NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT SC1601C-TB-C

Port Royal Sound to St Helena Sound, South Carolina

Introduction

NOAA Coastal Mapping Program (CMP) Project SC1601C-TB-C provides a highly accurate database of new digital shoreline data for portions of the outer coast of South Carolina from Port Royal Sound to Saint Helena Sound. Project SC1601C-TB-C is a subproject of a larger project, SC1601-TB-C, which extends from Wassaw Sound to Winyah 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

NOAA's National Geodetic Survey (NGS) Remote Sensing Division (RSD) formulated the 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 acquisition, 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.

Quantum Spatial, Inc. (QSI) was responsible for the planning, acquisition, and processing of all imagery and lidar data in order to support feature compilation. This includes the establishment of ground control and the post-processing of airborne GPS data. In addition, QSI provided shapefiles of the flight lines and exposure centers of the imagery to be used for compilation.

Field Operations

All of the field operations for SC1601-TB-C were conducted by QSI which included the planning, acquisition and post-processing of aerial imagery and lidar data to support photogrammetric processing and feature compilation, as well as the establishment of ground control, the post-processing of airborne Global Positioning System (GPS) data and calibration of the lidar data.

A total of 280 ground control points (GCPs) were established in project SC1601-TB-C using a combination of traditional static, fast-static, rapid-static, real-time kinematic, and post-processed kinematic GPS techniques. Six additional photo-identifiable check points were also occupied at well-defined, discrete locations. Survey field work was performed between July 2016 and February 2017. A Ground Survey Report is on file with other project data within the RSD Electronic Data Library.

The aerial photography acquisition phase of the project was conducted by QSI's subcontractor Richard Crouse and Associates (RCA) between December 2016 and March 2017. A total of 27

flight lines of natural color imagery were acquired within a tolerance of 25% of the Mean Lower Low Water (MLLW) tide stage. Of the 27 flight lines acquired, eleven were used in project SC1601C-TB-C. Imagery was captured with an approximate nominal ground sample distance (GSD) of 0.30 meters through the use of a large format Intergraph Z/I Digital Mapping Camera (DMC) with a focal length of 92 mm.

The lidar acquisition was conducted between December 2016 and March 2017 and consisted of a total of 988 lines flown over 46 lidar acquisition missions with an average point density of 14 pulses per square meter and a nominal swath width of 291 meters and a 30% swath overlap. Topographic/bathymetric ("topobathy") lidar data was collected through the use of a Riegl VQ-880-G sensor. The topobathy data was used to derive the Mean High Water (MHW) and MLLW shorelines, while the NIR data was used as an aid to developing the water surface model necessary for applying refraction corrections to the topobathy data. The flight lines were required to be collected within 20% of the mean range of MLLW. For further information about all field operations see the “Topobathymetric LiDAR and Shoreline Mapping Report” on file within the RSD Electronic Data Library.

GPS Data Processing

Each acquisition aircraft used by QSI was equipped with either a POSAV Applanix Model 510 IMU or a dual frequency Trimble BD960 to collect the Airborne Global Positioning System (ABGPS) and Inertial Measurement Unit (IMU) data. NGS Continuously Operated Reference Stations (CORS) and several cooperative CORS stations were used for base stations on the project, with at least two of these CORS stations being used to process each POSAV dataset to achieve the final image center locations. For further information refer to the Airborne Positioning and Orientation Report (APOR) on file with other project data within the RSD Electronic Data Library.

Lidar Data Processing

Lidar point cloud data for all of the areas were processed from January 2017 to June 2018. Riegl RiProcess software was utilized to transform the lidar point cloud into a mapping projection and to check the calibration stability. Terrasolid software was used for assessing relative and absolute accuracies between overlapping lifts and relative with each lift, initial point cloud classification, editing of the lidar point cloud, and for classification of water surface, erroneous returns, bathymetric surface and bare earth points. QSI refracted water column points using Riegl’s RiHydro tool as well as QSI’s proprietary software Las Monkey. NOAA VDatum software was used to convert the vertical datum of the lidar points from NAD83 ellipsoid to local MHW and MLLW tidal datums. QTModeler and custom ArcGIS Scripts were used to produce bare earth MHW and MLLW digital elevation models (DEMs) at a 1 meter grid resolution and to create and format the MHW and MLLW vectors into shapefile format.

