H13251

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13251

LOCALITY

State(s):	Alaska
General Locality:	Kuskokwim Bay, AK
Sub-locality:	Kwigillingok to Kulvagavik

2019

CHIEF OF PARTY
Andrew Orthmann

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13251**

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:	**Kuskokwim Bay, AK**
Sub-Locality:	**Kwigillingok to Kulvagavik**
Scale:	**10000**
Dates of Survey:	**07/07/2019 to 08/13/2019**
Instructions Dated:	**05/10/2019**
Project Number:	**OPR-R341-KR-19**
Field Unit:	**Terrasond**
Chief of Party:	**Andrew Orthmann**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 3N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13251

Project: OPR-R341-KR-19

Locality: Kuskokwim Bay, AK

Sublocality: Kwigillingok to Kulvagavik

Scale: 1:10000

July 2019 - August 2019

Terrasond

Chief of Party: Andrew Orthmann

A. Area Surveyed

The project area is located in southwest Alaska near the entrance to the Kuskokwim River in a relatively remote area of the Arctic. The area was uncharted at the time of this survey. Vessel traffic in the region largely consists of barges that are transiting to or from Bethel (population 6,456), the hub for SW Alaska which is located up the Kuskokwim River, as well as native communities in the region.

The area is heavily influenced by current and sediment transport from the Kuskokwim River. As a result it is relatively shallow with shifting shoals, sandbars, and channels. Sand and mud are the predominant bottom types.

The area is normally not navigable during winter due to discontinuous sea ice in the bay and river ice flows from the Kuskokwim River. The area is open and exposed in all directions except the north.

Bathymetric data collection was carried out in July and August of 2019 under project OPR-R341-KR-19, with final processing and reporting carried out from September through December, 2019. Supporting tide data was acquired from June through October, 2019. Work was completed concurrently with other assigned areas within Kuskokwim Bay and near Nunivak Island, and done in accordance with the Hydrographic Survey Project Instructions (dated May 10th, 2019) and the NOS Hydrographic Surveys Specifications and Deliverables (HSSD), March 2019 edition.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
60° 0' 42.72" N 163° 8' 12.7" W	59° 47' 8.27" N 162° 25' 39.03" W

Table 1: Survey Limits

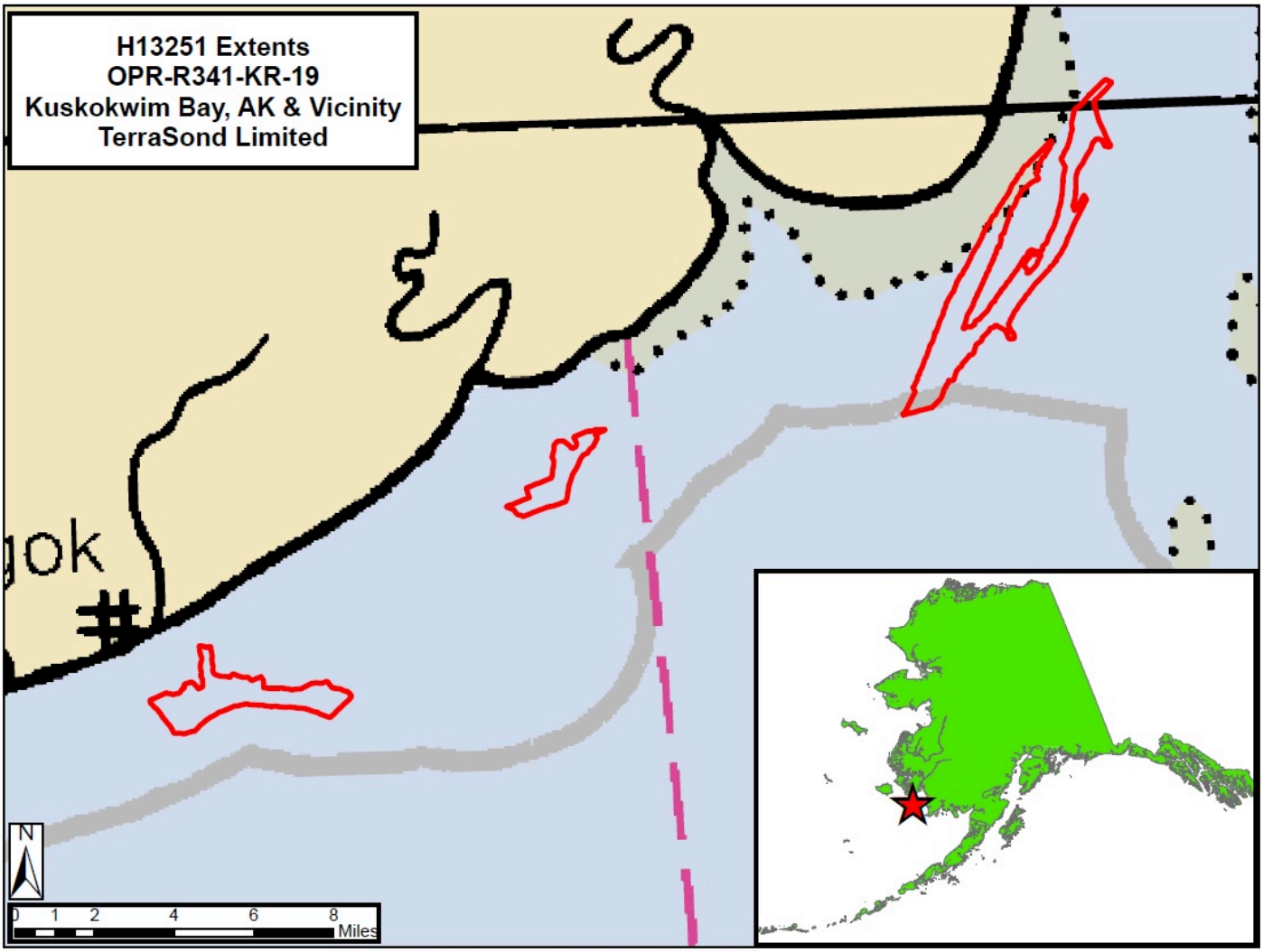

Figure 1: Image showing survey extents.

Data was successfully acquired to the survey limits or the NALL, whichever was encountered first.

The NALL for this survey was the 3.5 m depth limit. 3.5 m water depth was achieved at the required line spacing (200 m). Additional data was acquired inside the NALL per request from NOAA OPS, discussed in the coverage section below.

Two lines were intentionally extended outside the assigned survey limits on the NE part of the survey for approximately 1 km. This was done to achieve good overlap with prior junctioning survey H12164 from 2010.

A.2 Survey Purpose

The overall project OPR-R341-KR-19 is intended to provide contemporary surveys to update National Ocean Service (NOS) nautical charting products in the U.S. Arctic to support commerce in the region. Automatic Identification Systems (AIS) traffic patterns feeding the Hydrographic Health model, along with direct user feedback helped to define the survey area in Kuskokwim Bay, Southwest Alaska. This area is largely unsurveyed and contains mud flats, uncharted shoals, and poorly modeled tides, forcing vessel traffic between the Kuskokwim River and northern communities to take an extended southerly route to stay in safe water. Surveying these areas within Kuskokwim Bay will allow for shorter routes, increasing the safety and efficiency of vessel traffic. This work will also directly support the maritime services available to the native communities of Kwigillingok and Kongiganak.

