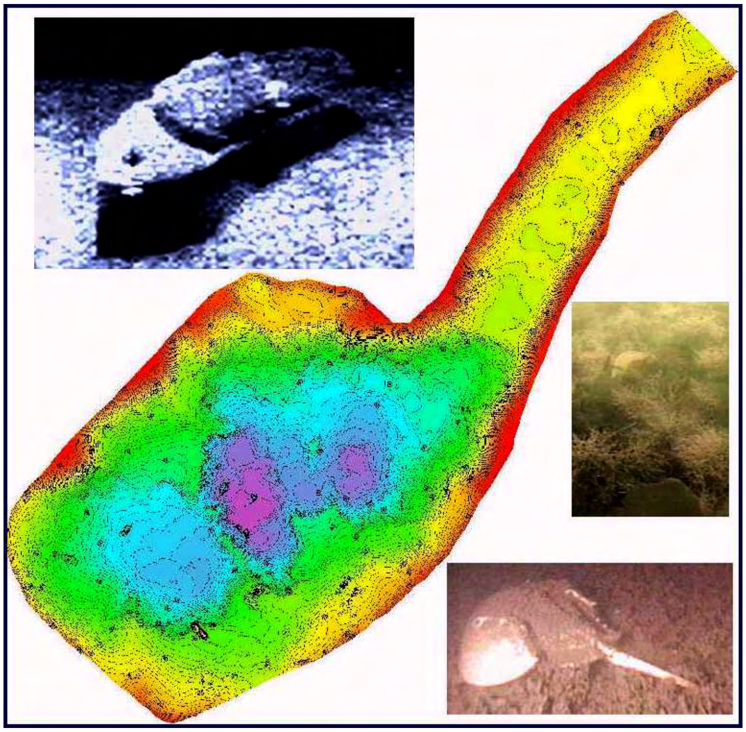
MULTIBEAM AND SEABED CLASSIFICATION SURVEYS

LITTLE BAY, NORTON BASIN, GRASS HASSOCK CHANNEL,
AND THE RAUNT
JAMAICA BAY, NEW YORK



Prepared by:

CR Environmental, Inc.
639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Prepared for:

Barry A. Vittor & Assoicates
656 Aaron Court, Building 6
Willow Park Office Complex
Kingston, New York 12401

March 2001

TABLE OF CONTENTS

FIGURES

PLANS

1.0 INTRODUCTION

During the period of October 2 through 7, 2000, CR Environmental, Inc. of Falmouth, Massachusetts, and Marine Search & Survey of Wilmington, Delaware, performed a multibeam bathymetric survey and a seabed classification survey (side-scan, video survey and RoxAnn) at Little Bay and Norton Basin in Jamaica Bay, New York. The seabed classification survey was also performed at two reference areas, the Raunt and Grass Hassock Channel in Jamaica Bay. Norton Basin and Little Bay are being studied as a potential demonstration project by the U.S. Army Corps of Engineers, New York District (USACE-NYD) for a beneficial uses application of dredged material. The proposed project would place dredged material in the existing borrow pits to enhance the hydrology and aquatic habitats of the two basins. The seabed classification and bathymetric survey completed under this contract will be used in coordination with analysis of biological and hydrological baseline conditions to determine if the proposed restoration could enhance the hydrology and available aquatic habitats in Norton Basin and Little Bay.

Figure 1 is an electronic chart printout of the entire study site in Jamaica Bay. Figure 2 is a detailed electronic chart printout of the Raunt and Figure 3 shows detailed charts of Little Bay, Norton Basin and Grass Hassock Channel. The sections that follow describe the survey and data processing methods, and data products. Accompanying the report are bathymetric maps of Little Bay and Norton Basin, side-scan mosaics, RoxAnn seabed classification maps, and select photographic images from video footage taken at each of the four study areas. These products are to be used to plan future sampling programs at the study site.

2.0 SURVEY OPERATIONS AND PERSONNEL

Field operations were performed from CR Environmental's 32-ft aluminum survey vessel, *Cyprinodon*, based in Woods Hole, MA. This vessel has a large enclosed pilothouse for survey electronics, a 5KW generator, a hydraulic winch, and an A-frame to deploy the survey and sampling equipment. Horizontal positioning for the survey was accomplished with a Trimble AG 132 DGPS outfitted with an Omnistar Satellite Differential receiver that provided sub-meter accuracy.

CR Environmental provided a four-man survey crew including: John H. Ryther, Jr., manager of the field operation; Christopher Wright, field scientist and navigator; Eric Steele, field technician and captain; and field scientist, Vince Capone of Marine Search and

Survey. Mr. Capone was responsible for operation of the multibeam and RoxAnn systems. Specification sheets for equipment are provided in Appendix A.

2.1 Multibeam Survey

A Reson 8101 Multibeam system, including a TSS Motion Sensor, SG Brown Gyro, the Trimble DGPS and the Coastal Oceanographics' Hypack Hysweep software was used to accomplish the multibeam survey in Little Bay and Norton Basin. The Reson 8101 operates at 240 kHz and has a swath coverage width of 150 degrees with 101 beams providing total bottom coverage up to 7.4 times the water depth.

Prior to survey operations, a patch test calibration of the multibeam system was performed using the Hypack software. This test was used to determine the exact orientation of the multibeam transducer along with delay time between the GPS and echosounder and any misalignment of the gyrocompass. Sound velocity profiles were also obtained in both Little Bay and Norton Basin with an Odom Digibar that were entered into the Hypack software.

