COLUMN EXPERIMENTS FOR GROUNDWATER REMEDIATION POST-MINE CLOSURE AT THE WOLVERINE MINE, YUKON

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ABSTRACT

Many coal mines and metal mines are contributors to heavy metals and selenium contamination in the aquatic environment. Groundwater containing elevated metals (including selenium) mitigating from underground workings has been identified as a potential concern following mine closure from Yukon Zinc Corporation's (YZC) Wolverine Mine zinc-silver mine. To mitigate any adverse effects, a passive biological treatment system (Biopass) will be constructed in the small creek downslope of the mine workings pre-closure. A laboratory based column experiment was conducted to evaluate the components of the Biopass that would best remove contaminants of concern, including sulphate, selenium, aluminum, arsenic, cadmium, copper, lead, nickel and zinc. Five cylindrical columns (2.5 m high x 0.25 m diameter) contained mixtures of gravel and native creek bed substrate, and four columns were amended with either i) manure, ii) sewage sludge, iii) sewage sludge and zero-valent iron, and iv) sewage sludge, wood chips and alfalfa. A fifth column was run as a control, and contained only gravel and substrate. The experimental columns were operated for 80-130 days, with influent water pumped to simulate a groundwater flow of 2.3 L/day. The influent water was sourced from the on-site facilities containing mine-affected water.

The effectiveness of each column at removing the contaminants of concern was evaluated by comparing the mass accumulation of the contaminants within the inflow streams to the mass accumulation in the outflow streams. The concentrations of contaminants in the outflow streams were compared to background values in the small creek. The control column and the three columns containing sewage sludge also removed greater than 90% of the cadmium, copper, lead and zinc from the inflow stream. The column with sewage sludge and zero-valent iron also removed 99% of the sulphate from the inflow stream. The column containing manure increased the amounts of sulphate, aluminum, arsenic and nickel in the effluent stream.

The results of this experiment are encouraging as both sulphate (associated with acid mine drainage) and selenium were removed to background creek concentrations in the control column and the column with zero-valent iron and sewage sludge amendments. With no amendments to the biological system (i.e., most cost effective treatment system) very good results were achieved, and with a simple amendment of zero-valent iron (in the form of steel wool) sulphate removal was increased to 99% from 77%. Also, while the columns achieved quite effective (i.e., ~60%) removal of contaminants at a circum-neutral pH, when the pH decreased to 5.2, the average removal efficiency increased in all five columns (i.e., ~80%). These results indicate that an in-situ passive treatment system could be an effective treatment method under low flow conditions for contaminated mine effluent.