

Representing Bridges in or near TUFLOW

What to represent?

- Soffit
- Deck
- Piers
- Channel shape changes
- Associated structures (weirs, sluices, etc.)

What are our options?

- Pure TUFLOW representations
 - Energy Losses
 - Flow Constrictions
- One-dimensional representations
 - ESTRY culverts
 - ISIS structures
- Something more complicated

Which Approach?

- Bill's recommendations:
 - Pure 2D Approach where structure width $> 2x$ 2D cell width
 - ESTRY 2D Approach elsewhere

Which Approach?

- Edenvale's recommendations
 - If embedding a 1D model (ISIS/ESTRY), use the 1D model.
 - If working primarily in 2D, use Bill's recommendations, but also take into account required output accuracy.

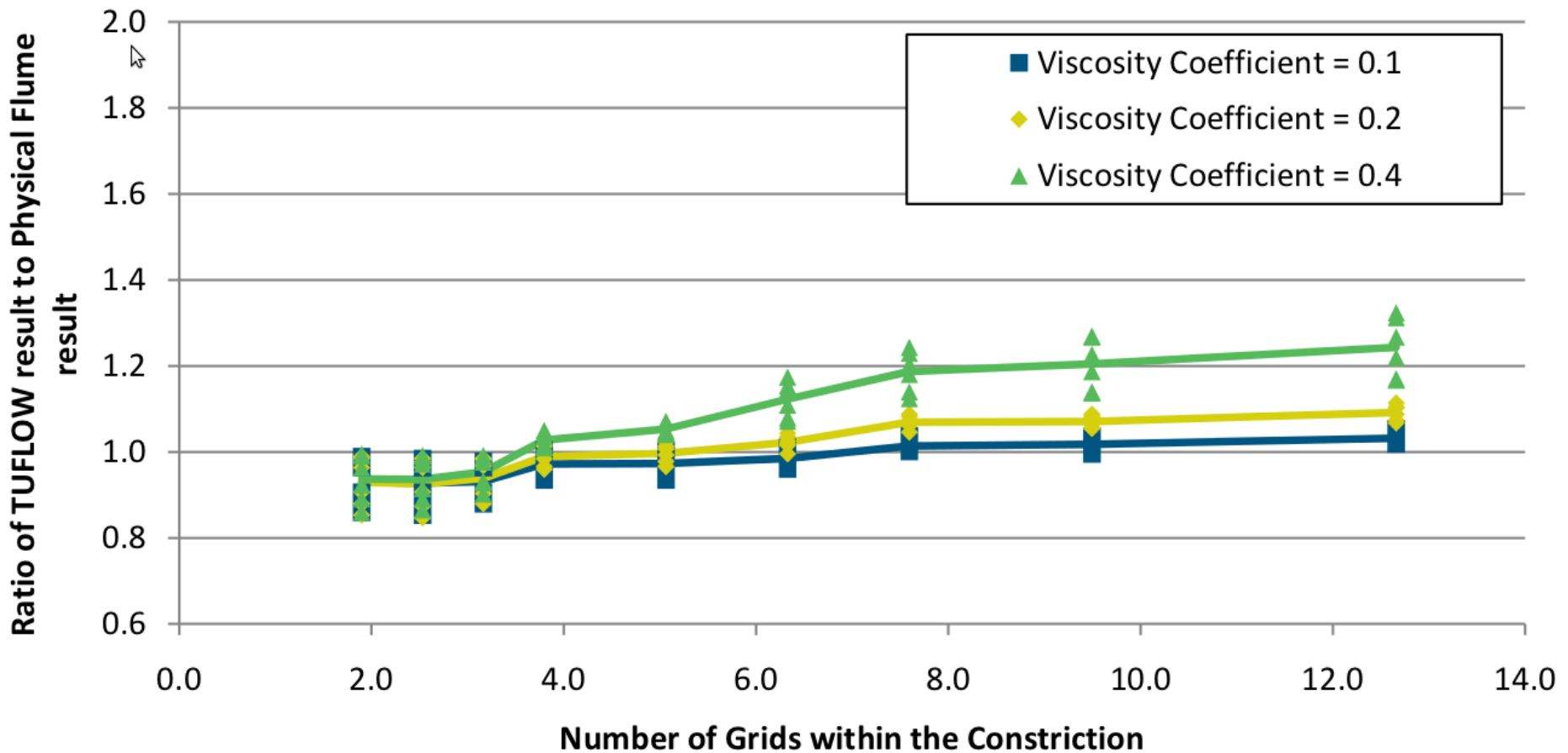
Which Approach?

