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# Lock & Dam No. 7 Upper Approach Outdraft

## Mississippi Managers Meeting February 2020

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St. Paul District, H&H Branch

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# Overview

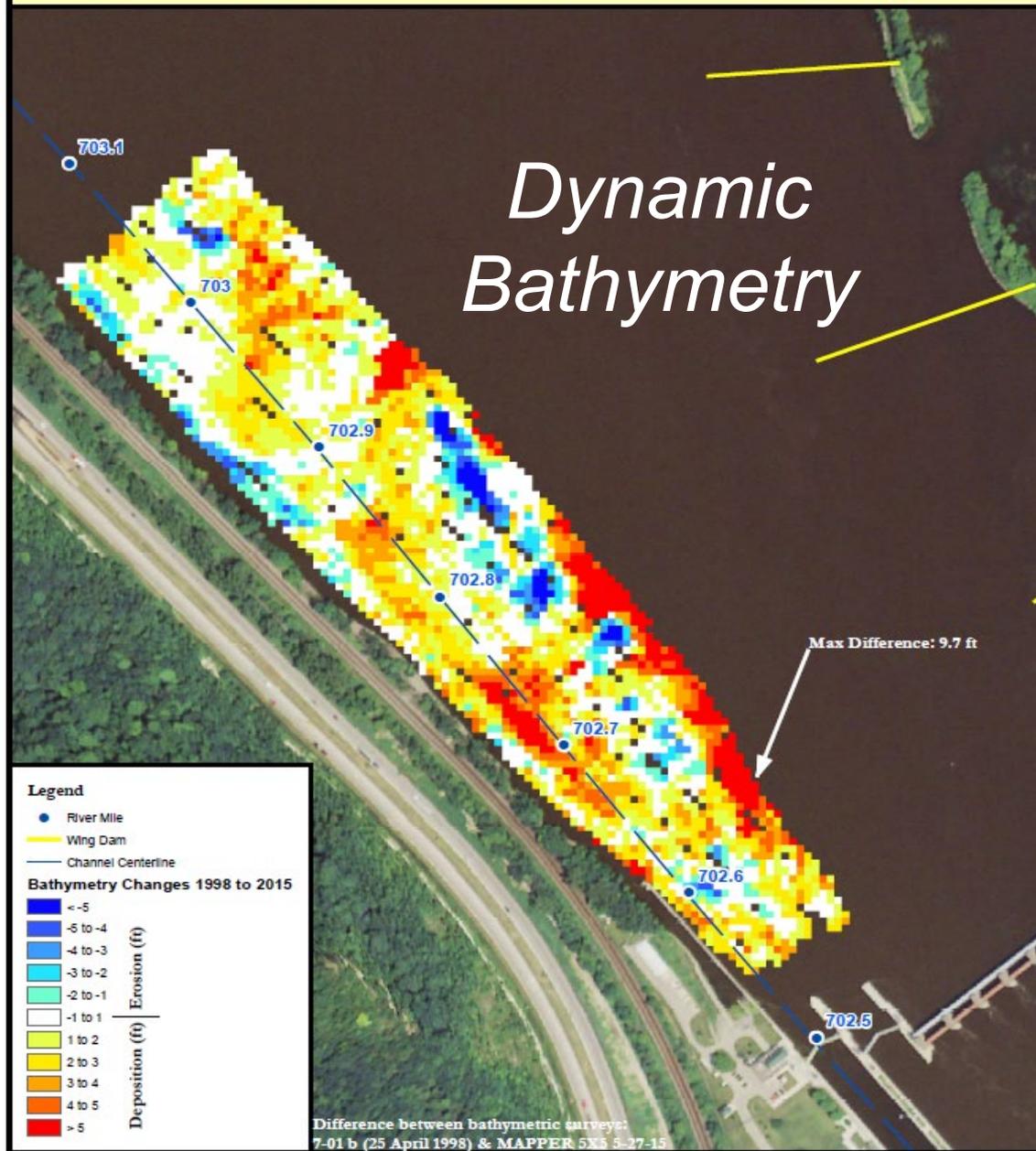


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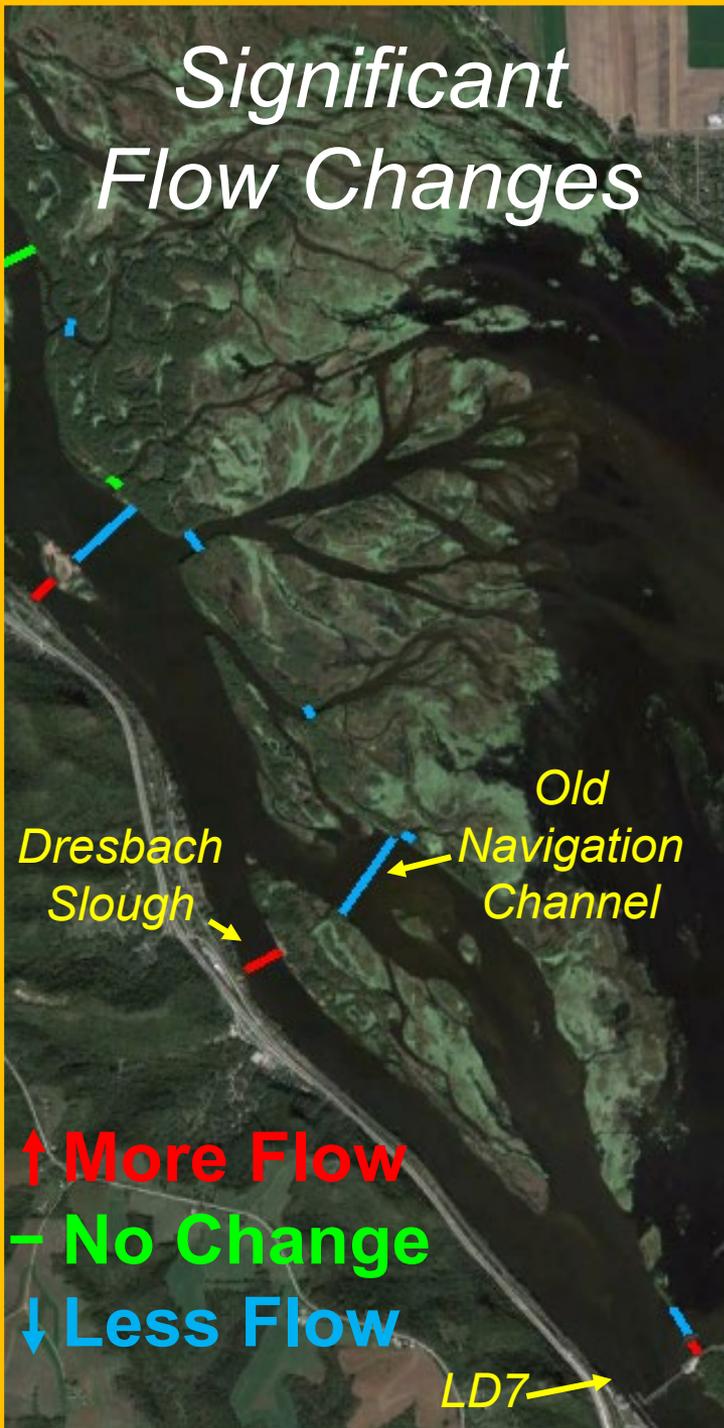
- Lock & Dam 7 Upper Approach Hydraulics
  - ▶ Dynamic Bathymetry
  - ▶ Flow Shifts
- 2019 Condition Recap
  - ▶ Abnormally high, extended flows
- 2019 Alternative Analysis
  - ▶ Dredging, Weir Modification
- Discussion

