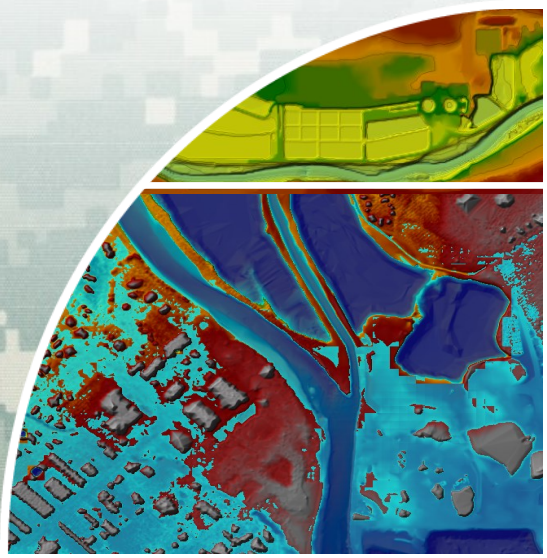
1D/2D Direct Connections: Transitioning between 1D and 2D Channels

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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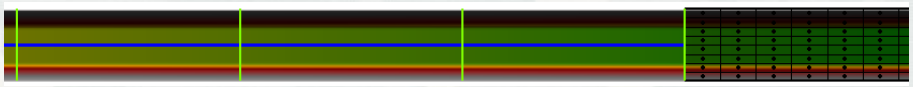

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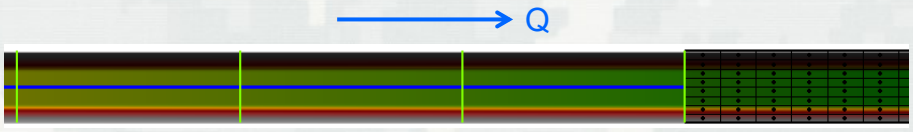
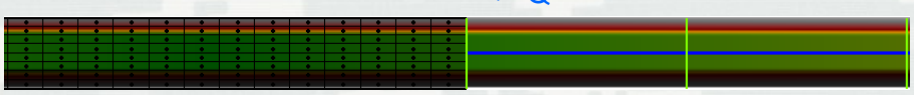
1D-2D Connection



2D-1D Connection



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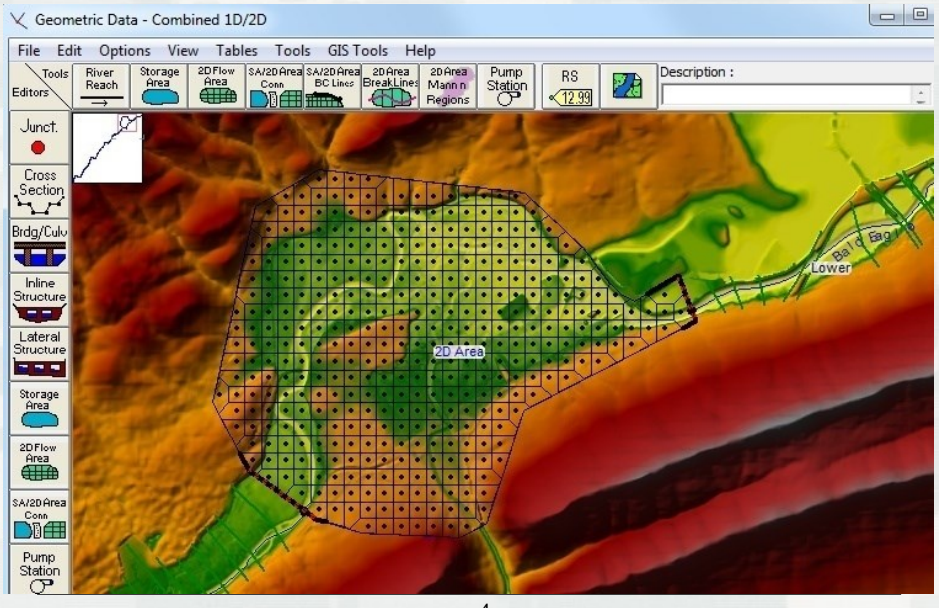
1D to 2D to 1D Connection



