

# TUFLOW 2015 Release

## New Features



# Map Output Enhancements



# Reminder of New Map Output Formats in 2013-12

- GIS Grids (.asc and .flt)
- 12D (.tmo)
- Blue Kenue (.t3s and .t3v)
- SMS Triangles Option  
(also used for .wrb and .t3 outputs)
- WaterRIDE (.wrb)



# Map Output Formats – .xmddf

- Compression now supported
- XMDF Output Compression == [ {OFF} | ON | <level> ]
  - 9 levels of compression
  - <level> is from 0 to 9 with 0 being no compression
  - Default level for ON is level 1
  - Higher levels more compressive, computationally intensive
- Compressed output files compatible with TUFLOW Utilities, Crayfish, SMS
- Up to 80% smaller files (depends on the model)
- Default Output Format for 2015 Release will be XMDF Level 1 Compression
- DAT will be default if “Defaults == PRE 2015”



# Map Output Formats – NetCDF (.nc)

- Include “NC” in “Map Output Format ==”
- Same output as for ASC or FLT, but in one .nc file
- NETCDF Output Compression == [ {OFF} | ON | <level> ]
  - <level> is from 0 to 9 with 0 being no compression
  - Default level for ON is level 1
  - Higher levels more compressive, computationally intensive
- NETCDF Output Start Date == [ { 2000-01-01 00:00 } | OFF | <date> ]
  - <date> must be in isodate format
  - NETCDF files require a start date in some GIS packages
- NETCDF Output Time Unit == Min | {Hour} | Day
- NETCDF Output Direction == {Angle} | Bearing

# Discussion on NetCDF / XMDF compression

- NetCDF generally larger
  - Grid based
  - Default is to use half the smallest 2D cell size
- NetCDF compress better as there is more redundant areas around grid extent (always a rectangle)
- Compression ratio depends on the fraction of cells / model area that is wet
  - Direct rainfall models with no Map Output Cutoff Depth will not compress well
- Default is for compression level 1 for both NetCDF and XMDF files

# Map Output Formats – Compression

- Comparison 1 .xmdf and .nc compression (both use HDF5 compression)
- Separate hydrology model, ~100,000 cells 72 hour simulation, hourly output
- Runtime ~ 35 min

Level	XMDF File Size (MB)	XMDF Compression Ratio	NetCDF File Size (MB)	NetCDF Compression Ratio	Ratio XMDF / NC	Runtime Increase (%)
OFF	287	1.00	1,847	1.00	0.16	0
<b>Level 1</b>	<b>101</b>	<b>0.35</b>	<b>252</b>	<b>0.14</b>	<b>0.40</b>	<b>0.8</b>
Level 5	97	0.34	237	0.13	0.41	1.2
Level 9	56	0.20	230	0.12	0.24	9.2



# Map Output Formats – Compression

- Comparison 2
- Direct Rainfall, ~35,000 cells 2.5 hour simulation, output every 2 minutes
- Runtime ~ 15 min

Compression Level	XMDF File Size (MB)	XMDF Compression Ratio	NetCDF File Size (MB)	NetCDF Compression Ratio	Ratio XMDF / NC	Runtime Increase (%)
OFF	125.6	1.00	1505	1.00	0.08	0.0
<b>Level 1</b>	<b>72.9</b>	<b>0.58</b>	<b>34.7</b>	<b>0.02</b>	<b>2.10</b>	<b>2.3</b>
Level 5	70.6	0.56	26.9	0.02	2.62	3.3
Level 9	70	0.56	25.8	0.02	2.71	10.5

# Map Output Formats – Compression

- Comparison 3
- Separate Hydrology, ~280,000 cells 3 hour simulation, output every 10 minutes
- Runtime ~ 45 min

Compression Level	XMDF File Size (MB)	XMDF Compression Ratio	NetCDF File Size (MB)	NetCDF Compression Ratio	Ratio XMDF / NC	Runtime Increase (%)
OFF	215	1.00	1273	1.00	0.17	0.0
<b>Level 1</b>	<b>57</b>	<b>0.27</b>	<b>138</b>	<b>0.11</b>	<b>0.41</b>	<b>0.3</b>
Level 5	54	0.25	126	0.10	0.43	0.9
Level 9	53	0.25	122	0.10	0.43	7.1

# Map Output Formats – NetCDF (.nc)

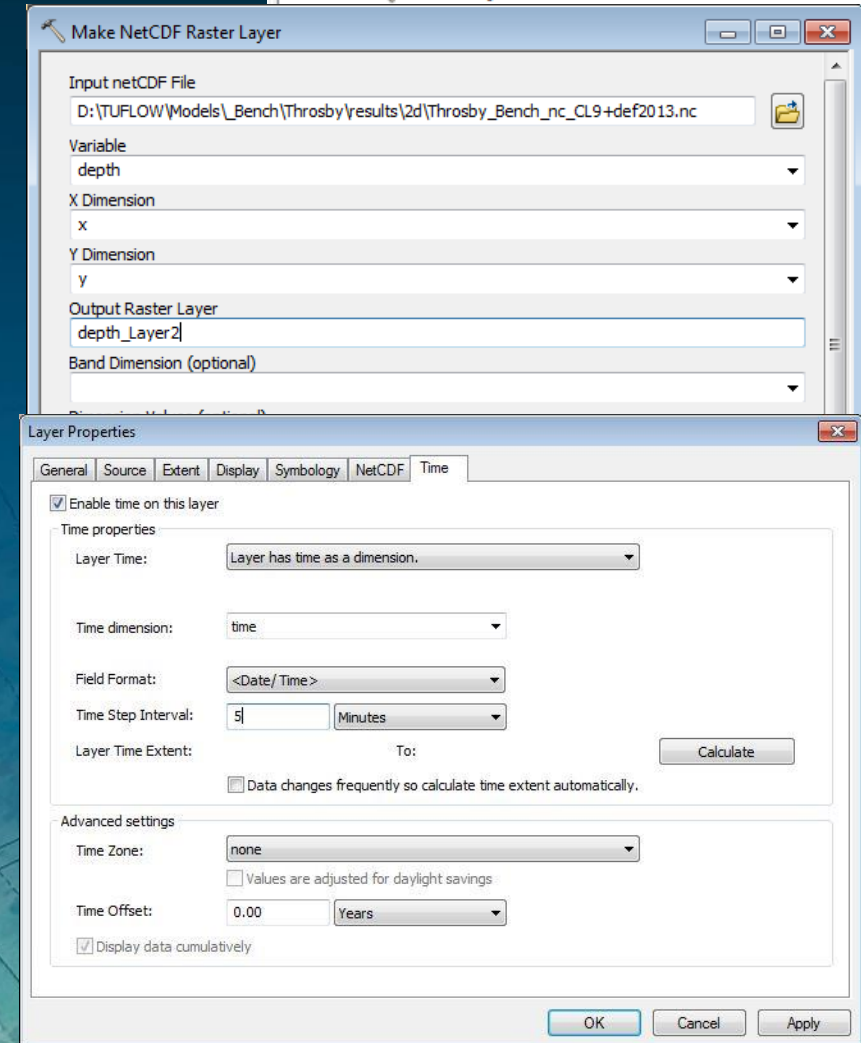
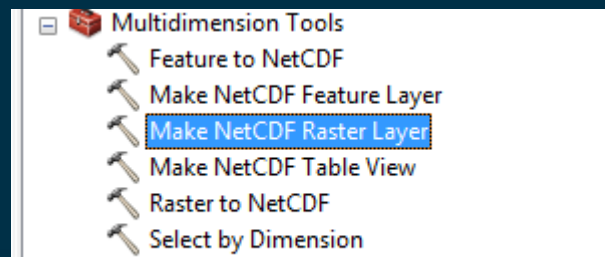
- NetCDF widely recognised
- Native Support in:
  - Matlab
  - ArcMap
  - NETCDF files require a start date in some GIS packages (ArcMap)
- Some support
  - Python (requires NetCDF library to be installed, not entirely simple)
  - QGIS (compressed version not yet supported, can be projection / shift)



# Map Output Formats

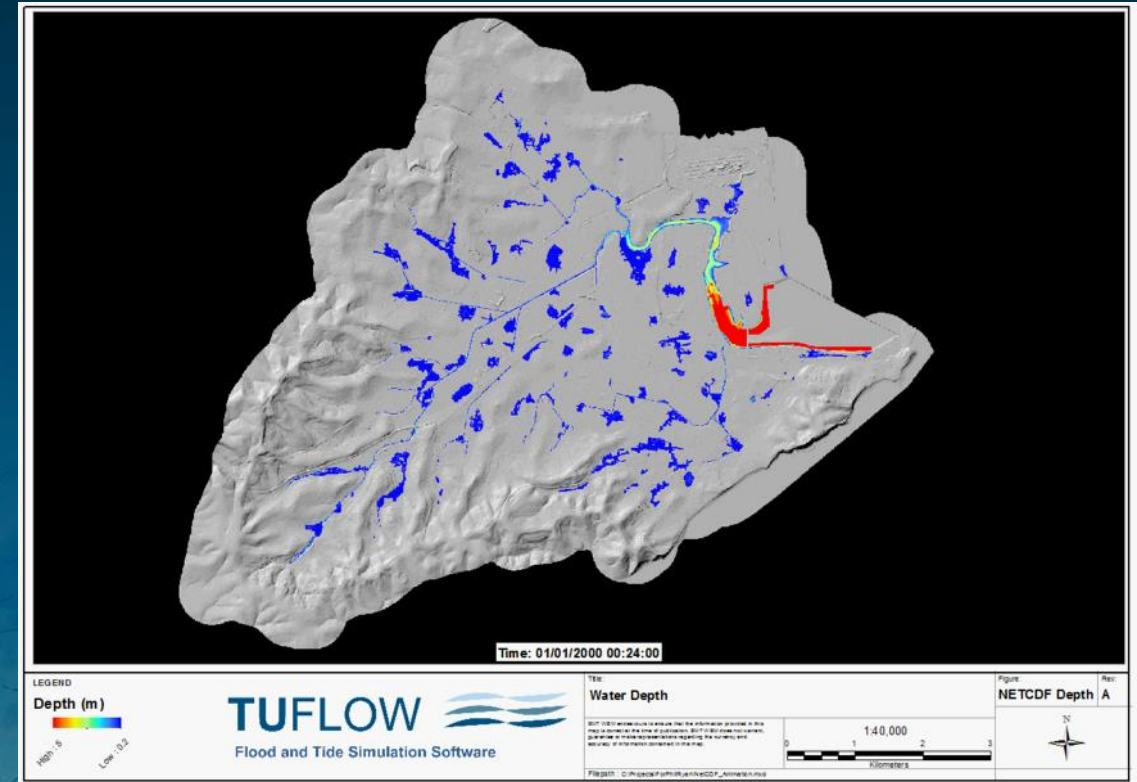
## NetCDF (.nc) in ArcMap

- ArcMap has native support for NetCDF Raster
- Accessed through multi-dimension tools
- Time needs to be enabled, then use time slider to control
- ArcMap 10.3 has option to render vectors from 2 grids (magnitude and direction)



# Map Output Formats – NetCDF (.nc) in ArcMap

- Animation – Throsby / Cottage Creek Newcastle
- Netcdf output (~280,000 2D cells)
- Experiences in ArcMap
  - Relatively easy to bring .nc files into ArcMap
  - Switching between data variables not as easy
  - Animations can be slow to process
  - Some experimentation with codecs may be required (some failed)



# NetCDF

- For ArcMap and FEWS users NetCDF is preferred for time-varying capability
- For SMS / QGIS Crayfish users stick with .xmdf and or .asc /.flt
- Useful scripting

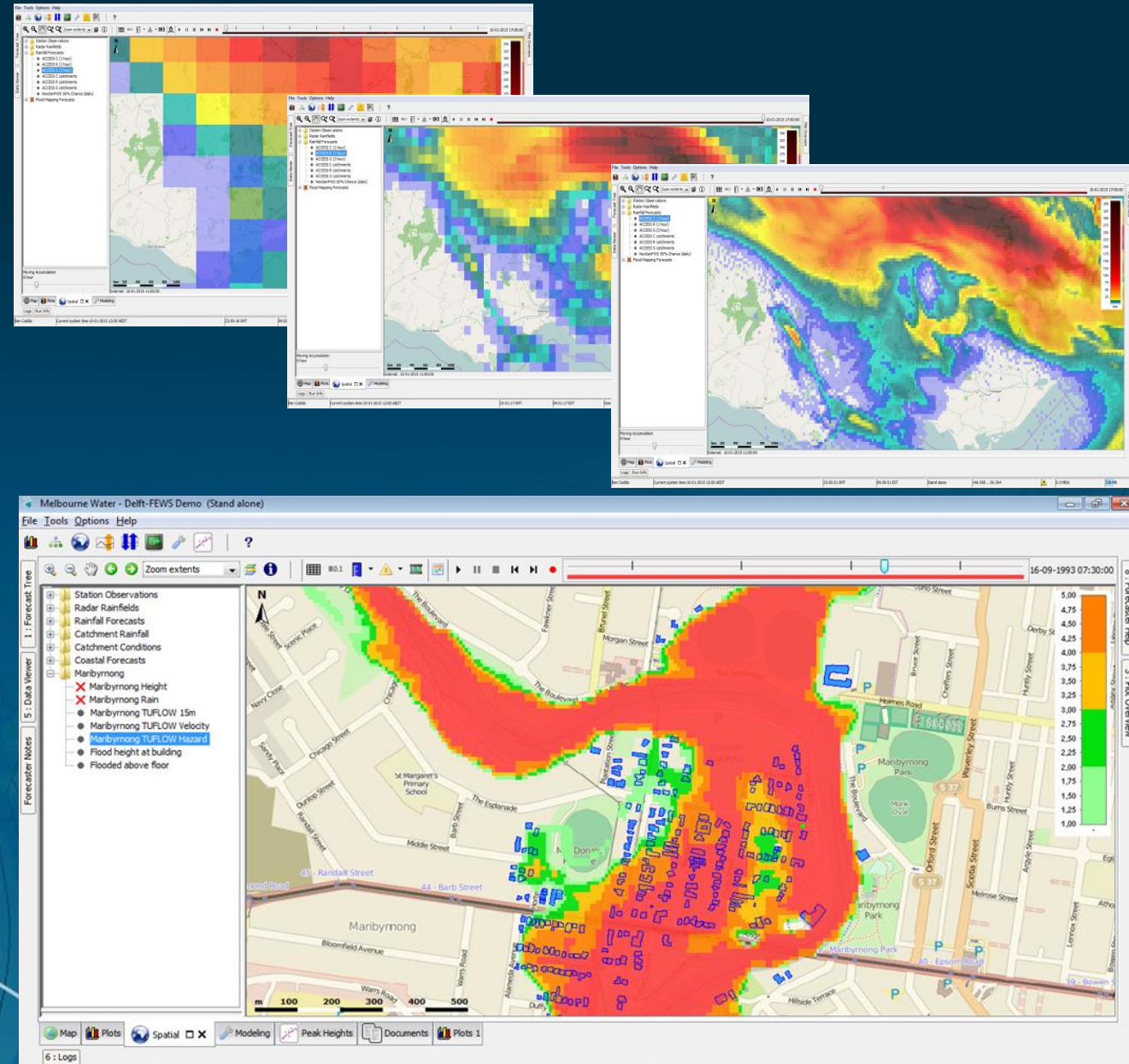
```
Command Window
>> fname = 'C:\TUFLOW\Preso\UK2015\matlab\C13_Results.nc';
>> ncdisp(fname)
Source:
      C:\TUFLOW\Preso\UK2015\matlab\C13_Results.nc
Format:
      netcdf4
Global Attributes:
      title      = 'C13_Compression_CL9'
      source     = 'TUFLOW Build: 2015-10-PS-Dev-IDP-w64'
      references = 'Not completed yet'
      comment    = 'Contains raster TUFLOW output, TUFLOW netcdf version: 1'
Dimensions:
      x          = 815
      y          = 760
      time       = 76      (UNLIMITED)
Variables:
      time
      Size:      76x1
      Dimensions: time
      Datatype:  double
      Attributes:
                  standard_name = 'time'
                  long_name     = 'time'
                  units          = 'hours since 2000-01-01 00:00'
```





# Delft-FEWS

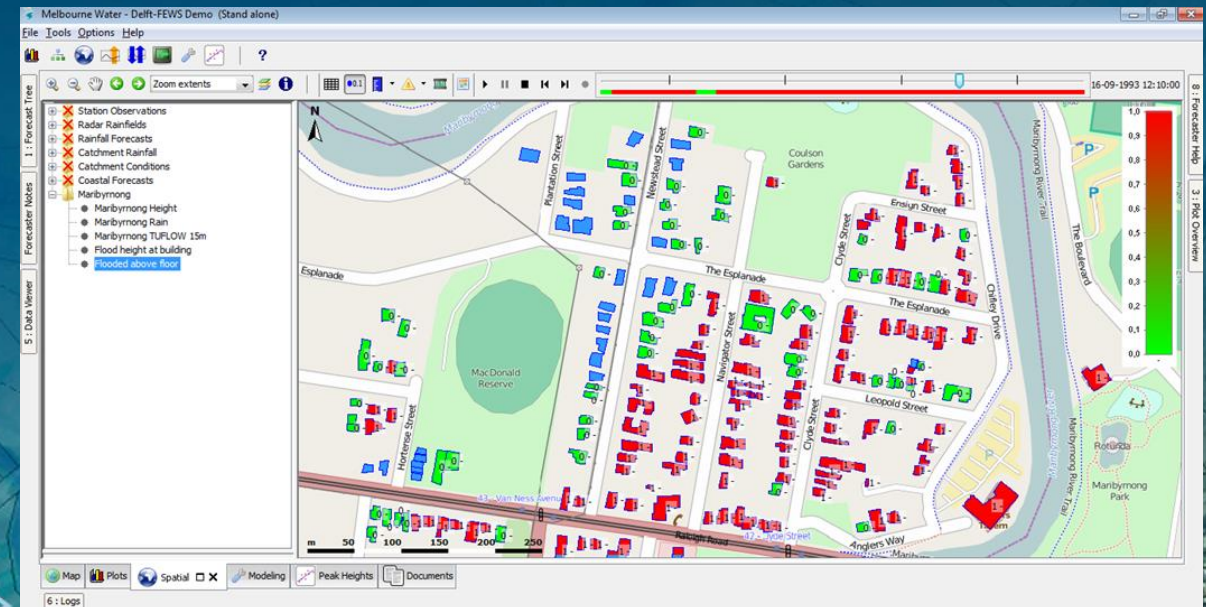
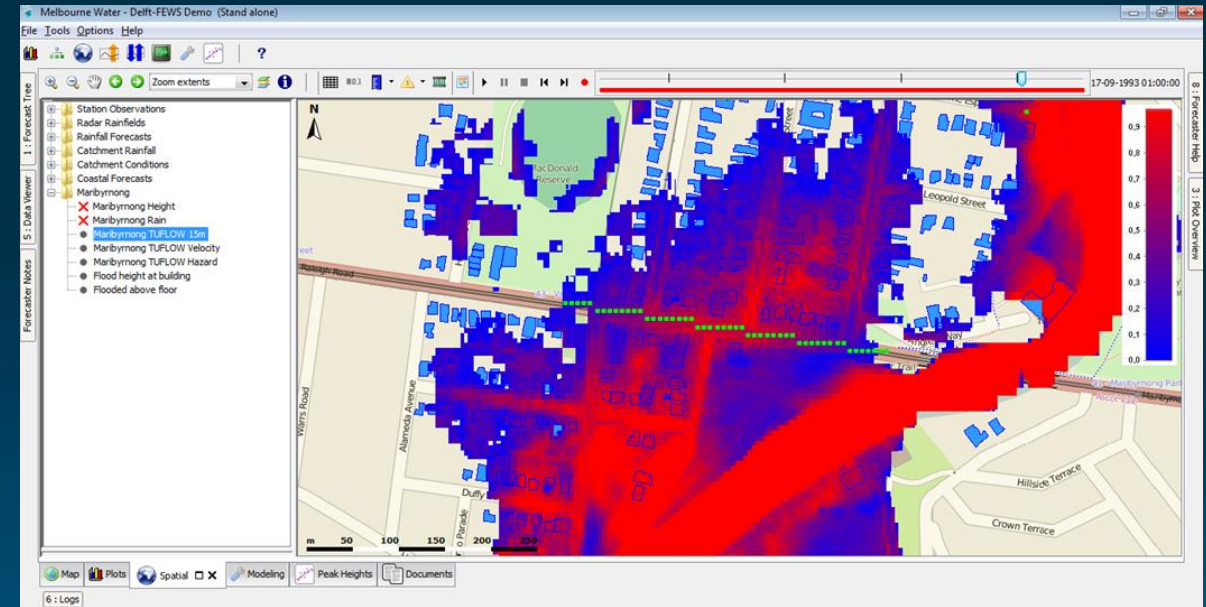
- General adapter for simulation of TUFLOW from FEWS (Classic & GPU)
- TUFLOW can be configured as a stand alone module in FEWS, or as part of a workflow (i.e. typical hydrologic / hydraulic model sequence)
- Any TUFLOW output can be loaded into FEWS for further analysis and triggering thresholds / alarms





