F00817

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	F00817

LOCALITY

State(s):	Washington
General Locality:	Puget Sound
Sub-locality:	Eagle Harbor

2020

CHIEF OF PARTY
Michelle M. Levano, LTJG/NOAA

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

F00817

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):	**Washington**
General Locality:	**Puget Sound**
Sub-Locality:	**Eagle Harbor**
Scale:	**10000**
Dates of Survey:	**10/07/2020 to 10/23/2020**
Instructions Dated:	**09/02/2020**
Project Number:	**S-N919-NRT3-20**
Field Unit:	**NOAA Navigation Response Team - Seattle**
Chief of Party:	**Michelle M. Levano, LTJG/NOAA**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 10N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

Table of Contents

List of Tables

List of Figures

Descriptive Report to Accompany Survey F00817

Project: S-N919-NRT3-20

Locality: Puget Sound

Sublocality: Eagle Harbor

Scale: 1:10000

October 2020 - October 2020

NOAA Navigation Response Team - Seattle

Chief of Party: Michelle M. Levano, LTJG/NOAA

A. Area Surveyed

The survey area is located in Puget Sound within the sub locality of Eagle Harbor.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
47° 37' 29.17" N 122° 31' 29.85" W	47° 36' 9.85" N 122° 28' 32.16" W

Table 1: Survey Limits

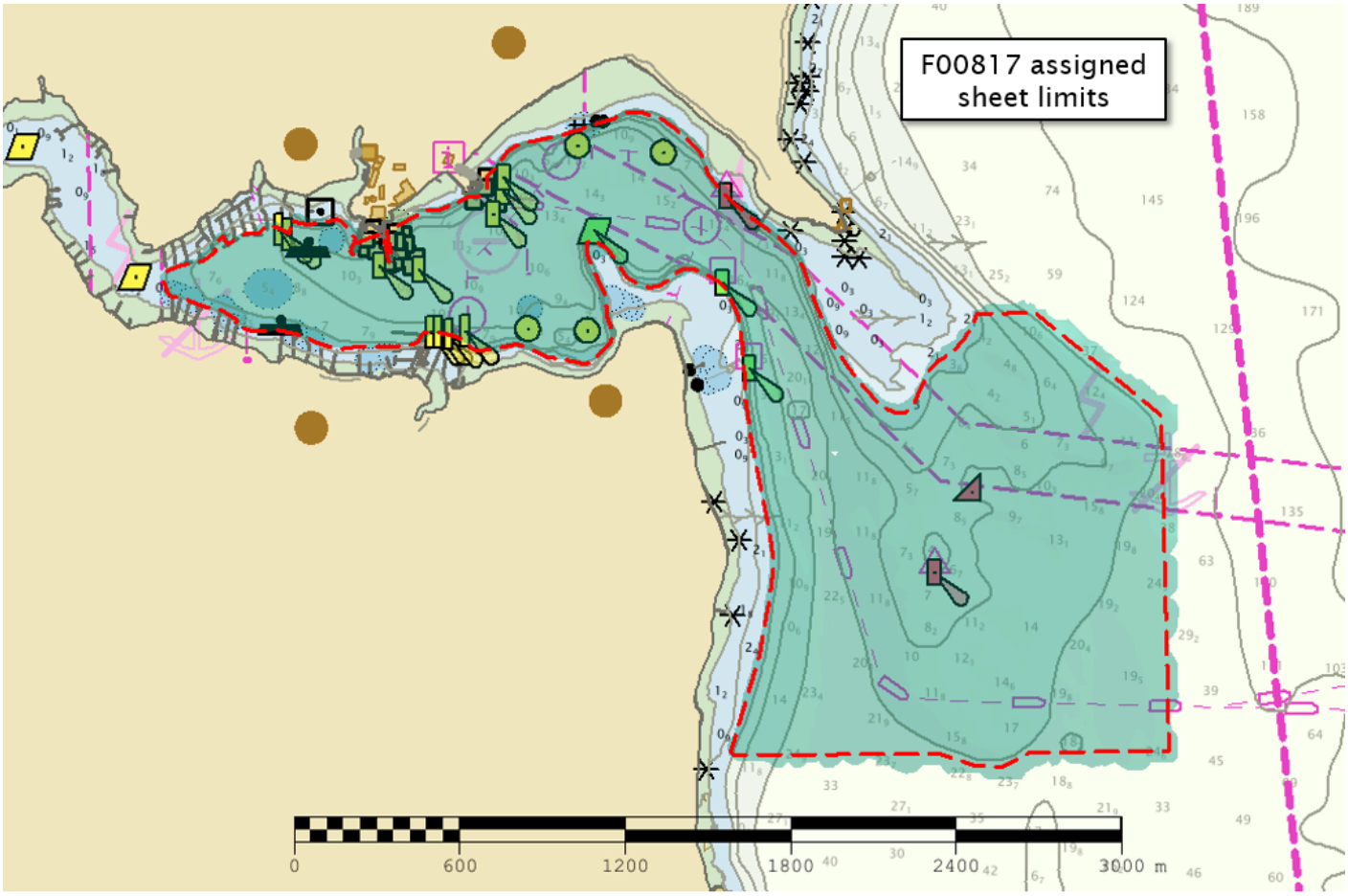


Figure 1: F00817 sheet limits (in blue) overlaid on chart US5WA14M.

Data were acquired to the survey limits in accordance with the requirements in the Project Instructions and the 2020 NOS Hydrographic Survey Specifications and Deliverables (HSSD). (Figure 1)

A.2 Survey Purpose

The Regional Navigation Manager has requested a new survey in Eagle Harbor to update the nautical chart. This area is a busy ferry route and a grounding or allusion would impact thousands of commuters. Survey data from this project is intended to supersede all prior survey data in the common area.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

Data acquired in F00817 meet multibeam echo sounder (MBES) coverage requirements for object detection, as required by the HSSD. This includes crosslines (see Section B.2.1), NOAA allowable uncertainty (see Section B.2.10), and density requirements (see Section B.2.11). Additional compliance statistics can be found in the Standards and Compliance located in Appendix II of this report.

The surface was analyzed using the HydrOffice QC Tools Grid QA feature (Figure 2). Density requirements for F00817 were achieved with at least 99.5% of surface nodes containing five or more soundings as required by HSSD Section 5.2.2.3. The few nodes that did not meet density requirements are due to sparse data in the outer beams, especially near steep sand waves, slopes and rocky areas where acoustic shadowing occurred, and at the edges of the survey limits.