Furthermore, this project will provide support for other NOAA Hydrographic surveys and regional tidal products by installing temporary water level measuring stations in the vicinities of Cape Newenham and Nushagak Peninsula located in Bristol Bay.

Survey data within the survey limits is intended to supersede all prior survey data within the project limits.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

A.4 Survey Coverage

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

Water Depth	Coverage Required
All waters in survey area within Sheet 6	Set Line Spacing MBES at 200 m (Refer to HSSD Section 5.2.2.4 Option A)
All waters in survey area	Complete 5301 LNM. Transit mileage, system calibration mileage and data which do not meet HSSD specifications shall not count towards the completion of the LNM requirement. Notify the COR/Project Manager upon nearing completion of LNM requirement. The final survey area shall be squared off and ensure the full investigation of any features within the surveyed extent.

Table 2: Survey Coverage

Coverage requirements were met.

5,761 linear nautical miles (LNM) was acquired project-wide, which exceeded the required minimum of 5,301 LNM. The overage of 460 LNM (about 8.7% of required LNM) was collected to compensate for any inefficiencies incidental to the execution of line collection such as excess crossline LNM, data acquired on turns in order to scout depths between lines in shallow water, or lines ran closer together than required.

Kwigillingok and Kongiganak Approaches

Coverage in this sheet was extremely depth limited. Though the desired outcome was to survey the approaches to Kwigillingok and Kongiganak to assist the barge traffic which services the communities, the NALL (3.5 m depth limit in this area) was reached up to 4 NM offshore of these communities. This information was relayed to OCS OPS who requested a best-effort to acquire additional soundings inshore of the 3.5 m in order to find deeper water.

Each area was revisited on separate high tides. The ASV-CW5 was pushed inshore of the 3.5 m depth limit as shallow as safely possible within its radio range limits (about 3 km) from the Qualifier 105, which had to wait in deeper water due to its draft. Though MLLW depths generally less than 1 m were achieved, no water of significantly deeper depth was found. Relative to the 3.5 m depth limit, the effort advanced the survey coverage an additional 1.2 NM towards Kwigillingok and 0.5 NM towards Kongiganak but still left a relatively large gap between this survey and the communities.

Note that effort was made to fill in the area inside of 3.5 m to the project standard of 200 m spacing as timing of high water allowed, but since survey inside of the NALL was not required some gaps in the spacing were intentionally left at the approach to Kwigillingok.

Correspondence is available in Appendix II.

Images below show this area.

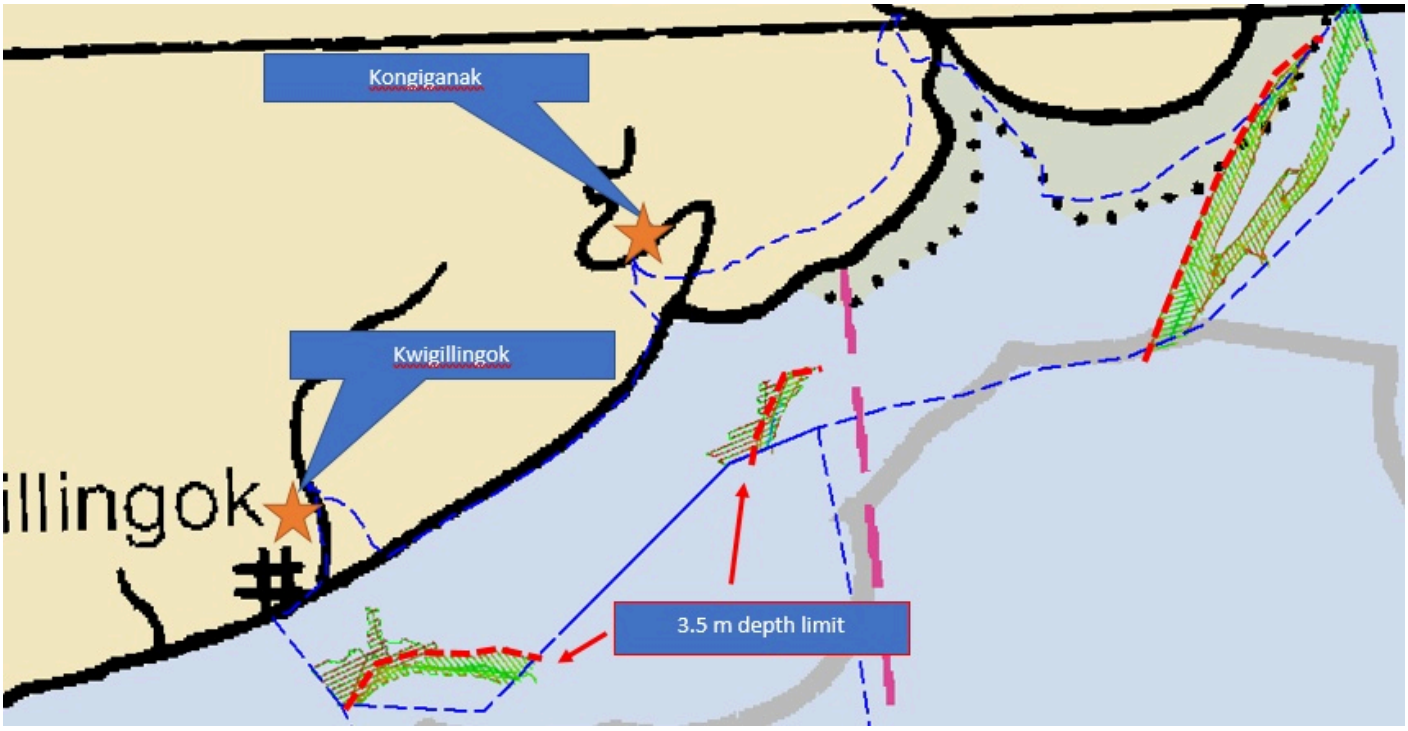

Figure 2: Figure showing the approximate 3.5 m depth limit, which was located well offshore of the communities of Kwigillingok and Kongiganak. Additional data was acquired inshore of the 3.5 m limit.

