



Installation of J-Hook Vanes to Mitigate Bank Erosion as Part of a Time Critical Removal Action

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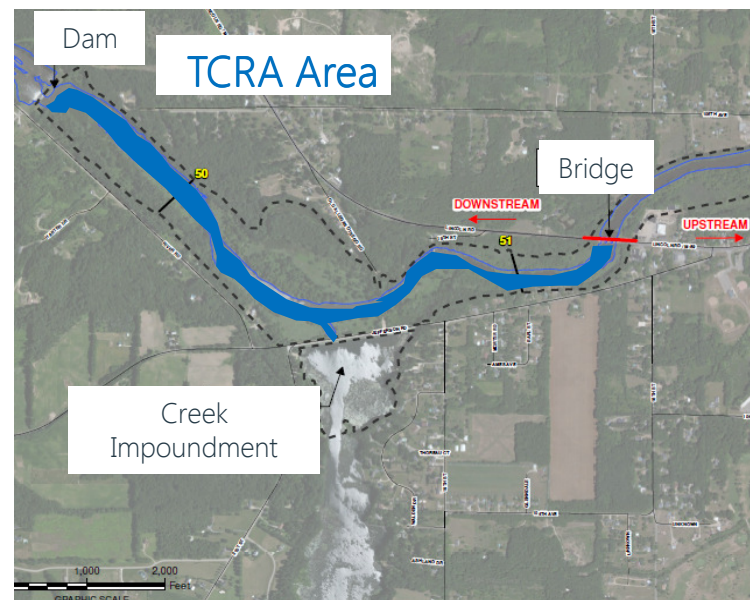
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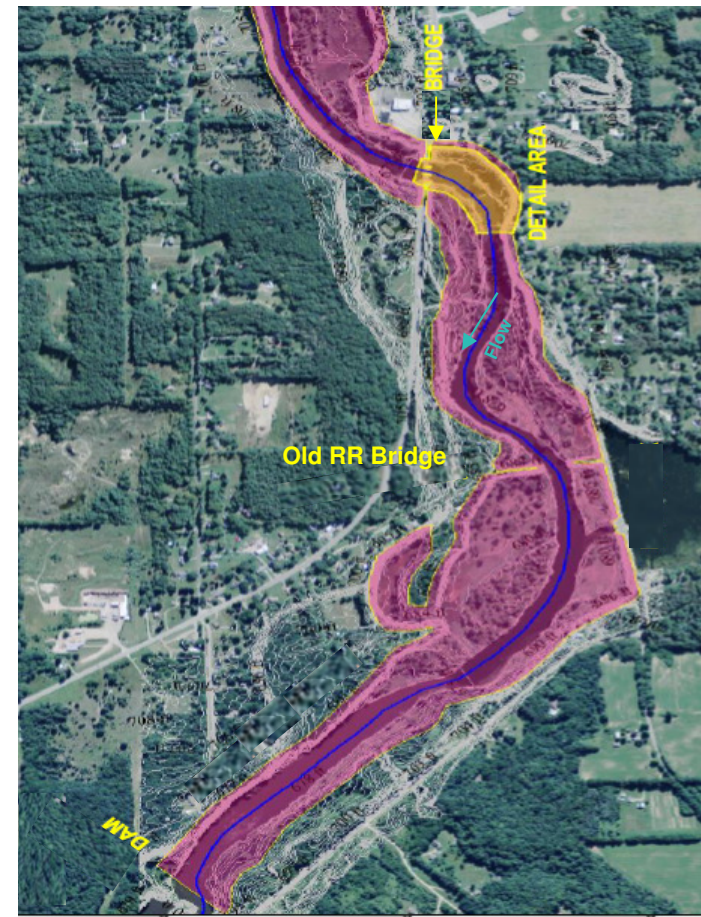
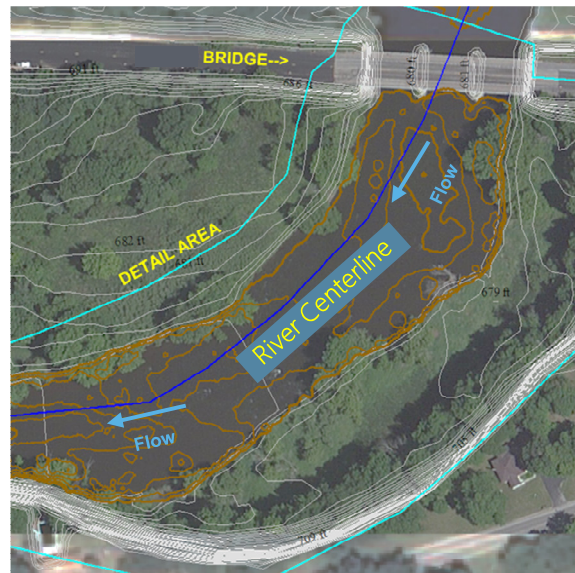
Background

