W00276

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey	**Hydrographic Multibeam Survey**
Project No.	**OSD-UNH-07**
Registry No.	**W00276**

LOCALITY

State	**Maine**
General Locality	**Kittery**
Sub-locality	**South Gerrish Island**

2007

UNH Summer Hydrographic Field Course 2007

NOAA FORM 77-28
(11-72)

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

REGISTRY No

HYDROGRAPHIC TITLE SHEET

W00276

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

State Maine

General Locality Kittery

Sub-Locality South Gerrish Island

Scale 1:10,000 **Date of Survey** 06/06/2007 to 06/07/2007

Instructions dated **Project No.** OSD-UNH-07

Vessel R/V Coastal Surveyor

Chief of party Andrew Armstrong, University of New Hampshire

Surveyed by UNH Summer Hydrographic Field Course 2007

Soundings by echo sounder, hand lead, pole Kongsberg EM3002D duel head multibeam echosounder

Graphic record scaled by

Graphic record checked by **Automated Plot**

Verification by Atlantic Hydrographic Branch

Soundings in **fathoms** *feet* **at** **MLW** **MLLW** MLLW

REMARKS:

Data was acquired by Group 1 of the University of New Hampshire, Center for Coastal and Ocean Mapping Hydrographic Field course.

NOAA FORM 77-28 SUPERSEDES FORM C&GS-537

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 Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.

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II . SURVEY FEATURE REPORT – N/A

III . FINAL PROGRESS SKETCH – N/A AND SURVEY OUTLINE

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V . SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

SEPARATES TO BE INCLUDED WITH THE SURVEY DATA

I . ACQUISITION AND PROCESSING LOGS

II . SOUND SPEED DATA

III . STATEMENT OF WORK – N/A

IV . CROSSLINE COMPARISONS – N/A

Descriptive Report to Accompany South Gerrish Island Survey

Summer Hydro Course, Group 1
Kittery, Maine
May - June 2007
Center for Coastal and Ocean Mapping / Joint Hydrographic Center
University of New Hampshire

A. AREA SURVEYED

The survey area was near Kittery, Maine, off-shore of the southern part of Gerrish Island as shown in Figure 1 below. The survey area is bounded to the North by 43°04’11”N, to the West by 70°40’38”W, to the South by 43°03’31”N, and to the East by 70°39’47”W.

Data were acquired as part of the summer hydrographic training course at the University of New Hampshire, Center for Coastal and Ocean Mapping and Joint Hydrographic Center. The area surveyed was selected to overlap lidar data to be collected during summer 2007 for comparison purposes.

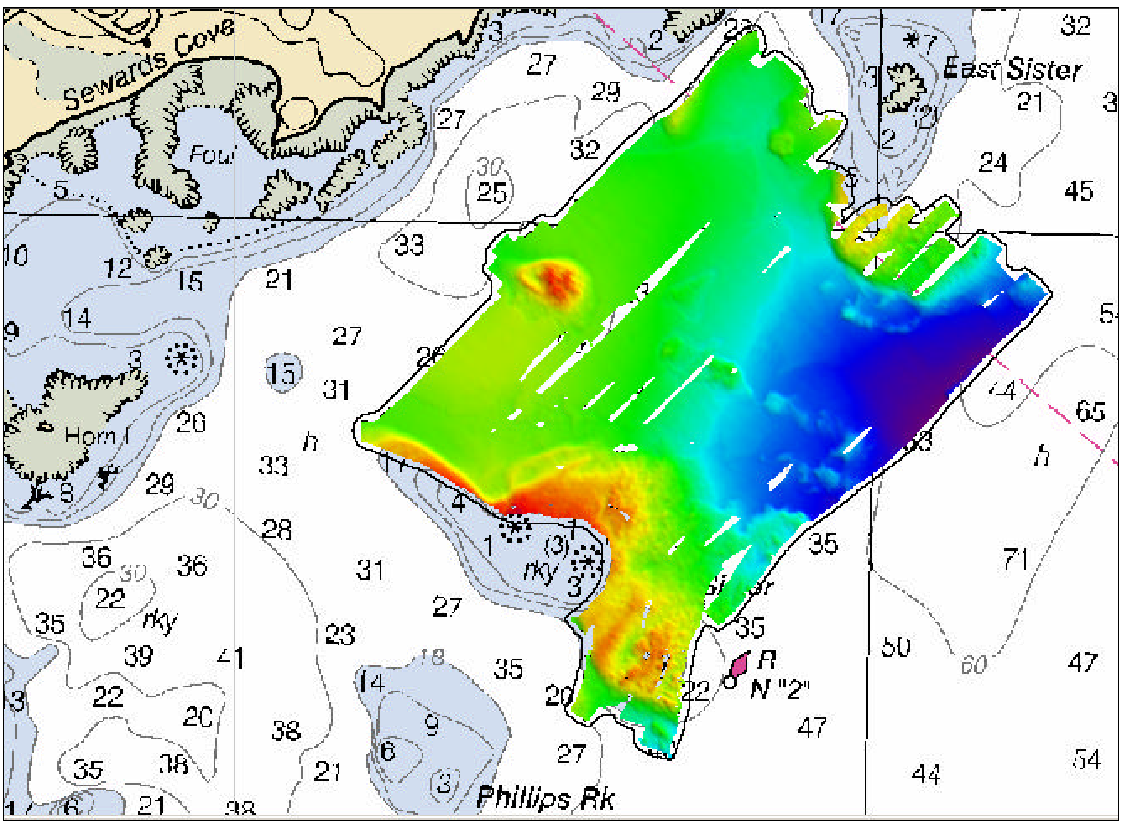


Figure 1: South Gerrish Island Survey area

Multibeam echosounder (MBES) data was obtained in the survey area between 1.5 and 20 meters of depths. When conditions allowed, MBES data was acquired parallel to contours in depths with areas shoaler than 3 meters obtained during higher stages of tide and in calm conditions due to safety considerations. Full coverage was not obtainable due to weather and time constraints.

Mileage for the R/V Coastal Surveyor:

12.9 - lineal nautical miles of multibeam mainscheme only sounding lines.
0.0 - lineal nautical miles of multibeam crossline sounding lines.
0.0 - lineal nautical miles of multibeam developments sounding lines.

Total statistics for the survey:

0.16 - total square nautical miles collected.
June 6-7, 2007 (Dn 157 and 158) were the dates of acquisition.

B. DATA ACQUISTION AND PROCESSING

B1. Equipment and Vessels

1.0 Software

Specific software used during the survey is listed and described below.

1.1 Data Acquisition Software

1.1.1 MapInfo™

MapInfo™ was used to create line plans to be run in Hypack while surveying. The HydroMI, an HSTP -produced and -maintained MapBasic program, is used through MapInfo to convert both the Mapinfo lines into the Hypack (.lnw) format and the tide and tidal zoning files into a format that is useable in CARIS HIPS.

1.1.2 HYPACK®

The Hydrographic software package (version 4.3a) from HYPACK Inc., was used for line planning and vessel navigation. The program allows for planned lines to be displayed with reference files such as RNC/ENC charts and georeferenced bathymetric digital terrain models.

1.1.3 Seafloor Information System SIS

Seafloor Information System (SIS) version 3.4.1 (Build 112, May 1, 2007) provided by Kongsberg Maritime AS was the software package used to acquire and log multibeam echo sounder and backscatter data from the EM3002D system on the Coastal Surveyor during acquisition.

Multibeam data was logged in the SIS format with file extension (.all).

Surface sound speed was incorporated through SIS and sound speed profile data was processed in SIS. Water column profiles were created, archived, and applied in real-time during data acquisition.

1.2 Data Processing Software

1.2.1 CARIS

CARIS HIPS™ (Hydrographic Information Processing System) was used to process all multibeam data including data conversion, tide correcting, merging along with cleaning and filtering as necessary. CARIS HIPS also calculated the Total Propagated Error (TPE) used to produce Bathymetry Associated with Statistical Error (BASE) surfaces which assisted the Hydrographer in data cleaning and analysis. A CARIS BASE surface of type CUBE at one meter resolution is the main deliverable.

2.0 Hardware

2.1 Hardware Systems Inventory

Equipment used for data acquisition and survey operations during this survey are listed below. Installation and calibration dates along with models and serial numbers are included where applicable.

2.2 Sound Speed Equipment

2.2.1 SV Plus Applied Microsystems Profiler

Coastal Surveyor was equipped with a SV Plus Applied Microsystems sound velocity profiler (Fig. 2) S/N 3319 used to acquire sound speed data in the water column. Its field accuracy is 0.05 m/s with precision of 0.03 m/s and a sampling rate of 25Hz.

2.2.2 Smart SV&T Applied Microsystems Profiler

Coastal Surveyor was equipped with a Smart SV&T Applied Microsystems (Fig. 3) S/N 5218 sound velocity profiler mounted in front of the transducers. The sound speed information from this device was integrated in real time with the EM3002D processing unit and used as surface sound speed for beam forming at the transducer face. On Dn158, the electronics in this profiler came out of its housing and had to be replaced by an Odom Digibar profiler.

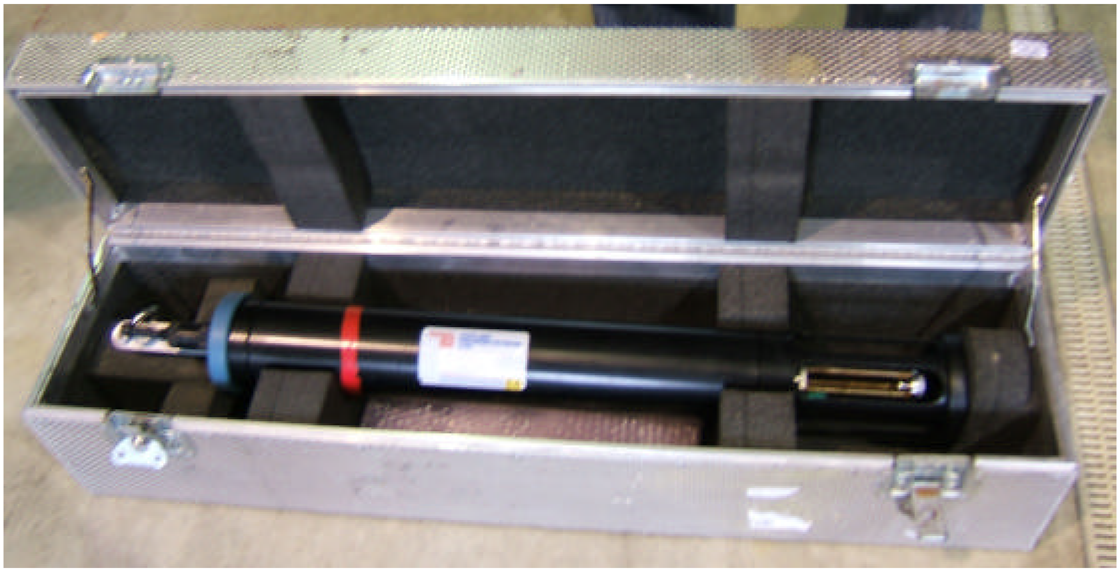


Figure 2: SV Plus Sound Velocity profiler

Figure 3: Smart SV&T Surface Sound Speed unit mounted with Transducers

2.2.3 Odom Digibar Pro profiling sound velocimeter

After the Smart SV&T damage on Dn158, R/V Coastal Surveyor was equipped with an Odom Digibar Pro model DB1200 S/N 98139 profiling sound velocimeter mounted in front of the transducers. The sound speed information was input into the EM3002D processing unit and used as surface sound speed for beam forming at the transducer face. No data was collected for the South Gerrish Island survey using this sensor.

