H13807

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13807

LOCALITY

State(s):	Minnesota
General Locality:	Western Lake Superior
Sub-locality:	Duluth, MN and Superior, WI

2023

CHIEF OF PARTY
Dan Jacobs

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13807**

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):	**Minnesota**
General Locality:	**Western Lake Superior**
Sub-Locality:	**Duluth, MN and Superior, WI**
Scale:	**10000**
Dates of Survey:	**08/18/2023 to 09/10/2023**
Instructions Dated:	**07/06/2023**
Project Number:	**S-Z934-NRTST-23**
Field Unit:	**NOAA Navigation Response Team - Galveston**
Chief of Party:	**Dan Jacobs**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Low Water Datum 601.1 ft IGLD-1985 Lake Superior**

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 15N, IGLD. 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 H13807

Project: S-Z934-NRTST-23

Locality: Western Lake Superior

Sublocality: Duluth, MN and Superior, WI

Scale: 1:10000

August 2023 - September 2023

NOAA Navigation Response Team - Galveston

Chief of Party: Dan Jacobs

A. Area Surveyed

The Port of Duluth is located at the westernmost tip of Lake Superior and the Great Lakes-St. Lawrence Seaway System.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
46° 47' 27.09" N 92° 5' 34.55" W	46° 41' 19.81" N 91° 51' 12.23" W

Table 1: Survey Limits

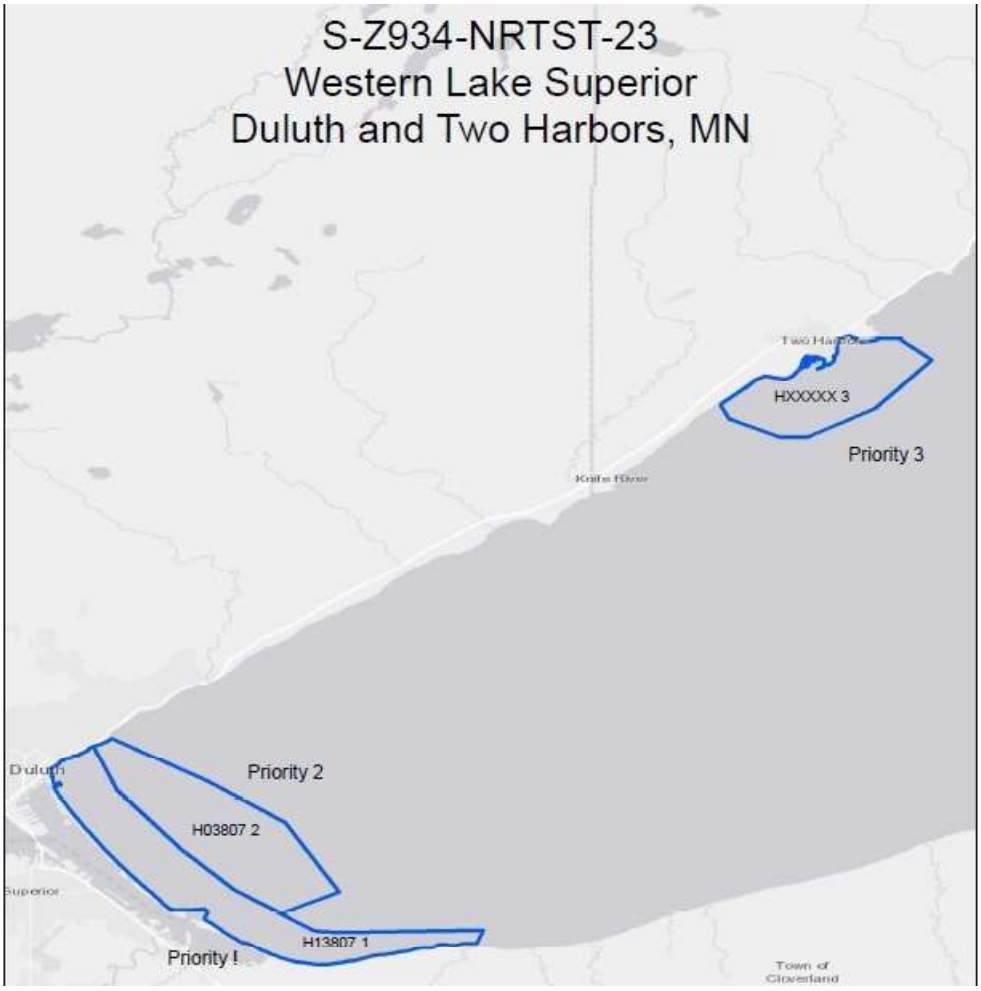


Figure 1: Assigned Survey Area, H13807.

Project time constraints (30 days, allotted) precluded NRTST Boat Team personnel from finishing the survey sheet H13807.

A.2 Survey Purpose

The Port of Duluth is located at the westernmost tip of Lake Superior and the Great Lakes-St. Lawrence Seaway System. Duluth provides significant economic and social value to this region. The U.S Army Corps of Engineers surveys and maintains the navigable waterways inside the breakwater, but the area just outside the breakwater also has significant vessel traffic and accurate updated charts are required. Two Harbors, MN supports the shipment of taconite by vessel and is also an area in need of updated bathymetric data. The data from this project will help support the Great Lakes Restoration Initiative's habitat mapping program. It will also be used to update NOAA National Ocean Service products, the navigational chart and hydro health

model in this area. 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.

The entire survey is adequate to supersede previous data. Flier Finder was invoked via QC3 Tools of Pydro Explorer v22.1 (r10883). Note that 174 fliers still exist, mostly over the charted wreck near Duluth Harbor. These fliers are most likely legitimate soundings of railings and rigging atop the wreck. Edge fliers exist on the edges of coverage where 6 iterations of flier edits occurred. The edge fliers will continue regenerating into good coverage at this phase of cleaning. Least depths were designated over steep seabed features. NRT personnel believe they have cleaned the fliers as best as practical.
QC3 Tools of Pydro Explorer v22.1 Holiday Finder discovered 2 holidays on the nearshore boundaries of coverage.
Please reference the Supplemental Records folder for these Pydro-generated outputs.

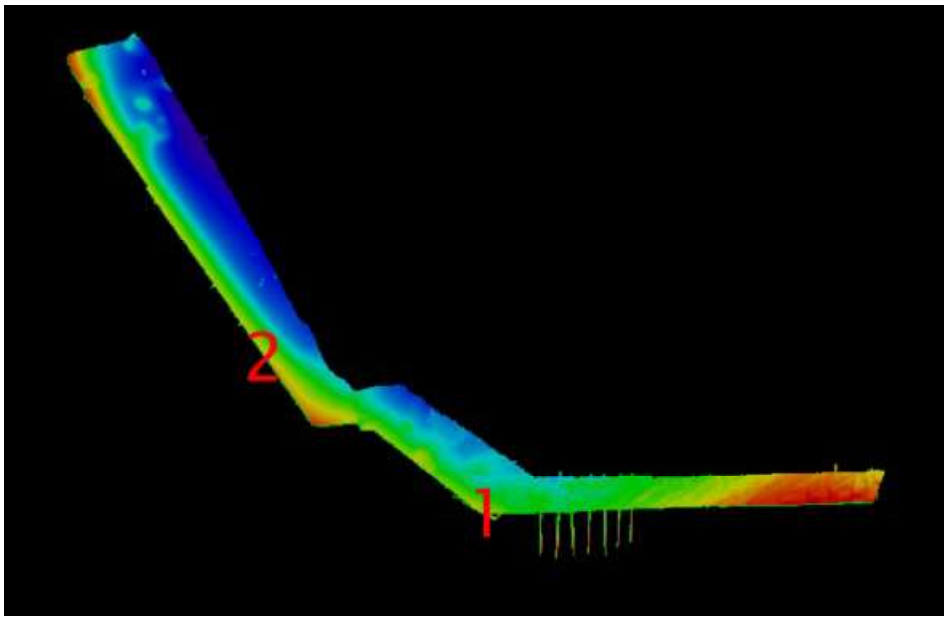


Figure 2: Two holidays exist (red numbers)

A.4 Survey Coverage

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

Water Depth	Coverage Required

Table 2: Survey Coverage

H13807 Object Detection MBES coverage to the project's sheet limits were not achieved due to a 30 day project time limit.

