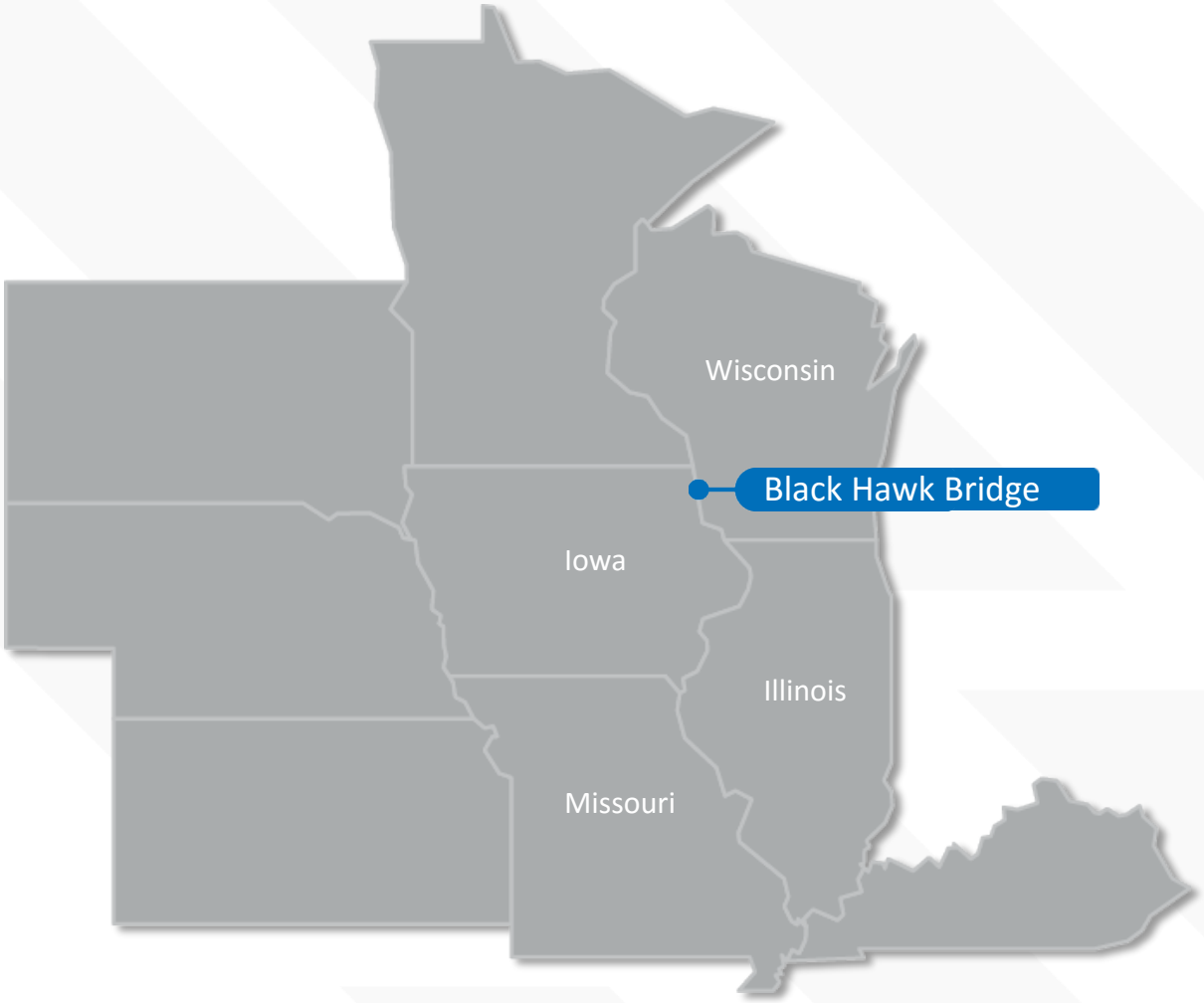
2D Hydraulics
Black Hawk Bridge
Lansing, Iowa