2.3 Vertical Control Equipment

2.3.1 Water Level Gauge

For details on the vertical control equipment used, see the vertical control report in Appendix IV.

2.4 Horizontal Control Equipment

A Trimble GPS 5700 Real Time Kinematic (RTK) was utilized which was transmitted using Radio Modem Trimble Trimmark 3. The output from the Trimmark 3 was conveyed through to the POS/MV. The base station is occupied by Trimble 5700 RTK S/N 0220358293, combined with Trimble Trimmark 3 S/N 4526152517. At the R/V Coastal Surveyor, the RTK signal was received by Trimble Trimmark3 modem S/N 452615253 and then imputed into the POS/MV (S/N 2171) for that unit’s positional update as navigational information to the sonar system.

2.5 Kongsberg EM3002D Multibeam Echosounder (MBES)

Coastal Surveyor was equipped with two Kongsberg EM3002D MBES transducers, Sonar head – port side S/N 322 and Sonar head – starboard side S/N 481. Both transducers were mounted on the front pole of the R/V Coastal Surveyor as shown in Figures 4 and 5.

The EM3002D is a shallow water MBES with a nominal frequency of 300 kHz but real frequencies of 293 kHz and 307 kHz were used. The swath is made up of 160 beams each transducer with an along-track and across-track beamwidth of 1.5°. The system was used in the EQUIANGULAR beam spacing mode.

2.6 Positioning, Heading, and Attitude Equipment

2.6.1 Applanix Positioning and Orientation System for Marine Vehicles (POS/MV)

The R/V Coastal Surveyor was equipped with an Applanix POS/MV model MV V4 S/N 2171. The POS/MV calculates the position, heading, attitude, and vertical displacement (heave) of a vessel. It consisted of a rack mounted version 2.12 POS Computer System (PCS), a strap down IMU-200 (Inertial Measurement Unit), and two NovAtel GPS antennas corresponding to GPS receivers in the PCS (see Fig. 6). The port side antenna S/N 60004297 was designated as the primary receiver, and the starboard side antenna S/N 60008122 was the secondary receiver.

Figure 4: Head transducers

Figure 5: Pole mounting in the RV Coastal Surveyor bow

Differential correctors are supplied to the POS MV by Trimmark3 radio modem. The positioning mode in Applanix was either Fixed or Float RTK mode. In the event that RTK was not available or clearly received, a secondary positioning system, C-Nav, was setup as a backup.

Figure 6: POS/MV antennas mounted on the R/V Coastal Surveyor (top-rear view)

2.6.2 Real Time Kinematic positioning (RTK)

For the South Gerrish Island survey, the base station was occupied by Trimble GPS 5700 Real Time Kinematic (RTK) S/N 0220358293, combined with a transmitting Radio Modem, Trimble Trimmark 3 S/N 4526152517. At the R/V Coastal Surveyor, the RTK signal was received by Trimble Trimmark3 modem S/N 452615253 and then imputed into the POS/MV (S/N 2171) for that unit's positional update as navigational information to the sonar system.

The base station, Trimble 5700 RTK using GPS antenna type Zephyr Geodetic S/N 60073787, observed the GPS signal to determine real time position and carry out position correction calculations. The differential corrections in Fixed-RTK mode were generated by this Trimble base station, output in CMR format, and transmitted by radio modem the base station Trimmark3. The RTK signals were transmitted at 10 watts in CMR format at 19200 baud and were clearly received by R/V Coastal Surveyor throughout survey acquisition.

2.6.3 C-NAV

Coastal Surveyor was equipped with C-Nav world Differential GPS S/N 787004 which was operated as a secondary differential positioning system in case of a missing or unclear RTK signal from the base station. This ensured that if the RTK signal was lost, the POS/MV would still be receiving differential correctors.

3.0 Vessel

3.1 Vessel Information

The Coastal Surveyor was equipped to acquire multibeam echosounder (MBES) and surface and profile sound speed data. See Table 1 for the vessel details.

Figure 7: RV Coastal Surveyor

	R/V Coastal Surveyor
Official Number	**999206**
USCG	Designated Research Vessel, subchapter "C"
Length Overall	40 feet
Beam	12 feet
Draft, Maximum	3.7'
Max Survey Speed	10 knots
Attitude & Positioning Equipment	POS/MV V3
Type of operations	Research vessel

Table 1: Vessel Details

4.0 Personnel Inventory

Personnel associated with this survey included participants, instructors, and vessel personnel associated with the University of New Hampshire summer field course.

Group Participants:
- Lynnette Morgan
- Mohammad Yazid
- Jose Gianella
- Robert Bogucki

Instructors:
- CAPT (r) Andrew Armstrong
- Semme Dijkstra

RV Coastal Surveyor crew:
- Ben Smith
- Bridget Kelley

B2. Quality Control

Internal consistency and integrity of data collected for the South Gerrish Island survey were manually examined by the Hydrographer in CARIS subset mode. The internal consistency and integrity of data collected for the survey were found to be very good.

1.0 Procedures

1.1 Multibeam Echo Sounder Acquisition and Monitoring

Methods of acquisition took into consideration system performance limitations, the bottom topography, water depth, and the ability of the vessel to safely navigate the area.

All multibeam data were acquired in Seafloor Information System format (ALL) and monitored in real-time using the SIS data display windows associated with the EM3002D. Adjustable parameters that were used to control the EM3002D from the SIS software included operating in manual, equi-angular mode with the port coverage set at 60/10 and the starboard coverage set at 10/60. These parameters were adjusted to limit the beam foot print size to ensure object detection. Additionally, vessel speed was kept below 8 knots to ensure the required along-track coverage for object detection. Mainscheme multibeam sounding lines were generally run parallel to the contours at a line spacing approximately three times the water depth.

1.2 Crosslines

No multibeam crosslines were collected during this survey due to weather constraints and time limitations.

A few holiday lines and portion of the mainscheme were run roughly perpendicular to other mainscheme. These areas of overlap were manually examined. The overlapping lines showed good agreement (within 0.1m) with mainscheme data.

1.3 Junctions

The South Gerrish Island survey conducted for the summer 2007 hydrographic course overlapped in its entirety with the summer 2006 hydrographic course data. A comparison was conducted between the two survey data sets. Agreement was within 1m.

1.4 Uncertainty Modeling

An understanding of the errors inherent in the multibeam systems and ancillary equipment is required for the proper use of CARIS HIPS & SIPS 6.1. These values are used to generate an uncertainty model needed to compute the Total Propagated Error (TPE) estimation and for the creation of Bathymetry Associated with Statistical Error (BASE) surface. Uncertainty information for Coastal Survey has been entered into the HIPS Vessel File (HVF). The uncertainty information entered reflects the statistical accuracy to which equipment can measure a value or to which a value was measured in the case of offsets.

Error estimates for Coastal Surveyor were compiled from manufacturer specification sheets for each sensor (Heave, Pitch, Roll, Position, and Heading) and calculated for instrument reading uncertainty for static measurements (Draft and Offset measurements). CARIS and NOAA recommendations were used where appropriate. A full spreadsheet of the values utilized along with the source and comments is included in Appendix V.

1.5 Data Quality Factors

Lines (holidays) run at later times then the mainscheme lines showed an approximate 0.2m vertical offset with the initial NOAA tide gauge data applied, 8423898.tid and the ShallowWater08_ZoningCORP.zdf. The summer course participants focusing on vertical control for the summer course reviewed the data at the NOAA gauge and the CCOM backup gauge, see Appendix IV for the detailed report that explains the need for and use of the CCOM backup gauge. The CCOM backup gauge was formatted into the CARIS .tid format and the .zdf file was edited to accommodate this alternate gauge. Once the 8423898C.tid and the CCOM_ShallowWater08_ZoningCORP.zdf files were applied to the data, the areas that had previously shown a 02.m vertical offset showed at most a 0.1m offset.

1.6 Accuracy Standards

All data meet the data accuracy specifications as stated in the *NOS Hydrographic Surveys Specifications and Deliverabls (NHSSD)*, dated April 2007.

The bathymetric data acquired during this project has been examined and it meets or exceeds the specifications defined in the *NHSSD*. In accordance with the *NHSSD*, the vertical accuracy standards are S-44 IHO Order 1 for water 100 meters or less in depth.

B3. Corrections to Echo Soundings

1.0 Vessel

1.1 Vessel HVFs

The CARIS HIPS Vessel File (HVF) was created and used to define the vessel’s offsets and equipment uncertainty. The HVF was used for converting and processing data collected by the survey platform. An HVF Report was produced in the CARIS Vessel Editor. This text file lists out specific HVF entries and is included in Appendix V.

1.2 Vessel Offsets

Sensor offsets were measured with respect to the vessel’s reference point at the top center of the inertial measurement unit (IMU). Specific offset values were input into the POS/MV and SIS for application during acquisition. The IMU to port antenna separation was input into the lever arm tab of the POS/MV setup. The IMU to the port and starboard transducers, mounting angles of the transducers, and the waterline were input into the SIS sensor location fields. Offsets were also included in the TPE portion of the HVF for uncertainty processing. Offsets for the R/V Coastal Surveyor are included in Appendix V.

2.0 Transducers

2.1 MBES Calibration

A patch test was conducted for the EM3002D dual head acquisition system on Coastal Surveyor. A description and the results of the MBES Calibration (patch test), along with the acquisition and processing log, are included in Appendix V. The results of the patch test were inserted into the HVF to be applied to the data during post-processing in CARIS.

3.0 Draft

3.1 Dynamic Draft Settlement & Squat

Dynamic Draft Settlement and Squat (DDSSM) testing was not conducted in 2007. The results from the 2006 DDSSM for Coastal Survey were utilized in the HVF to be applied to the data in post-processing in CARIS. The 2006 results are included in Appendix V.

3.2 Static Draft and Loading

A site tube was used to measure the Coastal Surveyor static draft. The waterline value for Dn 157 and 158 was 0.499m, which was entered in the SIS software and applied to the data during acquisition. Loading information was gathered from readings of the site tube before and after surveying each day. The loading uncertainty was calculated to be 0.01m and entered in the TPE section of the CARIS HVF.

4.0 POS/MV Correctors

4.1 POS/MV GAMS Calibration

A GAMS calibration for the POS/MV was performed in the vicinity of Portsmouth Harbor on Dn157. The GAMS calibration procedure was conducted in accordance with section 4-24 to 4-32, of the *POS/MV Version 4 Installation and Operation Manual*, Revision 1, 2005. During GAMS calibration, the positioning system used was in Fixed RTK mode. Results of the GAMS calibration and screen grabs of settings are included Appendix V.

4.2 Position Computation

The POS/MV was used for positioning multibeam data aboard R/V Coastal Surveyor. The POS/MV controller software was used to monitor position accuracy and quality during data acquisition. This ensured that positioning accuracy requirements were met, as outlined in section 3.1 of the *NOS Hydrographic Surveys Specifications and Deliverables*. The POS/MV controller software provides clear visual indications whenever accuracy thresholds are exceeded.

Differential corrections were received via radio modem the base station setup at Odiorne Point. These correctors were input via serial cable into the POS/MV for positioning during data acquisition. Fixed or Float RTK was the mode during acquisition of the South Gerrish Island survey. Detailed information is provided in the Horizontal Control report included in Appendix IV.

4.3 Heading, Pitch, and Roll Computations

The heading computed by the POS/MV along with the pitch and roll values were used as correctors for the multibeam data. These correctors were applied in the SIS software during acquisition.