- 2D-only representations conserve momentum but 1D/2D links do not.
- Well-schematised 2D is probably better than well-schematised 1D.
- Well-schematised 2D needs smaller cells than 2D with 1D embedded.

2D channel representation

- Cells in channel width:
 - Bill's recommendation: >4
 - Edenvale's recommendation: $>6-8$
 - Leister's recommendation: $4-8$
- Leister's results suggest
VISCOSITY COEFFICIENT $== 0.1$
for channel widths > 8 cells.

2D channel representation



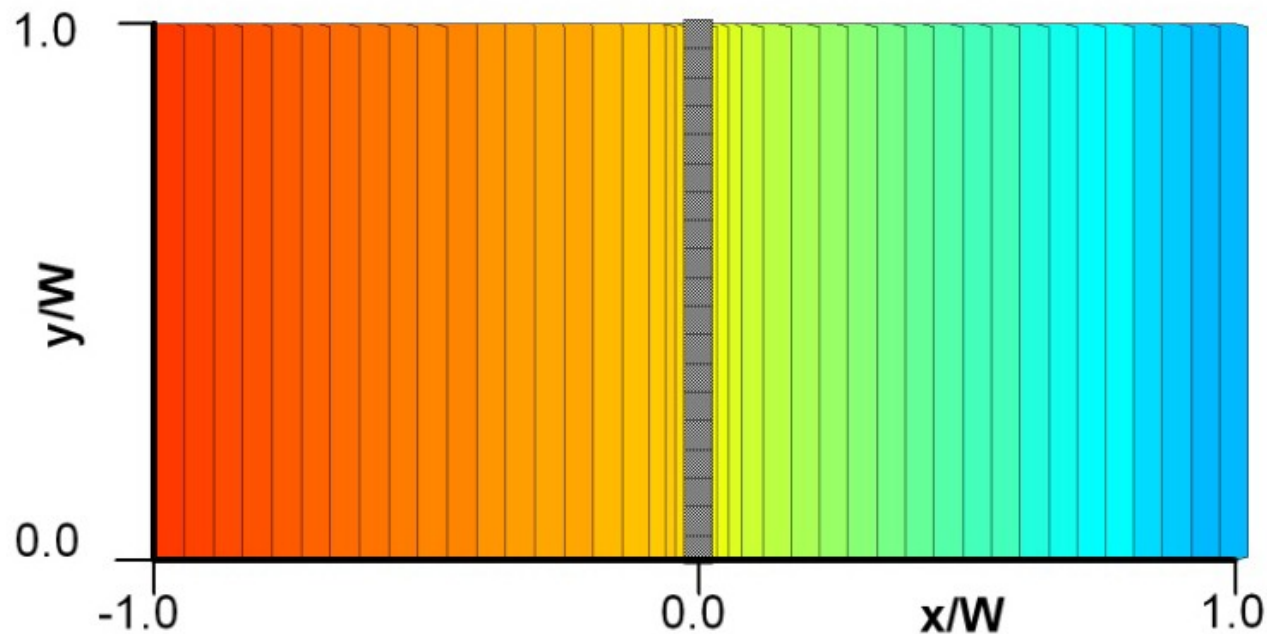
from Leister (2011)

2D bridge representation

- Energy loss methods
 - Apply energy losses at some cells
 - Uses TUFLOW flow constrictions
 - Suitable only where water does not reach bridge soffit

2D bridge representation

- Constant energy loss across whole channel



Cells with Flow Constrictions spanning entire channel.

