

2D Hydraulic Modeling Webinar Series

Evaluating Detailed Bridge Hydraulics and Scour with SMS/SRH-2D and HEC-RAS 2D

March 12, 2026

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**TRANSPORTATION
HYDRAULICS
SOLUTIONS**

2D Hydraulic Modeling Webinar Series Objectives

- Highlight best practices in 2D modeling for transportation hydraulics
- Showcase new features and capabilities in SMS/SRH-2D
- Share examples of 2D modeling applications
- Compare SRH-2D and HEC-RAS 2D modeling approaches
- Provide an open forum for questions and other insights

Agenda

- 2D Hydraulic Modeling Webinar Series Page and Resources
- Current version of SMS/SRH-2D
- New bridge scour training course opportunity
- **Computing Bridge Scour with 2D Modeling**
- **Scour Parameter Extraction with SRH-2D/SMS and HEC-RAS 2D**
- Tips and Tricks

2D Hydraulic Modeling Webinar Series Page

<https://aquaveo.com/software/sms/srh2d-hydraulic-modeling-webinar-series>

- Sign up to receive future webinar invites
- SMS Hot Keys and Tips
- Sample Theme file
- Presentation slides and recording links
- PDH certificate
- Modeling resources

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2D Hydraulic Modeling Webinar Series

Aquaveo LLC and Transportation Hydraulics Solutions LLC have partnered to deliver a new **2D Hydraulic Modeling Webinar Series** designed to help engineers enhance their modeling capabilities and understanding of transportation hydraulics.

This ongoing series will:

- **Highlight best practices** in 2D modeling for transportation hydraulics, with emphasis on detailed bridge and culvert hydraulics and bridge scour analyses.
- **Showcase new features and capabilities** in SMS/SRH-2D for transportation-related hydraulic applications.
- **Compare SRH-2D and HEC-RAS 2D modeling approaches** for bridge hydraulics and scour analysis, explaining best practices and potential differences in results.
- **Provide an open forum** for both new and experienced 2D modelers to ask questions, share insights, and suggest ideas for future improvements and developments.

Webinars are offered quarterly.
To receive invitations to upcoming sessions, please **sign up for the 2D Modeling Webinar Series mailing list** (see form to the right).

Questions or suggestions for future webinar topics?
Email Scott Hogan: scott.hogan@transportationhydraulics.com.

Webinar Resources

- [SMS Hot Keys and Helpful Tips](#)
- [Sample Theme File](#)

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2D Hydraulic Modeling Resources

[2D Hydraulic Modeling Resources](#) page

- SMS Quick References and Sample Files
- Software download and [licensing](#)
- FHWA 2D Hydraulic Modeling Reference Document
- Training links
- SMS wiki page
- Tutorials
- You Tube Videos
- Past FHWA 2D Hydraulic Modeling User's Forum Videos
- Additional resources

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 <p>Groundwater Modeling System</p> <p>3D groundwater flow & transport and subsurface simulations v10.8 Learn more v10.9 Beta Now Available</p>	 <p>Surface-water Modeling System</p> <p>Surface-water solutions for coastal & riverine environments v13.4 Learn more New Release!</p>	 <p>Watershed Modeling System</p> <p>All-in-one hydrologic & hydraulic solutions including pipe networks v11.3 Learn more</p>
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2D Hydraulic Modeling / Bridge Scour Resources

- SMS wiki: [Bridge Scour Methodology](#)
- SMS wiki: [Bridge Scour Workflow](#)
- Recommended [Tutorials](#): Bridge Scour, Bridge Scour Scenarios
- [HEC-RAS Docs](#)

General SMS Tutorials	
Title	SMS 13.4
<i>Overview</i>	PDF  Data 
<i>2D Summary Table</i>	PDF  Data 
<i>3D Bridge</i>	
<i>Annotated Cross Sections</i>	PDF  Data 
<i>Automatic Mesh Refinement</i>	PDF  Data 
<i>Bridge Meshing</i>	PDF  Data 
<i>Bridge Scour</i>	PDF  Data 
<i>Bridge Scour Scenarios</i>	PDF  Data 

SMS 13.4 Current Release

- Current version: SMS 13.4.10
- Build date: February 9, 2026
- Several revisions/bug fixes
 - [SMS Release Notes](#)



From Modeling to Mitigation: An Applied Bridge Scour Master Class

Practical training connecting hydraulic modeling, bridge scour evaluation, and practical bridge design decisions.
Designed for engineers at all levels of bridge scour experience.

Developed and
Presented by:

*Nationally recognized
instructors in bridge
hydraulics and scour analysis.*

Dr. Lyle Zevenbergen, PE
LWZ LLC

Scott Hogan, PE
Transportation Hydraulics Solutions LLC

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TOPICS COVERED

Hydraulic Modeling

- 2D modeling best practices for bridge hydraulics
- SMS/SRH-2D Bridge Scour Tool
- HEC-RAS 2D Bridge Scour Tool

Scour Evaluation

- Stream stability and long-term degradation
 - Contraction scour
 - Pier scour
 - Abutment scour

Design Decisions

- Countermeasure design and foundation options
- Alternative analysis to reduce scour
 - Bridge scour analysis review

Computing Bridge Scour with 2D Modeling

Overview

- Background
- Key advantages over 1D modeling
- Best Practices and Recommendations
- Worst case scour concept
- Extracting Hydraulic Parameters
- Tools & Capabilities

Computing Bridge Scour with 2D Modeling

Background

A few common quotes from practitioners:

“Most bridge scour equations were developed from laboratory or reach-averaged hydraulic conditions, so why is 2D modeling really necessary for bridge scour analysis?”

“If Scour Equations Are 1-D, Why Use 2-D Modeling?”

“The scour equations didn’t become 2-D just because the model did.”

Computing Bridge Scour with 2D Modeling

Background

Responses:

2D modeling becomes appropriate when flow complexity exceeds the assumptions inherent in 1-D models (e.g. skewed bridges, split flow, lateral velocity gradients, etc.).

The 2D modeling is used to improve how we compute and extract hydraulic parameters, not replace scour methodology.

Computing Bridge Scour with 2D Modeling

Key advantages over 1D modeling

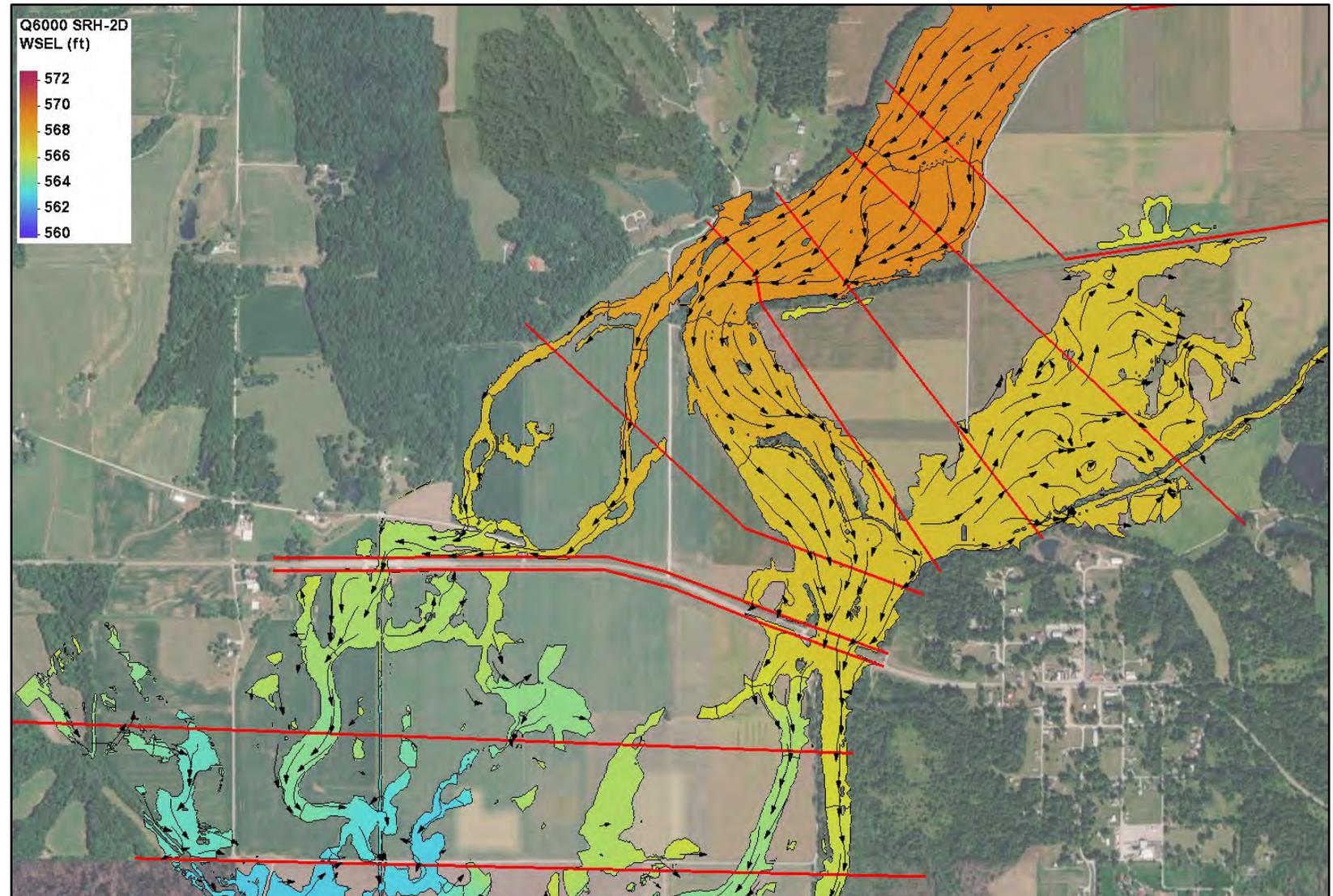
1D Modeling Assumptions	2D Modeling Advantage
Flow path and direction specified by user	Flow path and direction computed
Potential flow split location and magnitude computation directed by user	Flow splits computed based on the mesh representation of the terrain
Flow distributed based on available conveyance area (overbank conveyance not preserved)	Flow distribution based on momentum and continuity
Cross-sectional averaged velocity	Detailed velocity magnitude and direction computed at every mesh element
Average WSEL computed at each cross section	WSEL computed at every mesh element
Flow direction/angle of attack assumed	Flow direction computed at every element
Contraction/expansion zones (ineffective areas) and loss coefficients specified by user	Contraction/expansion zones and losses computed

Computing Bridge Scour with 2D Modeling

Key advantages over 1D modeling

SRH2D Example:

- Split flow path
- Hydraulic controls
- Multiple openings
- Varied WSEL

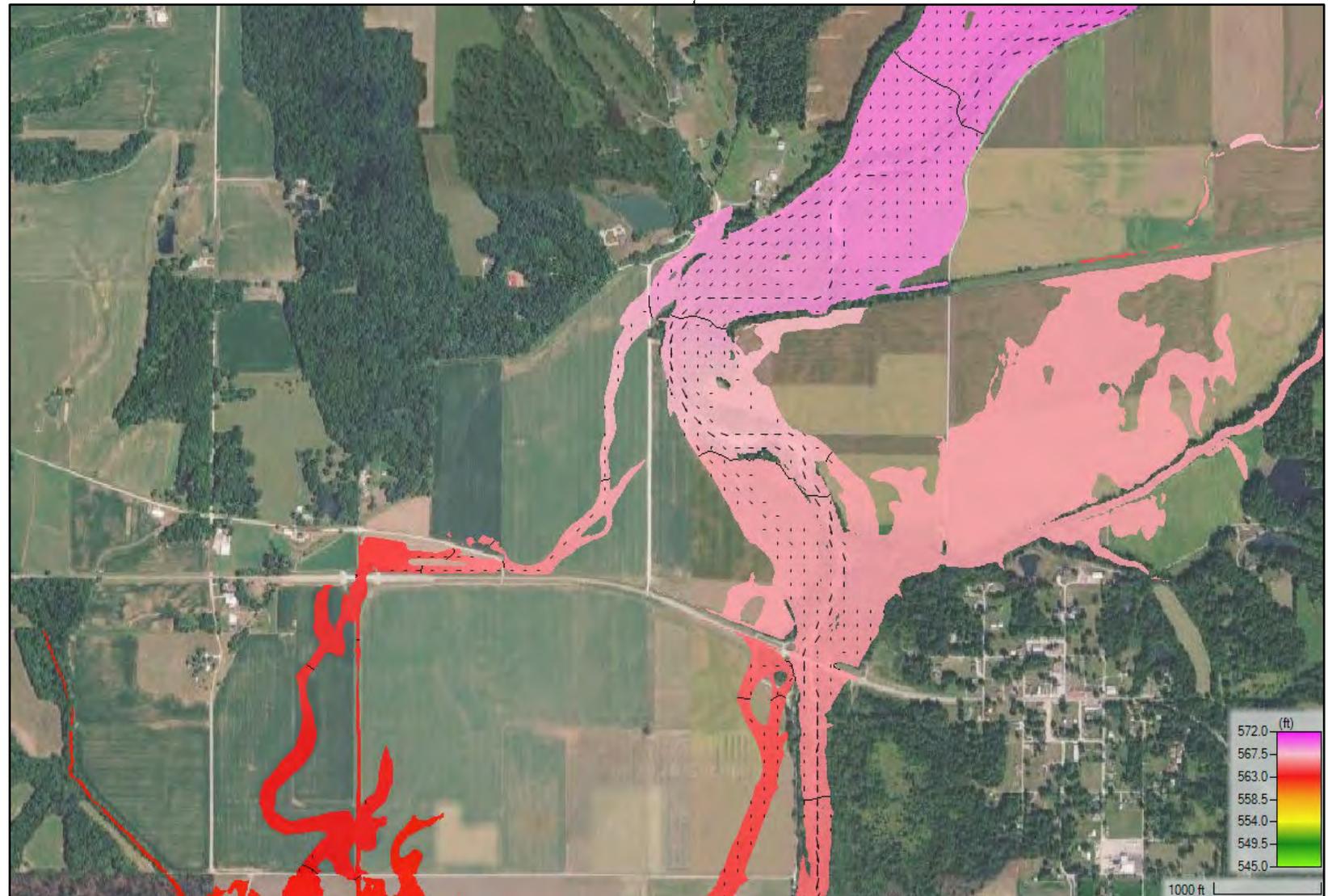


Computing Bridge Scour with 2D Modeling

Key advantages over 1D modeling

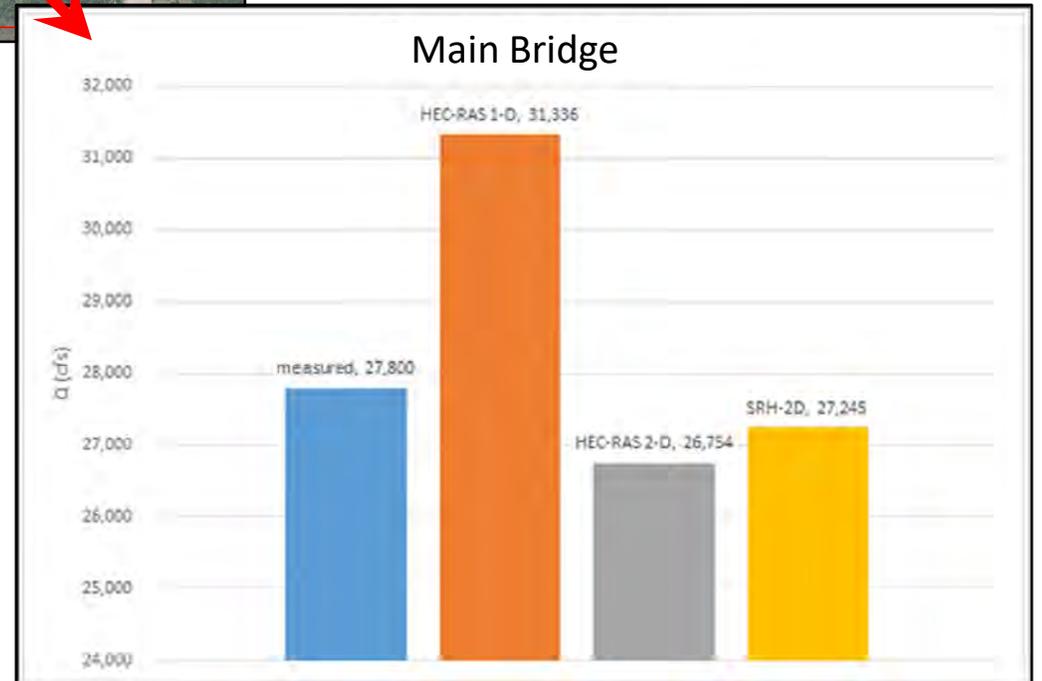
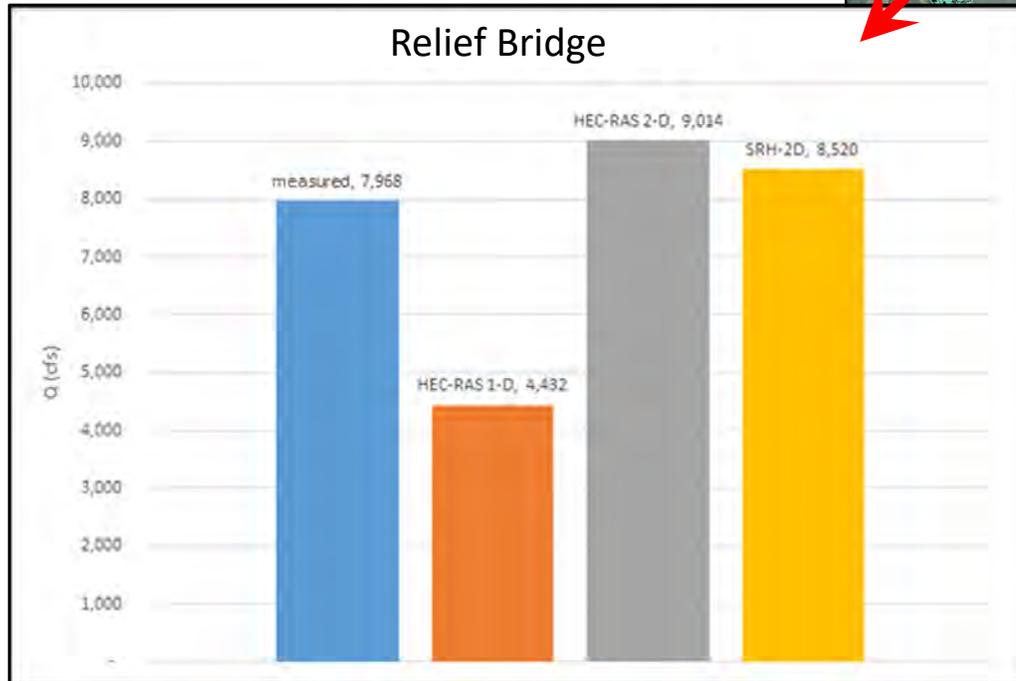
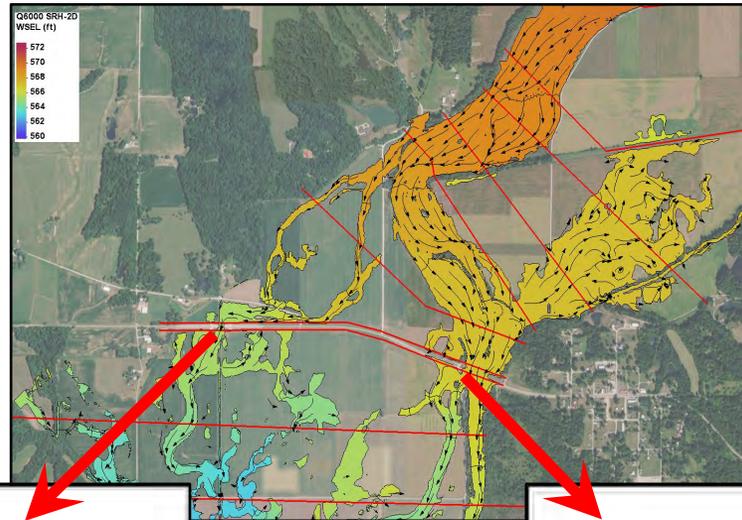
HEC-RAS2D
comparison:

- Similar mesh geometry



Computing Bridge Scour with 2D Modeling

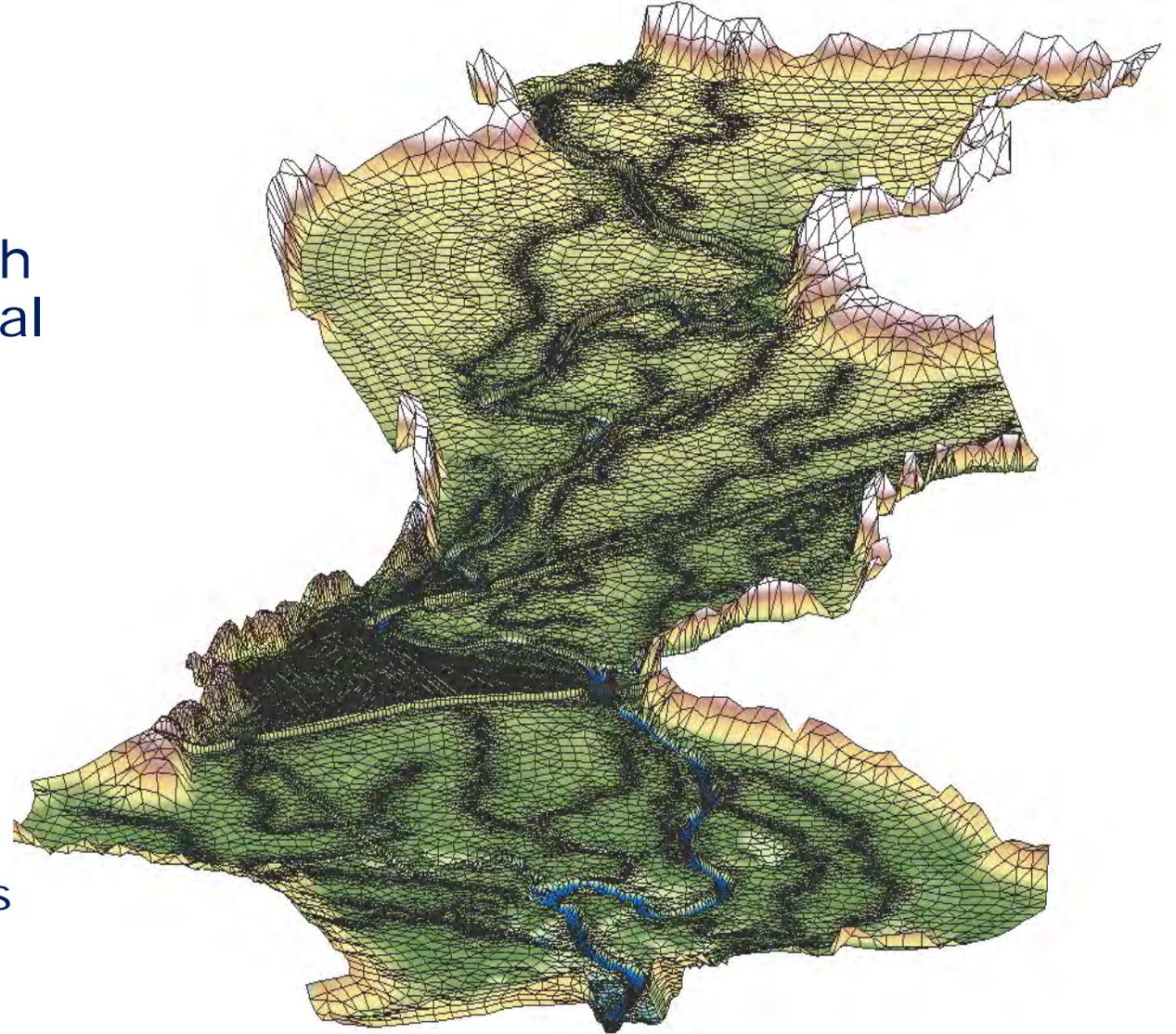
1D vs. 2D modeling



Computing Bridge Scour with 2D Modeling

Meshing Best Practices

- Acquire accurate terrain and bathymetric data in critical areas
- Place boundary conditions far enough from area of interest to avoid artificial influences
- Follow a detailed meshing strategy:
 - Smaller elements at bridge openings, constrictions, levees/roadway embankments, sharp bends, flow splits
 - Larger elements in hydraulically uniform floodplain areas
 - Use breaklines to align elements with hydraulic controls and other key features
- Sensitivity testing



Computing Bridge Scour with 2D Modeling

Missing best Practices

- Generating breaklines for mesh generation
- SMS Toolbox 
Coverages -Features from Raster
 - Streams
 - Ridges
 - Channel bank lines