4.4 Heave Computation

Real time heave correctors from the POS/MV were used as correctors for the multibeam data. These correctors were applied in the SIS software during acquisition.

The POS/MV on Coastal Surveyor is equipped with the TrueHeave™ option. Stored TrueHeave™ data contain time stamps with attitude, position, acceleration, and rotation information. TrueHeave™ data were acquired during acquisition. These data were not loaded nor applied to the data in CARIS HIPS & SIPS 6.1. This was due to the True Heave being collected relative to the IMU, while the data from the .all file converted into CARIS already had offsets applied and was therefore referenced to the transducers.

5.0 Sound Speed

5.1 SV Plus Applied Microsystems Profiler

Sound speed casts from the SV Plus Profiler were processed and applied to the data in the SIS software as correctors to the echosounder data. No post-processing of sound speed was performed on the data.

6.0 Water Level

6.1 Correctors

Unverified observed water level correctors were applied to the data. Tide data downloaded from the Center for Coastal and Ocean Mapping (CCOM) backup gauge was converted into the CARIS readable 8423898C.tid file and applied with an edited version of the CCOM_ShallowWater08_ZoningCORP.zdf provided by CO-OPS. The .tid file was applied to data along with the zone definition file (.zdf) in CARIS HIPS & SIPS 6.1 using the load multiple tide function. For details into the issues leading to the use of the backup gauge, see the vertical control section C1 of this document and the vertical control report in Appendix IV.

Observed tides were applied to the South Gerrish Island data. It will be necessary for the processing branch to apply the final approved water levels (smooth tides) to the survey data during final processing of the survey.

6.2 Vertical Datum

The vertical datum for this project is Mean Lower-Low Water (MLLW).

B4. Data Processing

1.0 Multibeam Processing

1.1 Flowchart

A detailed *Data Processing Work Flow* is included for reference in Appendix V.

1.2 CARIS functions and Total Propagated Error

Raw (.all) multibeam data from the SIS acquisition software were converted to HDCS format in CARIS HIPS & SIPS 6.1 through Hot Fix 13. Tide corrections, dynamic draft correctors, bias information and timing errors were applied to the data during "Merge". Sound speed corrections, sensor lever arm information, and attitude correctors were not applied in HIPS during data processing because they had already been applied to the data during acquisition. Once lines were merged, the Total Propagated Error (TPE) was computed in HIPS to determine the quality of the multibeam data.

The TPE takes into account uncertainties in the measurements coming from each sensor (Heave, Pitch, Roll, Position, Heading, Sound Velocity, and Tide) and uncertainties in static measurements (Draft and Latency) to calculate the total uncertainty associated with each sounding. CARIS HIPS & SIPS 6.1 uses the vertical uncertainty from TPE to produce a Bathymetry Associated with Statistical Error (BASE) surface. BASE surfaces produced for this survey were of CUBE surface type. These BASE surfaces and child layers (Depth, Uncertainty, Standard Deviation, Mean, Hypothesis Strength, Hypothesis Count, Density, and User Nominated) were used for directed data editing, to demonstrate coverage, and to check for systematic errors such as tide, sound velocity, or attitude and timing errors.

Vessel heading, attitude, and navigation data were only reviewed and/or edited in navigation editor and attitude editor as deemed necessary by the Hydrographer. The multibeam data were reviewed and edited in HIPS swath editor and subset mode as needed.

1.3 Coverage

The BASE (CUBE) surface produced as a deliverable was at a 1m resolution to ensure object detection of a 2m object.

1.4 Designated Soundings

In areas of with significant features where the CUBE surface did not depict the desired depth for the given area, a designated sounding was selected.

Designated soundings were selected based on the difference between the CUBE surface and reliable shoaler sounding(s) being more than half of the allowable IHO Order 1 error budget as stated in section 5.1.1.3 of the *NOS Hydrographic Surveys Specifications and Deliverables* .

C. VERTICAL AND HORIZONTAL CONTROL

A summary of horizontal and vertical control for this survey follows. Detailed reports for vertical and horizontal control are included in Appendix IV.

C1. Vertical Control

The vertical datum for this project is Mean Lower-Low Water (MLLW). The operating NOAA tide station at Fort Point, NH (8423898) served as the reference station and as the initial source for water level reducers for the South Gerrish Island survey during acquisition.

An Aanderaa strain gauge was installed at the station listed below. The gauge was put in as a backup to the current NOAA gauge installation.

Data from the backup gauge was utilized as the source for water level reducers in post processing due to problems with the Aquatrak Controller in the NOAA gauge prior to its replacement on June 7, 2007. Data for the South Gerrish Island survey was collected on June 6 and 7, 2007 and was therefore affected by these issues. A tide file was produced from the Aanderaa gauge and utilized with the current zoning file as water level reducers.

Station Name	**Date of Installation**	**Date of Removal**
CCOM Backup	June 4, 2007	Still collecting at time of report

Field Hydrographic course participants at the University of New Hampshire were responsible for installation of the water level gauge at the US Coast guard base Portsmouth Station in New Castle, New Hampshire as a backup to the NOAA gauge.

C2. Horizontal Control

The RTK base station is located on the top of Seacoast Science Center, Rye Beach, New Hampshire. Its position was determined using GPS satellite observation for three hours, and the data was submitted to OPUS. The data was processed to produce positional information for the station including its accuracy. The final position of the station was: 43º02'43,37191" N 70º42'49.69890 W height -13.912 m. The horizontal position accuracy at the RTK base station was 0.013 meter and 0.025 in vertical, respectively.

The horizontal datum for this project is the North American Datum of 1983 (semi major axis 6,378,137 m with an eccentricity squared 0.006694300229).

D. RESULTS AND RECOMMENDATIONS

D.1 Chart Comparison

The 1m resolution BASE surface was brought into Fieldsheet Editor in HIPS 6.1. The soundings were displayed with the applicable charts displayed behind for comparison. The BASE surface was also displayed as a translucent layer to reveal trends.

The South Gerrish Island survey was compared with the chart 13283 "Portsmouth Harbor-Cape Neddick Harbor to Isles of Shoals", scale 1:20 000, 19 edition Feb/05.

Chart 13283

The twenty eight soundings shown in NOAA chart 13283 generally agree with the depths from the survey (Fig. 8) with the exception of one 30 feet sounding. This sounding located at 43° 03' 48" N and 70° 40' 23" W is six feet deeper than the charted depth in the surrounding area.

Figure 8: Charted (13283) 30 feet sounding and surrounding soundings from BASE surface

In a shoal area of the survey, a discrepancy of 1 foot was found 43° 03' 57" N and 70° 40' 23" W, see Figure 9.

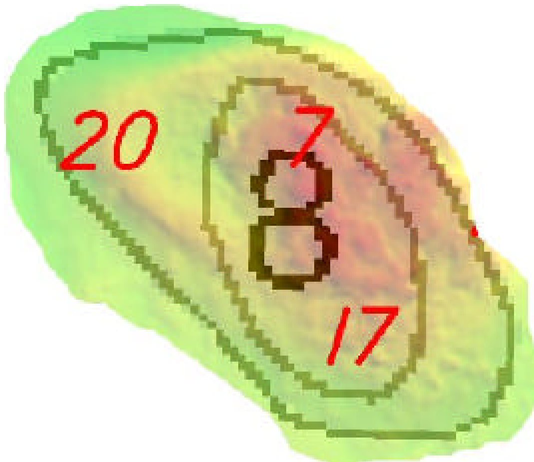
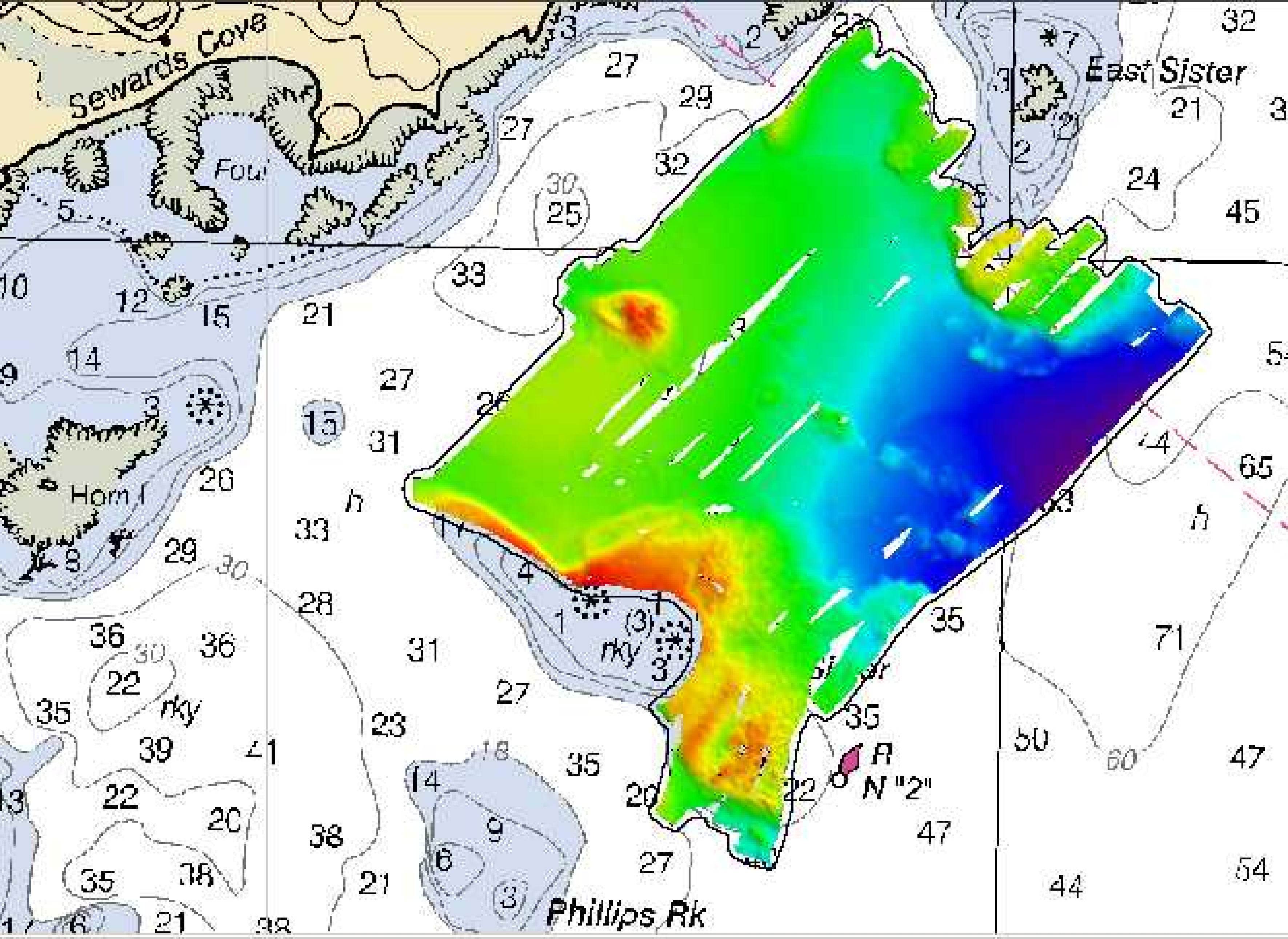


Figure 9: Charted (13283) 8 foot sounding and surrounding soundings from BASE surface

Chart Comparison and Recommendations

The Hydrographer has determined that the data meets accuracy requirements for IHO Order 1. The BASE surfaces with the application of designated soundings are adequate to supersede prior surveys in their common areas. Final chart comparisons are required by the processing branch due to the fact that verified water level data (smooth tides) have not yet been applied to the data.


