

Bathymetric Mapping of the Waccamaw River, Horry County, SC



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INTRODUCTION

The Center for Marine and Wetland Studies (CMWS) was established by the Horry County Higher Education Commission to facilitate basic and applied research within the College of Natural and Applied Science at Coastal Carolina University (CCU). Since the late 1980's, the Center has interacted with many federal and state agencies and collaborated with other universities to develop effective research programs focused on scientific issues of concern both locally and nationally. The Center is composed of a combination of Coastal Carolina University faculty and staff that have developed research programs focused on regional watershed management and coastal marine and wetland systems.

The CMWS at CCU conducted bathymetric mapping of the Waccamaw River (Oct. – Dec. 2010) from Enterprise Landing to Red Bluff Road in Horry County, South Carolina (Figure 1). Mapping consisted of a combination of multibeam and single beam data to characterize river morphology to assist Horry County and the United States Army Corps of Engineers (USACE) in managing the river and adjacent lands. The data was merged with previously collected bathymetric data (2009) from Enterprise Landing to the Horry-Georgetown County line to provide a continuous dataset from the Horry-Georgetown County line through Red Bluff Rd.

METHODS

Bathymetric data was collected on the Waccamaw River from Oct - Dec 2010. Daily data acquisition activities associated with the project are provided in Table 1. Multibeam data acquisition was suspended from Oct. 18 to Nov. 1 due to damage incurred to the bow-mounted

pole supporting the transducers. Data acquisition resumed after a new pole and mount was fabricated and proper offset and calibration tests were conducted.

Multibeam and single beam mapping were conducted with a Real-Time Kinematic Global Positioning System (RTK-GPS). An Ashtech Z-Xtreme receiver with an Airlink modem was used as a base station to broadcast real-time corrected GPS data to the roving multibeam and single beam systems. A base station was set-up on established benchmarks and positional accuracy was determined by comparison of established benchmark values versus collected data. A list of all benchmarks used during the project is provided in Appendix 1. Hard copy records of all pre-survey calibrations are provided with this report. All hydrographic data collection requirements listed in the Scope of Work (SOW) were met. All data provided to USACE is in UTM meters (NAD83, Zone 17N).

Multibeam mapping was conducted along the thalweg of the river and in areas > 10 ft water depth dependent on obstructions and potential safety concerns for the instrumentation and crew. Single beam surveys were conducted in shallower reaches free of obstructions in areas where the multibeam system was unable to map. As a result of decreasing river discharge and associated declines in river stage throughout the project (Figure 2), data collection along the banks of the river was limited. Numerous fallen trees throughout the entire river and tree cover also limited our ability to conduct bank-to-bank mapping (Figure 3)

Multibeam

Data Acquisition

Swath bathymetry data were collected using a Kongsberg EM3002 dual head multibeam echosounder system aboard the 24 ft. vessel *Privateer* (Figure 4). The acquisition software used was the Seafloor Information System (SIS), which allowed for real-time monitoring of the multibeam sonar data via multiple numerical and visual data displays. The multibeam data were checked in real-time for quality. At the beginning and conclusion of each survey day, a sound velocity profile (SVP) was obtained using an AML Oceanographic Smart SV&P probe and input into the multibeam acquisition software to account for refraction of the sound waves through the water column. Additional sound velocity casts were taken when needed as water column characteristics changed throughout the day. During data acquisition, the EM3002 system also integrated heave, pitch and roll data collected at 100 Hz from a Seatex Seapath 200 RTK vessel reference unit (MRU-5), which was centered approximately 15 cm above the bow-mounted sonar heads in a waterproof subsea bottle. Further, two L1/L2 GPS antennas mounted along the vessel centerline provided both accurate heading and RTK-GPS positions that were collected at a 25 Hz sampling rate and referenced to an accompanying base station located less than 8 km from the survey site. A workflow diagram for multibeam data acquisition is provided in Figure 6. CCU's Swath Bathymetry Field Data Acquisition Standard Operating Procedure is provided in Appendix 2. At the conclusion of a survey day, the raw Simrad EM3002 data files were imported into CARIS HIPS and SIPS software (v. 7.0) for post-processing. This included minor data cleaning (flagging of outliers) and the application of a geoid file for tide correction referenced to the NAVD 88 vertical datum.

Data Processing

Bathymetric data were post-processed using CARIS HIPS ver. 7.0 hydrographic data processing software. Post-survey data cleaning, as well as Bathymetry Associated with Statistical Error (BASE) Surface creation using swath angle algorithm, were applied in CARIS HIPS. Soundings (xyz) were exported from a BASE Surface as xyz text file with 50 cm spatial resolution. The xyz were imported into Fledermaus Dmagic ver. 7.1 to grid. In Dmagic, the 50 cm decimated xyz text files were interpolated into 50 cm digital elevation model (DEM) grids. The 1m Fledermaus grids were exported as ArcInfo ASCII raster files (.asc), which were converted into 1m bathymetry ArcInfo grids in ArcGIS. Final x,y,z soundings, surface models, and derived products are relative to the NAVD88 vertical datum.

Single Beam

Data Acquisition

Single beam data acquisition was conducted aboard a 20 ft Carolina Skiff (Figure y). Each single beam survey boat was outfitted with a Knudsen Mini-Sounder (210 kHz) , TSS DMS-05 motion reference unit, Ashtech Z-Xtreme GPS receiver, and dual frequency GPS antenna. Sound velocity profiles conducted at the beginning and end of surveying each day were used to determine water column sound velocity. All instrument and water level offsets were measured and entered into HYPACK. HYPACK software was used for navigation and data

acquisition. A diagram illustrating single beam data acquisition and processing workflow is provided in Figure 7.

Data Processing

Raw depth and position data were merged, heave/pitch/roll and tide corrections were applied, and data were processed to produce a corrected, RTK-positioned depth with HYPACK software. Initial outlier points were removed using the HYPACK Single Beam editor and exported as a text file. Final filtering and smoothing was performed with a customized MATLAB script.

RESULTS

Multibeam and Single Beam Data

Multibeam and single beam data products are provided on external hard drives accompanying this report and can also be acquired through the eCoastal database available online through Coastal Carolina University. Multibeam data are provided as ESRI ArcGIS grids with accompanying raw and processed data and single beam data are provided as a feature class titled “spot_elevation_point”.

TABLES

Table 1. Summary of daily work performed, area, personnel, and weather on data acquisition days for the Waccamaw River Mapping Project.

