

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MD0402B

Eastern Chesapeake Bay, Miles River to Choptank River, Maryland

Introduction

NOAA Coastal Mapping Program (CMP) Project MD0402B provides a highly accurate database of new digital shoreline data of the eastern shore of the Chesapeake Bay from Miles River to Choptank River, including Poplar Island. Project MD0402B is a subproject of a larger project, MD0402, which extends from Carpenter Point southward to Cambridge, Maryland.

Successful completion of the project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs and digital feature data of the coastal zone which complements the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from aerial photography and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

Project Design

Tuck Mapping Solutions, Inc. (TMSI) utilized the photographic mission data for this project as provided the NOAA staff. Revisions to the photographic mission due to Aberdeen Proving Grounds restricted airspace were developed using the guidelines of the Coastal Mapping Program Specifications for Shoreline Mapping and the Project Instructions prepared by the Remote Sensing Division (RSD) of the National Geodetic Survey, NOAA on June 09, 2004. The guidelines discussed the project's purpose, geographic area of coverage, scope and priority; photographic and ground control requirements; flight line priority, tide and sun angle coordination; Global Positioning Systems (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact and communication information.

The project limits were provided by NOAA on both hardcopy nautical charts and as digital shapefiles. These sources were used to depict the approximate locations of the shoreline to be mapped. TMSI created a Project Layout Diagram, flight maps and input files for the aircraft's flight management system based on flight lines provided by NOAA. Due to security procedures at Aberdeen Proving Grounds several of the flight lines had to be modified and additional flight lines added to provide coverage of the project area.

Field Operations

TMSI acquired imagery for the MD0402 suite of subprojects on May 10 and November 12, 2005; April 18 & 29, May 25, September 25, and October 31, 2007; March 25, April 16, May 24, and August 21, 2008; March 24 and May 21, 2009; August 7, October 8, and November 7, 2010. Aerial photographic coverage of the project site consisted of natural color and black & white infrared photographs at a nominal scale of 1:30,000. A waiver to utilize a 700nm filter during the acquisition of the B&W IR photography was approved previously by NOAA without requiring a new camera calibration report by the USGS. Tide-coordinated, black and white infrared imagery was collected at both the mean high water (MHW) and mean lower low water (MLLW) levels. Natural color imagery was acquired during a period when MHW was not being exceeded over most of the project and a variance was granted to allow use of the imagery where MHW was exceeded. All photography was acquired using a Leica RC30 camera (NOAA camera designation number 20) at an altitude of 15,000 feet for a nominal scale of 1:30,000.

TMSI performed the necessary GPS surveys to locate aerial control and checkpoints. Multiple two hour sessions observed by TMSI were submitted for OPUS solutions and a mean of the values was used to determine the control and checkpoint coordinates. For more information, please refer to the Photographic Flight Reports and Ground Control Reports.

GPS Data Reduction

GPS data was collected and processed to provide precise positions of the camera centers for application as photogrammetric control in the aerotriangulation phase of the project. Data was downloaded from the NSG CORS web site for Horn Point (HNPT), which collected data at a rate of one second and five second intervals at various times over the duration of the flights. The five second data was re-sampled to one second intervals for reliable and accurate ABGPS processing. Also utilized were the CORS stations SOL1 (Solomons Island 1), collecting at rate of five seconds, and LOYR (LOYOLA R), collecting at a rate of one second. All five second data was re-sampled to a one second interval for reliable and accurate ABGPS processing. SOL1 has been decommissioned since August of 2007. MDSI (Solomons Island) is a five second station that replaced SOL1 and has been operational since September of 2007. MDSI was not utilized to process the ABGPS trajectories from the date specified above.

ABD 105 (Monument 105) was also used to acquire data for ABGPS processing at a one second collection rate. It is located at Aberdeen Proving Grounds in Aberdeen, MD and is a first order horizontal monument and a first order class one vertical monument. The horizontal and vertical positions were provided by the APG staff and checked with two OPUS solutions.

After the flight missions, the project data was downloaded and processed using NovAtel's Waypoint GrafNav (7.80.2315, 7.80.2517, 8.10.2313 and 8.30.0623) software. Forward and reverse trajectories were compared during the processing phase to ensure accuracy. Camera event file data was then applied to the final trajectory to obtain coordinates for the photo centers. A GPS Data Processing Report was written and is on file with other project data within the RSD Applications Branch (AB) Project Archive.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to extend the network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. TMSI personnel initiated the softcopy aerotriangulation work in October 2009, utilizing a digital photogrammetric workstation (DPW), which is a configuration of computer processor and monitor, and BAE Systems SOCET SET ver. 5.4 software equipment and peripheral devices. The softcopy aerotriangulation work was completed in November 2009 (Color) and April 2011 (IR).

