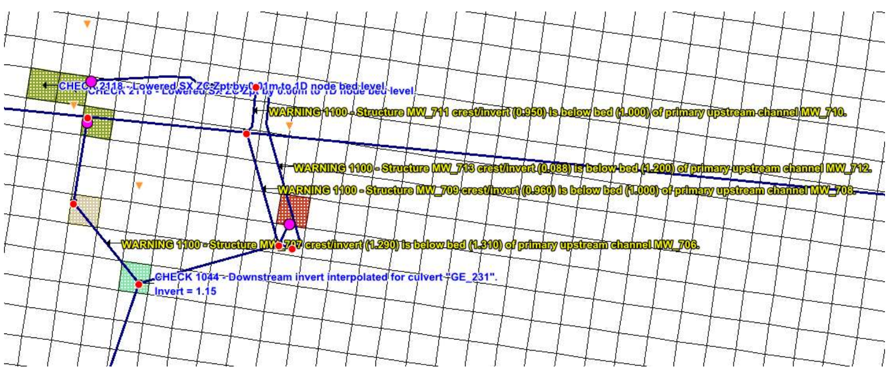
From little things, big errors may grow – A look at the importance of QA on hydraulic models.



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Presentation Outline

- Introduction
  - Why are we looking at this?
  - Why is it important?
- Overview of five common issues that were identified
- Summary of other issues tested
- Conclusion
  - Summary of outcomes.
  - Where to from here.

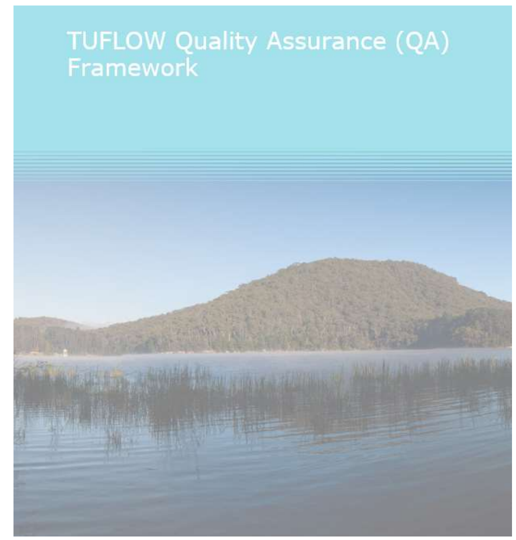
Acknowledgements:

Greg Eaton of GHD who assisted with reviews and testing.

The former 'Flood Mapping & Mitigation' team at Melbourne Water, particularly Ruwan Jayasinghe and Rod Watkinson.

Introduction

- Melbourne Water (MW) needed a formal review process to efficiently check whether a model was "fit for purpose"
- Through the review of a number of models, a Quality Assurance (QA) framework was developed to guide this process
- Reviews highlighted that with increasing model complexity and/or size there can be a loss of focus on checking the fundamentals (i.e. are pipes are snapped & below ground)
- Testing was then undertaken to determine the impact of some modelling parameters or issues on the results



Common Issues - Overview

Issue Outline

- Describe what is wrong or poorly represented with current arrangement

Solution Outline

- Explain how it can be modelled better to more closely represent reality

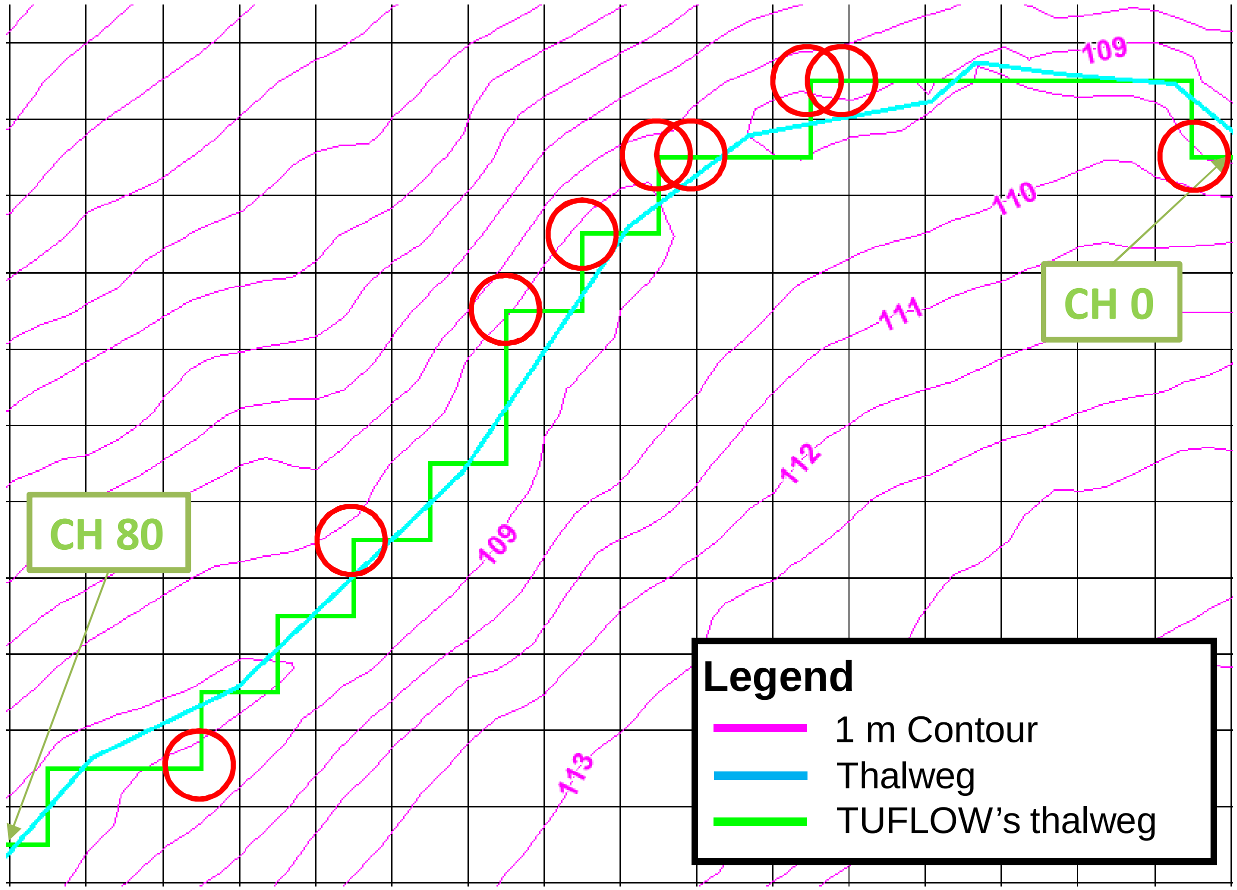
Impact of Change

- Outline how the change affects the results in terms of afflux. (Afflux = 'Solution WSL' - 'Issue WSL')

