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PROJECT MEMORANDUM

To:	**Wolfden Resources Inc.**	**Fax No.:**	**Via email**
Attention:	**Andrew Mitchell**	**CC:**	**J. Cassie**
From:	**Holger Hartmaier (Ext. 113)**	**Date:**	**May 1, 2007**
Subject:	**High Lake Project- Response to Regulatory Requests- Grays Bay Dock Site Bathymetry Differences**		
No. of Pages (including this page): 6 Pages		**Project No:**	**0385-003-22.3**

REGULATORY QUESTION:

This response addresses the apparent differences noted between bathymetric measurements obtained by means of marine seismic surveys and those obtained by drilling within the proposed dock site footprint at Grays Bay.

RESPONSE:

1.0 MARINE BATHYMETRY AND SEISMIC SURVEYS

A bathymetric and marine seismic reflection survey of the proposed Grays Bay dock site area was carried out by Associated Mining Consultants Ltd. (AMCL) for BGC Engineering Inc. (BGC) between July 26 and August 2, 2005. The objective of the survey was to map the water bottom and bedrock topography over an area of about 300 m x 100 m along the shore, encompassing the 20 m depth contour line. The purpose of the survey was to provide sub-sea information to support the positioning and alignment design of the proposed dock structure.

The following is a summary of the pertinent details concerning the marine surveys conducted (from AMCL, 2005):

- The line spacing averaged 5 m sub-parallel to shore with perpendicular lines at 25 m spacing.
- A total of 18.4 line km of seismic data were acquired.
- The seismic reflection method measures contrasts in acoustic impedance within the material, which is a product of a material's density and the velocity of acoustic waves within the material. Strong acoustic impedance contrasts exist across the water-bottom/sediment interface and across the sediment/bedrock interface. Weaker acoustic impedance contrasts can exist within sedimentary layers above the bedrock. This method is commonly used to map bathymetry, sedimentary layering, presence of boulders in the sediment and submarine bedrock topography.

- In marine or lake environments, the seismic event is produced by an acoustic source, usually a piezo-electric plate or an air-gun located just below the surface, with resulting arrival times recorded at hydrophones towed behind the source. The depths to layer boundaries are determined by round trip travel times from the source to the layer boundaries and back to the hydrophones and by the velocities of travel within the layers.
- Bathymetric data were collected using a Furuno depth sounder with Trimble 5700 GPS antenna attached to the top of the transducer mounting pole. The GPS system obtained real-time corrections from the Canadian Differential GPS (CDGPS) correction network (for more information see their website at www.cdgps.com).
- A tidal gauge was also installed in the area of the survey to monitor tidal changes and make appropriate corrections during processing. The amplitude of the tidal variation was less than 12 cm and is not a major source of error in this study.
- The seismic data were collected using a bubble-pulser as the marine energy source, and a hydrophone cable as the receiver. The bubble-pulser was manufactured by Datasonics of Maine, USA. It produced a 400 Hz wavelet, with an approximate bandwidth from 200 to 800 Hz. At that frequency and with the velocity of the seismic wave in water (1500 m/s), the wavelength is in the order of 3 to 4 m, making it very difficult to unambiguously map any horizon less than 2 m in thickness.
- The seismic source was towed on the side of boat while the hydrophone cable was dragged 5 m behind the source. The source was triggered every second and the signal recorded on a PC-based 16-bit analog to digital data-acquisition card.
- Resolution and depth of penetration are always a concern in the design of marine seismic surveys and there is always a compromise between the two. The earth acts as a low pass filter so that the greater the desired depth of exploration, the lower the resolution.
- In general, the seismic data obtained during the survey was excellent, providing clear imaging of the bedrock to depths of greater than 60 m.
- Correlation of the bedrock reflector from line to line was unambiguous and a bedrock elevation map was derived using a 1500 m/s velocity for the overlying saturated sediments and water column.
- The accuracy for the depth to bedrock interpreted is $\pm$ 0.5 m for depths of up to 5 m below water bottom and $\pm$ 10% of the depth for depths in excess of 5 m. This accuracy takes into consideration the error on the time pick and the calibration process of the velocity to convert from 2-way travel time to depth. If borehole information was available to calibrate the data, the accuracy could be improved to 5%.
- A bedrock contour map and sediment isopach map were generated from the data points and gridded using a 2.5 m x 2.5 m cell size.
- The contour plan was then used to generate cross-sections along north-south lines at 5 m spacing. The cross sections show the sea-bottom and bedrock surface profiles based on the contours generated from the data points.

2.0 DRILLING INVESTIGATIONS

The 2005 bathymetric surveys were used to refine the location and orientation of the proposed dock structure. To confirm the proposed dock layout, drilling investigations were carried out between April 29 and May 6, 2006 from the ice surface in Grays Bay to confirm water depth, marine sediment thickness and bedrock type.

To simplify the correlation between the geophysical data and the drilling data, drill holes were located along selected profiles chosen from the geophysical sections prepared by AMCL. In total, 11 boreholes were drilled offshore in the dock site area in 2006.