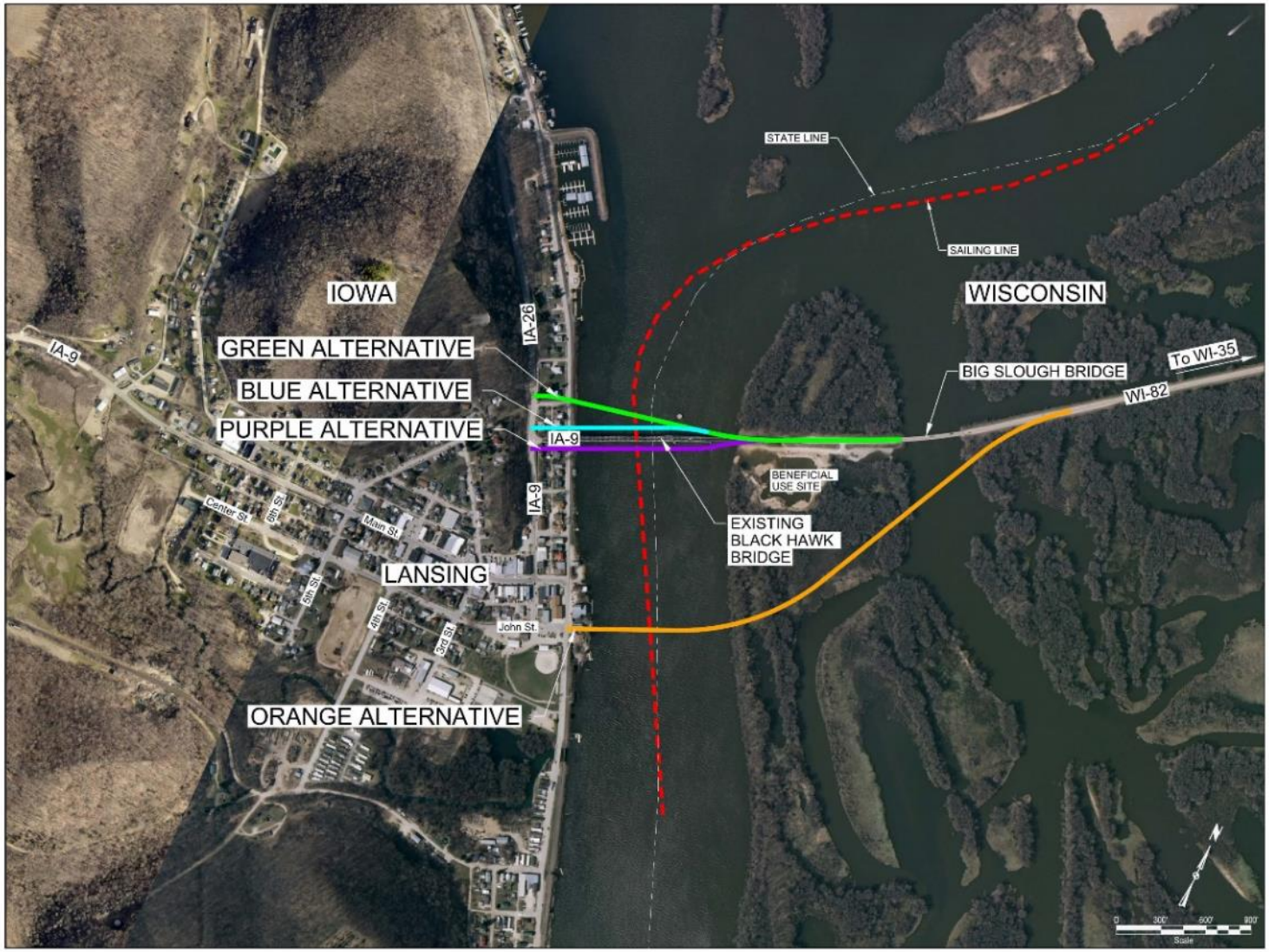
March 8, 2018

BLACK HAWK BRIDGE – LANSING, IA



IA-9 / WI-82 OVER MISSISSIPPI RIVER

ENVIRONMENTAL DOCUMENTATION PHASE



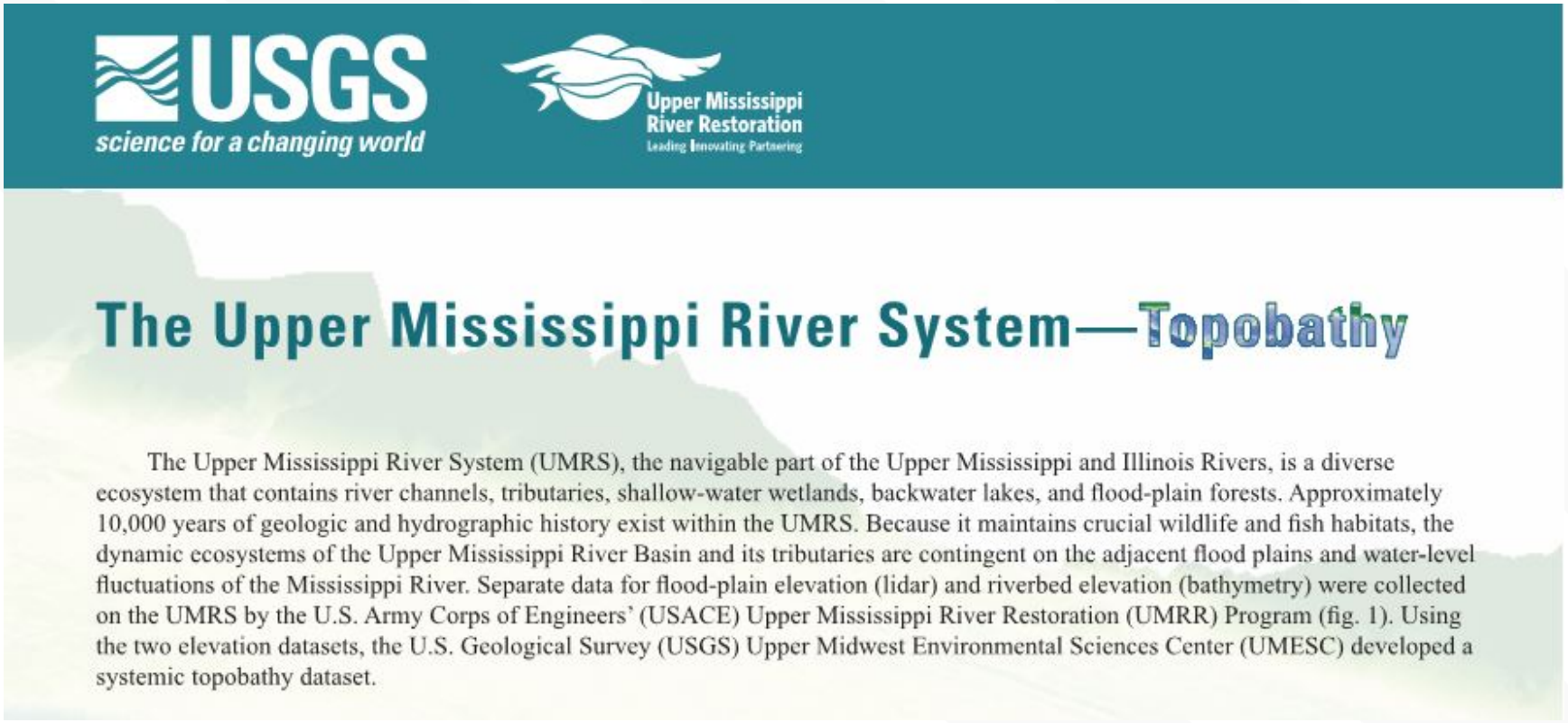
BARGE CRASHES

BARGE SIMULATION

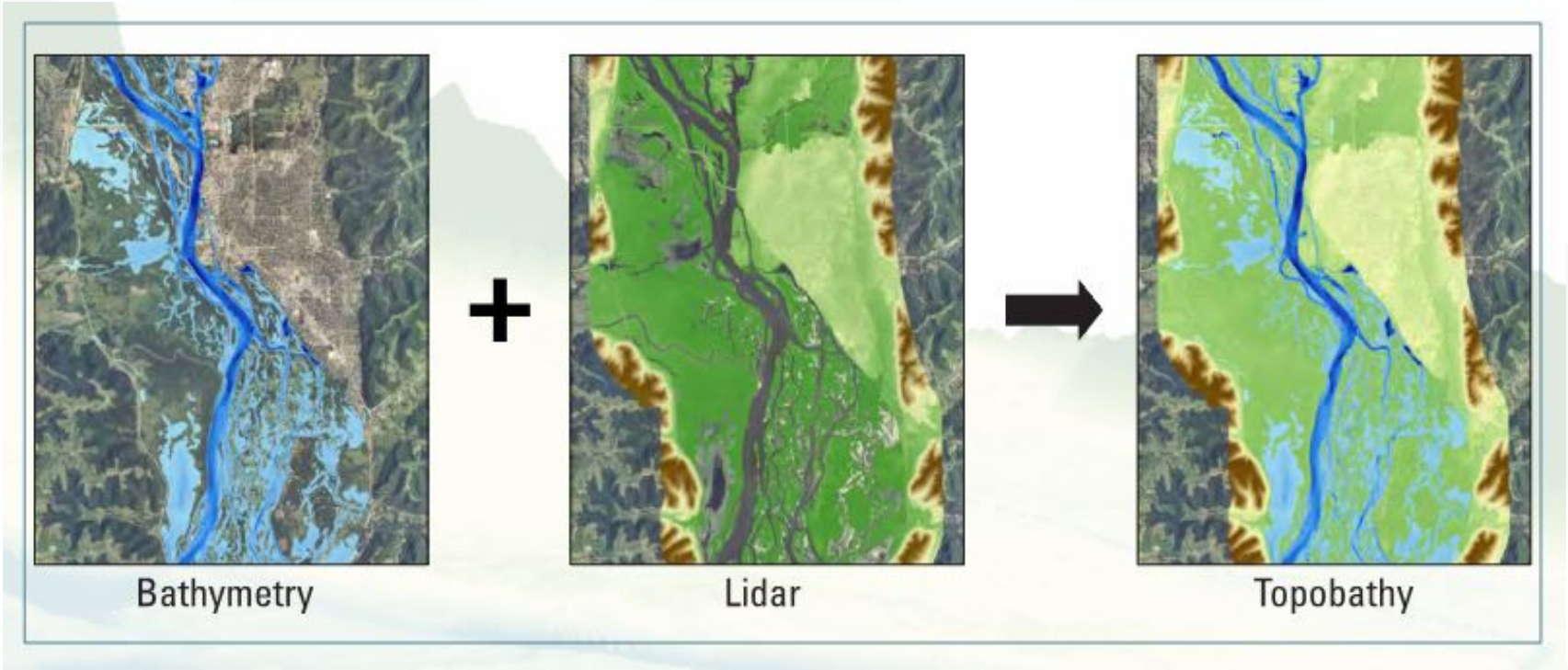
BARGE SIMULATION STUDY

- Seamen's Church Institute (SCI)
  - Determine navigation span length for each alignment.
  - 2D hydraulic model to generate velocity vectors for simulation.
  - River current has significant effect on barge tow.
  - Velocity vectors were extremely important due to channel bend.

