U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey	**Hydrographic**
Project No.	**M-I907-NF-14**
Registry No.	**H12639, H12640**

LOCALITY

State	**Puerto Rico**
General Locality	**Caribbean Sea**

2014

CHIEF OF PARTY

Timothy Battista, Mike Stecher

LIBRARY & ARCHIVES

DATE **April 2014**

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

H12639
H12640

HYDROGRAPHIC STYLE 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.

FIELD No
NOAA Ship Nancy Foster

State	Puerto Rico
General Locality	Caribbean Sea
Sub-Locality	Lang Bank and Southwest Shoal, St Croix
Scale	1:40,000, 1:10,000
Date of Survey	March 12, 2014 to April 2, 2014
Instructions dated	February 21, 2014 Project No. M-I907-NF-14
Vessel	NOAA Ship Nancy Foster
Chief of party	Timothy Battista
Surveyed by	NOAA Center for Coastal Monitoring and Assessment
Soundings by	Reson 7125-SV2
Graphic record scaled by	N/A
Graphic record checked by	N/A
Automated Plot	N/A
Verification by	N/A
Soundings in	Meters at MLLW
Remarks	All times are UTC.

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ACRONYMS AND ABBREVIATIONS

BAG	Bathymetric Attributed Grid
BASE	Bathymetry Associated with Statistical Error
CCMA	Center for Coastal Monitoring and Assessment
CO-OPS	Center for Operational Oceanographic Products and Services
CTD	Conductivity Temperature Depth
CUBE	Combined Uncertainty and Bathymetry Estimator
DGPS	Differential Global Positioning System
FPM	Field Procedures Manual (April 2014)
GAMS	GPS Azimuth Measurement Subsystem
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSSD	Hydrographic Survey Specifications and Deliverables Manual (April 2012)
HSTP	Hydrographic Systems Technology Programs
HSX	Hypack Hysweep File Format
HTD	Hydrographic Surveys Technical Directives
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
MLLW	Mean Lower Low Water
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
OMAO	Office of Marine and Aviation Operations (NOAA)
POS/MV	Position and Orientation System for Marine Vessels
PPS	Pulse per second
ROV	Remotely Operated Vehicle
R/V	Research Vessel
SAT	Sea Acceptance Test
SBE	Smooth Best Estimate
SBET	Smooth Best Estimate and Trajectory
SVP	Sound Velocity Profiler
TPE	Total Propagated Error
TPU	Total Propagated Uncertainty
TSG	Thermosalinograph
USCRTF	U.S. Coral Reef Task Force
ZDA	Global Positioning System timing message
ZDF	Tide Zone Definition File

Data Acquisition and Processing Report
M-I907-NF-14 Caribbean Sea, USVI
March 2014
NOAA Ship Nancy Foster
Center for Coastal Monitoring & Assessment, Biogeography Branch
Lead Scientist, Timothy Battista

INTRODUCTION

In June 1998, the U.S. Coral Reef Task Force (USCRTF) was established by Presidential Executive Order 13089. The USCRTF mission is to lead, coordinate, and strengthen U.S. government actions to better preserve and protect coral reef ecosystems. The National Oceanic and Atmospheric Administration's (NOAA) Center for Coastal Monitoring and Assessment (CCMA) Biogeography Team is supporting the USCRTF mandate. The Biogeography Team has completed its eleventh year of an ongoing scientific research mission on board the NOAA Ship *Nancy Foster* from March 12th to April 2nd, 2014.

This report applies to surveys H12639 and H12640 located in the Caribbean Sea near St. Croix. These surveys were performed under M-I907-NF-14 as specified in the Hydrographic Survey Project Instructions signed on February 21st, 2014. The objective of this project was to collect a bathymetric dataset in waters greater than 10 meters with complete multibeam coverage, along with backscatter suitable for seafloor characterization in high-priority conservation areas. The delineation and identification of seafloor habitats within areas mapped during the mission was assisted by the use of an ROV with video and camera capabilities.

All references to equipment, software, and data acquisition and processing methods were valid at the time this document was prepared. Any deviations from these methods will be specifically addressed in the Descriptive Reports of the project surveys.

A. EQUIPMENT

Detailed descriptions of the equipment and systems, including hardware and software, used for bathymetric data acquisition and processing appear below.

