

# SA/2D Connections

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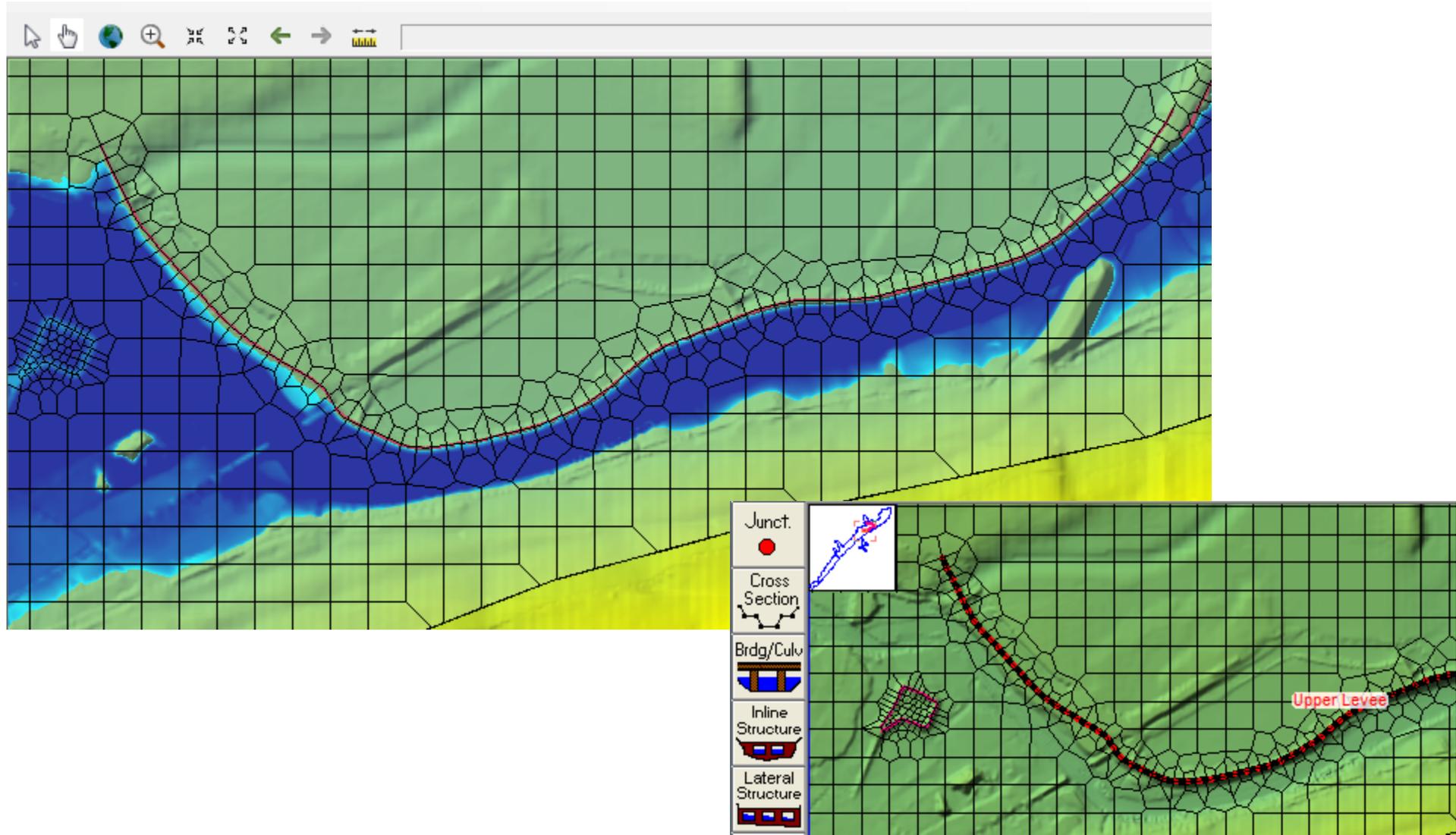


# Internal SA/2D Area Conn

- Discuss using SA/2D Area Conn inside of 2D areas
  - **aka Hydraulic Structures (HS)**



# Hydraulic Structure Example





# Hydraulic Structures (HS)

- User entered station/elevation data overrides terrain data
- Can add breaches
- Can add culverts and gates
  - **Culvert/Gates can be georeferenced**
- Can model with weir equation or 2D equation
- HS centerline is also a breakline



# Levees With HS

- **When:**
  - Bad Terrain data
  - Structure too high for 2D equations (i.e. water fall), Weir equation is a better solution
  - Need Culverts, Gates, or Breaching
- Create the HS and enter the Station/Elevation (SE) data
- The user entered SE data controls the flow over the structure



# “Levees” Without HS

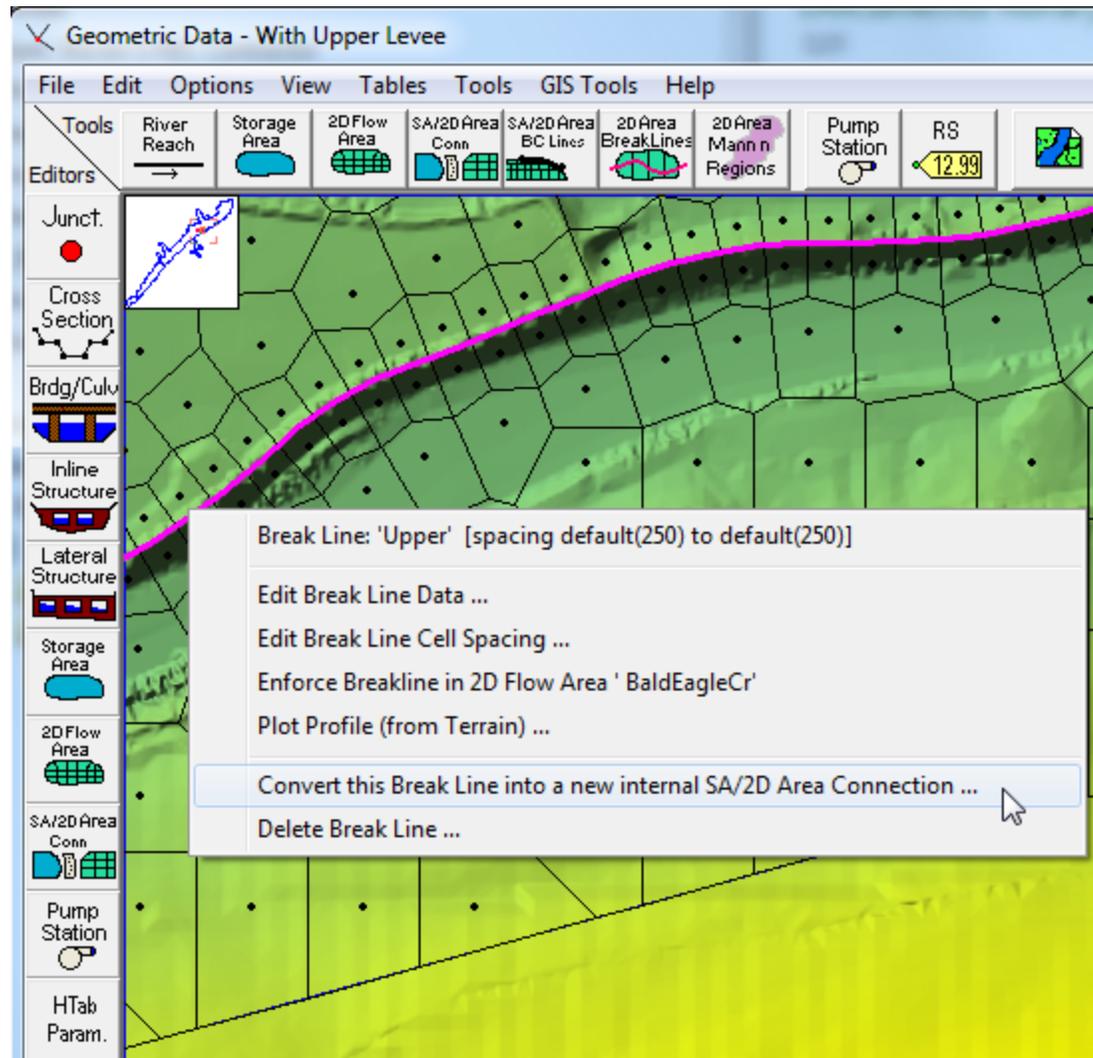
- Breaklines may be all that is needed!
- **IF**
  - The terrain data is good enough
  - The Faces line up accurately
  - Normal 2D Equation is appropriate
  - No culverts, gates, breaches, etc.
- **THEN**
  - No HS required!



# Overview Data Entry

- Create HS Centerline
  - Convert existing breakline (if breakline already exists)
  - Download centerline (if available)
  - Or draw by hand
- HS goes left to right looking downstream (for positive flow convention)
- Edit Centerline/Breakline and Cell Mesh, as needed (the centerline is also a breakline)
- Enter station/elevation of weir
- Enter culverts, gates, breach, etc.
- Select 2D Domain or Weir Eq.

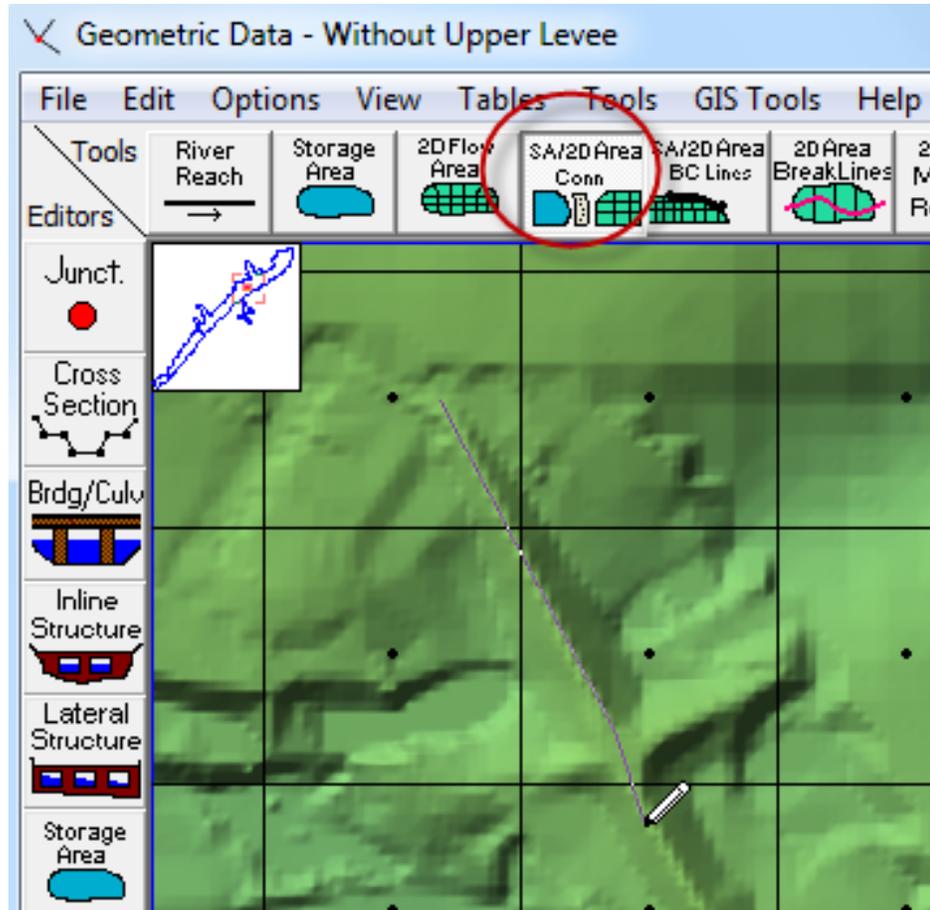
# Converting a Breakline



- If a Breakline has already been created, then it can be converted to a hydraulic structure.
- Left-click on the Breakline and select **Convert...**



# Drawing HS Centerline



- Click **SA/2D Conn** and draw the location of the HS
- Double-click to finish drawing and name the HS
- Copy coordinates from Excel



# HS Centerline Table



The screenshot shows the HEC-HMS software interface. The main window is titled "Geometric Data - Without Upper Levee". The "GIS Tools" menu is open, showing various options. The "SA Connections Centerlines GIS Coordinates" dialog box is also open, showing a list of names and a table for selected area edit options.

