NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT CA2101A-CS-N

Port of San Francisco, California

Introduction

NOAA Coastal Mapping Program (CMP) Project CA2101A-CS-N provides highly accurate digital shoreline data for key areas of change within the Port of San Francisco, California. 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 design of Project CA2101A-CS-N was accomplished by the Requirements Branch (RB) of the Remote Sensing Division (RSD) in response to the need for timely updates to the NOAA chart suite within key U.S. ports. Project requirements were formulated as a result of analysis conducted within the Coast and Shoreline Change Analysis Program (CSCAP), in which NOAA nautical chart products are compared to contemporary high-resolution imagery in order to ascertain the need for more current shoreline data. A Chart Evaluation File (CEF) was forwarded to the Applications Branch (AB) of RSD once the change analysis was completed. Refer to the CSCAP memorandum for Project CA2103-CS-T for details of the chart comparison process.

Field Operations

The field operations consisted of collection of kinematic Global Positioning System (GPS) data and Inertial Measurement Unit (IMU) data, and the acquisition of aerial imagery. Three strips of 4-band digital images (RGB+NIR) utilized for this project were acquired with a NOAA King Air (N68RF) aircraft in August 2022 using a DSS 6150/6100 aerial camera at a nominal altitude of 10,500 feet, resulting in an approximate ground sample distance (GSD) of 0.23 meters for project imagery. Although imagery was not acquired in strict coordination with local tides, the goal was to collect all imagery below Mean High Water (BMHW).

Direct Georeferencing Data Processing

The GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (DG) of the imagery. The airborne kinematic data for project CA2101-CS-N was processed in September 2022 using Applanix POSPac MMS (ver. 8.7) software, utilizing the IN-Fusion PP-RTX processing mode, which is an implementation of Trimble's *CenterPoint RTX* GNSS correction service. For further information refer to the Airborne Positioning and Orientation Reports (APORs) on file with other project data within the RSD Electronic Data Library.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the digital aerial imagery camera centers required for digital feature extraction. The predicted horizontal accuracy of the imagery was calculated using an Exterior Orientation Total

Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level was calculated to be 0.61 meters. Stereo-models were examined in order to verify the quality of the DG data and ensure acceptable levels of parallax for mapping purposes. Additionally, at least four, independent, 3rd-order NGS control points were measured and verified in the acquired imagery.

Compilation

Data compilation was accomplished by a member of AB in December 2022. Digital feature data was compiled from the RGB imagery using ESRI's ArcGIS Pro stereo Feature Extraction software (ver. 3.0.2). Feature identification and attribution within the GC were based on image analysis of the aerial imagery and information extracted from the largest scale NOAA Electronic Nautical Charts (ENC) 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 CA2101A-CS-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.2 meters at the 95% confidence level. This predicted accuracy of compiled well-defined points is derived by doubling the imagery accuracy computed from the EO-TPU tool.

The following table provides information on the images used in the project completion:

Date	Time (UTC)	Flight Line / Images	Tide Level*
4-AUG-2022	19:16 – 19:19	62-008 / 52579 – 52593	0.7 m
4-AUG-2022	19:23 – 19:26	62-007 / 52594 – 52608	0.7 – 0.8 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 from various NOS gauges in the vicinity of the project. The elevation of the MHW tidal datum in the project area ranges between 1.63 – 1.97 meters above MLLW.

Quality Control / Final Review

The final review of the project was completed by senior CMP personnel in December 2022, and included analysis of DG 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 ESRI's ArcGIS Pro software. All project data was evaluated for compliance to CMP requirements.

