NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT VT1001A-CM-N

Lake Champlain, Crown Point to Corlaer Bay, Vermont and New York

Introduction

NOAA Coastal Mapping Program (CMP) Project VT1001A-CM-N provides highly accurate digital shoreline data for Lake Champlain from Crown Point to Corlaer Bay, in Vermont and New York. Project VT1001A-CM-N is a sub-project of a larger project VT1001-CM-N which extends from Crown Point to Riviere Richelieu at the Canadian border. 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 photographic mission instructions for this project following standard mission guidelines. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; photographic 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's flight management system.

Field Operations

The field operations for VT1001-CM-N consisted of the collection of static and kinematic GPS data, Inertial Measurement Unit (IMU) data, the acquisition of aerial imagery and the collection of ground control points (GCPs). The photographic mission operations were conducted in October 2009 and June 2010 with the NOAA Citation (N52RF) aircraft. Color and near-infrared (NIR) digital images were acquired concurrently with an Applanix Digital Sensor System (DSS) 439 aerial camera system. Fourteen flight lines were acquired at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters. Ten of these flight lines covered sub-project VT1001A-CM-N. Tide coordination during imagery acquisition was not required for this project.

Quantum Spatial, Inc. (QSI) was contracted by NGS to perform field operations consisting of the collection of thirteen ground control points. Five control points were established in project VT1001A-CM-N using static GPS techniques. Survey field work was performed in October 2017. A Ground Photo Control Report was written and is on file with other project data within the RSD Electronic Data Library.

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 final processing of kinematic GPS data using Applanix POSPAC (ver. 5.4) was performed in September 2013. For more information refer to the Airborne Positioning and Orientation Reports (APOR) on file in the RSD Electronic Data Library.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish the network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was completed by QSI personnel in February 2018 utilizing a softcopy photogrammetric workstation. The color and NIR images were measured and adjusted as separate blocks using DAT/EM Summit Evolution (ver. 7.5) photogrammetric software. The Match AT automated aerotriangulation system (ver. 8.0.6) was used to perform automatic point measurements, interactive point measurements of tie points and the block adjustment. Upon successful completion of the aerotriangulation process, the Match AT 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 1.22 meters for the color and 1.25 meters for the NIR photos based on a 95% confidence level. An Aerotriangulation Report was completed and 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

The data compilation phase of this project was accomplished by a member of QSI in September 2018. The work was accomplished using a Digital Photogrammetric Workstation (DPW), which consists of a stereo-enabled PC-based graphics workstation running the Windows 2010 operating system and a suite of digital photogrammetric software known as DAT/EM Summit Evolution Professional (ver. 7.5). Feature identification and the assignment of cartographic codes were based on image analysis of the project digital images 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 Project VT1001A-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled from the color imagery to meet a horizontal accuracy of 2.4 meters. The NIR imagery was not used to compile features and was only used as a reference during compilation. These predicted accuracies of compiled well-defined points, computed at the 95% confidence level, are derived by doubling the circular error calculated from the aerotriangulation statistics.

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

Date	Time (UTC)	Color Imagery		NIR Imagery		Lake Level*
		Roll	Strip/Images	Roll	Strip/Images	
19-OCT-2009	14:51-14:55	09NC10	50-013 / 2555-2583	09NR11	50-013 / 2399-2427	29.1 m
19-OCT-2009	15:28-15:32	09NC10	50-012 / 2790-2824	09NR11	50-012 / 2634-2668	29.1 m
19-OCT-2009	15:36-15:40	09NC10	50-014 / 2825-2853	09NR11	50-014 / 2669-2697	29.1 m
19-OCT-2009	16:11-16:18	09NC10	50-011 / 3061-3106	09NR11	50-011 / 2905-2950	29.1 m
19-OCT-2009	16:25-16:34	09NC10	50-010 / 3115-3182	09NR11	50-010 / 2959-3026	29.1 m
19-OCT-2009	17:01-17:11	09NC10	50-009 / 3359-3434	09NR11	50-009 / 3203-3278	29.1 m
19-OCT-2009	17:16-17:26	09NC10	50-008 / 3435-3509	09NR11	50-008 / 3279-3353	29.1 m
19-OCT-2009	17:52-18:02	09NC10	50-007 / 3676-3749	09NR11	50-007 / 3520-3593	29.1 m
19-OCT-2009	18:09-18:12	09NC10	50-006 / 3750-3768	09NR11	50-006 / 3594-3612	29.1 m
19-OCT-2009	18:38-18:40	09NC10	50-005 / 3933-3948	09NR11	50-005 / 3777-3792	29.1 m

* Lake levels are given in meters above NGVD 1929 and are based on approved water surface elevations at the USGS gage #04294500 in Burlington, VT. The plane of reference (Low Lake Level) in Lake Champlain is 28.3 meters above NGVD 1929 (mean sea level).

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by senior CMP personnel. The final QC review was completed in September 2018. 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 ArcGIS (ver. 10.7.1) software. All project data was evaluated for compliance to CMP requirements.

