

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MI1001C-CM-N

Little Traverse Bay and Lake Charlevoix, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI1001C-CM-N provides highly accurate digital shoreline data for Little Traverse Bay and Lake Charlevoix, Michigan, as well as Lake Michigan shoreline from Good Hart south to Norwood. The project also includes the Port of Charlevoix. MI1001C-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 Procedure. 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 consisted of the collection of static and kinematic GPS 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 2010 to July 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. Lake water levels were within the acceptable range of the charting datum for all imagery. For subproject MI1001C-CM-N, only 21 strips each of color and IR were used.

Photo Science, Inc. (PSI) was contracted by RSD to perform multiple phases of project completion, beginning with collection of ground control points (GCPs). A total of eight GCPs were established in subproject MI1001C-CM-N using static GPS techniques. Two additional photo-identifiable check points were also occupied at well-defined discrete locations. Survey field work was performed in August 2014. See the Ground Control Report for more information.

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 more 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 (AT) 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 PSI personnel in January 2015 utilizing a softcopy photogrammetric workstation. The color and IR images were measured as a single block using the Intergraph ImageStation Automatic Triangulation (ISAT) (ver. 5.1) photogrammetric software. The BINGO (ver. 6.2) software was used to perform the block adjustment, and analysis tools within Bingo were used to 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 0.8 meters based on a 95% confidence level. An Aerotriangulation Report was completed and is on file with other project data in the RSD Electronic Data Library.

Compilation

The data compilation phase of the project was initiated by PSI personnel on 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 MI1001C-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.6 meters at the 95% confidence level. This predicted accuracy of well-defined points is based on a doubling of the circular error derived from aerotriangulation statistics.

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

Date	Time (UTC)	Color Imagery		Infrared Imagery		Water Level*
		Roll	Images	Roll	Images	
6-29-11	21:50-22:02	11NC47	13996-14072	11NR26	7930-8006	176.2

6-30-11	16:12-16:16	11NC48	14811-14835	11NR27	8745-8769	176.2
6-30-11	16:20-16:24	11NC48	14836-14859	11NR27	8770-8793	176.2
6-30-11	16:42-16:43	11NC48	14905-14912	11NR27	8839-8846	176.2
6-30-11	16:57-16:58	11NC48	14972-14979	11NR27	8906-8913	176.2
6-30-11	17:02-17:03	11NC48	14980-14987	11NR27	8914-8921	176.2
6-30-11	18:43-18:48	11NC48	15219-15252	11NR27	9153-9186	176.2
6-30-11	18:53-18:58	11NC48	15253-15282	11NR27	9187-9216	176.2
6-30-11	20:59-21:02	11NC49	15338-15361	11NR28	9272-9295	176.2
6-30-11	21:08-21:08	11NC49	15365-15367	11NR28	9299-9301	176.2
7-3-11	17:04-17:05	11NC43	11782-11787	11NR22	5716-5721	176.2
7-3-11	17:07-17:11	11NC43	11788-11817	11NR22	5722-5751	176.2
7-3-11	18:09-18:12	11NC43	11955-11976	11NR22	5889-5910	176.2
7-3-11	18:19-18:21	11NC43	11977-11990	11NR22	5911-5924	176.2
7-3-11	18:27-18:33	11NC43	11991-12025	11NR22	5925-5959	176.2
7-3-11	18:37-18:41	11NC43	12026-12054	11NR22	5960-5988	176.2
7-3-11	18:46-18:51	11NC43	12055-12084	11NR22	5989-6018	176.2
7-3-11	18:55-19:00	11NC43	12085-12121	11NR22	6019-6055	176.2
7-3-11	19:05-19:11	11NC43	12122-12159	11NR22	6056-6093	176.2
7-3-11	19:15-19:27	11NC43	12160-12239	11NR22	6094-6173	176.2
7-3-11	19:32-19:44	11NC43	12240-12319	11NR22	6174-6253	176.2

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

Quality Control / Final Review

Quality control (QC) tasks were conducted during all phases of project completion by a senior member of PSI. The final QC review was completed in May 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 10.4.1 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color 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:

- 14886, Inland Route, Cheboygan to Conway, 1:20,000 scale, 12th Ed., Sep./14
- 14911, Waugoshance Pt to Seul Choix Pt, 1:80,000 scale, 22nd Ed., Feb./16
- 14913, Grand Traverse Bay to Little Traverse Bay, 1:80,000 scale (incl. 1:10,000 insets), 20th Ed., Jan./16
- 14942, Lake Charlevoix, 1:30,000 scale (incl. 1:10,000 inset), 27th Ed., Dec./15

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
- GC11080 in shapefile format
- Chart Evaluation File in shapefile format