Sewards Cove
East Sister
Horn I
rky
rky
R
N "2"
Phillips Rk

APPENDIX I

TIDE NOTE AND GRAPHICS

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IV.A.1 - TIDE AND WATER LEVELS

IV.A.1.i - Station Description

A back up water level sensor was installed on June 4, 2007 at the US Coast guard base Portsmouth Station in New Castle, New Hampshire in support of the Field Hydrographic Course at the University of New Hampshire. The reason for the installation was because the permanent tide gauge installed and operated by NOAA was showing data gaps in both the transmission and on the internal data logger. Data from the newly installed back up water level sensor would be used to fill any gaps in the data from the primary NOAA gauge if necessary.

On June 7, 2007 Carl Kammerer of the Joint Hydrographic Center (JHC) replaced the Aquatrak Controller in the NOAA gauge. After the replacement of the controller there were three data gaps each of which were only 6 min long. The gaps were on June 6, 2007 at 12:12 (UTC), June 9, 2007 at 21:00 (UTC) and June 13, 2007 at 19:24 (UTC). Surveying for this project was scheduled to be done between June 11th and 13th. However, due to rough seas, 3-5 ft, no data was collected on June 13th. Thus the previously mentioned gaps in the primary gauge data did not effect the survey.

In order to prepare for the back up gauge installation a team of students from the Center of Coastal and Ocean Mapping (CCOM) made a reconnaissance trip to the site and determined the most appropriate location to install the backup gauge was along was along the eastside of the covered Coast Guard pier. This location was chosen because of its vicinity to the survey area and the primary NOAA gauge, the USCG pier provided an excellent structure for mounting the gauge and a floating dock provided a working platform for banding the sensor's cable to the piling.

The backup sensor was mounted inside a 4-in diameter white PVC pipe using a 5" stainless steel section of althread. This section of althread penetrated through both the pipe and mounting hole on the end of the sensor (see IV.A.2). Stainless steel nuts and washers were used to fasten the sensor in an upright position to prevent pivoting of sensor around the mounting rod. The offsets for the sensor int eh PVC pipe are shown in appendix IV.A.3. The 10-ft PVC pipe was attached to the piling with steel banding. The cable connecting the sensor to the datalogger was routed up the same piling the PVC pipe was mounted to, under the wood flooring of the pier and inside the covered building where the entire logging unit; which includes the logger, battery, compensating unit and external battery; rested in place against a metal support beam. Mounting the logger inside the building both protected the unit from weather, which was important because the unit itself was not fully weather resistant and water leaked through the seam around the door, and provided a dry place for the tide observer to download data or perform maintenance on the logger.

The primary NOAA water level sensor is an Aquatrak acoustic sensor with a SUTRON data logger. The sensor has an accuracy of ±0.025% of the range and a resolution of

0.001 m, these specifications can be found on the Aquatrak website http://www.aquatrak.com/. The backup water level sensor is an Aanderaa strain gauge with an accuracy of ±0.2% of the range and a resolution of 0.1% of the range.

IV.A.1.ii - Logging Parameters

The CCOM backup gauge was programmed to log battery voltage, water level, and water temperature every 30 seconds. It takes 15 seconds to log all four measurements, 5 seconds for battery voltage, 5 sec for water level and 5 sec for water temp. Each measurement is a 30 sec average time stamped with the time at the beginning of the first measurement. The raw measurements from the Aanderaa sensor are converted to depth in meters using eq. 1.1 provided in the Aanderaa Instruments datasheet for water level/temperature series 3791-3798.

$$WaterLevel(m) = \frac{A + B * N + C * N^2 + D * N^3}{d * g} \tag{1.1}$$

where A, B, C and D are coefficients given in the sensor's calibration sheet, N is the raw data value measured by the logger, d is the density of water (g/cm^3), and g is gravity. The coefficient values for the backup sensor are shown in the table below. Note that the table shows a value of 0.00 for water density and based on the sensor data sheet *g* is 9,80665 (the international standard). Uncertainty is introduced by the fact that these values are not site specific.

CH	Parameter	Unit	A	B	C	D
00	Battery Voltage	Volt	+0.000E+00	+1.000E-02	+0.000E+00	+0.000E+00
02	Water Level	m	-8.645E-02	+5.138E-03	+6.808E-08	+0.000E+00
03	Water Temp	Deg. C	-7.823E+00	+4.321E-02	+5.084E-06	+0.000E+00

Table 1 – Coefficients in the Aanderaa datalogger used to convert from raw measurements to volts, m, and Deg. C.

The converted data (volts, m, Deg. C) were logged to a 128 Mb compact flash card in an Persistor Instruments Inc. external data logger. The NOAA gauge takes a 181 sec average every 6 min on the hour (i.e. 00:06, 00:12, 00:18, …) and time stamp of the reading is centered in the averaging period

Drift of the Aanderaa Datalogger 3634 was monitored during maintenance trips. The clock in the data logger was synced with GPS time, which was retrieved from a handheld Garmin GPS receiver, on the day of installation (June 4, 2007 UTC). By June 13, 2007 the datalogger was reading 7 sec slower than GPS time on the handheld receiver.

IV.A.1.iii - Sensor movement

The water level readings were tied into the local tidal datum though spirit leveling. Installation levels were conducted on June 6 and 7 of 2007 and check levels were conducted on June 15, 2007 (see IV.A.3 and IV.A.4). There was a maximum difference in elevation of 0.002 m between the 2007 installation levels and the NOAA published benchmark elevations, which can be found at the http://tidesandcurrents.noaa.gov,).

A total of 7.03 hrs of gauge to staff comparisons were observed during 5 different periods of time between June 4th and June 6th (see IV.A.5). A benchmark elevation drawing is shown in appendix IV.A.6. For each period of observations the average difference for the CCOM gauge to staff, NOAA gauge to staff, and NOAA gauge to CCOM gauge comparisons were computed**.** The average of those five averages was then used as the final staff constant for each of the three comparisons. Because of the 7 second clock drift in the Aanderaa datalogger (see IV.A.6) the measured water levels values from the Aanderaa sensor were interpolated to the 6 min interval using the MATLAB function 'interp1()' in order to compute the gauge to gauge comparisons. Residuals from the final staff constant for each of the three comparisons show the NOAA sensor to be the most stable with a standard deviation of 0.007 m (see IV.A.7). The fluctuation in comparisons of the CCOM gauge to the staff and the NOAA gauge suggested movement of the CCOM sensor. Check levels run on June 15, 2007 showed an elevation difference of -0.001m which meant there was little to no movement in the sensor and the fluctuation in staff to gauge comparisons was due to either phase lag in the water level introduced by the stilling well or observer error. Based on the gauge to gauge comparisons there was a measurement shift in one of the sensors that corresponds with the time Carl Kammerer replaced the Aquatrak controller in the NOAA gauge. Prior to the replacement of the controller there signal of the difference had an increasing trend of 0.006 m/day and a peak-to-trough amplitude of approximately 6cm. After the controller was replaced the trend reduces to -0.0001 m/day and the amplitude reduces to approximately 2cm (Fig. IV.A.1.iii.a). The frequency of the signal appears to match that of the tidal signal with a positive difference during periods of low tide and a negative difference between periods of high tide. This means that at high tide the Aanderaa sensor was reading higher than the Aquatrak whereas at low tide the Aanderaa sensor was reading lower than the Aquatrak. Also the amplitude of the signal in the differences appears to scale with the amplitude of the tide, as the amplitude of the tide increased the amplitude differences increased and as the amplitude in the tide decreased so did the amplitude of the differences. Although the Aanderaa sensor installed for the CCOM gauge was last calibrated by the manufacture in June of 2000, which leaves suspicion as to the accuracy of the gauge, the record of differences between the two gauges over the 7 day period of time suggests the uncertainty of the data from the NOAA gauge was improved from 6 cm to 2 cm when the new Aquatrak controller was installed on June 7, 2007 at 20:18 (UTC).

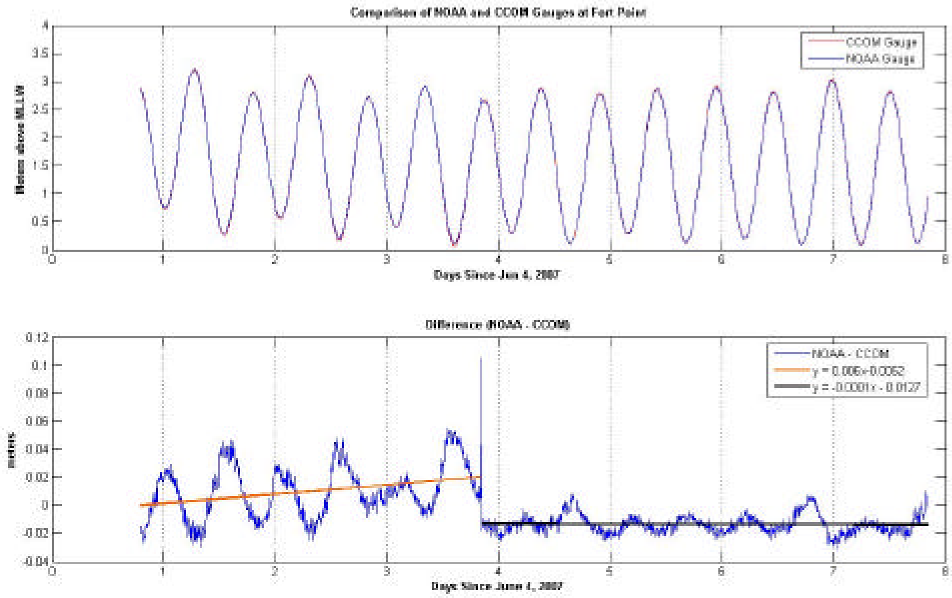
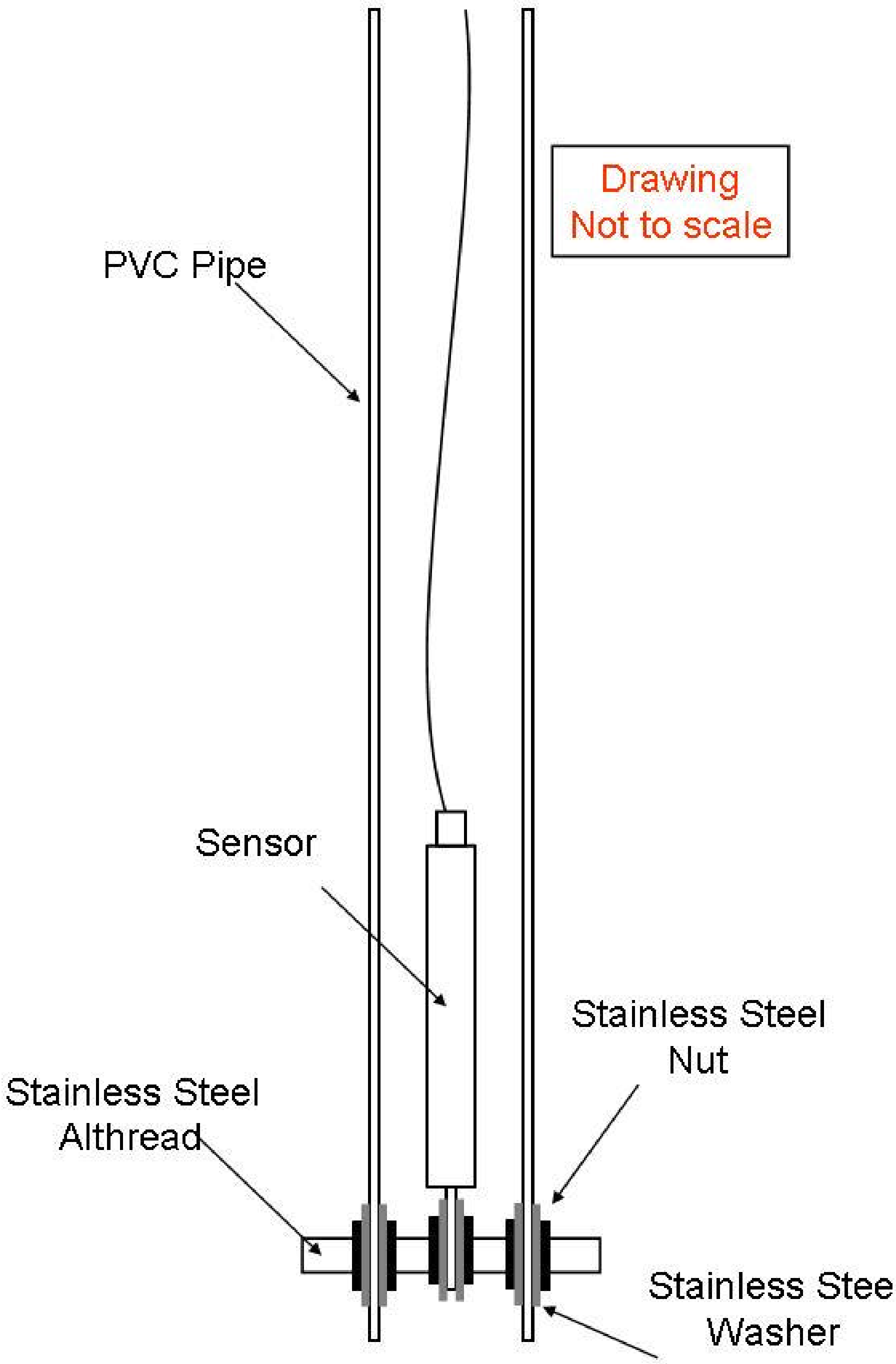


