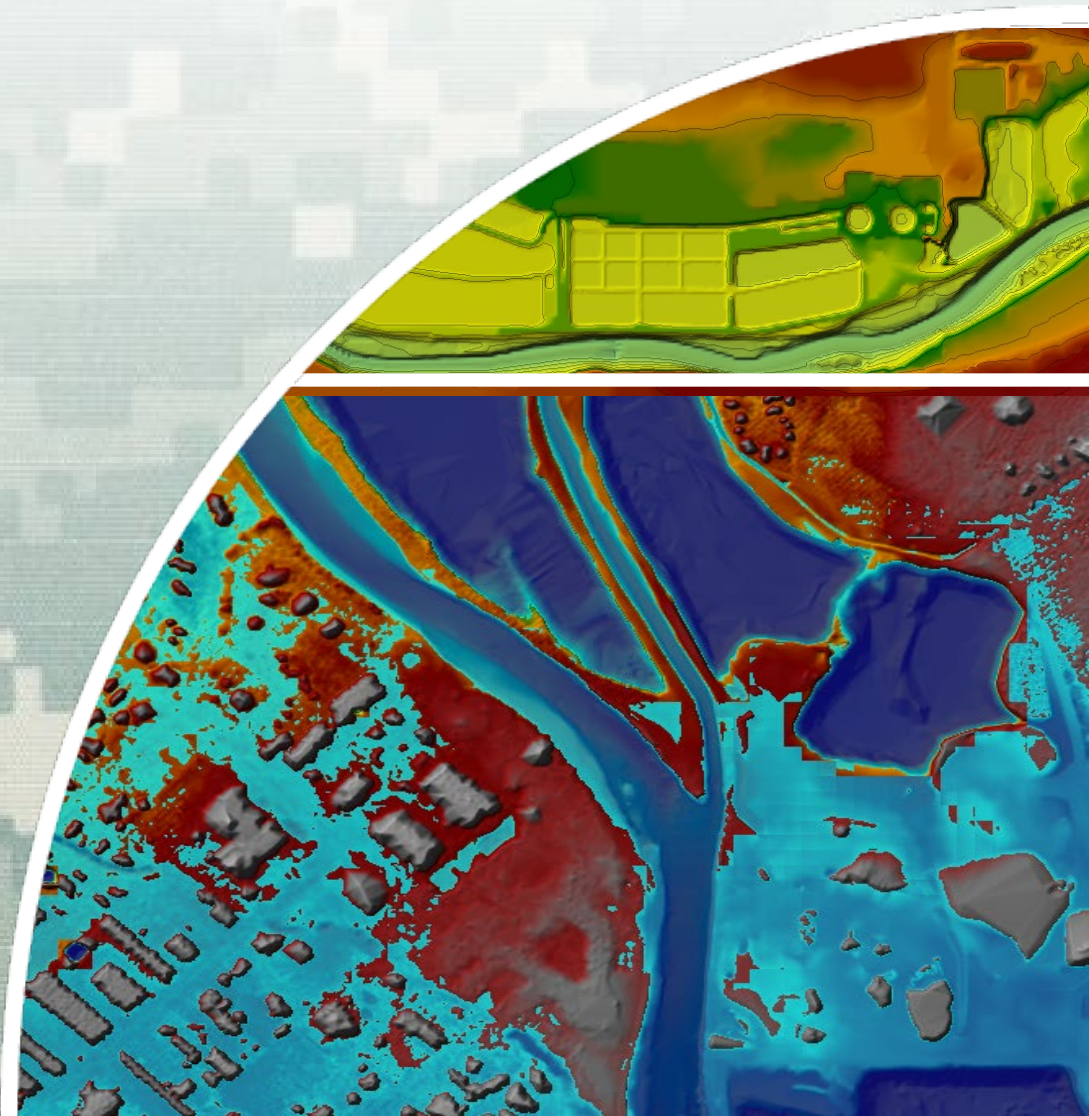
1D/2D Direct Connections: Transitioning between 1D and 2D Channels

Stanford Gibson, PhD
Sediment Transport Specialist
Hydrologic Engineering Center

Slides and Content by:

Steve Piper
Cameron Ackerman, PE, D.WRE



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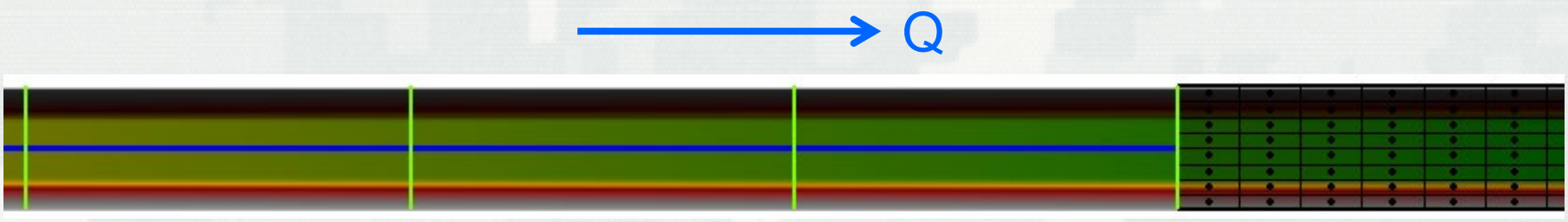
1D-2D Connection



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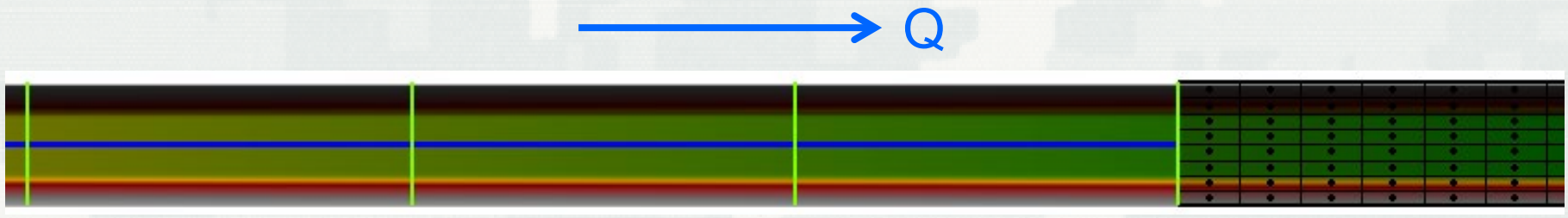
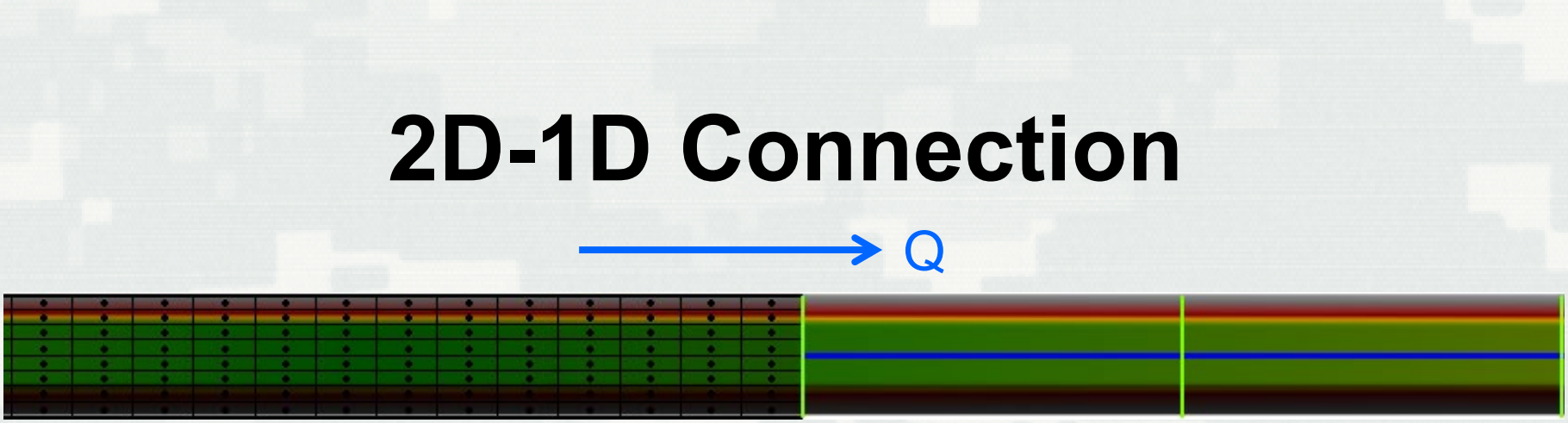
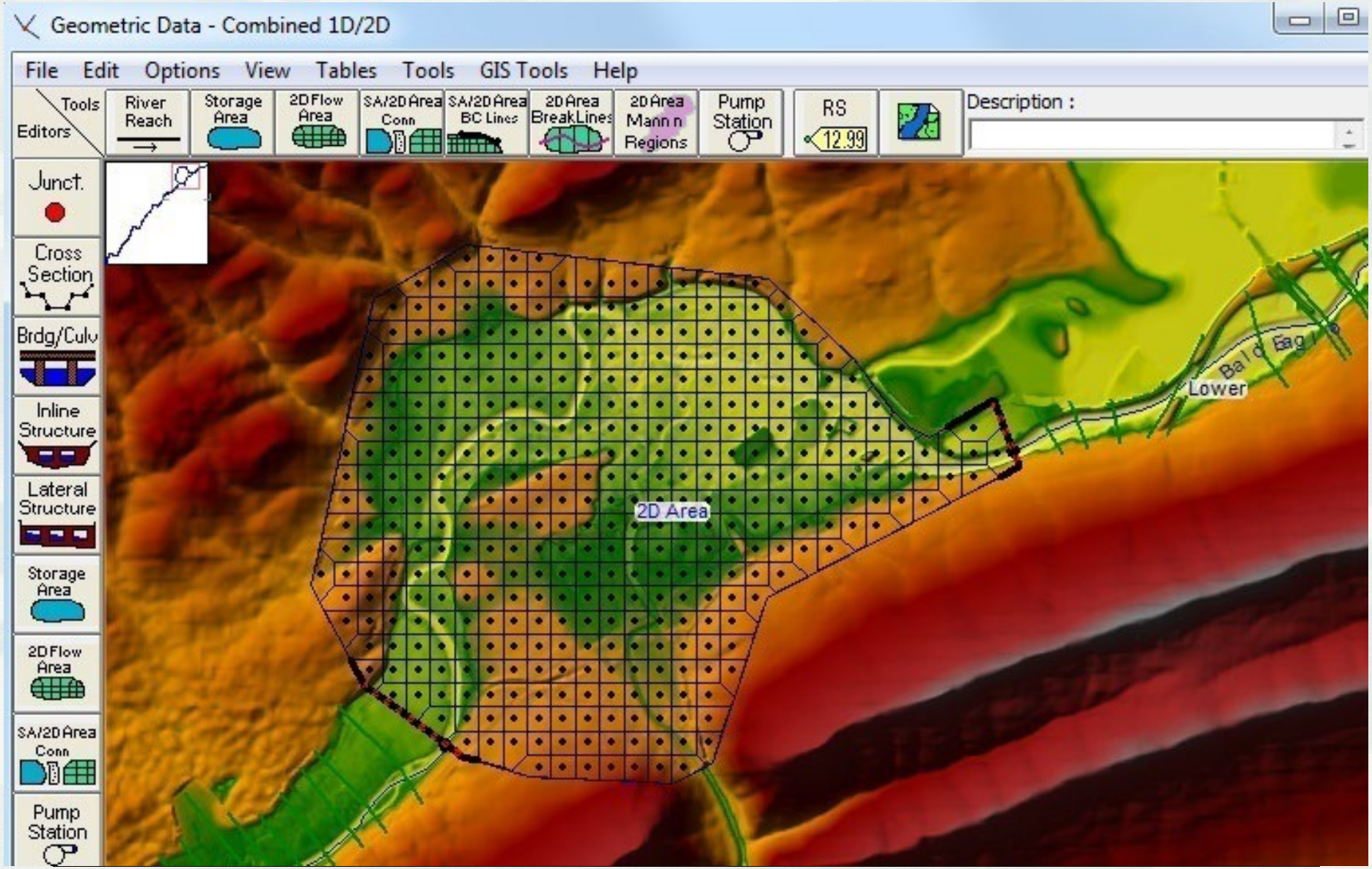