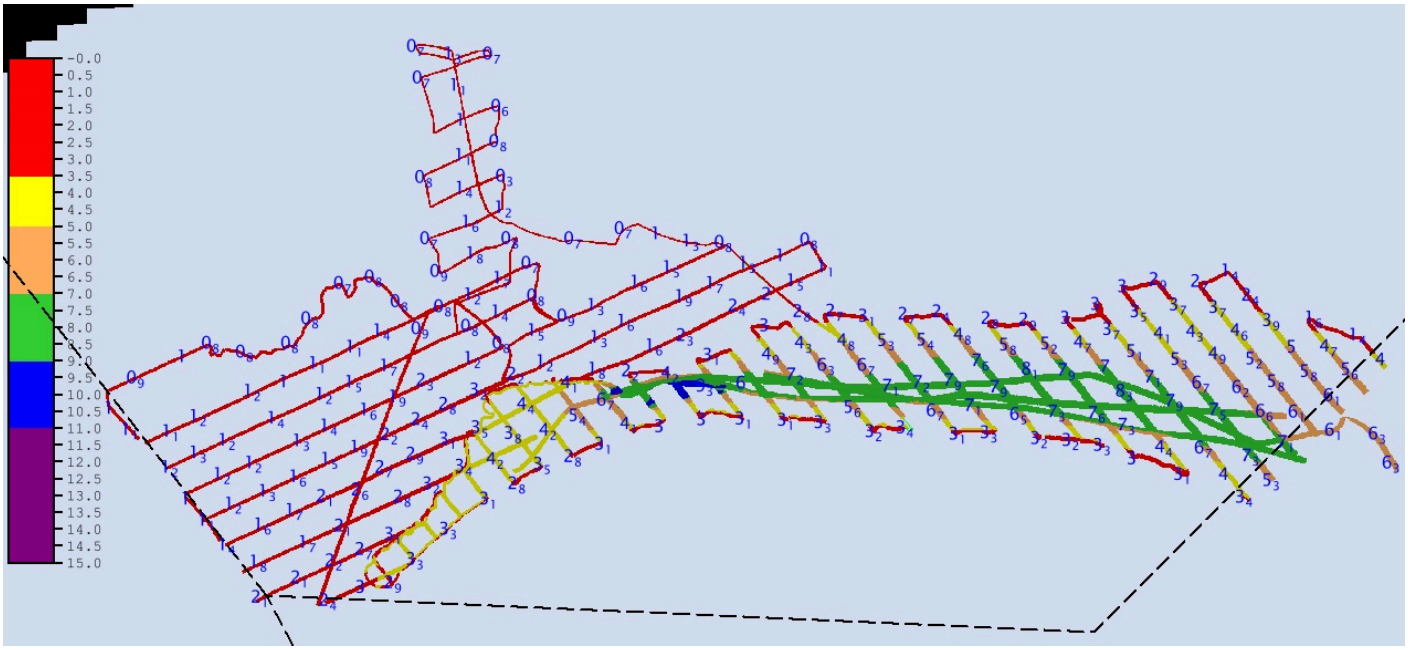

Figure 3: Figure showing the approach to Kwigillingok. Soundings (blue, in meters) were aquired inshore of the 3.5 m depth limit at high tide in order to search for deeper water to better develop the approach.

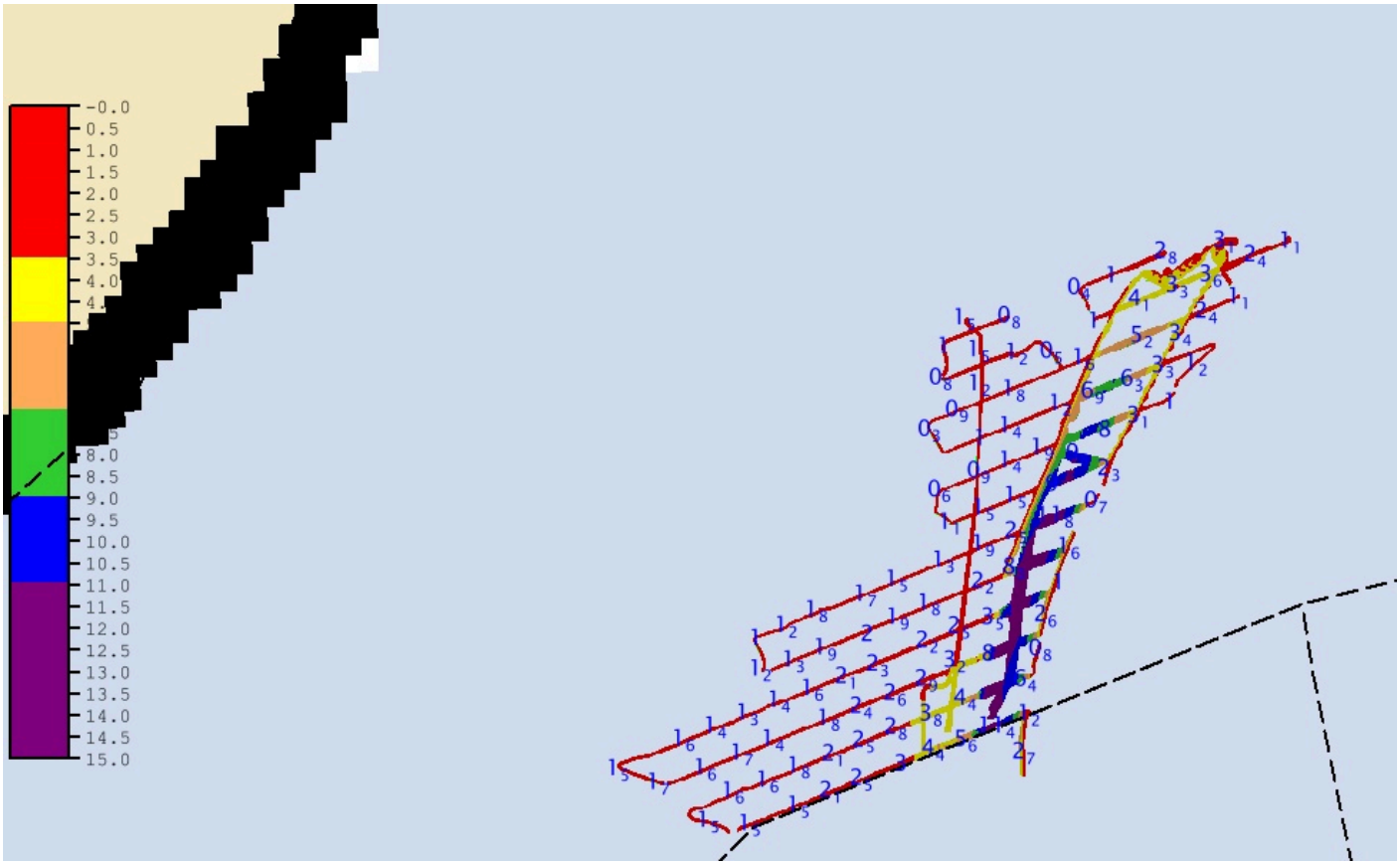

Figure 4: Figure showing the approach to Kongiganak. Soundings (blue, in meters) were acquired inshore of the 3.5 m depth limit at high tide in order to search for deeper water to better develop the approach.

