H12522

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H12522

LOCALITY

State(s):	Alaska
General Locality:	Bering Sea
Sub-locality:	6 NM South of Red Dog Mine

2013

CHIEF OF PARTY
Marta Krynytzky

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Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H12522**

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

State(s):	**Alaska**
General Locality:	**Bering Sea**
Sub-Locality:	**6 NM South of Red Dog Mine**
Scale:	**40000**
Dates of Survey:	**07/20/2013 to 08/21/2013**
Instructions Dated:	**04/03/2013**
Project Number:	**OPR-S325-KR-13**
Field Unit:	**TerraSond Limited**
Chief of Party:	**Marta Krynytzky**
Soundings by:	**Multibeam Echosounder Single Beam Echosounder**
Imagery by:	**Side Scan Sonar**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Notes in red were generated during office processing. The processing branch concurs with all information and recommendations in the DR unless otherwise noted. Page numbering may be interrupted or non-sequential. All pertinent records for this survey, including the Descriptive Report, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.

Table of Contents

List of Tables

List of Figures

Descriptive Report to Accompany Survey H12522

Project: OPR-S325-KR-13

Locality: Bering Sea

Sublocality: 6 NM South of Red Dog Mine

Scale: 1:40000

July 2013 - August 2013

TerraSond Limited

Chief of Party: Marta Krynytzky

A. Area Surveyed

A navigable area survey (H12522) was conducted in the area 6 NM South of Red Dog Mine, Alaska, in accordance with the NOAA, National Ocean Service, Statement of Work (SOW), OPR-S325-KR-13, dated April 5th, 2013 and Hydrographic Survey Project Instructions dated April 3rd, 2013. Hydrographic survey data collection began July 20th, 2013 and ended August 21st, 2013.

Multibeam echosounder (MBES), side scan sonar (SSS), and single beam (SBES) operations were conducted in accordance with the project work instructions, which specified 200 meter (m) set line spacing SBES or MBES (with backscatter) from the inshore limit to 10m water depth, and 200% SSS with concurrent set line spacing SBES or MBES (with backscatter) for depths greater than 10 m.

The inshore limit was the farthest offshore of either the 3 m depth contour, or the line defined by the distance seaward from the MHW line which is equivalent to 0.8 mm at the scale of the largest scale nautical chart. The largest scale nautical chart, 16005, has a scale of 1:700,000, which places the navigational area limit line (NALL) 560 m offshore of the MHW line.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
67° 31" 27.27' N 163° 53" 44.66' W	67° 26" 25.69' N 164° 15" 49' W

Table 1: Survey Limits

The coordinates given above are the northeast and southwest limits of the survey.

The survey limit and inshore limits (farthest offshore of either the 3 m depth contour or the NALL) were met. Note that although the NALL was 560 meters offshore, the skiff worked inshore to the 3 m depth contour since the near-shore area was determined to be navigable by shallow drafted vessels. The 3 m contour (which was found to be within 30-50 m of the MHW line on average) was also achieved.

A.2 Survey Purpose

The purpose of this project is to provide an updated survey for the approaches to Red Dog Mine. It addresses approximately 30 square nautical miles (SQNM) of area identified as “Critical” and “Priority 2” in the 2012 NOAA Hydrographic Survey Priorities (NHSP) document. The best scale chart at the time of this survey (16005) is 1:700,000, with extremely sparse soundings, and is not suitable for navigating the area.

The area is located on the relatively shallow and flat expanse of the Chukchi Sea coastal area. Wind has a greater effect on water levels than tides, which vary daily by less than 1 m. Features were rare, consisting primarily of ice scours and associated sediment piles that seldom produce more than a half meter of elevation above the seafloor. Slope is flat to gentle, increasing as the shore is approached.

This arctic area is ice-bound for the majority of the year, with the ice-free season typically only extending from July through October. The nearby mine, operated by Teck Resources Limited, is one of the world’s largest zinc and lead mines, and accounts for 79% of U.S. zinc mine production, and 33% of U.S. lead mine production. Ore is mined and stored year-round, but can only be transported from the site during the limited ice-free season.

During the ice-free season, the area is frequented by freighters, which are loaded with the ore to be hauled to various ports worldwide. According to FedNav International, the company which currently has the contract to carry ore from Red Dog overseas, typical freighters that transit the area include Panamax (averaging 720 ft length, 106 ft beam, 47 ft draft loaded) and Handymax (averaging 623 ft. length, 106 ft. beam, 43 ft. draft). Rarely post-Panamax vessels have also loaded ore here (up to 753 ft. length, 121 ft. beam, 48 ft. draft).

Freighters currently anchor at least 3 NM offshore (to avoid entering State waters), and maintain at least 10 ft. under keel clearance. The ore is brought to the freighters and loaded by a barge and tug operation (currently operated by Foss Marine Holdings, Inc.). Barges are loaded at the Red Dog port with ore through a conveyor system installed on the dock.

Local vessel traffic is minimal in the area. During survey operations, skiffs were occasionally observed transiting through the survey area, closely following the beach. The nearby village of Kivalina (population 374) is just north of the survey area, and residents conduct subsistence activities along the coast.

The area is very exposed and open in all directions (except the northeast) to the Chukchi and Bering Seas as well as Kotzebue Sound. Storms are frequent and intense in the region, with no protected anchorages nearby suitable for vessels of any significant draft.