# Mississippi River - Lock and Dam 7

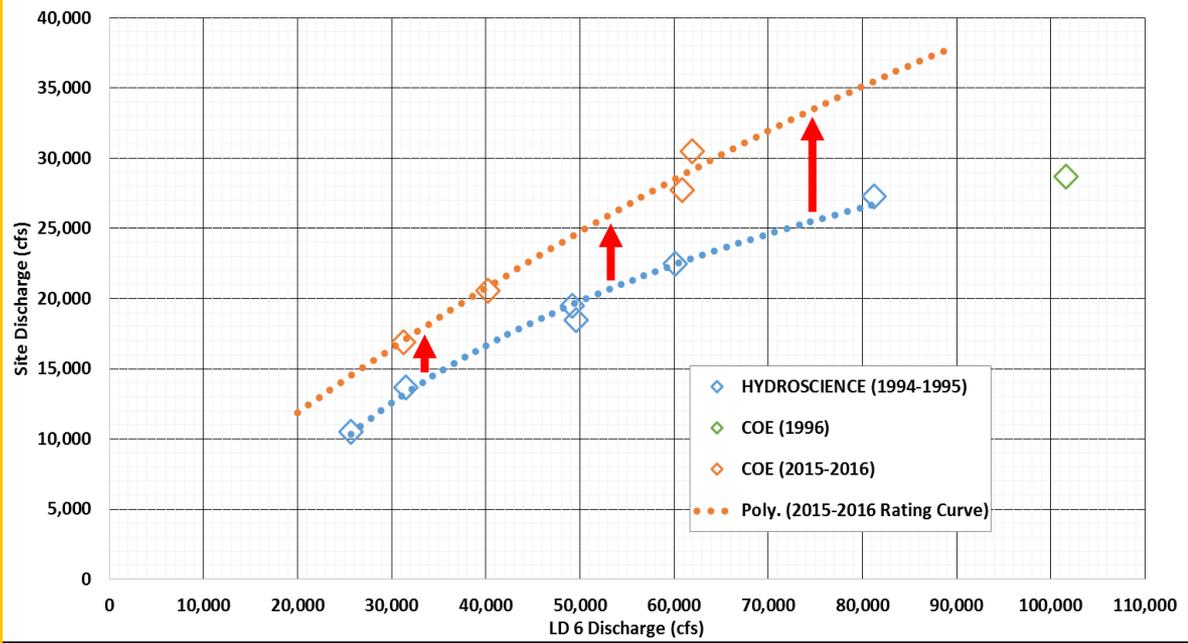
## Upper Approach Bathymetry Changes - 1998 to 2015



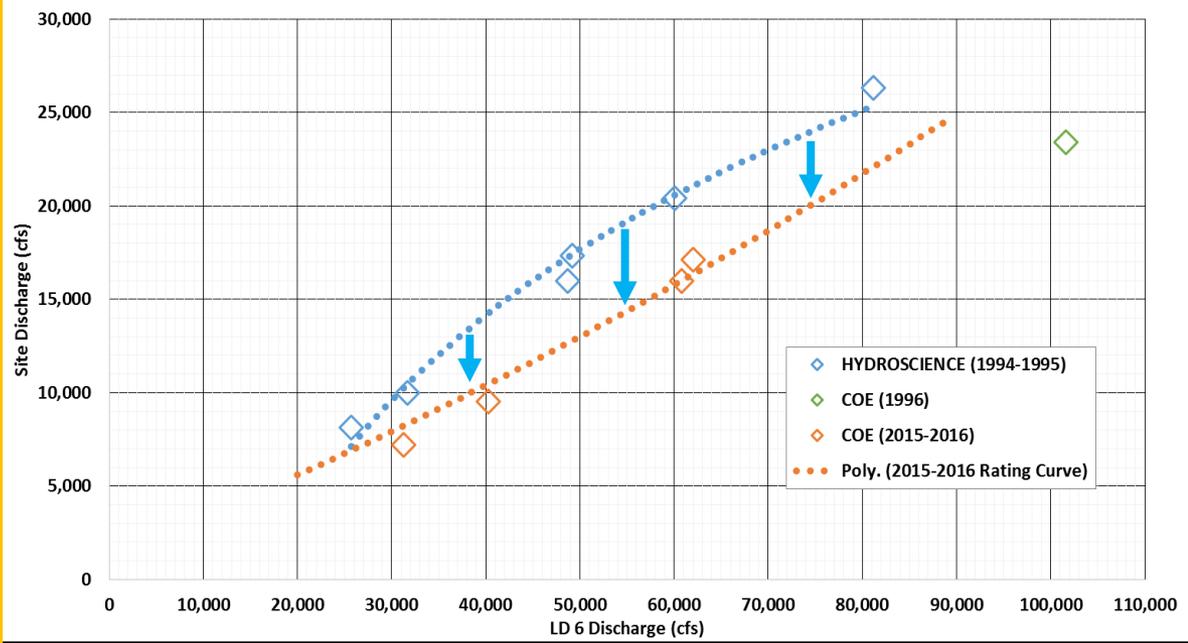
# Significant Flow Changes



Mississippi River - Pool 7  
RM 705.00 SW (2000') - Dresbach Slough



Mississippi River - Pool 7  
RM 704.80 - Old Navigation Channel



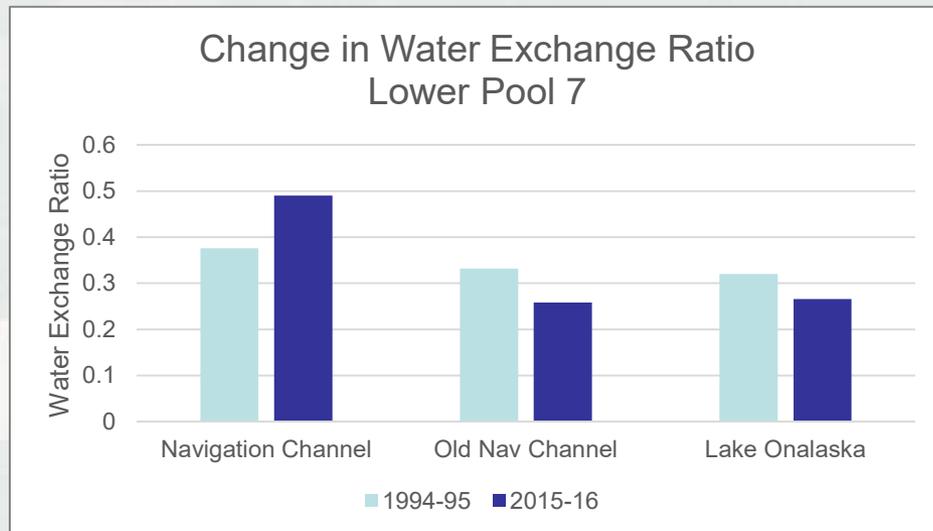
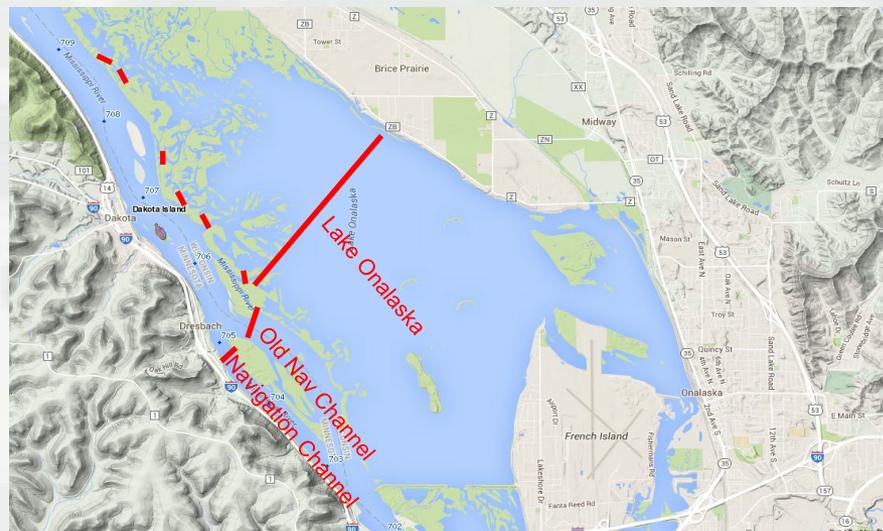