**GIS Tools Menu:**

- Reach Invert Lines Table ...
- XS Cut Lines Table ...
- Lateral Structures Centerlines Table...
- Storage Area/2D Flow Area Outlines Table ...
- Storage Area/2D Flow Area Outlines Filter (multiple) ...
- Storage Area/2D Flow Area Connection Centerline Table ...
- 2D Flow Area Boundary Condition Lines ..
- Breaklines Cell Spacing Table...
- Breaklines Coordinates Table...
- Land Cover Regions Table...
- GIS Levee Lines Table ...
- GIS Ineffective Area Lines ...
- Stream Node (River Station) ...
- GIS Cut Lines
- Scale Cut Lines to Reach L...
- GIS Coordinate Operations ...
- Plot GIS Profile Reach Bou...
- Limit GIS Bounds to Bridge...
- Plot GIS Reach Bounds fro...
- Make GIS Ticks ...

**SA Connections Centerlines GIS Coordinates Dialog:**

Names (Select one or Many):

- Dam
- Lower Levee
- Middle Levee
- Upper Levee

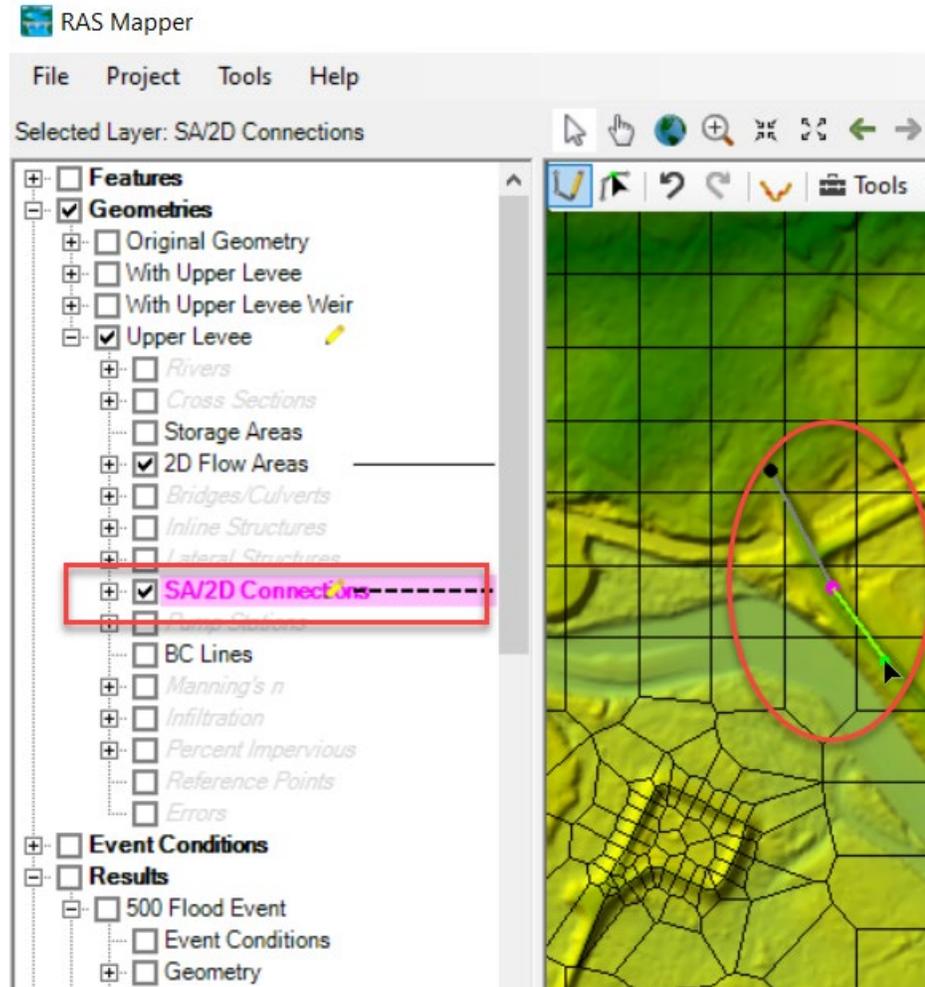
Selected Area Edit Options:

Add Multiply Set Values Replace Round

	X (ft)	Y (ft)
1		

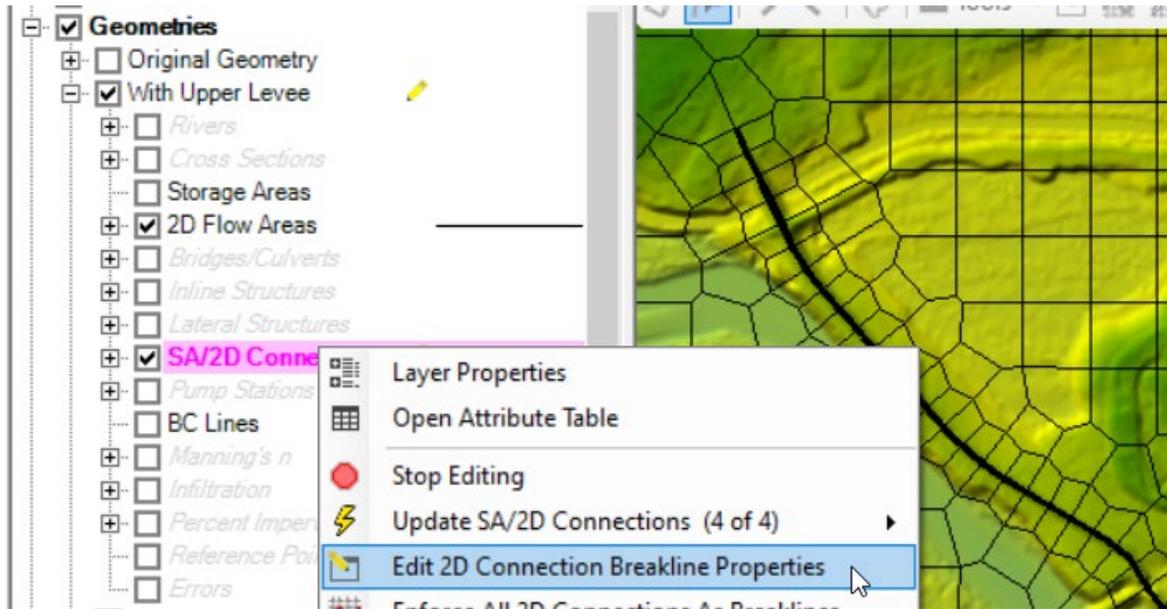
Buttons: Import Lines, Filter Line(s), Lengths, OK, Cancel

# HS Centerline w/ Editing Tools

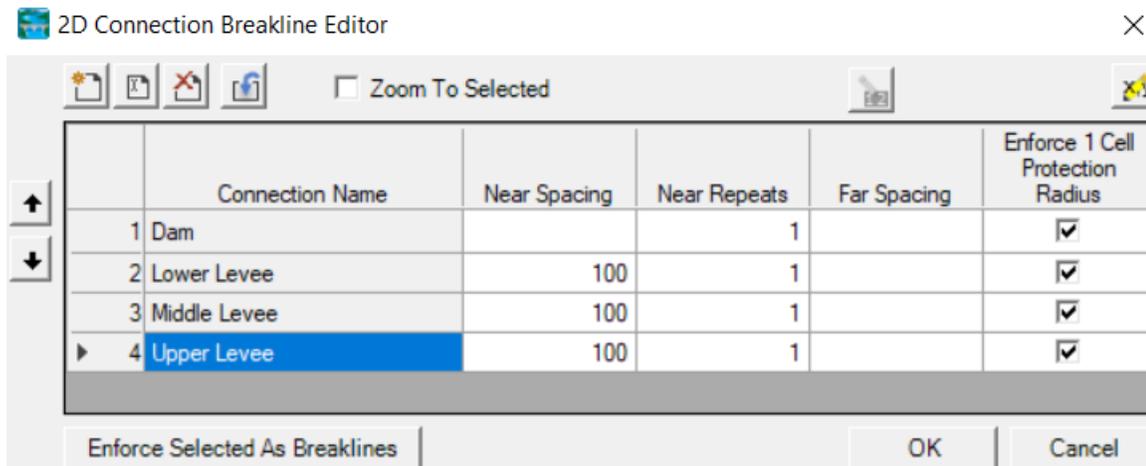


- CL can also be added from RASMapper
- Click **SA/2D Conn** and draw the location of the HS
- Double-click to finish drawing and name the HS
- Or CL can be imported as shapefile
- Weir SE data still on 2D Conn Editor/Geom Editor