Figure IV.A.1.iii.a – The top plot is a seven day record of both the NOAA and CCOM gauges. The blue line in the bottom plot is the difference between the two gauges. The spike in the data is at 20:18 (UTC) on June 7, 2007 and marks when the Aquatrak controller was replaced in the NOAA gauge. The orange line is a linear fit to the data before the controller was replaced and the black line is a linear fit to the data after the controller was replaced.

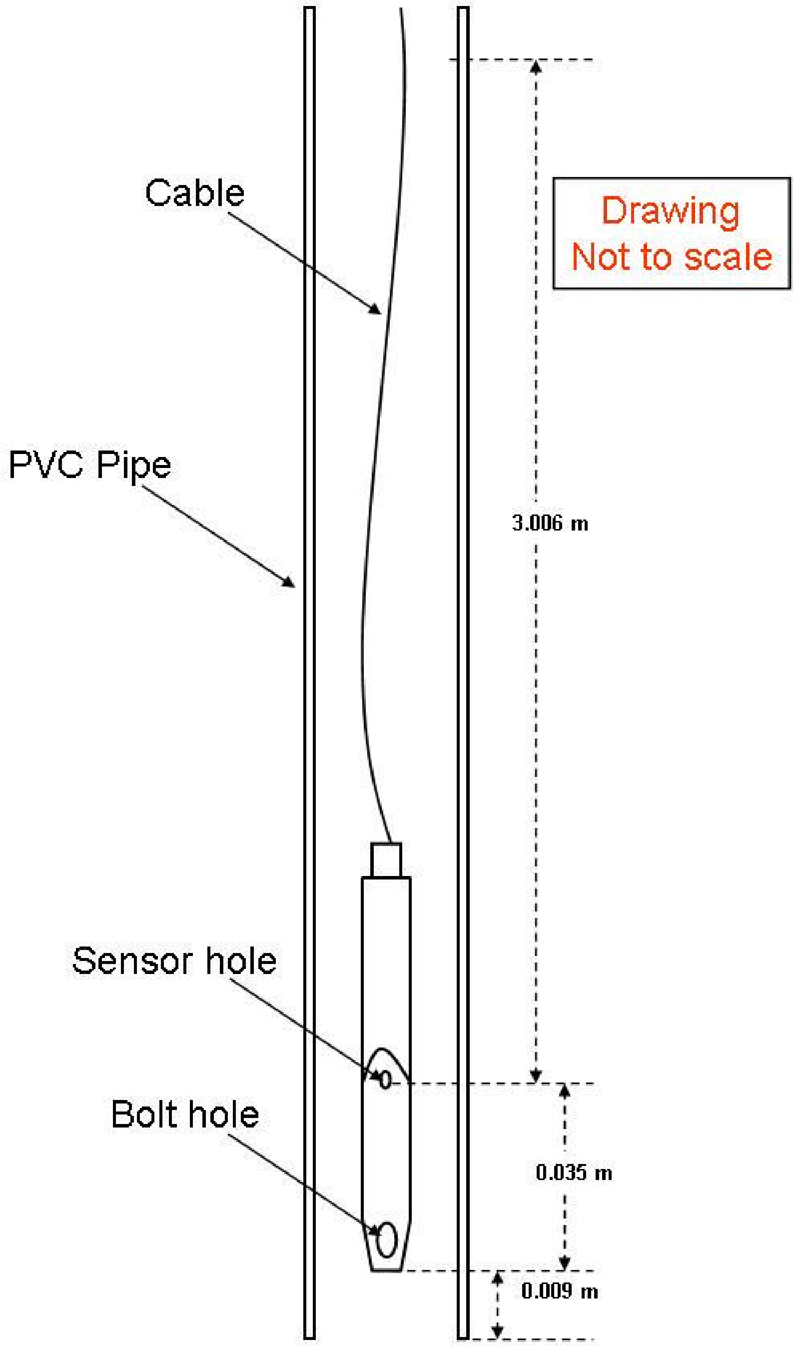
IV.A.1.iv - Tidal zoning

A discrete tidal zoning for Piscatuaqua River Entrance was designed by CO-OPS. This zoning scheme used NOAA gauge 8423898 Fort Point as the reference station. The time and range correctors for the survey area were -6 min and x1.00, respectively. The uncertainty associated with the zoning scheme is approximately 0.2m (personal correspondence with C. Kammerer)

IV.A.2 - SENSOR PVC MOUNT



IV.A.3 - SENSOR OFFSETS



IV.A.4 - ABSTRACT OF LEVELING

Abstract of Leveling (MLLW)

Fort Point, New Hampshire

Date of Levels: 6/6/2007 - 6/8/2007

Benchmarks: CONSTITUTION NO 1 1941, NO 1 1919, NO 6 1944, 842 3898 TIDAL US
Number of benchmarks: 5
PBM: 2 1919

Installation Levels

(all elevations in meters)

From	To	Forward	Backward	Delta	Mean	Elevation	MLLW BM name
						6.690	2 1919
2 1919	CONSTITUTION 147 NO 1 1941	-0.680	0.681	0.001	-0.6805	6.010	CONSTITUTION 147 NO 1 1941
CONSTITUTION 147 NO 1 1941	NO 1 1919	-1.570	1.569	-0.001	-1.5695	4.440	NO 1 1919
NO 1 1919	NO 6 1944	0.052	-0.054	-0.002	0.0530	4.493	NO 6 1944
NO 6 1944	Staff Stop	-1.168	1.168	0.000	-1.1680	3.325	Staff Stop
2 1919	842 3898 TIDAL US	-3.775	3.776	0.001	-3.7755	2.915	842 3898 TIDAL US
842 3898 TIDAL US	Portsmouth USCG 1994	5.963	-5.961	0.002	5.9620	8.877	Portsmouth USCG 1994
NO 6 1944	Aqua Old	0.855	-0.855	0.000	0.8550	5.348	Aqua Old
Staff Stop	PVC Pipe	-1.643	1.644	0.001	-1.6435	1.682	PVC Pipe
PVC Pipe	Backup Orifice	-3.006			-3.0060	-1.325	Backup Orifice

Bench Mark	Elevation from 2007 Levels	Published Elevations	Difference
2 1919	6.690	6.69	0.000
CONSTITUTION 147 NO 1 1941	6.010	6.009	0.001
NO 1 1919	4.440	4.439	0.001
NO 6 1944	4.493	4.491	0.002
842 3898 TIDAL US	2.915	2.915	0.000
Portsmouth USCG 1994	8.877	8.879	-0.002

Note 1) The measurement between PVC Pipe and Backup Orifice was made using a steel tape.
Note 2) Published elevations are from the CO-OPS website tidesandcurrents.gov

IV.A.5 - COMPARISON OF INSTALL AND CHECK LEVELS

Abstract of Leveling (MLLW)

Fort Point, New Hampshire

Date of Levels: 6/6/2007 - 6/8/2007

Benchmarks: CONSTITUTION NO 1 1941, NO 1 1919, NO 6 1944, 842 3898 TIDAL US
Number of benchmarks: 5
PBM: 2 1919

Installation Levels

(all elevations in meters)

From	To	Forward	Backward	Delta	Mean	Elevation	MLLW BM name
						6.690	2 1919
2 1919	CONSTITUTION 147 NO 1 1941	-0.680	0.681	0.001	-0.6805	6.010	CONSTITUTION 147 NO 1 1941
CONSTITUTION 147 NO 1 1941	NO 1 1919	-1.570	1.569	-0.001	-1.5695	4.440	NO 1 1919
NO 1 1919	NO 6 1944	0.052	-0.054	-0.002	0.0530	4.493	NO 6 1944
NO 6 1944	Staff Stop	-1.168	1.168	0.000	-1.1680	3.325	Staff Stop
2 1919	842 3898 TIDAL US	-3.775	3.776	0.001	-3.7755	2.915	842 3898 TIDAL US
842 3898 TIDAL US	Portsmouth USCG 1994	5.963	-5.961	0.002	5.9620	8.877	Portsmouth USCG 1994
NO 6 1944	Aqua Old	0.855	-0.855	0.000	0.8550	5.348	Aqua Old
Staff Stop	PVC Pipe	-1.643	1.644	0.001	-1.6435	1.682	PVC Pipe
PVC Pipe	Backup Orifice[1]	-3.006			-3.0060	-1.325	Backup Orifice1

Check Levels[3]