Date	Survey Type	Work Performed	Area	Personnel	Weather
14-Oct	multibeam	water level test	Conway	Marshall, Phillips	82°F, Wind:5knts
15-Oct	multibeam	survey	Conway-north	Marshall, Johnson	73°F, Wind: variable
18-Oct	multibeam	survey	Conway-north	Marshall, Phillips	81°F, Wind: variable
1-Nov	multibeam	survey	Conway-south	Marshall, Phillips	74°F, Wind: light
2-Nov	multibeam	survey	Conway-south	Marshall, Phillips	72°F, Wind:5-10knts
3-Nov	multibeam	survey	Conway-south	Marshall, Phillips	56°F, Wind:5knts
5-Nov	multibeam	survey	Conway-Lees Landing	Marshall, Phillips	63°F, Wind:10knts
8-Nov	multibeam	survey	Conway-south	Marshall, Phillips	67°F, Wind:5knts
12-Nov	single beam	survey	Hwy 22-north	McCoy, Phillips	45°F, Sunny, Wind: light
17-Nov	multibeam	survey	Conway-south	Marshall, Phillips	68°F, Wind:10knts
18-Nov	multibeam	survey	Conway-south	Marshall, Phillips	66°F, Wind:5knts
30-Nov	single beam	survey	Middle Mill	Marshall, Johnson	55°F, Cloudy, Wind:5knts
2-Dec	single beam	survey	Middle Mill	Marshall, Johnson	50°F, Sunny, Wind: light
3-Dec	single beam	survey	Middle Mill	Johnson	40°F, Sunny, Wind:10knts
7-Dec	single beam	survey	Conway-north	Marshall, Johnson	40°F, Sunny, Wind:10knts

FIGURES



Figure 1. Map of the Waccamaw River, Horry County, SC indicating areas mapped by CCU CMWS.



USGS 02110704 WACCAMAW RIVER AT CONWAY MARINA AT CONWAY, SC

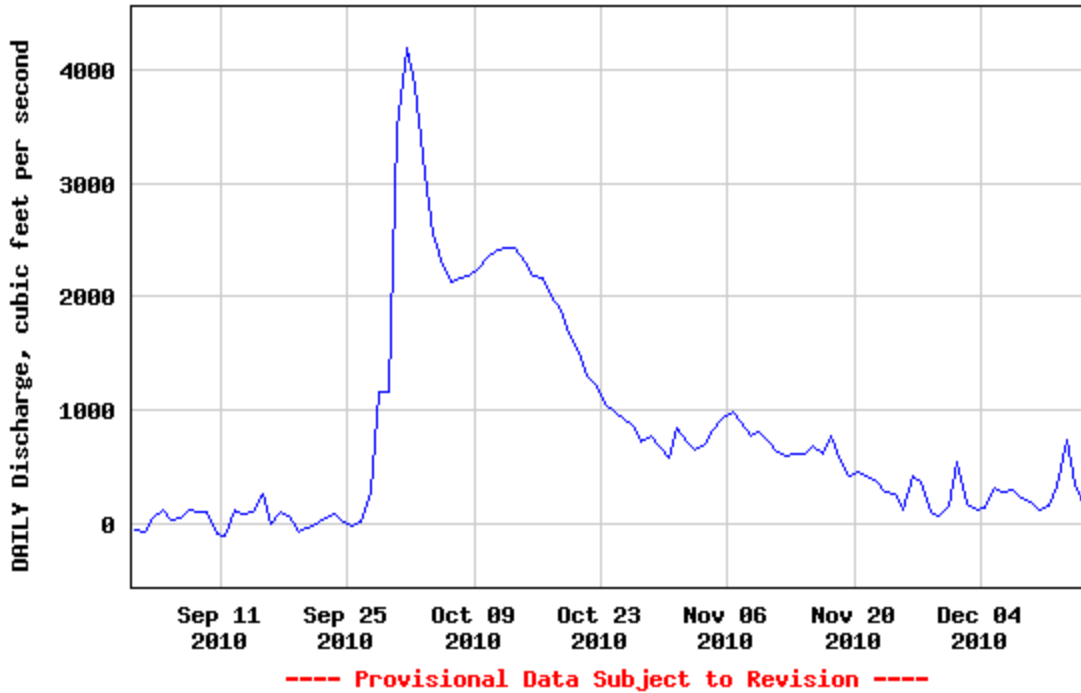


Figure 2. Daily Waccamaw River discharge at Conway Marina, Conway, SC, Sep. 1 – Dec 15, 2010. Downloaded at: http://waterdata.usgs.gov/sc/nwis/current/?type=dailystagedischarge&group_key=county_cd (12-22-10).



Figure 3. Representative pictures indicating obstructions that limited mapping coverage along the river banks while mapping the Waccamaw River.



Figure 4. The multibeam data acquisition boat, a 24 ft. Privateer.