- Time critical removal action on a Michigan river
- Bank stabilization and sediment removal project along 1.7 miles of river
- Unique challenges in the TCRA project area due to dams, bridges, water control structures, natural constriction
- Compressed schedule (data collection, design, and construction complete in 26 months)



Bridge and other complications

- Constriction at the bridge, higher velocity flows
- Bridge supports deflect flow toward the left descending bank
- Split thalweg downstream of bridge in shallow waters
- Homes on the bluff downstream of the bridge

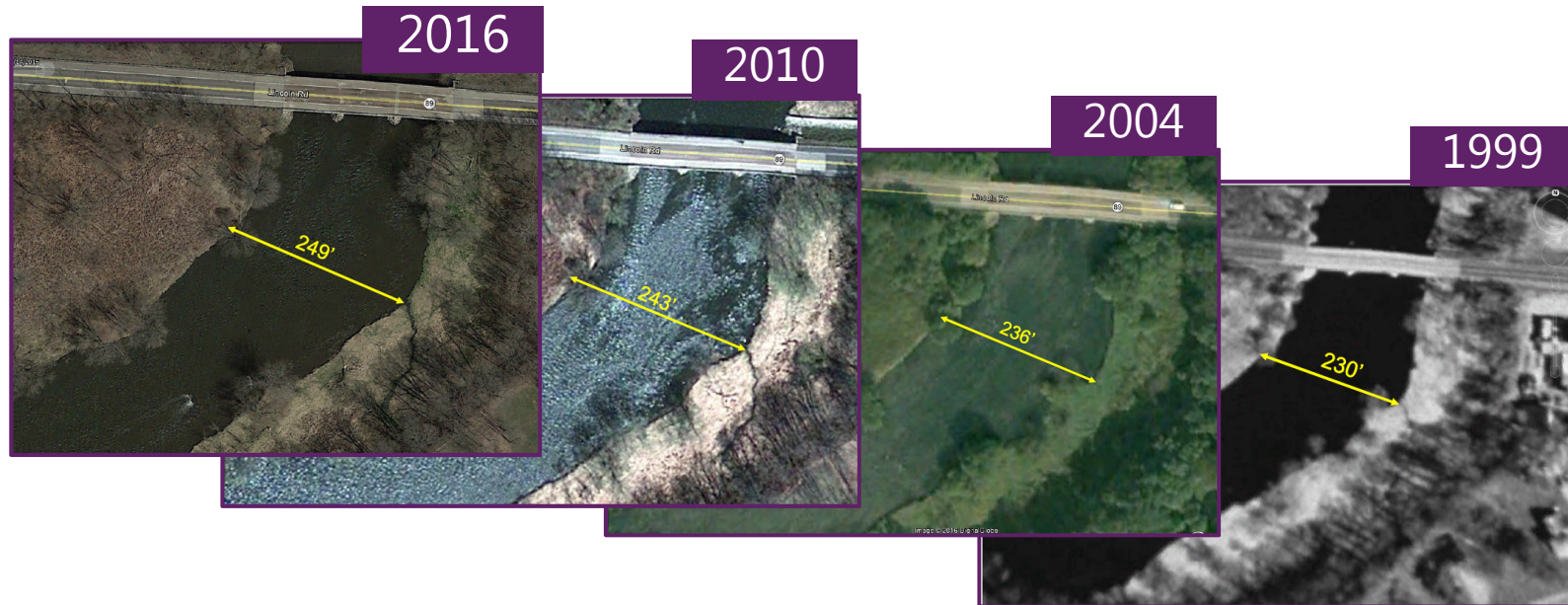
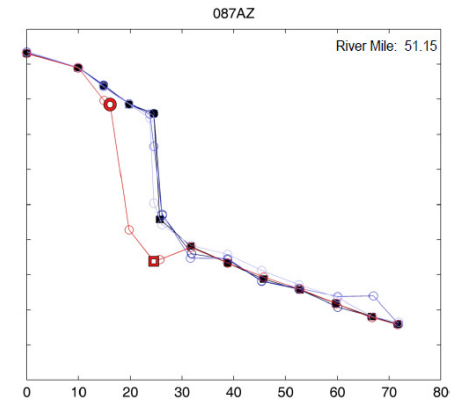