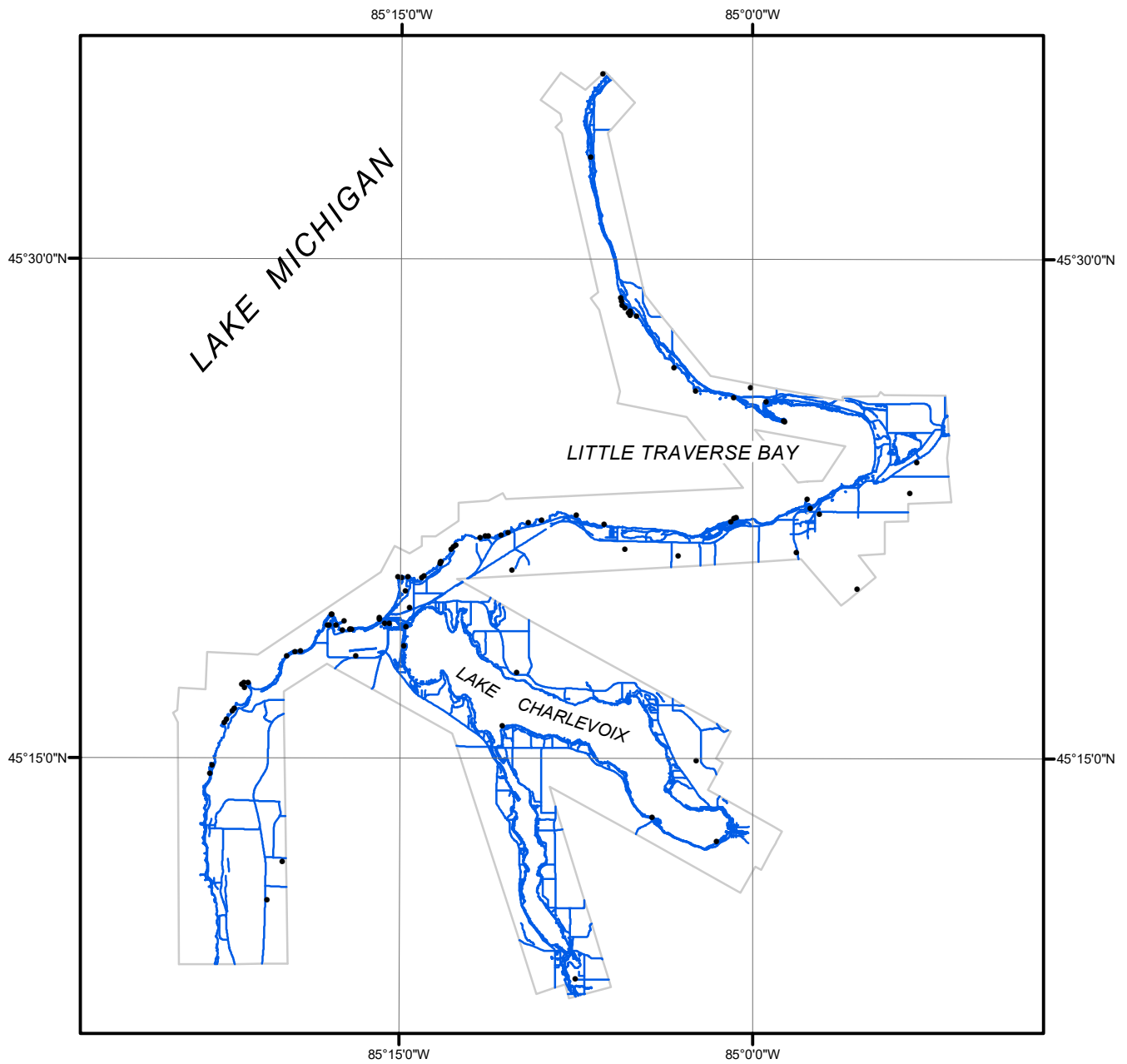
NOAA Shoreline Data Explorer

- GC11080 in shapefile format
- Metadata file for GC11080
- Digital copy of the PCR

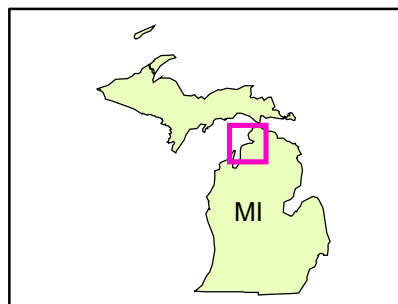
End of Report

LITTLE TRAVERSE BAY AND LAKE CHARLEVOIX

MICHIGAN



Overview



MI1001C-CM-N

GC11080