Figure 1: Image showing the conveyor structure at Red Dog dock, and ore barge. A freighter can be seen waiting offshore to receive the load.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

A.4 Survey Coverage

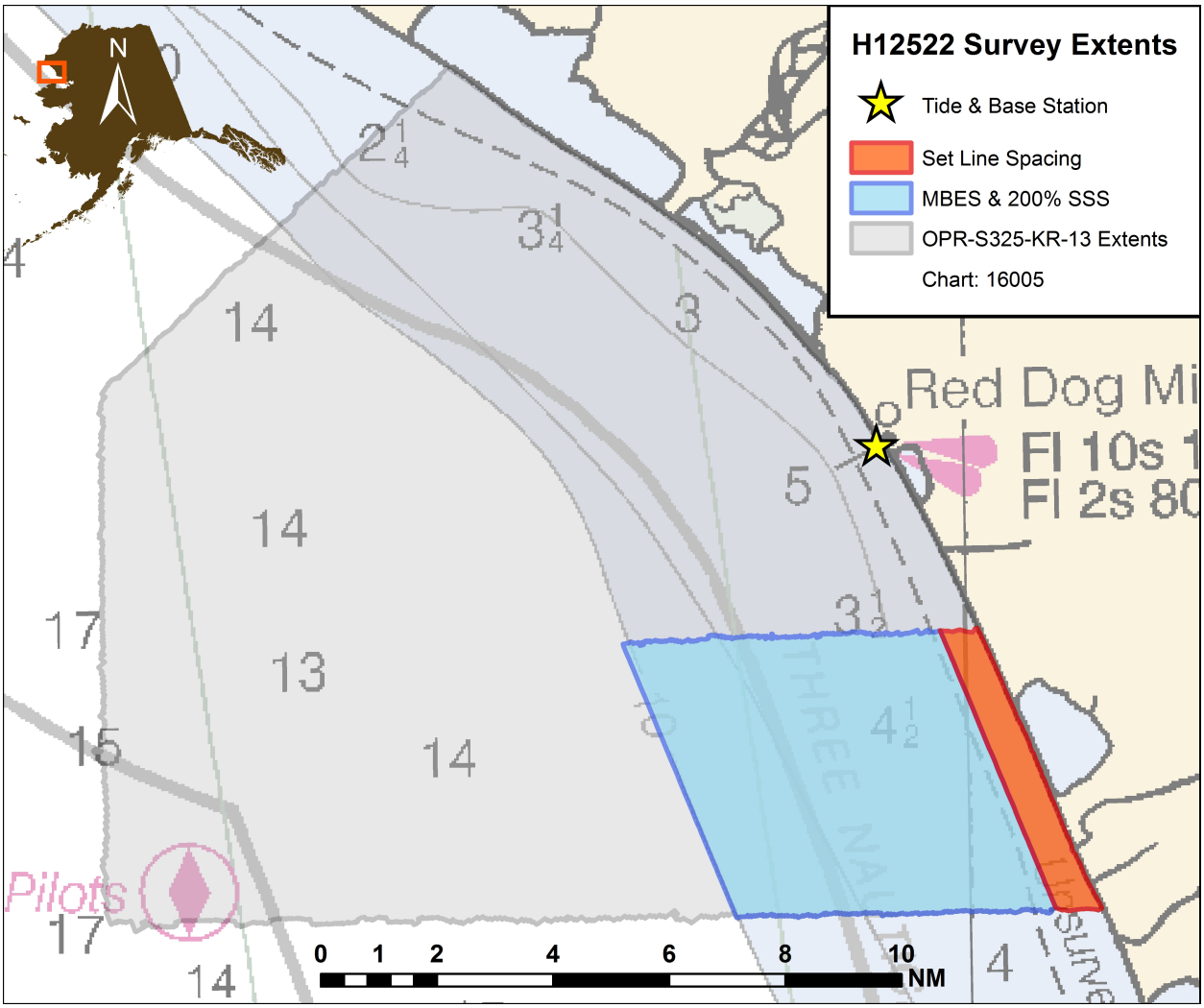

Figure 2: Survey extents and overview.

The 200 m set line spacing requirement for depths less than 10m were generally met. This depth area was primarily surveyed by skiff using SBES, though a small portion was surveyed with MBES. In isolated cases, lines may vary to slightly over 200 m apart in instances of line driving "wobble" when weather made line driving problematic.

The 200 % SSS requirements for depths greater than 10 m were generally met. Gaps in the 200 % coverages are extremely rare and, where they do occur, are small and along-track in nature, indicating possible short dropouts in SSS logging. These gaps received at least 100 % coverage of good quality from an adjacent pass. They also received partial to full coverage from the MBES system, which was run concurrently with SSS collection.

The concurrent (with SSS) set line spacing requirement for depths greater than 10 m requirement was met. MBES (with backscatter) data was logged simultaneously with all SSS data. Line spacing for SSS and MBES data was 100 m or 75 m, which coincided with the SSS range scale in use. Significant features evident in the SSS records were developed with the MBES system to “Object Detection” standards.

A.5 Survey Statistics

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

	Vessel	***Qualifier 105***	***Q15 Skiff***	***Total***
LNM	**SBES Mainscheme**	0	23.4	23.4
	MBES Mainscheme	0.7	0	0.7
	Lidar Mainscheme	0	0	0
	SSS Mainscheme	0	0	0
	SBES/MBES Combo Mainscheme	0	0	0
	SBES/SSS Combo Mainscheme	0	0	0
	MBES/SSS Combo Mainscheme	626.3	0	626.3
	SBES/MBES Combo Crosslines	61.6	4.6	66.2
	Lidar Crosslines	0	0	0
Number of Bottom Samples				3
Number AWOIS Items Investigated				0
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Items Investigated by Dive Ops				0
Total Number of SNM				30.0

Table 2: Hydrographic Survey Statistics

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

Survey Dates	Julian Day Number
07/20/2013	201
08/02/2013	214
08/03/2013	215
08/04/2013	216
08/05/2013	217
08/06/2013	218
08/07/2013	219
08/08/2013	220
08/21/2013	233

Table 3: Dates of Hydrography

The total number of SNM were determined to be 30.4 during office review.

