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TECHNOLOGY EVALUATION

Emerging Technology Bulletin

Constructed Wetlands Treatment for Toxic Metal Contaminated Waters

Colorado School of Mines

Technology Description: The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in a man-made wetland ecosystem (see Figure 1) to accumulate and remove metals from influent waters. The treatment system incorporates principal ecosystem components found in wetlands, including organic soils, microbial fauna, algae, and vascular plants.

Influent waters, which contain high metal concentrations and have a low pH, flow through the aerobic and anaerobic zones of the wetland ecosystem. Metals are removed by filtration, ion exchange, adsorption, absorption, and precipitation through geochemical and microbial oxidation and reduction. In filtration, metal flocculates and metals that are adsorbed onto fine sediment particles settle in quiescent ponds or are filtered out as the water percolates through the soil or the plant canopy. Ion exchange occurs as metals in the water come into contact with humic or other organic substances in the soil medium. Oxidation and reduction reactions that occur in the aerobic and anaerobic zones, respectively, play a major role in removing metals as hydroxides and sulfides.

Waste Applicability: The wetlands-based treatment process is suitable for acid mine drainage from metal or coal mining activities and other leachates or wastewater that are mildly acidic or mildly alkaline and contain toxic metals. Wetlands treatment has been applied with some success to wastewater in the eastern regions of the United States. The process may have to be adjusted to account for differences in geology.

Test Results: The final year of funding for the project under the Emerging Technology Program was completed in 1991. The funding was used to build, operate, monitor, and assess the effectiveness of a constructed wetlands in treating a portion of the discharge of acid mine drainage from the Big Five Tunnel near Idaho Springs, Colorado. Results of the study have shown that by optimizing design parameters, removal efficiency of heavy

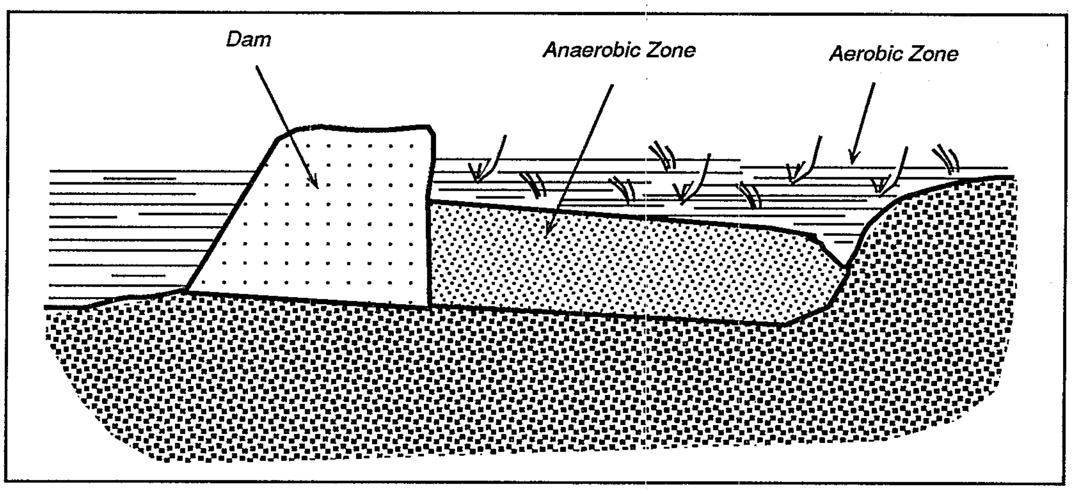

Figure 1. *Typical Wetland Ecosystem.*

metals from the discharge can approach the removal efficiency of chemical precipitation treatment plants. An example of the optimum results from the 3 years of operation are as follows:

- pH was raised from 2.9 to 6.5.
- Dissolved aluminum, cadmium, chromium, copper, and zinc concentrations were reduced by 98 percent or more.
- Iron was reduced by 84 percent.
- Lead was reduced by 94 percent.
- Nickel was reduced by 84 percent or more.
- Manganese removal was relatively low with reduction between 9 and 44 percent.
- Biotoxicity to fathead minnows and Ceriodaphnia was reduced by factors of 4 to 20.

One of the final goals of this project will be the development of a manual that discusses design and operating criteria for construction of a full-scale wetland for treating acid mine discharges. This manual will be available in the Spring of 1992.

In 1990, the pilot-scale constructed wetlands system won a "National Honor Award" in the Engineering Excellence Awards competition of the American Consulting Engineers Council.

As a result of the success of this technology in the SITE Emerging Technology Program, it has been selected in the Records of Decision (RODs) for both the Clear Creek Site in Colorado and the Buckeye Landfill Site in Eastern Ohio. The full-scale constructed wetlands employed to remediate the discharge of the Burleigh Tunnel near Silver Plume on the Clear Creek/Central City Site will be evaluated as a SITE Demonstration Project under Cooperative Agreement with the state of Colorado.

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