Combined 1D River and 2D Floodplain/Levee Areas

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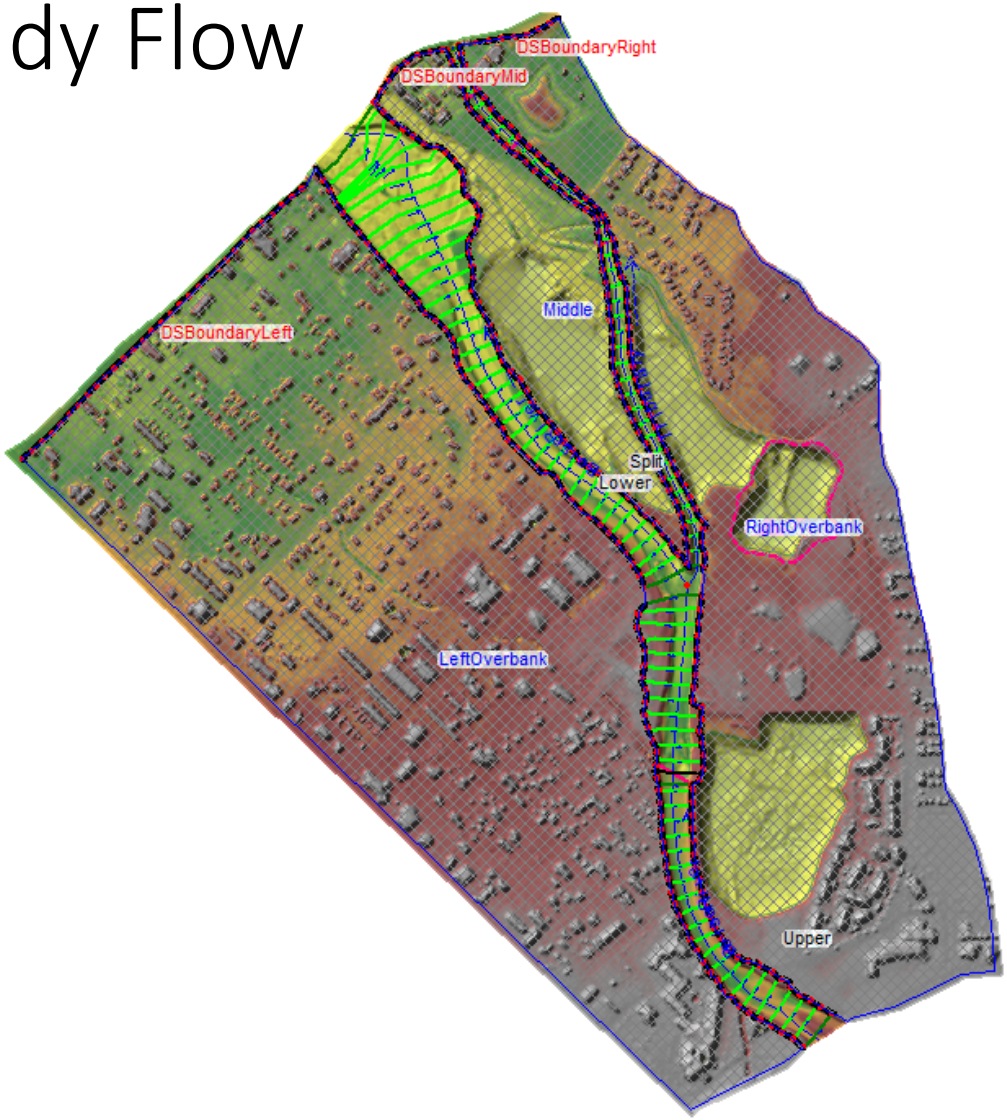
IWR

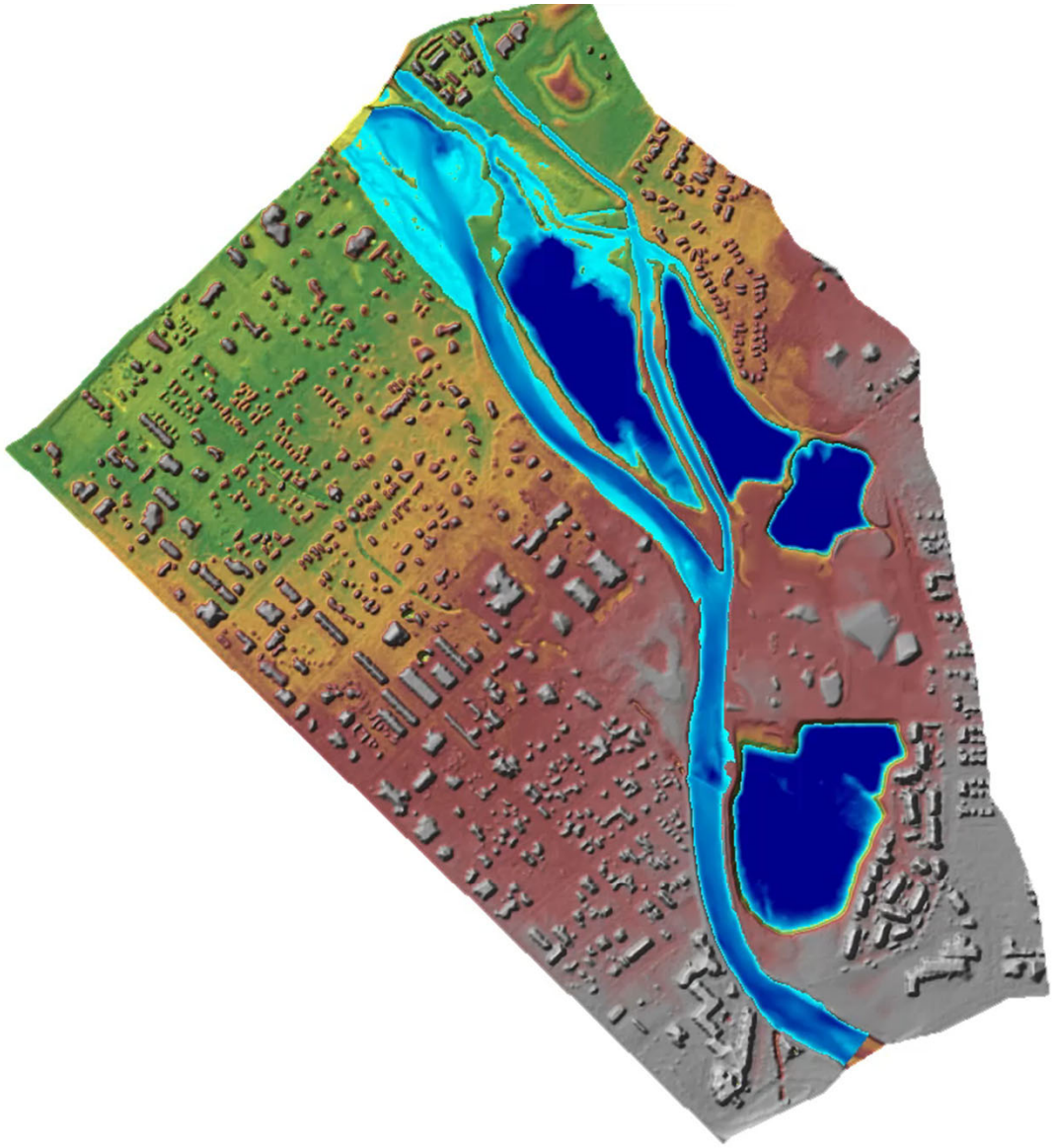
HEC

Combined 1D / 2D Modeling

- Use both 1D and 2D hydraulics in the same domain
- Leverage advantages of 1D or 2D where needed
- Common applications:
  - 2D in overbanks
  - 2D in protected areas
  - Channel transitions from 1D to 2D

