

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MI1001G-CM-N

White Lake to Port Sheldon, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI1001G-CM-N provides highly accurate digital shoreline data for a portion of Lake Michigan from White Lake to Port Sheldon, MI including various tributaries. MI1001G-CM-N is a subproject of a larger project, MI1001-CM-N, which covers the entire eastern shore of Lake Michigan. 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, photographic requirements, Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys, and data recording and handling instructions. RB also created project layout diagrams, flight maps, and input files for the aircraft's flight management system.

Field Operations

The field operations consisted of the collection of static and kinematic GPS data, Inertial Measurement Unit (IMU) data, the acquisition of digital aerial imagery, and the collection of ground control points. Photographic mission operations for MI1001-CM-N were conducted from September 7, 2010 to July 5, 2011 with the NOAA King Air (N68RF) aircraft. Two hundred and four flight lines of color (RGB) imagery, along with simultaneous black & white infrared (IR) imagery, were acquired with an Applanix Digital Sensor System (DSS) 439 aerial camera at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters. For subproject MI1001G-CM-N, only seventeen strips of color imagery were used.

Quantum Spatial (QS) was contracted by RSD to collect ground control points (GCPs). A total of six GCPs were established for MI1001G-CM-N using static GPS techniques. One additional photo-identifiable check point was also occupied at a well-defined discrete location. Survey field work was performed between August 9 and August 11, 2014.

GPS Data Reduction

The GPS/IMU data was processed by RSD personnel to yield precise positions and orientations of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. 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 kinematic GPS data was processed using Applanix POSPAC (ver. 6.1) software in January 2013. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the Remote Sensing Division Electronic Data Library. All positional data is referenced to the North American Datum of 1983 (NAD 83).

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a 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 QS personnel in December 2014 using a softcopy photogrammetric workstation. The RGB and IR images were measured and adjusted as a single block using Intergraph ImageStation Automatic Triangulation (ISAT) software (v. 13.0) which was used to perform automatic point measurements and interactive point measurements of tie points. The photo measurements were then exported into BAE Systems BINGO aerotriangulation software (v. 6.2) within SOCET SET to perform the final bundle block adjustment. The analysis tools within BINGO were used to further refine the AT solution and to evaluate the accuracy of the adjustment. 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 0.9 meters based on a 95% confidence level. As a final check, each of the four ground control check points were measured and the coordinates compared to the coordinates of the surveyed points. An Aerotriangulation Report was completed and is on file with other project data within the RSD Electronic Data Library.

Compilation

The data compilation phase of the project was initiated by QS personnel in February 2015. The work was accomplished using a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components and other associated peripheral devices. The Feature Extraction module was used within BAE Systems' SOCET SET (version 5.6) photogrammetric software. 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). Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for Project MI1001G-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.8 meters at the 95% confidence level. This predicted accuracy of well-defined points is based on a doubling of the circular error derived from the aerotriangulation statistics.

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

Date	Time (UTC)	Color Imagery		Infrared Imagery		Lake Level
		Roll	Images	Roll	Images	
07-04-2011	18:37 – 18:46	11NC51	16560 – 16625	11NR30	10494 – 10559	176.3
07-04-2011	18:51 – 19:01	11NC51	16626 – 16692	11NR30	10560 – 10626	176.3
07-04-2011	19:08 – 19:17	11NC51	16713 – 16778	11NR30	10647 – 10712	176.3
07-04-2011	19:22 – 19:29	11NC51	16779 – 16822	11NR30	10713 – 10756	176.3
07-04-2011	19:33 – 19:39	11NC51	16823 – 16868	11NR30	10757 – 10802	176.3
07-04-2011	19:44 – 19:51	11NC51	16869 – 16914	11NR30	10803 – 10848	176.3
07-04-2011	19:56 – 19:58	11NC51	16915 – 16923	11NR30	10849 – 10857	176.3
07-04-2011	20:02 – 20:04	11NC51	16924 – 16933	11NR30	10858 – 10867	176.3
07-04-2011	20:08 – 20:09	11NC51	16934 – 16944	11NR30	10868 – 10873	176.3
07-04-2011	20:14 – 20:15	11NC51	16945 – 16955	11NR30	10879 – 10889	176.3
07-04-2011	20:22 – 20:26	11NC51	16956 – 16985	11NR30	10890 – 10919	176.3
07-04-2011	20:39 – 20:44	11NC51	17051 – 17082	11NR30	10985 – 11016	176.3
07-04-2011	20:49 – 20:53	11NC51	17086 – 17115	11NR30	11017 – 11049	176.3
07-04-2011	21:35 – 21:37	11NC51	17232 – 17242	11NR30	11166 – 11176	176.3
07-05-2011	16:39 – 16:42	11NC52	17243 - 17262	11NR31	11177 – 11196	176.3
07-05-2011	16:46 – 16:49	11NC52	17263 - 17282	11NR31	11197 – 11216	176.3
07-05-2011	16:53 – 16:57	11NC52	17283 - 17310	11NR31	11217 – 11244	176.3

*Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the Holland station in Michigan. The Low Water Datum (LWD) for Lake Michigan is 176.0 meters.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of QS. The final QC review was completed in April 2015. 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 10.1 software. All project data were evaluated for compliance to CMP requirements.