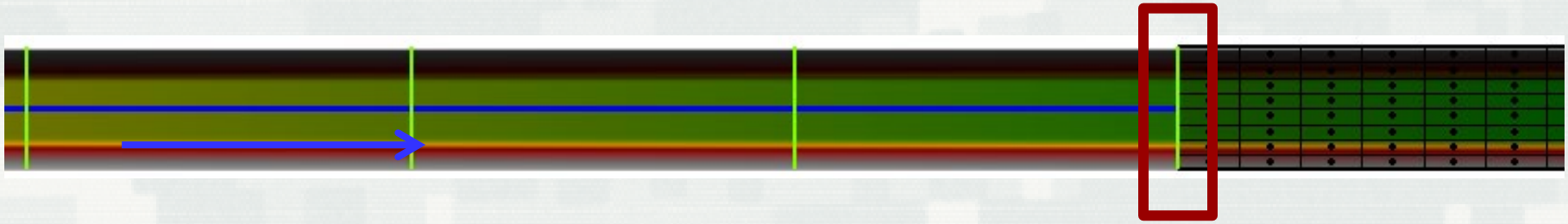
2D-1D Connection



1D to 2D to 1D Connection



Three Critical Take-Aways:
Managing Instabilities at 1D-2D Transitions



1. Cross section and mesh boundary must be *identical* at the connection.

2. 1D First→2D Second.
   1D uses lagged 2D result, which can cause instability.

3. Output choices can mask instabilities at the boundaries.

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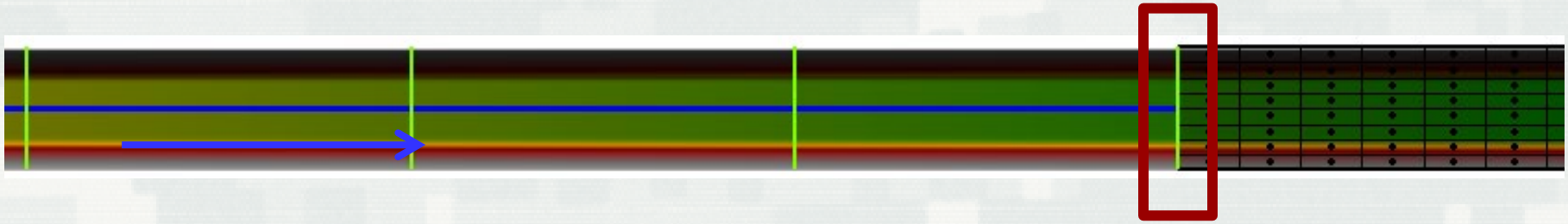

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Requirements for Connecting 1D to 2D Channels Directly

1. Choose a 1D Flow Location

2. Carefully align 1D XS with 2D area boundary

3. 1D XS Station/Elevation must be exactly the same as 2D area terrain.

4. Same Manning's n at the 1D-2D boundary.

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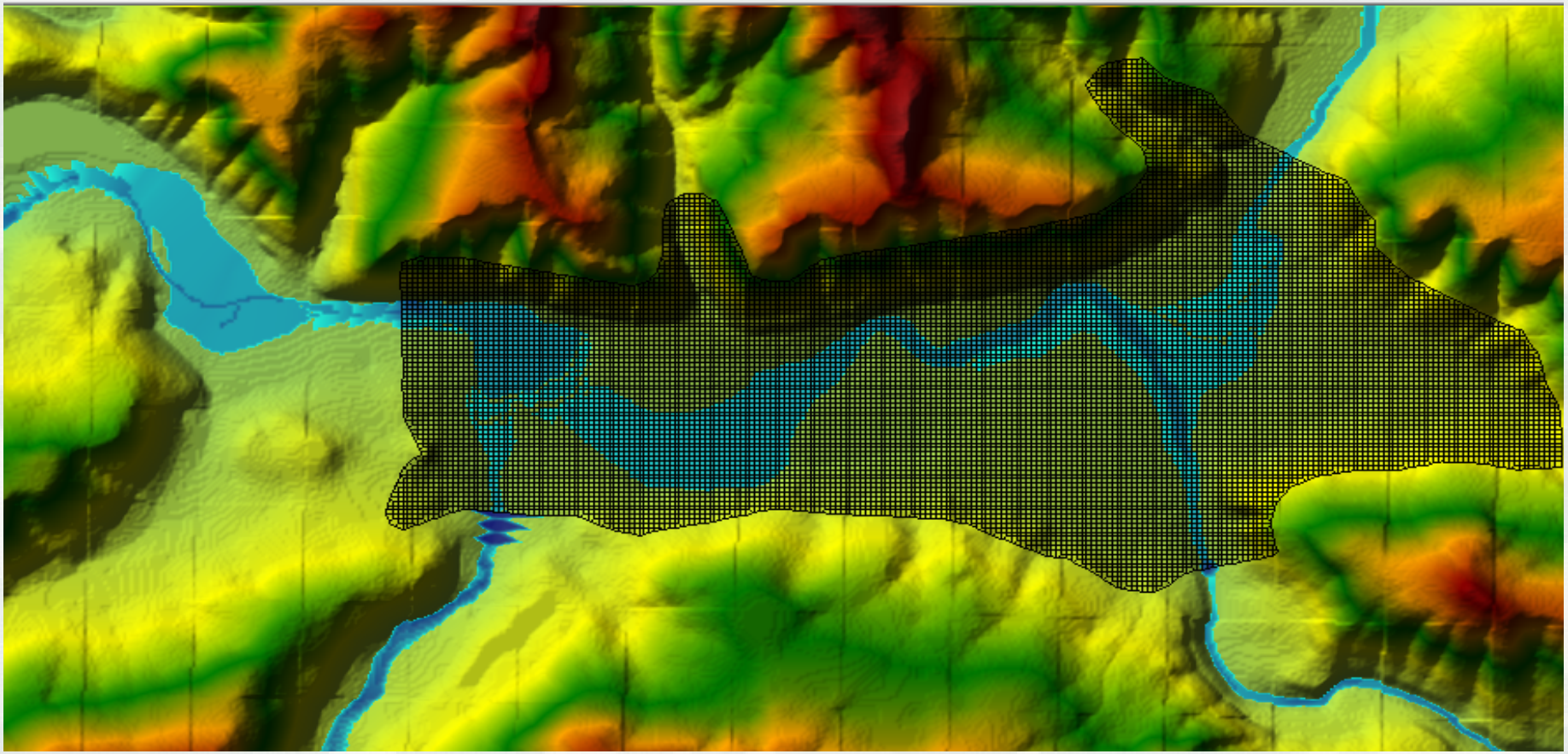

1D/2D Locations

- 1D to bay estuary or alluvial fan

- 1D river with regions of 2D river
  - Complicated bridge/multiple opening
  - Complex junction
  - Detailed WSEs (e.g. sharp bend)
  - Detailed Velocities

Requirements for Connecting 1D to 2D Channels Directly

1. Choose a 1D Flow Location…

   …or move connection away from the area of interest.