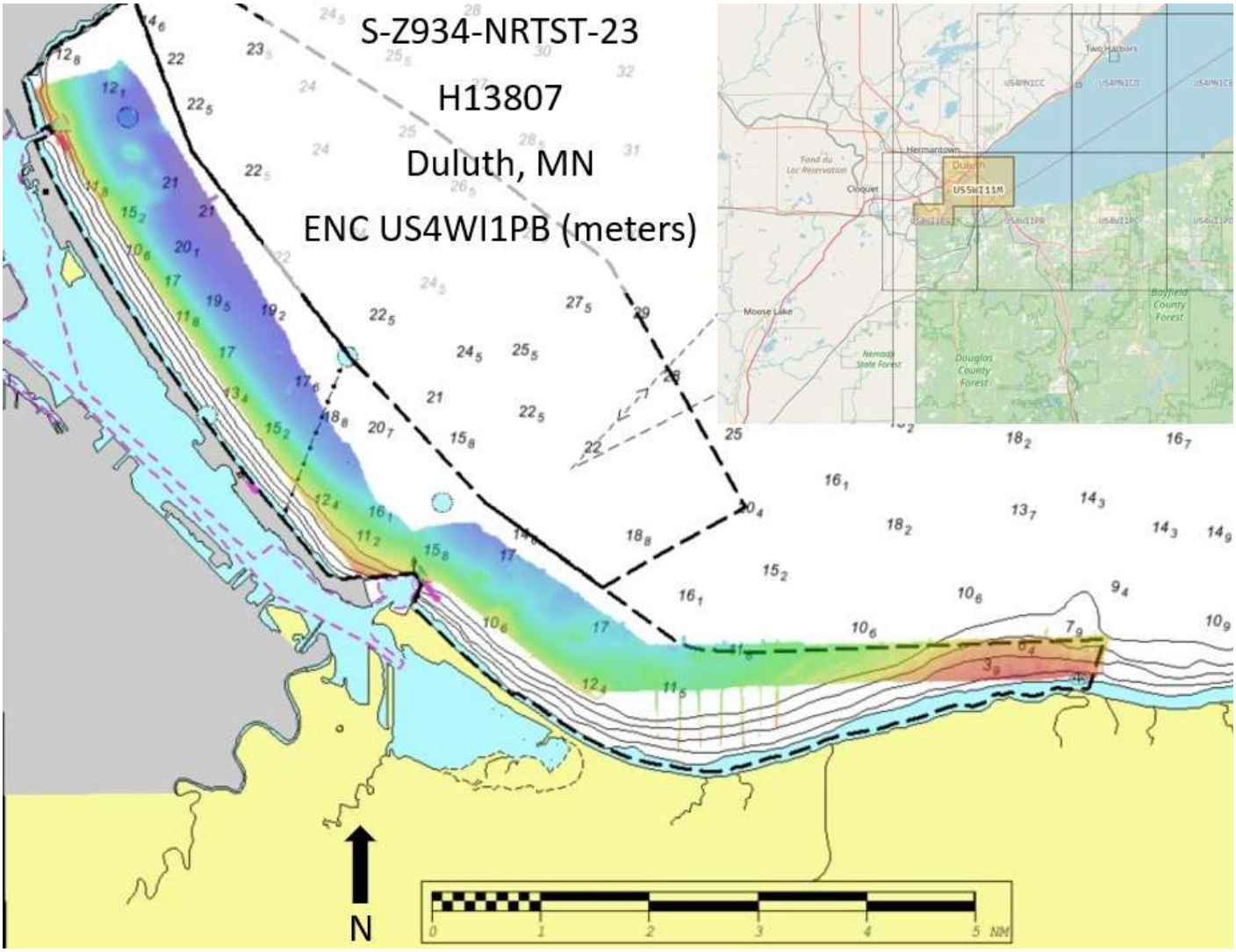


Figure 3: H13807 Survey Coverage (rainbow) vs Assigned Sheet Limits (black dashed polygon)

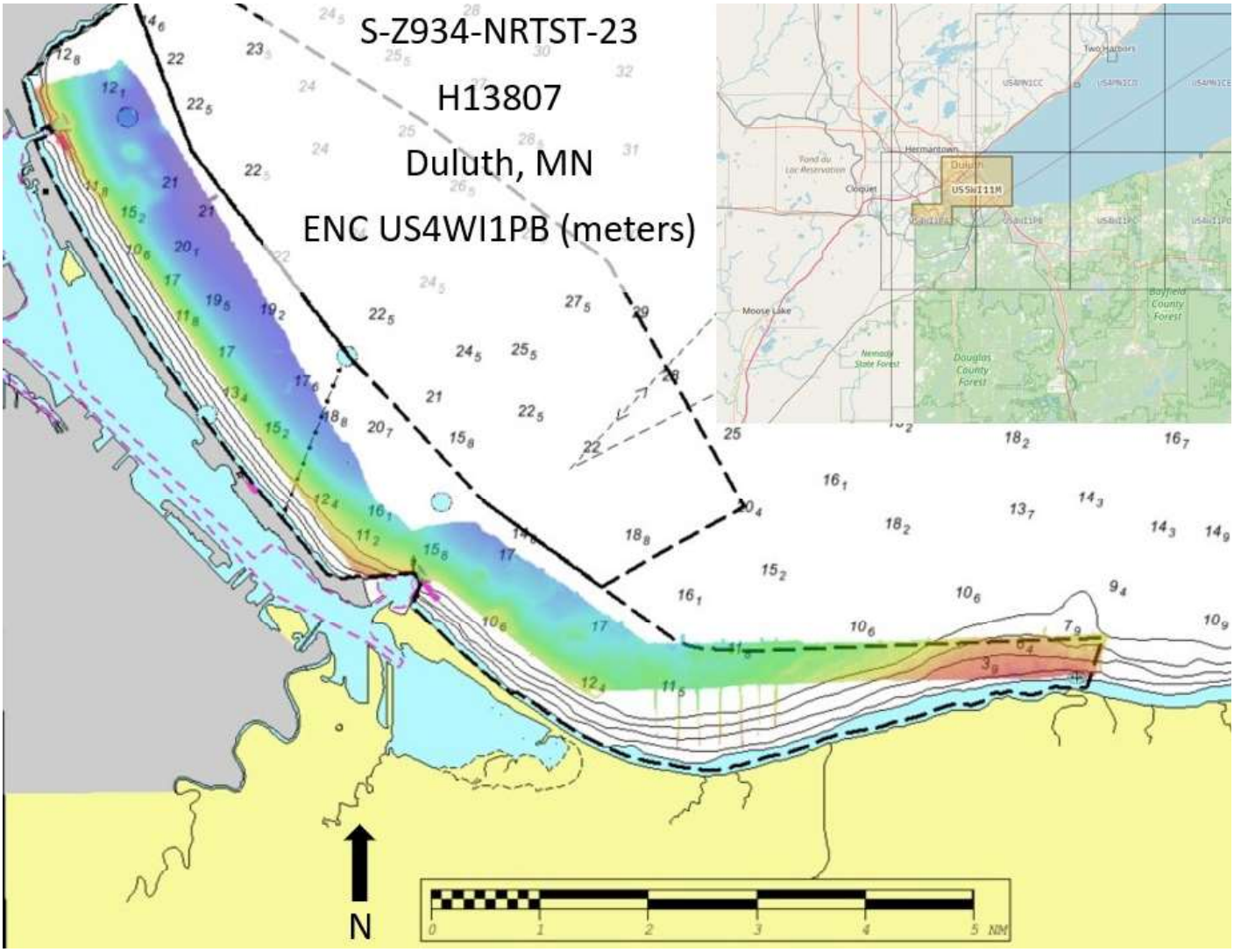


Figure 4: H13807 Survey Coverage (rainbow) vs Assigned Sheet Limits (black dashed polygon)

A.6 Survey Statistics

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

	HULL ID	*S3008*	*Total*
LNM	**SBES Mainscheme**	0.0	502.582
	MBES Mainscheme	502.582	0.0
	Lidar Mainscheme	0.0	0.0
	SSS Mainscheme	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0
	SBES/MBES Crosslines	26.832	26.832
	Lidar Crosslines	0.0	0.0
Number of Bottom Samples			0
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			7.29

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
08/18/2023	230
09/10/2023	253

Table 4: Dates of Hydrography

H13807 survey operations commenced on DN230 and concluded on DN253. Thirty days of travel were allotted for this project which included 6 days of travel from/to Stennis Space Center, Mississippi.

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	***S3008***
LOA	10.0 meters
Draft	0.5 meters

Table 5: Vessels Used

Figure 5: NRT Vessel

NRT Vessels are 30 foot, aluminum hulled fire boats modified for NOAA hydrographic survey operations. S3005 and S3008 are powered by dual 225 horsepower Honda outboard engines. A Honda 3000 watt generator supplies AC power for two workstations, 5 monitors, one POS system, one multibeam echosounder system, and one side scan sonar system.

B.1.2 Equipment

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

Manufacturer	Model	Type
Kongsberg Maritime	EM 2040C	MBES
EdgeTech	4125	SSS
SonTek	CastAway-CTD	Conductivity, Temperature, and Depth Sensor

Table 6: Major Systems Used

Figure 6: Kongsberg EM2040C MBES used aboard S3008

Figure 7: Edgetech 4125 Side Scan used aboard S3008

Figure 8: Castaway Sound Speed Sensor used aboard S3008

Please reference NRT-Stennis (S3005) and (S3008) DAPRs, accompanying this project for a complete listing of equipment and specifications. Note that S3005 was not used for this project.

B.2 Quality Control

B.2.1 Crosslines

A crossline percentage of 5.3 percent met the minimum percentage requirements as specified in the HSSD, Section 5.2.4.2. Uncertainty standards between a 1m Mainscheme grid versus a 1m Crossline grid passed NOAA IHO TVU requirements. See graphic below.
Surface Node Uncertainty Standards and Surface Node Density Standards (HSSD 5.2.2.2) were achieved at a 99 percent pass rate implementing the Grid QA v6 utility in QC Tools v.3.10.6. See graphics, below.