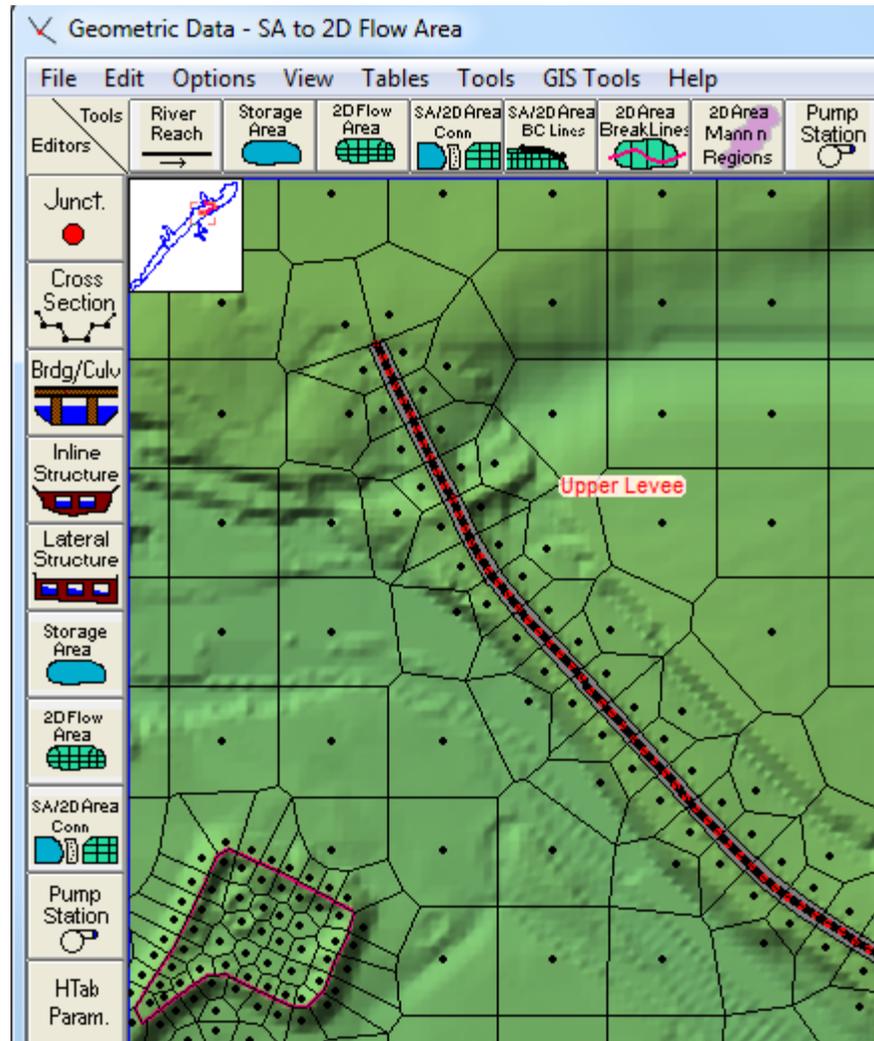
# HS Cell Spacing



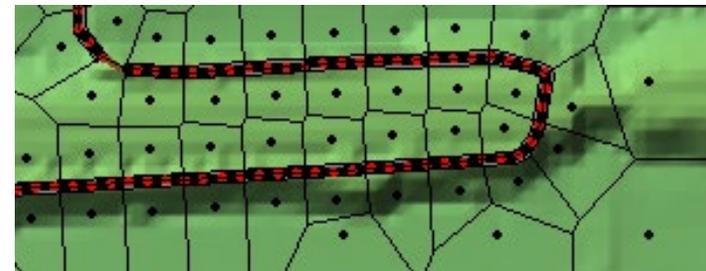
- HS/Breakline can be enforced while still in Edit mode
- Additional Cells can be added along the HS centerline
- Cell spacing should not be made too small!



# Inspect Cells Around HS

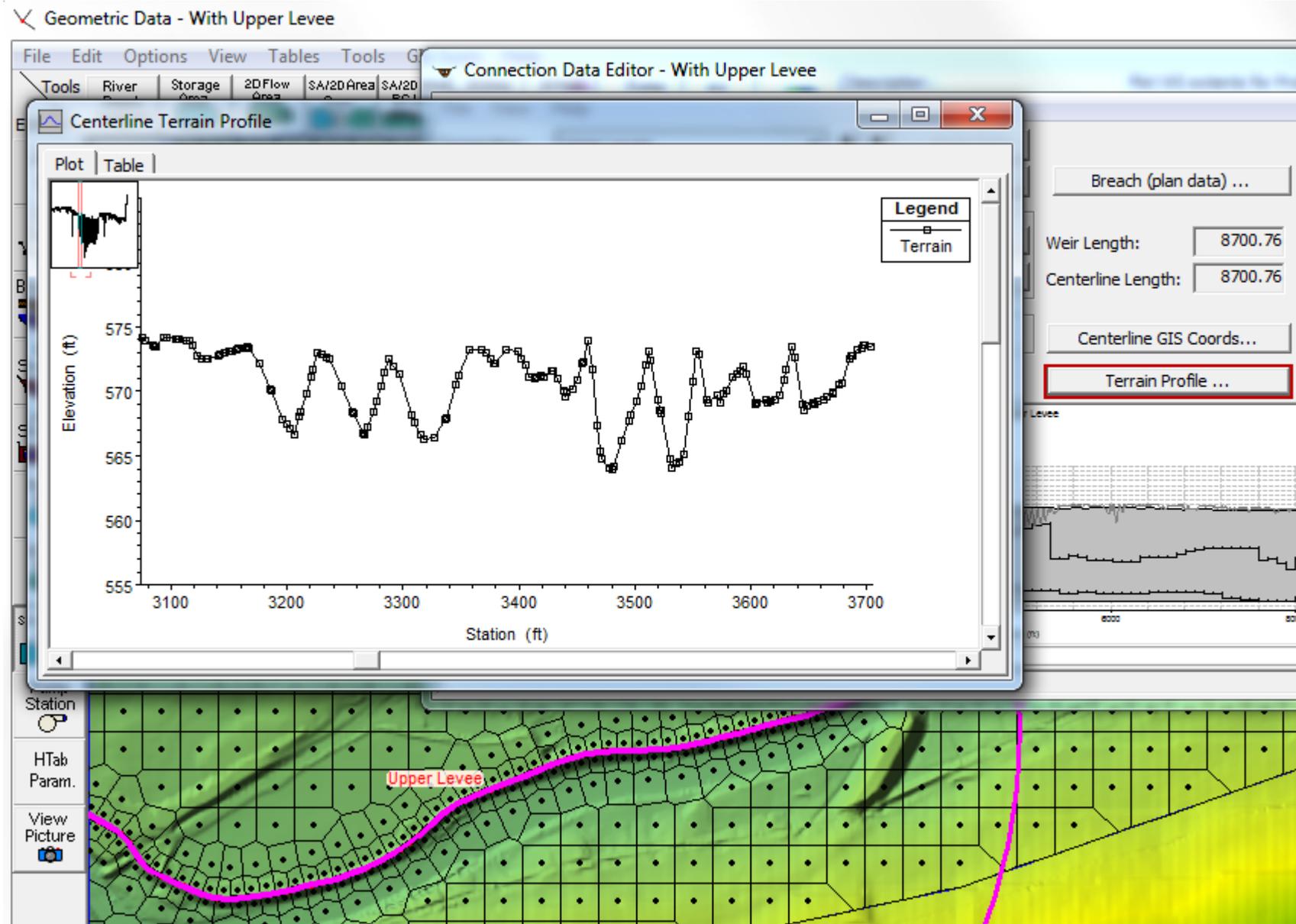


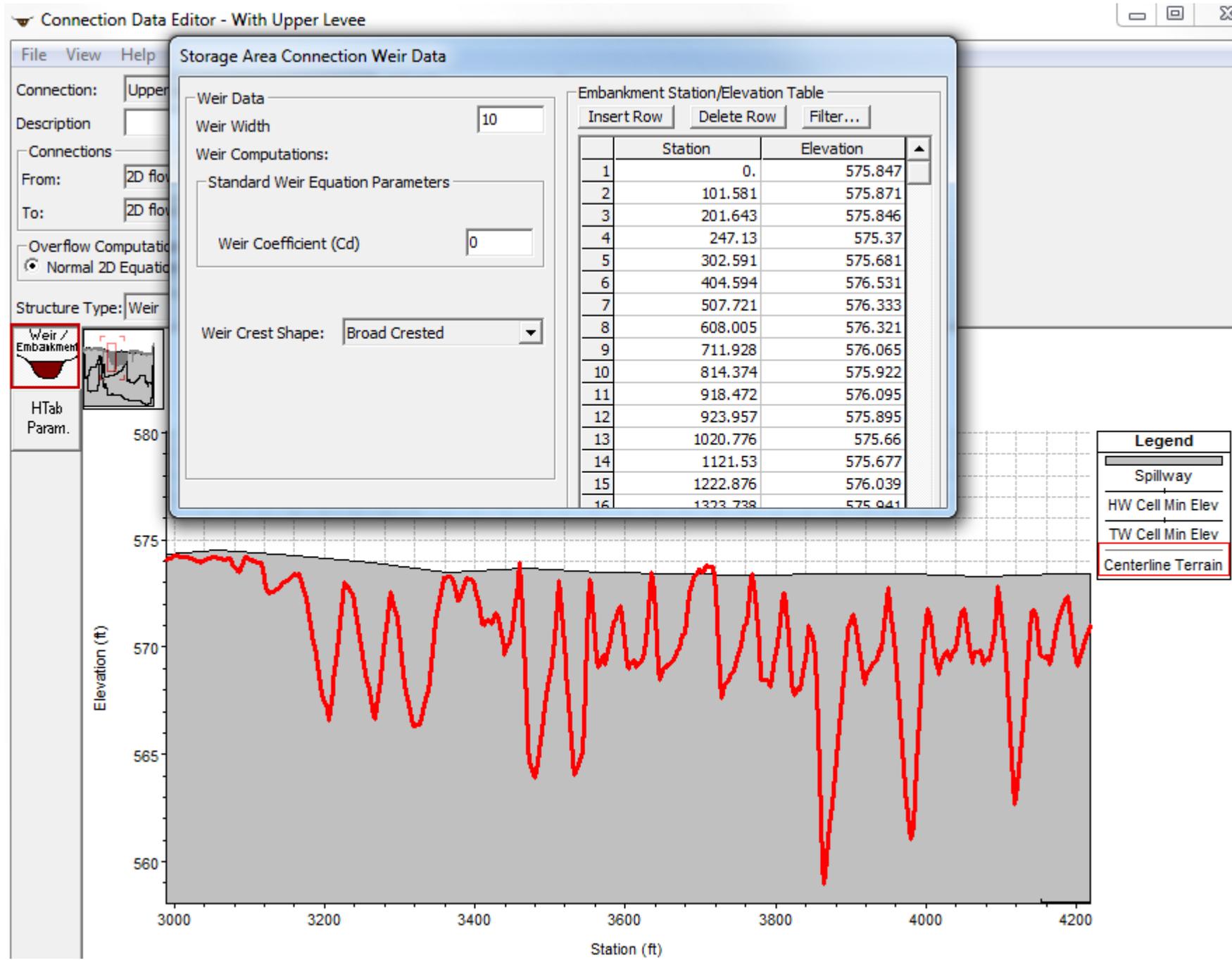
- RAS will show the HS as a black line w/ red dots
- Inspect the line for problems
  - **Start/End of HS!**
  - **Tight Curves**





# Terrain CL Profile Missing Levee







# Check Weir/GIS Length

✕ Edit and/or create lateral structures

File Edit Options View Tables Tools GIS Tools Help

Tools River Reach Storage Area 2D Flow Area SA/2D Area Conn SA/2D Area BC Lines 2D Area BreakLines 2D Area Mann n Regions Pump Station RS 12.99 Description : Plot WS extents for Profile: (none)

Editors Junct. Cross Section Brdg/Culv Inline Structure Lateral Structure Storage Area 2D Flow Area SA/2D Area Conn Pump Station HTab Param. View Picture

Connection Data Editor - With Upper Levee

File View Help

Connection: Upper Levee Apply Data

Description Breach (plan data) ...

