



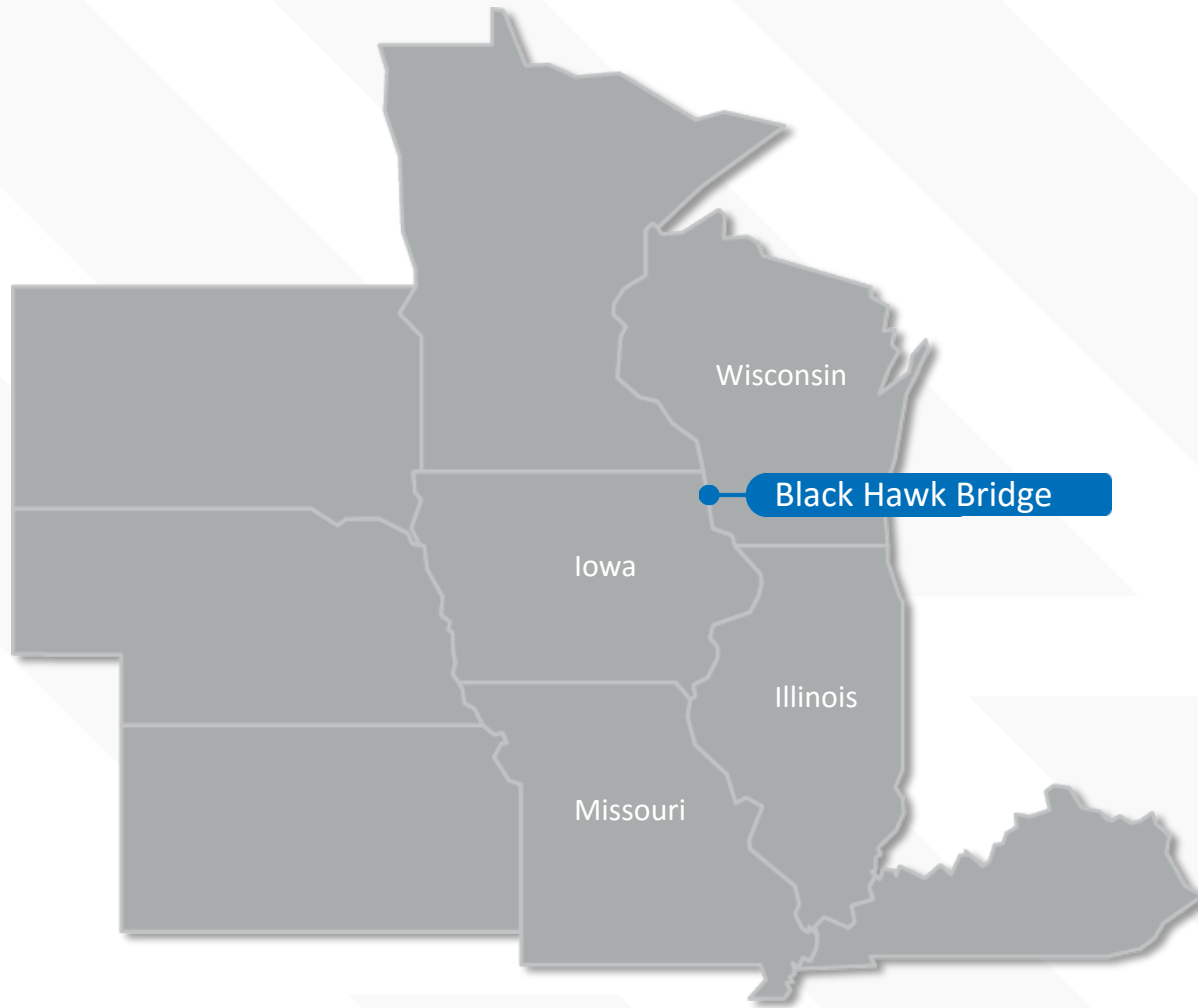
**BURNS & MCDONNELL**

# 2D Hydraulics Black Hawk Bridge Lansing, Iowa

**March 8, 2018**



# BLACK HAWK BRIDGE – LANSING, IA

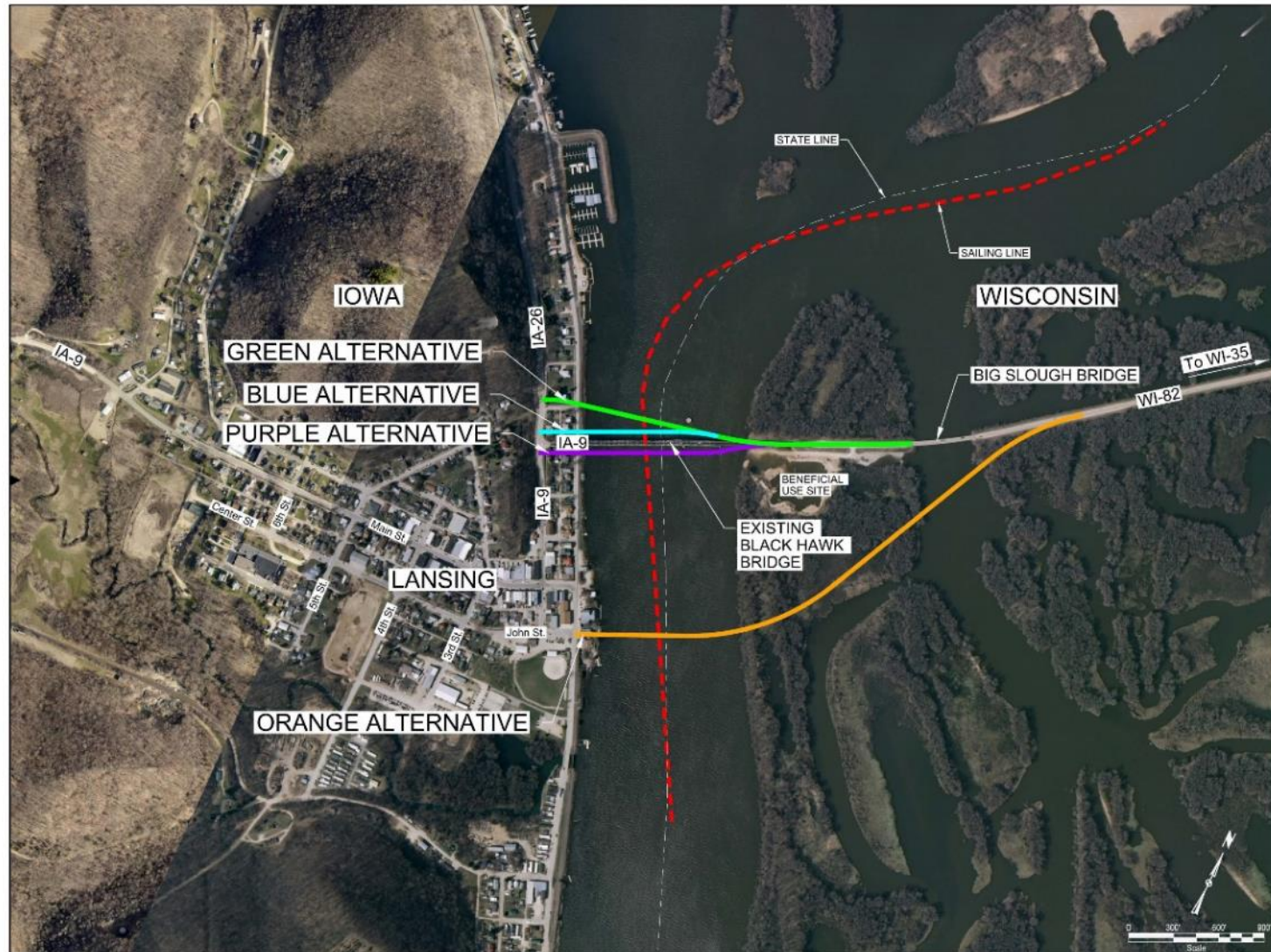




# IA-9 / WI-82 OVER MISSISSIPPI RIVER



# 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

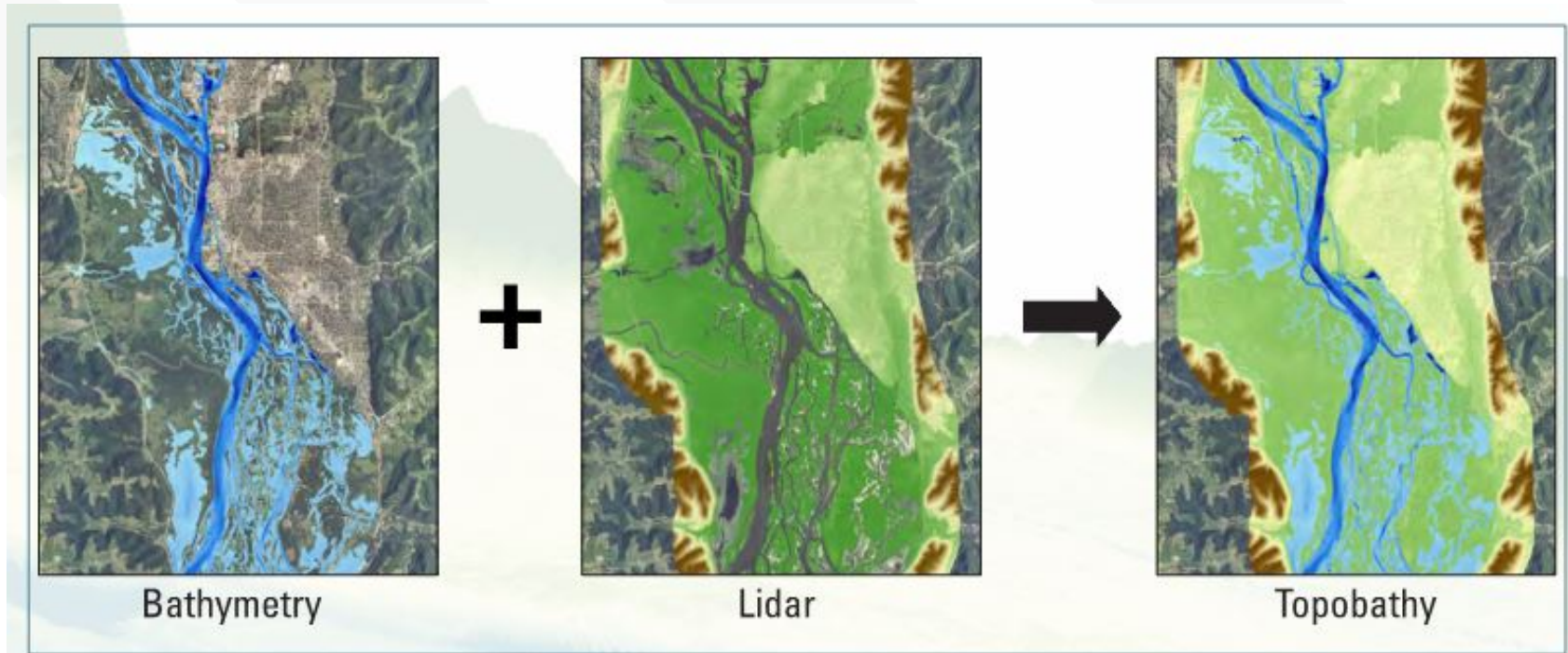


## The Upper Mississippi River System—Topobathy

The Upper Mississippi River System (UMRS), the navigable part of the Upper Mississippi and Illinois Rivers, is a diverse ecosystem that contains river channels, tributaries, shallow-water wetlands, backwater lakes, and flood-plain forests. Approximately 10,000 years of geologic and hydrographic history exist within the UMRS. Because it maintains crucial wildlife and fish habitats, the dynamic ecosystems of the Upper Mississippi River Basin and its tributaries are contingent on the adjacent flood plains and water-level fluctuations of the Mississippi River. Separate data for flood-plain elevation (lidar) and riverbed elevation (bathymetry) were collected on the UMRS by the U.S. Army Corps of Engineers' (USACE) Upper Mississippi River Restoration (UMRR) Program (fig. 1). Using the two elevation datasets, the U.S. Geological Survey (USGS) Upper Midwest Environmental Sciences Center (UMESC) developed a systemic topobathy dataset.