- MDOT notification of work
- Bridge supports were shallow
- MDOT requirements (100 foot buffer)
- Pre and post bridge inspection



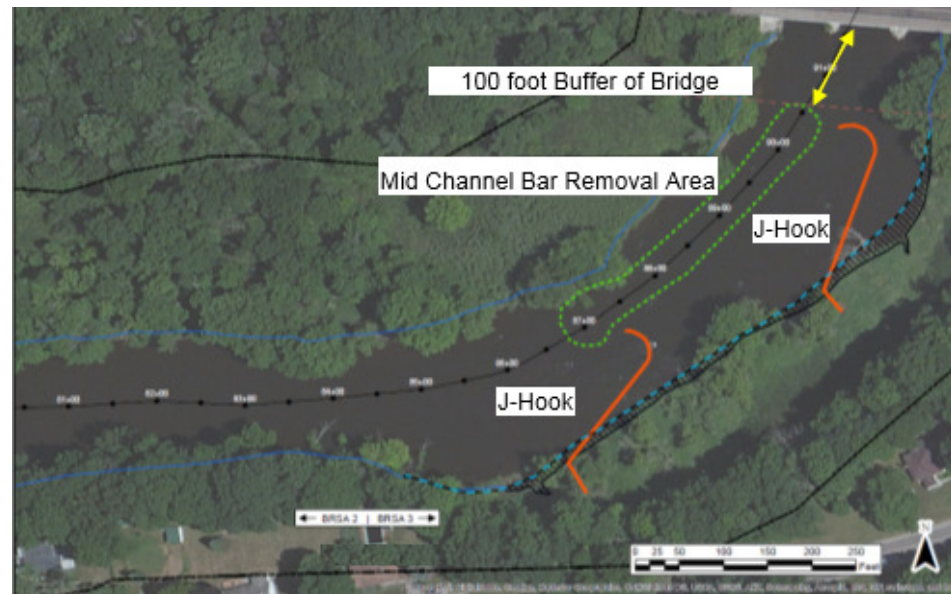
Evidence of erosion

- Erosion pin evidence
 - Loss of ~10-12 feet over 12 years in select areas
- Historical aerials



Design approach

- J-hook vanes re-direct water away from left descending bank
- Minor reshape of thalweg by limited excavation of clean mid-channel bar to direct flow to channel centerline. Keeps flow away from both banks
- Bank build-out provides the width: depth ratio for a stable channel and keeps mid-channel bar from reforming
- Joint planting bank treatment provides protection against expected flows