Table 1. NOAA Ship Nancy Foster Hardware

Hydrographic Systems Inventory Cruise# M-I907-NF-14				**HARDWARE**
Equipment type	Manufacturer	Model	Serial #	Firmware
Reson	Reson	7125-SV2	1812025	MR 7.1.1
Reson Projector Unit	Reson	TC 2160	2308096	N/A
Reson Projector Unit	Reson	TC 2163	4408349	N/A
Reson Receiver Unit	Reson	EM 7200	2908034	N/A
Inertial GPS PCS	Applanix	POS/MV 320 V4	2249	3.2
IMU	Applanix	LN 200	447	N/A
DGPS	Trimble	DSM 132	224096283	3.0
SVP	Sippican	Deep Blue	n/a	N/A
SVP	SBE	SBE 19	1448	N/A
SVP	Reson	SVP 71	2008048	N/A

A1. SURVEY VESSEL

The NOAA Ship *Nancy Foster* (R352) is fifty-seven meters in length, has a beam of twelve meters, and draws approximately three meters of water. During the Charleston, South Carolina drydock period in November of 2005, numerous survey hardware and software installations were implemented by NOAA's Office of Marine and Aviation Operations (OMAO) to make multibeam data acquisition a more integral component of the ship's research support.

Figure 1. NOAA Ship *Nancy Foster*

A2. MULTIBEAM SYSTEMS

The *Nancy Foster* is equipped with a Reson SeaBat 7125-SV2 dual frequency multibeam sonar capable of operating at 200 or 400 kHz and integrated Reson SVP 71 sound velocity sensor. The *Nancy Foster* also has a Kongsberg EM1002, which was used during this survey, but all data was rejected and not submitted due to poor sonar performance. The 7125-SV2 multibeam is mounted on the hull, and is located port of the keel, and forward of the reference point of the vessel. The 7125-SV2 was operated at 400 kHz for the duration of the cruise. The 7125-SV2 produced a 128-degree swath of 512 equiangular beams with an along-track beam width of 1.1 degrees and across-track beam width of 0.5 degrees.

For this survey all multibeam data were acquired with the SV2 custom bracket selected in the hardware configuration with offsets entered from the vessel survey. Range adjustments were made during acquisition as dictated by changes in water depth. Other sonar parameters were kept a constant to maximize backscatter quality. Hypack HYSWEEP was used to acquire all multibeam data in the HSX file format and backscatter in the 7K file format.

A3. POSITION, HEADING and MOTION REFERENCE SYSTEMS

The *Nancy Foster* is outfitted with an Applanix Position and Orientation System for Marine Vessels (POS/MV) 320 version 4, Differential Global Positioning System (DGPS) and inertial reference system, which was used to measure attitude, heading, heave, and position. The system is comprised of an Inertial Motion Unit (IMU), dual frequency (L1/L2) Global Positioning System (GPS) antennas, and a data processor.

A Trimble DSM132 differential beacon receiver acquired corrections from the U.S. Coast Guard (USCG) beacon located at Isabel, Puerto Rico (295 kHz) and provided differential corrections to the POS M/V. The DSM132 was also configured to receive correctors from Omnistar when the vessel was out of range of the Isabel station. Positions from the systems were displayed in real-time using Hypack and POSView software and continuously monitored during survey operations.

Position, timing, heading and motion data were output to the Hypack acquisition system using the POS/MV real-time ethernet option at 25 Hz. Additionally, using the ethernet logging controls, the POS/MV was configured to log TrueHeave™ an all of the raw observable groups needed to post process the real-time sensor data if required. The POS/MV logged 13 megabyte (MB).000 files, which resulted in multiple files created per day.

The POS/MV also provided time synchronization of sonar instruments and data acquisition computers using a combination of outputs. The Reson processors and Hypack acquisition computers were provided a Pulse Per Second (PPS) and National Marine Electronics Association (NMEA) ZDA date and time message to achieve synchronization with the POS/MV. All messages contained time strings that enabled the acquisition computers and sonars to synchronize to the time contained within the message.

A position check between the POS/MV and DSM132 positioning system was documented while the vessel was secured and relatively motionless while tied up at the pier in St. Croix on March 23rd, 2014 (DN082). Logged position data from the POS/MV and DSM132 were compared with satisfactory results. Detailed information on the position confidence check is located in Separates I section of each of the DR reports for H12639 and H12640.