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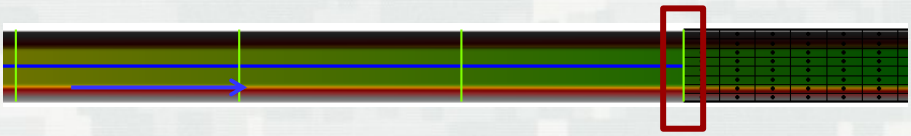
Three Critical Take-Aways:
Managing Instabilities at 1D-2D Transitions



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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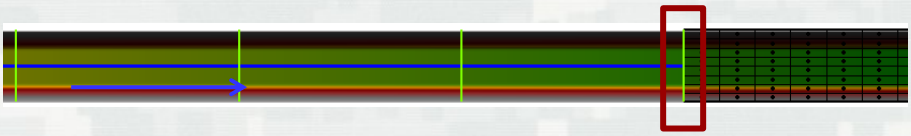

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Requirements for Connecting 1D to 2D Channels Directly

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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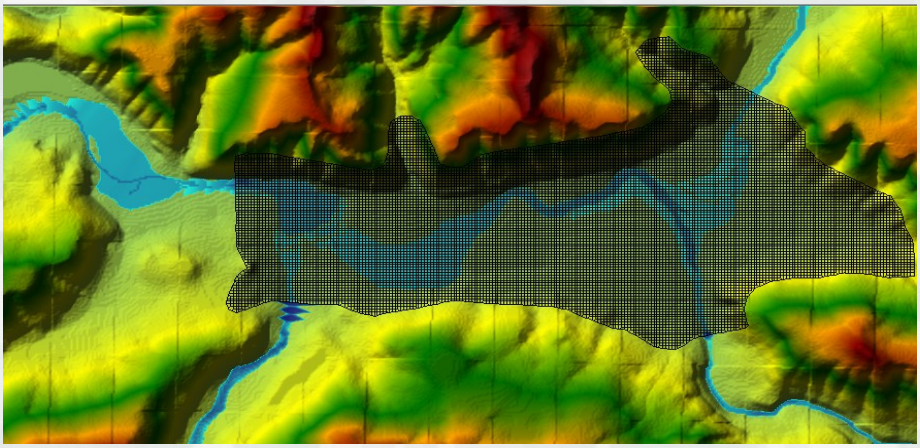

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1D/2D Locations

- 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

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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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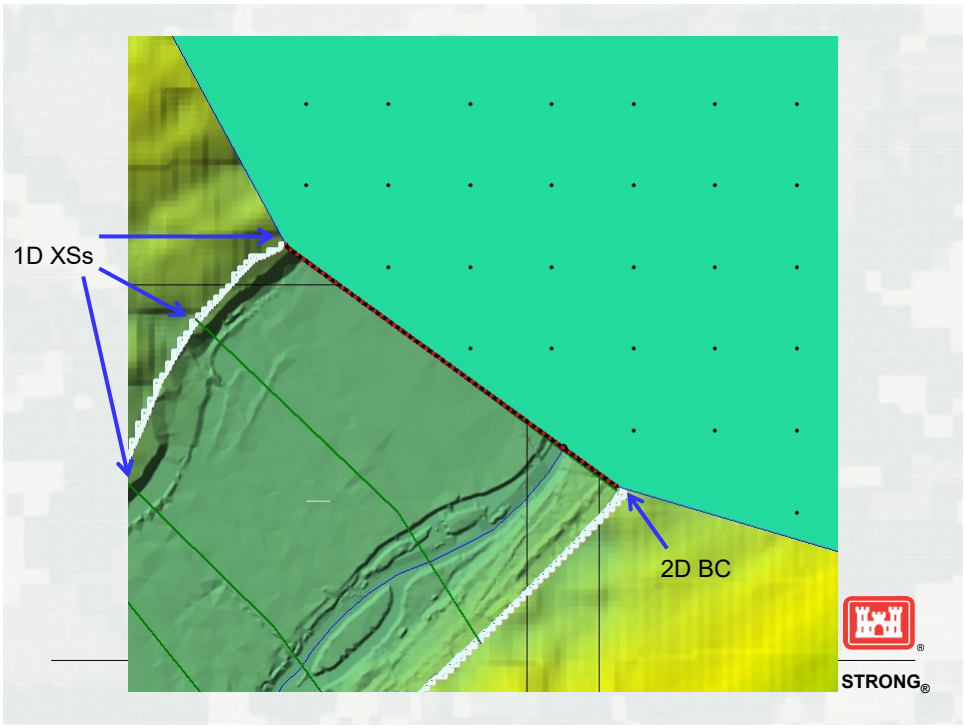