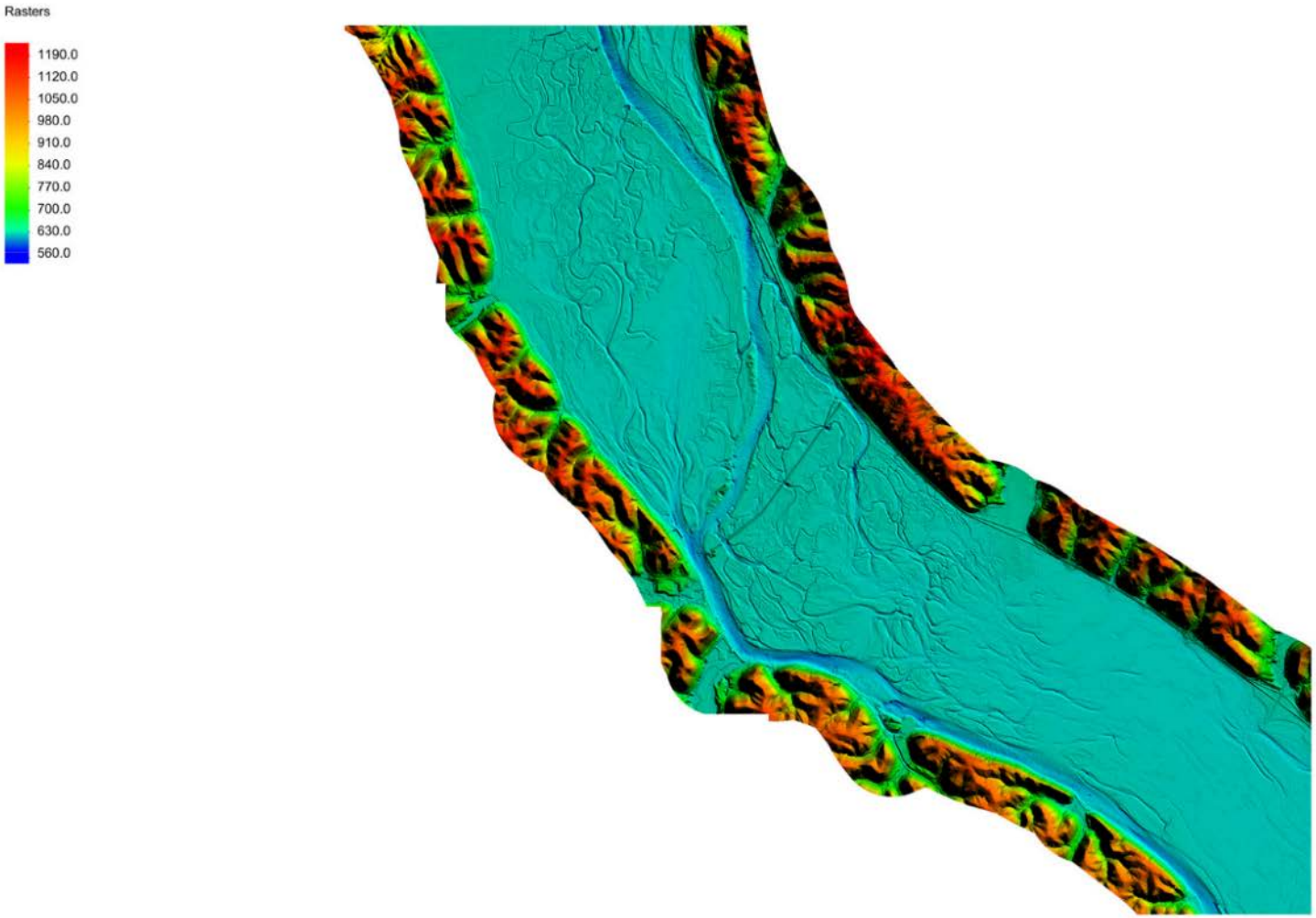
2D HYDRAULICS – NEED SURVEY DATA



USGS TOPOBATHY



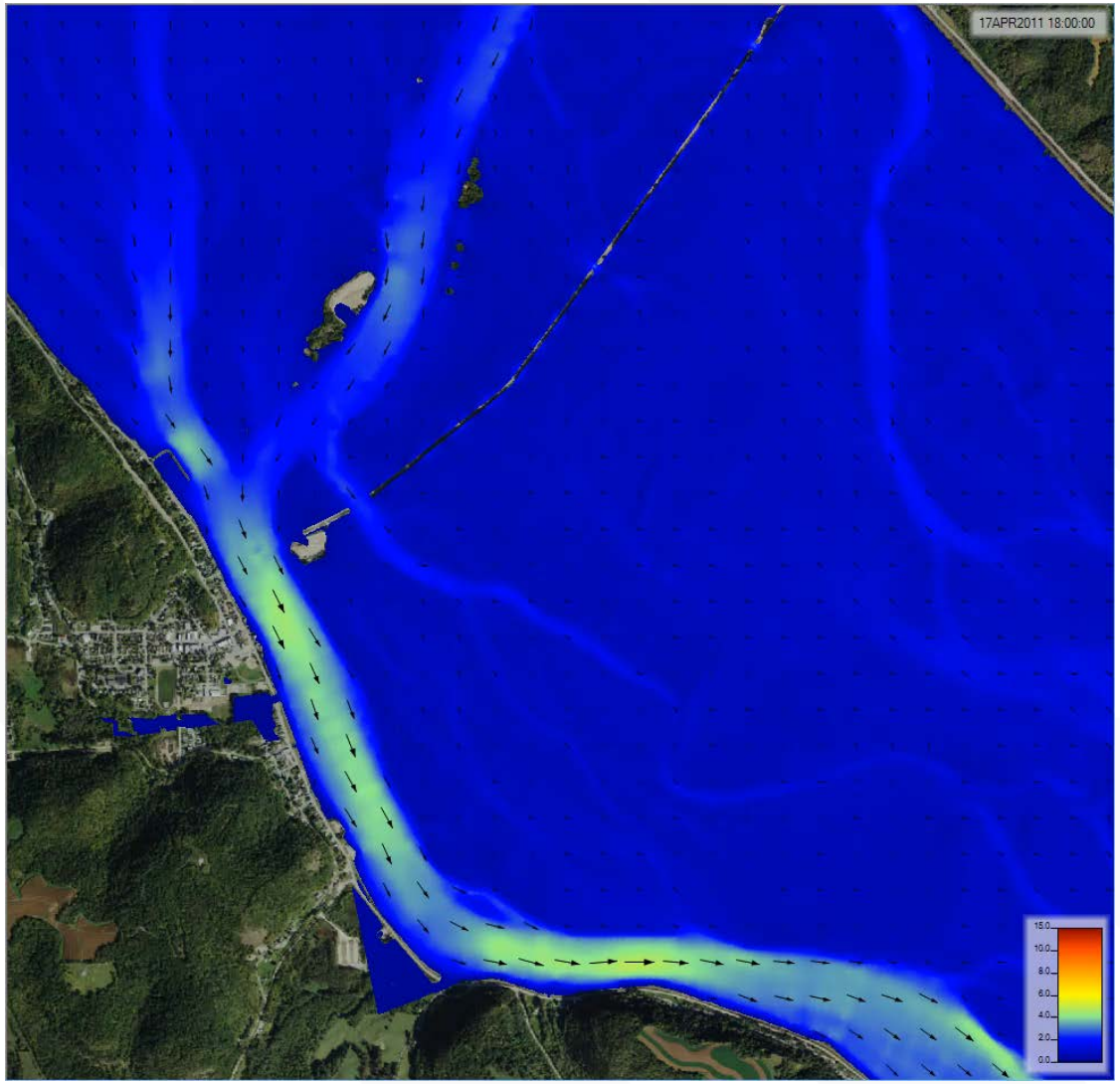
MISSISSIPPI RIVER – POOL 9 TOPOBATHY



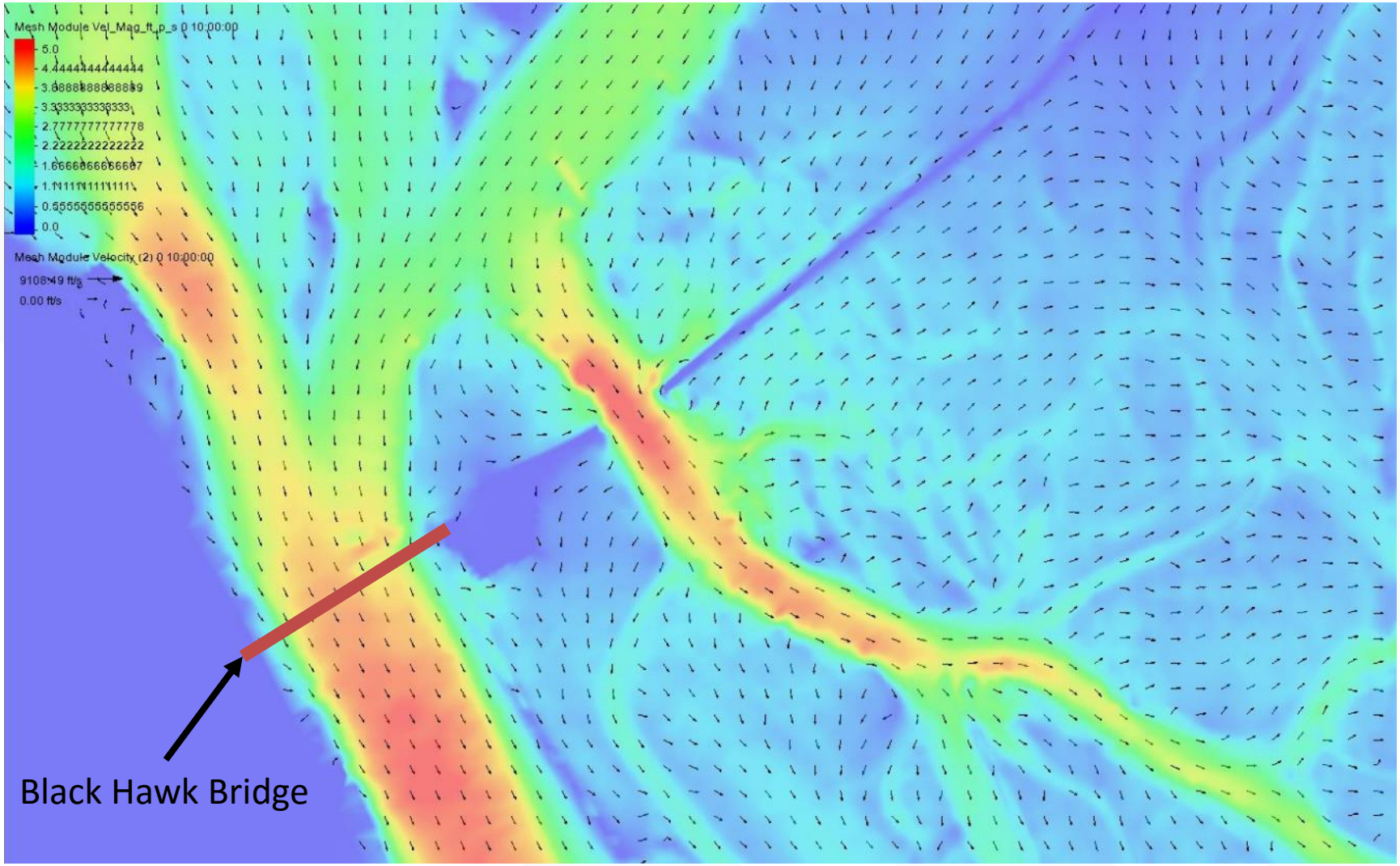
2D FLOODPLAIN ANALYSIS

1. Started with FEMA HEC-RAS 1D Floodplain Model.
2. Generated HEC-RAS 2D model/calibrated with 1D model.
3. Developed SMS 2D model for check of velocity vectors.