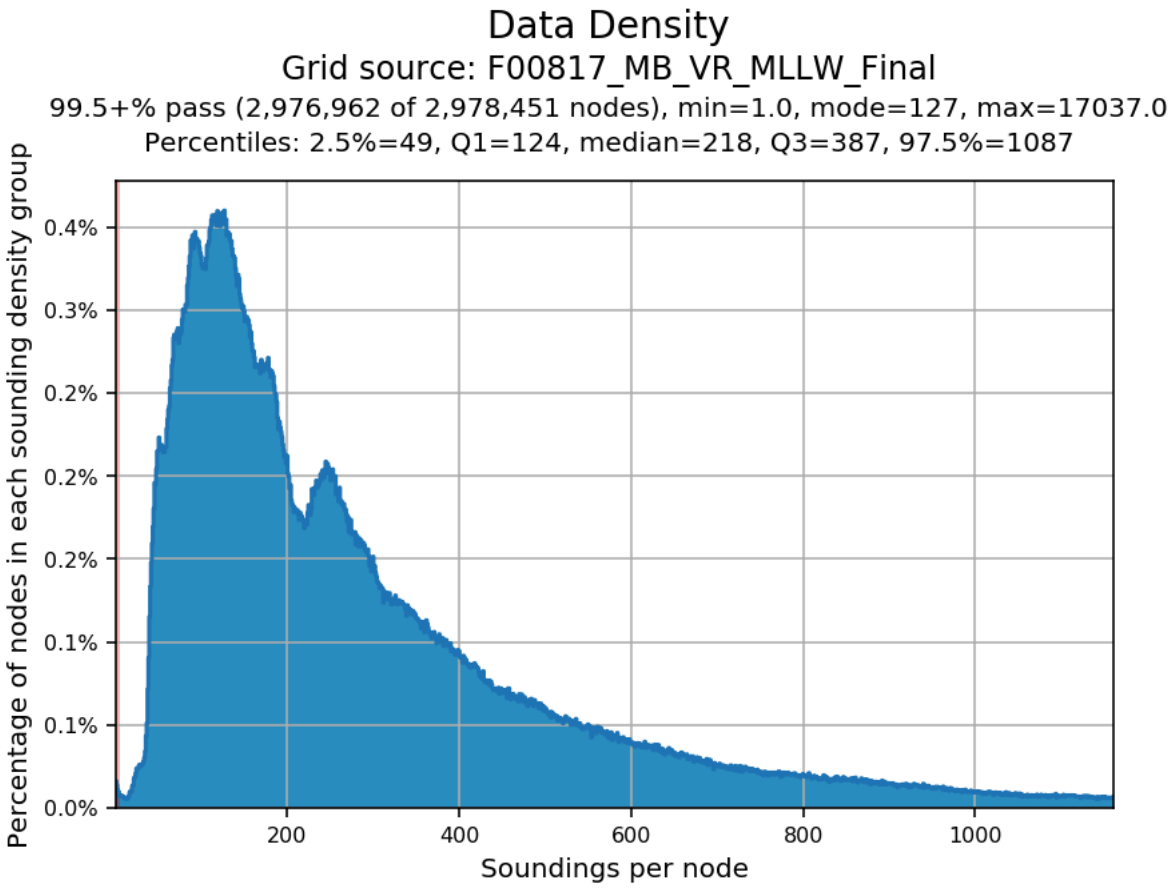


Figure 2: Pydro derived histogram plot showing HSSD object detection compliance of F00817 MBES within the finalized CUBE surface.

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	Object Detection Coverage (Refer to HSSD Section 5.2.2.2)

Table 2: Survey Coverage

The entirety of F00817 was acquired with Object Detection, meeting the requirements listed above and in the HSSD. See Figure 3 for an overview of coverage.

F00817 data were reviewed in CARIS HIPS and SIPS for holidays in accordance with Section 5.2.2.3 of the HSSD. 23 holidays were identified via HydrOffice QC Tools Holiday Finder tool. This tool automatically scans the surface for holidays as defined in the HSSD and was run in conjunction with a visual inspection of the surface by the hydrographer.

In all areas where the 3.5 meter (or as assigned in project instructions) depth contour or the sheet limits were not met, the Navigable Area Limit Line (NALL) was defined as the inshore limit of bathymetry due to the risks of maneuvering the survey vessel in close proximity to the shoreline and obstructions. (Figures 4,5,6).

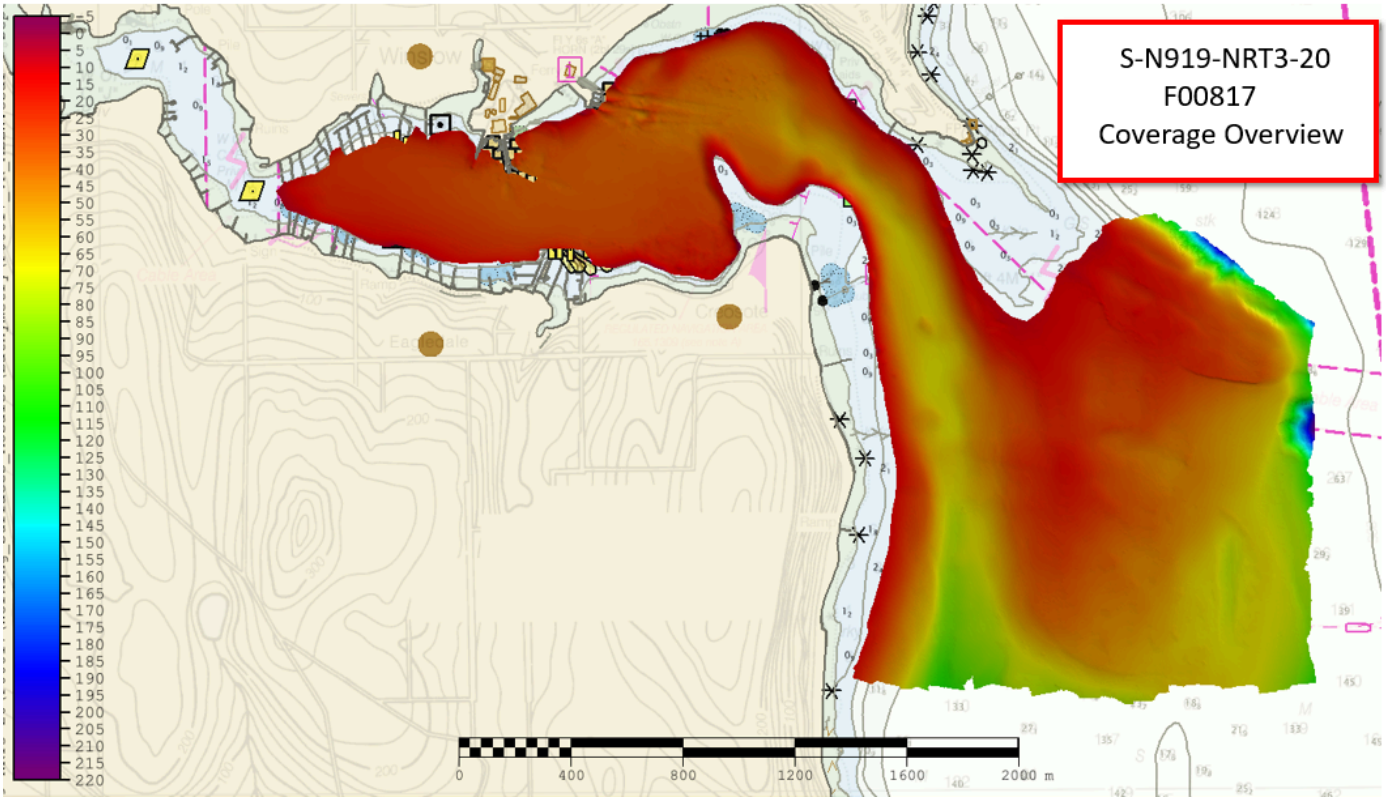


Figure 3: F00817 survey coverage overlaid onto Chart US5WA14M.

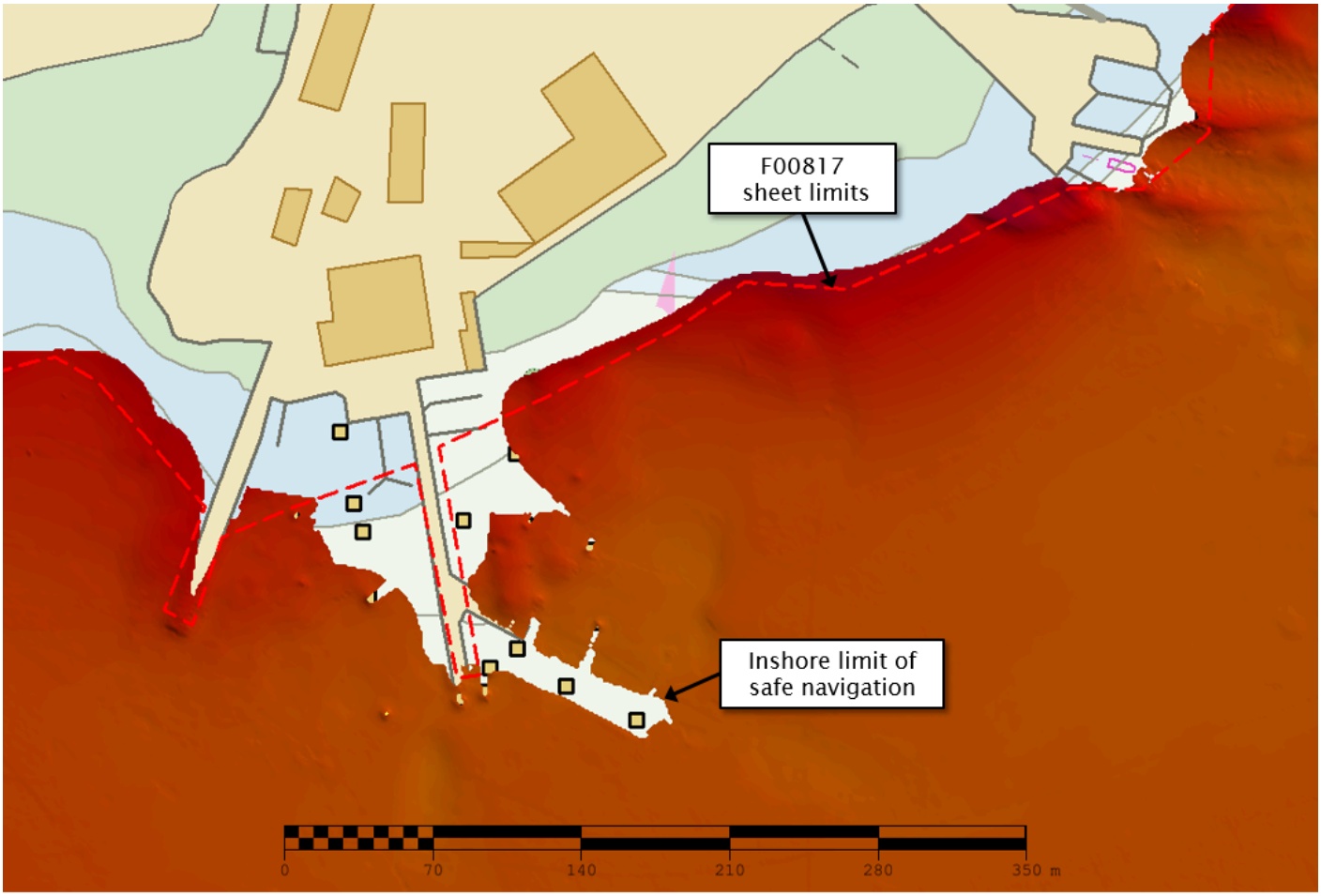


Figure 4: Example of NALL determination due to piers and ferry terminal.