Aerotriangulation of this project was performed as two blocks. One block consisted of color photography and the second block consisted of B&W IR photography (both the MHW and the MLLW IR).

The color imagery was measured and then ground control applied to produce an acceptable solution. The MLLW imagery was measured, and then all tie points were passed to the MHW imagery. The ground control along with multiple photo identifiable points from the color imagery was used to produce the values for the IR imagery. Upon successful completion of the block adjustment, BAE Systems' SOCET SET Multi-Sensor Triangulation (MST) module provided the RMS of the standard deviations for all aerotriangulated ground points, which were used to compute a predicted horizontal circular error of 0.5 meters for the color photographs. The B&W IR photographs have a predicted horizontal circular error of 0.6 meters. An Aerotriangulation Report is on file with other project data within the RSD AB Project Archive.

The project database consists of camera calibration data, interior orientation parameters for each frame, airborne GPS antenna position and offset data, adjusted exterior orientation parameters for each frame, positional listing of all measured points, the control file and refined image coordinates as listed in the Project Database section of the Aerotriangulation Report. Positional data is based on the North American Datum of 1983 (NAD 83), and is referenced to UTM Zone 18 in meters.

Compilation

The data compilation phase of the project was accomplished by TMSI in August 2011. Digital mapping was performed using Digital Photogrammetric Workstations (DPWs) in conjunction with BAE SOCET SET ver. 5.4. Feature identification and the assignment of cartographic codes were based on image analysis of natural color photography and B&W IR photography and information extracted from appropriate NOAA Nautical Charts and the US Coast Guard Light List. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST) as required.

Cartographic features were compiled to meet a horizontal accuracy of 1.2 meters at the 95% confidence level. This predicted accuracy of compiled, well-defined points is derived by doubling the circular error derived from aerotriangulation statistics.

The following table provides information on the imagery used to complete this project:

| Date | Time (UTC) | Roll Number | Frames | Scale | Tide Level* |
|------------|---------------|-------------|-------------|----------|-------------|
| 5/10/2005 | 12:58 – 13:00 | 0520CN01 | 0001 – 0005 | 1:30,000 | 0.6** |
| 5/10/2005 | 13:01 – 13:02 | 0520CN01 | 0006 – 0009 | 1:30,000 | 1.1** |
| 5/10/2005 | 13:36 – 13:37 | 0520CN01 | 0077 – 0079 | 1:30,000 | 1.0** |
| 5/10/2005 | 13:37 – 13:38 | 0520CN01 | 0080 – 0083 | 1:30,000 | 0.6** |
| 5/10/2005 | 13:38 – 13:39 | 0520CN01 | 0084 – 0085 | 1:30,000 | 0.5 |
| 5/10/2005 | 13:44 – 13:46 | 0520CN01 | 0086 – 0090 | 1:30,000 | 0.5 |
| 5/10/2005 | 13:46 – 13:47 | 0520CN01 | 0091 – 0093 | 1:30,000 | 0.6 |
| 5/10/2005 | 13:48 | 0520CN01 | 0094 | 1:30,000 | 0.9** |
| 5/10/2005 | 13:48 – 13:49 | 0520CN01 | 0095 – 0096 | 1:30,000 | 0.8** |
| 5/10/2005 | 14:05 – 14:06 | 0520CN01 | 0124 – 0125 | 1:30,000 | 0.8** |
| 5/10/2005 | 14:06 – 14:09 | 0520CN01 | 0126 – 0132 | 1:30,000 | 0.7** |
| 5/10/2005 | 14:13 – 14:15 | 0520CN01 | 0133 – 0136 | 1:30,000 | 0.7** |
| 5/10/2005 | 14:28 | 0520CN01 | 0153 | 1:30,000 | 0.9** |
| 5/10/2005 | 14:28 – 14:29 | 0520CN01 | 0154 – 0156 | 1:30,000 | 1.0** |
| 5/10/2005 | 14:30 – 14:32 | 0520CN01 | 0157 – 0162 | 1:30,000 | 0.5 |
| 5/10/2005 | 14:37 – 14:40 | 0520CN01 | 0163 – 0170 | 1:30,000 | 0.5 |
| 4/18/2006 | 18:45 – 18:46 | 0620CN01 | 0059 – 0060 | 1:30,000 | 0.1** |
| 4/18/2006 | 18:46 | 0620CN01 | 0061 | 1:30,000 | 0.2** |
| 11/12/2005 | 16:09 – 16:10 | 0520R05 | 0567 – 0568 | 1:30,000 | 0.5 |
| 11/12/2005 | 16:11 – 16:13 | 0520R05 | 0569 – 0574 | 1:30,000 | 0.4 |
| 11/12/2005 | 17:17 – 17:22 | 0520R05 | 0639 – 0649 | 1:30,000 | 0.6 |
| 5/25/2007 | 17:32 – 17:33 | 0720R01 | 0105 – 0108 | 1:30,000 | 0.3** |
| 5/25/2007 | 17:44 – 17:45 | 0720R01 | 0124 – 0125 | 1:30,000 | 0.3** |
| 5/24/2008 | 13:44 – 13:45 | 0820R02 | 0351 – 0352 | 1:30,000 | 0.4 |
| 5/24/2008 | 13:46 | 0820R02 | 0353 | 1:30,000 | 0.3** |
| 5/24/2008 | 13:50 – 13:52 | 0820R02 | 0354 – 0359 | 1:30,000 | 0.4** |
| 5/24/2008 | 13:53 – 13:54 | 0820R02 | 0360 – 0362 | 1:30,000 | 0.5 |
| 5/24/2008 | 15:33 – 15:34 | 0820R02 | 0373 – 0374 | 1:30,000 | 0.2** |
| 5/24/2008 | 15:34 – 15:35 | 0820R02 | 0375 – 0377 | 1:30,000 | 0.4** |
| 8/21/2008 | 16:32 – 16:33 | 0820R02 | 0414 – 0416 | 1:30,000 | 0.2** |
| 8/21/2008 | 16:44 – 16:46 | 0820R02 | 0417 – 0422 | 1:30,000 | 0.2** |
| 8/21/2008 | 19:56 – 19:58 | 0820R02 | 0443 – 0448 | 1:30,000 | 0.2** |
| 8/21/2008 | 19:59 – 20:00 | 0820R02 | 0449 – 0451 | 1:30,000 | 0.3** |
| 8/21/2008 | 21:26 – 21:27 | 0820R03 | 0502 – 0504 | 1:30,000 | 0.5 |