1D/ 2D Unsteady Flow

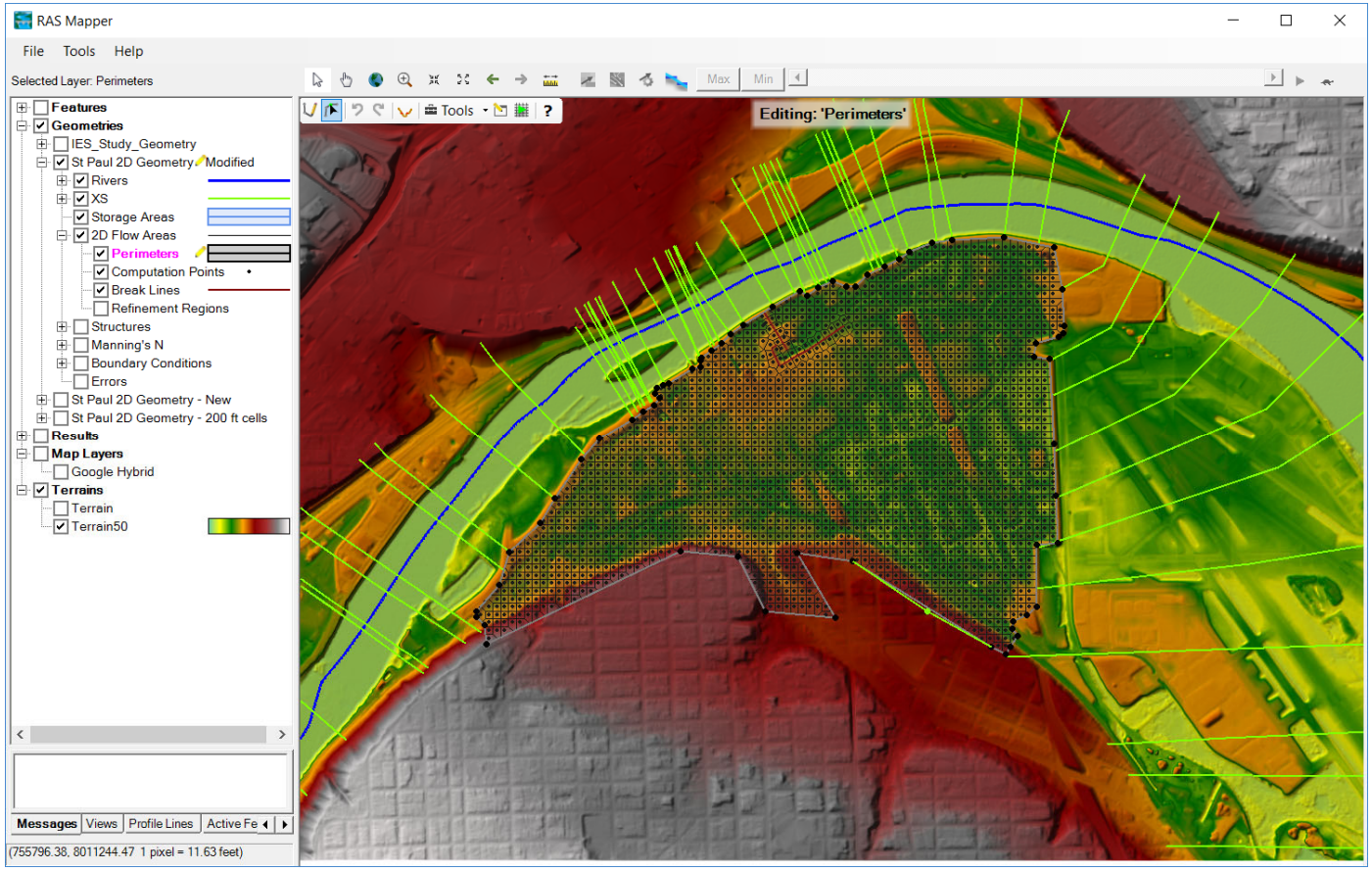



15
0
4
1000 ft

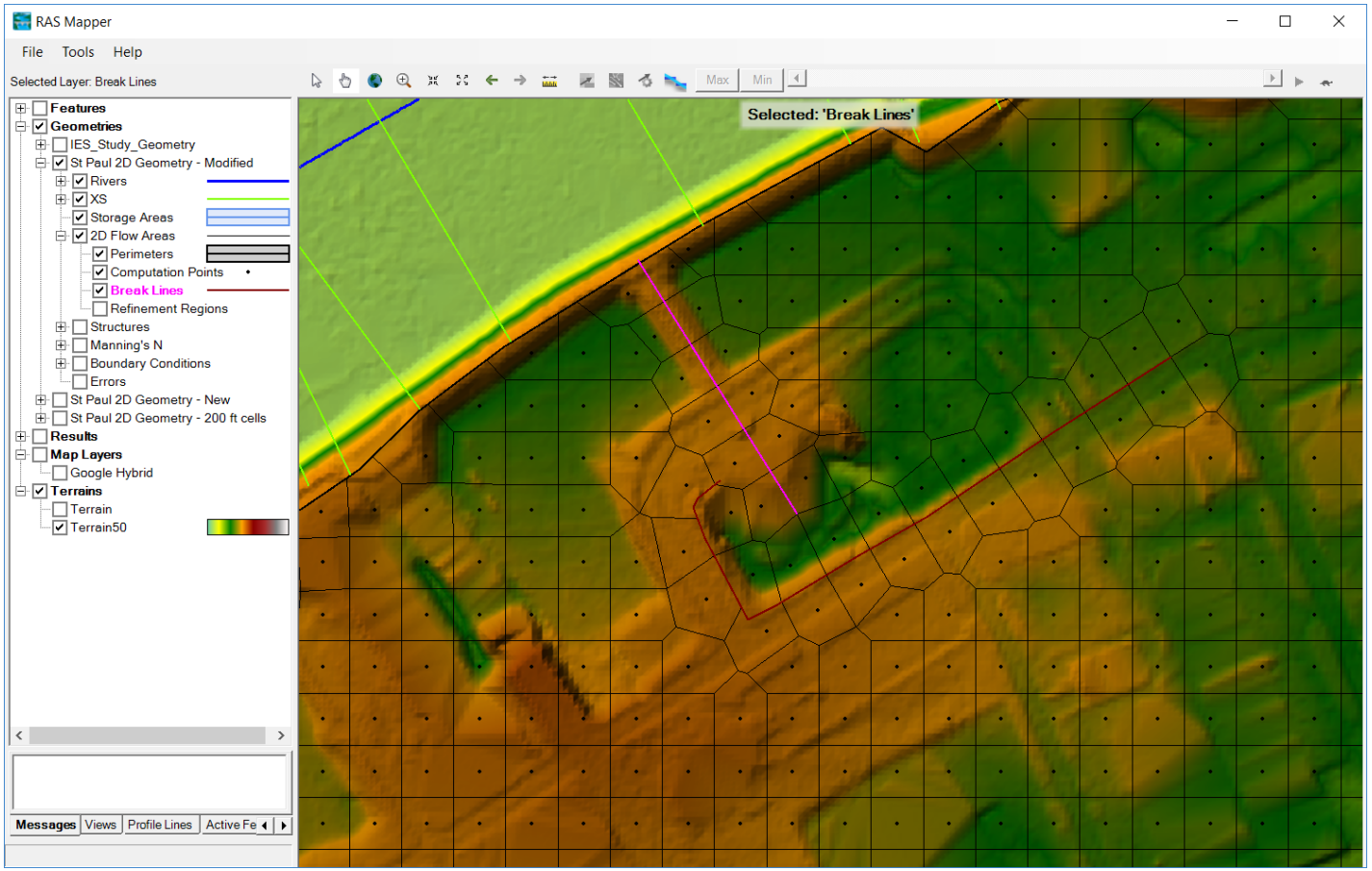
Overview

- Connecting 2D overbanks to 1D channels with lateral structures
- Selecting appropriate parameters
- Selecting appropriate computation options