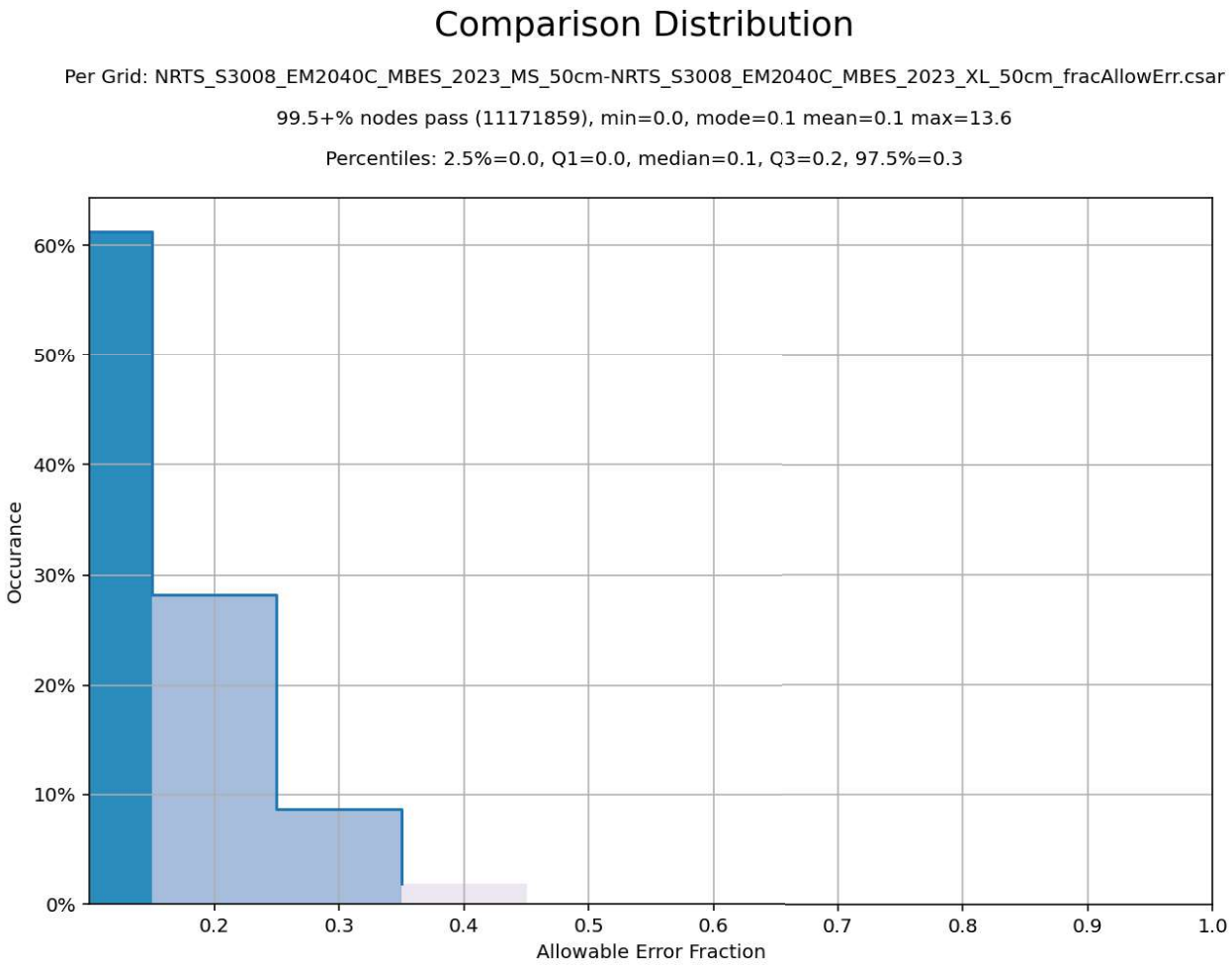


Figure 9: MS vs XL Surface Comparison

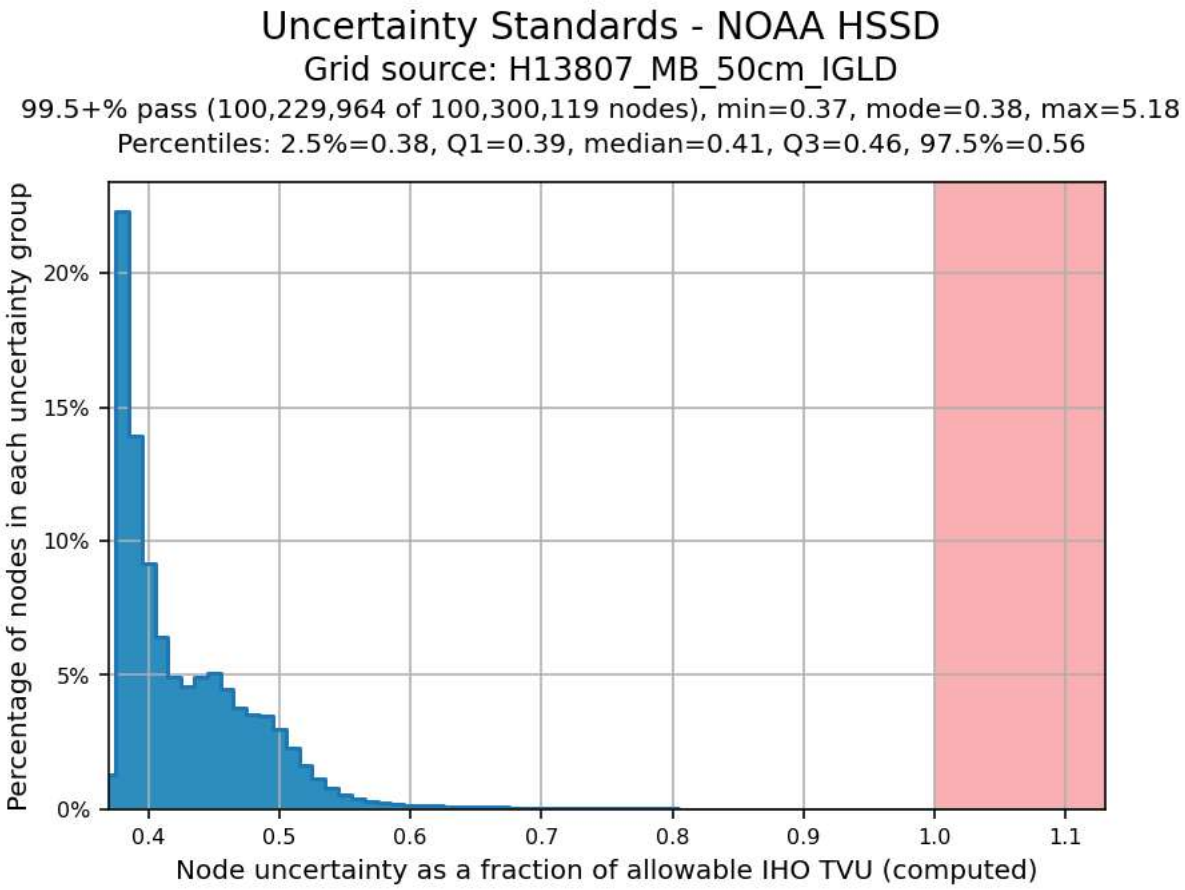


Figure 10: TVU Pass in Grid QA

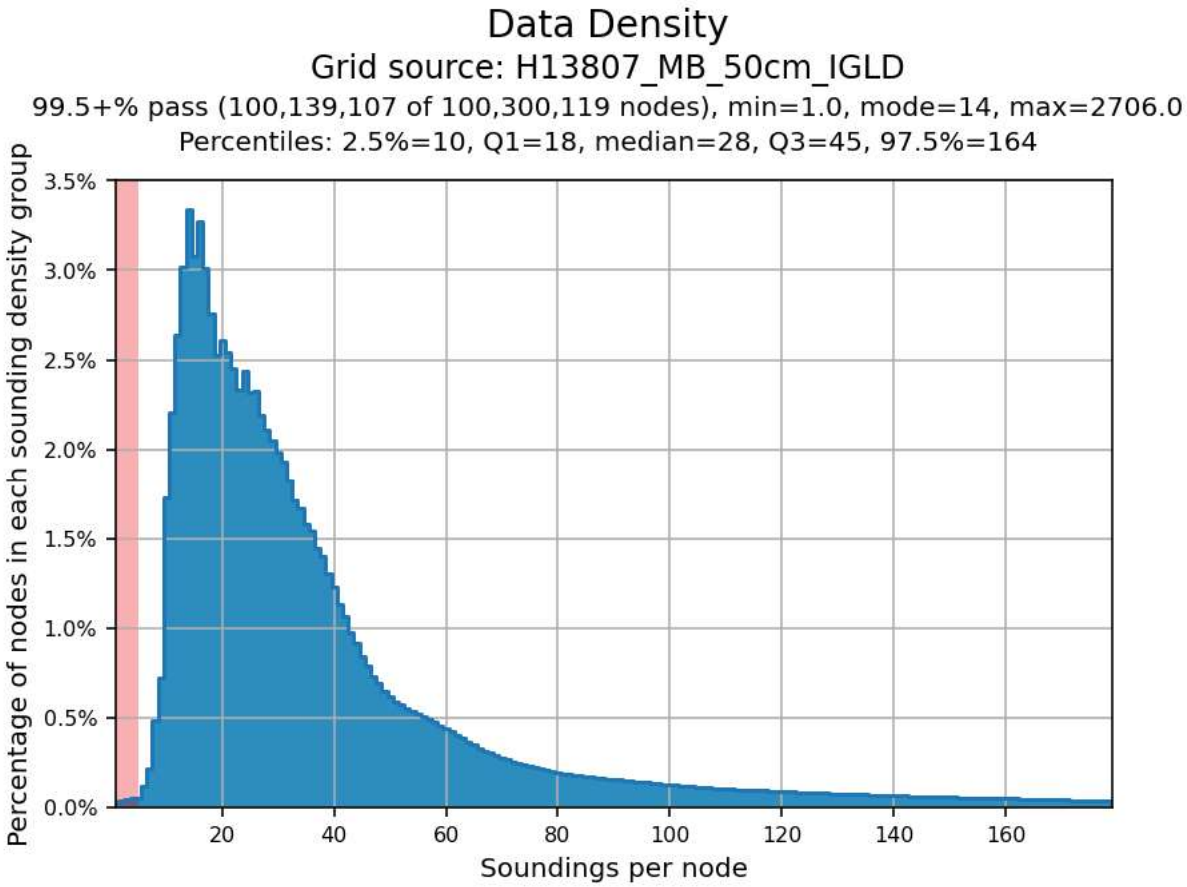


Figure 11: Node Density Pass in Grid QA

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.04 meters	0.04 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
S3008	4 meters/second	0 meters/second	0 meters/second	0.2 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Per HSSD, Section 5.2.3.3 the above sound speed uncertainty values were implemented and lie within conservative range estimates.

B.2.3 Junctions

No Junctions were prescribed per Project Instructions.

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

Vessel Hull Design is Noisy

Bubble sweep artifacts did contribute to noisy MBES data on the outer beams of S3008. Hull design modifications are being investigated by NRB/HSTB to mitigate the issue.

