NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT VA1802D-TB-N

Chesapeake Bay, Church Neck to Fishermans Island, Virginia

Introduction

NOAA Coastal Mapping Program (CMP) Project VA1802D-TB-N provides highly accurate digital shoreline data for a portion of southeastern Chesapeake Bay, from Church Neck to Fishermans Island, in Virginia. Project VA1802D-TB-N is a subproject of a larger acquisition project, VA1802-TB-N, which extends from Pocomoke Sound southward to Fishermans Island on the eastern shore of the Chesapeake Bay. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

Project Design

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, image requirements, Global Positioning System (GPS) data collection procedures and guidelines, instructions for data recording and handling, and mission communication protocols. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system.

After completion of the acquisition phase, NOAA tasked the data processing and compilation phase of the project to Dewberry. RSD formulated the task order Project Instructions for this project following the guidelines of the "Scope of Work, Shoreline Mapping for the Coastal Mapping Program" (SOW), Version 14A, dated October 24, 2012. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; data processing, accuracy, and compilation requirements; product delivery and reporting instructions; and contact and communication information. NOAA also provided shapefiles depicting the shoreline to be mapped and the boundaries of the main project area.

Field Operations

The field operations consisted of acquisition of topographic/bathymetric (topobathy) lidar data, digital aerial imagery, static and kinematic GPS data, and Inertial Measurement Unit (IMU) data. Static GPS data were collected to support aerial data acquisition and processing operations, as well as to assess the accuracy of post-processed lidar data.

Lidar Data Acquisition

A total of 866 lines of topobathy lidar were collected at a nominal altitude of 1,300 feet with a 50% swath overlap and an aggregate nominal point density of 18 pulses per square meter. The lidar data was acquired from March to May 2018 using a Riegl VQ880G lidar system on board a

NOAA Twin Otter aircraft (N57RF).

Digital Aerial Imagery Acquisition
37 lines of natural color (RGB) and near-infrared (NIR) digital aerial imagery were collected in April and May 2018 using an Applanix Digital Sensor System (DSS) 580/560 dual camera onboard the NOAA King Air aircraft (N68RF). All lines were collected at approximately 7,500 feet within +/- 2 hours of the predicted MLW tide stage. For subproject VA1802D-TB-N, portions of 11 lines were used. Project imagery has a GSD of 0.14 meters. The NIR images were not used.

GPS Data Processing

GPS and IMU data were processed by RSD personnel to yield precise sensor positions and orientations for direct georeferencing (DG) of imagery. A local GPS base station established for use as a reference station was used to process most of the kinematic GPS data. The position of the base station was determined using the NGS Online Processing User Service (OPUS), which computed fixed baseline solutions from nearby CORS stations. Remaining kinematic GPS data was processed utilizing the IN-Fusion PP-RTX processing mode, which is an implementation of Trimble's CenterPoint RTX GNSS correction service. All airborne kinematic data was processed using Applanix POSPac MMS (ver. 8.2) software in August 2018. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Electronic Data Library.

Lidar Data Processing

RSD performed the initial processing and quality control for the raw topobathymetric lidar data for Project VA1802-TB-N, including calibration and refraction correction. Dewberry was subsequently contracted by RSD to perform further data processing, accuracy assessment and creation of the deliverable products from the lidar data.

Dewberry utilized a variety of software for lidar data processing, including TerraScan, TerraModeler, Esri's ArcGIS, LAStools, and Dewberry proprietary software. Data processing included additional quality checks and accuracy assessments of the preliminary swath data, point classification, automated and manual editing of the lidar tiles, QA/QC, and final formatting of the LAS tiles. The final processed lidar products that were delivered to RSD included a fully classified point cloud, one meter resolution tiled topobathymetric bare earth models, tiled clipped topobathymetric bare earth models, tiled topobathymetric standard deviation models in ERDAS Imagine format, one meter resolution tiled DZ orthos in GeoTiff format, a bathymetric void polygon shapefile, an area of interest shapefile, a lidar tile index shapefile, a DEM tile index shapefile, and FGDC compliant metadata files.

RSD received classified lidar tiles covering the project area and used NOAA VDatum software to convert the vertical datum of the lidar points from NAD83 ellipsoid to local MHW and MLLW tidal datums. QT Modeler and custom ArcGIS Scripts were used to produce bare earth MHW and MLLW digital elevation models at a 1-meter grid resolution and to create and format the MHW and MLLW vectors into shapefile format.

