

Enhanced *In Situ* Reduction of cVOCs using Zero-Valent Iron

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ABSTRACT: The enhanced *in situ* reduction of chlorinated volatile organic compounds (cVOCs) was evaluated at Site 13 of the former Naval Surface Warfare Center (NSWC) White Oak in Silver Spring, Maryland. Following pneumatic fracturing of the tight saprolite formation, the FeroxSM method was utilized to deliver approximately 77,150 pounds of zero-valent iron (ZVI) into 15 boreholes, spaced approximately 34 feet apart within the <1-acre treatment area. Five days after injection, reducing conditions were evident in the injection area by the increase in pH (i.e., from 4.85 pre- to 7.18 post-injection) and the decrease in oxidation-reduction potential (ORP) (i.e., from 294 mV pre- to -290 mV post-injection). Apparent reducing conditions (pH of 7.39 and ORP of -249 mV) continued in the treatment area through 1 year after injection of ZVI. Contaminant concentrations in the treatment area showed significant decreases immediately after the fracturing and injection. The 1,1,2,2-Tetrachloroethane (PCA) concentration in the remediation area dropped from 700 µg/L (pre-injection) to 130 µg/L (5 days after the injection), and then to 110 µg/L (1 month after the injection) and 51 µg/L (3 months after the injection). One year after the injection, the PCA concentration is <2 µg/L (nondetect). Similarly, the trichloroethylene (TCE) concentration in the remediation area dropped from 150 µg/L (pre-injection) to 22 µg/L (5 days after the injection), and then to 17 µg/L (1 month after the injection) and 8 µg/L (3 months after the injection). One year after the injection, the TCE concentration is <2 µg/L (nondetect). Reductions in cVOC concentrations have not necessarily been observed in the nearest downgradient wells. In fact, slight increases have occurred followed by decreases in concentrations, suggesting that some of the contamination may have been pushed outward during the injection. The 1-year post-injection ORP values suggest more reducing conditions than before the injection. Long-term monitoring will continue until remediation goals are met as specified in the Record of Decision for Site 13. It is now certain that ZVI was effective at decreasing cVOCs in the source area and an effective radius of at least 20 feet was demonstrated in the saprolite formation using ARS's FeroxSM method; however, there are uncertainties: Was sufficient ZVI injected to create strongly-reducing conditions that promote abiotic degradation processes? Post-injection ORP levels in the source area are on the order of -200 mV and some modest increase in intermediate by-products have been observed (although their concentrations appear to be decreasing). Both suggest that biological degradation may be a key component.