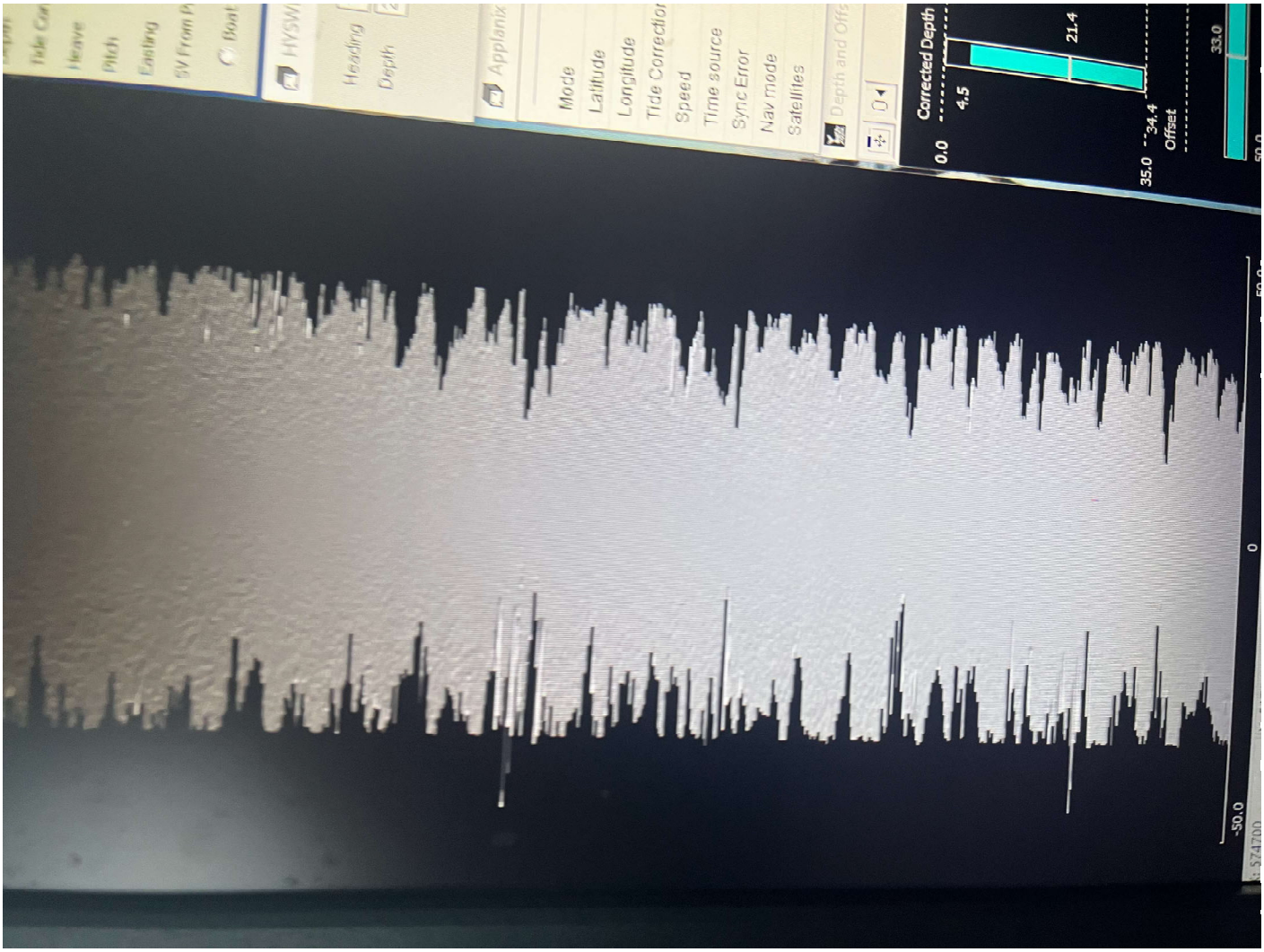


Figure 12: Noisy Hull Design, 2-3FT seas

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: Sound Speed Cast Frequency: Sound Speed Cast Frequency: Sound speed cast frequency for H13807 was not less than one cast per every four hours of survey.

Cast frequency met or exceeded 1 cast per every 4 hours of survey.

B.2.8 Coverage Equipment and Methods

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

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

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

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Backscatter data was processed using FMGT and Caris softwares - a departure from standard backscatter processing using only CARIS. The new SOP is included in the DAPR's Appendices Folder.

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
Applanix	POSPac	8.9
CARIS	HIPS and SIPS	11.4.25

Table 9: Primary bathymetric data processing software

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

Manufacturer	Name	Version
CARIS	HIPS and SIPS	11.4.25

Table 10: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2023.

NOAA Profile Version 2023 was utilized by the Caris Object Catalogue, Caris HIPS and SIPS, version 11.4.25

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
H13807_MB_50cm_IGLD	CARIS Raster Surface (CUBE)	0.5 meters	3.06 meters - 22.76 meters	NOAA_0.5m	Object Detection
H13807_MB_50cm_IGLD_Final	CARIS Raster Surface (CUBE)	0.5 meters	3.06 meters - 22.76 meters	NOAA_0.5m	Object Detection

Table 11: Submitted Surfaces

H13807 is an Object Detection Coverage survey per the Project Instructions and conform to the coverage requirements cited in the 2022 HSSD, Section 5.2.2.2. The project consists of a 50 centimeter MBES Surface and a 50 centimeter Finalized Surface.

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 Low Water Datum 601.1 ft IGLD-1985 Lake Superior.

ERS Datum Transformation

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

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	S-Z934_VDatum_100m_NAD83_2011-LWD_IGLD85_geoid18

Table 12: ERS method and SEP file

The vertical datum for this project is IGLD85.

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 15.

PPP

Trimble CenterPoint RTX is the preferred method where horizontal accuracies of 2cm or less may be achieved without the use of reference stations. CenterPoint RTX service was accessed via an internet connection within one hour after field operations had concluded. Applanix POSPac MMS 8.8 software was used to access Trimble RTX servers to produce a Smoothed Best Estimate of Trajectory (SBET) file implementing the Applanix proprietary "SmartBase" algorithm. The SBET file consisted of GPS position and attitude data corrected and integrated with inertial measurements and correctors which were then exported to the reference ellipsoid. These SBET navigation and attitude files were applied to all lines in CARIS and supersede initial positioning and attitude data.

RTK

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 15N. Horizontal and vertical positioning were achieved in accordance with practices outlined in the DAPR. Processing and products for Survey H13807 were conducted and completed in NAD 83 per HSSD specification. Refer to the DAPR for a complete description of horizontal control procedures. RTX Precise Positioning-Real Time Extended (PP-RTX) processing methods were used in Applanix POSPac MMS software to produce Smoothed Best Estimate of Trajectory (SBET) files and their associated uncertainty for post-processing horizontal correction.

WAAS

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

D. Results and Recommendations

D.1 Chart Comparison

A chart comparison for US4WI1PB was performed with Pydro's CA Tool. The S57 sounding layer and comprehensive results for this comparison can be found in the Supplemental Records folder of the Descriptive Report. Additionally, a comparison between Charted and Surveyed contours occurred for H13807. A deepening trend is occurring in the nearshore areas of H13807 where survey soundings deviated by 0.20-1.50 meters. See graphics below for specific information. Although 35 DtoN candidates were flagged, none were deemed dangerous due to commercial ship drafts of 10.2 meters or less.

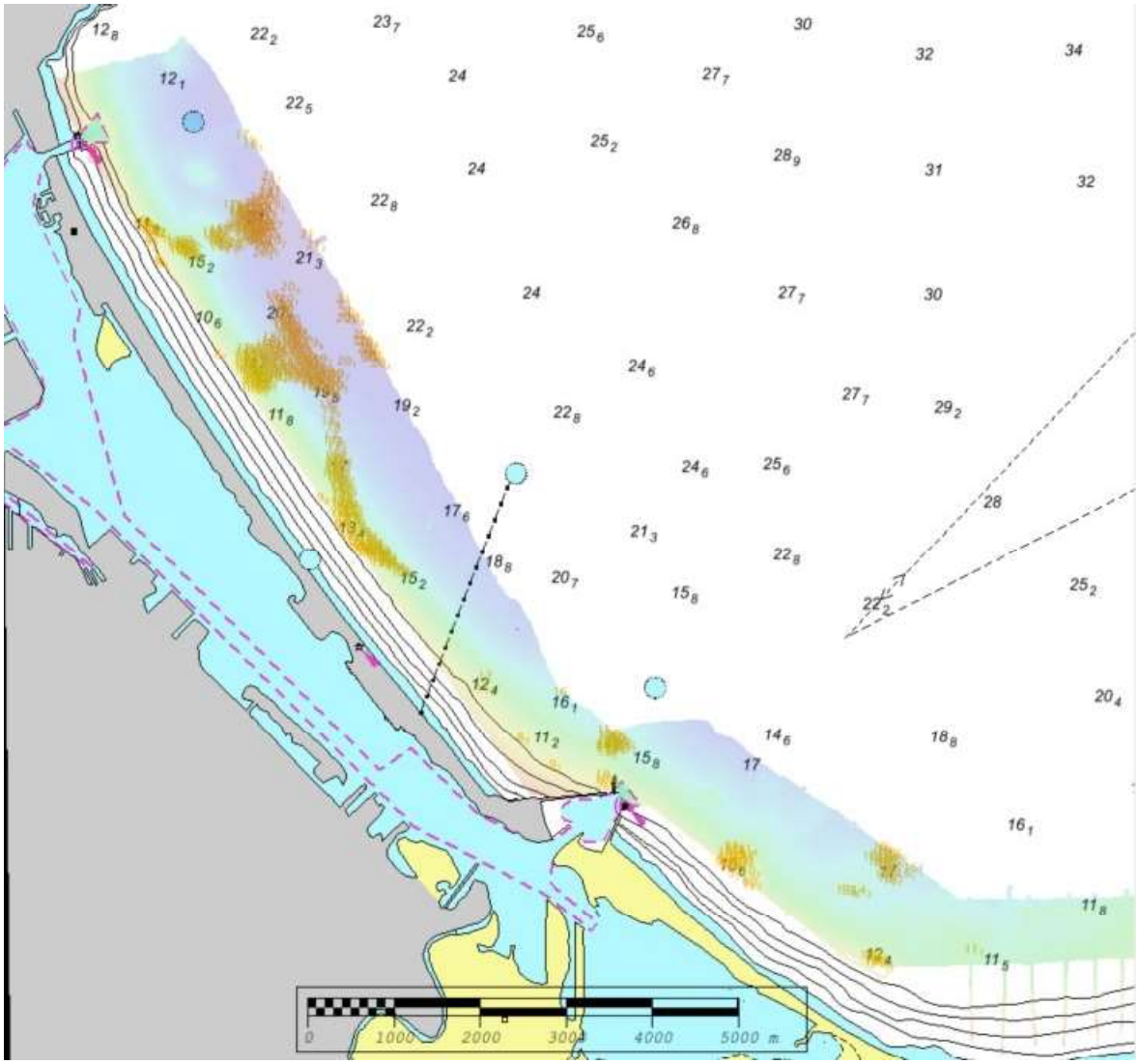


Figure 13: H13807 Soundings (orange color) deviating from US4WI1PB Soundings (back color).