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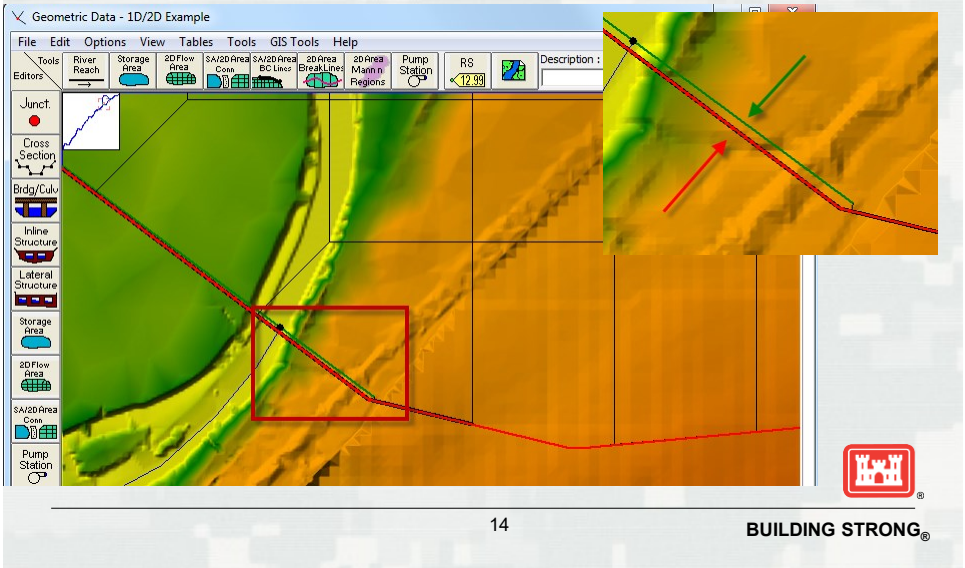
Checking 1D/2D Boundary



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Requirements for Connecting 1D to 2D Channels Directly

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

Why is this so important?

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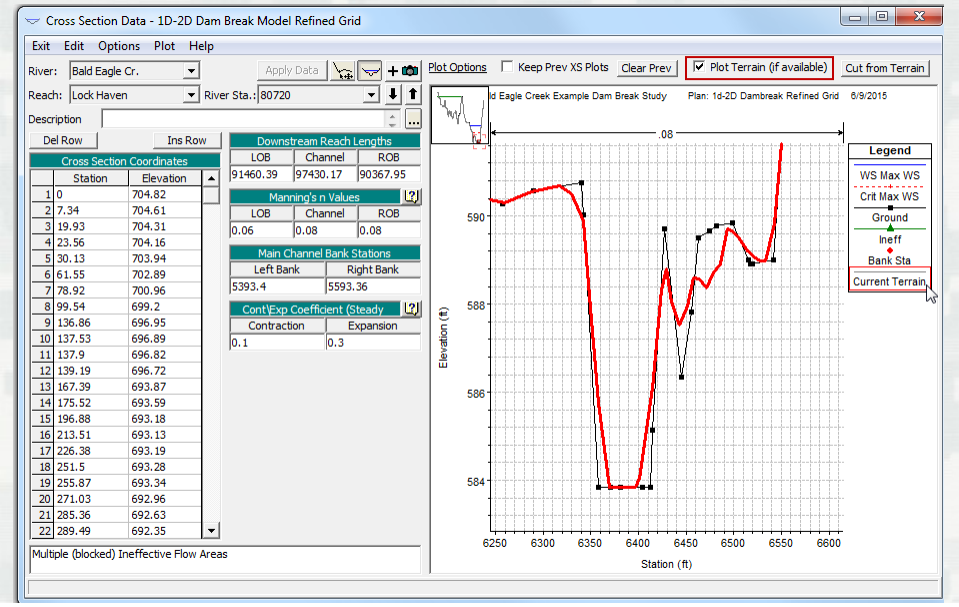
1D Sta/Elev vs Terrain



