Field-Scale Treatability Study to Evaluate In Situ Bioremediation via Soil Mixing of EVO and ZVI to Reduce Munitions Constituents

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Background/Objectives. The former West Virginia Ordnance Works, now the McClintic Wildlife Management Area (MWMA) near Point Pleasant, West Virginia, was used by the US Army to manufacture 2,4,6-trinitrotoluene (TNT) during the early 1940s. Residual nitroaromatic contamination is still present in some areas of the site, which is listed on the National Priorities List (NPL). A wastewater handling system, consisting of a pumping station, two small tanks, and two large earthen constructed wet wells, was used to handle red and yellow wastewaters during TNT manufacture. A record of decision was approved in 1988 to address contamination in these areas. The remedy included groundwater extraction and treatment until cleanup criteria were met. A groundwater treatment system was constructed and operation began in 1997 and continued to operate nearly continuously. Excavation and treatment of approximately 1,000 cubic yards of contaminated soil was completed in 2004 and new extraction wells were installed in a more highly contaminated area in 2005. New extraction wells have achieved capture; however, contamination levels have remained essentially constant. A treatability study using in situ enhanced bioremediation was conducted 2008-2010, which was effective in reducing concentrations of nitroaromatics; however, concentrations rebounded once the carbon source was exhausted, indicating a contaminant source is still present. A study conducted January 2014 to June 2016 further characterized the site and identified contaminant sources in the saturated and vadose zones. The USACE and Aptim initiated a treatability study in 2017 to evaluate the effectiveness of in situ bioremediation using emulsified vegetable oil (EVO) and zero valent iron (ZVI) to degrade nitroaromatics and the effectiveness of soil blending to distribute the amendments in these zones. Another objective of the study is to determine the cost benefit of adding ZVI with the EVO to accelerate degradation of the source material.

Approach/Activities. Two areas of contamination were selected for the treatability study. One area (50 ft X 100 ft) was treated with both EVO and ZVI to a depth of 13 ft except for the eastern 20 ft which was treated to a depth of 28 ft. The second area (50 ft X 75 ft) was treated with only EVO to a depth of 15 ft. Depth to groundwater is approximately 4 ft. Field activities included abandonment of extraction and monitoring wells, installation of new monitoring wells, baseline sampling, soil mixing to distribute amendments into the saturated and vadose zones, surface stabilization, and performance sampling. After mixing and surface stabilization, an additional monitoring well was installed within each mixing area and soil samples were collected via direct push to determine how effectively the amendments were distributed within the mixing areas. Soil mixing was completed in November 2017 and the first three performance sampling events were completed in February, May, and August 2018; by the time of the conference, two additional performance sampling events will have been completed.

Results/Lessons Learned. Results to date appear very positive. This paper will present the methods and techniques used to complete the treatability study, results of baseline and performance sampling results to date, and a discussion of degradation trends observed. Lessons learned associated with execution of soil blending activities will be discussed, including site conditions, equipment used, amendment deployment methods, and mixing techniques.