The mining industry is working to build cleaner solutions for water being discharged into the surrounding environment.

A Responsible Approach

Overcoming the mine water management challenge.

BY VALÉRIE BERTRAND

IF EVER THERE WAS an industry that put water professionals to the test, it would be mining. It demands excellence and innovation in all aspects of water management and treatment. The interplay between all aspects of a mine's operation and water cannot be understated. Whether being used in mining processes or protecting the water in the surrounding environment, water considerations must take place at every stage of a mine's life.

Canadian mines provide a range of metals and minerals essential to daily life. From the mundane, like health supplements and toothpaste, to the modern technologies of smartphones and electric car batteries, our need for these resources is clear. And our need to responsibly extract these resources in a sustainable way is more important than ever. Mining companies are focused on minimizing their impact and their footprint, and that includes the responsible use of water in their operations.

Water management plans

Responsible use of water includes implementing water management plans from the inception of the project through to closure, as an integral part of the mine design and operation. Gone are the days of thinking about closure at the end of a mine's life, we now consider closure right from project inception. It's not a matter of cleaning up water after the fact; it's about protecting it from the start. Early planning allows the mine to take advantage of natural landforms and water flows to minimize the need for treatment down the line and for efficient use of water on site.

Key elements in the responsible use of water resources include a robust water balance, which considers the influence of the various sources of flow onto and within the property and releases to the environment. An understanding of the seasonal flows is critical in the Canadian climate where a large part of surface water flow occurs in the "freshet" period of spring thaw, often followed by limited flows the rest of the year and frozen conditions over winter. Consideration of annual water use for mine operations must be understood and planned for so that the sudden onset of clean snow melt can either be diverted or contained in sufficiently large ponds. In a changing climate where freshet flows, rainfall, and storm events differ from the historical record, sensitivity analysis is a necessary exercise to test for and adapt to possible upset conditions. Climate change will have a strong influence on future water management procedures, discharge quantities, water treatment requirements, and effluent discharge and quality in the short and long term.

Groundwater inflows can be an additional source of water and require

management year-round, including in winter when ponds and water lines may be frozen at surface. Deep groundwaters intercepted by mining can be saline and may require specialized handling and water treatment such as a desalination plant, which can be more complex and expensive than standard water treatment plants. Failure to identify the key driving factors of the water balance increases the risk of costly last-minute adaptations, or long-term liabilities associated with capture and treatment of water.

Where waste meets water

The valuable commodities we gain from mining often constitute a small fraction of the materials extracted from the ground. What we don't use is stored in waste rock stockpiles or tailings containment facilities. Early waste management planning allows for mine infrastructure to be designed for optimal storage conditions of wastes in relation to water bodies, to minimize water management and treatment needs.

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Understanding of mine waste composition and contamination potential is another key element in effective waste and water management. Water that comes into contact with these mined materials must be monitored to verify or control their quality prior to discharge back into the environment. Not all wastes release harmful contaminants, but some wastes are enriched in the metals that are being mined. Chemical constituents naturally present in the rock can have a different behaviour once rock is crushed or ground and exposed to the environment. Metals and other chemicals can dissolve on contact with water or react (oxidize) under ambient conditions to generate acidic drainage (or acid rock drainage), which can increase the rate of chemical release from the wastes. Residuals from explosives (nitrate and ammonia) and mill process reagents such as cyanide and sulfate compounds, if present, can also add to the contamination potential of the wastes. The chemical composition and structure of chemical compounds in the wastes and contact waters can affect their release mechanisms. Understanding these processes is necessary for the design of effective contaminant control measures, optimization of water management and water treatment, and effective mine closure.

Stornoway Diamond Corporation's Renard Mine in northern Quebec is one case in point. Rigorous baseline studies on water, soil, rock, air, and the receiving environment at the project stage informed the mine waste and water infrastructure designs and management plans. Due to the sensitivity of the pristine receiving environment, the full mine footprint was designed to be contained within one small watershed in order to minimize contact water management needs. Some potential contaminants were identified in specific waste streams in the form of low solubility silicate minerals, which have the potential to be released as suspended solids in site drainage. Residual nitrogen products from explosives use were also identified as potential contaminants in mine contact water. Identification of these sources and their release mechanisms were used to design control mechanisms for operation and prepare for clean closure at the onset of the project. The domestic wastewater is treated to remove nitrate, ammonia, and phosphorus through a nitrification/de-nitrification biological treatment process and membrane filtration.

All site contact waters at the Renard Mine are captured, pumped, and treated to remove suspended solids to levels that are well below the effluent limits in order to prevent the release of chemicals to the receiving environment. A robust explosives management plan is in place to minimize explosives use and loss during mining, minimizing the contaminant charge on mine waste contact water. Treated separately through a high-tech facility including a final stage of micro filtration at four microns, the effluent discharge water quality surpasses the highly restrictive limits set by the province.

Key elements

Robust waste and water management plays a key role in the fiscally, socially, and environmentally responsible operation and closure of mining facilities. For these plans to be effective, they must be adapted to site specific conditions, be adaptable to operational changes, and be integrated in the process of planning for permanent closure.

Key elements of water and waste management plans for the responsible use of resources include:

- A water balance where all water inflows and outflows are identified and quantified, accounting for forecasted changes in climate.
- Reduction of mine contact water volume by diverting clean water from the site and reusing process water or mine contact water to the extent possible, minimizing freshwater use.
- Handling of contact water by segregation of the different water types for efficient and effective treatment.
- An understanding of the contaminant sources: the chemical and physical properties of the wastes generated, their reactivity under site conditions, and their variability.
- An understanding of the properties of the receiving environment, its absorptive capacity, and cumulative effects.

Mining certainly presents a technical challenge when it comes to water management. The complexities that sites present from geochemical interactions, to infrastructure site selection, to climate change considerations, provide an exciting field of practice. Ultimately, with careful planning, diligent oversight, and innovative thinking, we are able to mine responsibly while protecting our water resources. WC

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