B. Data Acquisition and Processing

B.1 Equipment and Vessels

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

B.1.1 Vessels

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

Hull ID	*Qualifier 105*	*Q15 Skiff*
LOA	32 meters	4.6 meters
Draft	1.8 meters	0.5 meters

Table 4: Vessels Used

The Qualifier 105 (Q105) is a steel-hulled vessel 32 m in length. It is owned and operated by Support Vessels of Alaska (SVA) of Homer, Alaska. It was chartered by TerraSond to serve as the primary platform for this survey. Among other equipment, it was outfitted with a pole-mounted MBES and towed SSS systems. It also housed staff and on-site processing, and performed bottom sample collection and tide operations.

The Q15 skiff is an aluminum skiff 4.6 m in length. It is also owned by SVA, but was operated by TerraSond. Among other equipment, it was outfitted with a pole-mounted SBES system. It was periodically deployed from the Q105 to collect SBES data in the shallower portions of the survey area.

B.1.2 Equipment

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

Manufacturer	Model	Type
Odom Hydrographic Systems	Echotrac CV100	SBES
Applanix	POSMV 320 V5	Positioning and Attitude System
AML Oceanographic	AML SV+	Sound Speed Profiler
Odom Hydrographic Systems	Digibar Pro	Sound Speed Profiler
Sea-Bird Electronics	SBE 26+	Submerged Tide Gauge
Trimble	5700	Positioning System (Q15 skiff)
Trimble	NETRS	Positioning System (Base Station)
Valeport	Rapid SVT 200Bar	Sound Speed Profiler
Oceanscience	Underway SV400	Sound Speed Deployment System

Table 5: Major Systems Used

Equipment configurations, operations, and data acquisition and processing are described in the DAPR.

A Reson Seabat 7101 (MBES) and EdgeTech 4200 (SSS) were also used during the survey.

B.2 Quality Control

B.2.1 Crosslines

Crosslines, acquired for this survey, totalled 10.2% of mainscheme acquisition.

Crosslines were collected to meet the 8% requirement for set-line spacing surveys described in the HSSD. Crosslines were evenly distributed across the project area, and effort was made to ensure crosslines from each vessel overlapped mainscheme lines from the other vessel. Note: SSS data was not required nor logged during crossline collection.

To evaluate crossline to mainscheme agreement, CARIS HIPS' crossline comparison (QC Report) function was utilized. In CARIS HIPS, a 4 m resolution BASE surface was created from mainscheme-only data for each vessel. Each crossline was then run through the QC Report process, which calculated the difference between accepted crossline soundings and the BASE surface (depth layer). Crosslines with at least 95% of soundings comparing to within IHO Order 1 were considered to "pass", while those with less than 95% of soundings comparing to within IHO Order 1 were considered to "fail".

Three combinations of the crossline comparisons were accomplished: First, the MBES crosslines were compared to the MBES mainscheme surface. Second, SBES crosslines were compared to the SBES mainscheme surface. And finally, as a check of agreement between separate vessels and survey systems, SBES crosslines were compared to the MBES mainscheme surface.

Agreement between mainscheme and crosslines is excellent for both vessels. The vast majority of crossline comparisons pass with 100% of soundings comparing to within IHO Order 1. The lowest percentage was 97.082%.

Refer to the project DAPR for more details concerning analysis methodology. Refer to Separate II: Digital Data for the detailed Crossline QC Reports.

B.2.2 Uncertainty

Hull ID	Measured - CTD	Measured - MVP	Surface
Qualifier 105	0 meters/second	1.565 meters/second	0.025 meters/second
Q15 Skiff	0 meters/second	1.565 meters/second	0 meters/second

Table 6: Survey Specific Sound Speed TPU Values

All soundings were assigned a horizontal and vertical value for estimated total propagated uncertainty (TPU). The parameters and methods used for computation of sounding uncertainty are detailed in the project DAPR, with the following exceptions:

1. During TPU computation, an uncertainty of 1.565 m/s was entered for estimated sound speed error, based on an analysis of the variance in sound speed between profiles during this survey.

The BASE surfaces were finalized in CARIS HIPS so that the final uncertainty value for the each grid cell is the greater of either standard deviation or uncertainty. The uncertainty layer of the final surface was then examined for areas of uncertainty that exceeded IHO Order 1.

Uncertainty for the SBES surface ranged from 0.22 to 0.35 m, with the majority between 0.20 and 0.25. Uncertainty for the MBES surface ranged from 0.09 to 0.29 m, with the majority between 0.10 and 0.15 m. Few exceeded IHO Order 1. Highest uncertainties were found in the rare areas of changing bottom topography and on features where high standard deviations are common across the relatively large grid size (4m), and on the outer edges of swathes without adjacent overlap.

The sound speed TPU value for "Measured - MVP" is suspect given that the DAPR mentions cast to cast variance reaching close to 12 m/s on the upper end.

B.2.3 Junctions

This survey junctions with two contemporary surveys, both of which were collected concurrent with this sheet.

The junctions were compared by creating a difference surface in CARIS HIPS using the 4 m resolution finalized BASE surfaces, extracting the difference for each grid cell, and computing statistics.