Aerotriangulation

The aerotriangulation (AT) phase of the project was performed by QSI using digital AT methods to establish the network of photogrammetric control required for the compilation phase. The Bingo automated aerotriangulation system (version 6.9) was used to perform automatic point measurements and interactive point measurements of tie points. Upon successful completion of the aerotriangulation process, the Bingo 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 0.4 meters based on a 95% confidence level. For further information see the Aerotriangulation Report 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) and the North American Vertical Datum of 1988 (NAVD88).

Compilation

The data compilation phase of project SC1601C-TB-C was initiated by QSI personnel in June 2018. NGS supplied the lidar derived MHW and MLLW shapefiles to be edited, attributed and generalized by QSI. Additional features were then manually compiled using stereo imagery. This work was accomplished using a suite of digital photogrammetric software known as DAT/EM Summit Evolution (version 7.5) on a stereo-enabled PC-based graphics workstation. Feature identification, segmentation, and attribution were 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 SC1601C-TB-C were determined according to standard Federal Geographic Data Committee (FGDC) practices. Stereo compiled cartographic features 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. The lidar derived features had horizontal accuracies that varied depending on location and shoreline type ranging from 1.4 to 1.9 meters.

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

Date	Time (UTC)	Roll ID	Strip ID	Image IDs	Tide Level *
12/30/2016	19:46 – 19:52	1641M01	54-012	16 – 1	-0.1 m
01/08/2017	15:12 – 15:15	1741M01	54-009	1 – 15	0.1 m
01/08/2017	15:21 – 15:26	1741M01	54-010	18 – 1	0.1 m
01/08/2017	15:30 – 15:31	1741M01	54-008	2 – 5	0.1 m
01/08/2017	15:35	1741M01	54-017	36 – 33	0.1 m
01/08/2017	15:55 – 15:57	1741M01	54-018	30 – 36	0.1 m
01/08/2017	16:00 – 16:01	1741M01	54-019	35 – 29	0.2 m
01/08/2017	16:19 – 16:21	1741M01	54-020	29 – 34	0.2 m
01/08/2017	16:23 – 16:24	1741M01	54-021	33 – 29	0.3 m
01/13/2017	18:42 – 18:47	1741M02	54-011	18 – 1	-0.1 m
01/13/2017	18:50 – 18:53	1741M02	54-009	2 – 15	-0.2 m

* Water levels are given in meters above MLLW and are based on verified observations recorded by the NOS tide gauge at Charleston, Cooper River Entrance in South Carolina. The elevation of the MHW tidal datum at the Charleston gauge is 1.65 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of QSI. The final QC review was completed in September 2018. The review process included analysis of AT 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 ArcGIS (ver. 10.4) 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 chart was used in the comparison process:

11516, Port Royal Sound and Inland Passages, 32nd Ed., Dec. 2013
11517, St. Helena Sound, 18th Ed., Dec. 2007

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

- Project database
- Ground Survey Report
- Aerotriangulation Report
- Orthoimagery Project Report
- Topobathymetric LiDAR and Shoreline Mapping Report
- GC11259 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

