U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

DESCRIPTIVE REPORT

Type of Survey: Navigable Area

Registry Number: H12936

LOCALITY

State: Puerto Rico

Sub-locality: 10 NM North of Isla de Culebra

2016

CHIEF OF PARTY
Timothy Battista

LIBRARY & ARCHIVES

DATE: April 2016

NOAA FORM 76-35A (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NUMBER:

H12936

HYDROGRAPHIC TITLE SHEET

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:	**Puerto Rico**
General Locality:	**Caribbean Sea**
Sub-Locality:	**10 NM North of Isla de Culebra**
Scale:	**N/A** Date of Survey: **April 19 to April 26, 2016**
Instructions Dated:	**N/A** Project Number: **M-I907-NF-16**
Vessel:	**NOAA Ship *Nancy Foster***
Chief of Party:	**Timothy Battista**
Surveyed by:	**CCMA Biogeography Branch**
Soundings by:	**Reson 7125 SV2, Kongsberg EM710**
Graphic record scaled by:	**N/A**
Graphic record checked by:	**N/A**
Protracted by:	**N/A**
Automated Plot:	**N/A**
Verification by:	
Soundings in:	**Meters at MLLW**

Remarks:
1) All Times are in UTC.
2) This is a Coral Reef Mapping Project and Hydrographic Survey.

The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Any revisions to the Descriptive Report (DR) generated during office processing are shown in bold red italic text. The processing branch maintains the DR as a field unit product, therefore, all information and recommendations within the body of the DR are considered preliminary unless otherwise noted. The final disposition of surveyed features is represented in the OCS nautical chart update products. All pertinent records for this survey, including the DR, are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/.

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ACRONYMS AND ABBREVIATIONS

AtoN	Aid to Navigation
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DN	Day Number
DtoN	Danger to Navigation
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSSD	Hydrographic Surveys Specifications and Deliverables
IHO	International Hydrographic Organization
MBES	Multibeam Echosounder System
MLLW	Mean Lower Low Water
NAD83	North American Datum of 1983
QC	Quality Control
RNC	Raster Navigational Chart
TPU	Total Propagated Uncertainty
UTM	Universal Transverse Mercator
RNC	Raster Navigation Chart
ENC	Electronic Navigation Chart

Descriptive Report to Accompany Hydrographic Survey H12936
Project M-I907-NF-16
Locality: Caribbean Sea
Sub-locality: 10 NM North of Isla de Culebra
April 2016
NOAA Ship Nancy Foster
Chief Scientist: Tim Battista
Lead Hydrographer: Mike Stecher

A. AREA SURVEYED

The Center for Coastal Monitoring and Assessment (CCMA) conducted hydrographic survey operations in the Caribbean Sea, 10 NM North of Isla de Culebra, Puerto Rico. The survey H12936 was conducted without formal project instructions, for project M-I907-NF-16.

A1. SURVEY LIMITS

The extents of the H12936 survey limits are listed in Table 1.

Table 1 H12936 survey limits

Northeast Limit	Southwest Limit
18.56 N	18.46 N
65.13 W	65.34 W

A2. SURVEY PURPOSE

The project is being conducted in support of the National Center for Coastal Ocean Science (NCCOS) to provide bathymetric data of critical benthic habitats in selected areas off of the coast of St. Thomas, USVI. Bathymetric data from the project was collected with multibeam echosounder (MBES) and will be utilized by the Office of Coast Survey (OCS) to update the nautical charts in the surveyed area.

A3. SURVEY QUALITY

The entire survey is adequate to supersede previous surveys.

A4. SURVEY COVERAGE

This survey was conducted using the complete coverage MBES specification as defined in the Hydrographic Survey Specifications and Deliverables March 2016 (HSSD). While conducting the survey, bathymetric coverage was monitored by creating CUBE surfaces with 2m, 4m, 8m and 16m resolutions as per HSSD. Sounding densities generally meet the 95% of all nodes population criteria, except in areas where MBES data were shadowed by features of significant height and from ping drop outs from the 7125-SV2.

Due to a balance between coverage and time allotment the entire survey sheet was not completed. A fill plan was created for all holidays greater than the required specifications. There are no holidays over the tops of potentially significant features. For depths up to 30m there were

no holidays spanning more than 3 nodes observed; for depths greater than 30m, some insignificant holidays are present.

Sheet H12936 had water depths between approximately 25-462m. The reef shelf, from approximately 25m to 100m, was surveyed with a Reson 7125-SV2. The EM710 was used to QC the 7125 SV2, in the deeper locations for complete MBES coverage of the sheet, as well as to achieve overlap with the adjacent sheet to the north, H12756, which was surveyed in 2015.

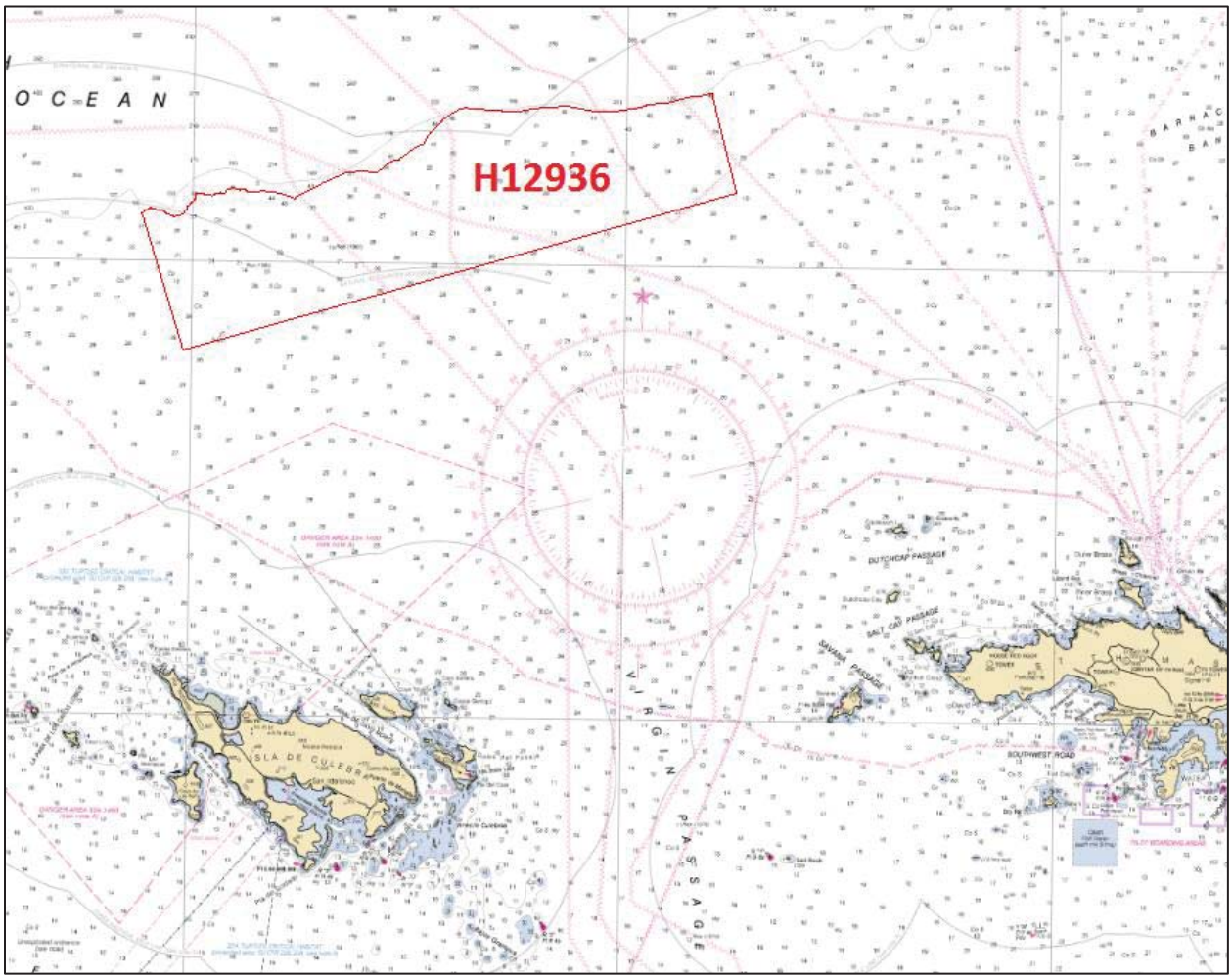

Figure 1 H12936 Sheet Overview

A5. SURVEY STATISTICS

Detailed survey statistics for H12936 are provided in Table 2.

Table 2 H12936 Hydrographic Survey Statistics

Survey Statistics	MBES
MBES main scheme (nm)	502.5
Crosslines (MBES nm)	20.8

Additional full coverage MBES (nm)	0
Additional full coverage MBES crosslines (nm)	0
Number of item investigations that required additional survey effort	0
Number of bottom samples	0
Total number of square nautical miles	35.9

Data acquisition was conducted from April 19, 2016 (DN 110) to April 26, 2016 (DN 117). Table 3 lists specific dates of survey and patch test data acquisition. Patch test data was used to determine system biases in support of the survey and are also included with the digital deliverable.

Table 3 H12936 Days of Acquisition

Dates of Acquisition	
April	19-26, 2016
Dates of Patch Test Acquisition	
April	7 & 13 2016

A6. SHORELINE

Shoreline investigation was not required for M-I907-NF-16.

A7. BOTTOM SAMPLES

Bottom Samples were not required for M-I907-NF-16.