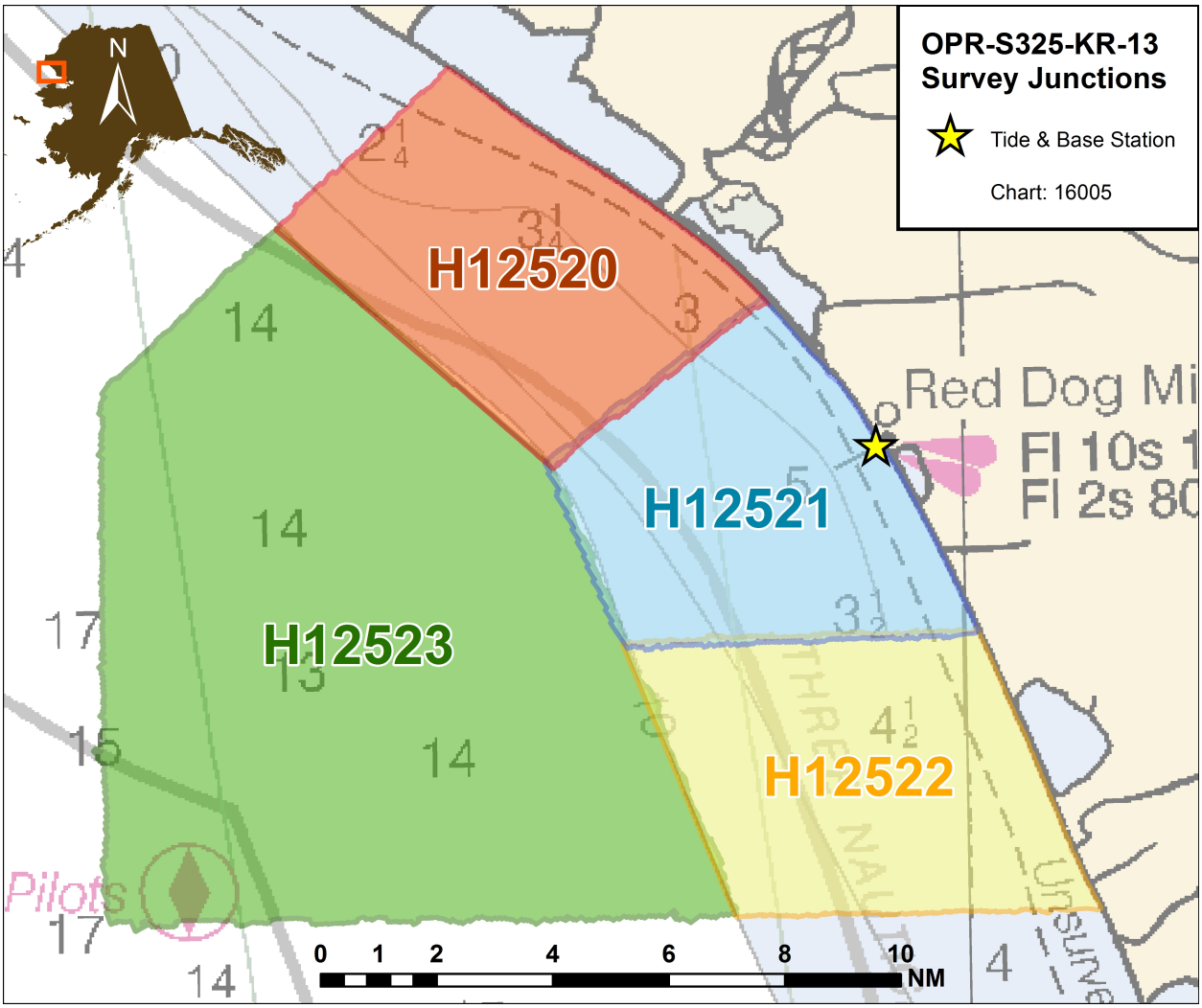

Figure 3: Survey junctions with this survey (yellow).

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H12521	1:40000	2013	Terrasond, Ltd.	N
H12523	1:40000	2013	Terrasond, Ltd.	W

Table 7: Junctioning Surveys

H12521

This survey and H12521 are in excellent agreement, with an average difference of 0.02 m (with a standard deviation of 0.06 m), and extremes of -0.267 m and 0.35 m. No differences exceeded IHO Order 1, and the data is within specifications.

H12523

This survey and H12523 are in excellent agreement, with an average difference of 0.05 m (with a standard deviation of 0.05 m), and extremes of -0.36 m and 0.19 m. No differences exceeded IHO Order 1, and the data is within specifications.

B.2.4 Sonar QC Checks

Echosounder confidence checks consisting of bar checks, lead-lines, and acoustic comparisons were undertaken on this project. Checks occurred normally on a weekly basis.

Five bar checks were completed for the MBES system on the Q105, and one was completed for the SBES system on the Q15 skiff. Bar checks served as a check on both real-time as well as processed depth accuracy, and were also used to refine the sonar acoustic center offset. Results were very good, comparing on average to 0.05 m or better of the actual bar depth.

Six lead line comparisons were completed for the MBES system on the Q105, and one was completed for the SBES system on the Q15 skiff. Others were attempted but were unsuccessful due to current. Agreement varied from 0.01 m to 0.62 m, results which were deemed acceptable given the conditions and variables surrounding the lead line collection.

Effort was made in the field to ensure significant overlap was achieved between the independent echosounder systems on the two survey vessels (Q105 MBES and Q15 skiff SBES) for comparison purposes. The overlap area was examined in CARIS HIPS Subset mode to check matchup. Overall the two vessels show very good agreement with each other, usually comparing to 0.05 m or better.

Refer to the bar check and lead line logs available in Separate I: Acquisition and Processing Logs for specific results. Refer to the project DAPR for more information regarding the QC checks.