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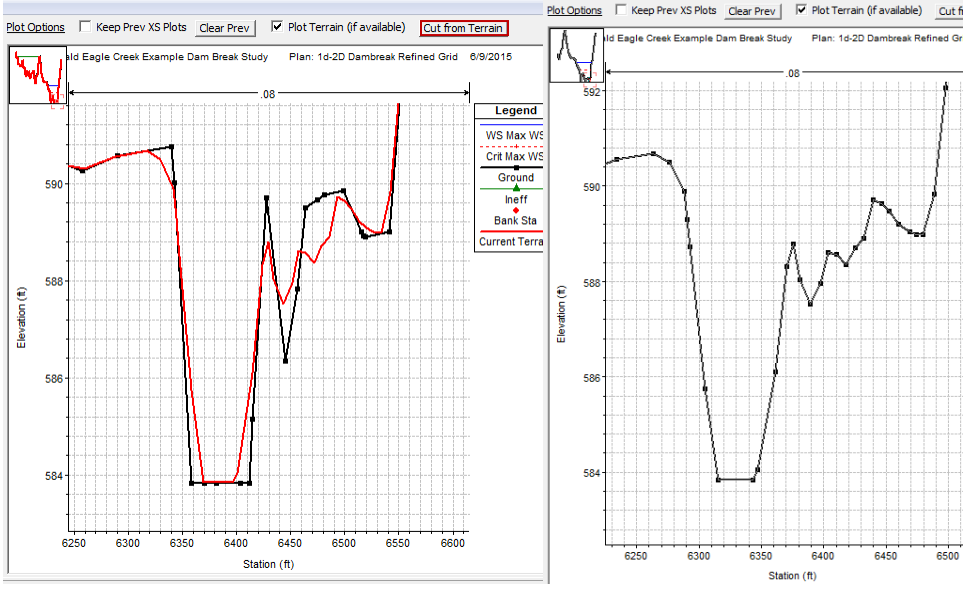
Update1D Sta/Elev



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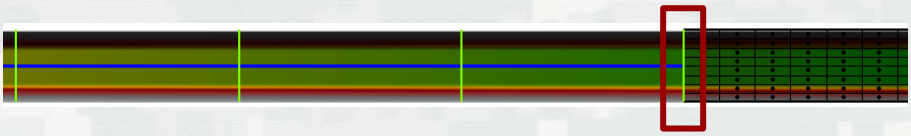
Three Critical Take-Aways:
Managing Instabilities at 1D-2D Transitions



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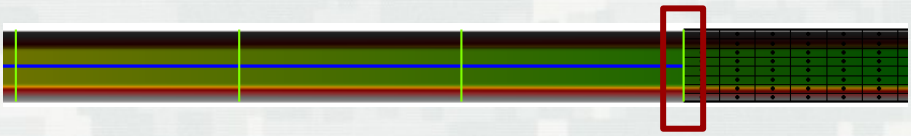

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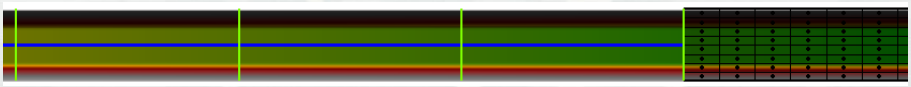
1D/2D Solution Overview



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

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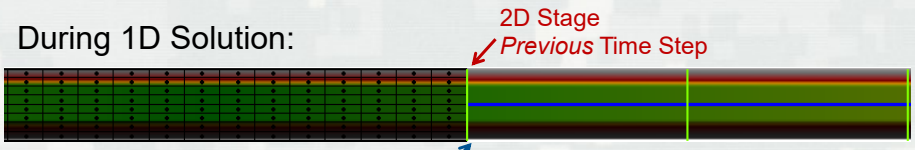
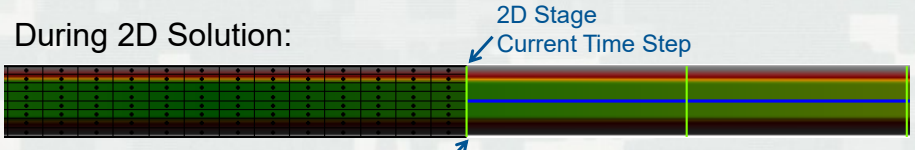
1D/2D Solution Overview

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.