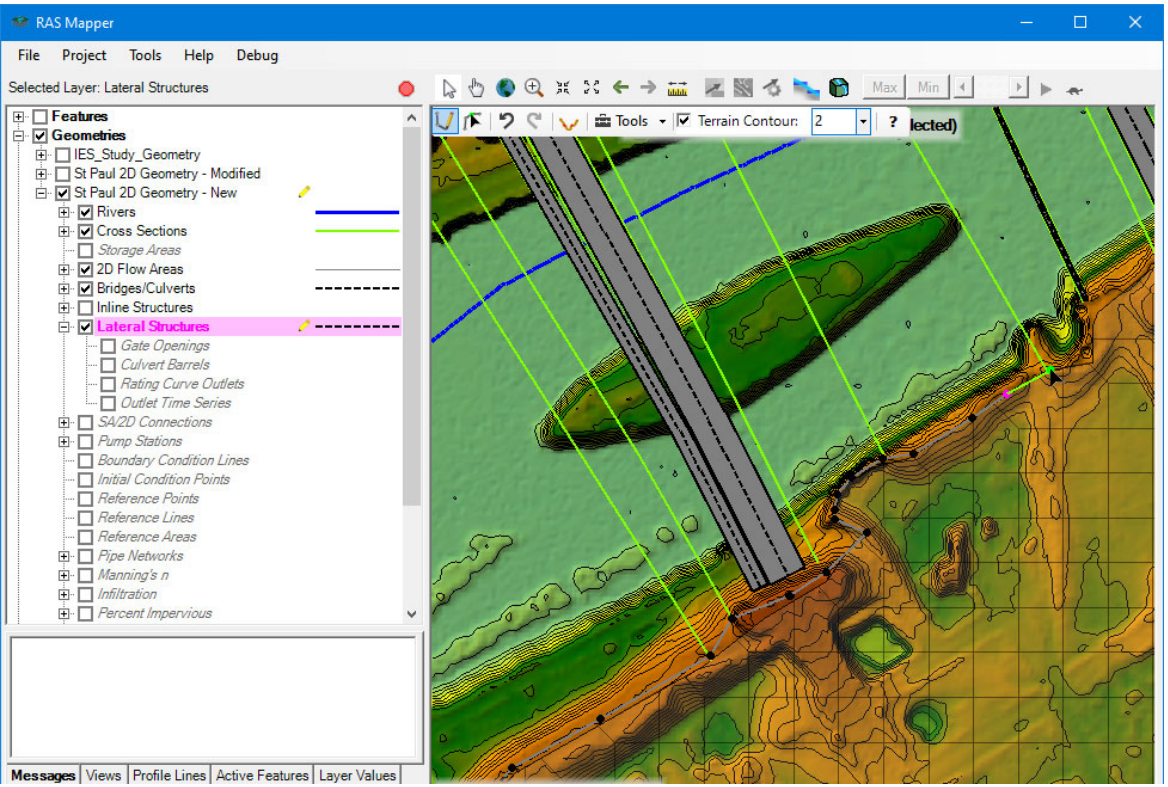
Modeling a Leveed Area in 2D

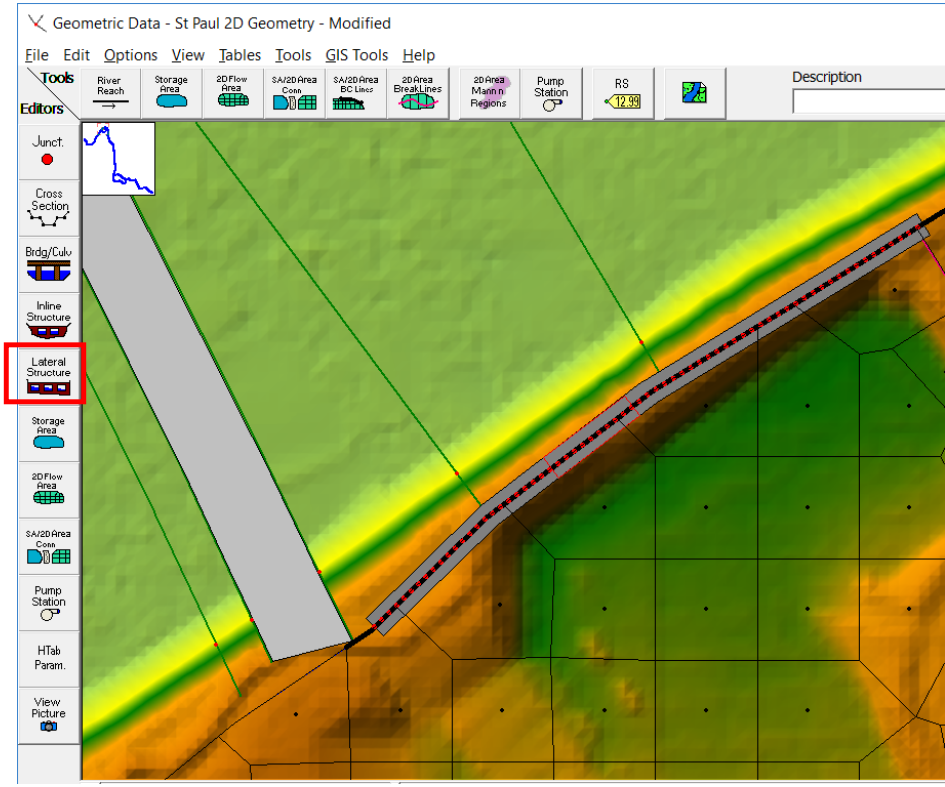


Modify The Mesh as Needed

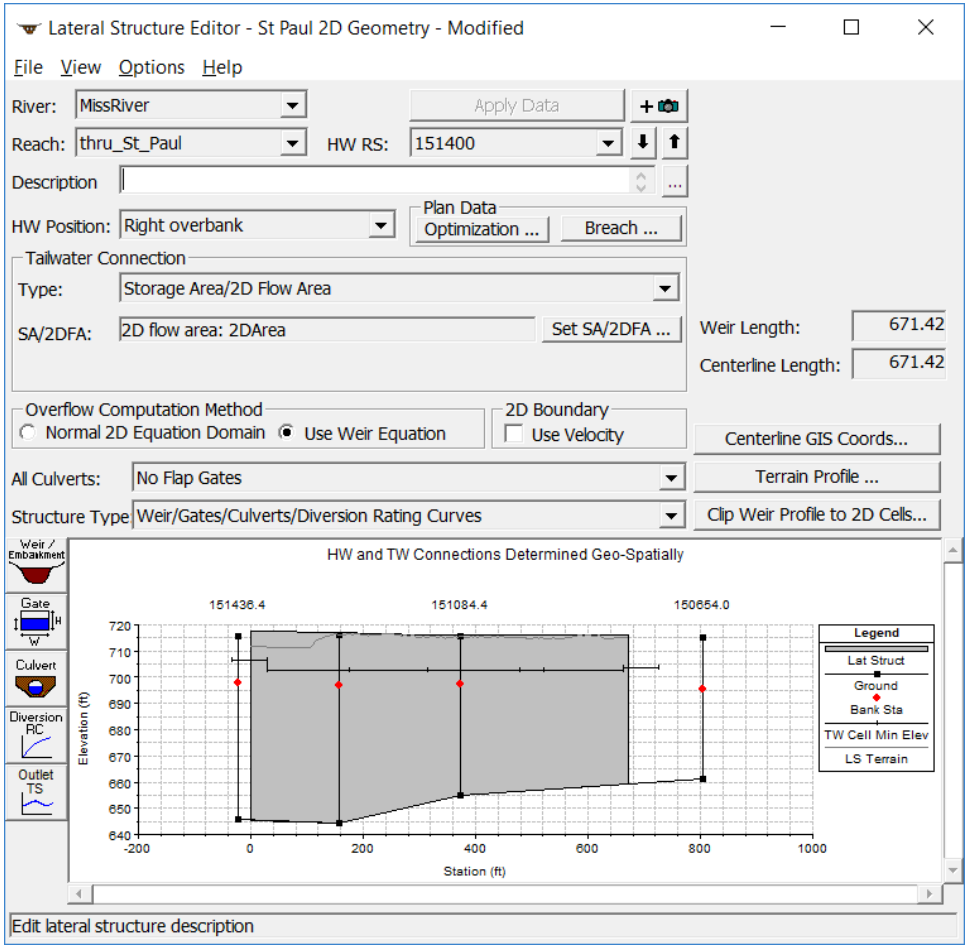


Connecting a 2D Flow Area to a 1D River Reach with Lateral Structures

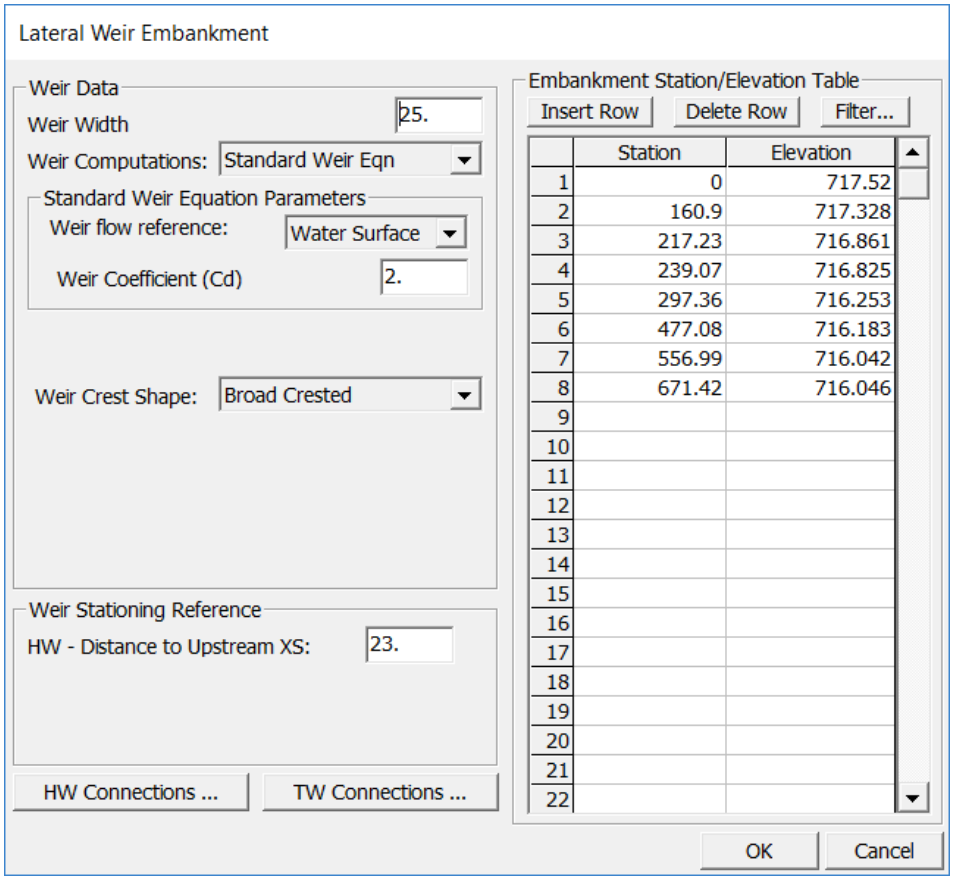


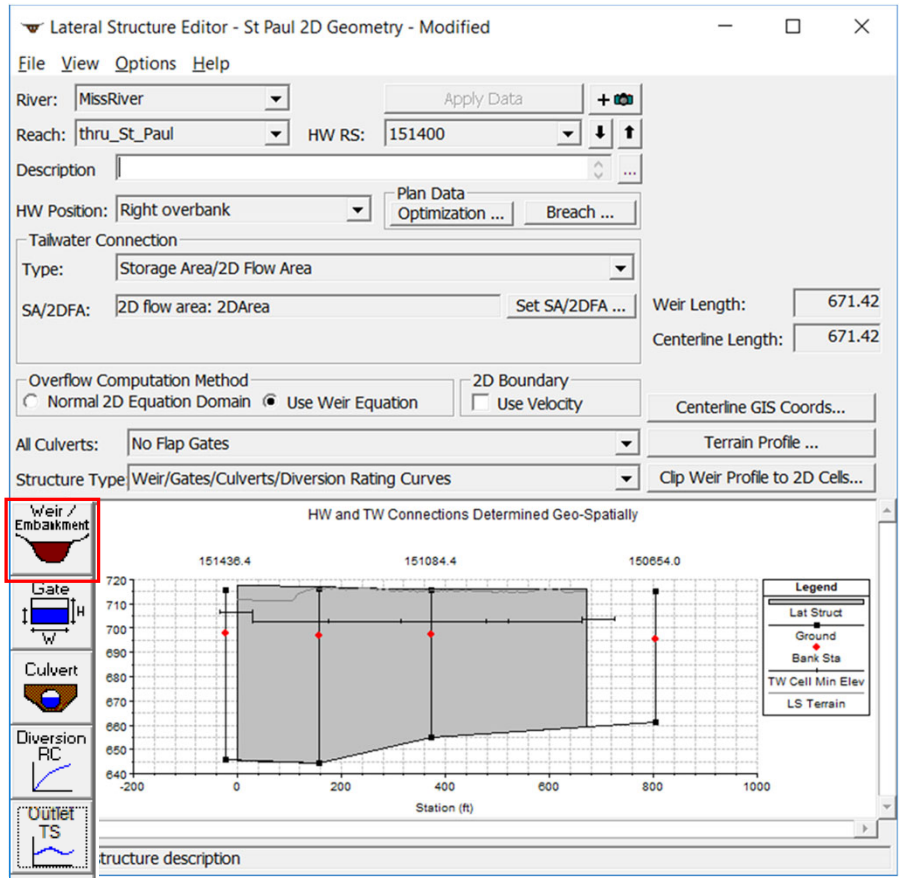


Lateral Structure Editor

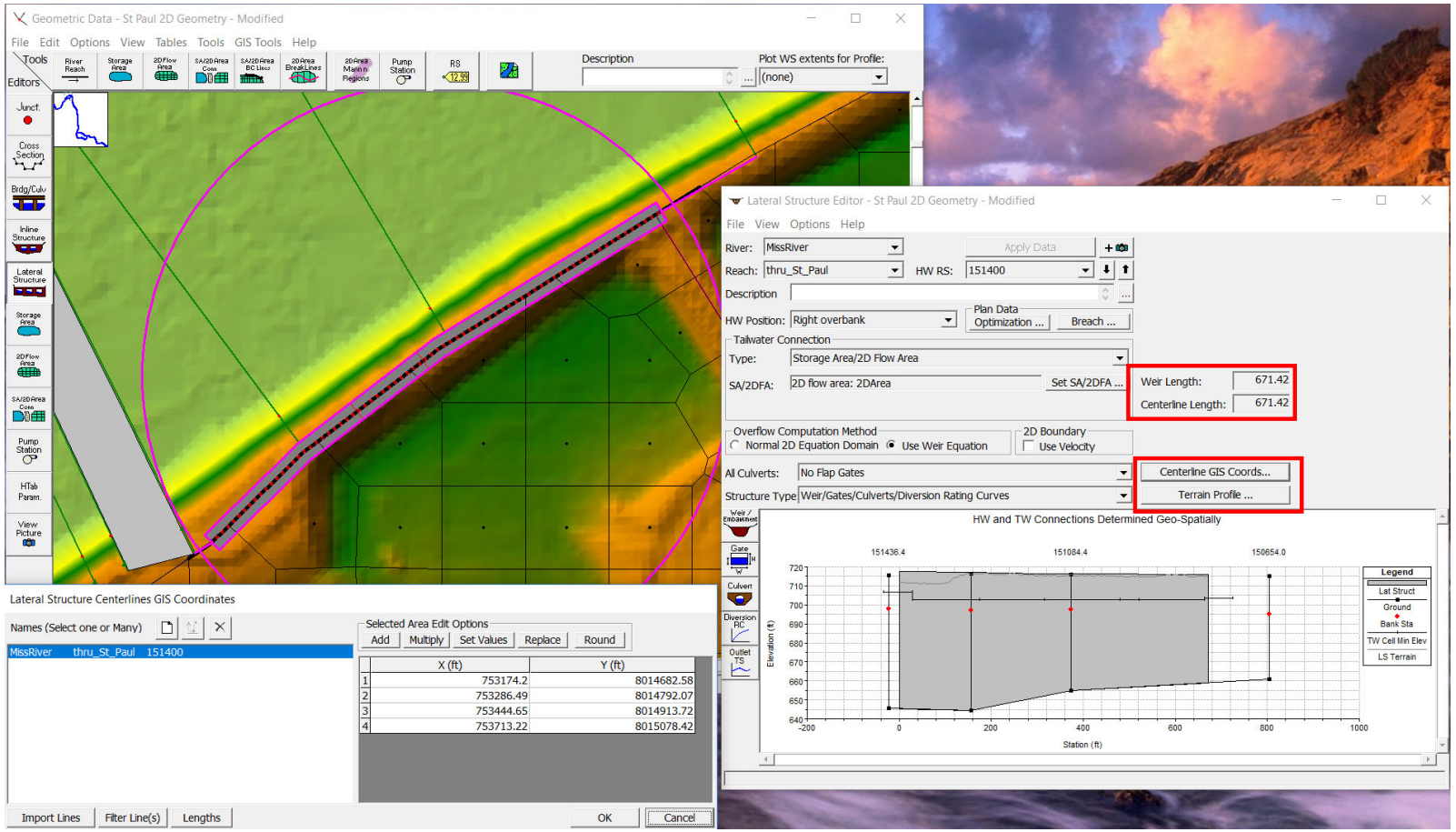


Weir/Embankment

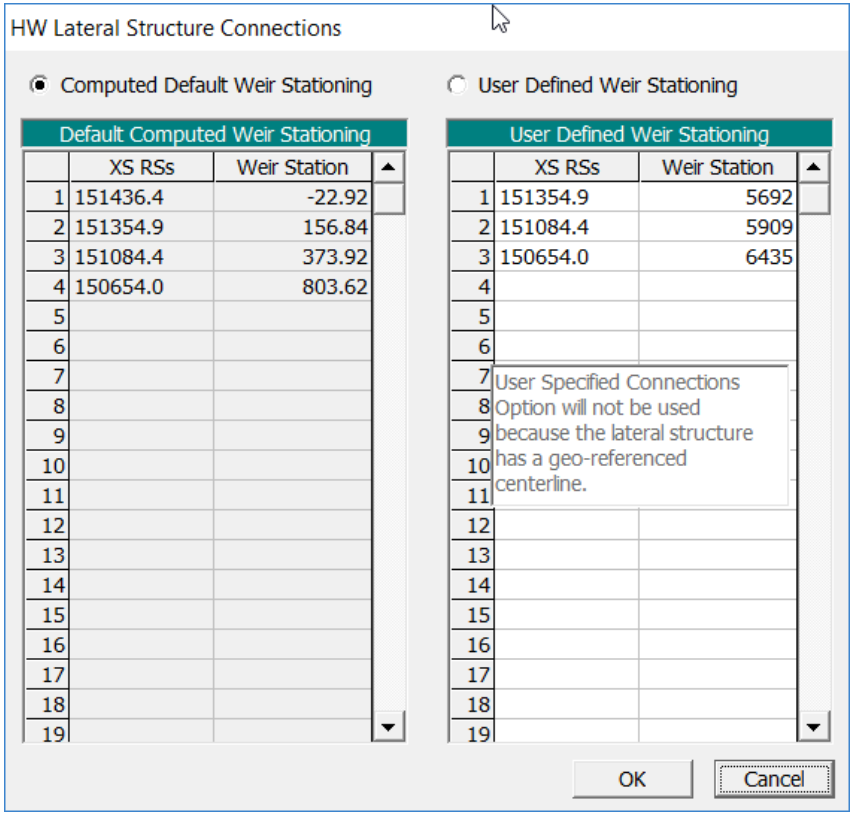


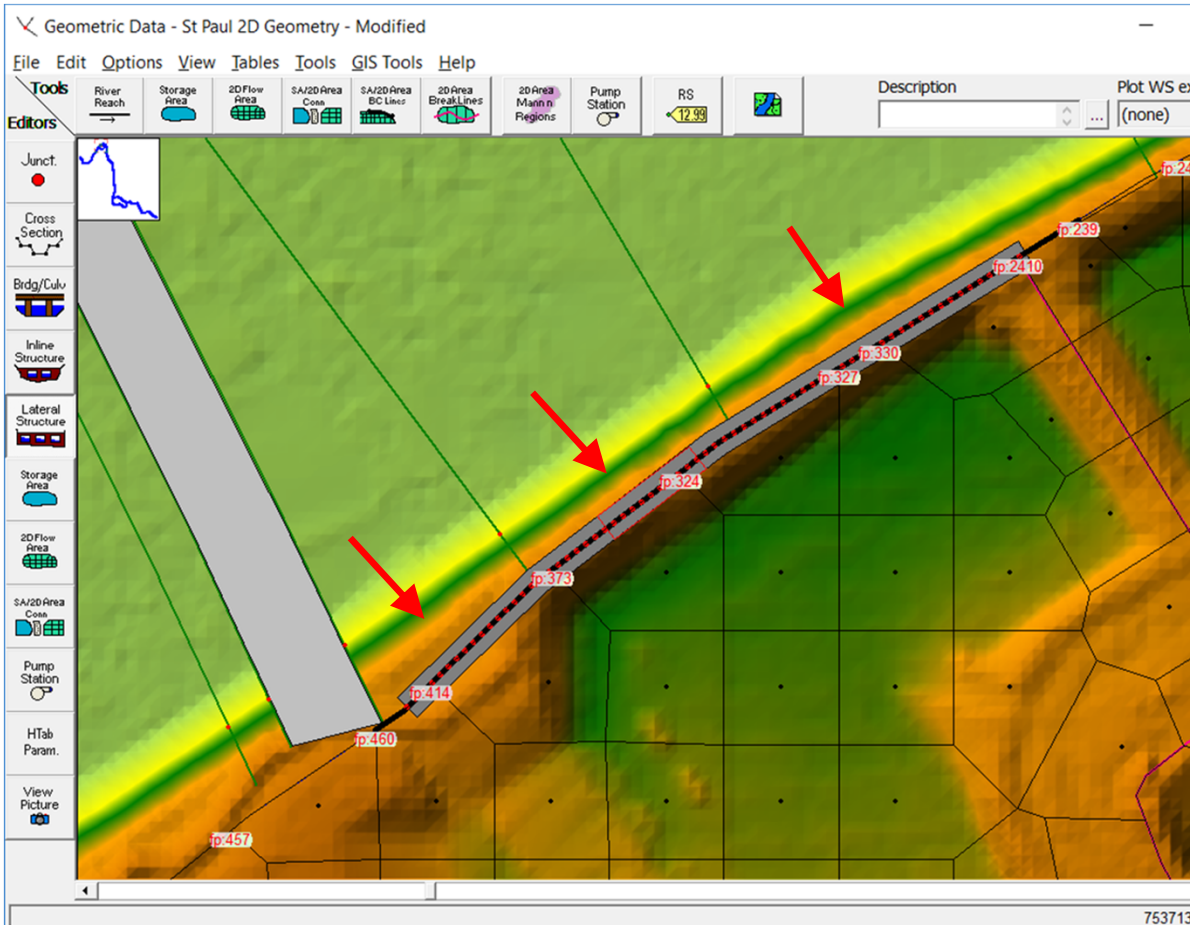


Weir Length vs GIS Length



Lateral Weir Headwater Connections (HW)