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

- 14782, Cumberland Head to Four Brothers Islands, 26th Ed., May 2017
- 14783, Four Brothers Islands to Barber Point, 21st Ed., Feb. 2019
- 14784, Barber Point to Whitehall, 21st Ed., Feb. 2017

End Products and Deliverables

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

Remote Sensing Division Electronic Data Library

- Project database
- Ground Photo Control Report
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- GC11337 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

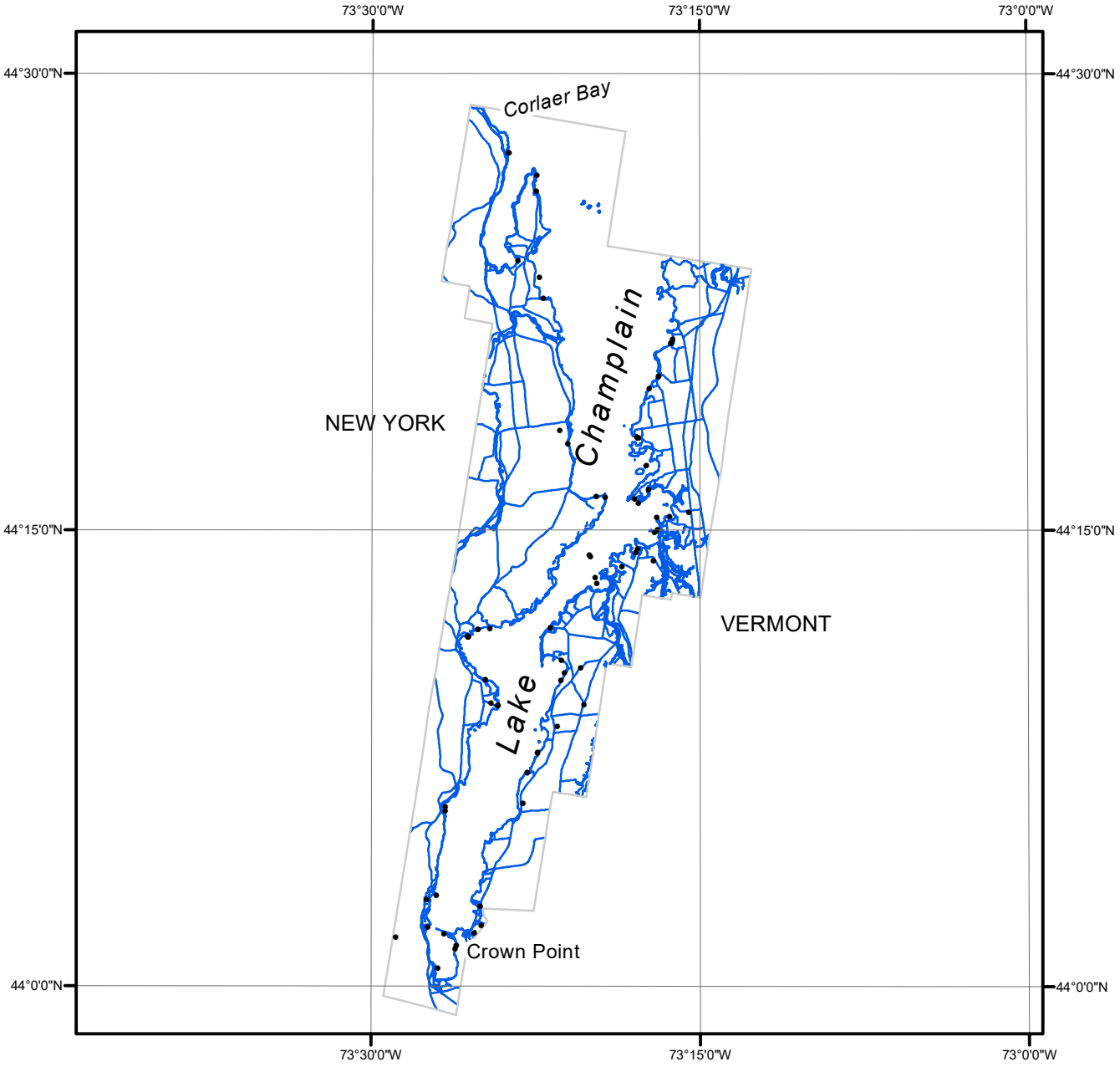
NOAA Shoreline Data Explorer

- GC11337 in shapefile format
- Metadata file for GC11337
- PCR in Adobe PDF format

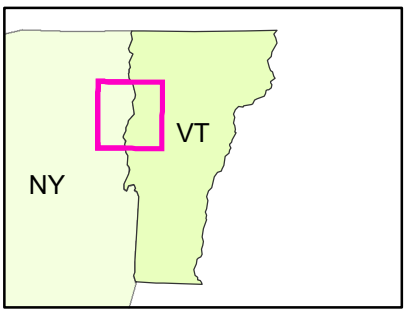
End of Report

LAKE CHAMPLAIN, CROWN POINT TO CORLAER BAY

VERMONT AND NEW YORK



Overview



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GC11337