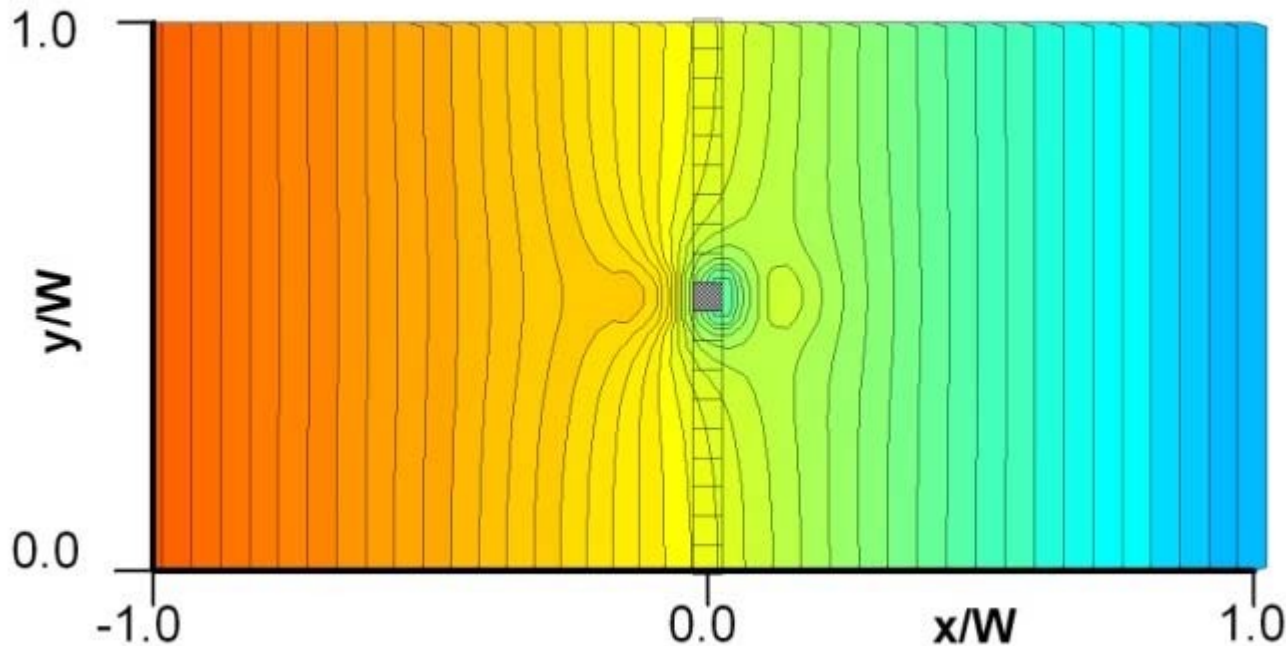
Energy Loss applied uniformly.

2D bridge representation

- Blockage methods
 - Apply blockage (and, optionally, energy losses) at some cells
 - Uses TUFLOW flow constrictions
 - Suitable only where water does not reach bridge soffit

2D bridge representation

- Blockage only at obstructed areas



Cells with Flow Constrictions only at bridge piers and abutments.

Energy loss and blockage applied locally.

2D bridge representation



2D bridge representation

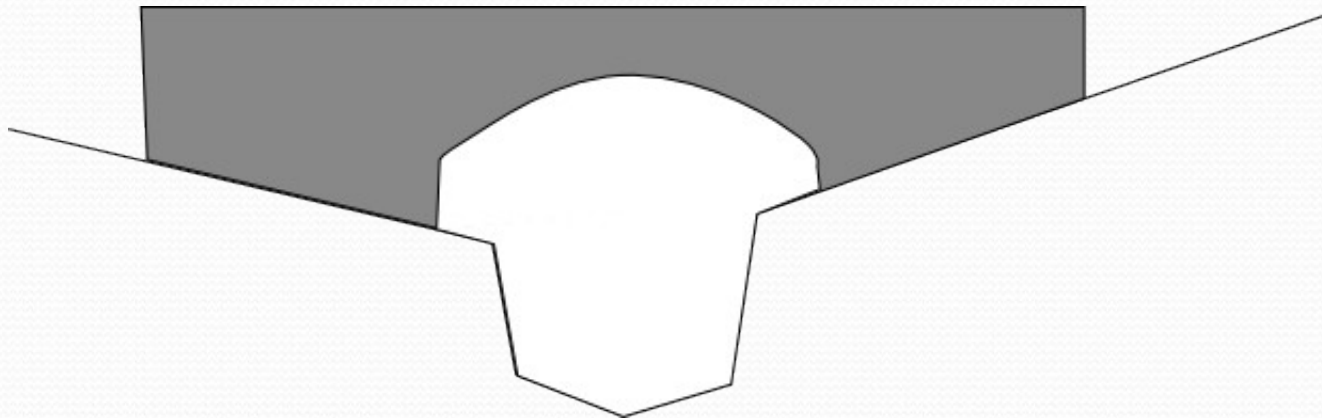
- Layered blockage methods
 - Apply blockage (and, optionally, energy losses) at some cells dependant on the water level
 - Uses TUFLOW layered flow constrictions
 - Suitable for most bridges.
 - Difficult to apply to arches/variable soffit levels.

2D bridge representation

- Layered blockage applied throughout bridge

Cells with Flow Constrictions across the channel. Variation at bridge piers and abutments.

Energy loss and blockage applied locally, dependent on the current water level.