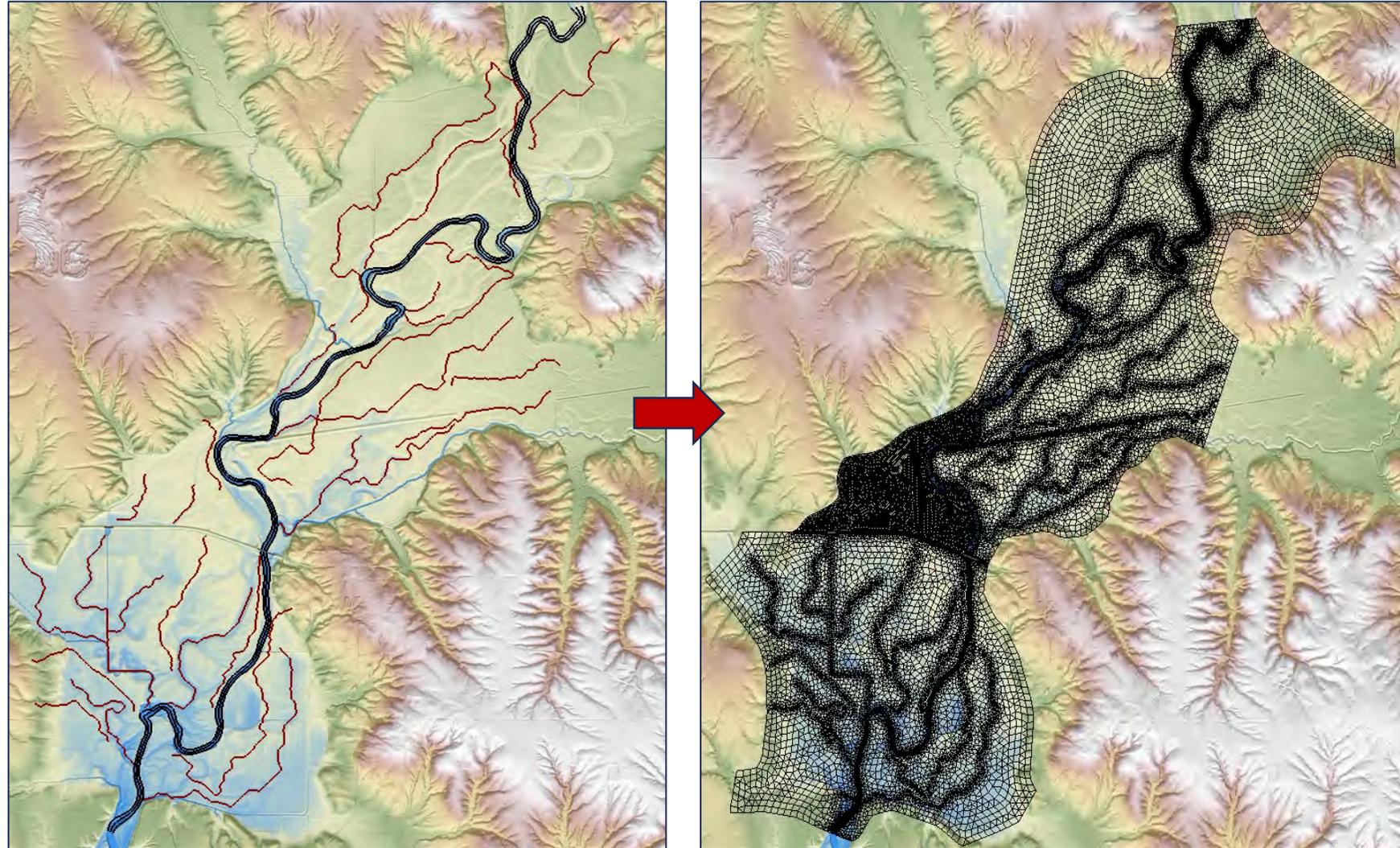
SMS Tutorials

Extract Features

PDF  Data 

Extract Features for Mesh Generation

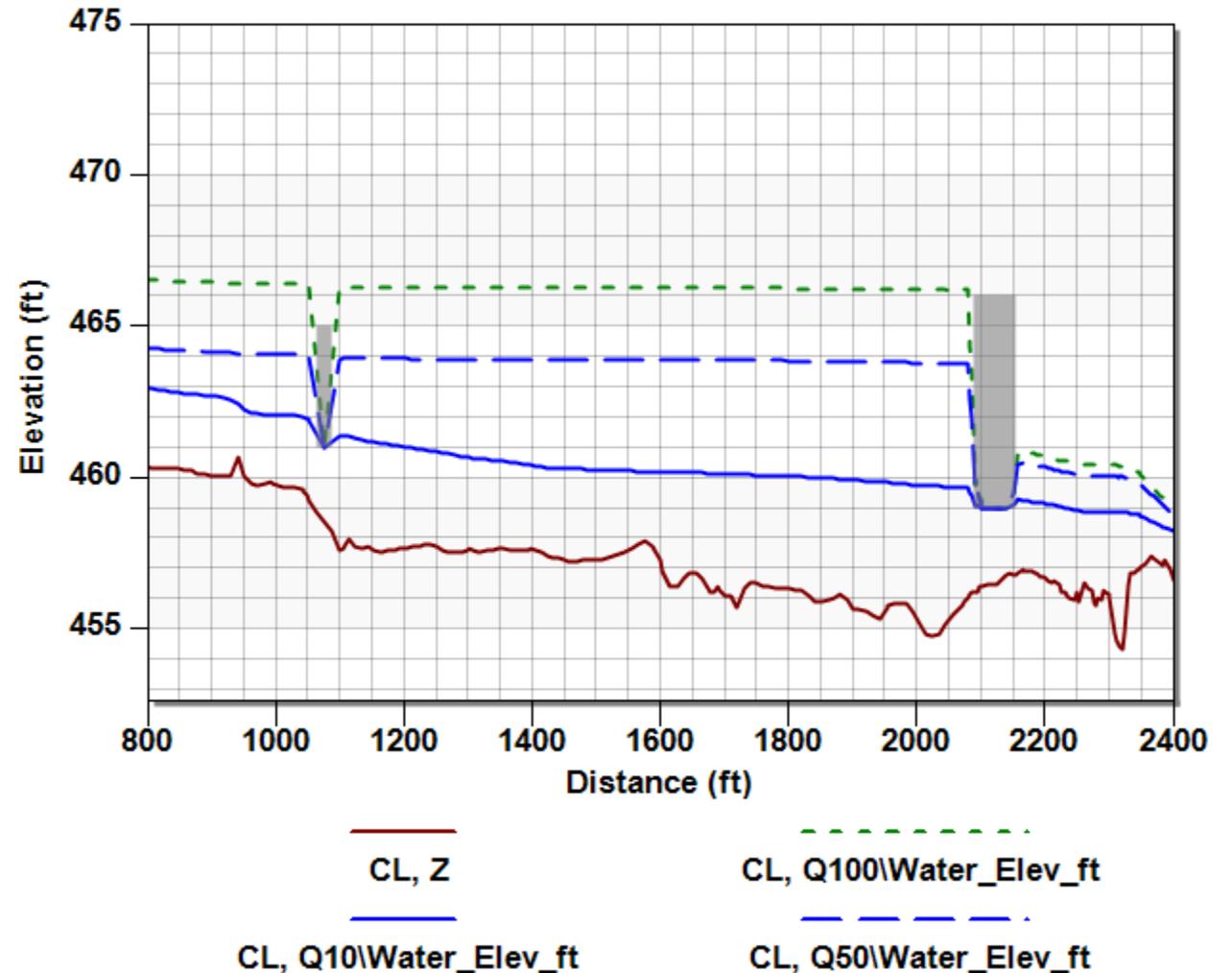
PDF  Data 



Computing Bridge Scour with 2D Modeling

Evaluating Worst Case Scour

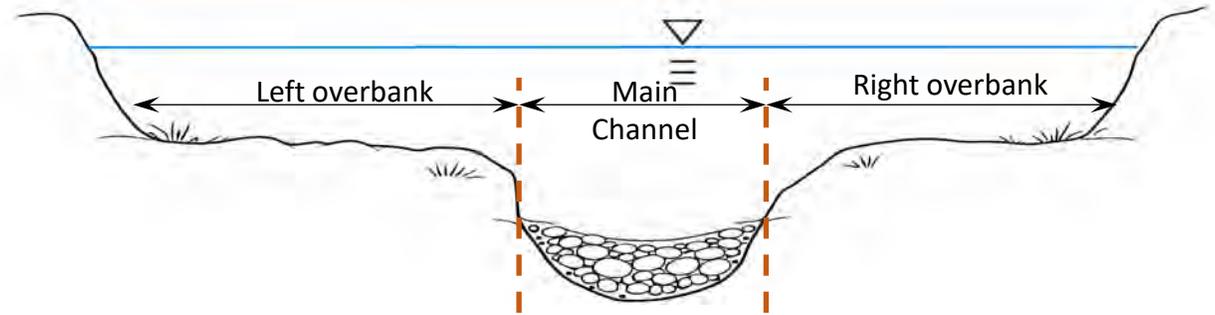
- The worst scour does not always occur at the highest flow
- Evaluate multiple flow scenarios to assess maximum scour potential
- Recommended Flows
 - Q100 (Design)
 - Q500 (Check)
 - Incipient overtopping
 - Other site-specific critical flows



Computing Bridge Scour with 2D Modeling

Parameter Extraction

- y_1 (y) – Average depth at approach channel, or overbank
- Q_1 – Flow in approach channel, or overbanks
- W_1 – Width of flow in channel or overbanks
- $Q_2(Q)$ – Flow in contracted section channel or overbanks
- $W_2(W)$ – Width of contracted flow in channel or overbanks
- y_0 – Average flow depth at contracted section prior to scour
- q_1 – Unit discharge in approach channel or overbanks
- q_2 – Unit discharge in contracted section channel or overbanks
- y_p – Depth upstream of pier (local or at max q)
- V_p – Velocity upstream of pier (local or at max q)



Critical Velocity

$$V_c = K_u y^{1/6} D^{1/3}$$

Contraction Scour

Live Bed Condition	Clear Water Condition
$y_s = y_1 \left(\frac{Q_2}{Q_1} \right)^{6/7} \left(\frac{W_1}{W_2} \right)^{k_1} - y_0$	$y_s = \left(\frac{K_u Q^2}{D m^{2/3} W^2} \right)^{3/7} - y_0$

Abutment Scour

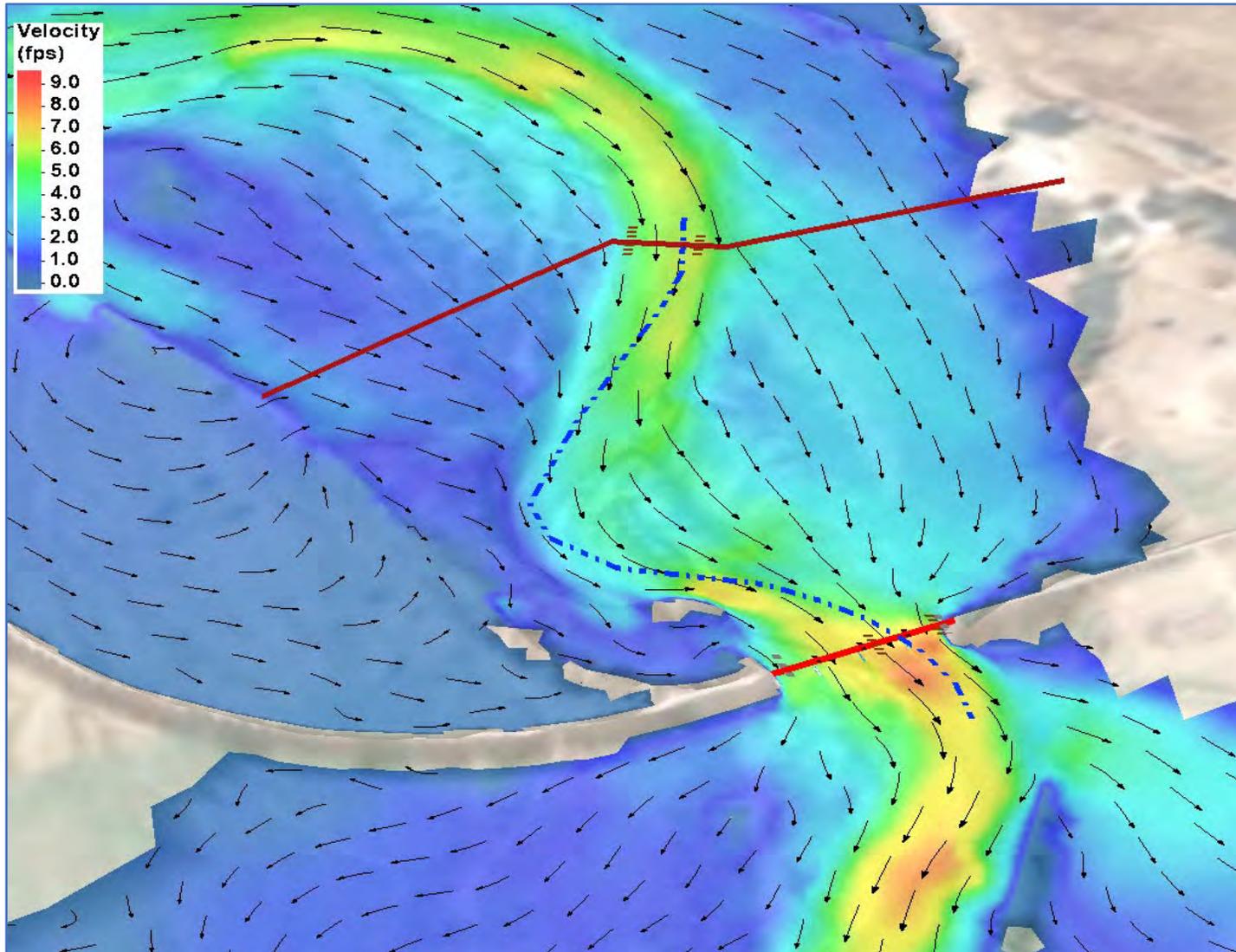
$y_{max} = \alpha_{A/B} y_1 \left(\frac{q_2}{q_1} \right)^{6/7}$	$y_{max} = \alpha_{A/B} \left(\frac{q_2}{K_u D_{50}^{1/3}} \right)^{6/7}$
---	--

Pier Scour

$y_s = 2.0 K_1 K_2 K_3 \left(\frac{a}{y_p} \right)^{0.65} Fr_1^{0.43}$	$\left(Fr_1 = \frac{V_p}{(g y_p)^{0.5}} \right)$
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Computing Bridge Scour with 2D Modeling

Parameter Extraction – Approach and Contracted Section Locations



Approach Section

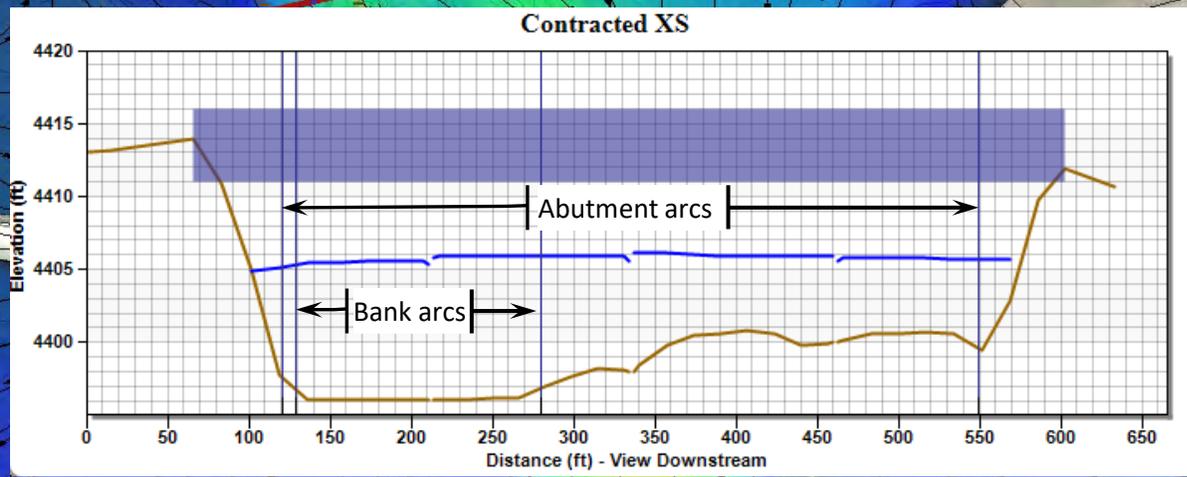
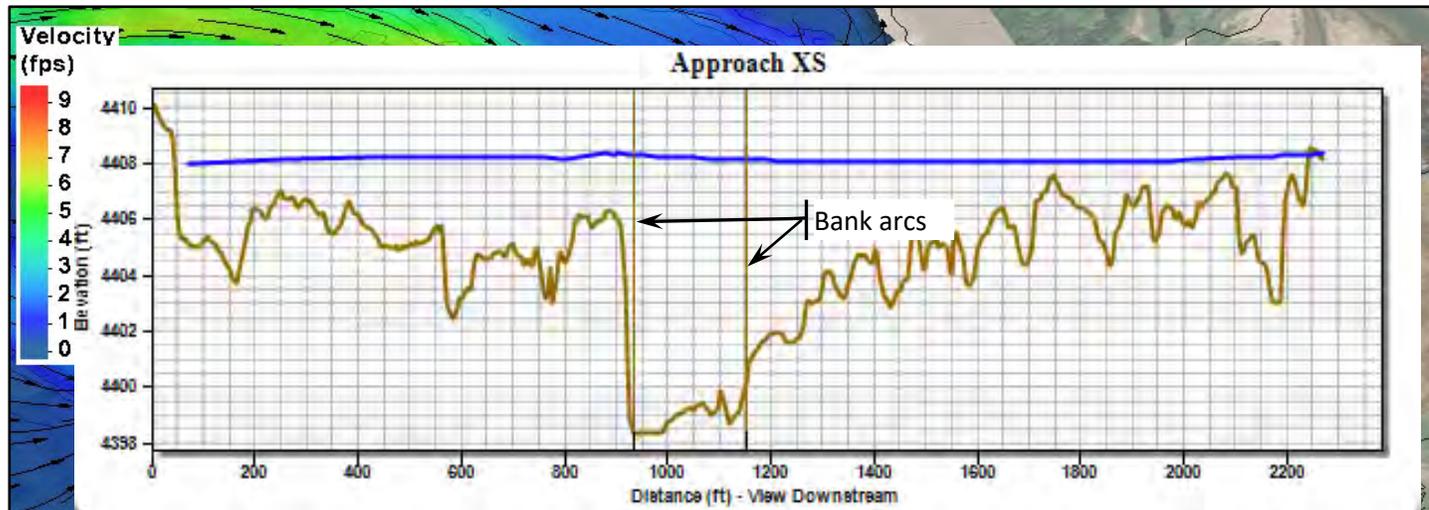
- Upstream of location where overbank flows are diverted towards main channel
- Representative of average upstream hydraulics and sediment transport