Modeling inputs

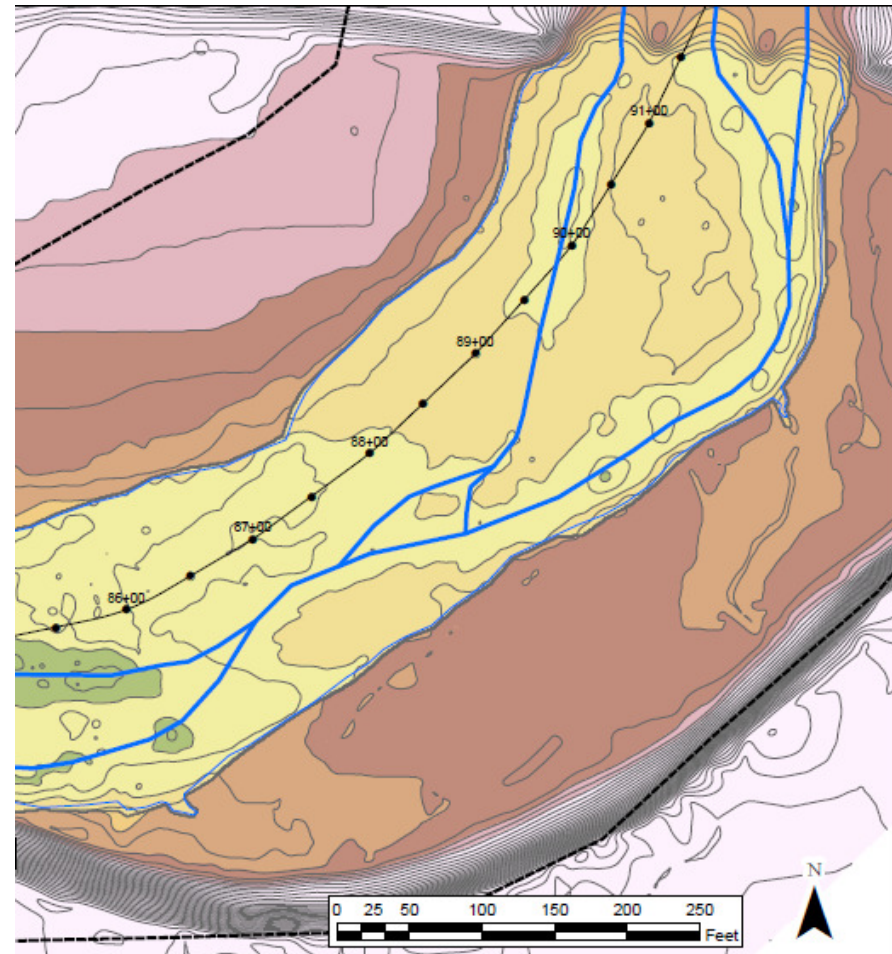
- Topography and bathymetry
- Pre-construction dominant channels shown as blue line
- As bathymetry was updated, so were the HEC RAS and Delft 3D models

Legend

- RIVER STATIONING
- RIVER CENTERLINE
- DOMINANT CHANNELS

ELEVATION (FT, NGVD29)

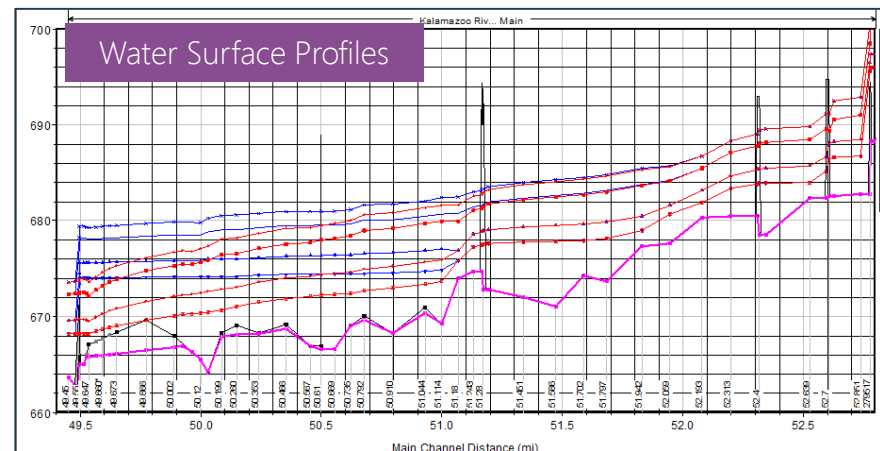
< 670	676.1 - 678
670.1 - 672	678.1 - 680
672.1 - 674	680.1 - 682
674.1 - 676	682.1 - 684
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Modeling

