NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT NY0401

South Shore Long Island Sound

Introduction

This project consisted of shoreline mapping in the State of New York using aerial photography and lidar. This project was located along the South Shore of Long Island Sound from Lawrence Point on the East River to Little Gull Island at the eastern end of Long Island Sound.

The project limits for NY0401 are approximately:

41º13' north latitude, 74º02' west longitude
40º41' north latitude, 74º02' west longitude
40º41' north latitude, 72º00' west longitude
41º13' north latitude, 72º00' west longitude

The area is depicted within NOAA nautical charts 12354, 12363, and 13205. The project includes planning, tide coordination, aerial imagery acquisition, lidar acquisition, ground control survey, aerotriangulation, map compilation, tide/shoreline definition, and report writing. Aerial photography and lidar acquisition was completed over the project area shoreline and used to produce shoreline mapping. Tidal observations were monitored during photography and lidar acquisition from existing tide gages using the NOAA's National Ocean Service CO-OPS web site.

The project database consists of information measured and extracted from Airborne GPS/IMU controlled aerial imagery and lidar data. Project survey data is referenced to the North American Datum of 1983 (NAD 83). Aerotriangulation was conducted in softcopy using Intergraph ISAT software. Map compilation was accomplished using Zeiss P1 and P2 Analytical Stereoplotters and a DAT/EM SUMMIT Evolution Softcopy Stereoplotter. Lidar data processing was accomplished using Optech's REALM, Terrasolid's TerraScan, and Applied Imagery's QT Modeler software. Preliminary map review was performed on Pentium 4CPU, 2GHz computer workstations using MicroStation software. The final map editing and formatting was completed using ARCMap software. Preliminary Shapefiles were submitted for NOAA's review. Review comments were incorporated into the digital files and Final Shapefiles were delivered. Lidar data was also delivered.

Project Design

AERO-METRIC, INC. designed the project. The design was based on Coastal Mapping Program Specifications for Shoreline Mapping and Project Instructions prepared by NOAA, June 14, 2004. Project Instructions were revised August 3, 2004 in accordance with contract negotiations.

The project limits were provided by NOAA on hardcopy Nautical Charts 12354, 12363, and 13205 and also in digital ArcView Shapefile format. These sources were used to depict the approximate locations of the shoreline to be mapped.

Color imagery was planned to adequately cover the land-water interface in stereo within the project area using the digital waypoint files provided by NOAA. Eight flight lines were planned at 1:30,000 scale. The flight lines were planned with 60% forward overlap and 30% sidelap between parallel strips. Imagery acquisition was planned to take place at tide stages at or below the MHW level.

The sun angle for all imagery was to be at or above 30 degrees above the horizon. Weather conditions were to be suitable for acquisition with no clouds present. Minimum visibility at the time of exposure was to be 8 miles. Flight crews were to coordinate with ground personnel who were monitoring weather conditions along the shoreline to determine if the conditions were adequate for image acquisition.

Lidar data acquisition was planned to adequately cover the land-water interface with a maximum "Mass Point" spacing of 1.5 meters. The data was to be collected at tide stages at or below the MLLW level.

Airborne GPS/IMU control was planned for the project. Base stations were to be deployed on two published geodetic control marks near the project area. In addition, GPS data was to be downloaded from CORS stations near the project area during the photographic imagery and lidar acquisition.

Four ground control/check points were to be surveyed at well-defined, photo identifiable locations evenly distributed throughout the project area for the photographic imagery. Thirty ground control/check points were to be surveyed at locations evenly distributed throughout the project area for the lidar data. These thirty-four points were to assist in orienting the lidar data and to support the aerotriangulation.

See Survey Control Report for NOAA, South Shore Long Island Sound, NGS Project No. NY0401, dated May 2, 2005. (Revised July 27, 2005.)

See Aerial Photography Report, South Shore Long Island Sound, NGS Project No. NY0401, dated August 4, 2005.

See Lidar Report, South Shore Long Island Sound, NGS Project No. NY0401, dated April 14, 2006.

See Airborne Positioning and Orientation for Aerial Photography Report, South Shore Long Island Sound, NGS Project No. NY0401, dated January 24, 2005.

See Airborne Positioning and Orientation for Lidar Report, South Shore Long Island Sound, NGS Project No. NY0401, dated January 24, 2005.