Lateral Weir Tailwater Connections (TW)

TW Lateral Structure Connections

Computed Default Weir Stationing User Defined Weir Stationing

Default Computed Weir Stationing

	2D Face Points	Weir Station
1	456	-34.3083
2	412	28.59606
3	368	174.9681
4	319	314.8326
5	322	479.7218
6	325	521.3957
7	2408	663.5559
8	239	725.6677
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

User Defined Weir Stationing

	2D Face Points	Weir Station
1	454	5470.98
2	411	5537.3
3	368	5703.08
4	319	5861.57
5	322	6048.15
6	325	6095.38
7		
8		
9		
10		
11		
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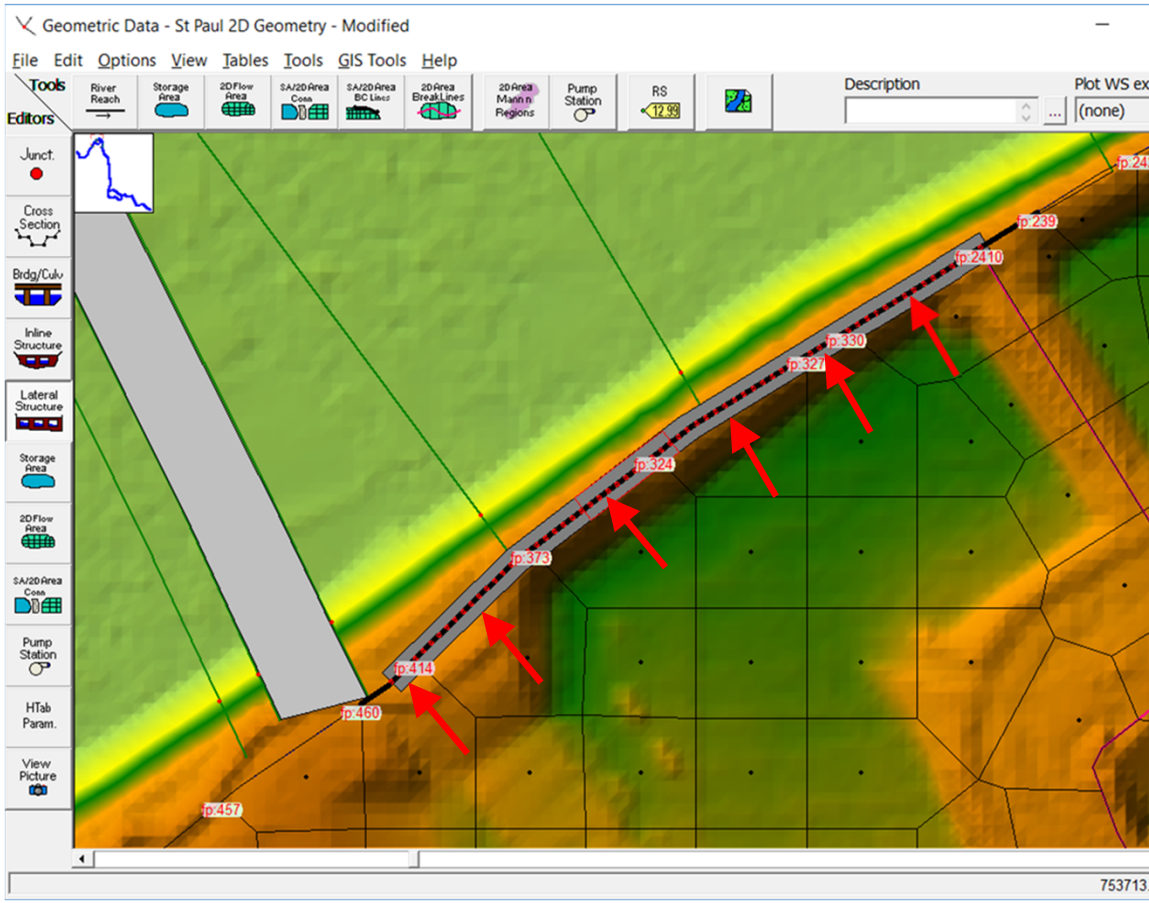
17		
18		
19		

User Specified Connections Option will not be used because the lateral structure has a geo-referenced centerline.

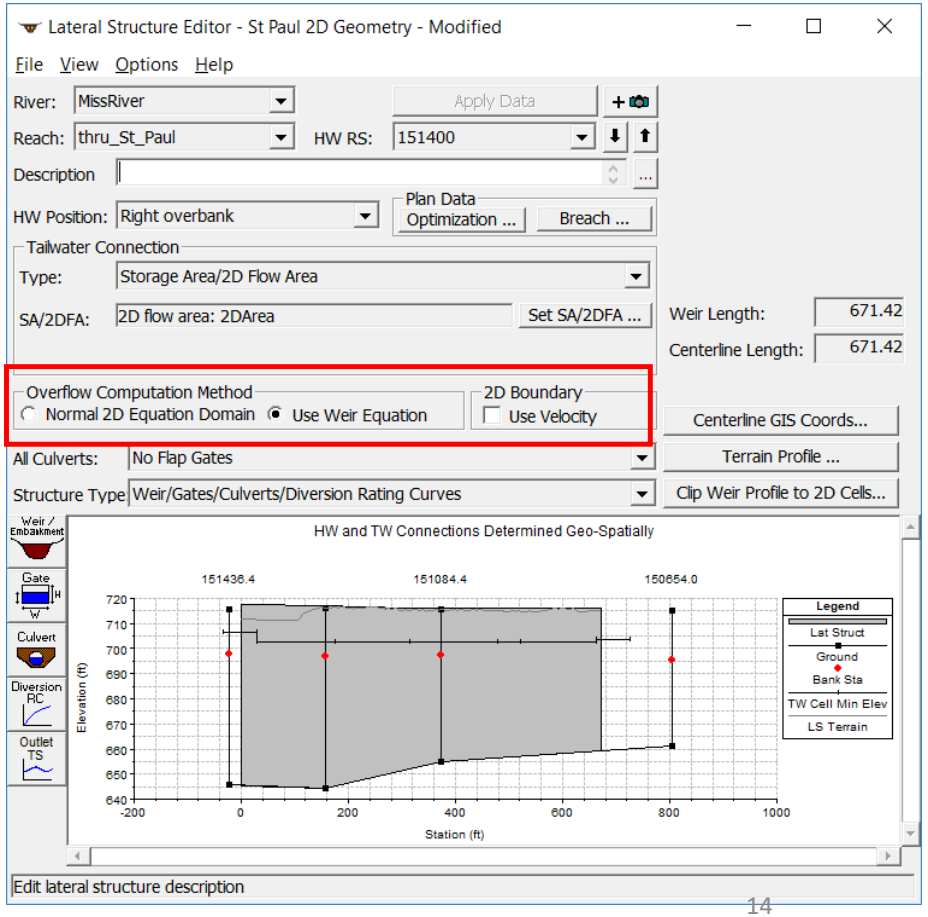
OK Cancel



Overflow Computations

- Weir Equation
  - $Q = CLH^{3/2}$
  - Good for free fall conditions
  - Not great for submerged weir

- 2D Equation
  - Simply modifies cell face properties
  - Good for highly submerged conditions



Weir Coefficients for Lateral Structures

What is being modeled with the Lateral Structure	Description	Range of Weir Coefficients
Levee/Roadway – 3ft or higher above natural ground	Broad crested weir shape, flow over Levee/road acts like weir flow	**1.5** to **2.6** (2.0 default) SI Units: 0.83 to 1.43
Levee/Roadway – 1 to 3 ft elevated above ground	Broad Crested weir shape, flow over levee/road acts like weir flow, but becomes submerged easily.	**1.0** to **2.0** SI Units: 0.55 to 1.1
Natural high ground barrier – 1 to 3 ft high	Does not really act like a weir, but water must flow over high ground to get into 2D area.	**0.5** to **1.0** SI Units: 0.28 to 0.55
Non elevated overbank terrain. Lat Structure not elevated above ground	Overland flow escaping the main river.	**0.2** to **0.5** SI Units: 0.11 to 0.28

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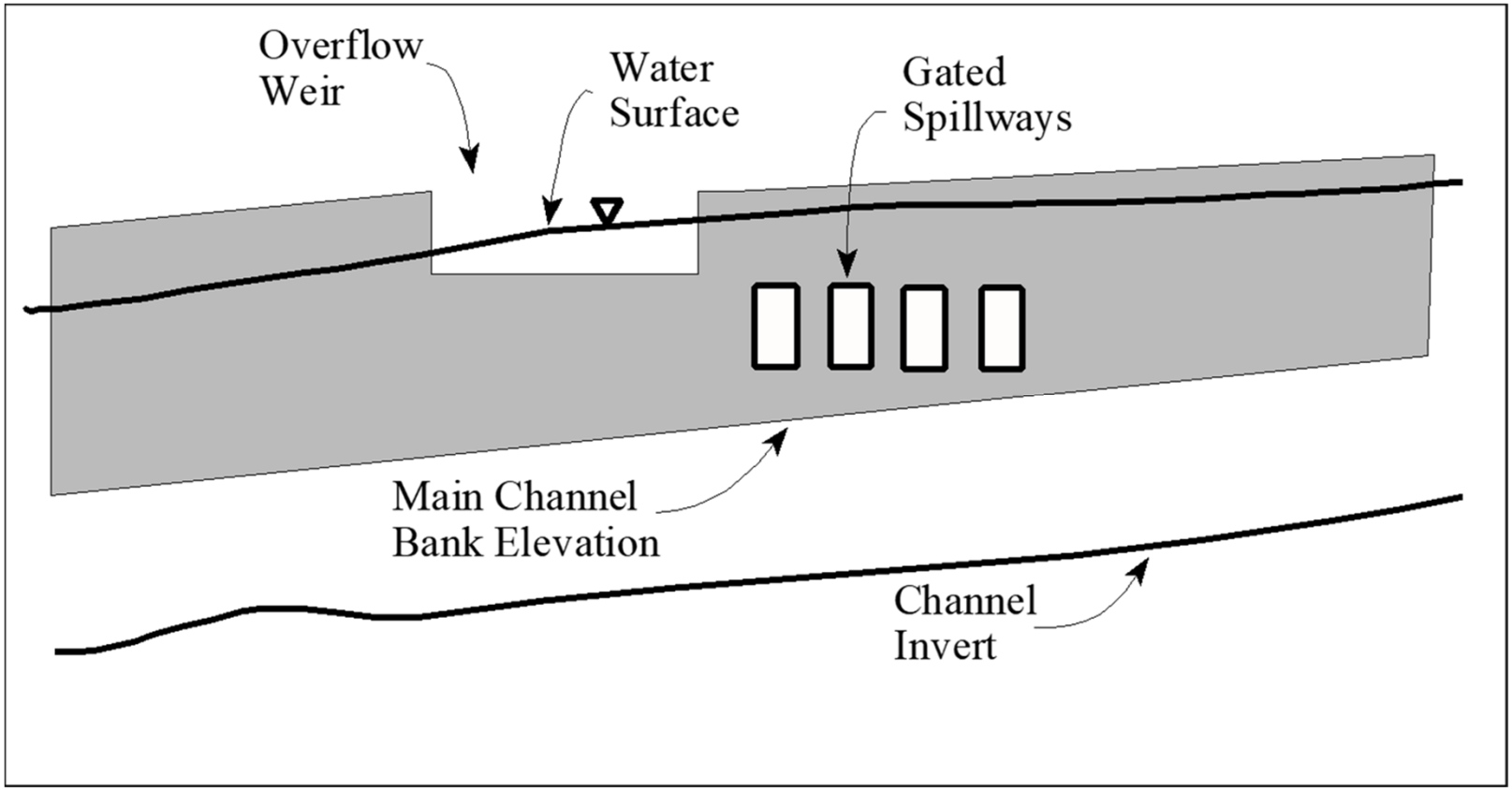
Weir Computation