# Flow Changes



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## Water exchange – a surrogate for geomorphic change





U.S. ARMY

# Hydraulic Model



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- 2D Model Developed
- ~4 River Miles
- Assess existing conditions/Validate
- Test Alternatives
- ***Goal: Reduce Velocities around Upper Approach***



# Alternatives



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- Unique channel
  - Shallow + narrow : limits options
- Hydraulic model used to evaluate various alternatives
  - ▶ Simple Non-Structural alternatives
    - Dredging
  - ▶ Complex Structural
    - Dredging with structures
- Only one alternative showed potential

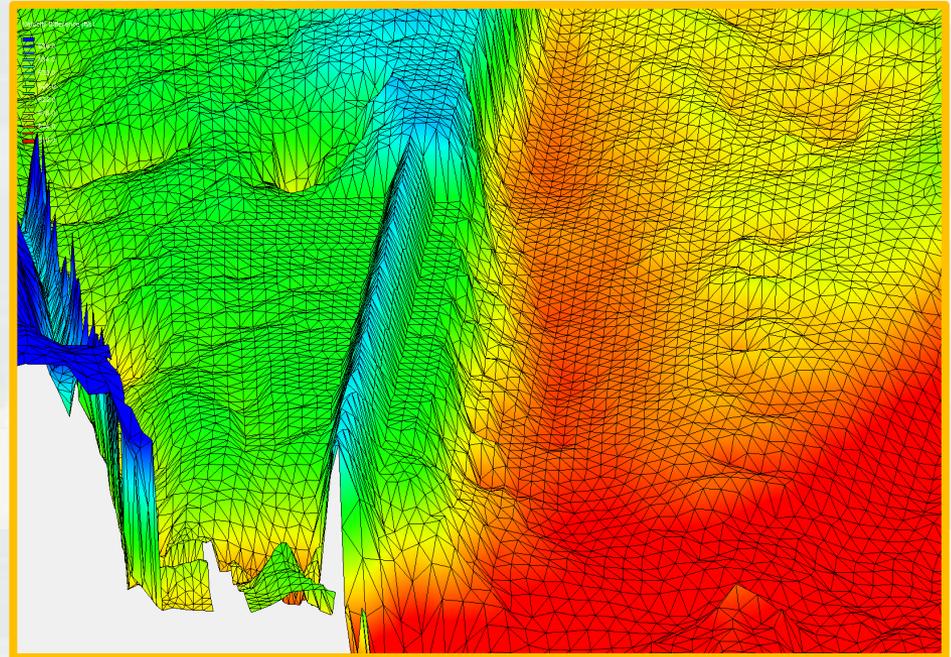
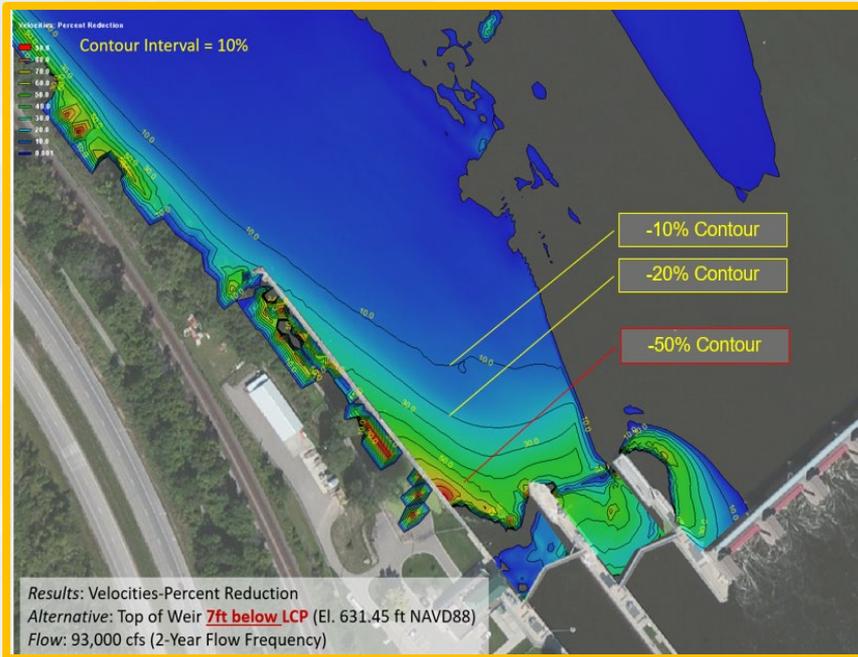


# Constructed Alternative



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- Rock Weir at **7ft below LCP** (El. 631.45 ft NAVD88)
  - Lowers velocities by 20-50% (near Upper Approach)
    - ▷ “Nudge” in the right direction

