NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT
PROJECT GA0205
JEKYLL ISLAND, GEORGIA TO FERNANDINA BEACH, FLORIDA
SOUTHEASTERN GEORGIA COAST

Introduction

Coastal Mapping Program Project GA0205 requires that Western Air Maps, Inc. and its affiliated production team members work together to produce all of the required components needed for constructing an accurate feature database of new digital shoreline data covering the area from near the southern end of Jekyll Island, Georgia to Fernandina Beach, Florida, including St, Andrews Sound, Jekyll Sound and the Cumberland River and Sound.

The design of project GA0205 encompasses the SOW requirements and special instructions that NOAA set forth for the project area. The project addresses NOAA's need for aerial acquisition of tide coordinated black and white infrared and natural color photography of the project area. Successful completion of project GA0205 resulted in the densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and a Digital Cartographic Feature File (DCFF) of the coastal zone which meets the requirements of the NOAA CMP.

The project database is comprised of elements that were extracted and measured from aerial photographs and other data related to photogrammetric compilation. The feature database produced at Western Air Maps was compiled using softcopy photogrammetry as well as cartographic and GIS methods. The project survey data is referenced to the North American Datum of 1983.

Project Design

Project instructions for Project GA0205 were received from NOAA's Remote Sensing Division on March 11, 2002. These instructions outlined the purpose of the project and the geographic area of coverage for the project. The photographic requirements for the project include the need to acquire tide coordinated photography, GPS data collection procedures, guidelines for ground control surveys, data recording, reporting and handling instructions, and contact and communication information. Western Air Maps, Inc. personnel prepared a comprehensive work plan designed to address specific project requirements based on NOAA's project GA0205 instructions, NOAA's standard SOW general specifications, NOAA provided nautical charts, and NOAA provided tide coordination time windows for the period April 1, 2002 to October 31, 2002. Additional tide coordination time windows for periods through January 2003 were requested and provided to Western Air Maps, Inc. for the purposes of project planning. Western Air Maps, Inc. submitted a work plan and flight maps to NOAA for approval. Western Air Maps, Inc.'s work plan initially assigned Air Photographics, Inc. the responsibility of acquiring the aerial photography and Metro Engineering and Surveying Company Inc. the responsibility of conducting the ground control survey. Western Air Maps Inc. was responsible for softcopy aerotriangulation utilizing ground control and airborne GPS data, as well as for the initial map compilation and

attribution of the interim shape files. BAE Systems ADR had the responsibility for quality control review and validation of the aerotriangulation results, for conversion of Western Air Maps initial map files into SOCET SET files for NGS review, for applying any NGS changes to the mapping and for consolidating the shape files and migrating the attribution of the interim shape files to the C-COAST attribution schema and delivering these final files to NGS. Western Air Maps, Inc. would be responsible for preparing the final Project Completion Report. NOAA approved the tentative work plan and the flight maps in the fall of 2002.

NOAA conducted an on-site project kickoff meeting in Overland Park, Kansas, in which NOAA representatives spent time briefing the participants. Western Air Map's, Ocean Surveys and BAE Systems ADR personnel participated in person, while Metro Engineering and Surveying Company, Inc. and Air Photographics, Inc. personnel participated in the briefing via conference call.

Field Operations.

Western Air Maps, Inc. conducted a survey and aerial photography acquisition planning meeting via conference call between Western Air Maps, Inc., Metro Engineering and Surveying Company, and Air Photographics, Inc., to plan and develop an initial production schedule and to coordinate surveying and aerial photography activities for the project. A Western Air Maps, Inc. representative was at the project location to monitor the subcontracted team members to ensure all pre-flight survey duties were completed and ABGPS base station locations were coordinated between Metro Engineering and Surveying Company and Air Photographics, Inc.

