Development of a Custom Carbon Amendment Strategy Using Biochar for a Mercury-Contaminated River

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Background/Objectives. Operations at the former DuPont Waynesboro facility from 1929 to 1950 included a mercuric sulfate catalyst that resulted in the release of inorganic mercury into the South River. Loading from historically contaminated bank soils is the primary, on-going pathway allowing mercury to enter the aquatic system. The approach to remediate mercury (Hg) impacts from erosion of bank soils along the South River in Waynesboro, Virginia includes a unique, layered cap which incorporates biochar (BC).

Extensive research has shown that BC is effective at removal of mercury in water. The cap includes a reactive layer of BC to remove Hg from bank storage water that drains through the cap back to the South River after precipitation and storm events. During the initial remedial design phase, BC was selected as the reactive layer instead of activated carbon due to its sustainable sources, availability and lower price per pound compared to activated carbon; BC also has a lower greenhouse gas footprint compared to activated carbon.

Approach/Activities. BC has been incorporated into the cap using two designs. The initial cap design for the first two BMAs included a 6-inch layer of BC mixed with a planting substrate (PS) in a 50:50 ratio by volume (PS+BC). This mixture was then placed into 12-inch geocells, and covered with an additional 6 inches of PS. The BC was purchased directly from a vendor in chip format, and mixed on site with the PS material using an excavator.

A thinner cap profile had to be considered for the third BMA due to space constraints. Based on that evaluation, the bank cap included the use of an activated carbon reactive core mat (RCM) for a small section of the cap profile which had to be placed in the wet, and the PS+BC mixture above the water table. During the evaluation of the thinner cap profile, use of a manufactured biochar coated aggregate (AG) was also explored. The AG will be implemented for the next (fourth) BMA to be constructed. The manufactured material consists of a gravel aggregate coated with 10% BC by mass (AG+BC).

Results/Lessons Learned. There were several important findings based on the evaluation of the PS+BS to create a thinner cap. While the PS+BC had the lowest raw material cost of all options evaluated, it had the highest overall in-place cost, due to the labor required to mix and place the material, and increased geocell costs. The lowest overall in-place cost is for the AG+BC, which also has the advantages of being able to be placed in the wet, and providing a proven consistency of BC in the cap layer. The increased carbon density compared to the PS+BS also allowed for placement of a much thinner cap, reducing the material costs for geocell and lowering the impact of the cap on the river flow geometry. The assessment and outcome of several phases of remediation demonstrate the importance of revisiting assumptions and approaches in an adaptive management framework during a long-term, multi-phased remediation, to ensure the remedy is optimal.