Contracted Section

- Location of maximum flow contraction within bridge footprint

Computing Bridge Scour with 2D Modeling

Parameter Extraction – Channel Widths



Approach Section

- Upstream of location where overbank flows are diverted towards main channel
- Representative of average upstream hydraulics and sediment transport

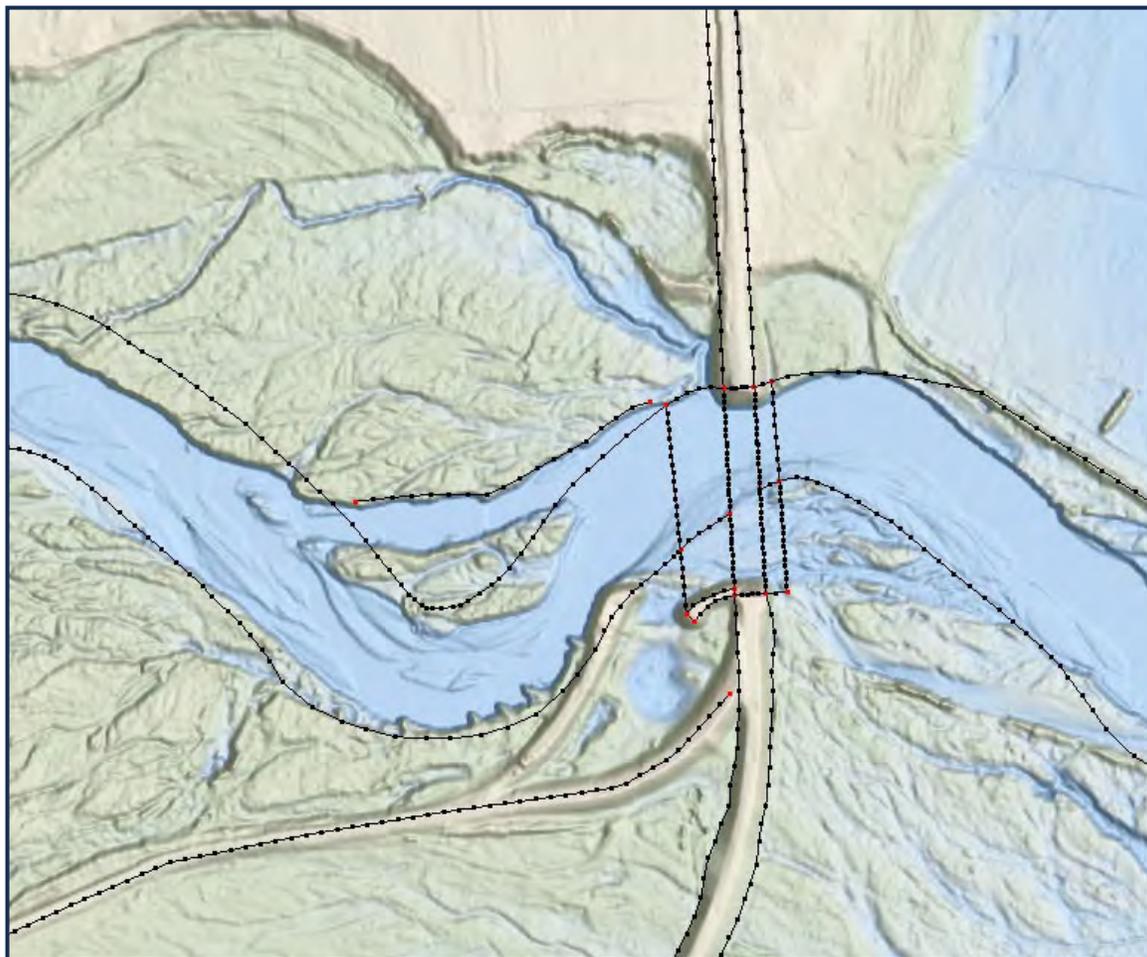
Contracted Section

- Location of maximum flow contraction within bridge footprint

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

Mesh Development – Conceptual Mesh

SRH2D/SMS 13.4



Breaklines are needed to align element faces with hydraulic controls

RAS 2025

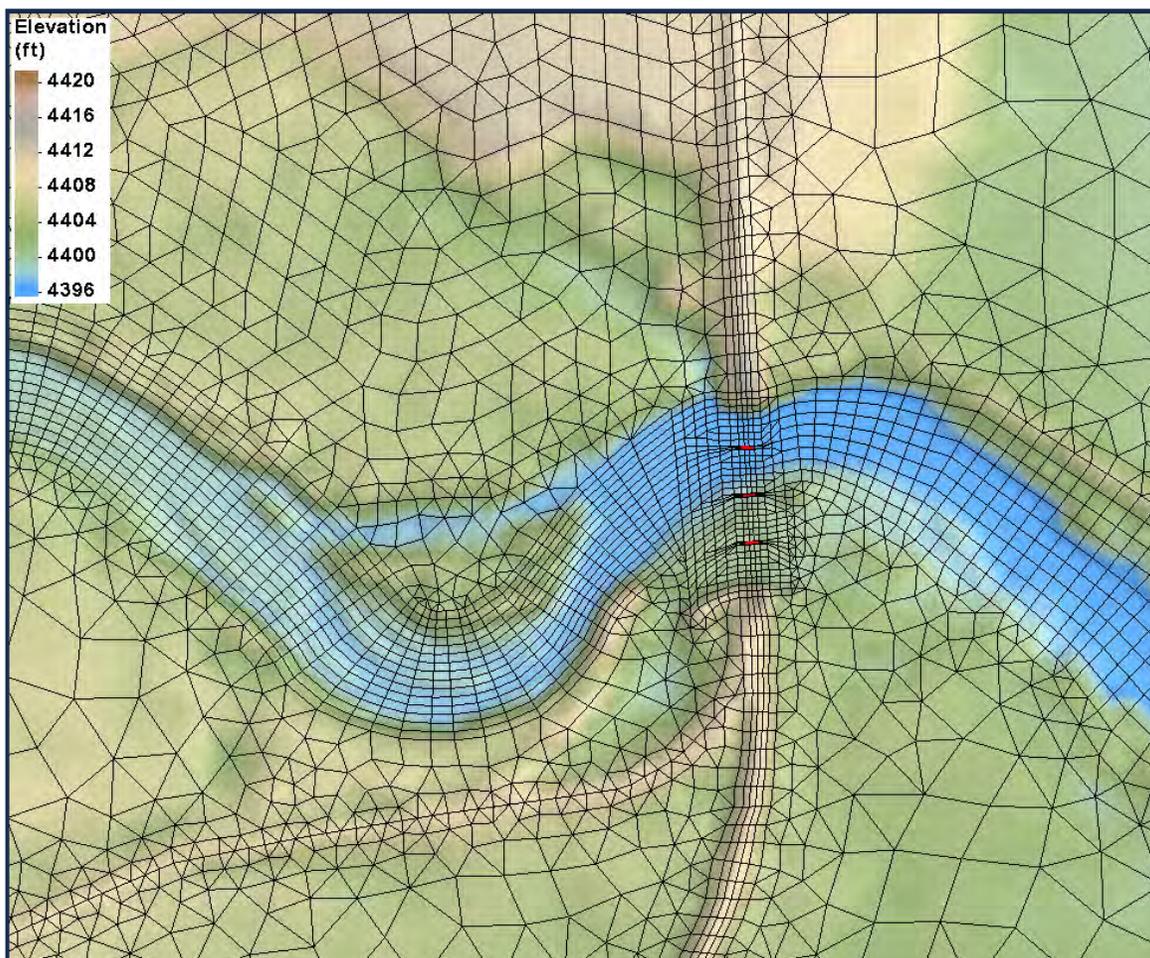


Breaklines are needed to align element faces with hydraulic controls **and pier geometry**

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

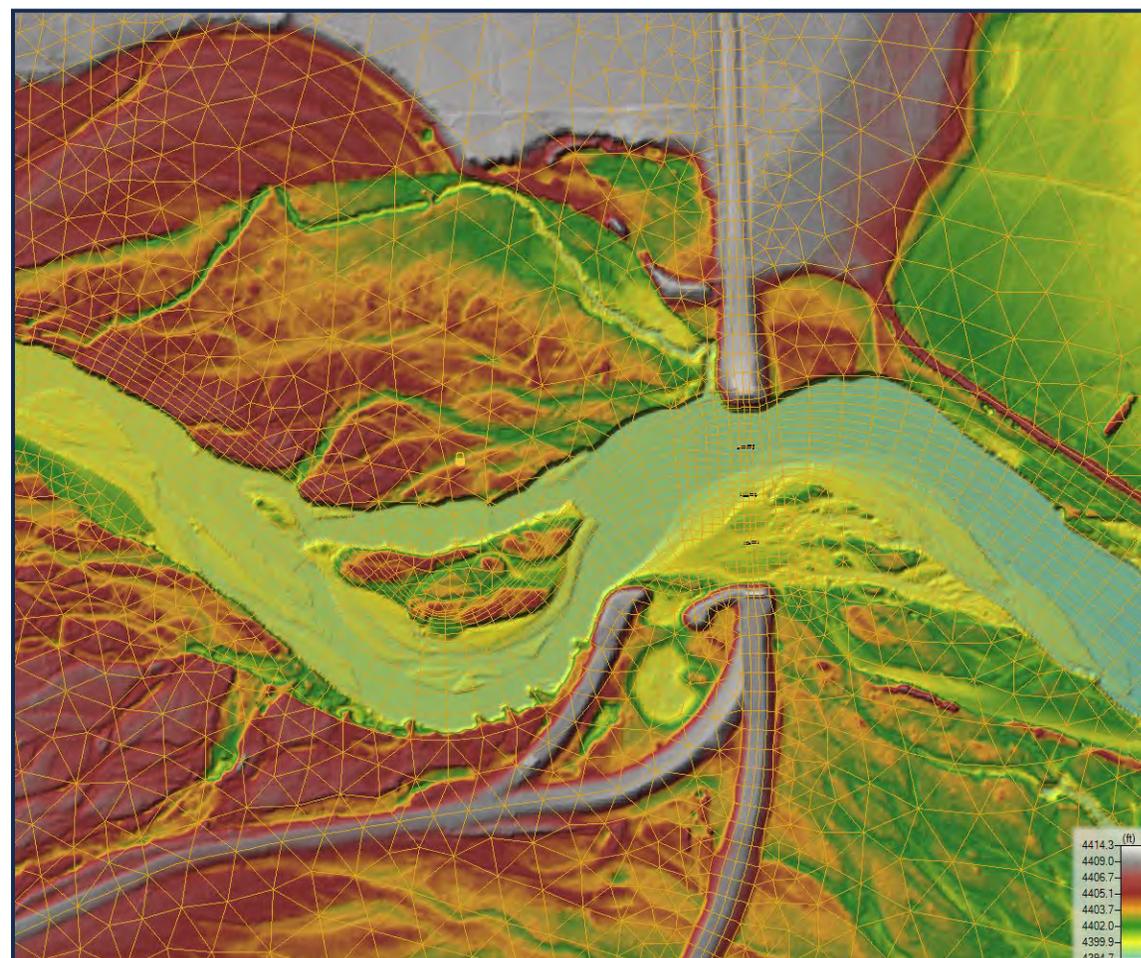
Mesh Development

SRH2D/SMS 13.4



Piers are added automatically as holes in the mesh with the 3D Structures Tool

RAS 2025

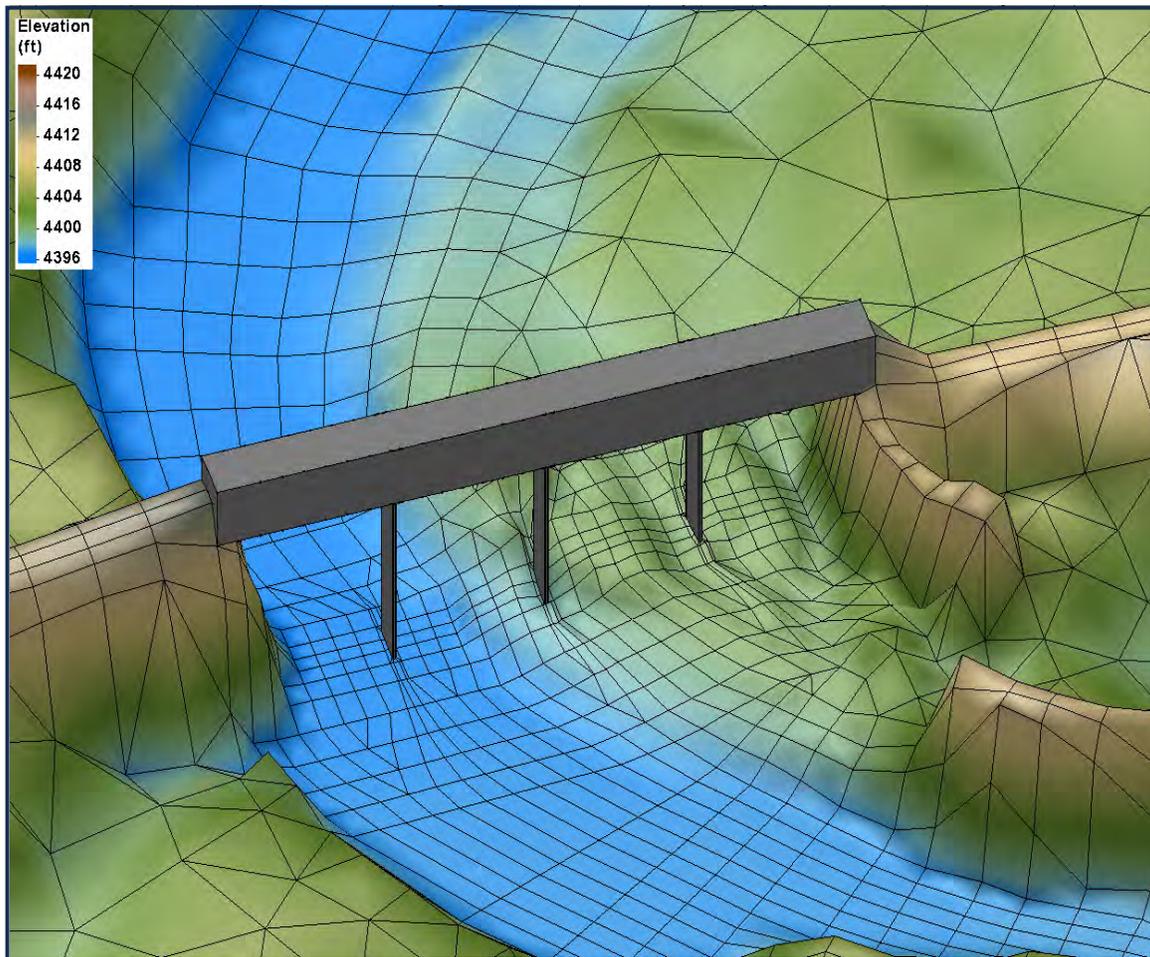


Piers added with terrain modifications and in bridge editor.
Element edges must intersect pier length and width.