B. DATA ACQUISITION AND PROCESSING

B1. EQUIPMENT AND VESSELS

The M-I907-NF-16 Data Acquisition and Processing Report (DAPR), submitted under supplemental reports, cover equipment details and vessel information as well as the data acquisition and processing procedures used for this survey. There were no vessel or equipment configurations used during data acquisition that deviated from those described in the DAPR.

B1.a Vessels

The vessel used during this survey is listed in Table 4.

Table 4 Vessel Specifications

NOAA Ship Nancy Foster	
	
Hull Number	R352
Builder	McDermott, Inc
Year Built	1990
Weight	1190 long tons
Length Overall	187’
Beam	40’
Draft, Maximum	11.2’
Cruising Speed	10.5 knots
Max Survey Speed	7 knots

B1.b Equipment

Equipment systems used during data acquisition are listed in Table 5.

Table 5 Equipment Used

Type	Manufacturer	Model
Multibeam Echosounder	Kongsberg	EM710
Multibeam Echosounder	Reson	7125-SV2
Surface Sound Speed	Reson	SVP-71 (2)
Primary Sound Speed Profiler	OceanScience	uCTD
Secondary Sound Speed Profiler	Sea-Bird	SBE-19
Positioning & Attitude	Applanix	POS/MV 320 v4

Positioning & Attitude	Trimble	DSM132

B2. QUALITY CONTROL

The Reson 7125-SV2 exhibited some minor internal data consistency issues. Although the survey meets the desired IHO specifications, some occasional motion-related noise was observed along the outer beam overlap between adjacent lines. This mainly seemed to occur in moderate to heavier sea states, suggesting that this minor artifact was primarily related to a POS/MV configuration that prioritizes the EM710 (which requires an extraneous lever arm and rotation to the 7125-SV2), and in some cases errors in the real time roll stabilization. A representative area where this artifact occurs is shown below, both with a Standard Deviation surface (range 0-0.5 m) and a Depth surface, which shows the artifact's minimal effect on data quality.

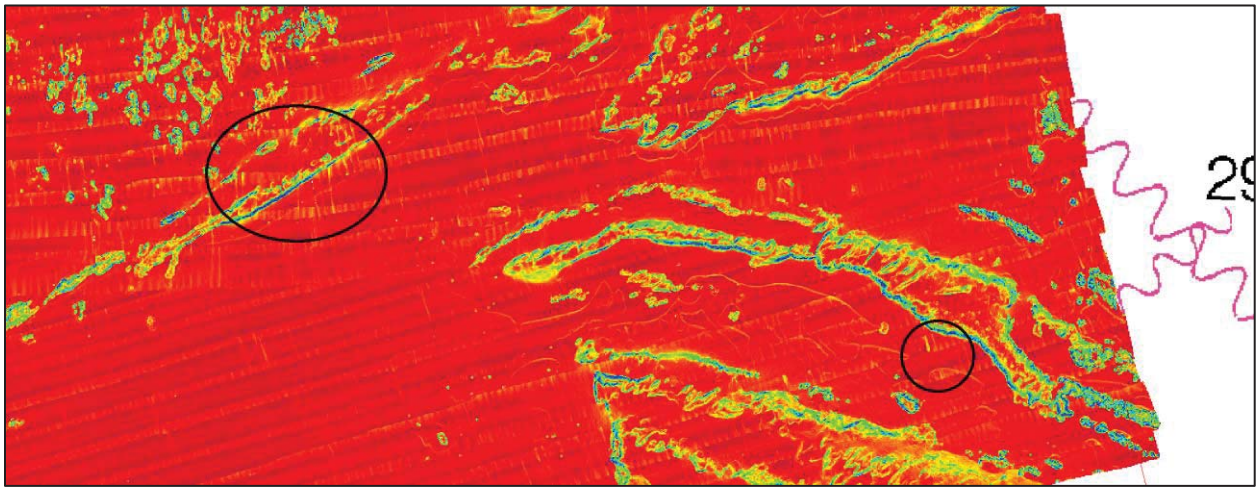

Figure 2 Example of Minor Outer Beam Motion Artifact (Standard Deviation)

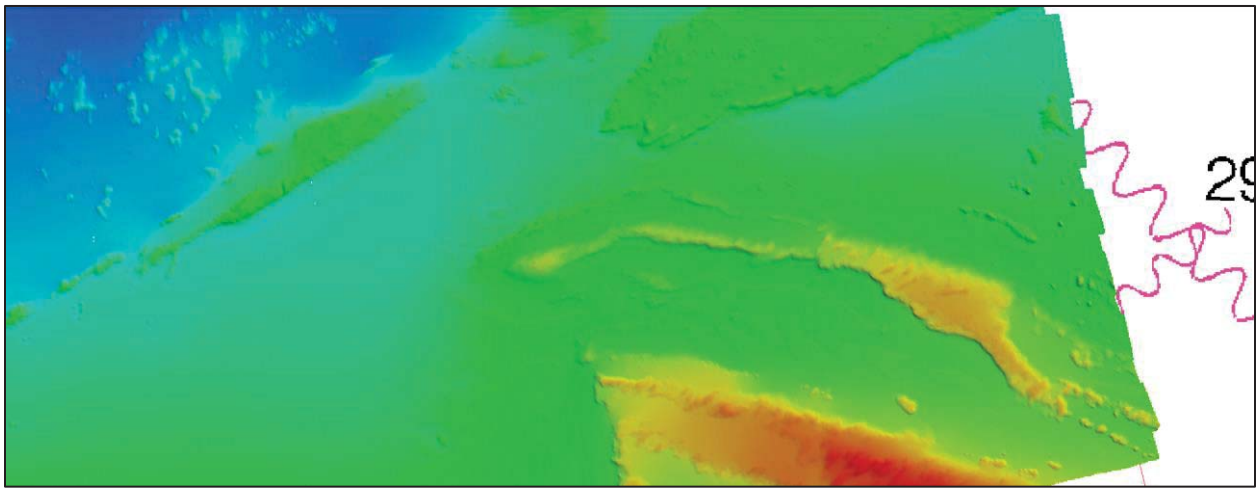

Figure 3 Example of Minor Outer Beam Motion Artifact (Depth)

Overall, the survey data showed acceptable internal consistency. Results from the crossline analysis, final CUBE surface uncertainties, the Total Vertical Uncertainties (TVU QC), and

standard deviation statistics computed between the 7125-SV2 and the EM710 indicate acceptable internal consistency of the MBES data. Additionally, chart and junction survey comparisons with previously collected MBES data sets support data confidence.

B2.a Crosslines

A total of 20.8 nautical miles of crosslines, or 4.1% of all survey lines, were run for analysis of survey accuracy. Crosslines were run in a direction of less than 45 degrees to main scheme lines across most of the surveyed area, providing a good representation for analysis of consistency and IHO compliance. For water depths less than 100m, IHO Order 1 was used for compliance, and for water depths greater that 100m IHO Order 2 was used.

Crossline analysis was performed using the CARIS Hydrographic Information Processing System (HIPS) QC Report tool. This tool compares crossline data to a gridded surface and reports results by beam number and IHO compliance. Crosslines were compared to a 4m CUBE surface encompassing mainscheme data for depths less than 100m for IHO Order 1. Crosslines were compared to a 16m CUBE surface encompassing mainscheme data for depths more than 100m for IHO Order 2. The QC Report plots are included in Separate II Digital Data. The results of the analysis meet the requirements as stated in the HSSD.

B2.b Uncertainty

Survey specific uncertainty parameters for tide and sound speed are included in Table 6. As described in the M-I907-NF-16 DAPR, the TCARI methodology for tidal correction creates an uncertainty model by propagating water level uncertainties, datum uncertainties, and TCARI grid vertical uncertainties. This error budget overwrites previously-defined error sources in CARIS, and is applied as part of the TPU processing.

Table 6 TPU Values for Tide and Sound Speed

Total Propagated Uncertainty Computation in CARIS HIPS*		
Tide Values	**Uncertainty* (m)**	**Day Number Range**
Tide Value Measured	Defined by TCARI	all
Tide Value Zoning	Defined by TCARI	all
Sound Speed Values	**Uncertainty* (m/s)**	
Sound Speed Measured (SN 5510)	4.0	all
Surface Sound Speed	0.20	all

During surface finalization in HIPS, the "greater of the two" option was selected, where the calculated uncertainty from Total Propagated Uncertainty (TPU) is compared to the standard deviation (StdDev) of the soundings influencing the node, and where the greater value is assigned as the final uncertainty of the node. The uncertainty of the finalized surface increased for nodes where the StdDev of the node was greater than the TPU. For simplicity in the following discussion of uncertainty values among the four delivered surfaces, one surface evaluated against IHO Order 1 and 2 (the 4 m and 16 m surfaces, respectively) will be presented here.

The resulting "greater of the two" calculated uncertainty values of all nodes in the 4m finalized surface range from 0.46 m to 1.67 m. The resulting calculated uncertainty values of all nodes in the 16m finalized surfaces range from 0.80 m to some nodes up to 6.79 m. The maximum uncertainty values here are associated with a high standard deviation in the depth surface caused by steep and irregular seafloor features beyond the shelf edge.

To more easily determine if surface grid nodes met IHO Order 1 and 2 specifications, a TVU QC check was performed in addition to the HIPS QC Report tool. This routine is used to identify nodes in the finalized CUBE surfaces that have estimated uncertainties that exceed specifications. Specifically, the TVU QC layer compares the estimated uncertainty of the depth to the allowable uncertainty of the depth estimate node by node.