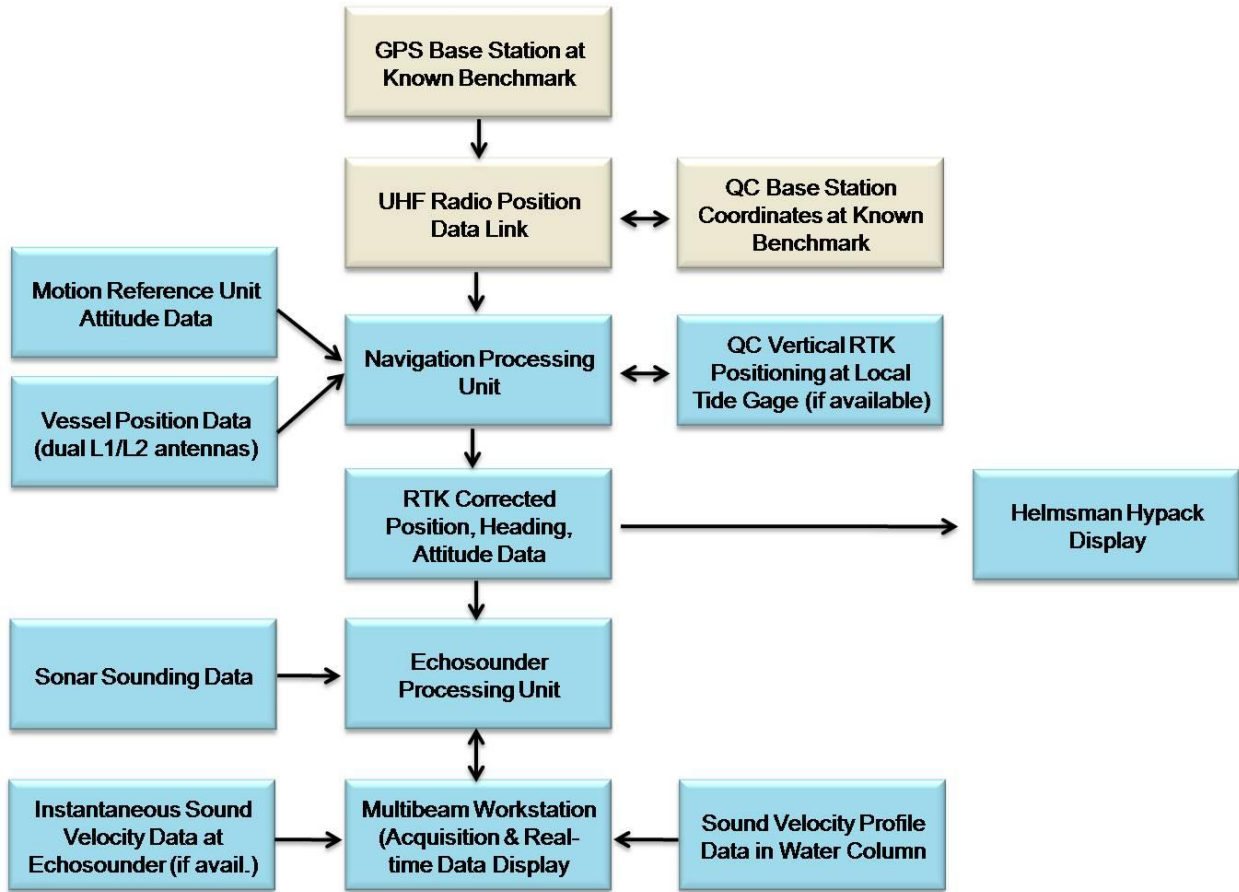


Figure 5. Multibeam bathymetry work flow diagram.



Figure 6. The single beam data acquisition boat, a 20 ft. Carolina Skiff.

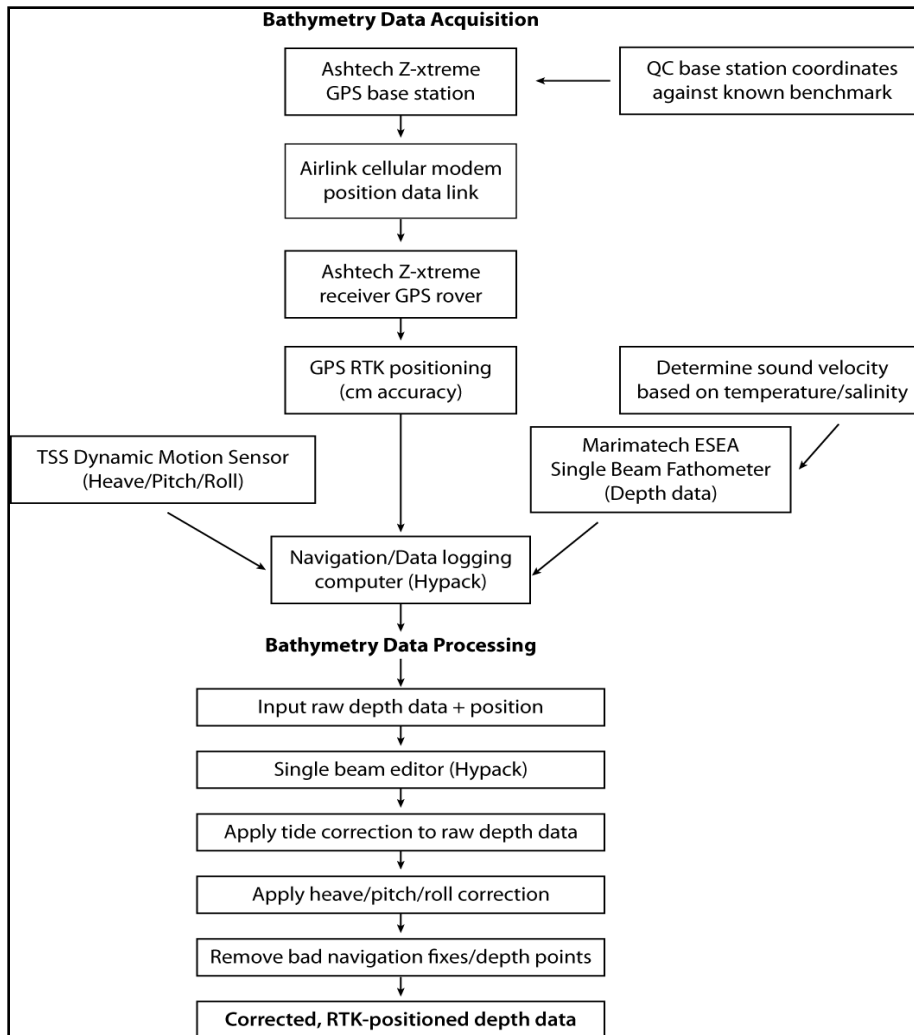


Figure 7. Single beam data acquisition and processing workflow diagram.

APPENDICES

Appendix 1: Survey Monuments Utilized for Project

(Designation: 026 057, 026 057 AZ MK)

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

DATABASE = ,PROGRAM = datasheet, VERSION = 7.85

1 National Geodetic Survey, Retrieval Date = DECEMBER 21, 2010

DD1641 *****

DD1641 HT_MOD - This is a Height Modernization Survey Station.

DD1641 DESIGNATION - 026 057

DD1641 PID - DD1641

DD1641 STATE/COUNTY- SC/HORRY

DD1641 USGS QUAD - CONWAY (1980)

DD1641

DD1641 *CURRENT SURVEY CONTROL

DD1641

DD1641 * NAD 83(2007)- 33 48 02.13742(N) 079 00 11.61599(W) ADJUSTED

DD1641 * NAVD 88 - 12.77 (meters) 41.9 (feet) GPS OBS

DD1641

DD1641 EPOCH DATE - 2002.00

DD1641 X - 1,012,058.504 (meters) COMP

DD1641 Y - -5,208,155.544 (meters) COMP

DD1641 Z - 3,528,076.263 (meters) COMP

DD1641 LAPLACE CORR- -2.76 (seconds) DEFLEC09

DD1641 ELLIP HEIGHT- -21.473 (meters) (05/15/09) ADJUSTED

DD1641 GEOID HEIGHT- -34.23 (meters) GEOID09

DD1641 HORZ ORDER - FIRST

DD1641 ELLP ORDER - THIRD CLASS I

DD1641

DD1641.The horizontal coordinates were established by GPS observations

DD1641.and adjusted by the SOUTH CAROLINA GEODETIC SURVEY in May 2009.

