

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT WA1206-CM-N

Seattle and Lake Washington Ship Canal, Washington

Introduction

NOAA Coastal Mapping Program (CMP) Project WA1206-CM-N provides highly accurate digital shoreline data for the port of Seattle and the Lake Washington Ship Canal, in Washington. 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 photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedure Version II. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; photographic requirements; flight line priority; Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling 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 consisted of the collection of static and kinematic Global Positioning System (GPS) data, Inertial Measurement Unit (IMU) data, and the acquisition of aerial imagery. The tide coordinated photographic mission operations were conducted on September 13 and 14, 2012 for Mean High Water (MHW) imagery and April 30, 2014 for Mean Lower Low Water (MLLW) imagery with the NOAA King Air (N68RF) aircraft. Twelve strips of color (RGB) and infrared (IR) digital images were acquired concurrently with an Applanix Digital Sensor System (DSS) 439 aerial camera at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters.

GPS Data Reduction

The GPS/IMU data was collected and processed by RSD personnel to yield precise positions and orientations of camera centers in order to provide a control network necessary for aerotriangulation. 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 kinematic GPS data was processed using Applanix POSPAC (ver. 5.4) software in September 2012 for MHW imagery and in April 2014 for MLLW imagery. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the Remote Sensing Division Electronic Data Library.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a 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 performed by RSD Applications Branch (AB) personnel in February 2015 utilizing a softcopy photogrammetric workstation. The color and IR digital images were measured and adjusted as a single block using the Multi-Sensor Triangulation (MST) module of BAE Systems SOCET SET (v 5.6.0) software. Upon successful completion of this process, the MST module provided the standard deviations for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error of 0.4 meters based on a 95% confidence level. An Aerotriangulation Report was written 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 this project was accomplished by a member of AB in May 2015. 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 SOCET SET (v 5.6.0) 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), 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.

Spatial data accuracies for Project WA1206-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 0.8 meters at the 95% confidence level. This predicted accuracy of compiled well-defined points is derived by doubling the circular error calculated from the aerotriangulation statistics.

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

Date	Time (UTC)	Color Imagery		Infrared Imagery		Tide Level*
		Roll	Images	Roll	Images	
9-13-2012	22:14 – 22:17	12NC74	27833 – 27901	12NR57	14648 – 14666	3.3 m
9-13-2012	22:22 – 22:28	12NC74	27902 – 27946	12NR57	14667 – 14711	3.2 – 3.3 m
9-13-2012	22:33 – 22:39	12NC74	27947 – 27987	12NR57	14712 – 14752	3.2 – 3.3 m
9-13-2012	22:51 – 22:54	12NC74	28002 – 28023	12NR57	14767 – 14788	3.2 m
9-14-2012	22:52 – 22:54	12NC75	28024 – 28041	12NR58	14789 – 14806	3.1 m

9-14-2012	22:58 – 23:01	12NC75	28042 – 28059	12NR58	14807 – 14824	3.2 m
9-14-2012	23:05 – 23:08	12NC75	28060 – 28079	12NR58	14825 – 14844	3.1 – 3.2 m
9-14-2012	23:13 – 23:16	12NC75	28080 – 28100	12NR58	14845 – 14865	3.2 m
9-14-2012	23:20 – 23:23	12NC75	28101 – 28116	12NR58	14866 – 14881	3.2 m
9-14-2012	23:28 – 23:29	12NC75	28117 – 28128	12NR58	14882 – 14893	3.2 m
9-14-2012	23:34 – 23:36	12NC75	28129 – 28143	12NR58	14894 – 14908	3.2 m
4-30-2014	17:36 – 17:38	14NC39	8774 – 8791	14NR32	5854 – 5871	0.2 m
4-30-2014	17:43 – 17:45	14NC39	8792 – 8809	14NR32	5872 – 5889	0.2 m
4-30-2014	17:50 – 17:52	14NC39	8810 – 8829	14NR32	5890 – 5909	0.1 m
4-30-2014	17:57 – 18:00	14NC39	8830 – 8850	14NR32	5910 – 5930	0.0 m
4-30-2014	18:04 – 18:06	14NC39	8850 – 8866	14NR32	5931 – 5946	0.0 m
4-30-2014	18:11 – 18:13	14NC39	8867 – 8878	14NR32	5947 – 5958	0.1 m
4-30-2014	18:17 – 18:19	14NC39	8879 – 8893	14NR32	5959 – 5973	0.2 m
4-30-2014	18:23 – 18:29	14NC39	8894 – 8934	14NR32	5974 – 6014	0.2 m
4-30-2014	18:33 – 18:35	14NC39	8935 – 8953	14NR32	6050 – 6033	0.2 m
4-30-2014	18:40 – 18:46	14NC39	8954 – 8998	14NR32	6034 – 6078	0.3 m
4-30-2014	20:38 – 20:41	14NC40	8999 – 9020	14NR33	6079 – 6100	0.1 m

*Tide levels are given in meters above MLLW and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations at NOS gauges. The height of the MHW tidal datum in the project area varies between 3.1 – 3.3 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in August 2015. 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 10.1 software. All project data was evaluated for compliance to CMP requirements.