This routine uses the ratio method which visualizes the ratio of the uncertainty at a node to the maximum allowed IHO uncertainty for each node via a computed layer in CARIS. The TVU QC layer scales with depth and demonstrates what fraction of the total allowable error budget is consumed by the estimated uncertainty. The TVU QC layers are labeled as IHO_Order_1 or 2, and reside as child layers within the finalized 2m, 4m 8m and 16m CUBE surfaces. The TVU QC layers were reviewed with filters set to -1 to -100, and areas that had populated node values were further examined by the data processor. These nodes generally reside in areas of dynamic seafloor features.

As shown in Figure 4, the statistics from the TVU QC layers indicate that both the 16m and 4m areas have low mean values (-0.4, and -0.6 respectively). The 16 m surface also has no nodes which eclipse the IHO Order 2 error budget (its minimum value is -0.8), while the 4 m surface has very few nodes beyond -1 (and its minimum value is only -1.9). Therefore both these representative surfaces meet their relevant IHO Order specifications (as do the 2 m and 8 m surfaces).

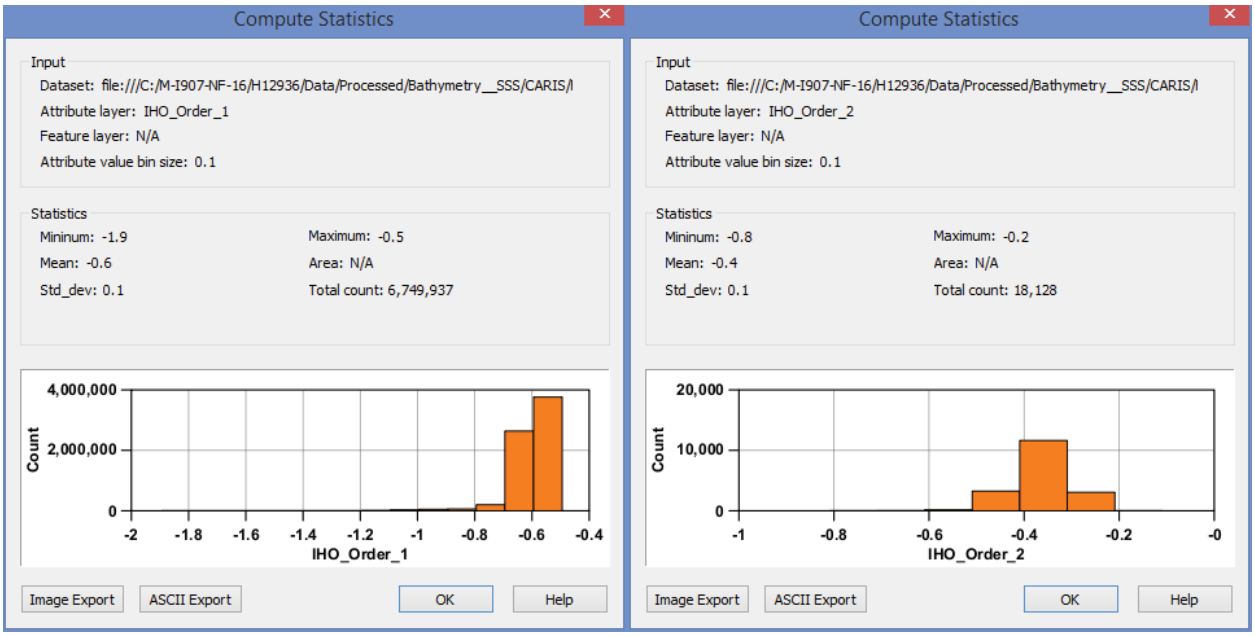

Figure 4 TVU QC Histograms for Both 4m and 16m CUBE Surfaces

B2.c Junctions

As there were no formal project instructions for M-I907-NF-16, there were no sheet junctions stipulated. Data from previous Coral Reef Mapping Project cruises was available, however. So a junction analysis was conducted with H12936 and data from NOAA Ship *Nancy Foster* acquired in 2015 (Sheet H12756) via surface difference of the sheets' respective 8m resolution surfaces. The mean comparison value is -0.8 m, with a standard deviation of 3.8 m, and minimum and maximum values of -87.8 m and 32.8 m, respectively.

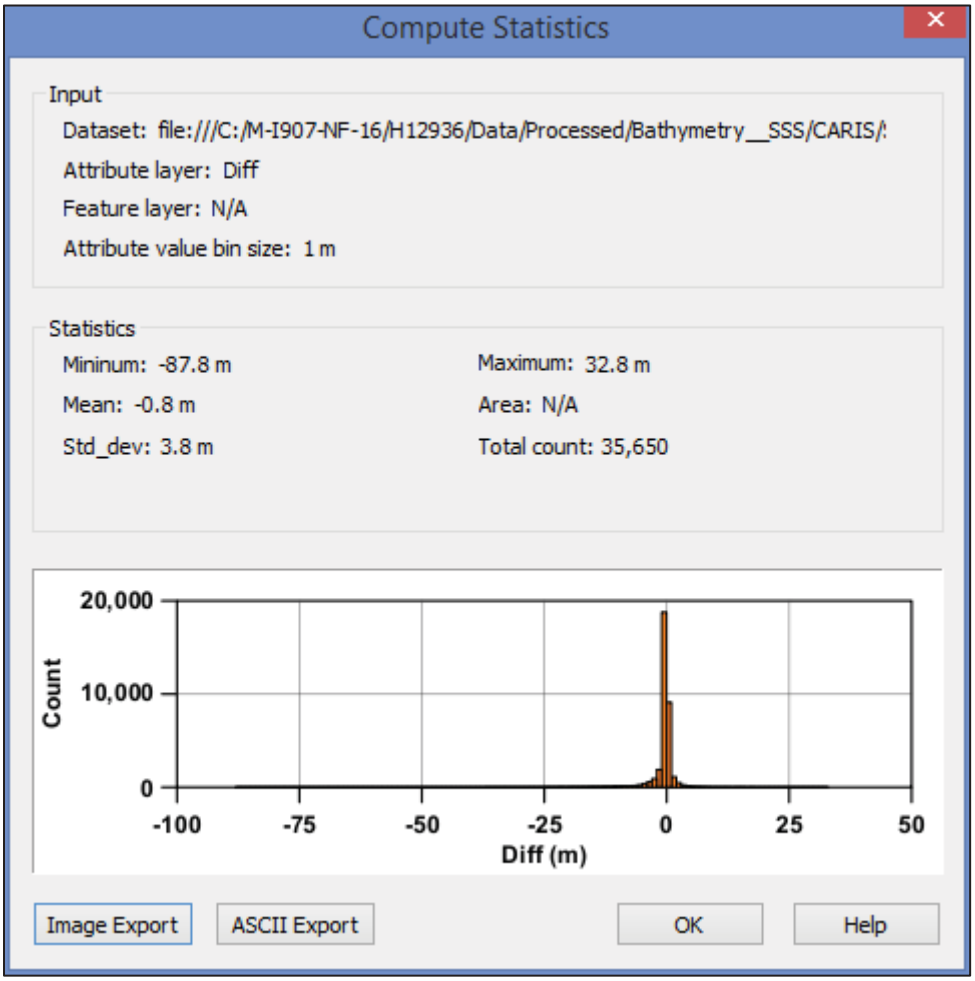

Figure 5 H12936 and H12756 Difference Surface Statistics

The fairly high standard deviation and minimum/maximum values (Figure 5) can be attributed to the 8 m resolution surfaces covering much of the shelf edge and the steep slopes that accompany this feature. Slight inaccuracies in positioning and minor variabilities in surface node locations can generate high values for each of this difference statistics along bathymetric features of this kind. The values are more reasonable viewed in profile along the sloped area with the section tool and the difference surface enabled, as depicted in Figure 6. The difference value trends near zero with spikes occurring near the shelf edge.

