

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT NJ0301C

Delaware River, Darby Creek to Philadelphia

Pennsylvania and New Jersey

Introduction

Coastal Mapping Program (CMP) Project NJ0301C provides a highly accurate database of new digital shoreline data for a portion of the Delaware River. This project area includes both sides of the Delaware River from Darby Creek to Philadelphia, including Camden, Paulsboro, and a portion of the Cooper River, Schuylkill River, and Mantua Creek. Project NJ0301C is a subproject of a larger project, NJ0301, which includes the Delaware River extending from Liston Point, Delaware northward to Trenton, New Jersey.

Successful completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and a Geographic Cell (GC) of the coastal zone which compliments 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 photography 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 design of project NJ0301 was based on a comparison of image analysis to cartographic detail depicted on the pertinent NOAA nautical charts of the project site. The Remote Sensing Division (RSD) of the National Geodetic Survey, NOAA, formulated the NJ0301 Project Instructions (September 23, 2003 - revised) which contains the specific field and photo mission operational guidelines. The instructions, as provided to Tuck Mapping Solutions, Inc. (TMSI), discussed the project's purpose, geographic area of coverage, scope and priority; photographic and ground control requirements; flight line priority; tide and sun angle coordination; Global Positioning Systems (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact communication information.

Nautical charts provided by RSD showed the limits of the color, black & white infrared (B&W IR) and tide sensitive photography areas. Photo scales for the color and B&W IR photography were determined by RSD staff to attain the required mapping accuracies. A waiver to utilize a 700nm filter during the acquisition of the B&W IR film was approved previously. NOAA approved a waiver for this filter on the camera without requiring a new camera calibration report by the USGS.

Included in correspondence from TMSI to NOAA on July 25, 2002, was a document titled Quality Control Procedures for NOAA Coastal Mapping Projects. These procedures and requirements were followed by TMSI throughout the project.

Field Operations

In compliance with the Project Instructions (Section 3.1), Keystone Aerial Survey, Inc. (KASI) located at the North Philadelphia Airport and a sub-consultant to TMSI was tasked with acquiring kinematic airborne GPS controlled imagery. Tide coordinated flight times were provided to KASI by TMSI. The natural color (NC) photographic mission conducted on November 9-10, 2003, with a Cessna 310 aircraft, acquired thirteen (13) strips of 1:24,000 and two (2) strips of 1:30,000 scale photography. The missions to acquire the B&W IR tide coordinated photography began on February 25, 2004, and concluded on June 23, 2005, using five different twin engine aircraft. Thirteen (13) strips of B&W IR tide coordinated photography were acquired through the use of a Wild RC-30 camera, NOAA camera designation number 19. The photo mission was scheduled to have been completed in the spring of 2004. However, it was determined in May 2004 that a large portion of the imagery was acquired outside of the tidal tolerance levels and a rescheduled completion date was set for late 2004. Due to prevailing winds, currents, river levels, and atmospheric conditions which all have an influence on tidal levels, the final photography was not completed until June 2005. One area of the project was problematic concerning the tide coordinated photography. Line 24014 covered Rancocas Creek and was flown multiple times for MLLW without apparent success according to the tide verification process. RSD reviewed the imagery and determined photography from the March 11, 2004, flight could be used to map the MLLW. Inspection of the MLLW flight November 15, 2004, indicated the tide was 1.2 feet higher than the March 11, 2004, flight but actually the water was lower than on the November 15, 2004, imagery. The portion of Rancocas Creek covered by the imagery in question is upstream of a bridge under construction and does not have the width or depth to support commercial activities as per an email from NOAA on April 12, 2005. Compilation of MLLW, if required, was completed using the November 15, 2004, imagery. Please refer to the Tabulation of Aerial Photography for additional information. Flight lines 24009, 24010, and 24011 have patched portions flown in opposite compass headings.