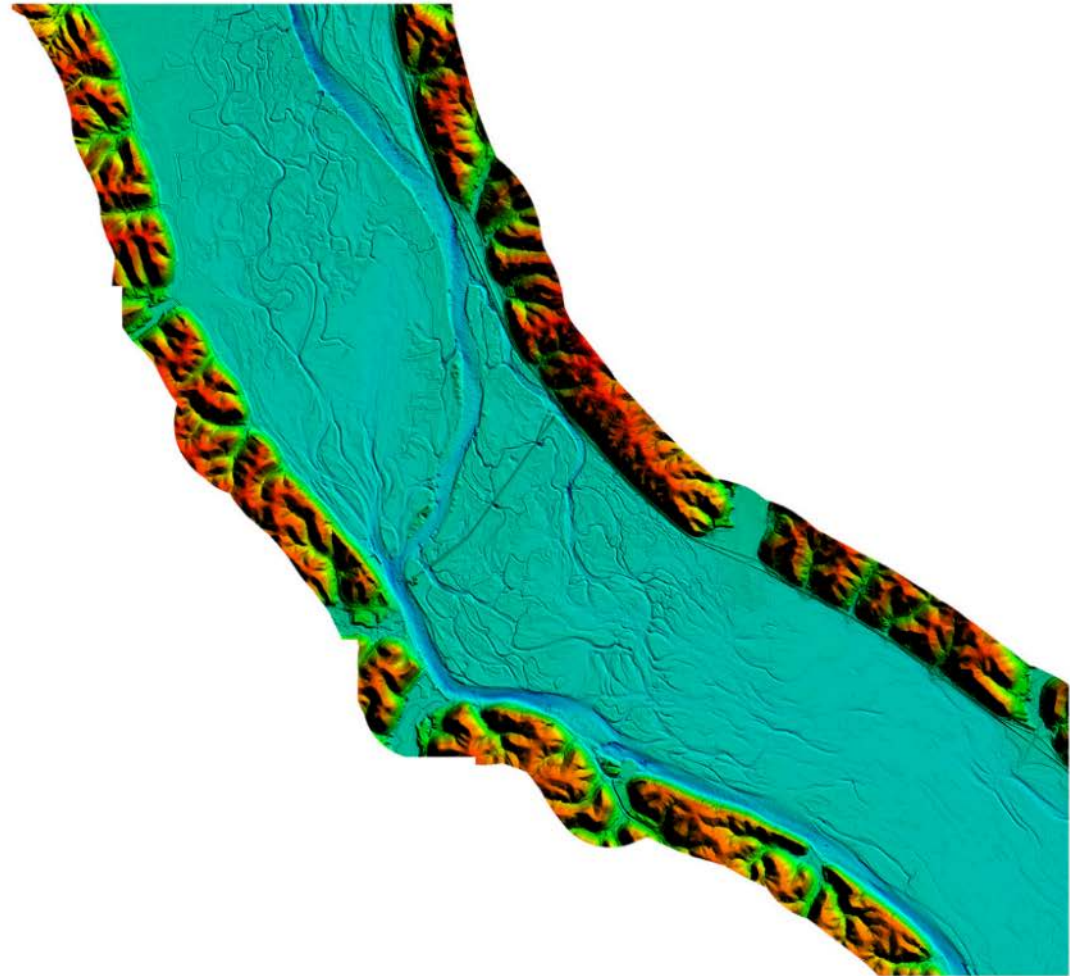
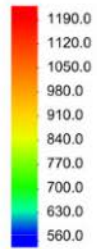