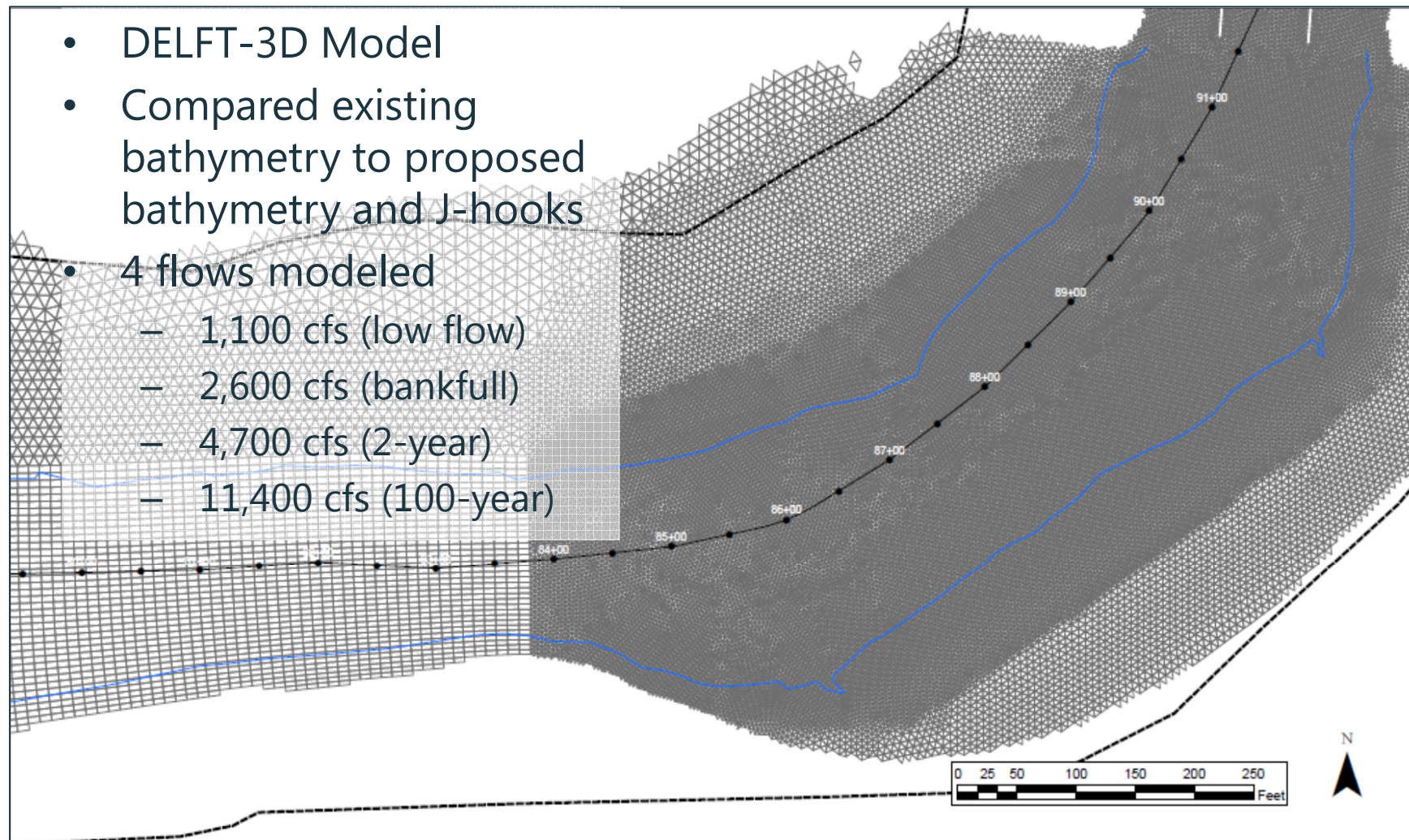
- A water surface profile model was developed using the available river bathymetric mapping and LiDAR topographic data
- HEC-RAS version 5.0 was used to create a one-dimensional, steady flow model
- A wide range of discharges were modeled (for a dam-in and dam-out scenario). The flows used ranged up to the 100-year flood flow.
- Channel n-values were 0.025 for the existing condition and 0.3 for dam out condition

