Installation of J-Hook Vanes to Mitigate Bank Erosion as Part of a Time Critical Removal Action

Anita Emery-DeVisser (anita.devisser@woodplc.com), Wayne Ingram, PE,
Jeshua Hansen, PE (Wood Environment & Infrastructure Solutions, Inc. [Wood], Novi, MI, USA)
Seth Jelen, PE CFM (Wood, Portland, OR, USA)
Cynthia Draper, PE, (Wood, Kennesaw, GA, USA)

Background/Objectives. A time critical removal action (TCRA) for sediment and bank remediation was performed at a Superfund site in Michigan within a 1.7-mile river reach. The scope of the TCRA project included remediation of PCBs in riverbank soil and sediment upstream of a degrading dam. One segment of river presented unique challenges to riverbank remediation and stabilization that required specific engineering and construction solutions. Challenges included modeling and working within higher river velocities which were directed toward a cut bank curve by highway bridge pilings. Objectives for this segment included designing and implementing a solution that would remove PCB-impacted material, stabilize banks, and place in-stream structures to return river flow to the center of the channel.

Approach/Activities. The challenges associated with the bridge abutments and river forces caused the formation of a mid-channel bar and a split thalweg that redirected the channel flow towards the left-descending bank. To develop the engineering design, a focused evaluation was undertaken to understand the factors associated with interaction of the bridge abutments, river flow, and the cut bank curve including a review of current bathymetry, historical aerial photography, inundation history, local hydrology, MDOT bridge as-built plans, erosion pin data, and hydraulic modeling using both HEC-RAS and DELFT3D. While the solution for mitigating potential PCB contribution to the river and stabilizing and restoring riverbanks in other portions of the river used a combination of remedial excavation and installation of natural bank treatments, the solution for this segment of river was to build out the bank to its historical position, remove the mid-channel bar, and then install an armored bank and J-hook vanes to redirect flow and shear forces to the center of the river. The Delft 3D model was revised and updated from the previous model with a 4-meter grid. The new model provided more detail on flow depth, velocity, and bed shear stress along the area of bank erosion in a “Detail Area”, with a finer resolution triangular grid of about 1 meter in size to assist in the evaluation of the J-hook vane design.

Results/Lessons Learned. A more aggressive approach to bank protection was needed downstream of the bridge abutment than designed for other areas. The design and construction included redundancy to maintain stability during 100-year storm events. There were initial concerns that the J-hooks would be an impediment to recreational users of the river. Work group meetings were held between the agencies and modelers/designers to provide the detailed hydraulic model results and case studies of J-hook vane use on similar rivers and proven benefits. With agreement of regulators and clients, two J-hook vanes were installed using standard construction equipment – instream excavation to reach proper elevation, and placement with an in-stream excavator. Following initial installation, there were two minor adjustments of boulders to achieve the proper finished elevation. Since installation, the river has experienced several flood events (the largest being a ~50-60-year return period); the J-hooks are functioning as planned, returning river flow to the channel centerline.