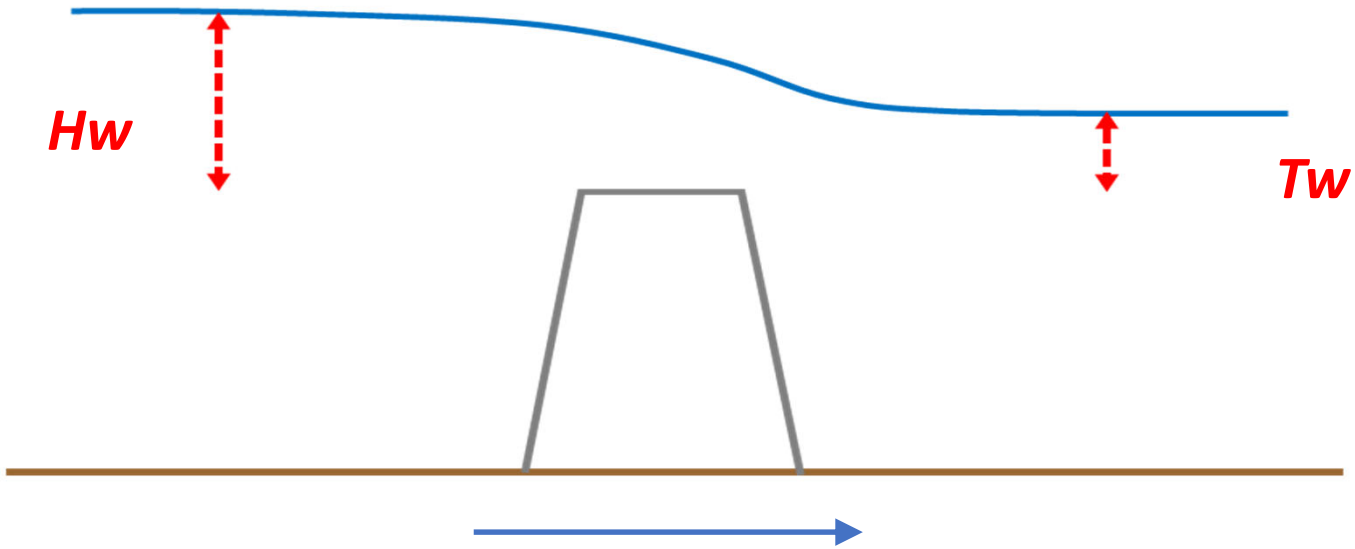


Computation Considerations

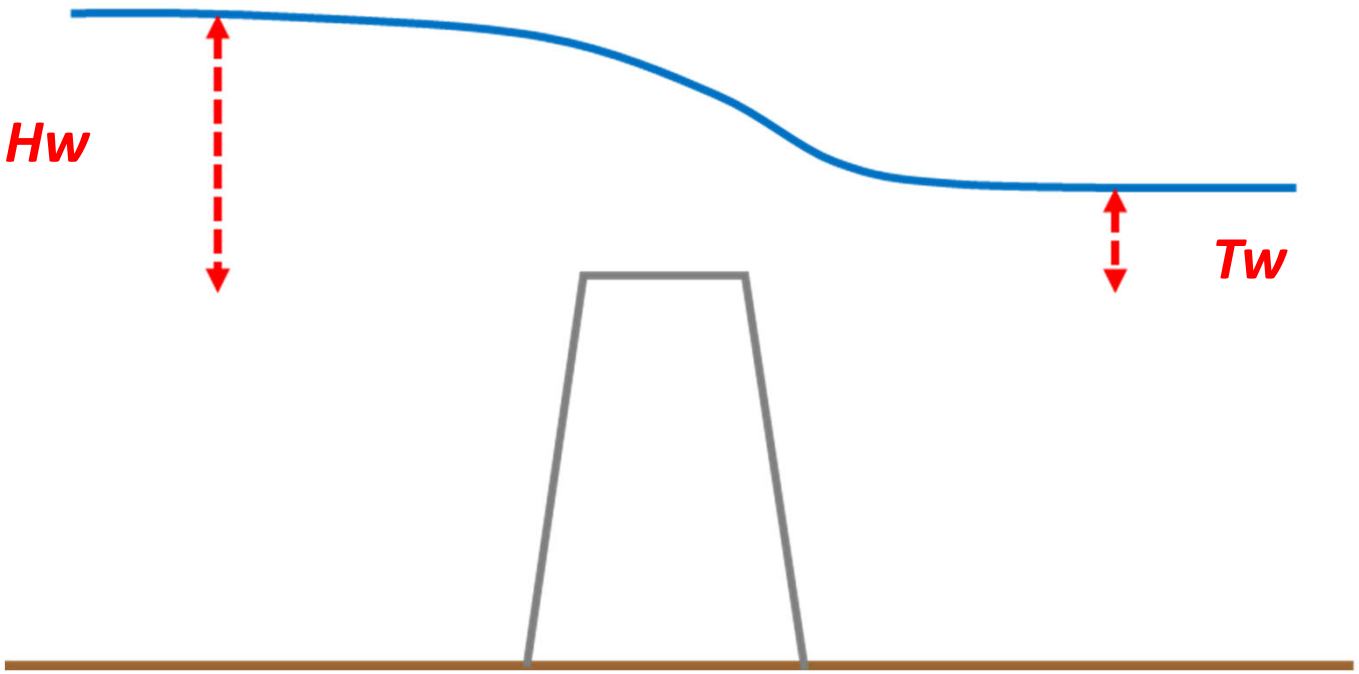
- Flow is assumed constant over the timestep
  - Long timesteps can transfer too much volume and oscillate
- Order of computations
  - 1D computes first then 2D
  - Weir flow is computed with current HW (1D) and previous TW (2D)
- Tailwater elevations
  - TW elevations of each connected cell is used
- Weir submergence

Weir Submergence

- Tailwater begins to impact weir flow
- A weir submergence curve is used to compute the reduction in flow
- This can be a dramatic reduction

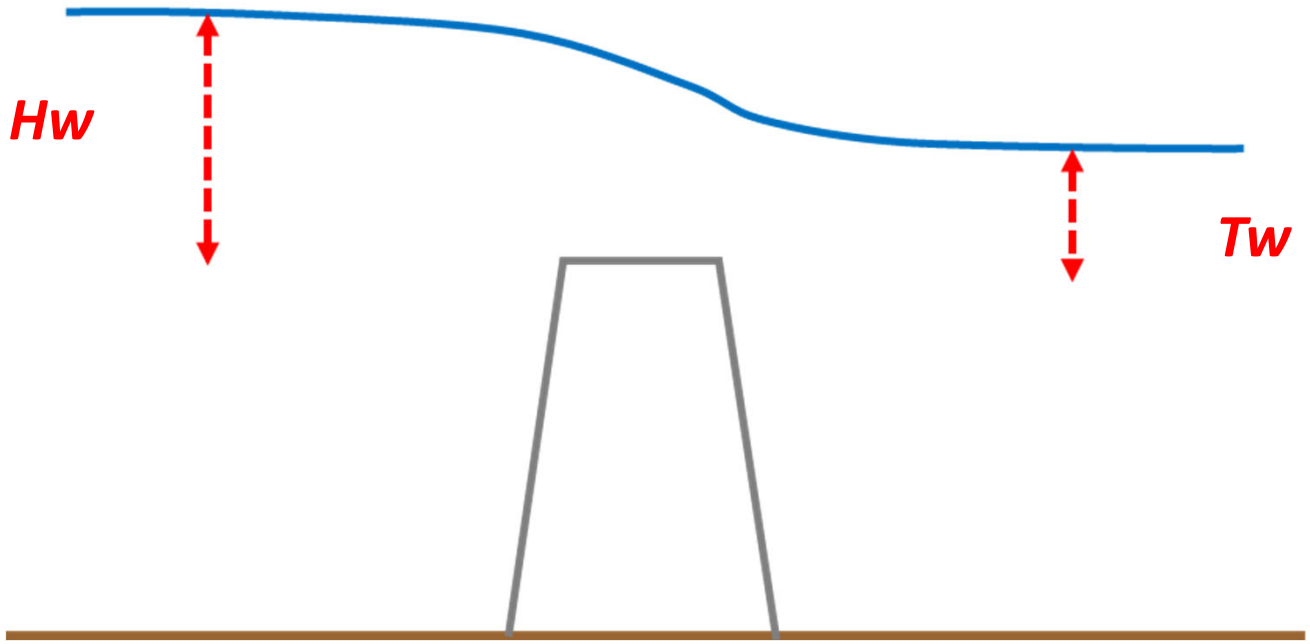


Will Weir Submerge?



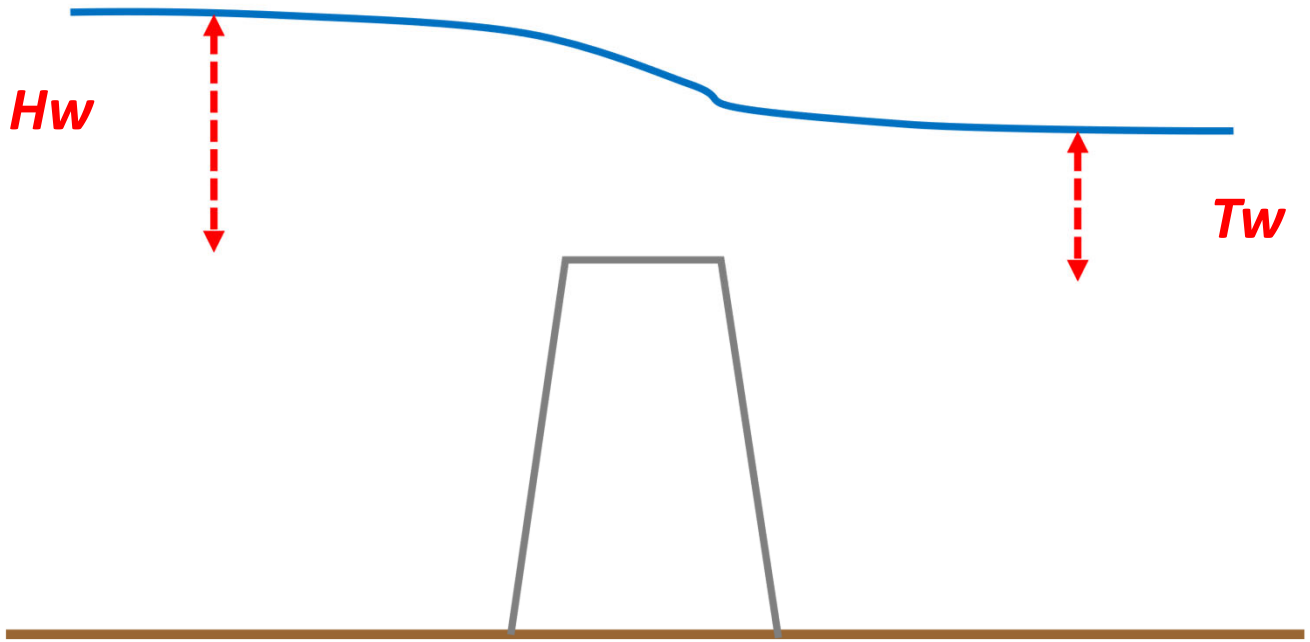
Tw / Hw = 0.25

Will Weir Submerge?