Connections

From: 2D flow area: BaldEagleCr Set SA/2D ... Weir Length: 8700.76

To: 2D flow area: BaldEagleCr Set SA/2D ... Centerline Length: 8700.76

Overflow Computation Method

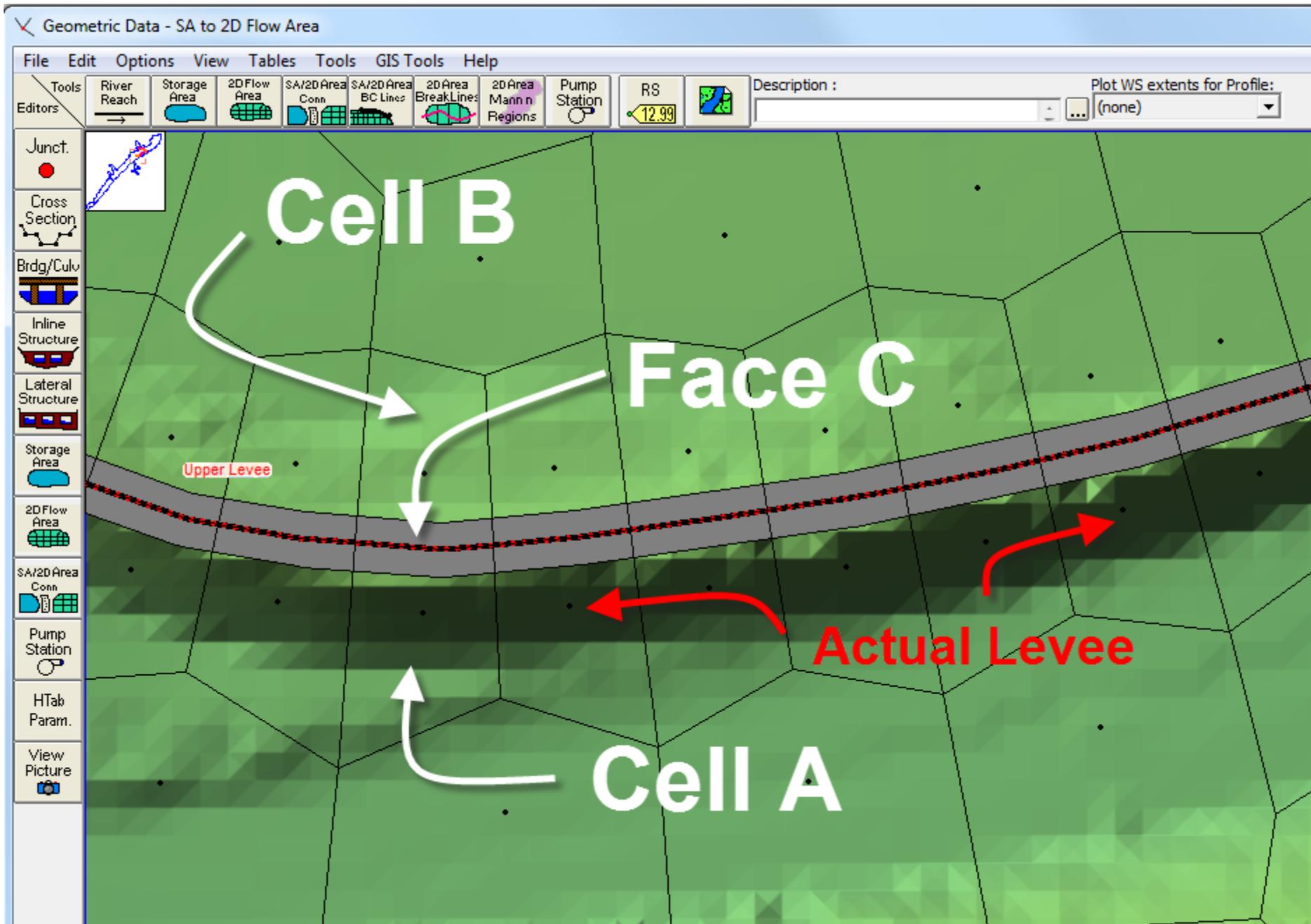
Normal 2D Equation Domain  Use Weir Equation Centerline GIS Coords... Terrain Profile ...

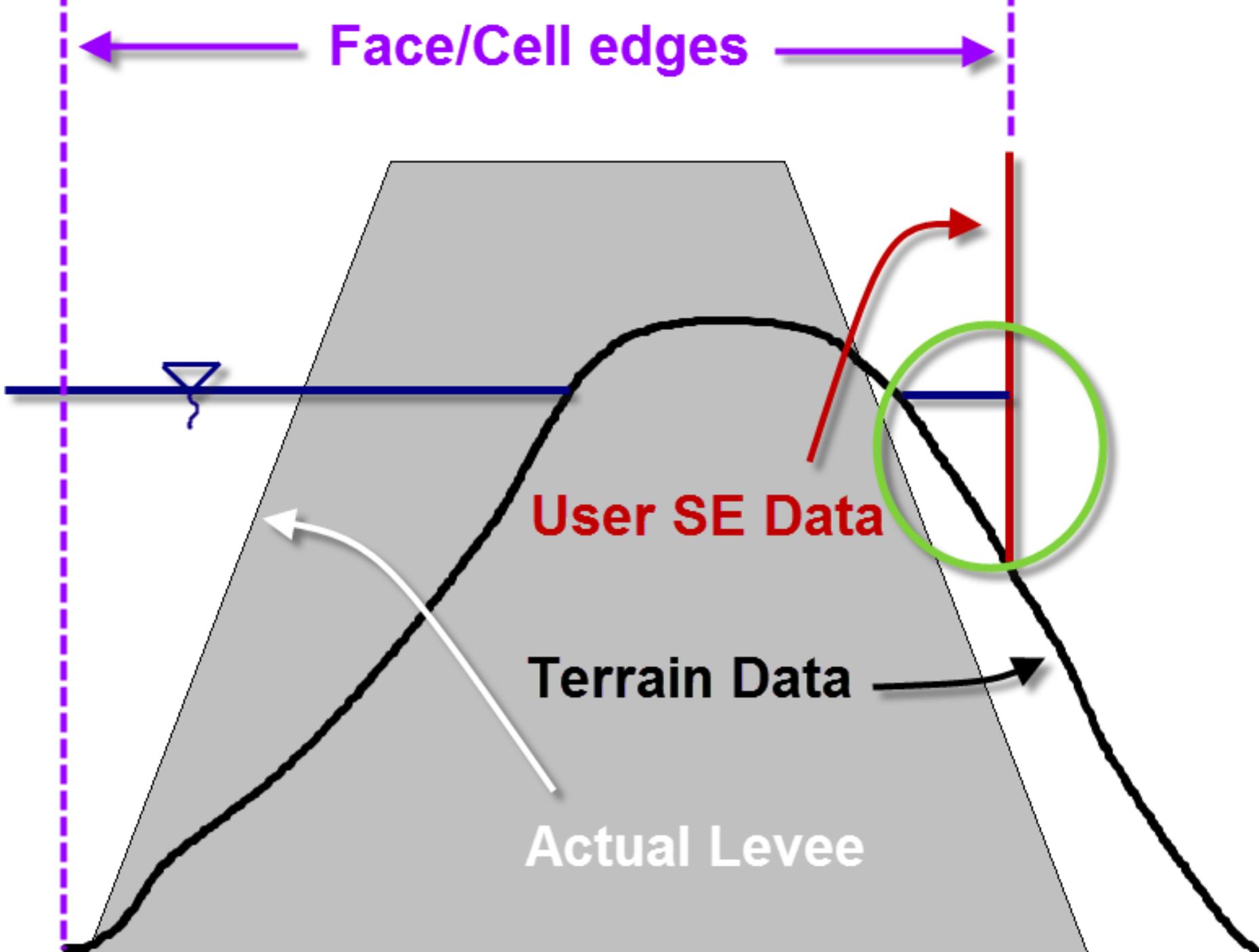
Structure Type: Weir

Weir / Embankment

HTab Param.

Select connection to Edit







# Hydraulic Structures Options



Geometric Data - Single 2D Area - Dam as Internal Struct

File Edit Options View Tables Tools GIS Tools Help

Tools River Reach Storage Area 2D Flow Area SA/2D Area Conn SA/2D Area BC Lines 2D Area Break Lines 2D Area Mann n Regions

Editors

Junct. Cross Section Brgd/Culv Inline Structure Lateral Structure Storage Area 2D Flow Area SA/2D Area Conn Pump Station HTab Param. View Picture

Connection Data Editor - Single 2D Area - Internal Dam Structure

File View Help

Connection: Sayers Dam Apply Data

Description Breach (plan data) ...

Connections

From: 2D flow area: BaldEagleCr Set SA/2D ...

To: 2D flow area: BaldEagleCr Set SA/2D ...

Weir Length: 6882.06

Centerline Length: 6882.06

Centerline GIS Coords...

Terrain Profile ...

Overflow Computation Method

Normal 2D Equation Domain  Use Weir Equation

Structure Type: Weir, Gates, Culverts, Outlet RC and Outlet TS

Flap Gates: No Flap Gates

Weir / Embankment Gate Culvert Outlet RC Outlet TS

Sayers Dam

Elevation (ft)

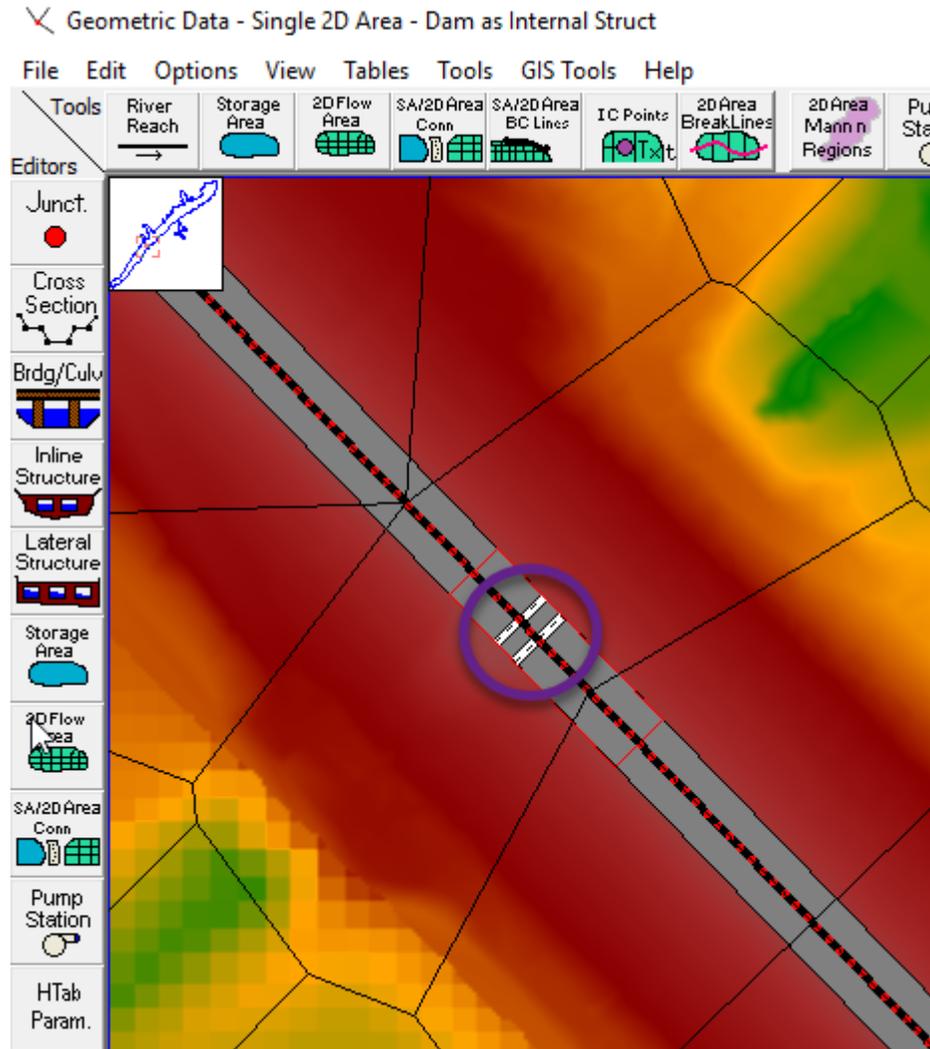
Station (ft)