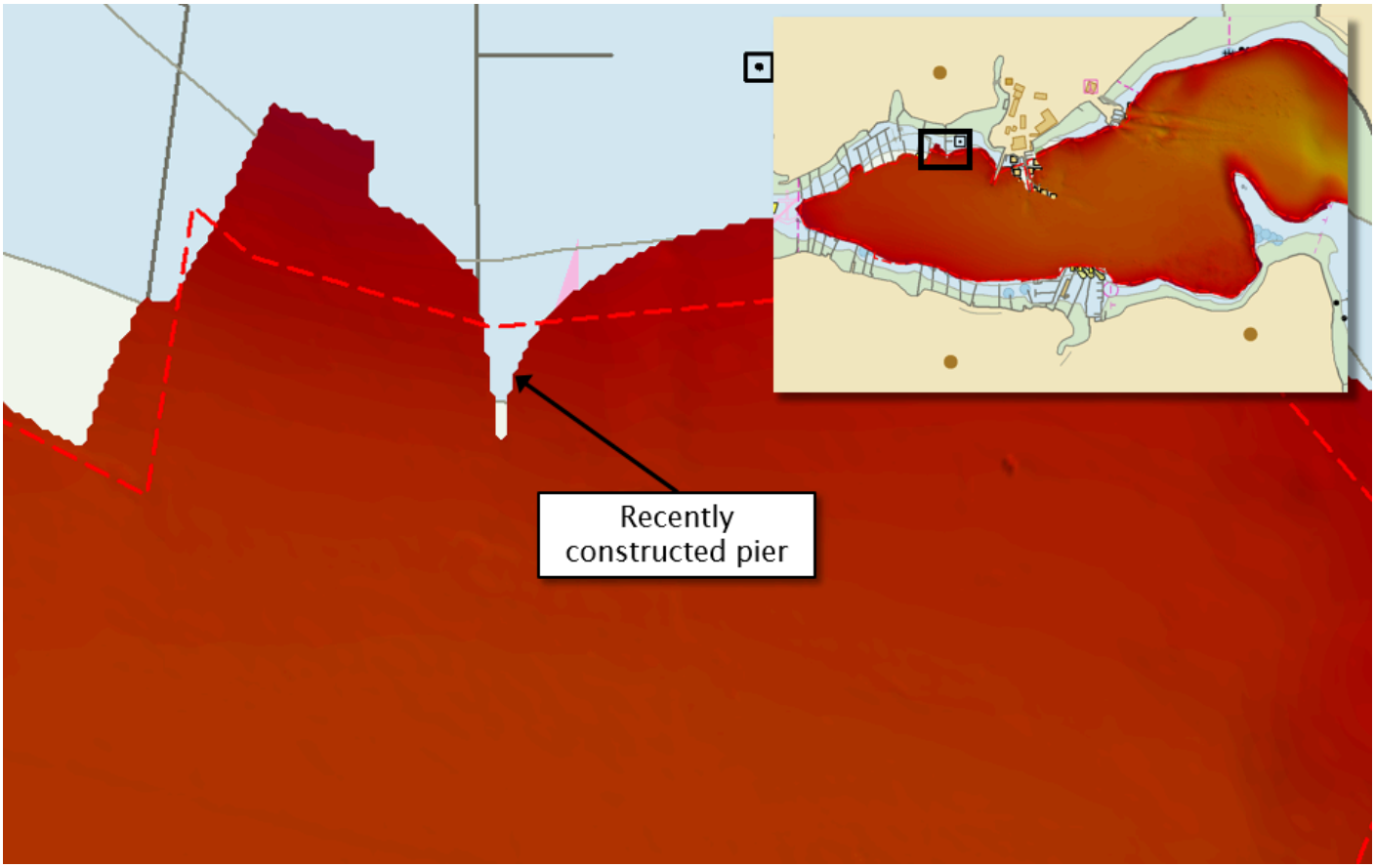


Figure 5: NALL not met due to recent pier construction.

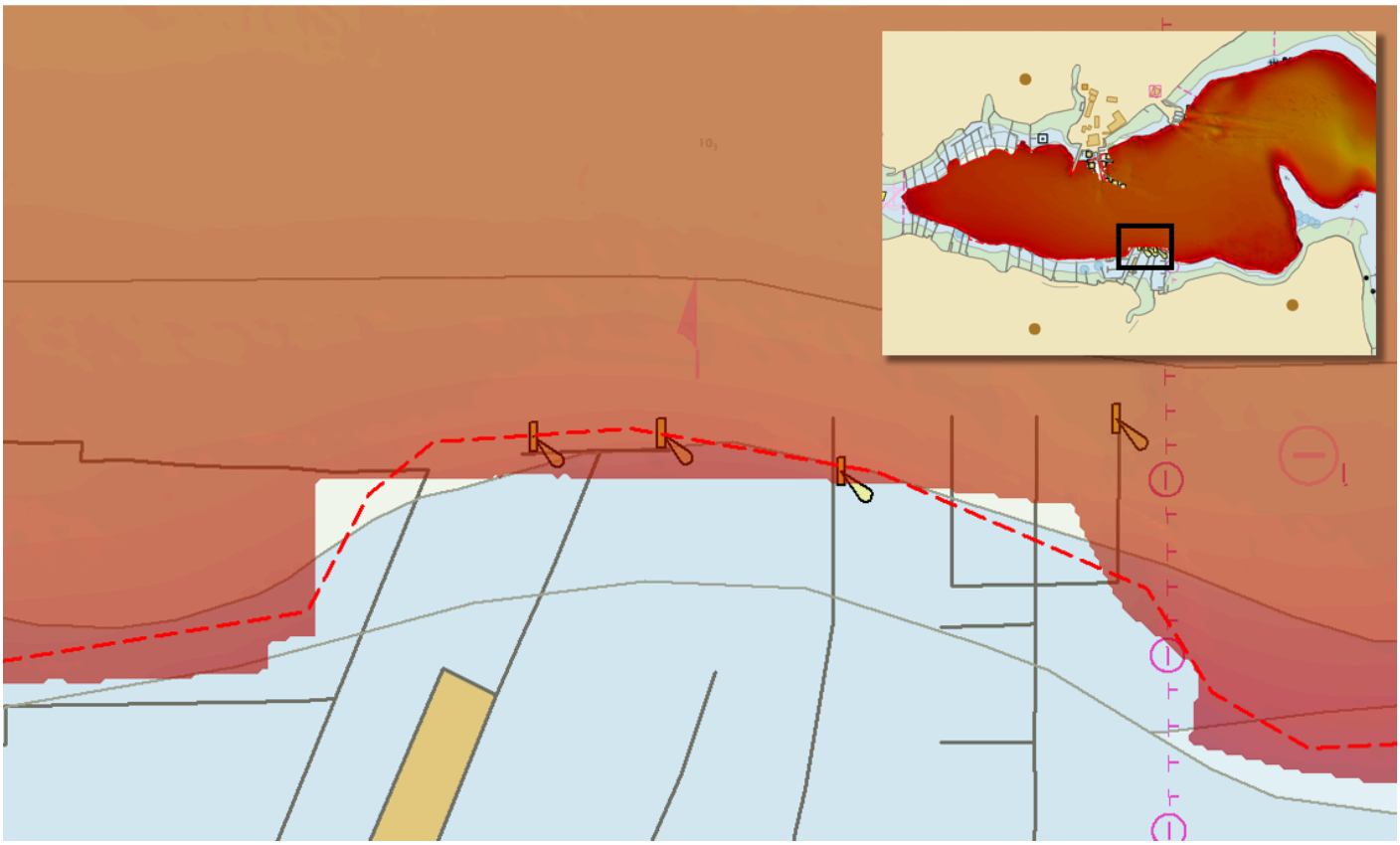


Figure 6: Inshore limit reached around pier and moored vessels.