# USGS TOPOBATHY



# MISSISSIPPI RIVER – POOL 9 TOPOBATHY

Rasters

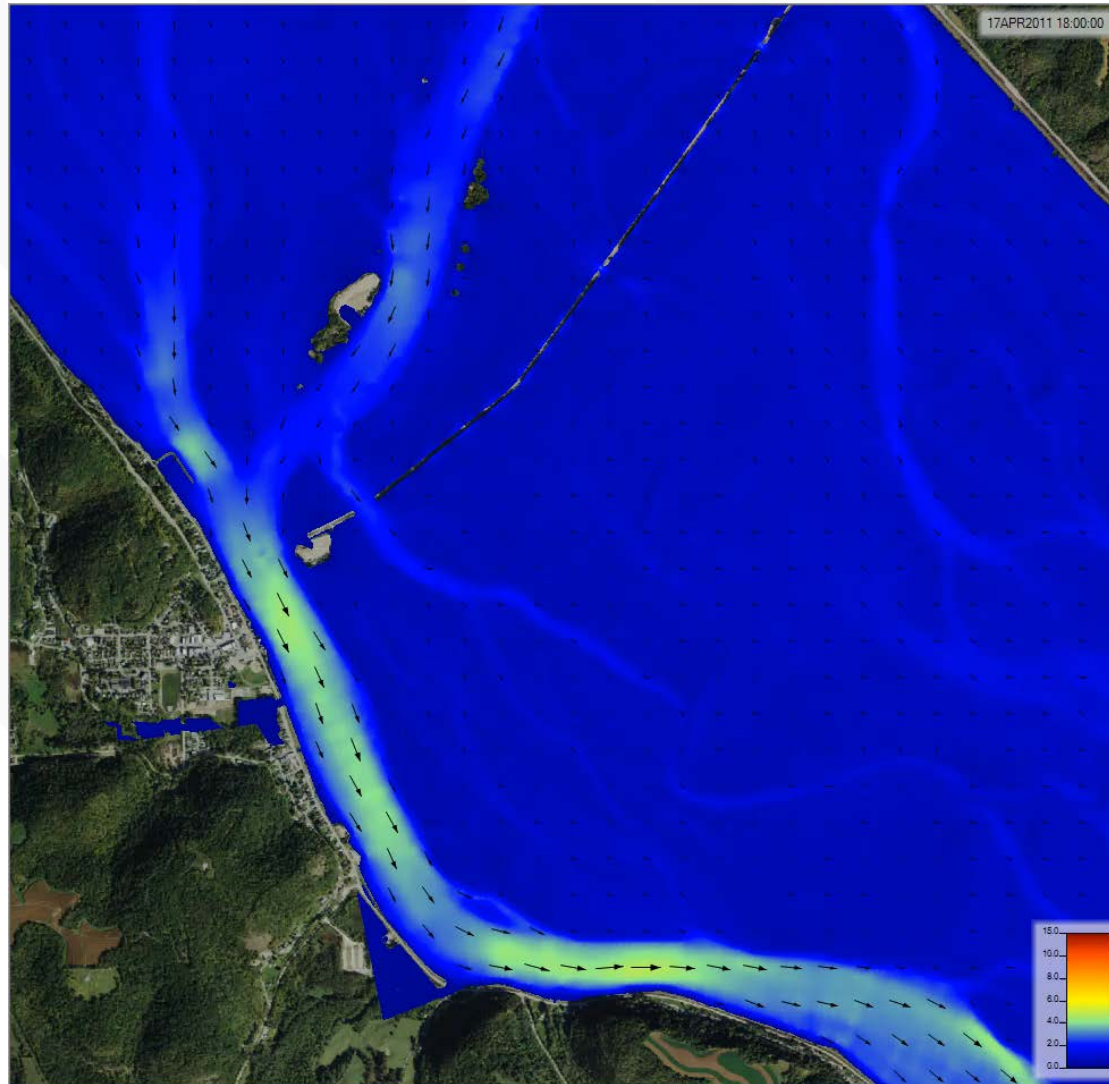


# 2D FLOODPLAIN ANALYSIS

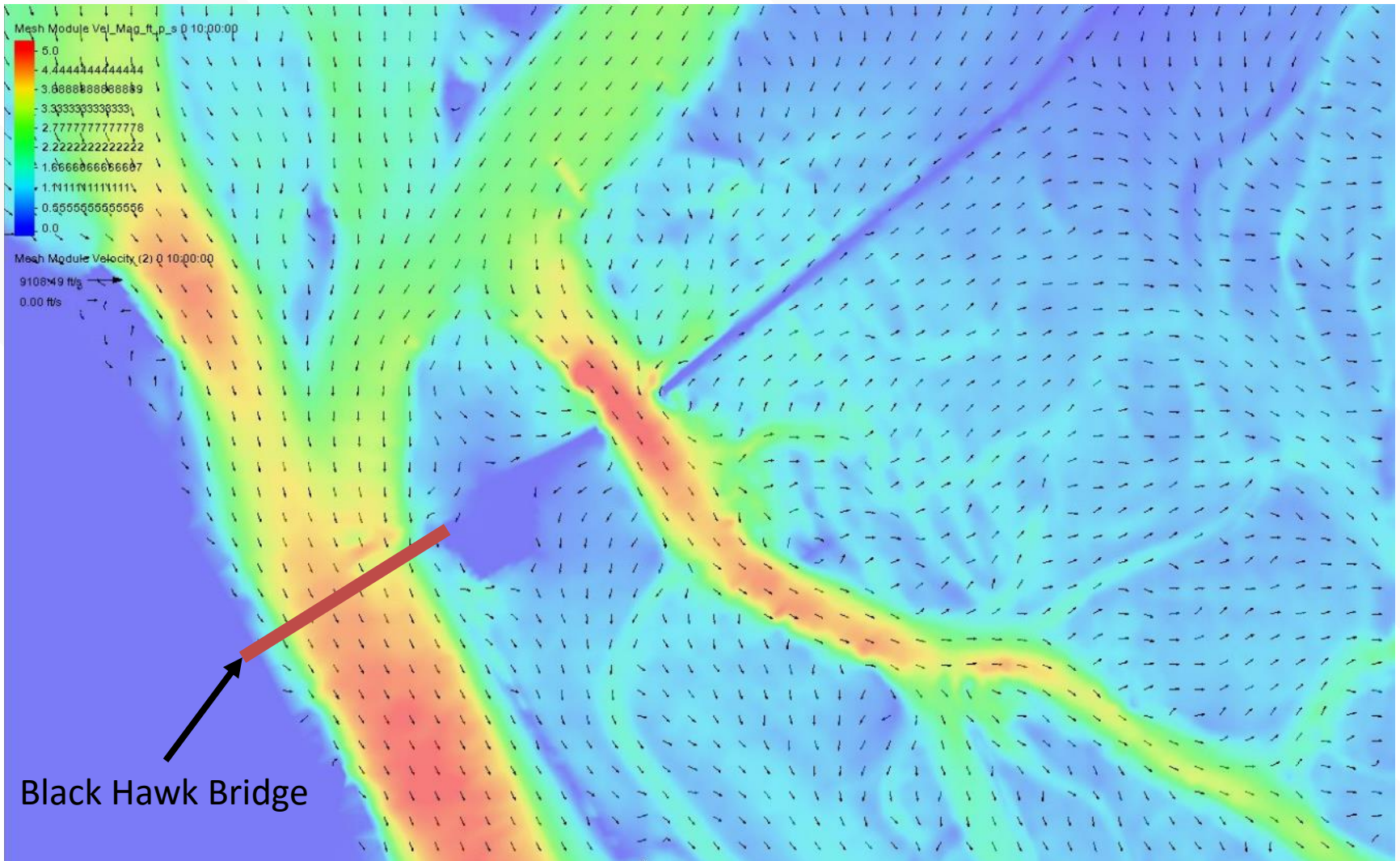
1. Started with FEMA HEC-RAS 1D Floodplain Model.
2. Generated HEC-RAS 2D model/calibrated with 1D model.
3. Developed SMS 2D model for check of velocity vectors.