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

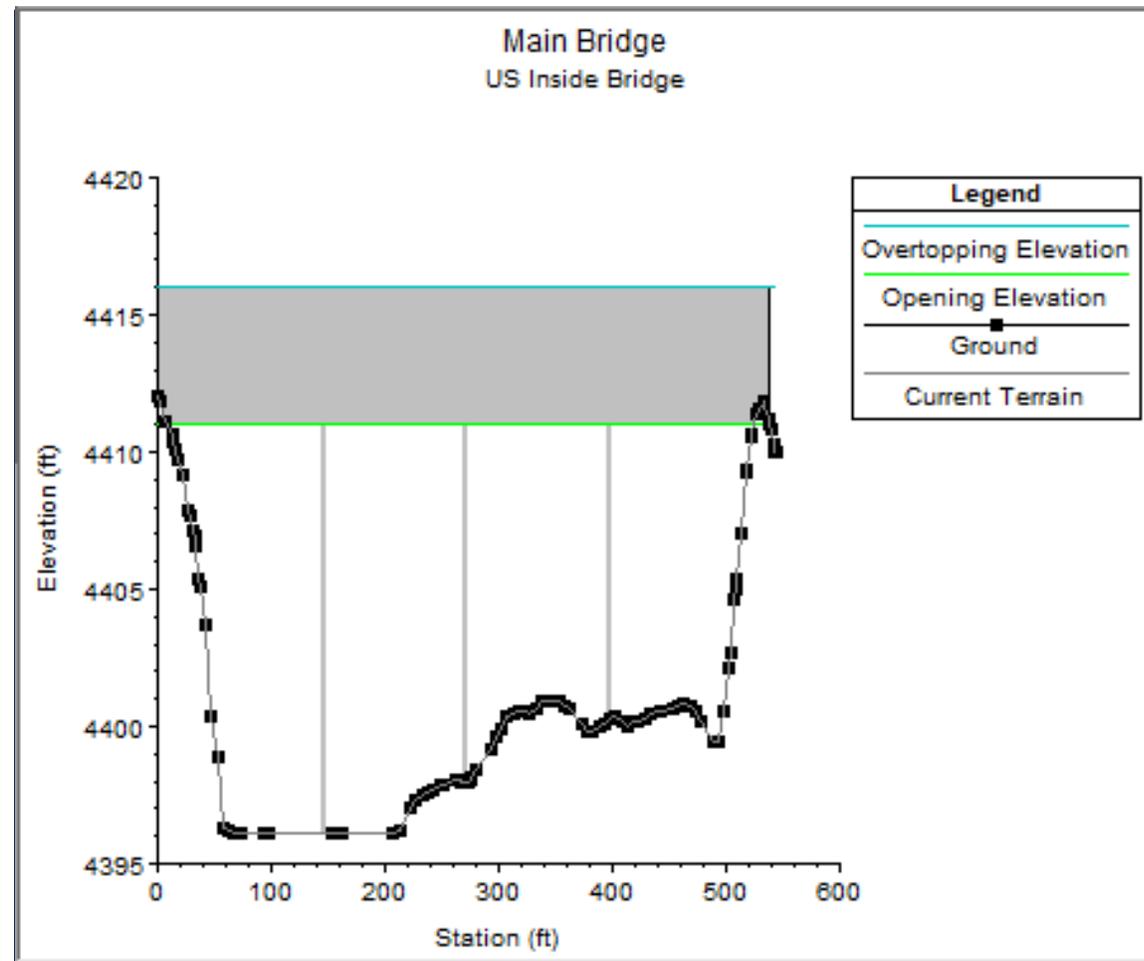
Structure Data for Pressure Flow and Overtopping

SRH2D/SMS 13.4



3D Structure represents pressure ceiling at each element
Overtopping computed as 1D weir flow

RAS 6.7 (beta 5)

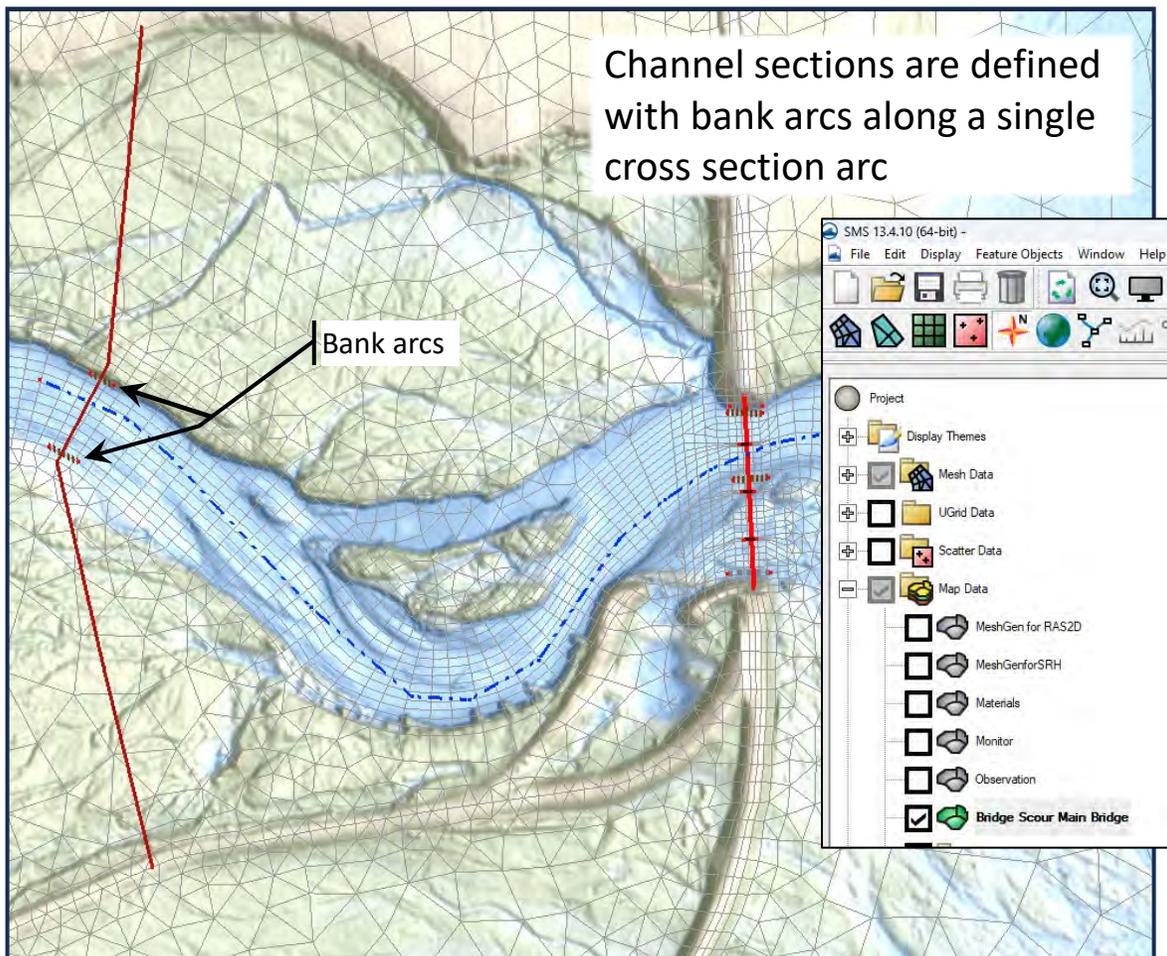


Bridge average low chord elevation represents pressure ceiling
Overtopping can be computed as 2D weir flow

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

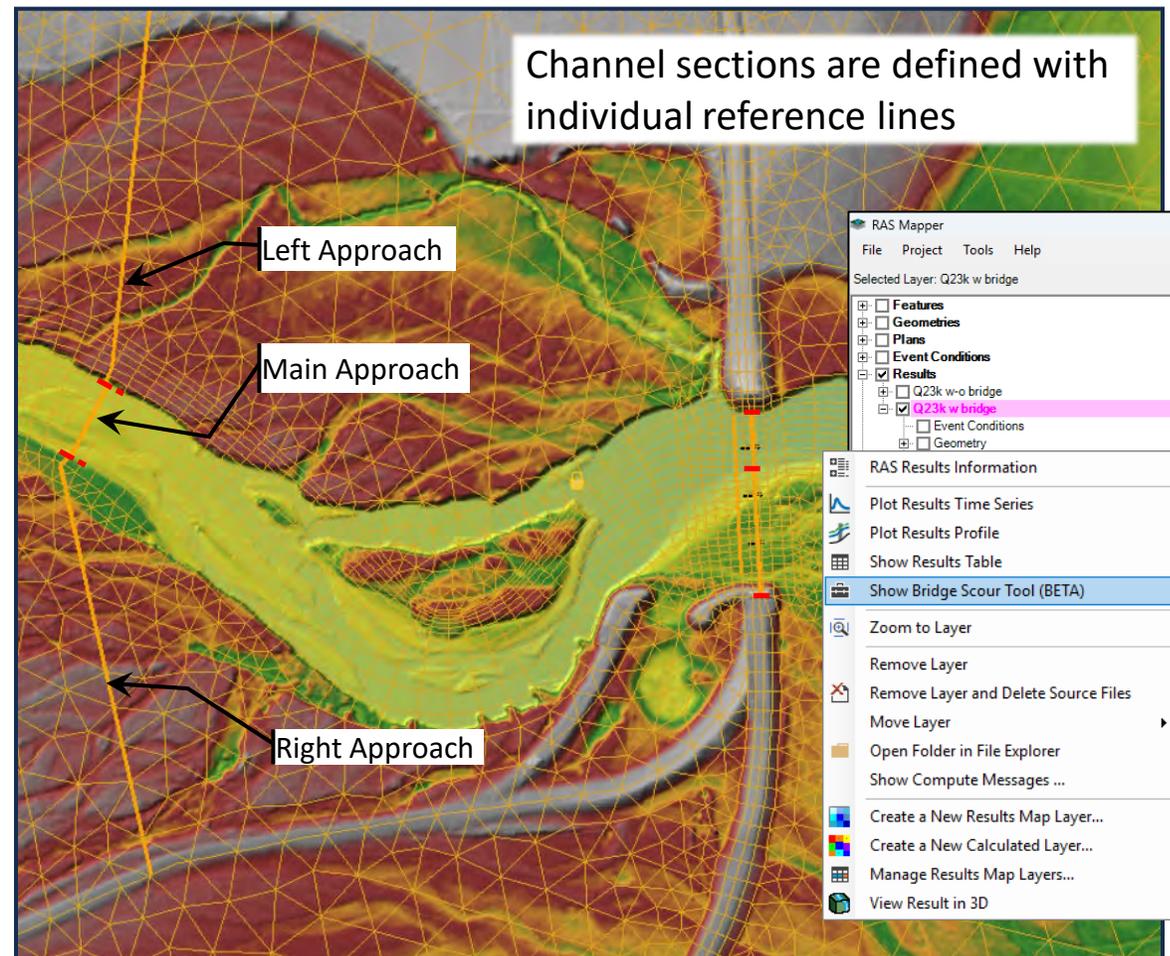
Bridge Scour Tools

SRH2D/SMS 13.4



Averaged hydraulic parameters extracted from the approach and contracted sections.

RAS 6.7 (Beta 5)



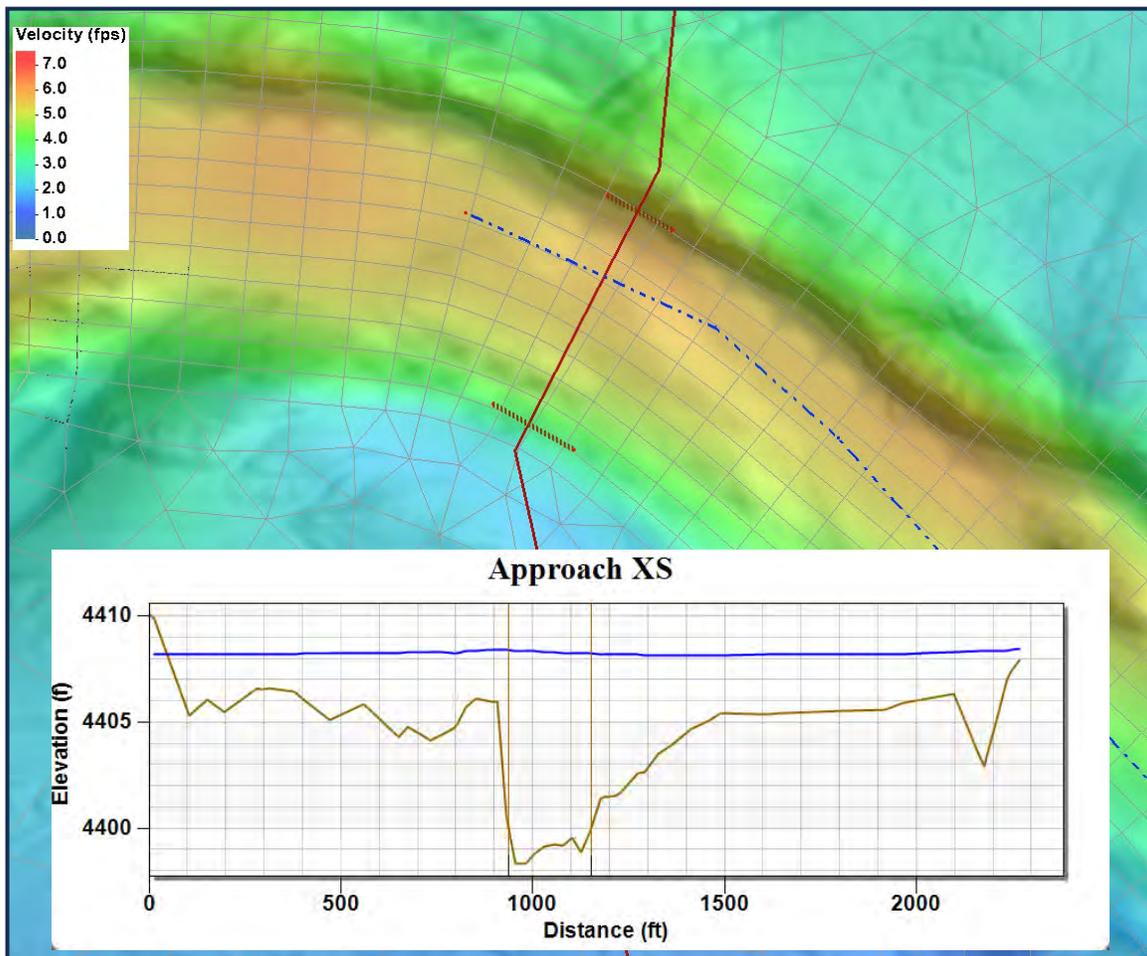
Reference lines must align with element faces and limits.