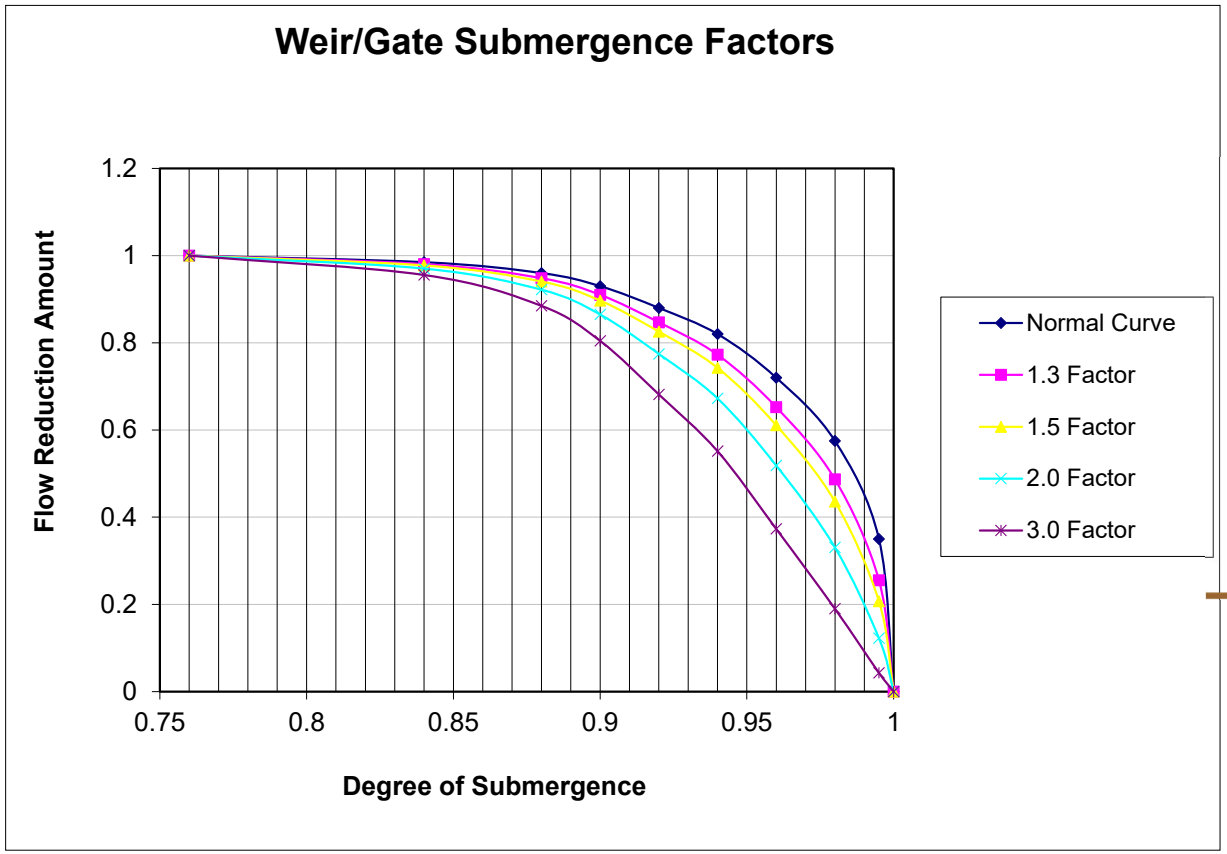
Tw / Hw = 0.5

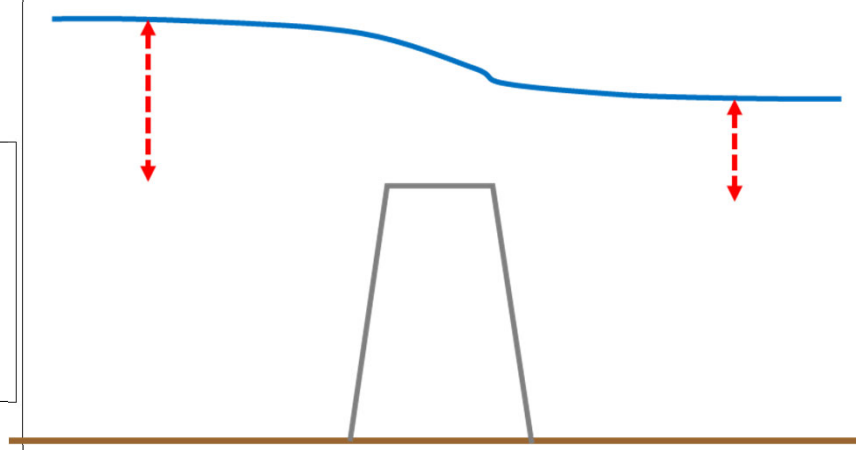
Will Weir Submerge?