Example 1 - "Gully" Lines

ISSUE OUTLINE

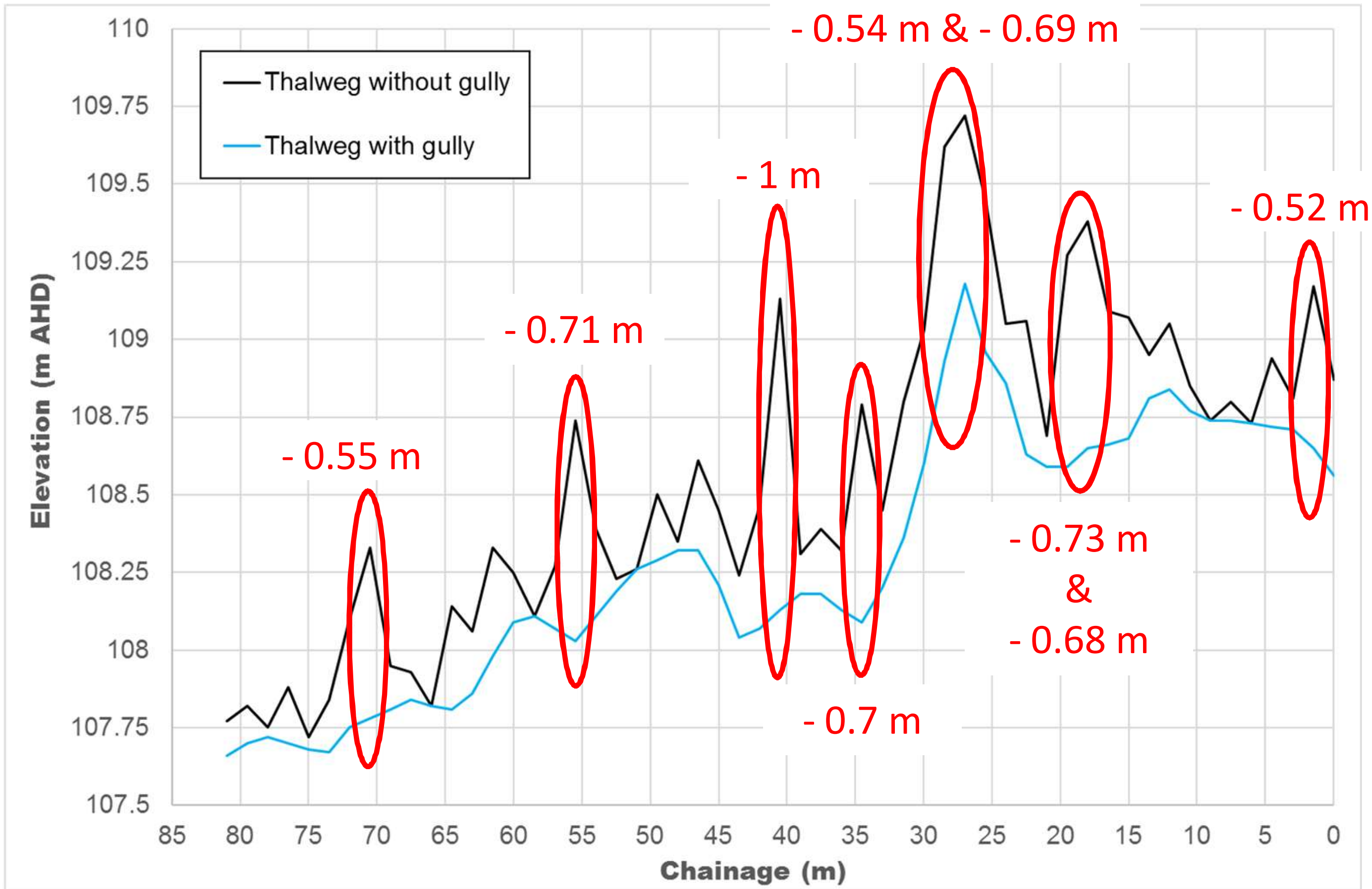
Thalwegs often don't align with the model grid, so without manipulation TUFLOW sees artificial high points



Example 1 - "Gully" Lines

SOLUTION OUTLINE

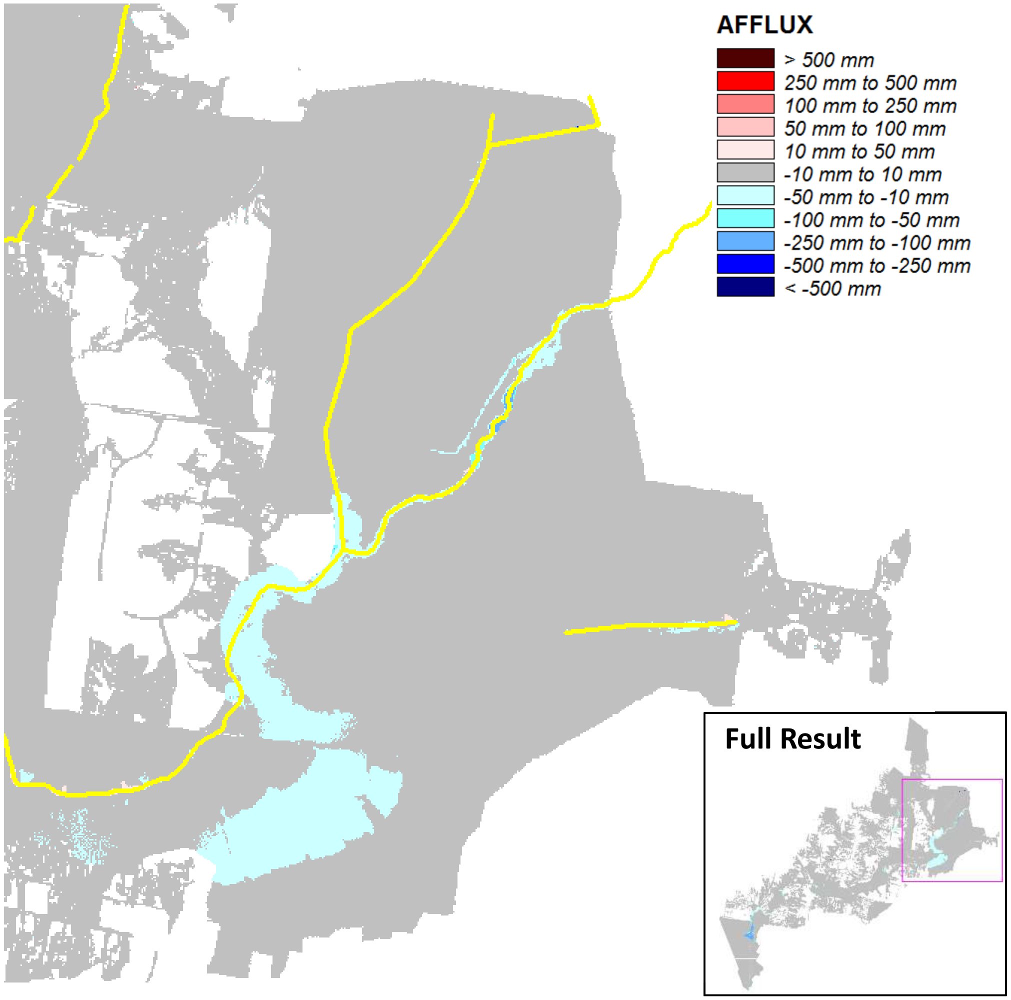
Introducing a "gully" terrain modification will force TUFLOW to adopt an elevation that is no higher than that along the thalweg in the base terrain data