# Delft-FEWS

- 1D data exchange:
  - Time series from FEWS converted from XML to TS1 via pre-adapter
  - TUFLOW CSV output imported directly into FEWS
- 2D data exchange:
  - Grid rainfall from FEWS via NetCDF
  - TUFLOW output as FEWS format NetCDF



# Map Output Formats – waterRIDE .wrr

- Include “WRR” in “Map Output Format ==”
- Same output as for ASC or FLT, but in one .wrr file
- Non rotated (as per .asc and .flt)
- Outputs limited to:
  - Elevation
  - Water levels
  - Velocities (scalar and vector)
  - Velocity-Depth Product (optional)
  - One hazard category (optional)
- Other data types are post processed within WaterRide

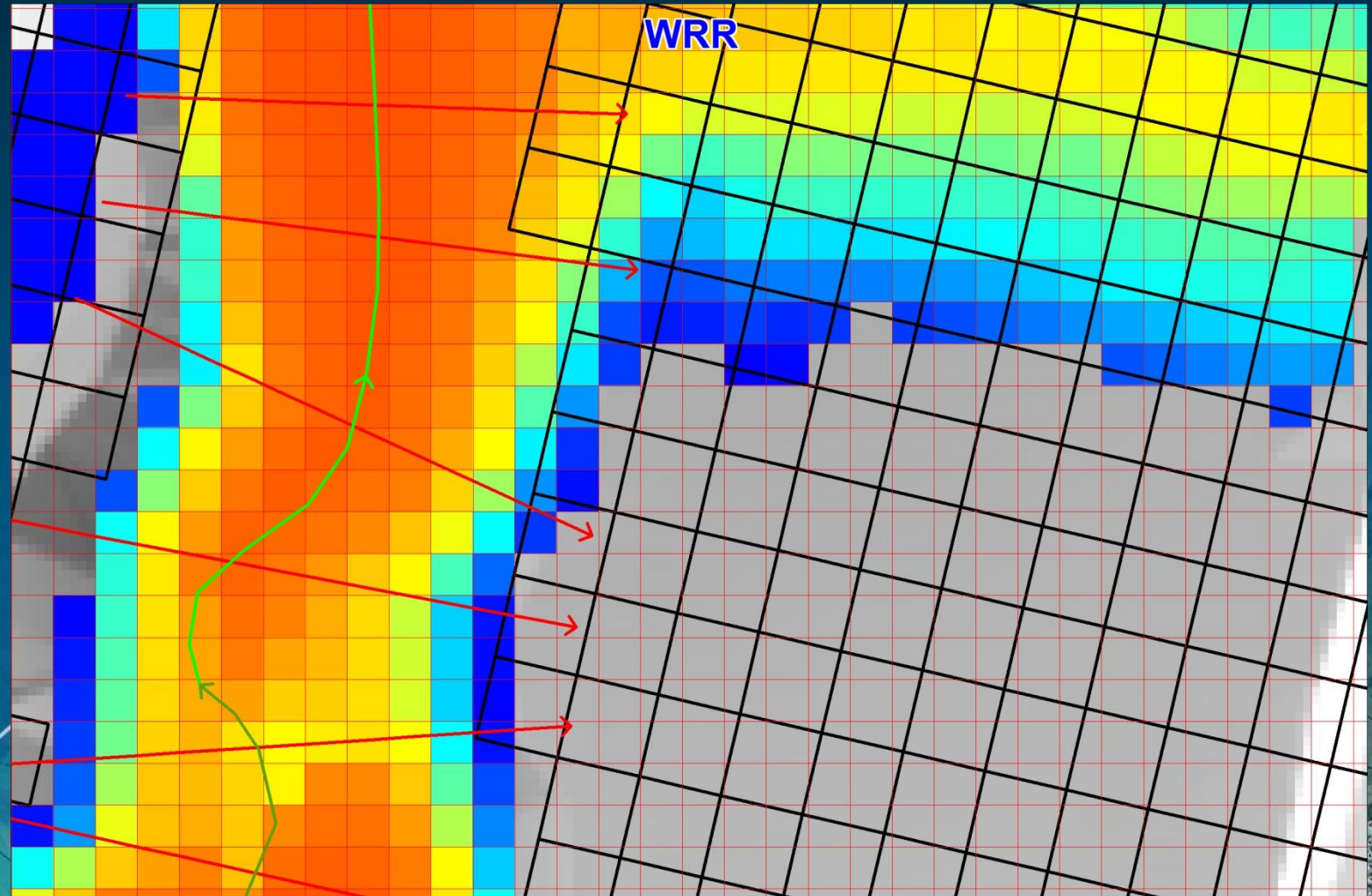


# Map Output Formats – waterRIDE .wrc

- Combination of:
  - Triangular mesh (.wrb) for 1D elements
  - Raster (.wrr) file for each 2D domain
    - Same cell size and rotation as 2D domain
    - Outputs cell centre values
- .wrc in output directory (text file)
- .wrb and .wrr files in WaterRide subfolder

# WaterRide Outputs

- Difference between formats
- For triangles data stored at vertices
- For quads (squares) data stored at centre



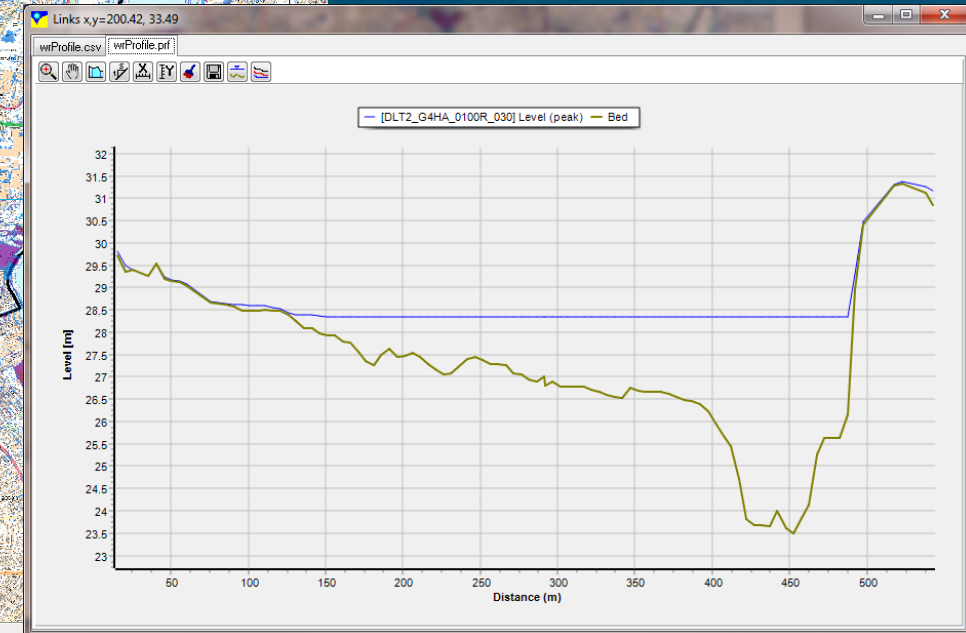
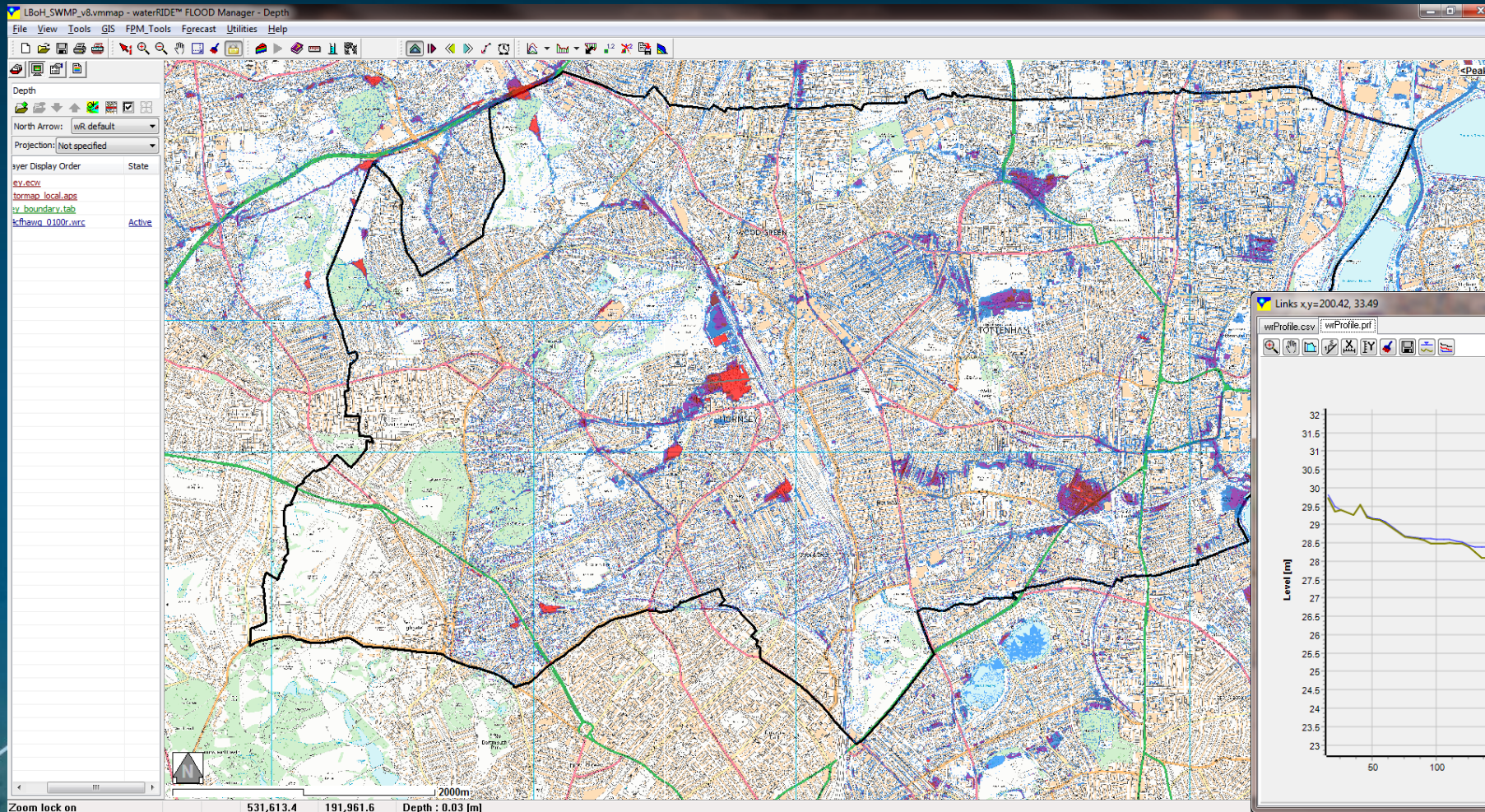


# WaterRide Outputs

- WRR largest of these formats
  - Reduce by reducing "Grid Output Cell Size =="
  - Single raster file for entire model
  - Interpolated to raster based on 1D WLL and 2D mesh
- WRB intermediate in size formats
  - Single TIN for entire model
  - Contains all outputs in single file and each 2D cell split into 4 triangles
  - Slow for large models
- WRC smallest dataset
  - Potentially multiple files (WRR and WRB)
  - Loaded in via single .wrc file



# Map Output Formats – waterRIDE .wrc

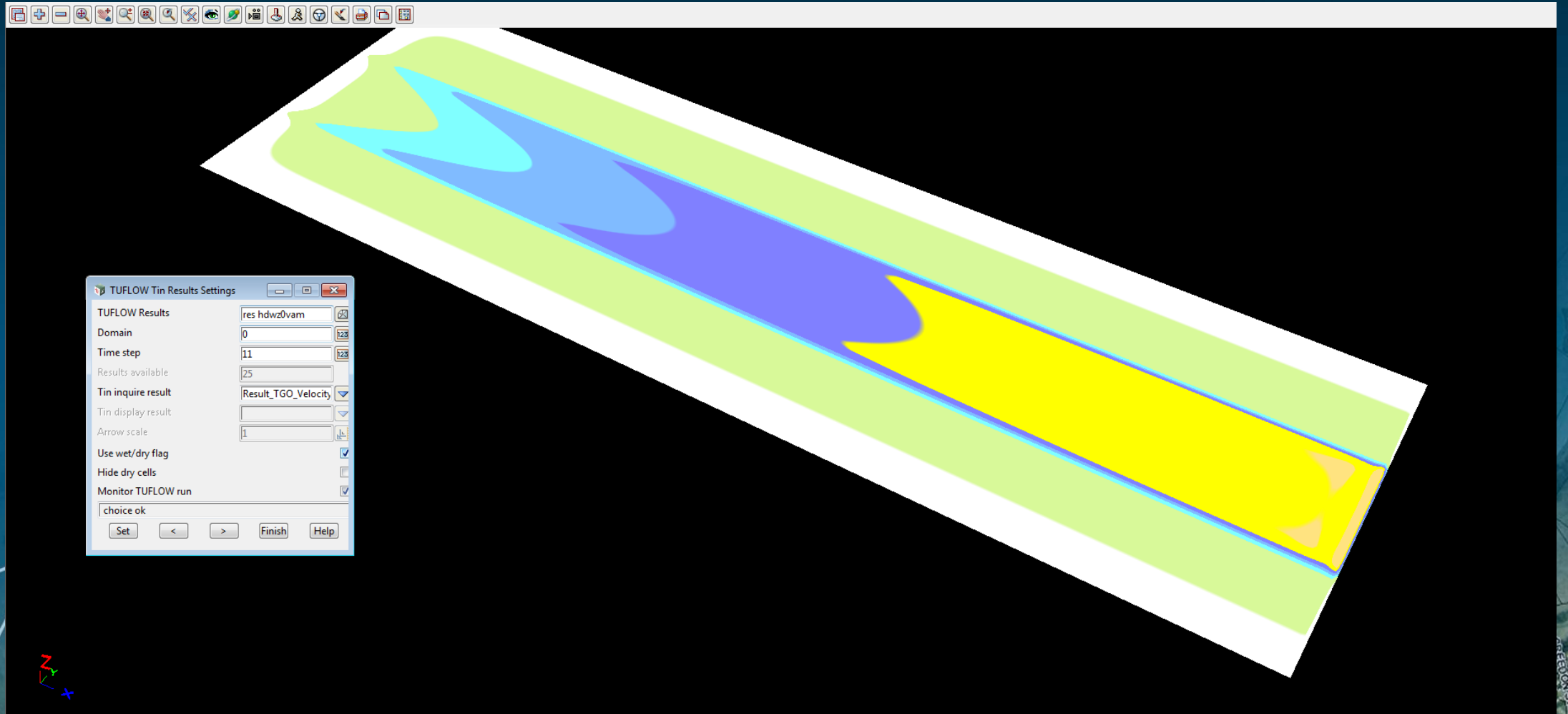




# Map Output Formats – 12D .tmo & .tgo

- .tmo and .tgo are output formats developed with 12D Solutions
- .tmo contains 2D model output as rotated grid
  - No 1D water level lines as yet
  - Limited to depth, level, velocity (scalar and vector) and unit flow (scalar and vector)
- .tgo non rotated grid output as per .asc, .flt, .wrr and .nc
  - All output parameters available (>60 different types)
  - Includes 1D water level lines and any M2D domains via mesh interpolation
  - Same interpolation as described in .wrr slides earlier

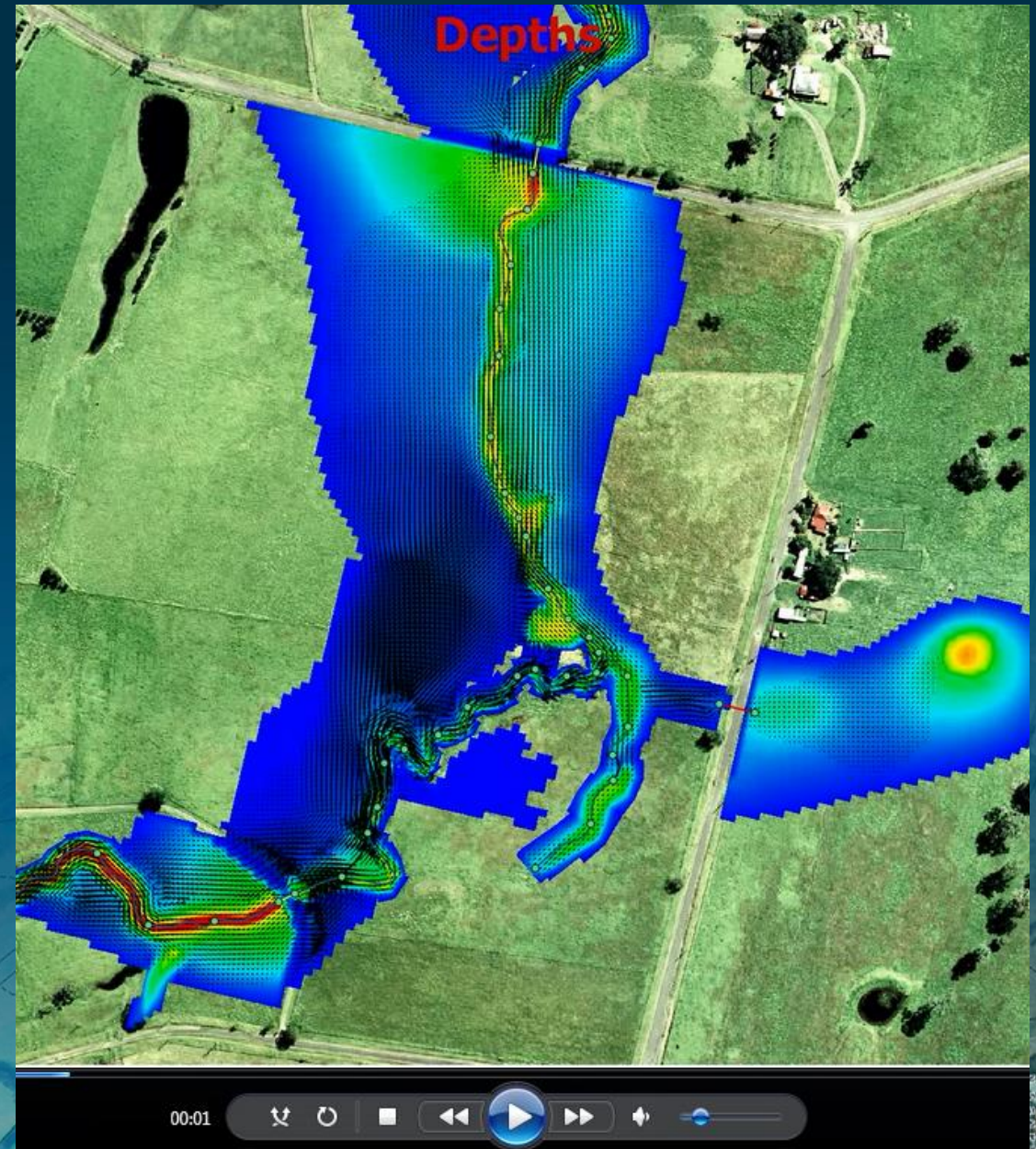
# Map Output Formats – 12D .tmo & .tgo





# QGIS Crayfish Plugin

- See Lutra presentation for the latest!
- Ability to load in .dat or .xmdf files (including compressed xmdf)
- Step through time-varying results
- Animations can be exported
- TUFLOW FV results also supported





