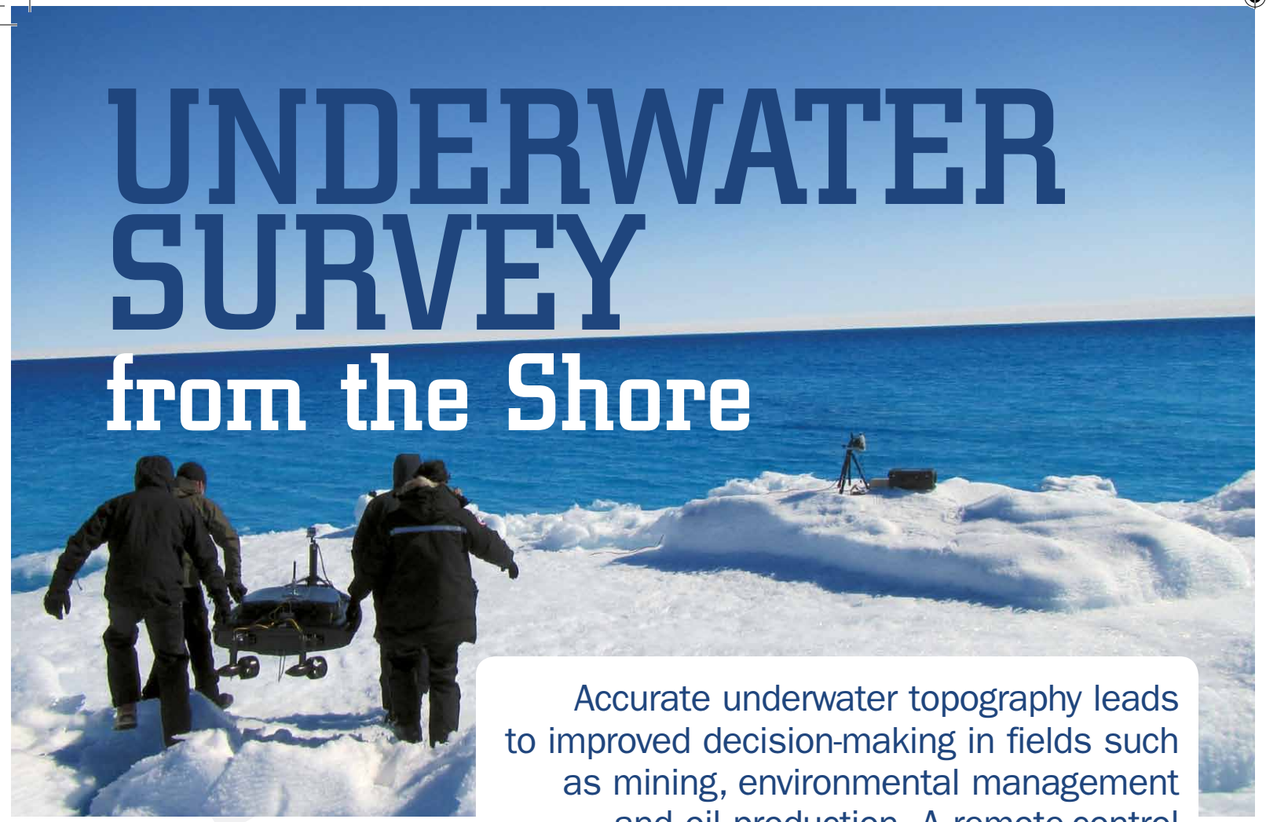
UNDERWATER SURVEY from the Shore



Accurate underwater topography leads to improved decision-making in fields such as mining, environmental management and oil production. A remote-control surveying technology makes it easier and safer to gather critical data.

By Christine L. Grahl

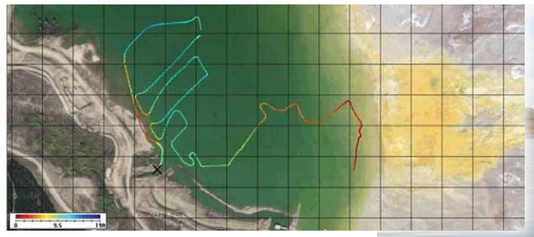
Mining, like many industrial processes, is critically dependent on water. The most obvious water feature of many mines is an earthwork tailings dam, behind which is a tailings settling facility (TSF). A slurry of water and fine sediment (tailings) is pumped to the TSF, where natural processes of sedimentation and consolidation produce water at the surface above a layer of thickening sediment. The dam is created using natural topography, and the sediment height gradually builds until the entire volume is full of solid deposits. While the TSF is in operation, water derived from the tailings is continuously reclaimed and reused. Land surveying is key to ensuring the safe operation, monitoring and maintenance of the TSF; RTK GNSS surveys produce topographic maps that are used to generate accurate models of the tailings facility above the water level.

