Golder Associates

# TECHNICAL MEMORANDUM

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**DATE** July 29, 2010 **PROJECT No.** 09-1436-5008/2000

**TO** Geoff Sinnett
Ministry of Agriculture and Lands, Crown Land Restoration Branch

**cc** Dawn Flotten

**FROM** Karl Manzer **EMAIL** kmanzer@golder.com

**LADYSMITH HARBOUR BATHYMETRIC AND SIDESCAN SURVEY**

The following technical memorandum summarizes the results of a bathymetric and sidescan sonar survey of Ladysmith Harbour near Slack Point, conducted on September 10, 2009. This memorandum is to report specifically on the seabed bathymetry and obstructions as detected during our surveys of the area.

## 1.0 INTRODUCTION

The objective of the bathymetric and sidescan surveys of Ladysmith Harbour was to create a detailed bathymetric chart of the harbour and the area around Slack Point for use in slope stability assessments, to help select sediment sample locations, and to characterize variations in the bottom cover. These surveys are part of a larger geotechnical and environmental program, as outlined in our letter, *Proposed Scope of Work for Environmental and Geotechnical Investigation of Ladysmith Harbour, Ladysmith, BC* dated November 18, 2008.

## 2.0 SCOPE OF WORK

The scope of work for this particular survey was to create a detailed bathymetric chart of district water lots 2016 and 651 as well as the sideslopes of Slack Point using a multibeam echosounder method. In addition, sidescan sonar was used to provide additional seabed information, particularly in near-shore shallow water which could not be imaged with the multibeam transducer around the Slack Point shoreline. Multibeam techniques provide a dense high-quality bathymetric dataset that is automatically corrected for boat heave and roll. Sidescan sonar imagery supplements the bathymetric survey, often providing more detail on the nature and composition of the sea floor features.

# 3.0 METHODOLOGY

The following methods were employed to address the project objectives:

- Real-time kinematic differential global positioning system (RTK) for navigation, and data positioning;
- RTK monitoring of tidal fluctuations;
- Multibeam bathymetry using a shallow water echosounder;
- Heave, pitch, roll, and heading compensation; and
- Sidescan sonar.

## 3.1 Navigation

Primary positioning and navigation control of the survey vessel were undertaken with a Trimble GNSS R8 RTK GPS. This receiver provides updated positions every second and is accurate to better than 5 cm. The horizontal datum used in navigation was WGS84, and also used in presentation of the results.

Navigation data was input in real-time to a computer running Coastal Oceanographics Hypack 6.2a software. Survey lines were not planned using Hypack in advance of the work due to the many anchored vessels and other obstacles in the survey area.

## 3.2 Vertical Datum and Control

The RTK GPS elevation data were used to provide accurate elevation control to better than 5-cm accuracy during data collection. As required by the project, the vertical datum used is Geodetic, as opposed the Chart Datum as is normally used in bathymetric mapping.

## 3.3 Multibeam Bathymetry

Multibeam bathymetric techniques use sonar transducers that transmit a beam of sound energy perpendicular to the longitudinal axis of the boat. Back-scattered energy from the sea bottom is processed to produce a swath of bathymetric information. In this way, a single boat pass can provide bathymetric data for a swath width that is typically one to four times the water depth.

A Reson SeaBat 8124 Multibeam System was used for the bathymetric work, producing 80 beams nominally 1.5°x1.5°, resulting in a 120° swath width. The transducer was side-mounted on a 19-foot shallow draft aluminum survey boat. The data were acquired on a computer using Coastal Oceanographics Hysweep software.

The primary navigation and position control GPS unit noted above was a Trimble GNSS R8 RTK GPS, accurate to better than 5 cm in horizontal and vertical position. A HEMISPHERE VS-110 operated as a heading sensor. The system consists of two GPS antennas mounted at a 2-m spacing perpendicular to the boat axis. Heading is computed from the positions of each antenna relative to the other.

A TSS DMS-05 Inertial Motion Sensor was mounted directly above the multibeam transducer, and provided correction for heave, pitch, and roll due to water surface disturbances.

An AML SV*Plus* Sound Velocity Profiler was used to measure the sound velocity through the water column. This data is incorporated in the processed dataset.

The multibeam data were processed using Hysweep software. Corrections for tides, water sound velocity variation, and geodetic elevation adjustment were applied to ensure accurate elevation data.

### 3.4 Sidescan Sonar

Acoustic images of the seafloor were acquired with an Imagenex Sportscan dual-frequency digital sidescan sonar system. The sidescan can operate at 330 kHz and 800 kHz frequencies. Images are collected directly to a laptop computer through the serial port. Concurrent streaming of RTK GPS data provided position and speed control to the sidescan data collection software. The sidescan towfish was hard mounted on the side of the vessel. Survey lines were not linear due to the many vessels and breakwaters. Overlapping coverage was collected at the high frequency (800 kHz).

## 4.0 FIELDWORK

The geophysical survey was carried out on September 10, 2009 by Karl Manzer of Golder Associates, Ltd. and Alex Howden of CRA-Canada Surveys Inc. using the 19' aluminum vessel “CRA-Surveyor”. Data collection was timed for high-tide to maximize the shallow water area of survey coverage. Bathymetric and sidescan data were collected simultaneously over the area of interest.