# Map Output Formats – Directly to GIS

- Map Output Format == GIS
- GIS Grid Vector Type == Point | {Region}
- GIS Grid Vector Direction == {Angle} | Bearing | Verbose
  - Verbose gives, angle, bearing and X and Y components
- GIS Grid Vector SF == <scale factor>
- GIS Grid Vector TTF == <tail thickness factor>

# Gridded Rainfall

- Time Varying Gridded Rainfall
  - Series of .asc grids
  - Series of .flt grids
  - Single NetCDF file containing all times
- Less memory intensive than 2d\_rf polygons
- Use with new RFR and RFC map outputs



# New Map Output Data Types

- New map output parameters
  - RFR = Rainfall Rate (units mm/hr or inches/hr)
  - RFC = Cumulative Rainfall (mm or inches)
  - VA = Velocity Angle (angle of flow)
  - Available for dat, xmdf, nc, tgo, asc, wrd, flt and gis formats
- Example: “Map Output Data Types == h v q VA RFR RFC”

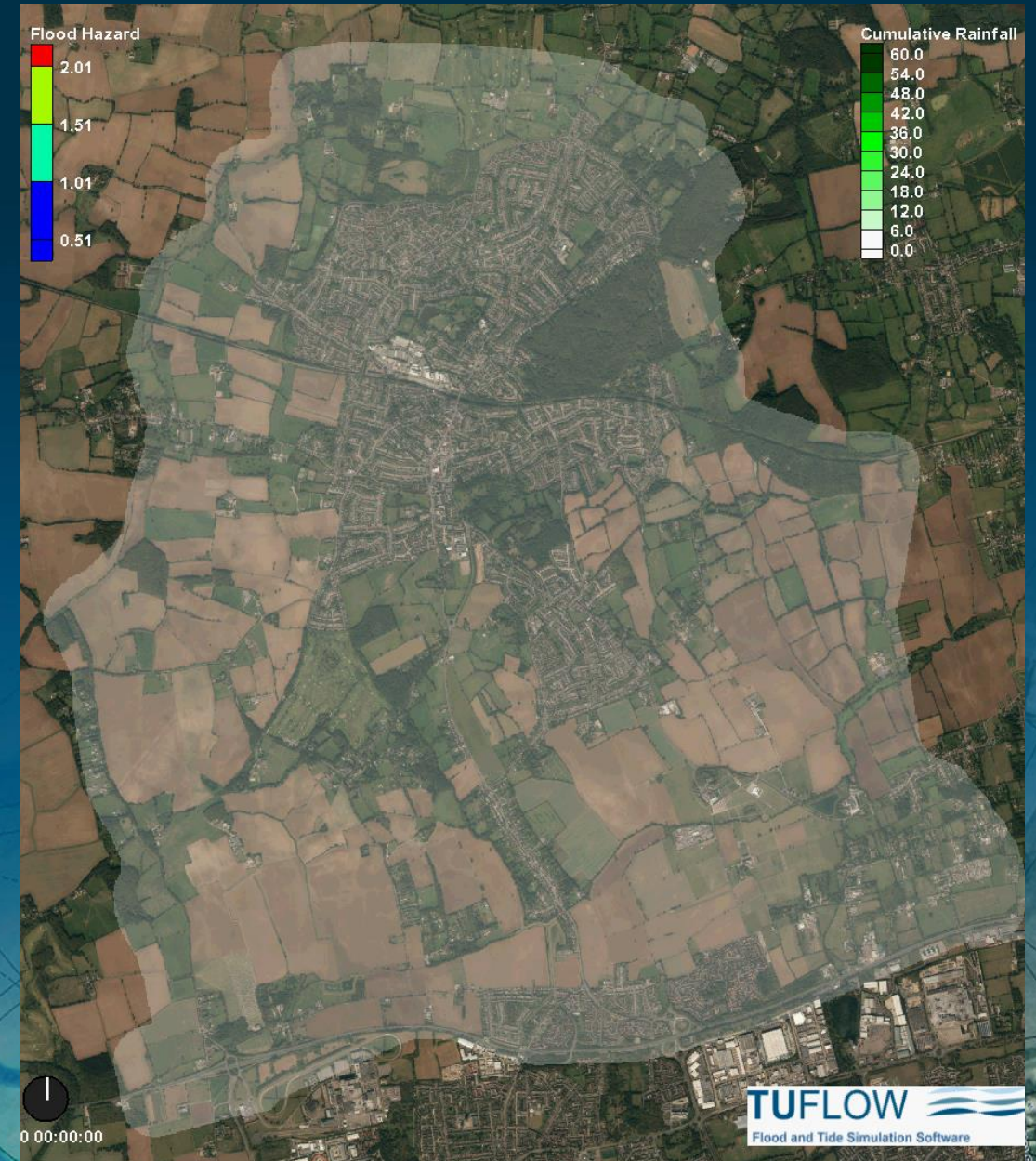
# Gridded Rainfall from Points

- "Rainfall Control File == <my\_rain.rcf>" plus new .rcf commands
- Create gridded rainfalls from point locations
  - TIN (triangulation)
  - IDW (inverse distance weighing)
  - Polygons
  - RF Interpolation Method == [ TIN | POLY | IDW | {no default} ]
- RF Grid Format == [ ASC | FLT | NC | {no default} ]
- RF Grid Cell Size == 10 (if not specified 10 x cell size is used)
- RF Grid Size (X,Y) == x,y (if not specified TUFLOW model domain is used)
- RF Grid Origin == x,y (if not specified TUFLOW model domain is used)



# Rainfall Grids

- Time varying rainfall grids
  - Interpolated from gauges
  - Radar imagery
  - Meteorological Forecasts
- Together with GPU solver opportunities for 2D flood forecasting





# TUFLOW AD Map Output

- TUFLOW AD (Advection Dispersion) outputs now compatible with other Map Output Formats
  - Previously only .dat and .xmdf supported
- Tracer concentration over time for each tracer (up to 20 per simulation)



# Output Zones

- .tcf file “Define Output Zone ==” ... “End Define” blocks, for example
  - Define Output Zone == A3
    - Read GIS Output Zone == ..\model\mi\2d\_oz\_A3.mif
    - Map Output Formats == FLT XMDF
    - End Map Output == 6.0
    - Map Output Interval == 360
    - FLT Start Map Output == 0.5
    - FLT End Map Output == 4.0
    - FLT Map Output Interval == 1800
    - FLT Map Output Data Types == h Z0
    - Write Check Files Include == DEM\_Z
    - End Define
- Model Output Zones == A1 | A3
- Use “Map Output Entire Model == OFF” to not output for whole model
- Set “Map Output Interval == 0” to suppress temporal (time) map output (ie. only maximums and/or minimums if specified)



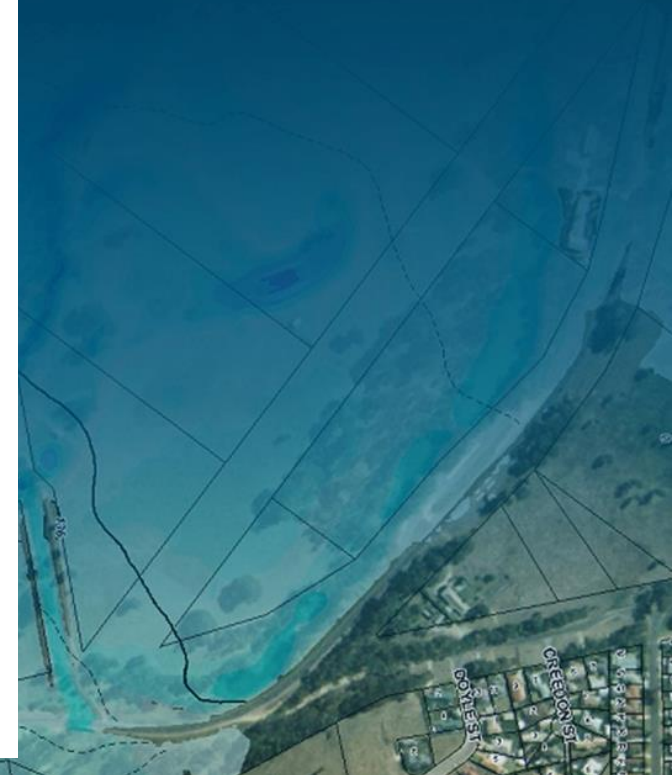
# Output Zone Examples

```
! OUTPUT COMMANDS
!
Output Folder == ..\results\M08\2d ! Send TUFLOW 2D output to this folder
Map Output Data Types == h V q d ! Output water levels, velocities, unit flows, depths
Start Map Output == 0
Map Output Interval == 900
Map Cutoff Depth == 0.05

Model Output Zones == DS

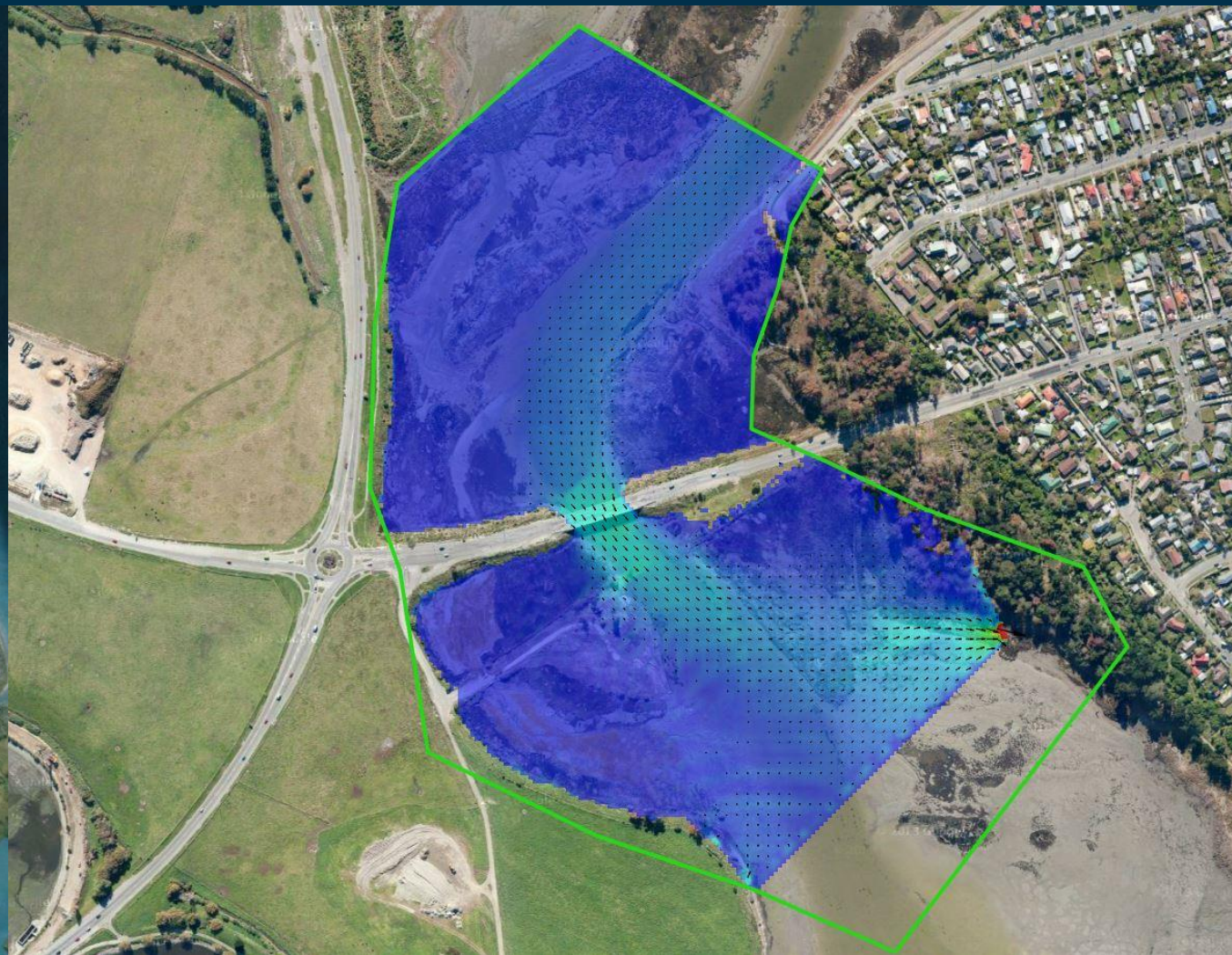
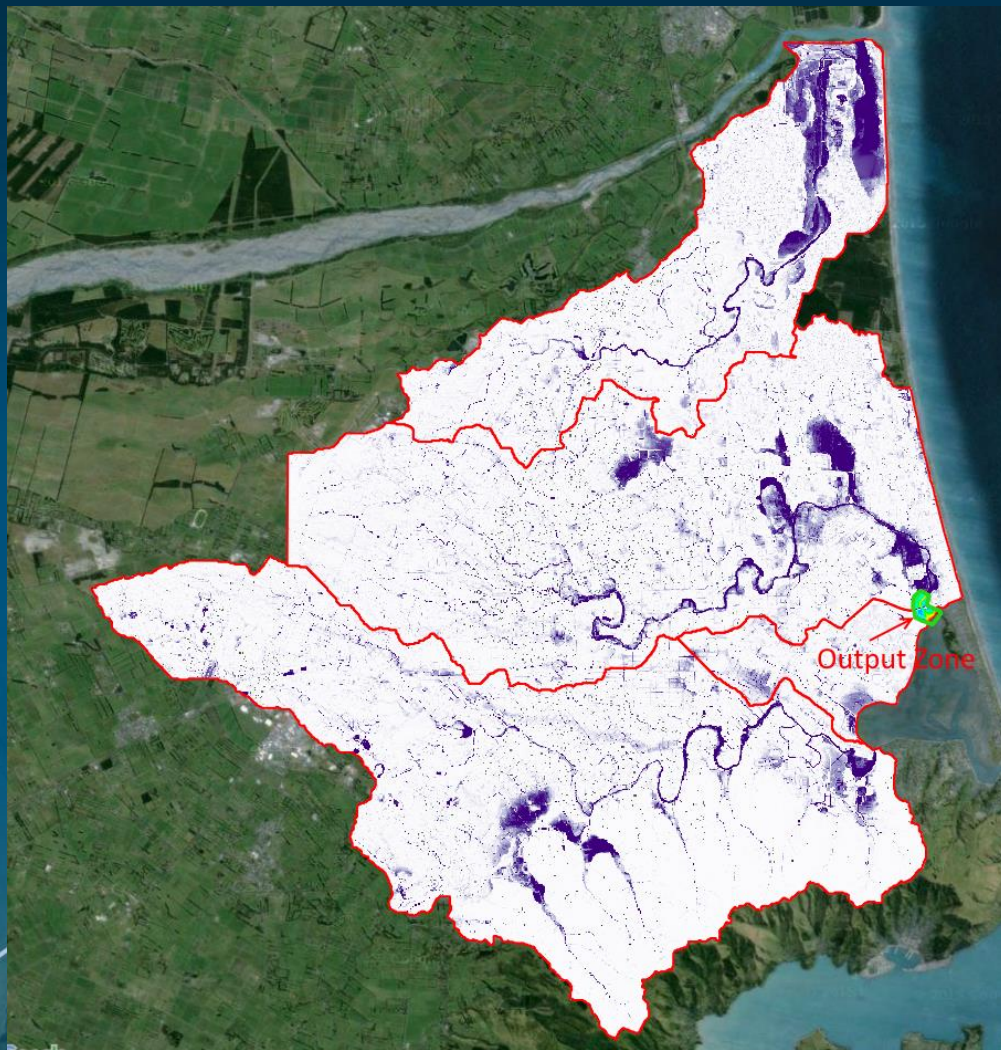
Define Output Zone == Town
  Read GIS Output Zone == ..\model\mi\2d_oz_town.MIF
  Map Output Format == asc nc xmdf
  Map Output Interval == 120
  asc Map Output Data Types == h v d z0 z1
  Output Folder == ..\results\M08\2d\town
  Maximums and Minimums == ON MAXIMUMS ONLY
End Define

Define Output Zone == DS
  Read GIS Output Zone == ..\model\mi\2d_OZ_boundary_001.MIF
  Map Output Format == xmdf
  Map Output Interval == 60
  Start Map Output == 20.0
  End Map Output == 60
  grid Map Output Data Types == h v
  Output Folder == ..\results\M08\2d\ds
  Maximums and Minimums == OFF
End Define
```





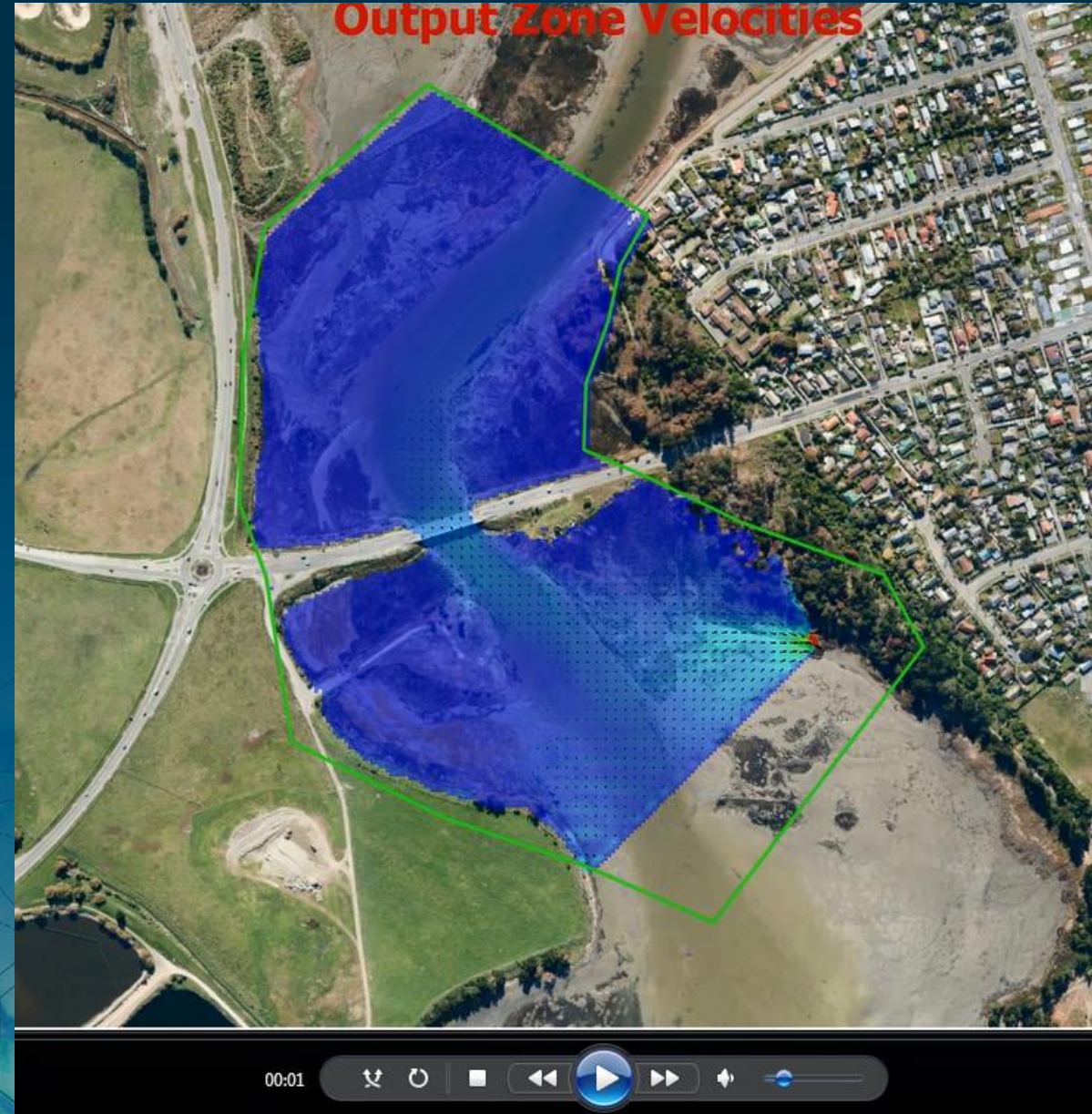
# Output Zone Examples





# Output Zone Example

- Used to identify issues at downstream boundary
- Large GPU model with >10 million 2D cells
- Grid output >100MB per output interval
- Needed output every 10 mins over 36 hours
- Output zone used to focus in on area



