Geophysical Investigation of the Gullbridge Tailings Facility, Central Newfoundland

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Recent concerns have been raised over the physical stability of the Gullbridge tailings dam at the site of an abandoned copper mine in central Newfoundland. The present research aims to understand the physical characteristics of the dam and map contamination in an adjacent wetland through non-invasive geophysical survey methods. The Gullbridge mine was centered over a volcanogenic massive sulphide ore deposit consisting mainly of copper-zinc. It produced 3 million tonnes of ore between 1967 and 1972 averaging approximately 1.1 % copper. An earthenware dam was designed to act as a barrier separating copper tailings from wetlands immediately to the west. A small river runs along the western boundary of the wetlands, about 500 m from the tailings dam. It provides drinking water to the town of South Brook and flows into a salmon habitat, so contamination of the water is a concern. In 2012 a section of dyke embankment collapsed, releasing tailings contaminated with copper and zinc into the wetlands. It is estimated that 100,000 m^3 of contaminated water spilled from the breach. In November 2013 the abutment height was reduced and the base widened to improve stability, however there are still concerns about contamination from a new spillway and dam leakage. Tailings dams such as the one in Gullbridge require continuous monitoring over time, but monitoring at the Gullbridge site did not begin until 2011, 42 years after its construction. There is little information known about the construction history and design of the original dam, and it is expected that the physical properties over the dam have significantly changed over time. Historical tailings dam failures have been linked to issues such as internal and external erosion, the liquefaction phenomenon and overtopping. These changes lead to physical instabilities that geophysical methods can detect. The focus of the present study is on targeting possible early stage seepage issues creating internal erosion and other potential structural issues. In particular, ground-penetrating radar (GPR), direct-current resistivity (DCR) and spontaneous-potential survey methods were used for detecting seep related erosion and delineating fluid flow through the embankment. As a secondary focus, the adjacent wetland was analyzed using the electromagnetic ground conductivity surveys with the aim of producing a ground contamination map. The copper tailings at Gullbridge have a signature conductivity high that can be mapped as seepage pathways associated with recent breaches.