

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MI0906A

Saginaw Bay, Point Lookout to Caseville, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI0906A provides a highly accurate database of new digital shoreline data for a portion of Saginaw Bay from Point Lookout to Caseville, and includes Bay City, MI.

Successful completion of this project resulted in 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.

The project database consists of information measured and extracted from aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

Project Design

The NOAA National Geodetic Survey (NGS) 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, dated 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.

This project used digital aerial imagery previously acquired under a contract with the National Geospatial-Intelligence Agency (NGA). The purpose of the NGA project was to produce digital ortho-rectified images maps of the U.S./Canada border regions in the Great Lakes. NOAA recognized the value of using the NGA project data for updating the nautical charts under the Coastal Mapping Program, and arranged with NGA to obtain the original stereo imagery and associated positioning data needed for photogrammetric mapping.

NOAA forwarded all of the NGA provided project imagery, aerotriangulation output data, ground control coordinates, airborne GPS and IMU data, and Photogrammetric Reports to Western Air Maps, Inc. (WAM)/Wilson & Company in order to support photogrammetric processing and feature compilation. NOAA also provided shapefiles depicting the shoreline to be mapped, the boundaries of the main project and sub-project compilation areas, and flight lines and exposure centers of the imagery to be used for compilation.

Field Operations

Since all source data was provided by NGA through NOAA, WAM was not required to perform any field operations in connection with this project. The field operations that were performed by

NGA's contractor (3001, Inc.) and their sub-contractor (Photo Science, Inc.) are described in detail in their Photogrammetric Report for AOI 37, which covers this project area. Following is a brief summary of the field operations as described in that report.

AOI 37:

Field operations included the surveying of ground control points (GCPs) and the acquisition of aerial imagery. Coordinates of sixteen (16) GCPs were established using static and rapid-static GPS techniques. Survey field work was performed on 8/08/2008 – 8/09/2008 by Photo Science, Inc. Aerial imagery was acquired using a Z/I DMC digital camera operated by Photo Science, Inc. in three flights between 8/20/2008 and 9/01/2008. Twenty-seven (27) lines of panchromatic, RGB, and NIR imagery were acquired at an approximate altitude of 9,840 feet above mean terrain, resulting in a nominal pan-sharpened image resolution of 0.30 meters GSD. Airborne GPS and Inertial Measurement Unit (IMU) data were collected during the image acquisition flights, along with NAVCOM VueStar data (a global satellite based GPS augmentation system), in order to determine precise camera position and orientation parameters.

GPS Data Reduction

Since pre-processed GPS and IMU data was provided by NGA through NOAA, Western Air Maps/Wilson & Company was not required to perform any GPS data reduction for this project. All GPS/IMU data processing tasks were completed by Photo Science, Inc. and are described in detail in their Photogrammetric Report for AOI 37, which covers this project area. Following is a brief summary of the GPS/IMU data processing tasks described in that report.

Final GCP coordinate values were determined utilizing precise point positioning techniques using Applanix TerraPOS (ver. 1.2) software and the NGS Online Positioning User Service (OPUS). Though the NAVCOM VueStar system provided decimeter level GPS navigation information in real time, the airborne GPS (ABGPS) data was post-processed using TerraPOS software to improve on the real time results. The Applanix POSPac (AIR) software (ver. 5.1) was used to process the IMU data, and with the POSProc and POSEO modules, the post-processed GPS was combined with the IMU data to compute an optimally accurate navigation solution, and final exterior orientation (EO) parameters (x, y, z, omega, phi, kappa) for each photograph.

Aerotriangulation

Since final exterior orientation values for each photograph were provided by NGA through NOAA, Western Air Maps, Inc. (WAM)/Wilson & Company was not required to perform any Aerial Triangulation (AT) for this project. All AT tasks were completed by Photo Science, Inc. and are described in detail in their Photogrammetric Report for AOI 37, which covers this project area. Following is a brief summary of the AT tasks described in that report.

Z/I Mission software (ver. 1.4.0.10) was used to export the frame exposure information collected during the flights, and convert it into ImageStation Photogrammetric Manager (ISPM) format. Intergraph ISPM software (ver. 5.2) was used to create a project from these frame exposure files. Z/I Post Processing System (PPS) software (ver. 5.3) was then utilized to produce 8-bit GeoTIFF images from the raw image data collected during the flights, and corrected EO parameters derived from ABGPS/IMU data were incorporated.

For each DMC virtual image stereo pair, correlated points were generated by an automatic point-matching algorithm using Intergraph ImageStation Automatic Triangulation (ISAT) software (ver. 5.1). Similarly, for each block of images, tie points (photo-identifiable points that occur in the overlap between adjacent flight lines) were automatically generated and GCPs were measured. The ISAT software was then used to develop a least squares bundle adjustment for each block, using the generated tie points, measured GCPs, and post-processed ABGPS/IMU solution as observations.