A4. SOUND SPEED MEASURMENT SYSTEMS

Hand launched Sippican Deep Blue Expendable Bathythermographs (XBTs) were the primary sound speed measurement instrument for this cruise. The Sea-Bird Electronics (SBE) sound velocity profilers used for QA/QC were factory calibrated prior to the start of acquisition. The calibration and comparison results are included in Appendix IV section of the DAPR for M-I907-NF-14.

A4.a SBE 19*Plus*

A SBE 19Plus Conductivity Temperature Depth (CTD) instrument for determining sound velocity throughout the water column was used to QA/QC the XBT's. Several SBE 19Plus sound velocity casts were deployed in conjunction with the XBT on DN71 and DN085 for comparison purposes. Sound velocity casts were processed with Pydro's Velocipy software and converted to Caris format. The vessel's hydraulic winch was rigged through the block of the port J-Frame davit, which provided a consistent rate of descent for acquisition of the SBE 19Plus data.

A4.b Reson SVP-71

A Reson SVP-71 sensor mounted on the Reson 7125-SV2 sonar head was input into the Reson 7- P processor. Sound speed values from the sensor were used in real-time during acquisition for beam forming on the 7125's flat array.

A4.c Sippican Expendable Bathythermograph (XBT)

Sippican Deep Blue XBTs were used as the primary CTD system for this cruise. They were deployed at approximately 4 hour intervals and QC'd with several SBE19Plus SVP casts. XBT casts were processed with Pydro's Velocipy software and converted to Caris format. The XBT was deployed off the aft deck while underway with an LM-3A hand-held launcher. All SVP casts were concatenated into one SVP file for each survey sheet.

A5. ACQUISITION AND PROCESSING SYSTEMS

All acquisition and processing workstations are located in the Dry Lab of the *Nancy Foster* and are networked together, and with the ship backup system. Coastal Oceanographics Hypack/Hysweep V2013 was used for 7125-SV2 bathymetric data acquisition and vessel navigation. The system provided precise time tagging of the sensor data and real-time data displays for quality control. Data was acquired in three formats: .RAW, .HSX and .7K. A combination of the Geocoder implementation included with Hypack and Fledermaus were used to process the backscatter acquired by the 7125-SV2.

Bathymetric survey data was converted and processed in Caris HIPS with modifications to the default CUBE (Combined Uncertainty Bathymetric Estimator) Parameters.XML. The default CUBE Parameters.XML was replaced with the file issued to all NOAA hydrographic field units included with the Field Procedures Manual (FPM). Processing methodology followed the standard Caris HIPS CUBE workflow. These steps include data conversion, filtering, sound velocity correction, tide correction, Total Propagated Error calculation, TrueHeave application, merging, and editing.

Table 2. Acquisition and Processing Software

Hydrographic Systems Inventory	**Cruise# M-I907-NF-14**		**SOFTWARE**
Equipment type	**Manufacturer**	**Model**	**Software Version**
Inertial GPS PCS	Applanix	POS/MV 320 V4	5.03
Navigation	Coastal Oceanographics	Survey	2013
Acquisition	Coastal Oceanographics	Hysweep	2013
Processing	NOAA	Velocipy	10
Processing	CARIS	HIPS & SIPS	7.1.2, 8.1.8
Processing	Fledermaus	FMGT	7.3.1
7k Control Center 7125	Reson	7125	FP1.3.2
7k Control Center 7125	Reson	7K UI	3.12.7.3
7k Control Center 7125	Reson	7K Center	3.7.11.11
7k Control Center 7125	Reson	7K IO	3.4.1.11