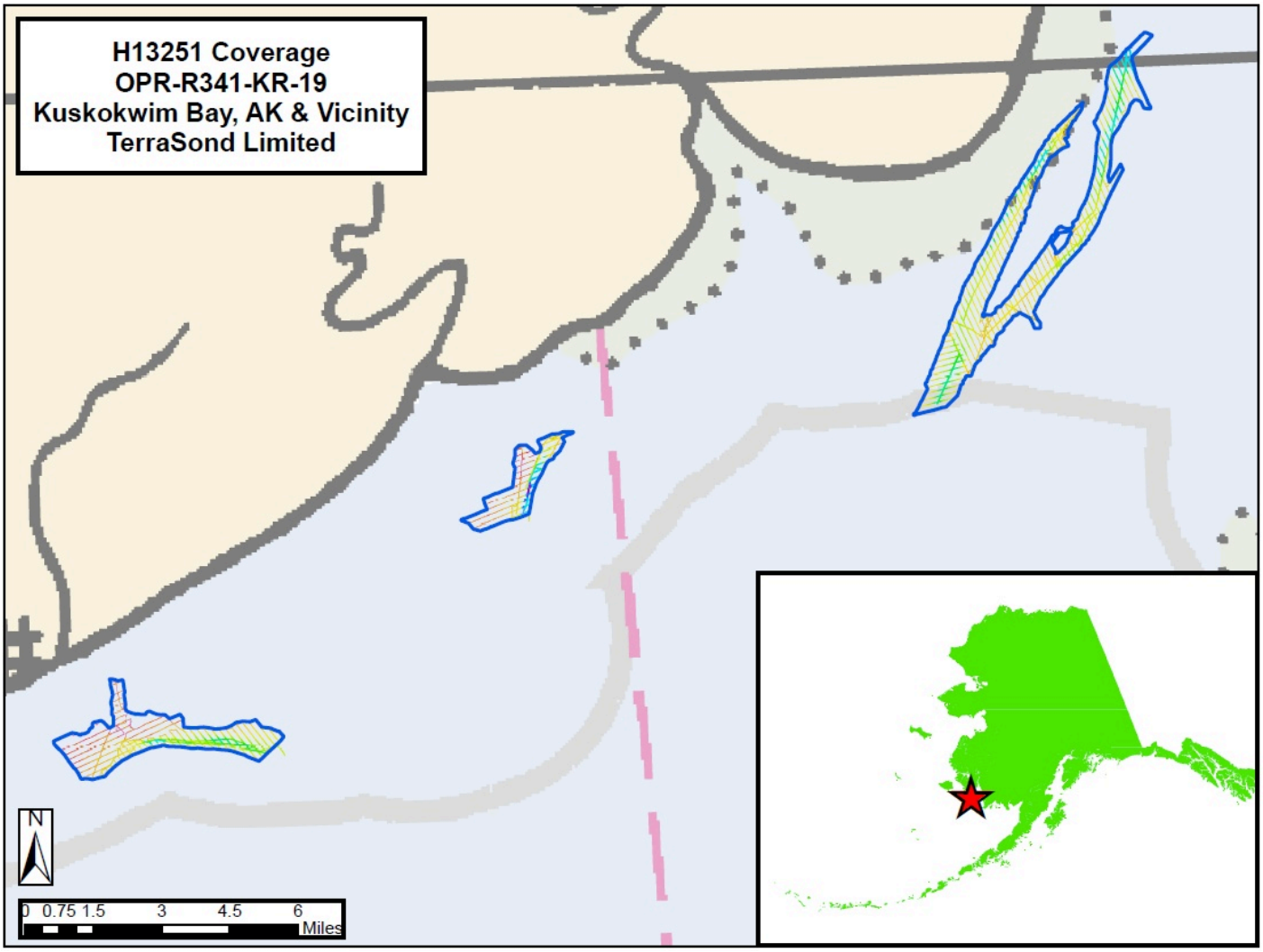

Figure 5: Image showing survey coverage.

A.6 Survey Statistics

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

	HULL ID	*ASV-CW5*	*Qualifier 105*	*Total*
LNM	**SBES Mainscheme**	0	0	0
	MBES Mainscheme	153.3	5.2	158.5
	Lidar Mainscheme	0	0	0
	SSS Mainscheme	0	0	0
	SBES/SSS Mainscheme	0	0	0
	MBES/SSS Mainscheme	0	0	0
	SBES/MBES Crosslines	14.3	0	14.3
	Lidar Crosslines	0	0	0
Number of Bottom Samples				3
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				9.9

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
07/07/2019	188

Survey Dates	Day of the Year
07/10/2019	191
07/11/2019	192
07/30/2019	211
07/31/2019	212
08/06/2019	218
08/07/2019	219
08/13/2019	225

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

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

B.1.1 Vessels

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

Hull ID	*ASV-CW5*	*Qualifier 105*
LOA	5.5 meters	32 meters
Draft	0.5 meters	1.8 meters

Table 5: Vessels Used

Figure 6: ASV-CW5 (foreground), and Q105 (background).

The Qualifier 105 (Q105) is a 32 m aluminum-hull vessel owned and operated by Support Vessels of Alaska. The Q105 acquired multibeam data and provided housing and facilities for on-site data processing. The vessel was also used to collect bottom samples, deploy/recover BMPG tide gauges, conduct sound speed casts, and deploy/recover the ASV-CW5 vessel.

The ASV-CW5 (C-Worker 5) is a 5.5 m aluminum-hull Autonomous Surface Vessel (ASV) owned and operated by L3-Harris ASV. The ASV was operated in an unmanned but monitored mode, collecting multibeam data in close proximity to the Q105.

B.1.2 Equipment

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

Manufacturer	Model	Type
Teledyne RESON	SeaBat 7125 SV	MBES
Teledyne RESON	SeaBat 7101	MBES
Applanix	POS MV 320 v5	Positioning and Attitude System
Teledyne Oceanscience	rapidCAST	Sound Speed System
Valeport	rapidPro SVT	Sound Speed System

Table 6: Major Systems Used

Both survey vessels were outfit for MBES data collection with similar survey equipment. The ASV-CW5 was equipped with a Reson SeaBat 7125 MBES while the Q105 used a Reson SeaBat 7101 MBES. Both vessels used Applanix POSMV 320 V5 (Wavemaster II) units for attitude and position measurements. Sound speed profiles were collected using a Valeport rapidPro SVT sensor (deployed using a Teledyne Oceanscience RapidCast system) from the Q105 only.

B.2 Quality Control

B.2.1 Crosslines

Effort was made to ensure crosslines had good temporal and geographic distribution, were angled to enable nadir-to-nadir comparisons, and that the required minimum percent of mainscheme LNM was achieved.

Crosslines were conducted with both vessels to ensure there was ample overlap for inter-vessel comparisons, with each vessel crossing the other's mainscheme lines. Since the two vessels worked in close proximity and normally ran parallel lines, crosslines were often collected in sets whenever both vessels were in simultaneous operation. Crosslines were also occasionally collected while transiting across the survey area to reach a different survey priority such as bottom sample locations or infills, leading to crosslines that were diagonal to the direction of mainscheme lines.

Since the area was uncharted, reconnaissance lines that followed the main channels were usually collected first before proceeding with collection of mainscheme lines that ran perpendicular to the channels. These reconnaissance channel lines sometimes doubled as crosslines. Use of these lines as crosslines as well as the collection of crosslines in two-vessel sets led to incidental collection of additional crossline LNM beyond the required 8% of mainscheme.

The crossline analysis was conducted using CARIS HIPS “Line QC Report” process. Each crossline (with all associated file segments) was selected and run separately through the process, which calculated the depth

difference between each accepted crossline sounding and a "QC" BASE (CUBE-type) surface's depth layer created from the mainscheme data. The QC surface was created with the same parameters and resolution used for the final surface, with the important distinction that the QC surface did not include crosslines so as to not bias the results. Differences in depth were grouped by beam number and statistics were computed, including the percentage of soundings with differences from the QC surface falling within IHO Order 1a.

