

# **NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT**

## ***PROJECT WI1001D-CM-N***

### ***Black River Point to Algoma, Lake Michigan, Wisconsin***

#### **Introduction**

NOAA Coastal Mapping Program (CMP) Project WI1001D-CM-N provides a highly accurate database of new digital shoreline data for a portion of the western shore of Lake Michigan, in Wisconsin. The project extends from Black River Point to Algoma and includes several tributaries of the lake. Project WI1001D-CM-N is a sub-project of the larger project WI1001-CM-N, which includes shoreline mapping from Burns Waterway Harbor, at the southern end of Lake Michigan, to Little Bay de Noc, including Green Bay and Door Peninsula. 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 Project Instructions for this project following the guidelines of the “Scope of Work, Shoreline Mapping for the Coastal Mapping Program” (SOW), Version 13B, January 2008. 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. RB created a project layout diagram, flight maps and input files for the aircraft’s flight management system.

#### **Field Operations**

The field operations consisting of the collection of static and kinematic GPS data and the acquisition of digital aerial imagery was performed by RSD personnel. One hundred fifty-one flight lines (151) were planned to cover the entire project. Of these, seventeen (17) flight lines consisting of non-tide coordinated natural color imagery and Black and White infrared (B&W IR) imagery were acquired concurrently using an Applanix DSS-439 dual-head camera system for sub-project WI1001D-CM-N. Aerial survey operations were conducted with the NOAA King Air (N68RF) aircraft during the period of August 6th, 2010 through September 30th, 2010. All imagery was flown at a nominal altitude of 10,000 feet resulting in an approximate ground sample distance (GSD) of 0.35 meters.

Photo Science, Inc. (PSI) was contracted by RSD to locate ten new photo control points and four check points. The control points and check points were photo-identifiable features located at well-defined locations. Refer to the Ground Survey Report for a listing of final coordinates, elevations, descriptions and a site map of the points.

#### **GPS Data Reduction**

GPS and IMU data was collected and 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 airborne kinematic data was processed using POSPAC version 5.4.0 GPS and IMU processing software. For further information refer to the Airborne Positioning and Orientation Reports (APOR) that are on file with other project data within the Remote Sensing Division 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 PSI personnel in March 2012 using a softcopy photogrammetric system. The color and B&W IR images were measured and adjusted as a single block using the Multi Sensor Triangulation (MST) module within the Socet Set (version 5.6.0) software. The BINGO aerotriangulation software was used to perform the final bundle block adjustment. The root mean square (RMS) of the standard deviations of the residuals for each aerotriangulated ground point were used to compute a predicted horizontal circular error of 0.5 meters 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, 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 the project was initiated by PSI personnel in March 2012. 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 W11001D-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.0 meter 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:

<b>Date</b>	<b>Time (UTC)</b>	<b>Roll #</b>	<b>Photo #s</b>	<b>GSD</b>	<b>Water Level*</b>
8-06-10	16:04-16:06	10NC28	12148-12159	0.35 m	176.3 m
8-06-10	16:04-16:06	10NR12	05254-05264	0.35 m	176.3 m
8-07-10	13:53-13:56	10NC29	12379-12397	0.35 m	176.3 m
8-07-10	13:53-13:56	10NR13	05484-05502	0.35 m	176.3 m
8-07-10	14:05-14:08	10NC29	12400-12420	0.35 m	176.3 m
8-07-10	14:05-14:08	10NR13	05506-05525	0.35 m	176.3 m
8-07-10	14:08-14:09	10NC29	12425-12428	0.35 m	176.3 m
8-07-10	14:09-14:11	10NC29	12431-12438	0.35 m	176.3 m
8-07-10	14:09-14:11	10NR13	05537-05543	0.35 m	176.3 m
8-07-10	14:15-14:20	10NC29	12439-12473	0.35 m	176.3 m
8-07-10	14:15-14:20	10NR13	05544-05578	0.35 m	176.3 m
8-07-10	14:45-14:47	10NC29	12576-12586	0.35 m	176.3 m
8-07-10	14:45-14:47	10NR13	05681-05691	0.35 m	176.3 m
8-07-10	14:50-14:52	10NC29	12587-12597	0.35 m	176.3 m
8-07-10	14:50-14:52	10NR13	05692-05702	0.35 m	176.3 m
8-07-10	15:32-15:33	10NC29	12717-12725	0.35 m	176.3 m
8-07-10	15:32-15:33	10NR13	05823-05830	0.35 m	176.3 m
8-07-10	15:45-15:49	10NC29	12739-12763	0.35 m	176.2 m
8-07-10	15:45-15:49	10NR13	05844-05869	0.35 m	176.2 m
8-07-10	15:54-15:56	10NC29	12766-12785	0.35 m	176.3 m
8-07-10	15:54-15:56	10NR13	05871-05890	0.35 m	176.3 m
9-12-10	16:37-16:39	10NC20	08623-08639	0.35 m	176.1 m
9-12-10	16:37-16:39	10NR19	09361-09377	0.35 m	176.1 m
9-12-10	16:44-16:47	10NC20	08640-08657	0.35 m	176.1 m
9-12-10	16:44-16:47	10NR19	09378-09395	0.35 m	176.1 m
9-27-10	14:29-14:32	10NC23	10336-10354	0.35 m	176.2 m
9-27-10	14:29-14:32	10NR22	10931-10949	0.35 m	176.2 m
9-27-10	14:38-14:44	10NC23	10366-10410	0.35 m	176.2 m
9-27-10	14:38-14:44	10NR22	10962-11005	0.35 m	176.2 m
9-27-10	14:45-14:46	10NC23	10417-10420	0.35 m	176.2 m
9-27-10	14:45-14:46	10NR22	11012-11015	0.35 m	176.2 m
9-27-10	14:49-14:50	10NC23	10447-10455	0.35 m	176.2 m
9-27-10	14:49-14:50	10NR22	11041-11050	0.35 m	176.2 m

9-27-10	14:55-15:09	10NC23	10456-10553	0.35 m	176.2 m
9-27-10	14:55-15:09	10NR22	11051-11148	0.35 m	176.2 m
9-30-10	15:10-15:12	10NC25	10994-11007	0.35 m	176.2 m
9-30-10	15:10-15:12	10NR40	16528-16540	0.35 m	176.2 m

\* Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the Kewaunee, Wisconsin station. The Low Water Datum (LWD) for the portion of Lake Michigan covered by this project is 176.0 m. 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 June 2012. 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 10.2.2 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color and B & W 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:

- 14903, Algoma to Sheboygan, WI, 1:120,000 scale, 24th Ed.
- 14910, Lower Green Bay, Algoma and Oconto, 1:80,000 scale, 23rd Ed.
- 14922, Manitowoc and Sheboygan, 1:10,000 scale, 20th Ed.

## 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 Survey Report
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- Project Completion Report (PCR)
- Project database
- GC10927 in shapefile format
- Chart Evaluation File in shapefile format