A6. SURVEY METHODOLOGY

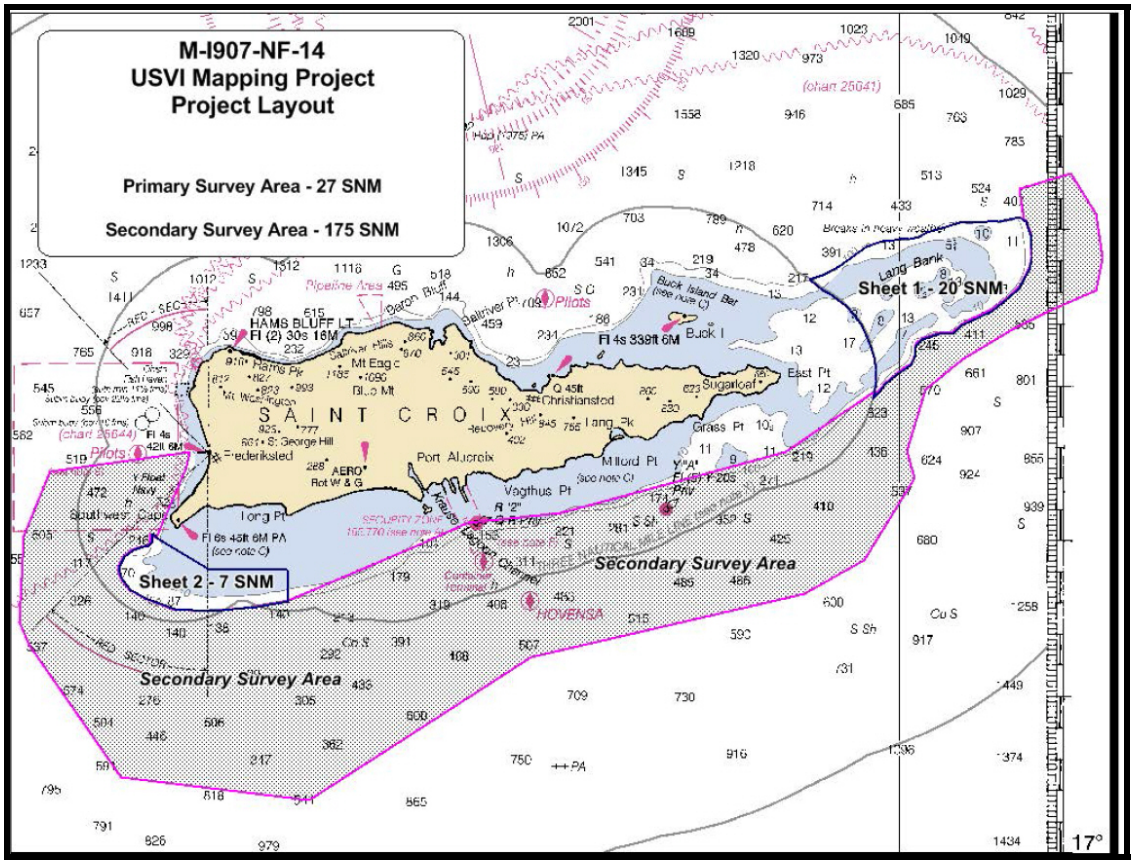
A6.a Mobilizations

Mobilization of the Nancy Foster occurred in Frederiksted, St. Croix at the Frederiksted Pier on March 11th-12th, 2014. Vessel offsets, draft and uncertainties used in the HIPS Vessel Files (HVF) were confirmed from the two vessel surveys performed on 2/7/06 and 2/28/11, and reconfirmed with hand tape measurements. These vessel offsets and uncertainties are used in the HVF for the 7125-SV2. No modifications to the survey vessel or sensor installation points have occurred since the close of M-I907-NF-13 that would impact offsets or dynamic draft tables. Once installation was complete and the hydrographer was confident that all sensors were operational, the survey vessel underwent system calibration tests and patch tests.

A6.b Survey Coverage

Survey coverage was based on the survey limits depicted by the M-I907-NF-14 USVI Mapping Project Instructions from the Atlantic Hydrographic Branch signed February 21, 2014. Sheets H12639 (Sheet 1) and H12640 (Sheet 2) were surveyed with line orientation appropriate for each of the survey boundaries, approximately parallel to contour or the orientation adjusted for encountered sea states. The survey project boundaries of H12639 and H12640 were completed. Sheet H12641 was not surveyed due to the *Nancy Fosters* inoperable deep water EM1002 multibeam system.

Figure 2. M-I907-NF-14 Sheet Layout



A6.c Multibeam Sonar Operations

Complete multibeam coverage was a requirement for this survey. Multibeam operations utilized the techniques defined by the Hydrographic Survey Specifications and Deliverables Manual, April 2014 (HSSD). The sonar systems were tuned to simultaneously maximize bathymetric and backscatter data quality by not over-saturating sonar returns by using Pydo's SATMON utility. The multibeam sonar was operated at different range scales throughout the survey by adjusting the depth range to obtain the best coverage in varying depths of water. Other parameters were left at a constant to maintain backscatter integrity.

