BATHYMETRIC MAPPING IN THE FORGE RIVER

FINAL REPORT

for

Environmental Protection
Town of Brookhaven
One Independence Hill
Farmingville, NY 11738

by

Roger D. Flood
Marine Sciences Research Center
School of Atmospheric and Marine Sciences
Stony Brook University
Stony Brook, NY 11794-5000

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INTRODUCTION

The Forge River is a shallow estuary in the Town of Brookhaven on the south shore of Long Island. It has its headwaters in central Long Island and it empties into Moriches Bay. The Forge River is of particular interest because there is continuing Federal, County and Town interest in understanding the present conditions and in determining how to restore the health of this system. It is important to know the bathymetry of the entire estuary in order to create realistic models of water circulation and water quality. Information presently available on Forge River bathymetry comes from National Ocean Survey (NOS) water depths collected in the 1930s (information that is shown on nautical chart 12352_2) and from water depth data collected by Suffolk County in 2006. However, the NOS data on water depth is no longer correct (there have been extensive modifications to the estuary over the last 70 years), and the Suffolk County data on water depth is confined to the channels.

This report describes the results of a bathymetric survey undertaken in the Forge River during December 2007 and January 2008. We collected data from the Forge River (south of the railroad bridge), from five tributaries of the Forge River (Lons Creek, Poospatuck Creek, Wills Creek, Ely Creek and Old Neck Creek), and from adjacent Moriches Bay. The survey provides data on the present-day bathymetry of the region; however, this depth information is not to be used for navigation.

EQUIPMENT

The depth data collected during this project was collected using a Innerspace Technology INNERSPACE 455 or a Bruttour CEESTAR single-beam echosounder operating at 200 kHz to measure water depth and a GARMIN N17 DGPS unit using WAAS differential corrections to determine position. These sensors were mounted on a 16-foot Boston Whaler. The depth and position data were recorded on a laptop computer using HYPACK hydrographic survey software (version 6.2). The HYPACK program also provided guidance to the helmsman for following preplanned survey lines. The survey software was controlled through use of a weather-sealed, high-visibility touch screen monitor which allowed us to conduct the survey in an open boat. We attempted to collect data on December 18, 19, 30 and 31 in 2007 and on January 8 in 2008. The engine on the Boston Whaler failed on December 19, and a new engine was fitted to the boat on December 28; however, no depth data is used from December 19. The INNERSPACE 455 echosounder was used on December 18 and 19 and the CEESTAR echosounder was used on December 30 and 31 and on January 8. We had anticipated using the leased INNERSPACE 455 echosounder on all survey days, but we had to return the INNERSPACE 455 before the vessel could be repaired. We completed the survey using our CEESTAR digital echosounder. Both echosounders work well in shallow water (water depths to less than 0.5 m). The INNERSPACE 455 echosounder was initially preferred because it provided an image of the depth profile that could be compared with the digital data and because it could make up to 20 depth measurements per second. In contrast, the CEESTAR echosounder provided no image of the depth profile and could make up to 6 depth measurements per second.

Water-level data were collected at one-minute intervals during the survey activities using a Seabird SBE-26 water-level gauge deployed at the Forge River Town Marina. Water levels were manually recorded at several times daily with respect to a fixed reference point to allow the one-minute water-level data to be referenced to a known elevation. The elevation of our fixed reference point was measured with respect to a benchmark referred to in a prior bathymetric survey reported in 2006 by A. James de Bruin & Sons, LLP to the County of Suffolk Department of Public Works entitled "Maintenance Dredging at Forge River Town of Brookhaven." The benchmark is located at NAD 83 State Plane Coordinates (N.Y. L.I. Zone) N=232,120.79 ft E=1,307,812.67 ft, which is near the launch ramp at the Brookhaven Town Marina on the Forge River. The elevation of this bench mark is given as 4.5 feet above MLW (Mean Low Water). MLW is defined as the average of the low tides for 19 years, and the actual elevation of MLW can change over time due to factors such as global sea-level rise or local ground movement. We do not know the basis of MLW used by de Bruin in the Suffolk County survey, although the General Notes on the survey suggests that MLW is 0.35 feet above mean sea level (MSL) (one would expect MLW to be below MSL). However, this is an important datum since the Suffolk County surveys of 2006 are conducted with respect to this benchmark. To avoid confusion with tidal datums defined by others, we will refer to MLW defined on the de Bruin survey as "MLW_DB", and we will reference the water depths measured during our survey to MLW_DB. The depth data are reported in meters and positions are reported with respect to the WGS-84 horizontal datum.