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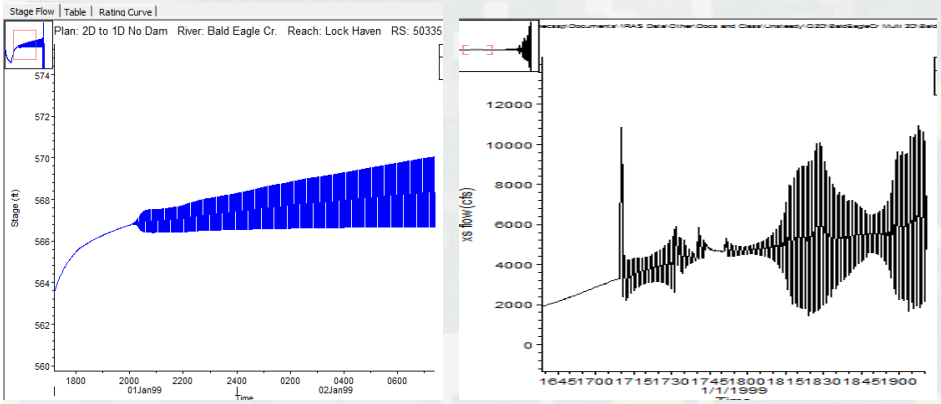
Discontinuity between 1D and 2D results at the transition can cause instabilities:

Boundary instabilities can cause oscillate



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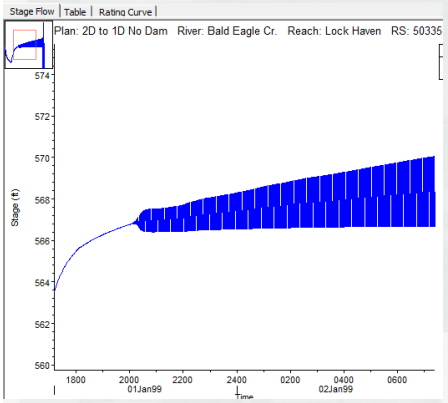
That's fascinating…

…How do you fix it?



- 1D/2D Iterations
- Smaller Time Step

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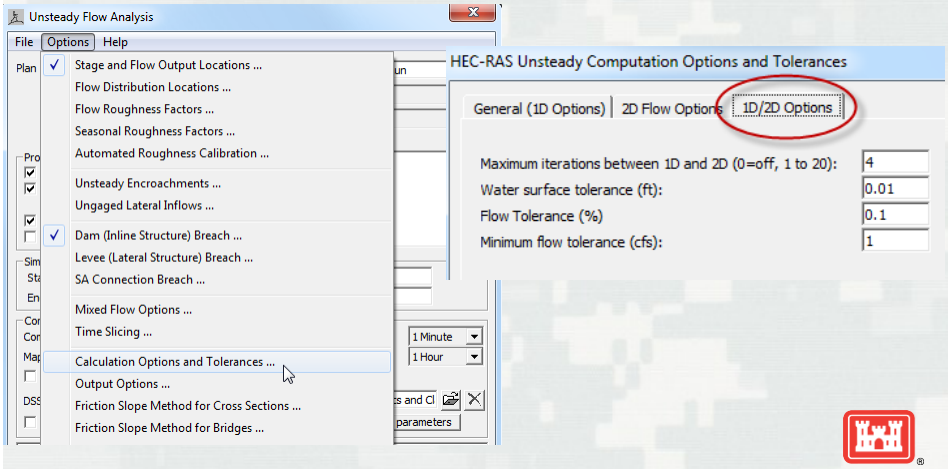
1D/2D Iterations



