ARD Source Control Opportunities at the Red Dog Zinc and Lead Mine, Northern Alaska, USA

Located in the Western Brooks Range of Alaska, the Red Dog Mine is the most northerly active, zinc-lead open-pit mine on earth. Mining of high grade zinc and lead sulfide ores results in the production of waste rock that is mostly acid generating. Control and treatment of ARD from waste rock and pit walls is the most critical environmental activity at the mine site. The treatment of this ARD water is expensive today and will be a major component of post-closure costs in the future. In order to reduce the amount of water treatment in the near term and longer term, Red Dog has initiated programs to minimize the production of ARD at the source, through construction of engineered cover systems, and through improvements in the collection and treatment of the ARD waters.

The semi-arid, non-glaciated terrain surrounding the Red Dog mine lacks thick unmineralized soil, or glacial materials acceptable for the construction of engineered cover systems. Unmineralized shale from the excavation of the deposits is the only source of abundant material for building covers. Fortunately, two formations contain shale that provide the necessary geotechnical specifications, and physical and nutrient requirements for plant growth. The Kivalina member of the Kuna Formation is a calcareous shale of Mississippian age with good acid neutralization potential. It is the footwall formation to the Red Dog deposit and can be weakly mineralized with zinc and lead but in most areas it is less than 1,000 ppm combined zinc and lead. The thinly laminated shale is quickly broken down by carbonic acid in rain water to form a black material containing abundant fines which can be compacted to provide adequate infiltration barriers. The Okpikruak Formation is post-mineralization aluminous shale with very low metal values but with almost no acid neutralization potential. The Okpikruak shale also decomposes rapidly to form material containing abundant fines which can be compacted to provide adequate infiltration barriers. Test plots established by the Alaska Plant Materials Center on weathered rock from both rock types provided good plant growth confirming what is seen on hillsides in the area of the mine. When Red Dog chose to conduct a large scale test of an engineered dry cover system on the Oxide waste rock pile in 2008, weathered Kivalina shale was chosen as the cover material. A two-layer, dry cover system was constructed with buried monitoring instrumentation and it is in the second year of a three year evaluation. To date the cover system is performing as designed by reducing infiltration of precipitation by ~ 85%.

Runoff from the Main Waste Stockpile at Red Dog from it's opening in 1989 until 2008 ran directly into the tailings impoundment. Each year the runoff, with Total Dissolved Solids (TDS) values as high as 70,000 ppm, raised the TDS of the water in the tailings pond. In 2008 a collection system of shallow sumps was installed at the base of the stockpile to collect water for treatment in a new water treatment plant. The collection system ran only during periods of surface runoff in the summer months. Geotechnical wells drilled near the base of the stockpile indicated that warm water from the stockpile was flowing under the collection sumps throughout the winter. In 2010, ground resistivity surveys were conducted along the waste stockpile. These surveys confirmed that high sulfate water was flowing year-round under the collection sumps. Additional geotechnical holes were drilled along the base of the stockpile in 2010 to confirm depths to water and bedrock. In late fall 2010, four new wells, drilled to bedrock, were installed in place of the shallow sumps. The new wells should allow ARD water to be collected and treated year-round to help lower the TDS content of the tailings impoundment, allowing Red Dog more flexibility in maintaining its water balance, both now and into the future.

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