Tw / Hw = 0.75

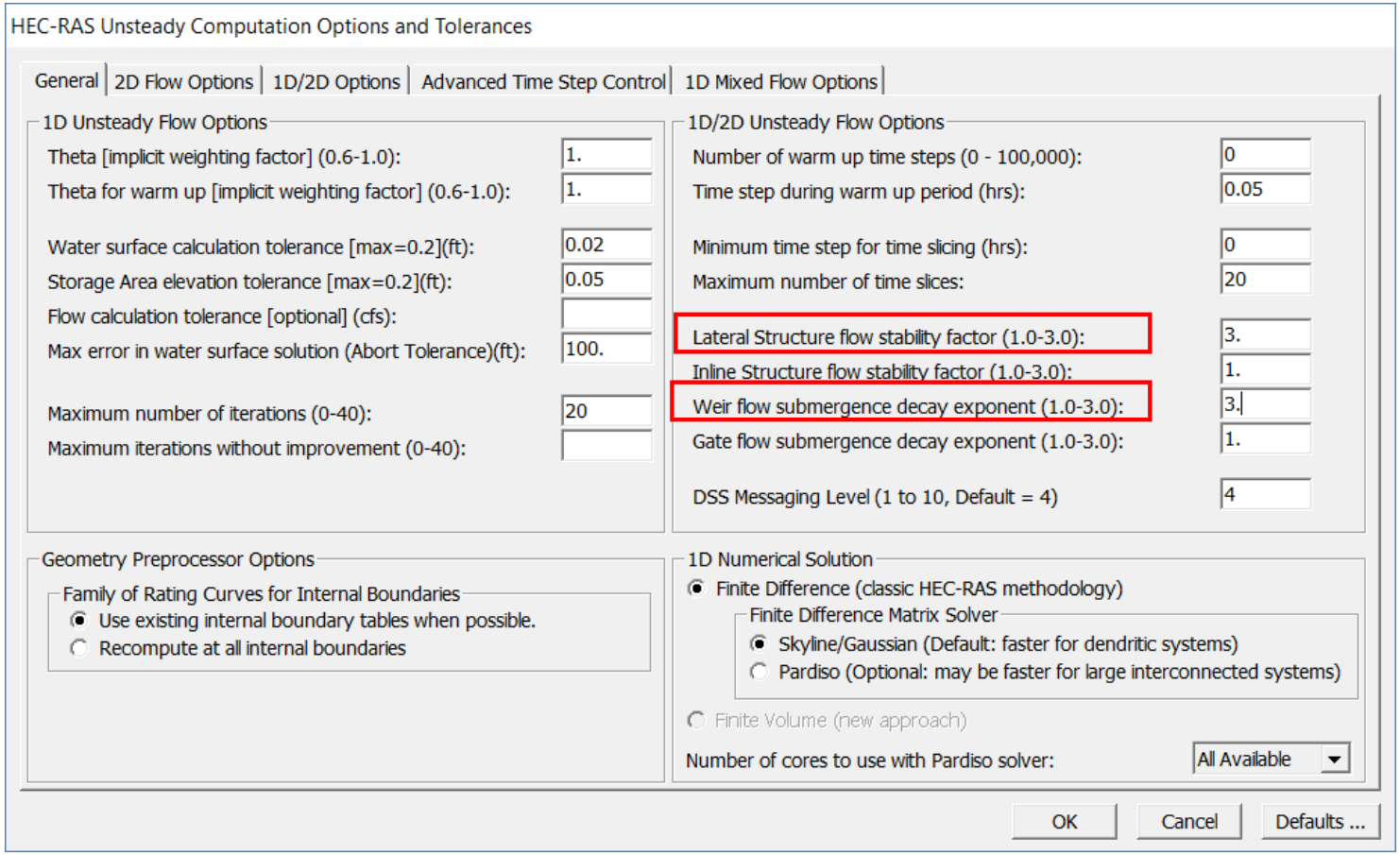
Weir Submergence Curves





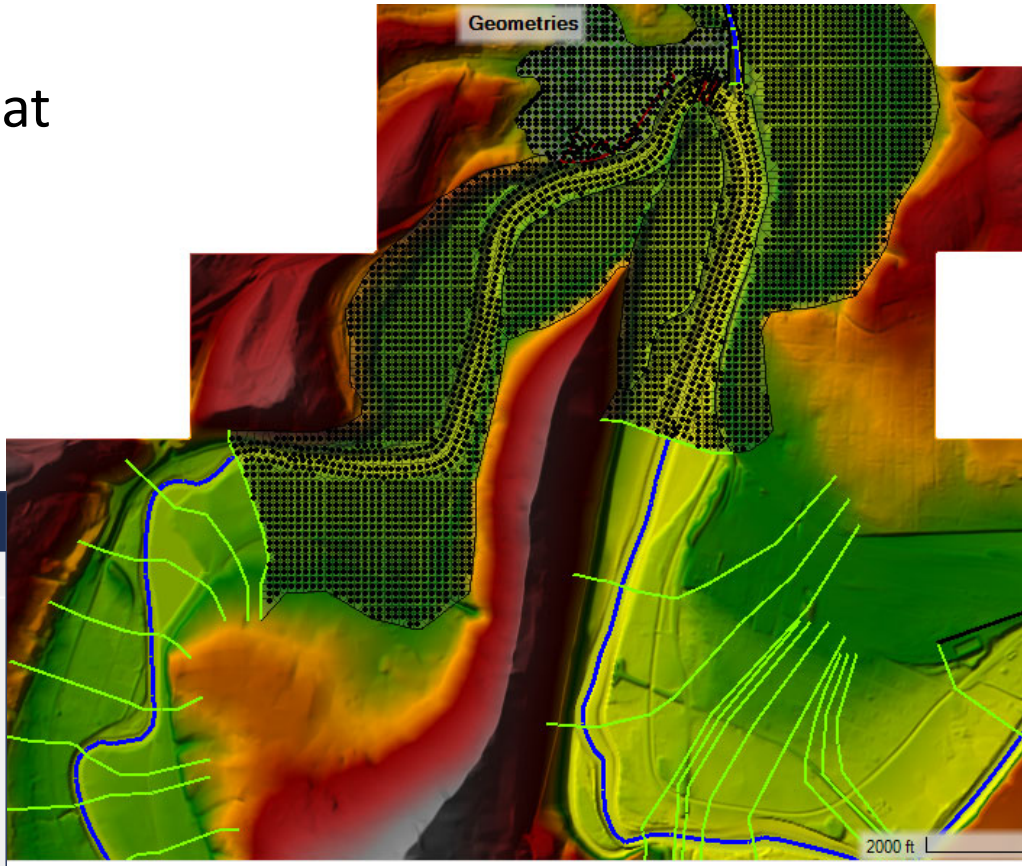
Tw / Hw = 0.76

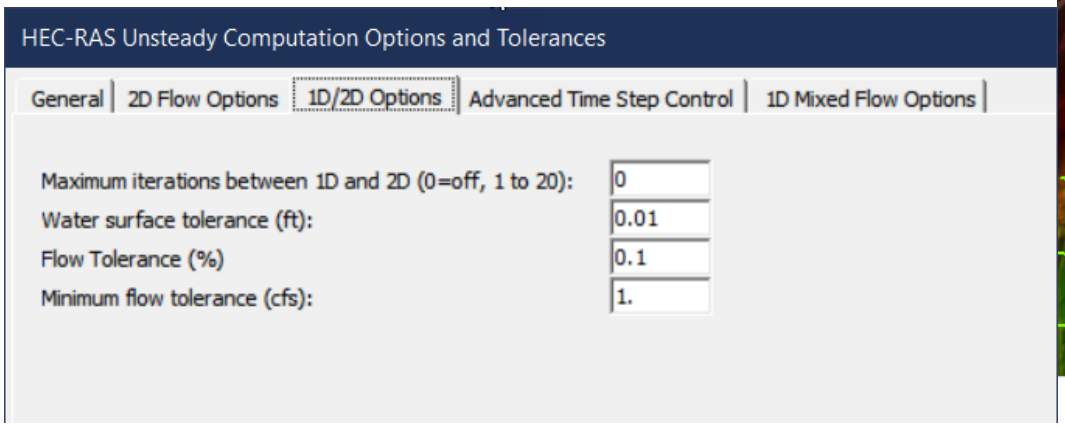
Lateral Structure Computational Options



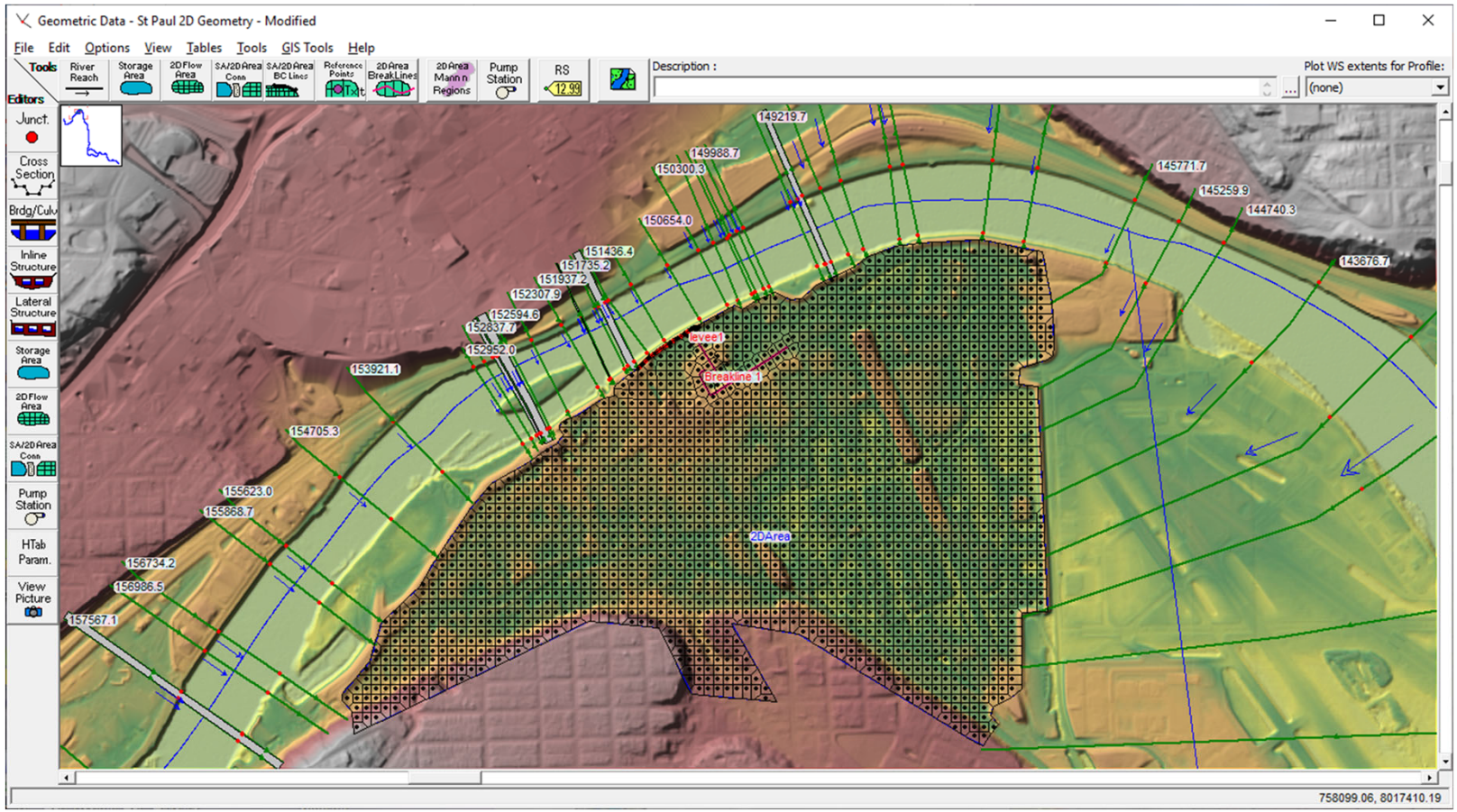
1D/2D Iterations Option

- Monitors WSEL and Flow Tolerance at boundaries
- Iterates the 1D and 2D domain until tolerances are met
- Off by default (0 iterations)