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

- 14906, South Haven to Stony Lake, MI, 1:120,000 scale, 25th edition
- 14931, Dermo Bayou to Bass River, MI, 1:15,000 scale, 24th edition
- 14933, Grand Haven, 1:15,000 scale, 25th edition
- 14934, Muskegon Lake, 1:15,000 scale, 29th edition
- 14935, White Lake, 1:10,000 scale, 21st edition

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

- Ground Control Report
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- Project Completion Report (PCR)
- Project database
- GC11086 in shapefile format
- Chart Evaluation File in shapefile format

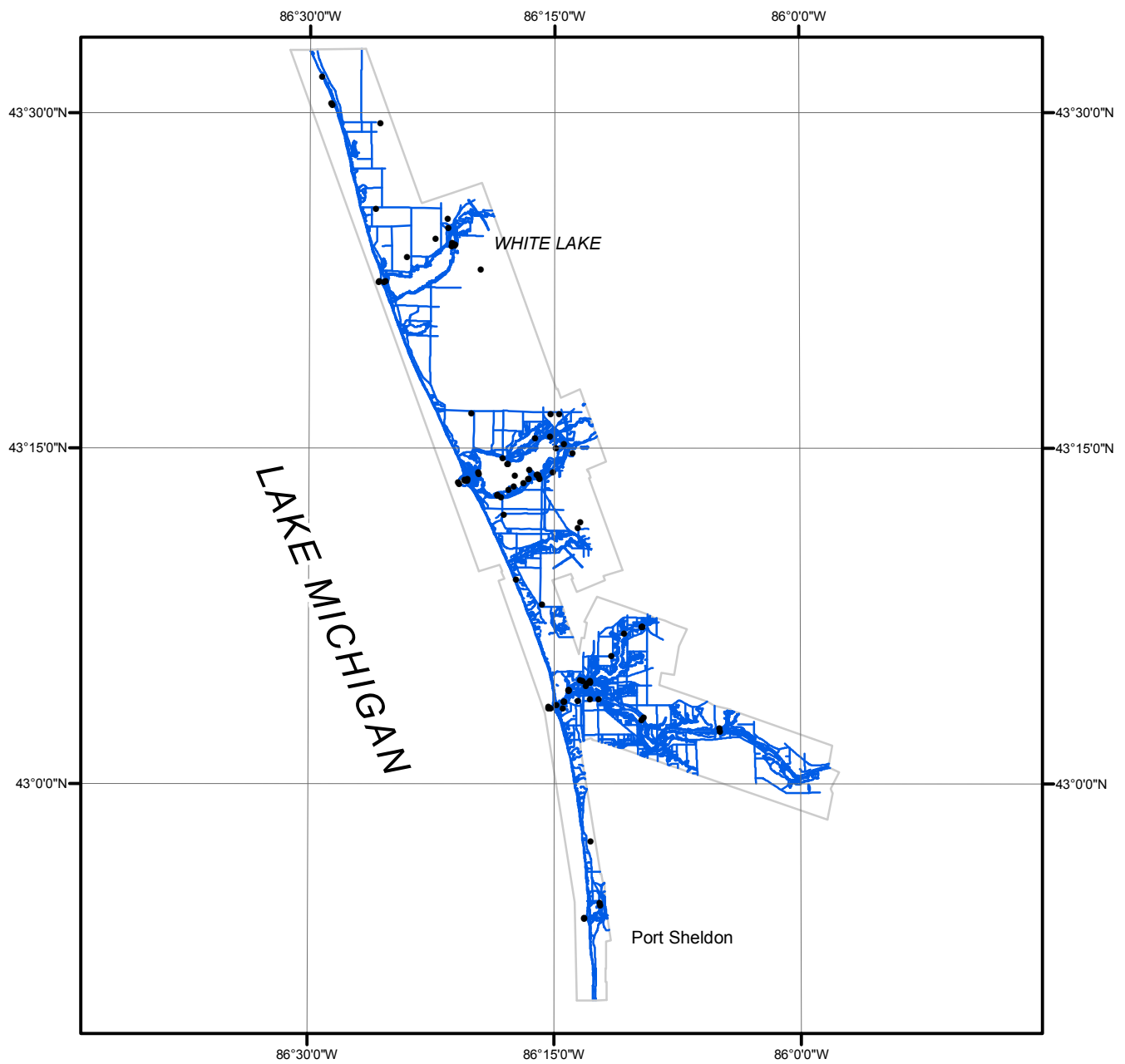
NOAA Shoreline Data Explorer

- GC11086 in shapefile format
- Metadata file for GC11086
- Digital copy of the PCR in Adobe PDF format

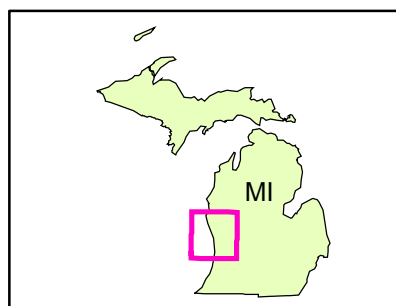
End of Report

WHITE LAKE TO PORT SHELTON

MICHIGAN



Overview



MI1001G-CM-N

GC11086