wk PA Rep (2001)*
[73] Concur with clarification. Chart 92 *Wk PA Rep (2001)*
[74] Concur with clarification. Chart 128 *Wk PA Rep (2001)*
[75] Concur with clarification. Chart 102 *Obstn PA Rep (2001)*
[76] Concur
[77] Concur
[78] Concur
[79] Concur
[80] Concur
[81] Concur
[82] Concur
[83] Concur
[84] Concur
[85] Concur. Chart landmark SILO at survey position.

[86] Concur with clarification. Retain charted pile. Add pile symbology and note piles from the present survey based on chart scale.
[87] Concur. Chart landmark TOWER at survey position.
[88] Concur
[89] Mooring buoy not shown based on chart scale.
[90] Concur
[91] Concur
[92] Do not concur. Chart 102 *Co Hd*
[93] Concur
[94] Sixteen of these Dangers to Navigation fall on W00005. The following dangers to navigation forwarded to MCD on Sept. 22, 2003 have not been shown on the H-drawing based on shoaler selected depths on the present survey.

| Latitude | Longitude |
|---|---|
| 13˚27'31.35"N | 144˚40'18.22"E |
| 13˚27'12.56"N | 144˚39'55.1"E |
| 13˚26'51.91"N | 144˚40'18.98"E |

[95] Concur
[96] Concur
[97] Letter is attached to this report.

# Danger to Navigation Report

**Hydrographic Survey Registry Number: W00005 and W000006**

**Survey Title:** **State: Marianas Islands**
**Locality: Guam**
**Sub-locality: Apra Harbor**

**Project Number: 00601 01US02 and 00602 01US02 (U.S. Naval Oceanographic Office)**

**Survey Dates: January - February 2001**

Depths are reduced to Mean Lower Low Water using verified tides.
Positions are based on the WGS84 horizontal datum.

**CHARTS AFFECTED:**

| Chart | Scale | Edition | Date |
|---|---|---|---|
| 81048 | 1:100,000 | 8th | 02/27/93 |
| 81054 | 1:10,000 | 13th | 02/03 |

**DANGERS:**

| Feature | Depth(ft) | Latitude (N) | Longitude (E) |
|---|---|---|---|
| Sounding | 27 feet | 13°27'15.85" N | 144°37'35.16" E |
| Sounding | 57 feet | 13°27'01.02" N | 144°38'55.8" E |
| Sounding | 12 feet | 13°27'39.91" N | 144°39'42.43" E |
| Sounding | 17 feet | 13°27'36.16" N | 144°40'22.36" E |
| Sounding | 9 feet | 13°27'31.86" N | 144°40'20.16" E |
| Sounding | 10 feet | 13°27'31.35" N | 144°40'18.22" E |
| Sounding | 5 feet | 13°27'12.56" N | 144°39'55.1" E |
| Sounding | 45 feet | 13°27'00.55" N | 144°39'54.84" E |
| Sounding | 12 feet | 13°26'53.34" N | 144°39'32.5" E |
| Sounding | 38 feet | 13°26'46.76" N | 144°39'58.62" E |
| Sounding | 27 feet | 13°26'51.91" N | 144°40'18.98" E |
| Sounding | 15 feet | 13°27'01.29" N | 144°40'18.69" E |
| Sounding | 32 feet | 13°26'31.91" N | 144°39'56.78" E |
| Sounding | 27 feet | 13°26'12.79" N | 144°39'41.85" E |
| Sounding | 29 feet | 13°26'00.85" N | 144°40'26.72" E |
| Sounding | 29 feet | 13°25'56.01" N | 144°40'23.51" E |
| Sounding | 26 feet | 13°25'53.63" N | 144°40'26.94" E |
| Sounding | 27 feet | 13°25'49.99" N | 144°40'25.98" E |
| Sounding | 28 feet | 13°25'46.95" N | 144°40'20.97" E |

## Danger to Navigation Report

| | | |
|---|---|---|
| Sounding | 32 feet | 13°25'52.8" N 144°40'03.57" E |
| Wreck | 38 feet | 13°27'34.08" N 144°37'58.4" E |
| Wreck | 58 feet | 13°27'32.55" N 144°39'43.64" E |
| Wreck | exposed | 13°26'49.07" N 144°40'13.12" E |
| Wreck | 27 feet | 13°26'06.59" N 144°40'24.26" E |
| Obstruction | 27 feet | 13°25'14.78" N 144°40'08.92" E |
| Obstruction | unknown | 13°25'15.59" N 144°38'19.3" E |

**COMMENTS:**

These soundings and features are from Outside Source Data hydrographic surveys conducted by the U.S. Naval Oceanographic Office. Features contained in this danger to navigation report were evaluated by the Pacific Hydrographic Branch and deemed to meet NOAA standards for hydrographic surveys, unless otherwise noted.