DD1641

DD1641.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).

DD1641.See National Readjustment for more information.

DD1641.The horizontal coordinates are valid at the epoch date displayed above.

DD1641.The epoch date for horizontal control is a decimal equivalence

DD1641.of Year/Month/Day.

DD1641

DD1641.The orthometric height was determined by GPS observations and a

DD1641.high-resolution geoid model using precise GPS observation and

DD1641.processing techniques. It supersedes the leveled height previously

DD1641.determined for this station.

DD1641

DD1641.The X, Y, and Z were computed from the position and the ellipsoidal ht.

DD1641

DD1641.The Laplace correction was computed from DEFLEC09 derived deflections.

DD1641

DD1641.The ellipsoidal height was determined by GPS observations

DD1641.and is referenced to NAD 83.

DD1641

DD1641.The geoid height was determined by GEOID09.

DD1641

DD1641; North East Units Scale Factor Converg.

DD1641;SPC SC - 219,946.949 794,452.234 MT 0.99979627 +1 06 25.2

DD1641;SPC SC - 721,610.73 2,606,470.58 iFT 0.99979627 +1 06 25.2

DD1641;UTM 17 - 3,741,838.797 684,841.819 MT 1.00002121 +1 06 40.1

DD1641

DD1641! - Elev Factor x Scale Factor = Combined Factor
DD1641!SPC SC - 1.00000337 x 0.99979627 = 0.99979964
DD1641!UTM 17 - 1.00000337 x 1.00002121 = 1.00002458
DD1641
DD1641: Primary Azimuth Mark Grid Az
DD1641:SPC SC - 026 057 AZ MK 135 50 16.8
DD1641:UTM 17 - 026 057 AZ MK 135 50 01.9
DD1641
DD1641|-----|
DD1641|PID Reference Object Distance Geod. Az |
DD1641| dddmmss.s |
DD1641| DD1640 026 057 AZ MK APPROX. 1.2 KM 1365642.0 |
DD1641| DL3236 HORRY GEORGETOWN TECH BASE ARP 460.950 METERS 1825837.1 |
DD1641| DD1659 026 057 RM 1 33.650 METERS 35601 |
DD1641|-----|
DD1641
DD1641 SUPERSEDED SURVEY CONTROL
DD1641
DD1641 NAD 83(2001)- 33 48 02.13905(N) 079 00 11.61724(W) AD() 2
DD1641 NAD 83(1986)- 33 48 02.14746(N) 079 00 11.62261(W) AD() 2
DD1641 NAD 27 - 33 48 01.53366(N) 079 00 12.49726(W) AD() 2
DD1641 NAVD 88 (06/15/91) 12.790 (m) 41.96 (f) ADJUSTED 1 2
DD1641 NGVD 29 (03/21/89) 13.101 (m) 42.98 (f) ADJUSTED 1 2
DD1641
DD1641.Superseded values are not recommended for survey control.
DD1641.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
DD1641.See file dsdata.txt to determine how the superseded data were derived.
DD1641
DD1641_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SPT8484141838(NAD 83)
DD1641_MARKER: DD = SURVEY DISK
DD1641_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
DD1641_SP_SET: CONCRETE POST
DD1641_STAMPING: HORZ 026 - 057 1981
DD1641_MARK LOGO: SCGS
DD1641_PROJECTION: RECESSED 5 CENTIMETERS
DD1641_MAGNETIC: M = MARKER EQUIPPED WITH BAR MAGNET
DD1641_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
DD1641+STABILITY: SURFACE MOTION
DD1641_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DD1641+SATELLITE: SATELLITE OBSERVATIONS - May 29, 2008
DD1641
DD1641 HISTORY - Date Condition Report By
DD1641 HISTORY - 1981 MONUMENTED SCGS
DD1641 HISTORY - 1986 GOOD SCGS
DD1641 HISTORY - 20080529 GOOD SCGS
DD1641
DD1641 STATION DESCRIPTION
DD1641
DD1641'DESCRIBED BY SOUTH CAROLINA GEODETIC SURVEY 1981 (MJH)
DD1641'THE STATION IS LOCATED ABOUT 4 MILES EAST SOUTHEAST OF CONWAY,
DD1641'ABOUT 10 MILES WEST OF MYRTLE BEACH, IN THE NORTH WEST CORNER
DD1641'OF THE FRONT LAWN OF GROVE MANUFACTURING COMPANY.
DD1641'
DD1641'TO REACH THE STATION FROM SC HIGHWAY S-26-544 OVERPASS
DD1641'ON US 501 ABOUT 3 MILES SOUTHEAST OF CONWAY GO SOUTHEAST ON US
DD1641'501 FOR 0.8 MI TO ENTRANCE TO GROVE MANUFACTURING COMPANY