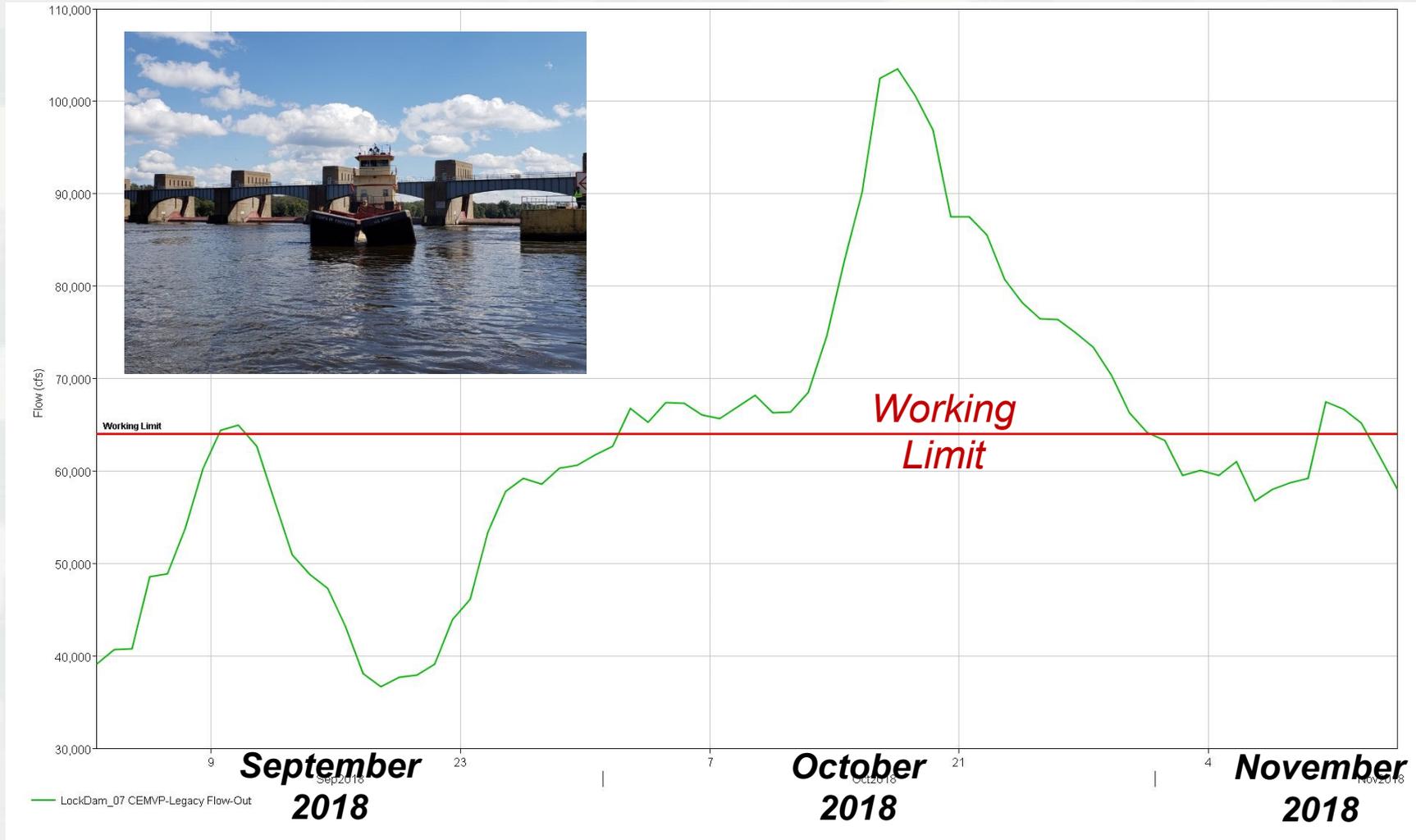




# Flows during construction (2018)



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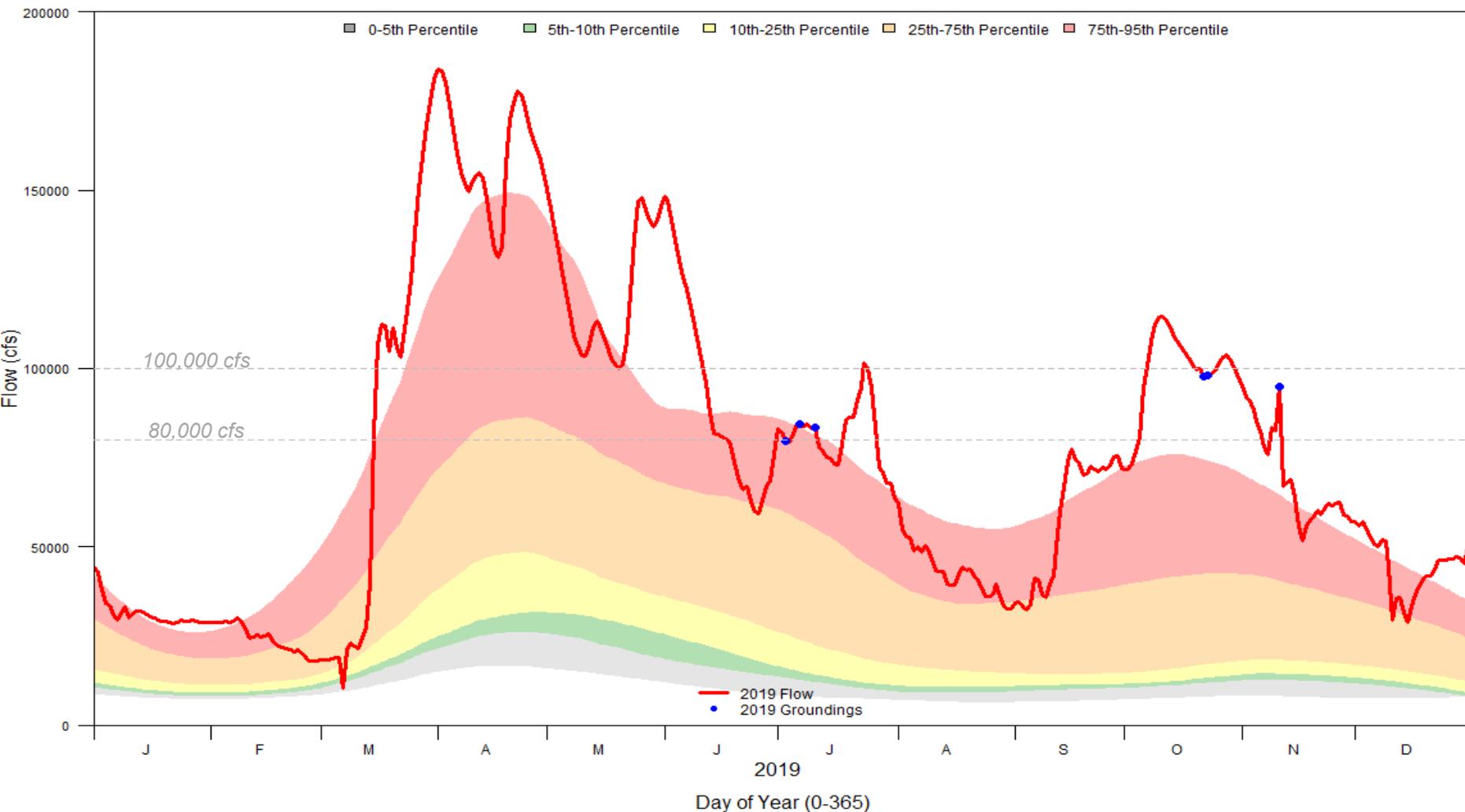


# 2019 Flows = Dynamic Year



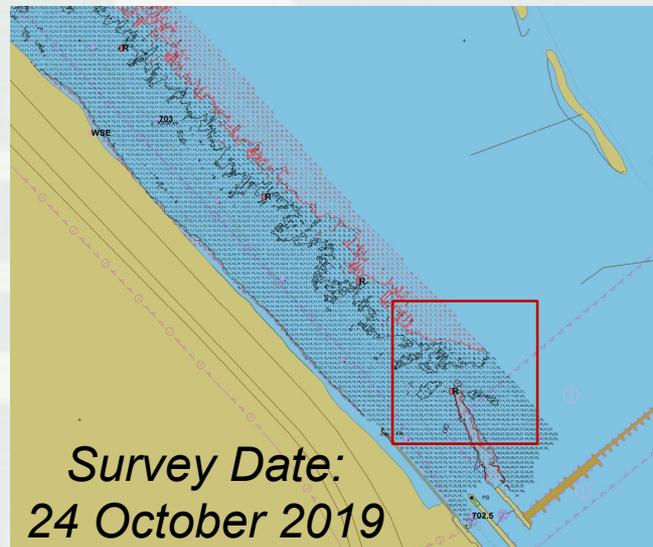
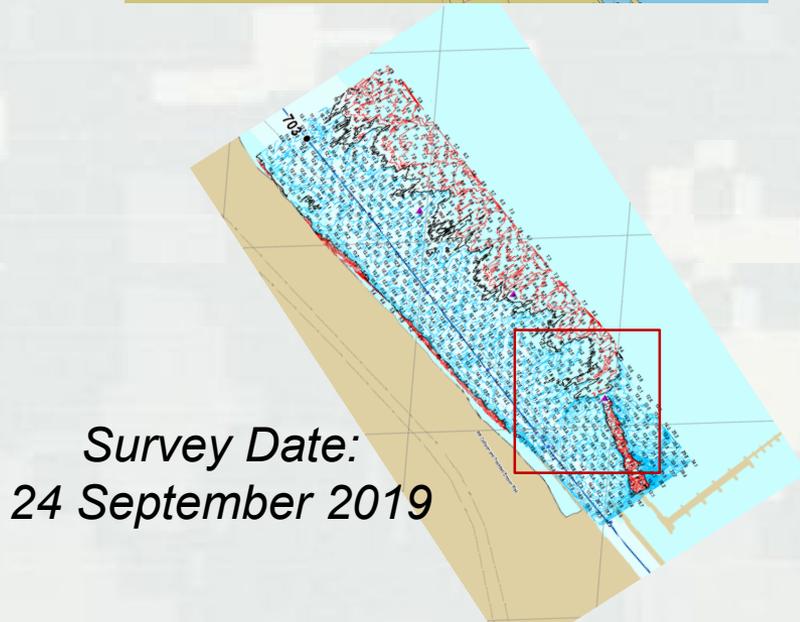
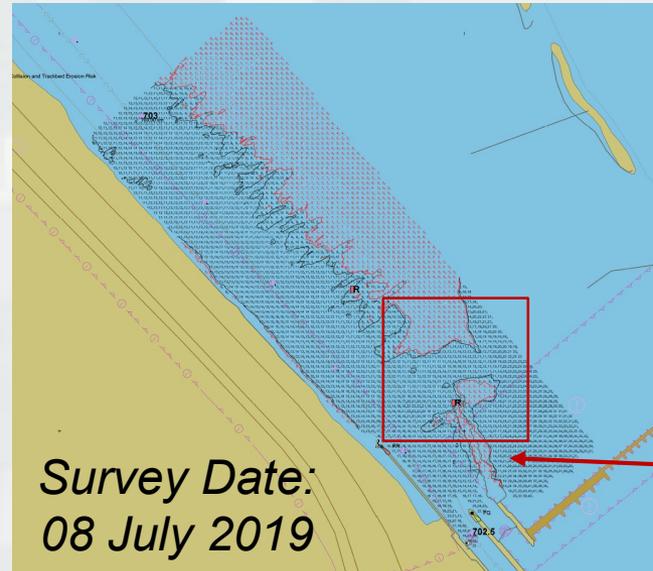
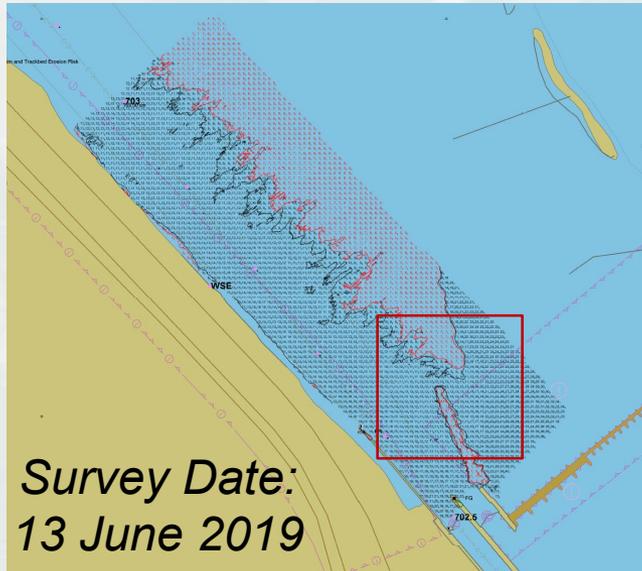
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Mississippi River at Lock & Dam 7 Flow History (1959-2020)