The Hypack navigation software also converted the Latitude/Longitude positions to the New York Long Island NAD 83 grid system.

Following system calibrations, 3 to 4 tracklines were run at each site, providing complete bathymetric coverage of Little Bay, Norton Basin and the wider section of the Norton Basin entrance channel.

2.2 Seabed Classification Survey

After the bathymetric survey was completed, the vessel was demobilized of the multibeam system and set up for the seabed classification survey. The following equipment was used during the seabed classification survey: a Marine Micro Systems RoxAnn Seabed Classification System, an Edgetech digital side-scan sonar system and a Minnow Marine underwater video sled. Side-scan sonar, video sled, and RoxAnn surveys were performed at the Raunt, the Grass Hassock Channel and in Little Bay and Norton Basin. Side-scan sonar coverage was not obtained at the channel entrance to Norton Basin due to the operational depth limit of approximately 10 feet.

2.2.1 Side-scan sonar

An Edgetech Model 272 dual frequency side-scan towfish with an Analog Control Interface (ACI), topside processing computer and the Oceanic Imaging Consultants (OIC) GeoDas software were used to collect the side-scan sonar data. The Model 272 towfish operates on 100 or 500 kHz and will collect sonar data from 25 to 300 meters to each side of the vessel. The ACI interface digitizes the sonar signal and allows for starboard and port gain adjustments. GeoDas-PC is a Windows based side-scan sonar data acquisition system that interfaces with the GPS system and provides fully geo-coded displays. The system allows for playback, re-processing and mosaicing of side-scan data on a desktop PC.

At the lower Raunt, four lines approximately _ mile long were run at the 50 meter scale and the 100 kHz frequency. The coverage extended from buoy R "2" at the entrance of Runway Channel to buoy N "2". At the upper Raunt, two lines approximately _ mile long were run from buoy C "3" to C "7".

At the Grass Hassock Channel, three 1 _ mile lines were run at the 100 meter scale and 100 kHz from buoy N "16" to the entrance channel at Norton Basin.

In Little Bay and Norton Basin, data were collected along three side-scan lines at the 100 m scale and a frequency of 100 kHz. In additional, high resolution 500 kHz data were collected at both sites to help locate and map the wrecks and bottom obstructions in these areas.

2.2.2 RoxAnn seabed classification system

RoxAnn is a hydro-acoustic processor. When connected to a standard single beam echosounder it will discriminate between different seabed material types and output data in a quantitative format ready for computer analysis and display. The RoxAnn system derives its information from the first and second echo returns from the echosounder. An index "E 1" is derived from the first return and is related to seabed roughness. An "E2" index is produced from the second return and is related to the hardness of the seabed. Every seabed material has a unique signature that is a combination of roughness and hardness. RoxAnn data needs to be calibrated using bottom samples or bottom photography. During this study, the underwater video sled (described below) was used to ground truth the RoxAnn data.

The RoxAnn processing system was interfaced to an Odom Hydrotrack single-beam echosounder with a 200 kHz 8-degree transducer and the Trimble DGPS. RoxAnn data were collected along the side-scan transects and at several zig/zag cross tie lines in each study area.

2.2.3 Underwater video sled

The Minnow Marine Underwater Video sled consisted of a lightweight aluminum sled with a high resolution Sony camera, Ocean Motions Housing and 250 watt lights. A 100 m Kevlar cable provided a real time video display to a high-resolution monitor on the survey vessel. Data was recorded in the camera, and on a topside VCR. Three to five minute tows or drifts with the video sled were conducted at approximately 10 stations at both the Raunt and Grass Hassock Channel, 3 stations at Little Bay and 6 stations at

Norton Basin. These station positions are listed in Table 1. Figures 4, 5, 6, 7 show the video tow location maps of Little Bay, Norton Basin, the Grass Hassock Channel and the Raunt, respectively. The maps of Little Bay and Norton Sound also show bathymetric contours at 10 ft intervals.

3.0 DATA PROCESSING AND PRODUCTS

3.1 Multibeam Data Processing and Data Products

The multibeam bathymetric data was tide corrected using the NOAA Tide Station at Sandy Hook with the corrections for Motts Basin and was edited using the Hypack program to remove data spikes caused by fish schools and other water column interference. Once the edited x, y, z data set was created, the data were grided and contoured using SURFER 7.0 and plotted at CR Environmental's data processing facility using an HP 42 inch Design Jet Model 500 Plotter. In addition, a shaded relief map was produced for Little Bay to highlight the shipwreck and bottom obstruction locations (Figure 11).

The multibeam data products for Little Bay and Norton Basin are presented in Figures 8, 9, 10, and 11 of this report and in the accompanying plans:

Plan 1 Bathymetric Map of Little Bay Scale 1" =100'

Plan 2 Bathymetric Map of Norton Basin Scale 1" =100'

Plan 3 Bathymetric Map of the Norton Basin Entrance Channel Scale 1" =100'

Plan 4 Sun Projection (shaded relief map) of Little Bay Scale 1" =100'

Plan 1 and Plan 2 are also plotted on clear film to be used as overlays on the side-scan mosaics.

3.2 Side-scan Sonar Data Processing and Data Products

Side-scan data was processed using the OIC GeoDas software. The navigation data was smoothed, amplitude and gain settings applied, the water column removed and digital side-scan mosaics created on screen. All the side-scan mosaics were plotted as negative images. In addition, high-resolution side-scan images of selected bottom targets (Table 2) and geologic features were created for inclusion in the report.