# HEC-RAS 5.03 - 2D



# SMS 12.2 - 2D





# 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

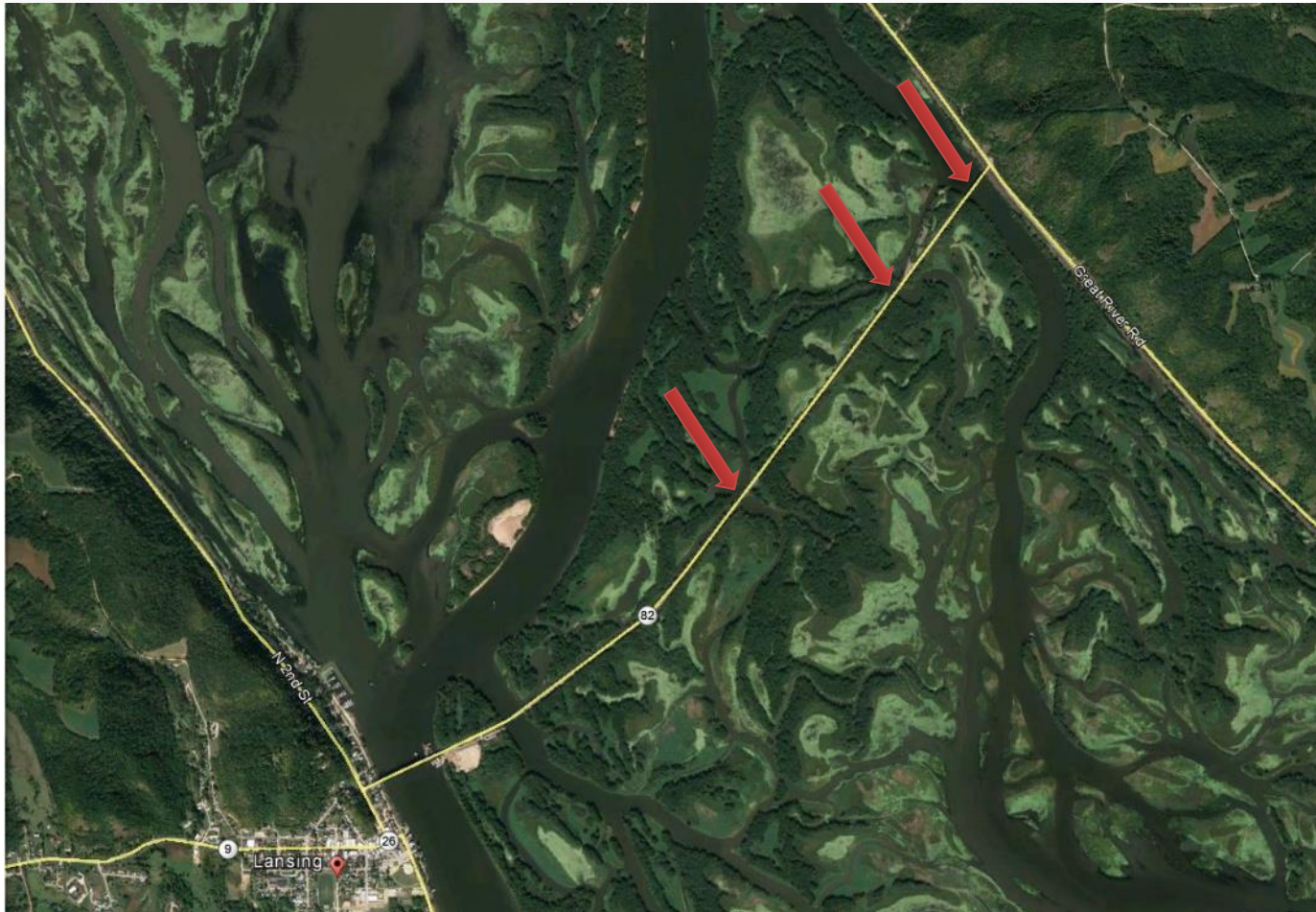


# SIMULATION RESULTS

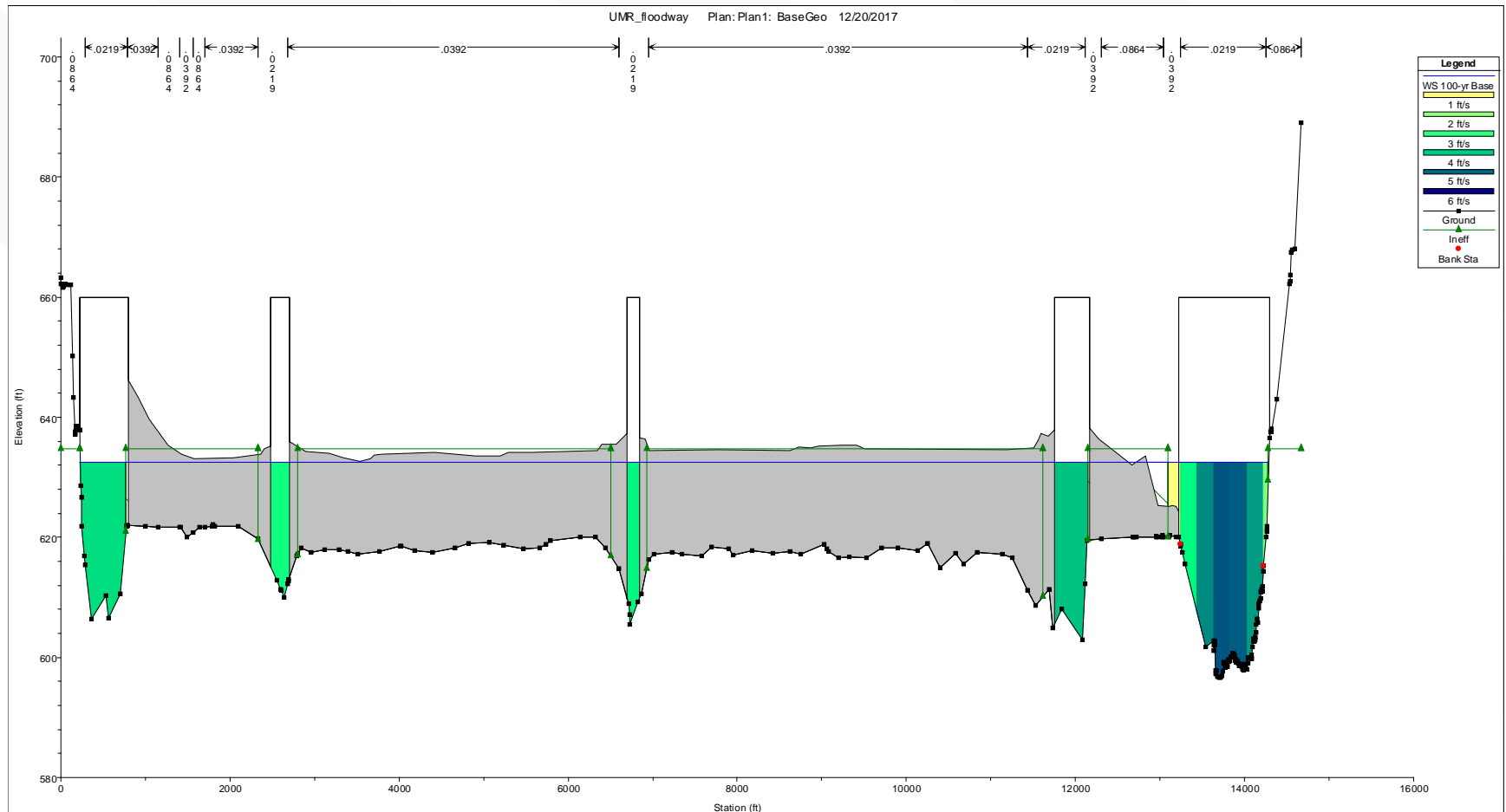
- Pilots saw immediate improvement with 750' span compared to existing.
- 850' simulation was not needed. USCG concurred.
- Established required navigation span for each alignment.
- Small reduction in navigation span can provide substantial savings.
- Construction scenario was valuable. Assist boat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