Prior to the aerial photographic missions Western Air Maps, Inc. selected the necessary control point network. The primary project control network originated from two first-order horizontal and vertical points, with one base station occupying NGS Monument "Q199" and the other base station occupying a photo point named "Dover ALT". Metro Engineering and Surveying Co., Inc. used five Trimble 4000 SSE and two 4000 SSI dual frequency receivers while conducting the GPS survey. Metro Engineering and Surveying Co., Inc. used two GPS receivers as base stations. Metro Engineering and Surveying Company was responsible for the generation and maintenance, while in the field, of NGS Station Description/Recovery Form (DR Form), photographs of each permanent mark and panel set, NOAA Form 76-53 for each panel, Visibility Obstruction Diagrams, and GPS Observation Logs being prepared during this phase of the project. Metro Engineering and Surveying Co., Inc. used Trimble Geomatics Office, version 1.01 to process and adjust the GPS data and produce final values for the photo points. Data was imported into Trimble Geomatics Office (ver. 1.01) where each data file for each point was reviewed by comparing the antenna heights, antenna types, and start and end times to the field GPS Station Observation Logs. After each GPS file and point was edited, the data was processed using a Broadcast Ephemeris and each baseline was solved as an Ion Free Fixed Solution. See the GA0205 Ground Control Survey Report for additional details regarding the conduct of the survey and the QA/QC methodology employed to verify the ground control survey.

With a Western Air Maps, Inc. representative on site, Air Photographics, Inc. flew the natural color and MLLW black-and-white infrared photography on December 29, 2002 using a Piper Navajo aircraft which was equipped with a Wild RC-30 aerial camera equipped with forward motion compensation and stabilized camera mount. Air Photographics, Inc. flew the MHW black-and-white infrared photography on January 8, 2003. Air Photographics, Inc. produced near vertical, metric quality, tide-coordinated, kinematic Global Positioning System (GPS) positioned, aerial photography exposed along WAM defined flight lines covering the project area. Accurate

flight line navigation was maintained using an Accunav V5A GPS flight management system. Airborne kinematic GPS data was collected during the natural color and MLLW aerial photographic flights, but airborne kinematic GPS data was not collected during the MHW mission because the GPS unit malfunctioned and failed to record data. Novatel dual frequency GPS receivers were utilized both in the aircraft and at the ground stations. Air Photographics, Inc. maintained the tidal-coordinated flight schedule that WAM derived from the NGS supplied tidal tables. All photography was acquired using Air Photographics, Inc. Wild RC-30 camera at an altitude of approximately 15,000 feet for a nominal photo scale of 1:30,000. Photographic coverage, resolution, photo overlap, and metric quality were adequate for the performance of the aerotriangulation phase.

The following is a summary of film types, filters, altitude, and negative scales produced for each type of aerial photographic flight:

Color photography of the entire project area was acquired with Kodak Aerocolor Negative Film 2445 utilizing a 420 nanometer filter at 15,000' AMT, 1:30,000 negative scale on December 29,2002. Black and White Infra-Red photography of the tidal basin areas at MLLW and MHW tidal stages were acquired using Kodak Black & White Infra-Red (IR) Film 2424 utilizing a 705 nanometer filter at 15,000' AMT, 1:30,000 negative scale. The MLLW black-and-white infrared photography was flown on December 29, 2002, while the MHW black-and-white infrared photography was flown on January 8, 2003.

All film that was exposed was sent to NOAA's film processing contractor, HAS. The film, upon NOAA's acceptance, was scanned at 16 microns and delivered to Western Air Maps via DVD.

GPS Data Reduction

GRAFNAV was used to compute the coordinates of the camera nodal for each exposure. This was accomplished by computing the aircraft's antenna position every one half of a second. The position of each photo is then interpolated between the adjacent half second interval positions. GRAFNAV scans the entire data set and determines the best section of data to solve the integer ambiguities. The software then solves the remainder of the data and recomputes the ambiguities when necessary. The software computes the forward and backward solution and will combine the two solutions to provide an optimal final solution. Base station static processing utilized OPUS processing to locate the final positions of the base stations. Final post processed files were reformatted and used in Intergraph's ISAT and inpho's PATB bundle adjustment software packages for aerotriangulation processing. See Airborne Positioning and Processing Report for further details on the reduction and processing of the ABGPS data.

