CONSTRUCTED WETLAND DESIGN AND OPTIMIZATION FOR METAL AND METALLOID TREATMENT AT THE MINTO MINE, IN THE YUKON, CANADA

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Constructed wetland treatment systems (CWTSs) can treat various contaminants in water when designed and executed in a scientifically guided manner. A site-specific CWTS is being developed for Capstone Mining Corporation's Minto Mine (Yukon), using a scaled phased approach to allow for flexibility for modifications and optimisations along each step. The phases are: (1) site assessment and information gathering, (2) technology selection and conceptual design, (3) pilot-scale testing and optimisation (controlled environment), (4) onsite demonstration-scale confirmation and optimisation and (5) full-scale implementation. The first three phases have been completed successfully, and a year of testing performed on site for Phase 4.

Innovations in the design development included application of genetic and growth-based microbial community profiling (MCP testing) to guide system design in a site-specific context. Pilot-scale testing allowed for selection of the optimal design from several options and for testing of different predicted closure water chemistries (Fig. 1), including concentrations beyond the most elevated predictions, including associated near-term and long-term scenarios (with and without nitrate, which could be present from blasting residues and affect selenium treatment). The pilot-scale CWTS confirmed plant amenability to transplantation, and the design selected for further testing achieved 92% removal of copper (mean influent 146 µg/L, outflow 11.3 µg/L) and 41% removal of selenium (mean influent 10.2 µg/L, outflow 6 µg/L; Fig. 1).

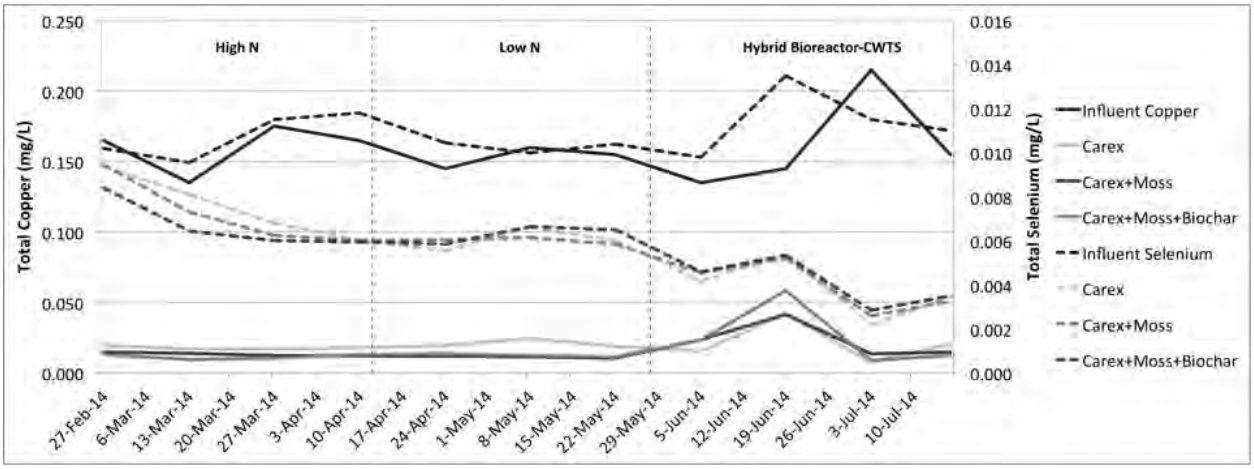

Fig. 1 – Performance of selenium and copper treatment over time at pilot-scale

A mass-balance of the pilot-scale systems confirmed that elements were sequestered to sediments, with less than 0.5% of the copper and 2% of the selenium transferred to the plant leaves (Fig. 2). Removal rate coefficients were developed from the pilot-scale wetlands to allow for appropriate modelling and sizing of on-site systems. Further, MCP testing and physicochemical parameters (that explain the performance and are used as decision variables) outlined expected system maturation timelines through pilot-scale testing and setting subsequent expectations for on-site implementation.

