

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

## ***PROJECT VA0602D***

### ***Pamunkey River, Virginia***

#### **Introduction**

The Coastal Mapping Program (CMP) Project VA0602D provides coastal mapping for the Pamunkey River in Virginia from West Point to a location just upriver from U.S. Route 360, including detailed digital mapping of the Mean High Water Line (MHW), Mean Lower Low Water Line (MLLW), and other coastal features. VA0602D is a subproject of a larger project VA0602, which also includes the Mattaponi and York Rivers.

Successful completion of the 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 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 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**

All work performed under this task order adhered to the Shoreline Mapping SOW 13B dated January 2008. The Shoreline Mapping SOW 13B provided guidance for all stages of acquisition, processing, and collection of data necessary to complete this task order. The initial project layout, flight lines, and waypoint files were developed by NGS and provided to Woolpert for completion of this task order. Shapefiles for project delivery areas were provided by NOAA to Woolpert.

#### **Field Operations**

Field operations consisted of tide gauge installation, ground control survey activities, and acquisition of aerial photographs. Prior to aerial acquisition, Woolpert installed an Aquatrak tidal gauge on the Pamunkey River to assist in tidal monitoring. The tidal gauge location and height was surveyed in and tied into local monumentation. The tide gauge was surveyed at installation, at 6 month intervals during aerial acquisition, and upon removal of the sensor to account for any possible movement of the sensor due to flooding, ice flow, or other natural or manmade events.

Woolpert surveyed in a total of 19 control points for the project (13 control points plus an additional 6 QC points within the project area.) Due to the length of time for acquisition, many targets needed to be refreshed during the acquisition period due to removal, destruction,

or fading. In some cases photo identifiable points were used due to target destruction/removal immediately prior to acquisition. Additional information on survey control can be found in the Photogrammetric Ground Control Report for this project.

Aerial photography acquisition for VA0602 was completed September 24, 2007 through July 3, 2008. All photographs were acquired with a Leica RC30 camera mounted in a Piper Navajo aircraft (N423AC). The airborne collection took place over 14 total flight dates within the proper tidal windows. The sessions occurred on the following dates:

<u>Month/Day</u>	<u>Year</u>
September 24, 25, 29, 30	2007
October 12, 13, 15	2007
April 16, 17, 18	2008
May 7, 29	2008
June 9	2008
July 3	2008

Acquisition occurred at a scale of 1:30,000 with a forward overlap of 60% and average side lap of 30%. A total of five (5) flight lines were acquired for each BWIR MLLW, BWIR MHW, and Color. Overall there were 1072 exposures: Approximately 390 each of MLLW and MHW BWIR photographs, and 291 Natural Color photographs; though not all were used.

All aerial photography was tide coordinated. All computations were performed as per the NOAA Special Publication: *Computational Techniques for Tidal Datums Handbook*, September 2003 and Attachment J of the SOW: *Tide Coordination Requirements* Version 1, September 30, 2004. The Tidal datum for the subordinate station at the Pamunkey Indian Reservation was computed by Tide By Tide Analysis (TBYT) using the Modified Range Ratio – Semidiurnal Tides method. Predictions of the MHW and MLLW Tide Window for Tide Coordination were performed by SEAS under the direction of NOAA personnel using the preferred programs: *Tide8+*, Nobeltec's *Tides & Currents* and the Naval Observatory's Sun Angle Calculator and prescribed methods.

## **GPS Data Reduction**

The aerial imagery was collected while recording dual-frequency Airborne GPS data time-stamped with the exposures of the camera. The ABGPS configuration in the aircraft consists of Applanix POS AV model 5.10 to collect the ABGPS events. The ABGPS data was pre-processed utilizing POSPAC 4.4 and post processed utilizing GrafNav to resolve the photo center coordinates of each image.

GPS data was processed to provide accurate positions of camera centers for application as photogrammetric control in the aerotriangulation phase of the project, and the results from the ABGPS processing can be found in the VA0602 Airborne Positioning and Orientation report. However, for this project Woolpert did not utilize the ABGPS solutions because it was found to have a significant level of error versus the ground control. Error was not consistent and could not be attributed to incorrect datum or a standard shift. ABGPS for several of the missions was re-run with the same results. Receivers and GPS equipment, at the time of this report were checked and found to have no issues. For further information on this issue, please refer to the VA0602 Triangulation Report, section ABGPS.

