



# Tracking AMD trace metals in an anthracite passive treatment system in the Shamokin Creek watershed

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## Extended Abstract

While passive treatment systems like this one primarily aim to add alkalinity and precipitate Fe under oxic or anoxic conditions, the fate of trace metals in such systems is less well understood. The system examined here treats roughly half the discharge from the Corbin Drift mine in the Shamokin Creek watershed within the Western Middle Anthracite field near Shamokin, PA. The water entering the treatment system typically has a pH  $\approx$  4.4 and [Fetot] of 20 mg/L. Water passes through the system's oxidation pond and either through three vertical flow wetlands (VFWs) or additional oxic overflows to reach the exit near a pH of 5 and [Fetot] less than 3 mg/L.

We examine Zn, Ni, and Co concentrations throughout the system, along with Fe and Al, to determine if trace metals are likely co-precipitating with iron oxyhydroxide sediments, being transported with Fe colloids through the system, or following a different pattern. Our sample locations include the surface overflows between successive ponds and the standpipes discharging water that has traveled through the reducing mushroom compost and neutralizing limestone of the previous VFW pond. Comparison of 0.45  $\mu$ m field-filtered and ultrafiltered (3 kDa) samples by inductively coupled plasma mass spectrometry (ICP-MS) allows us to differentiate between metal concentrations associated with colloids and those that are truly dissolved.

Results indicate that primarily oxidation processes are removing Fe from the discharge, suggesting that the formation of Fe oxyhydroxides is the dominant mechanism of Fe removal in this system. The trace metals, however, remain dissolved in these oxic waters with only a small fraction in the colloidal phase. Added alkalinity in the anoxic portions of the system appears to facilitate precipitation of Al hydroxides, and concentrations of Zn, Ni, and Co are also substantially lower in these segments of the system matching the pattern of Al concentrations more than Fe. Concentrations of each of the trace metals in the effluent are 70–80% of the influent concentrations. A relevant fraction of the Zn from the anoxic zones is in the colloidal phase, likely in the form of nanoscale ZnS particles.

We plan sequential digests of sediment, during deposition and from older deposits, to understand the mechanism of trace metal removal, but current results suggest that their fate is independent of the dominant iron chemistry. Current results may have particular implications for passive treatment strategies in areas with relatively high trace metal concentrations or for those that don't accompany alkalinity additions with anoxic conditions.

**Keywords:** Vertical flow wetland, trace metals, chemistry, colloids