# Extreme Output Zones

- Brisbane River Detailed Model
- 22 output zones defined (in read file)
- Can be turned on or off in .tcf
- Can be conditional using scenarios

```
!
! OUTPUT ZONES
Read File == ..\model\GIS\output_Zones\BR_D_Output_Zones_001.trd

! Centenary | Kholo_Ck | Bulimba_Ck | Colleges | KPT | Brem_001 | Mt_Crosby | Ironpot | U_Bremer | Bar | Karana | U_Loc | Fairney |

Model Output Zones == Kholo_Ck | Bulimba_Ck ! Apply output zones as required
```

```
Define Output Zone == Colleges
  Read GIS Output Zone == ..\model\GIS\output_zones\2d_OZ_Colleges.MIF
  Map Output Format == XMDP SMS Triangles
  Map Output Data Types == h V Q
  Map Output Interval == 900 !15 minutes
  !Start Map Output == 50
!End Map Output == 100
End Define

Define Output Zone == KPT
  Read GIS Output Zone == ..\model\GIS\output_zones\2d_OZ_KPT.MIF
  Write Check Files Exclude == qqq
  Map Output Format == XMDP SMS Triangles
  Map Output Data Types == h V Q
  Map Output Interval == 900 !15 minutes
  Start Map Output == 0
!End Map Output == 100
End Define

Define Output Zone == Brem_001
  Read GIS Output Zone == ..\model\GIS\output_zones\2d_OZ_Bremer_001.MIF
```

```
If scenario == test
  Read GIS Output Zone == ..\model\GIS\output_zones\2d_OZ_Mt_Crosby_small.MIF
  Map Output Format == XMDP SMS Triangles
  Map Output Data Types == h V Q
  Map Output Interval == 12 !15 minutes
  Start Map Output == 17
  End Map Output == 17.25
Else
```



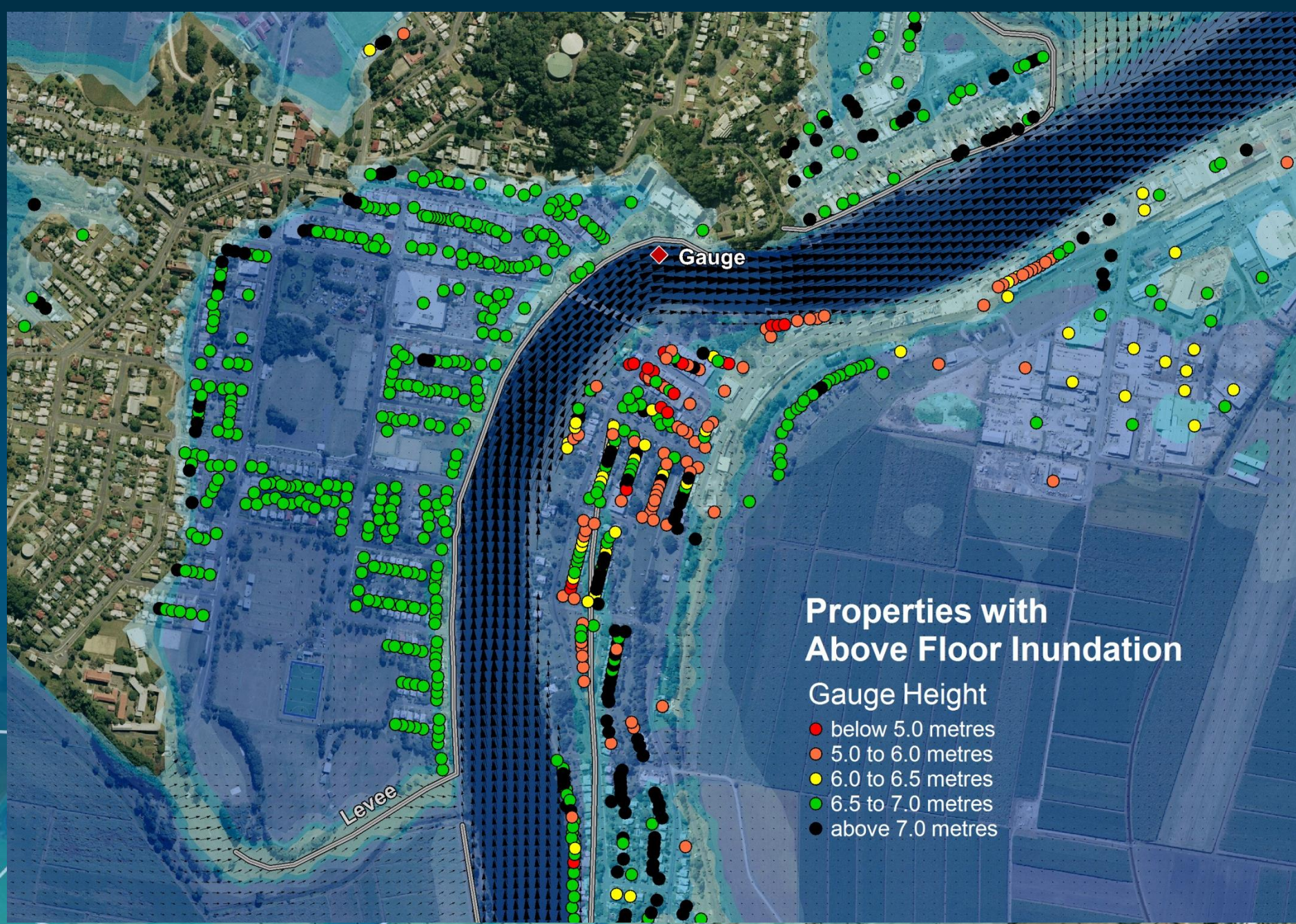
# Read GIS Objects Add Gauge Levels [ Zpt ] [ Use ZC ] ==

- One or more GIS layers of, for example, buildings (receptors)
- As each property ground and/or floor level is inundated record
  - Level on each gauge
  - Simulation time
- A single point file layer output with a \_GOp extension
- Gauge(s) are defined as points in 2d\_po layers using the "G" type
- .mif and .shp supported
- Options
  - Zpt – Modifies Zpts within polygons, eg. set the Zpts to the building floor level
  - Use ZC – Ignores elevation attribute and uses existing elevation



# Add Gauge Levels

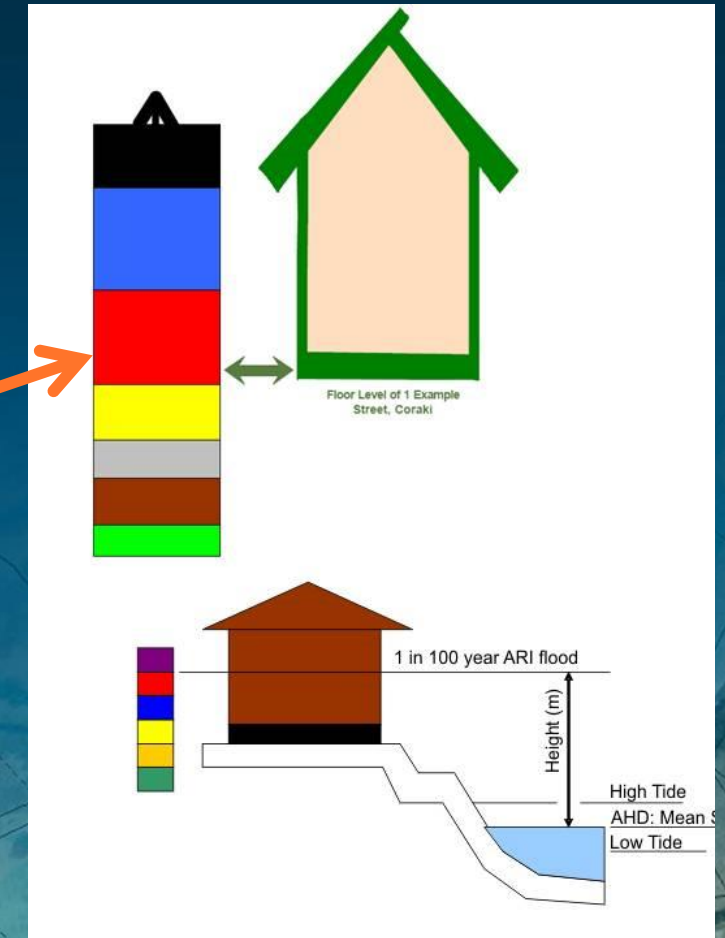
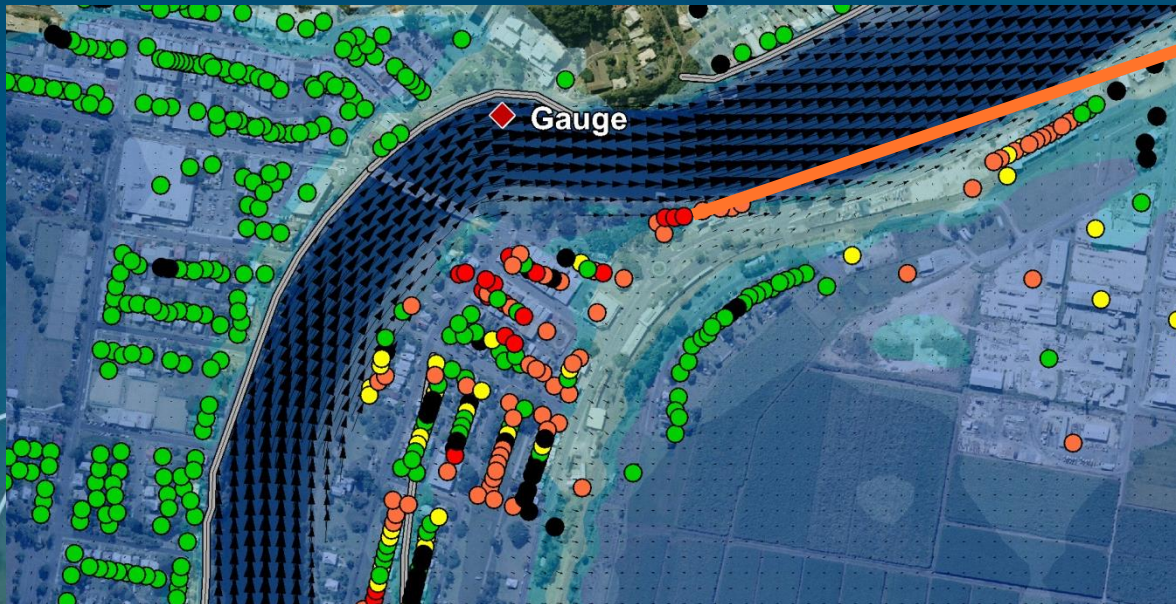
- Properties populated with warning time and gauge height when
  - ground floods
  - floor floods





# Making Flood Warnings Useful

- Critical gauge heights for each building placed somewhere permanent (eg. inside the electricity box)
- Send messages to residents and owners
- Residents/owners can make an informed decision on the action to take (such as taking the TV downstairs!)



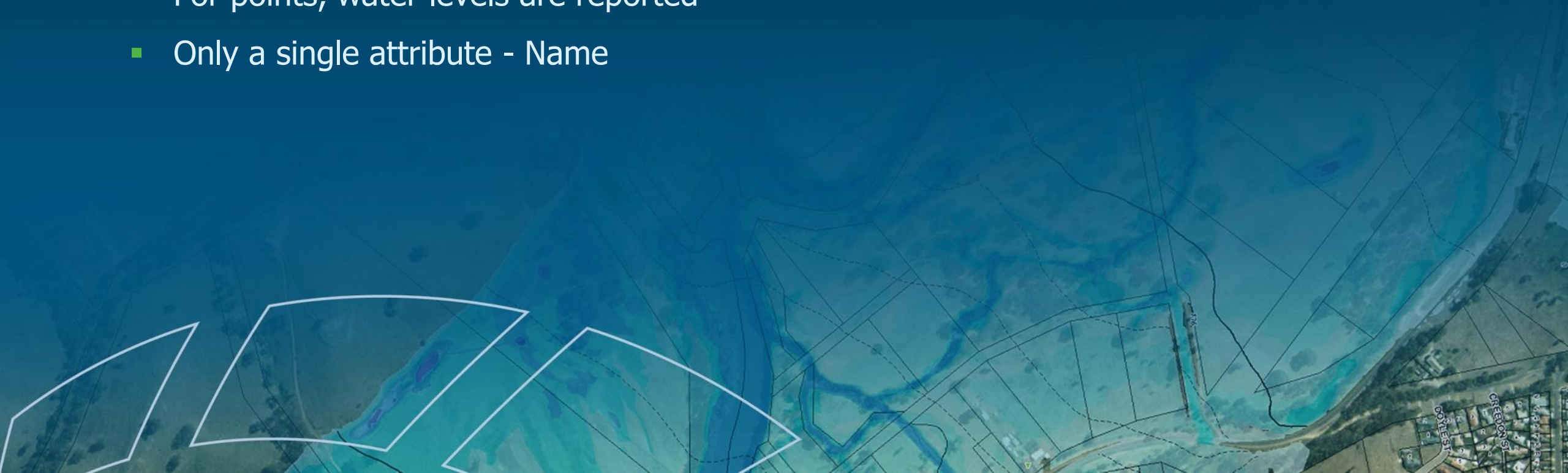
# New Structure Output

- Combines multiple 1D channels and 2D elements
  - Automatically combines 1D structures
  - Cumulates any intersected 1D channels and 2D cells for “QS” lines in a 2d\_po layer
- \_SQ.csv – Flows through combined channels/2D lines
- \_SHmx.csv
  - Q Below, Q Above, Q Total
  - A Below, A Above, A Total
  - V Below, V Above, V Combined
  - h U/S, h D/S, dh, Time

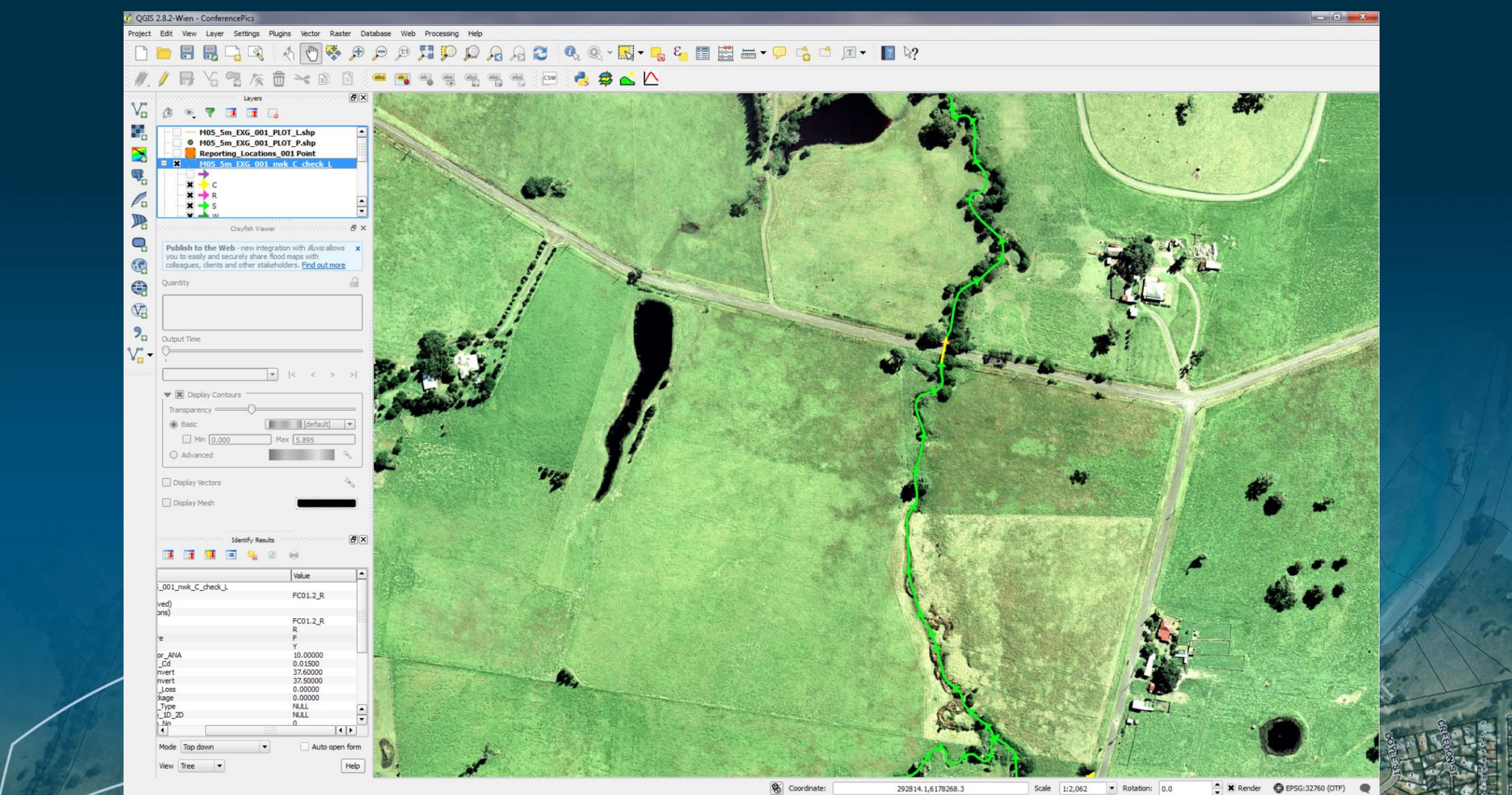


# Reporting Locations

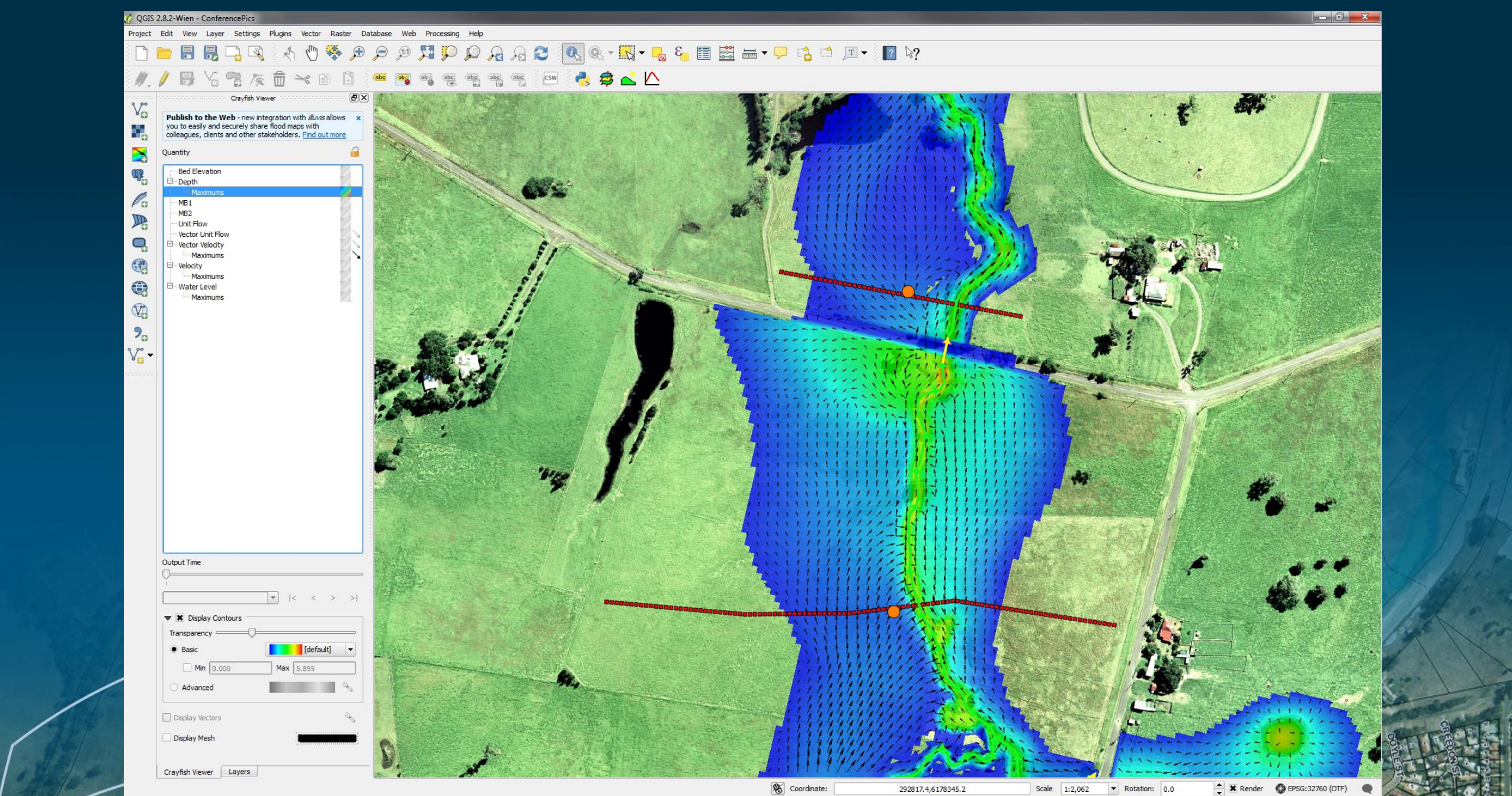
- Combines multiple 1D channels and 2D elements, including M2D
- For lines, flows are reported
- For points, water levels are reported
- Only a single attribute - Name