The side-scan mosaics for Little Bay, Norton Basin, Grass Hassock Channel, and the Raunt are presented in Figures 12, 13, 14, and 15, respectively, and in the following plans.

Plan 5 Side-scan mosaic of Little Bay Scale 1”=100’

Plan 6 Side-scan mosaic of Norton Basin Scale 1”=100’

Plan 7a Northeast side-scan mosaic of Grass Hassock Channel Scale 1”=100’

Plan 7b Southwest side-scan mosaic of Grass Hassock Channel Scale 1”=100’

Plan 8 Side-scan mosaic of Lower Raunt Scale 1”=100’

Plan 9 Side-scan mosaic Upper Raunt Scale 1”=100’

3.3 RoxAnn Data Processing and Data Products

The RoxAnn system was calibrated in the Raunt and Grass Hassock reference areas. Calibration was conducted by comparing video sled and RoxAnn data for several co-located positions representing different substrate and habitat types. Calibration was conducted in relatively flat portions of these channels.

Sediment bottom types included: silty sand, silty sand with sea lettuce patches, amphipod mat, sand with patchy amphipod mat, amphipod/sponge bottom, shell bottom, and soft black mud with a microbial mat or mineral precipitate. RoxAnn data were edited and contoured using Surfer 7. RoxAnn data products provided with the report are listed below: RoxAnn Seabed Classification maps of Little Bay, Norton Basin, Grass Hassock Channel, and the Raunt are presented in Figures 17, 18, 19, and 20. Bathymetric contours at 10-foot contour intervals are also shown on the maps of Little Bay and Norton Basin.

3.4 Underwater Video Editing and Data Products

At CR Environmental, underwater videotapes were examined and a copy of selected unedited footage sent to Barry A. Vittor & Associates and the USACE-NYD. Select photographic JPEG images from the video footage in each study area were captured using a video frame grabber system (Figures 21 through 30).

A list of these photographic images is provided below.

Figures 21, 22, 23, 24 The Raunt

Figures 25, 26, 27 Grass Hassock Channel

Figures 28, 29 Norton Basin

Figure 30 Little Bay

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Volume Calculations

Approximate surface areas and volumes were calculated for Little Bay and the southern portion of Norton Basin (i.e. the entrance channel was excluded) based on the gridded multibeam bathymetric data. Calculations were conducted using Surfer™ V. 7.0. Calculated volumes include the total water volume under current conditions and the volume remaining after hypothetical filling to a depth of 15 feet below Mean Lower Low Water. The planar surface area reported in Table 3 is the area represented by a perfectly horizontal plane across the basin at the minimum recorded water depth. The bottom surface area estimate represents the actual area of the basin benthos. Volume estimates are considered approximate and do not account for the portion of the basins located between the minimum sounding depth (3.3 ft for Norton Basin, 5 ft for Little Bay) and the true shoreline.

4.2 Multibeam and Side-scan Data

The Multibeam bathymetric data revealed three major 60 to 65 ft borrow pits in Little Bay and three major 45 to 50 ft borrow pits in Norton Basin. The multibeam and the side-scan data also depict several 30 to 40 ft wrecks, as well as extensive debris such as tires, pilings, and other man-made structures. In Norton Basin, a few smaller targets, possibly submerged automobiles and smaller boat wreckage were depicted on the side-scan sonar records on the eastern shore.

The GeoDas side-scan software has a target view feature depicted in Figure 31 that enables the operator to click on a target and obtain the position, length, width and height of a wreck or bottom feature. Table 2 provides a list and positions of the major wrecks and bottom targets in Little Bay and Norton Basin and provides thumbnail images. These wrecks and bottom obstruction locations are plotted on Figures 32 and 33. Note that some of these targets plot outside of the bathymetric contours depicted on Figures 32 and 33. This is because the side-scan signal travels at an angle closer to horizontal (i.e., sea surface) than the multibeam signals, thus insonifying portions of the basins closer to the true shoreline. Figures 34 through 39 show enhanced side-scan sonar images of selected wrecks and bottom features from Little Bay and Norton Basin. From the shape and size of these wrecks, it is our opinion that these are modern boats probably less than 50 years old with no archaeological significance. However, further investigation of these wrecks may be warranted.

To enhance the bottom features, the side-scan mosaic plans were produced as negative images. The hard targets, such as the shipwrecks and pilings appear white with black acoustic shadows. The soft black mud in Little Bay and Norton Basin appears as a dark side-scan record and the harder bottom, such as sand and ledge or steep terrain appear as a lighter record. Overlaying the bathymetric contour map on the side-scan mosaic of Norton

Basin reveals that the 45 to 50 foot holes in Norton Basin are the soft mud bottom areas. In Little Bay, the 60 to 65 foot holes also appear as the darker side-scan images that represent the soft black mud bottom. The Little Bay side-scan mosaic also shows numerous irregular white fingers that probably represent the irregular dredge cuts and steep slopes from the former dredging operation.

Although the side-scan mosaics for the lower Raunt show an extremely uniform sand/silt bottom and do not show the patches of sea lettuce and amphipod mat observed on the bottom video, the side-scan mosaic of the upper Raunt does show some subtle bottom features that could represent a transition from the sand/silt bottom to the amphipod mat bottom. These bottom features at the upper Raunt are also shown as a screen capture in Figure 40 (right image). This mosaic and Figure 40 (left image) shows drag marks on the bottom that probably resulted from the underwater video sled making contact with the bottom during a video transect.