Averaged hydraulic parameters are extracted from individual reference lines for each channel section.

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

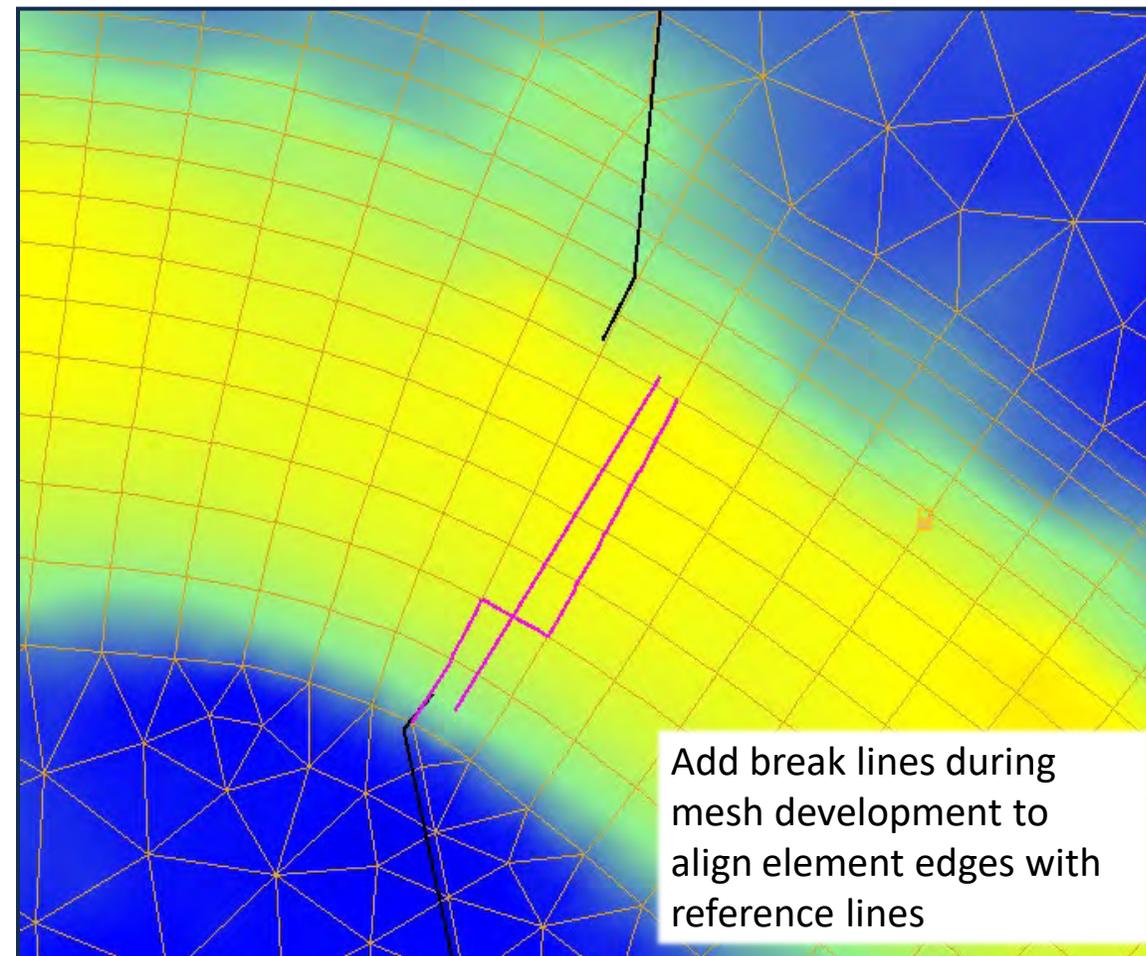
Approach Section

SRH2D/SMS 13.4



Bank stations set channel & overbank widths (W1) & flows (Q1)

RAS 6.7 (Beta 5)

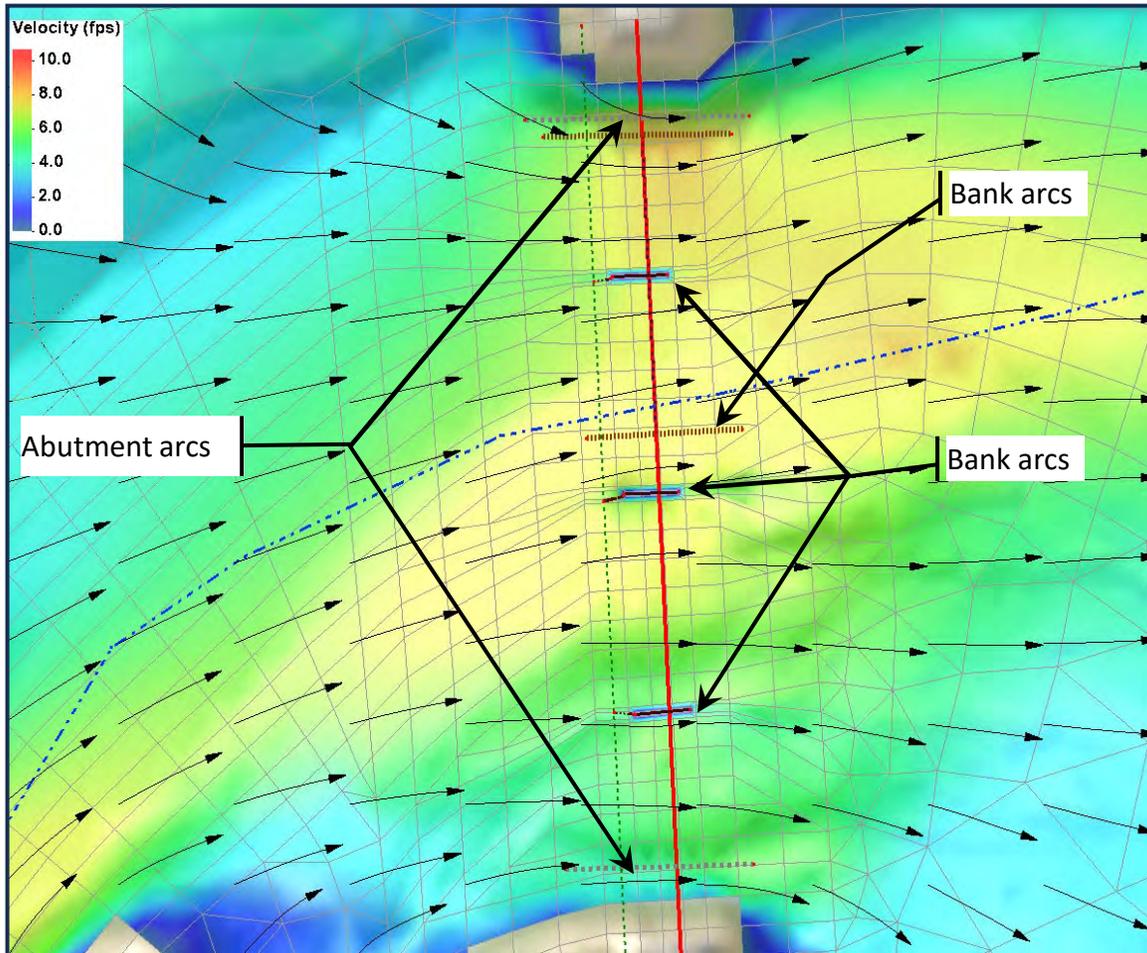


Reference lines are mapped to nearest element faces and limits to determine channel & overbank widths (W1) & flows (Q1)

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

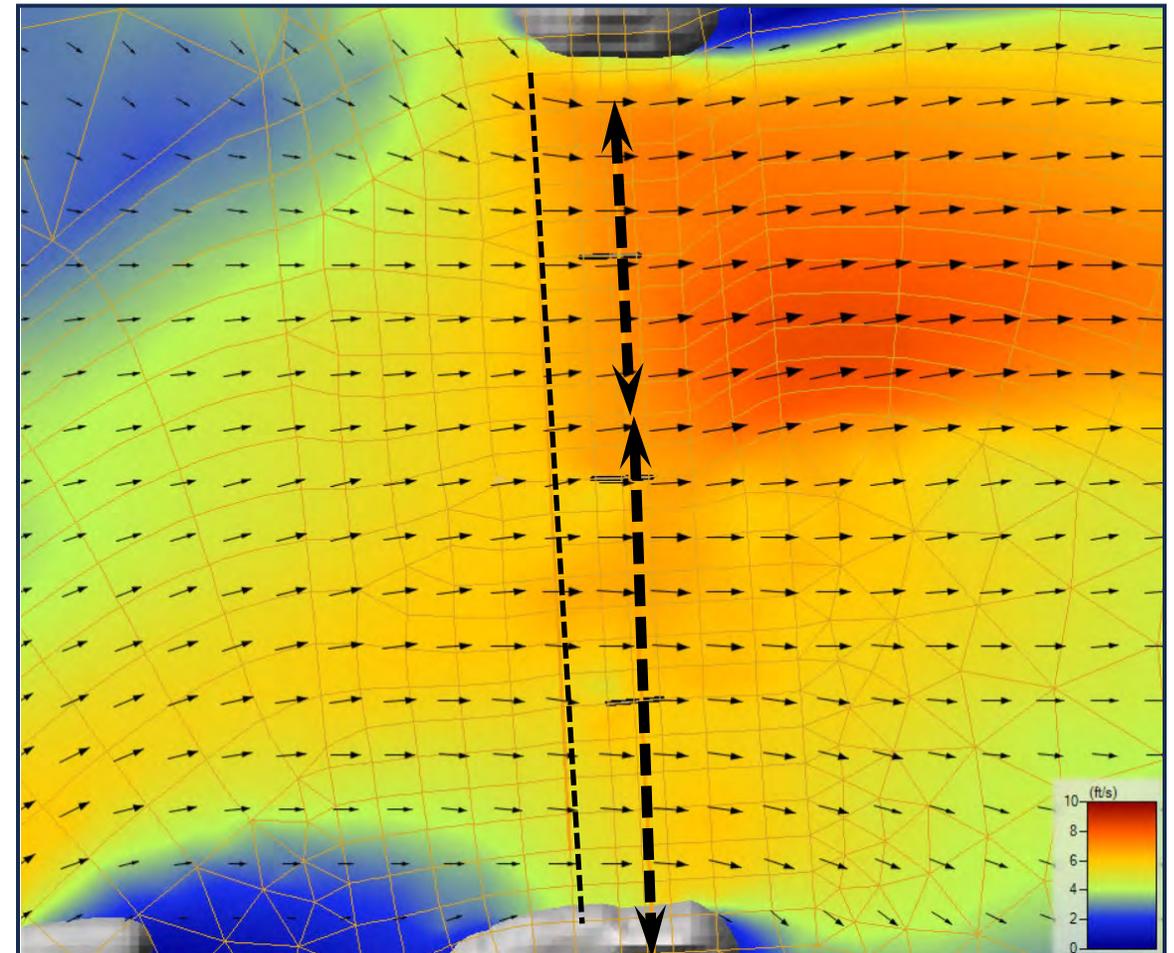
Contracted Section

SRH2D/SMS 13.4



Contracted width is automatically adjusted for bridge and pier skew based on computed angle of attack

RAS 6.7 (Beta 5)

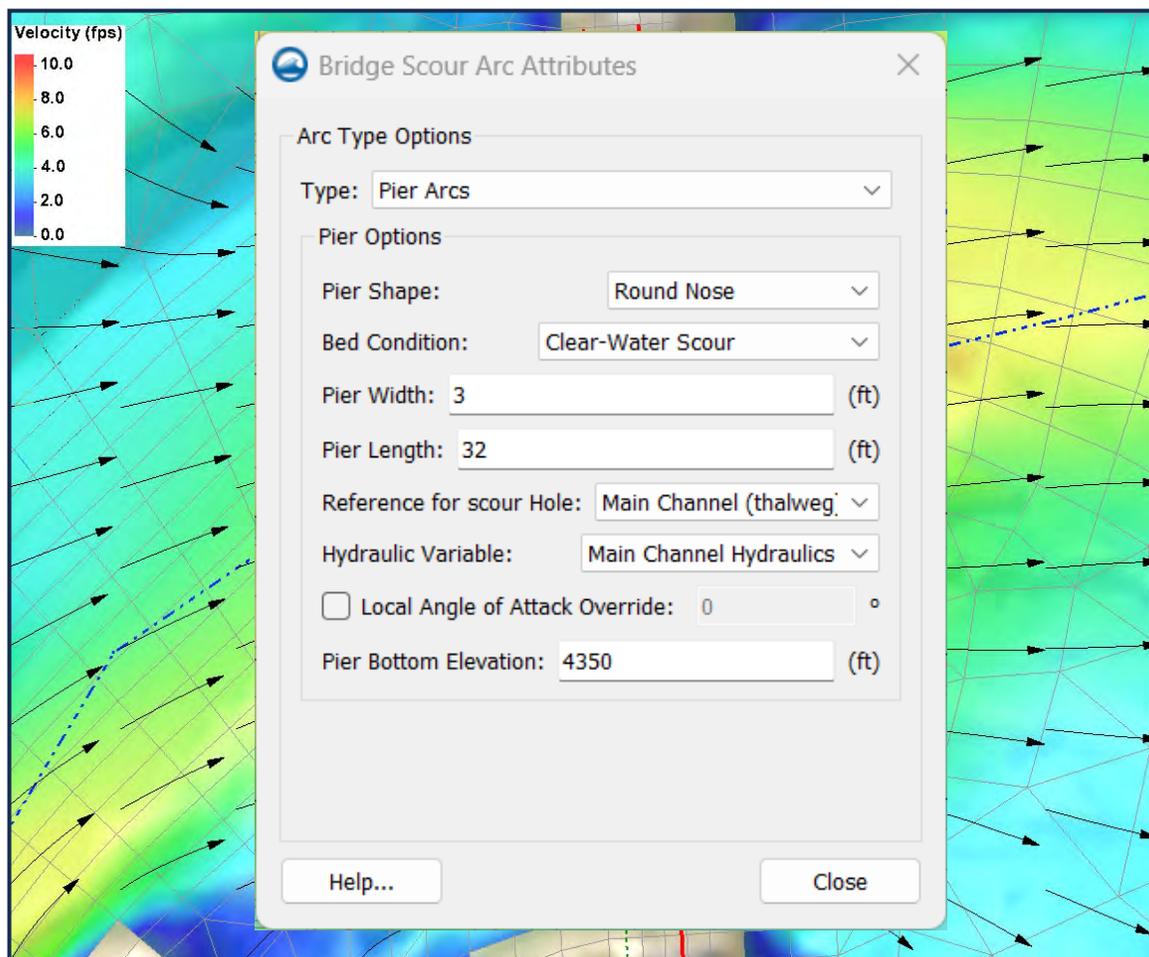


Contracted width is currently adjusted for pier width, but NOT for skewed bride or skewed piers width.