KASI used two base stations, KASPK and KAS. KASPK, the primary station, was a TRIMBLE dual frequency GPS receiver with an antenna mounted on the top of one of their hangers. KAS has the same configuration arrangement and is a backup for KASPK. There was one data failure on May 10, 2005, for KASPK that required the use of the backup station data. GPS data was submitted for OPUS solutions to verify the stations. KASI recommended James M. Stewart (JMS), Inc. to perform the necessary GPS surveys to locate aerial control and check points. CORS data was combined with the multiple two hour sessions observed by JMS to produce a network adjustment that verified the data previously submitted. See the Photographic Flight Reports and Ground Control Reports for additional information.

GPS Data Reduction

GPS data was collected and processed to provide precise positions of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. KASI acquired static GPS datasets of stations KASPK and KAS during all photography missions. After the flight missions, the project data was downloaded and processed using

GrafNav software Versions 6.03, 7.01, or 7.50.2117. Forward and reverse trajectories were compared during the processing phase to ensure accuracy. Camera event file data was then applied to the final trajectory to obtain coordinates for the photo centers. A GPS Data Processing Report was written and is on file with other project data within the RSD Applications Branch (AB) Project Archive.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to extend the network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. The softcopy aerotriangulation work was initiated by John F. Kenefick (JFK), Inc. personnel in summer 2004 utilizing a digital photogrammetric workstation (DPW) which is a configuration of computer processor and monitor and ZI ImageStation Photogrammetry Manager (ISPM) software equipment and associated peripheral devices. The softcopy aerotriangulation work was initiated by JFK, Inc. personnel in May 2004 and was completed in July 2005.

Upon completion of the measurement process, the data was exported and processed in JFK, Inc.'s PC-RABATS/BRATS Aerotriangulation software. The natural color 1:30,000 and 1:24,000 photography flown November 9-10, 2003, was processed as one block. The original flight of B&W IR MLLW 1:24,000 was processed as one block. There were three separate re-flight areas that were processed as individual blocks for assessment. The original B&W IR MHW was processed as one block. There was one separate re-flight block that was processed for assessment. Upon successful completion of the block adjustment, PC-RABATS/BRATS software provided the RMS of the standard deviations for all aerotriangulated ground points, which were used to compute a predicted horizontal circular error of 0.5 meters for all adjusted photographs. The Aerotriangulation Report is on file with other project data within the RSD AB Project Archive.

The project database consists of camera calibration data, interior orientation parameters for each frame, airborne GPS antenna position and offset data, adjusted exterior orientation parameters for each frame, and positional listing of all measured points, the control file and refined image coordinates as listed in the Project Database section of the Aerotriangulation Report. Positional data is based on the North American Datum of 1983 (NAD 83), and is referenced to the New Jersey State Plane Coordinate System.

Compilation

The data compilation phase of the project was accomplished by TMSI in January 2007. Digital mapping was performed using Digital Photogrammetric Workstations (DPWs) in conjunction with BAE SOCET SET ver. 5.0 and ver. 5.2. Feature identification and the assignment of cartographic codes were based on image analysis of 1:24,000 scale natural color photography, 1:24,000 scale B&W IR photography and information extracted from appropriate NOAA Nautical Charts and the US Coast Guard Light List. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST) as required.

Cartographic features were compiled to meet a horizontal accuracy of 1.0 meter at the 95% confidence level. This predicted accuracy of compiled, well-defined points is derived by doubling the circular error derived from aerotriangulation statistics.

See Table 1 for information on all aerial photographs used for Project NJ0301. It should be noted that the actual frames used to compile feature data for subproject NJ0301C represent a subset of the photography acquired for the larger project area.