When at least 95% of the sounding differences exceed IHO Order 1a, the crossline was considered to "pass," but when less than 95% of the soundings compare within IHO Order 1, the crossline was considered to "fail." A 5% (or less) failure rate was considered acceptable since this approach compares soundings to a surface (instead of a surface to a surface), allowing for the possibility that noisy crossline soundings that don't adversely affect the final surface could be counted as a QC failure in this process.

Lines selected as crosslines and their percentage (%) of soundings passing IHO Order 1a, sorted from highest passing to lowest, are listed below.

0982-ASV-CW5-219-Shallows-XL -- 100.0% pass
1034-ASV-CW5-219-F2EW02400 -- 100.0% pass
0708-ASV-CW5-211-AIS -- 100.0% pass
0772-ASV-CW5-212-F4NS07200 -- 100.0% pass
0702-ASV-CW5-211-F4EW01200 -- 99.7% pass
0689-ASV-CW5-AIS -- 99.5% pass
0098-ASV-CW5-188-F2NS03200 -- 98.4% pass

Results: Agreement between the mainscheme surface and crossline soundings is excellent. At least 95% of crossline soundings compare to the mainscheme surface within IHO Order 1a for all crosslines.

Refer to Separate II: Digital Data for the detailed Crossline QC reports.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via ERTDM	0.13 meters	0 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
ASV	2.81 meters/second	N/A meters/second	N/A meters/second	0.025 meters/second
Q105	2.81 meters/second	N/A meters/second	N/A meters/second	0.025 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

The NOAA-provided ERTDM model has an uncertainty of 0.13 meters. Refer to Appendix I for correspondence.

The uncertainty layer of the final surface was examined in CARIS HIPS. Uncertainty falls in the range of 0.263 to 0.657 m. Most grid cells are on the lower end of the uncertainty range, approximately 0.270 m. The larger values were observed to be on sand wave features or other areas of highly variable seafloor such as steep cut banks of shoals and sandbars as well as areas exhibiting bottom change, where many soundings of different depths contribute to the depth value of the relatively large 4 m grid cell resulting in a higher standard deviation of soundings contributing to the grid cell.

The final surface was also analyzed in QCTools (3.1.2), which reported that greater than 99.5% of grid cells in the final surface have uncertainty within allowable TVU for the depth.

B.2.3 Junctions

NOAA's "Gridded Surface Comparison V19.4" utility was used to complete the junction comparisons. The utility differences the surfaces from the junctioning surveys and generates statistics, including the percentage of grid cells that compare to within allowable TVU for the depth. 4 m-resolution CUBE surfaces were used for all Current surveys.

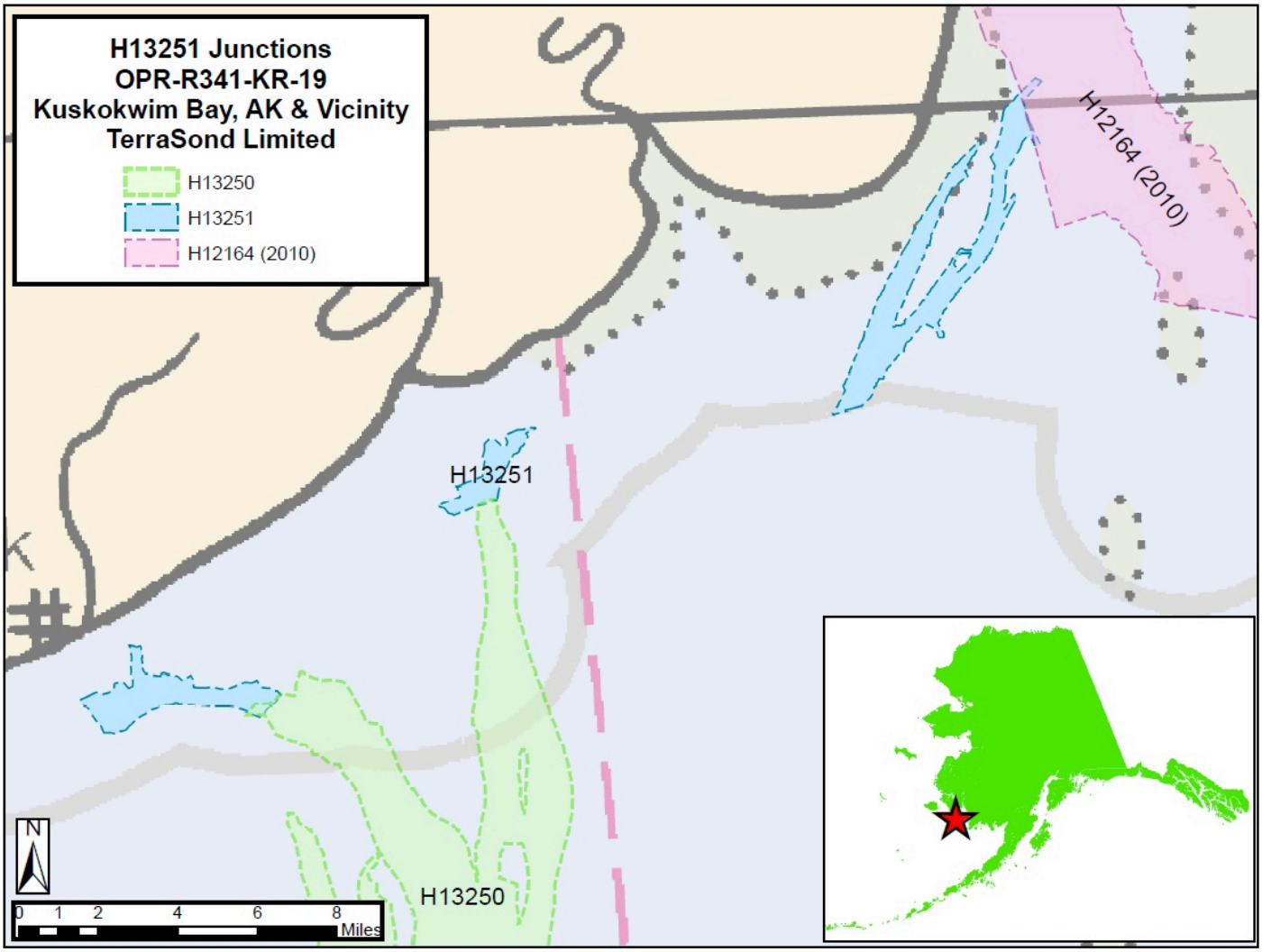

Figure 7: Image showing survey junctions.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13250	1:40000	2019	Terrasond, Ltd.	SW
H12164	1:10000	2010	Terrasond, Ltd.	NE

Table 9: Junctioning Surveys

H13250

Agreement between the two surveys is excellent, with a mean difference of 0.00 m with a standard deviation of 0.09 m. At least 99.5% of overlapping grid cells compare within the allowable TVU for the depth.

H12164

H13251 was compared to a combined MBES and VBES surface for H12164 downloaded from NOAA NCEI, "H12164_MBVB_4m_MLLW_combined.bag".

Agreement is extremely poor between the surveys. The mean difference is 1.14 m with a standard deviation of 4.4 m. Only 4% of grid cells agree within allowable TVU for the depth.