Table 3. Typical Reson 7125-SV2 Sonar Settings

7125-SV2 Parameter	Value
Range	Variable, depth dependent
Gain	20 dB
Power	220 dB
Spreading	30 dB
Absorption	110 dB/km
Ping Rate	9-30 p/s
Pulse Width	33 µs

A7. QUALITY ASSURANCE

Acquisition and processing methods followed systematic and standardized workflows as defined by the FPM. These procedures include, but are not limited to record and log keeping standards, software version management, and a multilevel review process. Final MBES survey data were converted and processed in Caris HIPS versions 8.1.8. Data processing methodology followed the standard Caris HIPS CUBE (Combined Uncertainty Bathymetric Estimator) workflow. The default CUBE Parameters.XML was replaced with a file issued by the NOAA Hydrographic Surveys Technical Directive (CUBEParams_NOAA.xml). This updated XML file uses the resolution dependent maximum propagation distance values required in the HSSD.

B. QUALITY CONTROL

B1. Data Acquisition

B1.a Multibeam

Incremental adjustments to the sonar range were made during acquisition to ensure acquisition of the best quality bathymetric and backscatter data. Vessel speed was adjusted in accordance with the HSSD to ensure required along-track coverage. Typical windows for monitoring raw sensor information included timing synchronization, surface-sound velocity, vessel motion, GPS quality, intensity, and satellite coverage.

Pre-cruise position confidence checks and multibeam lead line checks were conducted to confirm horizontal and vertical positioning accuracies. An SVP comparison check was performed by deploying an XBT and SBE 19*Plus* simultaneously to the seafloor. The sound speed profiles were computed for each of the sensors and compared to confirm that instrumentation was

functioning within instrument tolerances.

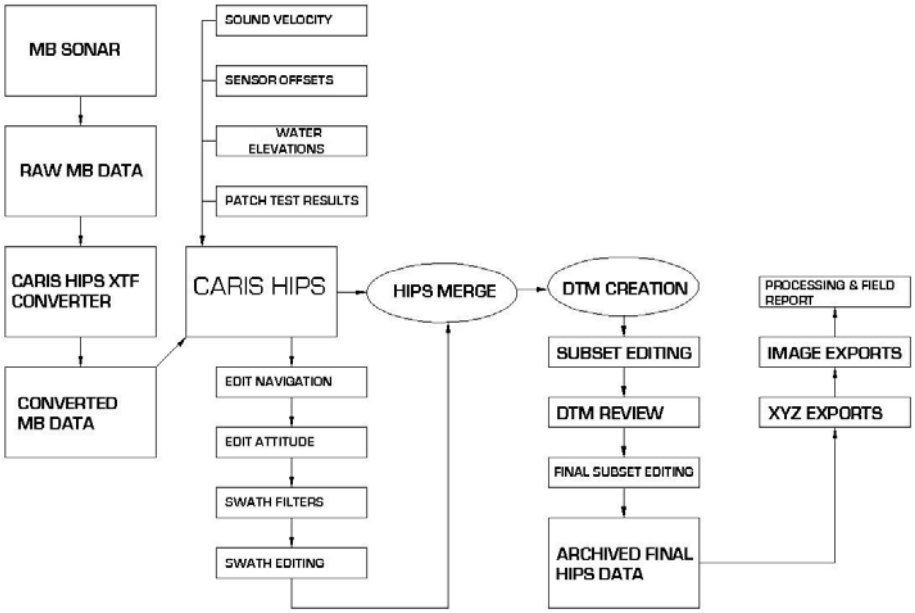
B2. DATA PROCESSING

B2.a Methodology Used to Maintain Data Integrity

The acquisition systems and survey protocols were designed with some redundancy to demonstrate that the required accuracy was being achieved during the survey and provide a backup to the primary systems. Data integrity was monitored throughout the survey through system comparisons. Position confidence checks and multibeam lead line checks were conducted to confirm required accuracy was being maintained. Two SVP comparison checks were performed by simultaneous deployment of an XBT and SBE19*Plus*. Sound speed profiles were computed for each of the sensors and compared to confirm instrumentation was functioning within instrument tolerances.

A general flow diagram of the data acquisition and processing pipeline is presented in Figure 3. This diagram graphically illustrates the general data pipeline and processing workflow from acquisition to delivery.