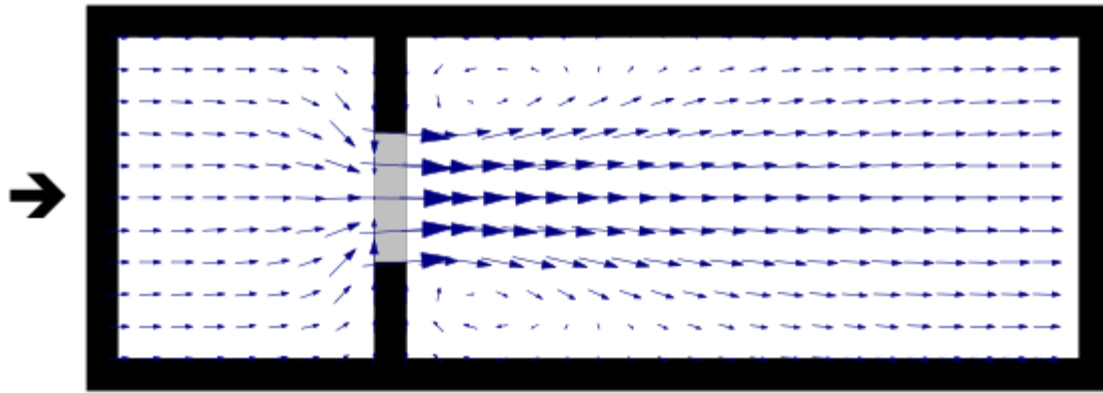
1D bridge representation

- ESTRY methods
 - Type of linking: HX/SX
 - Type of ESTRY unit: Bridge/Culvert
- Other external models
 - Type of linking: HX/SX
 - Choices specific to external model

1D bridge representation

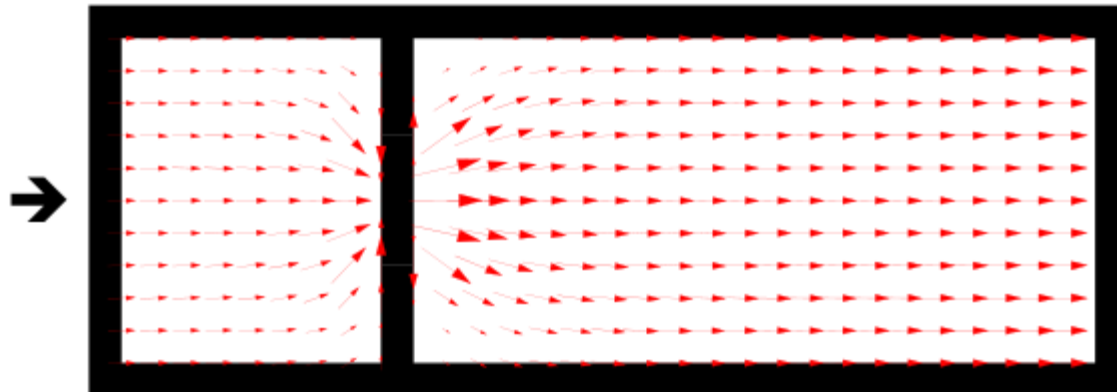
- HX vs. SX linking for embedded bridge structures
 - SX: more stable, excessive spreading at the outlet, zeroes momentum
 - HX: less stable, requires smaller 2D timestep, preserves some momentum