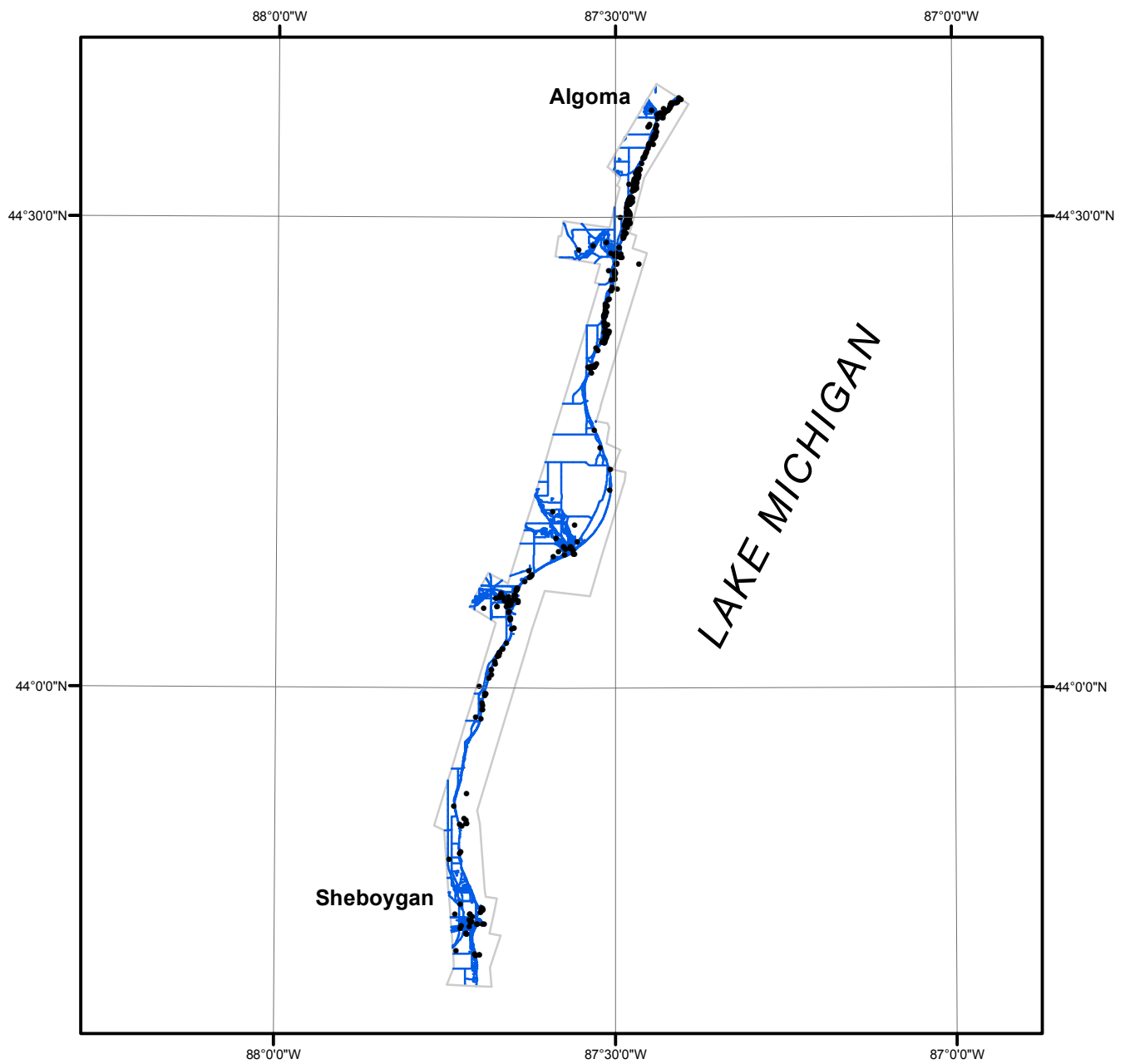
### NOAA Shoreline Data Explorer

- GC10927 in shapefile format
- Metadata file for GC10927
- Digital copy of the PCR

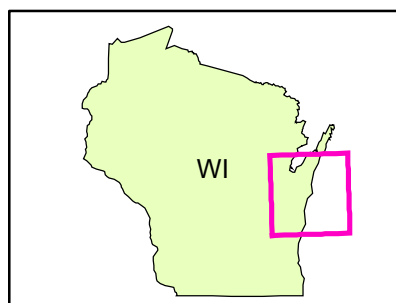
## End of Report

# BLACK RIVER POINT TO ALGOMA

## WISCONSIN



Overview



WI1001D-CM-N

GC10927