2. Carefully align 1D XS with 2D area boundary

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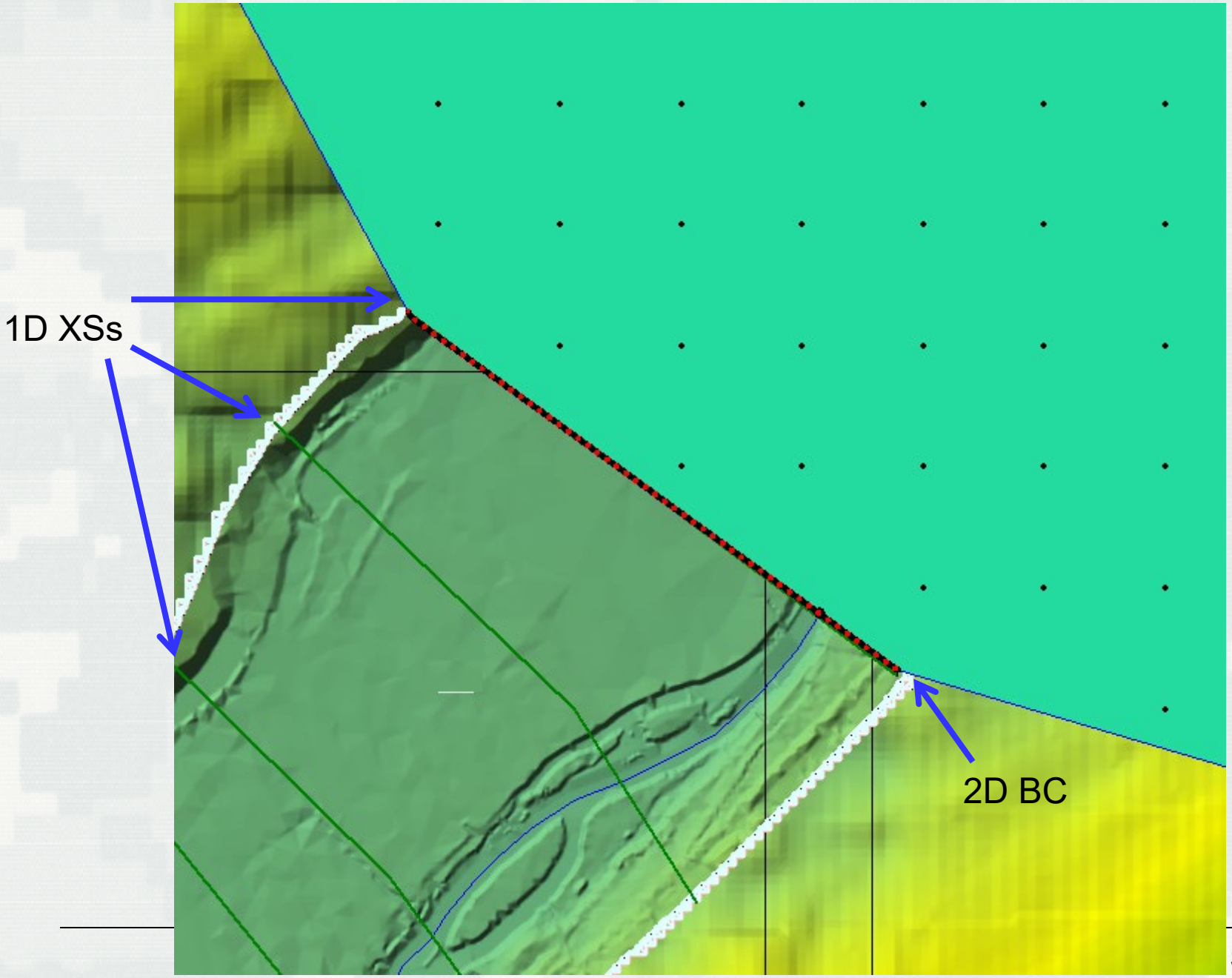
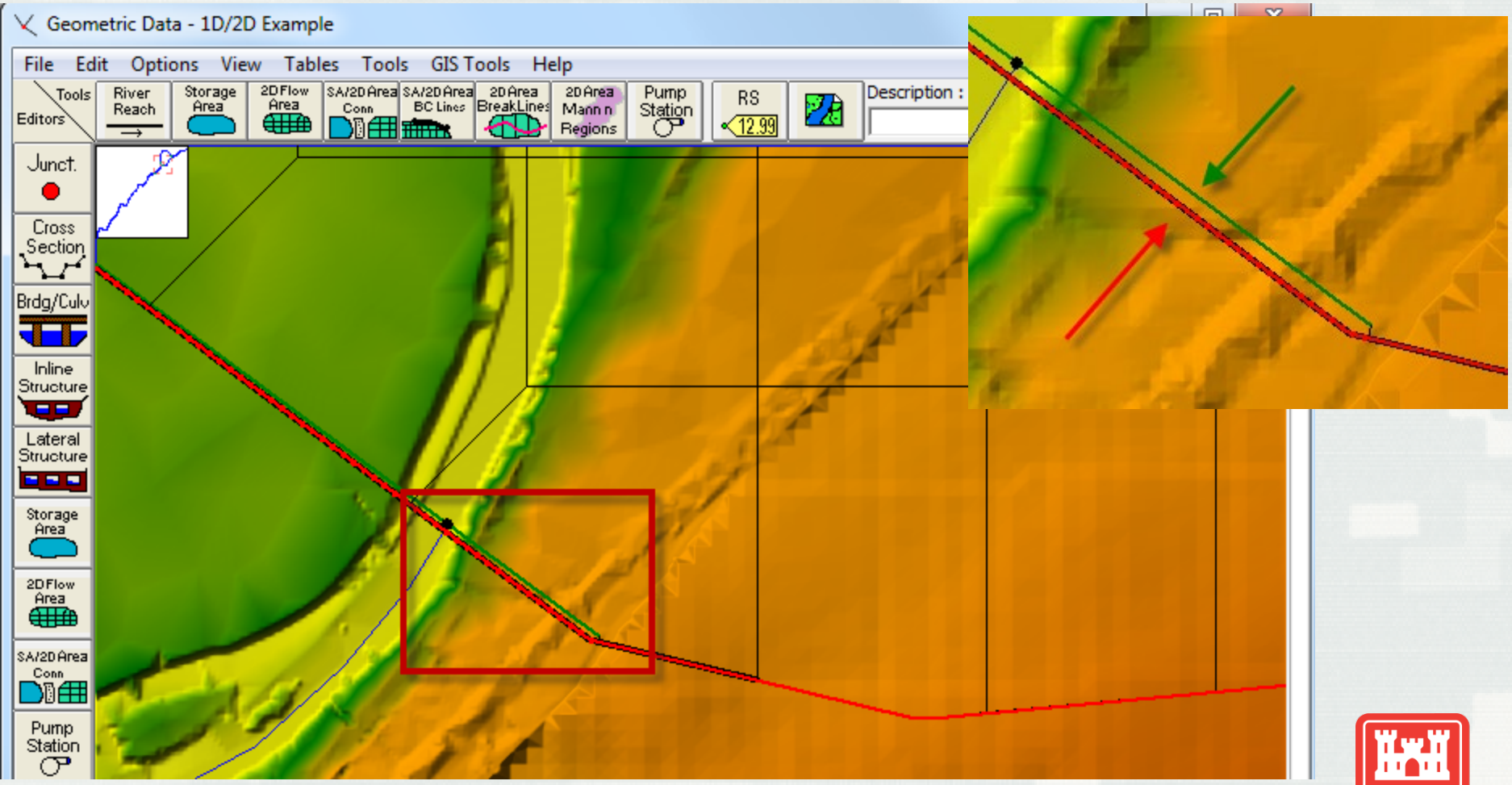

1D XSs
2D BC

Checking 1D/2D Boundary



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   Why is this so important?

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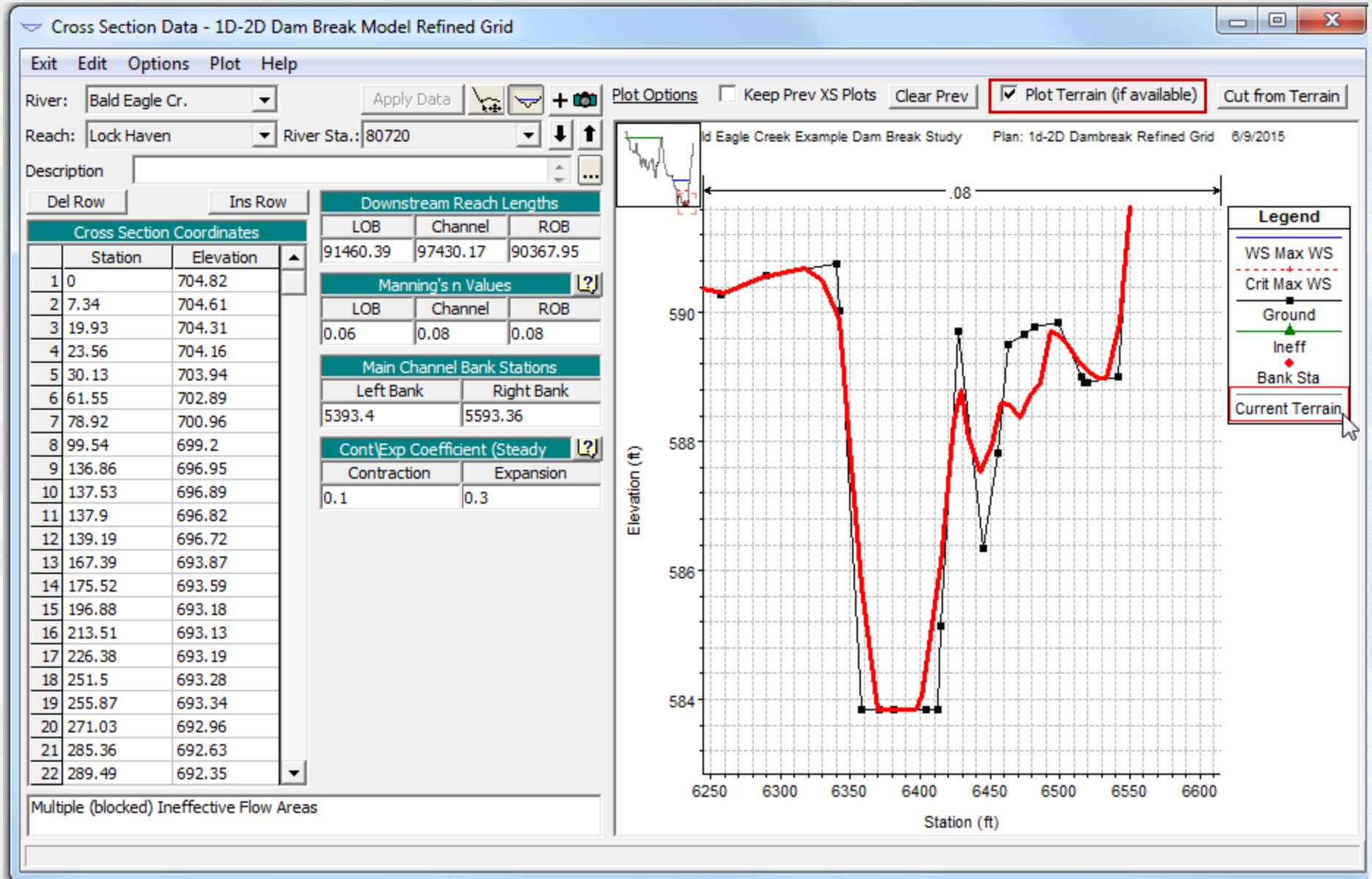
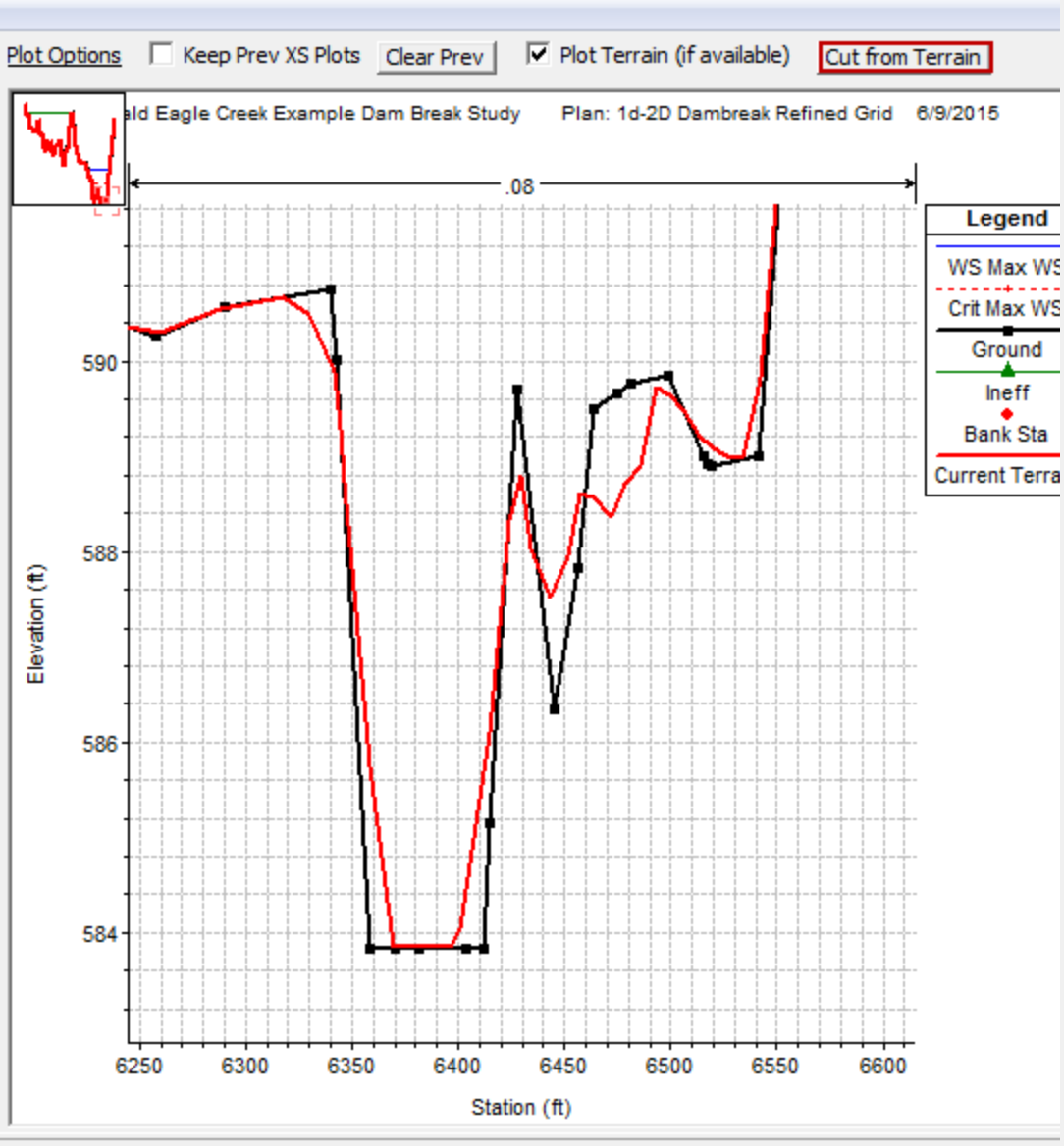
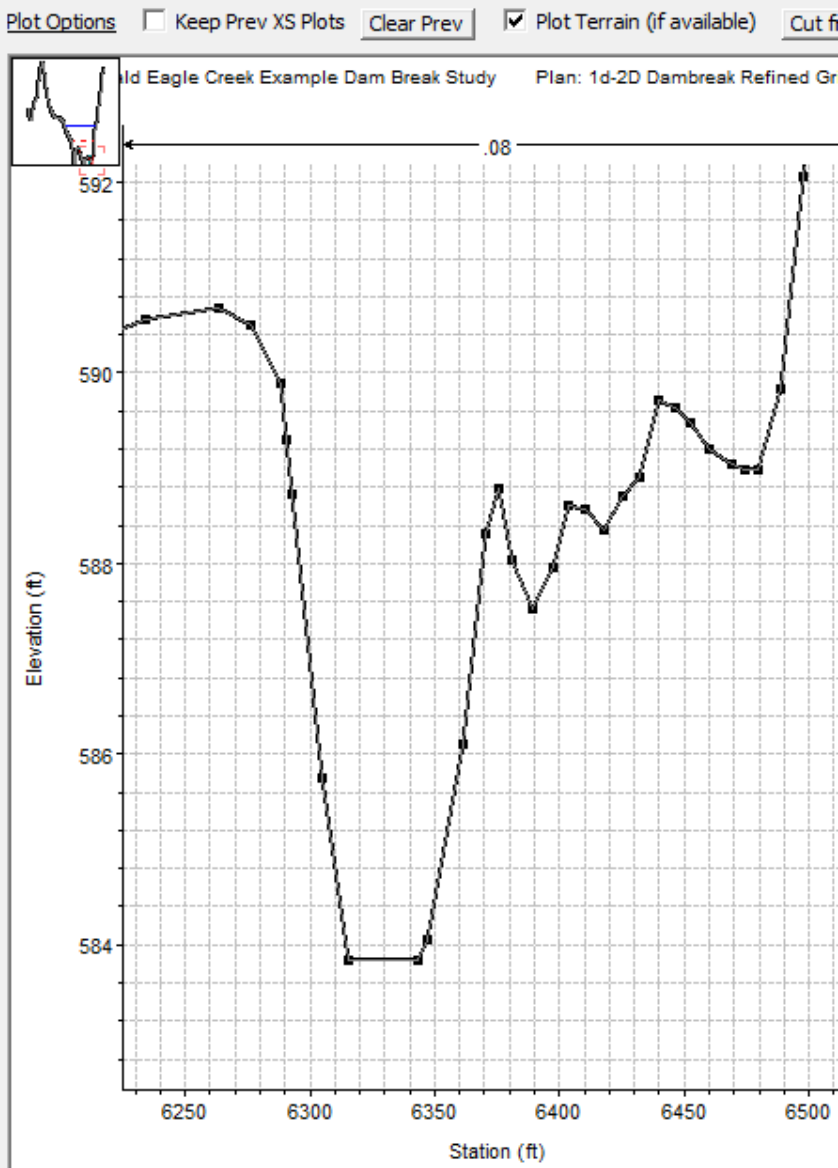
1D Sta/Elev vs Terrain