We planned to collect depth data along a series of tracks that were spaced about 50 meters apart in the across-river direction and at 50 m apart in the along-river direction (Figure 1). We collected over 165 kilometers (89 nautical miles) of tracks and over 700,000 discrete depth measurements (Figure 2). Not all planned survey tracks could be collected due to shallow water and time limitations, although all of the crossing tracks were run for the main channel and additional tracks were collected in the regions where the five tributaries enter the Forge River.

DATA PROCESSING

Data were recorded in HYPACK RAW format. The echosounding data was processed using SwathEd, a series of hydrographic data reduction programs developed by the University of New Brunswick (http://www.omg.unb.ca/omg/research/swath_sonar_analysis_software.html). This software package is primarily designed for the analysis of multibeam data, but there are also utilities that allow one to read and process single-beam data. Processing steps include depth and navigation editing to remove incorrectly digitized depths and positions, merging depth and water level (tide) data and binning of depths into a 5 meter grid. The binned survey data were imported into ArcView, along with a shoreline file created from air photos (the shoreline on the photos was assigned a depth of MLW), and the combined depth and shoreline data were gridded at 5 m using a least-squares algorithm. Contours were generated from the resulting grid at 0.1 m and 0.5 m intervals. While the 5 m grid reported here is appropriate for presenting our survey results, other grid intervals or gridding algorithms may be appropriate for specific uses.

We noted that in some places the depth data collected by the CEESTAR unit suggested local depressions and elevations of about 0.25 m deep and less than a few meters horizontally in

some of the deeper areas. We are unsure whether these local depressions and elevations represent the bottom conditions or are due to sound penetration into fine-grained sediments (depressions) or to obstructions such as branches (elevations). For the present purposes we tended not to remove these local high and low values, but it may be appropriate to further edit our depth data as the acoustic properties of these sediments are better understood.

INITIAL RESULTS

The water-level data collected during these surveys is shown in Figure 3. These data suggest a tide range of about 0.5 m during the survey, that high tide in the Forge River lags high tide at Sandy Hook by about one hour, that low tide in the Forge River lags low tide at Sandy Hook by about two hours, and that the tide range is about half that at Sandy Hook. The Sandy Hook water-level data is plotted with respect to MLLW (Mean Lower Low Water) while the Forge River water-level data is plotted with respect to MLW_DB. These plots also suggest that MLW_DB is a reasonable representation of Mean Low Water for the Forge River. We have assumed that water level measured at the Town Marina applies throughout the Forge River.

Figures 4-6 shows color-coded and contoured depth data from the survey. There is a clearly defined channel in the Forge River that extends from the Town Marina into Moriches Bay. The channel ranges from about 1.3 m to 1.8 m deep; however, the channel appears to be filled where it reaches the channel in Moriches Bay as a result of sand wave movement. There appears to be a flow connection between western Moriches Bay near the Forge River and Narrow Bay to the west through the trough of one or more sand waves. There is also a broad depression that connects the Forge River to Moriches Bay to the east.

