UTC Project Information

Project Title	MPC-619 – Evaluating Nonlinear Methods for Flood Hydrograph Generation to Evaluate Bridge Scour
University	Colorado State University
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Brief Description of Research Project	The most common cause of bridge failures is scour of bed material around bridge foundations by floods. For non-cohesive bed material, scour can occur rapidly, and maximum scour depths can be reached during a single flood event. For cohesive bed material, scour often occurs much slower, so the cumulative contribution of multiple storm events must be considered. Bed erosion depends nonlinearly on the streamflow rate, so scour calculations require an accurate representation of the distribution of flow rates that a bridge will encounter. In some cases, stream flows are obtained from unit hydrograph (UH) theory, which assumes a linear relationship between the excess rainfall in a watershed and the resulting streamflow at the watershed outlet (upstream of the bridge). However, the linearity assumption is increasingly recognized by hydrologists as invalid. Incorrectly assuming linearity can result in underestimation of the peak flows for large flood events. The overall goal of this project is to develop guidelines for using a nonlinear UH framework that recently became available in the widely used modeling software HEC-HMS. Theoretical approaches will be developed to estimate two functions that are required to implement the UH method. Its performance will be tested by comparisons to observed hydrographs for two large flood events in four basins in the Colorado Front Range. The importance of considering nonlinearity will also be assessed by comparing design flows from linear and nonlinear UH methods and by evaluating implications for bridge scour under a range of hypothetical scenarios.

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	While these results suggest that the basin response can have substantial implications for scour, additional research is needed in several areas. For example, the methods should be applied to other basins within the Colorado Front Range foothills and in other regions.
Impacts/Benefits of Implementation (actual, not anticipated)	This research demonstrated that the estimation of peak stream flows, and nonlinearity in basin response in particular, can have a significant impact on scour estimations and thus the design and safety of bridges. While further research is needed, this study provides one case study of such an effect and is expected to prompt other research in this area.
Web Links • Reports • Project Website	• MPC Research Report – Evaluating Nonlinear Methods to Generate Flood Hydrographs for Bridge Scour Applications