See NY0401 South Shore of Long Island Sound, NOAA Aerotriangulation Report, dated July 2005 (Revised December 2005).

Field Operations

Field Operations – Aerial Photographic Imagery

Photographic imagery for NY0401 was obtained on two dates. All lines (lines 1 through 8) were originally acquired on October 28, 2004, but once the photography was reviewed, lines 1 through 4 were later rejected due to sun angle tolerances exceeded. On March 22, 2005 these 4 lines were re-flown. The imagery for both missions was acquired with a Piper Navajo PA31-310 fixed wing aircraft. Color negative imagery was captured using a Zeiss RMK TOP 15 camera. Flight crews coordinated with ground personnel who were monitoring shoreline conditions to determine if conditions were suitable for imagery acquisition. Imagery was acquired at the nominal scale of 1: 30,000 along with the simultaneous collection of kinematic GPS and IMU positioning and orientation data. One differential base station (Station **U 325**) was deployed and used to capture simultaneous GPS data in the project area. In addition, GPS data was downloaded from two nearby CORS stations (**MOR1** and **ZNY1**) during the imagery acquisition. All base stations were observed with dual frequency GPS receivers. The number of GPS satellites tracked by the aircraft was four or more at all times and the PDOP never exceeded 7.0. The sun angle for all photography was at or above 30 degrees above the horizon. Weather conditions were clear during the flight mission. Minimum visibility at time of exposure exceeded 8 miles.

See Aerial Photography Report, South Shore Long Island Sound, NGS Project No. NY0401, dated August 4, 2005.

Field Operations – Lidar

Lidar data for NY0401 was obtained between October 28, 2004 and April 11, 2005 at a nominal altitude of 2000 meters Above Ground Level (AGL). The resulting average point density was less than the required 1.5 meters. The lidar collection sessions were all tide coordinated for tides at or below the MLLW level. October and November flight sessions were flown using a Bell helicopter owned by Richard Crouse and Associates, Incorporated. Due to the helicopter's limited fuel range and instrumentation combined with the short tide window, the December and April flight sessions were flown using a Piper Navajo fixed winged aircraft owned by AERO-METRIC. Flight crews coordinated with ground personnel who were monitoring shoreline conditions to determine if conditions were suitable for lidar acquisition. Lidar data was acquired along with the simultaneous collection of kinematic GPS and IMU positioning and orientation data. Two differential base stations (Stations **BRIDGE** and **U 325**) were deployed and used to capture simultaneous GPS data in the project area. In addition, GPS data was downloaded from two nearby CORS stations (**MOR1** and **ZNY1**) during the lidar acquisition. All base stations were observed with dual frequency GPS receivers. The number of GPS satellites tracked by the aircraft was four or more at all times and the PDOP never exceeded 3.0.

Before every data acquisition mission, the current tide heights were compared to the predicted tide heights to determine the quality of the predicted tide window. Several missions were cancelled due to higher than predicted tide stages.

Lidar data was collected along a particular flight line over tidal zones BIS44 and BIS45 (851-0560) five times during the predicted tidal windows, but none of the missions were at or below MLLW. The best attempt had BIS44 at 0.2 feet and BIS45 at 0.3 feet above MLLW. After contact with NOAA on April 29, 2005, it was determined that no further attempts of lidar acquisition would be necessary and the collected data would be accepted. This exception applied only to data "no higher above MLLW than .4ft" for tidal zones BIS41, BIS42, BIS43, BIS44, and BIS45. During an October 2005 teleconference with NOAA, it was determined that the tidal station South Jamesport was supposed to be used instead of station Montauk for tidal zones BIS30 through BIS45 (except BIS34). This change showed the new calculations to be 0.3 to 0.4 feet worse.

See Lidar Report, South Shore Long Island Sound, NGS Project No. NY0401, dated April 14, 2006.

Field Operations- Static GPS Control/Check Survey

Ground surveys for photogrammetric mapping and lidar were conducted from March 10 through March 21, 2005 by AERO-METRIC using GPS observations obtained with dual frequency GPS receivers. GPS static techniques were used to position ground check points for the lidar and photography. It was also used to established the relationship between the water level and the North American Vertical Datum of 1988 (NAVD88) for the mapping of the Mean Lower Low Water (MLLW) and Mean High Water (MHW) lines. For this reason, four Tidal Benchmarks (**AIRWAY**, **TIDAL 2 STA II 20**, **851 0560 TIDAL 8**, and **TIDAL 2 STA 18**) were directly observed.

