NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT OH0906A

Detroit River, Lake St. Clair to Lake Erie, Michigan and Ontario

Introduction

NOAA Coastal Mapping Program (CMP) Project OH0906A provides a highly accurate database of new digital shoreline data for the Detroit River and a portion of Lake Erie. The project extends from Belle Isle, Michigan in the northeast southward along the Detroit River to Celeron Island and eastward along the north shore of the western end of Lake Erie to Comet, Ontario, Canada.   Project OH0906A is a sub-project of a larger project, OH0906 which includes shoreline mapping from Belle Isle, Michigan on the Detroit River to Conneaut, Ohio on the south shore of Lake Erie at the Pennsylvania state line.

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/IMU data, and Photogrammetric Reports to Aero-Metric, Inc. in order to support photogrammetric processing and feature compilation. NOAA also provided shapefiles depicting the shoreline to be mapped, 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, Aero-Metric, Inc. 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 40 which covers this project area. Following is a brief summary of the field operations as described in that report.

AOI 40:
Field operations included the surveying of ground control points (GCPs) and the acquisition of aerial imagery. Coordinates of thirty-three (33) GCPs were established using static and rapid-static GPS techniques. Survey field work was performed on 08/05/2008 – 08/07/2008 by Photo Science, Inc. Aerial imagery was acquired using a Z/I DMC digital camera operated by Photo Science, Inc. in thirteen flights between 07/31/2008 and 10/07/2008. Fifty-six (56) 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, Aero-Metric, Inc. 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 40, 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, Aero-Metric, Inc. 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 40, 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. The results of the bundle adjustment were then checked to verify compliance with the accuracy requirement of the project.

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. Therefore Aero-Metric, Inc. 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) for both X and Y coordinates was computed, and these were used to compute a predicted horizontal circular error at the 95% confidence level of 0.13 meters for the AOI 40 image block.

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

Compilation

The data compilation phase of the project was initiated by Aero-Metric, Inc. in February 2010. Digital feature extraction was completed in a softcopy stereo environment using DAT/EM Systems Summit Evolution digital photogrammetric workstations with DAT/EM Capture for MicroStation software. Feature identification and the assignment of cartographic codes were based on image analysis of color negative photographs and information extracted from the appropriate NOAA Raster Navigational Charts and US Coast Guard Light List. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST). Nomenclature was assigned to selected cartographic features to refine general classification.

Spatial data accuracies for Project OH0906A 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. The 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 aerial photographs used in the project completion:

Date	Time (UTC)	AOI Block	Line Number	Photo Numbers	GSD (nominal)	Water Level*
07-31-08	14:43-14:45	40	80020	78-90	0.30 m	174.4
07-31-08	14:45-14:48	40	80020	91-105	0.30 m	174.7
07-31-08	14:48-14:50	40	80020	106-116	0.30 m	174.8
07-31-08	15:13-15:14	40	80019	114-104	0.30 m	174.8
07-31-08	15:14-15:16	40	80019	103-91	0.30 m	174.7
07-31-08	15:16-15:18	40	80019	90-77	0.30 m	174.4
07-31-08	15:44-15:45	40	80022	80-84	0.30 m	174.4
07-31-08	15:50-15:52	40	80022	115-123	0.30 m	175.0
07-31-08	16:22-16:23	40	80021	84-79	0.30 m	174.4
07-31-08	16:16-16:17	40	80021	120-112	0.30 m	174.8
08-01-08	13:33-13:35	40	80018	76-89	0.30 m	174.4
08-01-08	13:36-13:38	40	80018	90-103	0.30 m	174.7
08-01-08	13:38-13:39	40	80018	104-111	0.30 m	174.8
08-01-08	14:04-14:05	40	80017	107-102	0.30 m	174.8
08-01-08	14:05-14:07	40	80017	101-88	0.30 m	174.7
08-01-08	14:07-14:09	40	80017	87-76	0.30 m	174.4
08-01-08	14:43-14:44	40	80016	76-85	0.30 m	174.4
08-16-08	14:49-14:50	40	80023	86-81	0.30 m	174.4
08-31-08	13:32-13:33	40	80043	05-13	0.30 m	174.9
08-31-08	16:06-16:07	40	80044	20-14	0.30 m	174.9

* Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the Gibraltar, Wyandotte, Fort Wayne, and Windmill Point stations in Michigan.   The Low Water Datum (LWD) values for the Detroit River range from 173.6 m. in the south (Gibraltar) to 174.3 m. in the north (Windmill Point).