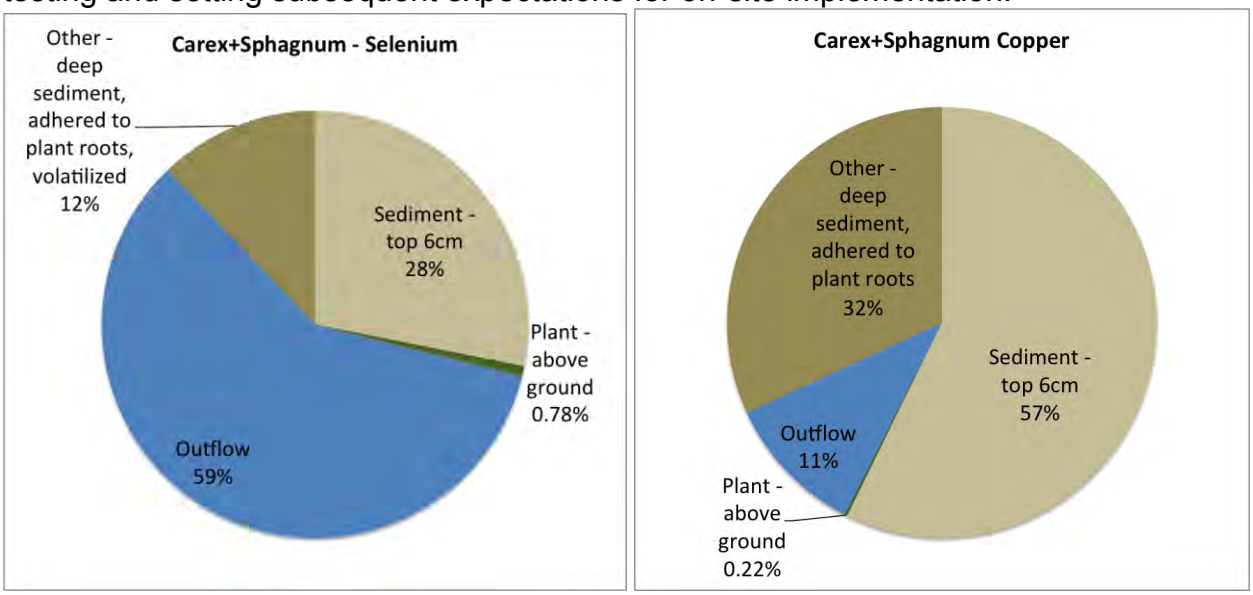

Fig. 2 – Mass balance of selenium and copper in pilot-scale treatment wetland

The optimised design was built at demonstration-scale (Phase 4) on-site in 2014 (Fig. 3), and has been operating since, following a path of maturation as predicted by the pilot-scale systems (Fig. 4). This maturation will be discussed in this presentation in the context of the previous 3 Phases. Highlights include a better than anticipated plant establishment, and initial performance during the commissioning period.

Fig. 4 – Demonstration-scale treatment wetland on site, 2015.

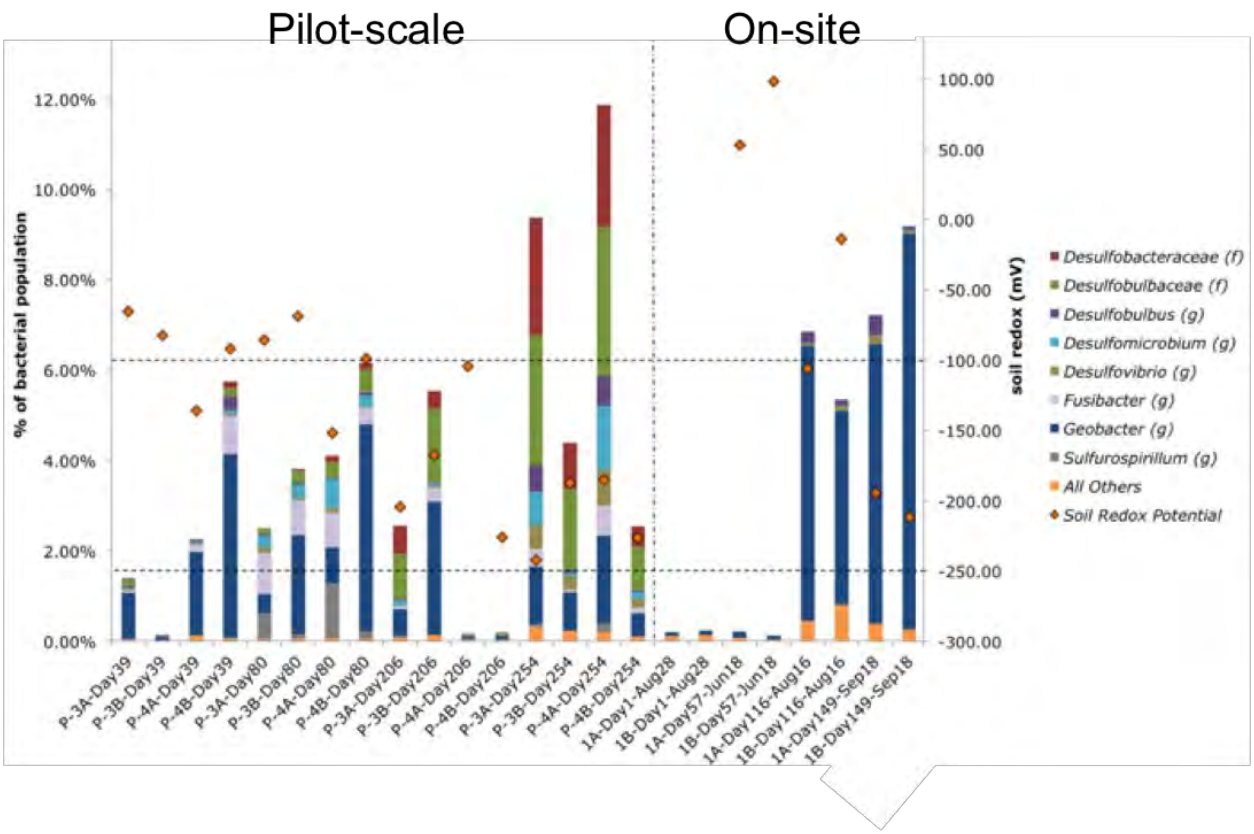

Fig. 5 – Comparison of soil redox (right axis, diamonds) and sulphide-producing microbial population (left axis; bar chart) for pilot-scale (off site) and demonstration-scale (on site) systems. Horizontal dashed lines indicate targeted soil redox range, as suggested by oxidation-reduction chemistry and refined by pilot-scale testing.

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