Pilot Study on In Situ Bioremediation of a Former Wastewater Treatment Pond Containing High Levels of PCBs

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Background/Objectives. Polychlorinated biphenyls (PCBs) are one of the most frequently reported contaminants associated with contaminated sediments in the country and ranks second after mercury for the basis for fish consumption advisories. Recent in situ studies have demonstrated the feasibility of PCB bioavailability reduction using activated carbon (AC) as an amendment. While in situ amendment studies are effective at reducing PCB bioavailability in sediments, a more desirable goal is to ultimately reduce the inventory of legacy PCBs in sediments while also reducing bioavailability to the food chain. We describe results from pilot-scale in situ treatment of sediment containing up to 1000 mg kg^{-1} PCBs using AC amended with PCB degrading microorganisms. The objectives of the study were: 1) demonstrate the scalability of growing PCB respiring microorganisms for field application, 2) develop and test the application of PCB halorespiring and degrading bacteria using pelleted AC as a delivery system, 3) assess the benefits of bioamended AC treatment on high levels of PCBs in sediments.

Approach/Activities. The innovative aspect of the technology is the application of anaerobic organohalide respiring bacteria and aerobic PCB degrading bacteria with selected activities to sediments with an AC agglomerate as a delivery system. The bioamended AC serves as a solid substrate for: 1) delivery of microorganisms into sediments, 2) sequestration and concentration of hydrophobic PCBs in close proximity to the biofilm of PCB transforming bacteria. Based on optimal cell titer and carbon loading rates determined in 0.26 m^2 caissons, a large field trial was conducted in four 7.3 m^2 caissons with the following treatments: no treatment, nutrients only, bioamended AC, bioamended AC and nutrients. The sediments were monitored for changes in total PCBs in the bulk sediment over a time period of 850 days.

Results/Lessons Learned. Methods were successfully developed for production-level scale-up of the microorganisms without residual POPs and development of an inoculation system to deploy active PCB-transforming microorganisms into PCB impacted soils and sediments. In the small caisson study the greatest level of PCB reduction in sediment, 80% after 300 days, was observed in the caisson treated with bioamended AC. PCB levels continued to decrease at a slower rate 5 years after treatment to 87% of the original PCB concentration. No significant change in PCB levels were observed in untreated sediments. In the large caissons the greatest reduction of PCBs, up to 57%, were observed in the caissons treated with bioamended AC. Some reduction in PCB levels were observed initially in the non-bioamended caissons, which was attributed to mixing of the sediment, but this reduction stopped after 374 days. Methodology, challenges associated with deployment and post-treatment results for total concentrations of PCBs will be discussed. The study demonstrates the successful treatment of sediments impacted with high levels of PCBs using in situ treatment with anaerobic dechlorinating and aerobic degrading microbes combined with AC. This field study shows the promise of bioremediation as a new strategy to help address the widespread need to reduce contamination of the aquatic food web from exposure to sediment-bound PCBs.