Aerotriangulation

Four strips of color photography, consisting of 78 photos flown December 29, 2002 were triangulated during the first phase of the project. The natural color photography was not tide coordinated. Also, eleven strips of BW IR photography, consisting of 63 photos flown December 29, 2002, were triangulated for the MLLW mapping. Eleven strips of BW IR photography, consisting of 64 photos flown January 8, 2003 was triangulated for the MHW mapping. The flight line configurations of both sets of BW IR photography were nearly identical, but differ from the flight line configuration of the color photography.

Airborne GPS data was used to determine photo centers for the color and MLLW BW IR photo

missions. The airborne GPS data collection failed during the MHW BW IR photo mission, so no photo center determinations could be made.

The color photography triangulation included 11 ground control points (nine targeted, two photo-identifiable) and five 'check' points. The MLLW BW IR and MHW BW IR triangulations included 10 ground control points (nine targets and one photo-identifiable) and two 'check' points. Because of the loss of the airborne GPS control, and the difficulty of seeing some of the targeted ground control, 28 photo-identifiable locations were brought over from the color photography aerotriangulation solution as additional X, Y and Z control. The control was considered adequate for the aerotriangulation and map compilation. The aerotriangulation for the color, MHW BW IR and MLLW BW IR photography was performed using images scanned at 16 microns to establish the network of control required for the mapping phase. The color photography was triangulated first to provide the supplemental photo-identifiable control for the two BW IR blocks. Z/I Imaging's ISAT AT software operating on an SSK Pro workstation was used for the automatic tie point generation and manual measurements of additional tie points and ground control points. The bundle adjustments were performed with Inpho's PATB-NT software (version 1.2.164). This software creates orientation files in ASCII format which can be directly imported into the SOCET SET Version 4.4.2 environment. The values from each of the three adjustments were used to compute a predicted horizontal circular error of 0.3 meters for the color photography and 0.4 meters for both MHW and MLLW adjustments. All three aerotriangulation adjustments and all output files are in NAD 83, NGVD 88, UTM zone 17, meters.

The SOCET SET project database consists of software parameters and options specific to the project, camera calibration data, interior orientation parameters, airborne GPS antenna position, offset data, adjusted exterior orientation parameters, and positional listings of all measured points. Positional data is based on the North American Datum 1983, and is referenced to Zone 17 North of the UTM Coordinate System. BAE Systems ADR conducted extensive QA/QC validation of Western Air Maps, Inc. aerotriangulation results for each aerial photography mission. BAE's rigorous QA/QC methodology validated Western Air Maps, Inc.'s aerotriangulation results. Refer to GA0205 Aerial Triangulation Report for further discussion of AT methodology, results and QC validation information.

Compilation

Upon completion of NOAA's on-site compilation training, Western Air Maps, Inc. began photogrammetric compilation of shoreline mapping in a pilot project area that extended from Kings Bay (to the North), and to Fernandina Beach (to the South) using SOCET SET Version 4.4.2 photogrammetric compilation software. Feature identification and the assignment of cartographic codes was based on image analysis of 1:30,000 scale natural color photographs. In addition, Western Air Maps, Inc. compilation specialists confirmed the identity of coast line features from the appropriate NOAA Nautical Charts, US Coast Guard Light List and US Geological Survey quadrangles covering the project area. Western Air Maps, Inc. used SOCET SET software and a softcopy workstation in order to be able to provide NOAA with SOCET SET feature databases as the interim deliverable instead of delivering interim ESRI shapefiles as outlined in the original work plan. By using NOAA's SOCET SET specification file, Western Air Maps, Inc. greatly increased the accuracy of the feature attribution at the time that the shoreline features were compiled. By using the NOAA SOCET SET specification file, 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.