Western Air Maps, Inc. (WAM)/Wilson & Company conducted a spot check of the NOAA provided AT solution to ensure that the AT results were of sufficient accuracy to proceed with shoreline compilation. This quality assurance step was conducted using Intergraph ISAT software, as the image data set had been triangulated previously (by Photo Science, Inc) using the same tool. After the Intergraph data had been converted into a format easily imported into SOCET SET, the images were again inspected to make sure that the data conversion had not introduced errors that would adversely affect data compilation.

The Photogrammetric Reports provided by NGA's contractor included accuracy analyses of their resultant orthophoto images, but did not include full accuracy assessments of the least squares bundle adjustments. Western Air Maps Inc./Wilson & Company used the ISAT output "control" files, which were provided with the rest of the project data, to compute the horizontal accuracy according to NOAA specifications. The "control" file provided the standard deviations of the residuals for each aerotriangulated ground point. From these standard deviation values the root-mean-square (RMS) values for both X and Y coordinates were computed, and these were used to calculate a predicted horizontal circular error at the 95% confidence level of 0.14 meters for the AOI 37 image block.

Positional data is referenced to UTM Zone 17N, North American Datum of 1983 (NAD83).

Compilation

The data compilation phase of this project was initiated by Western Air Maps, Inc. in December, 2009. Digital mapping was performed using SOCET for ArcGIS (Version 9.3) and SOCET SET (Version 5.5.0) software. Feature identification and attribution within the Geographic Cell (GC) were based on interpretation of the project imagery, and on information extracted from the appropriate NOAA nautical charts, the 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.

To expedite delivery and to assure quality, Western Air Maps/Wilson & Company delivered pilot compilation areas for review and comment. Upon receiving NOAA review comments, the pilot area shapefiles were finalized and then used as a template for the remaining compilation of shoreline in the project area. This quality assurance step was felt to be necessary to ensure that there would be no confusion regarding how the shoreline needed to be compiled. This particular production step was clearly defined in the project instructions as well as in the quality assurance/quality control plan submitted by Western Air Maps/Wilson & Co. and approved by NOAA at the start of the project.

Spatial data accuracies for Project MI0906A were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 0.3 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is calculated by doubling the circular error derived from the aerotriangulation statistics.

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

Date	Time (UTC)	AOI Block	Line Number	Photo Numbers	GSD (nominal)	Lake Level*
8/20/2008	16:21:56 – 16:30:10	37	76003	50 – 1	0.30m	176.2
8/20/2008	18:49:41 – 18:57:53	37	76002	1 – 50	0.30m	176.3
8/20/2008	19:03:12 – 19:05:39	37	76001	18 – 3	0.30m	176.3
8/20/2008	19:25:19 – 19:30:10	37	76009	15 – 45	0.30m	176.3
8/20/2008	19:35:41 – 19:40:35	37	76010	44 – 15	0.30m	176.3
8/20/2008	20:21:16 – 20:26:01	37	76012	41 – 13	0.30m	176.3
8/30/2008	19:28:39 – 19:34:29	37	76004	50 – 15	0.30m	176.3
8/30/2008	20:02:07 – 20:07:23	37	76011	14 – 43	0.30m	176.2
8/30/2008	20:12:19 – 20:14:17	37	76014	38 – 25	0.30m	176.2
8/30/2008	20:26:30 – 20:29:32	37	76016	12 – 29	0.30m	176.2
8/30/2008	20:56:26 – 20:58:34	37	76013	40 – 26	0.30m	176.2
8/30/2008	21:10:56 – 21:13:37	37	76015	19 – 34	0.30m	176.2
9/1/2008	16:13:24 – 16:15:25	37	76027	16 – 4	0.30m	176.2
9/1/2008	16:21:23 – 16:25:56	37	76023	26 – 1	0.30m	176.2
9/1/2008	18:05:17 – 18:08:46	37	76024	5 – 27	0.30m	176.2
9/1/2008	18:15:12 – 18:18:01	37	76026	19 – 3	0.30m	176.2
9/1/2008	18:24:38 – 18:27:35	37	76025	4 – 23	0.30m	176.2
9/1/2008	18:34:30 – 18:44:42	37	76022	62 – 4	0.30m	176.2
9/1/2008	18:51:48 – 18:59:11	37	76021	9 – 57	0.30m	176.2
9/1/2008	19:08:37 – 19:15:23	37	76020	54 – 15	0.30m	176.2
9/1/2008	19:30:40 – 19:31:17	37	76019	49 – 53	0.30m	176.2

* Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the Essexville station (#9075035) in Michigan. The Low Water Datum (LWD) for the portion of Lake Huron covered by this project is 176.0 m. above IGLD 1985.

Quality Control / Final Review

Western Air Maps, Inc. personnel conducted quality assurance reviews during all phases of project completion. The final QC review was completed in August 2010. 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 9.3 software. All project data was evaluated for compliance to CMP requirements.