DD1641'ON THE LEFT, TURN LEFT AND GO 0.15 MILES TO THE STATION ON THE
DD1641'RIGHT. TO REACH THE AZIMUTH CONTINUE AHEAD ON 501 0.8 MI
DD1641'TO PAVED ROAD LEFT, TURN LEFT AND GO EAST NORTHEAST FOR 0.2
DD1641'MI TO AZIMITH ON THE LEFT AT THE FENCE CORNER OF GROVE
DD1641'MANUFACTURING.
DD1641'
DD1641'THE STATION IS A STANDARD SCGS DISK
DD1641'STAMPED---026 057 1981---,
DD1641'SET INTO THE TOP OF A ROUND CONCRETE MONUMENT 30 CM IN DIAMETER
DD1641'FLUSH WITH GROUND. IT IS LOCATED
DD1641'39.81 METERS (130.6 FT) SOUTH FROM CENTER LINE OF ROAD,
DD1641'37.6 METERS (123.4 FT) NORTHEAST FROM THE NORTHEAST RAIL OF THE
DD1641'RAILROAD TRACTS,
DD1641'34.6 METERS (113.7 FT) EAST FROM THE EAST CORNER OF A 6 FT CHAIN
DD1641'LINK FENCE, AND
DD1641'5.4 METERS (17.90 FT) SOUTH FROM A 4 INCH SPRUCE TREE.
DD1641'THE UNDERGROUND MARK IS A STANDARD SCGS DISK
DD1641'STAMPED---026 057 1981---,
DD1641'SET INTO AN IRREGULAR MASS OF CONCRETE 1.3 METERS BELOW THE SURFACE.
DD1641'
DD1641'REFERENCE MARK NUMBER 1 IS A STANDARD SCGS DISK
DD1641'STAMPED---026 057 RM 1 1981---,
DD1641'SET INTO THE TOP OF A ROUND CONCRETE MONUMENT 30 CM IN DIAMETER
DD1641'FLUSH WITH GROUND. IT IS LOCATED
DD1641'46.7 METERS (153.3 FT) EAST FROM A FIRE HYDRANT,
DD1641'40.8 METERS (134.0 FT) NORTHEAST FROM THE NORTHEAST CORNER OF A 6
DD1641'FOOT CHAIN LINK FENCE,
DD1641'28.8 METERS (94.60 FT) SOUTHEAST FROM A TELEPHONE JUCTION BOX, AND
DD1641'6.2 METERS (20.40 FT) SOUTH FROM CENTER OF ROAD.
DD1641'MARK IS LEVEL WITH STATION.
DD1641'
DD1641'AZIMUTH MARK NUMBER 1 IS A STANDARD SCGS DISK
DD1641'STAMPED---026 057 AZ MK 1981---,
DD1641'SET INTO THE TOP OF A ROUND CONCRETE MONUMENT 30 CM IN DIAMETER
DD1641'PROJECTING 8 CM ABOVE THE GROUND. IT IS LOCATED
DD1641'15.8 METERS (51.7 FT) NORTHEAST FROM THE NORTHEAST RAIL OF THE
DD1641'RAILROAD TRACTS,
DD1641'6.3 METERS (20.30 FT) NORTHWEST FROM CENTER LINE OF ROAD,
DD1641'1.4 METERS (4.70 FT) SOUTHWEST FROM 4 INCH METAL LIGHT POST, AND
DD1641'0.8 METERS (2.7 FT) EAST FROM A 8 FOOT CHAIN LINK FENCE.
DD1641'TO REACH AZIMUTH MARK FROM THE STATION PROCEED SOUTHEASTERLY
DD1641'ON US HIGHWAY 501 FOR 1.3 KM (0.8 MI) TO A PAVED ROAD
DD1641'LEFT, TURN LEFT, GO NORTHEAST FOR 0.3 KM (0.2 MI) TO THE MARK
DD1641'ON THE LEFT.
DD1641'
DD1641'NO MEASUREMENT BETWEEN REFERENCE MARKS BECAUSE ONLY ONE RM.
DD1641'
DD1641'HEIGHT OF LIGHT SHOWN ABOVE THE MARK WAS 1.3 METERS.
DD1641'
DD1641' STATION RECOVERY (1986)
DD1641'
DD1641'RECOVERY NOTE BY SOUTH CAROLINA GEODETIC SURVEY 1986
DD1641'6.4 KM (4.0 MI) SE FROM CONWAY.
DD1641'3.6 KM (2.25 MI) SOUTHEAST ALONG U.S. HIGHWAY 501 BUSINESS (MAIN
DD1641'STREET) FROM THE CITY HALL AT 3RD AVENUE IN CONWAY, THENCE 0.8 KM
DD1641'(0.5 MI) SOUTH ALONG STATE HIGHWAY 544 TO THE INTERSECTION OF U.S.

DD1641'HIGHWAY 501, THENCE 1.6 KM (1.0 MI) SOUTHEAST ALONG U.S. HIGHWAY 501
DD1641'TO THE ENTRANCE ROAD TO GROVE MANUFACTURING COMPANY, THENCE 0.2 KM
DD1641'(0.1 MI) NORTHEAST ALONG THE ENTRANCE ROAD, SET NEAR A SMALL LONE PINE
DD1641'TREE IN THE SOUTHEAST ANGLE OF A RAILROAD CROSSING, 39.8 METERS
DD1641'(130.58 FT) SOUTH OF THE CENTER OF THE ENTRANCE ROAD, 37.68 METERS
DD1641'(123.62 FT) NORTHEAST OF THE NORTHEAST RAIL OF THE TRACKS,
DD1641'34.83 METERS (114.27 FT) EAST SOUTHEAST OF THE SOUTHEAST CORNER OF A
DD1641'SIX FOOT CHAIN LINK FENCE, 5.4 METERS (17.72 FT) SOUTH SOUTHEAST OF
DD1641'THE 9 INCH PINE TREE.

DD1641'THE MARK IS ABOVE LEVEL WITH ENTRANCE ROAD.

DD1641

DD1641 STATION RECOVERY (2008)

DD1641

DD1641'RECOVERY NOTE BY SOUTH CAROLINA GEODETIC SURVEY 2008 (DDW)

DD1641'STATION IS LOCATED 10.2 MI (16.4 KM) NORTHWEST OF MYRTLE BEACH, 8.1 MI

DD1641'(13.1 KM) NORTH OF SOCASTEE, 3.6 MI (5.7 KM) SOUTHEAST OF CONWAY.

DD1641'OWNERSHIP--SOUTH CAROLINA ELECTRIC AND GAS.

DD1641'

DD1641'TO REACH THE STATION FROM THE JUNCTION OVERPASS OF U.S. HIGHWAY 501

DD1641'AND STATE HIGHWAY 544, 2.7 MI (4.3 KM) SOUTHEAST OF CONWAY, GO

DD1641'EAST-SOUTHEAST ON HIGHWAY 501 FOR 0.8 MI (1.3 KM) TO THE JUNCTION OF

DD1641'ATLANTIC AVENUE, TURN RIGHT ON ATLANTIC AVENUE FOR 0.1 MI (0.2 KM) TO

DD1641'THE STATION ON THE RIGHT NEAR A LONE PINE TREE. STATION IS A CONCRETE

DD1641'POST RECESSED 0.2 FT (0.1 M) AND LEVEL WITH THE ROAD, 132.0 FT (40.2

DD1641'M) SOUTH OF THE CENTER OF THE ROAD, 17.8 FT (5.4 M) SOUTH OF THE

DD1641'2.0-FOOT PINE TREE WITH A SCGS REFERENCE WASHER AND BLAZE, 123.2 FT

DD1641'(37.6 M) NORTHEAST OF THE EAST RAIL OF A SET OF RAILROAD TRACKS, 121.0

DD1641'FT (36.9 M) SOUTHEAST OF THE SOUTHEAST CORNER OF A TRANSFORMER 34KV,

DD1641'110.2 FT (33.6 M) SOUTH OF SURVEY STATION 026 057 RM 1.