Update1D Sta/Elev





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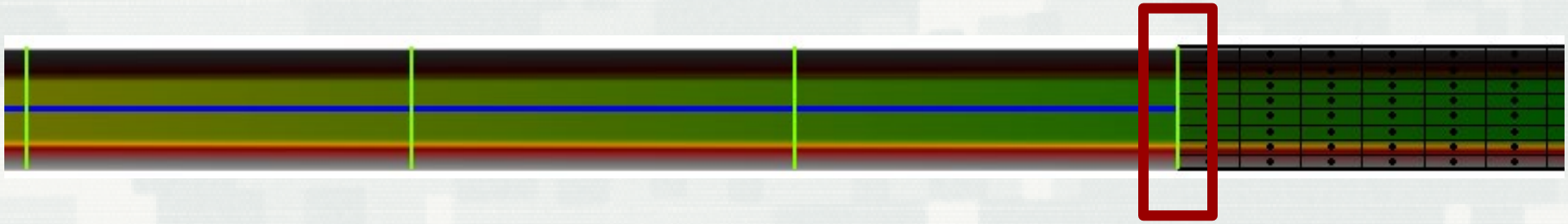
Three Critical Take-Aways:
Managing Instabilities at 1D-2D Transitions



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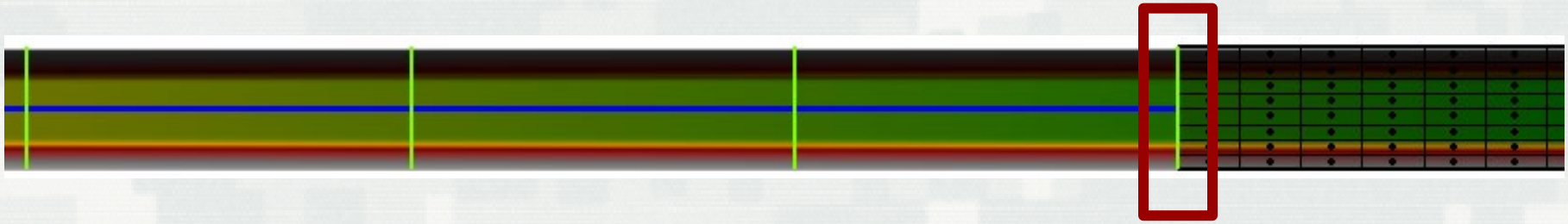

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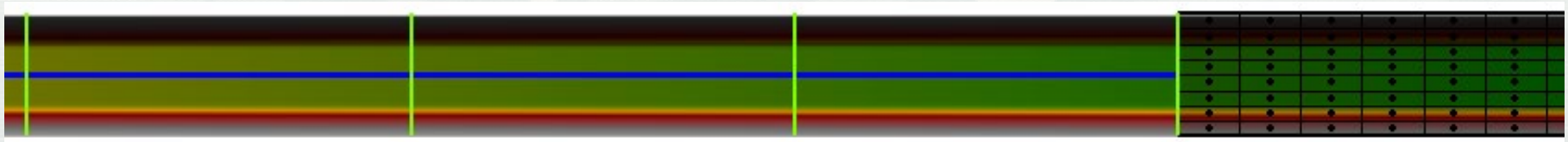
1D/2D Solution Overview

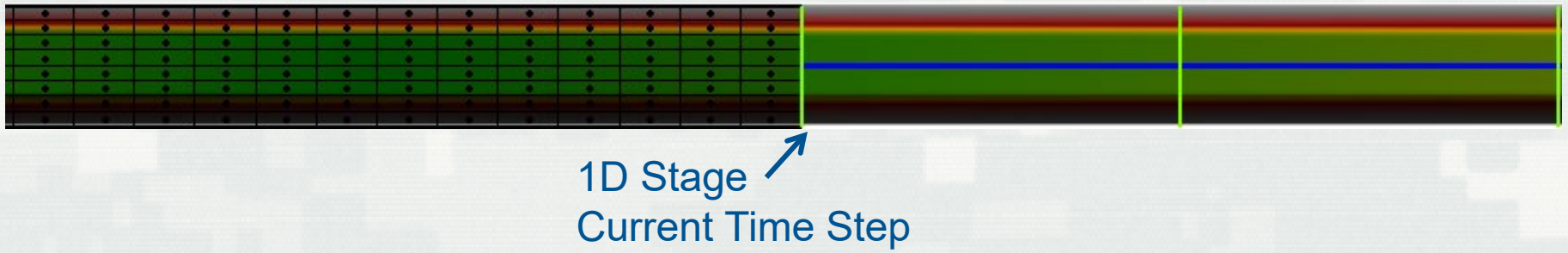


For each time step:

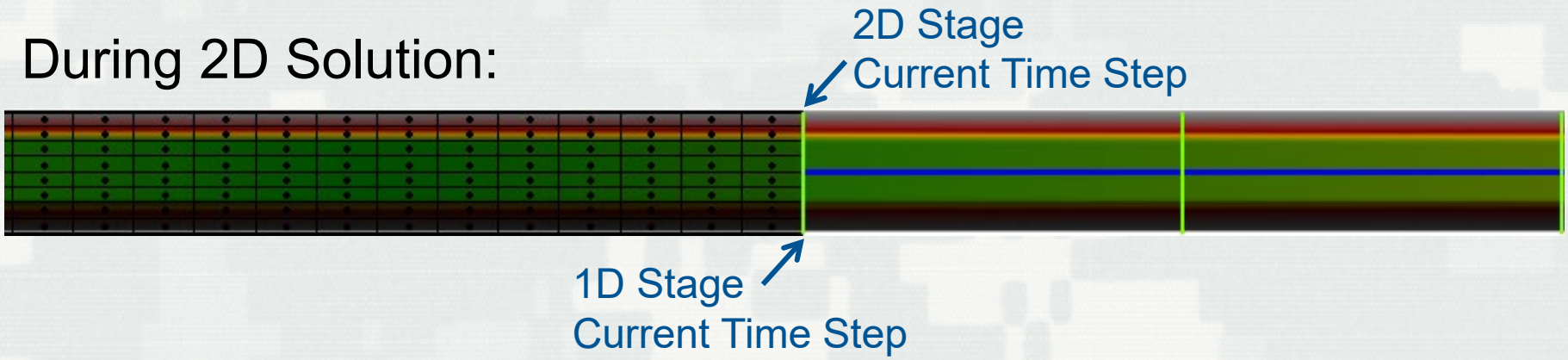
- **1D is computed first, then 2D**
- 2D has latest boundary conditions from 1D
- 1D gets “lagged” boundary conditions from 2D
- Upstream region uses the downstream WSE
- Downstream region uses upstream flow