A.6 Survey Statistics

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

	HULL ID	*S3006*	*Total*
LNM	**SBES Mainscheme**	0	0
	MBES Mainscheme	78.13	78.13
	Lidar Mainscheme	0	0
	SSS Mainscheme	0	0
	SBES/SSS Mainscheme	0	0
	MBES/SSS Mainscheme	0	0
	SBES/MBES Crosslines	9.8	9.8
	Lidar Crosslines	0	0
Number of Bottom Samples			0
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			1.03

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
10/07/2020	281
10/08/2020	282

Survey Dates	Day of the Year
10/09/2020	283
10/15/2020	289
10/16/2020	290
10/20/2020	294
10/21/2020	295
10/22/2020	296
10/23/2020	297

Table 4: Dates of Hydrography

Caris HDCS MBES acquisition line information confirms start of survey on DN281, 10/07/2020. This has been updated from DN282, 10/08/2020 in the Hydrographic Title Sheet and added to Table 4, Dates of Hydrography above.

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	*S3006*
LOA	34 feet
Draft	4 feet

Table 5: Vessels Used

Figure 7: NRT-Seattle S3006

B.1.2 Equipment

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

Manufacturer	Model	Type
Kongsberg Maritime	EM 2040C	MBES
AML Oceanographic	MicroX SV	Sound Speed System
YSI	CastAway-CTD	Conductivity, Temperature, and Depth Sensor
Applanix	POS MV 320 v5	Positioning and Attitude System

Table 6: Major Systems Used

The equipment was installed on S3006. The vessel is equipped with POS MV v5 system for positioning and attitude, Kongsberg EM 2040C for MBES, AML Oceanographic MicroX SVS surface sound speed sensor, and YSI CastAway-CTD casts. All data for survey F00817 was acquired by S3006. The vessel acquired multibeam depth soundings, and sound speeds profiles.

B.2 Quality Control

B.2.1 Crosslines

Multibeam crosslines were collected by S3006 (Figure 8) across a variety of depth ranges, water masses, and days. Crosslines were collected, processed and compared in accordance with Section 5.2.4.2 of the HSSD. A Variable Resolution (VR) surface was created of only mainscheme lines, and a second VR surface was created of only crosslines. A difference surface was generated in Pydro tool's Compare Grids by subtracting the crossline only surface from the mainscheme surface (mainscheme- crosslines= difference surface), from which statistics were derived. Statistics show the mean difference between the depths derived from mainscheme data and crossline data was 0.15 meters (with mainscheme being shoaler) and 95% of nodes falling within 0.24 meters (Figure 9). For the respective depths, the difference surface was compared to the allowable NOAA uncertainty standards (Figure 10).

In total, 99.5% of the depth differences between F00817 mainscheme and crossline data were within allowable NOAA uncertainties (Figure 10). The coloring represents areas where the TVUmax error tolerance in exceeded; red, orange and yellow colors represent areas where mainscheme data is deeper than crossline data; the blue shades represent where crossline data is deeper than mainscheme data.

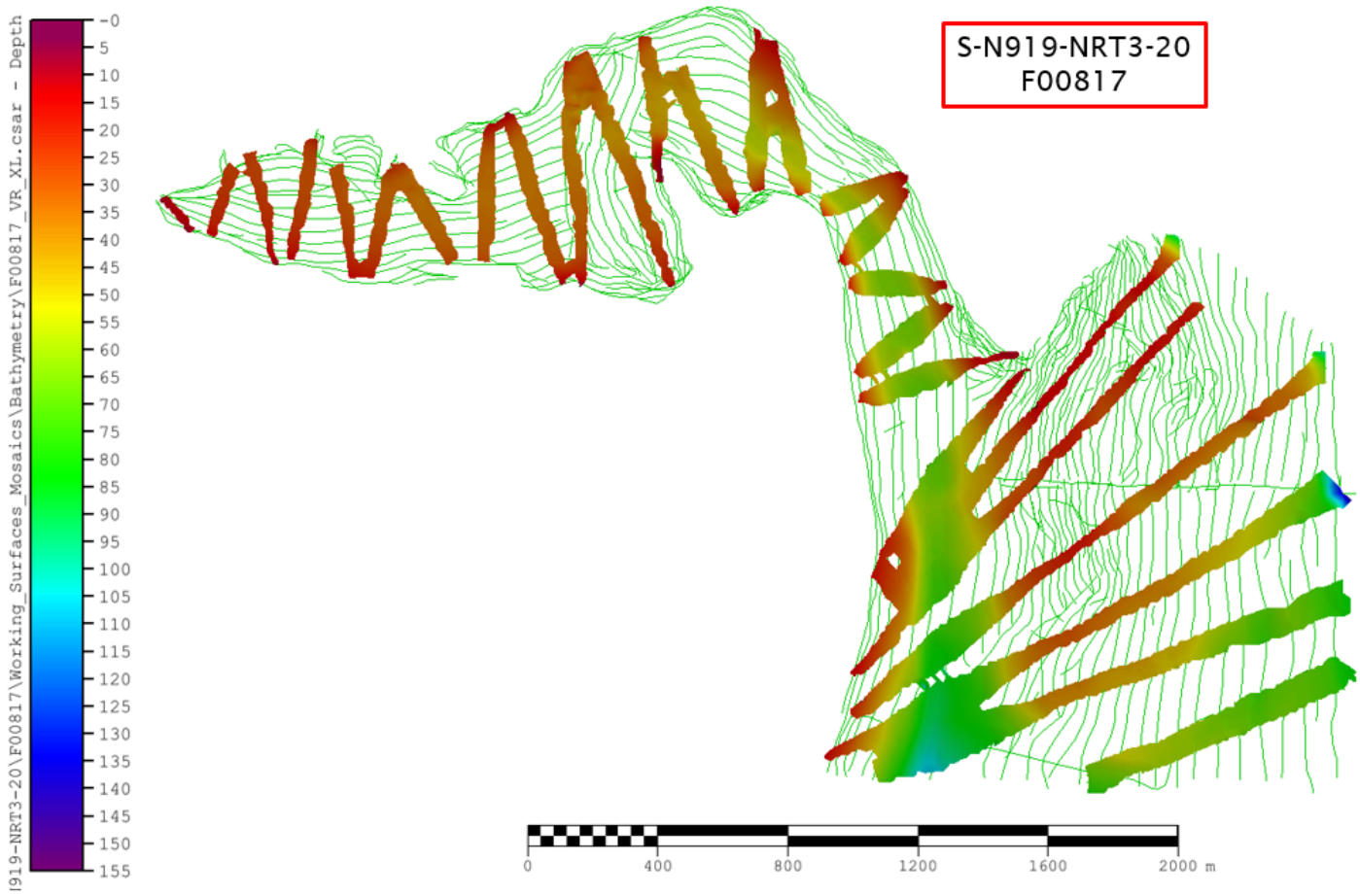


Figure 8: F00817 crossline surface overlaid on mainscheme tracklines showing good temporal and geographic distribution

