Geospatial Distribution of Trace Metals in Soils of a Mining Impacted Agricultural Watershed

A.L. Sikora* and R.W. Nairn

Abstract: The Elm Creek watershed, located in Ottawa County in northeastern Oklahoma, is situated to the west and south of the Tar Creek Superfund Site, part of the historic Tri-State Lead-Zinc Mining District (TSMD). Trace metals contamination has been documented in this region. However, questions remain about broader impacts in the Elm Creek watershed. Properties purchased by the Grand River Dam Authority (GRDA), a public power provider, are designated to be used as offsite mitigation for fish and wildlife impacts under the Pensacola Dam hydropower license of the Federal Energy Regulatory Commission. In this study, surface soil samples were obtained from the left and right stream terraces (top of bank, primary terrace, and lower terrace) of Elm Creek as well as from upland environments to evaluate lead, zinc, cadmium, and other metals concentrations for estimation of ecotoxic risk. Collected samples were homogenized, pulverized, and air dried in the laboratory and tested using a field portable X-ray fluorescence (XRF) spectrometer. Fifteen sampling locations (yielding 106 soil samples) along a 17 km stretch of Elm Creek were identified. Lead and zinc concentrations decreased as distance downstream increased, however, the TSMD-specific Sediment Quality Guidelines (SQG) for lead (150 mg/kg) and zinc (2,100 mg/kg) were exceeded in 48% and 32%, respectively, of the samples within the first 11.3 km of the creek. Of the total of 278 upland soil samples collected and analyzed with the XRF in the laboratory, no sample concentrations exceeded the Tar Creek Superfund Site-specific Remedial Goal (RG) concentrations of 400 mg/kg for lead, but 2.5% exceeded the RG for zinc (1,100 mg/kg). A subset of samples was analyzed for cadmium via ICP-OES. Of these samples, three of the 56 samples (5.4%) exceeded the cadmium RG of 10 mg/kg. The geospatial distribution of metals was evaluated, hot-spots identified, and spatial statistics conducted. The results of this study will influence long-term land use in the watershed.

Additional Key Words: XRF, ICP-OES, wetlands development, bottomland hardwood forests

1 Oral paper presented at the 2018 National Meeting of the American Society of Mining and Reclamation, St. Louis, MO: The Gateway to Land Reclamation, June 3 - 7, 2018. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

2 Amy Lynne Sikora, Graduate Research Assistant (student) and Robert W. Nairn, Professor, Center for Restoration of Ecosystems and Watersheds, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, OK 73019.

3 Work reported here was conducted near 36° 54’ 41.85” N; 94° 55’ 53.56” W.