The holes were staked out on the ice using CDGPS for positioning. Holes were drilled at the staked locations using a helicopter portable, skid-mounted BBS 1 drill rig. HW (88.9 mm outside diameter) casing with serrated edges was initially cut through the sea ice. The ice thickness was measured at each drill hole location. After the ice was cut, HW casing was set down the hole to the top of the marine sediments (if present). The casing was then slowly advanced through the marine sediments to the bedrock surface. In some cases, bedrock was overlain by a layer of till. In these cases, the casing was set into the till. Once the HW casing was set, NW (66.7 mm OD) casing was placed down the borehole and advanced approximately 0.3 m into the bedrock. After the NW casing was set, drill rods and a 10 foot core barrel were lowered down the borehole so bedrock coring could commence.

For each borehole, the following data was collected:

- Ice thickness.
- Depth of water to sea floor.
- Depth to top of rock.

Borehole logs showing the detailed sea bed conditions encountered at each location are given in the 2006 Geotechnical Investigation Report (BGC, 2007).

The elevation of the top of ice surface was obtained relative to assumed sea level (elevation 0.00 m) by applying a correction based on the relative density of seawater and ice, using the following formula for isostatic equilibrium:

$$Pi = Pwd/(d+f)$$

Where: Pi = Bulk density of snow/ice (assumed to be 913 kg/m^3)
Pw = Density of seawater (assumed to be 1024 kg/m^3)
d = depth of ice below sea level (draft)
f = thickness of ice above sea level (freeboard)
(d+f) = t, total measured ice thickness

The amount of freeboard (f) ranged from 0.15 m to 0.23 m. These values were then used as the assumed hole collar elevations and are given in the borehole logs. No correction for the collar elevation of the hole was applied for the potential deflection of the ice surface due to the imposed weight of the drill rig. There was no additional surveys conducted at the time of drilling to verify the collar elevation and "as-built" hole location. Therefore there may be a potential error between the set-out stakes and the actual hole location.

3.0 SOURCES OF ERROR

The noted differences between the water depth, sediment thickness and depth to bedrock obtained from the bathymetric surveys versus those obtained by drilling may be due to the following, including any combination thereof:

- Irregularities in natural seabed and bedrock topography, which may change quickly over short distances and are not resolved by the geophysics. The geophysical surveys cannot resolve highly irregular variations in bedrock topography. AMCL noted that the surveys could not unambiguously map any strata less than 2 m in thickness.
- Accuracy of depth measurements using seismic reflection techniques. As noted above in Section 1, AMCL reported that depths would be within 0.5 m up to 5 m depth and $\pm$10% for depths greater than 5 m. Therefore, for water depths of 20 m, errors of $\pm$ 2 m may be expected.
- GPS positioning accuracy. The CDGPS increases accuracy to $\pm$ 0.5 to 3 m compared to $\pm$ 10 m for a single GPS (www.cdgps.com). If there is a 3 m positional error bar on each bathymetric sounding location (data point) and a 3 m error bar on the surveyed location of the borehole, there can be significant variations in depth measurements associated with each location. The CDGPS website provides further details on the accuracy and errors associated with GPS surveys.
- The profiles used to position the borehole locations were derived from contours that were interpolated from the individual data points using a 2.5.m square grid. Therefore, at each given section, the profiles shown for seabed and bedrock surface are interpolated and may not accurately represent the actual position of each surface in the plane of the section.
- Prior to drilling, the anticipated relative depths to seabed and bedrock surface at each proposed borehole location were scaled from the geophysical sections, so there may be some errors associated with taking the measurements.
- Although great care was taken to collar each hole at its staked location, there may be inaccuracies associated with positioning the drill rig coincident with the surveyed stake.
- The sediment at the water/sediment interface is very loose and unconsolidated. The reflector chosen to represent the water/sediment interface on the geophysical profiles may not coincide with the inferred top of sediment determined by lowering the casing to the sea floor. The casing may penetrate to greater or lesser depths depending on local soil density and consistency.

For design purposes, the borehole depths to the various stratigraphic interfaces and coordinates are considered to provide the best and most accurate positioning of the seabed stratigraphy. AMCL noted that the bathymetric surveys could be improved to ± 5% if drill hole data was used to re-calibrate the interpretation. BGC would recommend that this be done as part of the next phase of the ongoing design work, since it would only require a desk-top re-analysis of the data. The revised seabed contours and isopach maps would provide a more accurate estimate of the volumes of material to be excavated and perhaps refine the positioning and orientation of the dock structure.

Despite the measurement inconsistencies noted, the bathymetric and sub-bottom profiling proved useful in confirming the alignment and location of the dock structure, avoiding the area of deep marine sediments. This interpretation was confirmed by the 2006 drilling program.

4.0 CLOSURE

We trust this information meets your requirements at this time. Should you have any questions or require additional information, please do not hesitate to contact the undersigned, at your convenience.

Yours truly,
BGC Engineering Inc.
Per:

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REFERENCES

Associated Mining Consultants Limited, 2005. Marine Seismic Survey, Grays Bay, Nunavut, prepared for BGC Engineering Inc., September 2005.

BGC Engineering Inc., 2007, 2006. Geotechnical Investigation Program, High Lake Project, NU, Final report prepared for Wolfden Resources Inc., March 26, 2007.

www.cdgps.com