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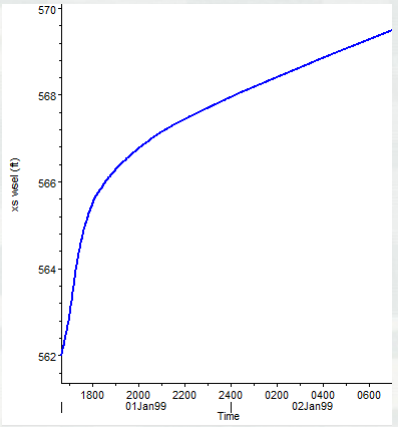
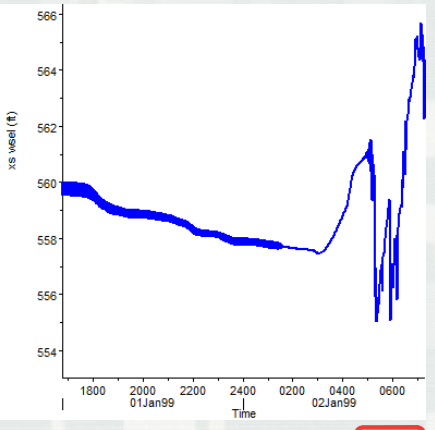
1D/2D Iterations

- 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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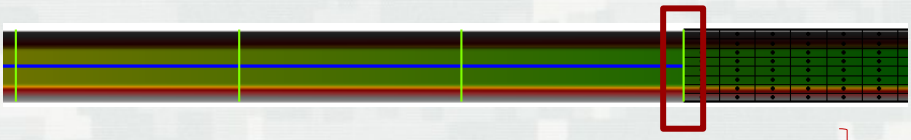

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Causes

3. Output choices can mask instabilities at the boundaries.

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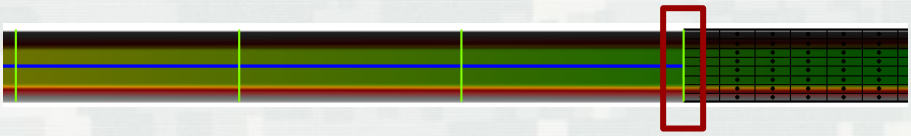

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Diagnostic

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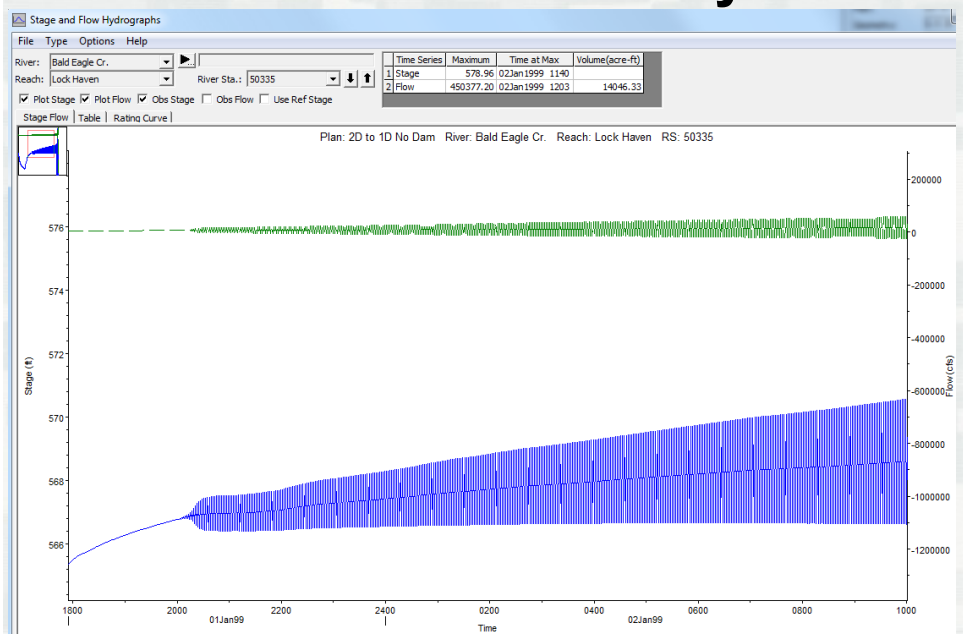
2D to 1D Instability