Figure 3. Flowchart of Data Acquisition and Processing Pipeline



B2.b HIPS Conversion

Multibeam data were converted from HSX format to Caris HDCS format using the Caris Conversion Wizard. HIPS ground coordinates (UTM NAD 83 20N) were selected in the Conversion Wizard dialogue and the device numbers fields were left blank since there were no duplicate sensors logged in the HSX files. No data were rejected based on quality flags during conversion. The Caris output window was monitored for failures during conversion.

B2.c Vessel Files

The HIPS HVF in Table 4 contains all offsets and system biases for the survey vessel and its systems, as well as error estimates for latency, sensor offset measurements, attitude and navigation measurements, and draft measurements. Sensor offsets values were calculated from a vessel survey performed in 2011 by the IMTEC Group, Ltd.

Table 4. HIPS Vessel Files

HIPS Vessel File	HIPS Converter	Sonar Type
NF7125-SV2_400kHz_512_2013	Hypack	Multibeam

The dynamic draft survey was performed during the Sea Acceptance Test (SAT) offshore of Charleston, S.C. in March 2006. OMAO representatives performed the survey and evaluated the results. The dynamic draft was determined using the reference surface method as per the FPM. Results of the dynamic draft survey were also entered into the vessel configuration files.

Total propagated uncertainty (TPU) values were entered into the vessel file based on current knowledge of the TPU/CUBE processing model. The manufacturers' published values were entered into the static sensor accuracy fields. Other values were either obtained from HTD 2007-10, calculated or estimated. TPU values for the *Nancy Foster* are listed in Table 5.

Table 5. Hydrographic Vessel File TPU Values

Manufacturer Accuracy Values for Total Propagation Uncertainty Computation	
HIPS Vessel File (HVF)*	
Motion Sensor	POS/MV
Position System 1	POS/MV Model 320 V 4
Position System 2	DSM132
Gyro - Heading	
Gyro (°)	0.020
Heave	
Heave % Amplitude	5
Heave (m)	0.050
Roll and Pitch	
Roll (°)	0.020
Pitch (°)	0.020
Navigation	
Position Navigation (m)	1.00
Latency	
Timing Trans (s)	0.010
Nav Timing (s)	0.010
Gyro Timing (s)	0.010
Heave Timing (s)	0.010
Pitch Timing (s)	0.010
Roll Timing (s)	0.010
Measurement	
Offset X (m)	0.002
Offset Y (m)	0.002
Offset Z (m)	0.002
Speed	
Vessel Speed (m/s)	0.015
Draft and Loading	
Loading	0.15
Draft (m)	0.15
Delta Draft (m)	0.030
Physical Alignment Errors	
Alignment	
MRU align Stdev gyro	0.0
MRU align roll/pitch	0.0
* *All values given as 1 sigma.	

Existing water level stations were used in conjunction with height and time correctors in a Caris tide zone definition file (ZDF). Predicted tides, adjusted to Mean Lower Low Water (MLLW), and ZDFs were supplied by the Center for Operational Oceanographic Products and Services (CO-OPS) prior to the commencement of survey operations. Verified six-minute-interval water level and final tide-zone correctors were applied while post-processing the data. During the computation of the TPE, survey-specific parameters including the estimated tidal errors were applied. The CO-OPS estimated tidal-error contribution to the total survey error budget is 0.10 meters at the 95% confidence level, and included the estimated gauge measurement error, tidal datum computation error, and tidal zoning error. It should be noted that the tidal error component can be significantly greater than stated if a substantial meteorological event or condition should occur during time of hydrography. The primary and subordinate stations experienced no downtime during periods of hydrographic survey.

The total tide uncertainty was entered in the HIPS Tide Value Zoning field during TPU computation. Sound speed and tide TPU values are listed in Table 6.

Table 6. TPU Values for Tide and Sound Speed

Total Propagation Uncertainty Computation in CARIS HIPS		
Tide Values	**Uncertainty (m)**	**Sheets**
Tide Value Measured	0.025	H12639, H12640
Tide Value Zoning	0.05	H12639, H12640
Sound Speed Values	**Uncertainty (m/s)**	
Sound Speed Measured (SN 7710)	4.0	H12639, H12640
Surface Sound Speed	1.0	H12639, H12640

B2.d Static Draft

Draft was measured pre- and-post cruise from draft marks on the port side of the vessel's hull for the 7125-SV2. The total draft change for the 7125-SV2 draft change was negligible. The draft value was entered into the "Waterline Height" field in the HVF.