Legend

- Spillway
- HW Cell Min Elev
- TW Cell Min Elev
- Centerline Terrain

Select connection to Edit

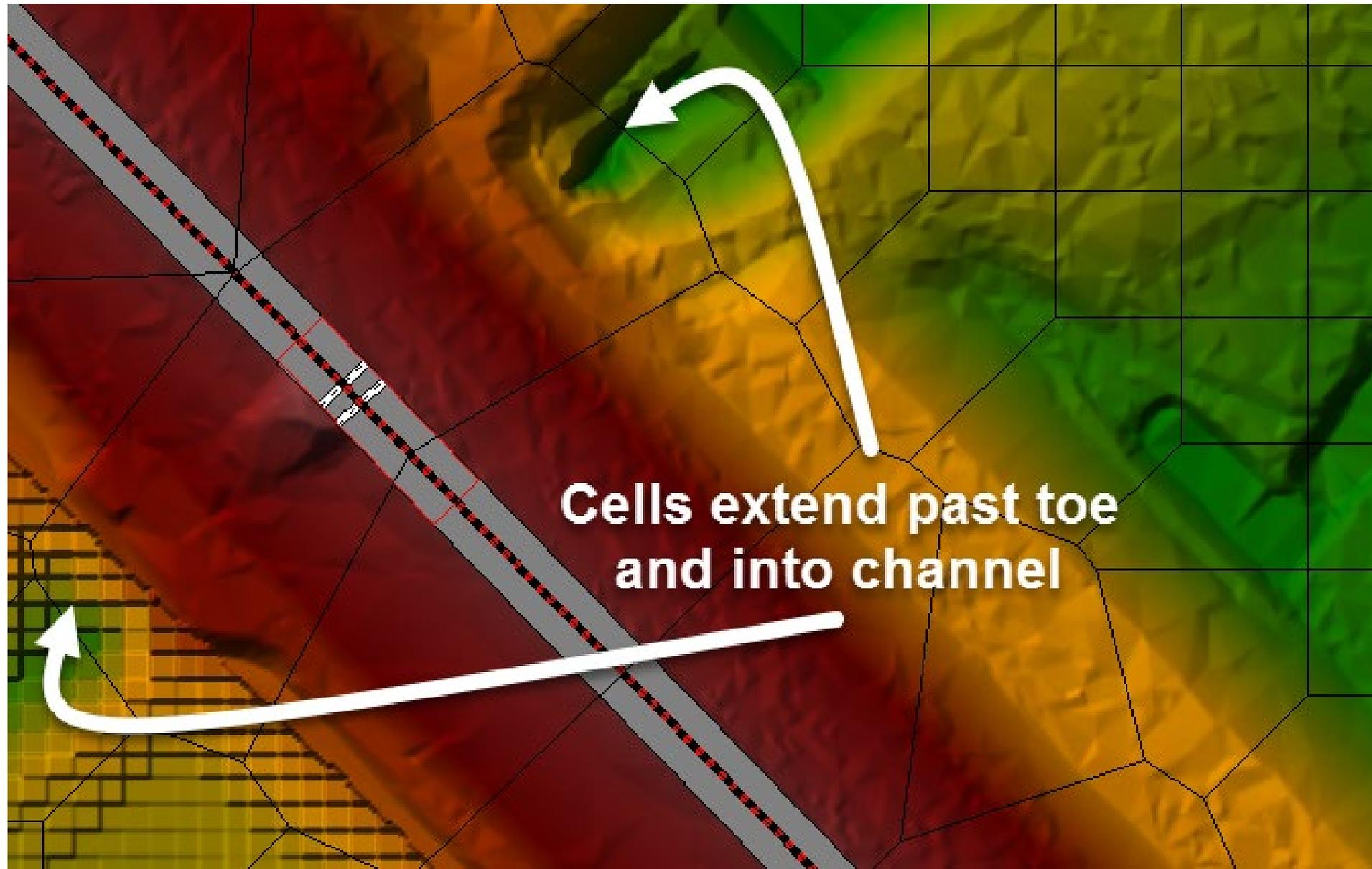
# Culverts & Gates inside a HS



- By default, culverts/gates are not georeferenced and transfer flow from immediately adjacent cells
- In this case, cells need to extend past toe and into channel

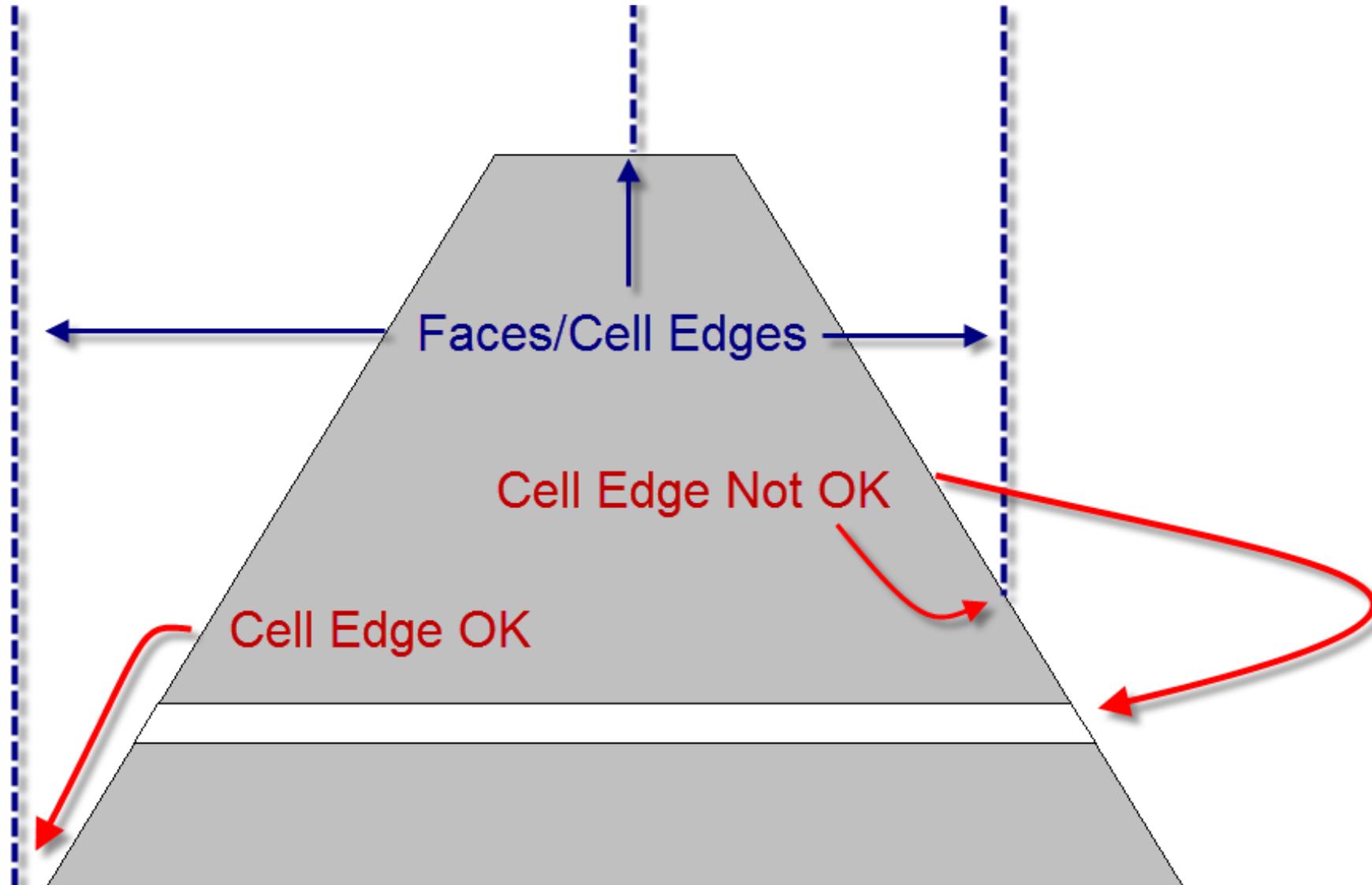


# Gates/Culverts and Cell Edges

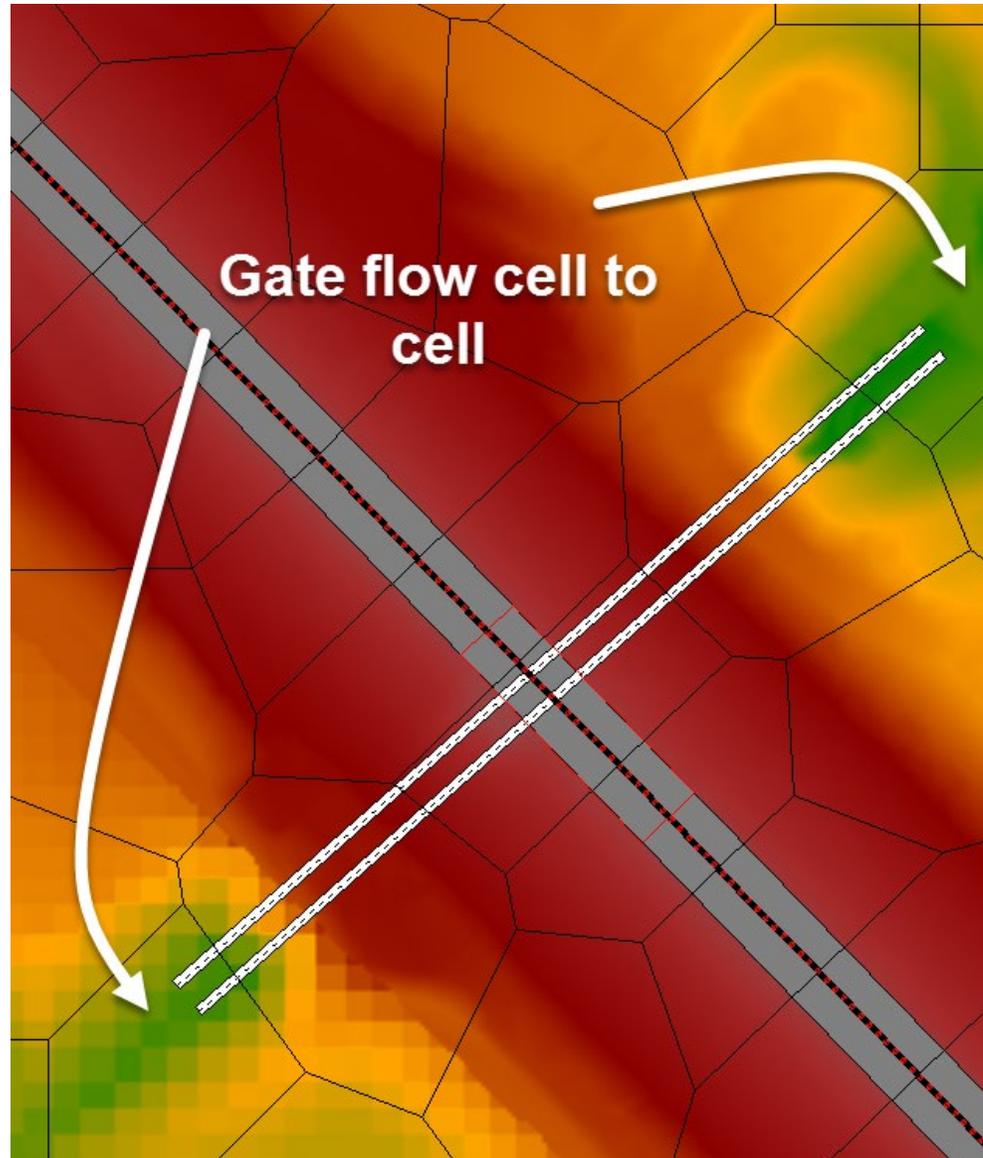




# Cell Edge Location for non-georeferenced culverts/gates



# Georeferenced Culverts & Gates



- Georeferenced culverts & gates transfer flow from distant cells
- In this case, cells do not need to extend past toe and into channel
- Small cells can still cause problems for 1D weir flow!