Example 1 - “Gully” Lines

IMPACT OF CHANGE

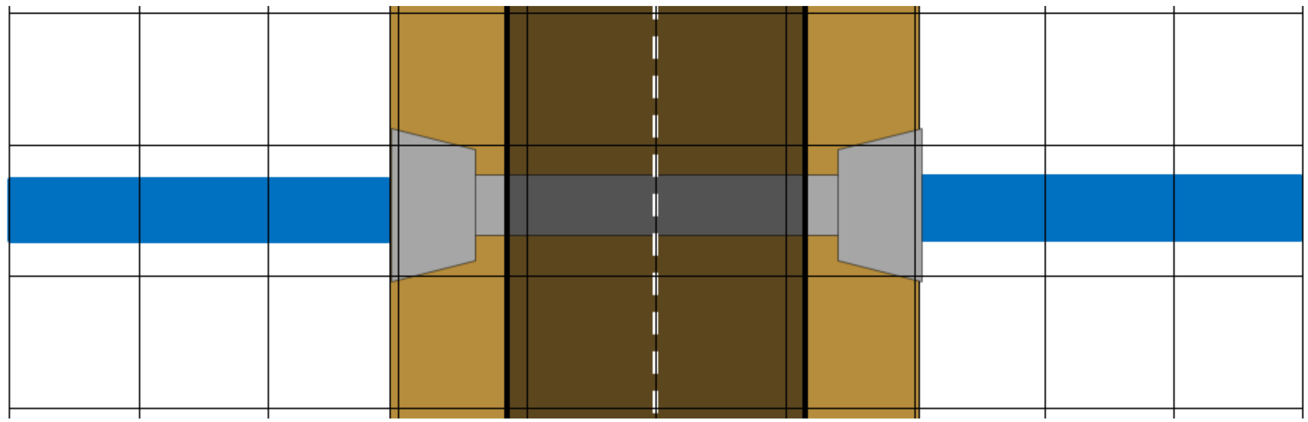
Adding “gully” lines was found to have a significant impact on flood levels along waterways (typically lower locally) by providing a more continuous flow path and/or altering timing of flows.

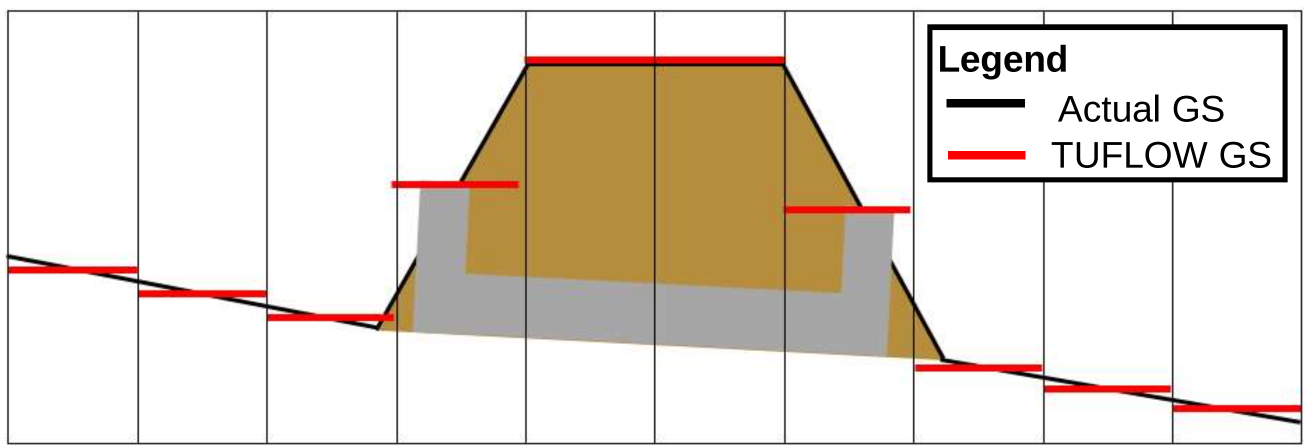


Example 2 - Headwall Representation

ISSUE OUTLINE

Representing headwalls as “pits” can restrict capacity of 1D element due to their finite size and ability to connect to the cell they fall in vertically (i.e. at any elevation)