In order to expedite the chart maintenance markup task, Western Air Maps, Inc. scanned NOAA nautical charts 11502 Doboy Sound to Fernandina, 1:80000, 29th Edition, 11503 St. Marys Entrance, 1:25000, 39th Edition, and 11504 St. Andrew Sound and Saltilla River, 1:40000, 15th Edition, which covered the project area, and georeferenced the charts so that they could be used as a backdrop to the aerial photography that was being used to compile the shoreline features. Having the nautical charts as a backdrop greatly aided the stereo compilers by providing a reference that could be used to help interpret the features that were being compiled from the aerial photography. Conversely, having the aerial photography and the shoreline feature database vectors overlaid onto the chart greatly aided in the chart maintenance markup task. Both the shoreline feature compilation and the chart maintenance markup task could be performed almost simultaneously and required that each stereo model only be called up and drawn in one time. Once the pilot project was completed it was sent to BAE Systems ADR for QA and QC review. The pilot project was then returned to Western Air Maps, Inc. for cleanup and was then submitted to NOAA for review and comment. NOAA cartographers did find some problems with the way some features were collected in the pilot project and conducted a follow-up QC/QA training session at Western Air Maps, Inc. office, in which a NOAA cartographer pointed out the errors that had been made in the pilot project and reviewed what corrections needed to be made to the existing mapping in the pilot project area prior to completing compilation in the remainder of the project area. Western Air Maps, Inc. finished data collection of the remainder of the project area and merged this mapping with the pilot Project mapping prior to submittal to NOAA as an interim deliverable for QC/QA review. NOAA pointed out that there were some areas within the project limits that had not been mapped as NOAA expected and it was determined that due to some confusion caused by some NOAA nautical charts that were marked up with certain work limits, the BW IR photography was incomplete in these areas and would have to be filled in as best they can be done using the natural color photography. Once these areas of concern were completed, the mapping was diligently reviewed with the on-line review consisting of reviewing stereo models with a SOCET SET softcopy workstation, reviewing the map features to ensure that the proper cartographic feature codes had been used for map feature attribution, and to check and validate the positional accuracies of digital map features prior to release of the SOCET SET feature database for data conversion, data transformation and GIS editing.

Cartographic features were compiled to meet a horizontal accuracy of 0.6 meters using the natural color photography at the 95% confidence level and 0.8 meters using the black and white infrared film from both the MLLW and MHW photographic missions. This predicted accuracy of compiled, well defined points is derived by doubling the circular error derived from aerotriangulation statistics. The values from each of the three aerotriangulation adjustments were used to compute a predicted horizontal circular error of 0.3 meters for the color photography and 0.4 meters for both MHW and MLLW adjustments.

The following provides information on aerial photographs used in the project completion process:

Date of Acquisition	Time (GMT) of Acquisition	Roll Number	Film Type	Photograph Numbers	Scale (Nominal)	Stage of Tide
12-29-02	16:43 to 16:55	0212CN01	NC	0001 thru 0022	1:30,000	0.1m
12-29-02	16:58 to 17:09	0212CN01	NC	0023 thru 0044	1:30,000	0.2m
12-29-02	17:11 to 17:33	0212CN01	NC	0045 thru 0088	1:30,000	0.3m
12-29-02	15:21 to 16:05	0212R01	BW/IR	0001 thru 0042	1:30,000	-0.2m
12-29-02	16:09 to 16:18	0212R01	BW/IR	0043 thru 0052	1:30,000	-0.1m
12-29-02	16:22 to 16:31	0212R01	BW/IR	0053 thru 0067	1:30,000	0.0m
01-08-03	15:46 to 16:01	0312R01	BW/IR	0001 thru 0014	1:30,000	1.1m
01-08-03	16:05 to 16:17	0312R01	BW/IR	0015 thru 0027	1:30,000	1.2m
01-08-03	16:30 to 16:51	0312R01	BW/IR	0028 thru 0047	1:30,000	1.3m
01-08-03	16:54 to 17:16	0312R01	BW/IR	0048 thru 0069	1:30,000	1.4m

The "Stage of Tide" is referenced to MLLW. The range of tide (MLLW to MHW) is 1.89 meters. The tide range (MLLW-MHW, 1983 to 2001 Epoch) at Fernandina Beach, Fl water level station is 1.89 meters.