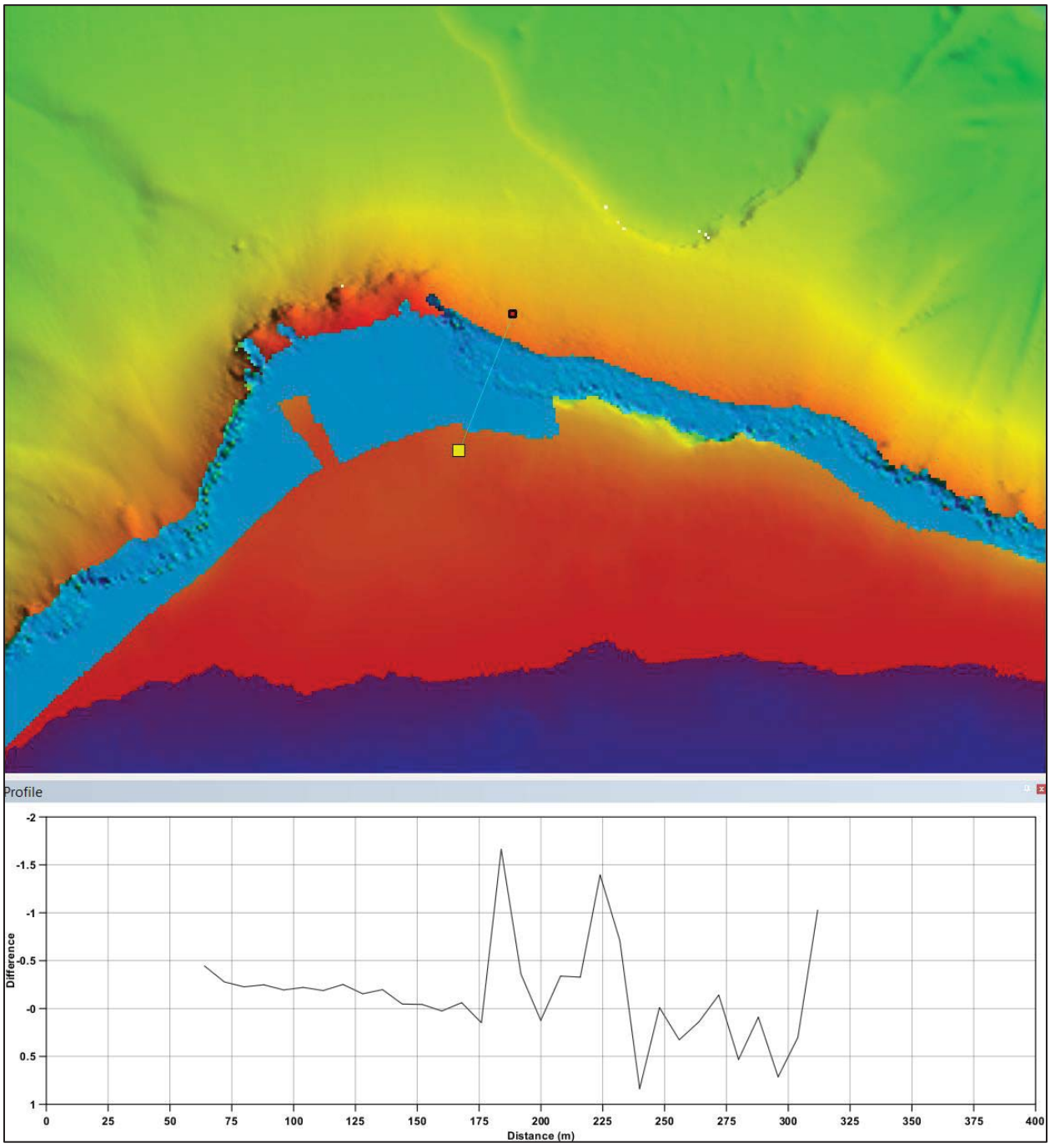

Figure 6 H12396 and H12756 8m Resolution Overlap Area (Blue) in Profile

Profile shows surface difference values hovering near zero with occasional spikes near the shelf edge

B2.d Sonar QC Checks

An EM710 crossline was run across the 7125-SV2 mainscheme of H12936 to provide additional evidence of sonar system alignment. Surface statistics were calculated on a 4m difference surface

between the crossline's surface (TCARI corrected to MLLW) and the final H12936_MB_4m_MLLW.csar surface (which is primarily composed of 7125-SV2 data). An agreeable mean difference of -0.1 m and standard deviation of 0.1 m were derived from surface difference statistics (see Figure 7). Additional sonar system quality control checks are discussed in the quality control section of the M-I907-NF-16 DAPR.

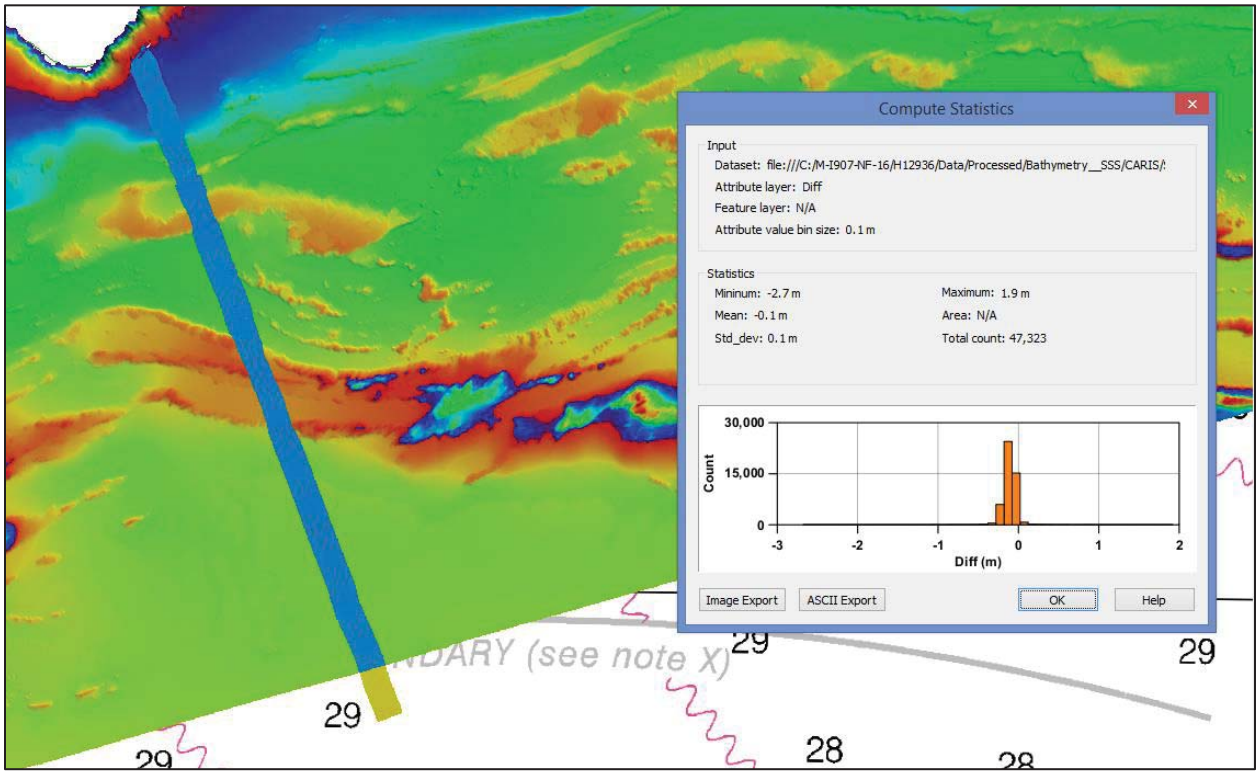

Figure 7 H12936 Mainscheme and EM710 Crossline 4m Surface Difference and Statistics

B2.e Equipment Effectiveness

The Nancy Foster's 7125-SV2 system has historically had problems with dropped pings, system crashes and minor swath issues that seem to reflect sound velocity and/or DGPS positioning and/or roll stabilization. All resources have been consulted about these continuing issues including Reson, Applanix, HSTP, Chief Survey Tech, Chief Electronic Tech and others to no avail. Some 7125-SV2 components were replaced in 2015 which included a new receiver, topside processor and SVP-71. This has seemed to resolve most of the problems that have been observed over the past few years. Although the system does collect data to IHO specifications, there still seems to be some minor internal inconsistencies that are evident within the data as mentioned previously. Overall the EM710 performed well, though on some occasions there was noise observed, which was attributed to sea states and cavitation under the hull.

B2.f Factors Affecting Soundings

Three lines of 7125-SV2 HDCS data were run at times over which the POSMV data wasn't usable in Applanix IN-Fusion SingleBase processing, and therefore no relevant SBET was created for these lines. Instead, raw DGPS position, real time motion data, and TCARI tidal data was used. The lines affected are from DN111: 2016_1111838 and 2016_1111838 and from DN112: 2016_1122042. See Section C2 for further information regarding SBET's and Horizontal Control.

B2.g Sound Speed Methods

An OceanScience uCTD was the primary sound velocity acquisition device. The uCTD was deployed at no more than 5 hour increments during survey while underway and actions were taken to try and distribute the casts evenly throughout out the survey area. Additional discussion of sound speed methods can be found in the M-I907-NF-16 DAPR.

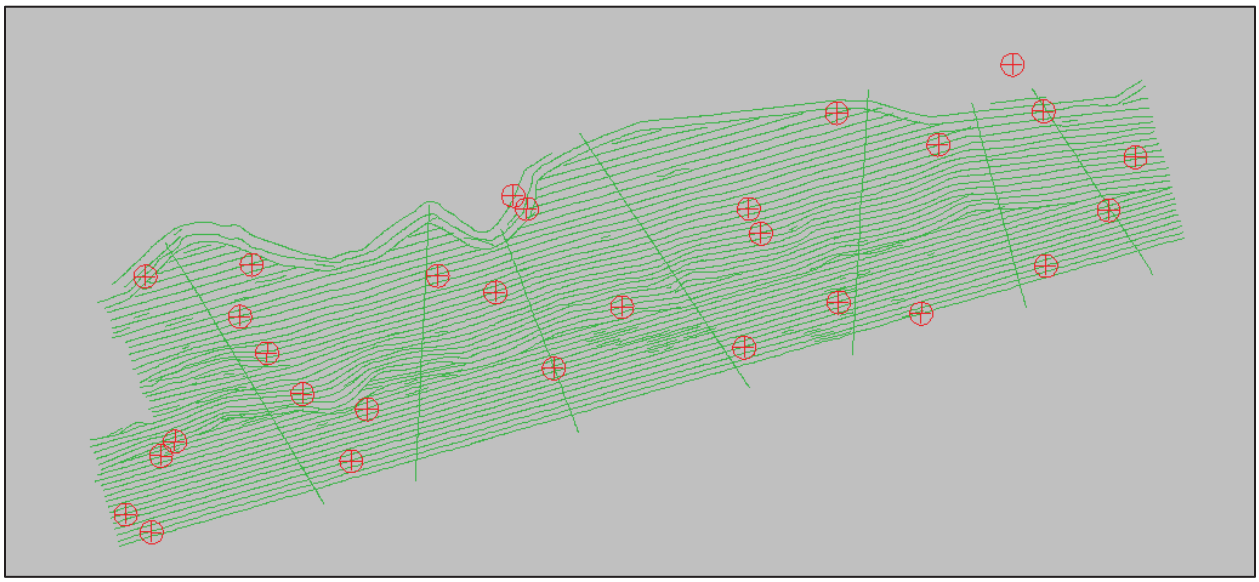

Figure 8 Spatial Distribution of H12936 uCTD Sound Velocity Casts

B2.h Coverage Equipment and Methods

All equipment and survey methods were used as detailed in the M-I907-NF-16 DAPR.

