NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT NY1104

Fire Island, New York

Introduction

NOAA Coastal Mapping Program (CMP) Project NY1104 provides a highly accurate database of new digital shoreline data for Fire Island, New York, along the southern shore of Long Island. Successful completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, airborne topographic LIDAR data, 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.

Project Design

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project supplementary to the Photo Mission Standard Operating Procedure Version II (7/1/1993), the GPS Controlled Photogrammetry Field Operations Manual (1/2/1996), and the Light Detection And Ranging (LIDAR) Requirements Version 5 (7/3/2003). The instructions discussed the project's purpose, geographic area of coverage, scope and priority; photographic and LIDAR requirements; flight line priority; Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact and communication information. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system.

Field Operations

The field operations consisted of acquisition of aerial LIDAR data, digital aerial imagery, static and kinematic Global Positioning System (GPS) data, and Inertial Measurement Unit (IMU) data. Aerial survey operations were conducted on October 25, 2011 with the NOAA Hawker Beechcraft King Air B300CER aircraft (N68RF). Natural color imagery was acquired (7 flight lines, 426 total images) using an Applanix DSS-439 digital camera system with 60 mm lens. Imagery was acquired at a nominal altitude of 5,000 feet, resulting in an approximate ground sample distance (GSD) of 0.18 meters. Although imagery was not acquired in strict coordination with local tides, the goal was to collect all imagery below Mean High Water (MHW). Additionally, topographic LIDAR data were collected, in tandem with the digital photographs, using a RIEGL Q680i-D LIDAR system.

Direct Georeferencing Data Processing

GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (DG) of the imagery. A local GPS base station was established for use as a reference station for kinematic GPS processing operations. 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. The airborne kinematic data was processed using Applanix POSPAC (ver. 5.4) software in November 2011. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Applications Branch (AB) Project Archive.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the camera centers required for digital feature extraction. The predicted horizontal accuracy of the imagery was determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using an Excel spreadsheet based Exterior Orientation Total Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level was calculated to be 0.7 meters. NGS third order geodetic control points were used to further test the horizontal integrity of the DG data. All stereo-models were examined and found to have acceptable levels of parallax for mapping purposes.

Ortho-image Processing

Ortho-images were created in November 2011 from the DSS-439 imagery and associated image EO data using Applanix RapidOrtho software. The United States Geological Survey (USGS) National Elevation Dataset (NED) was utilized to rectify the data.

LIDAR Data Processing

LIDAR point cloud data were processed in December 2011 using the following steps:

1) Optech's *Project Dashboard* pre-processing software to place the LIDAR point cloud into a mapping projection,
2) Terrasolid's suite of LIDAR calibration and editing software to correct alignment, remove erroneous returns, and classify bare earth points,
3) NOAA's VDatum software to convert the vertical datum of the bare earth points from NAVD88 to local MHW, and
4) GeoCue LIDAR processing software to produce MHW digital elevation models (DEM) at 1 meter grid resolution.

The journal article "Lidar-Derived National Shoreline: Empirical and Stochastic Uncertainty Analyses" (2010), published in the *Journal of Coastal Research,* contains more detailed information, and is on file in the RSD Project Archive.

Compilation

The data compilation phase of this project was completed in April 2013, and was accomplished in two phases.

1. *Automated extraction from LIDAR* – MHW shoreline vectors (in shapefile format) were delineated for the outer coast portions of the project area only, using the MHW DEM discussed above and a contouring script implemented within ESRI's ArcGIS 9.3 software. The ortho-images were subsequently used to review, edit, and attribute the LIDAR shoreline vectors. Based on the study referenced in the LIDAR processing

section, above, the LIDAR derived shoreline vectors were compiled to meet a horizontal accuracy of 5.0 meters at the 95% confidence level.

2. *Manual extraction from imagery* – Manual compilation was performed for all remaining portions of the project. The Feature Extraction software module within SOCET SET (ver. 5.6) was used in conjunction with stereo-models for the majority of these areas, with ortho-images being used in ArcGIS (ver. 9.3) for non-shoreline features in the Fire Island Inlet area, as well as for the extraction of roads throughout the project. Features compiled from ortho-images were likewise compiled to meet a horizontal accuracy of 5.0 meters at the 95% confidence level, whereas features extracted from stereo imagery using SOCET SET were compiled to meet a horizontal accuracy of 1.4 meters. This predicted accuracy of well-defined points measured during the compilation phase was derived by doubling the imagery accuracy computed from the EO-TPU tool.

Spatial data accuracies for project NY1104 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of the aerial imagery and information extracted from the largest scale NOAA nautical chart 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.

Note: Portions of Great South Bay shoreline covered by imagery acquired for NY1104 which were not compiled were determined not to have changed significantly from their charted representations.

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

Date	Time (UTC)	Roll #	Photo #s	~ GSD	Tide Level*
10/25/2011	14:06 – 14:09	11NC80	25108 – 25151	0.18 m	0.3 – 0.5 m
10/25/2011	14:15 – 14:19	11NC80	25152 – 25195	0.18 m	0.2 – 0.3 m
10/25/2011	14:23 – 14:31	11NC80	25196 – 25286	0.18 m	0.2 – 0.5 m
10/25/2011	15:04 – 15:10	11NC80	25421 – 25494	0.18 m	0.0 – 0.1 m
10/25/2011	15:15 – 15:21	11NC80	25495 – 25568	0.18 m	0.2 – 0.4 m
10/25/2011	15:26 – 15:27	11NC80	25569 – 25576	0.18 m	(not used)
10/25/2011	15:31 – 15:39	11NC80	25577 – 25667	0.18 m	0.0 – (-0.1) m

* Tide levels given in meters above MLLW and are based on actual observations at the Sandy Hook reference station with corrections applied to various substations throughout the project area. The height of the MHW tidal datum above MLLW in the project area varies from 0.2 to 0.9 meters.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a member of the Applications Branch. The final QC review was completed in April 2013. The review process included analysis of the DG 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 9.3 software. All project data was evaluated for compliance to CMP requirements.