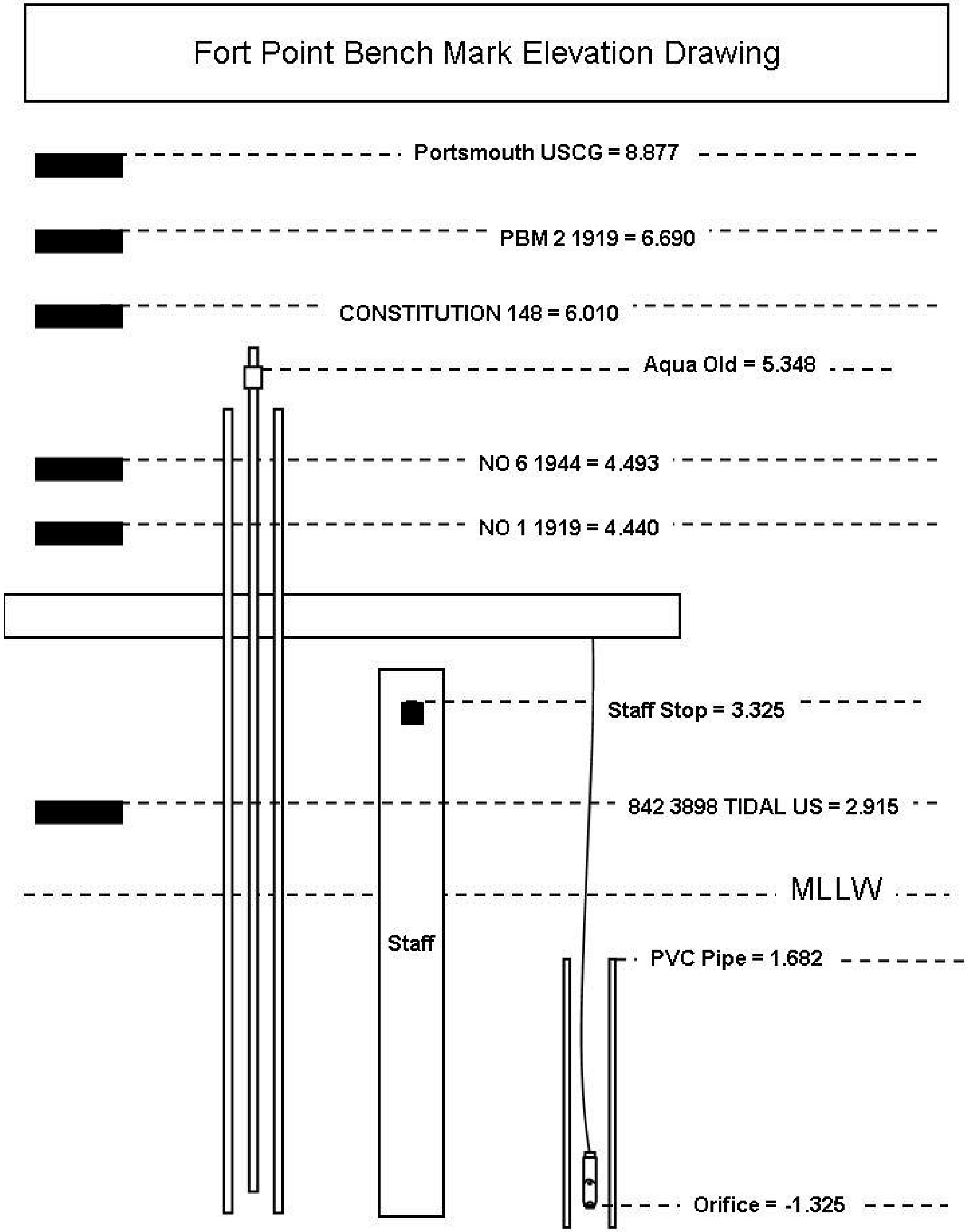
(all elevations in meters)

From	To	Forward	Backward	Delta	Mean	Elevation	MLLW BM name
						4.493	NO 6 1919
NO 6 1919	Staff Stop	-1.169	1.168	-0.001	-1.1685	3.325	Staff Stop
Staff Stop	PVC Pipe	-1.642	1.643	0.001	-1.6425	1.682	PVC Pipe
NO 6 1919	NO 1 1919	-0.055	0.055	0.000	-0.0550	4.438	NO 1 1919
PVC Pipe	Backup Orifice	-3.006			-3.0060	-1.324	Backup Orifice

From	To	Install Diff	Check Diff	Diff
NO 6 1919	Staff Stop	-1.1680	-1.1685	0.0005
Staff Stop	PVC Pipe	-1.6435	-1.6425	-0.0010
NO 6 1919	NO 1 1919	-0.0530	-0.0550	0.0020
PVC Pipe	Backup Orifice	-1.3245	-1.3240	-0.0005

Note 1) The measurement between PVC Pipe and Backup Orifice was made using a steel tape.
Note 2) Elevation of the primary bench mark was obtained from the CO-OPS website tidesandcurrents.gov
Note 3) Check levels were run to monitor the stability of the PVC Pipe that the back up sensor was mounted in.

IV.A.6 - BENCHMARK ELEVATION DRAWING



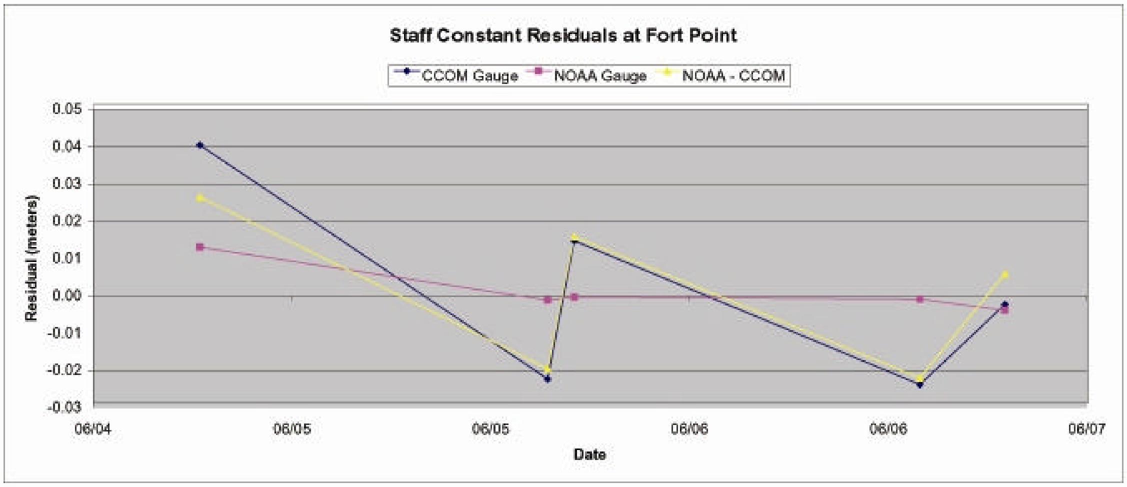
IV.A.7 - STAFF GAUGE COMAPRISON PLOT

Gauge Comparisons

CCOM Gauge			
Date/Time	Gauge Constant	Count	Residual
6/4/2007 18:24	-0.70	5	0.04
6/5/2007 15:24	-0.63	3	-0.02
6/5/2007 17:00	-0.67	87	0.01
6/6/2007 13:52	-0.63	65	-0.03
6/6/2007 19:00	-0.65	22	0.00
Average =	-0.66		
Stdev =	0.03		

NOAA Gauge			
Date/Time	Gauge Constant	Count	Residual
6/4/2007 18:24	0.652	6	0.012
6/5/2007 15:24	0.666	3	-0.003
6/5/2007 17:00	0.665	30	-0.002
6/6/2007 13:52	0.666	22	-0.002
6/6/2007 19:00	0.669	13	-0.005
Average =	0.663		
Stdev =	0.007		

NOAA - CCOM			
Date/Time	Gauge Constant	Count	Residual
6/4/2007 18:24	-1.35	5	0.025
6/5/2007 15:24	-1.30	3	-0.021
6/5/2007 17:00	-1.33	30	0.015
6/6/2007 13:52	-1.30	22	-0.023
6/6/2007 19:00	-1.32	13	0.006
Average =	-1.32		
Stdev =	0.02		



IV.A.8 - TIDE STATION REPORT

Tide Station Report

Station Name:	Fort Point CCOM Gauge	**Physical Location:**	New Castle, New Hampshire
Latitude:	43° 04' 17.8" N	**Longitude:**	070° 42' 38.2" W

Location:	**Name:**	USCG Portsmouth Station
	Owner:	USCG
	Address:	25 Wentworth Rd. New Castle, NH 03854
	Phone:	603-436-4415

Levels

Date leveled:	6-Jun-07	**Number of Benchmarks:**	6
Primary Benchmark:	2 1919		

Benchmark	MLLW elev (2007)	NAD83(1996) EH	GPS Obs Date
Portsmouth USCG	8.877	-19.23	7/1/2002
CONSTITUTION 147 RM 1	6.010	-22.10	6/22/2001

Remarks: The NAD83(1996) ellipsoid heights for benchmarks PORTSMOUTH USCG (PID AB2631) and CONSTITUTION 147 RM 1 (PID OC0429) were retrieved from the NGS database http://www.ngs.noaa.gov/cgi-bin/datasheet.prl.

Tide Staff

Date Installed:	5-Jun-07	**Graduation:**	metric
Length:	4 meters		
Staff Stop:	Aluminum angle bracket, 2 inches long		
Remarks:	Staff stop is mounted near the 4 meter mark on the staff.		

Gauge:

Data Logger

Date Installed:	5-Jun-07	**Type Manufacture:**	Aanderra
Serial Number:	47	**Calibration Date:**	22-Jun-00

	Time (UTC)			Time (UTC)	
Date	**Datalogger**	**GPS**	**Date**	**Datalogger**	**GPS**
6/4/2007	17:02:00	17:02:00	6/11/2007	20:22:40	20:22:46
6/6/2007	17:26:39	17:26:40	6/13/2007	15:42:53	15:43:00

Compensating UNIT

Serial Number:	3848	**Power:**	9 volt alkaline battery

External Data Logger SN:

Serial Number:	CF2-6992	**Manufacture:**	Persistor Instruments Inc.
Memory Card:	128 MB Compact flash card		

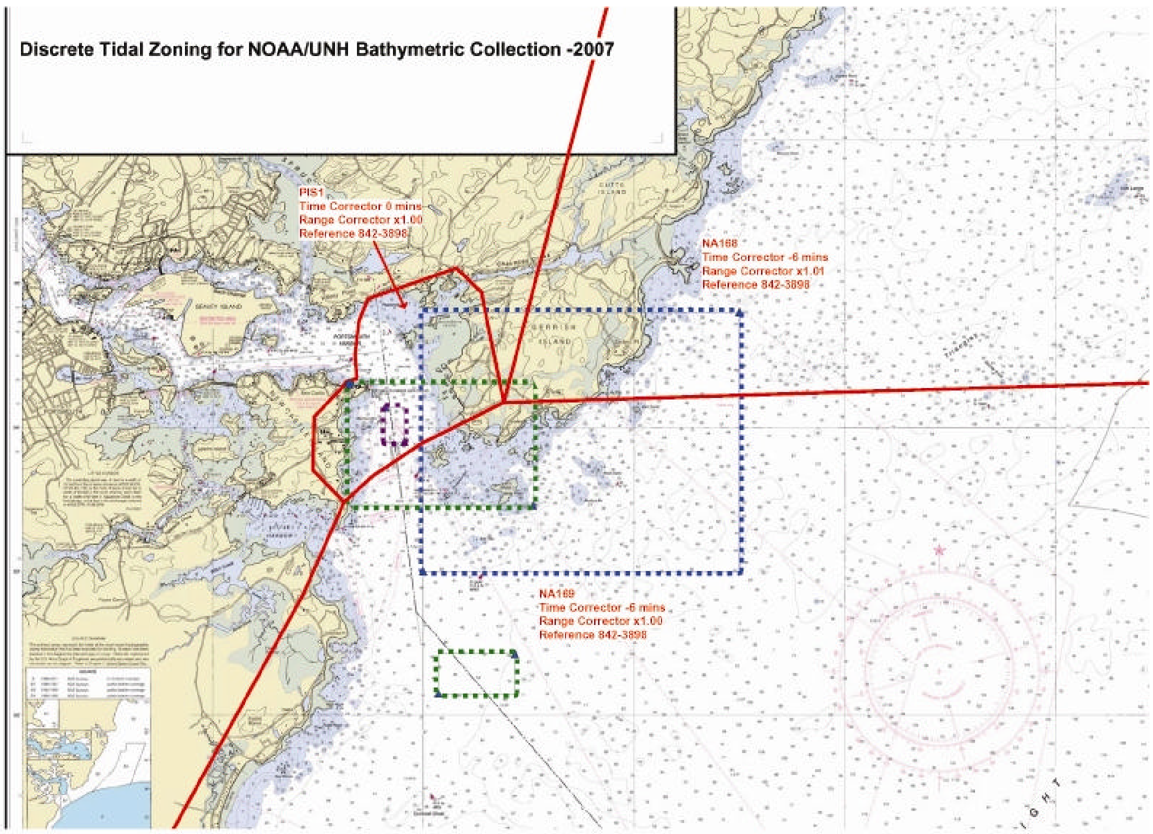
Remarks: The gauge is mounted inside a 10' long PVC pipe that is 4" in diameter. The sensor is fastened to the end of the pipe with a stainless steel rod. Holes were drilled into the pipe at 1 foot intervals. Steel banding was used to secure the pipe to one of the wood pilings suporting the USCG boat house.