Four of the tributaries to the Forge River have been dredged, and water depths inside the tributaries are deeper than in the Forge River itself. Ely Creek does not appear to have been recently dredged. The deepest water depths are found in Old Neck Creek, where it is up to 2.5 m deep and depths in the other dredged creeks have water up to 1.8 to 2.0 m deep. There are also relatively large dredged basins at the Town Marina and on the east side of the Forge River between Ely Creek and Old Neck Creek. The dredged channels in the creeks and the dredged basins are all deeper than the main dredged channel of the Forge River, and there are elevated sills that separate the channels in the creeks and the basins from the main dredged channel. Figure 7 shows a perspective view of the gridded bathymetry near the Town Marina and at the mouth of Wills Creek. Figure 7 shows that Wills Creek is separated from the main dredged channel by a elongated sill that is 0.2 m high. However, the small channel that connects Wills Creek and the main dredged channel actually runs beneath the outer portion of a large pier at the south end of the Town Marina. A vessel entering or exiting Wills Creek would actually pass over a area of shallower water to the south of the pier.

The overall precision and accuracy of the echosounding data collected during this study can be evaluated by calculating the standard deviation and range of values found within each of the 5 meter bins and by comparing our depth data with that collected by de Bruin for Suffolk County. There were a total of 37,249 with depth data, each with from 1 to 478 depth measurements. On average there were 19 depth data points per bin. The standard deviation of

the depths in each bin averaged 0.024 m (maximum value 0.55 m) and the depth range in each bin averaged 0.075 m (maximum range 1.27 m). Over 95% of the depth bins have a standard deviation less than 0.068 m and depth range less than 0.22 m, suggesting that the survey data is providing a reasonable characterization of the Forge River bathymetry. The higher values of standard deviation and depth range are along the edges of the Forge River channels and near shore where there is in fact a large depth range over a distance of a few meters.

The depth gridded depth data derived for this survey was compared to the spot depths presented on the AutoCAD drawings provided to Suffolk County by de Bruin. A total of 1,723 depths were compared, and on average the depths determined in this study were 0.05 cm deeper than those determined by de Bruin (standard deviation of 0.11 cm). There are some areas where depths differ by as much as 1 m, and a more careful evaluation will be needed to understand whether these discrepancies indicate a change in bottom conditions with time.

CONCLUSIONS

The results of this bathymetric survey provide new and important information about the bottom conditions in the Forge River at the time of this study, information that should be suitable for developing models of water flow and water chemistry.

SURVEY PRODUCTS

The results of this study are being delivered in as computer files containing the edited water depth, the binned water depths, and files containing gridded bathymetric data and depth contours that can be imported into ArcView or other GIS software. Coordinates in WGS84 are reported in degrees latitude and longitude or in UTM coordinates (meters) for Zone 18N. Water depths are reported in meters referenced to MLW_DB. We will continue to work with the Town of Brookhaven to create other products that may be required.

Edited depth data (one file per day, tab-delimited)

Column Headings:

Latitude = Latitude, degrees
Longitude = Longitude, degrees
Depth = Depth, meters, MLW_DB
X-coord = Easting, UTM Zone 18N (meters)
Y-coord = Northing, UTM Zone 18N (meters)

Files:

ES-data-1218.txt
ES-data-1230.txt
ES-data-1231.txt
ES-data-0108.txt

Binned depth data (tab delimited)

Column Headings:

easting = Easting, UTM Zone 18N (meters)(center of cell)
northing = Northing, UTM Zone 18N (meters) (center of cell)
mean = mean water depth in cell (meters, MLW_DB)
sdev = standard deviation of depth values in cell (m)
max = maximum value of depth values in cell (m)
min = minimum value of depth values in cell (m)
range = range of depth values in cell (m)
count = number of depth values in cell
id1 = date of survey providing data to cell (MMDD)
id2 = "
id3 = "
id4 = "

File:

FR-ES-binned.TXT

GIS Files (ArcView 3.1)

Files:

FR-5m-grid-m = 5-meter grid derived from binned data (depths in m)
FR-contour-10cm = 0.1 m contour of FR-5m-grid-m
FR-contour-50cm = 0.5 m contour of FR-5m-grid-m

Figure 1. Planned survey tracks in the Forge River, although it may not be possible to run all of the tracks due to shallow water or obstructions. These tracks are spaced at 50 m intervals and run parallel to and perpendicular to the channels and tributaries. This grid of tracks will provide sufficient information to create a detailed picture of the sea-bed morphology in this region.