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
- CSCAP evaluation memorandum
- Airborne Positioning and Orientation Report (APOR)
- Project database
- Project Completion Report (PCR)
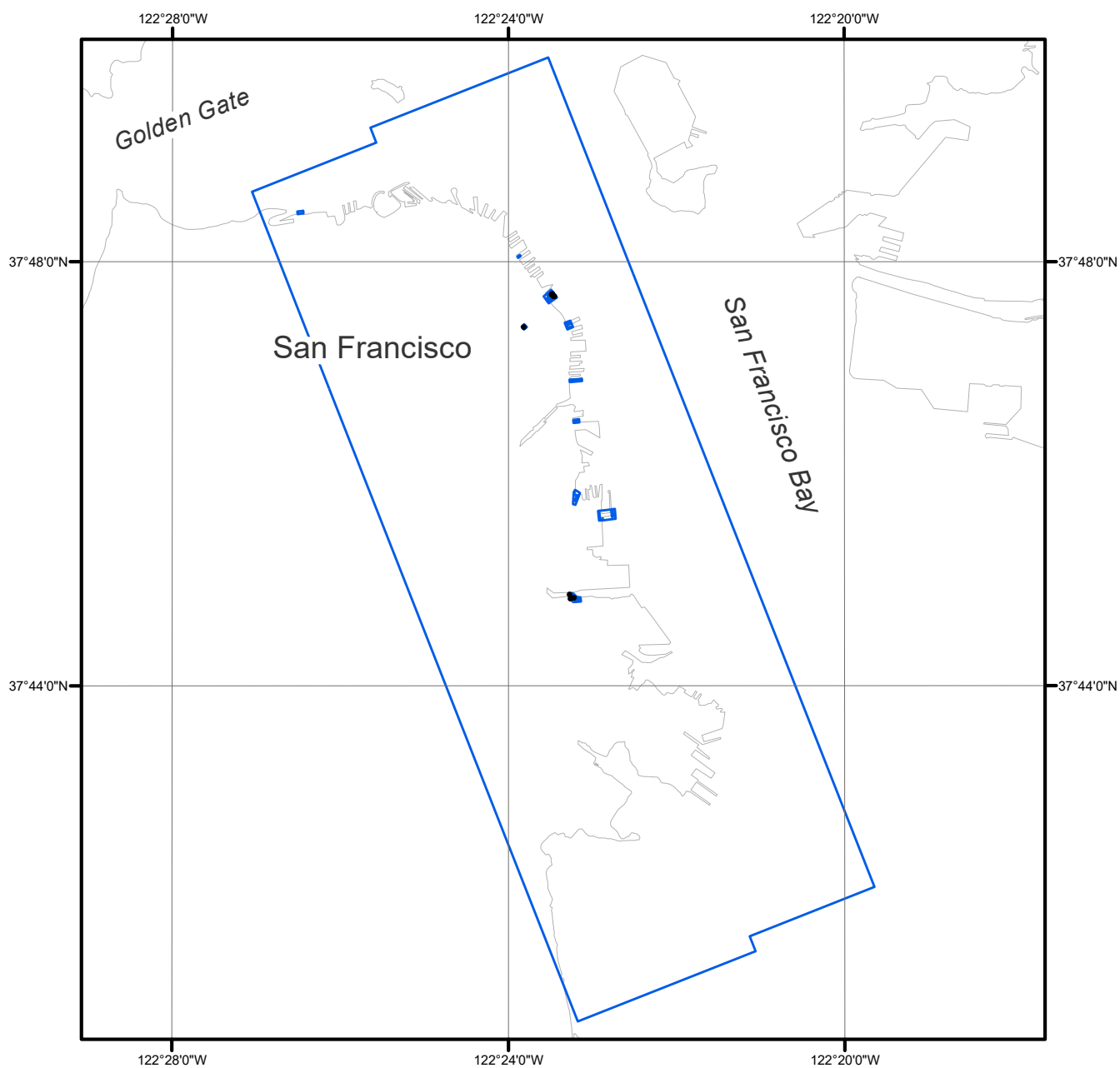- GC11896 in shapefile format
- CEF in shapefile format

NOAA Shoreline Data Explorer
- GC11896 in shapefile format
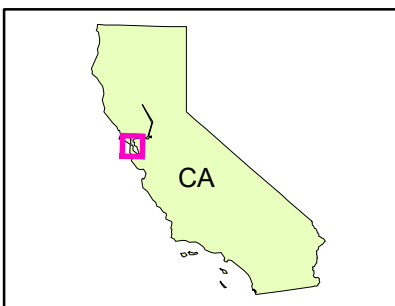- Metadata file for GC11896
- PCR in Adobe PDF format

End of Report

PORT OF SAN FRANCISCO

CALIFORNIA

122°28'0"W 122°24'0"W 122°20'0"W

Golden Gate

San Francisco

San Francisco Bay

37°48'0"N

37°44'0"N

122°28'0"W 122°24'0"W 122°20'0"W

Overview

CA

CA2101A-CS-N

GC11896