

Project Title: “Natural Attenuation of Arsenic in an Urban, Industrialized Watershed”

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Introduction to the Problem: The natural attenuation of contaminant metals within a watershed is controlled by processes that sequester the metal from solution to immobile soil or sediment solids. Observation of arsenic cycling in natural systems suggests that partitioning to iron (hydr)oxide minerals may immobilize arsenic within soils and sediments. The proposed research explores the extent of this attenuation process within an industrialized watershed impacted by arsenic contamination from historical industrial activities. The study combines field and laboratory studies designed to 1) determine the geochemical processes that control aqueous and solid phase arsenic speciation and 2) evaluate the most reliable methods and practices for sample collection, preservation, and characterization. The results of this research will aid in the overall development of assessment criteria and practices for determining the potential for attenuation of arsenic via partitioning to soil and sediment matrices.

Background: Arsenic contamination from historical industrial disposal activities and pesticide applications poses a threat to ground and surface waters throughout the United States. However, assessment of the long-term threat of arsenic at a watershed scale requires knowledge of the physical and chemical processes that influence arsenic mobility. Attenuation of arsenic may occur under certain settings through partitioning of aqueous arsenic to immobile solid phases within soil or sediment. In natural systems, sequestration of arsenic by iron (hydr)oxide minerals provides a potential long-term sink for soluble arsenic. Previous research has shown that the mobility of arsenic is influenced by perturbations in pH and redox status in aqueous systems. Changes in these geochemical parameters influence arsenic oxidation state and the dissolution-precipitation behavior of iron (hydr)oxide minerals. Development of a rationale approach to assess the potential for natural attenuation of arsenic within a watershed thus requires 1) understanding the primary geochemical processes that cycle arsenic and iron between the aqueous and solid state and 2) identification of the most reliable tools and practices for measurement of key geochemical parameters. To address this need, research has been undertaken in cooperation with the Region I EPA office to study the extent and mobility of arsenic contamination with an industrialized watershed in Massachusetts.

Objectives: To assess the potential for natural attenuation of arsenic within an industrialized watershed.

Approach: The goals of this research are 1) to assess the geochemical processes that control arsenic mobility in the Aberjona watershed, 2) to develop methods for characterizing solid phase arsenic speciation, and 3) to develop guidance for the assessment of natural attenuation on remediation of arsenic in soils and sediments. These goals have been addressed through field and laboratory studies. Assessment of arsenic mobility in a contaminated watershed has been carried out at the Industri-Plex Site in Woburn, Massachusetts, and the wetland immediately adjacent to the industrial site.

Accomplishments to date (June 2006): The main thrust of the field investigation has been completed and the results have been incorporated into the Feasibility Study prepared by EPA Region 1 to support selection of the remedy for ground-water contamination under Operable Unit 2 (Record of Decision signed in January 2006). The research findings have been documented within the following publications:

- Ford, R. G. 2004. Final Project Report, Natural Attenuation Study, Groundwater, Surface Water, Soil and Sediment Investigation, Industri-Plex Superfund Site, Woburn, Massachusetts. September 2, 2004, 114 pp., EPA 600/X-04/019. (<http://www.epa.gov/ne/superfund/sites/industriplex/230912.pdf>)
- Ford, R. G. 2005. The Impact of Ground Water-Surface Water Interactions on Contaminant Transport with Application to an Arsenic Contaminated Site, Environmental Research Brief, U.S. Environmental Protection Agency, Cincinnati, OH, EPA/600/S-05/002. (http://www.epa.gov/ada/download/briefs/epa_600_s05_002.pdf)
- Ford, R. G., Wilkin, R. T., Scheckel, K. G., Paul, C. J., Beck, F., Clark, P., Lee, T. 2005. Field Study of the Fate of Arsenic, Lead, and Zinc at the Ground-Water/Surface-Water Interface, EPA Report, U.S. Environmental Protection Agency, Cincinnati, OH, EPA/600/R-05/161. (<http://www.epa.gov/ada/download/reports/600R05161/600R05161.pdf>)

Near future tasks: Conduct long-term monitoring at the Industri-Plex Superfund Site to evaluate the performance of the natural attenuation remedy selected to address arsenic contamination in ground water.