## 5.0 RESULTS AND DISCUSSION

The resulting bathymetric chart of the surveyed area is displayed in Figure 1. This chart represents the seabed elevations as contour lines spaced at 50-cm intervals, and labelled every 2 m. In addition, color shading is used to show increasing depths as progressively darker blue colours. Seabed elevations in the area of the site ranged to approximately 12 m below the geodetic zero elevation.

The seabed depths are shown as negative numbers because they represent elevations relative to the land based topographic system. The topographic system shows land elevations as positive numbers above a government determined mean sea level, and is generally known as the geodetic datum. Normal bathymetric charts simply show depths as increasing numbers below a chart datum, which is generally selected as a minimum low tide. In Ladysmith Harbour the difference between mean sea level and chart datum is about 2.5 m.

The depth accuracy of the multibeam system is approximately ±0.1 m in the water depths encountered at the Ladysmith harbour site. After interpolating and contouring of the multibeam data, the resulting chart has a depth accuracy of approximately ±0.3 m for the area shown in Figure 1.

The sidescan results are given as Figure 2, showing a mosaic of the sidescan imagery with the bathymetric contours overlaid on top of the image. The sidescan data is interpreted for seabed features, such as vertical piles, sunken logs, vessel wrecks, cables/chains, and other submerged objects. These features are coded with coloured symbols and marked at their sidescan location on Figure 2.

Figure 2 shows a very large number of submerged objects in this part of Ladysmith Harbour. Many of these are related to the boat moorings, including many of the piles, cables, and possible concrete anchor blocks. It is not possible to determine which of these boat mooring features are in use, and which are relics that could pose a hazard to navigation. There are some features that are clearly hazards to navigation, including the two obvious vessel wrecks shown on Figure 2, and likely some of the piles, particularly if they are broken and possibly submerged.

## 6.0 CONCLUSION

Multibeam and sidescan data that were collected in Ladysmith harbour have been presented in Figures 1 and 2, as requested. These Figures represent the final deliverable for this particular task.

**GOLDER ASSOCIATES LTD.**

ORIGINAL SIGNED

ORIGINAL SIGNED

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KMM/MGM/rja

Attachments: Figure 1 – Seabed Contours
Figure 2 – Sidescan Sonar and Seabed Contours

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Notes:

1. Contours are interpolated from a multi-beam sonar survey performed by CRA Canada Surveys Ltd. on 2009-09-10. Geological surfaces may vary significantly in areas of sparse or no data.
2. Vertical datum: GSC vertical (MSL)
3. Horizontal datum: WGS-84, UTM Zone 10N
4. All coordinates are in metres.
5. Sonar equipment:
   Reson SeaBat 8124 multibeam echosounder system, 80 beams, 1.5°x1.5°, 120° width,
   TSS DSM-05 heave/pitch/roll motion sensor,
   Hemisphere VS110 heading and position sensor,
   AML SVplus velocimeter.
6. Positioning equipment: Trimble GNSS R8 RTK GPS receiver
7. Note that depth data is to nearest reflector which may not be directly below measurement location. Actual depths may vary, especially on steep slope reflectors.
8. An image has been added beneath the contours, with shading illumination from the north-east, and coloured-coded by depth.

Legend:

Seabed Contour, Major [m] (Golder, 2009)
Seabed Contour, Minor [m] (Golder, 2009)
Sidescan Sonar Track (Golder, 2009)
Shoreline & Existing Jetties

PROJECT

Ladysmith, BC

TITLE

SEABED CONTOURS
2009-09 SURVEY

Golder Associates
Burnaby, BC

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|---|---|---|---|---|
| PROJECT No. | 09–1436–5008 | | FILE No. | ...–2000_seabed |
| DESIGN | | | SCALE 1:1250 | REV. 1 |
| CADD | NT | 20091002 | Figure 1 | |
| CHECK | KM | 20091002 | | |
| REVIEW | MM | 20091002 | | |


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   AML SVplus velocimeter.
6. Positioning equipment: Trimble GNSS R8 RTK GPS receiver
7. Note that depth data is to nearest reflector which may not be directly below measurement location. Actual depths may vary, especially on steep slope reflectors.
8. The sidescan sonar image, a mosaic of the individual line scans, has been added beneath the contours.
9. The location of sidescan sonar picks is approximate.

Legend:

- Seabed Contour, Major [m] (Golder, 2009)
- Seabed Contour, Minor [m] (Golder, 2009)
- Shoreline & Existing Jetties
- Sidescan Sonar Pick: Boat
- Sidescan Sonar Pick: Pile
- Sidescan Sonar Pick: Log
- Sidescan Sonar Pick: Cable
- Sidescan Sonar Pick: Unknown Object
- Sidescan Sonar Pick: Unknown Object, Large

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|---|---|---|---|
| PROJECT | Ladysmith, BC | | |
| TITLE | SIDESCAN SONAR & SEABED CONTOURS 2009-09 SURVEY | | |
| PROJECT No. | 09-1436-5008 | FILE No. | ...-2000_sidescan |
| DESIGN | | SCALE | 1:1250 |
| CADD | NT 20100602 | REV. | 1 |
| CHECK | KM 20100602 | Figure 2 | |
| REVIEW | MM 20100602 | | |

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Burnaby, BC

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