Dual Frequency Echo Sounding for Sedimentation

How the CEE ECHO™ and CEESCOPE™ low frequency (24 kHz or 33 kHz) may be used to indicate regions of active sedimentation or determine recent deposition.

Dual frequency echo sounders from CEE HydroSystems allow the user to evaluate where recently deposited sediment may be present. All dual frequency units can operate high and low frequency sonar simultaneously effectively allowing two independent surveys to be done at once. Not only does this provide information about sedimentation, but it offers a valuable cross check on sounding results.

Typically, the high frequency (HF) will give a water depth to the first point of return. This can be sand or rock but also top of soft sediment or sub aquatic vegetation canopy. The low frequency (LF) will usually give the same depth response on sand and rock but the longer wavelength sonar ping may penetrate through the upper layers of bottom material and show a harder, more consolidated surface below.

Therefore, two depth results are obtained, the top of the sediment and the top of the harder or more compacted sub-bottom layer. This might be a river channel that has been dredged and subsequently refilled with recent sediment, or a concrete pond with sludge accumulation. Below is a sample of the water column display of a single ping for the two sonar frequencies as seen in HYPACK Hydrographic software using a CEESCOPE™ survey echo sounder system (200/33kHz option).

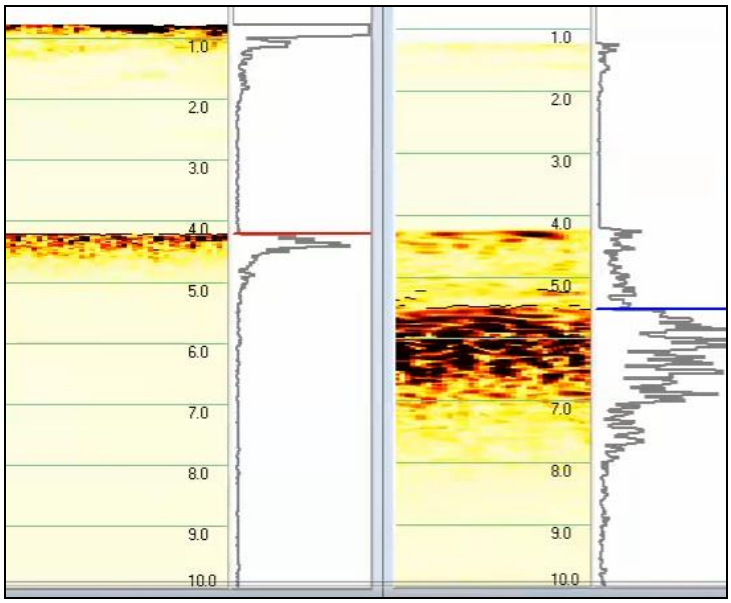

Figure 1: Dual Frequency Echogram sample in HYPACK®

The information in Figure 1 shows the HF data in the left column and the LF data in the right column. The red line indicates the computed HF depth (approx. 4.1m/13.5ft) with the blue line indicating the depth computed by the low frequency (approx. 5.4m/17.75ft).

The CEESCOPE™ and CEE ECHO™ output the computed “digital depth” as well as the full water column acoustic data as shown on Figure 1, at a ping rate of up to 20Hz. While the sediment surface is visible on the LF echogram, it is not the strongest intensity return; that is the layer shown by the black band of strong intensity 1-2m below. So, the echo sounder automatically picks the sub-bottom layer as the reported depth result. The ability to visualize this acoustic echogram data in real time and when processing in addition to the “digital depth” value is a crucial factor allowing proper interpretation as the survey results to be used in the final product. Additionally, a manual mode of operation allows a user to “tune” the echo sounder ping characteristics to optimize sub bottom feature detection. Therefore, dual frequency data highlights variation not only in water depth but also potential areas of sedimentation.