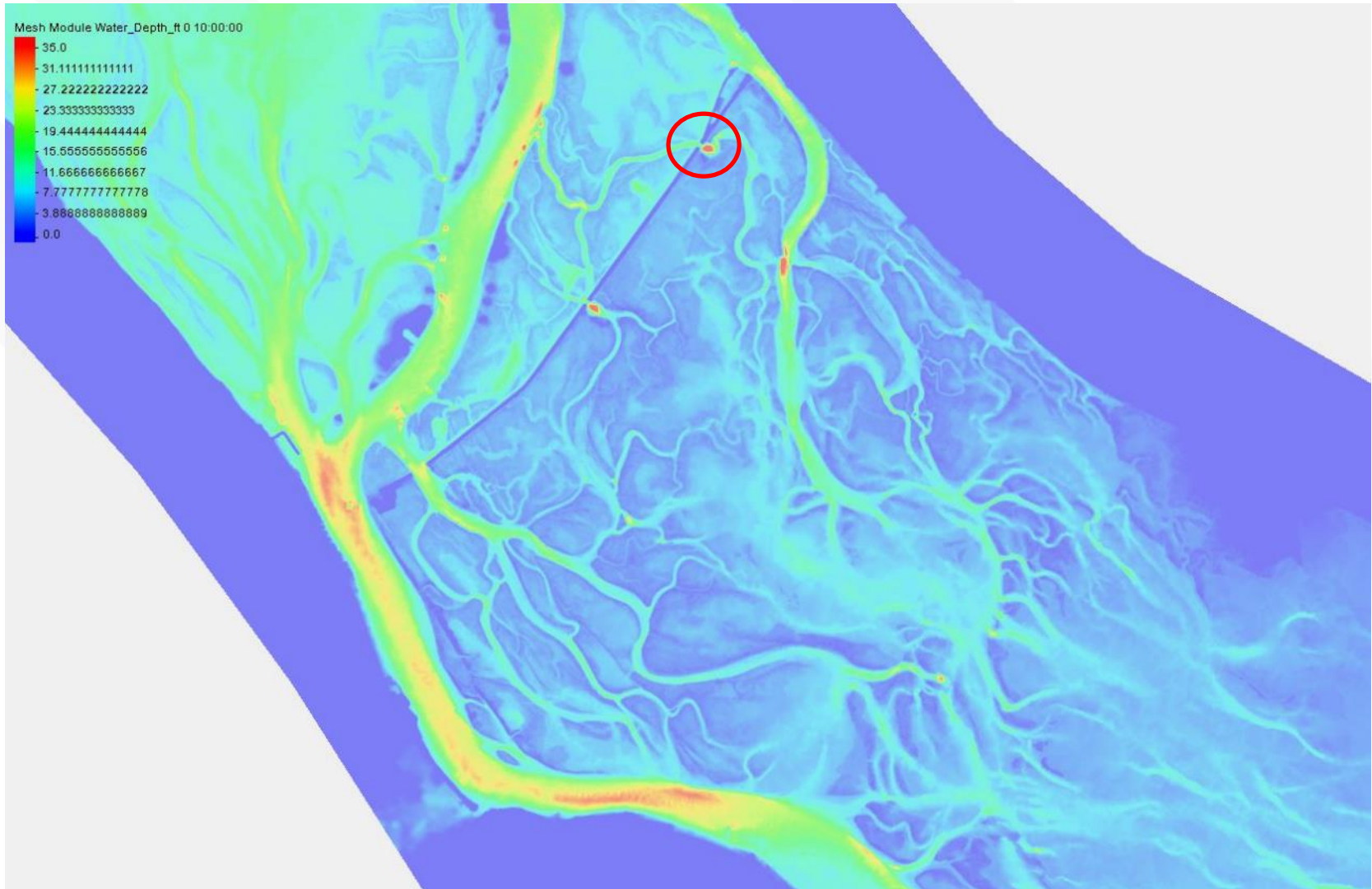
# WISCONSIN APPROACH BRIDGES



# FEMA 1D MODEL – BRIDGE SECTION

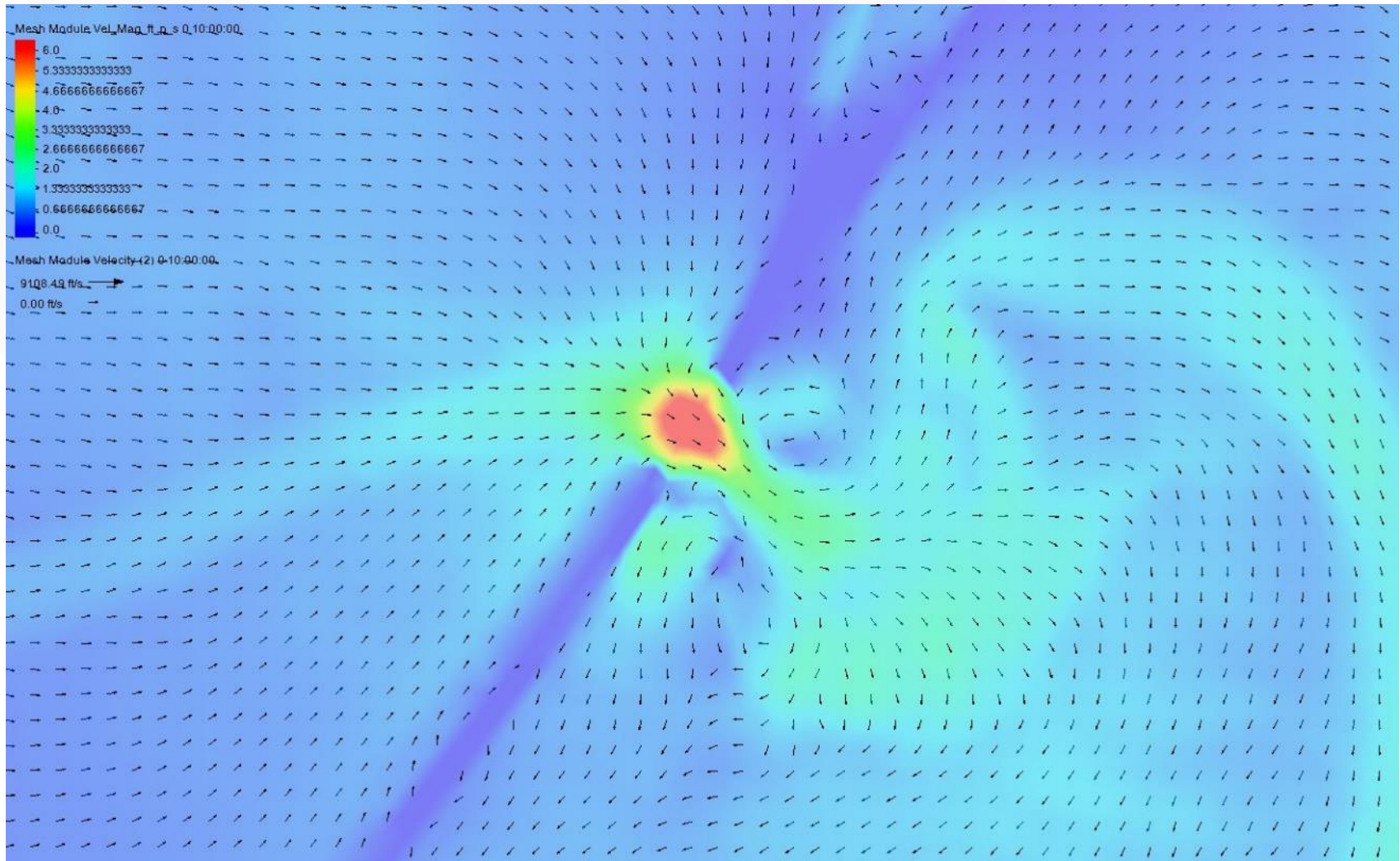


# SMS 12.2 - 2D ANALYSIS