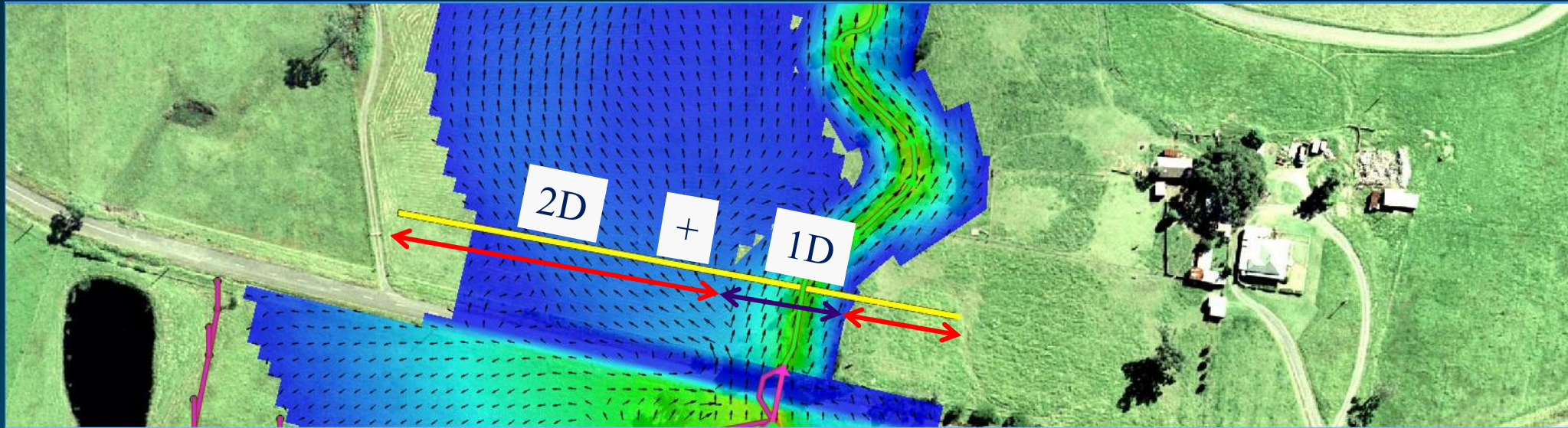




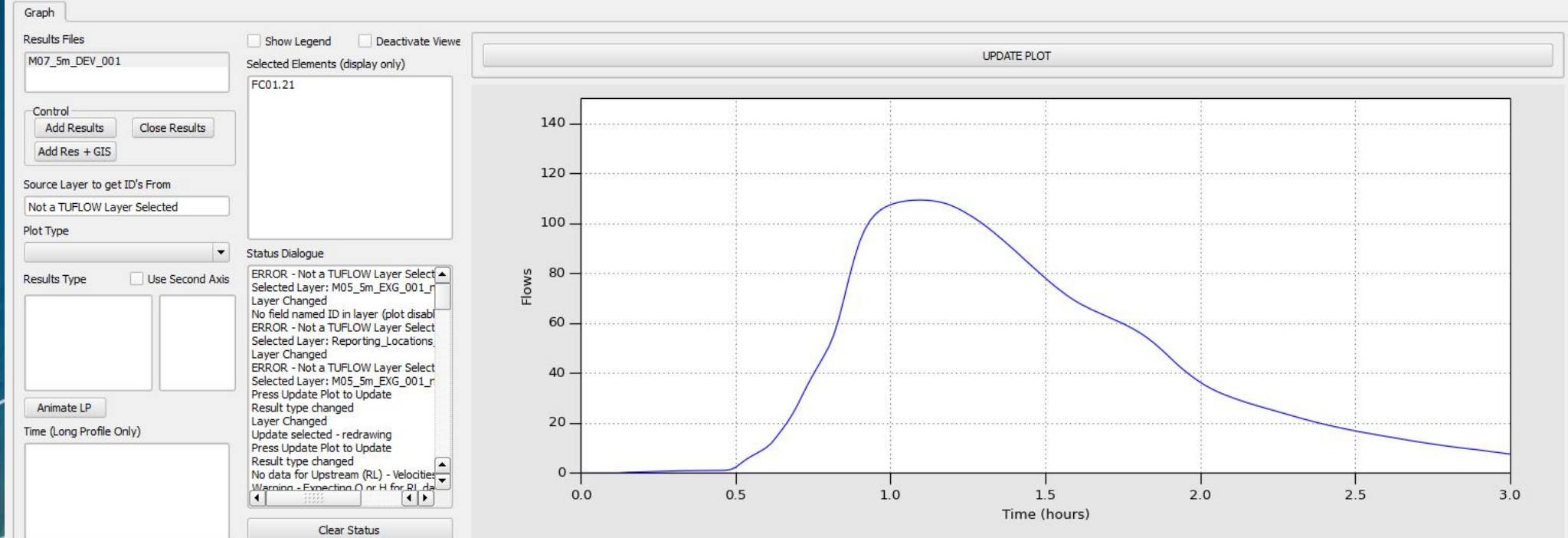




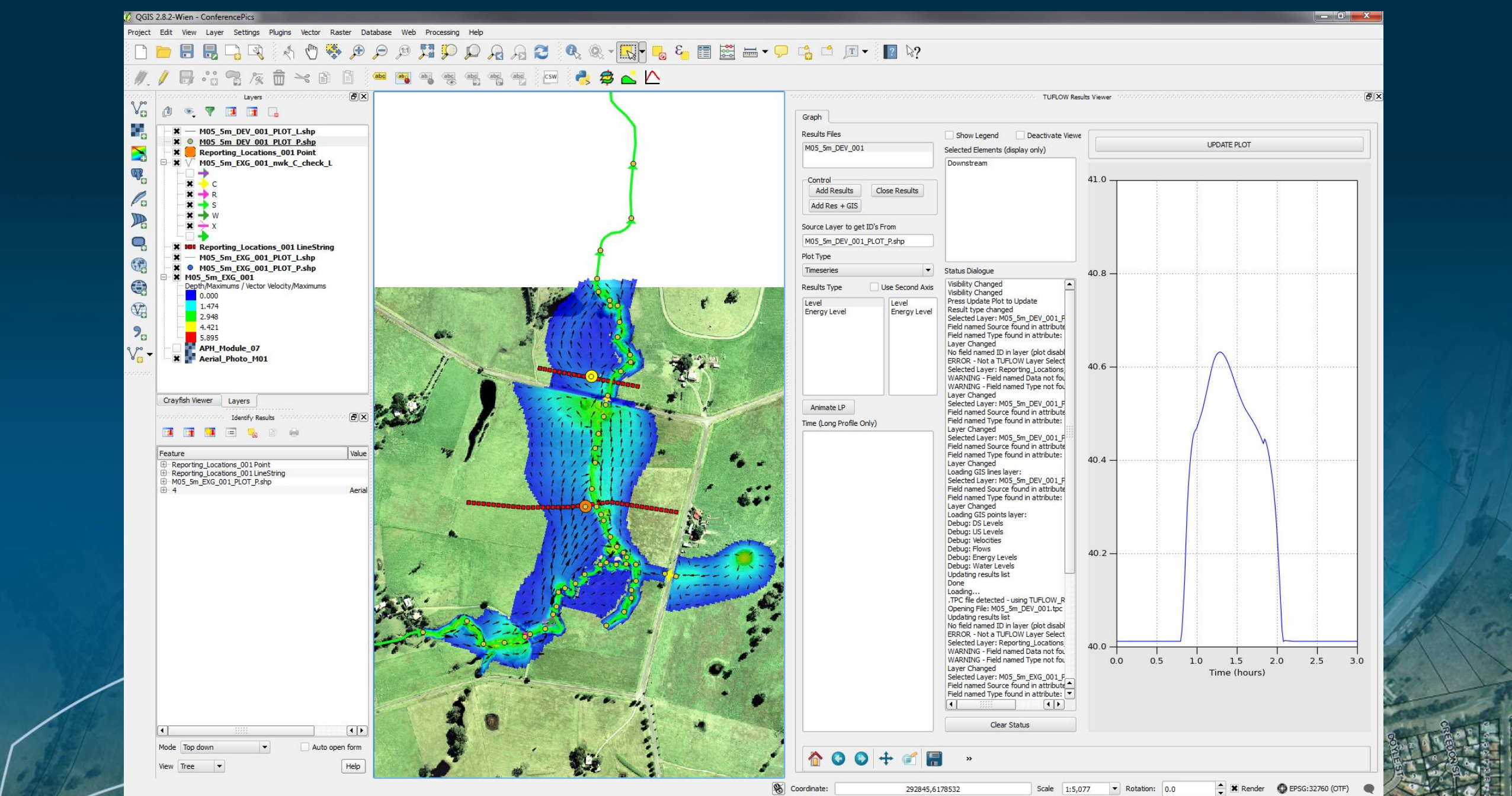




TUFLOW Results Viewer





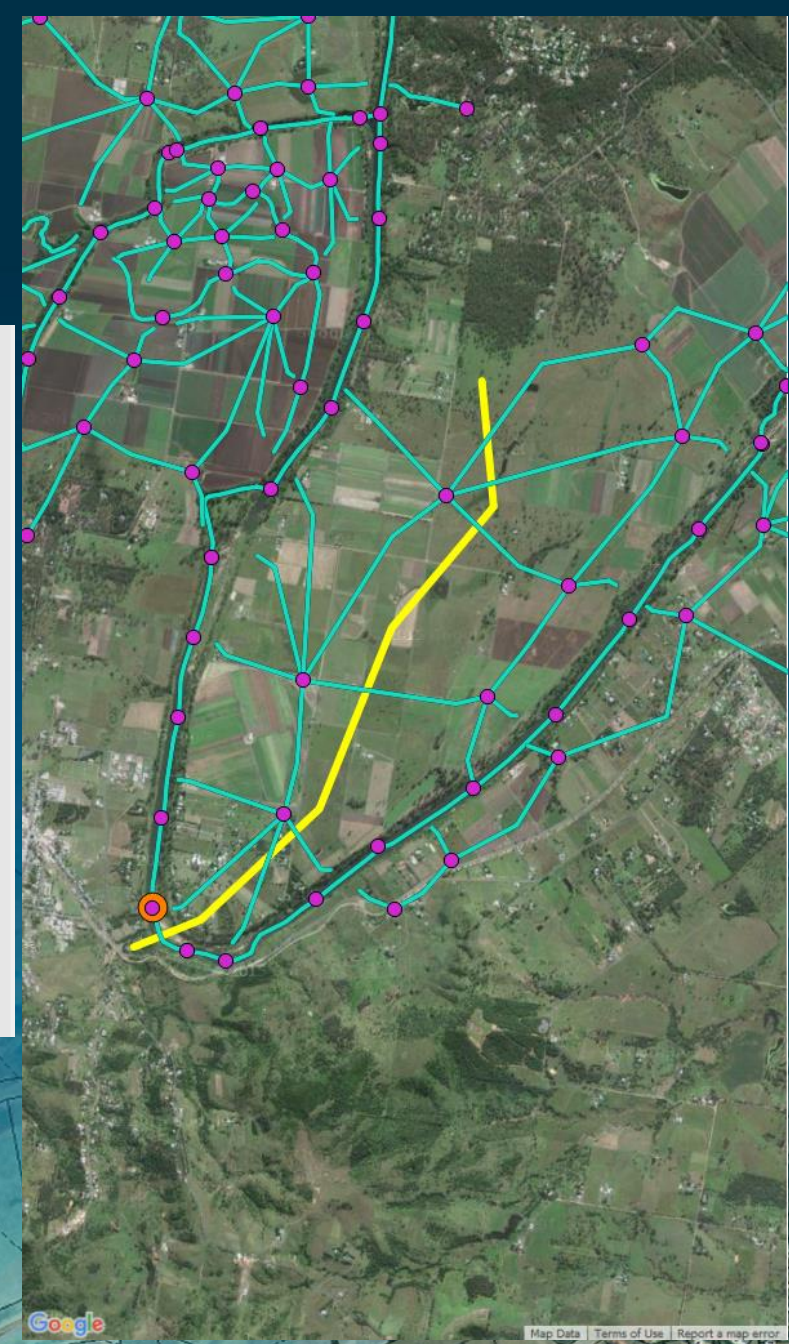
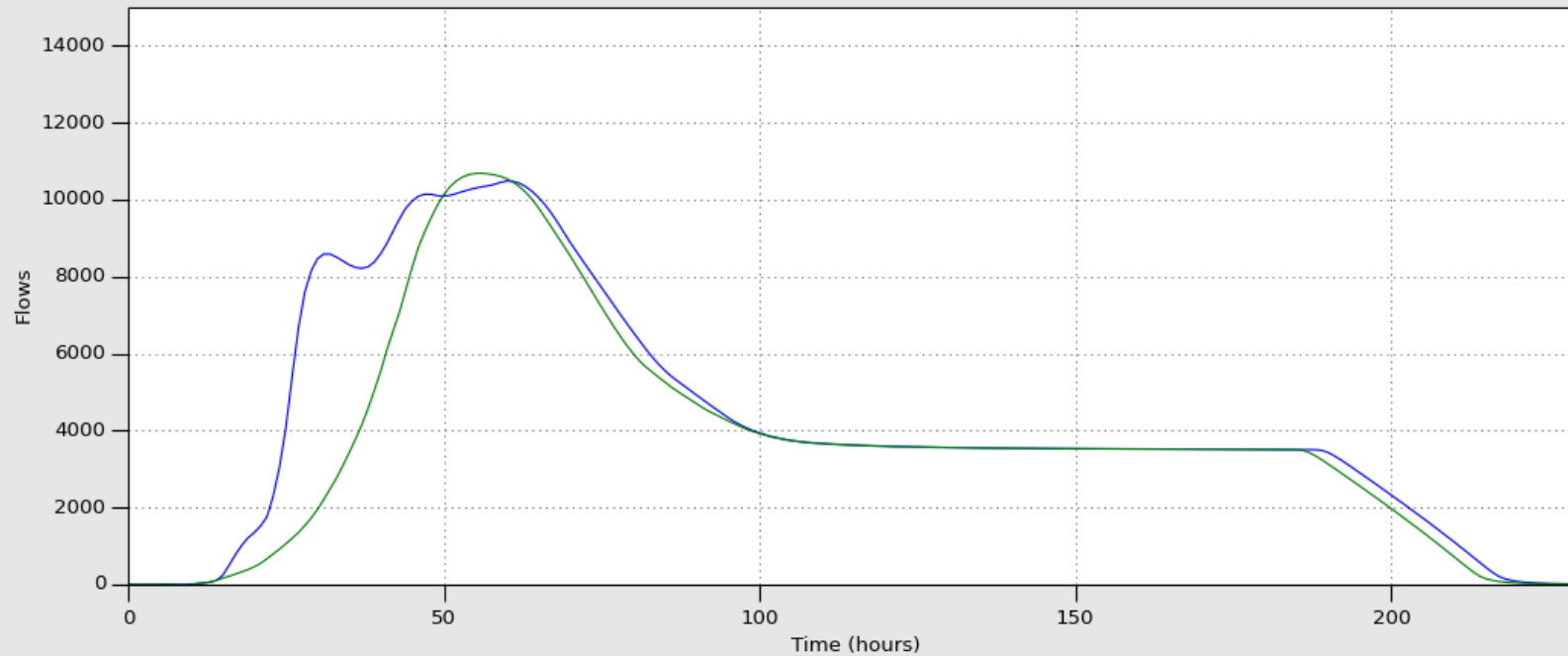








# Reporting Locations

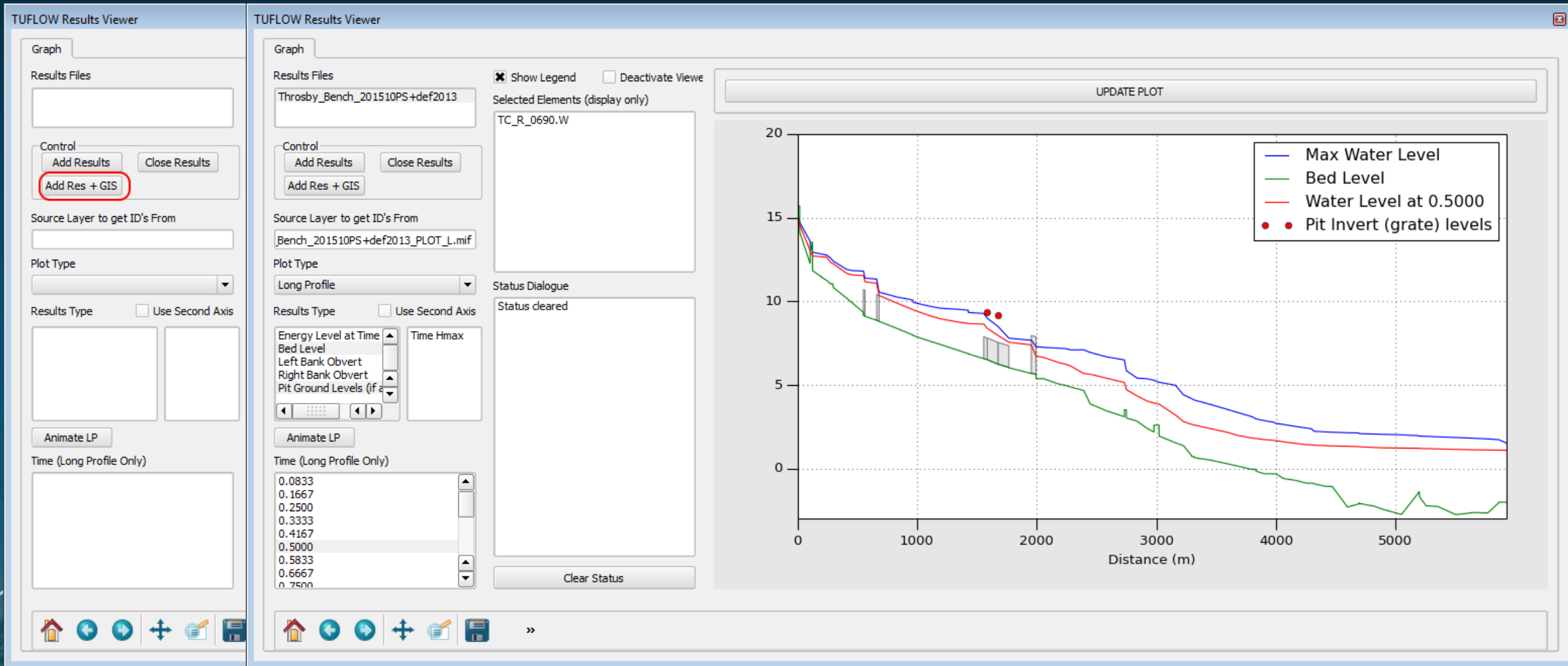


# QGIS Plotting Plugin

- Updated to include the new results format
- Previous version still supported, but doesn't have all the features!
- Now (hopefully) plays nicely for Linux users
- Add Result + GIS (loads both .csv and GIS data)
- Add Results (only .csv files – useful for loading additional results files)