1D/2D Solution Overview

During 1D Solution:



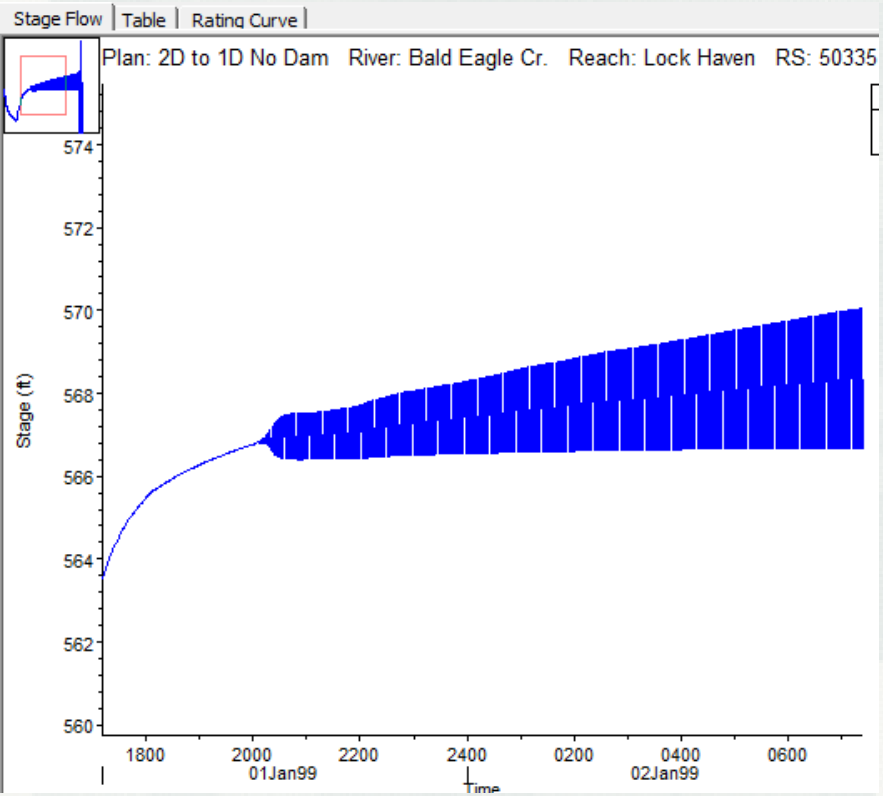
During 2D Solution:

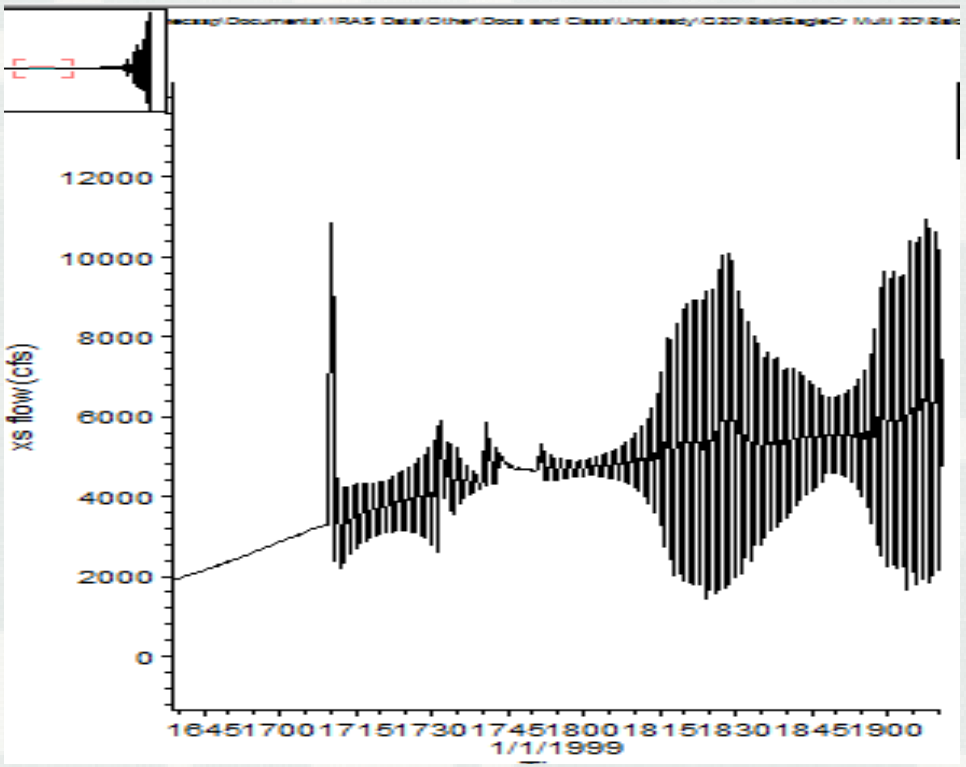


Large differences between current 1D stage and previous 2D stage, at the shared transition transect, can cause instabilities at the boundaries.

Discontinuity between 1D and 2D results at the transition can cause instabilities:

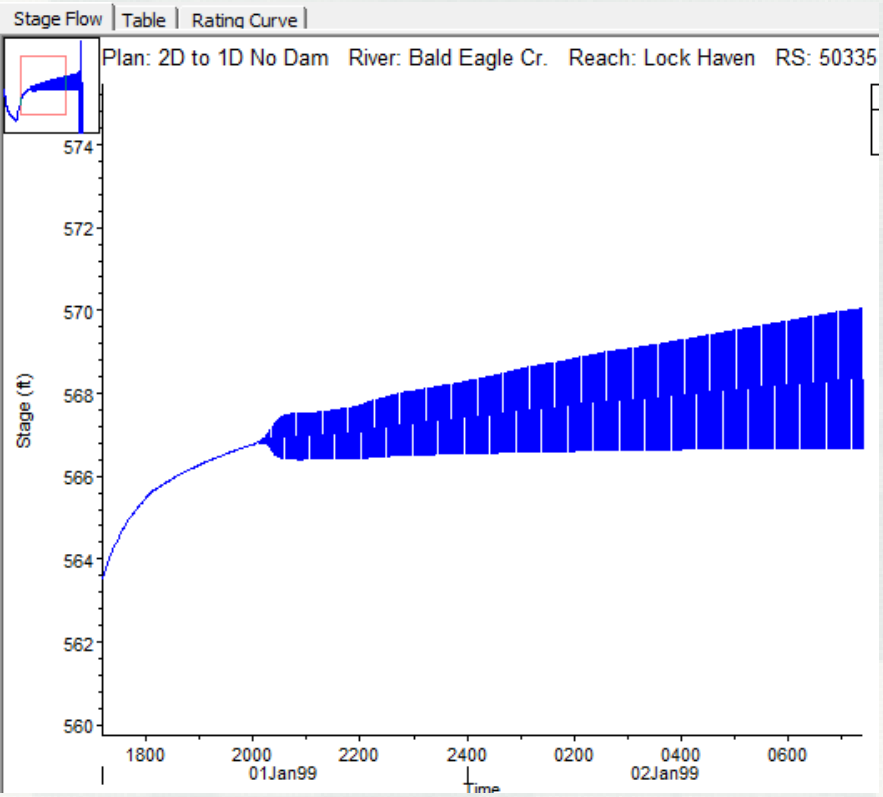
Boundary instabilities can cause oscillate





That's fascinating…

…How do you fix it?



- 1D/2D Iterations
- Smaller Time Step

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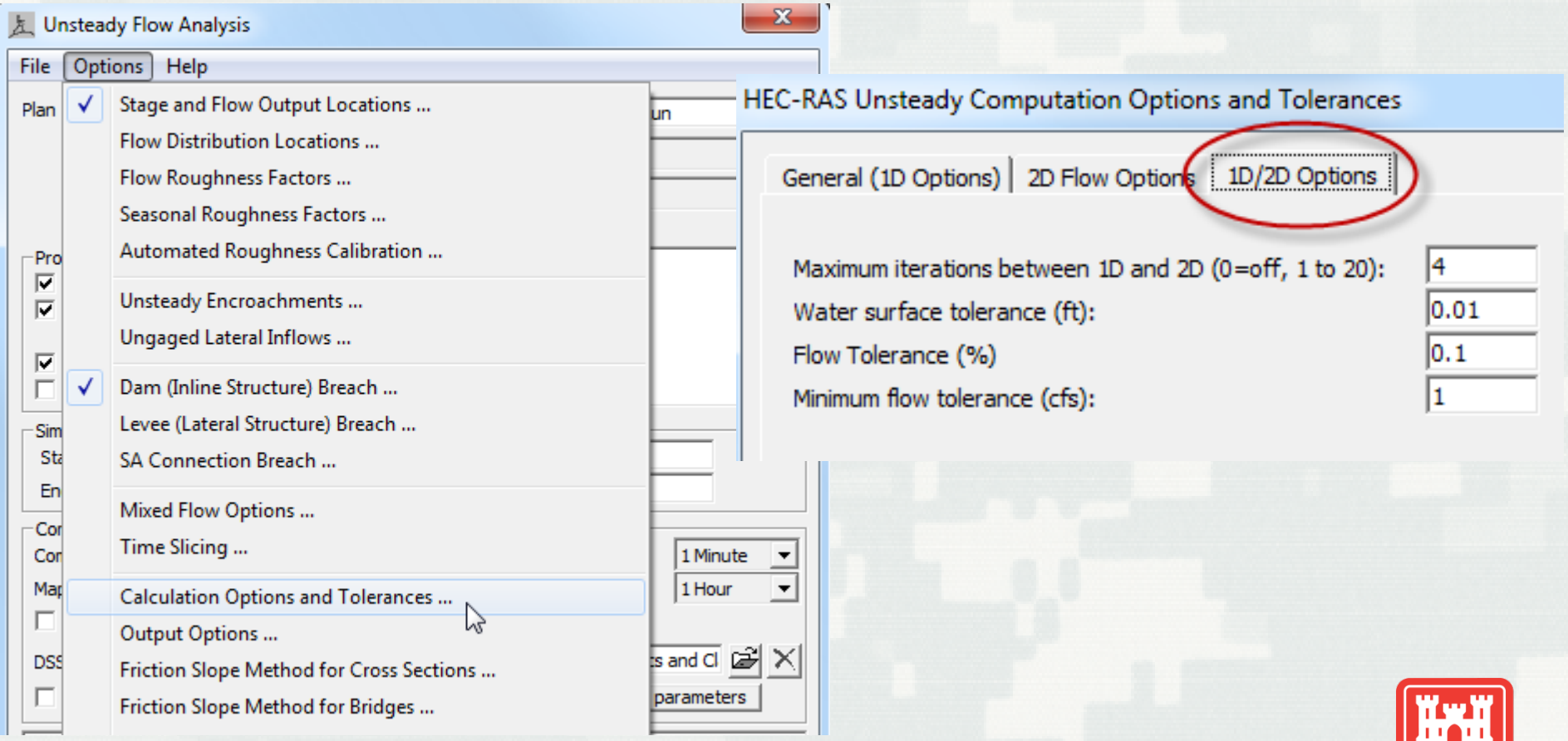
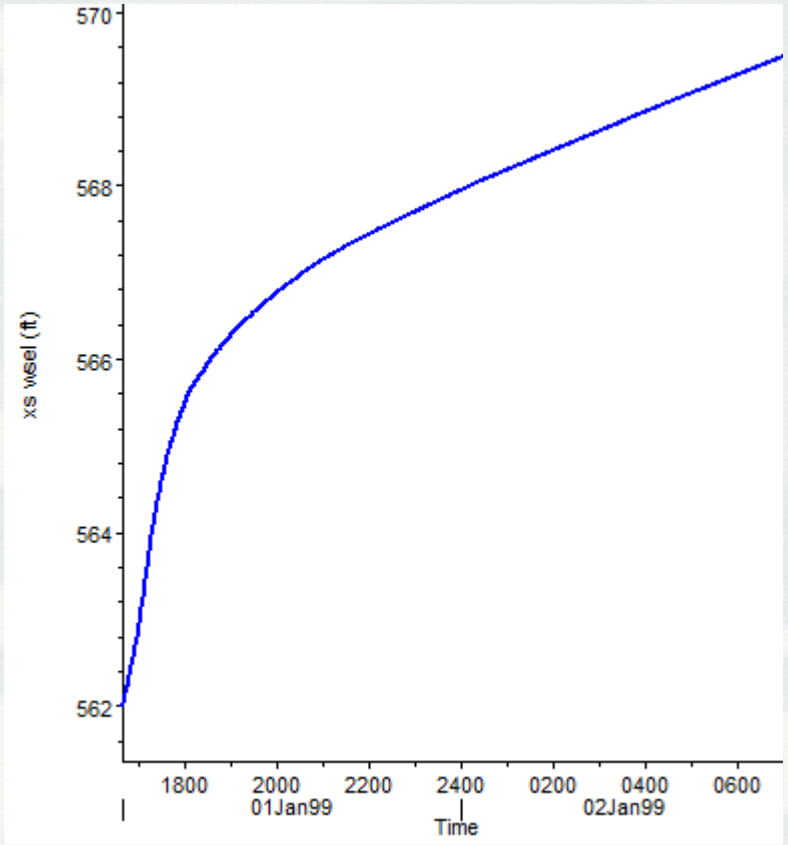
1D/2D Iterations