Questions concerning this report should be directed to the Chief, Pacific Hydrographic Branch at *(206) 526-6835*

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF COAST SURVEY
Pacific Hydrographic Branch
Seattle, Washington 98115-6349

September 25, 2003

MEMORANDUM FOR: Steven Hill
Marine Chart Division

FROM: Commander John E. Lowell, NOAA
Chief, Pacific Hydrographic Branch

SUBJECT: Updated ATON positions from hydrographic surveys W00005 and W00006.

Attached you will find updated positions for aids to navigation located in the Northern Marianas Islands, Guam. These aids were positioned during outside source hydrographic surveys W00005 (Apra Outer Harbor), and W00006 (Apra Inner Harbor). These surveys were conducted from 13 January – 07 February 2001 by the U.S. Naval Oceanographic Office. The Pacific Hydrographic Branch reviewed these positions for data quality purposes, and found that they meet NOAA standards for positioning fixed and floating aids-to-navigation. The distances off-station listed below are referenced from NOAA chart 81054, 13th edition (February 2003), with LNM updates through August 8, 2003.

| Latitude (N) | Longitude (E) | Description | Light List # | Characteristics | Distance off station | |
|---|---|---|---|---|---|---|
| 13:26:58.264 | 144:38:25.039 | Mooring Buoy "951" | | | 100 M | |
| 13:27:00.848 | 144:38:48.831 | Mooring Buoy "704" | | | 138 M | |
| 13:26:47.046 | 144:39:08.420 | Mooring Buoy | | | 40 M | |
| 13:26:45.973 | 144:39:15.184 | Mooring Buoy | | | 45 M | |
| 13:26:52.915 | 144:39:22.852 | Mooring Buoy | | | 123 M | |
| 13:27:04.355 | 144:39:50.757 | Mooring Buoy "F" | | | 80 M | |
| 13:27:32.366 | 144:39:20.109 | Cabras Channel Entrance Buoy #2 (red) | 30735 | R "2" Fl R 2.5s | 35 M | |
| 13:26:48.875 | 144:40:01.389 | Mooring Buoy "SM" | | 702 | 55 M | |
| 13:27:41.103 | 144:39:48.634 | Hansen Concrete Silo | | | 24 M | |
| 13:26:29.095 | 144:40:04.552 | Apra Inner Harbor Approach Rear Range Marker | 30795 | Iso R 6s 24ft | 11 M | |
| 13:26:32.330 | 144:40:01.880 | Apra Inner Harbor Approach Fwd Range Marker | 30790 | Q R 15 Ft | 35 M | |

Several new mooring buoys were also positioned during this survey:

| Latitude (N) | Longitude (E) | Description |
|---|---|---|
| 13:26:50.497 | 144:40:27.100 | Mooring Buoy |
| 13:27:37.952 | 144:39:30.311 | Mooring Buoy |
| 13:26:44.209 | 144:39:22.983 | Mooring Buoy |

Positions of navigational features were obtained using a Trimble 4700 receiver, affixed to a 2-meter antenna pole. All features were positioned using post-processed kinematic (PPK) GPS. Light characteristics were

confirmed for all navigational aids in the harbors; using binoculars, hand-held compass, stopwatch and the current chart.

Comparisons were made to the most recent copy of the Light List. Several lights and buoys were found to be significantly different from their charted position. In addition some items in the light list had no position. It is recommended that the attached positions also be used to update the Light List positions.

Because these positions originate form a survey conducted in early 2001, it is possible that many of these aids-to-navigation may have been repositioned since this survey. It is not recommended that the positions listed above supersede any information of a more recent date than February 7, 2001.

Subject: resend Wrapping up Guam
Date: Thu, 10 Jul 2003 17:18:05 -0500
From: "Ebrite, Scott" <ebrites@navo.navy.mil>
To: "Farr, Steve" <FarrS@NAVO.NAVY.MIL>,
"'Sean.C.Rooney@noaa.gov'"
<Sean.C.Rooney@noaa.gov>
CC: "'Edward.J.Vandenameele@noaa.gov'"
<Edward.J.Vandenameele@noaa.gov>,
"Van Norden, Maxim" <vannordenm@navo.navy.mil>,
"Clough, Marian"
<cloughm@navo.navy.mil>

> With respect to qusetion 1 concerning the questionable 9.5 meter sounding;
> After a thourough review of relevent data the conclusion is that the
> sounding is valid. Three different FST single beam tracklines run on
> three different days over a one week period converge and all show a series
> of hits at this location. The presence of an object/target is confirmed
> with side scan sonar data collected along two adjacent survey lines run on
> different days. It appears the target and the source of the sounding may
> be a mooring and/or mooring line off the NE corner of the drydock. I
> don't know where divers looked, but it apparently wasn't where the object
> is located. The Lidar group and FST stand by the data pending confirmation
> of the objects non-existance.