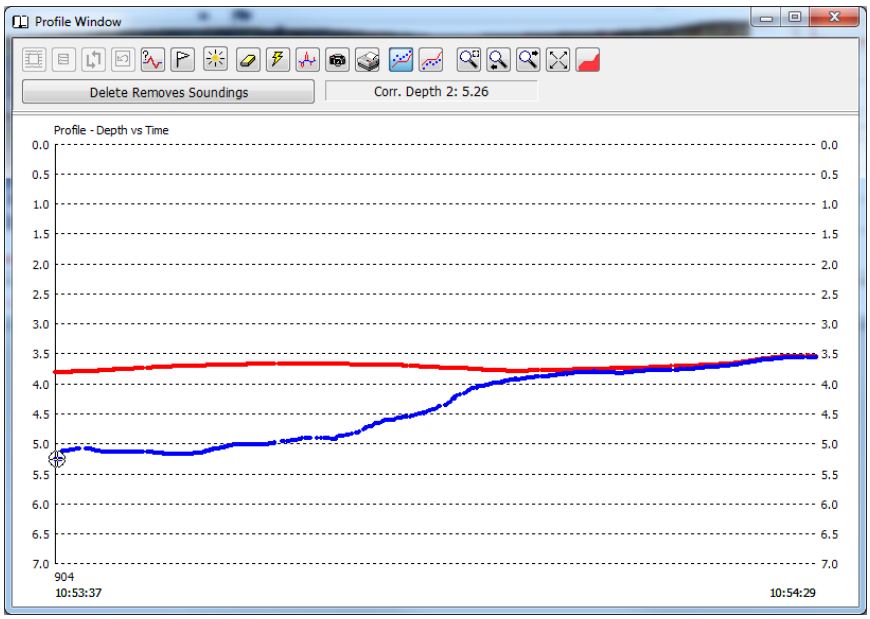

Figure 2: Digital depth profile without echogram from CEESCOPE™

The processed data above shows a clear indication of the apparent sediment layer that has filled the channel. The image below shows the “raw” acoustic signal of the corresponding profile showing the layers.

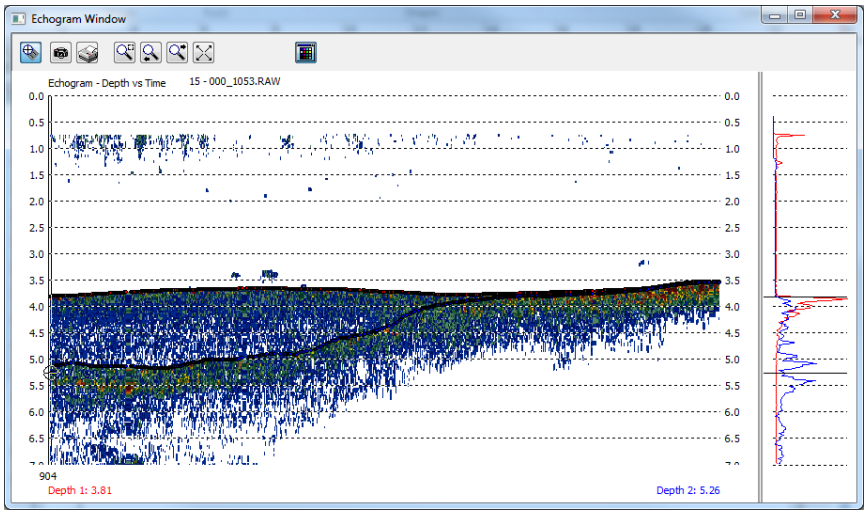

Figure 3: Echogram depth profile of CEESCOPE™

By collecting the two frequencies simultaneously it is possible to create two independent data sets. These data may be overlaid on top of each other to compare the two levels. By producing this result over a large area of coverage the differences can be visualized as a surface to surface comparison. The sample below shows potential sediment accumulation in the main channel of the waterway shown in Figure 2-3. The color of the pixels indicates the depth difference between the HF and LF surveys, and therefore surface sediment thickness.