Legend	
WS 11800 cfs (100-yr - ExCond Stoplogs0	
WS 11800 cfs (100-yr - FutCond S=0.055%	
WS 10-yr - ExCond Stoplogs0	
WS 10-yr - FutCond S=0.055%	
WS 1.1-yr AMS - FutCond S=0.055%	
WS 1.1-yr AMS - ExCond Stoplogs0	
WS 960 cfs (50%) - FutCond S=0.055%	
WS 960 cfs (50%) - ExCond Stoplogs0	
Ground	
Ground	

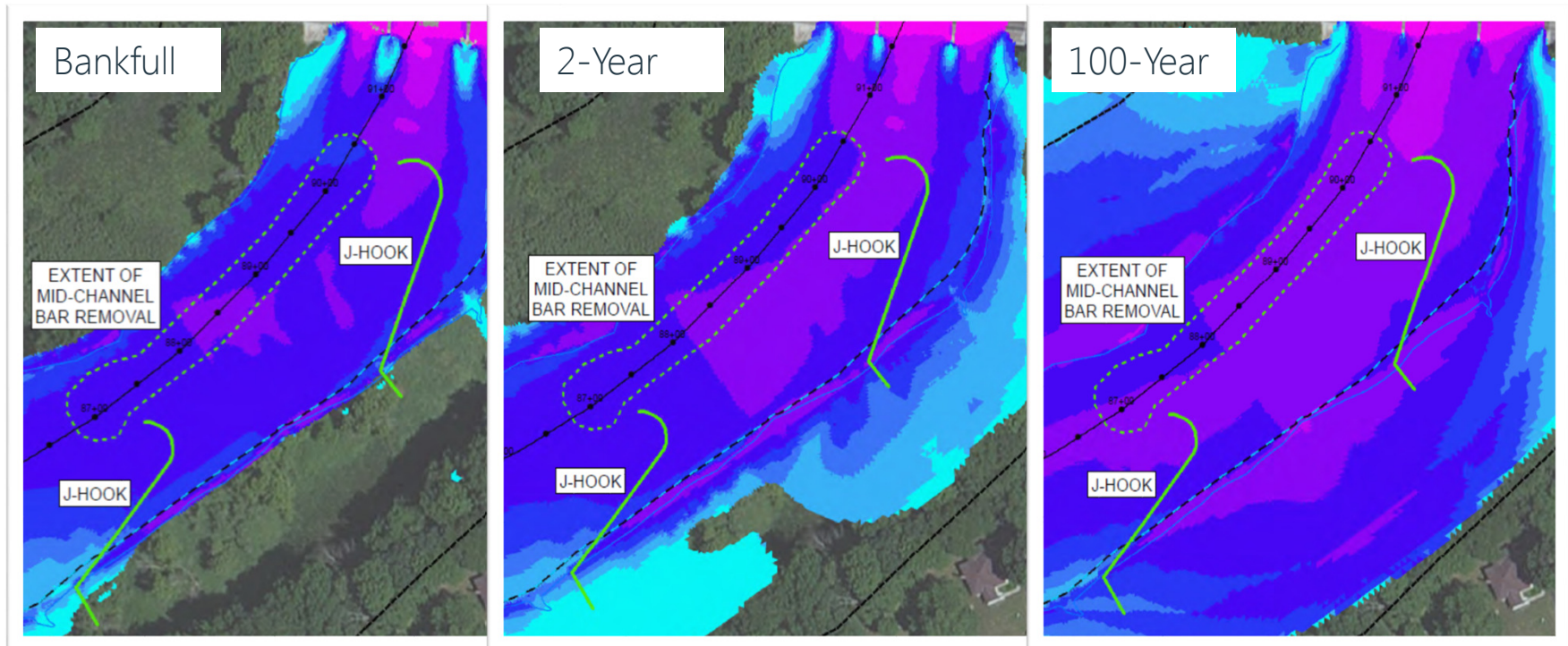


Comparison of Existing and Future Conditions

Overview of model setup and results

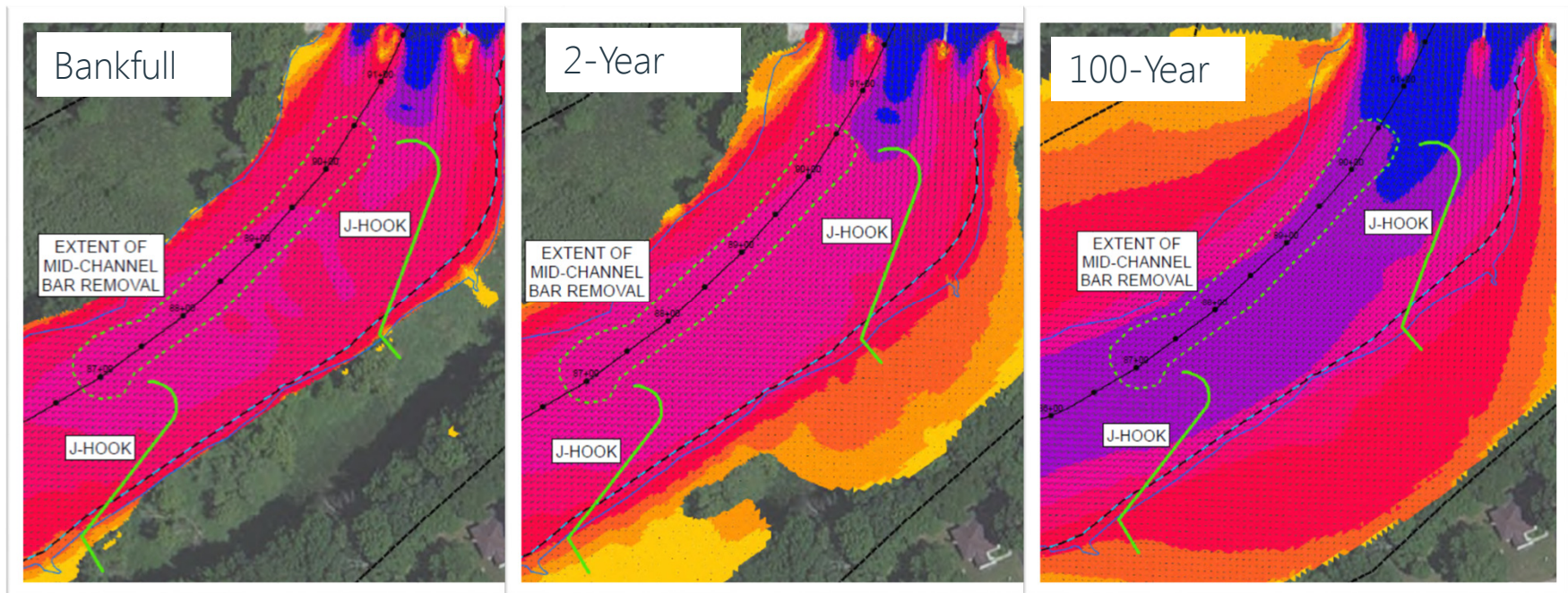


Delft 3D modeling – shear stress

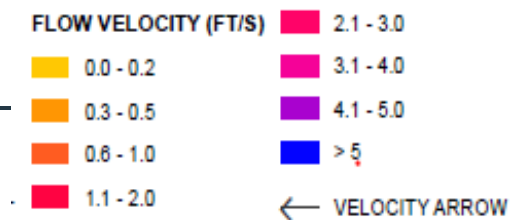


- Shear stresses were acceptable
- Rip rap on joint-planted bank was sized using model results