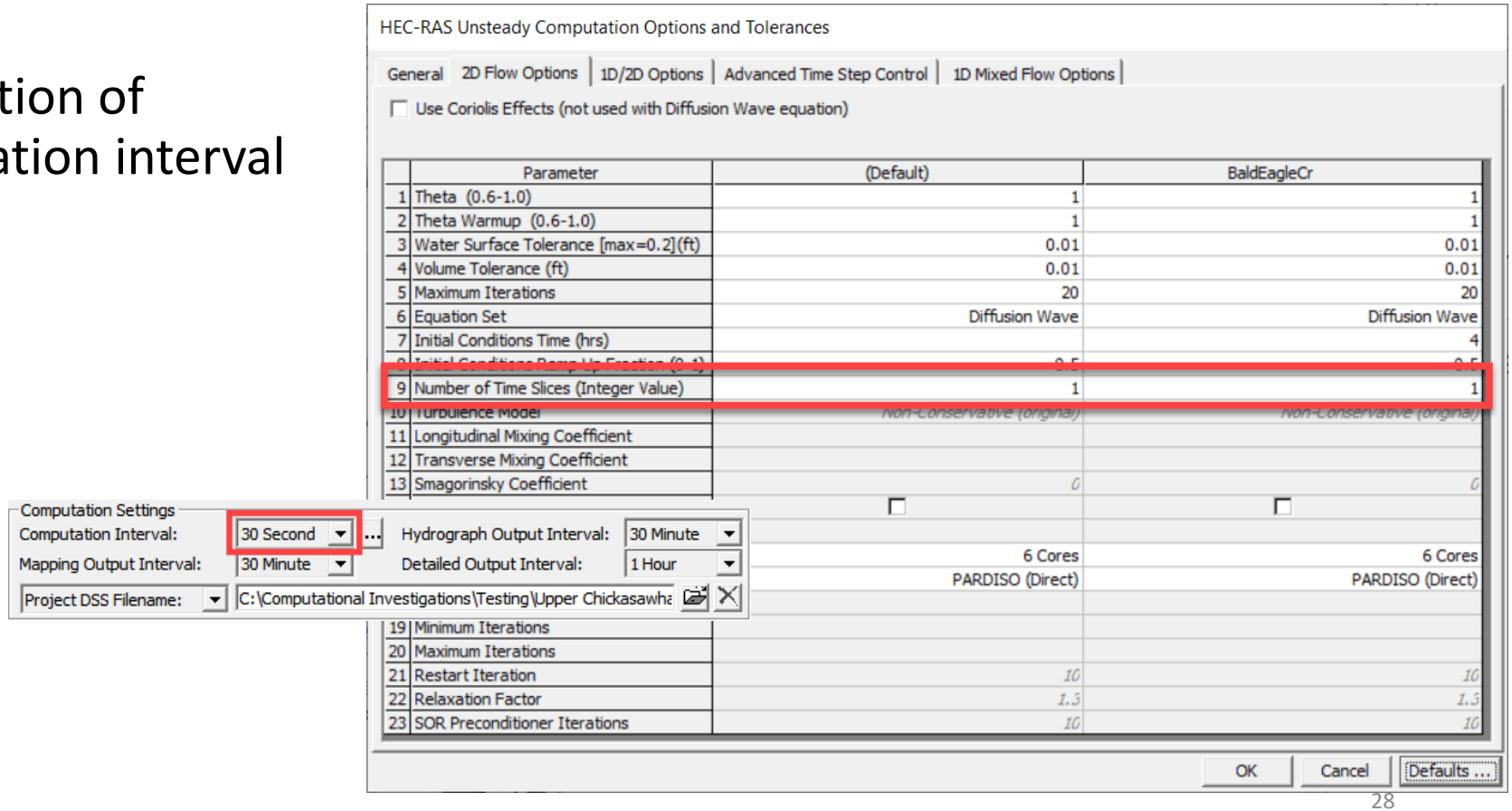


1D/2D Modeling Computational Time Step

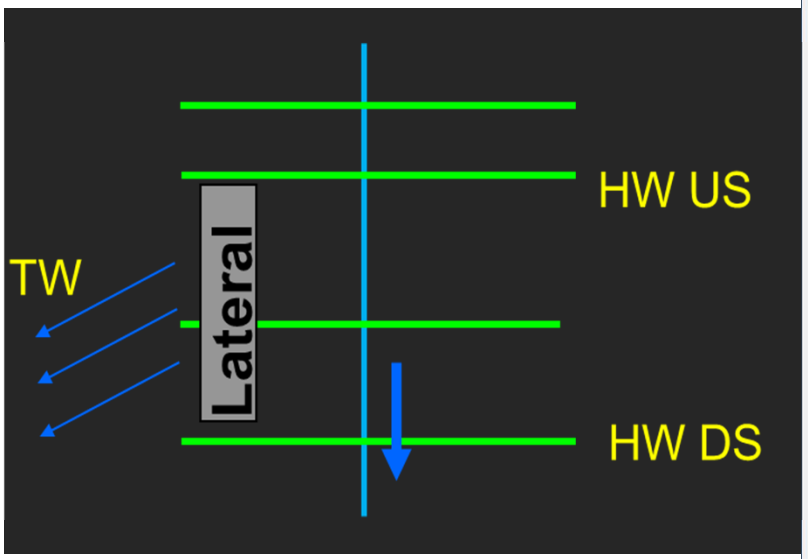


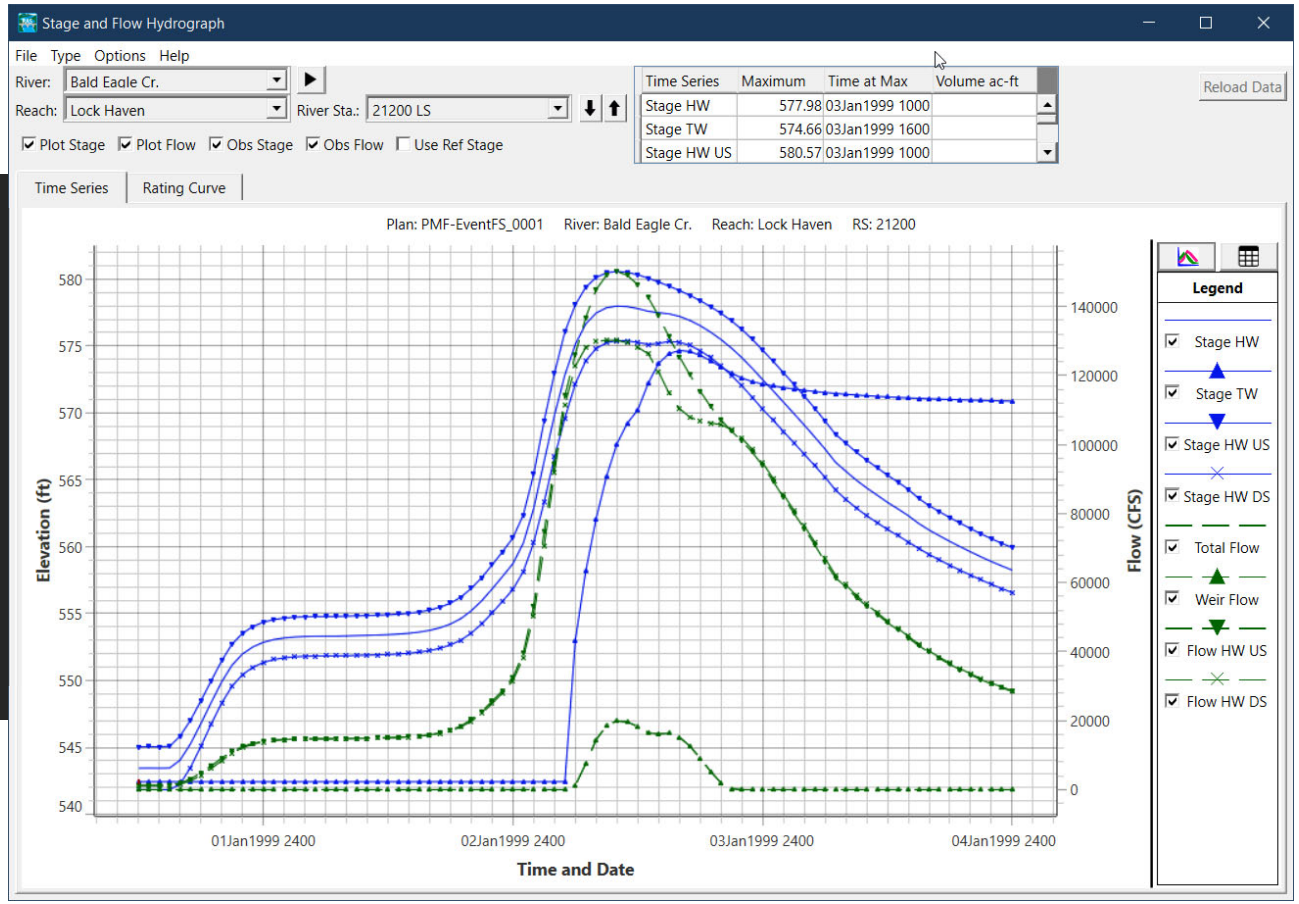
2D Time Slicing

- Use fraction of computation interval

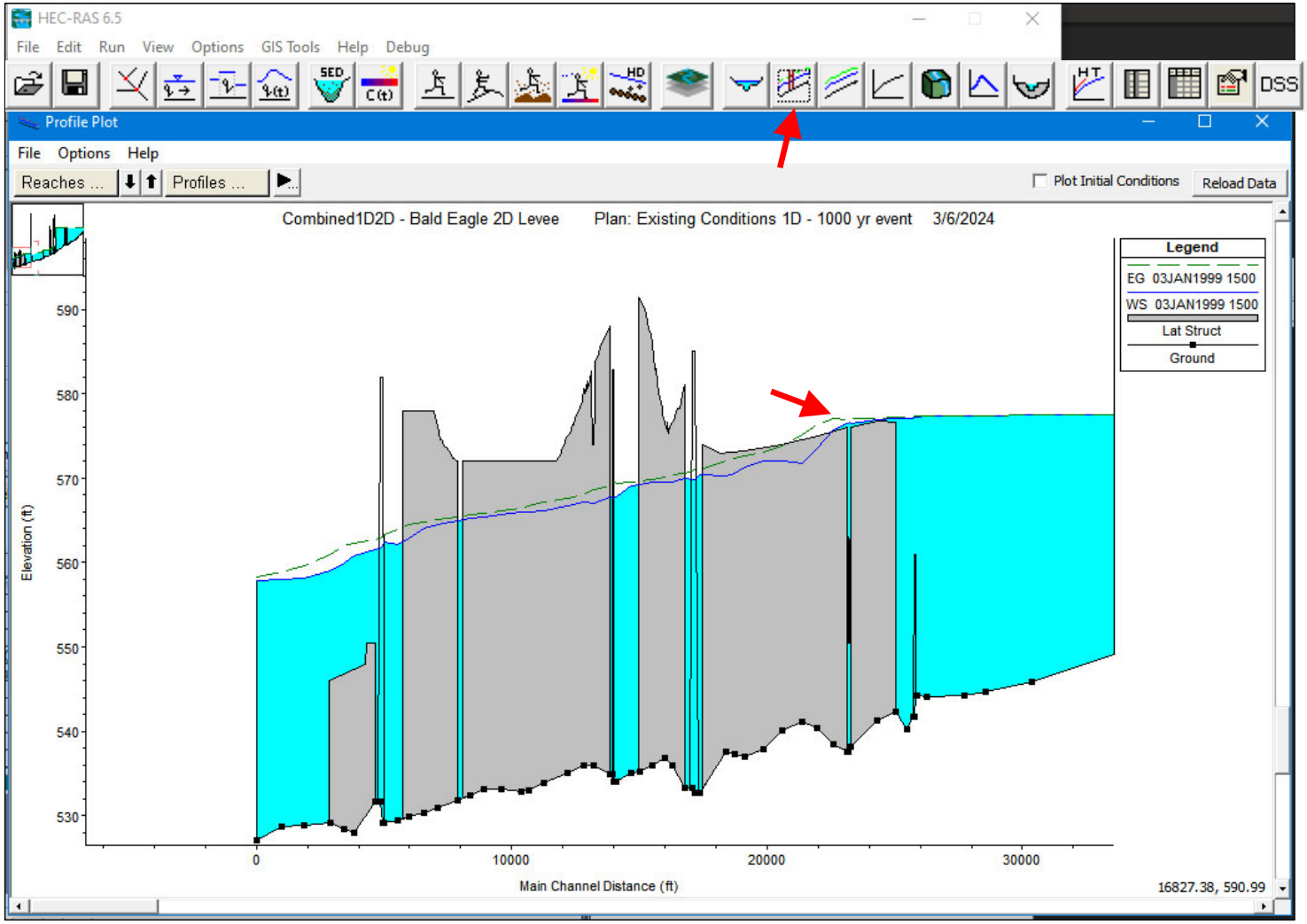


Hydrograph – Lateral Structure

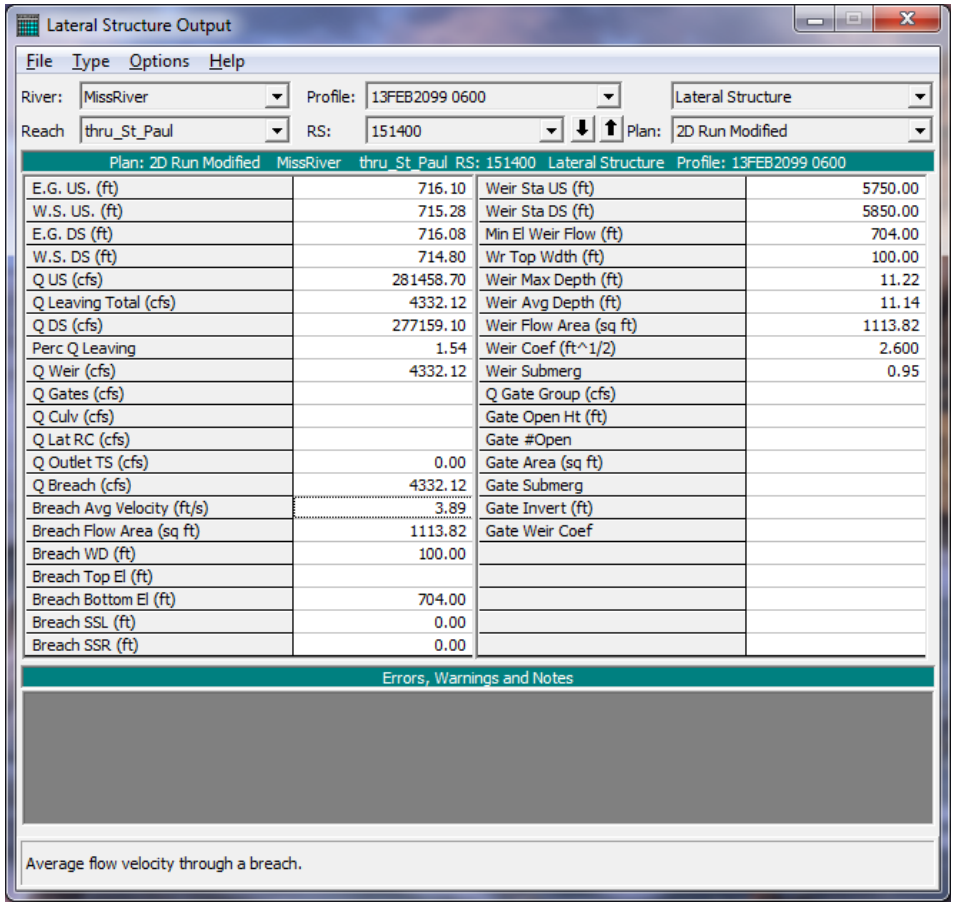




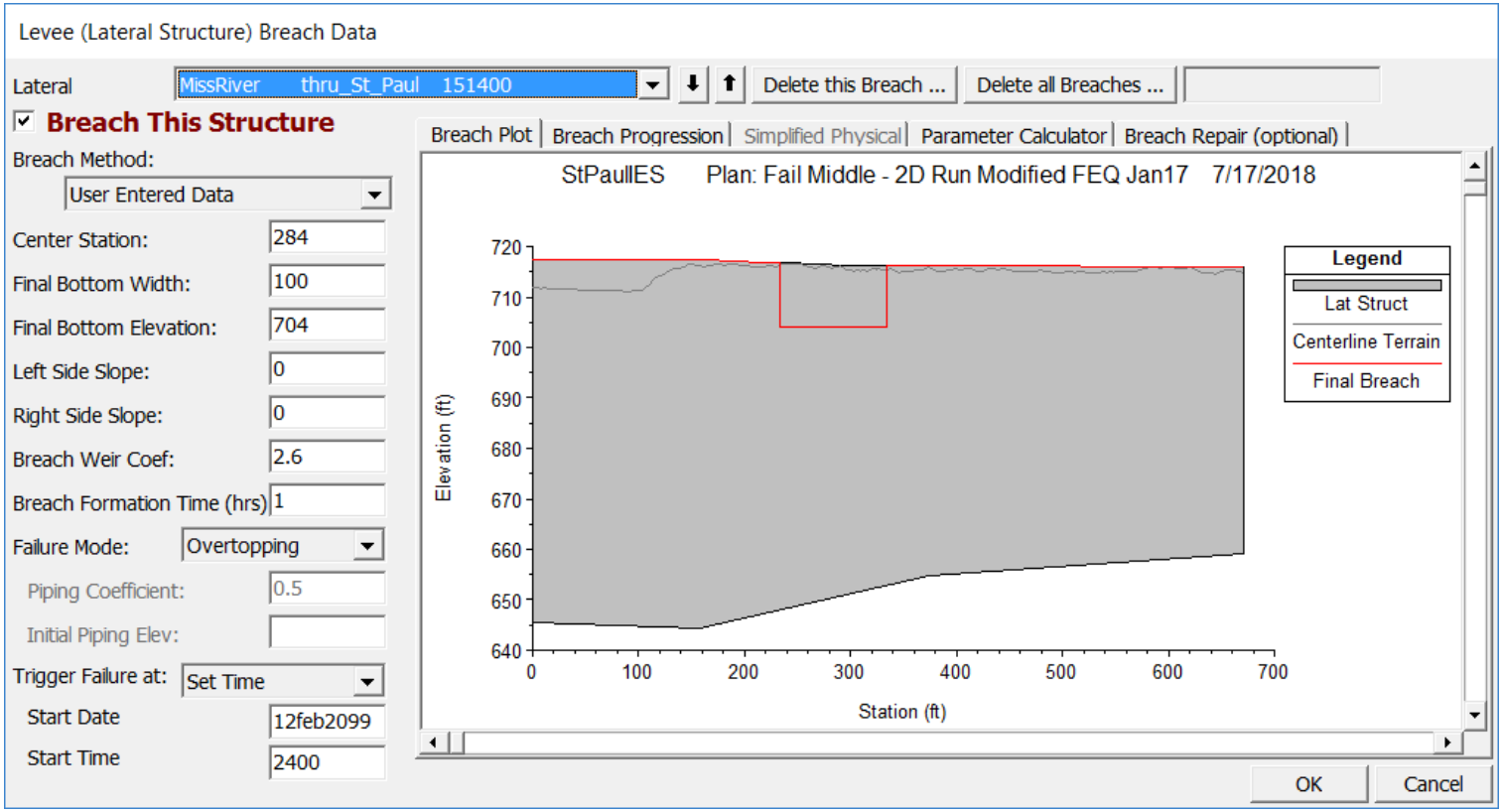
Profile Plot



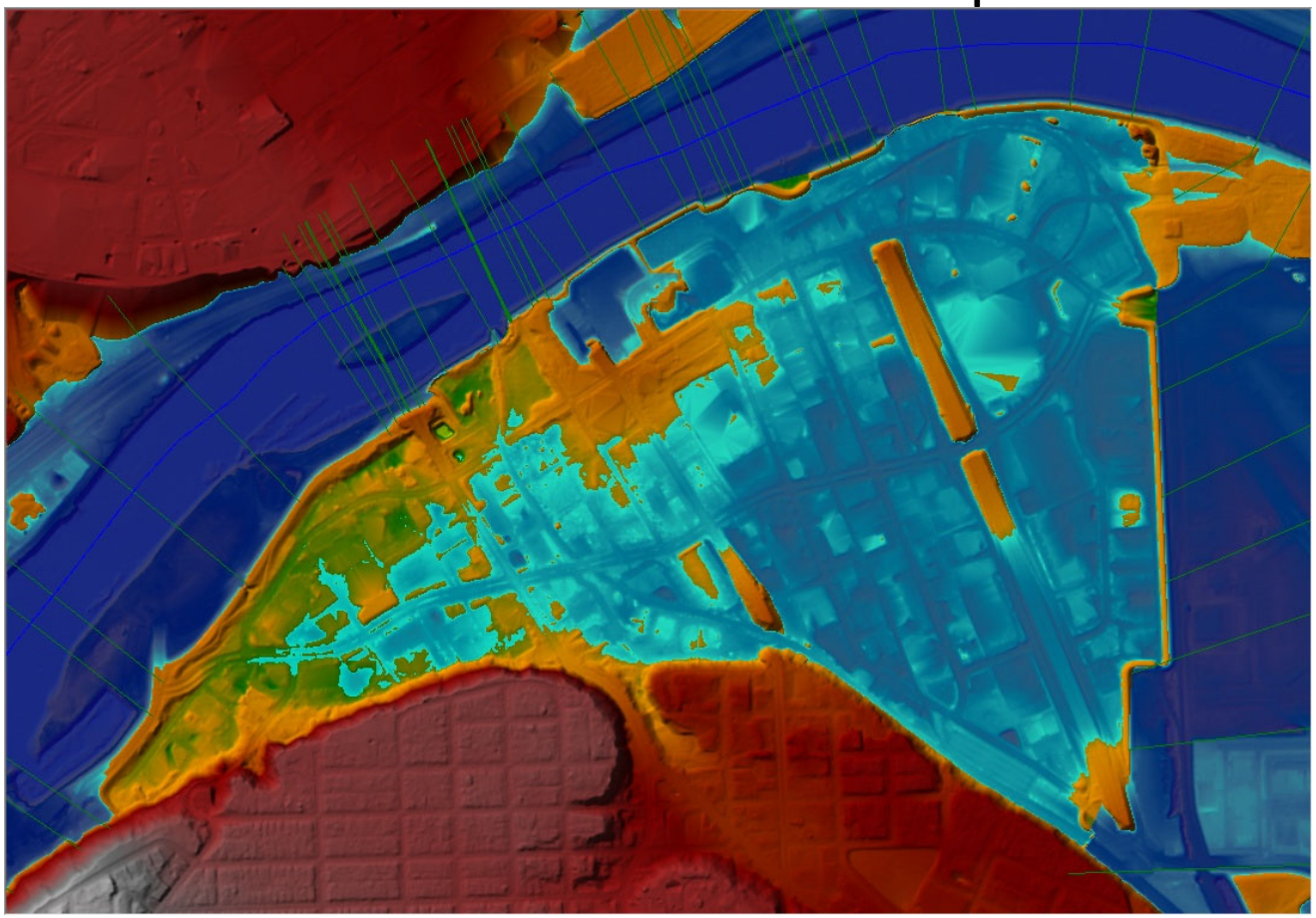
Lateral Structure Detailed Output

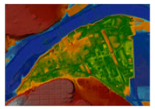


Levee Breaching



Saint Paul Levee Breach Example





Questions?

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