B.2.5 Equipment Effectiveness

Variable Roll Offset

A small variable roll offset was discovered during field operations, affecting the MBES data on the Q105. The issue was apparent as an across-track misalignment when adjacent multibeam lines were viewed in CARIS Subset Mode, indicating a change in the previously determined patch-test correction value for roll. The offset was found to be stable over short periods of time, indicating periodic movement in the

multibeam mounting pole as the suspect, possibly as a result of fluctuations in hydraulic pressure or vessel hull flex. Because the error would shift to a new value and tend to stay at that value for hours or days, it was possible to largely correct for the issue in processing by making small adjustments to the roll calibration. The adjustments were determined by systematic review of overlapping swaths, using both mainscheme data as well as "roll-check" lines that were run in the field following discovery of the issue. These adjustments, which ranged from 0 to 0.11 degrees, were applied as error values to the "Roll" sensor in the CARIS HVF. Though the issue was largely resolved in processing, some artifact remains in the data negatively affecting the final surface by up to 0.20 m in places. Despite the issue, the data is within specifications. More information is available in Section C of the DAPR.

Beam Pattern

A distinct beam pattern was obvious in the data set, with a fuzziness or "horn" like features on both sides of nadir on multibeam swaths, coinciding with the bottom detection shift from phase to amplitude detection. The pattern is common with Reson 8101/7101 multibeam sounders in certain bottom types. Power and range settings were adjusted in acquisition to minimize the issue, with little effect. However, the "horns", which can be as great as 0.20 m in height, appear to be largely ignored by the CUBE algorithm during surface creation, with minimal effect on the final surfaces.

The data is adequate for charting despite the beam pattern artifacts.

B.2.6 Factors Affecting Soundings

High amounts of sound-speed stratification was apparent in the survey area, which had a negative effect on multibeam data quality. Layering with abrupt changes in sound speed over short depth intervals are evident in most of the profiles. This led to general downward or upward across-track cupping in multibeam data, indicative of sound speed error.

To limit the error, profile collection frequency was increased from 4 hours to 2 hours early in the project. As a set-line spacing survey without a complete coverage requirement, it was possible to filter lines to remove outer beams most affected by error, and then manually edit to further reject erroneous or borderline data that negatively affected the final surfaces. Lines in the western part of the survey area, which were most affected, also received reruns and infills at the end of the project over the most affected areas.

Following the methods described previously, the final surfaces are negatively affected by sound speed artifact on the order of 0.20 m in places. Despite the error, data is within specifications.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: 2 hours

Casts were taken with an Ocean Science Underway SV system, which utilized a Valeport sound speed profiler. Casts were initially taken at a 4-hour interval, but the frequency was increased to a 2-hour interval for the majority of the project when sound-speed error became apparent.

The profiler was deployed while underway during survey operations. The profiler was lowered to as close to the seafloor as possible, and then retracted to the vessel and downloaded. Up and down portions of the cast were averaged and a combined cast output to CARIS SVP format with time and position.

Sound speed profiles were applied with the “nearest in distance within time” method in CARIS HIPS, with time set to 2 hours, with few exceptions (noted in Section B.3.)

B.2.8 Coverage Equipment and Methods

As coverage requirements differed for depths greater or lesser then 10 m, the 10 m curve was first established by running multibeam crosslines towards shore to establish the contour. Note that the location of the 10 m contour was dependent on preliminary tides and experienced slight shifts following application of final tide corrections.

To achieve 200 m spacing in the area shoaler than 10 m, a line plan of 190 m (to allow for line driving variance) parallel to the coast was developed. The lines were plotted in QPS QINSy or HYPACK acquisition software (depending on the survey vessel) and tracked during survey. The sub-10 m area was surveyed primarily with SBES by the Q15 skiff, while the outside portion was surveyed with MBES by the Q105 where it was safe for the larger vessel to operate.

To achieve the inshore limit (NALL or 3 m contour), the Q15 skiff collected SBES data while running parallel to the beach, as close as safely possible. The 3 m depth limit was achieved in general; however, in some instances the ever-present ocean swell prevented closer approach to the beach.

To achieve 200 % SSS coverage (with concurrent bathymetry) for depths greater than 10m, a line plan was developed and ran based on 90 m and 60 m intervals. The 90 m line plan was run whenever the SSS was operated at 100 m range scale, which allowed for 200% coverage given line driving variance. Similarly, the 60 m line plan was run whenever the SSS was operated at 75 m range scale. The transition from 100 m to 75 m range scale (and subsequent change in line plans) was determined by data-quality and found to generally occur in 13 m to 15 m water depth.

MBES (with backscatter) was logged at all times during SSS operations. The Reson Seabat 7101 in use on this project was operated in 239 beam mode, which provided good across-track resolution and data density meeting HSSD requirements, without the extreme data volume generated from higher beam modes.

SSS/MBES lines were run in a “race-track” pattern to assist with line turns while towing equipment. At completion of a survey line, instead of running the adjacent line that was only 60-90 m distant, 10-12 lines would be skipped, allowing a long gentle turn that minimized the necessity to frequently adjust SSS cable out. Skipped lines were therefore surveyed 10-12 lines later when the pattern returned to them.

During operations, the survey limits were displayed in QPS QINSy (or HYPACK). Logging was stopped at the survey limits, although excess was normally collected on run-ins and run-outs to ensure coverage met the boundary, especially for the SSS sonar which could have as much as 200 m of cable out.

During SSS/MBES collection on the Q105, survey speed was minimized, typically between 7-8 knots, to maximize along-track ping density. The SSS in use, an Edgetech 4200, was operated in “High-Speed” mode, thereby enabling its multi-pulse feature to allow for NOAA object detection requirements to be met at these speeds. Towfish altitude above the seafloor was continuously monitored and adjusted when necessary to ensure an altitude of 8% to 20% of the range scale in use was maintained.

Significant SSS contacts were further developed by MBES to “Object Detection” requirements.