Ancillary Sensor:

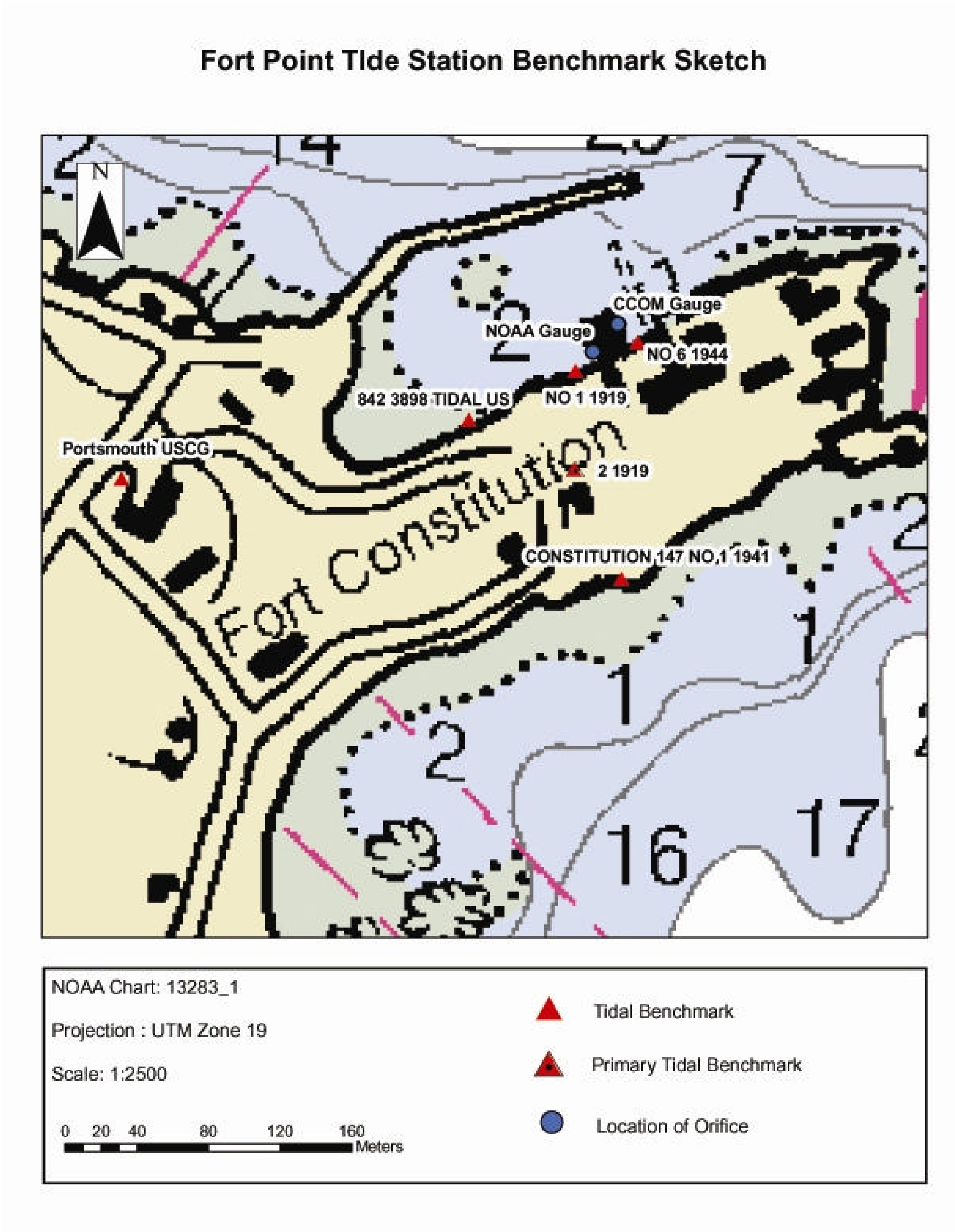
Type:	Temperature	**Serial Number:**	47
Manufacture:	Aanderaa	**Date Installed:**	5-Jun-07

Additional Remarks: The water level and temperature sensor is one unit. The clock in the data logger drifted ????? Sec over the duration of the installation.

IV.A.9 - TIDAL ZONING SCHEME



IV.A.9 - BENCHMARK SKETCH



IV.A.10 - TIDAL BENCH MARK PHOTOS

Stamping:	2 1919	**Lat:**	43° 04’ 18.0” N
Designation:	842 3898 TIDAL 2	**Long:**	070° 42’ 42.0”W
Monument Type:	US C&GS disk		

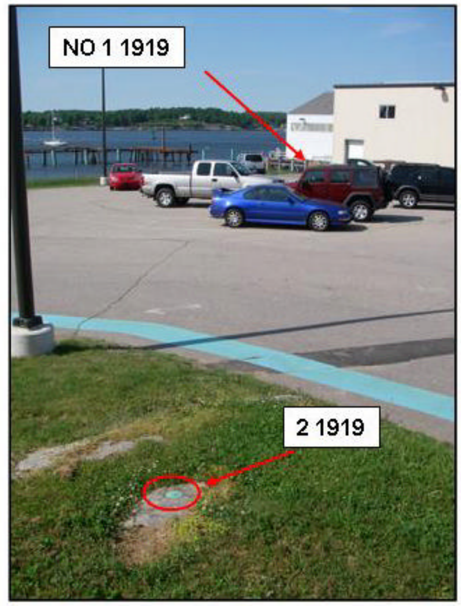


Figure 1 - Left photo is a close up of benchmark 2 1919. Right photo is looking NE from benchmark 2 1919 and shows NO 1 1919 in the background.

Stamping:	NO 1 1919	**Lat:**	43° 04’ 16.8” N
Designation:	842 3898 TIDAL 1	**Long:**	070° 42’ 39.2”W
Monument Type:	US C&GS disk		

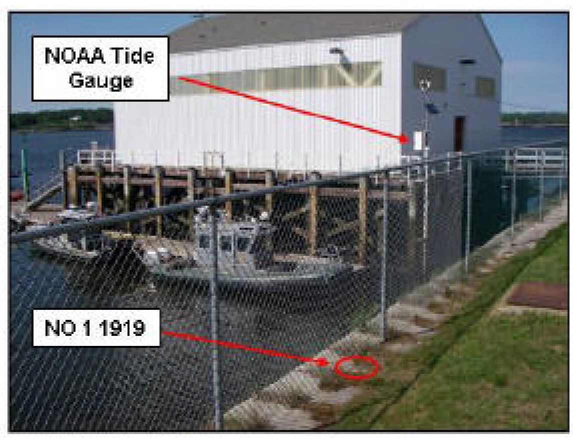


Figure 2 – Left photo is a close up of benchmark NO 1 1919. Right photo is looking NE with benchmark NO 1 1919 in the foreground. Note the NOAA tide gauge (Station number 8423898) at the SWcorner of the covered dock.

Alias: BM 4
Designation: 842 3898 TIDAL 1
Monument Type: Bolt (iron rod in rock)

Lat: 43° 04' 16.8" N
Long: 070° 42' 39.2"W

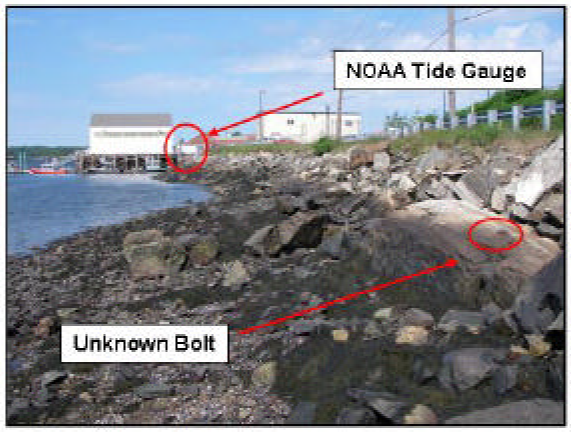


Figure 3 - Left photo shows BM 4 which is an iron bolt drilled into a bedrock out crop. Right photo is looking NE and shows the NOAA tide gauge in the background.

Stamping: NO 6 1944
Designation: 842 3898 TIDAL 6
Monument Type: US C&GS disk

Lat: 43° 04' 17.6" N
Long: 070° 42' 37.6"W

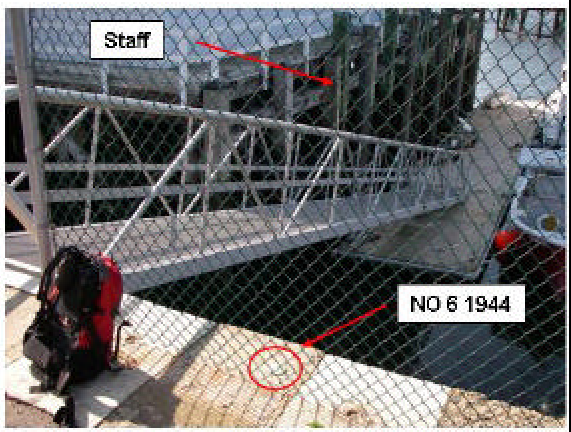


Figure 4 – Left photo is a close up of benchmark NO 6 1944. Right photo is looking NNW and shows the location of the of the benchmark relative to the tide staff, which is mounted on one of the pilings shown. The red arrow at the top of the right photos shows the approximate location of the tide staff. The sensor for the CCOM back up gauge is located a couple pilings seaward of the tide staff.

Stamping: Portsmouth USCG 1994 **Lat:** 43° 04' 16.8" N
Designation: Portsmouth USCG **Long:** 070° 42' 39.2"W
Monument Type: NGS disk

Figure 5 – Left photo is a close up of benchmark PORTSMOUTH USCG. Right photo is looking SE over benchmark PORTSMOUTH USCG and towards Went

Stamping: CONSTITUTION 147 NO 1 1941 **Lat:** 43° 11' 53.2" N
Designation: CONSTITUTION 147 RM 1 **Long:** 070° 52' 03.9"W
Monument Type: USC&G disk

Figure 6 – Left photo is a close up of benchmark CONSTITUTION 147 NO 1 1941. Right photo is looking NNE from benchmark CONSTITUTION 147 NO 1941 and shows the location of the backup tide gauge in the background.

IV.A.11 - FORT POINT BACKUP TIDE GAGE MAINTENANCE PROCEDURES

Location of tide gauge:

Tide gauge is located along the inside of the east wall of the aluminum building covering the USCG pier. It is leaning on the north-side of one of the pilings.