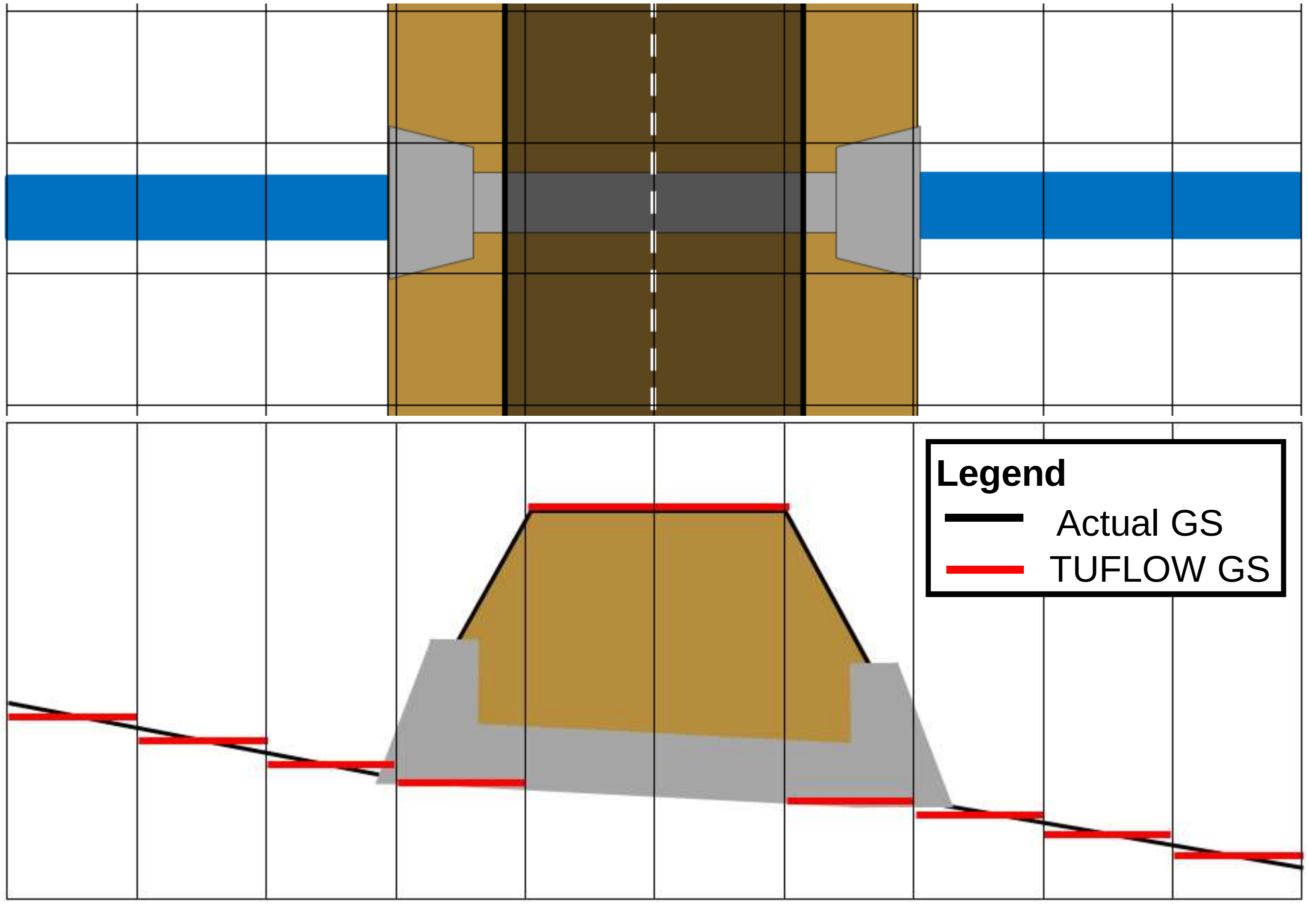




Example 2 - Headwall Representation

SOLUTION OUTLINE

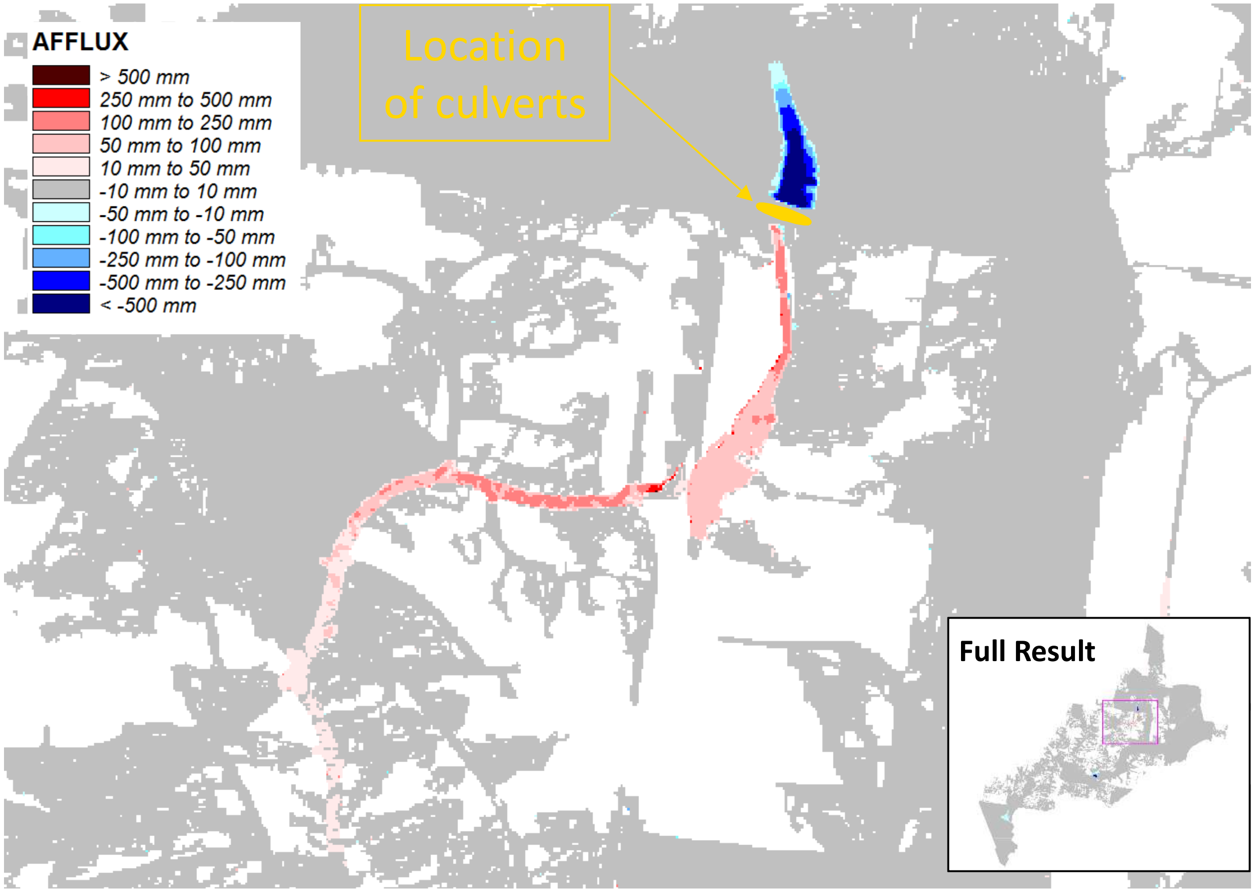
Changing “pits” to “SX” connections will better represent headwalls as they have infinite size and must connect to a cell with an elevation just below the invert of the culvert



Example 2 - Headwall Representation

IMPACT OF CHANGE

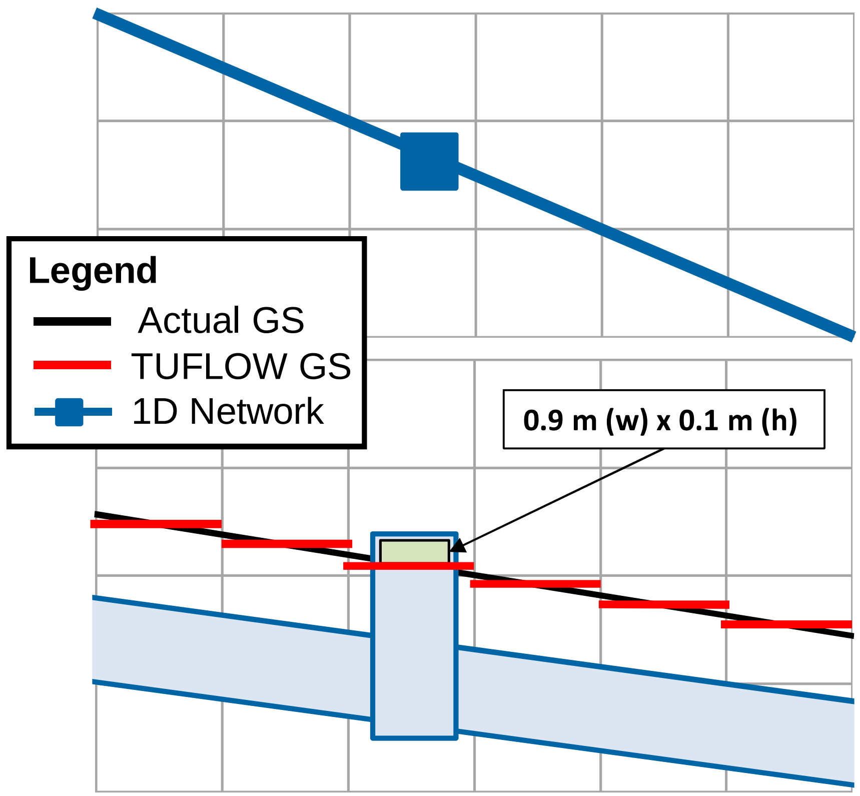
Modelling headwalled outlets as “SX” connections can have a significant impact on flood levels along waterways by removing constrictions on 1D elements that hold back water.