## **Aerotriangulation**

Aerotriangulation for this project was performed using a softcopy photogrammetric workstation to build the network of control for the compilation phase. Digital scans of the project photography were triangulated as three separate blocks. The first block was the natural color images at a scale of 1:30,000. The second block was the MHW B&W IR images at a scale of 1:30,000. The third block was the MLLW B&W IR images at a scale of 1:30,000.

The softcopy workstation consisted of a HP Workstation with Windows XP Professional OS with stereo viewing capability. BAE Systems SOCET SET v5.4.1 Domestic softcopy photogrammetry suite was used for the project setup and mensuration. The AT adjustment was performed using ORIMA v9.20a, a bundle block adjustment software from Leica. All the pass points were measured manually on the images by a Woolpert technician. Woolpert uses the SOCET SET APM module with a manual strategy since most automatically measured points need to be moved. After all the pass points for a block were measured, the ground control and the QC points were measured.

The Horizontal Accuracy Statement below is based on the circular horizontal accuracy of adjusted points in the aerotriangulation solution. This circular accuracy equals the radius of the 95% confidence circle as calculated from the horizontal (x and y) root-mean-square (RMS) values of the standard deviations for all triangulated ground points and is equal to 1.1 meters for all of the color images and 1.2 meters for all of the IR images. For additional information see the VA0602 Triangulation Report.

## **Compilation**

The NOAA on-site training for compilation feature extraction occurred in December 2008. Actual feature extraction production began in January of 2009. NOAA delivered shapefiles to Woolpert dividing the project area into 5 sub-areas.

- Preliminary Pilot Area
- VA0602A
- VA0602B
- VA0602C
- VA0602D

VA0602C covers approximately 50 linear shoreline miles up the Pamunkey River from the York River convergence. This sub-project was compiled using the MLLW, MHW, and the Color imagery.

Spatial data accuracies for Project VA0602D were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy at the 95% confidence level of 2.2 meters for features compiled from the color images, and 2.4 meters for features compiled from the IR images. This predicted accuracy of compiled, well-defined points is derived by doubling the circular error calculated from the aerotriangulation statistics.

Initial feature extraction for all areas occurred from January 2009 through June 2009. All compilation work performed under this task order followed the extraction methods and

features as described in Shoreline Mapping SOW 13B, dated January 2008. Digital feature extraction was completed in softcopy stereo environment using DAT\_EM Summit Softcopy systems software version 5.1, and Microstation V8. All coding and classification of features occurred within the Microstation environment as features were collected.

Below is the Data Compilation Sources Table which includes descriptive information at the time the imagery was acquired for VA0602D:

Date	Time (UTC)	Roll Number	Strip #	Photo Numbers	Scale (nominal)	Tide Level*
<b>Color</b>						
16-Apr-2008	20:10 – 20:12	0827CN01	30-004	0022 – 0026	1:30,000	0.1 – 0.0
16-Apr-2008	20:28 – 20:31	0827CN01	30-003	0050 – 0058	1:30,000	0.1 – 0.0
16-Apr-2008	20:54 – 21:01	0827CN01	30-002	0095 – 0109	1:30,000	0.1 – 0.5
18-Apr-2008	18:27 – 18:29	0827CN02	30-001	0121 – 0124	1:30,000	N/A †
07-May-2008	14:43 – 14:49	0827CN03	30-001	0126 – 0136	1:30,000	0.1 – 0.3
<b>Black &amp; White Infrared – MLLW</b>						
25-Sep-2007	19:10 – 19:12	0728R05	30-003	0572 – 0576	1:30,000	N/A †
25-Sep-2007	19:54 – 19:55	0728R05	30-002	0614 – 0616	1:30,000	N/A †
12-Oct-2007	15:04 – 15:05	0728R06	30-001	0711 – 0712	1:30,000	N/A †
13-Oct-2007	14:39 – 14:40	0728R06	30-001	0726 – 0728	1:30,000	N/A †
18-Apr-2008	20:11:42	0827R03	30-003	0309	1:30,000	0.2
07-May-2008	13:30 – 13:32	0827R04	30-002	0312 – 0315	1:30,000	0.2 – 0.1
07-May-2008	15:10 – 15:14	0827R04	30-002	0355 – 0362	1:30,000	0.1 – 0.2
07-May-2008	15:18 – 15:22	0827R04	30-001	0363 – 0372	1:30,000	0.2 – 0.1
29-May-2008	18:29 – 18:30	0827R05	30-003	0449 – 0451	1:30,000	0.1
09-Jun-2008	15:03 – 15:05	0827R06	30-004	0475 – 0479	1:30,000	0.1
<b>Black &amp; White Infrared – MHW</b>						
24-Sep-2007	16:04 – 16:05	0728R05	30-002	0485 – 0487	1:30,000	N/A †
25-Sep-2007	18:10 – 18:12	0728R05	30-001	0557 – 0561	1:30,000	N/A †
16-Apr-2008	14:33 – 14:34	0827R02	30-004	0030 – 0031	1:30,000	0.8
16-Apr-2008	14:45:45	0827R02	30-003	0046	1:30,000	0.8
16-Apr-2008	15:04:37	0827R02	30-004	0055	1:30,000	0.8
16-Apr-2008	17:56 – 17:58	0827R02	30-002	0090 – 0094	1:30,000	0.9
16-Apr-2008	18:03 – 18:05	0827R02	30-001	0095 – 0100	1:30,000	0.9 – 0.8
18-Apr-2008	17:25 – 17:28	0827R03	30-003	0242 – 0247	1:30,000	0.9 – 0.8
18-Apr-2008	17:30 – 17:32	0827R03	30-002	0248 – 0252	1:30,000	0.9 – 0.8

18-Apr-2008	17:37	0827R03	30-001	0254 – 0255	1:30,000	0.9
18-Apr-2008	18:03	0827R03	30-001	0275 – 0276	1:30,000	0.9
18-Apr-2008	19:18 – 19:19	0827R03	30-002	0286 – 0287	1:30,000	0.9
03-Jul-2008	16:19 – 16:20	0827R08	30-004	0667 – 0668	1:30,000	0.7
03-Jul-2008	16:31 – 16:32	0827R08	30-003	0671 – 0672	1:30,000	0.8

\* Tide levels are given in meters above MLLW and are based on observations of a contractor installed tide gauge at Lester Manor, with time and height corrections applied to various tide zones throughout the project area. The height of the MHW tidal datum in the Pamunkey River varies between 0.91 – 0.98 meters above MLLW.

† Tide levels were not applicable for any photos acquired completely over land (outside of the tide zones), and could not be determined for the photos acquired in September-October 2007, when water level data was not available for the Lester Manor tide gauge.

## Quality Control / Final Review

Data extraction/comparison occurred on the stereo workstations using the 1:30,000 scale BWIR MLLW, BWIR MHW, and Color imagery. In addition, Woolpert downloaded the highest scale nautical charts from <http://www.charts.noaa.gov> covering the project area. Compilers brought the charts into the stereo environment as a reference behind the compiled data. The following nautical charts were downloaded and used in comparison process:

- 12244 Pamunkey and Mattaponi Rivers, 1:40,000 Scale, Feb. 24, 2001

Quality control tasks were conducted during all phases of project completion. The final QC review was completed in September 2009. 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 Microstation 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).

## 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 Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10774 file contents, attached to PCR

### Remote Sensing Division Electronic Data Library

- Project database
- GC10774 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format