# Bathymetric Changes





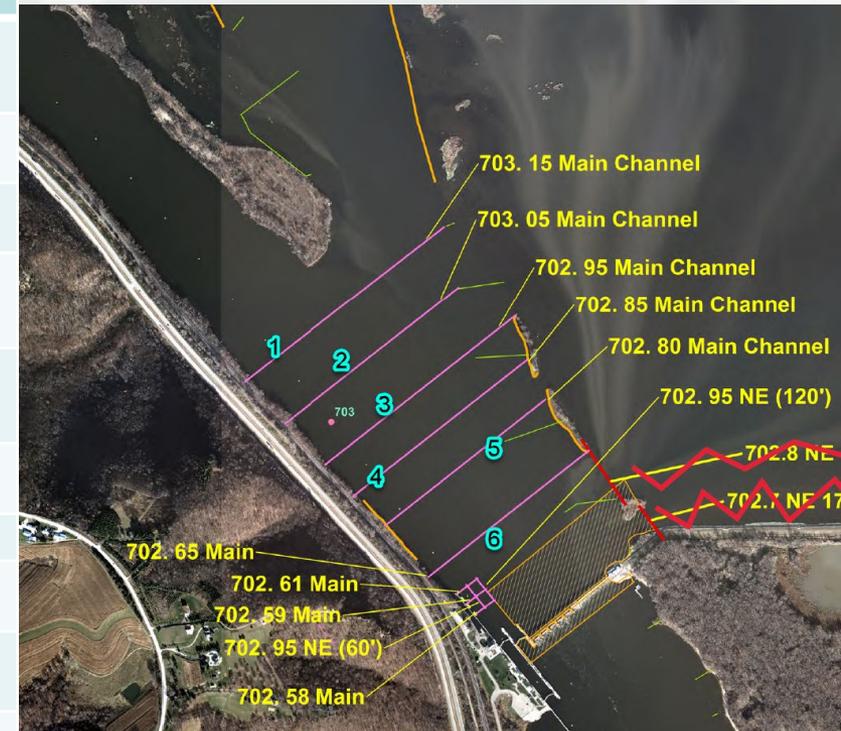
# 2019 Model Calibration Check



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## 2019 Measured Flows vs. Modeled Flow (2-Yr, 50% ACE) Comparison Measured: Q=86,000 cfs (July 2019) Modeled: Q=93,000 cfs

Measured XS:	1	2	3	4	5	6
Mesh:	"28Aug2019 _ConditionU pdate"	"28Aug2019 _ConditionU pdate"	"28Aug2019 _ConditionU pdate"	"28Aug2019 _ConditionU pdate"	"28Aug2019 _ConditionU pdate"	"28Aug2019 _ConditionU pdate"
Model Flow Condition:	Q2_93kcfs	Q2_93kcfs	Q2_93kcfs	Q2_93kcfs	Q2_93kcfs	Q2_93kcfs
Location (RM):	703.15	703.05	702.95	702.85	702.8	702.65
Model Velocity (ft/s)	2.12	2.53	2.55	2.61	2.71	2.80
Measured Velocity (ft/s)	2.22	2.99	2.81	2.77	3.00	2.74
%-Difference	-4.4%	<b>-15.5%</b>	-9.3%	-5.8%	-9.6%	-4.1%
Model Flow (cfs)	59,904	55,821	62,527	62,483	62,550	62,645
Measured Flow (cfs)	62,204	40,720	62,920	61,240	61,980	62,950
%-Difference	-3.7%	<b>37.1%</b>	-0.6%	2.0%	-0.9%	-0.5%