Table 1 - Compilation Sources

Date	Time (UTC)	Roll Number	Film	Frames	Scale (nominal)	Tide Level*
11/9/2003	1549-1720	0319CN01	NC	0002-0137	1:24,000	1.7 (MH)
11/9/2003	1725-1730	0319CN01	NC	0138-0147	1:30,000	1.7 (RP)
11/10/2003	1524-1625	0319CN02	NC	0158-0244	1:24,000	1.7 (MH)
11/10/2003	1640-1646	0319CN02	NC	0245-0254	1:30,000	1.8 (RP)
2/27/2004	1559-1636	0419R02	IR	0041-0084	1:24,000	0.3 (RP)
2/27/2004	1651-1736	0419R02	IR	0085-0134	1:24,000	0.1 (MH)
2/27/2004	1758-1850	0419R02	IR	0135-0177	1:24,000	0.1 (PH)
3/11/2004	1707-1710	0419R03	IR	0208-0213	1:24,000	0.3 (PH)
3/11/2004	1825-1828	0419R03	IR	0254-0259	1:24,000	1.7 (RP)
3/15/2004	1442-1448	0419R03	IR	0260-0272	1:24,000	2.6 (NB)
3/15/2004	1456-1457	0419R03	IR	0273-0276	1:24,000	1.4 (PH)
3/15/2004	1542-1545	0419R03	IR	0283-0289	1:24,000	2.4 (NB)
3/23/2004	1931-1937	0419R04	IR	0417-0450	1:24,000	1.7 (PH)
4/18/2004	1853-1857	0419R05	IR	0471-0482	1:24,000	2.5 (NB)
5/6/2004	1847-1849	0419R06	IR	0506-0511	1:24,000	1.8 (MH)
5/11/2004	1544-1626	0419R06	IR	0512-0552	1:24,000	0.1 (RP)
10/8/2004	1436-1438	0419R07	IR	0554-0559	1:24,000	1.7 (PH)
10/10/2004	1432-1434	0419R08	IR	0560-0563	1:24,000	1.6 (MH)
10/12/2004	1453-1541	0419R08	IR	0564-0627	1:24,000	1.7 (RP)
10/12/2004	1547-1701	0419R09	IR	0628-0703	1:24,000	1.8 (MH)
11/15/2004	1633-1700	0419R10	IR	0711-0742	1:24,000	0.0 (NB)
4/28/2005	1416-1421	0519R03	IR	0260-0270	1:24,000	0.0 (RP)
6/23/2005	1440-1448	0519R04	IR	0278-0294	1:24,000	0.0 (PH)
6/23/2005	1502-1506	0519R04	IR	0295-0301	1:24,000	0.1 (NB)

* Tide levels are given in meters above MLLW and are based on actual observations recorded by NOS gauges at the time of photography. The mean tide range for the project area varies from 1.7 to 2.5 meters. The specific gauges used to determine tidal heights within this project are (1) Reedy Point (**RP**), C & D Canal, Delaware, (2) Marcus Hook (**MH**), Pennsylvania, (3) Philadelphia (**PH**), Pennsylvania, and (4) Newbold (**NB**), Pennsylvania.

Final Review

A TMSI team completed the final review in March 2007. The GC was evaluated for completeness and accuracy. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of cartographic features 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 GIS 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:

- 12312 Delaware R., Wilmington to Philadelphia, 1:40,000, 53rd Ed., Feb./05
- 12313 Delaware R., Philadelphia and Camden Waterfronts, 1:15,000, 50th Ed., Jul./04

End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

RSD Applications Branch Project Archive:

- Hard copy of Airborne Positioning and Orientation Report
- Hard copy of Aerotriangulation Report
- Hard copy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10625 file contents

RSD Electronic Data Library:

- Project database
- GC10625 in shapefile format
- Digital copy of the PCR in Adobe PDF format