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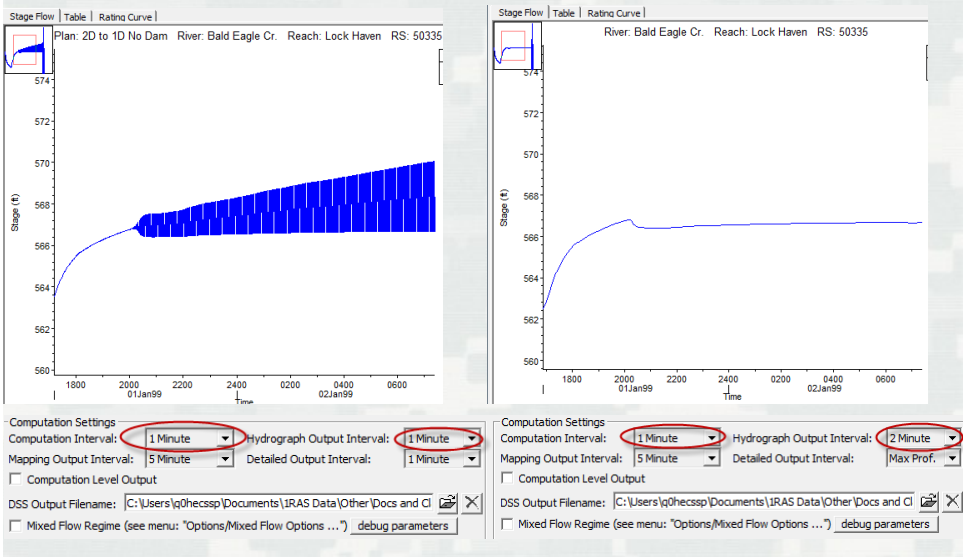
2D to 1D Instability



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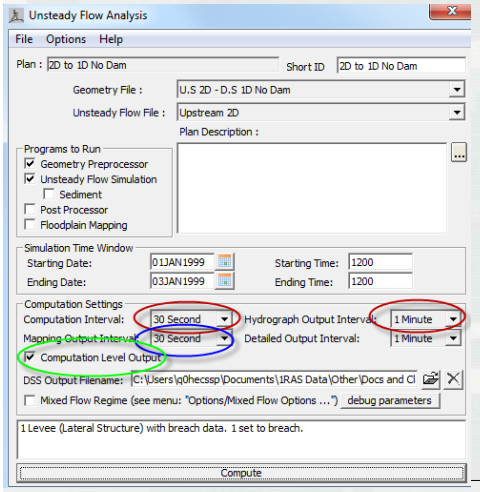
Output Options