Check points were observed twice for approximately two hours each session. Tidal Bench Marks were observed once for a minimal four-hour session. All observations were with dual frequency GPS receivers and processed relative to existing local NGS GPS control with NAVD88 orthometric heights.

Two NGS control stations (**BRIDGE** and **U 325**) were observed as base stations for the static GPS ground survey. NGS CORS data for stations **MOR1**, **NJI2**, and **ZNY1** were downloaded from the Internet for each day of the survey. In addition, COOP CORS data for station **RVDI** was downloaded for the two days (March 10 and 16) that base station **BRIDGE** was missing data. COOP CORS data for station **URIL** was downloaded for March 13 when base station **U 325** had stopped recording data prematurely. Photo ID points were surveyed near the shoreline.

A combination of the two NGS control stations (Stations **BRIDGE** and **U 325**) and two NGS CORS (**MOR1** and **ZNY1**) stations were also used to capture simultaneous GPS data for the aerial photography and lidar acquisitions.

GPS observations were made using a combination of dual frequency receivers: four Wild/Leica SR9500 receivers, two Wild/Leica SR530 receivers, and one Wild/Leica SR399 receiver. In addition, three NGS CORS and two COOP CORS base stations were incorporated into the network. They used one Ashtech Z-X receiver, one Ashtech Z-XII3 receiver, one Novatel NOVWAAS receiver, one Trimble 4700 receiver, and one Wild/Leica SR9500. Data was downloaded to laptop computers.

All of the observation files were processed using Leica - Static Kinematic Professional software (SKI-PRO), version 2.10. All input parameters were applied, HI (ARP) and type of antenna. IGS final orbits were used to process the data. The published NAD83 coordinate for one base station was used as the "seed coordinate" for processing for each session. The selected interval for processing was 5 seconds. A minimum angle of 15 degrees above the horizon was selected as the cut-off elevation for all carrier phase observations. The troposphere correction model used was the Modified Hopfield Model.

Baselines were exported out of SKI-PRO in NGS GFILE baseline vector format. These files were input into the NGS ADJUST (version 4.3) adjustment program. ADJUST was used to perform the unconstrained and final constrained adjustments of the static survey.

See Survey Control Report for NOAA, South Shore Long Island Sound, NGS Project No. NY0401, dated May 2, 2005. (Revised July 27, 2005.)

GPS Data Reduction

Airborne for Photography

During the aerial imagery missions, three GPS base stations were collecting data. One NGS base station (**U 325**) was deployed for the photo missions and two NGS CORS stations (**MOR1** and **ZNY1**) were continuously operating as part of the CORS network. The maximum range from the nearest base station used for any one session was less than 110 kilometers. The GPS trajectories had three-dimensional RMS values less than 0.08 meters.

For details regarding the deployment, collection and processing of the static GPS data see *Survey Control Report for NOAA, South Shore Long Island Sound, NGS Project No. NY0401, dated May 2, 2005. (Revised July 27, 2005.).*

The processing of the airborne positioning data was carried out using the suite of software supplied by Applanix that is collectively called POSPac. POSPac version 4.02 was used for the processing of this data set.

The raw airborne data is logged in a series of time sequential files each approximately 12.2 MB in size. The first step in the processing stream is to combine these files together and then extract them into individual data files that contain the raw GPS data, raw IMU data and camera event times. During this step the raw GPS data and the raw IMU data are checked for any lapses in data continuity.

When the data extraction is completed the next step is to process the airborne GPS data. For this project a total of two GPS trajectories were processed and then combined to create the final GPS positions for the aircraft antenna. For each base station the forward and reverse solutions were combined using a weighting scheme based upon the quality of the solution for each epoch. The combined solutions from each base station were then combined to create the final position file.

The GPS data was processed using a 10-degree elevation cutoff. The L2 frequency was utilized for kinematic ambiguity resolution as well as for ionospheric correction of the long trajectory. No satellites were rejected from the solution. The general quality of the airborne GPS trajectories was excellent. The RMS of the sensor position was less than 0.06 meters horizontally and less than 0.06 meters vertically. Most base station to aircraft vectors were processed using a fixed ambiguity solution.