1D bridge representation



Flow patterns using a 1D element connected to 2D HX links

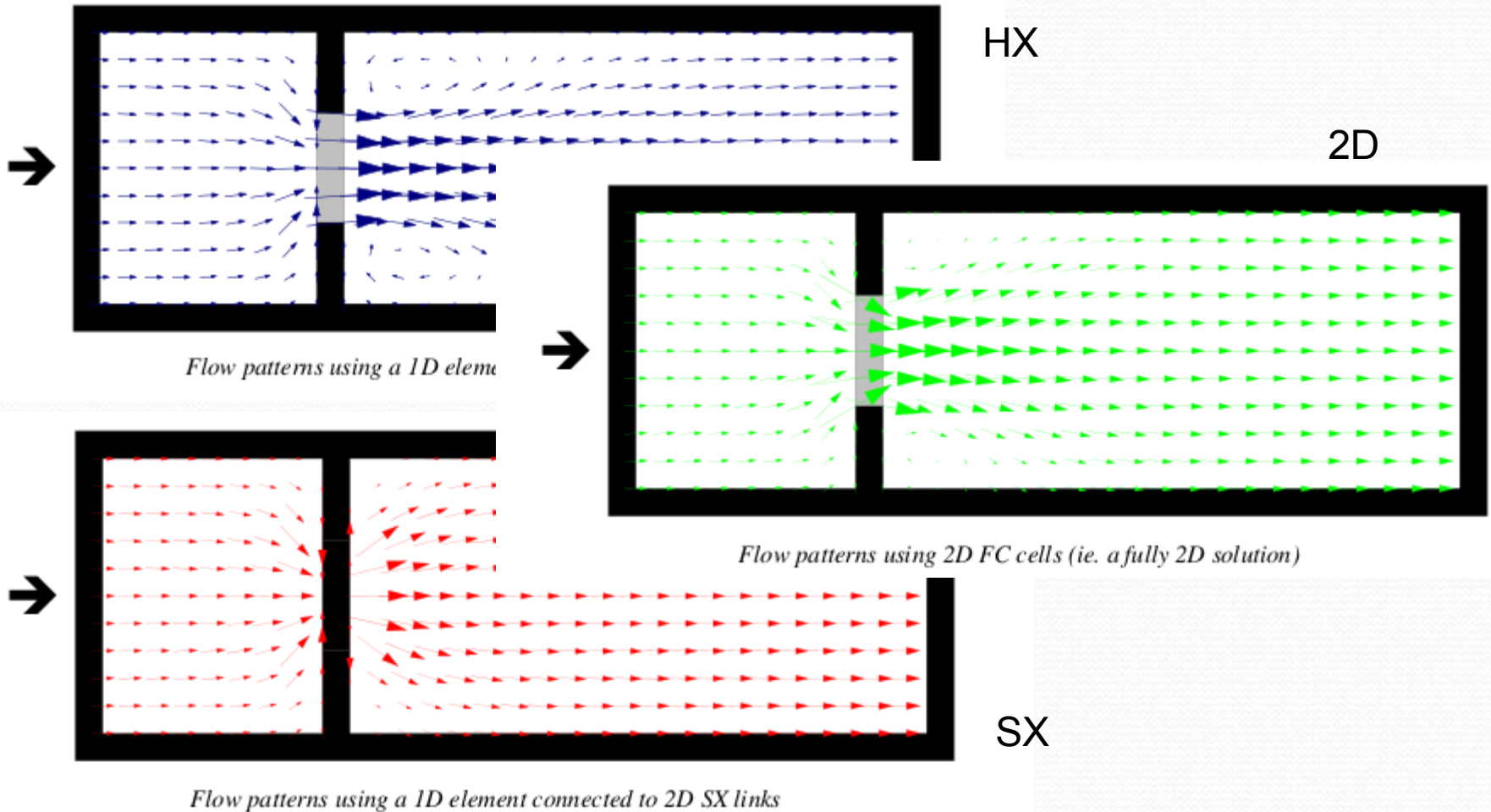
HX



Flow patterns using a 1D element connected to 2D SX links

SX

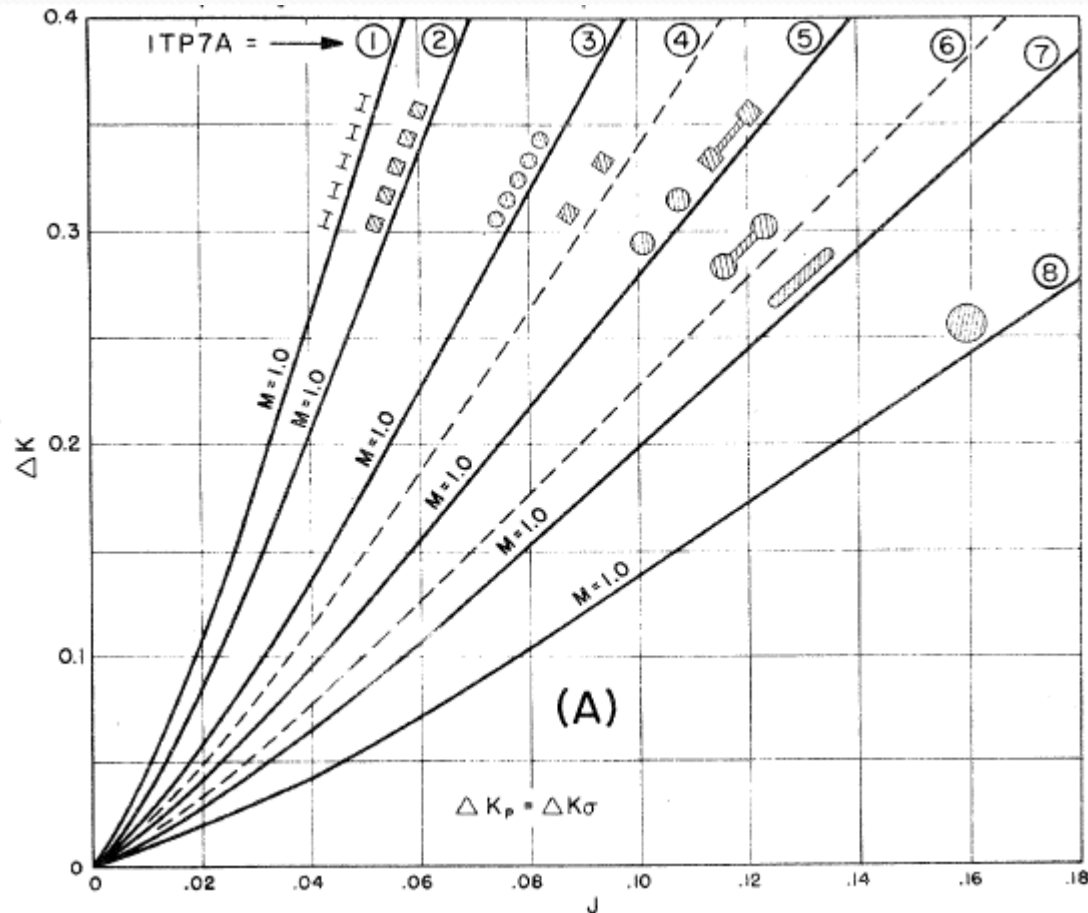
1D bridge representation



1D bridge representation

- ESTRY Bridges
 - Based on US FHA 1973
 - Using:
 - a constant form loss coefficient
 - a form loss coefficient varying with water level
- Estimation of the form loss coefficients can be tricky