The side-scan mosaics of the Grass Hassock Channel show more of a patchy bottom with varying bottom types. The mosaics show several irregular white patches that probably represent a harder sand/shell bottom. The darker bottom is most likely the amphipod mat and amphipod/sponge bottom. Figure 41 (left and right images) are screen captures of raw side-scan data from the Grass Hassock Channel that show the bank on the northern shore and the subtle bottom features that represent the transition from the sand/shell bottom to amphipod mat bottom.

4.3 RoxAnn Data

Video observations of the substrate and epifauna in the Raunt and Grass Hassock Channel broadly agreed with the RoxAnn bottom classification. The RoxAnn system correctly distinguished between areas of bare sand and areas that contained dense amphipod mats and amphipod/sponge bottom. The system did not accurately distinguish between areas containing sparse versus dense algae. The inability to distinguish between areas of dense and sparse algae may be due to the extent of the acoustic “footprint” of the transducer relative to the areal extent of the algae patches.

Video observations of the substrate in Little Bay and Norton Basin did not agree with RoxAnn data. RoxAnn incorrectly identified significant portions of these two basins as hard bottom. The dominant type of sediment observed in these areas was a fine black mud, usually covered with a veneer of white floc. The sediment possessed a strong ‘sewage’ and sulfide odor, suggesting reducing conditions. The floc resembled the zooglial biomass blooms that may occur in anoxic water. However, the floc may have resulted from precipitation of fresh-water minerals during mixing with salt water. The latter hypothesis is supported by the sound velocity profile for Little Bay, which may indicate a strong halocline.

Natural gases released by anaerobic microbial respiration are likely entrained in the sediment of Little Bay and Norton Basin. Video footage for portions of these basins shows a bottom that gently undulates when disturbed and microtopography consistent with the venting of trapped gases. If present in great enough quantities, sediment entrained gases can create a subsurface air-water interface which reflects acoustic energy. This reflection would greatly exaggerate the “E2” signature used by RoxAnn to characterize substrate hardness.

4.4 Underwater Video

The video of Little Bay shows an extremely soft black silt bottom with the white floc and some dead sea lettuce. The bottom has numerous depressions that probably represent gas pockets in the sediments. With the exception of a few larval fish, little marine life was observed on the video from Little Bay and Norton Basin relative to other areas where video was taken. In Norton Basin, the bottom was primarily the soft black silt but a few stations had a sparse amphipod mat/algal bottom. Only minimal video footage at three stations was collected in Little Bay due to the risk of hanging up the sled on the excessive amount of debris and bottom obstructions.

Unlike Little Bay and Norton Basin, the underwater video showed that the two reference areas, the Raunt and the Grass Hassock Channel, represent productive bottom habitats for a variety of marine life.

At the upper Raunt, the underwater video revealed sand/silt bottom with patches of sea lettuce, red algae and hydroids transitioning to patches of amphipod mat. The amphipod colonies ranged from sparse in the upper Raunt to extremely dense in the lower Raunt. Numerous juvenile horseshoe crabs, hermit crabs, sand shrimp, blue crabs and juvenile flounder were seen in the areas of amphipod mat. At the lower Raunt, the bottom transitioned from the amphipod mat to hard sand bottom with numerous hermit crabs at the sandy channel entrance. In the water column, many comb jellyfish were observed.

At the Grass Hassock Channel, the underwater video showed areas of sand, shell and gravel, amphipod mat, and amphipod/sponge bottom. Two of the most productive stations videoed in the Grass Hassock Channel were GH-06 and GH-07. At Video Station GH-07, an extremely dense amphipod or sponge bottom was observed with 5 to 6 inch high colonies. Video clips of this bottom type were sent to Barry Vittor for preliminary identification purposes, but samples will be required to confirm this bottom type. Small gobies and sand shrimp were observed darting in and out of the dense amphipod/sponge colonies. Live quahogs, juvenile horseshoe crabs, and blue crabs were also observed on the sponge/amphipod mat bottom at this reference site. GH-06, the deepest video station in the Grass Hassock at a depth of 55 ft, a softer bottom with sparse amphipod mat was observed on the bottom video. Numerous beer and soda cans, and dead marsh grass had accumulated in this deep hole and were observed on the bottom video. This was also an extremely productive bottom with gobies, sand shrimp, and almost 20 juvenile horseshoe crabs observed at this station.

The underwater video sled also recorded bottom wreckage at the center of the Grass Hassock Channel. Located on a hard sand bottom, this bottom debris was covered with algae and hydroids.

4.5 Final Products

By combining these four technologies, the multibeam bathymetry, side-scan sonar, the RoxAnn system, and the underwater video sled, a thorough seabed classification of Little Bay, Norton Basin, and the reference areas (Grass Hassock Channel and the Raunt) has been achieved. Each of these systems has its strengths and weaknesses, the side-scan system has the capability to discriminate small scale features; the multibeam provides quantitative bathymetric data for volume calculations; when properly calibrated, the RoxAnn system can be an effective low cost tool for showing subtle changes in the seabed; and the underwater video is an invaluable tool for ground truthing all these remote sensing systems.

In addition to the geo-referenced side-scan mosaics, bathymetric maps, RoxAnn maps, and JPEG photographic images, the data will be provided in digital format on CD-ROM. CR will also provide selected MPEG video clips of each of the bottom types observed in the study area.

