WATER QUALITY IMPROVEMENT AND BIOLOGICAL DEVELOPMENT IN MINE DRAINAGE TREATMENT WETLANDS[1]

Robert W. Nairn[2], Matthew N. Mercer, Choice M. Cogburn, Denae Athay, Stephanie A. Lipe, Virginia B. Arvidson, Megan Sprowls, and Keith A. Strevett

Abstract: Metal retention, alkalinity production and biological community structure were evaluated for an enhanced successive alkalinity producing system. The treatment wetlands consist of four 185-m^2 in-series cells comprised of alternating vertical-flow wetlands and surface-flow settling ponds. Acid mine drainage (AMD) from an abandoned underground mine in southeastern Oklahoma (USA) was directed to the pilot-scale system for two years. Mean influent water quality was characterized as follows: 660 mg/L net acidity as $CaCO_3$, pH 3.4, 215 mg/L total Fe, 36 mg/L Al, 14 mg/L Mn, and 1000 mg/L SO_4^{-2}. Final effluent water quality consistently met regulatory criteria for an active mine, with the exception of Mn concentrations, which decreased significantly in the final two cells. Metals were effectively retained in both aerobic and anaerobic portions of the treatment system. Substrate analyses indicated metals were sequestered in oxide/oxide-bound, carbonate, exchangeable, organically bound and sulfide forms, depending on mass loading, location and time. Alkalinity was generated in the vertical-flow cells by a combination of biogeochemical processes, including limestone and hydrated fly ash dissolution and bacterial sulfate reduction. Mean acidity removal rates (69 g m^{-2} day^{-1}) are comparable to other similarly designed systems. Although constructed solely for water quality improvement, the treatment system underwent substantial ecological development over the two years of study. Several species of macroinvertebrates, fish and vegetation volunteered into the systems. Over 50 families of macroinvertebrates representing more than 20 orders colonized the cells. *Typha*, *Ludwigia*, *Juncus* and *Salix* spp. dominated vegetation communities, but metal uptake in *Typha* was minimal and

[1]Paper was presented at the 2003 National Meeting of the American Society of Mining and Reclamation and the 9th Billings Land Reclamation Symposium, Billings MT, June 3-6, 2003. Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

[2]Robert W. Nairn, Associate Professor, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, OK; Matthew N. Mercer, U.S. Navy Environmental and Preventative Medicine Unit, Norfolk, VA; Choice M. Cogburn, Oklahoma Water Resources Board, Oklahoma City, OK; Denae Athay, Graduate Research Assistant, University of Oklahoma, Norman, OK; Stephanie A. Lipe, Tulsa, OK: Virginia B. Arvidson, Graduate Research Assistant, University of Oklahoma, Norman, OK, Megan Sprowls, Oklahoma Water Resources Board, Oklahoma City, OK and Keith A. Strevett, Associate Professor, University of Oklahoma, Norman, OK.

contributed little to overall metal budgets. Fish species found included *Lepomis macrochirus* and *Gambusia affinis*. Over all, treatment wetlands represent a cost-effective and sustainable technology for water quality improvement. Furthermore, these systems may provide desirable and vital habitat in mining impacted watersheds.

Additional Key Words: constructed wetlands, coal mining, ecological engineering, bioassessment