NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT VA0501D

Robins Neck to Buckroe Beach, Virginia

Introduction

NOAA Coastal Mapping Program (CMP) Project VA0501D provides a highly accurate database of new digital shoreline data for a portion of the Southwest Chesapeake Bay in Virginia and extends from Robins Neck in the north and to Buckroe Beach in the south. This project is a sub-project of a larger CMP Project VA0501 which extends from Hack Creek southward to Buckroe Beach, Virginia.

Successful completion of this 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 photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

Project Design

Project instructions for Project VA0501 were received from NOAA's Remote Sensing Division during January 2005. These instructions outlined the purpose of the project, the overall geographic area of coverage for the project, the definition of specific sub-areas to be delivered as priority areas and provided all necessary special compilation instructions, reporting and handling instructions, and contact and communication information. Western Air Maps Inc. (WAM) proceeded to derive a work plan that would comply with all of NOAA's requirements for this shoreline mapping project.

WAM personnel prepared a comprehensive work plan based on the project requirements specified in NOAA's project instructions, NOAA's standard Scope of Work (SOW) and NOAA provided charts and ESRI shapefiles. WAM used the color and tide coordinated BWIR aerial photography, ground control and aerial triangulation results from VA0501 Phase 1 to conduct the mapping and attribution services necessary to complete Phase 2. WAM was responsible for map compilation and attribution of the interim shape files. In addition, WAM was responsible for quality control and validation of aerotriangulation results, extraction and attribution of features into a SOCET SET feature database for NGS review, for applying NGS-specified changes to the mapping and for consolidating the shape files and migrating the attribution of the interim feature database to the C-

COAST attribution schema and deliver these final files to NGS. WAM prepared the final Project Completion Report. NOAA approved the tentative work plan in 2008.

Field Operations

Field survey operations, conducted by a subcontractor of WAM, Metro Engineering and Surveying Co., Inc. (Metro), consisted of the collection of static GPS data. Another subcontractor, Richard Crouse and Associates (RC&A) acquired the tide coordinated black and white infrared photography at Mean Lower Low Water (MLLW) and Mean High Water (MHW) tide stages, as well as non-tide coordinated natural color photos. Airborne Global Positioning System (ABGPS) data was collected for all photos.

The natural color photographic mission operations were conducted on October 17th and October 19th, 2005 using a Wild RC-30 camera (S-N 5282, lens S-N 13328). Tide coordinated MLLW black-and-white infrared photography was acquired January 27th, April 11th, May 22nd and May 24th, 2006. Tide coordinated MHW black-and-white infrared photography was acquired November 19th, 2005, March 18th and April 28th, 2006. The same flight line configuration of seven flight lines used for the natural color aerial acquisition missions was used for each tide coordinated BWIR acquisition mission. Richard Crouse used two additional NOAA approved Wild RC-30 cameras (S-N 5324, lens S-N 13365 and S-N 5368, lens S-N 13413) with a 705 nanometer filter to acquire the BWIR exposures. The collection of the B&W Infrared photographs was coordinated with both the MLLW and MHW tide levels based on predicted tides at the Lewisetta, VA tide gauge. All photographs were collected at the nominal scale of 1:30,000.

CORS and several Cooperative CORS served as ground stations during flight. Airborne kinematic GPS data was collected to determine precise camera positions in order to establish a control network necessary for aerial triangulation. Photo-identifiable ground control was collected to supplement the airborne kinematic GPS. Metro used two GPS receivers as rovers to observe each of the control points in the project area. Metro ran one 2.5 hour static session on each point. The GPS data was downloaded from the 4000SSE receivers and through Trimble Geomatics office software and converted into RINEX files for submittal to NGS for OPUS processing. Metro was responsible for the generation and maintenance, while in the field, of NGS Station Description-Recovery Form (DR Form), photographs of each photo control point surveyed, NOAA Form 76-53 for each panel, Visibility Obstruction Diagrams, and GPS Observation Logs.

GPS Data Reduction

The airborne GPS receiver (Topcon Legacy-E, L1-L2-GLONASS) was employed on these flights and collected time-tagged (dual frequency) satellite carrier phase data simultaneously with the ground station receivers. Novatel's Waypoint Software (GrafNav) was used in the Kinematic GPS Post Processing. Since October 2005, RC&A has used versions 7.6 to 7.8 of GrafNav. GrafNav uses an approach in that it scans the entire raw dataset and determines the best section of the dataset to solve the integer ambiguities. The program then solves the remainder of the dataset and re-computes the ambiguities (example, loss of lock). This software computes the Forward and Backward solution and combines these two solutions to provide an optimal solution. The resulting

values are accurate photo coordinates, in Easting, Northing and Height exported to Universal Transverse Mercator (UTM) Zone 18 projection. All photo elevations are computed relative to the base station coordinates and GEOID03 is applied to arrive at NAVD88 values.