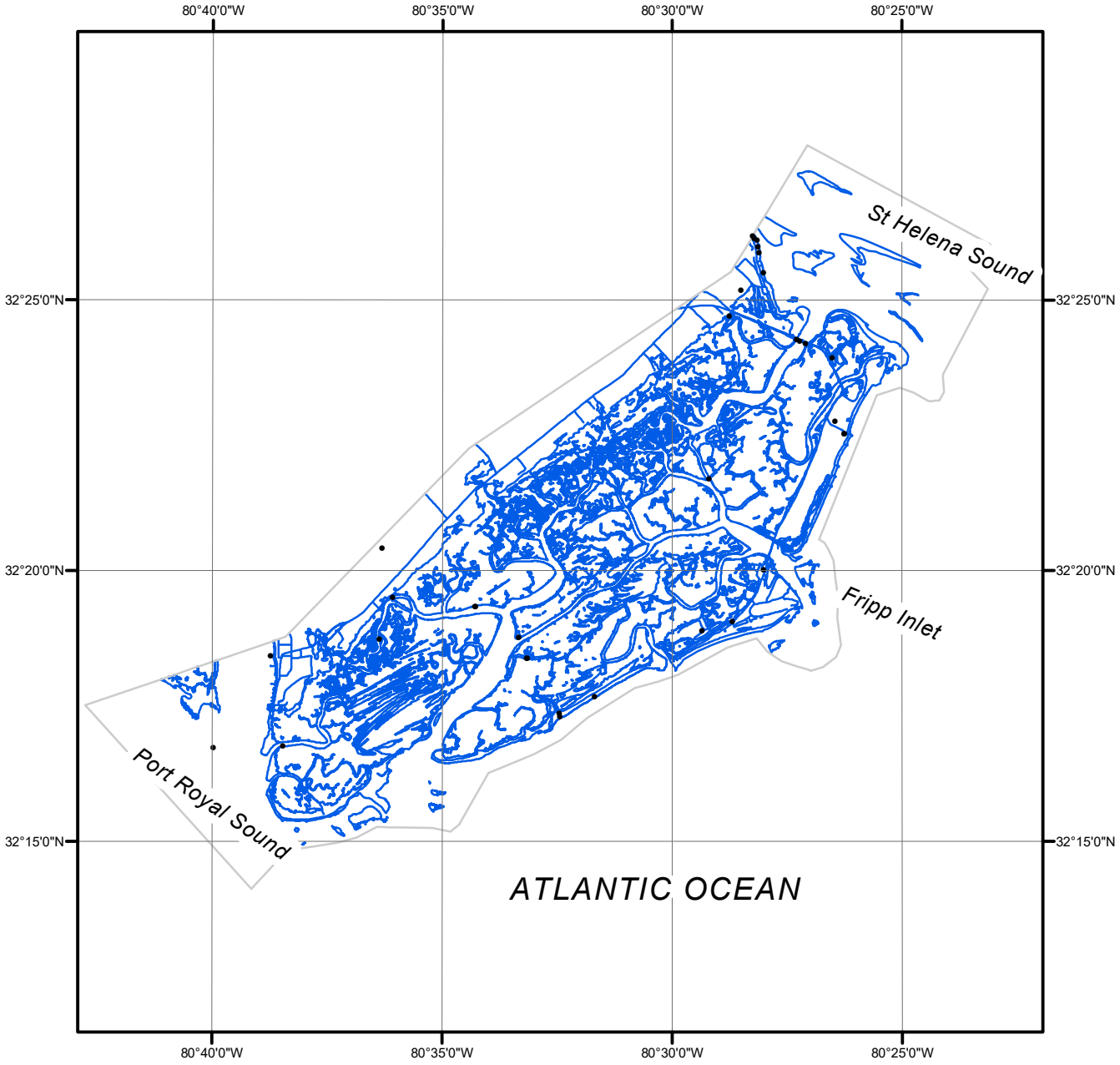
NOAA Shoreline Data Explorer

- GC11259 in shapefile format
- Metadata file for GC11259
- PCR in Adobe PDF format

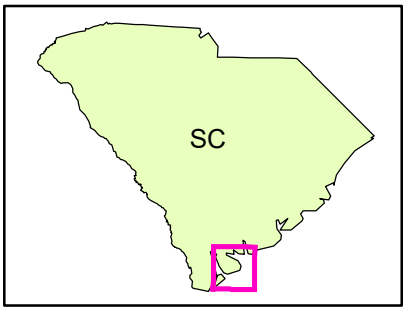
End of Report

PORT ROYAL SOUND TO ST HELENA SOUND

SOUTH CAROLINA



Overview



SC1601C-TB-C

GC11259