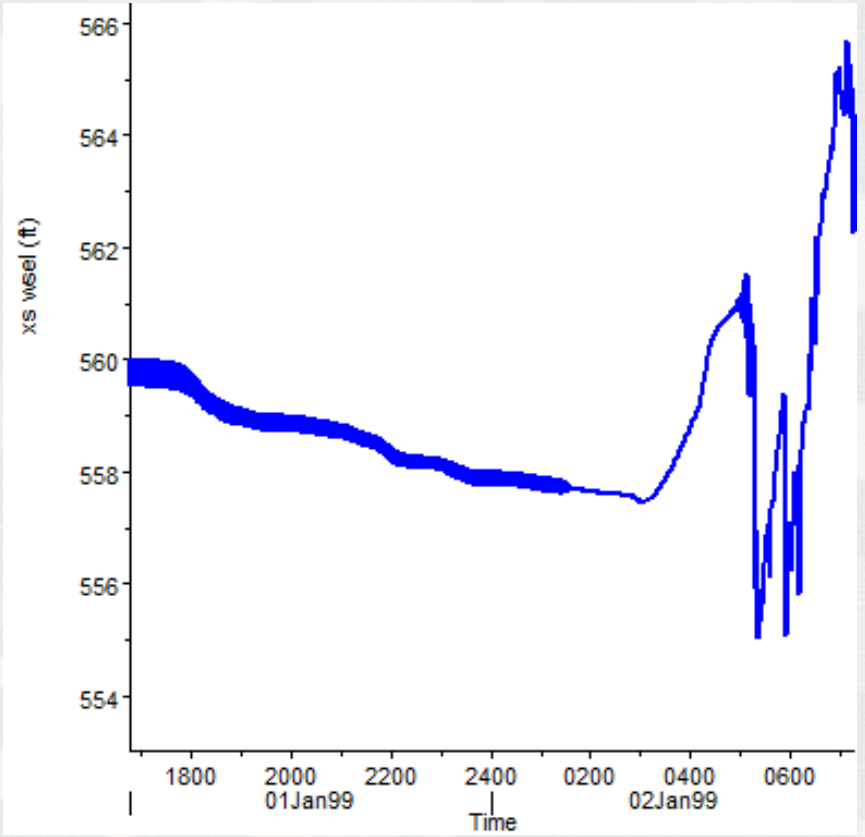


1D/2D Iterations

- For each time step: 1D is computed, then 2D
- Every 1D/2D boundary is checked for convergence
  - ▶ 1D to 2D WSE is checked
  - ▶ 2D to 1D Flow is checked
  - ▶ Lat Struct or SA Conn, Flow checked
    - **Flow is based on “assumed” WSE**
    - **Flow is re-computed from “computed” WSE**

2D to 1D Instability





- 1 Minute time step
- 4 Iterations Max

- 15 Second time step
- 0 Iterations

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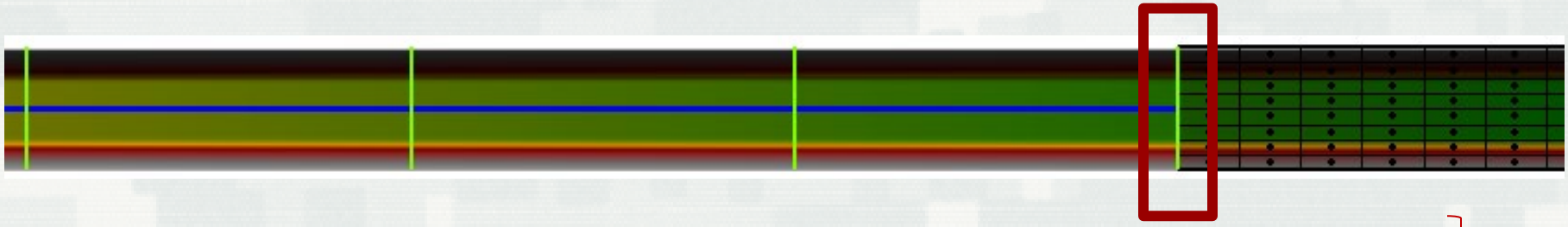

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Causes

3. Output choices can mask instabilities at the boundaries.

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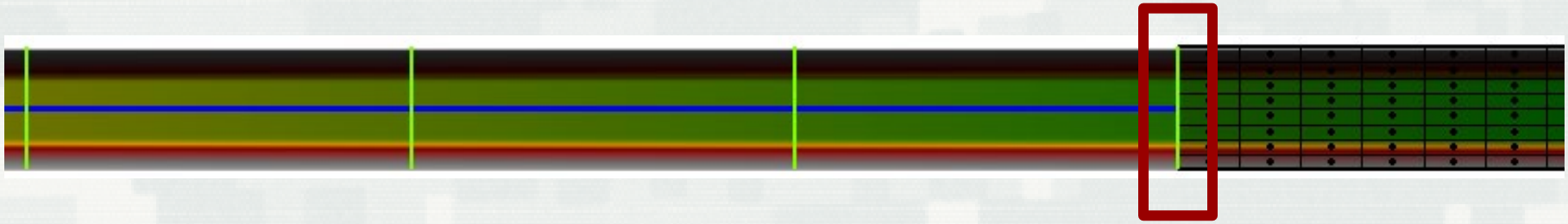

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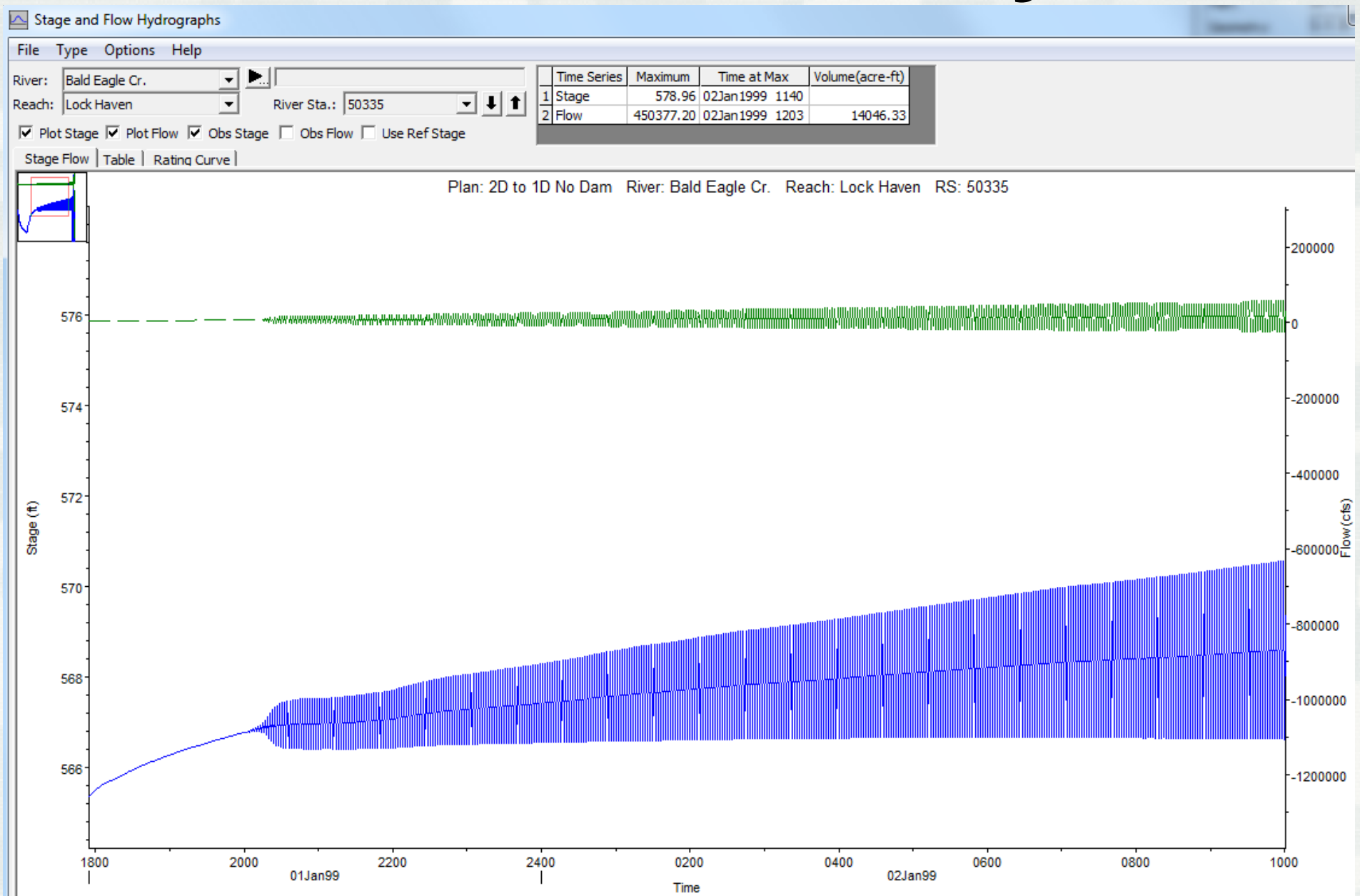
Diagnostic