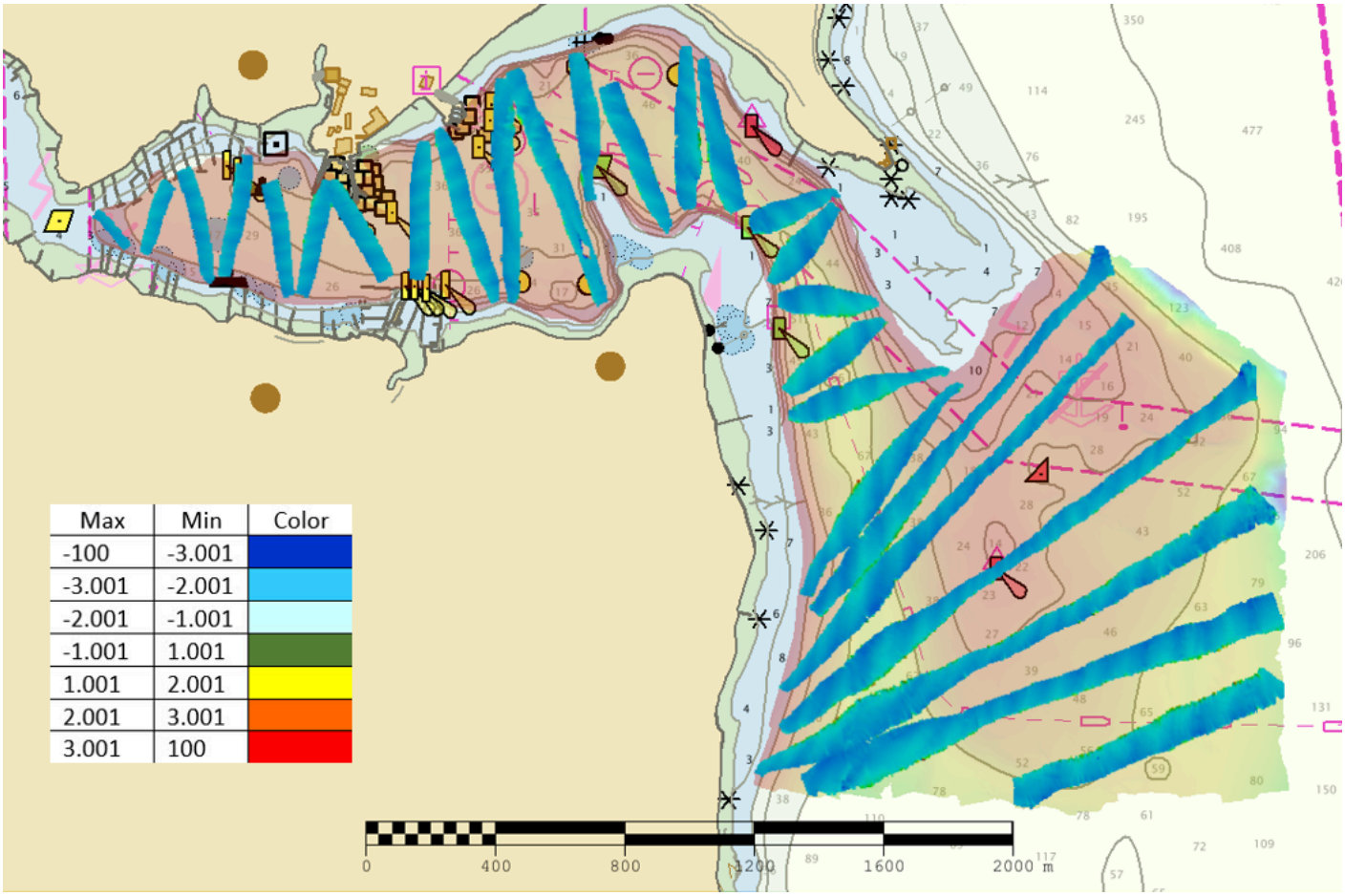
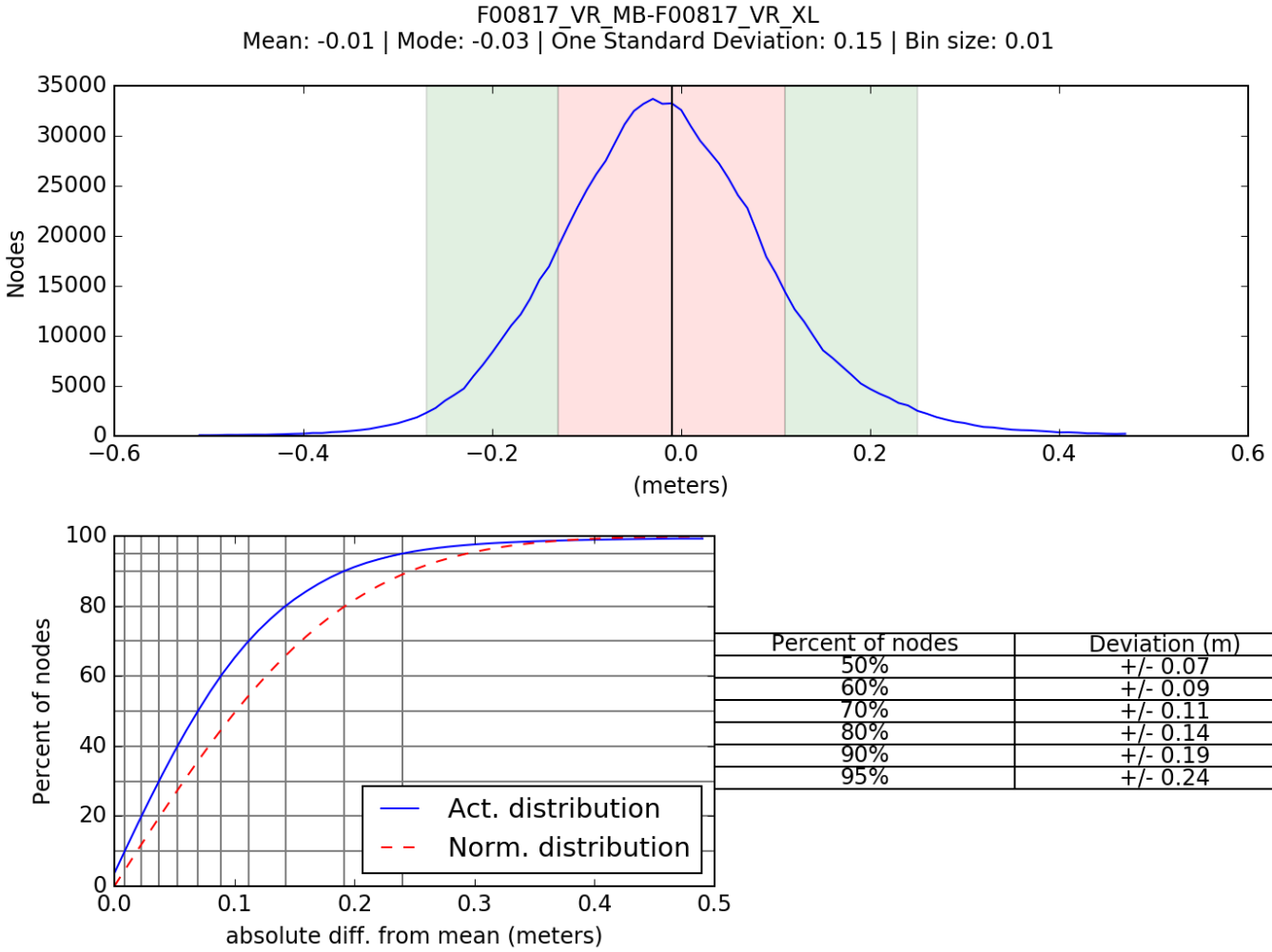


Figure 9: Depth Difference between F00817 mainscheme and crossline data as compared to NOAA allowable uncertainty standards for the associated depths.



Percent of nodes	Deviation (m)
50%	+/- 0.07
60%	+/- 0.09
70%	+/- 0.11
80%	+/- 0.14
90%	+/- 0.19
95%	+/- 0.24

Figure 10: The statistics and distribution plots of the difference between F00817 mainscheme and crossline data.

