VERMONT
AGENCY OF TRANSPORTATION

FACT SHEET

Flood Analysis of Bridge-Stream Interactions using Two-Dimensional Modeling of Vermont River Reaches

PROJECT TITLE

Flood Analysis of Bridge-Stream Interactions using Two-Dimensional Modeling of Vermont River Reaches

STUDY TIMELINE

June 2019 – September 2021

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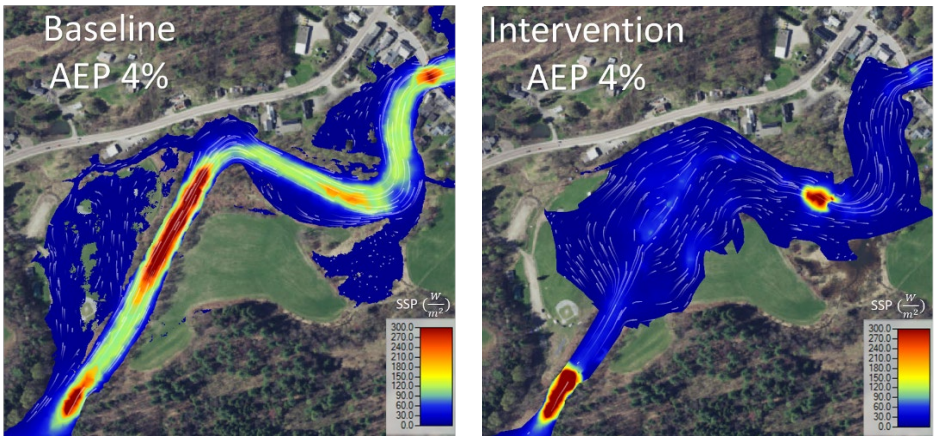
Introduction or Problem Statement

Bridge rehabilitation and new bridge designs are often performed by considering only the specific location. Studies that quantify or assess bridge-stream interactions at the river reach scale are sparse. Managers often struggle to prioritize interventions and assess their impacts up- and downstream of a given project location to address stakeholder concerns. The objectives of this project were to: (1) understand how bridges interact with rivers over a range of gradients; (2) understand how intervention impacts cascade up- and downstream; and (3) develop and evaluate a framework that combines stream channel gradient and specific stream power to identify transportation infrastructure most sensitive to flood mitigation interventions.



Methodology or Action Taken

A Hydraulic model using 2D HEC-RAS was developed and calibrated for ~42 km Mad River reach. Previously available 2D models of two additional reaches (~74 km Otter Creek and ~4 km Black Creek) were also used. These three river reaches cover a range of gradients from very low to high. A screening framework, that uses the 2D hydraulic modeling results, was developed to identify bridges and sites best suited for hydraulic intervention such as floodplain lowering and reconnection and addition of culverts for mitigating the impacts of extreme flood events. These interventions were then simulated in the developed 2D HEC-RAS models of the three study reaches. The results of the baseline and intervention models were examined to quantify bridge-river interactions on a reach scale, evaluate the overall effectiveness of the screening framework, and identify reach-level impacts of flood mitigation interventions.

Conclusions or Next Steps

The screening framework was developed and successfully evaluated using modeling results. The framework proved more useful in moderate to high gradient rivers where changes in gradient are more dramatic and frequent. The calibrated model showed how site specific interventions have cascading nonintuitive consequences throughout the study reach, demonstrating the value of 2D transient modeling. Longitudinal cascading impacts are more extensive in low gradient rivers, but is highly dependent on bridge-river physical

characteristics. Given a site specific intervention, the benefit of reducing stream power is more pronounced and varying in *moderate to higher* gradient rivers.

Potential Impacts and VTrans Benefits

This project demonstrated the value of performing 2D transient hydraulic modeling for reach-scale bridge-river analysis and design. The screening framework developed in this research can be employed for resource prioritization, holistic design of bridges, and bridge and river rehabilitation projects. The screening framework can be applied to other rivers under similar geographic and climatic conditions. This study serves as a proof of concept for a methodology to quantify bridge-river interactions on a river scale, and able to address stakeholder concerns about cascading impacts of planned bridge projects.

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research