Delft 3D velocity

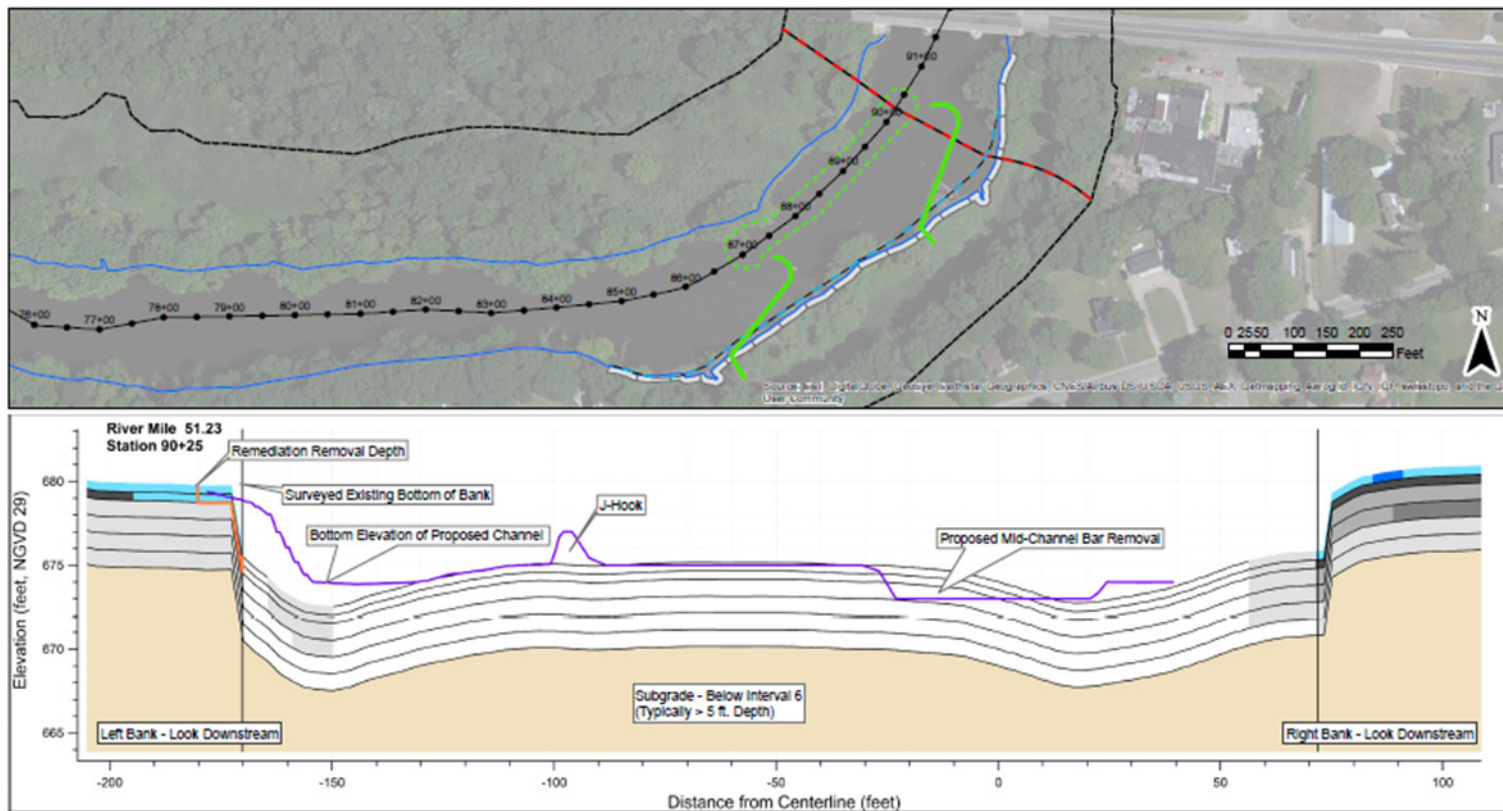


- Velocities within acceptable range
- Other areas within the project area had naturally-occurring higher velocities at these flows



Cross section visualization tool

- Provided benefits to design team, construction team, stakeholders as a communication tool
- Reality check for the design specifications



Implementation – build-out



- Originally planned for early spring, delayed to June due to high water and high velocities
- Began with bank build-out
 - Rock cofferdam
 - Fill up to 30 feet in width

Implementation – Mid Channel Bar

- Mid channel material removed was composed of cobble
- Cobble material was reused along the right descending bank for additional armoring
- As the water levels dropped in May, the excavator tracked in from the bank
- No turbidity limit excursions



Implementation – J-hooks

- Boulders were sized to withstand forces of 100 year + flow.
- J-hooks situated according to modeled locations; boulders placed guided by GPS survey equipment
- Height of J-hook in-field adjustment



Implementation – J-hooks



Aerial view after J-hook Installation

6 Months Post Construction



Results

- Post installation surveys confirm mid channel bar removal area is stable
- Experienced a significant flood event following installation – everything remained stable
- Deposition occurring as expected and desired inside of J-hook vanes along the left descending bank



After



Before



Questions