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

- 18446, Puget Sound, Apple Cove Point to Keyport, 1:25,000 scale, 18th Ed., Mar. 2011
- 18447, Lake Washington Ship Canal and Lake Washington, 1:10,000 scale, 30th Ed., Sep. 2012
- 18449, Puget Sound, Seattle to Bremerton, 1:25,000 scale, 19th Ed., May 2011
- 18450, Seattle Harbor, Elliott Bay to Duwamish Waterway, 1:10,000 scale, 19th Ed., Nov. 2012
- 18474, Puget Sound, Shilshole Bay to Commencement Bay, 1:40,000 scale, 10th Ed., Jul. 2014

End Products and Deliverables

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

Remote Sensing Division Electronic Data Library

- Project database
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- GC11140 in shapefile format
- Project Completion Report (PCR)
- Chart Evaluation File in shapefile format

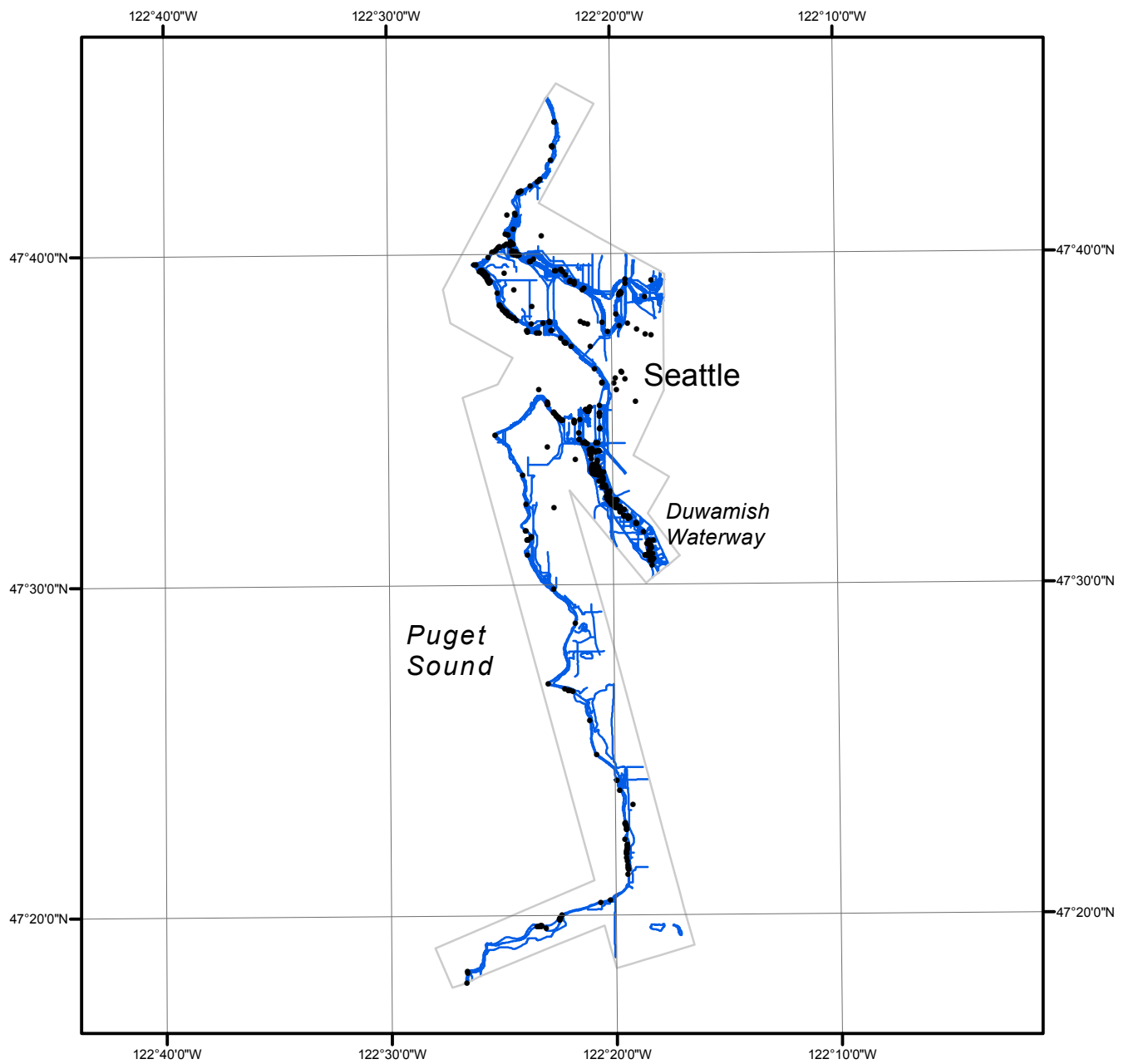
NOAA Shoreline Data Explorer

- GC11140 in shapefile format
- Metadata file for GC11140
- Digital copy of the PCR in Adobe PDF format

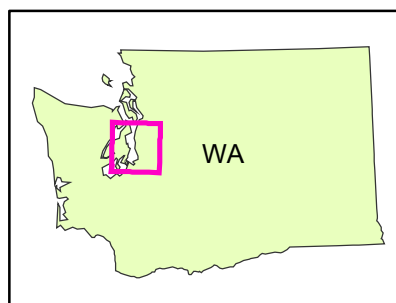
End of Report

SEATTLE AND LAKE WASHINGTON SHIP CANAL

WASHINGTON



Overview



WA1206-CM-N

GC11140