Challenges of Designing and Building a Passive Treatment System with Limited Topography, Hydraulic Head, and Available Land Area [1]

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Abstract: Mine waters at the Tar Creek Superfund Site, part of the Tri-State Lead-Zinc Mining District of Oklahoma, Kansas and Missouri, are characterized as net alkaline with elevated Fe, Zn, Pb, Cd and As concentrations. Successful passive treatment of these waters has been demonstrated when adequate land area, appropriate topography and satisfactory hydraulic head differences are available. In southeast Commerce, Oklahoma, artesian-flowing collapse features were filled in 2006 as part of a land reclamation project, which resulted in distributed upwelling of mine water. These seeps were captured in subsurface drains and discharged untreated to the headwaters of an unnamed tributary to Tar Creek. Consequently, mine waters no longer daylighted on site and instead were maintained at a depth of 3-4 feet below grade. Existing site surface elevation differences were minimal (~ five feet) and potential land area for construction was limited to ~2.5 acres held by a single cooperative landowner. In addition, the site is near schools, residences, and light industrial operations. Mine waters were pH 6 with 300 mg/L alkalinity, 134 mg/L Fe, 10 mg/L Zn, 60 ug/L Pb, 30 ug/L Cd, 40 ug/L As and >2000 mg/L sulfate with volumetric discharge rates of ~100 gpm. A four-process unit passive treatment system was designed and constructed to address these waters, consisting of an oxidation pond (OP), surface flow wetland (SFW), vertical flow bioreactor (VFBR) and final polishing unit (FPU). Innovative design aspects included shared design surface water elevations across units, use of z-piling and baffle curtains to extend hydraulic retention times and direct flows, solar-powered floating aeration devices (in the OP and FPU) and odor control (for the VFBR outlet), and nuisance mammal control strategies. During construction, unmapped mine shafts were encountered, leading to substantial uncontrolled flows into the OP and impacting other nearby artesian discharges. It is anticipated that successful passive treatment of the Southeast Commerce mine waters will lead to ecological recovery of the unnamed tributary.

Additional key words: oxidation pond, vertical flow bioreactor, solar-powered aeration, float-mix aerators, Tar Creek Superfund Site, mine drainage

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