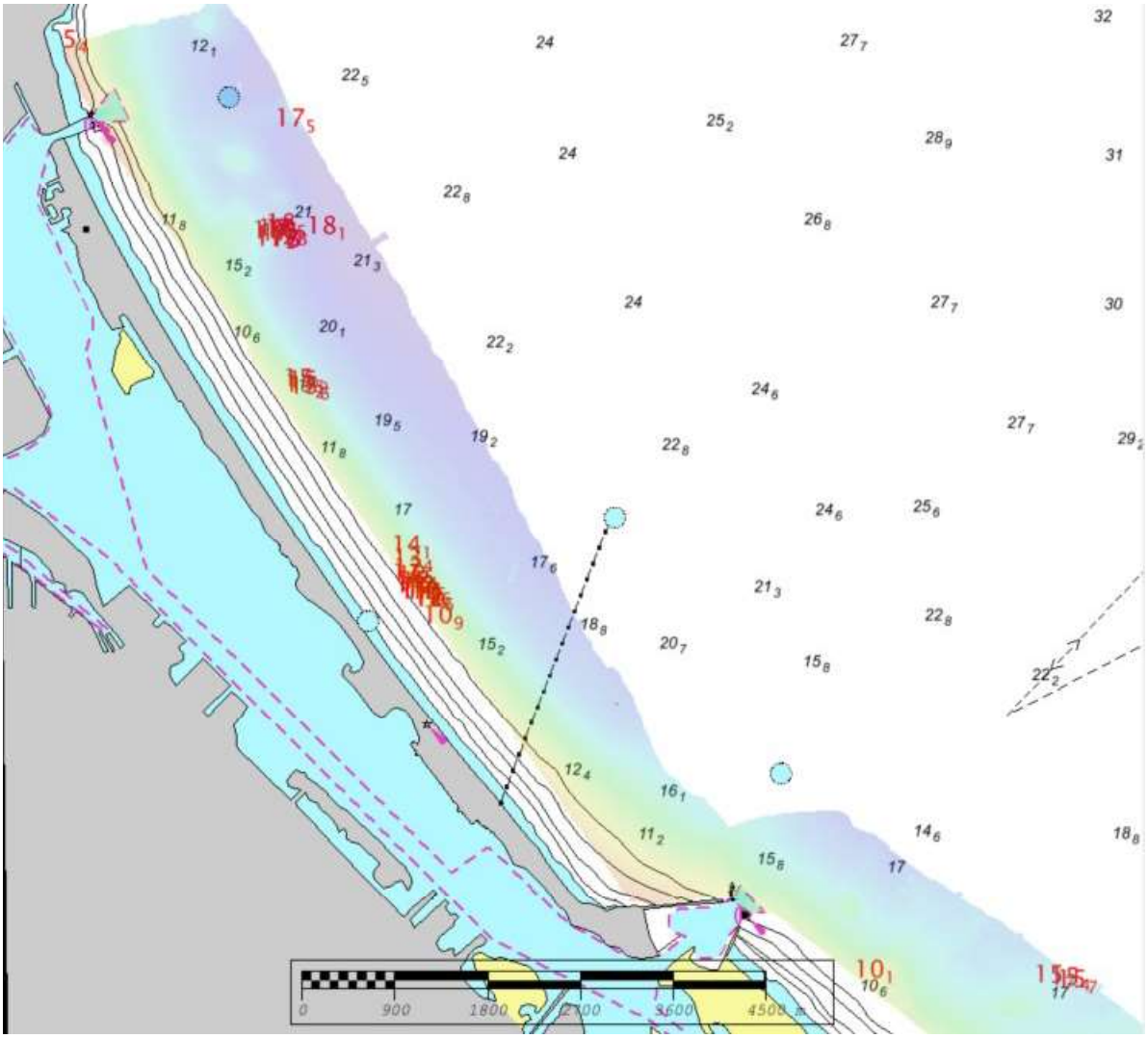


Figure 14: H13807 DtoN Candidates (red color) vs US4WI1PB Soundings (back color).