B3. ECHO SOUNDING CORRECTIONS

B3.a Corrections to Echo Soundings

All data reduction procedures conform to those detailed in the M-I907-NF-16 DAPR.

B3.b Calibrations

No additional calibration tests were conducted beyond those discussed in the M-I907-NF-16 DAPR.

B4. BACKSCATTER

MBES backscatter from the 7125-SV2 and EM710 was logged in the Hypack .7K and SIS .all formats, respectively. Data was processed and evaluated with a combination of Fledermaus FMGT and the Hypack implementation of Geocoder. The backscatter data was used in combination with the bathymetry to create Principal Component Analysis surfaces in GIS to delineate areas of difference. This information was then used to plan ROV transects to characterize benthic habitats in the surveyed regions.

The quality of the backscatter from the EM710 was compromised due to the EM710's use of slightly different frequencies across the swath. The variable frequencies used in different ping modes and MBE sectors are evident in the backscatter. The negative effect of the use of variable frequencies in the backscatter was mitigated by a series of adjustments made to each ping mode across the swath, one for each ping mode employed by the EM710. The adjustments to the backscatter strength were effective, and the delineations of the sectors were resolved. However, the backscatter adjustments entered into SIS did not always "stick" and the original default values would occasionally reappear within SIS degrading the quality of the backscatter.

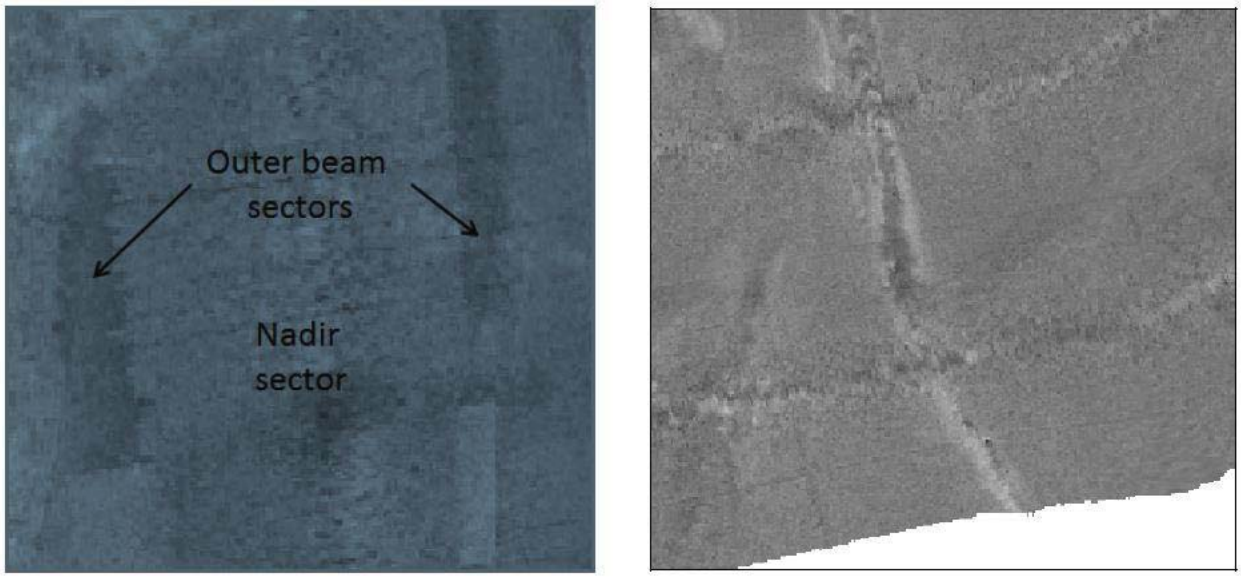

Figure 9 EM710 seafloor backscatter before (left) and after (right) applying sector adjustments

After acquisition of the 7125 SV-2 .7K files and subsequent post processing in CARIS, the data was exported in GSF format from CARIS for backscatter processing in FMGT. Occasional along-track gaps and degraded imagery from the intermittent sonar drop-outs and excessive roll are evident within the 7125 SV-2 backscatter data.

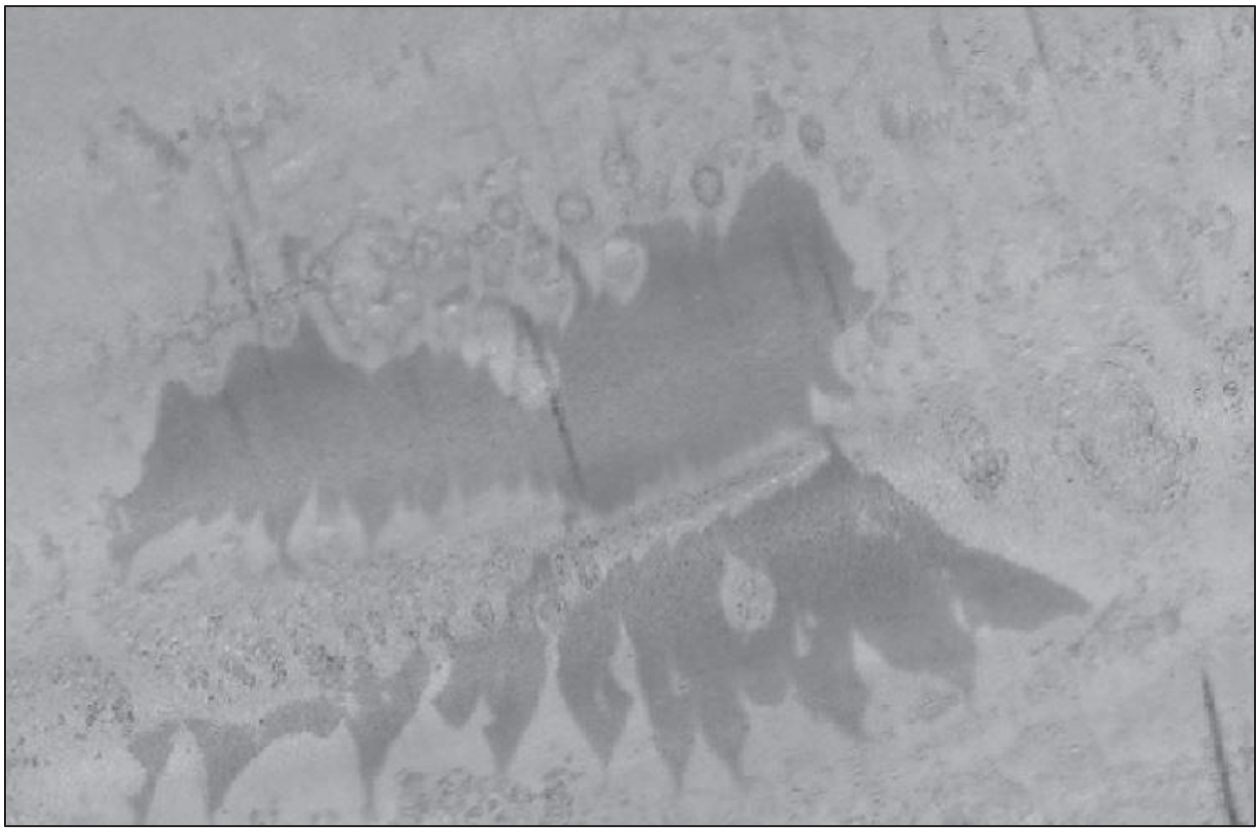

Figure 10 7125 SV-2 backscatter data example

B5. DATA PROCESSING

B5.a Software Updates

There are no software updates to report that aren't described in the M-I907-NF-16 DAPR, section A5.

B5.b Surfaces

Bathymetric grids were created relative to Mean Lower Low Water (MLLW) in CUBE format using complete coverage resolution requirements as described in the HSSD and using the CUBEParams_NOAA.xml file. BAGs were exported from CARIS with the identical name as the finalized surface from which they were derived.

Thorough analysis determined that the 2m resolution CUBE surface is an accurate representation of the seafloor in the shallow regions and the surface honors the shoalest reliable soundings within 1/2 of the allowable TVU, therefore no designated sounding were used on this survey sheet.

Table 7 lists the finalized CUBE surfaces submitted with this survey.

Table 7 H12936 MBES CUBE Surfaces

Surface Name	Resolution
H12936_MB_16m_MLLW_Final	16.0m
H12936_MB_8m_MLLW_Final	8.0m
H12936_MB_4m_MLLW_Final	4.0m
H12936_MB_2m_MLLW_Final	2.0m

C. VERTICAL AND HORIZONTAL CONTROL

No HorCon or VertCon operations were performed for this survey. A summary of horizontal and vertical control for this survey follows.

C1. VERTICAL CONTROL

The vertical datum for this project is MLLW 83-01 NTDE. Tidal data was applied with a finalized TCARI grid (NF1601.tc) supplied by CO-OPS with verified tides values obtained from the assigned NWLON tide gauges. Information related to tide correctors is included in Table 8, Table 9, and Table 10.

