

An XRF study in mechanisms of chromium removal from industrial storm water using peat medium

BRANDY D. STEWART¹, SARAH L NICHOLAS², PAUL EGER³, CODY SHEIK⁴ AND BRANDY M TONER¹

¹University of Minnesota

²Brookhaven National Laboratory

³Global Minerals Engineering

⁴University of Minnesota Duluth

Presenting Author: stewarb@umn.edu

Treatment processes for metals in industrial storm water can be cost prohibitive. Therefore, passive remediation strategies using natural materials and microbial processes have the potential to provide affordable solutions for removing metals from aqueous waste streams, which is important from regulatory and environmental quality perspectives. Our research explores the key chemical, biological and physical processes promoting removal of hexavalent chromium (Cr) from an industrial storm water treatment system by association with granular organic peat media. In this installation chromium is primarily in the water soluble and carcinogenic hexavalent form, chromate. Prior to treatment, chromate is converted to Cr(III) via an oxidation-reduction reaction using iron sulfate (Fe(II)SO_4). The resulting Cr(III) is less water soluble than chromate (Cr(VI)), making Cr precipitation as hydroxides likely. The removal capacity for Cr(III) is much higher than expected for adsorption and filtration alone, suggesting other mechanisms, including microbially mediated attenuation may play a role. In addition to filtration of Cr(III) precipitates, the presence of excess Fe(III) (from the pre-treatment step) could yield Cr(III) co-precipitation with Fe minerals and/or serve as a terminal electron acceptor.

Samples were collected from an industrial-sized installation in Howell, MI USA, where Cr-laden storm water is treated in large, flow-through tank reactors filled with a peat sorbent material. We sampled one reactor in four different locations at four depths for a total of 16 solid-phase peat material samples after 1 and 3.5 years. Chemical digestions show total Cr concentrations ranging from 400-900 mg/kg peat after 3.5 years dependent on depth and location. X-ray Fluorescence Microprobe (XFM) data reveal that Cr is heterogeneously distributed within the remediation media with both diffuse and “hot spot” features on the micron to 10s of micron scale and is highly correlated with Fe and Zn. Additionally, X-ray Absorption Near Edge Structure (XANES) results show both Cr(III) and metallic Cr-bearing particles in the same sample often as rind-like features accumulating on the surface of peat particles over time.