# Georeference Culverts & Gates

Connection Gate Editor

Gate Group: Gate #1

Gate type (or methodology): Sluice

Gate Flow

Sluice Gate Flow

Sluice Discharge Coefficient (0.5-0.7): 0.65

Weir Flow Over Gate Sill (gate out of water)

Weir Shape: Broad Crested

Weir Coefficient: 3

Submerged Orifice Flow

Orifice Coefficient (typically 0.8): 0.8

Head Reference: Sill (Invert)

Geometric Properties

Height: 15 Width: 7 Invert: 590

Opening Centerline Stations # Openings: 2

	Opening Name	Station	GIS Sta
1	Opening #1	5745	5746.035
2	Opening #2	5765	5765.018
3			
4			
5			
6			
7			

Opening GIS Data: Opening #1  
Length: 509.5

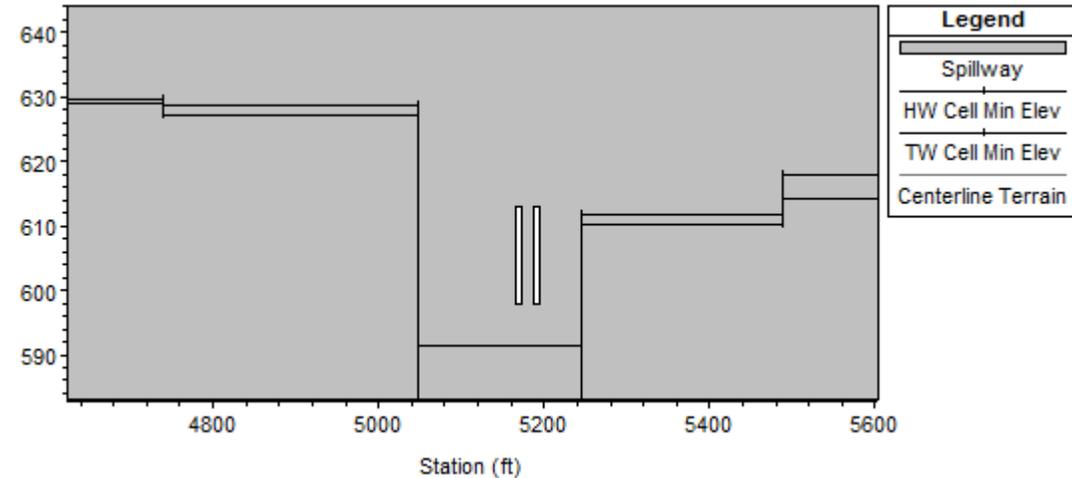
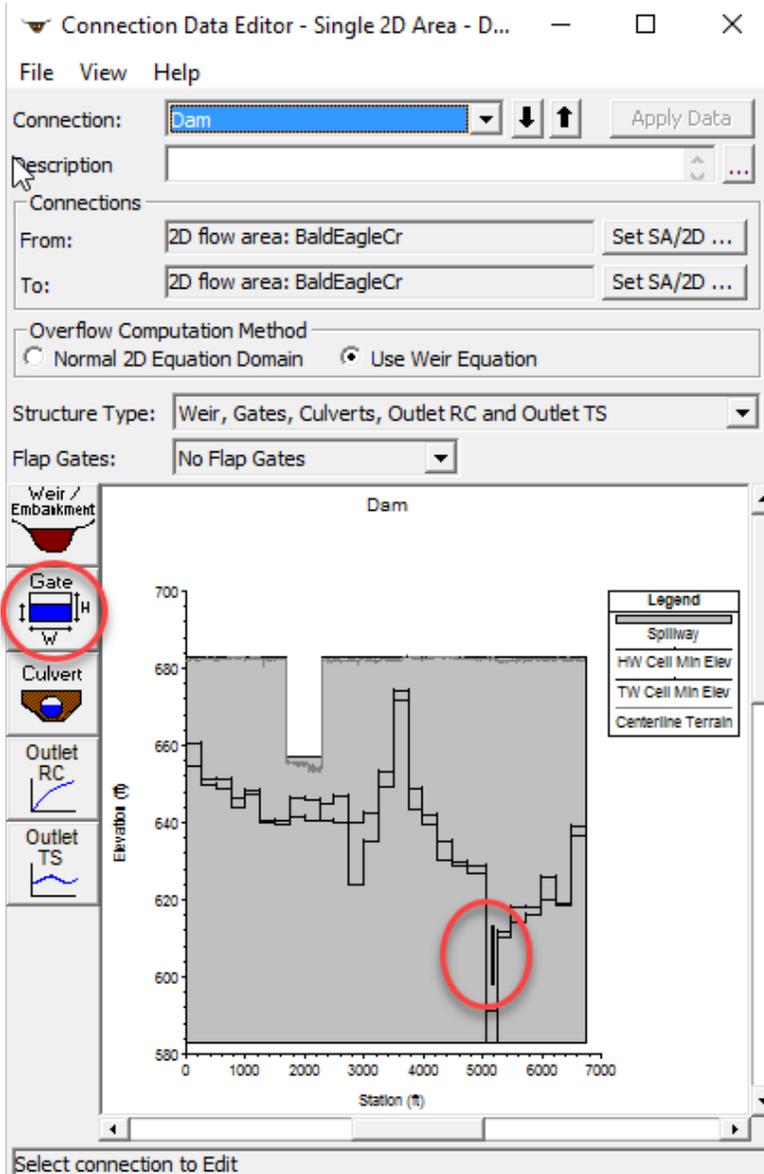
	X	Y
1	2007174.93	321353.6
2	2007546.11	321702.6
3		
4		
5		
6		
7		

Individual Gate Centerlines ...

OK Cancel Help

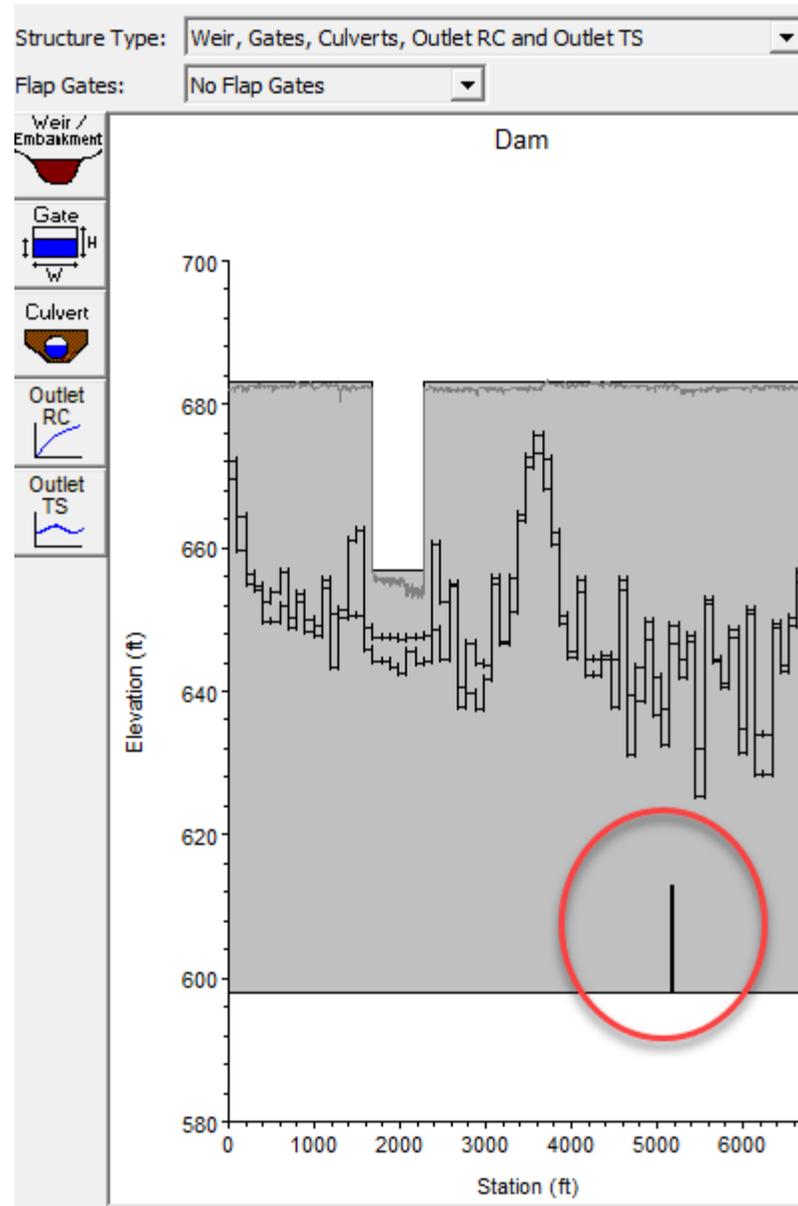
- Draw the centerline with the mouse pointer and then paste GIS coordinates for the appropriate opening
- Clicking on Individual Gate Centerlines will bring up a table that shows all of the openings

# Gate in channel above Cell Invert



- Non-georeferenced gate in channel above adjacent cell minimum

# Georeferenced Gate below adjacent cell Invert



- Small HW/TW cells on abutment next to HS do not show channel location
- This plot does not show whether the georeferenced gate centerline has been properly entered or not