Table 8 Tide Stations

Station Name	Station ID
Esperanza, PR	9752695
Lime Tree Bay, USVI	9751401
San Juan, PR	9755371
Magueyes Island, PR	9759110

Table 9 TCARI Water Level Files

File Name	Status
CO-OPS__9752695_Esperanza_Verified_040616-043016.txt	Verified
CO-OPS__9751401_LimeTreeBay_Verified_040616-043016.txt	Verified
CO-OPS__9755371_SanJuan_Verified_040616-043016.txt	Verified
CO-OPS__9759110_MagueyesIsland_Verified_040616-043016.txt	Verified

Table 10 TCARI Grid File

File Name	Status
NF1601.tc	Final TCARI Grid File

C2. HORIZONTAL CONTROL

The horizontal datum for this project is North American Datum of 1983 (NAD83) projected in Universal Transverse Mercator (UTM) Zone 20 with units in meters. All of the real-time navigation data were collected in DGPS mode. DGPS corrections were received from a U.S. Coast Guard transmission station broadcasting at 295 kHz located at Isabel, Puerto Rico.

Additionally, the horizontal positioning accuracy of nearly all lines was improved using SBET files that were derived from horizontal control stations using Applanix's IN-Fusion SingleBase processing. Again, the lines for which no SBET was created are from DN111: 2016_1111838 and 2016_1111838 and from DN112: 2016_1122042. CORS stations used to create SBET's for lines in sheet H12936 are listed below (Table 11).

Table 11 CORS Stations used for IN-Fusion SingleBase Processing

CORS Station Name	CORS Station ID
St. Thomas, USVI	STVI
Culebra Island, PR	CUPR
Fajardo, PR	PRFJ

D. RESULTS AND RECOMMENDATIONS

D1. CHART COMPARISON

The chart comparison was performed by comparing a shoal biased sounding layer generated in CARIS to the largest scale chart overlaying the project area. A 900-meter shoal biased sounding surface of the entire survey area was generated from a combined 4m CUBE depth surface covering both the 2m and 4m depth-threshold surfaces. The chart comparison was conducted by visually reviewing the resultant sounding surface and charted soundings.

D1.a Raster Charts

The raster chart comparison was performed by comparing RNCs covering the survey area to H12936 using visual comparison techniques. Detailed information regarding the RNC compared is listed in Table 12.

Table 12 RNC Compared to H12936

Chart	Scale	Edition Number	Edition Date	LNM Date	NM Date
25650	1:100,000	37	02/2014	10/22/2016	11/1/2016

Surveyed soundings generally compare to within a few fathoms with the charted soundings. There are some minor differences, nearly all of which have to do with slightly different locations of chart soundings and surveyed soundings overlaid on the heterogeneous seabed on the shelf.

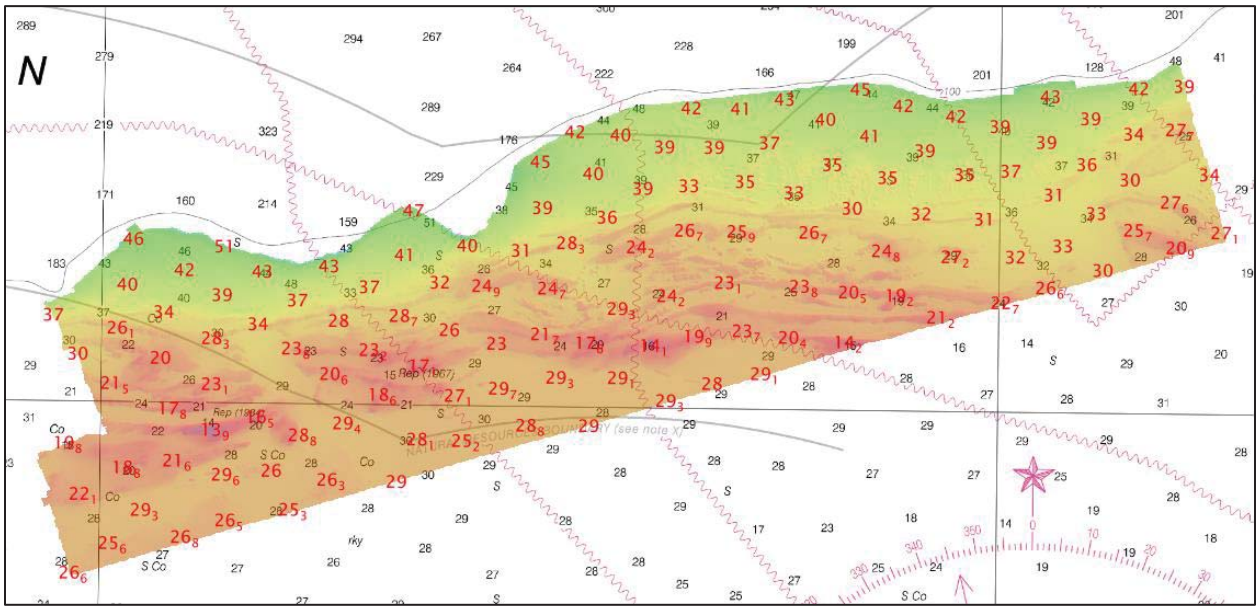

Figure 11 25650 Chart Comparison with Shoal-Biased H12936 Surface (red)

D1.b Electronic Navigational Charts

Table 13 details information related to the ENC compared to H12936.

Table 13 ENC Compared to H12936

ENC Name	Scale	Edition Number	Update Application Date	Issue Date
US4PR30M	1:100,000	9	02/25/2016	02/25/2016

An ENC to RNC comparison also reveals that the same sounding information was used to derive both types of charts and the agreements noted previously are also evident in the ENC charts.

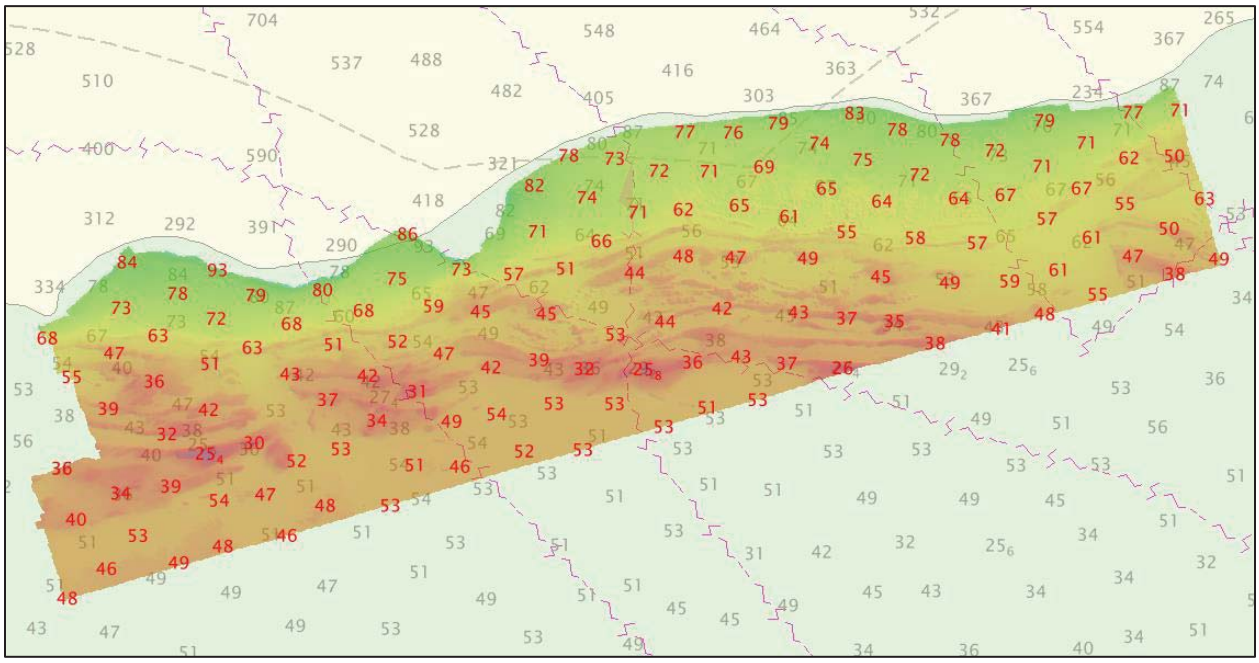

Figure 12 US4PR30M ENC Comparison with Shoal-Biased H12936 Surface (red)

D1.c AWOIS Items

There were no AWOIS investigations required for this project.

D1.d Charted Features

No charted features were located within the H12936 survey area.

D1.e Uncharted Features

No uncharted features were located within the H12936 survey area.

D1.f Dangers to Navigation

No Dangers to Navigation (DtoNs) were reported for this survey.

D1.g Shoal and Hazardous Features

No shoals or potentially hazardous features were located within the H12936 survey area.

D1.h Channels

The H12936 survey area does not contain any anchorage areas, maintained navigation channels or channel lines.

D1.i Bottom Samples

There was no bottom sample requirement for this survey.

D2. ADDITIONAL RESULTS

D2.a Shoreline

Shoreline investigation was not assigned for this project.

D2.b Prior Surveys

Aside from previously discussed charted comparisons and the junction analysis (Section B2.c), no comparisons with prior surveys were conducted.

D2.c Aids to Navigation

No Aids to Navigation (AtoNs) were charted or located within the H12936 survey area.

D2.d Overhead Features

There were no overhead bridges, cables, or other structures which would impact overhead clearance in the survey area.

D2.e Submarine Features

The H12936 survey area contained no submarine features.

D2.f Ferry Routes and Terminals

There were no ferry routes or terminals within the survey area.

D2.g Platforms

There were no platforms within the survey area.

D2.h Significant Features

No additional information of scientific or practical value was observed during the survey other than the benthic habitat characterization maps created by the CCMA scientific party. No anomalous tidal or environmental conditions were observed during the survey that impacted the quality of the survey.