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

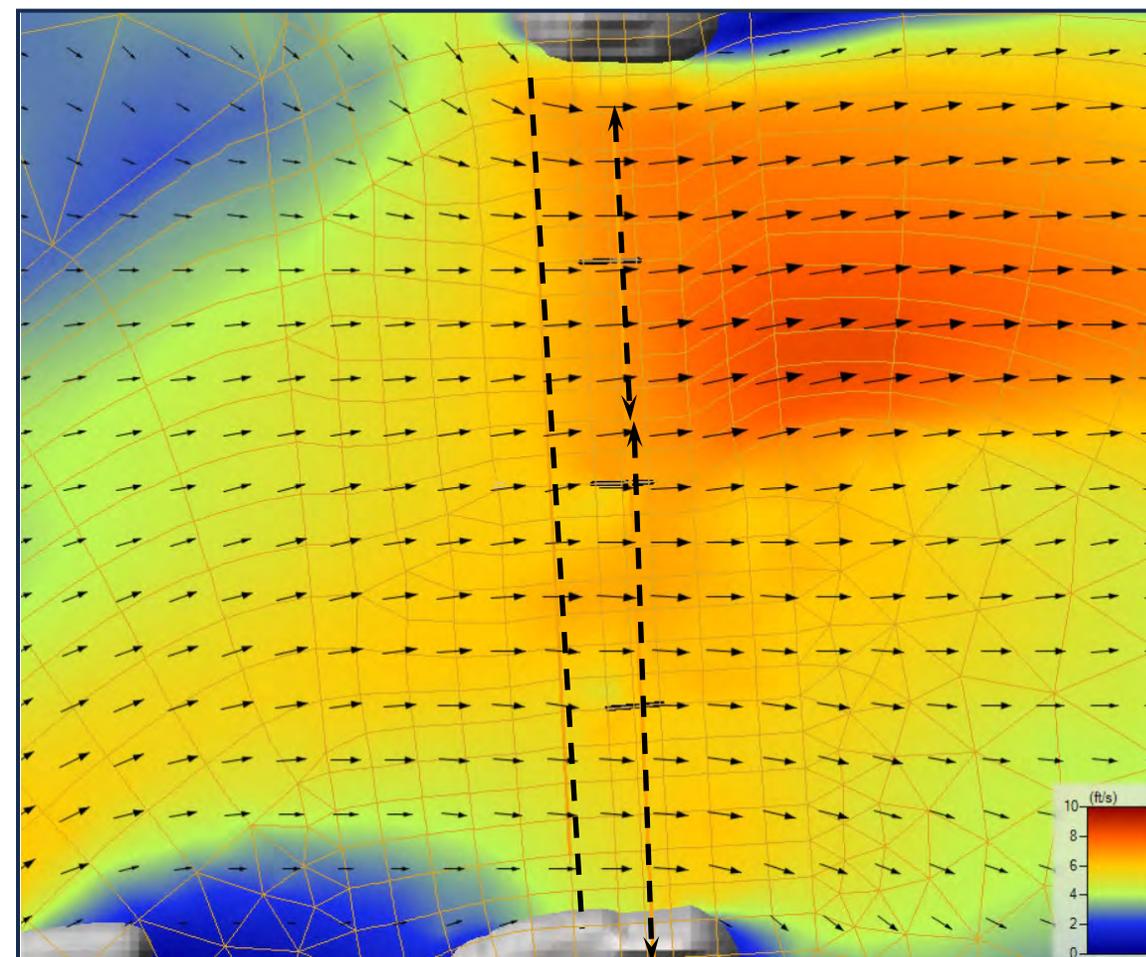
Contracted Section

SRH2D/SMS 13.4



Pier and abutment geometric data is entered as arc attributes
Channel bed gradation entered as Contracted XS attribute

RAS 6.7 (Beta 5)

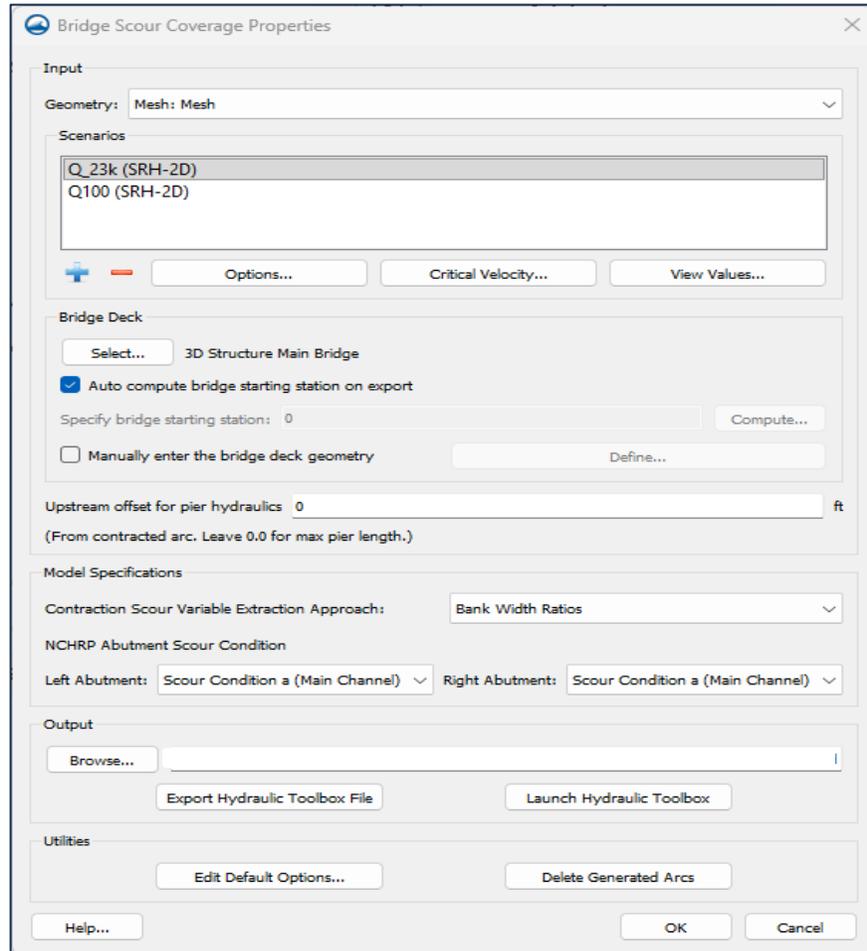


Pier and abutment geometric data and gradations need to be manually entered into the Hydraulic Toolbox calculators

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

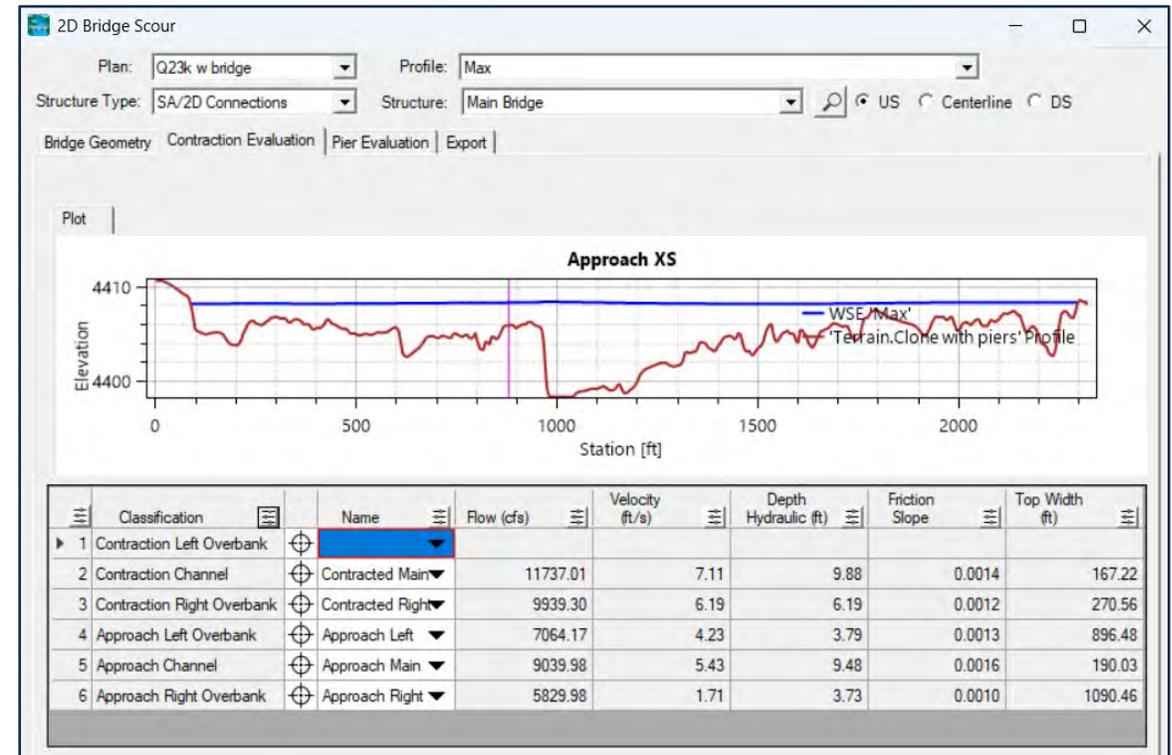
Data Extraction Tools

SRH2D/SMS 13.4



Exports multiple simulation data to a Hydraulic Toolbox file

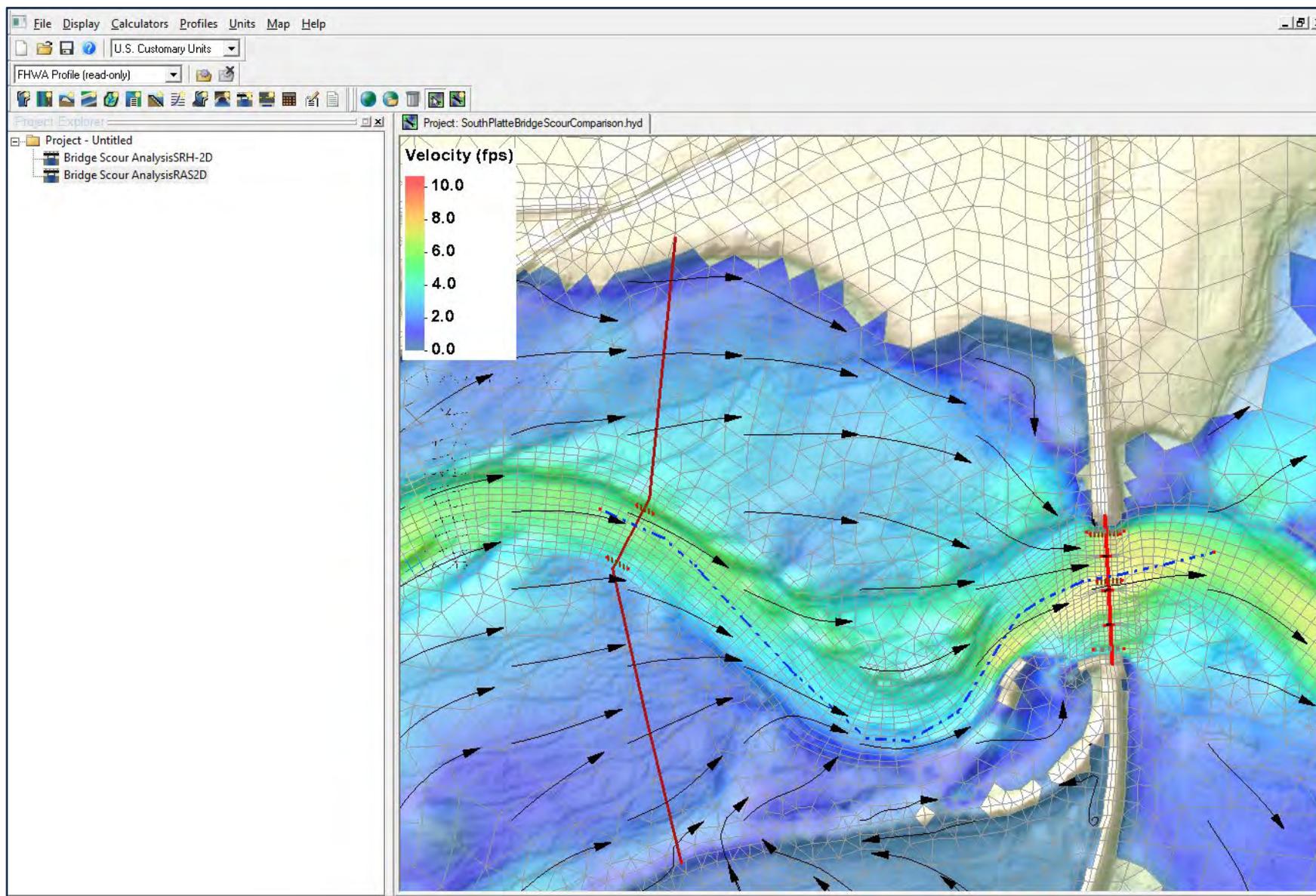
RAS 6.7 (Beta 5)