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion.   The final QC review was completed in June 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 were used in the comparison process:

14830, West End of Lake Erie, MI-OH, 1:100,000 scale, 32nd edition
14848, Detroit River, MI, 1:30,000 scale, 58th edition
14853, Detroit River, Lake St. Clair, St. Clair River, MI, 1:15,000 scale, 17th edition
14854, Trenton Channel and River Rouge, MI, 1:15,000 scale, 14th edition

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 GC10813 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project Database
- GC10813 in shapefile format
- Digital copy of the PCR in Adobe PDF format
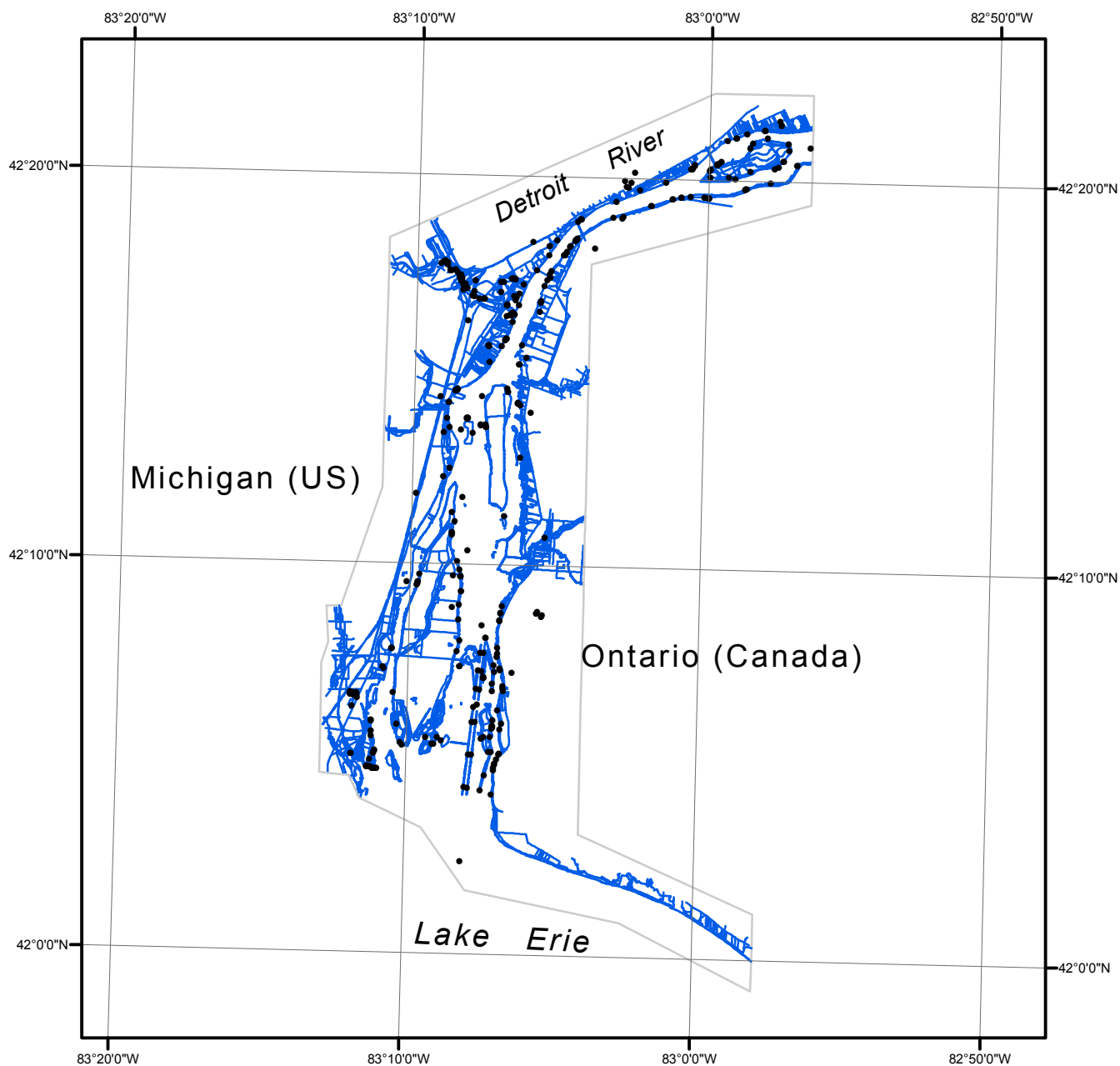- Chart Evaluation File in shapefile format

NOAA Shoreline Data Explorer

- GC10813 in shapefile format
- Metadata file for GC10813
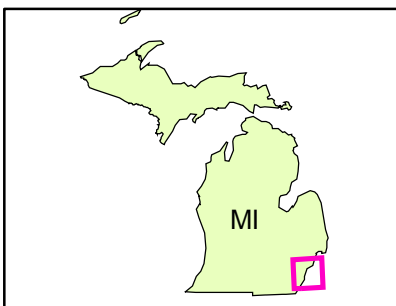- Digital copy of the PCR in Adobe PDF format

End of Report

DETROIT RIVER, LAKE ST CLAIR TO LAKE ERIE

MICHIGAN-ONTARIO

83°20'0"W   83°10'0"W   83°0'0"W   82°50'0"W

42°20'0"N

Detroit River

Michigan (US)

42°10'0"N

Ontario (Canada)

42°0'0"N

Lake Erie

Overview

MI

OH0906A

GC10813