Survey speed was also limited during SBES collection on the Q15 skiff, averaging 6 knots or less.

To confirm MBES and SBES coverage requirements following processing and rejection of erroneous soundings, 4 m resolution BASE surfaces were created and examined in context of the sheet limits and preliminary 10 m contour in CARIS HIPS. To confirm SSS coverage requirements, SonarWiz’s coverage check utility was utilized, which provided a color-coded report on areas with 200% or better coverage.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

Corrections applied to echo soundings are detailed in the project DAPR. No deviations occurred, with the following exceptions:

1. SVP exceptions

The following lines were sound-speed corrected with nearest-in-distance 4 hours instead of the standard 2 hours:

Q15_Skiff\2013-220\2013SK2201808
Q15_Skiff\2013-219\2013SK2191922
Q15_Skiff\2013-219\2013SK2191902
Q105\2013-201\0038_-_C1_E07920
Q105\2013-201\0039_-_C1_E08640

2. 2. Cable-out layback % exception

The following SSS lines used 90% cable out for layback computations instead of the standard 85%:

Q105_SSS\2013-218\0481-C1_C08760
Q105_SSS\2013-218\0483-C1_C08820

B.3.2 Calibrations

Calibrations were undertaken as described in the DAPR, no deviations occurred.

B.4 Backscatter

Multibeam backscatter was logged during this survey, but not processed. The MBES DB files as well as the MBES XTF files contain the backscatter records.

B.5 Data Processing

B.5.1 Software Updates

There were no software configuration changes after the DAPR was submitted.

The following Feature Object Catalog was used: V5.3.2

Data processing methods and software are described in the DAPR.

Note that SSS was processed in Chesapeake SonarWiz, not CARIS SIPS (bathymetric data was processed in CARIS HIPS). However, SSS data in SIPS format is provided with the survey deliverables under the "Q105_SSS" HIPS vessel file. The SIPS-format SSS data was supplied in order to provide SSS data in a format readable by CARIS SIPS, per the HSSD. The SIPS data set was created by exporting fully processed SSS data from SonarWiz in XTF format, and importing into CARIS. The SIPS data ("Q105_SSS") received spot checks only, to confirm positioning was comparable to SonarWiz, but the data set has not been fully reviewed and should be used for reference only. No data products were generated from the SIPS data set; contacts and coverage TIFs were produced from the fully reviewed SonarWiz data set.

B.5.2 Surfaces

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

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H12522_MB_4m_MLLW	MBES Tracline	4 meters	0 meters - 40 meters	NOAA_4m	MBES Set Line Spacing
H12522_SB_4m_MLLW	SBES	4 meters	0 meters - 40 meters	NOAA_4m	SBES Set Line Spacing

Table 8: Submitted Surfaces

The final depth information for this survey was submitted as a set of CARIS BASE surfaces which best represented the sea floor at the time of the 2013 survey. The surfaces were created from fully processed soundings with all final corrections applied. Surfaces were finalized and designated soundings were applied.

The surfaces were created using CUBE parameters that ensured a maximum propagation distance of the grid resolution divided by #2. 4 m was selected as the resolution for both surfaces per the requirements for “Set Line Spacing” (with concurrent 200% SSS coverage) described in the HSSD. Horizontal projection was selected as UTM Zone 3 North, NAD 1983.

A CARIS HOB file was submitted (H12522_FFF.HOB) with the survey deliverables as well. The final feature file (FFF) contains meta-data and other data not readily represented by the depth grids, such as bottom samples.

A SSS Contact Feature File (H12522_SSS_Contacts.HOB) is also included with the survey deliverables. SSS contacts (including significant, insignificant, and disproven) were attributed as “CSYMB” objects and are available for review in the SSS contact feature file, with contact images in the accompanying Multimedia folder. "SOUNDG" objects in the side scan contact feature file represent the least depth and position on significant contacts determined from MBES development and correspond to designated soundings. Note: "SOUNDG" objects are included in the SSS contact feature file for reference only; least depths on objects are represented in the final surfaces.

Each object is encoded with mandatory S-57 attributes, additional attributes and NOAA Extended Attributes (V#5.3.2).

Refer to the DAPR for more detailed discussion of the steps followed when acquiring and processing the 2013 survey data, including the surface creation and finalizing processes.

C. Vertical and Horizontal Control

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

C.1 Vertical Control

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

Standard Vertical Control Methods Used:

Discrete Zoning

The following National Water Level Observation Network (NWLON) stations served as datum control for this survey:

Station Name	Station ID
Red Dog Dock, AK	9491094

Table 9: NWLON Tide Stations

File Name	Status
9491094.tid	Final Approved

Table 10: Water Level Files (.tid)

File Name	Status
S325KR2013CORP_20131125.zdf	Final

Table 11: Tide Correctors (.zdf or .tc)

The NWLON station on Red Dog Dock (949-1094), was utilized on this project for tide corrections.

BMPG (bottom mounted pressure gauges) were deployed at the project extents to capture zoning characteristics across the area. Preliminary zones provided by CO-OPS were refined using the BMPG data.

Refer to the HVCR for more information regarding tides and tide zones.

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD83).

The projection used for this project is UTM Zone 3 N.

The following PPK methods were used for horizontal control:

Single Base

The CORS site in Kotzebue (OTZ1, operated by the FAA) was used extensively for comparison and QC purposes. It was also used for PPK processing for rare instances when REDD was not operational, as described in the HVCR and DAPR.