B2.e Sound Velocity

Sound speed profiles were applied to each line using the nearest in distance within time (five hour) option in the Caris SVP correct routine. Velocity casts were taken at approximately four-hour frequency intervals with the XBT. The online surveyors made periodic comparisons and verifications of sound-velocity measurements that were made during survey operations between the SVP-71 and XBT values.

B3. CARIS DATA PROCESSING

Two field sheets were created for each Survey Sheet. CUBE surfaces were created using grid-resolution thresholds and resolution dependent maximum propagation distances for complete coverage surveys as specified in the HSSD. Multibeam data processing followed the standard HIPS workflow for CUBE editing except that the hypothesis surface was not edited; instead, fliers influencing the CUBE surface were rejected. Subset tiles were used to track the progress of processing activities. Surfaces were reviewed for excessive motion artifacts or systematic biases. All crosslines were manually reviewed for internal consistency between the datasets and

comparison statistics were also computed using the HIPS QC Report tool. These results are included in the Separates II section of the DRs for both H12639 and H12640.

Data were reviewed in HIPS 2D subset with the CUBE reference surface visible. Soundings rejected by quality filters were displayed during editing, and any feature removed by a filter was manually re-accepted. Fliers making the CUBE surface shoaler than expected by more than the allowable IHO Order vertical error were rejected. Thorough analysis determined that the 1m 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 either Survey Sheet.

Survey coverage was reviewed to confirm where, if any, holidays greater than three nodes or data gaps over significant contacts existed. The HIPS density layer of each grid was reviewed to confirm that the minimum sounding density of five soundings per node was achieved for 95 percent of nodes populated by mainscheme survey lines. After finalizing the CUBE surfaces, Total Vertical Uncertainty Quality Check child layers were created and review for International Hydrographic Organization (IHO) compliance.

Below is a list of the general workflow for processing the multibeam data. Several of the steps are interim processes, such as the water levels, SVP, merge and were re-applied as needed. The TPU was also re-computed for the multibeam data as needed to reflect changes in the correctors.

1. Apply true heave
2. Load zoned tide
3. Apply daily concatenated sound speed profiles
    - “Nearest in distance within time 5 hour”
4. Merge
5. Compute TPU via values listed in Tables 5 and 6
6. Filters applied based on the following criteria:
    - Reject soundings with poor quality flags (0,1,2)
    - Reject by swath width 60/60
7. Data reviewed and fliers removed in Swath Editor and/or Subset Editor
8. Add data to field sheet:
    - “CUBE” weighted surface of appropriate resolution for water depth
        - Density & Local Disambiguation method
        - Advanced configuration using the 2010 NOAA field unit parameters of the appropriate resolution surface
9. Review CUBE surface with reference surface enabled
10. Finalize surfaces with uncertainty from “Greater of the two”
11. Create TVU QC child layer and review for IHO compliance.

B4. Final Bathymetric Processing

The finalized CUBE surfaces were generated using the "greater of the two" option for the final uncertainty value. Resolution dependent depth thresholds were also applied as defined in the HSSD.

Finalized surfaces were then reviewed in the HIPS 3D graphics window with an extreme vertical exaggeration to verify that all fliers have been removed from the surfaces. The BASE Surface to BAG (Bathymetric Attributed Grid) function was then used on each CUBE Depth surface and exported from HIPS for submittal.

C. CORRECTIONS TO ECHO SOUNDINGS

C1. Static Draft

Static draft values were obtained from visual observations of the projection draft marks on the starboard side of the Nancy Foster for the 7125-SV2. The static draft recorded on March 11th, 2014 was determined to be -2.053m. The draft values were entered into the 7125-SV2 HVF and confirmed with leadline comparisons against sonar soundings. The final 7125-SV2 draft reading difference at the end of the cruise on April 2nd, 2014 was determined to be negligible.

C2. Dynamic Draft

The dynamic draft survey was performed during the Sea Acceptance Test (SAT) offshore of Charleston, South Carolina in March of 2006. Representatives from the OMAO performed the survey and evaluated the results. The dynamic draft was determined using the reference surface method as per the FPM. Results of the dynamic draft survey were entered into the vessel configuration files.