Maintenance Procedures:

1) Call USCG base to notify we will be working there
2) Staff shots
    a. Read the water level on the staff mounted on the Eastside of the USCG pier every six minutes on the hour ex. 18:00, 18:06, 18:12, 18:18, 18:24, 18:30, 18:36, 18:42, 18:48, 18:54
    b. Simultaneously record what the gauge is reading
3) Check the time on the gauge (Compare GPS time to gauge)
    a. Use handheld GPS
    b. Record time on GPS
    c. Record time on Gauge
4) Download data from the gauge
    a. Open gauge
    b. Remove external data logger (black box) in lower left hand corner of gauge
    c. Open logger using small screw driver
    d. Press white button
        i. The LED on the logger should be flashing green while the card is still in
        ii. After pressing button the LED will flash red. This means thed ata is being written to the compact flash card
        iii. When the LED is solid green it is ready to be ejected.
    e. Eject compact flash card using black eject button
    f. Download data using compact flash card adapter.
        i. File will be at *.dat file
    g. After downloading data inspect to make sure it looks reasonable
        i. Times are correct, logging at 30 sec interval
        ii. Battery voltage
        iii. Reference number (76 or 77)
        iv. Water level
        v. Water temperature
    h. Insert compact flash card back into the external logger
    i. Replace screws
    j. Tape the connection back onto logger
5) Copy data to server: \Shared\Tide Data\Fort Point Backup Gauge\Flash Card Data data\Fort Point Backup Gauge\Flash Card Data
    a. Create a folder and name it the date the file was downloaded in the yyyymmdd format ex. 20070604

IV.A.12 - FORT POINT BACKUP GAUGE MAINTENANCE CHECKLIST

Tide Station Maintenance Checklist

Fort Point Backup Gauge

Date of visit: ____________ **Time of visit:** ____________ (UTC)

Location: Portsmouth Station USCG Base

Phone: 603-436-4415 **Address:** 25 Wentworth Rd.
New Castle, NH 03854

Visisting Crew

Observer: ______________________

Observer: ______________________

Observer: ______________________

Observer: ______________________

Gauge Time: ____________ (UTC) __________________ (Local)

GPS Time: ____________ (UTC) __________________ (Local)

Battery Voltage: ____________ volts

Memory Remaining: ____________ %

Staff Shots			
Time (UTC)	**Gauge (m)**	**Staff**	**Residual**

Average: __________________

Tide Station Supplies
External data logger
Electrical tape
Small phillips screwdriver
Serial cable for computer

APPENDIX II

SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

Offset Report for POS/MV IMU Reference Mark to Port/Starboard Transducers
R/V Coastal Surveyor
1-2 June 2007

R/V Coastal Surveyor sensor offsets for the 2007 Summer Hydrographic Field Course were measured on 1-2 June 2007 by UNH graduate students participating in the course. Measurements were made using metal measuring tape, string and plumb bob, spirit levels, T-squares and rulers. Redundant measurements were made by different field personnel whenever feasible. The purpose of undertaking the measurements was to calculate the offsets needed for the proper integration of EM3002D depth measurements with position and attitude data from the POS/MV system.

Measurements were divided into separate X, Y and Z components to minimize potential confusion during the processes of measurement, recording and analysis. Refer to Figures 2-5 for a general overview of measurement locations. The IMU reference mark is indicated by a black and white circle on the top of the IMU, where the point of measurement is the junction of the four black and white quarters.

Figure 1. R/V Coastal Surveyor.

IMU to Bow Centermark Offsets

Vertical

The vertical offset from the IMU reference mark to the bow centermark was measured in the following sequence:

Z1 – Offset from the IMU reference mark to IMU base
Z2 – Offset from the IMU base to the top of the stairs
Z3 – Offset from top of stairs to top of starboard rail
Z4 – Offset from top of starboard rail to bow centermark

Table I. Vertical offset results

Z1	0.168
Z2	-0.446
Z3	-1.126
Z4	0.501
Total Z Offset (Z1+Z2+Z3+Z4)	-0.903

Athwartships

The athwartships offset from the IMU reference mark to the bow centermark was measured in the following sequence:

Y1 – Offset from the IMU reference mark to mark on top of stairs
Y2 – Offset from mark on top of stairs to mark on bridge floor
Y3 – Offset from mark on bridge floor to starboard door
Y4 – Offset from starboard door to starboard rail
Y5 – Offset from starboard rail to bow centermark

Table II. Athwartships offset results

Y1	0.686
Y2	0.329
Y3	0.108
Y4	0.363
Y5	-1.354
Total Y Offset (Y1+Y2+Y3+Y4+Y5)	0.132

Fore-Aft

The fore-aft offset from the IMU reference mark to the bow centermark was measured in the following sequence:

X1 – Offset from IMU reference mark to bottom of stairs
X2 – Offset from bottom of stairs to mark on starboard cabin door
X3 – Offset from mark on starboard cabin door to mark on starboard rail
X4 – Offset from mark on starboard rail to bow centermark

Table III. Fore-aft offset results

X1	0.110
X2	0.668
X3	5.826
X4	1.531
Total X Offset (X1+X2+X3+X4)	8.135

Figure 2. General overview of IMU to Bow Centermark measurement locations.

Bow Centermark to Port Transducer Offsets

Vertical

The vertical offset from the bow centermark to the phase center of the port transducer was measured in the following sequence:

Z1 – Offset from bow centermark to transfer point
Z2 – Offset from transfer point to top of bow mount lip
Z3 – Offset from top of bow mount lip to mark on black line of bow ram
Z4 – Offset from mark on black line of bow ram to top of bow ram bracket
Z5 – Offset from top of bow ram bracket to top of mounting plate
Z6 – Offset from top of mounting plate to phase center of transducer

Table IV. Vertical offset results

Z1	-0.339
Z2	-0.742
Z3	0.574
Z4	1.543
Z5	1.038
Z6	0.226
Total Z Offset (Z1+Z2+Z3+Z4+Z5+Z6)	2.300

Athwartships

The athwartships offset from the bow centermark to the phase center of the port transducer was measured in the following sequence:

Y1 – Offset from bow centermark to transfer point
Y2 – Offset from transfer point to mark on black line of bow ram
Y3 – Offset from mark on black line of bow ram to bow ram bracket
Y4 – Offset from bow ram bracket to phase center of transducer

Table V. Athwartships offset results

Y1	0.000
Y2	-0.053
Y3	-0.026
Y4	-0.115
Total Y Offset (Y1+Y2+Y3+Y4)	-0.194

Fore-Aft

The fore-aft offset from the bow centermark to the phase center of the port transducer was measured in the following sequence:

X1 – Offset from bow centermark to transfer point
X2 – Offset from transfer point to mark on black line of bow ram
X3 – Offset from mark on black line of bow ram to top of mounting plate
X4 – Offset from top of mounting plate to transducer phase center

Table VI. Fore-aft offset results

X1	0.506
X2	0.401
X3	0.128
X4	-0.193
Total X Offset (X1+X2+X3+X4)	0.843

Bow Centermark to Starboard Transducer Offsets

Vertical

The vertical offset from the bow centermark to the phase center of the starboard transducer was measured in the following sequence:

Z1 – Offset from bow centermark to transfer point
Z2 – Offset from transfer point to top of bow mount lip
Z3 – Offset from top of bow mount lip to mark on black line of bow ram
Z4 – Offset from mark on black line of bow ram to top of bow ram bracket
Z5 – Offset from top of bow ram bracket to top of mounting plate
Z6 – Offset from top of mounting plate to phase center of transducer

Table VII. Vertical offset results

Z1	-0.339
Z2	-0.743
Z3	0.570
Z4	1.552
Z5	1.037
Z6	0.221
Total Z Offset (Z1+Z2+Z3+Z4+Z5+Z6)	2.297

Athwartships

The athwartships offset from the bow centermark to the phase center of the starboard transducer was measured in the following sequence:

Y1 – Offset from bow centermark to transfer point
Y2 – Offset from transfer point to mark on black line of bow ram
Y3 – Offset from mark on black line of bow ram to bow ram bracket
Y4 – Offset from bow ram bracket to phase center of transducer

Table VIII. Athwartships offset results

Y1	0.000
Y2	0.033
Y3	0.047
Y4	0.169
Total Y Offset (Y1+Y2+Y3+Y4)	0.248

Fore-Aft

The fore-aft offset from the bow centermark to the phase center of the starboard transducer was measured in the following sequence:

X1 – Offset from bow centermark to transfer point
X2 – Offset from transfer point to aft point on transducer mount*
(*carried up to mark on black line of bow ram)
X3 – Offset from aft point on transducer mount to phase center of transducer

Table IV. Fore-aft offset results

X1	0.506
X2	0.197
X3	0.185
Total X Offset (X1+X2+X3+X4)	0.888

Figure 3. General overview of Bow Centermark to Port and Starboard Transducer offset measurement locations (see insets A and B).

Figure 4. Inset A.

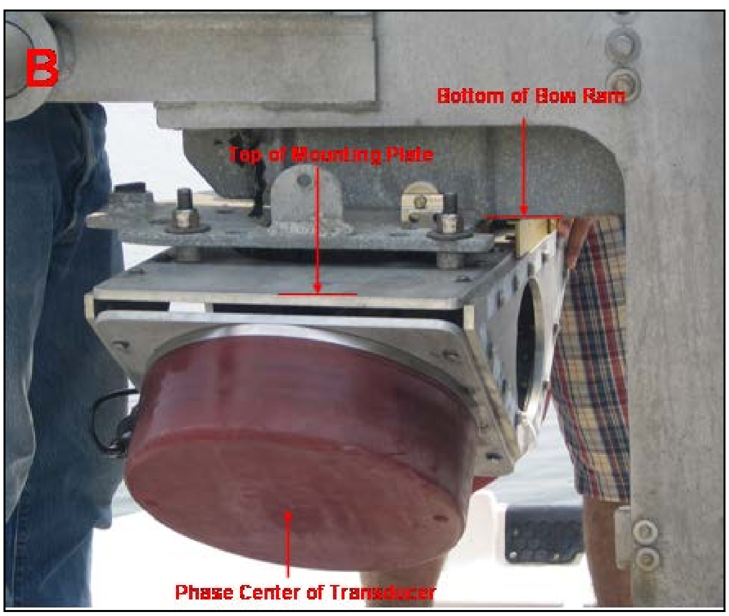


Figure 5. Inset B

Remarks

Due to measurement discrepancies between the offsets from the IMU reference mark to the bow centermark as measured by the 2007 and 2006 Summer Hydrographic Field Course personnel, the more recent set of measurements were rejected in favor of the values obtained in 2006. Therefore, the total offset between IMU reference mark to port and starboard transducers reflects the following:

IMU reference mark to Bow centermark
Measurement from 2006 CCOM Summer Hydrographic Field Course

X	8.211
Y	0.000
Z	-0.844

Bow centermark to Port transducer
Measurement from 2007 CCOM Summer Hydrographic Field Course

X	0.843
Y	-0.194
Z	2.300

Bow centermark to Starboard transducer
Measurement from 2007 CCOM Summer Hydrographic Field Course

X	0.888
Y	0.248
Z	2.297

Final Offsets

All values converted into the SIS – POS/MV reference frame, where X is fore/aft positive forward, Y is athwartships positive starboard, and Z is up/down positive down.

IMU to Port transducer

X	9.054
Y	-0.194
Z	1.456

IMU to Starboard transducer

X	9.099
Y	0.248
Z	1.453

APPENDIX III

FEATURES REPORT

(NO AWOIS ITEMS, DTONS, WRECKS, OR MARITIME BOUNDARIES)

APPROVAL PAGE

W00276

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 NGDC for archive

- W00276_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- W00276_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.

Approved: ______________________________

Lieutenant Matthew Jaskoski
Chief, Atlantic Hydrographic Branch