4.6 Recommendations

These data will be useful for planning future benthic sampling operations and to locate towable lanes for otter trawl tows. It is recommended that for future sampling operations, the Hypack navigation software and Trimble DGPS be utilized. The wrecks and obstructions in Little Bay and Norton Basin could be displayed on the helmsman's navigation display and the tows and sampling stations located to avoid these areas. The Hypack software could also be used to relocate the various bottom types or to return to a specific wreck or bottom target for further investigation.

It is our recommendation, that single beam bathymetric data with tight 25 ft line spacings be collected at the Raunt and the Grass Hassock Channel. As was done for Little Bay and Norton Basin, the bathymetric data could be plotted on clear film and overlays produced for the side-scan mosaics. These overlays are extremely helpful in the interpretation of the side-scan data.

During the October survey, only minimal time was spent calibrating the RoxAnn system and no sediment samples were taken. In addition, only minimal RoxAnn coverage due to the narrow beam width was obtained while running the wide-spaced side-scan lines and at a series of zig-zag lines across the study areas. This resulted in a lot of interpolation between the lines and some misinterpretation of the bottom type. If additional, RoxAnn surveys were performed, a full day should be planned for calibration which would include numerous video drops and sediment samples at each location.

Of all the survey systems, the underwater video sled was perhaps the most useful for the habitat mapping and examining the macrobenthos. This technology should be included in future biological survey and sampling operations. Finally, additional sampling using otter trawls or a biological dredge should be performed to collect specimens to positive identify the marine life observed on the underwater video.

TABLE 1
PHOTOGRAPH (VIDEO CAPTURE) LOCATIONS

The Raunt

Photo ID	X Coordinates	Y Coordinates	Latitude	Longitude
ra01	1031379.4	157661.0	40.599294	73.830286
ra02	1029671.2	158262.1	40.600953	73.836433
ra03	1029869.5	158077.5	40.600445	73.835721
ra04	1030420.8	157867.1	40.599865	73.833737
ra05	1031023.1	157576.6	40.599064	73.831570
ra06, ra07, ra08	1028900.3	158760.9	40.602326	73.839206
ra09	1026915.0	158566.9	40.601803	73.846357
ra10, ra11	1026337.1	157677.3	40.599364	73.848444
ra12, ra13	1026104.4	156549.6	40.596270	73.849288
ra14, ra15	1025889.5	155549.2	40.593525	73.850068
ra16, ra17	1025670.7	154620.8	40.590978	73.850862
ra18, ra19	1026316.6	157713.0	40.599462	73.848517
ra20	1027393.2	158700.9	40.602169	73.844634

Grass Hassock Channel

Photo ID	X Coordinates	Y Coordinates	Latitude	Longitude
gh01, gh02, gh03	1039532.9	158305.2	40.601015	73.800920
gh04	1040480.6	158310.8	40.601024	73.797507
gh05	1041308.6	158324.6	40.601057	73.794526
gh06	1041569.4	158854.7	40.602510	73.793582
gh07	1041779.9	159267.0	40.603641	73.792820
gh08	1045950.6	162792.1	40.613288	73.777769
gh09, gh10	1045441.8	165309.3	40.620201	73.779578
gh11, gh12	1045441.8	161253.6	40.609071	73.780485

Norton Basin

Photo ID	X Coordinates	Y Coordinates	Latitude	Longitude
nb01	1047346.7	157834.2	40.599670	73.772786
nb02, nb04	1047013.1	158569.2	40.601690	73.773981
nb05	1047491.3	157622.4	40.599088	73.772268
nb06	1047127.0	157782.5	40.599530	73.773578
nb07, nb08	1047738.0	158467.7	40.601406	73.771371

Little Bay

Photo ID	X Coordinates	Y Coordinates	Latitude	Longitude
lb01	1045622.0	157757.3	40.599471	73.778998
lb02, lb03	1045165.5	157393.6	40.598476	73.780645
lb04	1046185.0	158386.5	40.601194	73.776965

Notes:

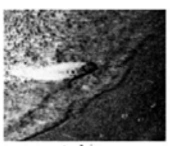
Northings and Eastings: NY State Plane Long Island grid (feet) NAD83.
Targets generally represent a point 20 seconds to 2 minutes into the video recording. Video drops were non-propelled low-speed drifts.

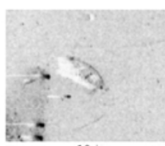
TABLE 2

SIDESCAN SONAR TARGET DESCRIPTIONS
LITTLE BAY AND NORTON BASIN

File ID	Easting	Northing	Height (meters)	Width (meters)	Length (meters)	Notes
TRG1.bmp	318842.56	48088.523	0.07	1.17	4.43	lb1wreck
TRG2.bmp	318831.63	48020.82	0.05	1.54	2.30	lb2rock
TRG4.bmp	318800.13	47977.863	0.80	1.54	4.99	lb4wreck
TRG10.bmp	318670.47	47933.406	0.03	1.99	5.77	lb10debris, pilings
TRG13.bmp	318615.06	47905.469	0.48	2.03	4.99	lb13wreck
TRG16.bmp	318559.94	47910.324	NA	NA	NA	lb16debris
TRG19.bmp	318558.28	48004.875	0.03	2.21	9.23	lb19wreck
TRG20.bmp	318506.5	47983.629	0.08	3.17	7.41	lb20wreck
TRG21.bmp	318529.25	48030.199	0.05	3.03	6.30	lb21wreck
TRG24.bmp	318636.97	48042.785	0.09	2.83	10.21	lb24wreck
TRG25.bmp	318649.44	48032.504	NA	3.48	8.63	lb25wreck, debris
TRG26.bmp	318651.19	48006.852	0.09	3.42	9.44	lb26wreck
TRG31.bmp	318525.41	48023.438	2.00	NA	11.01	lb31wreck
TRG32.bmp	319349.97	48229.176	1.42	1.61	5.19	Norton wreckage, possible cars
TRG33.bmp	319338.84	48165.633	2.60	1.32	2.04	Norton wreckage
TRG34.bmp	319351.28	48027.109	0.16	0.64	5.01	Norton debris
TRG35.bmp	319332.06	48016.527	0.54	1.57	4.04	Norton wreck
TRG37.bmp	318945.53	48303.926	0.33	3.36	10.92	Little Bay entrance
TRG38.bmp	318967.94	48317.172	0.64	0.77	4.37	Little Bay debris
TRG39.bmp	318924.47	48261.953	0.65	3.45	12.06	Little Bay entrance wreck