See the attached ppt file.

> <<DATA REVIEW.ppt>>
>
> Question 2 has been previopusly answered.
>
> Question 3 has been previously answered but in clarified here. Apra
> Harbor Guam was zoned by NOAA. All of the harbor fell in one zone. The
> areas outside the harbor and Agat BAy fell in another zone. Zone
> boundaries, NOAA tides from the Apra harbor gauge and the appropriate
> amplitude and time corrections as per NOAA and were applied.
>
> Question 4 previously answered.

>
> Question 5. Sumner data was all cleaned and edited in house and all
> correctors including tides applied.
>
> Question 6. USNS Sumner used the Fugro wide area DGPS corrections.
> However, system modeling of the system the the locations around Guam
> indicated the corrections would degrade the positioning accuracy to
less
> than the accuracy achieved using PPS. My undeerstanding is that
Sumner
> used the Fugro system and , as a result, the Sumner positioning
accuracy
> does not meet first order requirements and is degraded to second
order.
> Sumner maximum positioning error is approximately 12 meters.
Furthermore,
> Sumner data is NOT used within Apra harbor and should not be
included in
> the data for the harbor.. Sumner data is only used outside the
harbor
> along the NW side of the jetty
>
> -----Original Message-----
> From: Farr, Steve
> Sent: Monday, June 23, 2003 1:03 PM
> To: Ebrite, Scott; Pope, Robert
> Subject: FW: Wrapping up Guam
>
> Bob, Scott
>
> Can either of you answer questions 2 and 4? Possible 3 also, if you
have
> any knowledge ot the
> tide zoning used. Thanks. Send your answers to me or you can
repond
> directly to Sean, but still
> CC your answers to me so I'll know. If you have no input let me
know
> also. Thanks again.
> Hopefully these are the last issues with Guam.
>
> Steve
>
> -----Original Message-----
> From: Sean C. Rooney [SMTP:Sean.C.Rooney@noaa.gov]
> Sent: Thursday, May 29, 2003 12:33 PM
> To: Farr Steve
> Subject: Wrapping up Guam

>
>
> Hi Steve, just about finished up with my evaluation of the Guam data.
> Just wanted to check up on a few last things:
>
> 1. Did you ever find anything else out about these soundings?
> [Farr,Steve] Some preliminary info on question 12. I've done some
> investigation on these soundings. The 9.5 meter (31 foot) sounding may be
> suspect. There is a 9.6 meter sounding next to it from the data I used to
> produce my contours and shoal soundings. Both of these soundings came
> from FST single-beam data with little or no data around to support. The
> 9.8 and 9.9 also are from the single beam data - I have not investigated
> these soundings yet. The 10.0 further north seems to have the most chance
> of being correct. There are multiple hits of 10.1, 10.2 and 10.3 meter
> depths near and around that area. They could still be incorrect however.
> All of these suspect soundings came from the FST single-beam data. I need
> to do further investigation on the data to come to some firm conclusion.
> I'll let you what I determine once I have found the full resolution data
> and checked it out.
>
> 2. The smooth sheet states Lidar portion of the survey used KGPS in
> addition to DGPS. What was the KGPS used for? The smooth sheet also
> states the FST only used DGPS. Is it possible that the LIDAR claim of
> KGPS was really the PPKGPS work conducted by the FST?
>
> 3. Were co-tidal zones used? If so for which data sets? [Farr,Steve]
> Tides were applied, but I cannot find the tide files that were used.
> Will ask the data processors.
>
> 4. In the Lidar documentation a pressure recording gauge is mentioned
> in addition to the NOAA tide gauge, I am unclear was this instrument

used
> in Guam? If so how was this data applied?
>
> 5. The cruise report for the USNS Sumner, states that the Nav. data
was
> not cleaned for Guam (page 9, section 3). And that data was not
cleaned
> using area based editor (page 9-10, section 4). I assume that this
was
> done in the office, can you confirm?
>
> 6. The cruise report for the Sumner states that wide area DGPS was
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> for positing, but it also states in the notes (page 10, section 5)
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DATA REVIEW.ppt

Name: DATA REVIEW.ppt
Type: Microsoft PowerPoint Show
(application/vnd.ms-powerpoint)
Encoding: base64
Download Status: Not downloaded with message

Subject: resend of Wrapping up Guam
Date: Thu, 10 Jul 2003 17:21:39 -0500
From: "Ebrite, Scott" <ebrites@navo.navy.mil>
To: "Farr, Steve" <FarrS@NAVO.NAVY.MIL>,
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Name: DATA REVIEW.ppt
Type: Microsoft PowerPoint Show
(application/vnd.ms-powerpoint)
Encoding: base64
Download Status: Not downloaded with message

NOAA FORM 77-27(H)
(9-83)

