Courtesy of Inmarsat

The technology to monitor dams remotely and in real-time is available, the question is whether miners are open to using it.

The internet of tailings

Better connections, affordable sensors and smarter platforms are the foundation for modern tailings storage facility monitoring

By Cecilia Keating

Mine operators and regulators can now monitor readings from sensor equipment installed at tailings storage facilities more quickly, less expensively and without having to physically traipse around the tailings dam to manually collect the data. In some cases, engineers can check in on dams' sensor readings in near real time from thousands of kilometres away.

This is largely thanks to the technological sorcery of the internet of things (IoT). When mentioned in relation to mine tailings monitoring, IoT technology means that old-school geotechnical sensors – like thermistors, inclinometers and piezometers – are made "smart," or imbued with the ability to communicate. In other words, battery-charged data acquisition systems are matched to the sensors threaded across a tailings dam, collecting sensor data and transmitting it to a central hub through a communications network. That central gateway will, in turn, push data to a digital dashboard where mine engineers and regulators can review it.

"A fully automated monitoring system 30 years ago would have been very expensive compared to today," explained Vincent Le Borgne, R&D manager at GKM Consultants, a Montreal-based geotechnical monitoring firm that guides mine operators through

all stages of mine tailings monitoring, from installing sensors to commissioning data dashboards. "Historically, if there were any instruments at all on site, you would have a field technician or engineer who would manually read each instrument and then write it in a logbook and store it away somewhere."

This no longer has to be the case today, he said. "Tailings management is much more tightly controlled, and the tools are there; you have a small box called the data acquisition system that the sensor instrument is connected to. That automatically reads the instruments, stores the data locally and then transfers it to a central location or server, where it is available to the end user. It's a much more cost-effective way of doing monitoring that is only getting easier and easier with modern technology."

Automated monitoring systems are now much less expensive thanks to the advent of long-range, low-power wireless networks, Le Borgne explained. Data acquisition systems can transmit readings across a large mine for years using the same battery pack.

"Power requirements [for networks] have lowered tremendously over the last 20 years, which makes them easier to install on tailings networks that don't have electric power," explained Le Borgne. "We can now transmit over a 15-kilometre range." In the past, this would have only been possible by running a power cable. "Cables are very vulnerable, they can break very easily, especially in cold weather, and they are very expensive to install," he added.

GKM Consultants will help clients choose the right data acquisition system and tailor it to their needs. A product range that has taken off relatively recently, according to GKM Consultants field engineer Alexandre Cosentino, are Loadsensing dataloggers produced by IoT World Sensing, whose batteries last 10 years before needing to be replaced. This is a boon for sun-deprived Arctic mines in Canada that cannot use solar-power batteries.

While the instruments used to monitor tailings facilities have largely remained the same over the past several decades – tools dedicated to measuring water pressure, soil temperature, underground soil movement, weather conditions and water flow – there have been some additions.

Over the last decade, facility geometry surveying tools have matured, according to Chad LePoudre, vice-president of geoscience and materials testing at SNC-Lavalin. "Aerial drone survey technology allows for large areas to be evaluated by a single operator for a relatively low cost. For high risk sites, there are also relatively new radar monitoring systems that can provide alarms should dams or pit walls experience sudden movement."

He said that "regular surveys" that allow engineers to understand how a facility's shape is changing over time are "often underrated" as a tailings monitoring technique.

Monitoring in the cloud

An increasing number of miners are combining increasingly sophisticated tailings data acquisition with cloud-based data management systems. In this scenario, the on-site sensor information is pushed to the cloud, or the internet. It means that tailings monitoring can then be done remotely; an engineer or regulator in Montreal can log on to a website and check in on a mine tailings dam in the Arctic, in near real time.

GKM Consultants' Le Borgne said that San Diego-based software company Sensemetrics is one of "the few companies attempting to bring the industry into the modern age" by offering cloud-based data management systems.

"There is still a lot to be done to change mentalities," he said, noting that many of GKM's clients continue to "demand on-site-only data hosting and are completely hostile to the idea of cloud-based data management." GKM Consultants was one of the first to offer cloud monitoring in Canada as part of their services.

In Sensemetrics' solution, a wide array of different sensor types can communicate their readings to a distributed gateway network, which in turn utilizes cellular, wireless or satellite technology, as appropriate, to transmit findings to a data management system in the cloud. That online dashboard can then be accessed by mine operators and regulators anywhere in the world. This solution offers functions such as cross-organizational data sharing, advanced analytics and automated reporting.

Because Sensemetrics has already invested significant resources into designing "plug and play" technology, the system "does not require extensive implementation, large amounts of customization or specialized personnel dedicated to maintaining a complex system. It's a rapidly deployable and scalable solution to pressing mine problems, allowing engineers to focus on mine safety and productivity," said Sensemetrics CEO Matt Meehan.

Its system is currently installed at tailings facilities in South America and the U.S. At a recent deployment on an 11-km-long hybrid rock tailings dam facility in Central America with limited communication and power infrastructure, Sensemetrics said it took one of its employees two days to train mine operators and three days to set up the sensor network. This swift timeline is not unusual, said director of mining Alex Pienaar. "Anything from three to five days, typically even less, is an accurate installation time. It sounds unrealistic; people struggle to grasp that," he said.