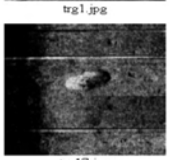
NA = Not Available
Coordinates: New York State Plane, Long Island grid, NAD83 (meters).
See Figure 32 for Little Bay target locations and Figure 33 for Norton Basin Target Locations.

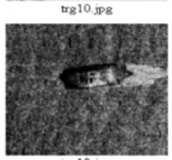

trg1.jpg

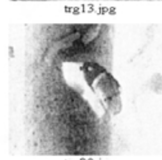

trg10.jpg


trg13.jpg

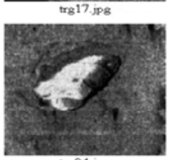

trg16.jpg

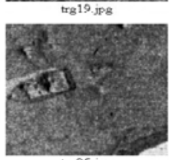

trg17.jpg

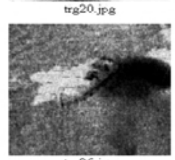

trg19.jpg


trg20.jpg


trg21.jpg

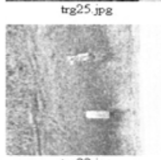

trg24.jpg


trg25.jpg


trg26.jpg

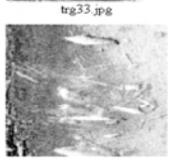

trg31.jpg

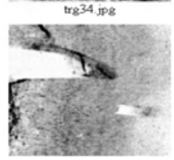

trg32.jpg


trg33.jpg


trg34.jpg


trg35.jpg





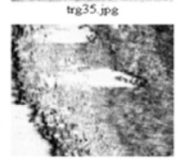


TABLE 3

LITTLE BAY AND NORTON BASIN VOLUME ESTIMATES

Little Bay (Does not account for 0 - 5 ft depths)*				
Planar Surface Area	1.07E+06	square feet	2.45E+01	acres
Bottom Surface Area	1.10E+06	square feet	2.52E+01	acres
Total Volume in Survey Area	3.27E+07	cubic feet	1.21E+06	cubic yards
Volume after filling to -15 ft MLLW	1.03E+07	cubic feet	3.83E+05	cubic yards
(volume between -5 ft MLLW and -15 ft MLLW)				
Fill Volume	2.24E+07	cubic feet	8.29E+05	cubic yards
Norton Basin (Does not account for 0 - 3.3 ft depths)*				
Planar Surface Area	2.42E+06	square feet	5.55E+01	acres
Bottom Surface Area	2.48E+06	square feet	5.69E+01	acres
Total Volume in Survey Area	6.33E+07	cubic feet	2.34E+06	cubic yards
Volume after filling to -15 ft MLLW	2.75E+07	cubic feet	1.02E+06	cubic yards
(volume between -5 ft MLLW and -15 ft MLLW)				
Fill Volume	3.58E+07	cubic feet	1.32E+06	cubic yards

* Estimates do not account for the portion of the basins located between the minimum sounding depth and the true shoreline.