D2.i Construction and Dredging

There was no construction or dredging activities observed during survey operations.

D3. NEW SURVEY RECOMMENDATIONS

It is recommended that this survey H12936 is used to supersede and update the existing nautical charts within the survey area.

D3.a Inset Recommendations

No inset recommendations are requested at this time for the surveyed area.

E. APPROVAL SHEET

As Lead Hydrographer, I have ensured that standard field surveying and processing procedures were followed in producing this examination in accordance with the Office of Coast Survey Hydrographic Surveys Division's Field Procedures Manual, and the Hydrographic Surveys Specifications and Deliverables. Field operations for this basic hydrographic survey were conducted under my daily supervision with frequent checks of progress and adequacy.

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to N/CS33, Atlantic Hydrographic Branch.

The Data Acquisition and Processing Report for M-I907-NF-16 is submitted separately and contains additional information relevant to this survey.

Michael Stecher

NOAA Contractor

Lead Hydrographer

CCMA Biogeography Branch

Mike Stecher

Digitally signed by Mike Stecher
DN: cn=Mike Stecher, o, ou=Solmar Hydro Inc, email=solmarhydro@gmail.com, c=US
Date: 2016.12.12 10:08:31 -08'00'

APPENDIX I

TIDES AND WATER LEVELS

UNITED STATES DEPARMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Silver Spring, Maryland 20910

TIDE NOTE FOR HYDROGRAPHIC SURVEY

DATE : July 13, 2016

HYDROGRAPHIC BRANCH: Atlantic
HYDROGRAPHIC PROJECT: M-I907-NF-16
HYDROGRAPHIC SHEET: H12936

LOCALITY: 10 NM North of Isla de Culebra
TIME PERIOD: April 19 - 26, 2016

TIDE STATION USED: Lime Tree Bay, St. Croix, VI 975-1401
Lat.17° 41.7' N Long. 64° 45.2' W
PLANE OF REFERENCE (MEAN LOWER LOW WATER): 0.000 meters
HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 0.214 meters

TIDE STATION USED: Esperanza, PR 975-2695
Lat. 18° 05.6' N Long. 65° 28.3' W
PLANE OF REFERENCE (MEAN LOWER LOW WATER): 0.000 meters
HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 0.221 meters

TIDE STATION USED: San Juan, PR 975-5371
Lat. 18° 27.6' N Long. 66° 07.0' W
PLANE OF REFERENCE (MEAN LOWER LOW WATER): 0.000 meters
HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 0.400 meters

TIDE STATION USED: Magueyes Island, PR 975-9110
Lat. 17° 58.2' N Long. 67° 02.8' W
PLANE OF REFERENCE (MEAN LOWER LOW WATER): 0.000 meters
HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 0.201 meters

REMARKS: RECOMMENDED Grid

Please use the TCARI grid "NF1601" as the final grid for project M-I907-NF-16, H12936, during the time period between April 19 - 26, 2016.

Refer to attachments for grid information.

Note 1: Provided time series data are tabulated in metric units (meters), relative to MLLW and on Greenwich Mean Time on the 1983-2001 National Tidal Datum Epoch (NTDE).

Note 2:

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DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OTHER, cn=HOVIS.GERALD.THOMAS.JR.1365860250
Date: 2016.07.11 10:38:46 -04'00'

CHIEF, PRODUCTS AND SERVICES BRANCH


Preliminary as Final TCARI Grid for NF-16-01 IOCM US Caribbean
9755371 SAN JUAN
9759110 MAGUEYES ISLAND
9752695 ESPERANZA
9751401 LIME TREE BAY
Image courtesy of NASA Earthstar Geographics SIO © 2016 Microsoft Corporation

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NOAA Ship NANCY FOSTER (MOA-NF)
439 West York St
Norfolk, VA 23510-1145

June 28, 2016

MEMORANDUM FOR: Gerald Hovis, Chief, Products and Services Branch, N/OPS3

FROM: M Stecher, NOAA Ship NANCY FOSTER (MOA-NF)

SUBJECT: Request for Approved Tides/Water Levels

Please provide the following data:

1. Tide Note
2. Final TCARI grid
3. Final zoning in MapInfo and .MIX format
4. Six Minute Water Level data (Co-ops web site)

Transmit data to the following:

solmarhydro@gmail.com

These data are required for the processing of the following hydrographic survey:

Project No.:	M-I907-NF-16
Registry No.:	H12936
State:	Puerto Rico
Locality:	10 NM North of Isla de Culebra
Sublocality:	

Attachments containing:

1) an Abstract of Times of Hydrography,
2) digital MID & MIF files of the track lines from Pydro

Year_DOY	Min Time	Max Time
2016_110	03:52:40	23:54:38
2016_111	00:06:06	23:56:07
2016_112	00:07:05	23:54:46
2016_113	00:13:21	23:48:55
2016_114	00:07:15	23:54:49
2016_115	00:06:58	23:54:42
2016_116	00:07:34	23:46:17
2016_117	00:06:51	10:18:51

WATER LEVEL INSTRUCTIONS
NF-16-01 IOCM US Caribbean
(01/06/2016 LH)

1.0. TIDES AND WATER LEVELS

1.1. Specifications

Tidal data acquisition, data processing, tidal datum computation and final tidal zoning shall be performed utilizing sound engineering and oceanographic practices as specified in National Ocean Service (NOS) Hydrographic Surveys Specifications and Deliverables (HSSD), dated May 2015, and OCS Field Procedures Manual (FPM), dated April, 2014. Specifically reference Chapter 4 of the HSSD and Sections 1.5.8, 1.5.9, 2.4.3, and 3.4.2 of the FPM.

1.2. Vertical Datums

The tidal datums for this project are referenced to Chart Datum, Mean Lower Low Water (MLLW) and Mean High Water (MHW). Soundings are referenced to MLLW and heights of overhead obstructions (bridges and cables) are referenced to MHW.

1.2.1. Water Level Data Acquisition Monitoring

The Commanding Officer (or Team Leader) and the Center for Operational Oceanographic Products and Services (CO-OPS) are jointly responsible for ensuring that valid water level data are collected during periods of hydrography. The Commanding Officer (or Team Leader) is required to monitor the pertinent water level data via the CO-OPS Web site at http://tidesandcurrents.noaa.gov/hydro.shtml, or through regular communications with CO-OPS/Oceanographic Division (OD) personnel before and during operations. During traditional non duty hours, the Commanding Officer/Team Leader may contact the Continuous Operational Real-Time Monitoring System (CORMS) watch stander who is available 24 hours/day - 7 days/week for assistance in assessing the status of applicable water level station operation. The CORMS watch stander may be contacted either by phone at 301-713-2540 or by email: CORMS@noaa.gov. Problems or concerns regarding the acquisition of valid water level data identified by the Commanding Officer/Team Leader shall be communicated with CO-OPS/OD (nos.coops.hpt@noaa.gov) to coordinate the appropriate course of action to be taken such as gauge repair and/or developing contingency plans for hydrographic survey operations. In addition, CO-OPS is required to coordinate with the Commanding Officer (or Team Leader) before interrupting the acquisition of water level data for the NWLON stations mentioned above for any reason during periods of hydrography.

1.2.2. The Hydro Hot List (HHL)

Please contact the CO-OPS/Hydrographic Planning Team (HPT) at nos.coops.hpt@noaa.gov and the Operational Engineering Team (OET) at nos.coops.oetteam@noaa.gov at least three business days before survey operations begin, and within 1 business day after survey operations are completed so that the appropriate CO-OPS National Water Level Observation Network (NWLON) control water level station is added to or removed from the CO-OPS Hydro Hotlist (HHL) (http://tidesandcurrents.noaa.gov/hydro). Include start and end survey dates, full project number (e.g. OPR-H355-TJ-10), and control station numbers. The notification must be sent to both teams as OET is responsible for configuring the stations in the CO-OPS data base and HPT manages the addition and removal of stations from the HHL.

Station	Station ID	Residual Control	Type (NWLON, PORTS©, etc.)	Comment
Lime Tree Bay	9751401	Residual Control	NWLON	
Esperanza	9752695	Residual Control	NWLON	
San Juan	9755371	Residual Control	NWLON	
Magueyes Island	9759110	Residual Control	NWLON	

Table 1: All stations that need to be added to the HHL in support of NF-16-01

It is important to know that the addition of a water level station to the HHL ensures the station is monitored by CORMS and any problems are reported daily. However, platforms should view the HHL each morning of active survey operations and click on the "Plot" to double check that there are no problems with the required stations on that day. If a platform notices problems with data on their survey day of operation, please contact HPT at nos.coops.hpt@noaa.gov, CORMS at CORMS@noaa.gov, and their respective headquarters point of contact at HSD or NSD. Stations on the HHL are given priority for maintenance should a station cease normal operation during scheduled times of hydrography. CO-OPS will notify a field unit within 1 business day if a HHL water level station ceases operation during scheduled times of hydrography. This is in addition to the daily CORMS report that CORMS sends to NOAA field units, if the field unit's e-mail address is added to the CORM's daily e-mail list. To be added to the CORMS daily HHL report, the platform should contact CO-OPS' Data Monitoring and Analysis Team (DMAT) at nos.co-ops.dmat@noaa.gov and request to be added.

If the stations are listed on HHL, then weekly priority processing will occur and, for those water level stations, verified 6-minute water level data will be made available every week on Monday or Tuesday. If Monday happens to be a federal holiday, then the 6-minute verified water level data will be made available on the following Tuesday or Wednesday. In order to ensure that verified data is correctly downloaded please **select a date that is more than 7 days prior to the day of interest** in the 'From' field on the CO-OPS website.