HEC-RAS 5.03 - 2D



SMS 12.2 - 2D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3.8888888888889
3.3333333333333
2.7777777777778
2.2222222222222
1.6666666666667
1.1111111111111
0.5555555555556
0.0
Mesh Module Velocity (2) 0 10:00:00
9108.49 ft/s
0.00 ft/s
Black Hawk Bridge

SEAMEN'S CHURCH INSTITUTE (SCI)

- SCI - Center for Maritime Education
  - State of the art simulators – Paducah, KY & Houston, TX.
  - Train over 1,600 mariners each year. USCG approved classes.
  - 12 – 65" LCD TV monitors.
  - Extensive data collection, setup and testing provide realistic navigation feel to pilots.

BLACK HAWK SIMULATION STUDY

- 4 pilots running different simulators concurrently.
- 15 barge tow (1200’ long x 105’ wide).
- At each alignment – 750’/800’/850’ spans, both travel directions, normal pool & flood stage, loaded and unloaded barges.
- Night-time simulation.
- Construction condition – falsework towers.
- Each simulation 10 -15 minutes. Debrief and survey completed after each run.

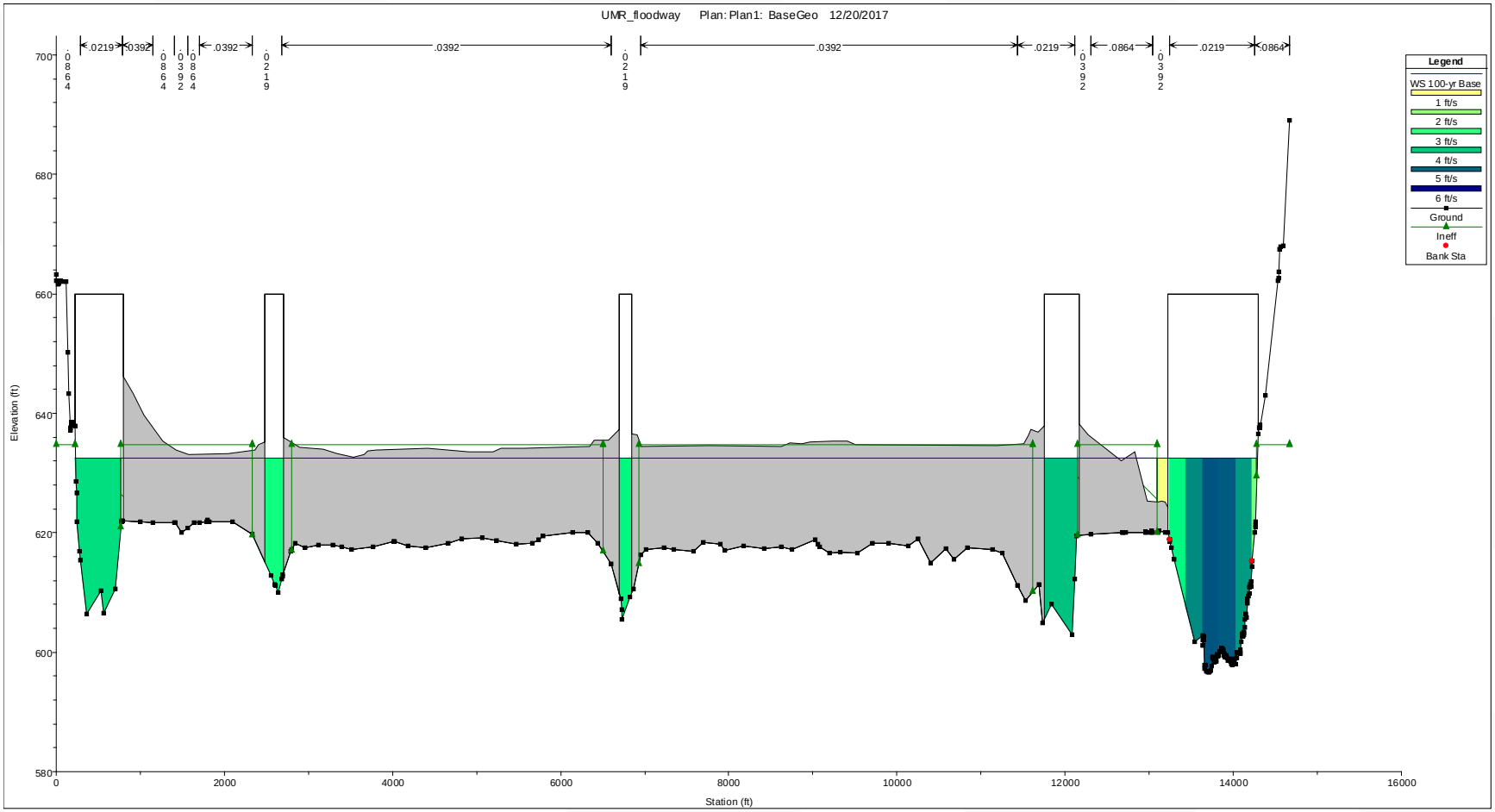
SIMULATOR - SEAMEN'S CHURCH INSTITUTE

SIMULATION RESULTS

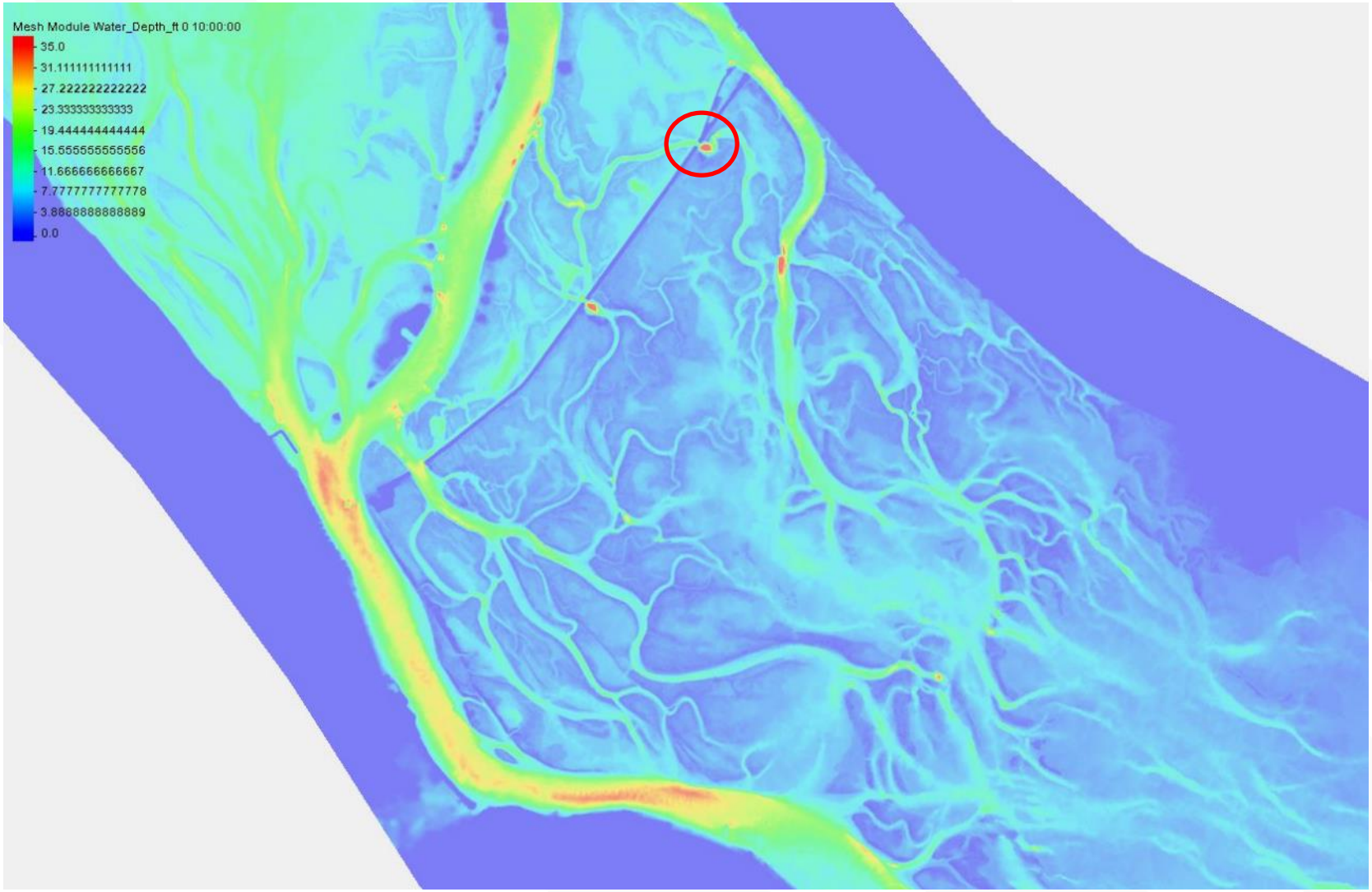
- Pilots saw immediate improvement with 750’ span compared to existing.
- 850’ simulation was not needed. USCG concurred.
- Established required navigation span for each alignment.
- Small reduction in navigation span can provide substantial savings.
- Construction scenario was valuable. Assist boat required for falsework towers.
- Preferred alignment option and bridge layout being studied.