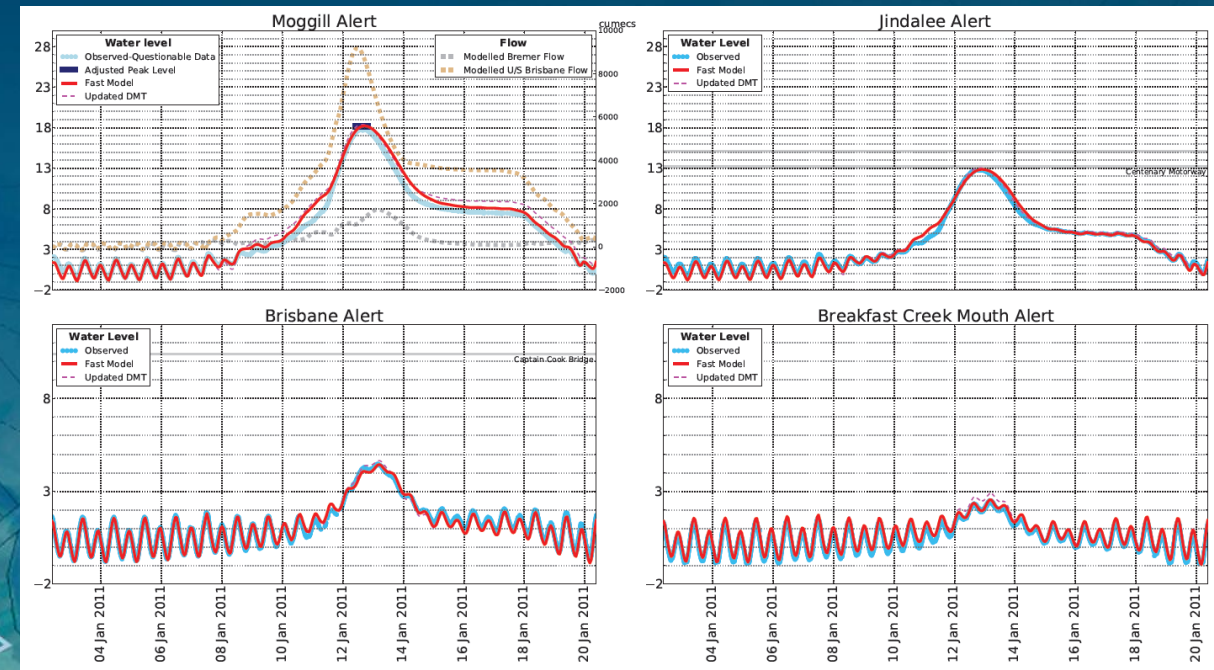


# QGIS Plotting



# New Python Library for Automating Plotting

- Python library, which is also used in QGIS
- Can be used to create plots from TUFLOW results
- Timeseries and Long Profile Functionality
- Other plotting options available





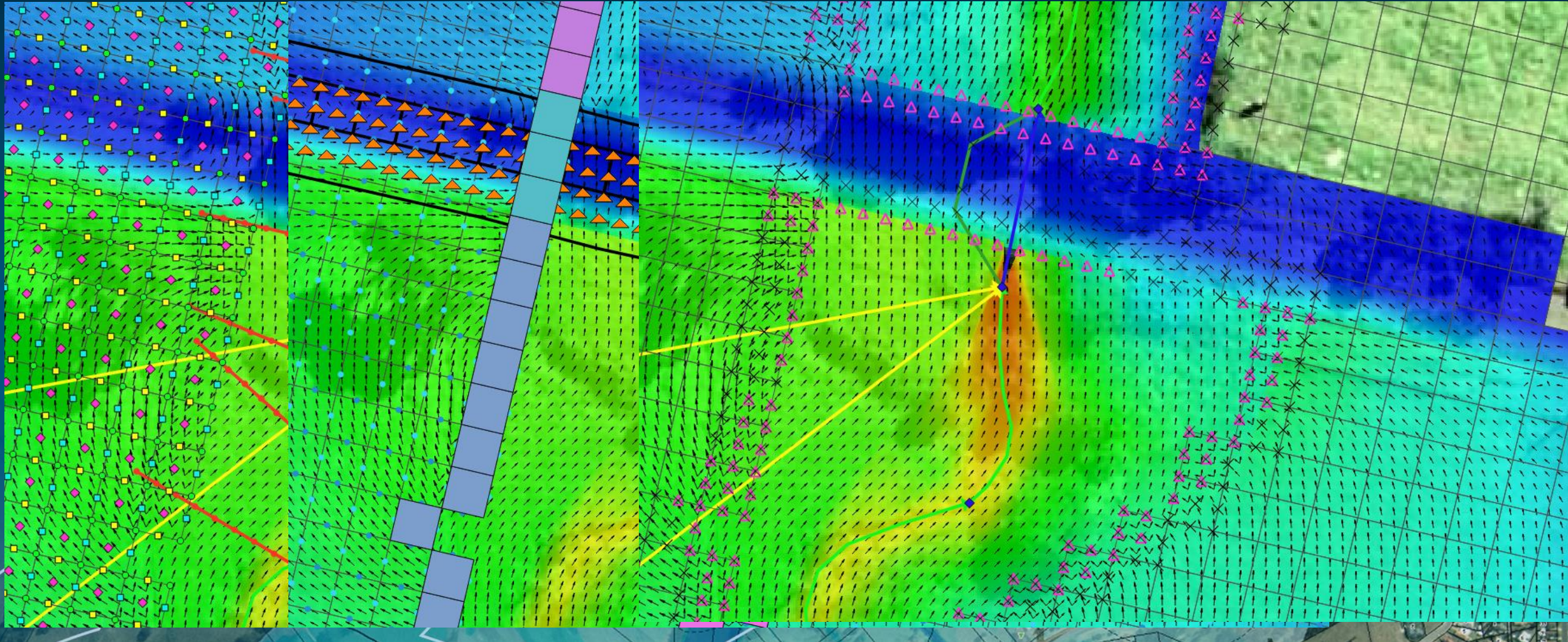
# Additional .shp Attributes

- Additional style attributes are added for a range of check and results GIS files
- Include rotation, magnitude and/or type attributes
- Allows for advanced rendering/styling when using the .shp format in QGIS / Arc Map
- Extra attributes also output for MIF files as MIF/MID files can be viewed in QGIS

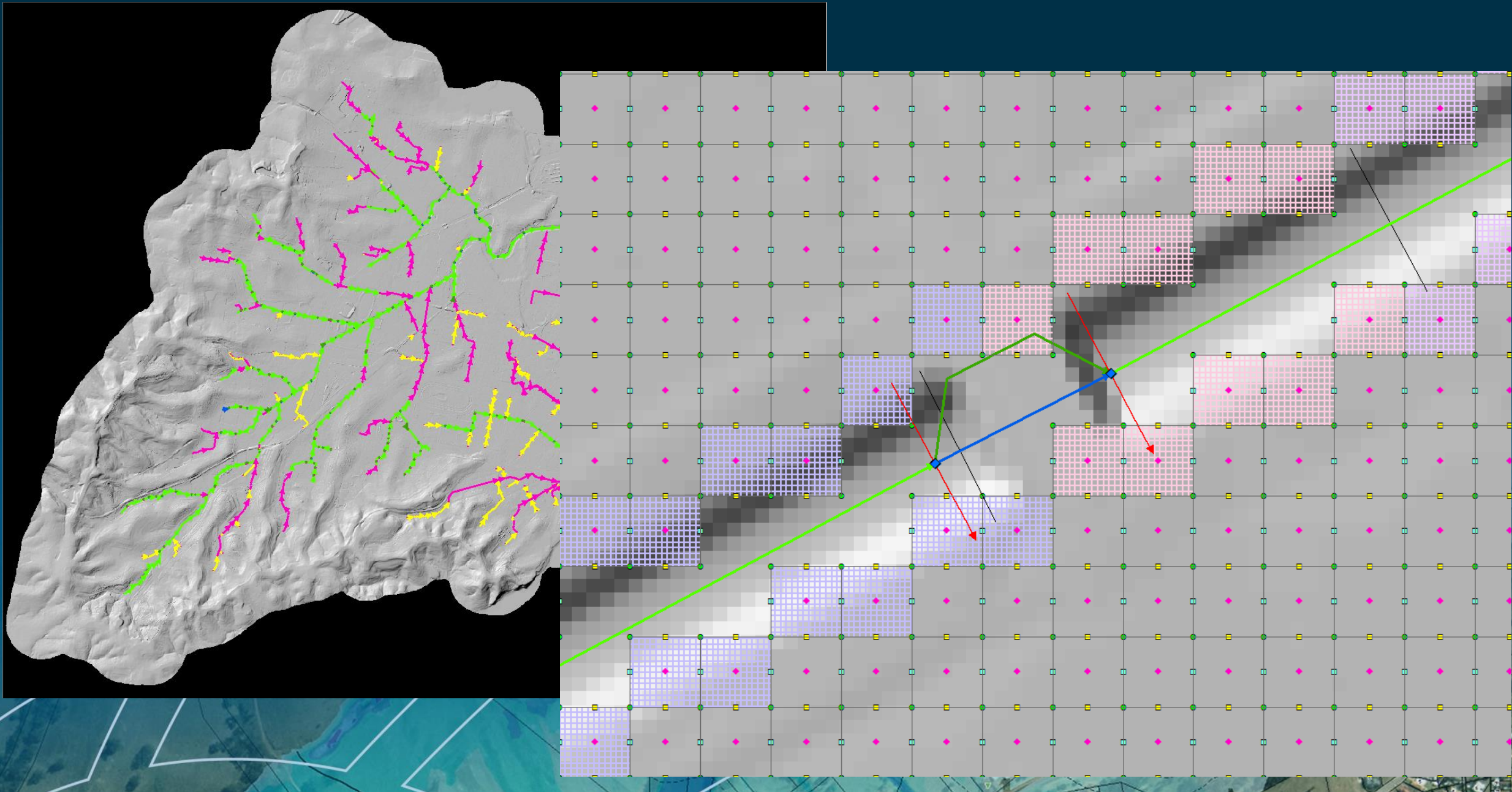




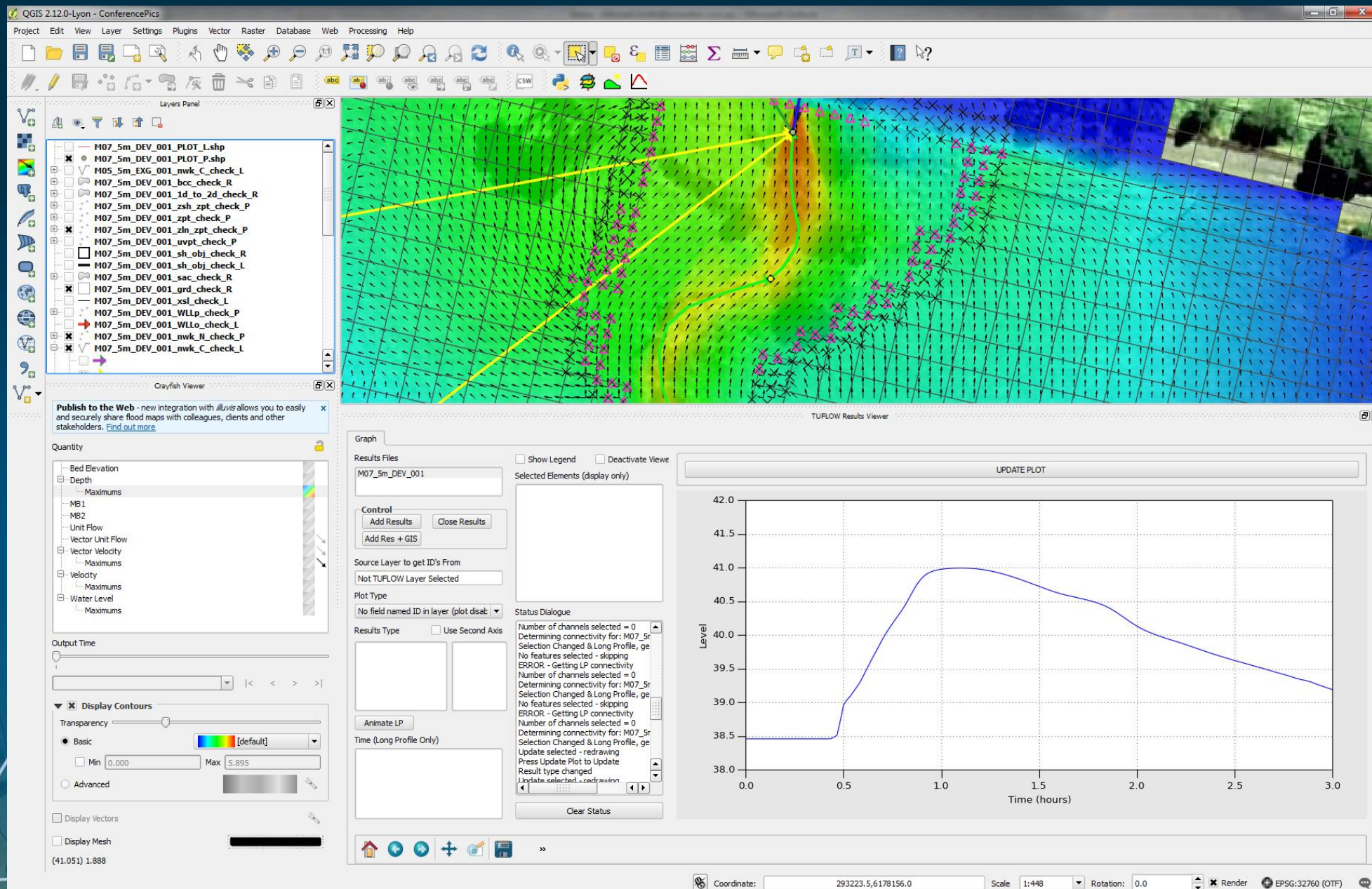
# QGIS – Check File Styling













# ArcGIS Check Symbolology

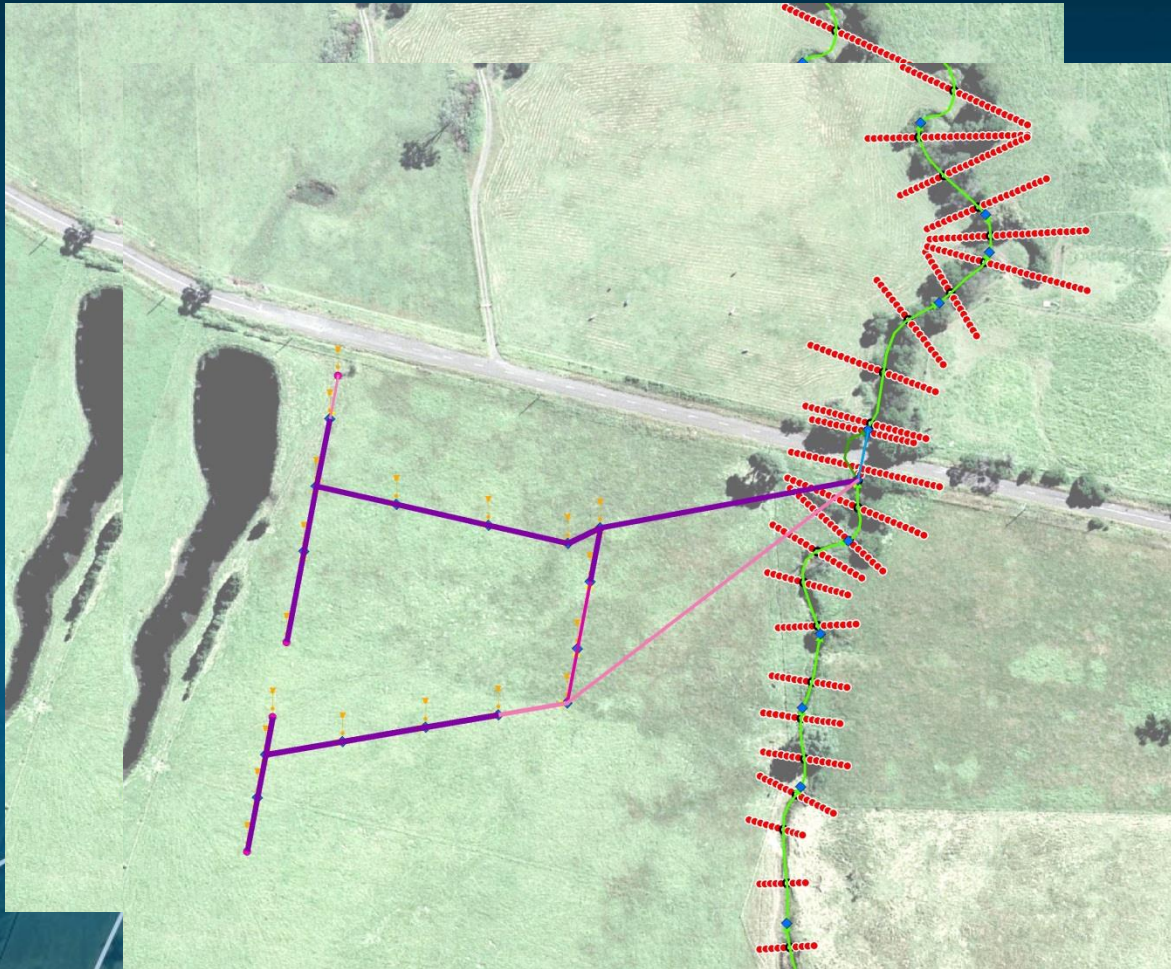
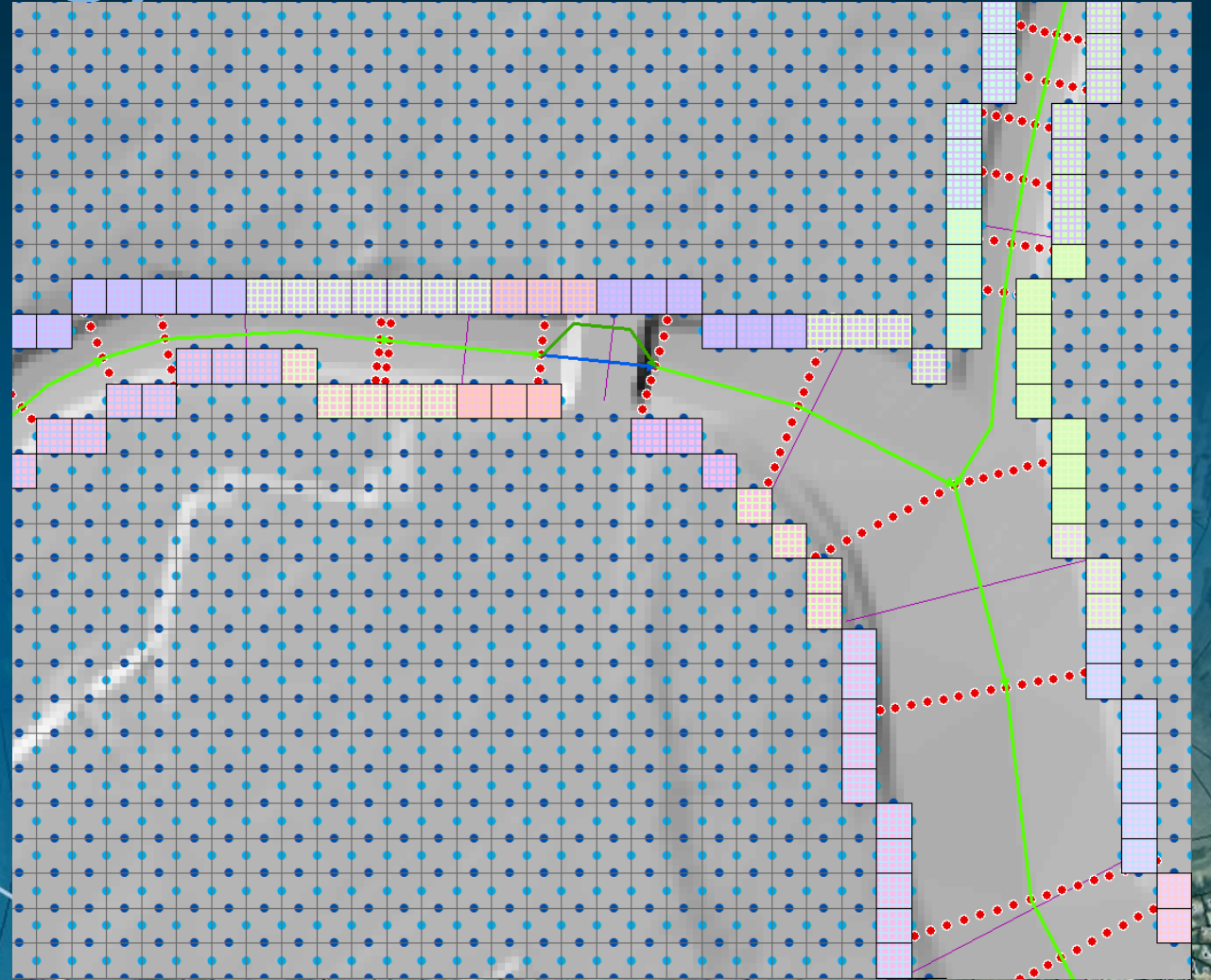
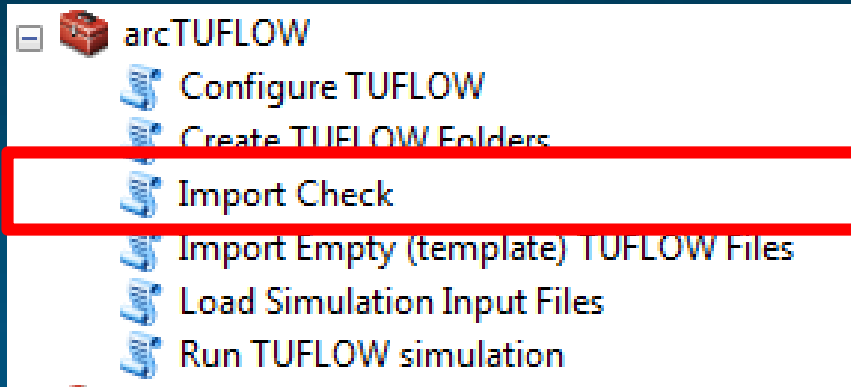