The next step in the processing flow was to take the final GPS trajectory and blend this with the IMU data collected during the mission. This step is carried out using the program POSProc that is also part of the POSPac suite. The general theory behind the POSProc processing is to create a blended solution that utilizes the strengths of the two systems to create an optimum solution.

The blending of these solutions is done in three steps. First the data is processed forward in time, and then reverse in time, and finally these two solutions are blended to create the final output. The other task that POSProc does in this step is to transfer the measurements from their source to the perspective center of the camera.

The end result of the POSProc processing is an SBET (Smoothed Best Estimated Trajectory) file. This file contains x,y,z coordinates as well as roll, pitch and yaw orientation angles for every 0.005 seconds during the entire mission.

The final step in the data processing stream is to create x,y,z coordinates and roll, pitch and yaw orientation angles for the exact moment the camera shutter opened for each image. This step is carried out using POSEO. The undulations for each exposure station were calculated from Geoid03 and the final EO file was output with NAD83-UTM Zone 18 coordinates and NAVD88 elevations. Coordinates and elevations were expressed in meters. The results of this step produce a text file which can be imported to a software package for the airborne triangulation process. The reformatted form of the POSEO is contained in the Aerotriangulation Report for NY0401.

See Airborne Positioning and Orientation for Aerial Photography Report, South Shore Long Island Sound, NGS Project No. NY0401, dated January 24, 2005.

GPS Data Reduction

Airborne for Lidar

During the lidar missions, four GPS base stations were collecting data. Two NGS base stations (**BRIDGE** and **U 325**) were deployed for the lidar missions and two NGS CORS stations (**MOR1** and **ZNY1**) were continuously operating as part of the CORS network. The maximum range from the nearest base station used for any one session was less than 40 kilometers. The GPS trajectories had three-dimensional RMS values less than 0.08 meters.

For details regarding the deployment, collection and processing of the static GPS data see *Survey Control Report for NOAA, South Shore Long Island Sound, NGS Project No. NY0401, dated May 2, 2005. (Revised July 27, 2005.).*

The processing of the airborne positioning data was carried out using the suite of software supplied by Applanix that is collectively called POSPac. POSPac version 4.02 was used for the processing of this data set.

The raw airborne data is logged in a series of time sequential files each approximately 12.2 MB in size. The first step in the processing stream is to combine these files together and then extract them into individual data files that contain the raw GPS data, raw IMU data and camera event times. During this step the raw GPS data and the raw IMU data are checked for any lapses in data continuity.

When the data extraction is completed the next step is to process the airborne GPS data. For this project a combination of two or three GPS trajectories were processed and then combined to create the final GPS positions for the aircraft antenna. For each base station the forward and reverse solutions were combined using a weighting scheme based upon the quality of the solution for each epoch. The combined solutions from each base station were then combined to create the final position file.

The GPS data was processed using a 10-degree elevation cutoff. The L2 frequency was utilized for kinematic ambiguity resolution as well as for ionospheric correction of the long trajectory. No satellites were rejected from the solution. The general quality of the airborne GPS trajectories was excellent. The RMS of the sensor position was between 0.02 and 0.04 meters horizontally and between 0.04 and 0.06 meters vertically. Most base station to aircraft vectors were processed using a fixed ambiguity solution.

The next step in the processing flow was to take the final GPS trajectory and blend this with the IMU data collected during the mission. This step is carried out using the program POSProc that is also part of the POSPac suite. The general theory behind the POSProc processing is to create a blended solution that utilizes the strengths of the two systems to create an optimum solution.

The blending of these solutions is done in three steps. First the data is processed forward in time, and then reverse in time and finally these two solutions are blended to create the final output.

The end result of the POSProc processing is an SBET (Smoothed Best Estimated Trajectory) file. This file contains x,y,z coordinates as well as roll, pitch and yaw orientation angles for every 0.005 seconds during the entire mission.

The undulations for each of the 0.005-second epochs were calculated from Geoid03 and applied to the SBET file. This file can be imported to a software package for the raw lidar data processing. The SBET files for each of the lidar acquisition missions are contained in the Airborne Positioning and Orientation for Lidar Report for NY0401.

See Airborne Positioning and Orientation for Lidar Report, South Shore Long Island Sound, NGS Project No. NY0401, dated January 24, 2005.