The SOCET SET feature database was exported into ESRI 3-D shapefiles. The shape files were then converted into a 3-D personal geodatabase using ESRI Arctoolbox software version 8.3. Using ESRI ArcMAP version 8.3, topology editing and creation rules were defined to process the data and render it topologically correct. The topological rules specified were that the data must not have dangles, must not have pseudo nodes, must not overlap, must not intersect and must not touch the interior. Using these rules, the data was then processed and the resultant errors were edited and the features were validated as being topologically correct. This process was utilized to edit and validate every arc feature type. The required QC entries in the database were added and the database fields were populated. The 3-D geodatabase was then converted into a 2-D geodatabase, this geodatebase was then coverted into 2-D shapefiles conforming to the Coastal Cartographic Object Attribute Source Table (C-COAST) specification and NOAA SOW instructions. The ESRI shapefiles were then transformed from NAD 83 UTM Zone 17N coordinate system to NAD 83 LAT/LONG geographic coordinates. All data conversion, datum transformation and editing functions were performed using ESRI ArcGIS version 8.3 tools.

Final Review.

A senior Western Air Maps, Inc. production reviewer familiar with shoreline mapping initiated the final review. The final deliverable digital cartographic feature file was thoroughly reviewed for completeness and accuracy. Additionally the data was submitted to NOAA and a Senior Cartographer conducted on-line review of the stereo models and submitted the review results to Western Air Maps, Inc for finalization of the database. Data review consisted of an on-line review of the final deliverable shape files for completeness and the associated shape file database

files for completeness of attribution to the C-COAST attribution specification. Since the chart maintenance task was also completed using digital mapping techniques, review of the chart markups was done both online by superimposition of the coast line mapping vectors with the georeferenced digital copies of the nautical charts and off-line with the review of the marked up hardcopy plots of digital nautical charts for comparison versus the NOAA supplied nautical charts. Western Air Maps, Inc. personnel used NOAA charts 11502 Doboy Sound to Fernandina, 1:80000, 29th Edition, 11503 St. Marys Entrance, 1:25000, 39th Edition, and 11504 St. Andrew Sound and Saltilla River, 1:40000, 15th Edition were used for off-line review. The cartographic feature attribution was reviewed by both the Western Air Map's GIS Manager and by Western Air Map's Lead Cartographic Finisher and judged to conform to C-COAST specification.

Project Final Data and Products

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 GPS Processing Report
- Hard copy of Aerotriangulation Report
- Page size graphic plot of DCFF contents
- Hard copy of the Project Completion Report