Figure 2. Survey tracks run on December 18, 30, 31 (2007) and January 8 (2008). All of the cross-channel lines and most of the along-channel lines were run. Depth data was collected while moving between lines as well as while running lines.

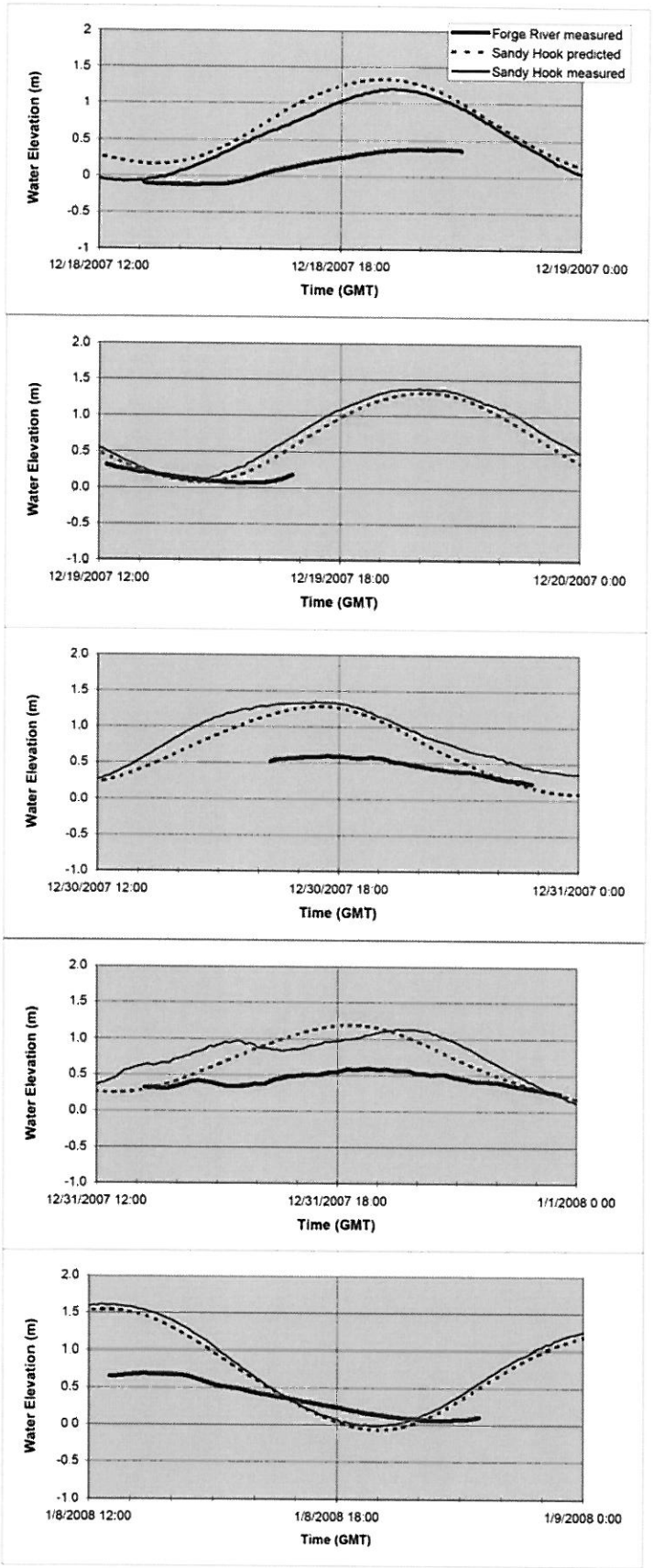

Figure 3. Tidal records from data collected on December 18, 19, 30, 31 (2007) and January 8 (2008) at the Town Marina in the Forge River and at Sandy Hook. The Forge River data was collected by this project while the Sandy Hook data was collected by NOAA. Elevations are in meters with respect to the MLW_DB datum in the Forge River and with respect to the MLLW datum at Sandy Hook. For Sandy Hook, both predicted and measured water levels are shown. The zero levels of the Forge River and for Sandy Hook water-level plots are consistent, suggesting that MLW_DB is a reasonable MLW level for the Forge River.