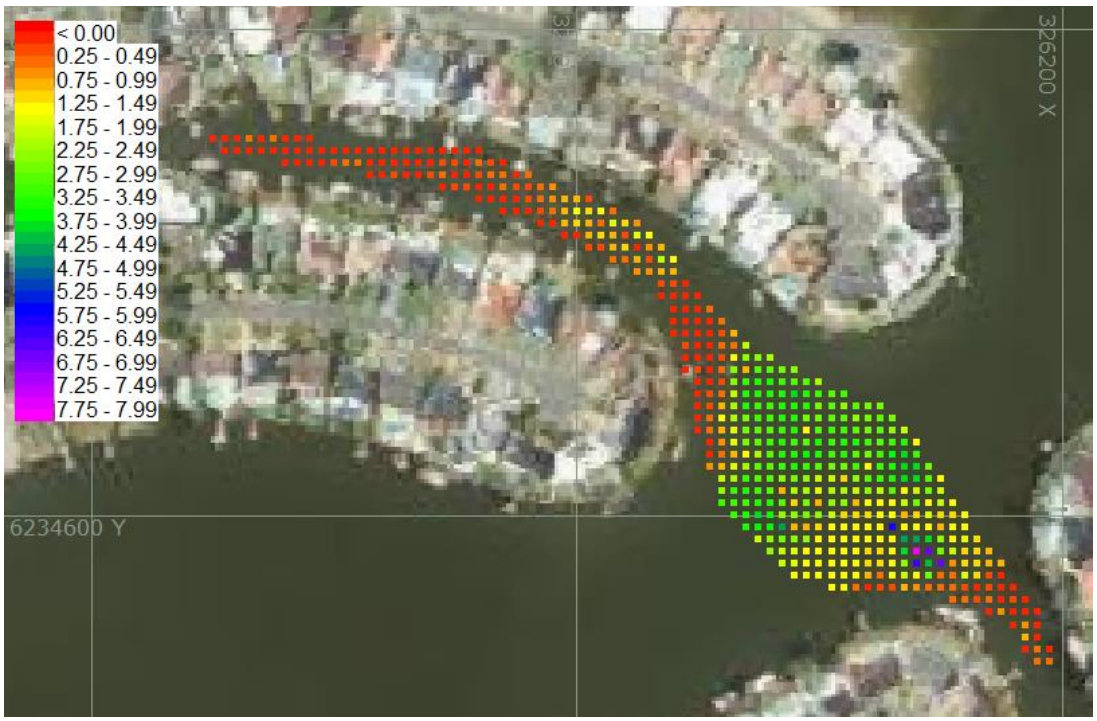

Figure 4: Surface to Surface comparison of dual frequency data (units are meters).

IMPORTANT: ***Dual Frequency Operational Considerations.***

The depths derived from a dual frequency system will **indicate** areas of sediment, for a true thickness value a manual probing/core sampling deployment should be used to correlate the echo sounder data against actual physical properties.

A key factor to understand is the limitation of LF operation in shallow water. While a CEE HF echo sounder may be able to read reliably in very shallow water (less than 0.2m/0.65ft for the CEESCOPE™ and CEE ECHO™) the LF will struggle to penetrate sediment to any extent in very shallow water due to the low power being used to enable such shallow readings. The shallowest the LF can reliably measure will be 0.6m/2ft below the transducer. We recommend operating in around 2m/6.5ft water depth to be able to generate sufficient acoustic energy to effectively penetrate softer material.

Typically, an echo sounder will calculate a depth based on the first point of return within the acoustic footprint generated. For this reason the best approach to collect survey data is to run perpendicular to the contour. To run parallel with contours in areas of varying depth will likely result in the depth values clipping on the shallower side of the vessel, this may not relate to the computed position and as such the resulting depth plots may not be an accurate representation of the profile. It may be possible to collect data along a contour in a maintained channel where depths are more constant. The operator should investigate this option further if that is to be the method used.