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

14863, Saginaw Bay, MI, 1:120,000 scale, 31st ed., Oct. /05

- Sebewaing Harbor, 1:20,000 scale inset

14867, Saginaw River, MI, 1:20,000 scale, 26th ed., July /03

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 Photogrammetric Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10800 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project database
- GC10800 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

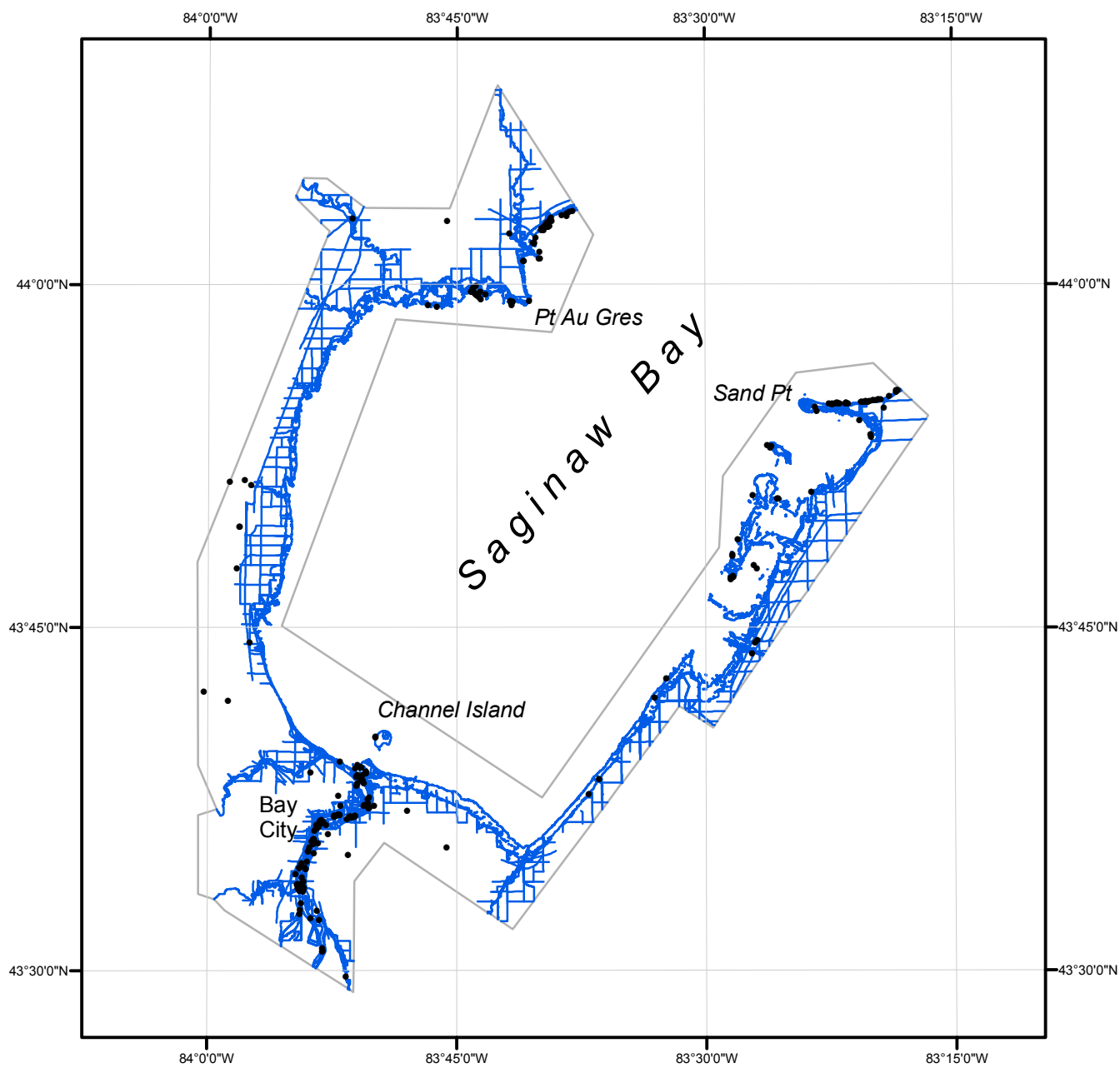
NOAA Shoreline Data Explorer

- GC10800 in shapefile format
- Metadata file for GC10800
- Digital copy of the PCR in Adobe PDF format

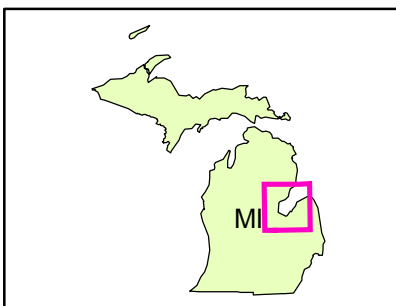
End of Report

SAGINAW BAY, POINT LOOKOUT TO CASEVILLE

MICHIGAN



Overview



MI0906A

GC10800