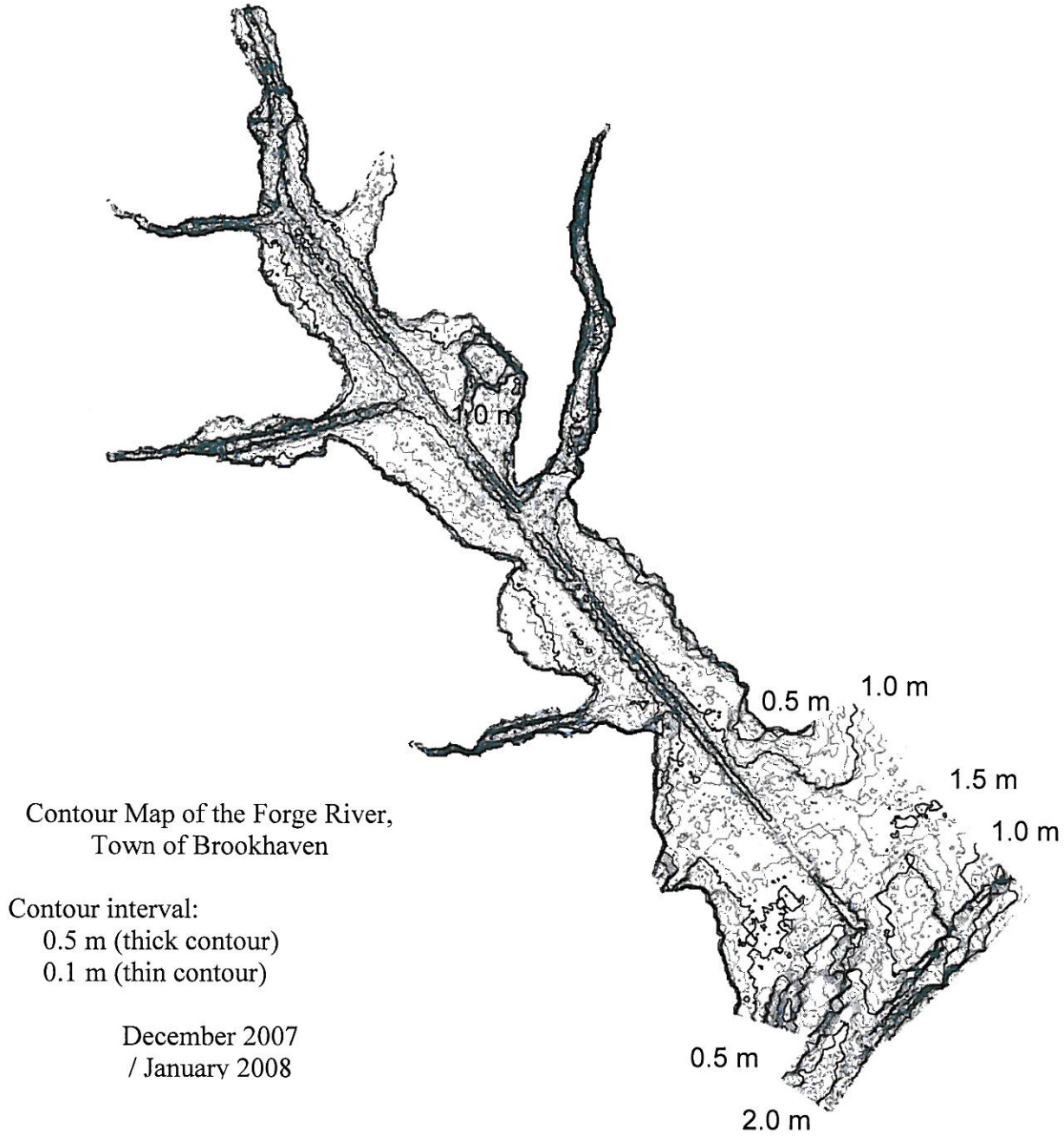

Figure 5. Bottom contours derived from the gridded data in Figure 4. The thicker contour lines are at 0.5 m depth intervals while the thinner contours are at 0.1 m depth intervals. The zero level of the contours is MLW_DB.