Aerotriangulation

AERO-METRIC acquired imagery for NY0401 on October 28, 2004 and March 22, 2005. Imagery was good quality with 60% forward overlap and 30% sidelap for parallel strips. The camera used for both missions was a Zeiss RMK TOP 15 equipped with Forward Motion Compensation, serial number 145852 (lens serial number 145902), with a calibrated focal length of 153.048mm. The project area was flown at a scale of 1:30,000. The imagery acquired was color negative film. The scanned images provided by NOAA were converted to compressed jpegs at 21- micrometer resolution with a Q factor of 7 and further processed to include overviews for softcopy aerotriangulation. The current USGS calibration report for this camera was submitted to NOAA.

Aerotriangulation was conducted in soft copy using a Dell PWS670 workstation, running under Windows XP Professional, Version 2002 Service Pack 2. The Dell workstation has a 3.20 GHz Xeon CPU processor and 2 GB of memory. Z/I Imaging's Image Station Automatic Triangulation (ISAT) software was used to complete the analytical aerotriangulation. Point matching was done in images along a strip, in images across strips, and in images of overlapping strips. The image coordinates from point matching were used with the airborne GPS/IMU exposures stations and ground surveyed control in the robust bundle-block adjustment, which automatically detects and removes any large point matching errors. Corrections for atmospheric refraction and earth curvature were enabled in the adjustment.

Thirty-four surveyed ground points were measured and used as vertical control in the aerotriangulation. Four surveyed ground points were measured and used to check the horizontal and vertical accuracy of the aerotriangulation.

Analysis of the bundle adjustment with the thirty-four vertical control points unweighted, the four check points unweighted and the ABGPS weighted, indicated a vertical bias for the ABGPS elevations for the photos taken 3/22/05 (strips 1-4) covering the east part of Long Island. There was no vertical bias indicated for strips 5 thru 8 taken 10/28/04 covering the west part of the island. The ABGPS elevations for strips 1 thru 4 were indexed by +2.1 meters to provide the best vertical fit to the ground control and check points on the eastern part of the island. After this index, the RMS of the unweighted elevation residuals for the thirty-four vertical control points and four checkpoints was 0.6 meters. The vertical control points were weighted for the final adjustment.

The bundle solution was acceptable. The Image RMS was 4.0 microns in the X direction and 4.4 microns in the Y direction. The 95% confidence circle radius for the horizontal accuracy of all ground points was 0.440 meters. The RMS of the checkpoints were: X=0.496 Y=0.536 Z=0.493 meters.

The project database consisted of project parameters and selected options, camera calibration data, control file data, refined image coordinates, Airborne GPS data, IMU orientation angles of camera centers, adjusted exterior orientation parameters for each image, a positional listing of all ground points used in the project, and a stereo model review. Positional data was based on the North American Datum of 1983, and was referenced to the UTM Coordinate System, Zone 18.

See NY0401 South Shore of Long Island Sound, NOAA Aerotriangulation Report, dated July 2005 (Revised December 2005).

Lidar Processing

Lidar data was collected between October 28, 2004 and April 11, 2005 at a nominal altitude of 2000 meters Above Ground Level (AGL). The resulting average point density was less than the required 1.5 meters. The lidar collection sessions were all tide coordinated for tides at or below the MLLW level.

The ABGPS/IMU post processed data along with the lidar raw measurements were processed using Optech Incorporated's REALM Survey Suite 3.5.4 software. The result was a "point cloud" of lidar measured points referenced to the ground control system.

REALM program bugs, unreported by Optech, were discovered to cause errors in the lidar "point cloud". After many delays with the software developer, the entire project had to be reprocessed using a revised version of REALM. The REALM program (version 3.4a) bugs had created false points that appeared to be islands. These anomalous islands along the shoreline were presumed to be natural features given that they were occurring on multiple flight lines and over multiple days that spanned a five-month period. The data delivered to NOAA originally found problems with the format of the DSM GeoTIFF files. AERO-METRIC recreated the DSM GeoTIFF files using the program QT Modeler and was preparing those files for re-delivery when the existence of the "islands" was found questionable. Utilizing the NY0401 imagery, an imagery model was set to verify the authenticity of the "islands". It was discovered that the "islands" were actually erroneous points. AERO-METRIC contacted Optech on December 16, 2005 and sample data and background information was sent. Optech discovered that a software bug in their REALM program was generating the erroneous points. Because this project is quite unique (requiring the lidar to record half of the data in the water and the other half on land), Optech required numerous datasets so that they could better diagnose the error and develop an accurate solution. Once the software bug was resolved, Optech provided AERO-METRIC with the revised version (REALM v3.5.4). This new software was then used to reprocess all of the lidar data sets to recreate the mass point cloud.