1.3. Operating Tide Reducer Stations

1.3.1. CO-OPS Long Term Water Level Station Operation and Maintenance

The NWLON stations Lime Tree Bay, VI (9751401), Esperanza, PR (9752695), San Juan, PR (9755371) and Magueyes Island, PR (9759110), will provide water level reducers for this project. Therefore it is critical that they remain in operation during the survey. See Sections 1.1. and 1.2. concerning responsibilities.

No leveling is required at stations Lime Tree Bay, VI (9751401), Esperanza, PR (9752695), San Juan, PR (9755371) and Magueyes Island, PR (9759110) by NOAA's Nancy Foster personnel.

CO-OPS/FOD is responsible for the operation and maintenance of all NWLON primary control stations. If a problem is identified at an NWLON primary control station, FOD shall make all reasonable efforts to repair the malfunctioning station. However, CO-OPS may request assistance from the NOAA ship or NRT personnel in the actual repair of the water level station to facilitate a rapid repair. CO-OPS/FOD and the Commanding Officer (or Team Leader) shall maintain the required communications until the repairs to the water level station have been completed.

1.3.2. Subordinate Station Requirements

No subordinate water level stations are required for this project, however, supplemental and/or back-up water level stations may be necessary depending on the complexity of the hydrodynamics and/or the severity of the environmental conditions of the project area. The installation and continuous operation of water level measurement systems (tide gauges) at subordinate station locations is left to the discretion of the Commanding Officer (or Team Leader), subject to the approval of CO-OPS. If the Commanding Officer (or Team Leader) decides to install additional water level stations, then a 30-day minimum of continuous data acquisition is required. For all subordinate stations, data must be collected throughout the entire survey period for which they are applicable, and not less than 30 continuous days. This is necessary to facilitate the computation of an accurate datum reference as per NOS standards.

1.3.3. Tide Component Error Estimation

This section is not applicable for this project. Tidal Constituent And Residual Interpolator (TCARI) automatically calculates the error associated with water level interpolation. This error is incorporated into the residual/harmonic solutions and included in the Total Propagated Error (TPE) for the survey. Uncertainty values input into TCARI model are 2-sigma. Pydro will automatically supply 1-sigma values to CARIS when computing uncertainty.

1.3.4. GOES Satellite Enabled Subordinate Stations

This section is not applicable for this project.

1.3.5. Benchmark Recovery and GPS Requirements

This section is not applicable for this project.

1.3.6. Residual Water Level Station(s) Data

Tidal Constituent And Residual Interpolation (TCARI) method uses harmonic constituents and residuals from historical and operating water level stations to provide precise water level correction for bathymetric surveys. Download the Preliminary/Verified data at following water level station(s) data for all periods of survey.

The operating stations at Lime Tree Bay, VI (9751401), Esperanza, PR (9752695), San Juan, RP (9755371) and Magueyes Island, PR (9759110) will provide residuals for this project and must remain in operation during all periods of hydrography.

Station Number	Station Name	Latitude(N)	Longitude(W)
9751401	**Lime Tree Bay, VI**	**17° 41.8'**	**64° 45.2'**
9752695	**Esperanza, PR**	**18° 05.6'**	**65° 28.3'**
9755371	**San Juan, PR**	**18° 27.5'**	**65° 07.0'**
9759110	**Magueyes Island, PR**	**17° 58.2'**	**67° 02.8'**

1.4. Tidal Constituent and Residual Interpolation (TCARI)

1.4.1. For hydrography in the area of US Caribbean, apply the TCARI grid "NF1601.tc" supplied in conjunction with the water level data from Section 1.3.6 to produce a seamless tide correction. Refer to the TCARI Field SOP for detailed TCARI instructions.

1.4.2. This section is not applicable for this project.

1.4.3. TCARI Graphic

A diagram which includes the exported TCARI grid boundary is provided in digital copy format to assist with the information provided in section 1.4.1.

1.4.4. TCARI Final Solutions

Upon completion of project, submit a Pydro generated request for smooth tides, with times of hydrography abstract and mid/mif tracklines attached. Forward this request to final.tides@noaa.gov. Provide the project number, as well as sheet number, in the subject line of the email.

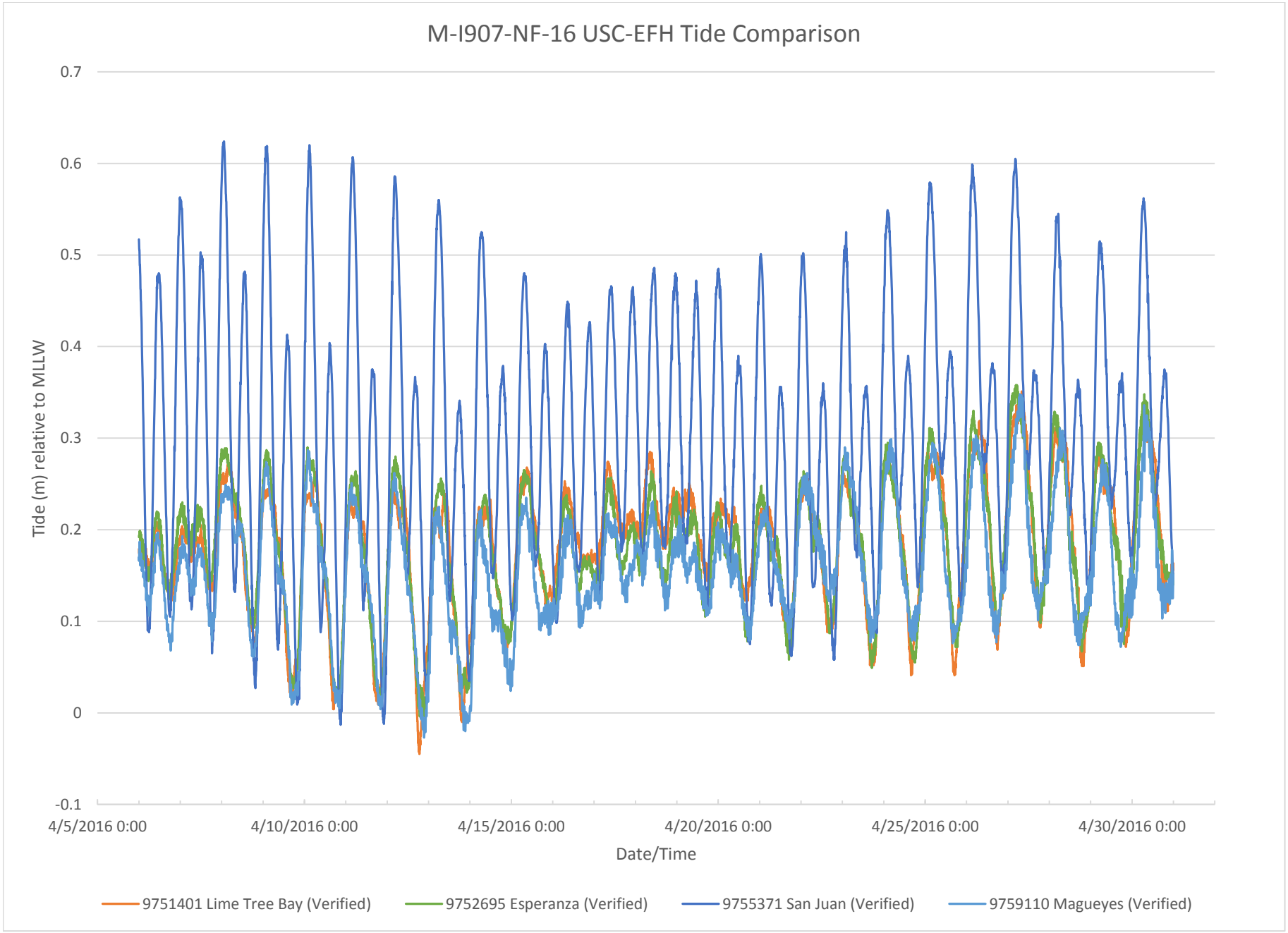
CO-OPS will review the times of hydrography, final tracklines, and six-minute water level data from all applicable water level gauges. If there are any discrepancies, CO-OPS will make the appropriate adjustments and forward a revised TCARI grid and solutions to the field group and processing branch for final processing.

1.5. Fetchtides

Preliminary and verified six minute water level time series data may be retrieved from the CO-OPS database via the Fetchtides application. Fetchtides provides a mechanism to store imported data locally and combines multiple days of data into one CARIS readable tide (.tid) file. Fetchtides is available for download at Hydrosoft Online (https://inside.nos.noaa.gov/hydrosoft/hydrosoftware.html. For more information, please see the Fetchtides User Manual in the FPM chapter 3 appendix.

1.6 Water Level Records

This section is not applicable for this project.


M-I907-NF-16 USC-EFH Tide Comparison
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Tide (m) relative to MLLW
4/5/2016 0:00
4/10/2016 0:00
4/15/2016 0:00
4/20/2016 0:00
4/25/2016 0:00
4/30/2016 0:00
Date/Time
9751401 Lime Tree Bay (Verified)
9752695 Esperanza (Verified)
9755371 San Juan (Verified)
9759110 Magueyes (Verified)

APPENDIX II

SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

H12936 does not include supplemental survey records and correspondence

APPROVAL PAGE

H12936

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

The following products will be sent to NCEI for archive

- H12936_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12936_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Briana Welton Hillstrom

Digitally signed by HILLSTROM.BRIANA.WELTON.1267667531
Date: 2017.12.19 10:56:38 -05'00'

Approved:_____

Commander Briana Hillstrom, NOAA
Chief, Atlantic Hydrographic Branch