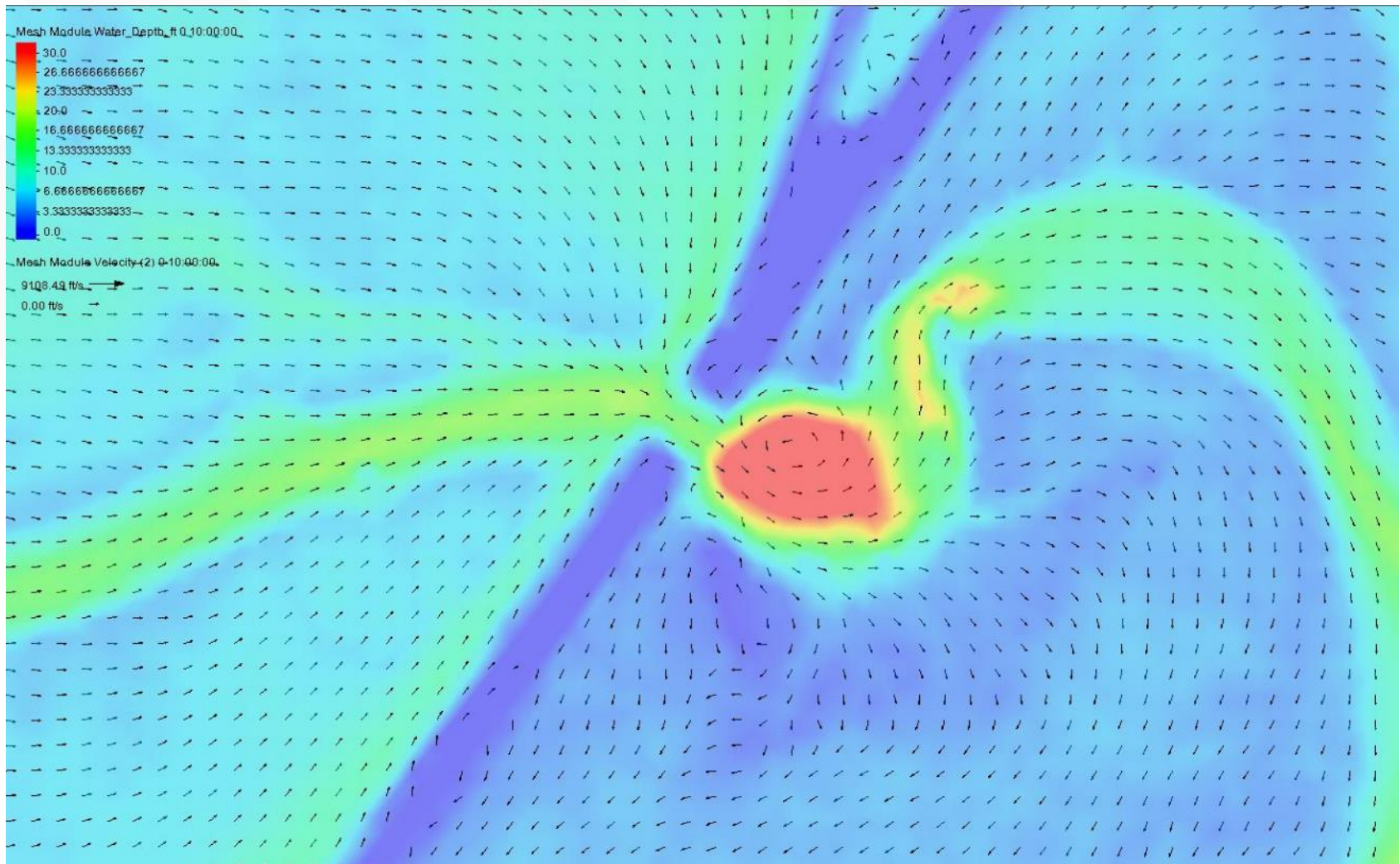




# SMS 12.2 - VELOCITIES

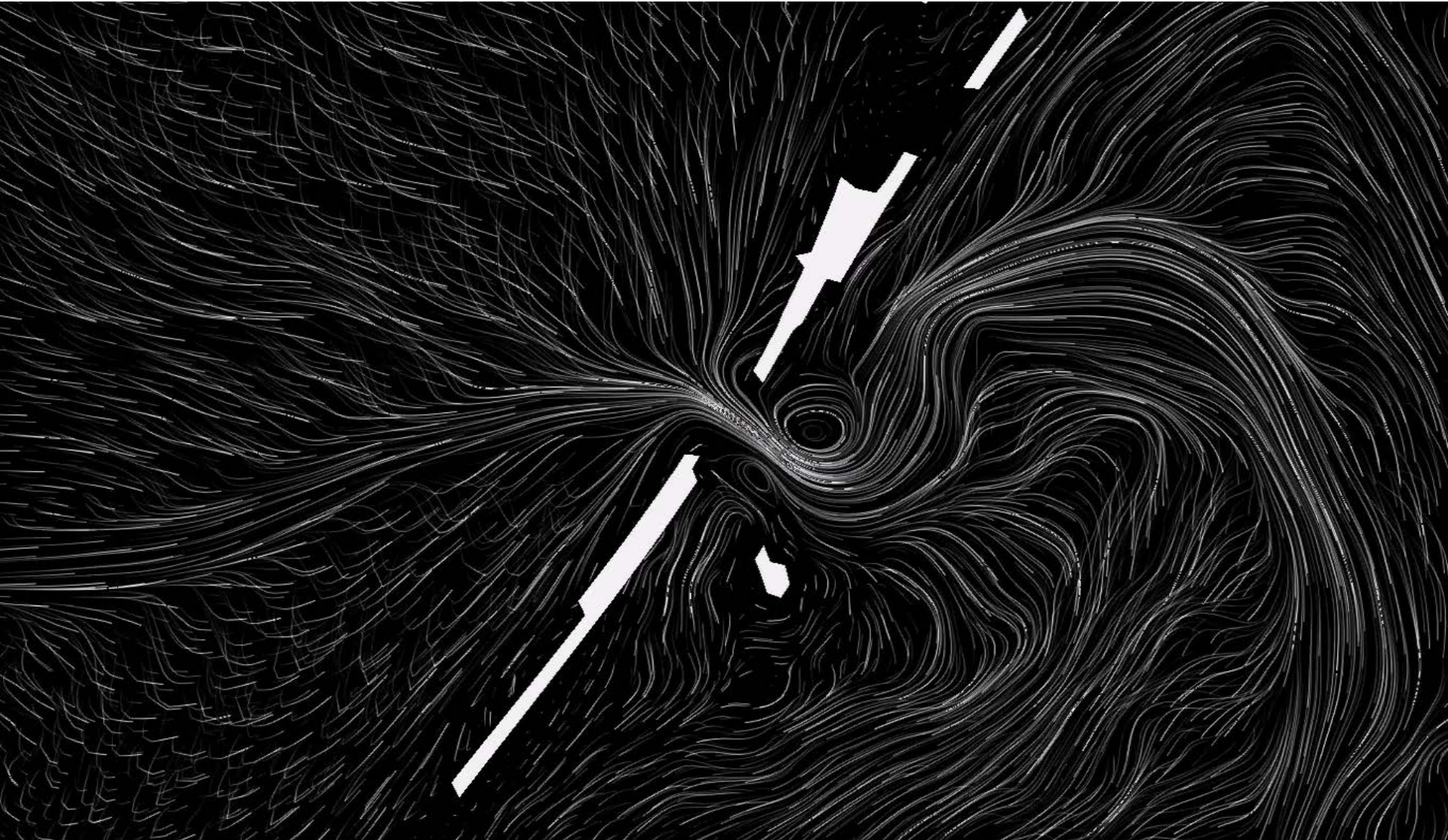


# SMS 12.2 – WATER DEPTH





# SMS 12.2 – FLOW LOOP