Ground control survey data files were downloaded from the GPS receivers and converted to a RINEX format. Metro Inc. used Trimble Geomatics Office (version 1.01) to perform preliminary processing of the collected GPS data. The data imported into Trimble Geomatics Office (ver. 1.01) was reviewed by comparing the antenna heights, antenna types and start and end times to the field GPS. Metro Engineering & Surveying Co., Inc. performed the final data reduction and computation of final coordinates through the NGS online GPS processing tool, OPUS. The RINEX files were then uploaded to OPUS. Each data file submitted was processed using the three (3) nearest CORS sites as selected by OPUS.

On several occasions WAM photogrammetrists employed Inertial Measurement Unit (IMU) whenever the equipment was available to compute the exterior orientation of each image at the moment of exposure by integrating the IMU data and the simultaneously collected GPS data along with locally positioned GPS base stations (CORS) on the ground. Applanix POSPAC versions 4.0 to 4.4 were used for this processing. The resulting values were accurate photo coordinates in easting, northing and height. All photo heights are computed relative to the base station coordinates and GEOID03 is applied to arrive at NAVD88 orthometric heights.

Aerotriangulation

The final photo center locations were output into text files which were then imported into Z-I Imaging's ISAT Aerotriangulation (AT) software for the point measurements and bundle adjustment phase. The AT for the color, MHW B&W IR and MLLW B&W IR photography was performed using images scanned at 25 microns.

Z-I Imaging's ISAT digital AT software (version 04.03.00.08) operating on an SSK Pro Workstation was used for the automatic tie point generation, manual measurements of additional tie points, ground control point measurements and bundle adjustments. The aerial photography was triangulated in three separate blocks - one for the color photographs, one for the MHW B&W IR photographs and one for the MLLW B&W IR photographs. The final bundle adjustment was verified by Inpho's PATB-NT AT software (version 1.2.164).

Upon successful completion of the aerial triangulation process, the ISAT software provided the RMS of the standard deviations of the residuals for each aerotriangulated ground point which were used to compute a predicted horizontal circular error of 0.3 meters for all photographs based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD Applications Branch (AB) Project Archive.

The project database consists of general project parameters, camera calibration data,

interior orientation parameters, ground control locations, Airborne GPS antenna position and offset data, adjusted exterior orientation parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983.

Compilation

The data compilation phase for sub project VA0501D was initiated by WAM in August 2008. Digital mapping was performed using SOCET SET (Version 5.4.1) software. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of 1:30,000 scale photographs and information extracted from the appropriate NOAA nautical charts, U.S. Coast Guard Light List and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for VA0501D were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 0.6 meters at the 95% confidence level. The predicted accuracy of compiled, well defined points is derived by doubling the circular error derived from aerial triangulation statistics.

The following table provides information on aerial photographs used in the project:

Date of Acquisition	Time (UTC)	Roll Number	Flight Line Numbers	Photo Numbers	Tide Level (m)
10-17-05	15:13-15:15	0528CN05	30-006	0094-0099	0.7
10-17-05	15:44-15:47	0528CN05	30-005	0118-0124	0.6
10-17-05	16:03-16:07	0528CN05	30-001	0152-0161	0.5
10-17-05	16:13-16:19	0528CN05	30-002	0162-0174	0.5
10-17-05	16:32-16:37	0528CN05	30-003	0193-0205	0.4
10-17-05	16:43-16:47	0528CN05	30-004	0208-0214	0.3
1-27-06	17:43-17:45	0628R01	30-006	0499-0504	0.2
1-27-06	17:55-17:58	0628R01	30-005	0514-0520	0.1
1-27-06	18:03-18:07	0628R06	30-001	0521-0530	0.0
1-27-06	18:19-18:24	0628R06	30-002	0541-0553	0.0
3-18-06	15:06-15:13	0624R01	30-003	0010-0021	0.8
3-18-06	15:23-15:25	0624R01	30-004	0024-0030	0.8
3-18-06	15:32- 5:39	0624R01	30-002	0032-0044	0.7
3-18-06	15:50-15:54	0624R01	30-001	0055-0064	0.7
3-18-06	16:00-16:04	0624R01	30-005	0065-0071	0.7

3-18-06	16:14-16:16	0624R01	30-006	0081-0086	0.7
5-24-06	16:59-17:05	0627R07	30-003	0843-0855	0.0
5-24-06	17:13-17:17	0627R07	30-004	0858-0864	0.0

* Tide levels are given in meters above MLLW and are based on various substations throughout the project area with corrections applied from the Lewisetta, VA reference station. The mean tide range in the project area varied between 0.0 m and 0.8 m.