The following CORS Stations were used for horizontal control:

HVCR Site ID	Base Station ID
OTZ1	OTZ1

Table 12: CORS Base Stations

The following user installed stations were used for horizontal control:

HVCR Site ID	Base Station ID
REDD	REDD

Table 13: User Installed Base Stations

The project base station (REDD) broadcasted RTK positions for real time and preliminary positioning for the majority of the project. REDD also continuously logged data, enabling PPK processing. All real-time positions were replaced in processing with PPK positions.

C.3 Additional Horizontal or Vertical Control Issues

3.3.1 Additional Issues

None to note.

D. Results and Recommendations

D.1 Chart Comparison

The chart comparison for H12522 was performed by examining all Raster Navigational Charts (RNCs) and Electronic Navigation Charts (ENCs) that intersect the survey area.

The chart comparison was accomplished by overlaying the finalized BASE surface with shoal-biased soundings, and final feature file on the charts in CARIS HIPS. The general agreement between charted soundings and H12522 soundings was then examined and a more detailed comparison was undertaken for any shoals or other dangerous features. Results are shown in the following sections.

It is recommended that this survey supersede charted data where they overlap.

USCG Notice to Mariners (NM) and USCG Local Notice to Mariners were checked for updates affecting the area. None were found that were issued subsequent to issuance date of the project instructions.

D.1.1 Raster Charts

The following are the largest scale raster charts, which cover the survey area:

Chart	Scale	Edition	Edition Date	LNM Date	NM Date
16005	1:700000	10	10/2007	10/16/2007	10/27/2007

Table 14: Largest Scale Raster Charts

16005

Only one sounding on chart 16005 intersects the survey area.

This survey found a depth of 7 fms 1 ft at the charted 4 1/2 fathom sounding. The discrepancy is likely due to shift in charted soundings due to the relatively large scale of the chart (1:700,000).

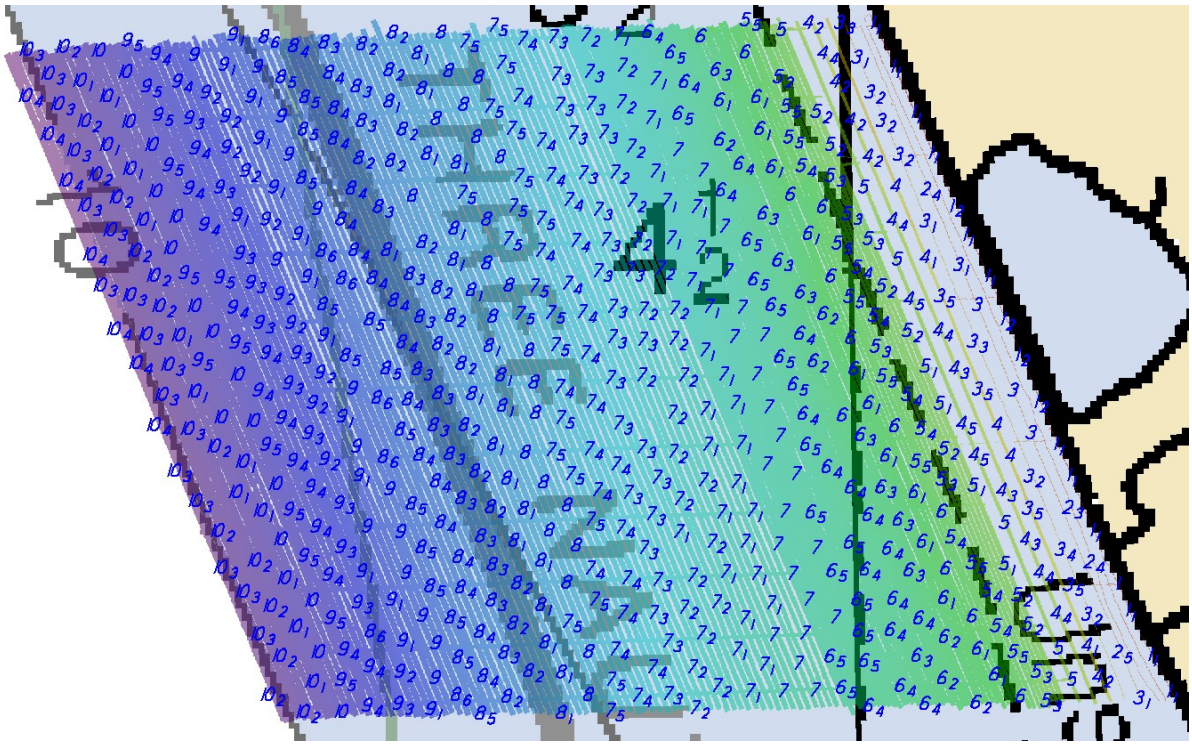

Figure 4: Soundings from this survey (blue, fathoms) overlaid on chart 16005.

D.1.2 Electronic Navigational Charts

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date	Preliminary?
US2AK92M	1:700000	7	05/02/2011	11/19/2012	NO

Table 15: Largest Scale ENCs

US2AK92M

The same differences observed for the RNC apply to this ENC.

D.1.3 AWOIS Items

No AWOIS items intersected the survey area. No items were found for inclusion into the database.

D.1.4 Maritime Boundary Points

No maritime boundary points were assigned for this survey.

D.1.5 Charted Features

There are no charted features labeled PA, ED, PD, or Rep. within the survey extents.

D.1.6 Uncharted Features

No uncharted features were found during this survey.

D.1.7 Dangers to Navigation

No dangers to navigation were found during this project.

D.1.8 Shoal and Hazardous Features

No shoal or hazardous features were found during this project.

D.1.9 Channels

No maintained channels exist in the survey area.

D.1.10 Bottom Samples

Bottom samples were collected for this survey. Bottom characteristics are encoded as SBDARE objects in the FFF included with the survey deliverables.

Three bottom samples were collected and all were recommended for charting.