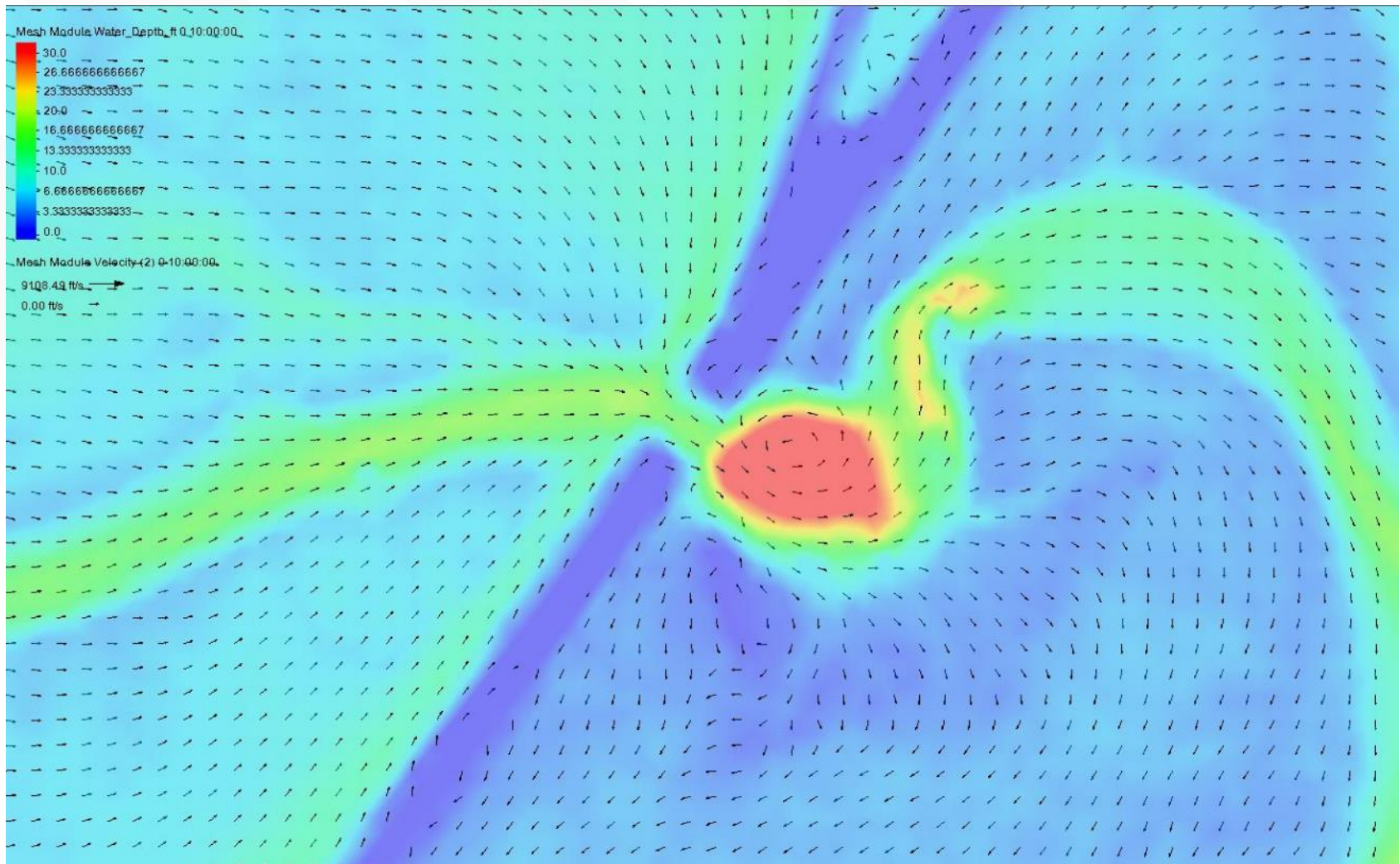




# MAY 2017 – EMBANKMENT FAILURE



# 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.



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