Quality Control

WAM personnel conducted quality control (QC) tasks during all phases of project completion. The final QC review was completed in December 2009. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of digital feature data 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 ESRI ArcGIS (v. 9.2) 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:

12222, Cape Charles to Norfolk Harbor, VA, 1:40,000 scale, 49th edition
12238, Mobjack Bay and York River Entrance, VA, 1:40,000 scale, 39th edition
12241, York River, Yorktown and Vicinity, VA, 1:20,000 scale, 22nd edition
12243, York River, Yorktown to West Point, VA, 1:40,000 scale, 13th edition

End Products and Deliverables

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

RSD Applications Branch Archive

- Hardcopy of the Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10737 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project database
- GC10737 in shapefile format
- Digital copy of the PCR in Adobe PDF format
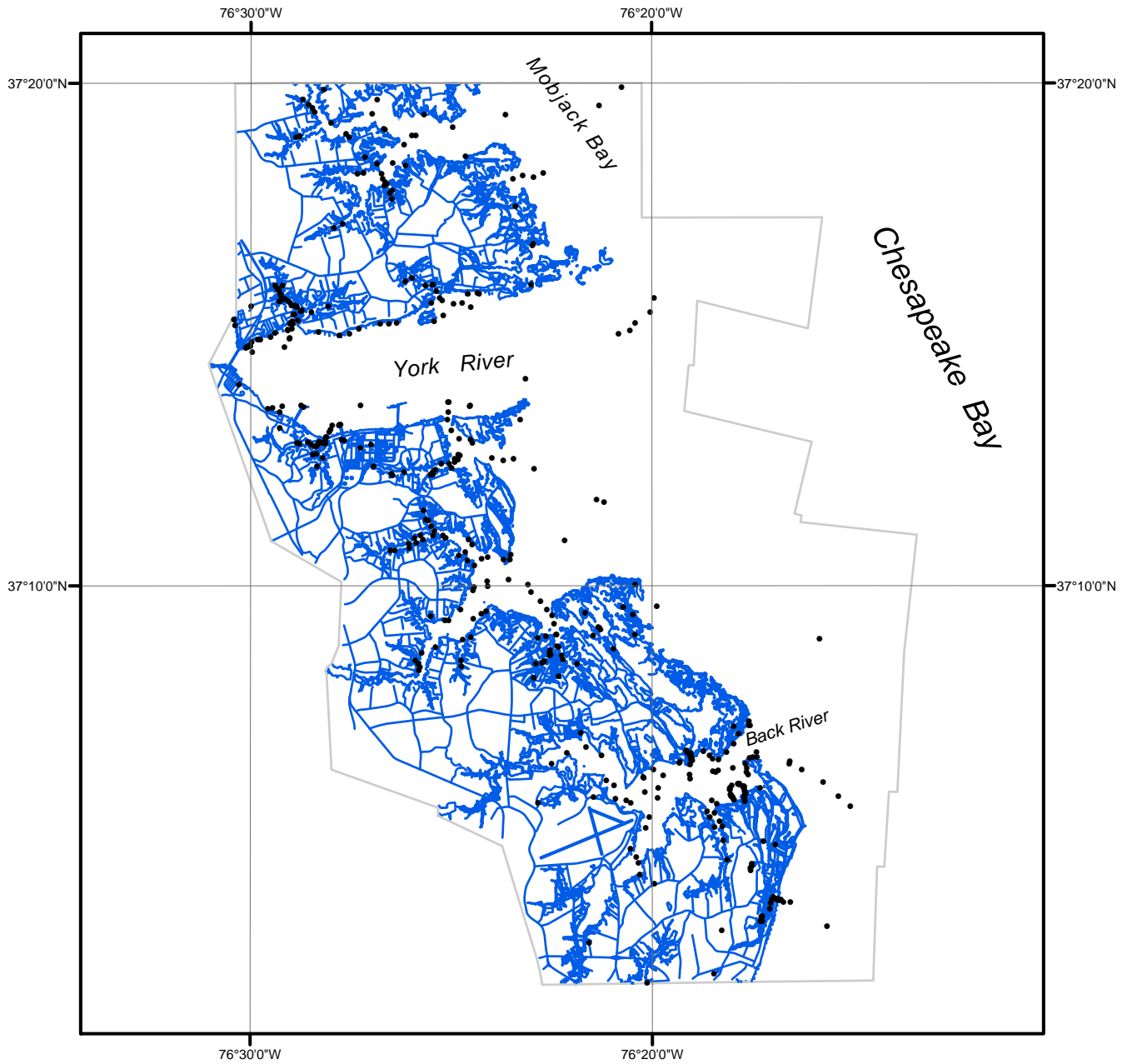- CEF in shapefile format

NOAA Shoreline Data Explorer

- GC10737 in shapefile format
- Metadata file GC10737
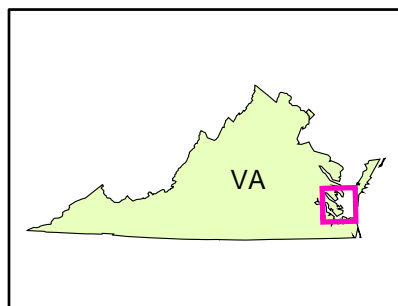- Digital copy of the PCR in Adobe PDF format

End of Report

ROBINS NECK TO BUCKROE BEACH

VIRGINIA

76°30'0"W   76°20'0"W

37°20'0"N   Mobjack Bay   37°20'0"N

Chesapeake Bay

York River

37°10'0"N   37°10'0"N

Back River

76°30'0"W   76°20'0"W

Overview

VA

VA0501D

GC10737