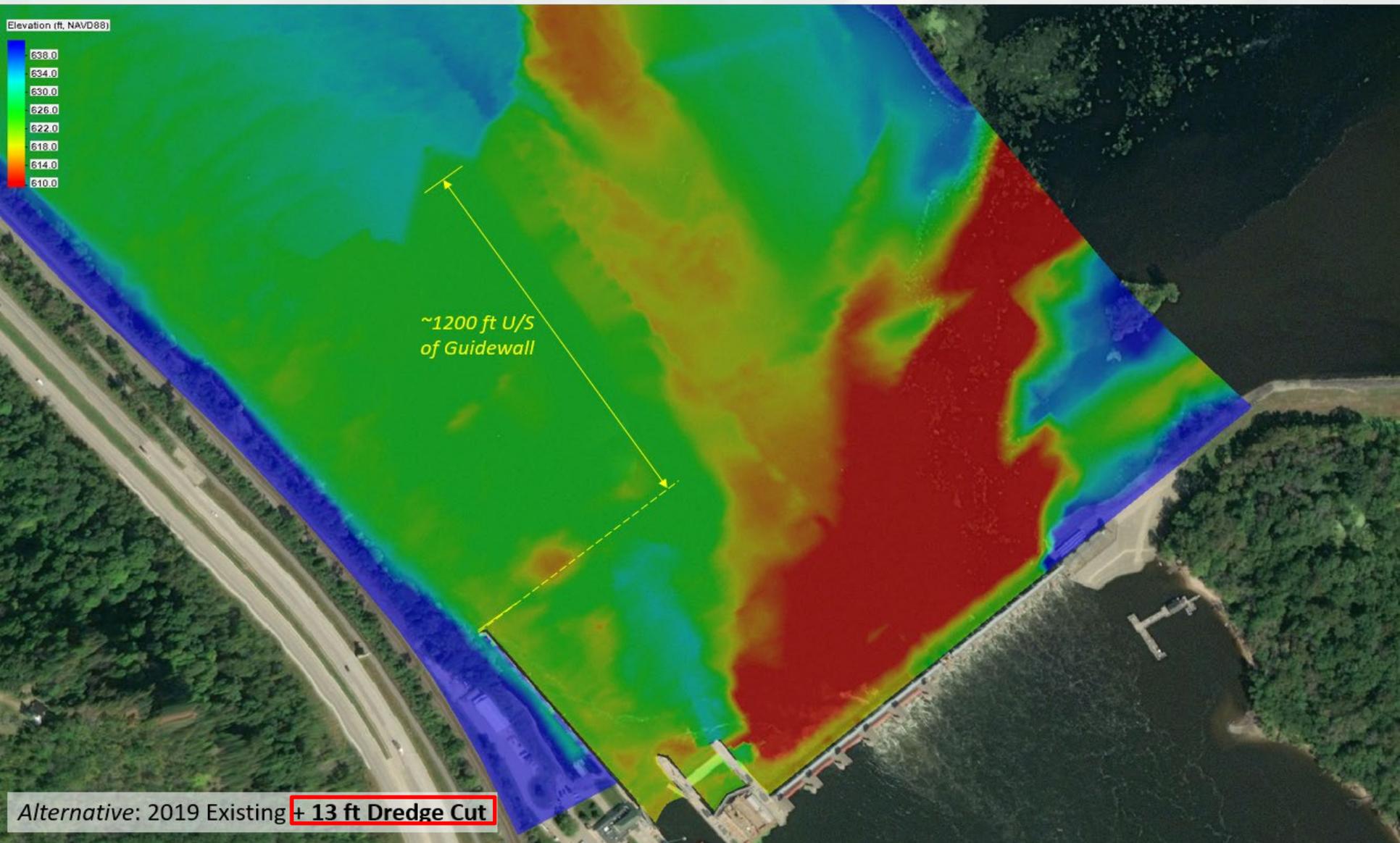




# 2019 Alternative Investigation



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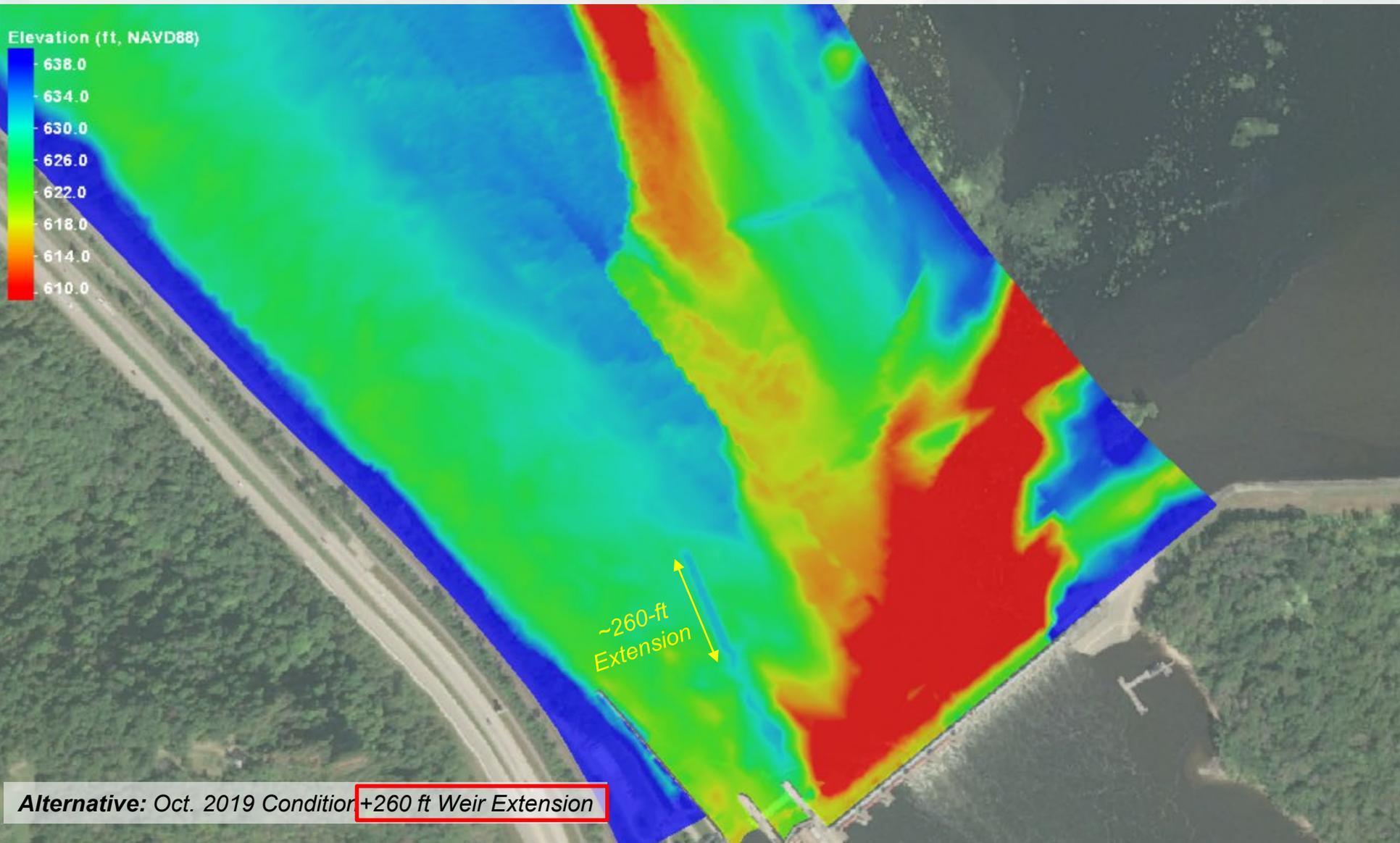
Alternative: 2019 Existing **+ 13 ft Dredge Cut**



# 2019 Alternative Investigation



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Alternative: Oct. 2019 Condition +260 ft Weir Extension

