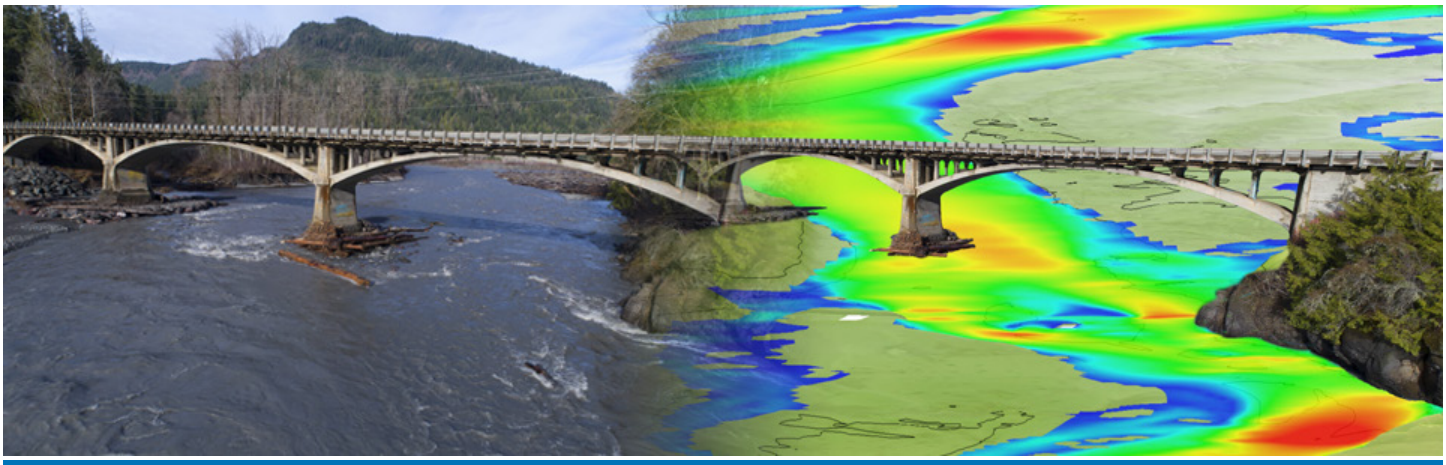
Collaborative Hydraulics: Advancing to the Next Generation of Engineering (CHANGE)

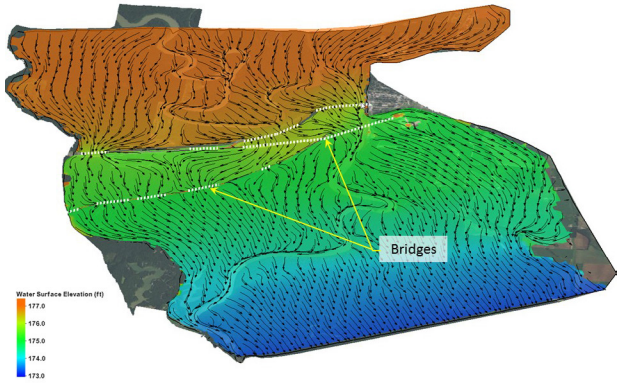
Next-generation hydraulic modeling tools improve the understanding of complex interactions between river or coastal environments and transportation assets, enabling better design, enhanced communication, and more efficient project delivery.



2D modeling tools allow for more reliable hydraulic design and more effective collaboration and communication with project partners.

Practicing engineers and designers have used one-dimensional (1D) hydraulic modeling tools routinely for nearly 60 years. Although user interfaces have greatly improved during this time, the underlying computational techniques have remained the same. These modeling techniques apply several simplifying assumptions that can lead to overly conservative, inadequate, or inaccurate results and are insufficient to meet many of today's project requirements.

For example, in recent years, resource agencies have increased their focus on assessment of environmental impacts associated with river crossings. As a result, hydraulic engineers have become responsible for demonstrating that impacts have been avoided or minimized to the extent possible. Traditional hydraulic tools do not effectively support these levels of inquiry and analysis.