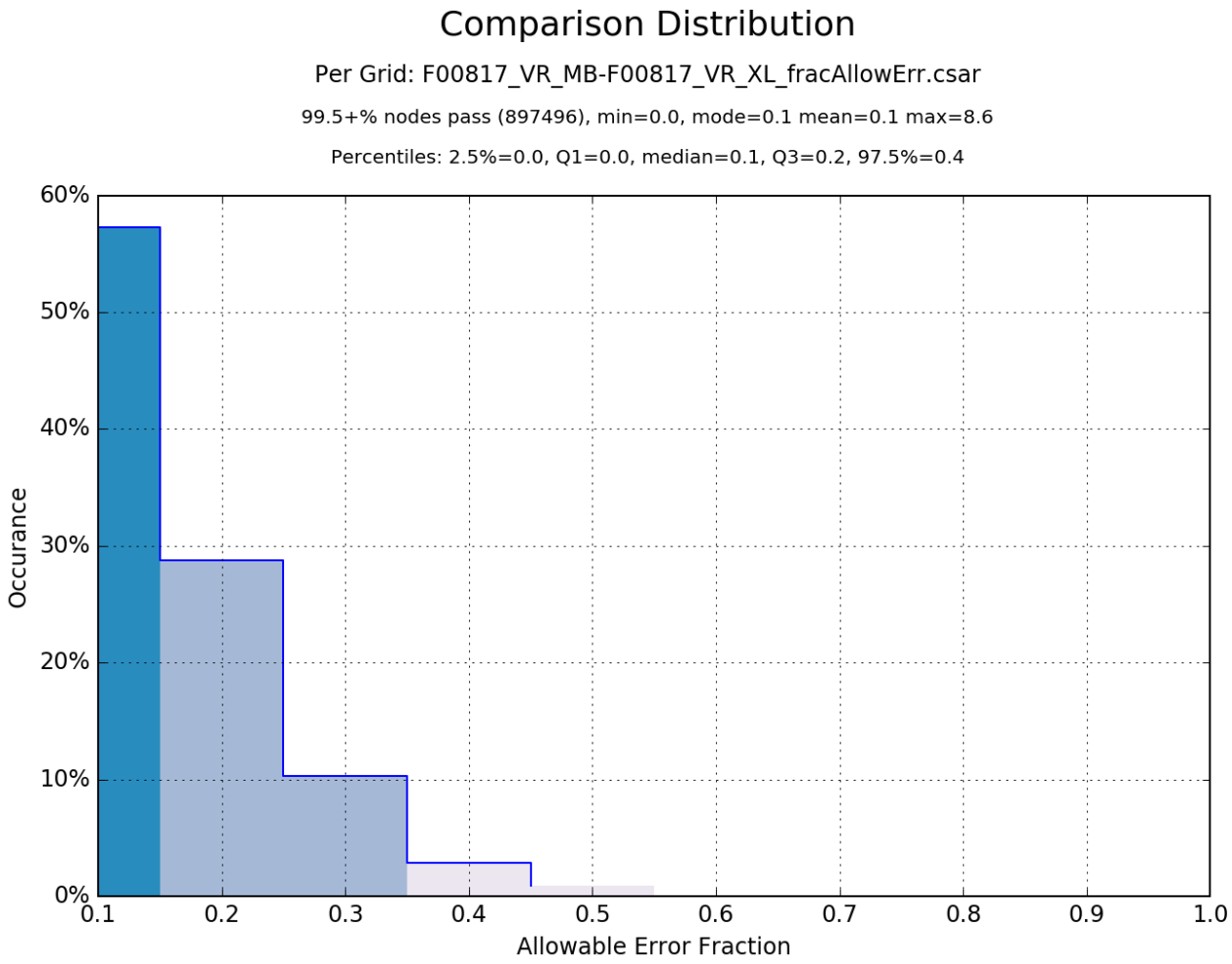


Figure 11: Histogram plot utilizing the magnitude of the Allowable Error Fraction to show the indication of what percentage of the total number of comparisons pass the TVU max test for F00817.

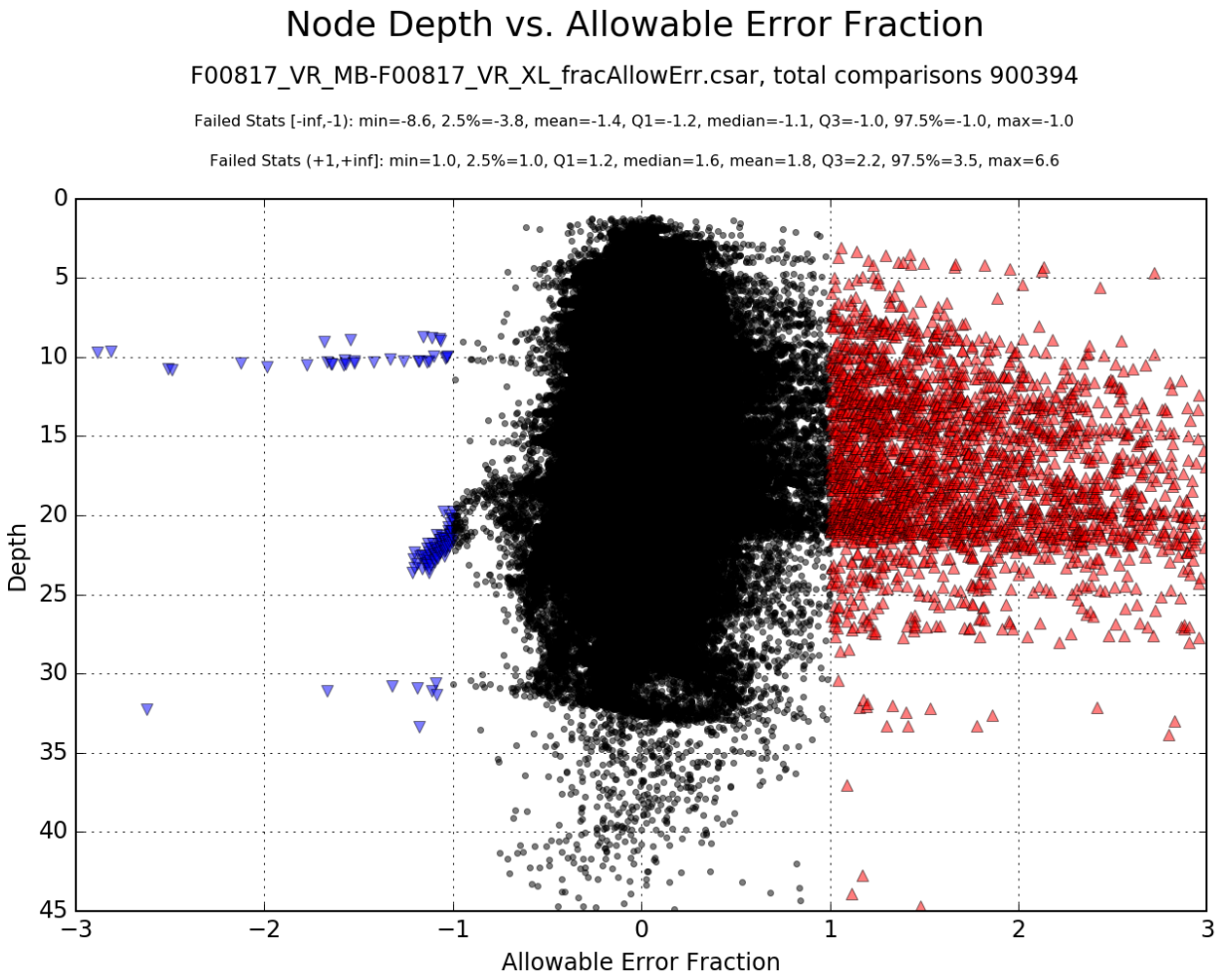


Figure 12: F00817 crosslines Node vs. allowable error fraction

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.0 meters	0.095 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
S3006	4 meters/second	N/A meters/second	N/A meters/second	0.5 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for F00817 were derived from a combination of fixed values for equipment and vessel characteristics, as well as field assigned values for sound speed uncertainties. The uncertainty for the VDatum model was provided to the field unit.

In addition to the usual a priori estimates of uncertainty provided via device models for vessel motion, ERS, real time and post processed uncertainty sources were also incorporated into the depth estimates of F00817. Real-time uncertainties from the Kongsberg 2040C MBES sonars were incorporated and applied during post processing. Uncertainties associated with vessel roll, gyro, and navigation were applied real-time. F00817 utilized kinematic (RTK) positioning service. The recorded delayed heave Applanix files included an estimate of the heave uncertainty and were applied during post processing. All of the aforementioned uncertainties were applied in CARIS. F00817 is an ellipsoidally referenced survey (ERS) and the tidal component was accomplished via separation model. The surface was analyzed using the HydrOffice QC Tools Grid QA feature to determine compliance with specifications. Overall, 99.0+% of nodes within the surface meet NOAA Allowable Uncertainty specifications for F00817.

B.2.3 Junctions

There are no contemporary surveys that junction with this survey.

B.2.4 Sonar QC Checks

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

B.2.5 Equipment Effectiveness

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

B.2.6 Factors Affecting Soundings

There were no other factors that affected corrections to soundings.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: Casts were conducted at a minimum of one every four hours in the deepest water nearest to the active survey area during launch acquisition. Casts were conducted more frequently in areas where the influx of freshwater had an effect on the speed of sound in the water column, when there was a change in surface sound speed greater than four meters per second, and over varying depths (Figure 13). SVP casts were applied to the MBES lines in CARIS using the “nearest in distance within time of 4 hours” method. All sound speed methods were used as detailed in the DAPR. .