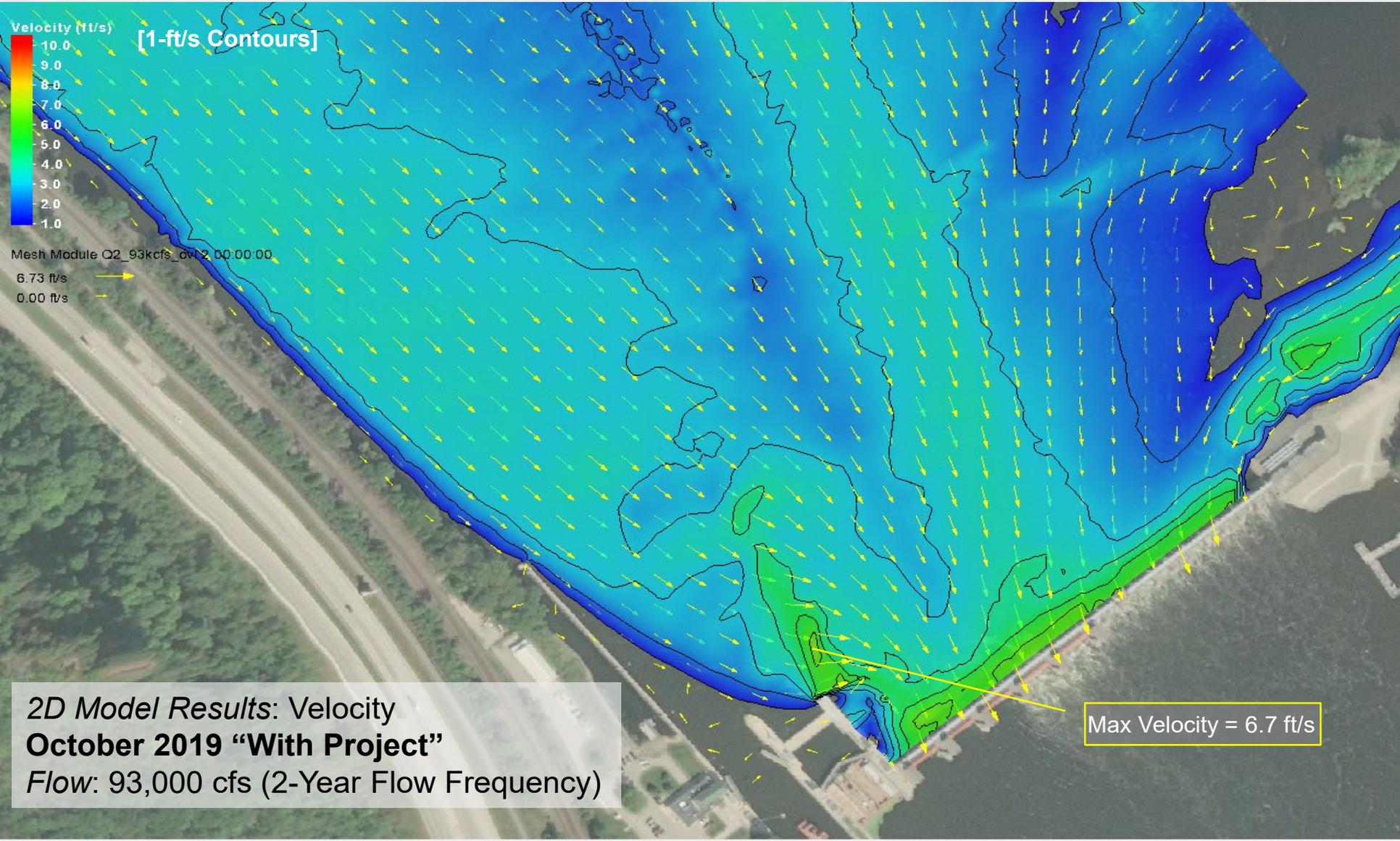


[1-ft Contours]

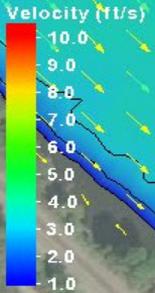
# 2019 Alternative Investigation



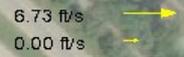
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[1-ft/s Contours]



Mesh Module Q2\_93kcfs\_ov2\_00:00:00



**2D Model Results: Velocity**  
**October 2019 "With Project"**  
Flow: 93,000 cfs (2-Year Flow Frequency)

Max Velocity = 6.7 ft/s

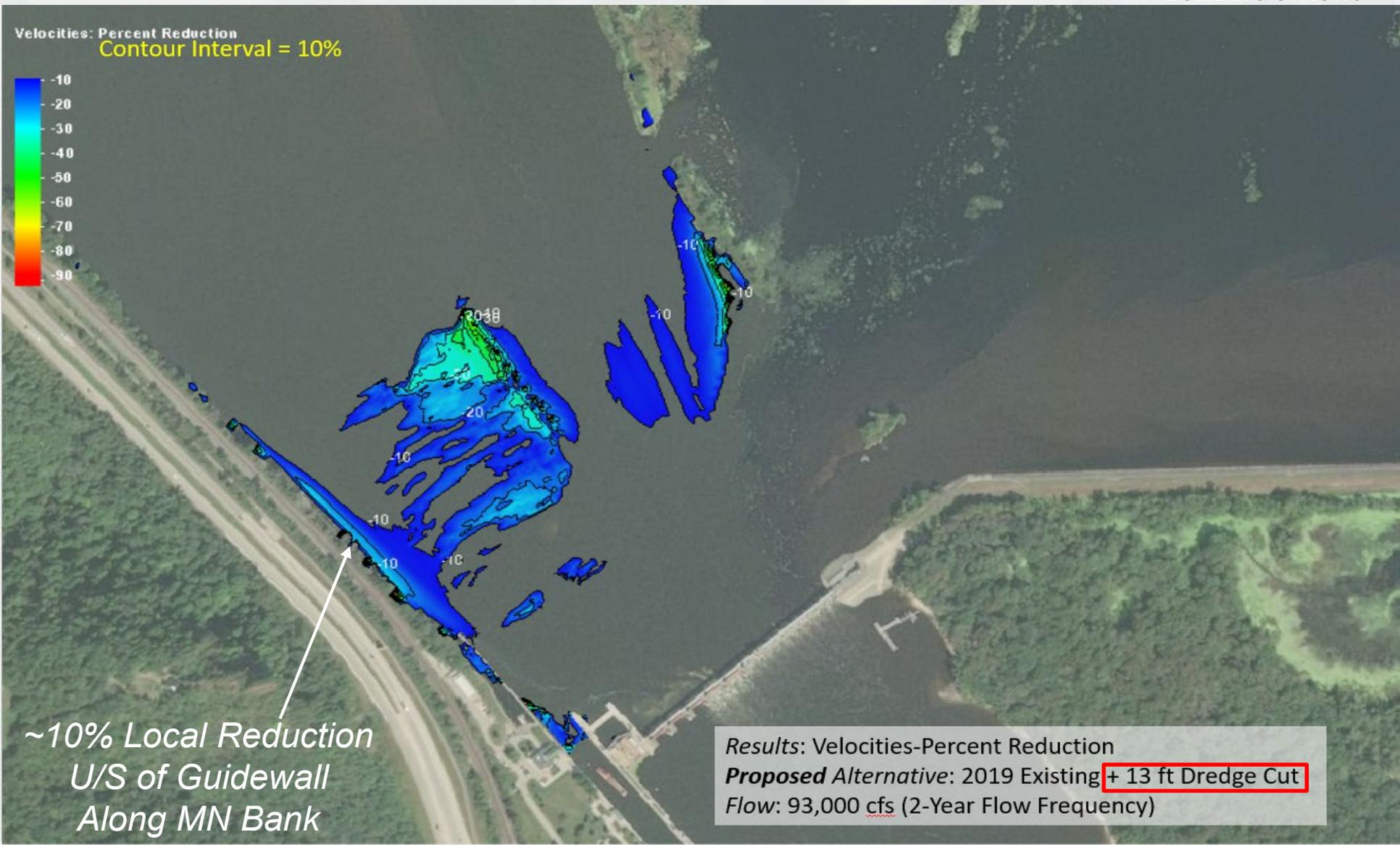


# 2019 Alternative Investigation



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Velocities: Percent Reduction  
Contour Interval = 10%