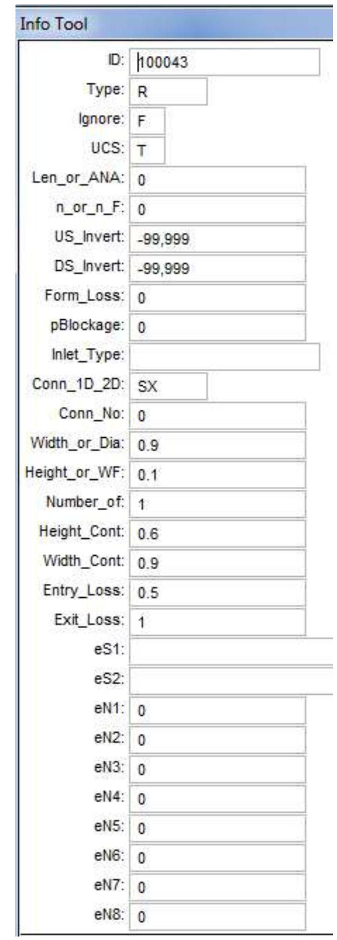


Example 3 - Choice of Pit Type

ISSUE OUTLINE

TUFLOW sees all “R” pits in the vertical dimension (i.e. as a SEP) and may understate inlet capacity due to inlet calculations and/or flow bypassing, especially where grates exist.



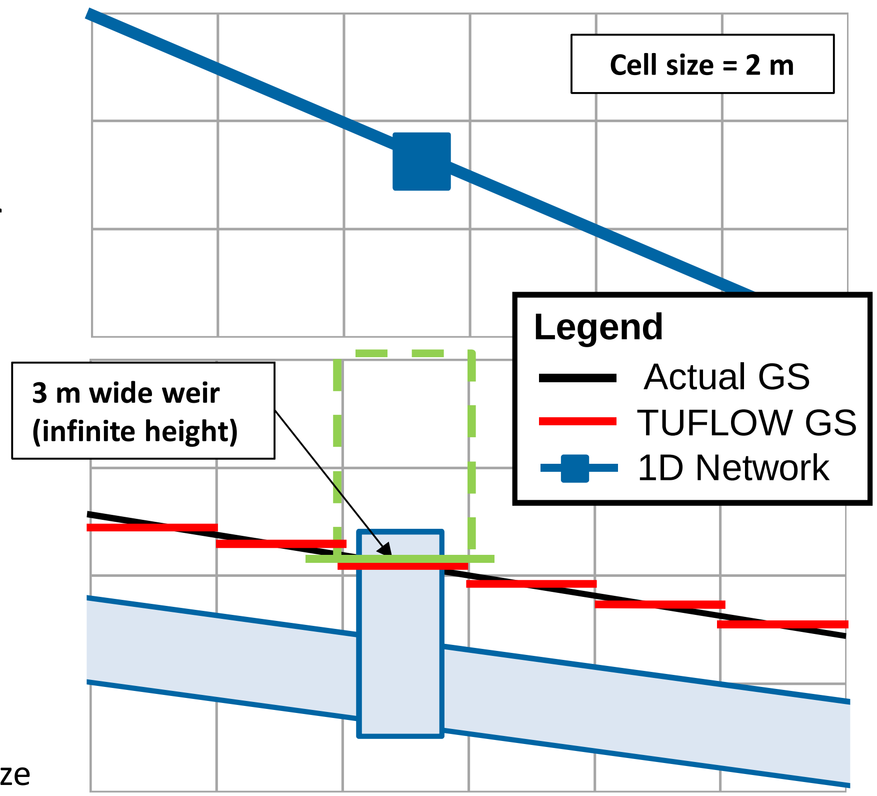


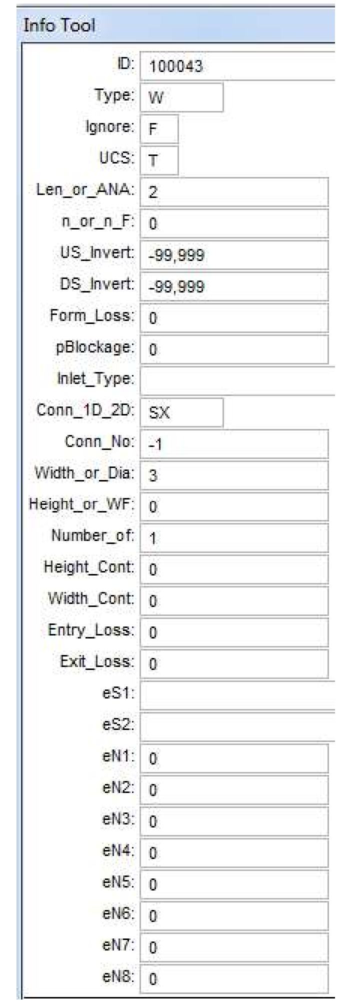
Example 3 - Choice of Pit Type

SOLUTION OUTLINE

Changing these pits to “W” pits with a width a bit larger than the cell (or pit perimeter) can increase the capacity of the pit and make an allowance for some of the unmodelled inlet capacity (i.e. house connections).

Note:
The test case also has ‘Conn_No’ of -1 & additional ‘ANA’ based on pit size