2D to 1D Instability



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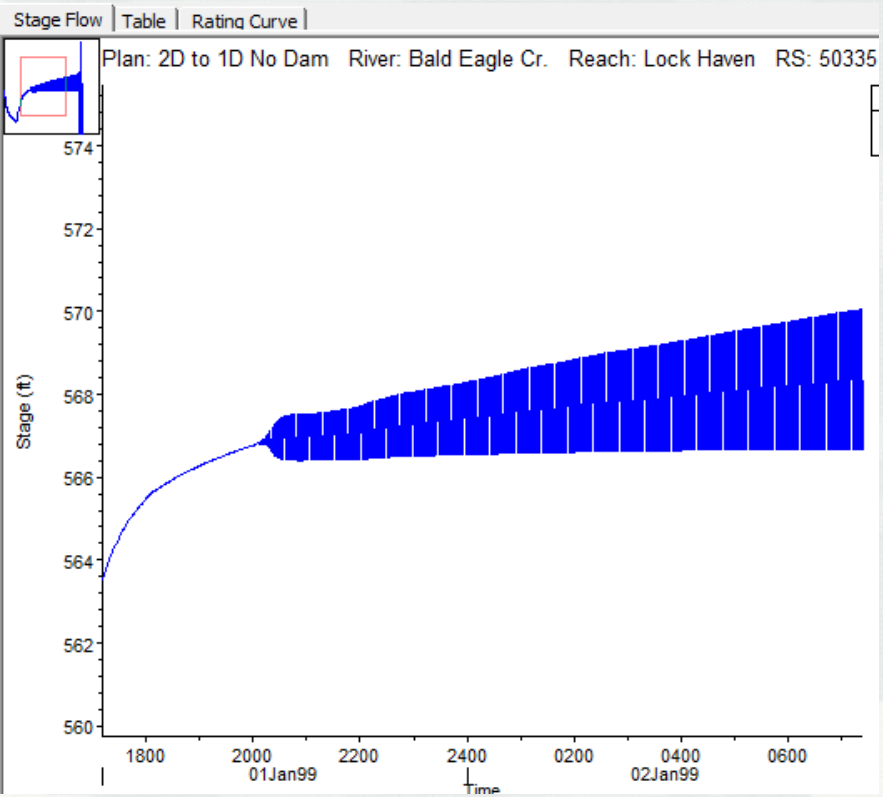
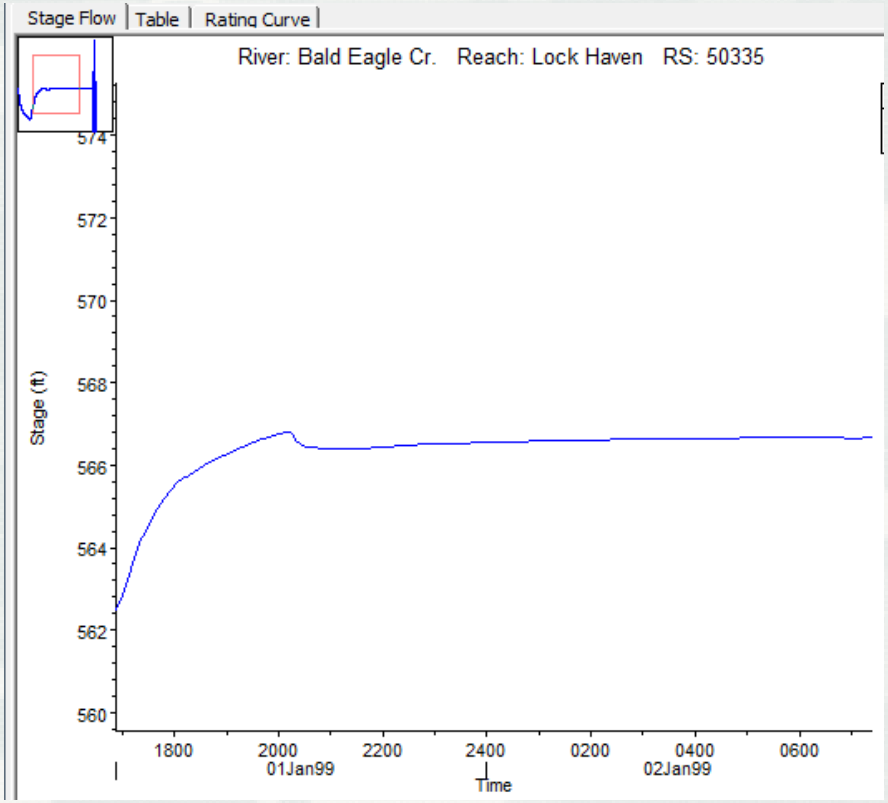
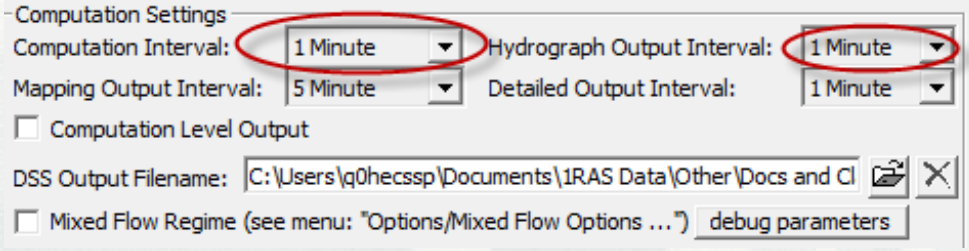
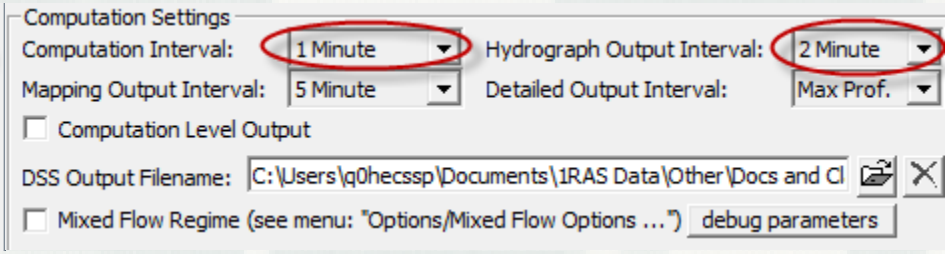
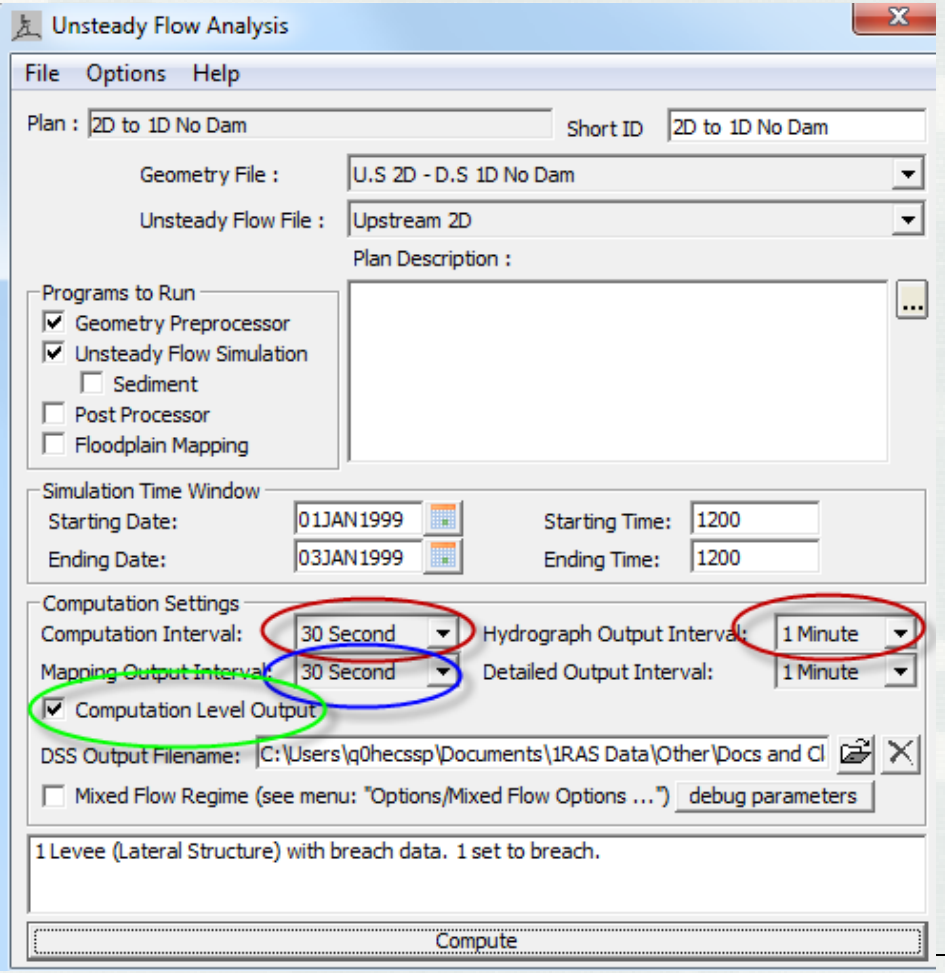