DD1641'

DD1641'NOTE-STATION IS NOT INTERVISIBLE WITH SURVEY STATION 026 057 AZ MK.

DD1641'RECOVERED BY R.P. MCKEOWN.

1 National Geodetic Survey, Retrieval Date = DECEMBER 21, 2010

DD1640 *****

DD1640 DESIGNATION - 026 057 AZ MK

DD1640 PID - DD1640

DD1640 STATE/COUNTY- SC/HORRY

DD1640 USGS QUAD - NIXONVILLE (1984)

DD1640

DD1640 *CURRENT SURVEY CONTROL

DD1640

DD1640* NAD 83(2007)- 33 47 33.02194(N) 078 59 39.03605(W) ADJUSTED

DD1640* NAVD 88 - 13.125 (meters) 43.06 (feet) ADJUSTED

DD1640 EPOCH DATE - 2002.00

DD1640 X - 1,012,976.442 (meters) COMP

DD1640 Y - -5,208,485.697 (meters) COMP

DD1640 Z - 3,527,330.964 (meters) COMP

DD1640 LAPLACE CORR- -3.03 (seconds) DEFLEC09

DD1640 ELLIP HEIGHT- -21.151 (meters) (05/15/09) ADJUSTED

DD1640 GEOID HEIGHT- -34.26 (meters) GEOID09

DD1640 DYNAMIC HT - 13.112 (meters) 43.02 (feet) COMP

DD1640 MODELED GRAV- 979,640.6 (mgal) NAVD 88

DD1640

DD1640 HORZ ORDER - FIRST

DD1640 VERT ORDER - FIRST CLASS II

DD1640 ELLP ORDER - THIRD CLASS I

DD1640

DD1640.The horizontal coordinates were established by GPS observations

DD1640.and adjusted by the SOUTH CAROLINA GEODETIC SURVEY in May 2009.

DD1640

DD1640.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).

DD1640.See [National Readjustment](#) for more information.

DD1640.The horizontal coordinates are valid at the epoch date displayed above.

DD1640.The epoch date for horizontal control is a decimal equivalence

DD1640.of Year/Month/Day.

DD1640

DD1640.The orthometric height was determined by differential leveling and

DD1640.adjusted in June 1991.

DD1640

DD1640.The X, Y, and Z were computed from the position and the ellipsoidal ht.

DD1640

DD1640.The Laplace correction was computed from DEFLEC09 derived deflections.

DD1640

DD1640.The ellipsoidal height was determined by GPS observations

DD1640.and is referenced to NAD 83.

DD1640

DD1640.The geoid height was determined by GEOID09.

DD1640

DD1640.The dynamic height is computed by dividing the NAVD 88

DD1640.geopotential number by the normal gravity value computed on the

DD1640.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45

DD1640.degrees latitude (g = 980.6199 gals.).

DD1640

DD1640.The modeled gravity was interpolated from observed gravity values.

DD1640

DD1640; North East Units Scale Factor Converg.

DD1640;SPC SC - 219,066.455 795,307.342 MT 0.99979596 +1 06 43.3

DD1640;SPC SC - 718,721.97 2,609,276.06 iFT 0.99979596 +1 06 43.3
 DD1640;UTM 17 - 3,740,958.163 685,697.182 MT 1.00002512 +1 06 57.4
 DD1640
 DD1640! - Elev Factor x Scale Factor = Combined Factor
 DD1640!SPC SC - 1.00000332 x 0.99979596 = 0.99979928
 DD1640!UTM 17 - 1.00000332 x 1.00002512 = 1.00002844

DD1640

DD1640 SUPERSEDED SURVEY CONTROL

DD1640

DD1640 NAD 83(2001)- 33 47 33.02315(N) 078 59 39.03793(W) AD() 2

DD1640 NAD 83(1986)- 33 47 33.03174(N) 078 59 39.04307(W) AD() 2

DD1640 NAD 27 - 33 47 32.41620(N) 078 59 39.92003(W) AD() 2

DD1640 NAVD 88 (05/15/09) 13.12 (m) 43.0 (f) LEVELING 3

DD1640 NGVD 29 (03/21/89) 13.438 (m) 44.09 (f) ADJUSTED 1 2

DD1640

DD1640.Superseded values are not recommended for survey control.

DD1640.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

DD1640.[See file dsdata.txt](#) to determine how the superseded data were derived.

DD1640

DD1640_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SPT8569740958(NAD 83)

DD1640_MARKER: DD = SURVEY DISK

DD1640_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT

DD1640_SP_SET: CONCRETE POST

DD1640_STAMPING: AZ MK 026 - 057 1981

DD1640_MARK LOGO: SCGS

DD1640_PROJECTION: FLUSH

DD1640_MAGNETIC: M = MARKER EQUIPPED WITH BAR MAGNET

DD1640_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO

DD1640+STABILITY: SURFACE MOTION

DD1640_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

DD1640+SATELLITE: SATELLITE OBSERVATIONS - May 29, 2008

DD1640

DD1640 HISTORY - Date Condition Report By

DD1640 HISTORY - 1981 MONUMENTED MJH

DD1640 HISTORY - 1986 GOOD SCGS

DD1640 HISTORY - 19970709 GOOD SCGS

DD1640 HISTORY - 20080529 GOOD SCGS

DD1640

DD1640 STATION DESCRIPTION

DD1640

DD1640'DESCRIBED BY SOUTH CAROLINA GEODETIC SURVEY 1986

DD1640'7.7 KM (4.8 MI) SE FROM CONWAY.

DD1640'3.6 KM (2.25 MI) SOUTHEAST ALONG U.S. HIGHWAY 501 BUSINESS (MAIN

DD1640'STREET) FROM THE CITY HALL AT 3RD AVENUE IN CONWAY, THENCE 0.8 KM

DD1640'(0.5 MI) SOUTH ALONG STATE HIGHWAY 544 TO THE INTERSECTION OF U.S.

