STREAMLINING IMPLEMENTATION OF SUSTAINABLE CHANNEL MAINTENANCE PRACTICES SJN 135356

BACKGROUND

Ohio Department of Transportation (ODOT) District and County staff are faced with the difficult task of implementing effective channel maintenance programs to ensure safe operation of roadways. Natural channel design practices are commonly used in stream restoration, but have been adapted to address streambank lateral migration and sediment aggradation maintenance problems at bridge openings. Environmental permitting requirements for maintenance and stream restoration projects vary significantly and it was unclear how to address environmental permitting requirements for these adapted practices. Additionally, the impact of these structures on channel hydraulics was unknown and could potentially impact flooding and roadway safety.

RESEARCH APPROACH

Seven pilot projects were implemented in three counties. Two single-arm vanes, three culvert-weirs, a low-weir, and bankfull partition were implemented and used as case-studies to identify permitting requirements. Two-dimensional hydraulics models of six pilot projects were developed to simulate as-designed, pre-maintenance, and post-maintenance conditions across a range of flow rates. All projects were documented with photos and video to develop multi-media educational materials and facilitate technology transfer to other Districts.

RESEARCH FINDINGS AND RECOMMENDATIONS

Preliminary monitoring and modeling results suggest that natural channel design-based maintenance practices can be sustainable alternatives to current practices. Additional implementation and monitoring are needed to assess performance across a range of conditions and explore the limits of the approach. Many projects can be permitted under the ODOT Regional General Permit. Implementation of these practices is relatively quick and cost-effective. Additional pilot projects in other Districts would help build capacity to shift the maintenance paradigm toward more sustainable and environmentally sound practices.

PILOT PROJECT IMPLEMENTATION

- Projects on smaller watersheds can be implemented in a couple of days or less at low cost

ENVIRONMENTAL PERMITTING

- Natural channel design-based maintenance practices can be permitted under the ODOT Regional General Permit Section B when directly adjacent to the structure with the purpose of protecting the structure

HYDRAULIC MODELING

- Culvert-weirs concentrate flow for low and intermediate events and enhance sediment transport through the culvert
- Culvert-weirs increase capacity at sites impacted by aggraded sediments, but decreases capacity relative to the designed and as-built condition
- Single-arm vanes shift shear stresses towards the center of the channel and reduce peak shear for the most frequent flow rates
- Single-arm vanes reduce peak shear stress and peak velocity at the opening

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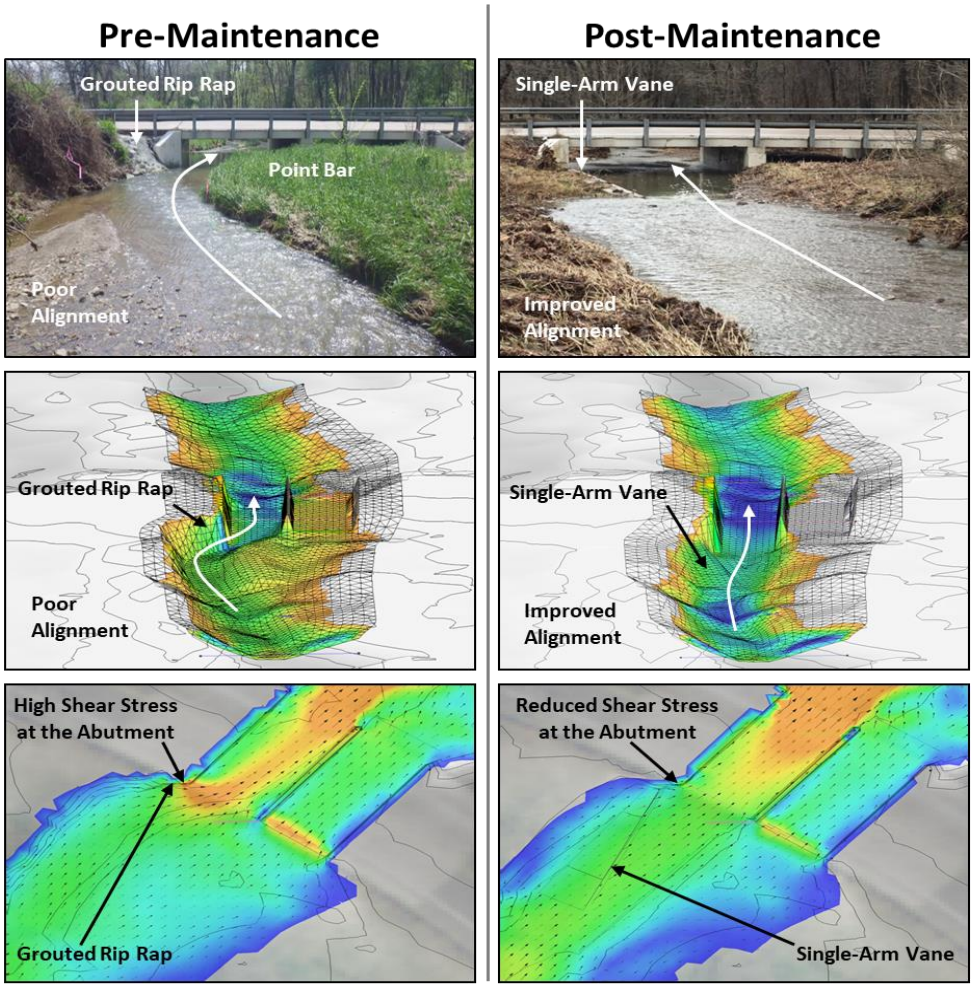

SINGLE-ARM VANES

Single-arm vanes were implemented to address streambank lateral migration that threatens an abutment or embankment. This common problem occurs when the streambed width at the bridge opening is much wider that the natural channel upstream. The common response is for sediment to deposit as flow depth and velocity decrease in the overwide section. A point bar forms blocking the opening. Meanders form initiating lateral migration of the bank into the abutment and embankment. The misaligned channel often reduces shear stress and velocity through the opening and may promote aggradation as well. Simple single-arm vanes transition flow through the opening smoothly and force alignment of flow. Projects can be permitted under the Regional General Permit Section B and typically are installed in one to four days with minimal equipment and materials cost.

CULVERT-WEIRS

Culvert-weirs were implemented at sites with sediment aggradation issues that decreased capacity in twin box culverts. A weir was placed in front of one opening when the width of the natural channel upstream was more consistent with the width of a single culvert. The low and intermediate flows were confined to a single culvert and enhanced sediment transport. High flows were still able to utilize the capacity of the second culvert as flow spilled over the weir. The design was able to clear sediment from the culvert during high flows without any additional maintenance. Culvert-weir projects were implemented in less than a day and covered under the Regional General Permit Section B. While sediment transport was enhanced, conveyance was reduced relative to the as-designed condition; however, the as-designed condition is only a temporary state as aggradation will resume unless addressed.

Top left) Aggraded sediment reduces capacity. Top middle) Installation of a culvert weir. Top left) Modeling results for culvert weir showing concentration of flow and shear stress in the right culvert after installing the culvert weir on the left culvert. Bottom left) Aggraded sediment prior to the installation of the culvert weir. Bottom right) Sediment following installation of culvert weir. Dashed line indicates sediment level prior to the maintenance activity.

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