Differences range widely, from -8.078 m (this survey shoaler) to 7.339 m (prior survey shoaler), showing a shift to the west in the river channel in the area of the junction. The junction is at the entrance to the Kuskokwim River in an extremely dynamic and changeable area. The DR for H12164 also noted bottom changes observed during the field work for that survey in 2010. Drastic change during the 9 years between the surveys is therefore not unexpected.

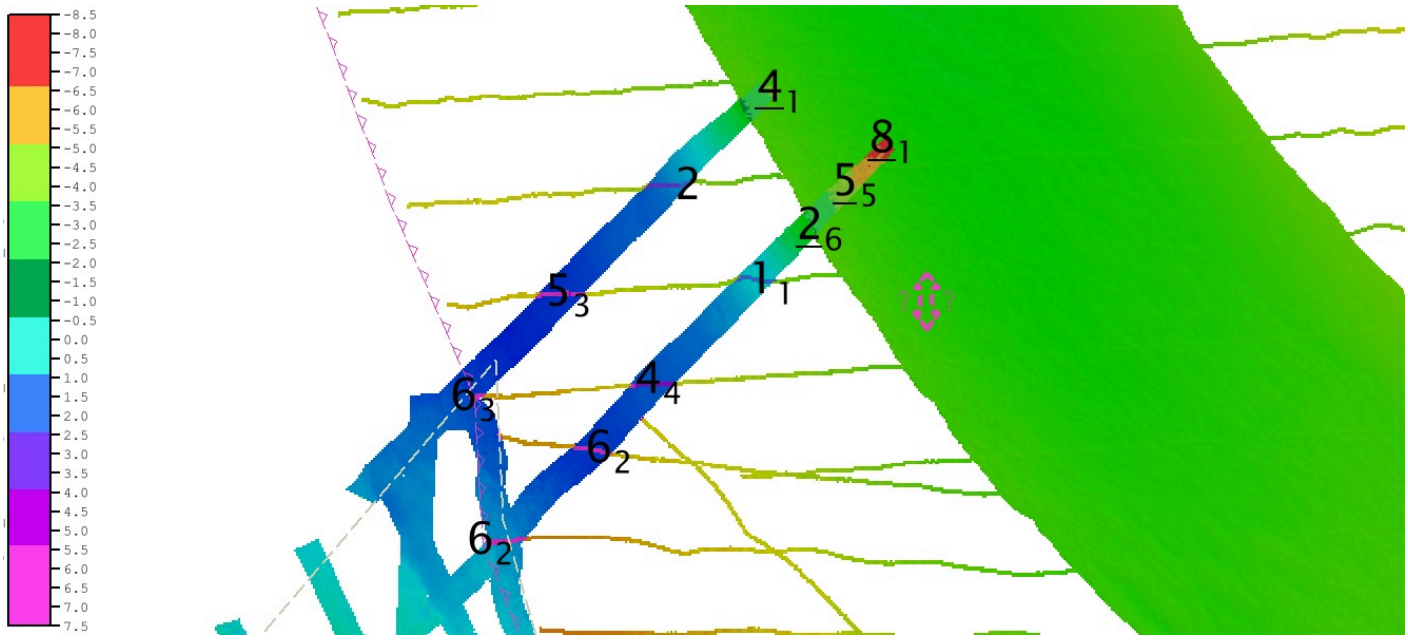

Figure 8: Image showing difference in meters (black soundings) between this survey and H12164, completed in 2010.

B.2.4 Sonar QC Checks

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

B.2.5 Equipment Effectiveness

POSMV Dropouts (ASV-CW5)

Approximately every 24 hours during survey operations the POSMV on the ASV-CW5 would drop offline. This was observed as sudden output of obviously erroneous data by the POSMV such as excessive vessel speeds, incorrect headings, and erroneous motion, followed by an automatic reinitialization of the POSMV. The issue would often repeat 1-2 additional times over a 5-10 minute period before resuming normal operations for an additional 24 hours. No definite cause was determined.

When this occurred the ASV-CW5 would break offline, note the issue in the acquisition log, circle back and proceed with rerunning the affected section of line. The affected section of line was subsequently rejected in processing. Since affected data was rejected and reran there is no adverse affect on final deliverables.

B.2.6 Factors Affecting Soundings

Bottom Change

Bottom change is evident throughout this survey, especially when data was collected days to weeks apart.

The survey area is a sediment deposition area at the mouth of a major river. Large tidal and riverine currents flow across the area and form transitory features such as channels, sandbars, and submerged shoal areas. Sandwaves and related signs of sediment transport are readily apparent in the MBES data.

As a result, vertical and horizontal busts that exceed allowable TVU occur periodically in the dataset. These changes commonly approach 0.4 to 0.5 m, with some change observed of up to 1.6 m (example below). No attempt was made to edit or otherwise manually choose a seafloor in areas where this occurred.

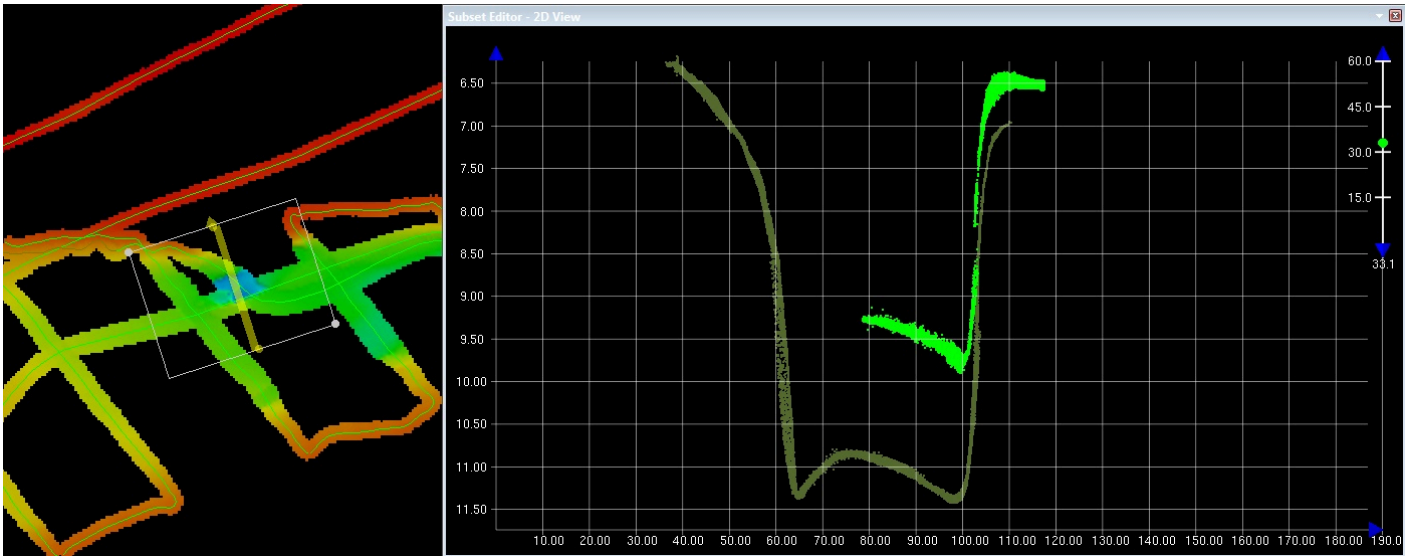

Figure 9: Example of bottom change (at 59-47-51 N, 163-04-45 W) in this survey. Soundings colored by day -- dark green on JD191, light green on JD218. Vertical bust of up to 1.6 m is due to bottom change over the 27 day period.