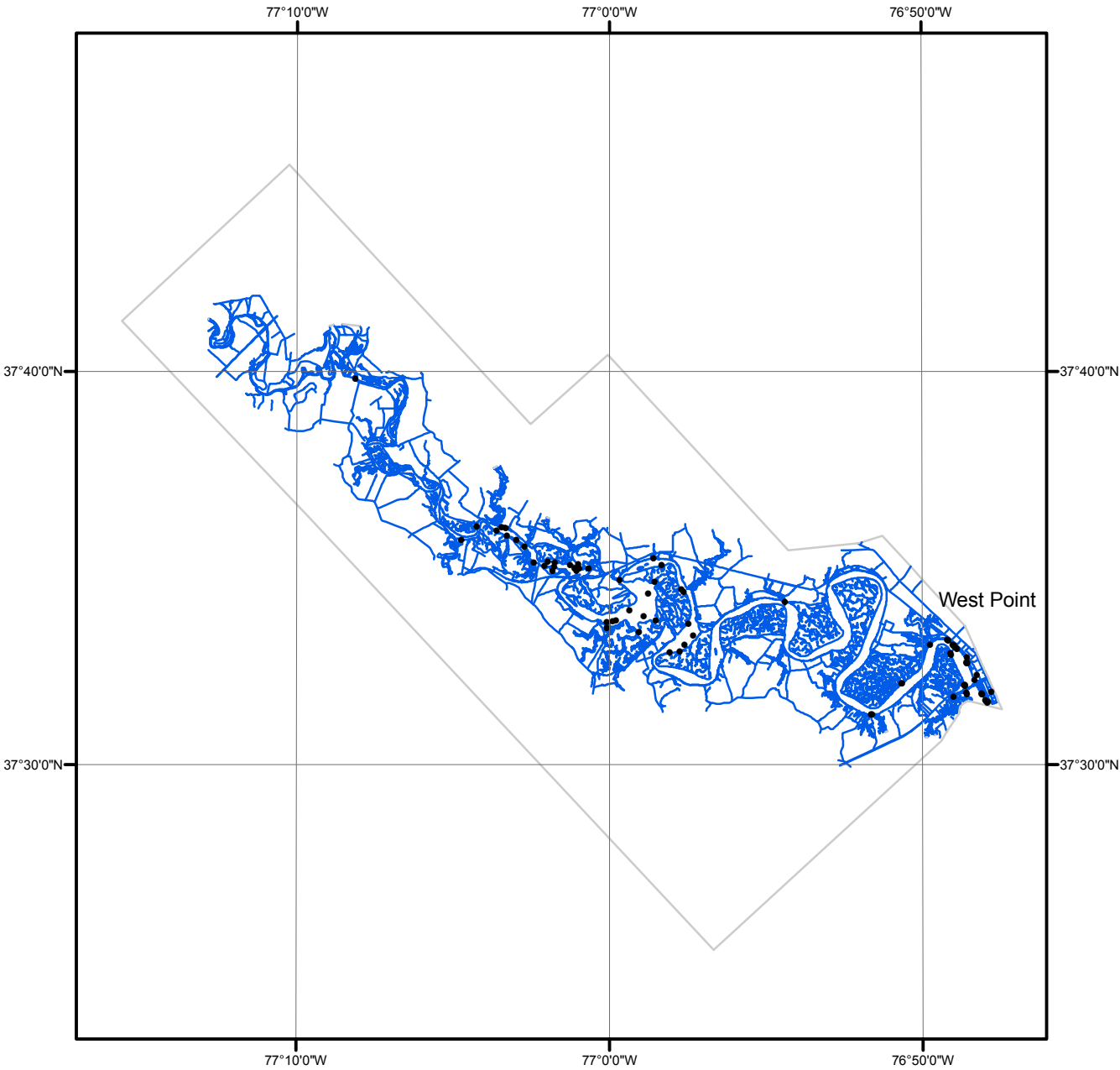
### **NOAA Shoreline Data Explorer**

- GC10774 in shapefile format
- Metadata file for GC10774
- Digital copy of the PCR in Adobe PDF format

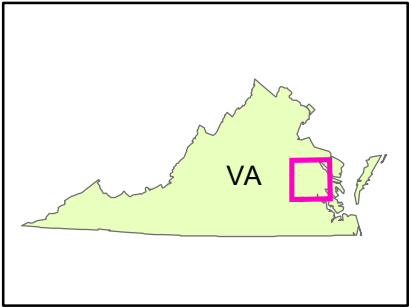
**End of Report**

# PAMUNKEY RIVER

## VIRGINIA



Overview



VA0602D

GC10774