1D bridge representation



1D bridge representation

- ESTRY Bridges
 - FHWA only applicable to uniform, unidirectional flow.
 - Less accurate than surrounding 2D model

1D bridge representation

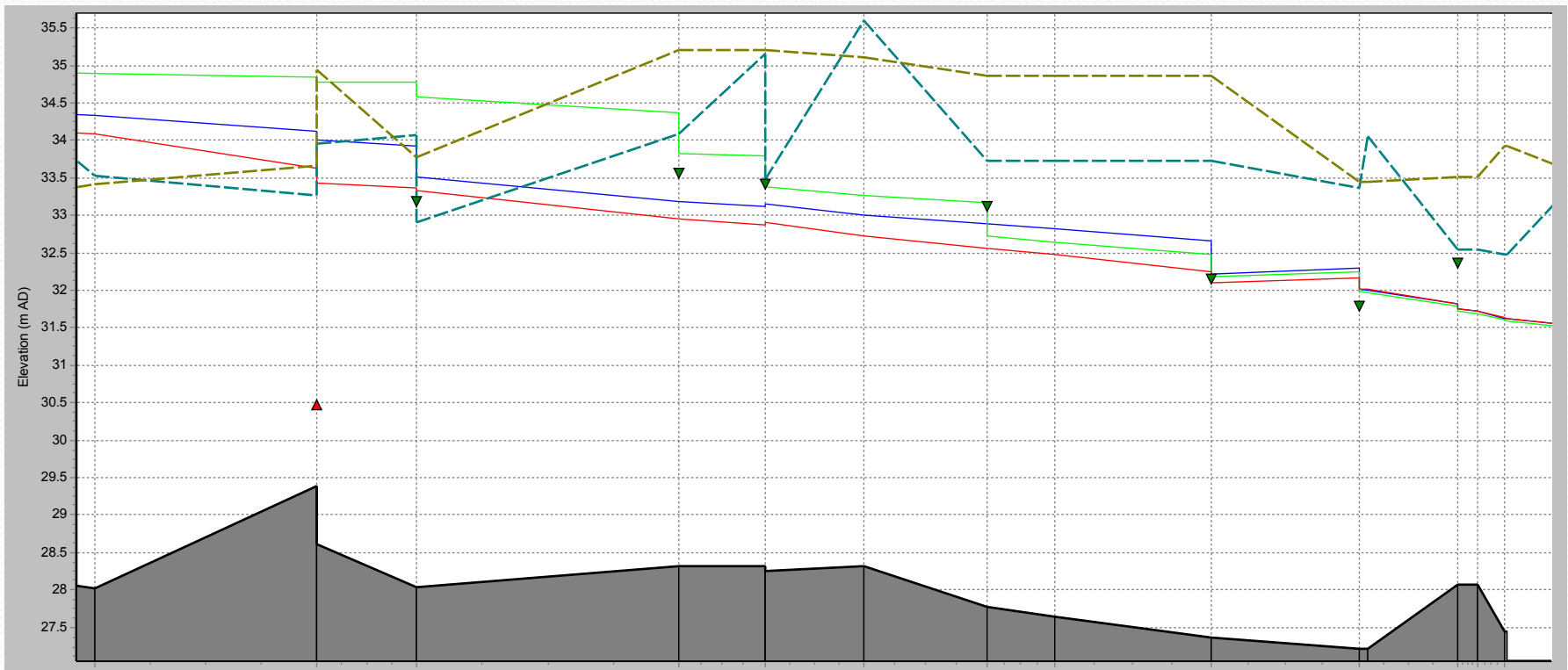
- ESTRY Culverts
 - Various culvert types: R, C, I
 - Lots of coefficients:
 - height contraction coefficient
 - width contraction coefficient
 - general entry loss coefficient
 - exit loss coefficient
 - Little guidance on estimation when connecting to 2D