Figure 6. Bottom contours from Figure 5 plotted on 2004 air photographs downloaded the New York State GIS web site. The thicker contour lines are at 0.5 m depth intervals while the thinner contours are at 0.1 m depth intervals. The zero level of the contours is MLW_DB.

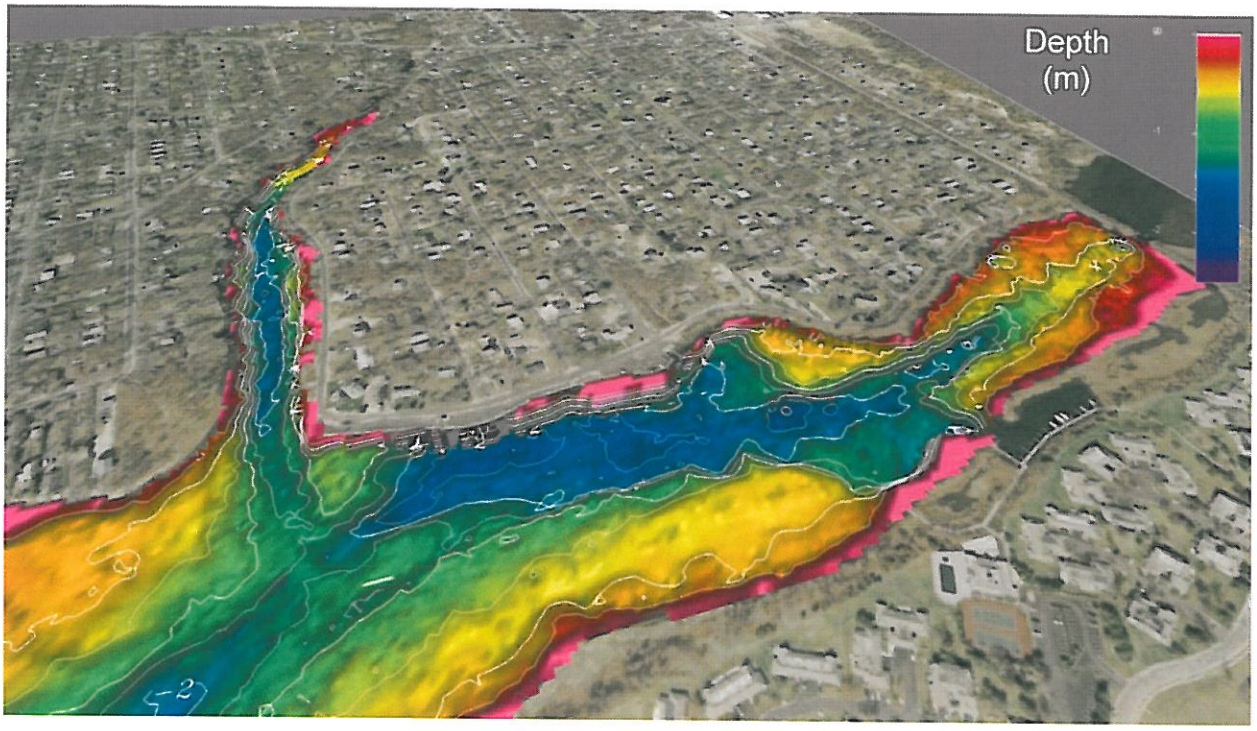

Figure 7. Oblique view of the upper portion of the Forge River and Wills Creek looking towards the northwest. Depths are in meters referenced to MLW_DB (thicker lines are at 0.5 m contour intervals, thinner lines are at 0.1 m contour intervals). This image shows that there is a slight rise of about 0.2 m in the channel that connects the main channel of the Forge River to Wills Creek. However, this small channel actually runs beneath the outer portion of a large pier at the south end of the Town Marina.