Table Of Contents

- ➔ X
- ☐ M07\_5m\_DEV\_001\_inverts\_check\_P
  - ◆ <all other values>
  - Location
    - 📍 D/S
    - 📍 Node
    - 📍 U/S
- ☐ M07\_5m\_DEV\_001\_iwl\_check\_P
- ☐ M07\_5m\_DEV\_001\_mhc\_check\_P
- ☒ M07\_5m\_DEV\_001\_nwk\_N\_check\_P
  - ◆ <all other values>
  - No\_Channel
    - ▼ 0
    - 1
    - ◆ 2
    - ◆ 3
    - ◆ 5
- ☒ M07\_5m\_DEV\_001\_nwk\_C\_check\_L
- ☐ M07\_5m\_DEV\_001\_WLLo\_check\_L
- ☒ M07\_5m\_DEV\_001\_WLLp\_check\_P
  - Style\_Type
    - 
    - ⊗ X
- ☐ M07\_5m\_DEV\_001\_xsl\_check\_L
- ☒ Aerial\_Photo\_M01.jpg
  - RGB
    - Red: Band\_1
    - Green: Band\_2
    - Blue: Band\_3

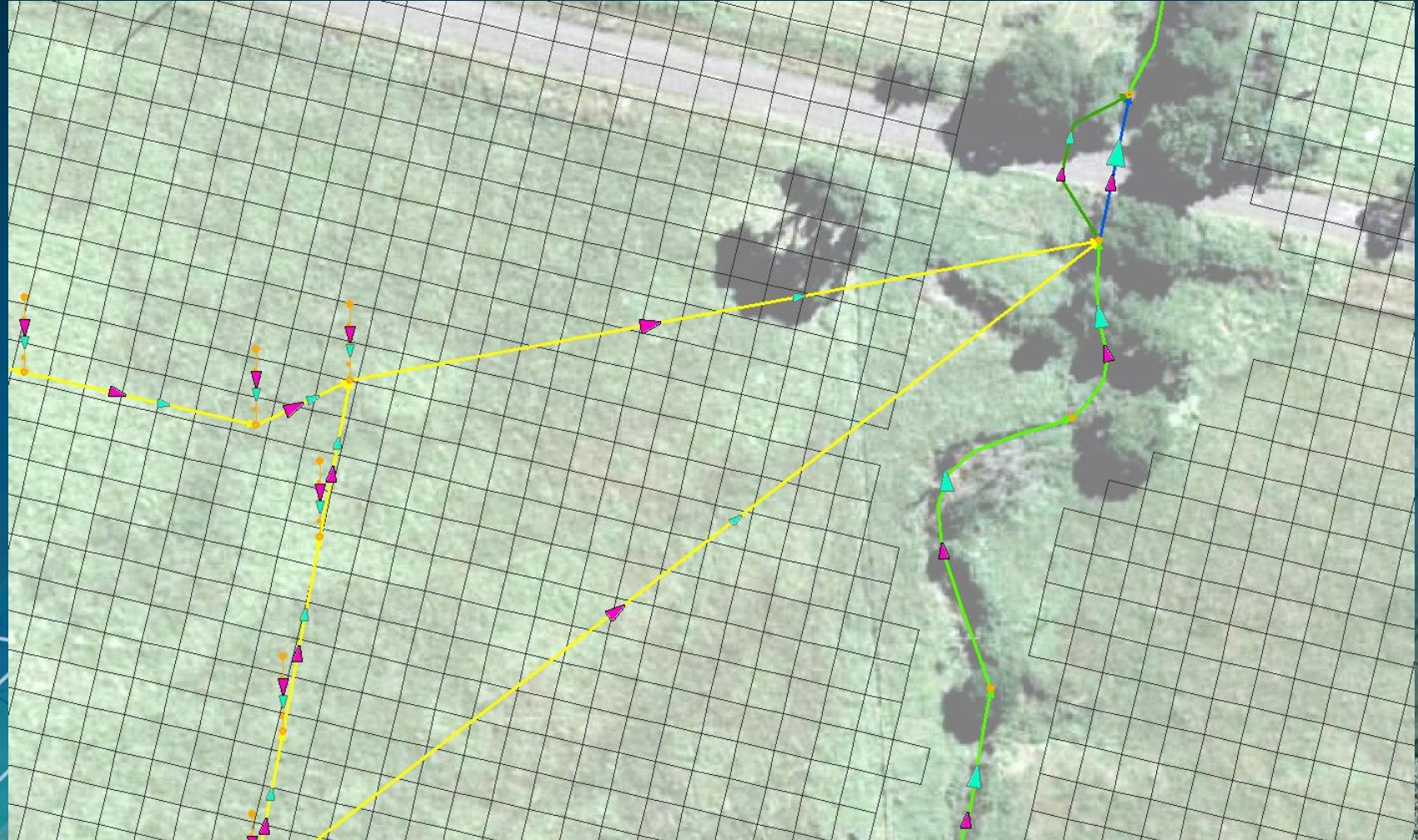
# ArcGIS Check Symbolology





# ArcGIS Additional Fields – TS Outputs

- Style\_Type
- Style\_SF
- Style\_dir





# GPU Solver now Supports Full Range of SA Inflow Options

- Read GIS SA [ {} | ALL | PITS | STREAM ONLY | STREAM IGNORE] == <gis\_layer>
- Read GIS Streams == <gis\_layer>
- SA Proportion to Depth ==
- eg. "Read GIS SA ==" will distribute inflows only to wet cells or lowest cell if all dry
- Previously only "Read GIS SA ALL ==" and "Read GIS SA STREAM ONLY ==" supported



# Number of GPU Devices

- Can now use more than 4 GPU devices in a single simulation
- Current limit is 16 but can be increased if required!
- Overheads can become significant, so check scalability
  - The larger the model the more benefit of multi GPU
- If multiple simulations, maximum efficiency by running simulations not across GPU cards
- eg. 4 x 2 GPU simulations better than sequential 1 x 8 GPU simulation

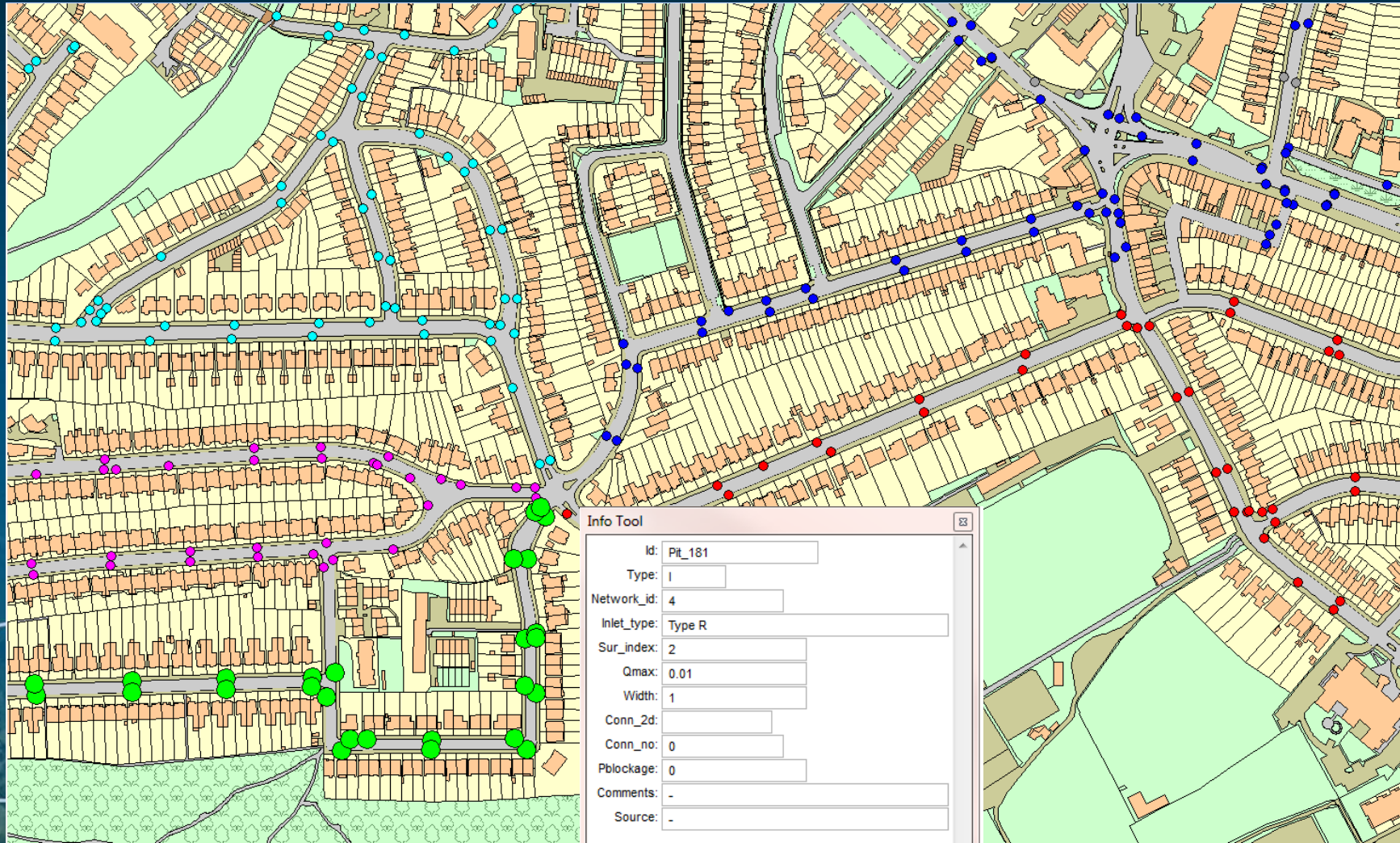


# GPU Virtual Pipes

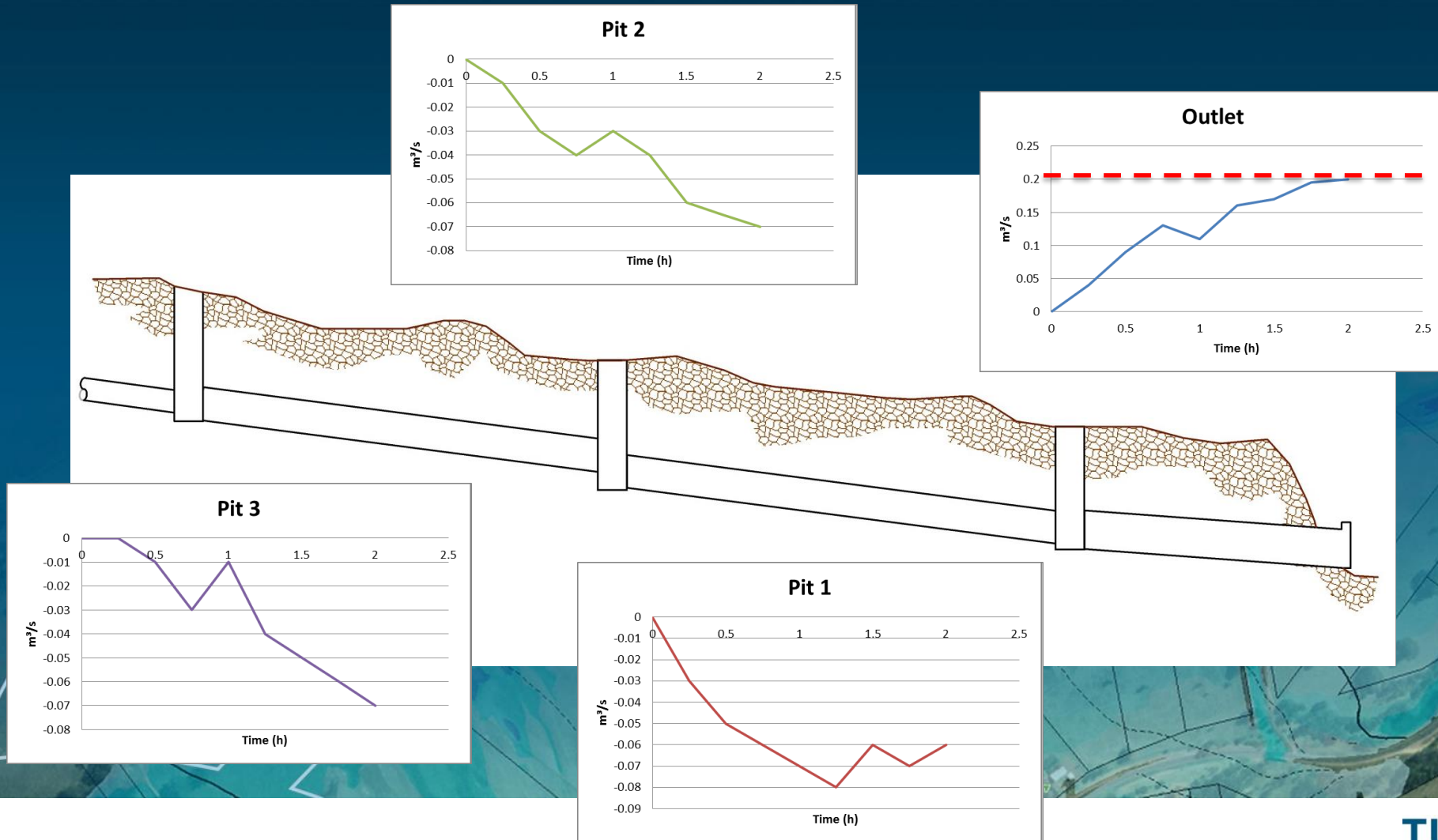
- Can be used to simulate flows in drainage network without full 1D model
- At the field / pit inlets:
  - A depth-flow relationship is applied
  - An outlet location is specified
- At the outlet:
  - A flow capacity is applied, if exceeded flows at the inlets are limited
  - Surcharge index controls which inlets are limited
  - Inlets can surcharge
  - At each inlet and outlet the flows and water levels are output in .csv and TS



# Attributes – Network ID

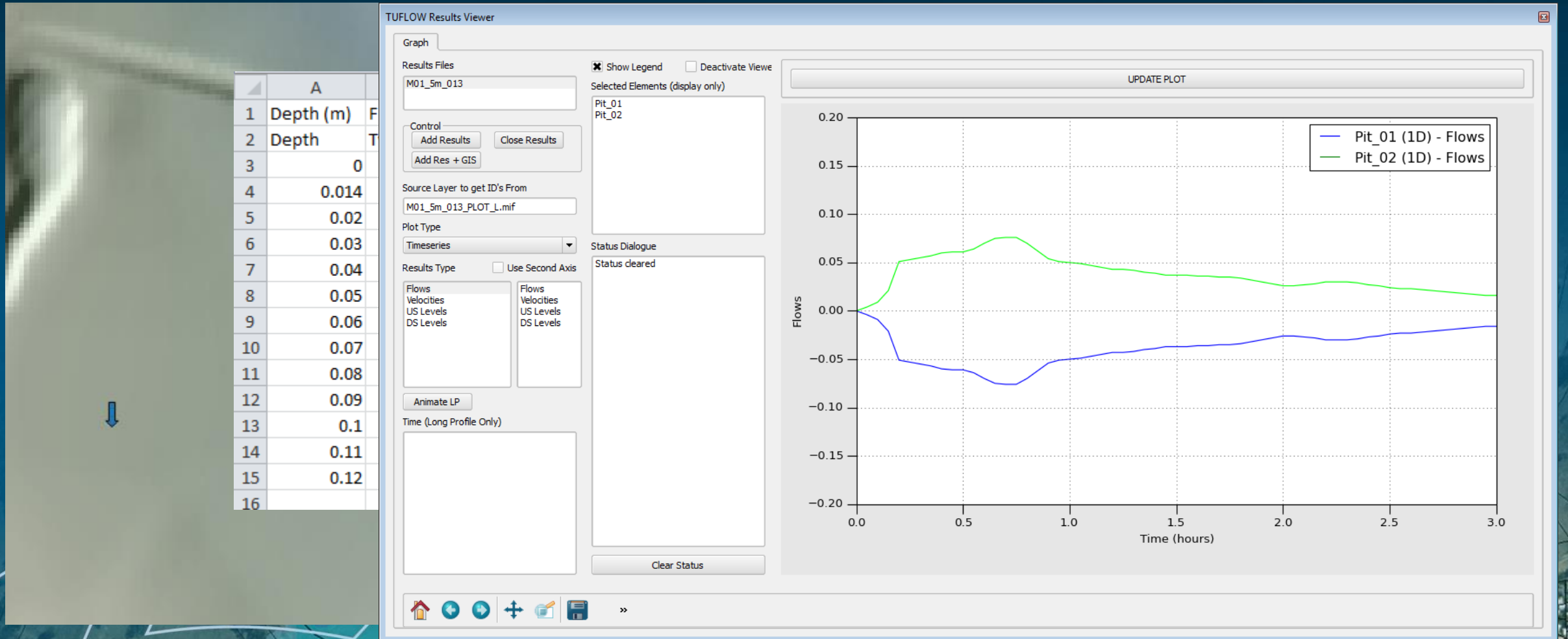


# How it works - Surcharging





# GPU Virtual Pipes



# GPU Enhancements

- Log Law option for flow resistance Shallow Flows – CPU and GPU
- Tracking of maximums
- Can now count and report NaN occurrences – these can occur if the model bounces and the GPU Solver repeats calculations using a shorter timestep
  - Reports to \_messages layer locations of occurrences
- For GPU Solver .tgc command “Thin Line as Thick ==” default is “ON”
- For GPU Solver improved velocity output interpolation to cell centres and corners
- If unstable (rare) last time in map output now output

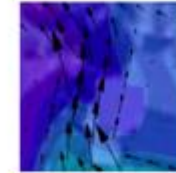


# TUFLOW Manual

- Yes, this time for real!