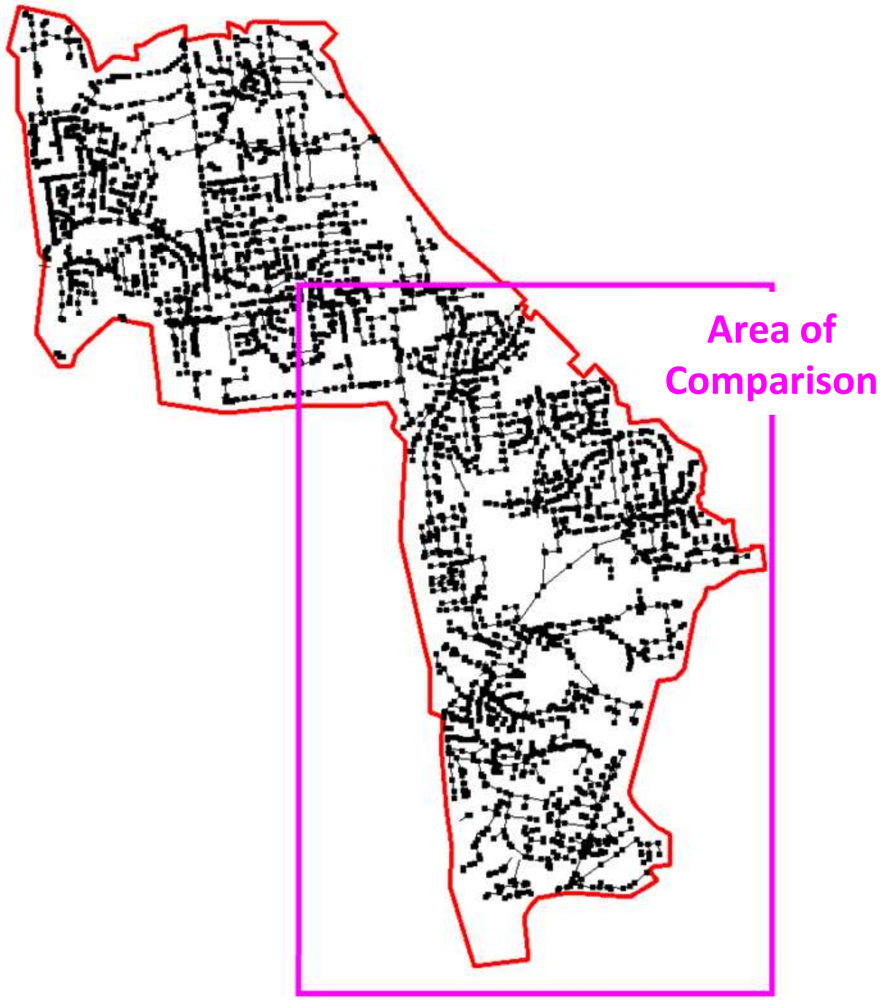




Example 3 - Choice of Pit Type

IMPACT OF CHANGE

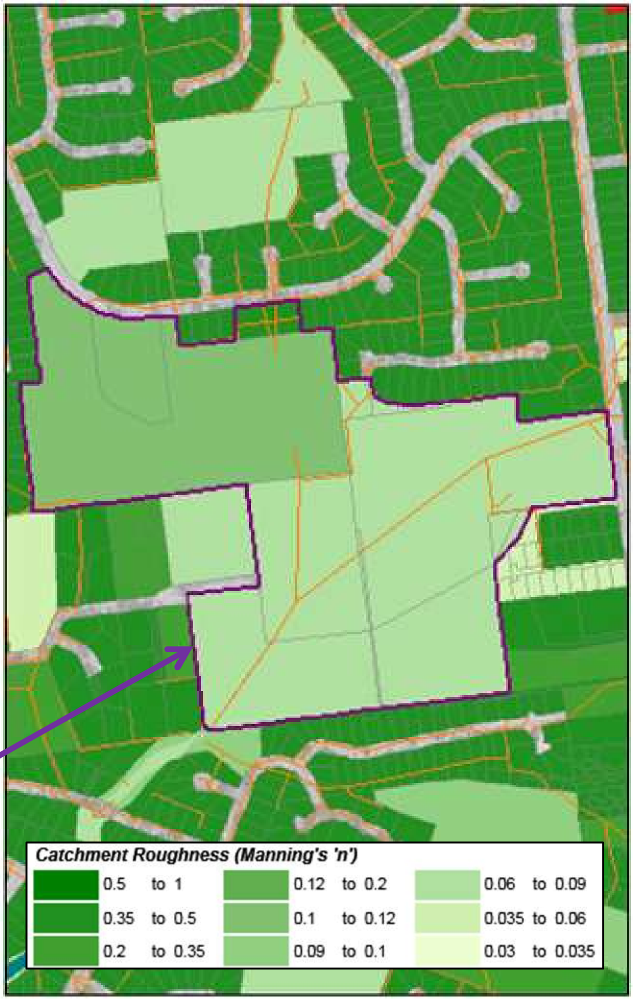
Converting “R” pits to “W” pits over the area show can significantly affect results by removing some of the constraint on flow getting into and out of the drainage system.



Example 4 - Catchment Roughness

ISSUE OUTLINE

Incorrectly classifying areas or applying broad definition of roughness can alter flow distribution by misrepresenting the resistance of areas and/or altering timing.



Area of material refinement

Example 4 - Catchment Roughness

SOLUTION OUTLINE

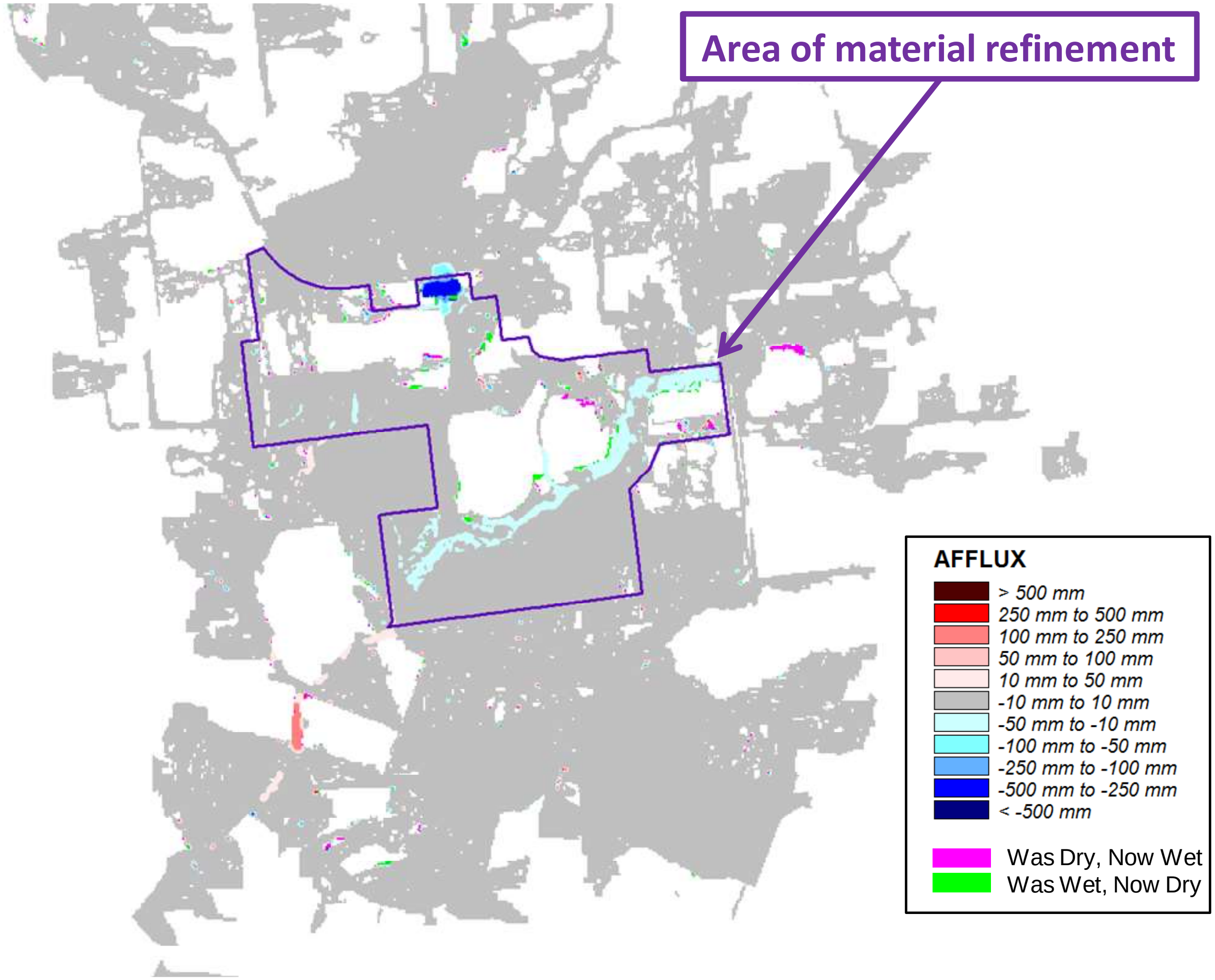
Refining roughness parameters and/or detail along key flow paths and areas where flow is distributed can identify preferential flow paths and better represent the actual resistance of the area.