DD1640'HIGHWAY 501, THENCE 2.9 KM (1.8 MI) SOUTHEAST ALONG U.S. HIGHWAY 501,

DD1640'THENCE 0.3 KM (0.2 MI) NORTHEAST ALONG A PAVED ROAD, SET NEAR A FIVE

DD1640'FOOT HIGH CAUTION LIGHT IN THE NORTHWEST ANGLE OF A RAILROAD CROSSING,

DD1640'1.18 METERS (3.87 FT) NORTH NORTHWEST OF THE CAUTION LIGHT,

DD1640'31.93 METERS (104.76 FT) SOUTHWEST OF A LIGHT POLE, 15.8 METERS

DD1640'(51.84 FT) NORTHEAST OF THE NORTHEAST RAIL OF THE TRACKS, 6.3 METERS

DD1640'(20.67 FT) NORTHWEST OF THE CENTER OF THE PAVED ROAD, 1.16 METERS

DD1640'(3.81 FT) EAST OF THE SOUTH CORNER OF A EIGHT FOOT CHAIN LINK FENCE

DD1640'SURROUNDING THE GROVE MANUFACTURING COMPANY.

DD1640'THE MARK IS 1.17 METERS SE FROM A WITNESS POST.

DD1640'THE MARK IS ABOVE LEVEL WITH ROAD.

DD1640

DD1640 STATION RECOVERY (1997)

DD1640

DD1640'RECOVERY NOTE BY SOUTH CAROLINA GEODETIC SURVEY 1997 (DDW)

DD1640'STATION IS LOCATED 4.3 MILES (6.9 KM) SOUTHEAST OF CONWAY, 9.35 MILES
DD1640'(15.05 KM) NORTHWEST OF MYRTLE BEACH. OWNERSHIP--SCDOT, DIRECTOR OF
DD1640'PRECONSTRUCTION, P.O. BOX 191, COLUMBIA, SC 29202, PHONE
DD1640'803-737-1350. TO REACH THE STATION FROM THE JUNCTION OVERPASS OF U.S.
DD1640'HIGHWAY 501 AND STATE HIGHWAY 544, 2.25 MILES (3.62 KM) SOUTHEAST OF
DD1640'CONWAY, GO EAST SOUTHEAST ON HIGHWAY 501 FOR 1.6 MILES (2.6 KM) TO A
DD1640'CROSSROAD (CENTURY CIRCLE) , TURN LEFT ON CENTURY CIRCLE FOR 0.2 MILE
DD1640'(0.3 KM) TO THE STATION ON THE LEFT NEAR A GUARD RAIL IN THE NORTH
DD1640'ANGLE OF A RAILROAD CROSSING. STATION IS A CONCRETE POST PROJECTING
DD1640'0.1 FOOT (3.0 CM) AND LEVEL WITH THE ROAD, 72.0 FEET (21.9 M) SOUTH
DD1640'SOUTHWEST OF A FIRE HYDRANT, 22.6 FEET (6.9 M) NORTHWEST OF THE CENTER
DD1640'OF THE ROAD, 27.4 FEET (8.4 M) WEST SOUTHWEST OF THE EXTENDED CENTER
DD1640'OF A ROAD LEADING TO SHIPPING AND RECEIVING, 51.2 FEET (15.6 M)
DD1640'NORTHEAST OF THE NORTHEAST RAIL OF THE TRACK, 9.6 FEET (2.9 M) SOUTH
DD1640'OF THE SOUTHEAST END OF A GUARDRAIL POST WITH A SCGS REFERENCE WASHER
DD1640'ATTACHED, 41.1 FEET (12.5 M) NORTH NORTHEAST OF A CROSSING SIGN POST,
DD1640'2.4 FEET (0.7 M) EAST SOUTHEAST OF A WITNESS POST. RECOVERED BY C.E.
DD1640'GEOGHEGAN.

DD1640

DD1640 STATION RECOVERY (2008)

DD1640

DD1640'RECOVERY NOTE BY SOUTH CAROLINA GEODETIC SURVEY 2008 (DDW)

DD1640'STATION IS LOCATED 9.4 MI (15.2 KM) NORTHWEST OF MYRTLE BEACH, 7.6 MI
DD1640'(12.2 KM) NORTH OF SOCASTEE, 4.3 MI (6.9 KM) SOUTHEAST OF CONWAY.
DD1640'OWNERSHIP--SCDOT, DIRECTOR OF PRECONSTRUCTION, P.O. BOX 191, COLUMBIA,
DD1640'SC 29202, PHONE 803-737-1350.

DD1640'

DD1640'TO REACH THE STATION FROM THE JUNCTION OVERPASS OF U.S. HIGHWAY 501
DD1640'AND STATE HIGHWAY 544, 2.7 MI (4.3 KM) SOUTHEAST OF CONWAY, GO
DD1640'EAST-SOUTHEAST ON HIGHWAY 501 FOR 1.6 MI (2.6 KM) TO THE JUNCTION OF
DD1640'CENTURY CIRCLE, TURN LEFT ON CENTURY CIRCLE FOR 0.2 MI (0.3 KM) TO THE
DD1640'STATION ON THE LEFT NEAR A METAL GUARD RAIL IN THE WEST ANGLE OF THE
DD1640'PAVED ENTRANCE DRIVE TO METGLAS INCORPORATED. STATION IS A CONCRETE
DD1640'POST FLUSH WITH THE GROUND AND LEVEL WITH THE CIRCLE, 23.0 FT (7.0 M)
DD1640'NORTHWEST OF THE CENTER OF THE CIRCLE, 25.5 FT (7.8 M) SOUTHWEST OF
DD1640'THE CENTER OF ENTRANCE DRIVE, 8.7 FT (2.7 M) SOUTH-SOUTHWEST OF THE
DD1640'SOUTH END OF A METAL GUARD RAIL, 39.7 FT (12.1 M) NORTHEAST OF A
DD1640'CONCRETE (MV) POST, 51.2 FT (15.6 M) EAST-NORTHEAST OF THE EAST RAIL
DD1640'OF A SET OF RAILROAD TRACKS, 2.5 FT (0.8 M) EAST-SOUTHEAST OF A
DD1640'WITNESS POST.

DD1640'

DD1640'NOTE-STATION IS NOT INTERVISIBLE WITH SURVEY STATION 026 057.

DD1640'RECOVERED BY R.P. MCKEOWN.

*** retrieval complete.

Elapsed Time = 00:00:01

**Appendix 2: Swath Bathymetry Field Data Acquisition
Standard Operating Procedure**

Swath Bathymetry Field Data Acquisition Standard Operating Procedure

*B&C Center for Marine & Wetland Studies
Coastal Carolina University
Conway, SC*

Survey Preparation

GPS Ephemeris & DOP

Pre-survey planning of satellite geometry and availability shall be reviewed prior to each day of data acquisition. The mapping specialist in charge must determine if there will be excessive periods of GPS outages or periods of high dilution of precision (DOP) and note such occurrences in the daily field notes.