# Breach for HS

**Storage Area Connection Breach Data**

SA Connection: Sayers Dam

**Breach This Structure**

Breach Method: User Entered Data

Center Station: 5250

Final Bottom Width: 446

Final Bottom Elevation: 585

Left Side Slope: 0.1

Right Side Slope: 0.1

Breach Weir Coef: 2.6

Breach Formation Time (hrs): 3.2

Failure Mode: Piping

Piping Coefficient: 0.5

Initial Piping Elev: 620

Trigger Failure at: WS Elev

Starting WS: 667

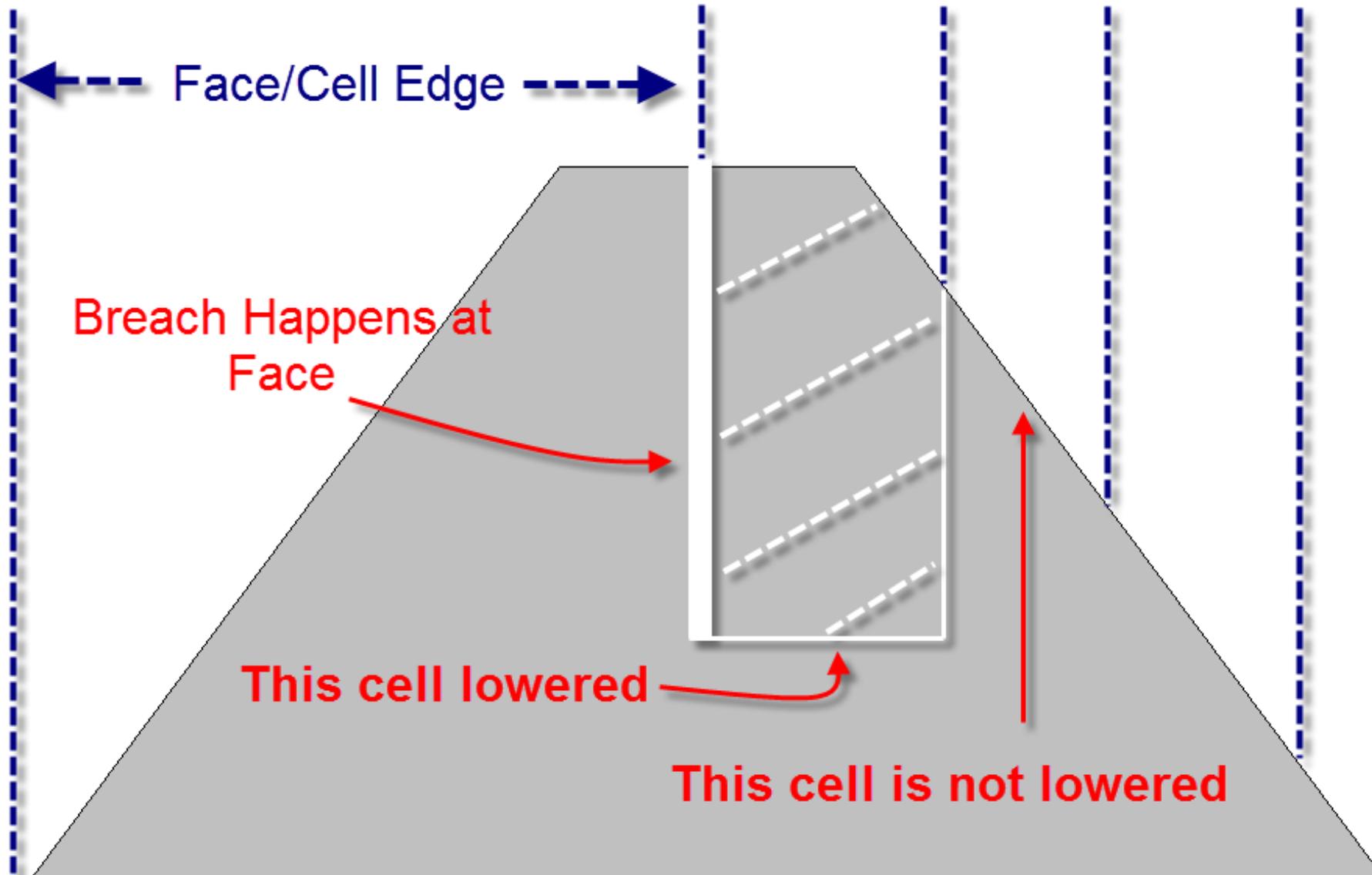
**Breach Plot** | Breach Progression | Simplified Physical | Breach

Legend: Spillway, Final Breach

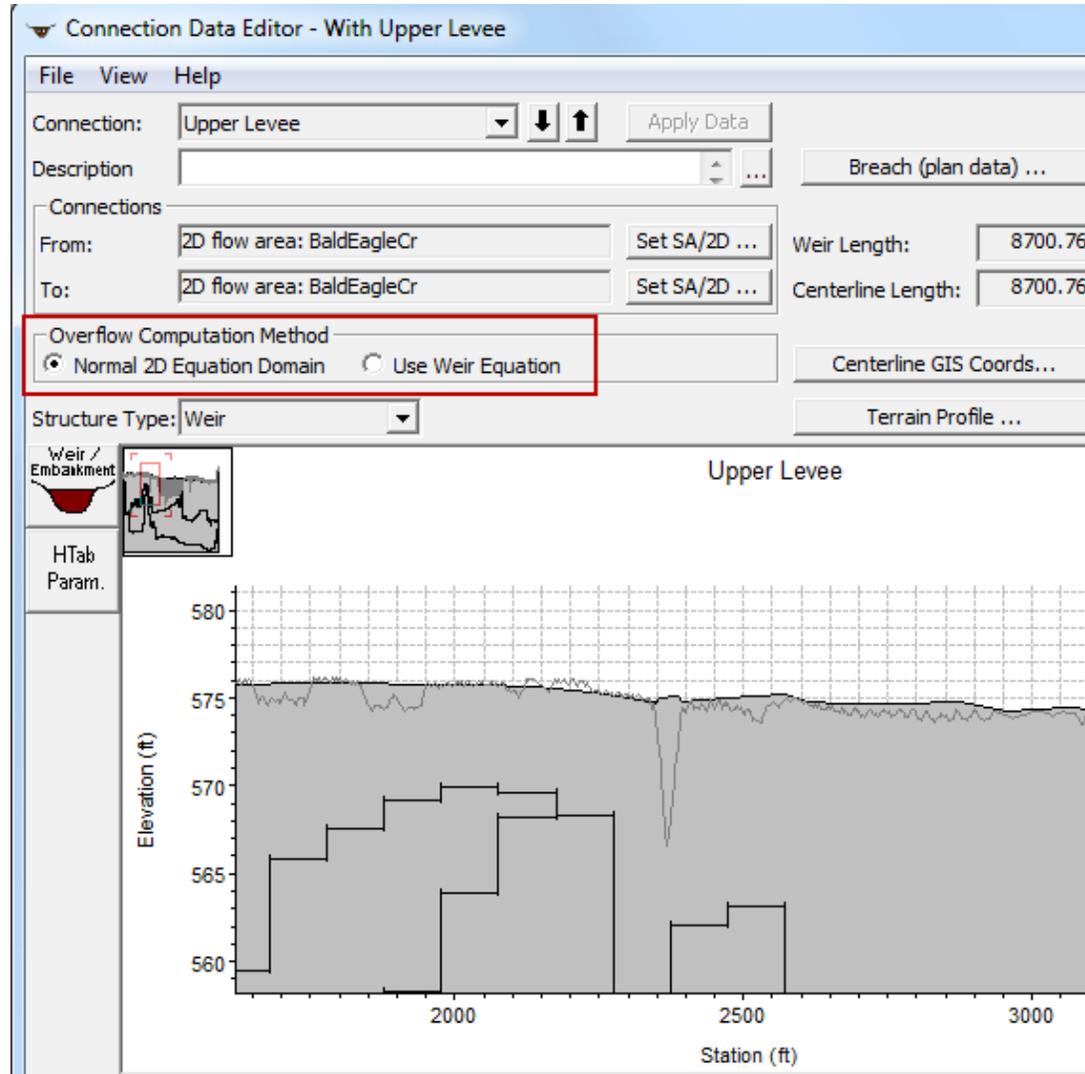
Elevation (ft) vs Station (ft) graph showing dam profile and breach line.



# HS Breach and Cell



# HS Equation Choice



- Normal 2D Equation Domain
  - flow across face computed with 2D flow equations
- Use Weir Equation
  - $Q = CLH^{1.5}$



# Normal 2D Equation Domain

- Face properties are adjusted for user entered SE Data, but 2D Area is solved in the normal manner
- Generally, faster, more accurate
- But not good for true weir type
- HS with culverts/gates can still use 2D for overflow
  - culvert/gate flow is computed separately



# Weir Equation

- Weir flow computed using [1D] weir equation and user SE Data
- Flow computed “just prior” to each iteration of 2D
- More appropriate for [non-submerged] weir flow

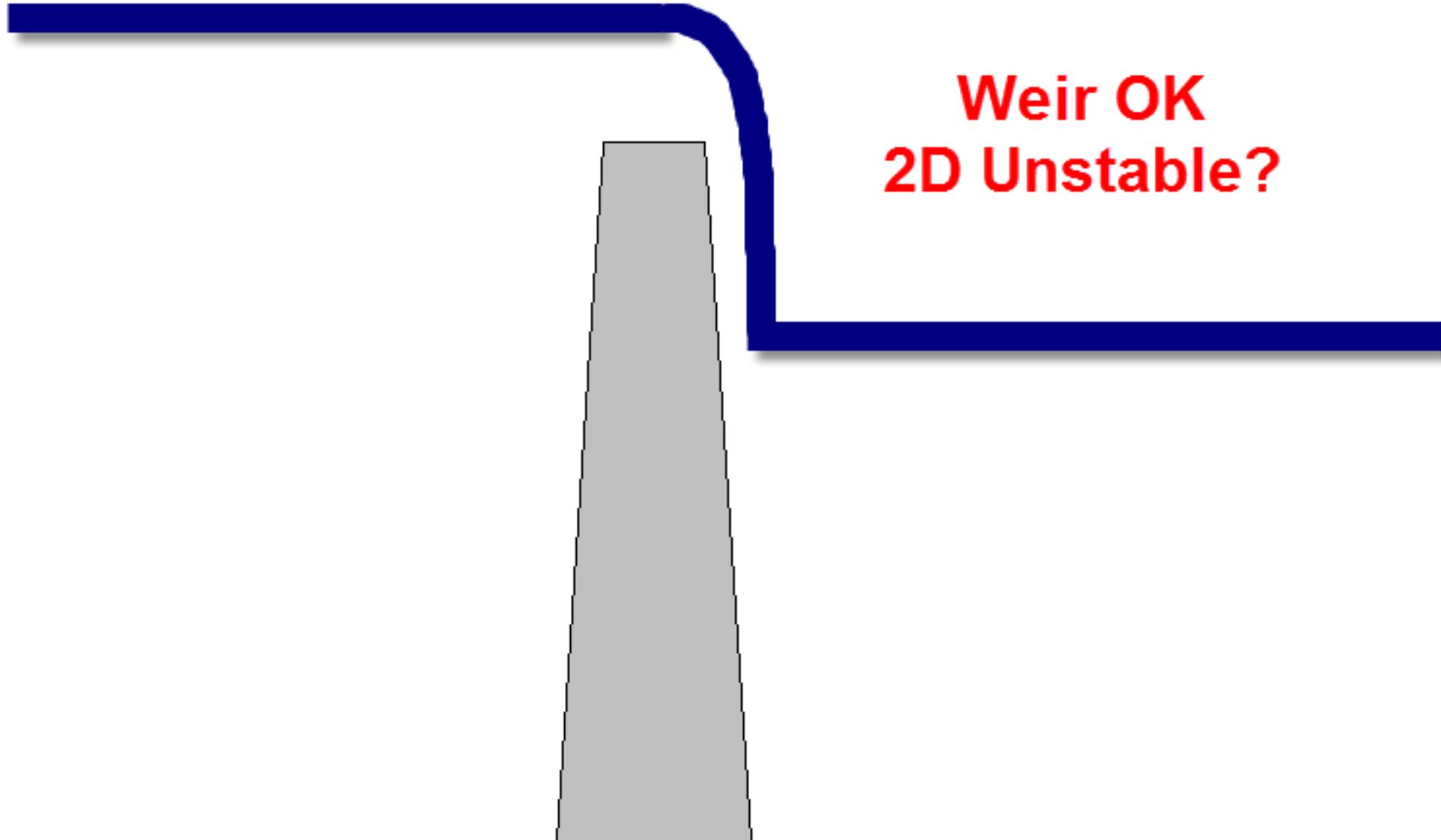


# Weir Equation continued

- Less desirable for submerged conditions
  - **Turn on Weir Submergence Decay Exponent!**
- May require “trial and error” solution causing 2D to iterate
- Gate and culvert flow are always computed “just prior” to 2D