3D graphical results from a 2D hydraulic model.

NEXT-GENERATION HYDRAULIC MODELING TOOLS

Two-dimensional (2D) hydraulic modeling software, graphical interfaces, and supporting resources are now available that can be applied to infrastructure design to improve understanding of the complex interactions between river or coastal environments and transportation assets. Recent advances in computer hardware, modeling software, Geographic Information Systems, and survey practices have made 2D modeling very efficient, intuitive, and accessible to engineers and designers.

Because 2D models avoid many of the limiting assumptions required by 1D models, the results can significantly improve the ability of highway agencies to design safer, more cost-effective, and resilient structures on waterways.

In addition, the 3D visualization capabilities of these modeling tools aid in communicating design results

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and implications to a variety of stakeholders through intuitive and visually rich graphical output.

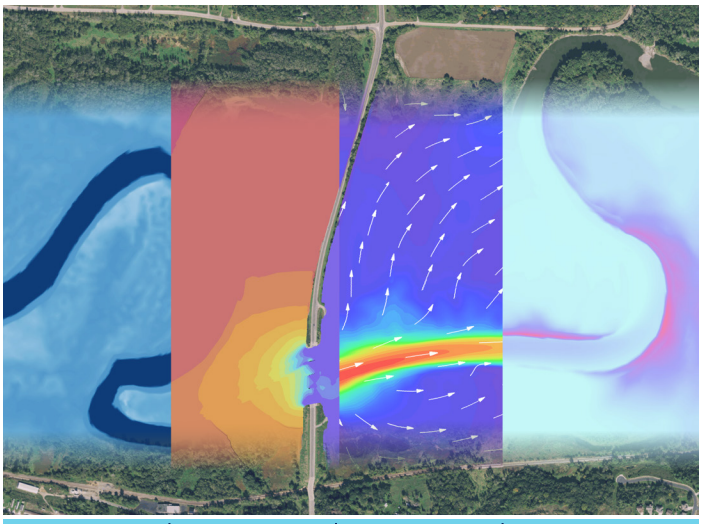
BENEFITS

- **Improved Quality and Resiliency.** 2D modeling results provide more accurate representations of flow conditions, including depths and velocities. Improved project quality may often be realized by using 2D modeling results to inform the location and size of structures, determine depths of bridge foundations, and analyze environmental impacts.
- **Enhanced Collaboration.** 3D graphical visualizations derived from 2D modeling offer better tools for communicating the often complex interaction between waterways, the transportation infrastructure, and the surrounding environment.
- **Streamlined Delivery.** Improved collaboration can help streamline project development, including environmental, regulatory, and engineering activities.

STATE OF THE PRACTICE

The EDC-4 CHANGE initiative introduced more than 40 DOTs to best-practice 2D hydraulic modeling tools. Implementation examples include:

- Nevada DOT is applying 2D hydraulic modeling to multiple projects and using unmanned aerial mapping technology to develop the supporting terrain data.
- Georgia DOT made 2D modeling mandatory on projects where water flow passes through multiple bridge openings and supports its use for other modeling situations.
- Montana DOT expanded the use of 2D hydraulic modeling to most of its bridge projects.
- Arizona DOT ramped up nine consulting firms to provide 2D hydraulic modeling services.



2D hydraulic models calculate depths, velocities, and other necessary design parameters.

- Alaska DOT initiated a cooperative agreement with the U.S. Geological Survey to apply 2D hydraulic modeling to multiple bridge projects.
- The New Mexico DOT Drainage Design Bureau is using 2D modeling in parallel with conventional 1D hydraulic models on multiple bridge replacement projects. They report that a 2D hydraulic model can be developed faster and with more confidence than similar 1D modeling efforts.

RESOURCES

FHWA EDC-5 Collaborative Hydraulics: Advancing to the Next Generation of Engineering (CHANGE)
https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/change2.cfm

FHWA Hydraulic Engineering
http://www.fhwa.dot.gov/engineering/hydraulics

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