C3. LeadLine Comparisons

A lead line check was performed against the multibeam echosounder on March 23rd, 2014 (DN082) while the vessel was tied up alongside the pier. The lead line reading (unconsolidated sediment) was taken port of the multibeam system. Digital data was logged simultaneously during the lead line procedure. The multibeam data was then converted and queried in Caris HIPS swath editor to confirm that the acoustic depths matched the lead line reading. The lead line readings agreed with the multibeam soundings within 0.10m. This value is deemed adequate, considering the conditions that the comparisons were performed in. These observations were recorded in the acquisition log and are also included in Appendix II Echosounder Reports.

C4. Heave, Roll and Pitch Corrections

An Applanix POS/MV 320 v4 integrated dual frequency GPS and inertial reference system was used for the motion sensor for this survey. The POS/MV 320 is a 6-degree of freedom motion unit, with a stated accuracy of 0.05-meter or 5 percent for heave, 0.01 degrees for roll and pitch and heading. Real-time displays of the vessel motion accuracy were monitored throughout the survey with the POS/MV controller program. If any of the vessel motion accuracy degraded to greater than 0.05 degrees RMS, survey operations would be suspended until the inertial unit was able to regain the higher degree of accuracy. Manufacturer reported accuracies as published on

the Caris HIPS TPU website (http://www.caris.com/tpu/) were entered into the HVF and used for TPU computations.

C5. Patch Test

A multibeam patch test was performed for the Reson 7125-SV2 sonar system on March 21st, 2014 (DN080). The purpose of the patch test was to measure alignment offsets between the IMU sensor and the multibeam transducer, while also determining time delays between the time-tagged sensor data. The patch test consisted of a series of lines run in a specific pattern, which were then used in pairs to analyze roll, pitch, and heading alignment bias angles.

Roll alignment was determined by evaluating the reciprocal lines run over a flat bottom. The pitch tests consisted of set of reciprocal lines located on a steep slope. The yaw error was determined by running parallel lines over the same slope separated by approximately four times water depth. Latency lines were ran at varying speeds over a changing slope in the same direction. All lines were run at approximately three knots to six knots. Patch tests were run in the local survey area over a previously surveyed feature.

Selected pairs of lines were then analyzed in HIPS Calibration editor to measure the angular sensor bias values. Visual inspection of the data confirmed each adjustment. Patch test values for the sonar system are listed in Table 7.

Table 7. Patch Test Values

M-I907-NF-14 Patch Test Values				
	Pitch	**Roll**	**Yaw**	**Latency**
7125-SV2	-0.70	0.030	0.090	0.00

C6. Tide and Water Level Corrections

The primary water level stations for this project were the Christiansted (9751364) and Lime Tree Bay (9751401), USVI tidal stations. The HIPS Zone Definition File (ZDF) *I907NF2014CORP* provided by CO-OPS was used to apply final zoned tides to the multibeam data. These primary stations experienced no down time during periods of hydrographic survey.

C7. Sound Velocity Correction

Sound velocity casts were generally performed at four hour intervals during survey operations. After each cast the sound speed data was reviewed for outliers or anomalies that could impact data quality. Additionally, the sound speed measured by the XBT at the surface was compared to the Reson SVP 71 surface velocities for agreement and to ensure that both systems were working properly. In addition to these periodic comparisons, a comparison check was performed by simultaneously deploying and XBT and a SBE19*Plus* to the approximately the seafloor. The comparison did not reveal any outstanding system bias's.

The sound speed correction was applied to each line using the nearest in distance within time (five hour) option in the HIPS SVP correct routine. All casts were concatenated into a HIPS SVP file for each survey sheet. Time, position, depth, and sound speed for each profile were included in the HIPS file.

D. LETTER OF APPROVAL

The letter of approval for this report follows on the next page.

LETTER OF APPROVAL

M-I907-NF-14

DATA ACQUISITION AND PROCESSING REPORT

This report and the accompanying data are respectfully submitted.

Field operations contributing to the accomplishment of M-I907-NF-14 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and associated data have been closely reviewed and are considered complete and adequate as per the M-I907-NF-14 *Hydrographic Survey Project Instructions* (February 21, 2014).

Mike Stecher

Digitally signed by Mike Stecher
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Date: 2014.10.30 08:55:12 -07'00'