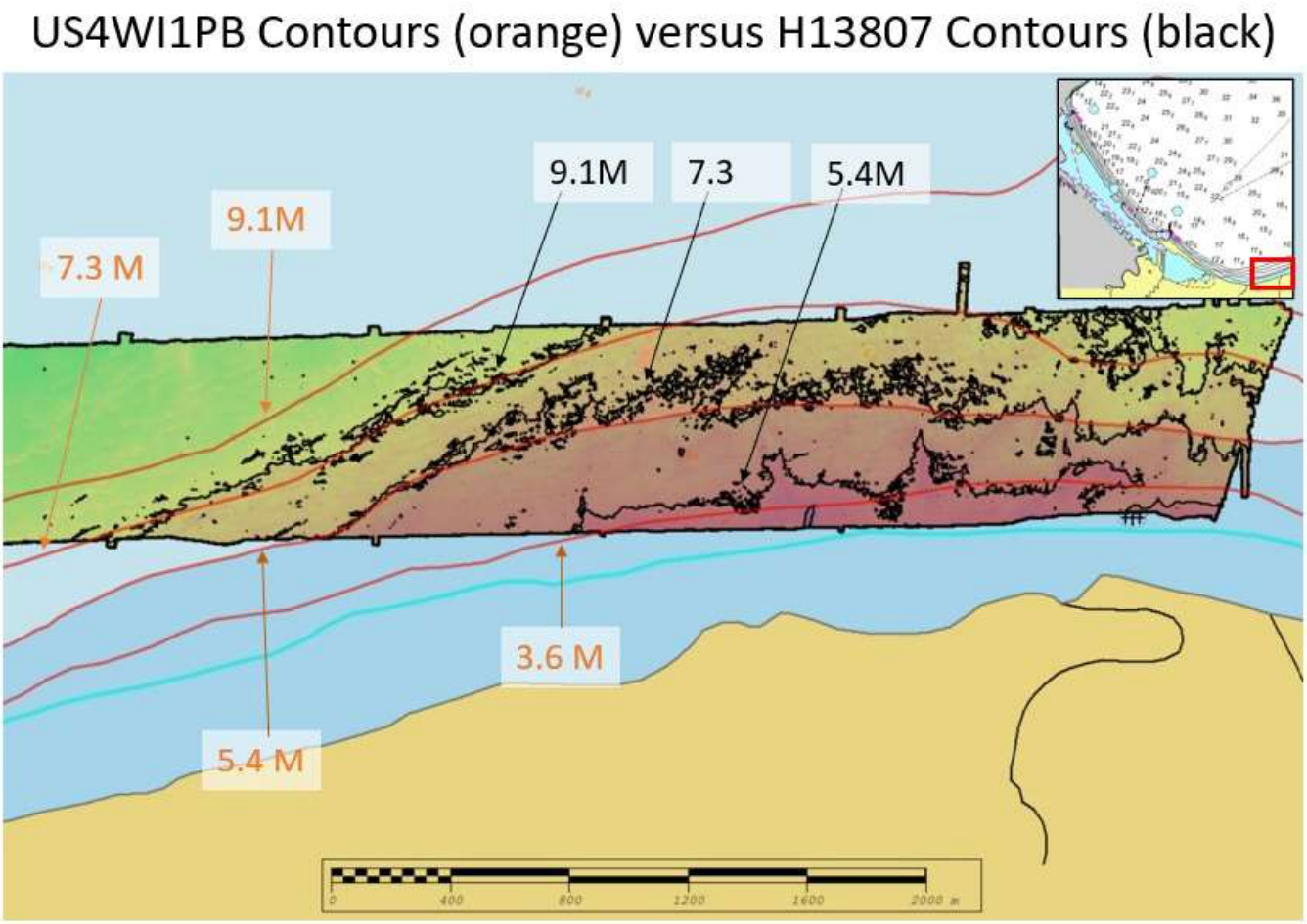


Figure 15: US4WI1PB contours vs H13807 contours_5

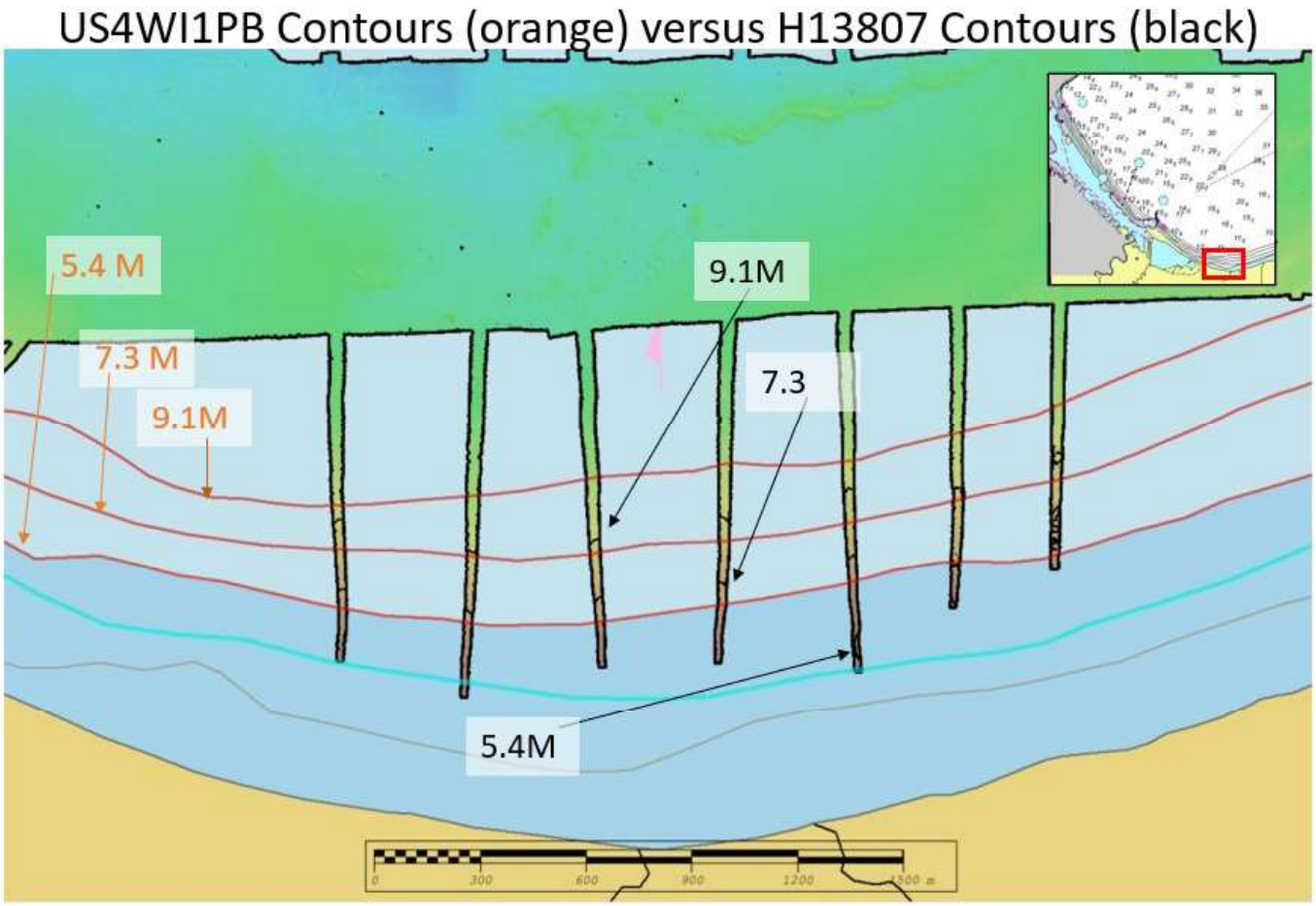


Figure 16: US4WI1PB contours vs H13807 contours_4

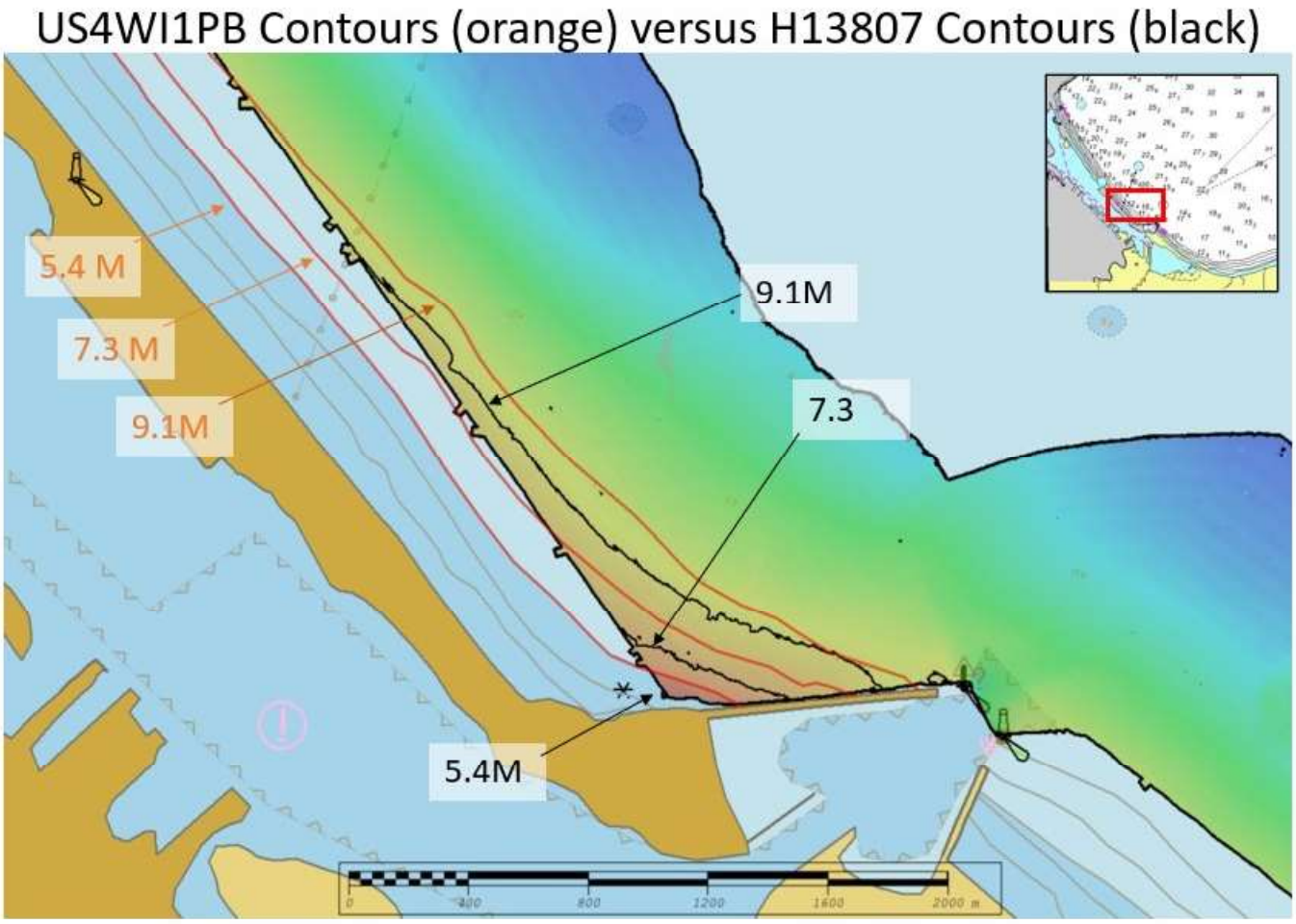


Figure 17: US4WI1PB contours vs H13807 contours_3

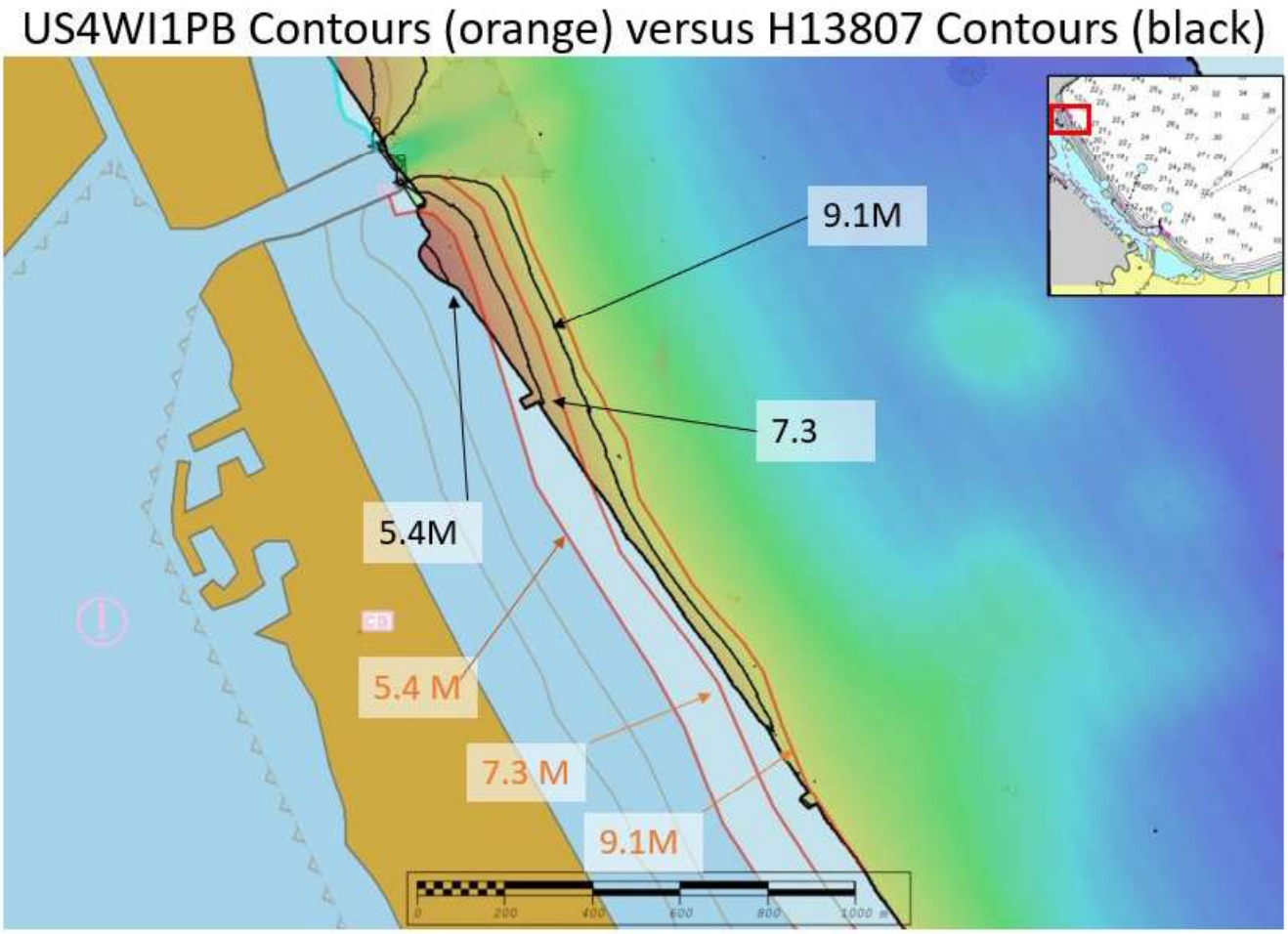


Figure 18: US4WI1PB contours vs H13807 contours_2

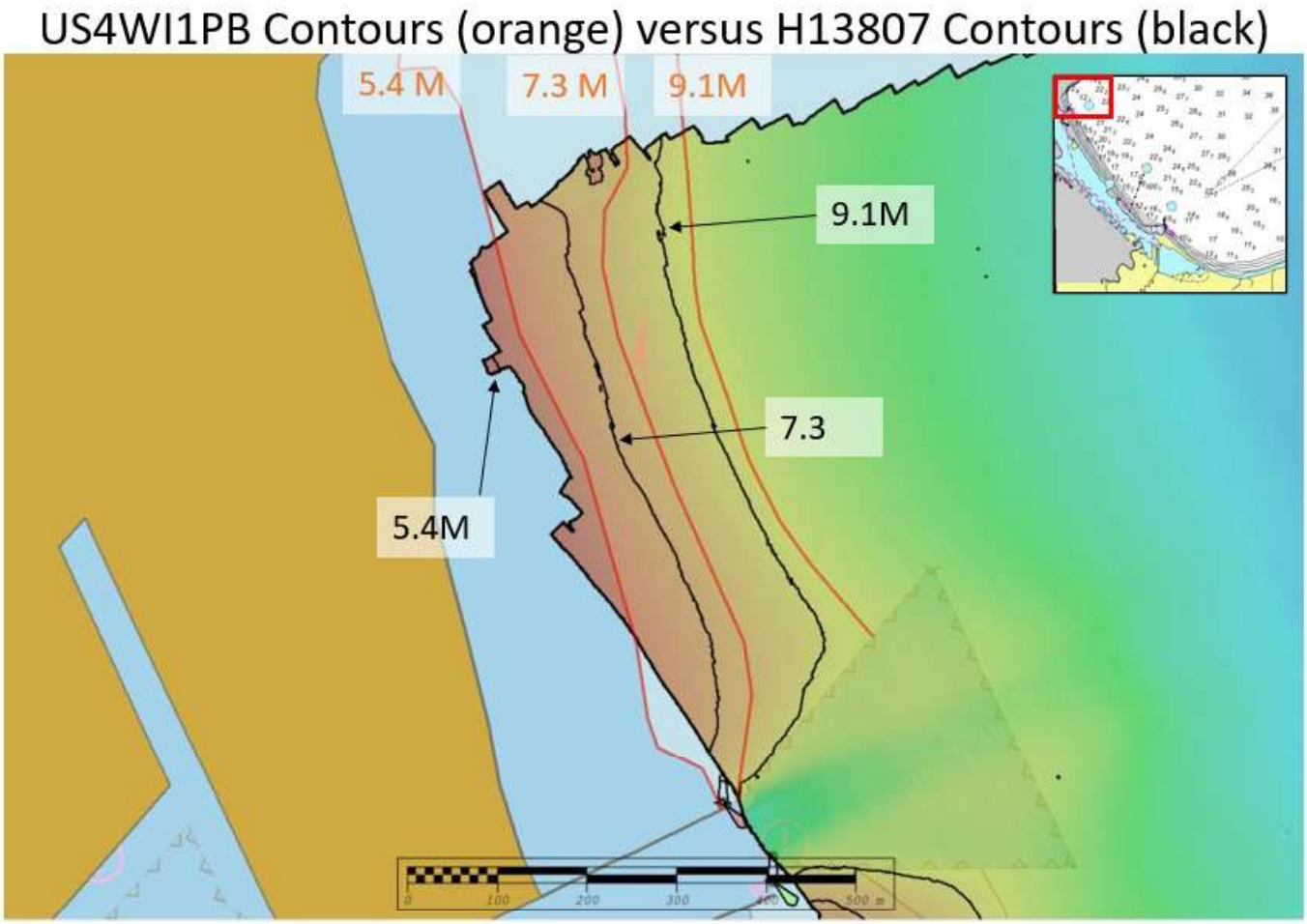


Figure 19: US4WI1PB contours vs H13807 contours_1

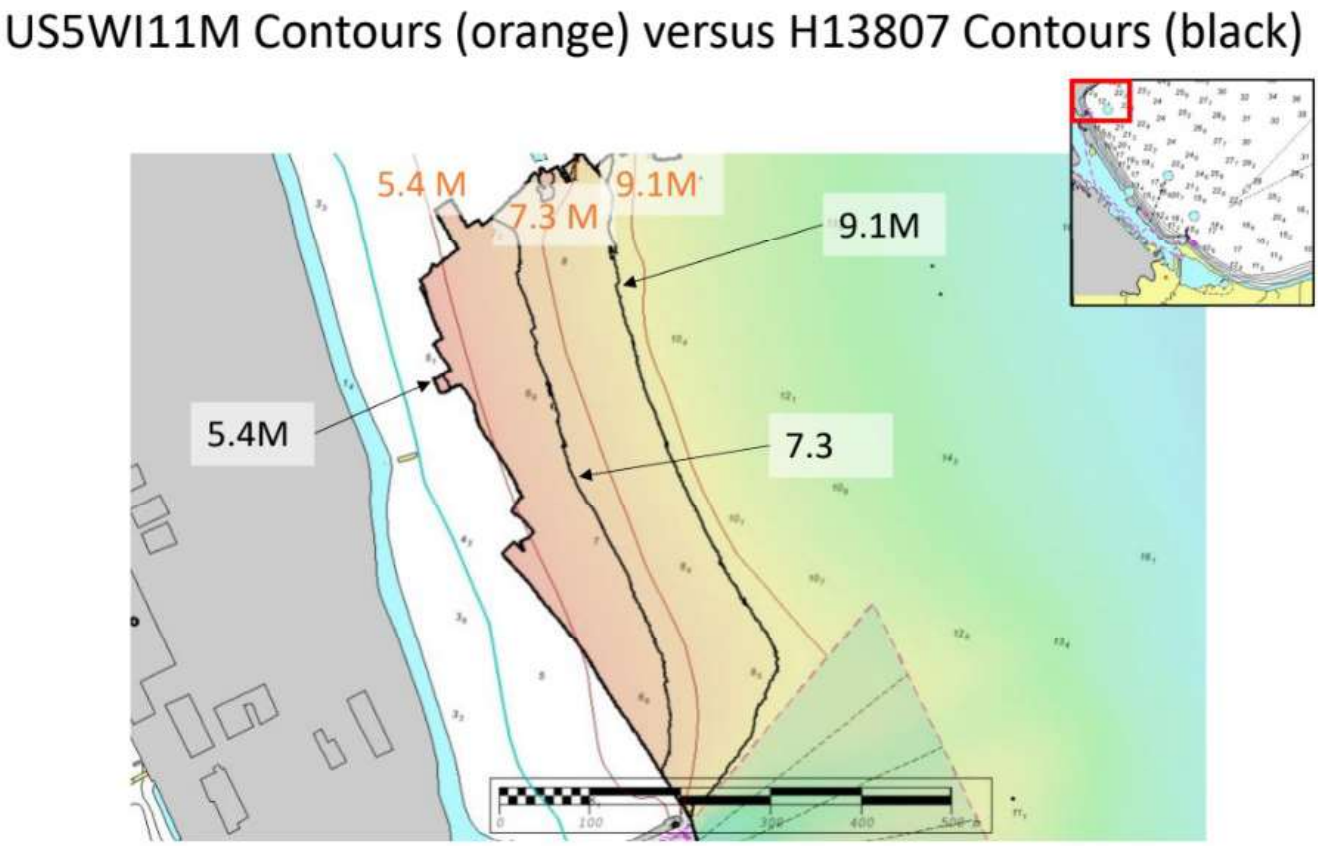


Figure 20: US5WI11M contours vs H13807 contours_1

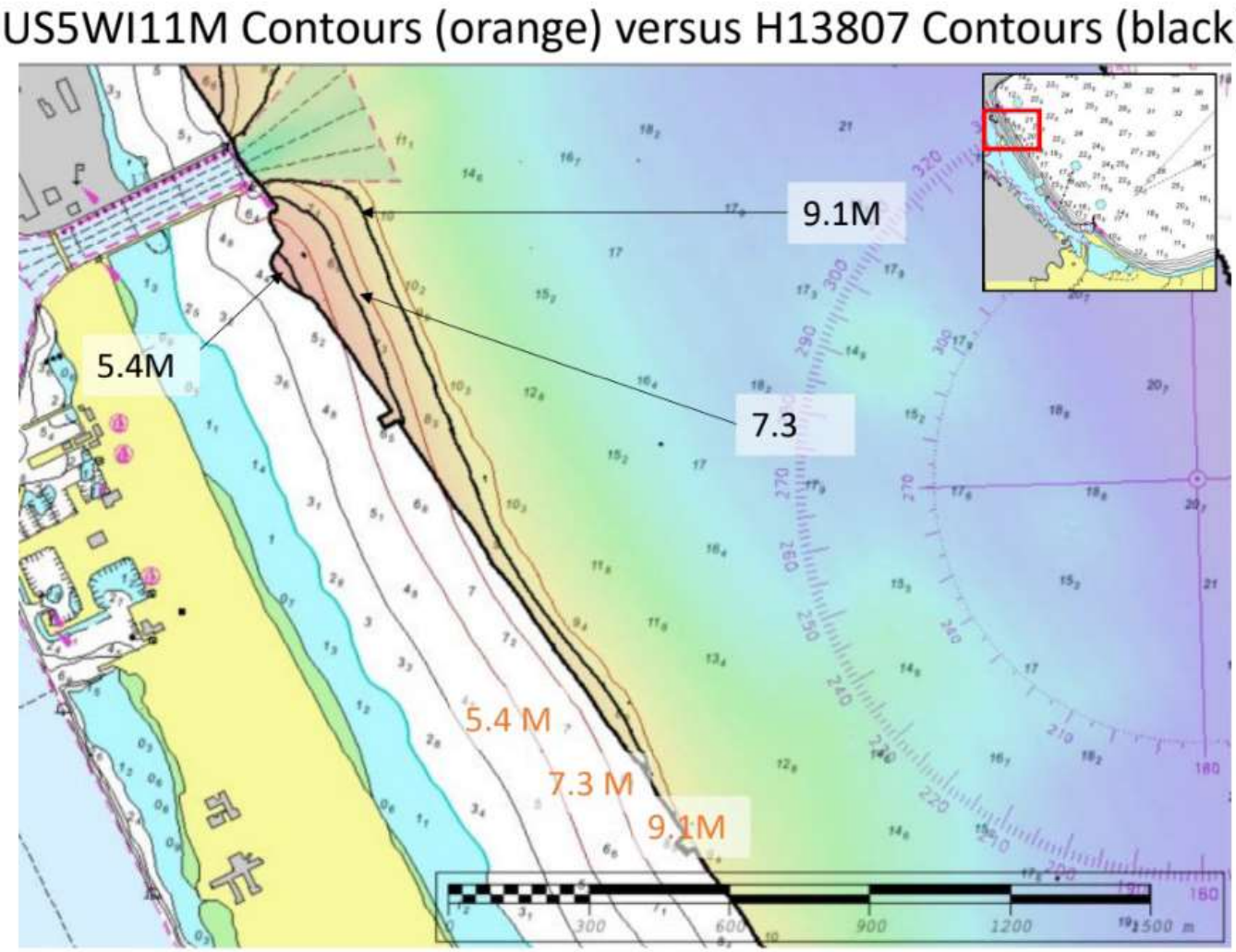


Figure 21: US5WI11M contours vs H13807 contours_2

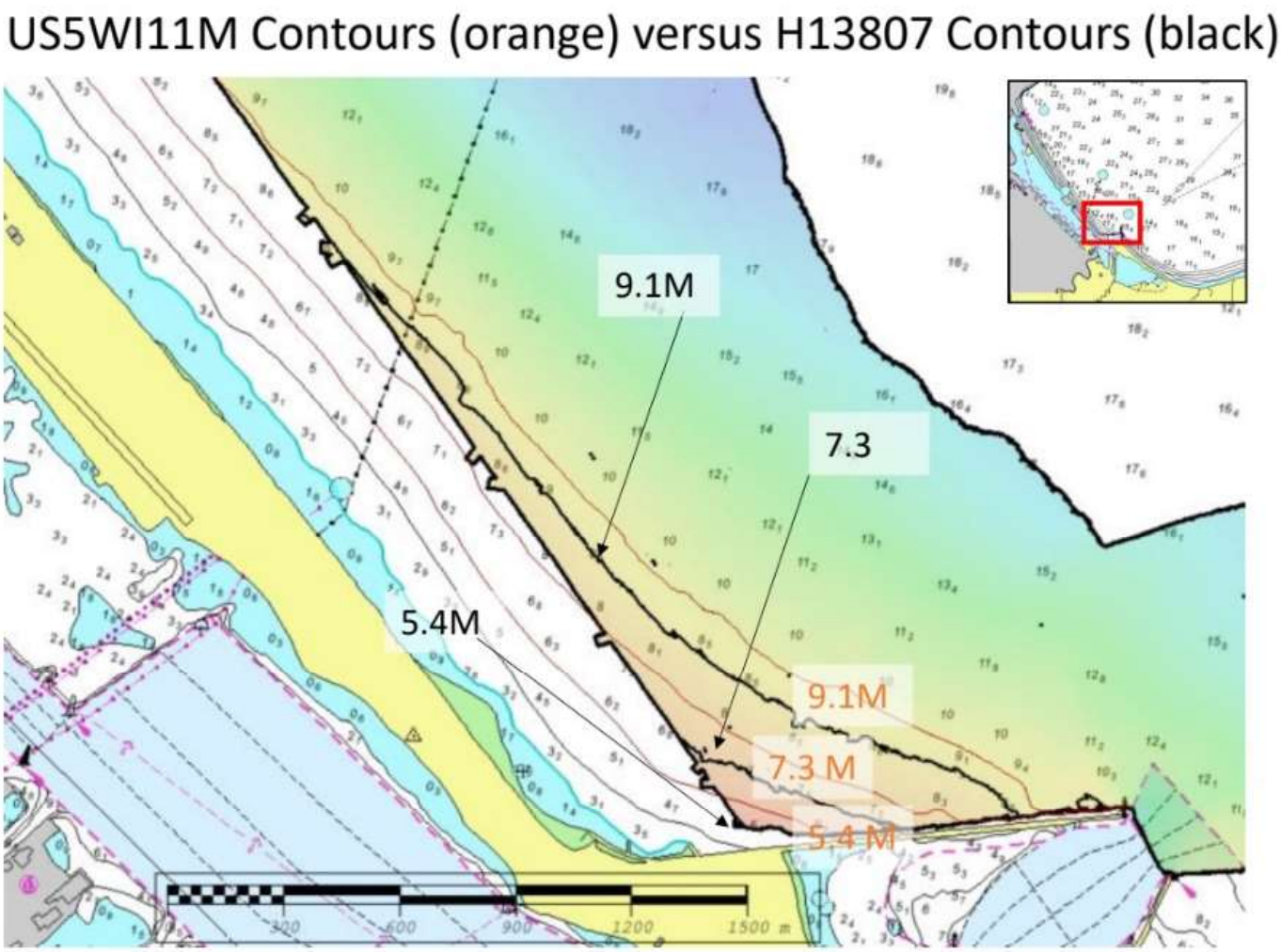


Figure 22: US5WI11M contours vs H13807 contours_3

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
US4WI1PB	1:80000	4	12/08/2022	12/08/2022
US5WI11M	1:15000	32	08/16/2023	08/16/2023