The lidar point cloud was compared to ground control points of a higher accuracy in order to

assess vertical uncertainty, and then combined with the morphologic slope around the derived shoreline to assess corresponding horizontal uncertainties. Based on this assessment, the MHW lidar-derived shoreline vectors meet a horizontal accuracy of 1.8 meters, and the MLLW lidar-derived vectors meet a horizontal accuracy of 2.4 meters, both at the 95% confidence level.

Aerotriangulation

The aerotriangulation (AT) phase of the project was performed by Dewberry using digital AT methods to establish the network of photogrammetric control required for the compilation phase. Inpho Match-AT software was used to perform automatic point measurements and interactive point measurements of tie points.

The Root Mean Square (RMS) of the standard deviations in both X and Y directions were calculated and used to determine predicted horizontal circular error at the 95% confidence level. The predicted horizontal accuracies for VA1802-TB-N are 0.4 meters for the main block, and 0.7 meters for a small sub-block covering Watt Island. An AT Report is on file with other project data within the RSD Electronic Data Library.

The project database consists of project parameters and options, camera calibration data, interior orientation parameters, ground control parameters, adjusted exterior orientation parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983 (NAD 83).

Compilation

Data compilation for project VA1802D-TB-N was initiated by Dewberry personnel in September 2019. RSD supplied the lidar-derived MHW and MLLW shapefiles to be edited and attributed by Dewberry. Additional features were manually compiled from stereo imagery using the Feature Extraction module of BAE's SOCET SET (ver. 5.6) digital photogrammetric software suite. Feature identification, segmentation, and attribution were performed within an Esri geodatabase using the SOCET for ArcGIS module of SOCET SET, based on imagery analysis of the processed digital images and information extracted from the appropriate NOAA Nautical Charts, the 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 project VA1802D-TB-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Stereo-compiled features from imagery were compiled to meet a horizontal accuracy of 0.8 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error calculated from the aerotriangulation statistics. Accuracies of lidar-derived features are discussed further above.

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

Date	Time (UTC)	Roll #	Flight Line / Photo ID	Tide Level*
30-Apr-2018	17:49 – 17:52	18VC24	45-001 / 5426 – 5444	0.1 – 0.3 m
30-Apr-2018	17:58 – 18:04	18VC24	45-002 / 5445 – 5480	0.1 – 0.2 m
30-Apr-2018	18:09 – 18:14	18VC24	45-003 / 5481 – 5516	0.1 – 0.2 m
30-Apr-2018	18:18 – 18:23	18VC24	45-004 / 5517 – 5552	0.0 – 0.2 m
30-Apr-2018	18:27 – 18:32	18VC24	45-005 / 5553 – 5588	0.0 – 0.1 m
30-Apr-2018	18:51 – 18:54	18VC24	45-011 / 5631 – 5658	0.0 – 0.2 m
30-Apr-2018	19:00 – 19:04	18VC24	45-010 / 5659 – 5686	0.0 – 0.2 m
30-Apr-2018	19:11 – 19:15	18VC24	45-009 / 5702 – 5728	0.0 – 0.1 m
30-Apr-2018	19:20 – 19:24	18VC24	45-008 / 5729 – 5756	0.0 – 0.1 m
30-Apr-2018	19:31 – 19:35	18VC24	45-007 / 5771 – 5798	-0.1 – 0.1 m
30-Apr-2018	19:40 – 19:44	18VC24	45-006 / 5799 – 5826	0.0 – 0.1 m

* Tide levels are given in meters above MLLW and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations from various NOS gauges in the vicinity of the project. The height of the MHW tidal datum in the project area varies between 0.58 – 0.83 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by senior Dewberry personnel. The final QC review was completed in January 2020. The review process included analysis of AT results and assessment of the identification and attribution of 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 ArcGIS software. All project data was evaluated for compliance to CMP requirements.

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

- 12222, Chesapeake Bay, Cape Charles to Norfolk Harbor, 55th Ed., Feb. 2015
- 12224, Chesapeake Bay, Cape Charles to Wolf Trap, 28th Ed., Dec. 2018
- 12226, Chesapeake Bay, Wolf Trap to Pungoteague Creek, 19th Ed., Aug. 2014

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

- Airborne Positioning and Orientation Reports (APOR)
- Topobathy Lidar Processing Report
- Aerotriangulation Report
- Project database
- GC11549 in shapefile format
- Project Completion Report (PCR)