As the water stored in the TSF is recycled, water balance engineering models rely on knowledge of the water volume in the impoundment. Additionally, the mine may have a legal obligation to periodically report the TSF water volume. Understanding the TSF bathymetry is crucial. However, unlike the advanced equipment and survey methods used for the above-ground portion of the TSF, surveying the underwater topography has commonly been subject to comparatively more rustic methods. Surveyors on small boats might simply use a long pole or weighted line to obtain the approximate depth to the sediment surface at discrete positions. Simple sonar systems have been used in place of the pole, with the depth reading logged alongside the position–still a labor intensive methodology. Traditional hydrographic surveys using single beam echosounders on dedicated survey boats are conducted periodically to obtain high-quality bathymetry, either using mine survey equipment or a contracted surveyor.

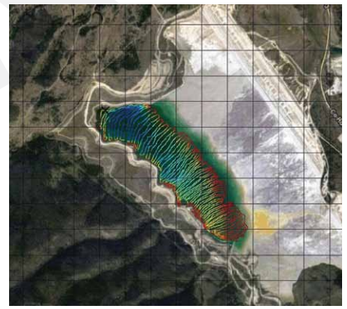
All of these methods require people out on the water, which, in the TSF environment, has specific safety considerations. As a waste product from an industrial process commonly involving aggressive acidic or basic solutions, water in the TSF may be hazardous. In addition, access to the water is difficult since the soft tailings deposits cannot be easily traversed.

Adrian McDonald, PhD, senior sales executive at The Oceanscience Group, headquartered in San Diego, says mine operators have long been seeking alternatives. "Mine operators have recognized that if available, TSF bathymetry data across many of their sites could be improved by faster, easier or more cost-effective surveys, then operational decision making and planning could be assisted on a short- and long-term basis," he explains.

One solution quickly gaining traction could be mistaken for a large toy at first glance. Far from it, the 60 pound, nearly 6-foot-long Z-Boat 1800, manufactured by Oceanscience, is actually a sophisticated remotely-operated hydrographic surveying



Opposite: U.S. polar scientists in Greenland use a Z-Boat 1800 to conduct studies on supraglacial lakes formed from ice meltwater. Above: Test survey results showing the track of the Z-Boat and associated depths on a portion of a mine tailings dam. Right: The boat is used to collect hydrographic survey data on a remote mine site. Below: Representative data from a bathymetric survey of a mine tailings dam.



tool. A single beam echosounder is combined with onboard GNSS to provide continuous measurement of the depth under the boat as it follows the survey line guided by the operator. However, instead of having this equipment directly connected to the survey laptop or data collector like on a typical survey launch, a long range wireless link is used to transmit survey data to the shore, where soundings and GNSS position are acquired using software such as HYPACK.

The display on the shore computer assists the operator in guiding the boat by displaying the boat position, heading and the completed survey track. The boat's onboard control and communications module (CCM) accepts up to three serial RS232 inputs: GNSS position, soundings from the sonar and boat heading from a magnetic compass. This data is combined into a single data stream, recorded on an internal memory card and simultaneously transmitted to the shore using either a Bluetooth or spectrum radio link.

According to McDonald, mine engineers interested in gathering TSF bathymetry using a remotely-operated boat typically have similar requirements, independent of where the mine is located. "They're looking for low complexity and high ease of use," he says. "Mine surveyors tasked with generating the bathymetry data usually require a system with simple work processes to limit the requirement for additional training or technical support. They also require resistivity to corrosion and degradation, even in solutions as aggressive as 20 percent sulfuric acid (pH 0.5). They need flexibility to match GNSS and sonar instrumentation to the individual site needs since most sites already have access to accurate RTK receivers used with the site corrections network that can be used on the remote survey platform. And they need modular construction to allow easy servicing. Since mine sites are often in remote locations, having discrete components that can be stocked as duty and spare items prevents downtime." The Z-Boat was designed to meet these requirements, McDonald says.