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

12352, Shinnecock Bay to East Rockaway Inlet (Small Craft), 1:40,000, 34th Ed., Sep./12

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 Data Acquisition Summary
- Hardcopy of the Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10978 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project database
- GC10978 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format

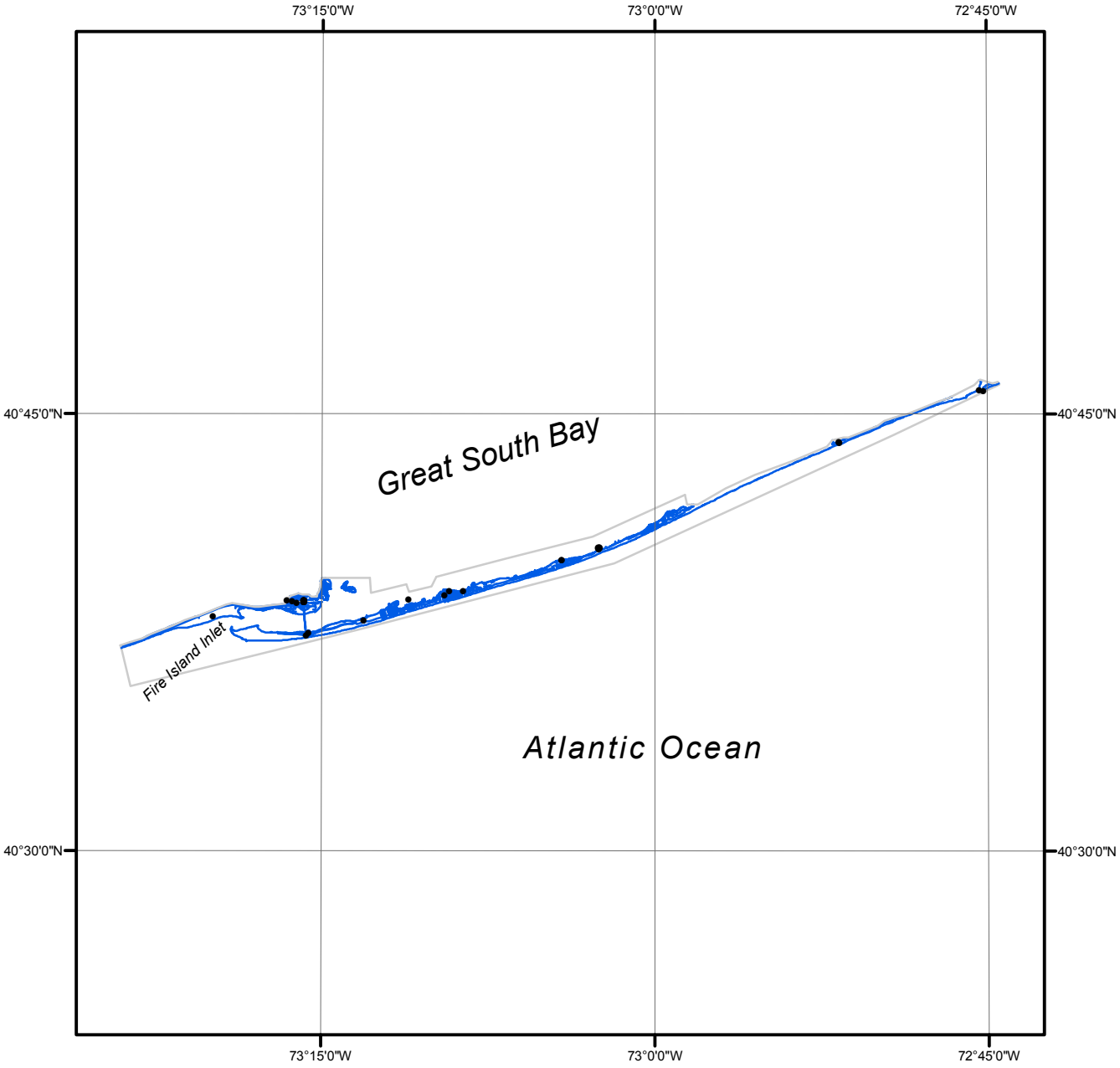
NOAA Shoreline Data Explorer

- GC10978 in shapefile format
- Metadata file for GC10978
- Digital copy of the PCR in Adobe PDF format

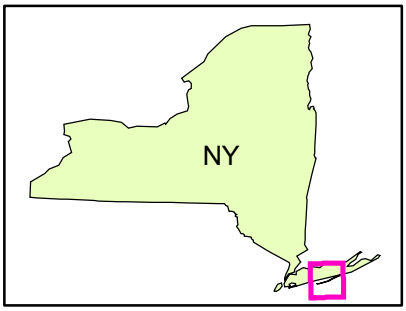
End of Report

FIRE ISLAND

NEW YORK



Overview



NY1104

GC10978