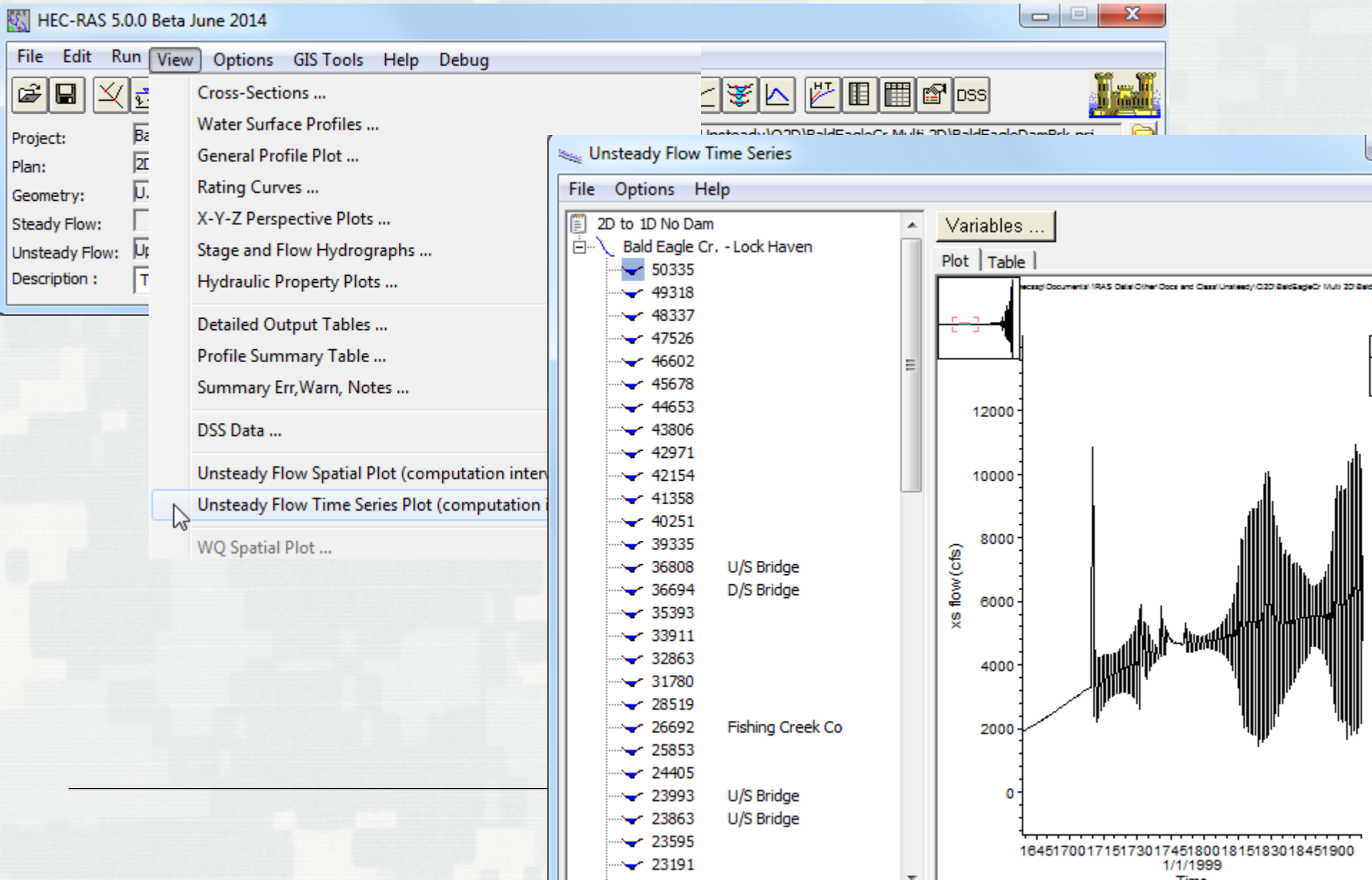


Output Options



- 30 Sec Time Step
- Hydrograph [DSS] limited to 1 Minute
- Mapping Output Interval [HDF5] can be same as computation
- Use Computation Level Output

Computation Level Output



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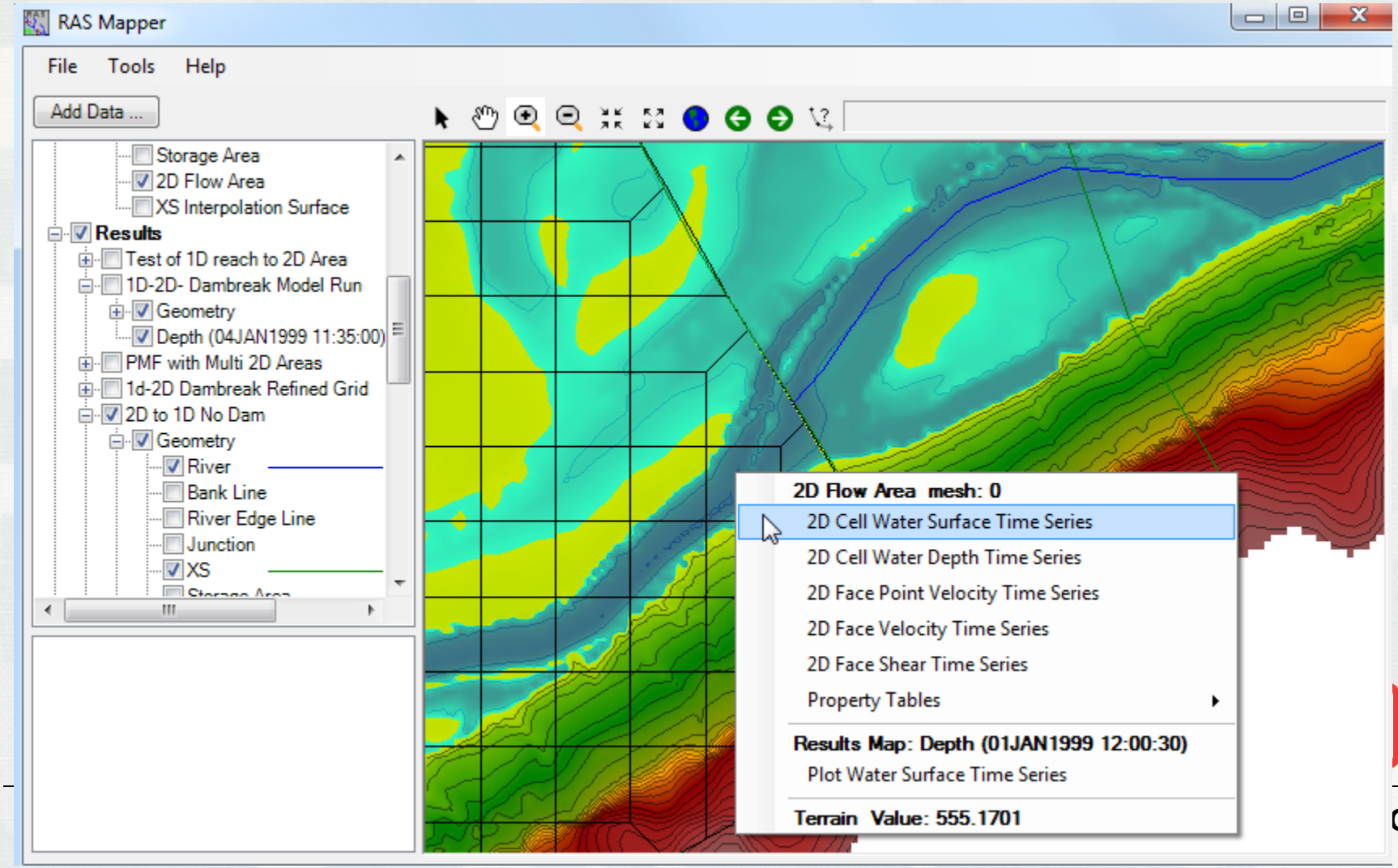

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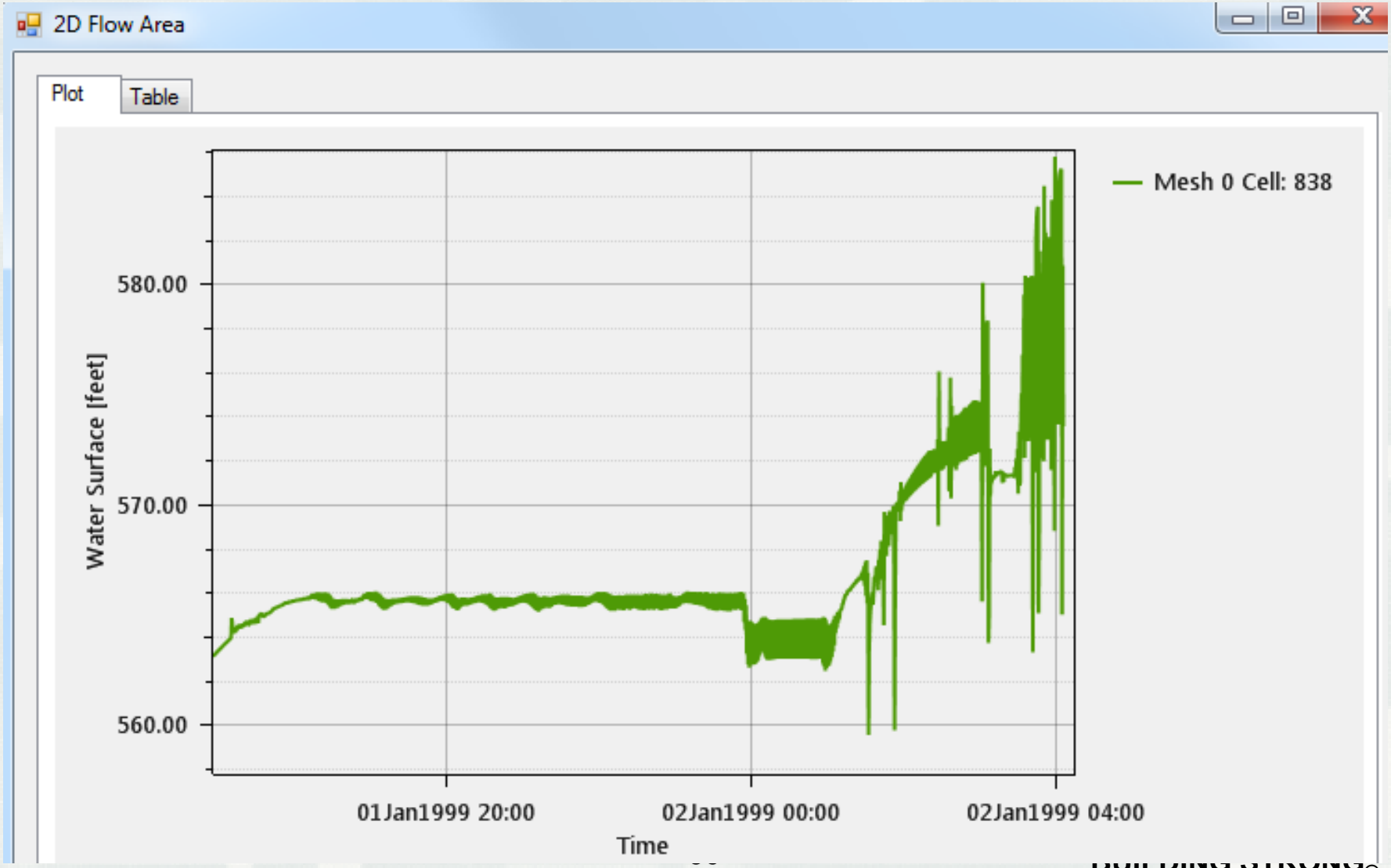

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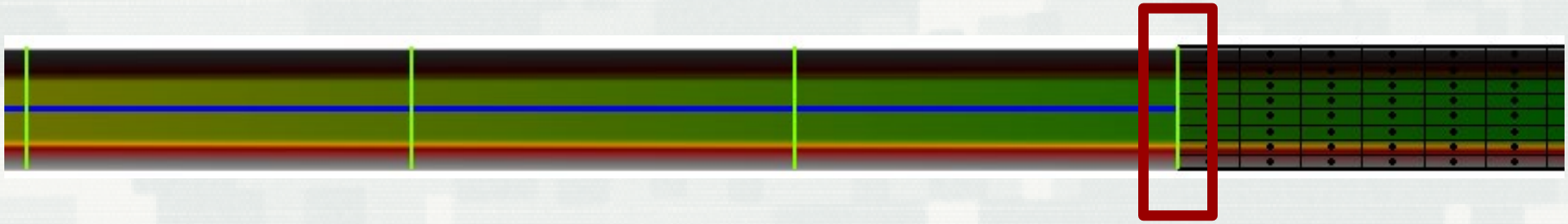

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