- CEF in shapefile format

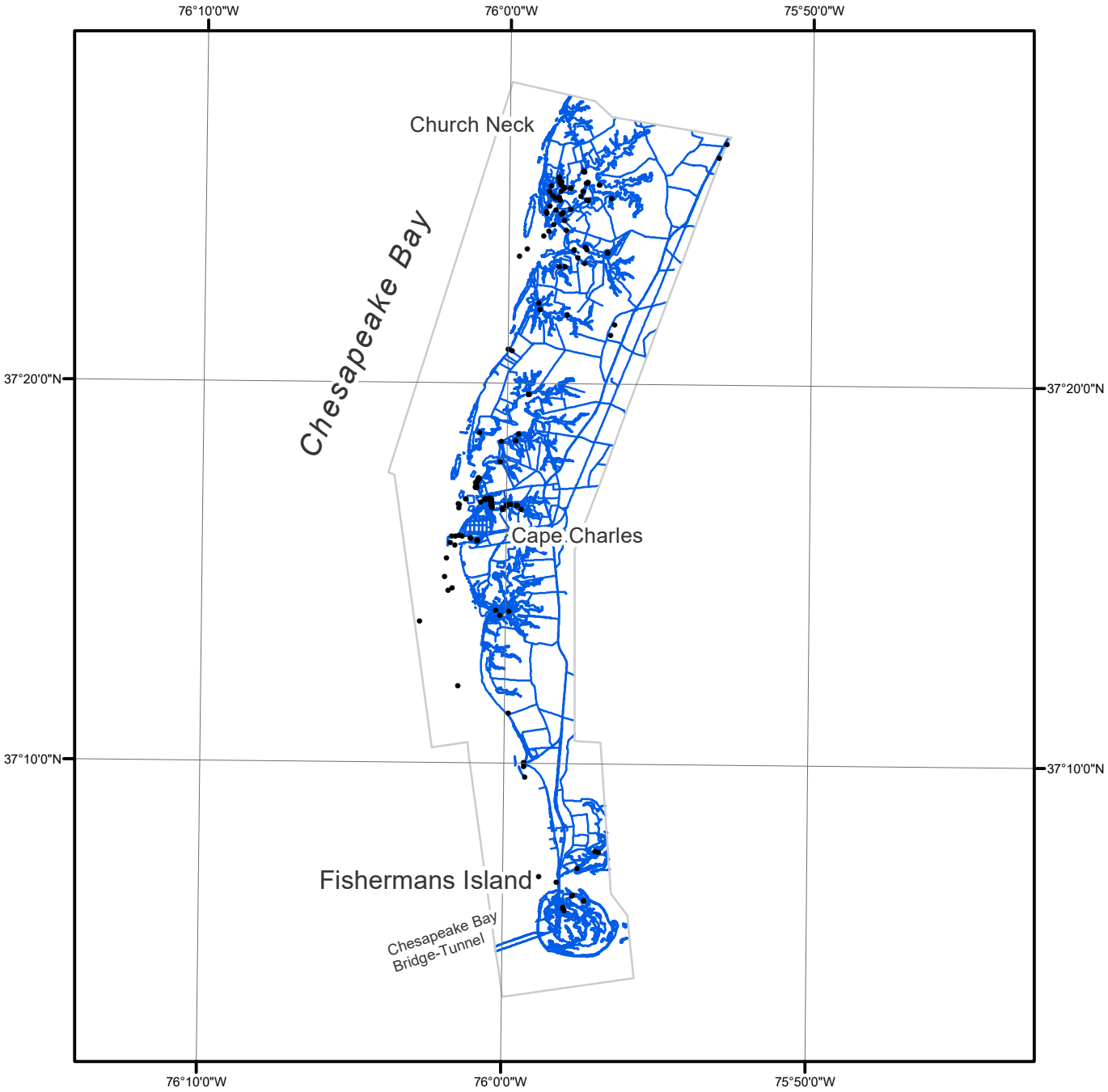
NOAA Shoreline Data Explorer

- GC11549 in shapefile format
- Metadata file for GC11549
- PCR in Adobe PDF format

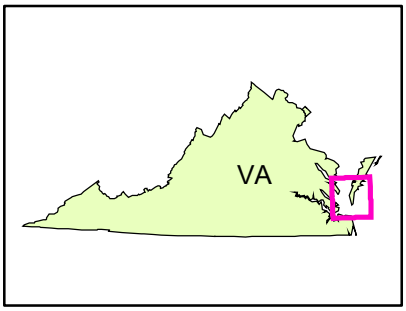
End of Report

CHESAPEAKE BAY, CHURCH NECK TO FISHERMANS ISLAND

VIRGINIA



Overview



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GC11549