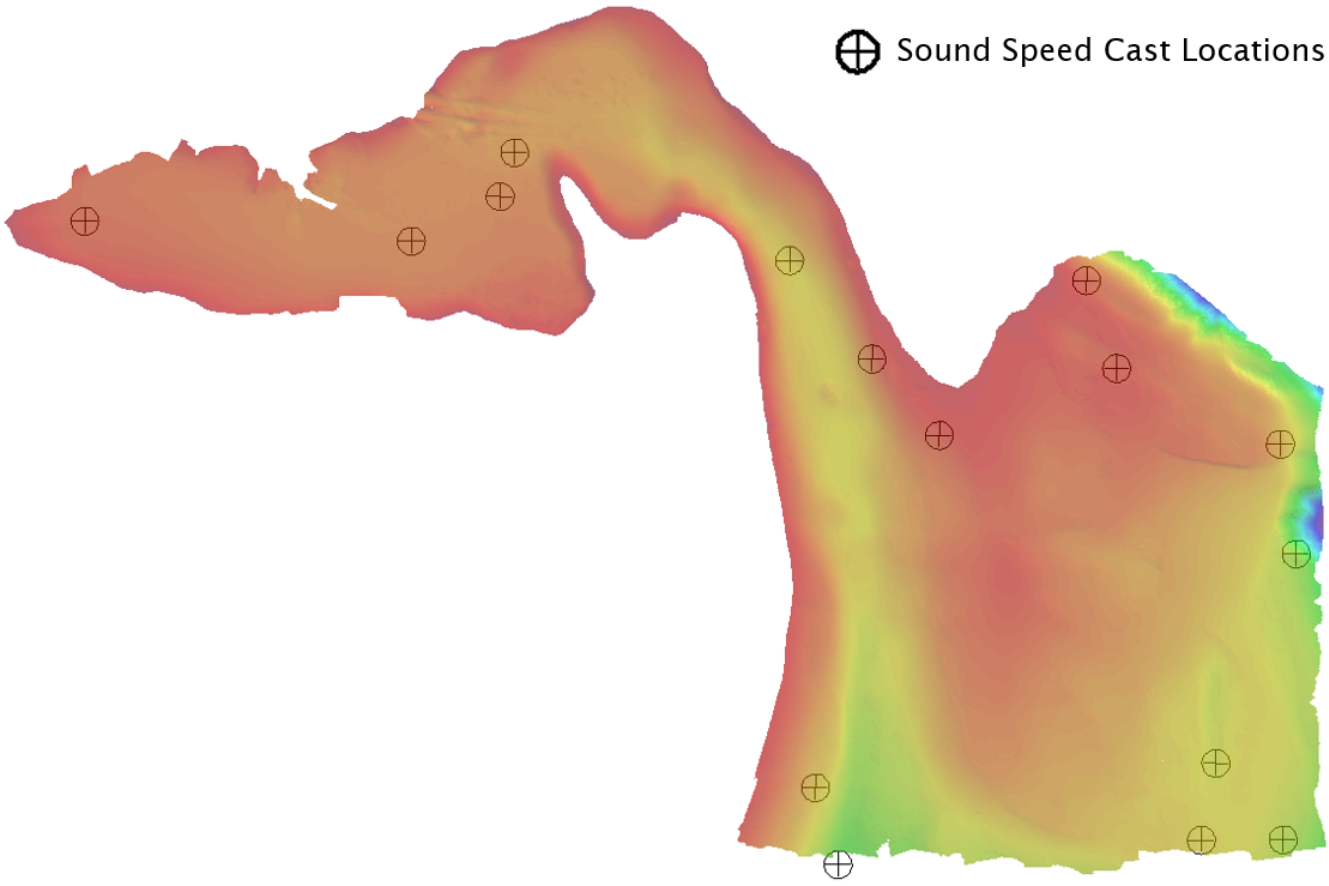


Figure 13: F00817 Sound Speed Cast Locations

B.2.8 Coverage Equipment and Methods

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

B.2.9 Density

The surface was analyzed using the HydrOffice QC Tools Grid QA feature and the results (Figure 14). Density requirements for F00817 were achieved with at least 99.5% of surface nodes containing five or more soundings as required by HSSD Section 5.2.2.3. The few nodes that did not meet density requirements are due to sparse data in the outer beams, especially near steep slopes and rocky areas where acoustic shadowing occurred, and at the edges of the survey limits.

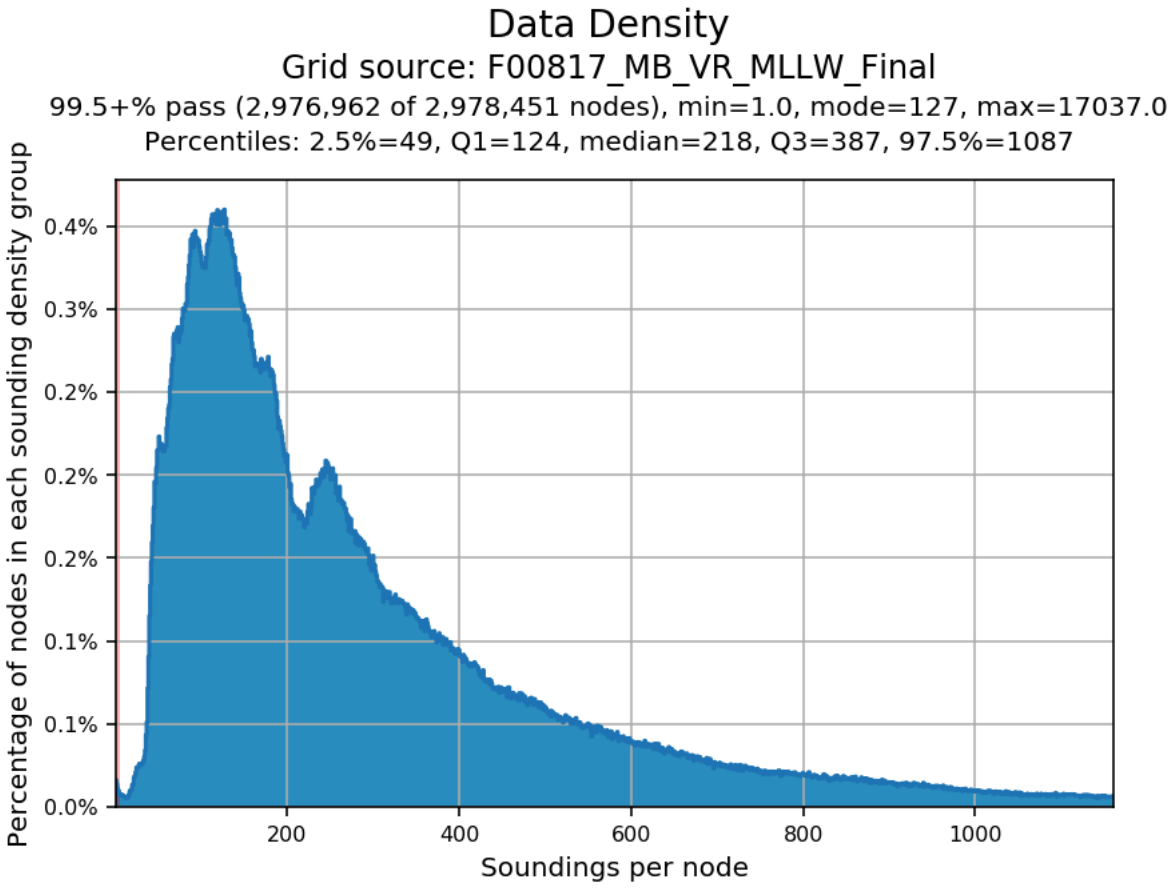


Figure 14: F00817 Data distribution.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

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

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Raw backscatter data is logged as .all files for delivery to NOAA's Pacific Hydrographic Branch. NOAA's Navigation Response Branch field units are waived from producing backscatter mosaics for the 2020 field season. All equipment and survey methods were used as detailed in the DAPR.

Backscatter mosaics and GSF products were created during office review.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following software program was the primary program used for bathymetric data processing:

Manufacturer	Name	Version
CARIS	HIPS and SIPS	11.3.1

Table 9: Primary bathymetric data processing software

The following Feature Object Catalog was used: NOAA Extended Attribute Files Version 2020.

The NOAA CUBE parameters defined in the HSSD were used for the creation of all CUBE surfaces for F00817. The surfaces have been reviewed where noisy data, or "fliers," are incorporated into the gridded solutions causing the surface to be shoaler or deeper than the true sea floor. Where these spurious soundings cause the gridded surface to be shoaler or deeper than the reliably measured seabed by greater than the maximum allowable Total Vertical Uncertainty at that depth, the noisy data have been rejected by the hydrographer and the surface recomputed.