# HS Weir Flow

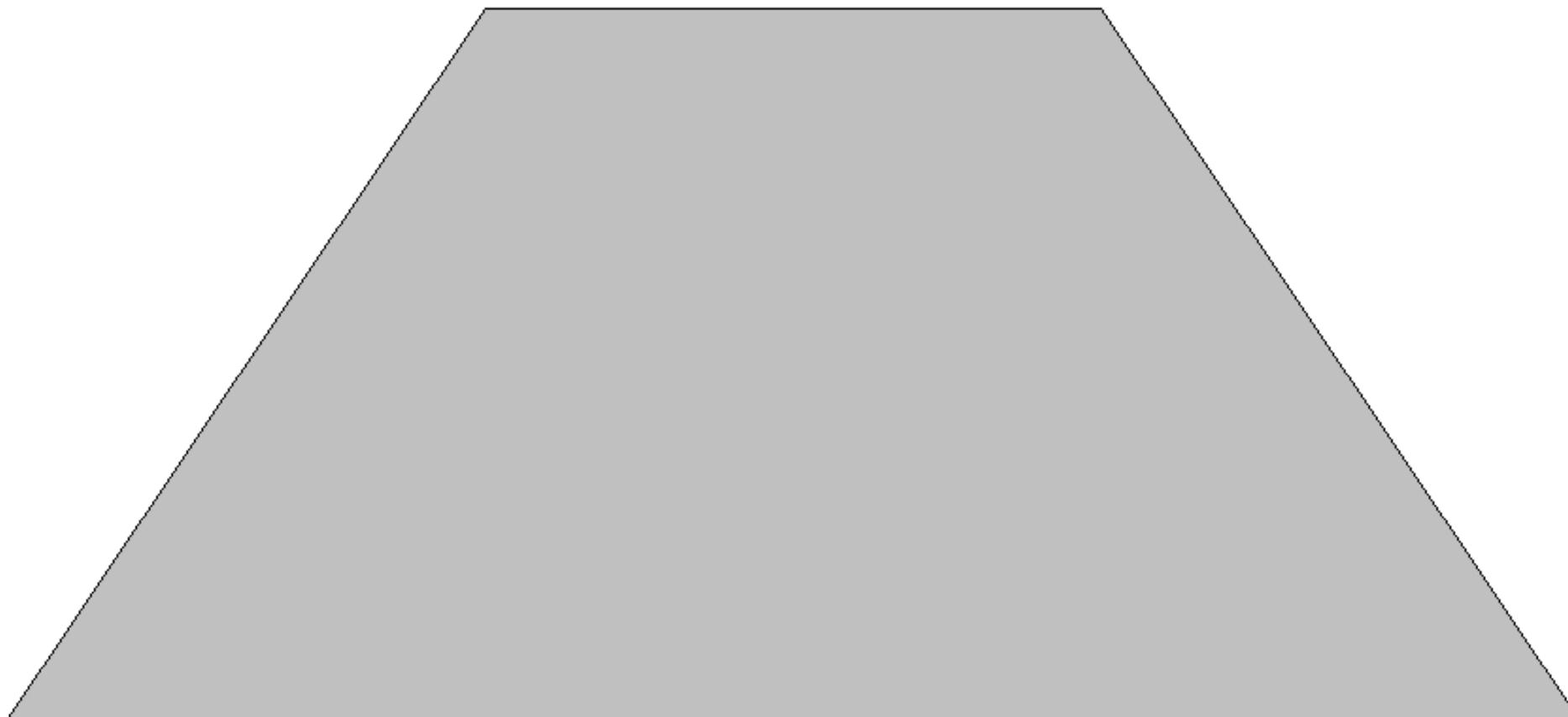




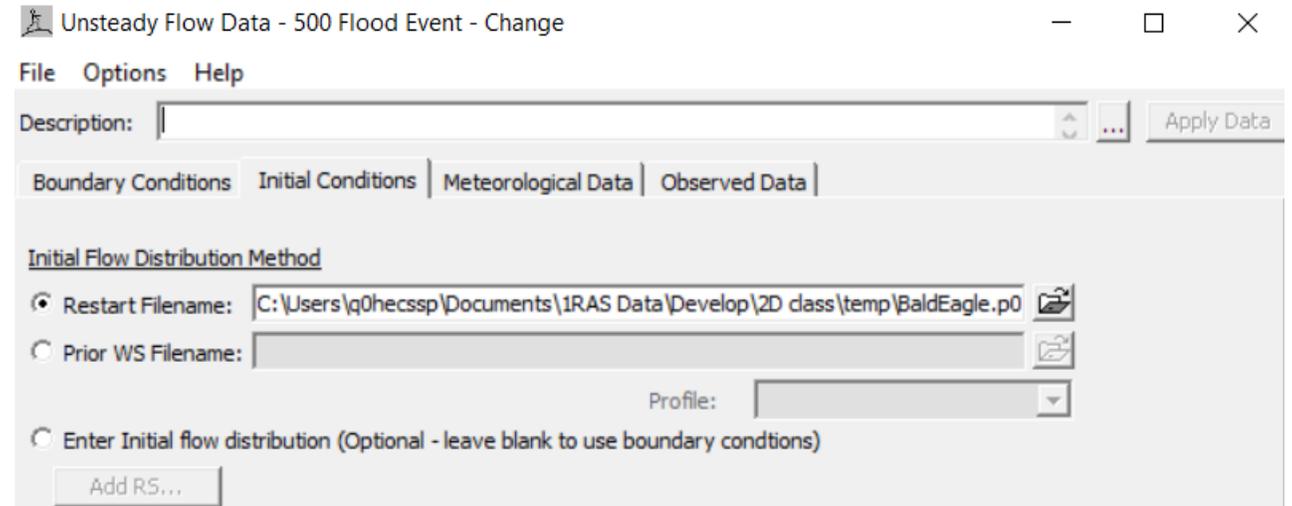
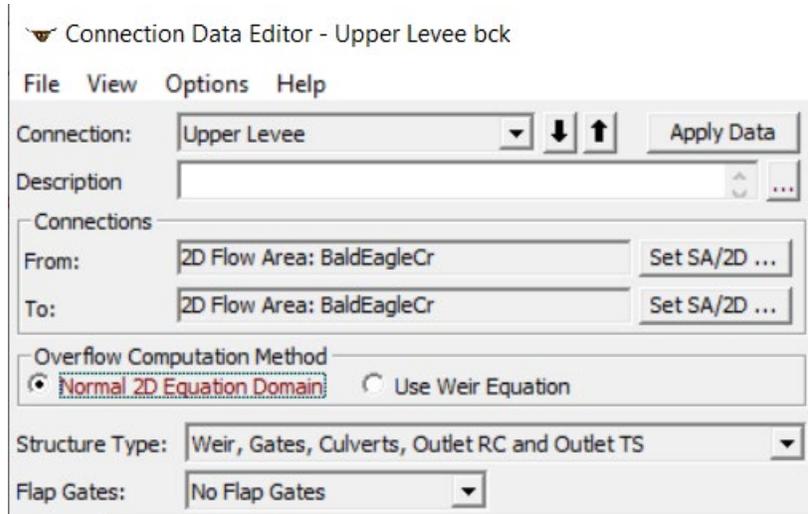
# HS 2D Flow



**2D Solution is better**



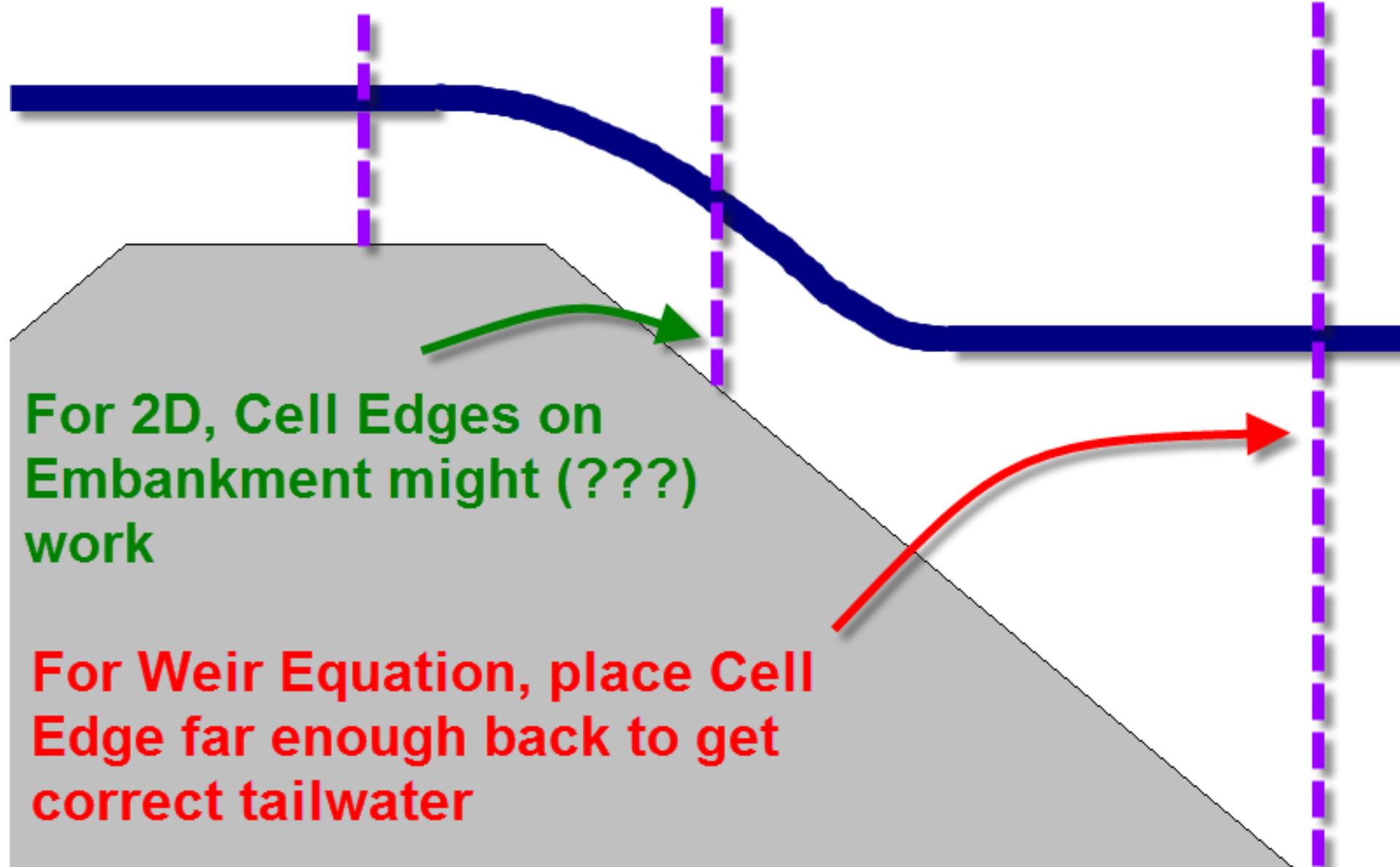
# Use Restart/Prior to Switch



- Can switch methods while when using a restart/prior WS method
- Really only viable for a single location such as a levee breach



# HS Tailwater Considerations



For 2D, Cell Edges on Embankment might (???) work

For Weir Equation, place Cell Edge far enough back to get correct tailwater

# Questions?