~10% Local Reduction  
U/S of Guidewall  
Along MN Bank

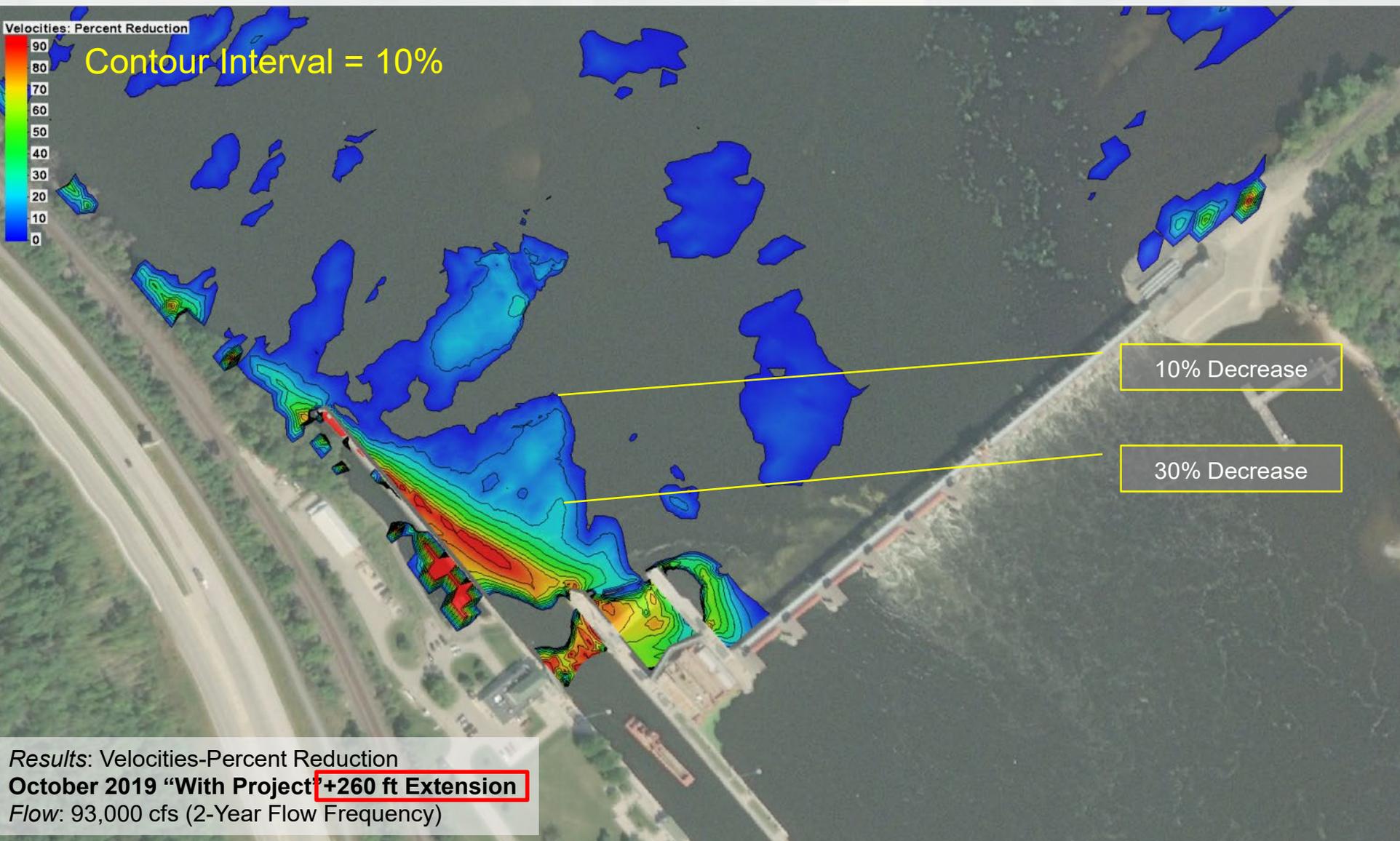
Results: Velocities-Percent Reduction  
**Proposed Alternative: 2019 Existing + 13 ft Dredge Cut**  
Flow: 93,000 cfs (2-Year Flow Frequency)



# 2019 Alternative Investigation



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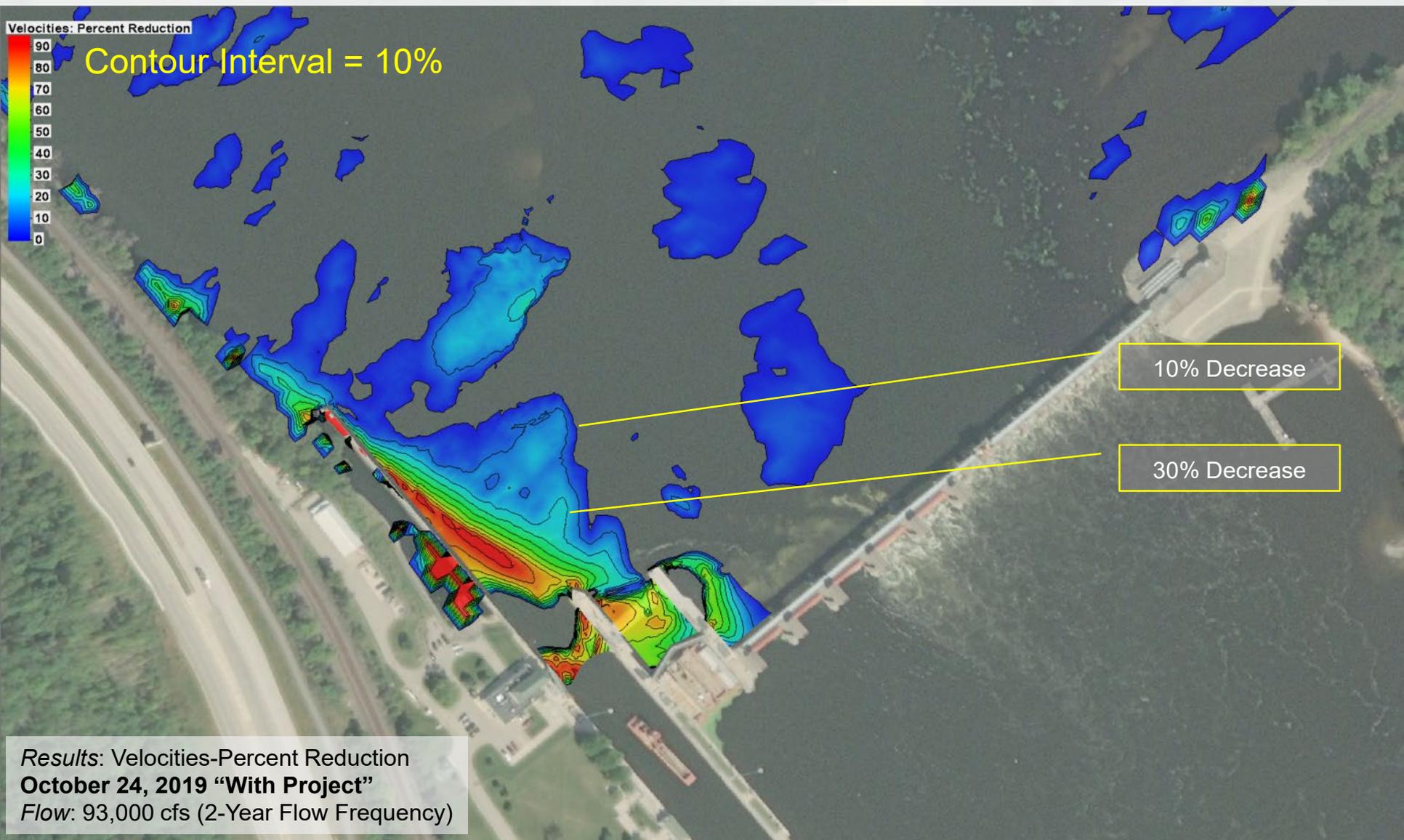




# 2019 Alternative Investigation



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Velocities: Percent Reduction

Contour Interval = 10%

10% Decrease

30% Decrease

Results: Velocities-Percent Reduction  
October 24, 2019 "With Project"  
Flow: 93,000 cfs (2-Year Flow Frequency)



# Summary



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- ▶ Outdraft Issue studied and river conditions modeled
- ▶ Evaluated Non-Structural & Structural alternatives
- ▶ Constructed Rock Weir Fall 2018
- ▶ 2019 Nav Season: High Flows, Difficult Conditions
- ▶ **Discussion**



# Path Forward?



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- ▶ Fill in current alignment to as-built elevation
  - Rock has settled/displaced
- ▶ Raise weir to 5-ft depth (*currently @ 7-ft depth*)
  - Further reduction in velocities (5-10%)
- ▶ Dredging
  - 13-ft showed some positive impact
- ▶ Investigate new structural solutions
  - Time +++
  - Cost +++