Area of material refinement

Example 4 – Catchment Roughness

IMPACT OF CHANGE

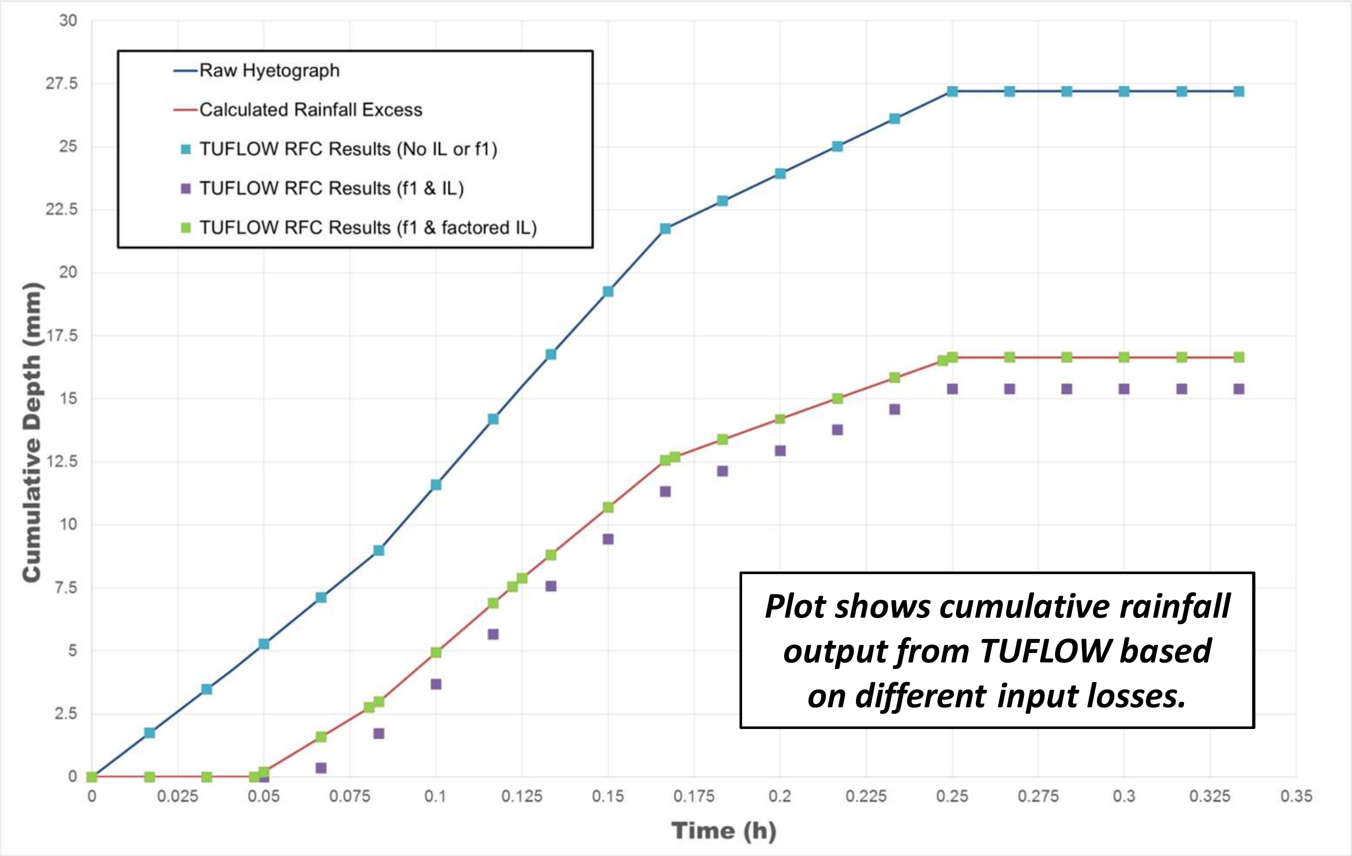
Representing realistic roughness along key flow paths can significantly affect results by altering the path and/or timing of flow through the area



Example 5 - “Rain on grid” modelling

ISSUE OUTLINE

Applying unfactored losses will underestimate runoff, by applying too much loss due to the order in which TUFLOW applies the rainfall factors & losses.

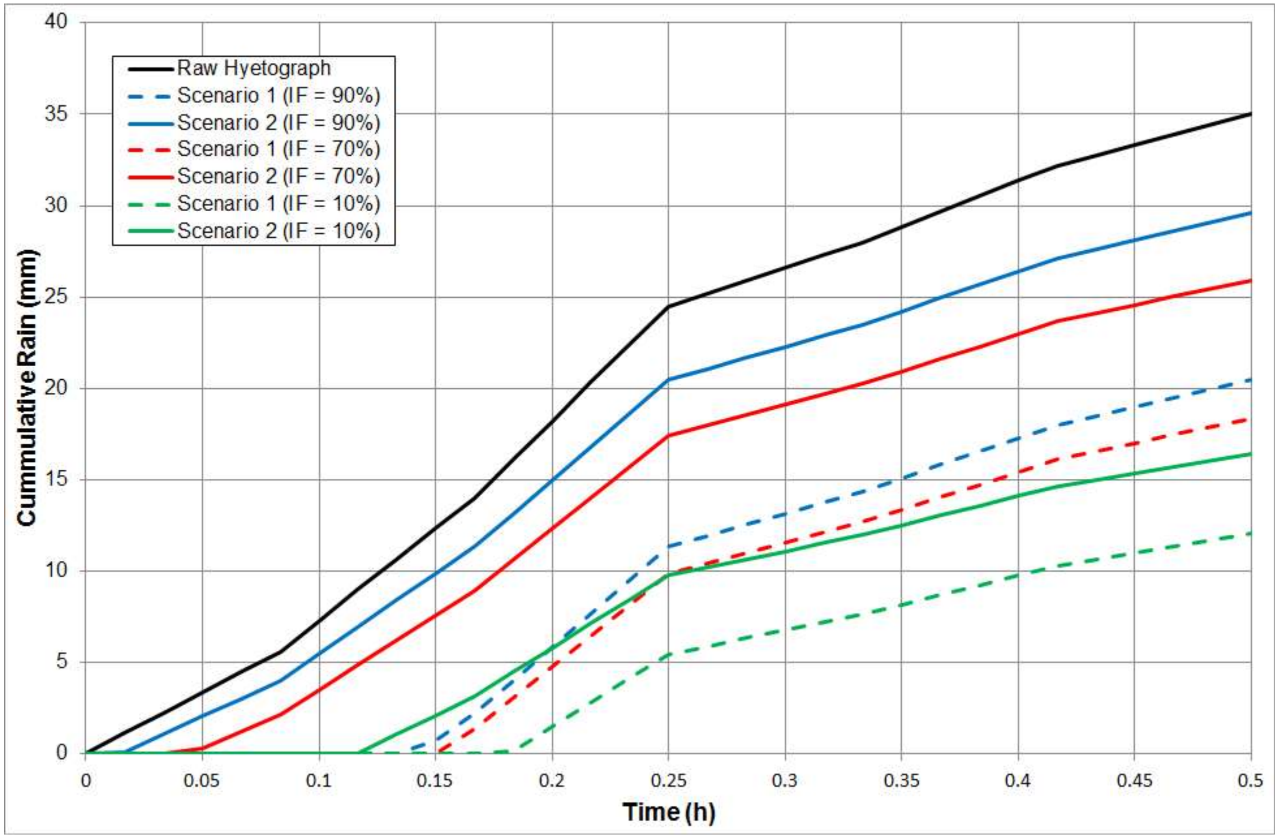


Example 5 - "Rain on grid" modelling

SOLUTION OUTLINE

Rainfall losses applied in TUFLOW should be factored down by the following:

- 'f1' and 'f2' factors
- Impervious fraction as losses only apply to pervious component

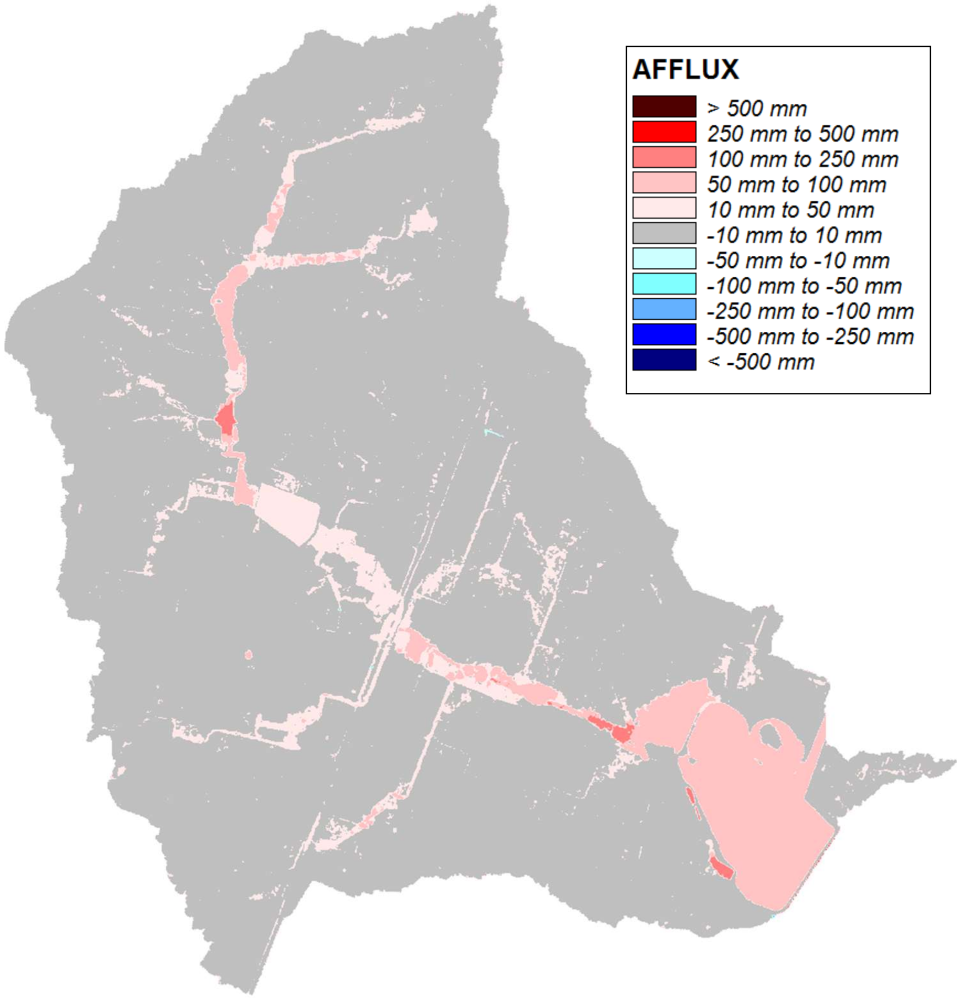


Plot shows change in cumulative rainfall between Scenario 1 (Unfactored losses) & Scenario 2 (Factored Losses)

Example 5 - "Rain on grid" modelling

IMPACT OF CHANGE

Factoring losses appropriately was found to significantly alter flood extents, levels and flows by increasing the volume of runoff in the model, especially along main drainage lines.



Summary of other tests

The following issues were also tested :

- Lowered cell wet/dry depth from 0.002m to 0.0002m
- Halving the 2D timestep
- Fixing drainage network issues (connectivity, cover, inverts and flat/negative grade)
- Using “I” channels to represent hydraulic properties of non-standard assets
- Additional nodal storage
- Cell orientation
- Revised subarea definition & inflow distribution (traditional hydrology/hydraulics)
- Applying all flow to surface (rainfall-excess on grid)
- Removing entrance/exit losses on pits
- Depth varying-roughness for distributed inflow models
- Changing “A” and “D” parameters on 2D/2D links

Conclusion

- It is important that we represent the physical processes occurring in catchments as realistically as possible – so there need to be a focus on checking the models interpretation of your input.
- Testing found that certain variables can have a significant impact on results both locally and more widely if it involves:

  a) Storing volume;

  b) Changing distribution of flow; and/or

  c) Significantly altering the timing of flows.
- This process highlighted a number of guiding questions and focus areas to target when reviewing *(We have these available as a 1 page handout today)*

TUFLOW QA Guiding Questions and Focus Areas

With acknowledgement to: The 'Flood Mapping and Mitigation' team at Melbourne Water, in particular Ruwan Jayasinghe.

Guiding Questions

- What is purpose of modelling (incl. perspective of all stakeholders)?
- How do you best represent reality within the model?
- Has TUFLOW correctly interpreted the model inputs based on above?

Focus Areas

1) Hydrology
   - Have we allowed for all areas that contribute pipe and/or overland flow?
   - Does there need to be routing off subarea or subareas?
   - Is applied impervious fraction representative and in line with guidelines?
   - Are losses appropriate – especially in "rain on grid" models?
2) Terrain
   - Is grid size and orientation appropriate?
   - Does model need terrain modifications to improve representation of flow controlling features within the catchment (i.e. gullies and ridges)?
3) Roughness
   - Is applied roughness representative and in line with guidelines?
   - Is definition consistent across catchment?
   - Are narrow areas of roughness continuous (i.e. creek thalweg or laneway)?
4) 1D Network
   - Are hydraulic properties of assets modelled correctly?
   - Are there any connectivity or grade issues?
   - What loss method is being used and are the applied losses appropriate?
   - Pits – where are these modelled, is inlet capacity being modelled & how are we allowing for connections not included in the model (i.e. direct house connections)?
5) Inflows
   - Is flow distribution appropriate (i.e. no bias of flow to certain areas)?
   - Does inflow location match RORB printout location (i.e. in terms of routing)?
   - Is correct hydrograph referenced in bc_dbase?
   - Is 100% of all hydrographs being applied (i.e. are factors applied in bc_dbase)?
6) DS Boundary
   - Are boundary condition far enough away from model area of interest?
   - Are 1D and 2D boundaries consistent?
   - Should boundaries vary with AEP?
7) Initial Conditions
   - Are 1D or 2D IWL required?
   - Does there need to be routing off subarea or subareas?
   - Have undrained depressions been accounted for (i.e. to avoid double counting losses)?
8) Model Runs
   - Are there any non-standard commands or changes to defaults in model run files?
   - Are sufficient storms\durations run for model to appropriately determine peak levels?
   - Are models run long enough for peak levels and/or time of inundation to be recorded?
9) Results
   - Are pipes running full where they are expected to be full (use "ccA" results)?
   - Are extents in the correct order (i.e. 1% > 2% > 5% > 10% > 20% AEP)?

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