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

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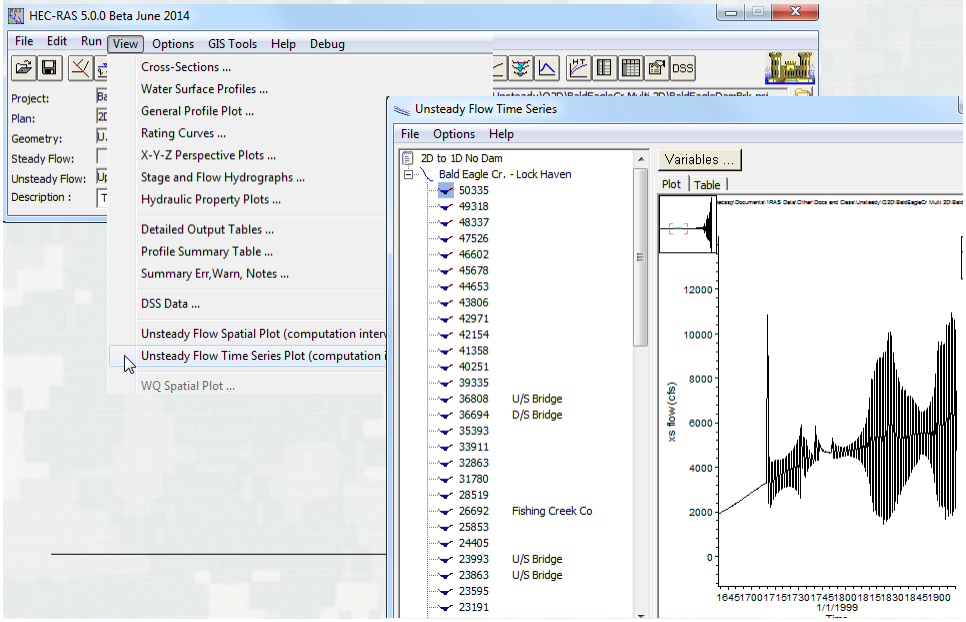
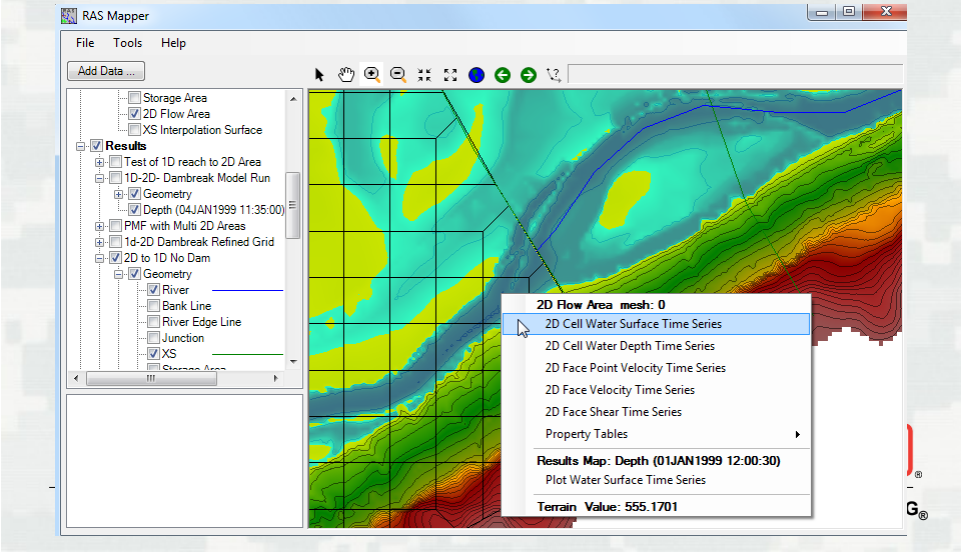
Computation Level Output



2D to 1D Instability



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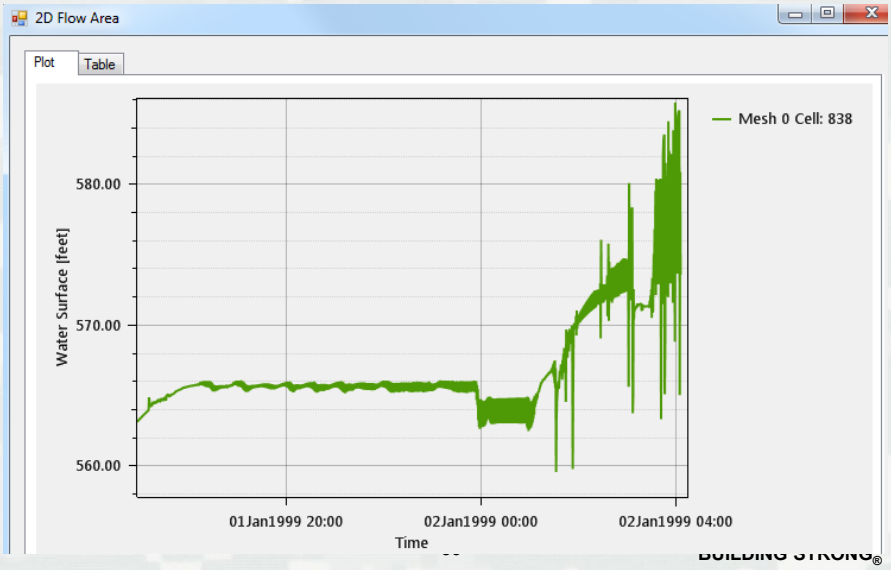
2D to 1D Instability



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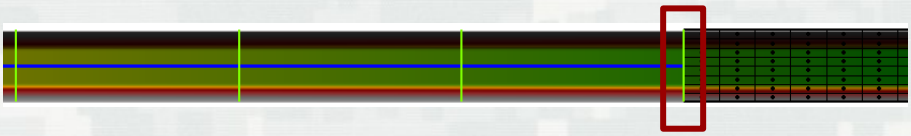

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