Survey Control

All horizontal or vertical controls used for Real-time Kinematic (RTK) GPS enabled mapping projects will utilize benchmarks registered with the South Carolina Geodetic Survey or the National Geodetic Survey (NGS) and be of third order accuracy or better. All work shall be relative to NAD83 (2007) as the horizontal input coordinate system and NAVD 88(NSRS) in the vertical plane. A minimum of five satellites shall be used to resolve vertical and horizontal positions at both the base and aboard the survey vessel. The monument name and general location shall be recorded in the daily field notes.

Base station quality relative to the local network of NGS/National Ocean Service (NOS) survey control markers shall also be recorded in the daily field notes. The quality check entails checking at least one known geodetic benchmark of third order horizontal and vertical accuracy in the local survey area. The surveyed northing, easting and orthometric height of the chosen benchmark as well as the NGS/NOS published northing, easting and orthometric height shall be recorded and compared. Acceptable values for RTK GPS enabled mapping projects should be within +/- 0.1 m (0.3 ft) both horizontally and vertically unless otherwise specified. For further quality analysis, the number of satellites currently tracked, as well as horizontal dilution of precision (HDOP) shall also be recorded in the daily field notes.

In the absence of an acceptable NGS/NOS survey control for either use as a base station location or quality check, a temporary benchmark (TBM) approved by the contractor and CMWS staff will be established.

General Navigation

The mapping specialist shall modify the vessel navigation software parameters to fit survey conditions. Modified parameters may include but are not limited to:

- Heave filter mode and average heave period
- GPS antenna attitude constraints
- RTK baseline search mode
- Waterline adjustments due to vessel loading changes and or water type

- DGPS link baud rate (i.e. radio or cellular communications)

Any changes made to navigation software parameters shall be recorded in the daily field notes and a copy of the parameters shall also be stored electronically for future reference.

Verify Vertical Positioning

When available, the mapping specialist will verify the accuracy of vertical RTK GPS elevation data collected onboard the survey vessel to nearby NOAA NOS, USGS, USACE, or other approved water level gauge stations at the start of a mapping project. As a general check, acceptable values should be within +/-0.25 m. Prior to data acquisition the operator will need to verify the datum being referenced by the gauge and account for differences between it and the datum being referenced aboard the survey vessel. Results shall be noted in the daily field notes.

Hydrographic Data Collection

CMWS data collection methods reference guidelines and general hydrographic surveying technique recommendations set forth in the following publications:

- U.S. Army Corps of Engineers Hydrographic Surveying Manual; EM 1110-2-1003 and Change 1
- NOS 2010 Hydrographic Surveys Specifications and Deliverables
- NOAA Office of Coast Survey 2010 Field Procedures Manual
- International Hydrographic Organization Publication C-13 Manual on Hydrography
- UNB-OMG/UNH-CCOM Shallow Water Multibeam Sonar Training Course (#52)
- FIG Guide on the Development of a Vertical Reference Surface for Hydrography

Field Notes:

Detailed field notes shall be recorded on a daily basis and supplemented with additional information as needed at the end of the survey. The following shall be included in the notes:

- Base station location (if RTK-based survey)
- Survey area, calendar date and day, Julian date
- Personnel/Operators
- General weather and sea state
- Line name, vessel speed, vessel heading and GPS status (i.e. DGPS/Float/Fix)
- Additional comments as outlined in this SOP

Echosounder System Setup

The mapping specialist shall run the echosounder processing unit built in self test (BIST) and record the results of the test in the daily field notes. As needed, the user shall also modify the multibeam acquisition software runtime parameters to fit survey conditions and note changes to in the daily field notes. Modified parameters may include but are not limited to:

- Sonar head sector coverage
- Beam spacing and width
- Bottom tracking mode
- Survey depth range

- Ping rate

Sound Velocity Profiles

Sound velocity profiles (SVP's) are to be collected at a minimum of twice daily. Additional casts may be required when noticeable changes in water properties are observed. Changes may be due to but are not limited to the following: tides, wind shifts, precipitation events, and proximity to swash, inlet or other water discharge area. For each sound velocity dip, the time, location, and chosen file name shall be recorded in the survey notes. Recorded SVP's shall be uploaded into the runtime parameters of the multibeam acquisition software and noted in the daily field notes.

Waterline/Sound Velocity QC

Changes in weight of the vessel due to loading may alter the position of the waterline. A lead-line test shall be conducted at the dock at the start of a new survey project and throughout the rest of the survey as deemed necessary by the mapping specialist. Result of the lead-line test shall be compared to the nadir beam depth after a current SVP has been uploaded into the system. The result should be less than ± 0.25 m and recorded in the daily field notes.

Patch Test

A patch test to properly align the multibeam system sensors will be conducted at any occasion the sonar heads or ancillary sensors (e.g. heave compensation unit or GPS antennas) may have undergone significant change in position or angular orientation on the survey vessel as to impact the quality of the survey or at the commencement of a new survey project. The patch test shall follow the guidelines as outlined in Chapter 12 of the U.S. Army Corps of Engineers Hydrographic Surveying Manual (EM 1110-2-1003 Change 1).

Results of the patch test shall be analyzed and changes incorporated back into the following system components:

- Navigation software
- Multibeam acquisition software
- Post-processing software vessel file

Any changes made to position or angular offsets of shall be recorded in the daily field notes.

Data Acquisition

The mapping specialist shall monitor data collection in real-time for significant static and dynamic artifacts and shall attempt to correct as conditions permit in the field. Monitoring data quality also applies to navigation inputs, and includes recording considerable degradation in the quality of the RTK GPS signal and or complete loss of communications with the RTK base station. The mapping specialist shall note any changes in GPS signal quality in the daily field notes.

During data acquisition the mapping specialist will establish additional survey tracks that will serve as Daily Alignment and Cross Check Analysis lines. During post-processing these lines will serve as a QA check of the overall survey and system accuracy.

Data Archiving & Initial Processing

At the conclusion of a survey day, all raw multibeam data files, sound velocity data files and other ancillary data shall be downloaded from the field system and backed up on a portable hard drive for transfer to a dedicated data server. Copies of daily field notes shall be given to the person in charge of post-processing. Data will undergo an initial quality check for large errors and undergo further bathymetric processing that will correct measured depths for departures from accepted true depths. Post-processing corrections shall include but are not limited to:

- Instrument error corrections
- Vessel offsets
- Velocity of sound corrections
- Motion and instrument latency corrections including heave, pitch, roll, and heading applied to soundings to correct for the motion of the vessel and its sensors during acquisition