Sound Speed Error

Sound speed or refraction error, observed as cupping in the outer beam data, was observed periodicially in this data set. This was not a major issue on this survey but adversely affects some lines by up to 0.20 m, which an effect on final surfaces which is within allowable TVU for the depth.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: 2 hours

Sound speed profiles or "casts" were acquired aboard the Q105 while underway with a Teledyne Oceanscience RapidCAST system, which utilized a Valeport rapidPro SVT sound speed profiler.

Surface sound speed at the sonar head was monitored continuously and a new cast was collected when the surface speed varied from the previous profile's speed at the same depth by greater than 2 m/s, leading to a cast interval of approximately 2 hours.

Casts were taken as deep as possible. On survey lines with significant differences in depth, the deeper portion of the line was favored to ensure that changes across the full water column were measured.

The cast data was used to correct the sounding data for both vessels, using the "nearest in distance within time" (set to 4 hours) within CARIS HIPS.

B.2.8 Coverage Equipment and Methods

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

B.2.9 GPS Vertical Busts

Vertical busts attributable to GPS positioning error between crosslines or overlapping mainscheme are apparent periodically in the data set. These are normally less than 0.15 m, with extreme cases showing up to 0.30 m of vertical separation. However, all crosslines--including those exhibiting or crossing areas exhibiting vertical busts--pass within IHO Order 1a, and final surfaces are within allowable TVU for the depth.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

Deviations from the Corrections to Echo Soundings section of the DAPR are itemized below. Note that in all cases final data is within specifications.

Delayed Heave Exceptions

The following lines could not have Delayed Heave loaded. This was usually due to a software crash or other issue causing logging to the associated POS file to cease early. Real-time heave was used instead during all processing phases including SVP correction, Compute GPS Tide, and Merge on these lines.

0709-ASV-CW5-211-F3EW00000_-_0001
0737-ASV-CW5-212-F4NS00200_-_0001
0738-ASV-CW5-212-F4NS00200_-_0001
0284-ASV-CW5-191-F1NS03400_-_0001
0285-ASV-CW5-191-F1NS03400_-_0001
0286-ASV-CW5-191-F1NS03600_-_0001
0287-ASV-CW5-191-F1NS03600_-_0001
0288-ASV-CW5-191-F1NS03800_-_0001

GPS Height Smoothing

The following lines were loaded with GPS heights that had been smoothed to remove spikes and/or short-term drifts using a 6-minute moving average. The smoothed GPS height data was loaded using CARIS' Generic Data Parser utility from text files at a rate of 1 Hz, which are included with the survey deliverables.

Since the smoothing process removed heave data from the GPS record, the Apply Dynamic Heave option was set to "None" during computation of GPS Tide for these lines. More details are available in the DAPR.

0735-ASV-CW5-212-F3EW00000_-_0001

Use of Applanix Smart Base (ASB)

ASB was used instead of the project default PP-RTX post-processing method in Applanix POSPac MMS software to improve vertical agreement on the following lines.

Vessel ASV, JD211, all lines with prefix 689 through 709

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

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

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: NOAA Extended Attribute Files V2019.3.

NOAA Extended Attributes were used for the Final Feature File (FFF) submitted with the survey deliverables.

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
H13251_MB_4m_MLLW_Final	CARIS Raster Surface (CUBE)	4 meters	0 meters - 80 meters	NOAA_4m	MBES Set Line Spacing
H13251_MBAB_1m_ASV_400kHz_1of1	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing
H13251_MBAB_1m_Q105_240kHz_1of1	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing

Table 10: Submitted Surfaces

The final depth information for this survey was submitted as a CARIS BASE surface (CSAR format) which best represented the seafloor at the time of the 2019 survey. The surface was created from fully processed data with all final corrections applied.

The surface was created using NOAA CUBE parameters and resolutions by depth range in conformance with the 2019 HSSD. The surface was finalized, and designated soundings were applied where applicable. Horizontal projection was selected as UTM Zone 3 North, NAD83.

A non-finalized versions of the CSAR surface is also included which does not have a depth cutoff applied. This does not have the "_Final" designation in the filename.

An S-57 (.000) Final Feature File (FFF) was submitted with the survey deliverables as well. The FFF contains data not readily represented by the final surface, including bottom samples and shoreline verification results (if any). Each object is encoded with mandatory S-57 attributes and NOAA Extended Attributes (V2019.3).

Georeferenced multibeam backscatter mosaics (Geotif format in NAD83 UTM Zone 3N, 1 m resolution) were also produced and are provided with the survey deliverables. One mosaic was produced for each vessel. Note that backscatter processing and mosaic generation was not a requirement and the mosaics are provided as-is. The mosaics may have flaws or holidays which could be addressed through further processing. However, they are of sufficient quality to show the relative changes in seafloor type across the survey area.

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.

ERS Datum Transformation

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

Method	Ellipsoid to Chart Datum Separation File
ERS via ERTDM	R341KR2019_ERTDM_NAD83-MLLW

Table 11: ERS method and SEP file

All soundings were reduced to MLLW using the ERTDM NAD83 to MLLW separation model grid file provided by NOAA using ERS methodology.

Discrete tide zones were generated using project gauge data but were used for comparison purposes only.

A comparison between the provided ERTDM model and a ERZT model created using the tide zones was undertaken. There is generally good agreement between the models, with project-wide agreement averaging 0.033 m with a standard deviation of 0.271 m.

See the HVCR for additional information.

C.2 Horizontal Control

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

The projection used for this project is Universal Transverse Mercator (UTM) Zone 3.

The following PPK methods were used for horizontal control:

- Smart Base
- RTX

The Trimble PP-RTX subscription-based correction service within POSPac was used for final positioning. Results were good overall, usually at 0.10 m or better vertically. Applanix Smart Base (ASB) was used on a

small number of lines (described previously in this report) to improve vertical matchup. Refer to the DAPR for additional details.

RTK

The survey vessels were configured to receive RTK-level correctors via Hemisphere AtlasLink SBAS (L-band) receivers. This was utilized throughout the survey on the ASV-CW5 but only briefly at the start of operations on the Q105. However, all real-time correctors were superseded in processing with PPK correctors from Applanix POSPac. Refer to the DAPR for additional detail.

WAAS

The FAA Wide Area Augmentation System (WAAS) was used for real-time positioning on the Q105 for the majority of the survey. These positions were superseded in processing with PPK correctors from Applanix POSPac, as described in the DAPR.

D. Results and Recommendations

D.1 Chart Comparison

The chart comparison was performed by examining the best-scale Electronic Navigational Charts (ENCs) that intersect the survey area. The latest edition(s) available at the time of report compilation were used.

The chart comparison was accomplished by overlaying the finalized BASE surface(s) with shoal-biased soundings and the final feature file (FFF) on the charts in CARIS HIPS. The general agreement between charted soundings and survey soundings was then examined and a more detailed comparison was undertaken for any shoals or other dangerous features. In areas where a large scale chart overlapped with a small scale chart, only the larger scale chart was examined.