U.S. DEPARTMENT OF COMMERCE

# HYDROGRAPHIC SURVEY STATISTICS

REGISTRY NUMBER: W00005

RECORDS ACCOMPANYING SURVEY: To be completed when survey is processed.

| RECORD DESCRIPTION | AMOUNT | RECORD DESCRIPTION | AMOUNT |
|---|---|---|---|
| SMOOTH SHEET | 1 | SMOOTH OVERLAYS: POS., ARC, EXCESS | NA |
| DESCRIPTIVE REPORT | 1 | FIELD SHEETS AND OTHER OVERLAYS | NA |

| DESCRIPTION | DEPTH/POS RECORDS | HORIZ. CONT. RECORDS | SONAR-GRAMS | PRINTOUTS | ABSTRACTS/ SOURCE DOCUMENTS | |
|---|---|---|---|---|---|---|
| ACCORDION FILES | | | | | | |
| ENVELOPES | | | | | | |
| VOLUMES | | | | | | |
| CAHIERS | | | | | | |
| BOXES | | | | | | |

SHORELINE DATA

SHORELINE MAPS (List): NA

PHOTOBATHYMETRIC MAPS (List): NA

NOTES TO THE HYDROGRAPHER (List): NA

SPECIAL REPORTS (List): NA

NAUTICAL CHARTS (List):

*OFFICE PROCESSING ACTIVITIES*

*The following statistics will be submitted with the cartographer's report on the survey*

| PROCESSING ACTIVITY | AMOUNTS | | |
|---|---|---|---|
| | *VERIFICATION* | *EVALUATION* | *TOTALS* |
| POSITIONS ON SHEET | | | |
| POSITIONS REVISED | | | |
| SOUNDINGS REVISED | | | |
| CONTROL STATIONS REVISED | | | |
| | TIME-HOURS | | |
| | *VERIFICATION* | *EVALUATION* | *TOTALS* |
| PRE-PROCESSING EXAMINATION | | | |
| VERIFICATION OF CONTROL | | | |
| VERIFICATION OF POSITIONS | | | |
| VERIFICATION OF SOUNDINGS | | | |
| VERIFICATION OF JUNCTIONS | | | |
| APPLICATION OF PHOTOBATHYMETRY | | | |
| SHORELINE APPLICATION/VERIFICATION | | | |
| COMPILATION OF SMOOTH SHEET | | | 0 |
| COMPARISON WITH PRIOR SURVEYS AND CHARTS | | | |
| EVALUATION OF SIDE SCAN SONAR RECORDS | | | |
| EVALUATION OF WIRE DRAGS AND SWEEPS | | | |
| EVALUATION REPORT | | | 330 |
| GEOGRAPHIC NAMES | | | |
| OTHER* (Chart Compilation) | | | 120 |
| *USE OTHER SIDE OF FORM FOR REMARKS — TOTALS | | | 450 |

| | | |
|---|---|---|
| *Pre-processing Examination by* | *Beginning Date* | *Ending Date* |
| *Verification of Field Data by* S. Rooney | *Time (Hours)* 0 | *Ending Date* |
| *Verification Check by* | *Time (Hours)* | *Ending Date* |
| *Evaluation and Analysis by* S.Rooney, L.Deodato, R. Davies | *Time (Hours)* 330 | *Ending Date* 09/30/2003 |
| *Inspection by* B. Olmstead | *Time (Hours)* 20 | *Ending Date* 09/30/2003 |

U.S. GOVT. PRINTING OFFICE 1983: 764-008/6061

**NOAA FORM 75-96**
(10-83)

**U.S. DEPARTMENT OF COMMERCE**
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

MARINE CHART BRANCH

# RECORD OF APPLICATION TO CHARTS

FILE WITH DESCRIPTIVE REPORT OF SURVEY NO. W00005

**INSTRUCTIONS**

A basic hydrographic or topographic survey supersedes all information of like nature on the uncorrected chart.

1. Letter all information.
2. In "Remarks" column cross out words that do not apply.
3. Give reasons for deviations, if any, from recommendations made under "Comparison with Charts" in the Review.

| CHART | DATE | CARTOGRAPHER | REMARKS |
|---|---|---|---|
| 81054 | 8/28/03 |  | Full ~~Part Before~~ After Marine Center Approval Signed Via |
|  |  |  | Drawing No. Application of soundings and features from smooth sheet. |
|  |  |  |  |
|  |  |  | Full Part Before After Marine Center Approval Signed Via |
|  |  |  | Drawing No. |
|  |  |  |  |
|  |  |  | Full Part Before After Marine Center Approval Signed Via |
|  |  |  | Drawing No. |
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|  |  |  | Full Part Before After Marine Center Approval Signed Via |
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SUPERSEDES C&GS FORM 8352 WHICH MAY BE USED.