Leadership in Sustainable Infrastructure

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Case Study

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DEPLOYMENT OF A LARGE-AREA GEOTECHNICAL MONITORING SYSTEM IN AN ARCTIC MINE

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1 Introduction

Construction and management of tailings and dikes in arctic mines are still to this day a challenge. One overlooked component of these large-scale projects is a modern instrumentation system. GKM Consultants, in collaboration with Agnico Eagle Mines, has developed, installed and maintained a complex network of geotechnical instruments at the Meadowbank mine. Located in Nunavut, the Meadowbank mine is an open-pit gold mine being excavated below the groundwater level in very close proximity to a number of lakes.

A thorough monitoring plan was set up with a large number of instruments disseminated over a large (8.55 km^2) area. The unique constraints of a gold mine located in the arctic made added challenges to the design, installation and commissioning of the monitoring system. The system has a real-time component that requires an innovative approach combining manual readings, data loggers, and cabled or radio communications. The custom-made visualization platform provides powerful tools to manage and understand the vast amount of data generated.

2 Overview of instrument choice

The three main types of instruments were installed by GKM Consultants: thermistor strings, piezometers, and time domain reflectometers (TDR) to follow soil movements. Instruments can be sorted by the importance of obtaining fast measurements from them. *Background* instruments are usually read manually whenever possible. *Regular* instruments are often read by hand on a daily or weekly basis or have a standalone dedicated data logger. Finally, *critical* instruments are connected to a radio-enabled data logging system. These instruments are typically in the vicinity of dikes where failure could have major consequences on operations.

Table 1 Number of instruments provided by GKM Consultants

Instrument type	Number provided by GKM Consultants	Total cable length (approximatively, m)
Piezometers	>146	>5000
Thermistor strings	>20	>100
TDR	>6	-

Thermistor strings, while a critical component of many arctic projects, can be difficult to install in temperatures below -20°C. Even cold-rated thermistor strings (or any electrical cable) can be manipulated slowly but any sharp movement or impact could break the sheath.

Piezometers are installed in grouted wells, with several depths at each borehole, giving the opportunity of having a 2D mapping of water pressures away from dikes. Special care has to be taken regarding cable management and protection from freezing during installation.

The ever-changing configuration of the dikes requires creative solutions for extending cables and maintaining function of both thermistors and piezometers over many iterations. Piezometers and data loggers that were installed early in the project were in the way of new embankments and dikes, requiring the cables to be protected and lengthened.

3 Data logging and network

Figure 1 (a) shows an overview of the work site, with the main data logger locations identified as well as the locations of the two base towers. *Background* instruments are often read and analyzed manually. *Regular instruments* often have a small dedicated data logger whose information is regularly collected by a field technician. When the technician returns to base, the data is added automatically to a database for online visualization and analysis.

Critical instruments are cabled back to a *nest*. The *nest* is a single data logger with one or several multiplexers that allow it to read a large number of instruments. It is connected back to the base station using a radio link to send back data that is automatically integrated into the database for visualization. The main types of configurations are shown figure 1 (b).

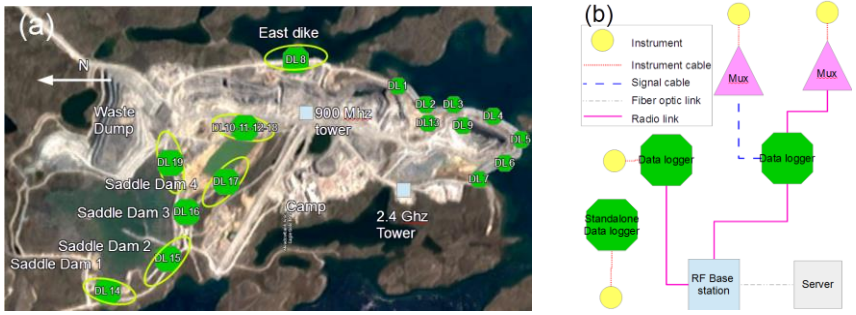

Figure 1 : (a) overhead view of the logger network (b) Schematics describing the standard setup of the system

4 Data visualization

A common pitfall of monitoring plan is that there is so much that some of it gets ignored. Visual indicators on plans show the values of specific instruments on a map with a color status, giving workers a quick overview of their worksite. Properly designed time graphs are another powerful tool to analyse data over long periods of time. Finally, displacement graphs are used to understand soil temperature data.

5 Conclusion

GKM Consultants designed and commissioned a large scale instrumentation plan. The long distances, large area and weather conditions all pose their own challenges. In an effort to optimize both costs and safety, a novel network of radio stations was deployed to provide near real-time measurements of critical parts of the work site. Important data was made readily available on an online platform to help engineers and project owners see the real-time status of their project.