At one mine site, an existing Trimble R8 RTK GNSS was integrated onto a twin motor Z-Boat with a 200 kHz echosounder. The Z-Boat accepts standard NMEA 0183 format ASCII data, and the R8 was switched to output NMEA messages through its serial port. With the GNSS equipment and echosounder functioning, the next step was to set up the acquisition software–in this case DrDepth, although professional survey packages such as HYPACK can also be used.

With the boat and shore laptop set up, the wireless link established and a radio repeater deployed for local RTK corrections, the system was transported in a mine truck to the tailings dam access point. McDonald says launching the boat requires safe access with hard ground, although only about 10 inches of water is needed to float the boat off.

"Instead of using the regular boat, fish finder, GPS and notebook like before, the mine was able to perform a safe, remote hydrographic survey of the 1.3 mile x 0.3 mile tailings dam using the Z-Boat and obtain a dataset vastly superior in coverage and accuracy compared to anything done before," McDonald says.

At yet another mine site in a remote location, engineers were relying on manual soundings taken with a weighted line and GNSS point shots. Obtaining accurate water volume measurements in this manner proved too laborious to provide a complete TSF bathymetric survey; hence, survey data available for water management modeling, while an improvement over no data, had significant uncertainty. Without an echosounder on their existing survey boat, much of the tailings dam was inaccessible by traditional means. Conducting surveys every two weeks with the Z-Boat provided a near real time view of the evolution of the TSF.

"The mine operator in this case noted that the system provided far better accura-

The Z-Boat 1800 used in Greenland was outfitted with a Seafloor Systems SonarMite 200 kHz depth sounder, a SonTek M9 acoustic Doppler current profiler and a Trimble R8 GPS receiver. Below: The Z-Boat is easy to transport to remote locations.

cy and increased confidence in the calculations based on the provided dataset," says McDonald. "At the completion of a survey, depths are converted to elevation and the data set is imported into ArcMap (Esri), MineSight, AutoCAD or other mine management software. The bathymetry dataset is merged with existing land survey topographic data to generate stage, volume and area curves for the TSF, offering engineers accurate existing water volumes and available storage above the existing water surface. Having better data, in terms of quality and quantity at the start of the process, benefits everything derived thereafter."

Improved safety is also a major benefit. "Mines are always looking for ways to incrementally improve safety," McDonald says. "Some locations will inherently have more risks concerned with tailings dam surveying than others, but in every single case, getting people off the water in an industrial tailings dam setting is a step in the right direction."

The remote-controlled survey boat is also finding applications in other markets. Environmental research, for example, often takes place in locations that are difficult to access by traditional means. When U.S. polar research scientists embarked on a study of Greenland's supraglacial lakes formed from ice meltwater in July, all of the equipment and personnel had to be transported to the remote locations by helicopter–including the survey boat. The boat had to be capable of handling the instrument payload, able to operate at up to 3,000 feet in distance, provide real-time GPS position and heading, and record lake bathymetry to centimeter-level precision.

The team used a Z-Boat 1800 equipped with a Seafloor Systems SonarMite 200 kHz depth sounder to accurately measure the lake bathymetry, and an acoustic Doppler current profiler (SonTek M9) for velocity measurements. The scientific payload included reflectance monitoring equipment used to help relate satellite measurements to actual supraglacial lake bathymetry. Precise positioning was provided by a Trimble R8 GPS receiver operated in RTK mode.

"The Z-Boat provided a solution where a larger boat would have been impossible to transport to the survey site," McDonald says.

Likewise, when an oil field service company needed a way to accurately and quickly determine the water volume in their customers' holding ponds, mobilizing a traditional survey boat was deemed too time-consuming and costly. With a remotely-operated survey boat, a single technician was able to survey several ponds in one day. "The boat can be carried in the back of a truck and deployed without assistance," McDonald says. "Real time data telemetry allows the operator to use the navigation display on the shore laptop to accurately guide the boat around the pond. Unlike a manned boat, the Z-Boat 1800 can reach the entire pond surface—even in only 12 inches of water depth, important because the ponds are often irregular in shape with shallow connecting lanes."

McDonald doesn't see the Z-Boat replacing traditional hydrographic survey equipment, which he says still has its place. Rather, the compact, remote-controlled system fills a gap that hasn't been addressed before. "Surveying firms that have been actively following technology trends are looking around at the market and asking, 'What can we do next?'" he says. "Where hydrographic surveying applications might have been previously cost-prohibitive or inaccessible, this technology is creating new opportunities."

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