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
F00817_MB_VR_MLLW	CARIS VR Surface (CUBE)	Variable Resolution	-0.57 meters - 67.22 meters	NOAA_VR	Object Detection
F00817_MB_VR_MLLW_Final	CARIS VR Surface (CUBE)	Variable Resolution	-0.57 meters - 67.22 meters	NOAA_VR	Object Detection

Table 10: Submitted Surfaces

The NOAA CUBE parameters defined in the HSSD were used for the creation of all CUBE surfaces for F00817. The surfaces have been reviewed where noisy data, or "fliers," are incorporated into the gridded solutions causing the surface to be shoaler or deeper than the true sea floor. Where these spurious soundings cause the gridded surface to be shoaler or deeper than the reliably measured seabed by greater than the maximum allowable Total Vertical Uncertainty at that depth, the noisy data have been rejected by the hydrographer and the surface recomputed.

C. Vertical and Horizontal Control

Field installed tide and GPS stations were not utilized for this survey. There is no HVCR report included with the submission of F00817.

C.1 Vertical Control

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

ERS Datum Transformation

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

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	S-N919_VDatum_100m_NAD83_geoid12b.csar

Table 11: ERS method and SEP file

C.2 Horizontal Control

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

The projection used for this project is Universal Transverse Mercator (UTM) Zone 10.

The following PPK methods were used for horizontal control:

- Smart Base

Smart Base processing methods were used in Applanix POSpac MMS 8.4 software to produce SBETs for post-processing horizontal correction. All of F00817 meets HSSD horizontal accuracy requirements.

D. Results and Recommendations

D.1 Chart Comparison

A comparison was performed between survey F00817 and ENC US5WA14M, using CARIS HIPS and SIPS sounding and contour layers derived from the finalized VR surface. The contours and soundings were overlaid on the charts to assess differences between the surveyed soundings and charted depths. ENCs were compared by extracting all soundings from the chart for general agreement and to identify areas of significant change.

All data from F00817 should supersede charted data. In general, surveyed soundings agree with the majority of charted depths. A full discussion of the disagreements follows below.

Soundings from F00817 are in a general agreement with charted depths on ENC US5WA14M, with most depths agreeing to within 1 meter.

Contours from F00817 are in a general agreement with charted contours on ENC US5WA14M. The largest differences are seen in the 29.7ft contour in areas near the Bainbridge Island Ferry Terminal where surveyed and charted contours differ by over 50 meters. Deeper depths are additionally shown within the ferry terminal itself. Furthermore, the hydrographer recommends the adjusting the 29.7ft contour in this area to accurately portray surveyed depths.

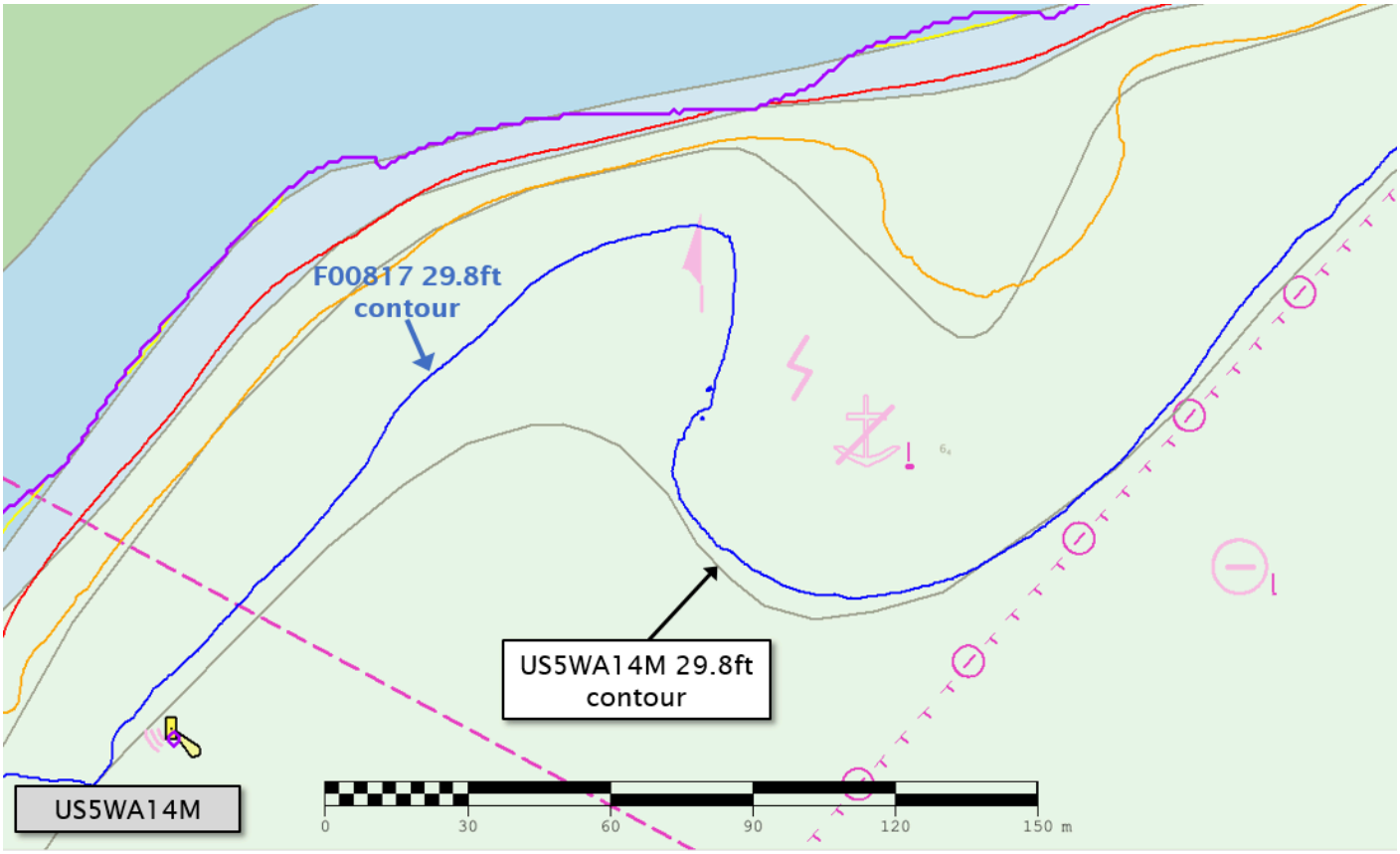


Figure 15: Comparison of US5WA14M charted contours and F00817 survey derived contours.

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
US5WA14M	1:10000	31	07/12/2019	05/13/2020

Table 12: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.3 Charted Features

Charted features exist and are addressed in the Final Feature File.

D.1.4 Uncharted Features

Survey F00817 has 8 new features that are addressed in the F00817 Final Feature File (FFF). Of these features, there are 5 new Obstructions, 2 new Pontoons, and 1 new wreck. None of these features were submitted as DTONs.

D.1.5 Channels

Channels, designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, and/or channel and range lines exist within the survey limits, but were not investigated.

D.2 Additional Results

D.2.1 Aids to Navigation

17 navigation lights exist in Eagle Harbor. All were observed on station but light characteristics were not seen due to daylight. 8 of the 12 buoys in the Coast Guard Light List are represented on ENC US5WA14M. All were observed serving their intended purpose with the exception of Eagle Harbor Regulatory Buoy J which is stationed in the shoalest north west corner of Eagle Harbor and not accessible.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

No bottom samples were required for this survey.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

Submarine features exist for this survey, but were not investigated.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

Washington State Department of Transportation operates a ferry route between Bainbridge Island and downtown Seattle. Two ferries operate the route daily on a rotating schedule every 40-50 minutes. The charted ferry route was accurate to the ship's movements during our survey. Directly to the west of the terminal is the Washington State Ferry Maintenance Facility which regularly has several ferries moored and under repair.

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor or environmental conditions exist for this survey.

D.2.9 Construction and Dredging

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

D.2.10 New Survey Recommendations

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

D.2.11 ENC Scale Recommendations

No new ENC scales are recommended for this area.

E. Approval Sheet

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

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

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

Approver Name	Approver Title	Approval Date	Signature
Annemieke Raymond	Acting Team Lead	03/03/2021	RAYMOND.ANNEMIEKE.SMITH.1365883048 Digitally signed by RAYMOND.ANNEMIEKE.SMITH.1365883048 Date: 2021.03.03 15:34:19 -08'00'
Timothy Wilkinson	Physical Science Technician	03/03/2021	WILKINSON.TIMOTHY.DAVID.1383074440 Digitally signed by WILKINSON.TIMOTHY.DAVID.1383074440 Date: 2021.03.04 13:20:07 -08'00'

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