Exports individual simulation data sets to a Hydraulic Toolbox file

Scour Parameter Extraction (SMS/SRH2D & RAS2D)

Hydraulic Toolbox



Scour Parameter Extraction (SMS/SRH2D & RAS2D)

Hydraulic Toolbox

Parameter	Value	U...	Notes
Check boxes for scour components to be computed			
Enable Scour Plot Options	<input checked="" type="checkbox"/>		
To plot scour components add specified bridge geometry and cross section information			
Import Geometry from HEC-RAS 1D File	Import		
Bridge Cross-Section & Geometry			
Cross-Section Name	Bridge Cross Section		
Define Cross-Section under Bridge	Define...		Data Exists
Define WSE immediately upstream of Bridge (~1 pier length or bridge width)	Define...		Measured at the 'local approach arc (used to co...
Define WSE at Bridge	Define...		Data Exists
Bridge Name	Bridge Deck Geometry		
Define Bridge Deck Geometry	Define...		Data Exists
Gradations			
Define Gradations	Define...		
Multiple Scenarios			
Scenario	SRH-2D Scour 23k		
Scenario Name	SRH-2D Scour 23k		
Create New Scenario	Create		The new Scenario will be a copy of the currently ...
Delete Current Scenario	Delete		
Long Term Degradation			
Contraction Scour	<input checked="" type="checkbox"/>		
Define Contraction Scour Parameters	Define...		
Left Bank Station	65.19	ft	
Define Left Overbank Contraction Scour Parameters	Define...		
Right Bank Station	235.91	ft	
Define Right Overbank Contraction Scour Parameters	Define...		
Approach Cross-Section	<input checked="" type="checkbox"/>		
Approach Cross-Section Name	Approach Cross Section		
Define Approach Cross-Section	Define...		Data Exists
Local Scour at Piers			
Local Scour at Piers	<input checked="" type="checkbox"/>		
Number of Piers	3		
Piers			
Pier Name	Pier 1		
Pier Geometry	Define...		Data Exists
Centerline Station of Pier	145.362	ft	
Define Pier Scour Parameters	Define...		
Pier Scour Reference Point	Thalweg		Thalweg specifies the depth and velocity at the

Bridge Scour Summary Table | Plot Preview | Color-Filled Plots | Bar Plot Scour Depth | OK | Cancel

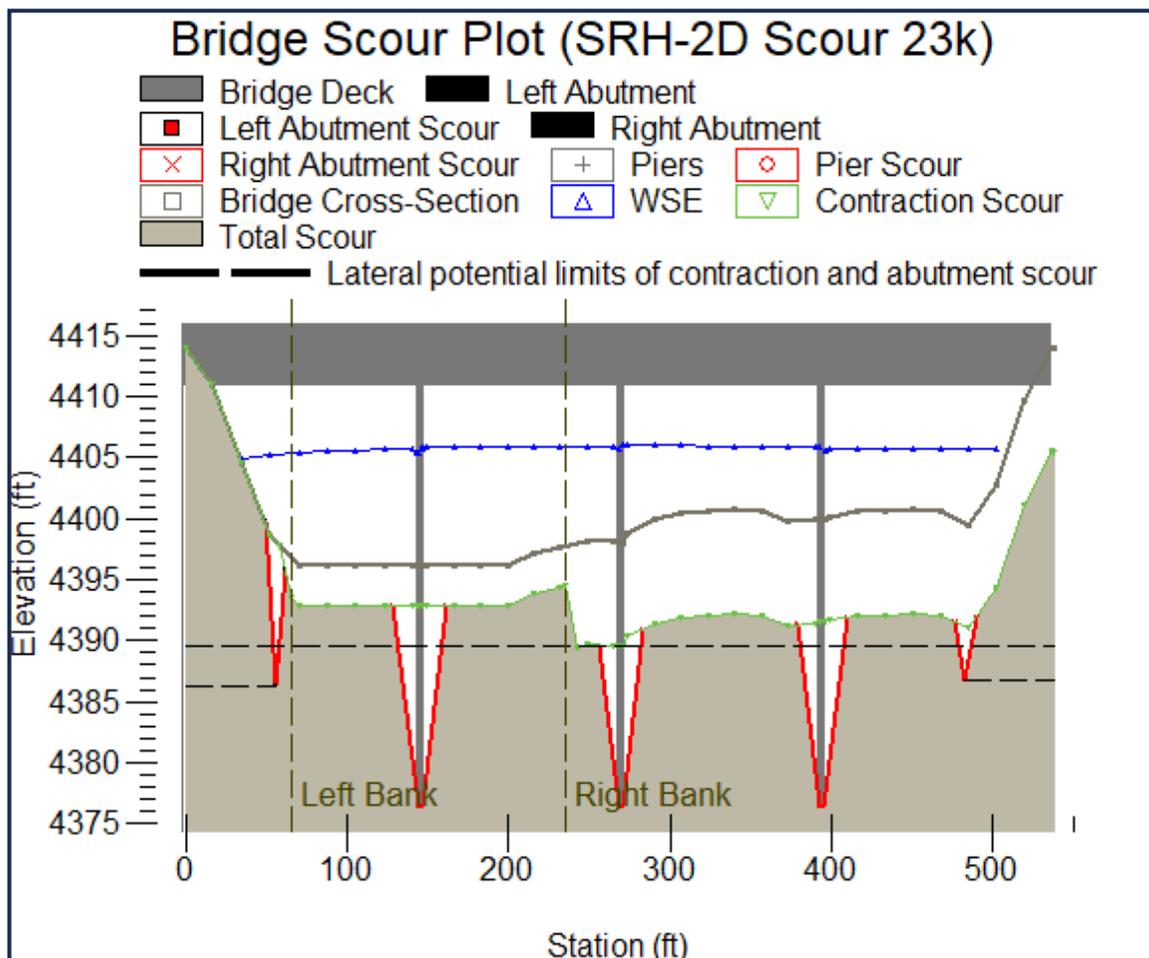
For HEC-RAS, enter:

- Bed gradation
- Bank Stations
- Pier geometry
- Angle of attack
- Adjusted contracted widths for bridge skew and pier effective widths
- Abutment station location and geometry
- Abutment scour condition
- Pressure scour variables

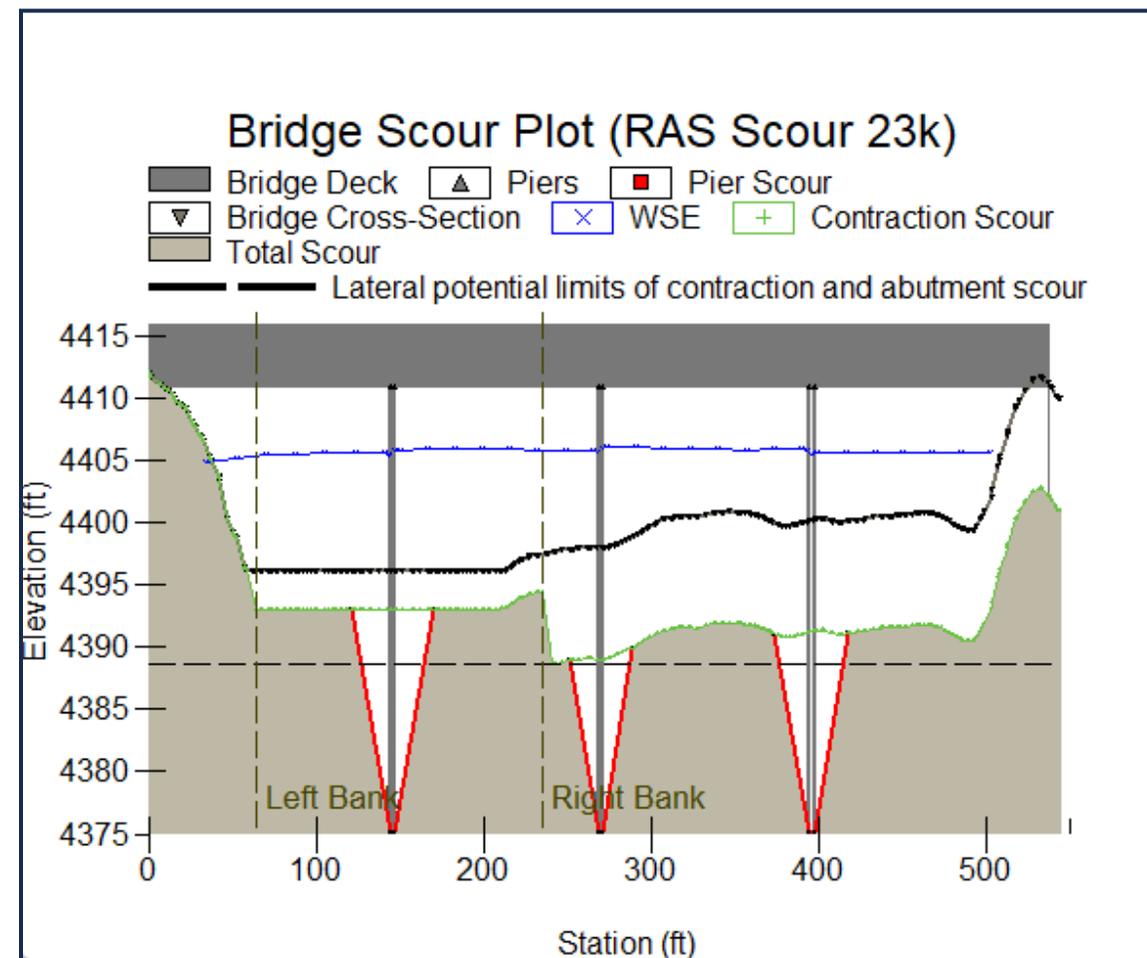
Scour Parameter Extraction (SMS/SRH2D & RAS2D)

Hydraulic Toolbox Scour Plots

SRH2D/SMS 13.4



RAS 6.7 (Beta 5)



The beta version does not currently export abutment scour or pressure flow parameters.

Questions

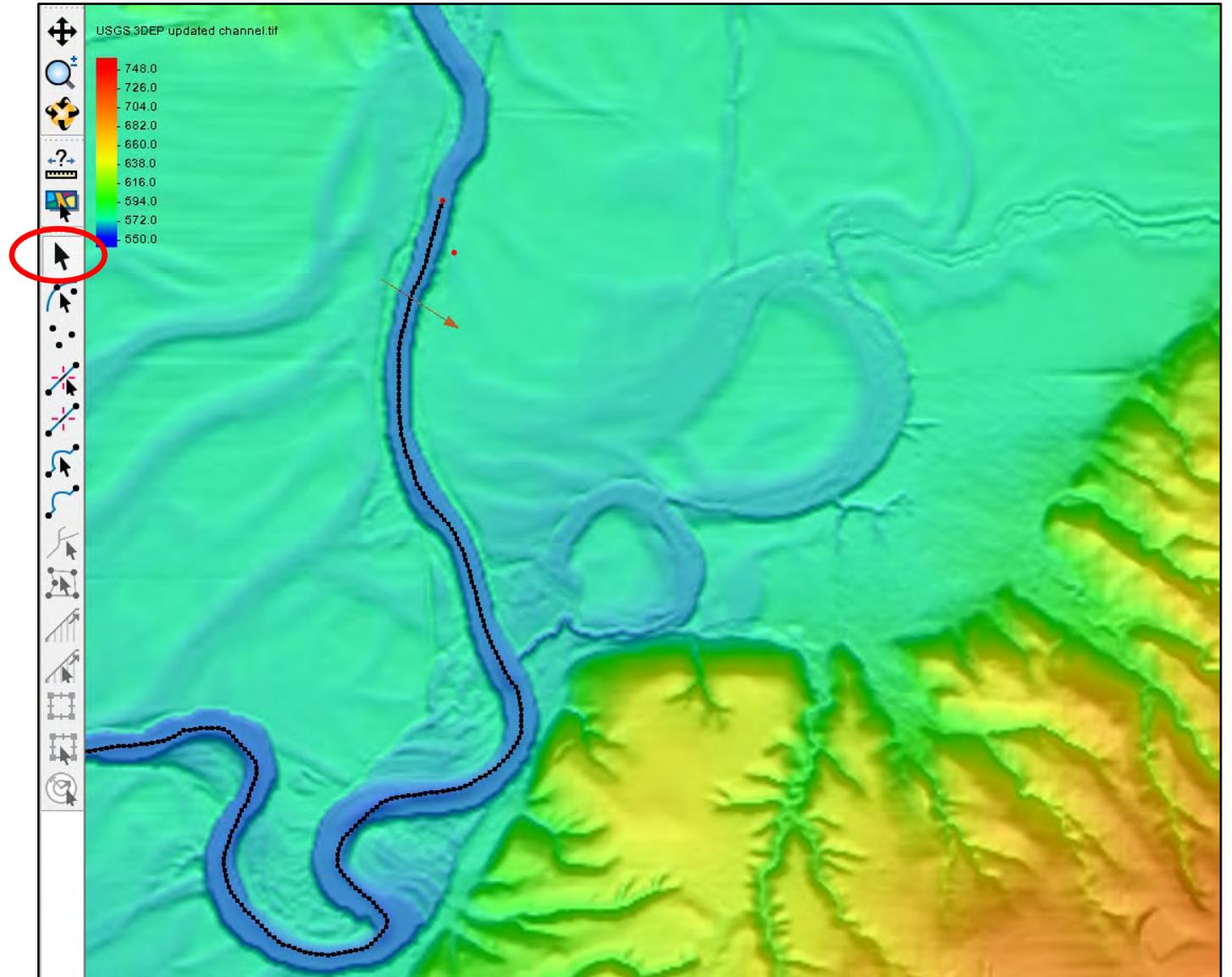


Tips and Tricks

SMS Universal Select Objects Tool

Select:

- Nodes
- Vertices
- Arcs
- Multiple objects





THANK YOU for participating!
Please contact us with any questions

Scott Hogan, PE

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