Table 13: 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

See Final Features File for Assigned/Charted/Investigated Features.

D.1.4 Uncharted Features

No uncharted features exist for this survey.

D.1.5 Channels

No channels exist within the survey limits.

D.2 Additional Results

D.2.1 Aids to Navigation

No Aids to navigation (ATONs) exist for this survey.

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

A charted pipeline (drinking water) appears to be incorrectly positioned 216 meters west of its surveyed location. A faint trace of the pipeline is evident in object detection MBES coverage.

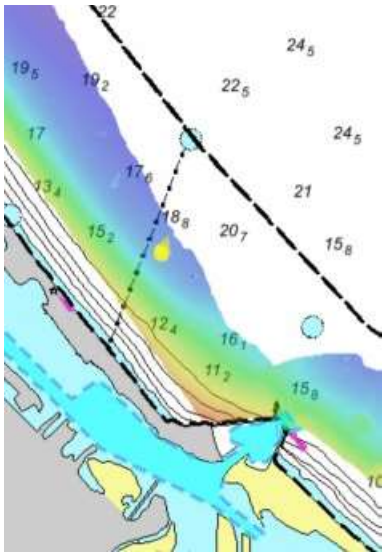
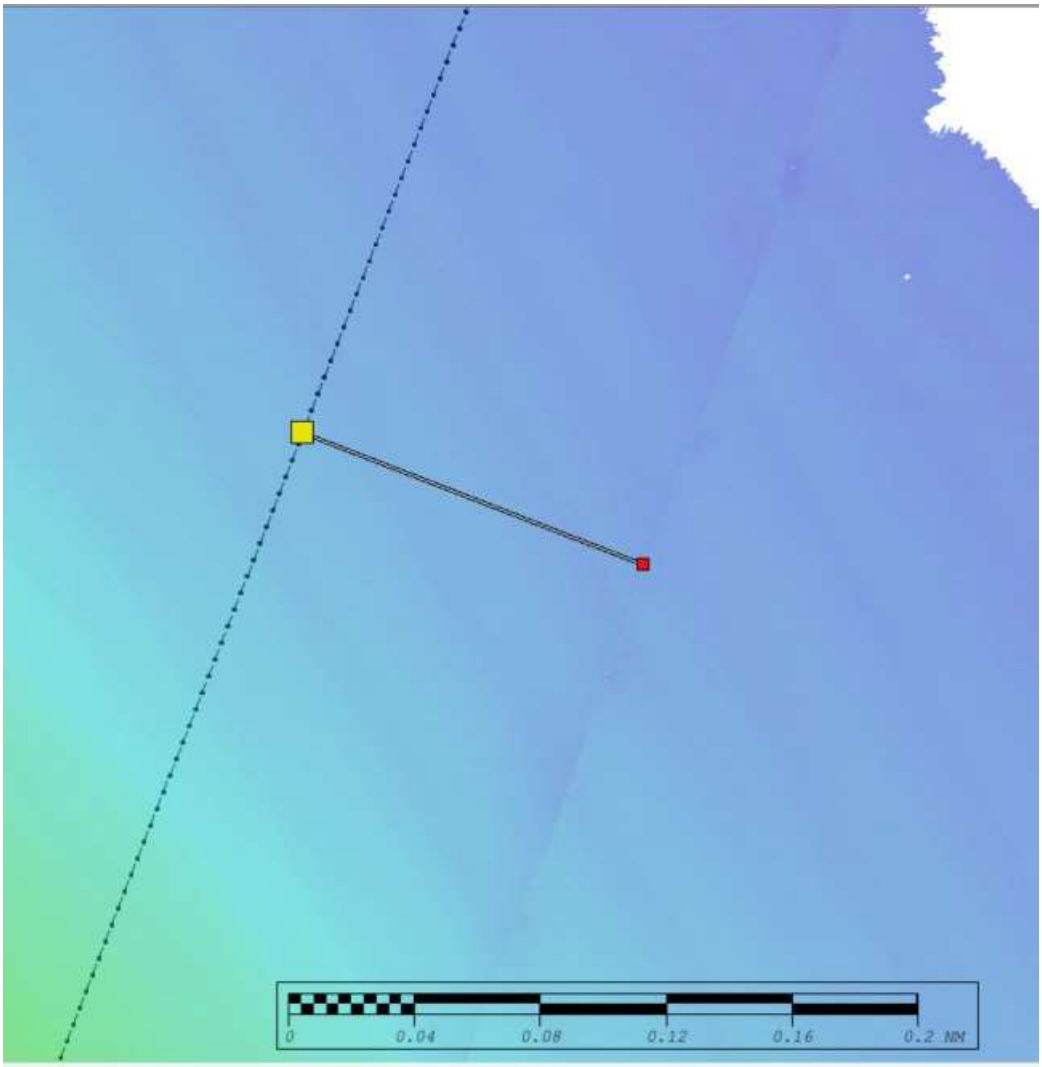


Figure 23: Charted (US4WI1PB) Drinking Water Pipeline



Distance (m)	Angle	Total Distance (m)	Distance To Home (m)	Angle To Home
216.11	111-48-03.89N	0.00	0.00	
		216.11	216.11	291-48-10.78N

Figure 24: Charted (US4WI1PB) Pipeline vs H13807 Coverage.

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

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.

Note 174 fliers still exist, mostly over the charted wreck near Duluth Harbor. These fliers are most likely legitimate soundings of railings and rigging atop the wreck. Other edge fliers exist on the edges of coverage where 6 iterations of flier edits occurred. The edge fliers will keep regenerating into good coverage. Least depths were designated over steep seabed features. NRT - Stennis personnel believe they have cleaned the fliers as best as possible.

Approver Name	Approver Title	Approval Date	Signature
Dan Jacobs	Chief of Party	12/13/2023	JACOBS.DAN.L.1151633478 Digitally signed by JACOBS.DAN.L.1151633478 Date: 2023.12.13 10:30:04 -06'00'
Brennan Perkins	Sheet Manager	12/13/2023	Brennan Perkins, CWP

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