Effects of Activated Carbon Dosage for Aquatic Bioaccumulation Control

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Background/Objectives. Sediments in the Great Lakes harbors often exhibit elevated levels of PCBs bioaccumulation, limiting their suitability for placement in open water and wetlands. Amending the sediment bioactive zone with a low dosage of activated carbon has the potential to provide bioaccumulation control (EPA, 2013) and serve as a dredged material management alternative, permitting expanded open water placement and aquatic beneficial use where confined disposal facility (CDF) capacity is being exhausted. Additionally, low dosages of activated carbon (AC) may be able to remediate highly dispersed contamination that will not recover readily without adding an amendment. There is a need to determine the optimal AC sediment amendment dosage to achieve reduction of PCBs bioaccumulation. Current in situ treatment applications typically use 3 to 5% activated carbon by dry weight (dw) or in excess of the total organic carbon (TOC) of the sediment (Patmont et al., 2015), but a reduced dosage would reduce AC costs and effects on benthic organisms, and would be less likely to alter other sediment characteristics.

Approach/Activities. Lake Erie sediments were collected from Cleveland Harbor, Ashtabula Harbor and Buffalo River. The sediments were characterized for organic matter, labile organic matter, hard organic matter, TOC, dry bulk density, grain size distribution, and PCB congener concentrations. The bioavailability of the PCBs was characterized by exposing the oligochaete *Lumbriculus variegatus* to the sediments in accordance with a 28-day bioaccumulation test procedure (EPA Test Method 100.3, USEPA 2000; Method E1688, ASTM 2010). The sediments were amended with several dosages (0.3% dw to 0.06% dw) of powdered activated carbon (PAC), placed in stainless steel barrels, and mixed for seven weeks using barrel rollers to achieve near equilibrium conditions among the sediment, AC and pore water. Then, 28-day bioaccumulation tests as described above were run on the amended sediments. Tissue samples were collected at the end of the exposure time and analyzed for % lipid and tissue PCBs congener concentrations. Tissue concentrations of the worms exposed to the amended and unamended sediments were compared to determine the reduction, if any, of PCBs bioaccumulation in the worms following carbon amendment and the smallest effective carbon dose as a function of sediment characteristics.

Results/Lessons Learned. Amending sediments with PAC greatly reduced bioaccumulation of the less chlorinated PCB homologs, generally hexa-PCBs and less chlorinated PCBs, in all three sediments tested. Powdered activated carbon dosages as low as 0.06% PAC dw yielded reductions in normalized PCB lipid concentrations ranging from 65% to greater than 85%. Results from PAC dosages of 0.1% dw yielded nearly the same results as dosages of 0.3% dw and therefore even considerably lower dosages may also yield substantial bioaccumulation control. The reduction for a given PAC dosage may be a factor of the sediment's organic matter composition, and the concentration, composition/distribution and bioavailability of the PCBs. Consequently, amending the bioactive zone of sediments or dredged material with activated carbon placed in aquatic sites can provide substantial bioaccumulation control.