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|------------|---------------|---------|-------------|----------|--------|
| 10/08/2010 | 15:06 – 15:09 | 1020R01 | 0100 – 0108 | 1:30,000 | 0.0 |
| 10/08/2010 | 15:13 – 15:16 | 1020R01 | 0109 – 0114 | 1:30,000 | 0.0 |
| 10/08/2010 | 15:29 – 15:33 | 1020R01 | 0125 – 0135 | 1:30,000 | 0.0 |
| 10/08/2010 | 15:39 – 15:40 | 1020R01 | 0136 – 0139 | 1:30,000 | 0.0 |
| 11/07/2010 | 15:30 – 15:32 | 1020R01 | 0166 – 0169 | 1:30,000 | -0.2** |
| 11/07/2010 | 15:45 – 15:46 | 1020R01 | 0186 – 0188 | 1:30,000 | -0.2** |
| 11/07/2010 | 15:46 – 15:49 | 1020R01 | 0189 – 0196 | 1:30,000 | -0.1 |
| 11/07/2010 | 15:57 – 16:02 | 1020R02 | 0200 – 0208 | 1:30,000 | -0.2** |

* Tide levels are given in meters above MLLW and were calculated using the Pydro software tool with discrete tidal zones referenced to verified water level observations at NOS gauges. The height of the MHW tidal datum in the project area varies between 0.40 - 0.67 meters above MLLW. Some of the images (indicated by **) were collected when the tide level was not within the standard tolerance for MHW or MLLW tide coordination, but a variance for use of the imagery was granted.

Quality Control / Final Review

A TMSI team initiated the quality control tasks in September 2011, and final QC was completed by a senior member of the RSD Applications Branch (AB) in August 2012. The Geographic Cell (GC) was evaluated for completeness and accuracy. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of cartographic features within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using GIS software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color photographs and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 12266, Choptank River and Herring Bay, 1:40,000 scale, 31st Ed., Oct. 2013
- 12270, Chesapeake Bay Eastern Bay and South, 1:40,000 scale, 36th Ed., Sep. 2013