When comparing to survey data, chart scale was taken into account so that 1 mm at chart scale was considered to be the valid radius for charted soundings and features.

Results are discussed below. It is recommended that in all cases of disagreement this survey should supersede charted data.

US3AK84M - The area is mostly uncharted on US3AK84M with little for comparison. There is minor overlap with DEPARE (Depth Area) objects on the ENC that are encoded with a depth of -1.8 to 0 m; these should be updated where they intersect this survey. There is a small amount of overlap on this survey's NE side. No soundings directly overlap. Nearby soundings differ by 2-3 m. It appears the river channel and corresponding mid-river shoal has shifted westward by up to 800 m in this area. However, this survey had insufficient overlap with charted data here to delineate the extent of the shift.

US4AK85M - Results of this comparison are similar to US3AK84M. The area is mostly uncharted on US4AK85M with little for comparison. There is minor overlap with DEPARE (Depth Area) objects on the ENC that are encoded with a depth of -3 to 0 m; these should be updated where they intersect this survey. There is a small amount of overlap on this survey's NE side. No soundings directly overlap. Nearby soundings agree within 0.2 m in a relatively shallow area at 59-59-15.0 N, 162-25-50.8 W to as poorly as 6.3 m of difference at 60-00-21.6 N, 162-26-13.0 W, where the chart shows a 5.7 m depth nearby while this survey shows approximately 12 m. The area of the 5.7 m charted sounding appears to have deepened significantly, and the river channel and associated mid-river shoal have migrated to the west.

US2AK95M - The area is uncharted on this small scale chart with no depths to compare. This survey intersects a depth area (DEPARE) object on the ENC with a depth range of -3.1 to 0.0 m. The DEPARE object extents should be modified based on this survey.

USCG Notice to Mariners (NM) and USCG Local Notice to Mariners (LNM) for District 17 from week 26/2019 through 34/2019 were checked and no items were found that affected the survey area.

Note that ENC metadata and non-specific geographic area objects on the ENCs that overlap the survey area were not investigated.

D.1.1 Electronic Navigational Charts

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

ENC	Scale	Edition	Update Application Date	Issue Date
US3AK84M	1:200000	12	08/07/2018	10/08/2019
US4AK85M	1:100000	12	09/09/2019	10/08/2019
US2AK95M	1:1534076	9	08/20/2018	10/16/2019

Table 12: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

Shoals or potentially hazardous features exist for this survey, but were not investigated.

Shoals, either exposed or submerged at low water, are common inshore of the 3.5 m depth limit. Areas inshore of 3.5 m should be clearly marked on the charts as unsurveyed or otherwise hazardous for navigation.

No DTONs were submitted for this survey. The CTNARE (CAUTION AREA) objects on the ENCs noting the region as a "Changeable Area" should be retained.

D.1.3 Charted Features

No charted features exist for this survey.

D.1.4 Uncharted Features

No uncharted features exist for this survey.

D.1.5 Channels

No channels exist for this survey. There are no designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, or channel and range lines within the survey limits.

D.2 Additional Results

D.2.1 Aids to Navigation

No Aids to navigation (ATONs) exist for this survey. Charted buoys on the large scale charts were outside the survey limits.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

Four bottom samples were assigned via the PRF. All assigned locations were in unnavigable areas. Therefore the assigned positions were shifted to the nearest navigable location.

Three samples were achieved, which returned primarily black to gray soft mud.

A fourth sample was attempted at 59-53-52.616 N, 162-34-14.079 W. Three attempts were made at the location but no sample could be obtained.

Refer to the FFF submitted with the survey deliverables for results.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features exist for this survey.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.8 Abnormal Seafloor or Environmental Conditions

As described earlier in this report, the area is in the depositional zone of a major river. Migrating sandbars, shoals, and channels are common. Sandwaves are evident on the seafloor in many areas.

During survey operations, currents of 2-3 knots were commonly experienced during the ebb and flood portions of the tidal cycle. Currents were generally oriented northeast-southwest, running parallel to the channels. Greatest currents were on the NE part of the survey at the entrance to the Kuskokwim River on ebb tides.

D.2.9 Construction and Dredging

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

D.2.10 New Survey Recommendations

The 3.5 m depth contour was reached well offshore in this area. As a result, despite additional effort by the field crew with the equipment available on site, a large gap between survey data and the communities of Kwigillingok and Kongiganak remains, and the final survey extents resulted in three disconnected polygons which do not provide nearshore soundings to connect a surveyed route with the Kuskokwim River.

Additional work is therefore recommended inshore of 3.5 m in the vicinity of the two communities as well as between the disconnected survey polygons. AIS data indicates barges navigate between these areas, likely timed at high tide--during which shoals appear to largely be submerged and navigable to very shallow drafted vessels. Depths of 0 m MLLW could be achieved with appropriate equipment and methodology, such as a skiff or other small vessel deployed during good weather from a larger support vessel, and tasked with performing transects with VBES timed around high water.

D.2.11 ENC Scale Recommendations

No new insets are recommended for this area.

E. Approval Sheet

Field operations and data processing contributing to the completion of this survey 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 hereby respectfully submitted for final review and acceptance.

The survey data meets or exceeds the requirements set forth in the 2019 NOS Hydrographic Surveys Specifications and Deliverables document as well as the Hydrographic Survey Project Instructions and Statement of Work. This data is adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies (if any) noted in this Descriptive Report.

Report Name	Report Date Sent
Survey Outlines	2019-09-10
MMO Training Logsheet and Observation Logs	2019-09-12
NCEI Sound Speed Data Submission	2019-09-12
Coast Pilot Report	2019-09-13
Tides and Water Levels Package - 9465419 Levelock	2019-11-15
Tides and Water Levels Package - 9465993 Ishkowik	2019-11-15
Tides and Water Levels Package - 9463502 Port Moller	2019-11-16
Tides and Water Levels Package - 9465203 Naknek	2019-11-18
Tides and Water Levels Package - 9465137 Cape Pierce	2019-11-19
Tides and Water Levels Package - 9465265 Kulukak Point	2019-11-20
Tides and Water Levels Package - AAAAAAA Cape Mendenhall	2019-11-23
Tides and Water Levels Package - BBBBBBB SW Kuskokwim Bay	2019-11-23
Tides and Water Levels Package - CCCCCCC Cape Corwin	2019-11-27

Approver Name	Approver Title	Approval Date	Signature
Andrew Orthmann, C.H.	TerraSond Charting Program Manager	12/15/2019	Andrew Orthmann Digitally signed by Andrew Orthmann Date: 2019.12.15 14:11:24 -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	Continuously Operating Reference Station
CTD	Conductivity Temperature Depth
CEF	Chart Evaluation File
CSF	Composite Source File
CST	Chief Survey Technician
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DP	Detached Position
DR	Descriptive Report
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
ERS	Ellipsoidal Referenced Survey
ERTDM	Ellipsoidally Referenced Tidal Datum Model
ERZT	Ellipsoidally Referenced Zoned Tides
FFF	Final Feature File
FOO	Field Operations Officer
FPM	Field Procedures Manual
GAMS	GPS Azimuth Measurement Subsystem
GC	Geographic Cell
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSD	Hydrographic Surveys Division

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

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