WISCONSIN APPROACH BRIDGES

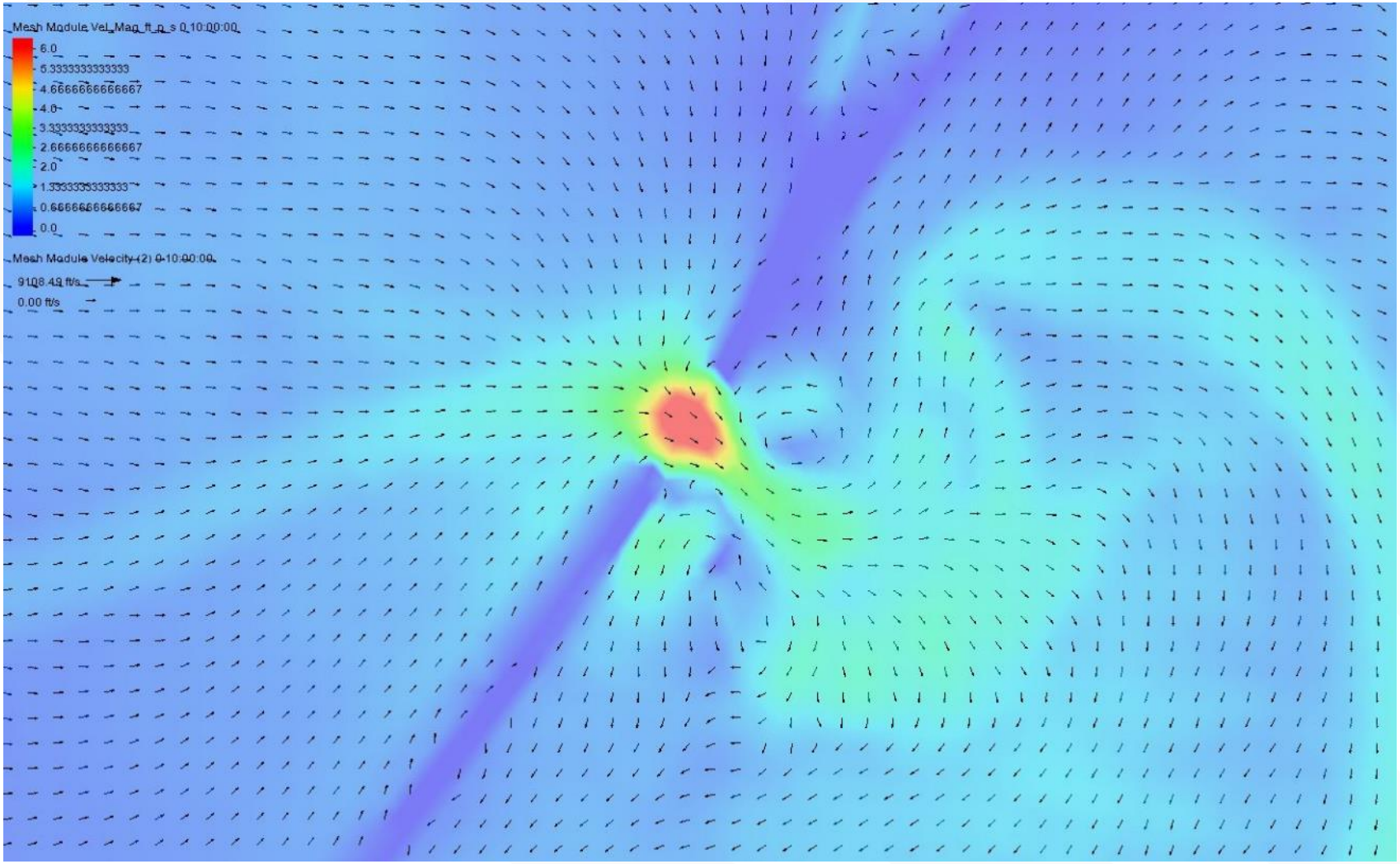
FEMA 1D MODEL – BRIDGE SECTION



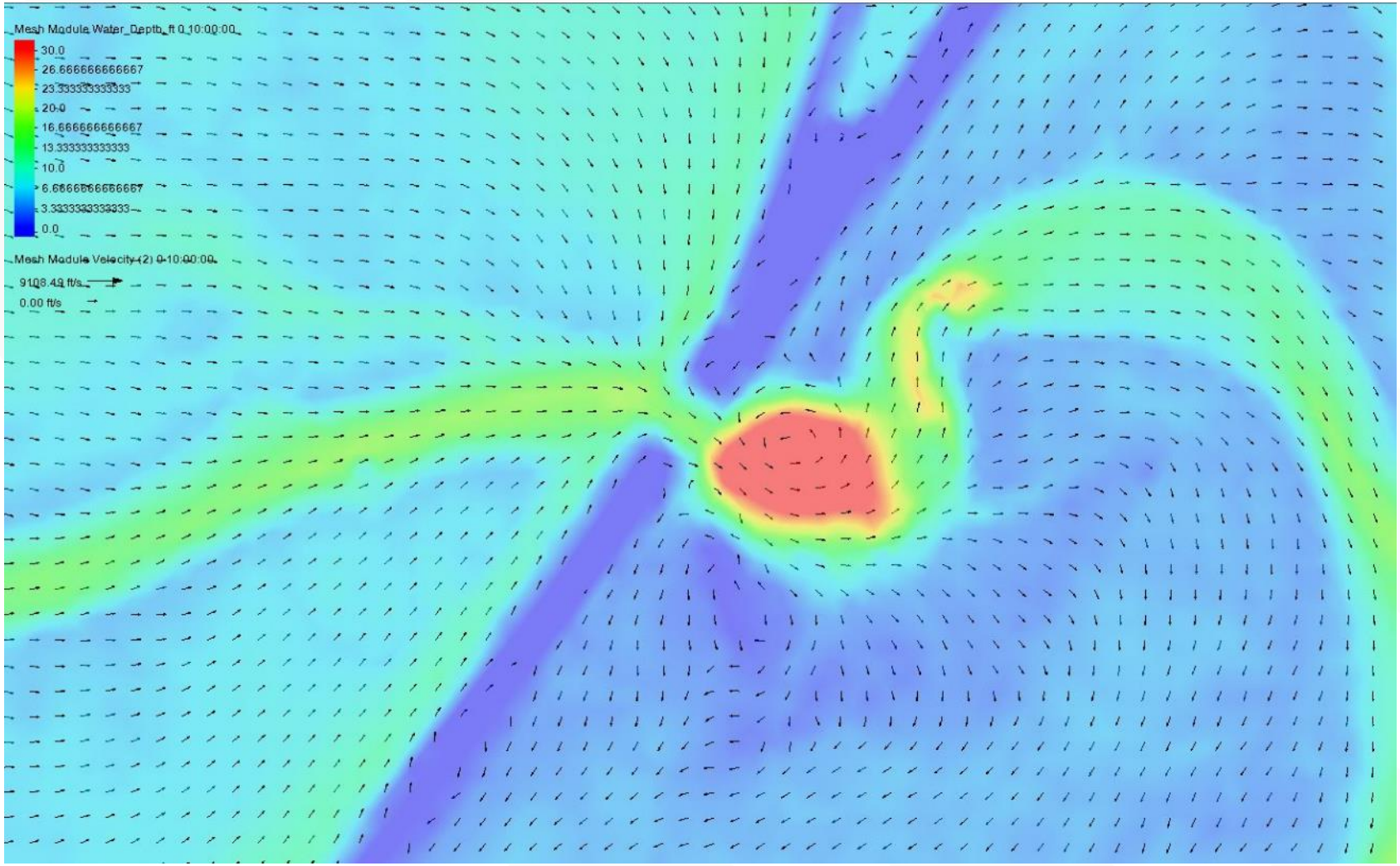
SMS 12.2 - 2D ANALYSIS



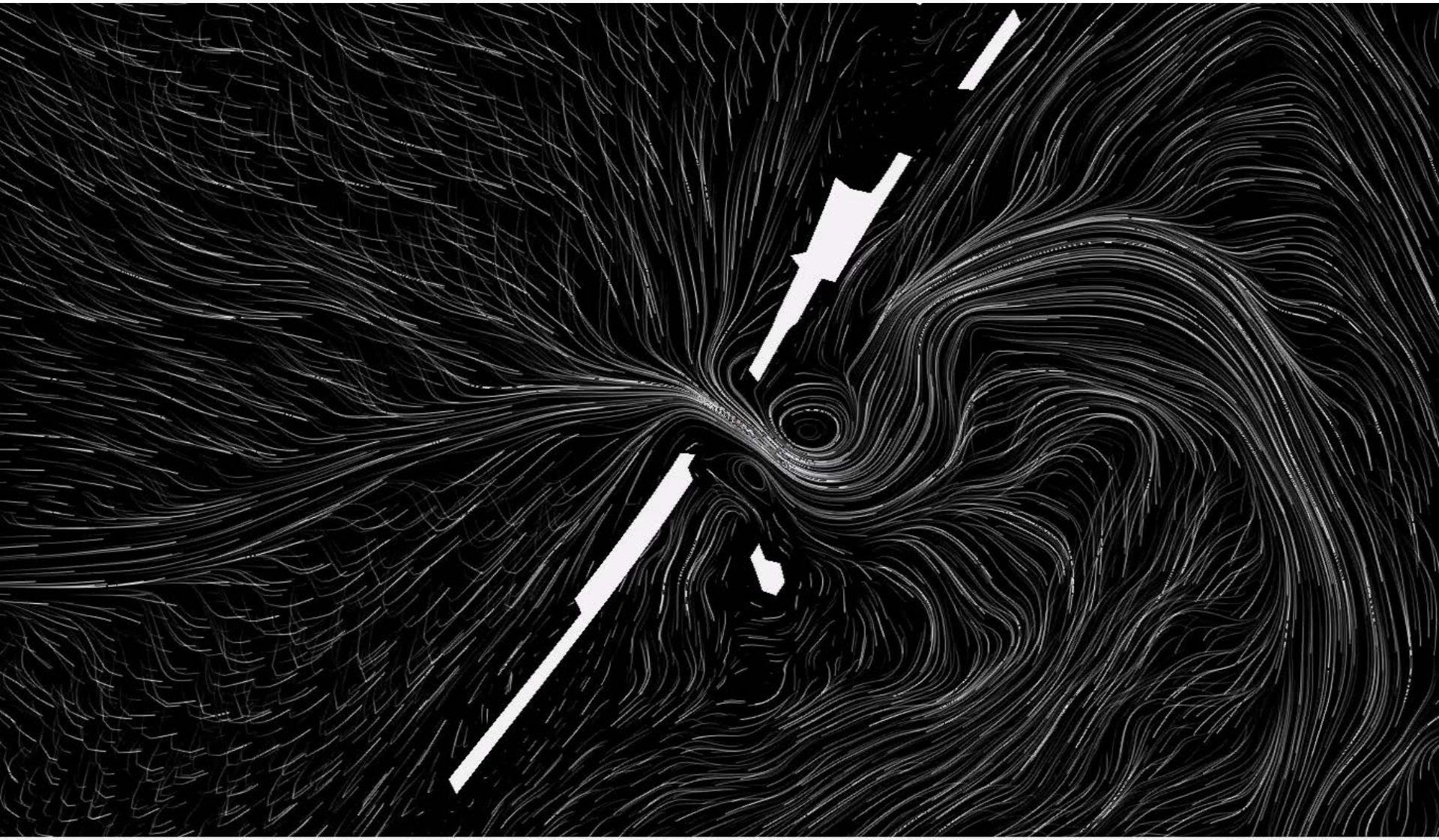
SMS 12.2 - VELOCITIES



SMS 12.2 – WATER DEPTH

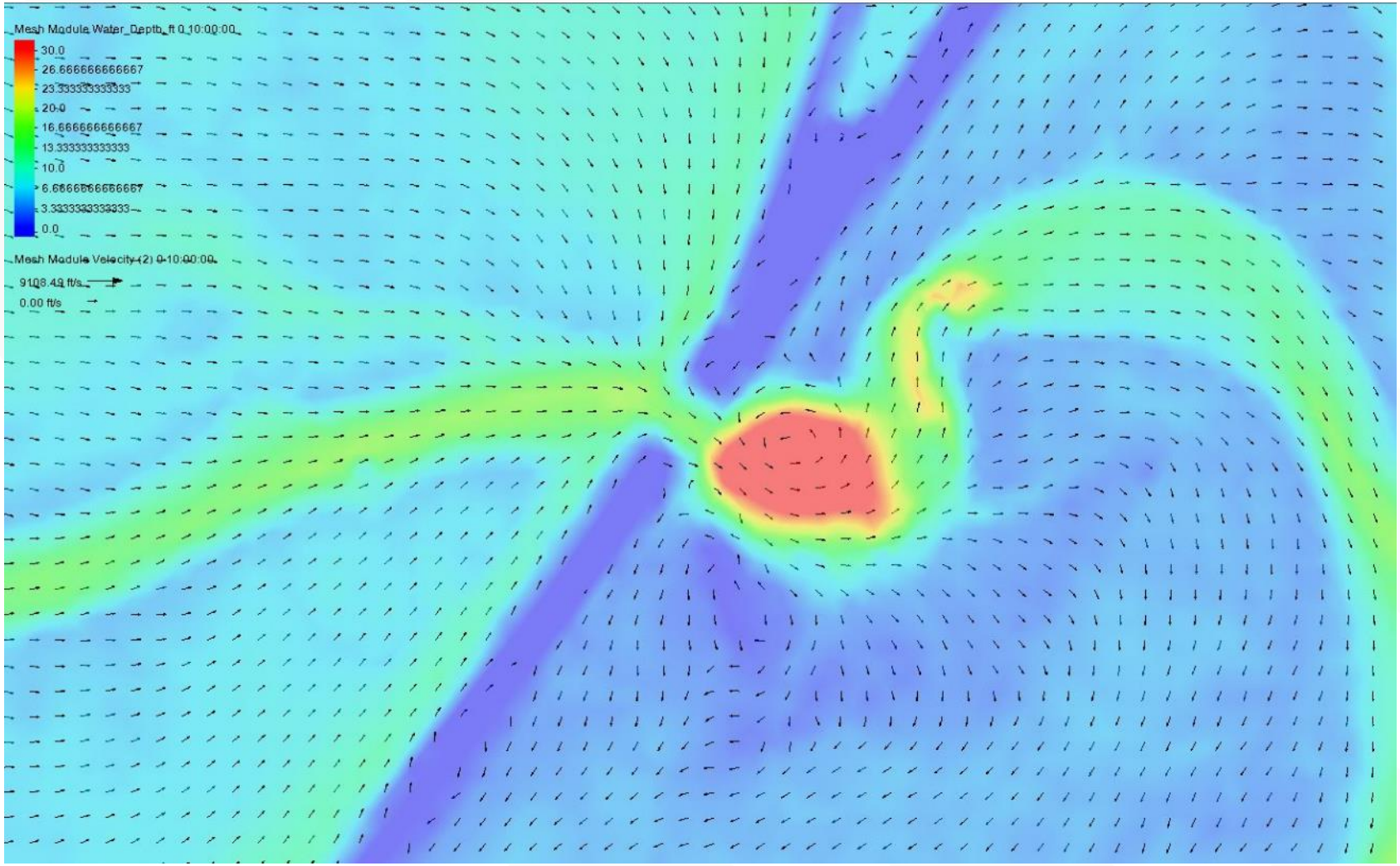


SMS 12.2 – FLOW LOOP



MAY 2017 – EMBANKMENT FAILURE

SMS 12.2 – WATER DEPTH



BENEFITS OF 2D HYDRAULICS

- Velocity vectors for barge simulation.
- More accurate velocities, angle of attack and flow depths for scour analysis.
- Better identify flow constrictions and vortices.
- Sediment transport/contraction scour analysis.
- Assist with proper sizing of causeway-type bridges.


BURNS McDONNELL