1D bridge representation

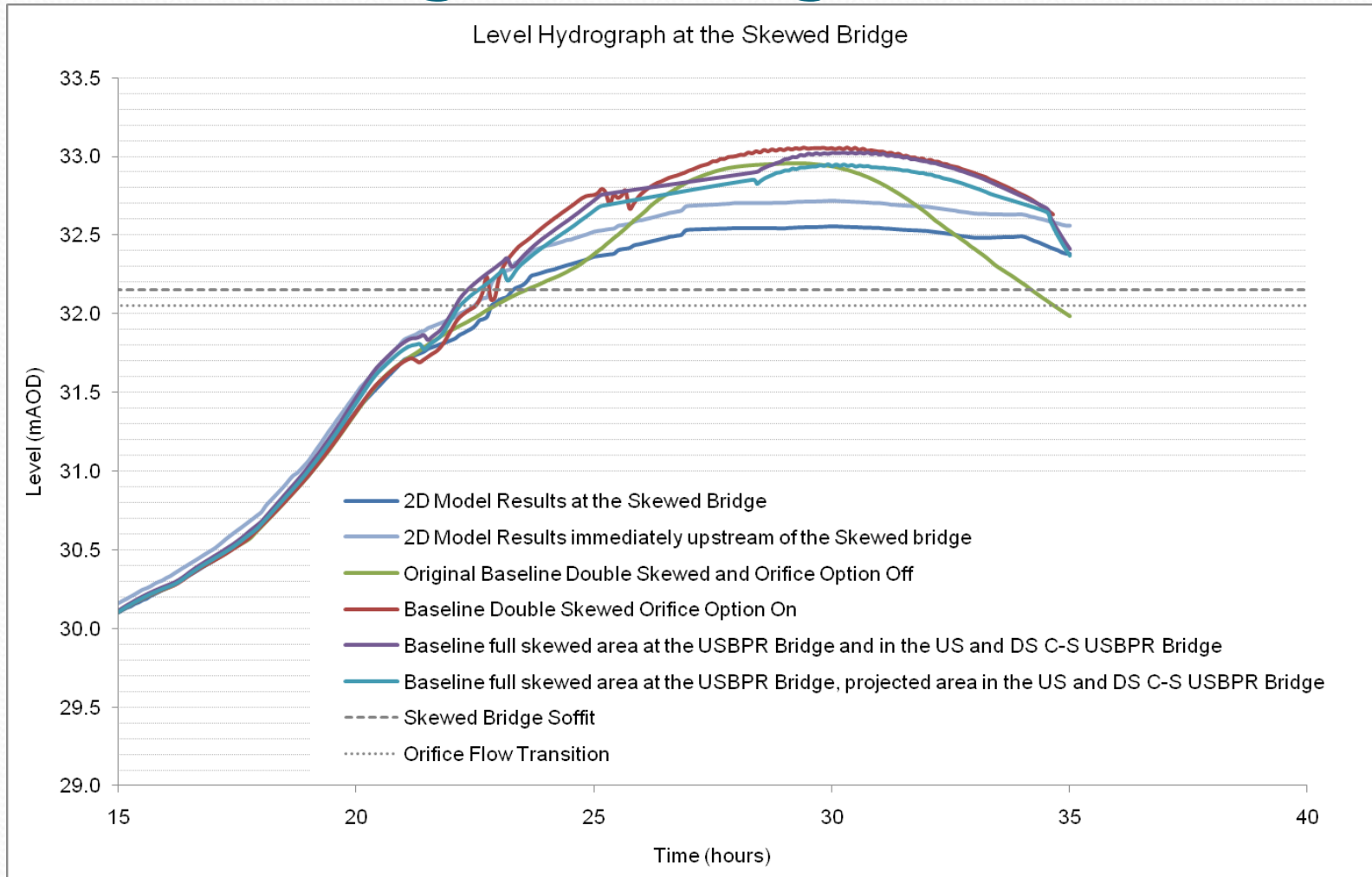
- Other Models: ISIS
 - USBPR Approach
 - “Arch Bridge” Approach
 - Orifice Units
 - Culverts of various shapes

What can go wrong?