The lidar point cloud was classified by importing the point cloud data in Terrasolid Limited's TerraScan and TerraMatch suite of software that is integrated with Bentley's MicroStation J. This software was initially used in an automatic mode to remove systematic errors found between flight lines and to classify the points to identify the ground (bare-earth surface). Once the automatic processing was completed, as a quality control measure, AERO-METRIC meticulously reviewed the generated surface data to insure that proper classification was achieved.

Thirty lidar checkpoints and four digital imagery checkpoints were derived as part the GPS ground survey portion of this project. Details of this survey are contained within the report entitled *Survey Control Report for NOAA Project NY0401* as previously mentioned. These thirty-four checkpoints were used to validate the quality and accuracy of the lidar data. The checkpoints were compared to the lidar "Last Return" DSM as required per the Project Instructions.

Unable to model the MLLW and MHW datum with the limited number of available tidal benchmarks, NOAA supplied a beta version of VDatum for the South Shore of Long Island Sound. The use of the VDatum program allowed the MLLW and MHW datum to be achieved. MLLW and MHW level lines were generated using Applied Imagery's QT Modeler software. The MHW level line was used as a reference when interpreting the shoreline from the color negative photography. However, the MLLW level line proved to be quite problematic. It was determined that the closeness of the acquisition of the lidar data to the MLLW stage hindered the generation of a continuous contour. Instead, the lidar surface depicted only the undulating water by drawing many small depressions where the surface falls below MLLW. After numerous correspondences with NOAA, it was determined and agreed on that the MLLW contour could not be derived. GeoTIFF DSM and Intensity images were also created with the QT Modeler software using 1.5-meter point spacing.

ASCII all-return point files, DSM GeoTIFF files, and intensity GeoTIFF files were delivered and the lidar derived MHW and MLLW contours were included in the compilation shape files.

See Lidar Report, South Shore Long Island Sound, NGS Project No. NY0401, dated April 14, 2006.

Compilation

The Compilation Phase NY0401 - South Shore Long Island Sound was accomplished by the AERO-METRIC, INC. GEO-SPATIAL Department during the period of June through August 2005. Digital mapping was accomplished using Zeiss P1 and P2 Analytical Stereoplotters and a DAT/EM SUMMIT Evolution Softcopy Stereoplotter. On the Zeiss Analytical Stereoplotters, the software used was Zeiss' PCAP and Boeing Autometric's KDMS mapping system. On the DAT/EM Softcopy Stereoplotter, the software used was DAT/EM's CAPTURE. Feature identification and the assignment of cartographic codes were based on image analysis of 1:30,000 scale natural color negative photographs and information extracted from the appropriate NOAA Nautical Charts and US Coast Guard Light List. 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.

Cartographic features in the area that is the East River west of Prospect Point were compiled to meet a horizontal accuracy of 1 meter at a 95% confidence level. For the remainder of the project the cartographic features were compiled to meet a horizontal accuracy of 3 meters at a 95% confidence level. The cartographic features were produced according to procedures that have been demonstrated to produce data of this accuracy.

The following table provides information on the aerial photographic imagery used in the project completion process:

					FRAME		IMAGERY			
	FILM		FLIGHT	ROLL	NUMBERS		TIME (UTC)		SCALE	TIDE
LOCATION	TYPE	DATE	LINE	NUMBER	START	END	START	END	(NOMINAL)	HT (ft)
LONG ISLAND, NY	Color	22-Mar-05	30001	0523CN01	001	015	16:53	17:00	1:30,000	-2.05
LONG ISLAND, NY	Color	22-Mar-05	30002	0523CN01	042	067	17:04	17:18	1:30,000	-2.61
LONG ISLAND, NY	Color	22-Mar-05	30003	0523CN01	016	041	17:21	17:32	1:30,000	-1.12
LONG ISLAND, NY	Color	22-Mar-05	30004	0523CN01	068	070	17:37	17:50	1:30,000	-1.31
LONG ISLAND, NY	Color	28-Oct-04	30005	0423CN01	001	025	17:30	17:40	1:30,000	0.05
LONG ISLAND, NY	Color	28-Oct-04	30006	0423CN01	097	108	18:28	18:32	1:30,000	-1.22
LONG ISLAND, NY	Color	28-Oct-04	30007	0423CN01	060	096	18:05	18:27	1:30,000	-1.32
LONG ISLAND, NY	Color	28-Oct-04	30008	0423CN01	026	059	17:46	18:00	1:30,000	-0.30