D.2 Additional Results

D.2.1 Shoreline

Shoreline verification was required for cultural or assigned features only. No cultural or assigned features intersected the survey area.

D.2.2 Prior Surveys

Comparison with prior surveys was not required. See Section D.1 for comparison to the existing nautical charts.

D.2.3 Aids to Navigation

ATONs did not exist in the survey area.

D.2.4 Overhead Features

No overhead features existed within the survey area.

D.2.5 Submarine Features

Seafloor features were rare, consisting primarily of ice scours and associated sediment piles.

D.2.6 Ferry Routes and Terminals

Ferry routes and terminals do not exist within the survey area.

D.2.7 Platforms

Platforms do not exist within the survey area.

D.2.8 Significant Features

All significant features and conditions encountered have been described previously. Refer to the FFF file submitted with the survey deliverables for any new feature charting recommendations.

D.2.9 Construction and Dredging

No construction or dredging was occurring within the survey extents, nor are there any known future plans for construction or dredging in the survey area.

D.2.10 New Survey Recommendations

None to note.

D.2.11 New Inset Recommendations

It is recommended that a larger scale chart and/or inset centered on the Red Dog Dock be issued using this survey data.

A new chart at a larger 1:40,000 scale is planned for the area of Red Dog Mine.

E. Approval Sheet

Field operations contributing to the completion of survey H12522 were conducted under my direct supervision with frequent personal checks of progress, integrity, and adequacy.

This report, digital data, and all other accompanying records are approved. All records are respectfully submitted and forwarded for final review.

The survey data was collected in accordance with the Statement of Work and meets or exceeds the requirements set in the 2013 NOS Hydrographic Surveys and Specifications Deliverables document. This data is adequate to supersede charted data in common areas. This survey is complete and no additional work is required with the exception of any deficiencies noted in the Descriptive Report.

Approver Name	Approver Title	Approval Date	Signature
Andrew Orthmann, C.H.	TerraSond Charting Program Manager	01/06/2014	Validity unknown Andrew Orthmann 2014.01.06 16:45:46 -09'00'
Marta Krynytzky, C.H.	TerraSond Lead Hydrographer	01/06/2014	Marta Krynytzky 2014.01.06 16:23:05 -09'00'

F. Table of Acronyms

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

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

Acronym	Definition
PRF	Project Reference File
PS	Physical Scientist
PST	Physical Science Technician
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPU	Total Porpagated Error
TPU	Topside Processing Unit
USACE	United States Army Corps of Engineers
USCG	United Stated Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDA	Global Positiong System timing message
ZDF	Zone Definition File

APPENDIX I

Tides and Water Levels

Contents:

1. Abstract of Times of Hydrography
2. Transmittal Letters for Tide Stations
3. Tides Correspondence

Abstract of Times of Hydrography

Project: OPR-S325-KR-13

Registry No.: H12522

Contractor: TerraSond Limited

Date: January 6th, 2014

Inclusive Dates: July 20, 2013 – August 21, 2013

Field work is complete.

All times UTC.

Times of Hydrography		
Day	**Start**	**Stop**
201	07:12:11	16:22:47
214	04:08:06	23:59:59
215	00:00:00	23:01:40
216	00:14:23	23:59:59
217	00:00:00	23:59:59
218	00:00:00	20:40:41
219	19:02:00	23:59:59
220	00:00:00	18:14:06
233	18:38:28	21:31:43

Transmittal Letters for Tide Stations

The NWLON tide gauge Red Dog Dock (949-1094) was utilized for tide corrections on this project. Tide zones were refined using temporary BMPG zoning guage deployments. Refer to the HVCR for more information.

All tide zoning data has been submitted to CO-OPS. Transmittal letter and tides correspondence follows.

JOA Surveys, LLC
SURVEYING GPS TIDES HYDROGRAPHY

2000 E. Dowling Road, Suite 10
Anchorage, AK 99507
(907) 561-0136 Phone
(907) 561-0143 Fax
www.joasurveys.com

December 16, 2013

Artara Johnson
OET/CO-OPS
1305 East-West Highway
Silver Spring, MD 20910-3281

Cc Andrew Orthmann, TerraSond Ltd., aorthmann@terrasond.com
Mark Lathrop, NOS/OCS mark.t.lathrop@noaa.gov

Re: Transmittal of Tidal Zoning Report for project OPR-S325-KR-2013

Artara:

The tidal zoning report for hydrographic survey OPR-S325-KR-2013 has been posted to the JOA FTP site. This report includes shape files of the contours used to generate the final zoning scheme, a text file of six minute readings for each zoning station, a report on the development of the final zoning scheme and the final zoning scheme in shapefile format. Each text file of six minute readings has two columns and is comma delimited. Column 1 is time referenced to UTC. Column 2 is water level in meters above STND. Below is the information needed to retrieve the report from the JOA FTP site:

Host: **ftp.joasurveys.com**
Username: **oet**
Password: **1305east-west**
Filename: **OPR-S325-KR-2013 Red Dog Zoning Report 20131216.zip**

Sincerely,

Nathan Wardwell
nathan@joasurveys.com

APPROVAL PAGE

H12522

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- H12522_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12522_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications.

Digitally signed by HOLMBERG.PETER.SCOTT.1365886101
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OTHER, cn=HOLMBERG.PETER.SCOTT.1365886101
Date: 2014.05.12 15:09:53 -07'00'

Approved:_____

Peter Holmberg
Cartographic Team Lead, Pacific Hydrographic Branch

The survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Benjamin K. Evans
2014.05.13 15:18:30 -07'00'

Approved:_____

LCDR Benjamin K. Evans, NOAA
Chief, Pacific Hydrographic Branch