- A comparison of ISIS approaches



What can go wrong?



So what should be done?

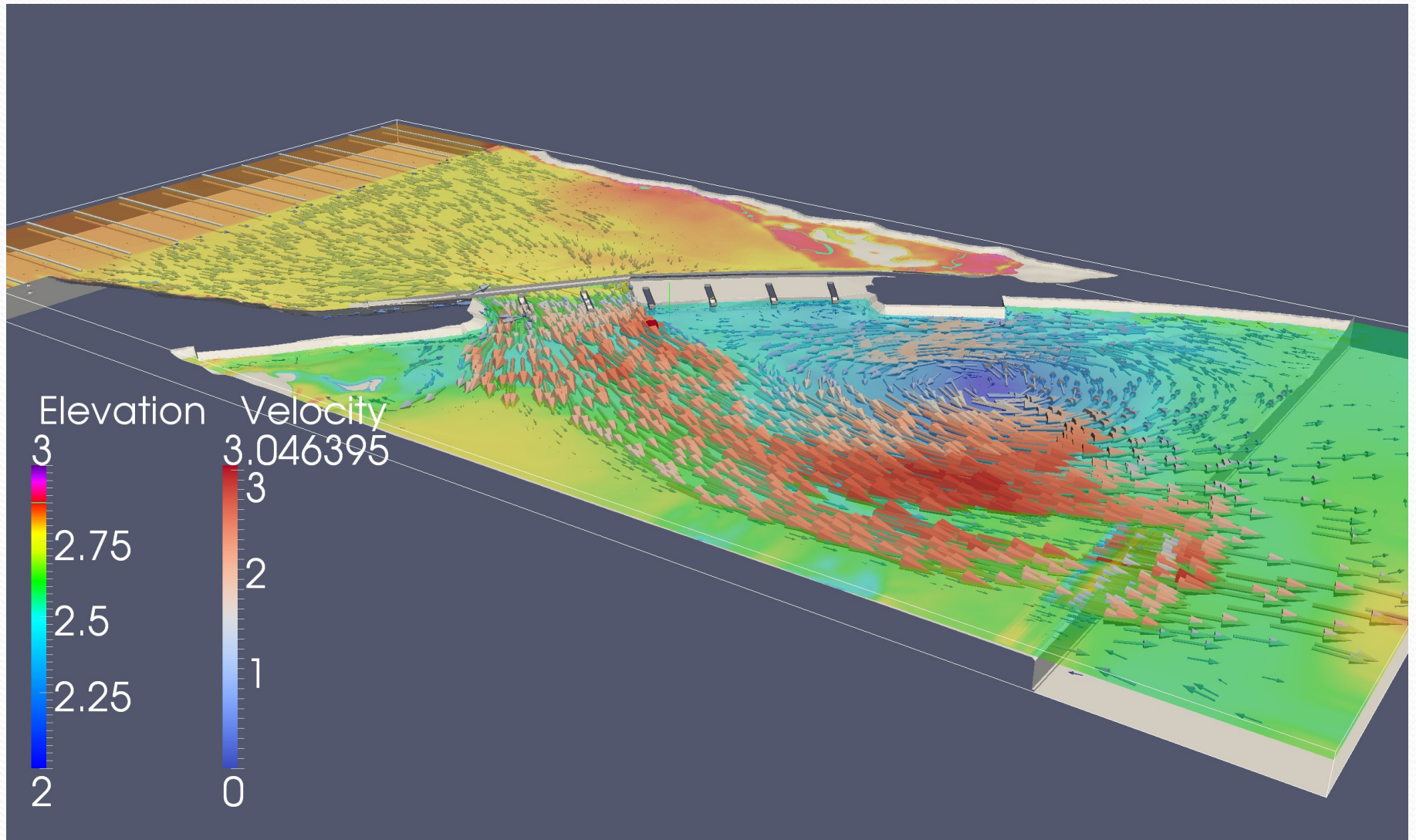
- When 1D/2D linking use 1D schematisation
- When using pure 2D, use a schematisation appropriate to the grid size.
- Read the manual. It gives useful information.

What to watch out for

- When using pure 2D, TUFLOW can overestimate with default viscosity values.
- Estimating coefficients for ESTRY is tricky.
- ISIS uses really confusing naming for bridge parameters.

Doing it better

- Of course,
 - very accurate local modelling of bridges
 - side-wall shear stress calculations
 - direct force calculations...require more than the shallow water equations...



This is a workshop!

- That's enough chat.
- Experiences on bridge modelling?
- Worries?
- How would you model...?
- What have you been talking about all this time?