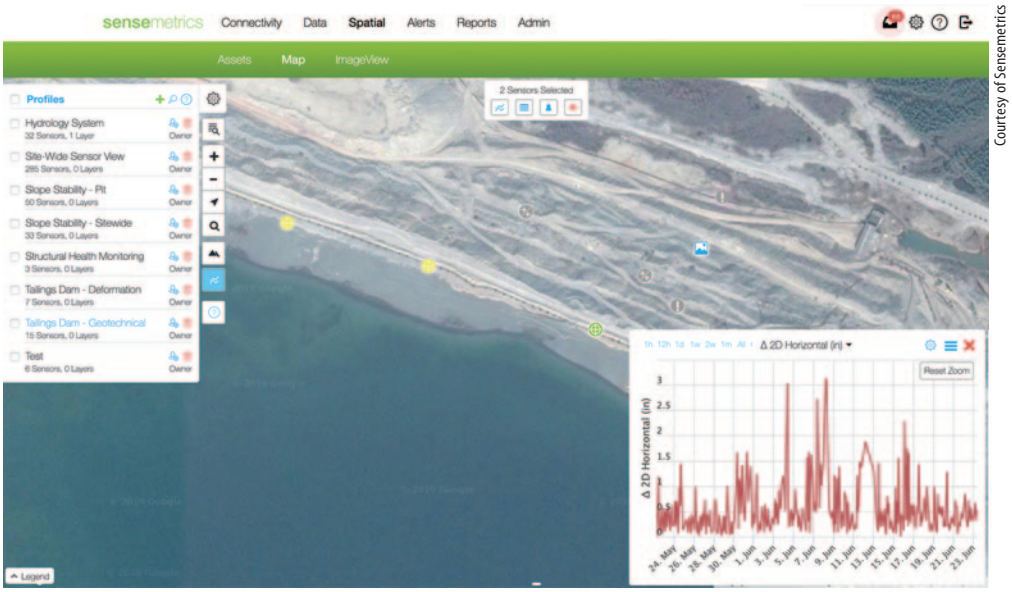
Sensemetrics' connectivity platform uses a variety of network protocols, including wireless mesh, LoRa or LoRaWan. This flexibility is useful, according to Meehan, because there are sometimes different network standards in different parts of a mine, "due to factors such as site topography, data type and density from selected sensors."

Sensemetrics' solution is also malleable to its own in-house data acquisition devices (whose batteries do not need to be replaced for the full life of the hardware) as well as to those manufactured by other parties, including Worldsensing and Geokon.

Satellite oversight

A new player hoping to shake up the mine tailings data acquisition and management space is the established British

satellite communications firm Inmarsat, which launched a new smart mine tailings monitoring solution in collaboration with the British arm of engineering consultancy Knight Piésold in February. Its solution works similarly to Sensemetrics', gathering information from on-site sensors using low-power wide-area wireless networks, like LoRaWan, before transmitting it to the cloud. However, according to Inmarsat, its solution provides standalone power and communications as part of the system, meaning it does not rely on traditional power or communications, which is vital for remote or closed sites.



Courtesy of Sensemetrics

Web-based tools such as Sensemetrics' data management systems are responsive, user-friendly solutions to tailings storage facility monitoring.

"Each sensor has its own LoRaWAN transponder and it's out there pinging away at data. Then we have a base station, which aggregates that data at the edge and transmits it via our satellite network," explained Joe Carr, Inmarsat's director of mining development.

Inmarsat was founded by the United Nations 40 years ago to locate ships in distress and continues to operate 13 satellites in order to broadcast maritime distress signals. It will use these same satellites to transmit mine tailings monitoring data securely to the cloud. "It's a 99.9 per cent reliable network," said Carr. "That's incredibly unique. You won't get anyone else who can provide the same data service in Peru as they can in Oman and in Mali."

As a result, regulators and companies "can manage their dams from wherever they are on the planet. It doesn't matter where the dam is, or where the person who is managing it is, they can log in to it and see what's happening in real time," said Carr. Customizable alarms can be set for when instrument readings start to rise or drop hazardously. Daily or hourly reports can be scheduled.

"So instead of the old model of going every six or 12 months with your independent auditor to a tailings dam, the auditor could look at the tailings dam every day if they wanted to and have a report every morning. They give actions and insights to the customer based on what's happening live as opposed to a single point every few months," Carr explained.

The solution is being rolled out globally after a successful two-month trial with an undisclosed mining customer where Inmarsat, "delivered hundreds of thousands of individual data points per month," according to Carr.

What's next?

GKM Consultants' Le Borgne expects cloud-based data management technology to sophisticate further, with data analysis set to leverage the power of big data. "No one is pushing the envelope yet to fully take advantage of these platforms, such as implementing machine learning, predictive monitoring, standardized modelling, BIM [building information modelling] integration," he said.

He said that the industry needs to undergo a culture change in order fully embrace the technologies that already exist. "What we often see right now, at least at larger or older mines, [is that] we speak to people in production, we speak to people in environment, we speak to people in geotech and they all have similar needs, but they don't talk to each other. So, we can have three clients on the same mine. The reality is that, with modern tech, it's fairly easy to integrate all these monitoring requirements in a single central system that will really cut costs and make more money available for better monitoring or other operations."

SNC-Lavalin's LePoudre predicts a similarly data-drenched future. He expects that over the next 10 years, software companies will "offer integrated management systems that allow data to be imported in real-time to complete three-dimensional geological models of tailings facilities and immediately update slope stability predictions, potentially even using artificial intelligence."

And, Meehan of Sensemetrics added, "as mining clients become more successful at addressing data management challenges, they will immediately progress to demanding platforms that are able to transform this data into insights that deliver value to departments across a mine's operations. Successfully providing this value will require platforms that build an ecosystem of technology partners to deliver outcomes that will leverage cutting edge technologies such as AI and machine learning." CIM