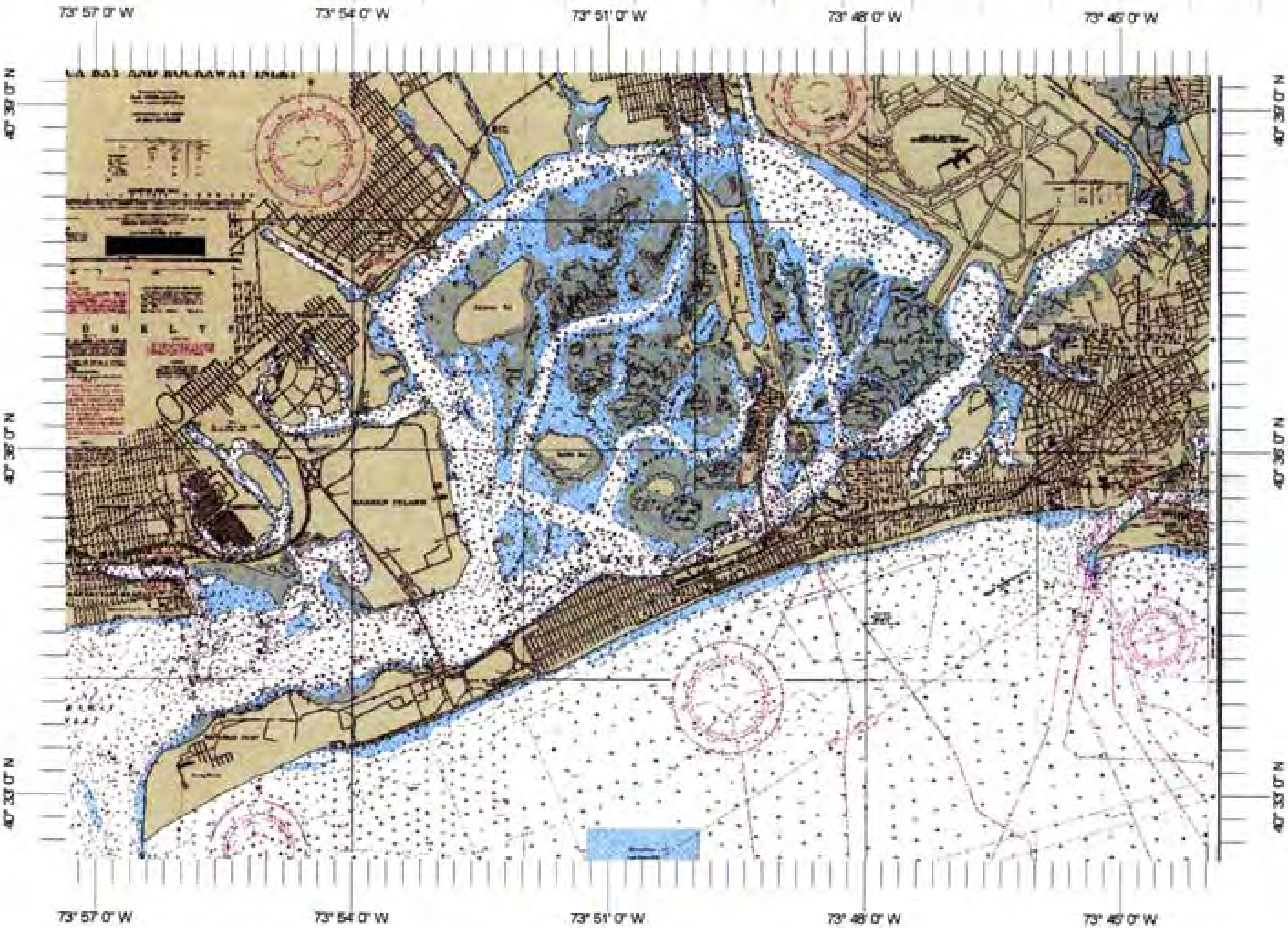


Chart Name:	Jamaica Bay And Rockaway Inlet
Chart ID:	12350S0
Top Left:	40° 39' 17" N 73° 57' 21" W
Bottom Right:	40° 32' 25" N 73° 43' 49" W

Figure 1.

