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GEOCHEMICAL ASSESSMENT OF SUBAQUEOUS TAILINGS DISPOSAL IN BUTTLE LAKE, BRITISH COLUMBIA

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EXECUTIVE SUMMARY

Limited evidence suggests that the chemical reactivity of tailings is in fact inhibited by storage underwater, and that such storage may be a preferred long-term disposal option. To assess the long-term environmental feasibility of subaqueous disposal of mine tailings, this report examines the waters and sediments of the south basin of Buttle Lake. British Columbia (the site of an inactive submerged tailing deposit). The Cu, Zn and Pb-rich mine tailings were deposited in the lake via a submerged outfall from 1966 to 1984. The tailings are presently areally widespread across the basin and are being covered by a thin veneer of natural sediments. This report presents a detailed study of the distributions of metals in both the solid phases and interstitial waters of the sediments, and in the overlying surface waters.

High resolution profiles of dissolved Zn, Cu, Pb, Cd, Fe and Mn distributions in interstitial waters are presented for four cores collected from the south basin of Buttle Lake in the autumn of 1989. Three of the cores penetrated through the tailings layer into natural (pre-mine) sediments; the fourth, collected near the former tailings discharge point, consisted entirely of relatively coarse-grained pyrite-rich tailings. The dissolved metal distributions are interpreted in concert with mineralogical data and high resolution measurements of major and minor element distributions, including C, N and S, in the associated solid phases.

Water quality sampling was also carried out at the four coring stations. The sampling included physical profiling and discrete water sampling at three depths (surface, mid and bottom) for general parameters and metals analyses. Present water quality sampling and review of past data indicate considerably decreased metal concentrations since metal loadings from Myra Creek were reduced by the implementation of a collection and treatment system in 1983. However, metal concentrations of zinc, copper and cadmium, **while** decreased, occasionally exceeded provincial objectives proposed for the lake, particularly at depth. Metal concentrations vary seasonally and the highest levels are found during the winter months; concentrations are also higher at depth but apparently not as a result of

metal releases from the sediment.

At all coring sites, a 1-2 cm thick veneer of natural, organic-rich sediments has accumulated on top of the tailings. The distribution of dissolved and solid-phase Fe and Mn indicates that the sediments are anoxic at all sites within a few cm of the sediment-water interface.

Fe and Mn oxides are enriched in the surface sediments at all locations, but these distributions are not in steady-state equilibrium with the respective pore water profiles. However, both elements are currently being progressively enriched in surface sediments by the diagenetic recycling of Fe and Mn in the upper few cm in all cores.

Dissolved Zn, Cu, Cd and Pb concentrations in pore waters from the former tailings-discharge area are very low in the upper two decimetres. The tailings at this location accumulated very rapidly, and the pore water results and benthic influx calculations indicate that there is currently no flux of Zn, Cu, Cd or Pb to the overlying water column at this site. In pore waters from the other locations, all of which are characterized by a layer of tailings up to three decimetres thick sitting atop methane-bearing anoxic natural sediments, dissolved Cu, Pb and Cd occur in relatively low concentration in the upper few centimetres Zn concentrations in the pore waters at shallow depths are slightly higher than in bottom water of the lake at all three sites, suggesting that there is an upward flux of the metal to the overlying water. However, the precipitation of Fe oxyhydroxides in the upper 30 to 50 mm at these locations appears to reduce the efflux of dissolved metals. Dissolved Zn, Cu. Pb and Cd are enriched together in specific, thin subsurface zones in all cores, indicating limited zones of release at depth. Such zones correlate with the presence of high dissolved organic carbon contents.

Benthic flux calculations indicate that effluxes of Zn, Cu, Cd and Pb from the sediments are very low, and are comparable in magnitude to fluxes associated with natural geochemical processes in lake and coastal marine sediments. A conservative (worst case) estimation suggests that less than 0.2 parts per trillion of Zn are being added to south basin deep water as a result of chemical reactivity of the metal-rich deposits on the lake floor. This amount is negligible, and it is reasonable to conclude that the submerged tailings are having no impact on Buttle Lake water quality at the present time. As burial by natural sediments continues, this conclusion will be reinforced.