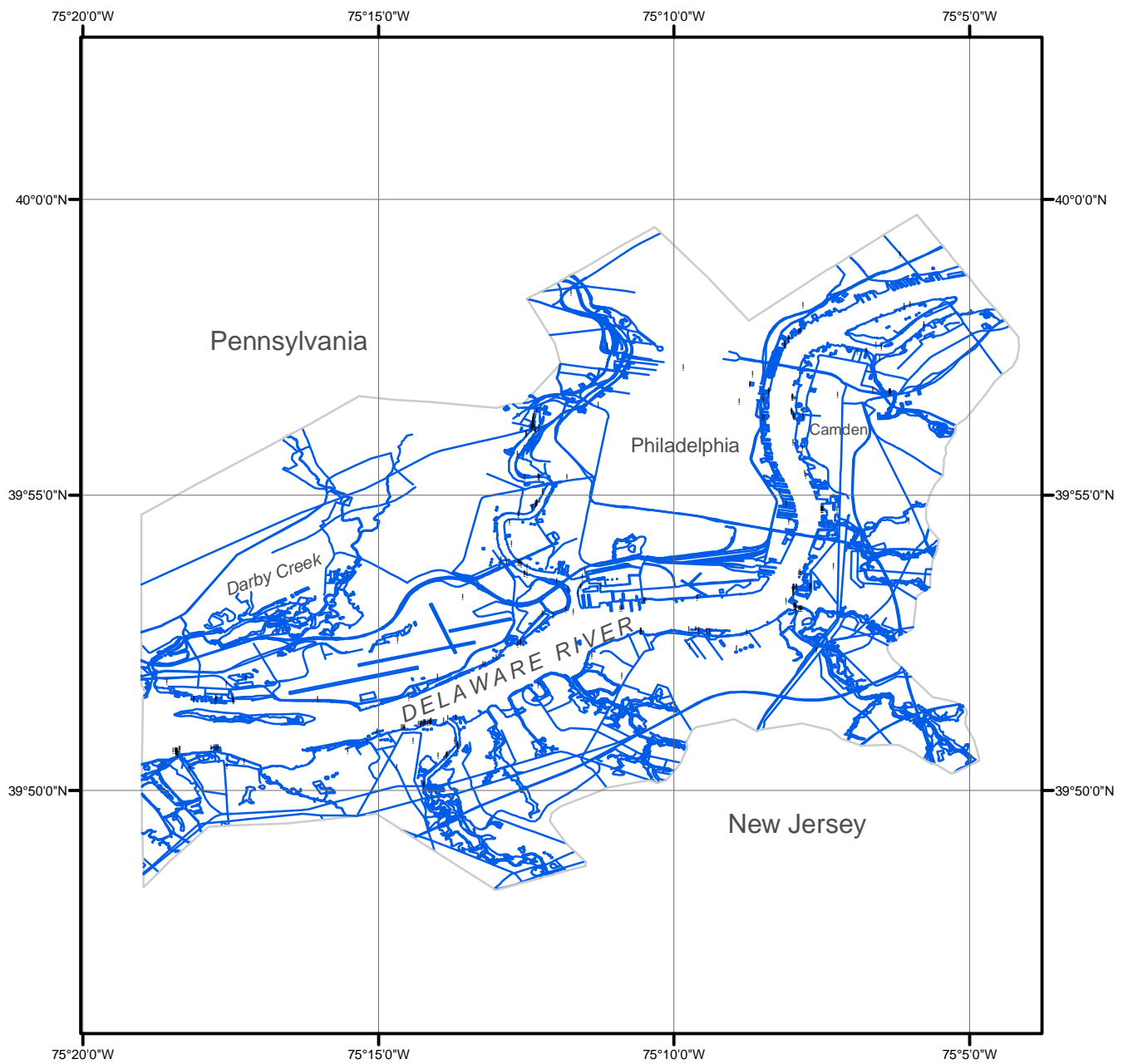
NOAA Shoreline Data Explorer:

- GC10625 in shapefile format
- Metadata for GC10625
- Digital copy of the PCR in Adobe PDF format

End of Report

DELAWARE RIVER, DARBY CREEK TO PHILADELPHIA

PENNSYLVANIA & NEW JERSEY



Overview



NJ0301C

GC10625