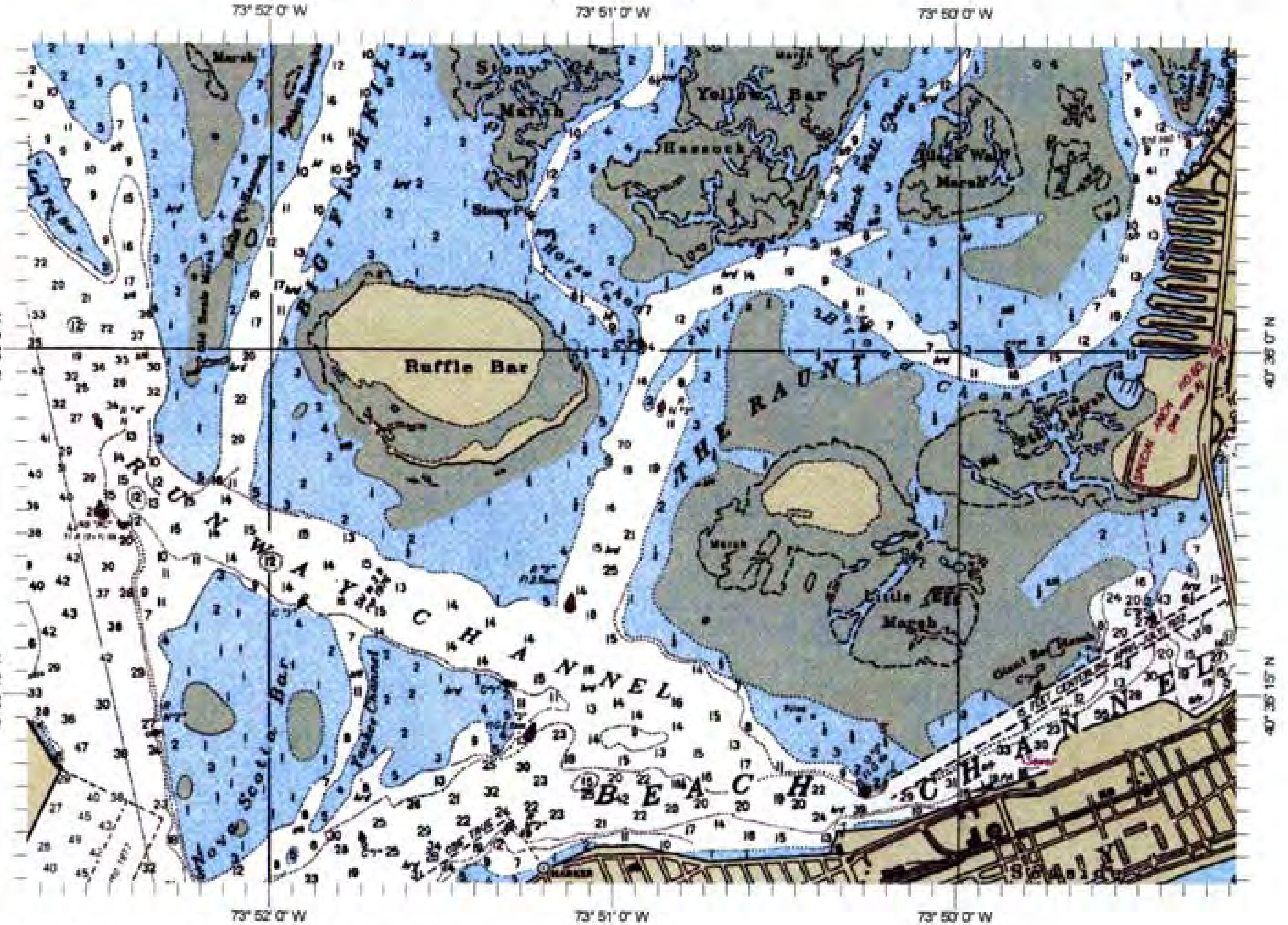


Chart Name:	Jamaica Bay And Rockaway Inlet
Chart ID:	12350S0
Top Left:	40° 36' 40" N 73° 52' 42" W
Bottom Right:	40° 34' 50" N 73° 49' 10" W

Figure 2.

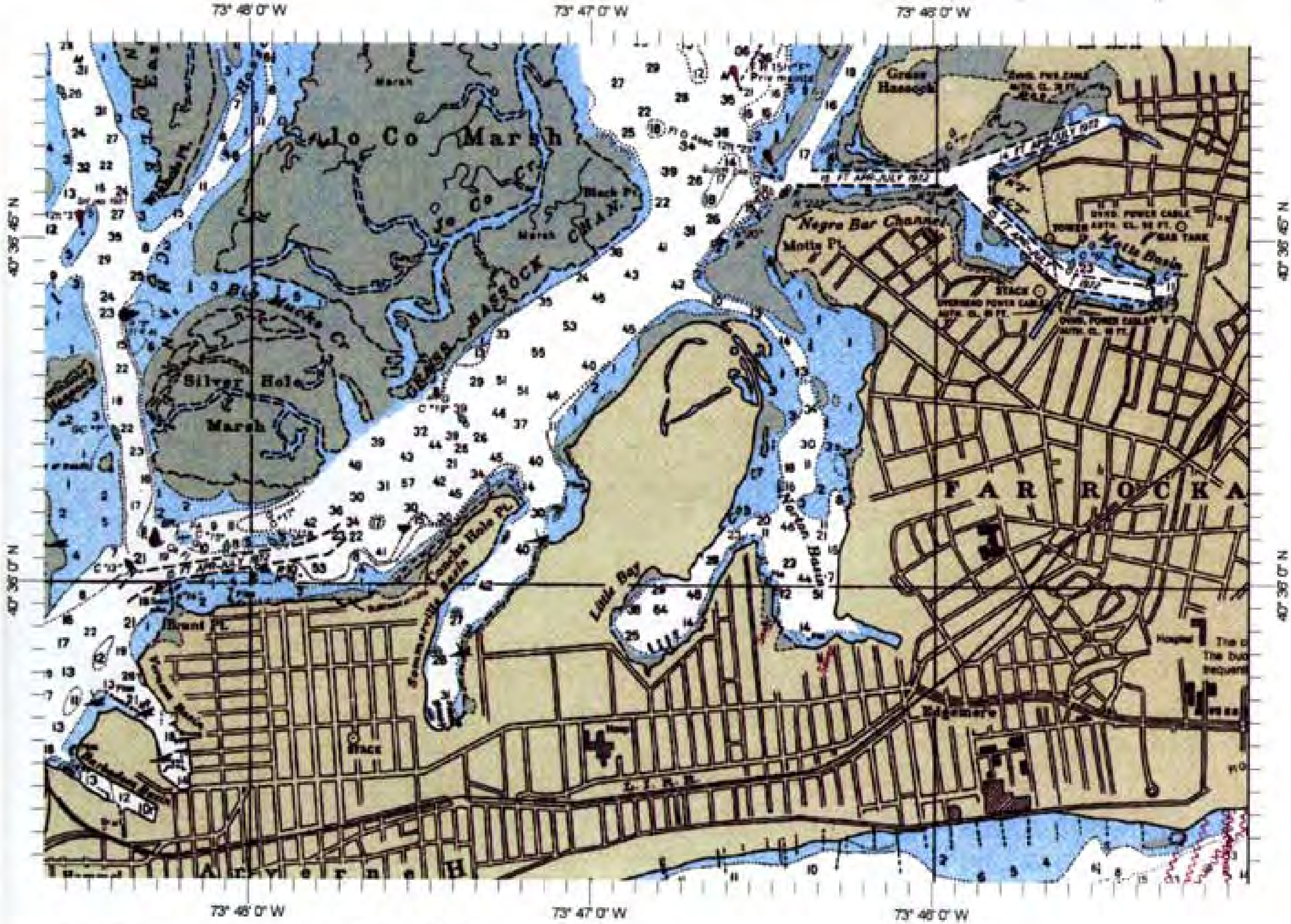


Chart Name:	Jamaica Bay And Rockaway Inlet
Chart ID:	12350S0
Top Left:	40° 37' 10" N 73° 48' 35" W
Bottom Right:	40° 35' 21" N 73° 45' 4" W

Figure 3.