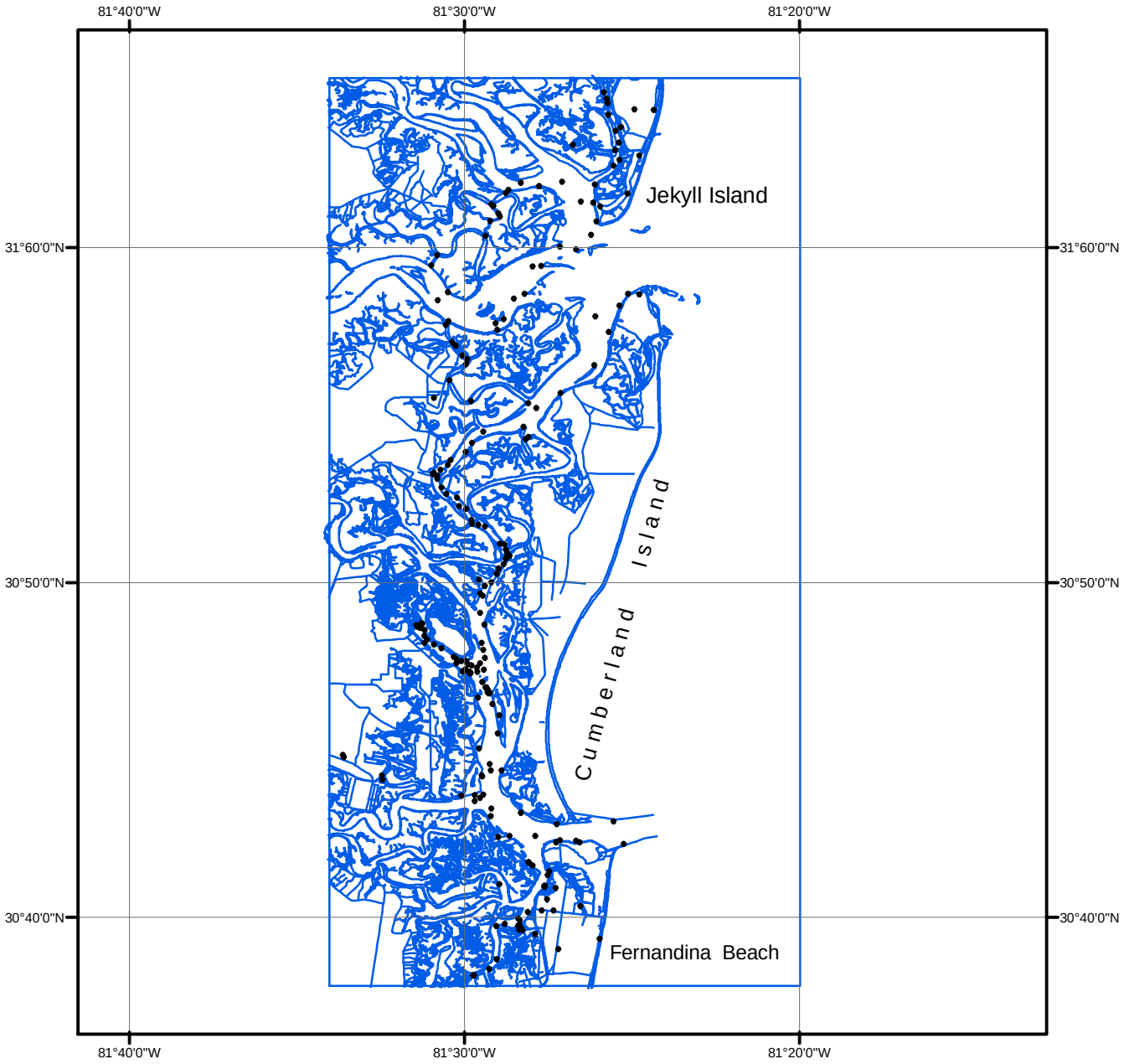
RSD Electronic Data Library:
- Project Database
- DCFF: GC10537
- Digital copy of DCFF in Shapefile format
- Digital Copy of Project Completion Report

NOAA Shoreline Data Explorer
- DCFF: GC10537
- Metadata file for GC10537
- Digital Copy of the Project Completion Report

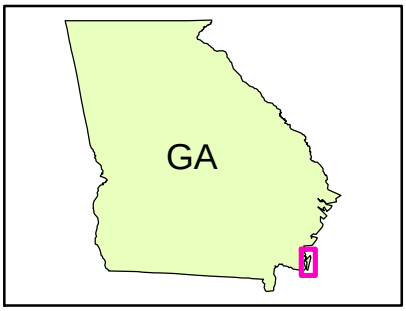
End of Report

JEKYLL ISLAND, GA TO FERNANDINA BEACH, FL

GEORGIA



Overview



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GC10537