The "TIDE HT" above is referenced to MHW. The tide range (MLLW-MHW, 1983 to 2001 Epoch) at the New London, CT water level station is 2.56 ft; at the New Haven, CT water level station is 6.15 ft; at the Bridgeport, CT water level station is 6.74 ft; at the Montauk, NY water level station is 2.07 ft; at the Silver Eel Pond, NY water level station is 2.33 ft; at the Eatons Neck, NY water level station is 7.12 ft; at the Kings Point, NY water level station is 7.16 ft; at the Horns Hook, NY water level station is 4.68 ft; at The Battery, NY water level station is 4.53 ft; and at the South Jamesport, NY water level station is 2.79 ft.

As the compilation was being completed, preliminary review of the data collected was performed on Pentium 4CPU, 2GHz computer workstations using MicroStation software. Paper check plots were produced and edited off-line. Corrections and additions were incorporated and the final editing and formatting was completed using ArcMap software. Preliminary Shapefiles were submitted for NOAA's review. Review comments were received from NOAA and there were some corrections to incorporate. The Final Shapefiles were prepared and delivered. Corrections based on NOAA comments were made during July 2006.

Quality Control / Final Review

Senior members of the AERO-METRIC, INC. GEO-SPATIAL and Imaging/Terrain Departments initiated the final review in July 2005. The Geographic Cell (GC) was evaluated for completeness and accuracy. Data review consisted of on-line and off-line evaluations of digital compilation and hard-copy products. The on-line review was comprised of reviewing stereo models on Zeiss P2 and SUMMIT Evolution Stereoplotters for cartographic feature codes selection, positional accuracies of features, and nomenclature. Scanned images of the largest scale nautical chart available were also used during the SUMMIT Evolution review. The cartographic feature attribution was judged to conform to C-COAST specifications. The off-line evaluation compared hard-copy plots of project data with the largest scale nautical chart available and the natural color photographs.

The following NOAA nautical charts were used for the chart comparison process:

12339 Tallman Island to Queensboro Bridge 1:10,000 44th Ed.
12354 Long Island Sound, Eastern Part 1:80,000 41st Ed.

12358 Shelter Island Sound and Peconic Bays 1:40,000 19th Ed.
12362 Point Jefferson and Mount Sinai Harbors 1:10,000 16th Ed.
12364 New Haven Harbor Ent. and Port Jefferson to Throgs Neck 1:40,000 35th Ed.
12365 Oyster and Huntington Bays 1:20,000 26th Edition
12366 Hempstead Harbor to Tallman Island 1:20,000 27th Ed.
12367 Greenwich Point to New Rochelle 1:20,000 23rd Ed.
13209 Block Island Sound and Gardiners Bay 1:40,000 24th Ed.
13212 Approaches to New London Harbor 1:20,000 36th Ed.

Chart 12363, Long Island Sound Western Part, 1:80,000, 39th Ed., was available but not used as larger scale charts covered it.

The lidar-derived MHW line was used as a reference in the final review of the compiled shoreline, and where the two lines diverged substantially, the manually compiled MHW line was adjusted to agree with the lidar MHW line. Review comments from NOAA were incorporated and completed in July 2006.

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:

- Hardcopy of Survey Control Report
- Hardcopy of Aerial Photography Report
- Hardcopy of Lidar Report
- Hardcopy of Airborne Positioning and Orientation Report for Aerial Photography
- Hardcopy of Airborne Positioning and Orientation Report for Lidar
- Hardcopy of Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)

RSD Electronic Data Library:

- Project database
- GC10618 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