End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

Remote Sensing Division Electronic Data Library

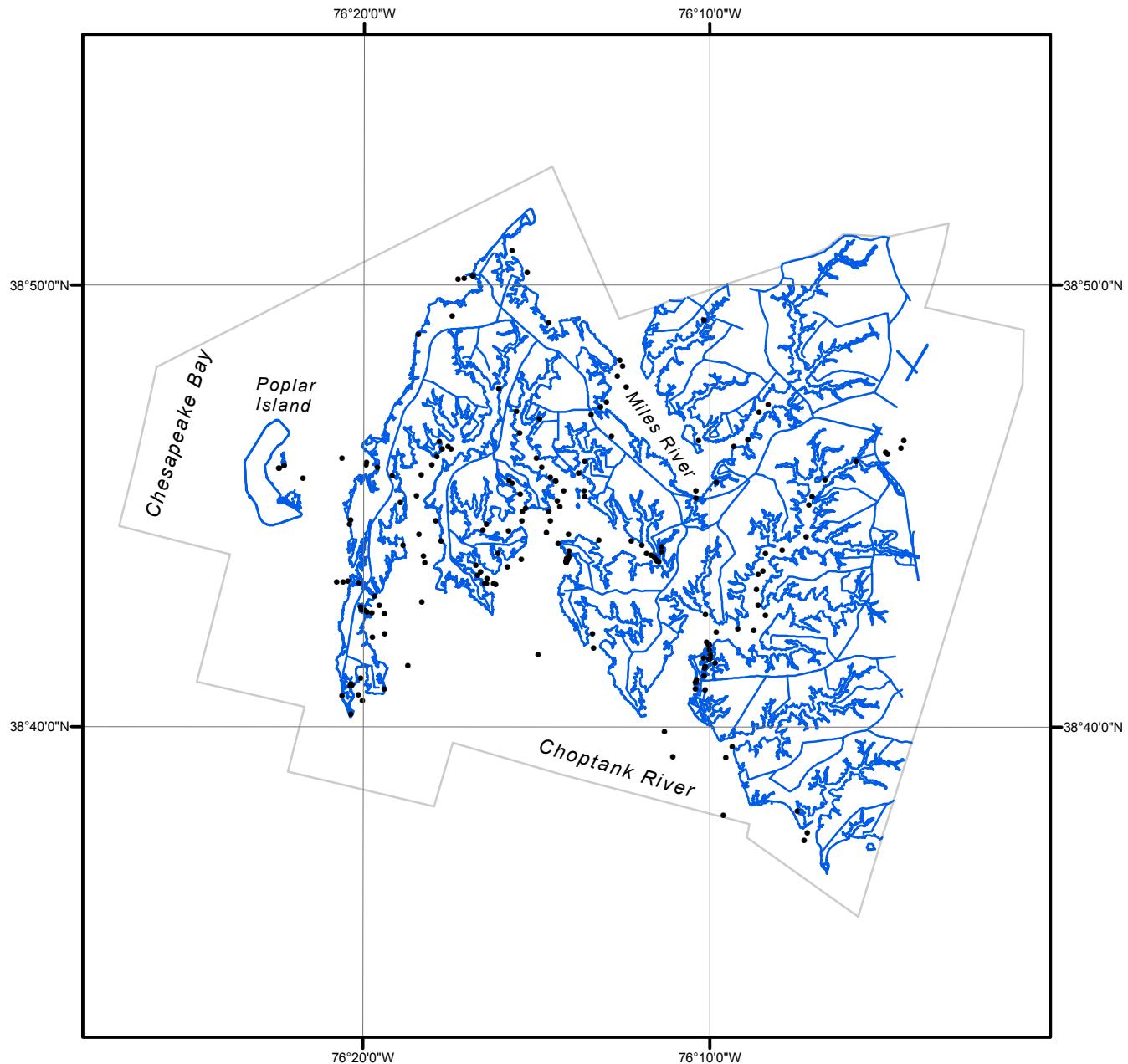
- Tabulation of Aerial Photography
- Airborne GPS Processing Report
- Ground Control Survey Report
- Aerotriangulation Reports (Color block and IR block)
- Project Completion Report (PCR)
- Project database
- GC10852 in shapefile format
- Chart Evaluation File (CEF) in shapefile format

NOAA Shoreline Data Explorer

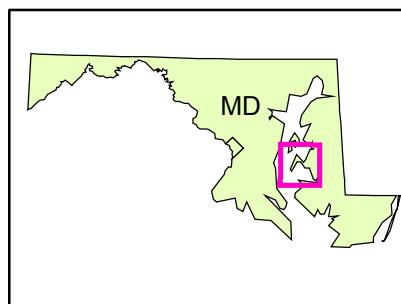
- GC10852 in shapefile format
- Metadata file for GC10852
- Digital copy of the PCR in Adobe PDF format

End of Report

EASTERN CHESAPEAKE BAY, MILES RIVER TO CHOPTANK RIVER MARYLAND



Overview



MD0402B

GC10852