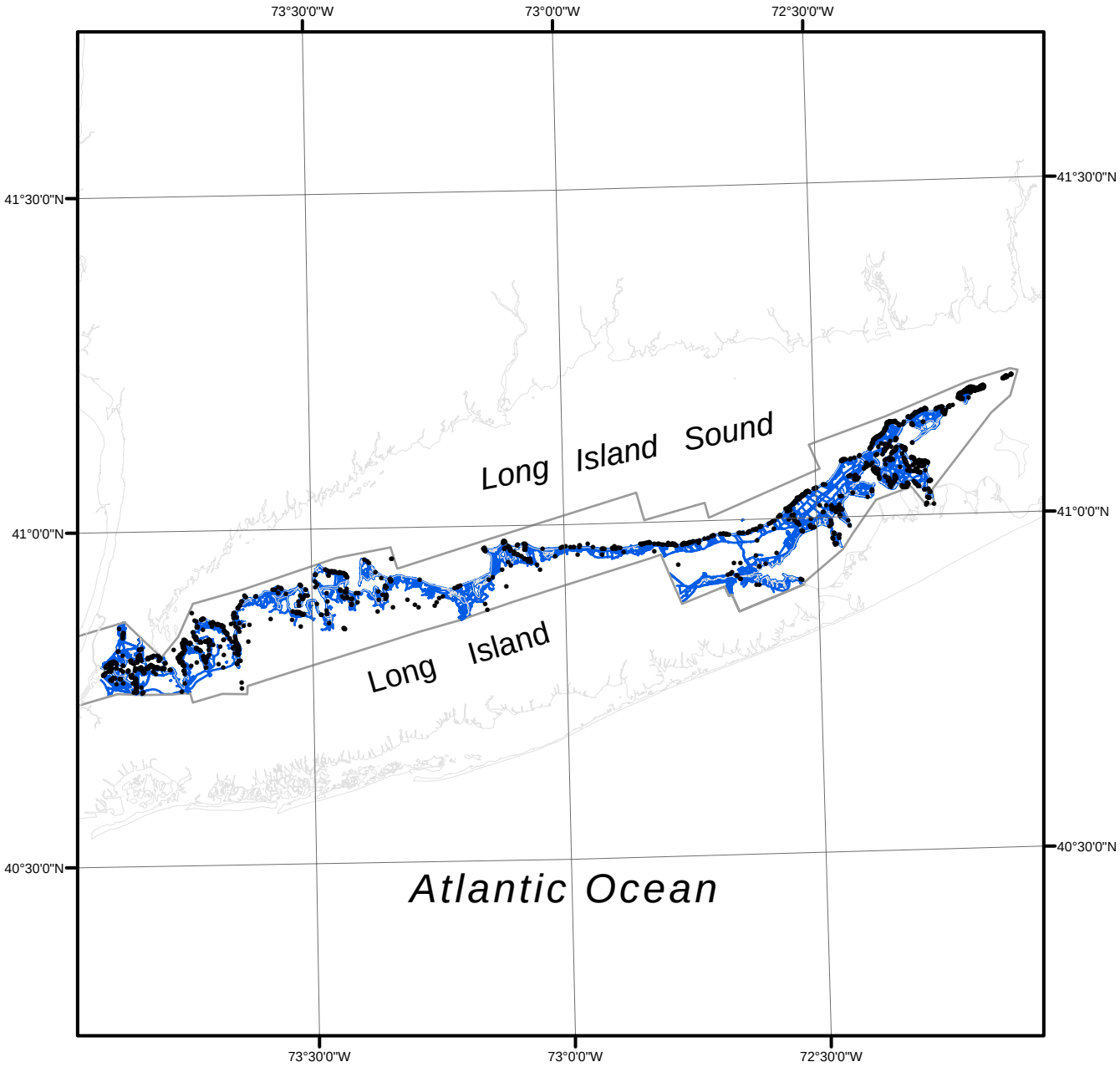
NOAA Shoreline Data Explorer:

- GC10618 in shapefile format
- Metadata for GC10618
- Digital copy of the PCR in Adobe PDF format

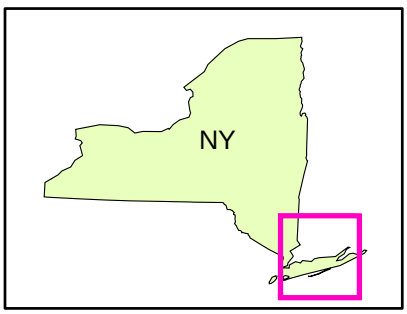
End of Report

SOUTH SHORE OF LONG ISLAND SOUND

NEW YORK



Overview



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