## TUFLOW User Manual 2015 (Build 2015-11-AA)

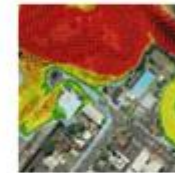
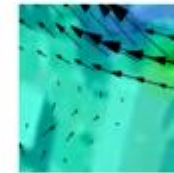
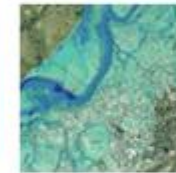
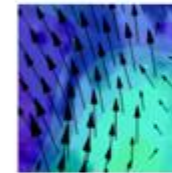


[www.tuflow.com](http://www.tuflow.com)

[www.tuflow.com/forum](http://www.tuflow.com/forum)

[wiki.tuflow.com](http://wiki.tuflow.com)

[support@tuflow.com](mailto:support@tuflow.com)



### How to Use This Manual

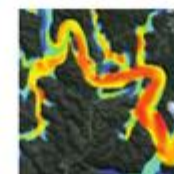
Chapters

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Appendices



.tcf File Commands

.tgc File Commands

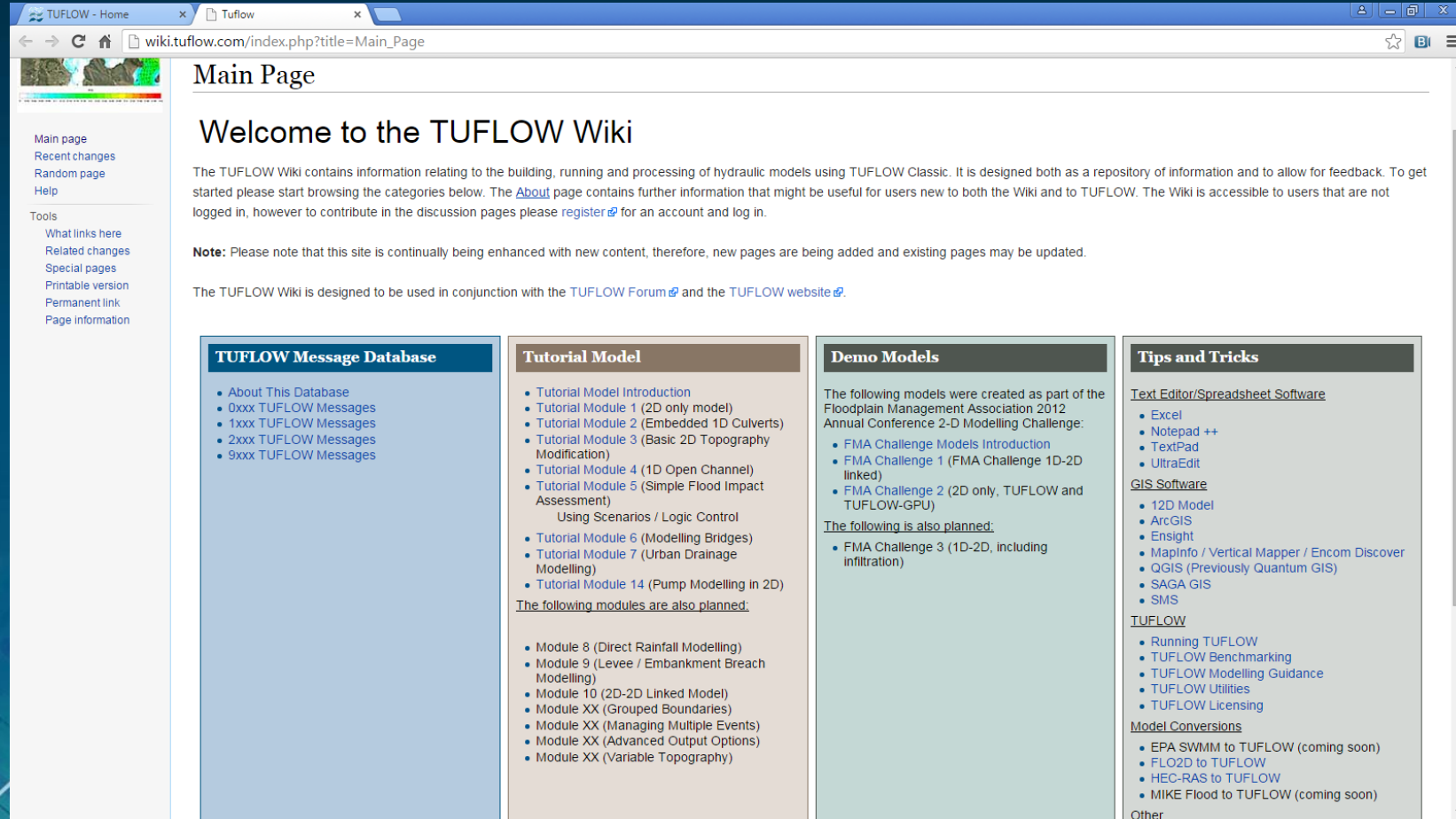
.tbc File Commands

.toc File Commands

.ecf File Commands

# TUFLOW Wiki Additions

- Currently 1,100 pages
- Substantial investment in
  - Messages
  - Tutorial Models
  - Demo Models
  - Tips and Tricks
- Transfer of manual content to Wiki
- Links in 2015 Manual
- Links to messages pages in .tlf and \_messages layer



The screenshot shows the TUFLOW Wiki Main Page in a web browser. The page has a blue header with the title "Main Page" and a welcome message. Below the header, there is a sidebar with links to "Main page", "Recent changes", "Random page", "Help", and "Tools". The main content area is divided into four columns: "TUFLOW Message Database", "Tutorial Model", "Demo Models", and "Tips and Tricks". Each column contains a list of links to various resources. The "TUFLOW Message Database" column lists links to "About This Database", "0xxx TUFLOW Messages", "1xxx TUFLOW Messages", "2xxx TUFLOW Messages", and "9xxx TUFLOW Messages". The "Tutorial Model" column lists links to "Tutorial Model Introduction", "Tutorial Module 1 (2D only model)", "Tutorial Module 2 (Embedded 1D Culverts)", "Tutorial Module 3 (Basic 2D Topography Modification)", "Tutorial Module 4 (1D Open Channel)", "Tutorial Module 5 (Simple Flood Impact Assessment)", "Using Scenarios / Logic Control", "Tutorial Module 6 (Modelling Bridges)", "Tutorial Module 7 (Urban Drainage Modelling)", "Tutorial Module 14 (Pump Modelling in 2D)", and "The following modules are also planned:". The "Demo Models" column lists links to "The following models were created as part of the Floodplain Management Association 2012 Annual Conference 2-D Modelling Challenge:", "FMA Challenge Models Introduction", "FMA Challenge 1 (FMA Challenge 1D-2D linked)", "FMA Challenge 2 (2D only, TUFLOW and TUFLOW-GPU)", "The following is also planned:", and "FMA Challenge 3 (1D-2D, including infiltration)". The "Tips and Tricks" column lists links to "Text Editor/Spreadsheet Software", "Excel", "Notepad ++", "TextPad", "UltraEdit", "GIS Software", "12D Model", "ArcGIS", "Ensign", "MapInfo / Vertical Mapper / Encom Discover", "QGIS (Previously Quantum GIS)", "SAGA GIS", "SMS", "TUFLOW", "Running TUFLOW", "TUFLOW Benchmarking", "TUFLOW Modelling Guidance", "TUFLOW Utilities", "TUFLOW Licensing", "Model Conversions", "EPA SWMM to TUFLOW (coming soon)", "FLO2D to TUFLOW", "HEC-RAS to TUFLOW", "MIKE Flood to TUFLOW (coming soon)", and "Other".

**Main Page**

## Welcome to the TUFLOW Wiki

The TUFLOW Wiki contains information relating to the building, running and processing of hydraulic models using TUFLOW Classic. It is designed both as a repository of information and to allow for feedback. To get started please start browsing the categories below. The [About](#) page contains further information that might be useful for users new to both the Wiki and to TUFLOW. The Wiki is accessible to users that are not logged in, however to contribute in the discussion pages please [register](#) for an account and log in.

**Note:** Please note that this site is continually being enhanced with new content, therefore, new pages are being added and existing pages may be updated.

The TUFLOW Wiki is designed to be used in conjunction with the [TUFLOW Forum](#) and the [TUFLOW website](#).

### TUFLOW Message Database

- [About This Database](#)
- [0xxx TUFLOW Messages](#)
- [1xxx TUFLOW Messages](#)
- [2xxx TUFLOW Messages](#)
- [9xxx TUFLOW Messages](#)

### Tutorial Model

- [Tutorial Model Introduction](#)
- [Tutorial Module 1 \(2D only model\)](#)
- [Tutorial Module 2 \(Embedded 1D Culverts\)](#)
- [Tutorial Module 3 \(Basic 2D Topography Modification\)](#)
- [Tutorial Module 4 \(1D Open Channel\)](#)
- [Tutorial Module 5 \(Simple Flood Impact Assessment\)](#)
- [Using Scenarios / Logic Control](#)
- [Tutorial Module 6 \(Modelling Bridges\)](#)
- [Tutorial Module 7 \(Urban Drainage Modelling\)](#)
- [Tutorial Module 14 \(Pump Modelling in 2D\)](#)
- [The following modules are also planned:](#)
- [Module 8 \(Direct Rainfall Modelling\)](#)
- [Module 9 \(Levee / Embankment Breach Modelling\)](#)
- [Module 10 \(2D-2D Linked Model\)](#)
- [Module XX \(Grouped Boundaries\)](#)
- [Module XX \(Managing Multiple Events\)](#)
- [Module XX \(Advanced Output Options\)](#)
- [Module XX \(Variable Topography\)](#)

### Demo Models

The following models were created as part of the Floodplain Management Association 2012 Annual Conference 2-D Modelling Challenge:

- [FMA Challenge Models Introduction](#)
- [FMA Challenge 1 \(FMA Challenge 1D-2D linked\)](#)
- [FMA Challenge 2 \(2D only, TUFLOW and TUFLOW-GPU\)](#)

[The following is also planned:](#)

- [FMA Challenge 3 \(1D-2D, including infiltration\)](#)

### Tips and Tricks

[Text Editor/Spreadsheet Software](#)

- [Excel](#)
- [Notepad ++](#)
- [TextPad](#)
- [UltraEdit](#)

[GIS Software](#)

- [12D Model](#)
- [ArcGIS](#)
- [Ensign](#)
- [MapInfo / Vertical Mapper / Encom Discover](#)
- [QGIS \(Previously Quantum GIS\)](#)
- [SAGA GIS](#)
- [SMS](#)

[TUFLOW](#)

- [Running TUFLOW](#)
- [TUFLOW Benchmarking](#)
- [TUFLOW Modelling Guidance](#)
- [TUFLOW Utilities](#)
- [TUFLOW Licensing](#)

[Model Conversions](#)

- [EPA SWMM to TUFLOW \(coming soon\)](#)
- [FLO2D to TUFLOW](#)
- [HEC-RAS to TUFLOW](#)
- [MIKE Flood to TUFLOW \(coming soon\)](#)

[Other](#)



TUFLOW - Home

TUFLOW Check Files - Tuf

wiki.tuflow.com/index.php?title=TUFLOW\_Check\_Files

format. These check files contain information on the data processed by TUFLOW, for example the \_zpt\_check file contains the final elevation at each zpt in the model.

Managing Check Files

The 2D and 1D check files can be controlled separately by having the `Write Check Files ==` in both the .tcf and .ecf files. However, `Write Check Files ==` in the .tcf file will automatically also write the 1D check files. There is no need to specify `Write Check Files ==` in the .ecf file unless a different folder path for the files is desired.

The check files for big models can get very large and consume quite a lot of hard drive space. It is possible to exclude or include certain check file types. This is done by specifying either "Include" or "Exclude" to the left of the equals sign:

`Write Check Files Exclude == <file list>`

`Write Check Files Include == <file list>`

The file list is a space separated list of files. To exclude the large grd, uvpt and zpt files specify:

`Write Check Files Exclude == zpt uvpt grd`

To output only the gridded elevations (DEM\_Z) the command would be :

`Write Check Files Include == DEM_Z`

Tips for Visualising Check Files

Depending on the size of the model, the check files may contain may contain thousands or millions of cells. As a modeller you pr value, however you may want to view this for the entire model. T In your GIS software to do this. Some tips are given below for a to be available in almost all GIS platforms:

- QGIS style check files
- MapInfo style check files
- ArcMap style check files

Check File Types

The check files are separated into 2D and 1D check files. The o .tcf and .ecf as described above. Not all check file types will be o (2d\_zsh) format topography modifiers then the \_zsh\_zpt check f file types is provided below. For more information on each of the It is also worth noting that the attributes of the check file may als model has soils specified (for infiltration) then the \_grd\_check fil specified this attribute is not output.

2D Check Files

TUFLOW - Home

TUFLOW Check Files - Tuf

wiki.tuflow.com/index.php?title=TUFLOW\_Check\_Files

2D Check Files

The table below contains a complete list of the 2D check files. Note that for linked 2D/1D or 2D/2D models these check files are outlined in the sections below.

Filename prefix / suffix	Brief Description
_2d_bc_tables_check.csv	Tabular data as read from the boundary condition database via any 2d_bc layers and after any adjustments (eg. time shift). Provides traceability to original data source. <b>Note: the boundary values do not include the effects of any 2d_bc attributes such as f.</b>
_bcc_check.mif _bcc_check_R.shp	GIS files providing trace back information and uses cells, rather than point/line objects to show 2D BCs.
_DEM_M.fit _DEM_M.asc	A DEM of the final material ID values, similar to the DEM_Z check grid described below. The .tcf command Grid Format can be used output this check file in ASCII

TUFLOW - Home

TUFLOW Check Files - Tuf

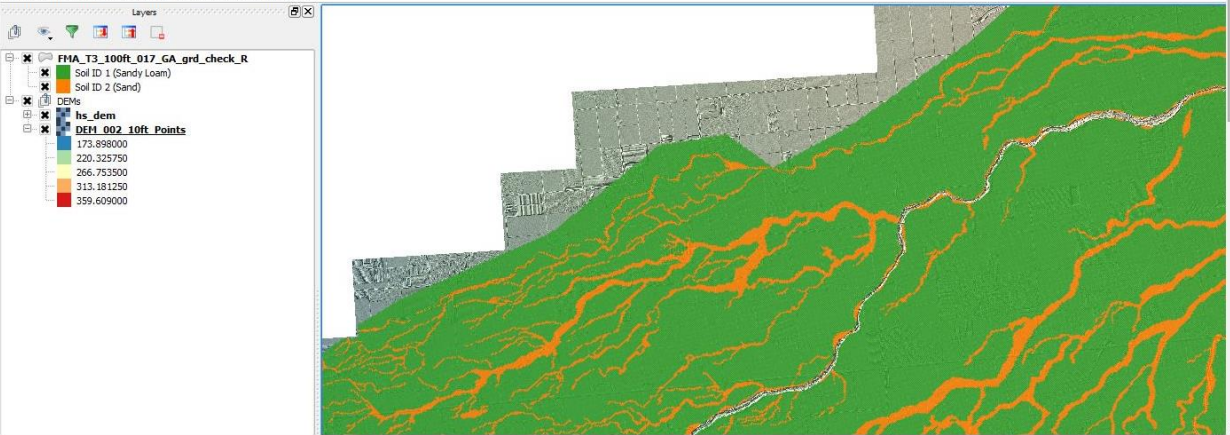
Check Files 2d grd - Tuflo

wiki.tuflow.com/index.php?title=Check\_Files\_2d\_grd

the_uvpt_check.mif _uvpt_check_P.shp	Cell width factor in the x-direction. This is only output for a GPU model only as the GPU model is a cell centred scheme and the CWF value is applied at the cell centre. For a TUFLOW "classic" simulation this is applied at the cell side and this is output in the _uvpt_check.mif
CWF_x (GPU model only)	
the_uvpt_check_P.shp	Cell width factor in the y-direction. This is only output for a GPU model only as the GPU model is a cell centred scheme and the CWF value is applied at the cell centre. For a TUFLOW "classic" simulation this is applied at the cell side and this is output in the _uvpt_check.mif
CWF_y (GPU model only)	
_uvpt_check_P.shp	
SRF (only if SRF feature used)	The Storage Reduction Factor for the cell.
Soil_ID (only if soil feature used)	The Soil ID for the cell. This is only output if a Set Soil, Read GIS Soil or Read GRID Soil command is specified for the simulation.

This file is very useful to apply a style or thematic map to. See the [Tips for visualising check files page](#). This allows a very easy way to visualise the final properties for large models.

An grd\_check file styled by the soil ID is below (in QGIS).



# URLs to Wiki Pages for ERRORS, WARNINGS and CHECKs (.tlf file and \_messages layer)

- .tlf file (right click and open link in browser)

```
WARNING 2218 - Manning's n value of 3. for Material 3 is unusually low or high.  
Material Line = 3, 3.000  
Wiki Link: http://wiki.tuflow.com/index.php?title=TUFLOW_Message_2218
```

- \_messages GIS layer (set up Wiki\_Link attribute as a hotlink)

Message	Wiki_Link
WARNING 2218 - Manning's n value of 3. for Material 3 is unusually low or high. Material Line = 3, 3.000	http://wiki.tuflow.com/index.php?title=TUFLOW_Message_2218
CHECK 1152 - For channel FC01.18, using centre cross-section and ignoring end cross-section(s).	http://wiki.tuflow.com/index.php?title=TUFLOW_Message_1152
CHECK 1152 - For channel FC01.40, using centre cross-section and ignoring end cross-section(s).	http://wiki.tuflow.com/index.php?title=TUFLOW_Message_1152
CHECK 1152 - For channel FC01.10, using centre cross-section and ignoring end cross-section(s).	http://wiki.tuflow.com/index.php?title=TUFLOW_Message_1152
CHECK 1402 - More than one culvert connected but could not create manhole at Node "Trunk_01.2.1".	http://wiki.tuflow.com/index.php?title=TUFLOW_Message_1402
CHECK 1402 - More than one culvert connected but could not create manhole at Node "Trunk_01.1.1".	http://wiki.tuflow.com/index.php?title=TUFLOW_Message_1402



# -ca Option

- XF Files are now disabled
- Original datasets now copied, not the .xf files
- For example
  - If a DEM is specified in "Read GRID Zpts == grid\dem.flt"
  - Previously .xf file copied
  - Now, original DEM grid copied

# -od Option

- The Output Drive for a simulation can be specified with the `-od` command line option
- For example `-odC` will redirect all outputs to the `C:\` drive
- Higher priority than the "Output Drive ==" command in the `.tcf`

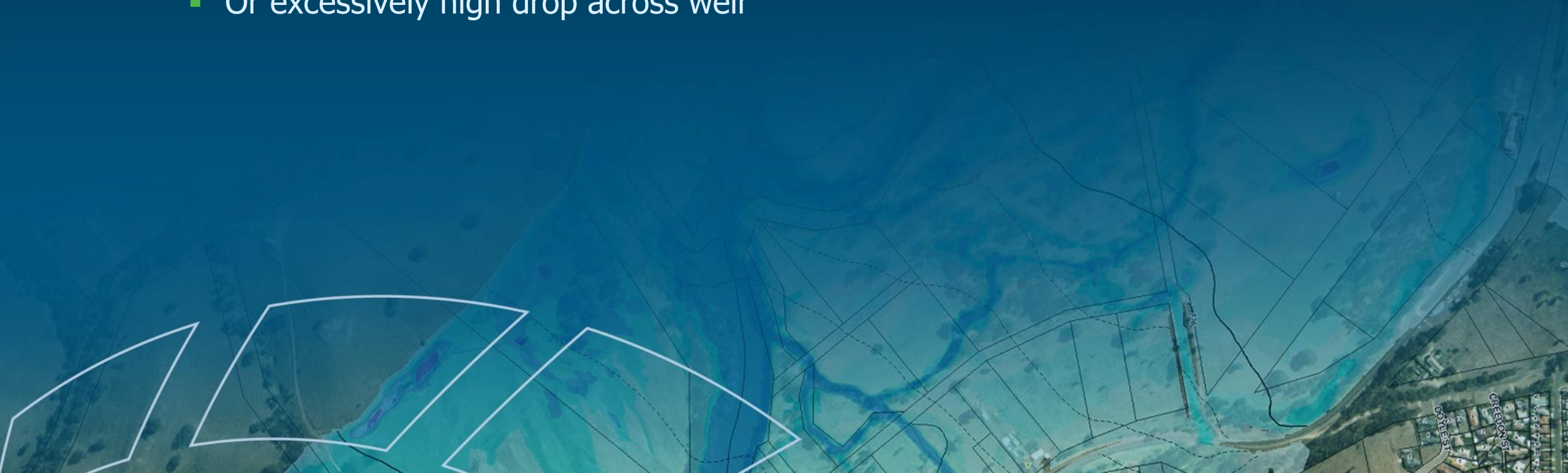


# Materials File ==

- 2<sup>nd</sup> argument applies factor to all n values
- “Materials File == my\_materials.tmf | 1.1”  
will increase all n values by 10%

# New Weirs in 2013-12 Release

- Fixed issue when approaching drowned flow causing
  - Unstable or unpredictable results caused by NaNs
  - Or excessively high drop across weir





# Operational Weirs

- Now available
- Can vary crest elevation and/or width using logic rules



# Layered FLC Default Approach == [ CUMULATE | {PORTION} ]

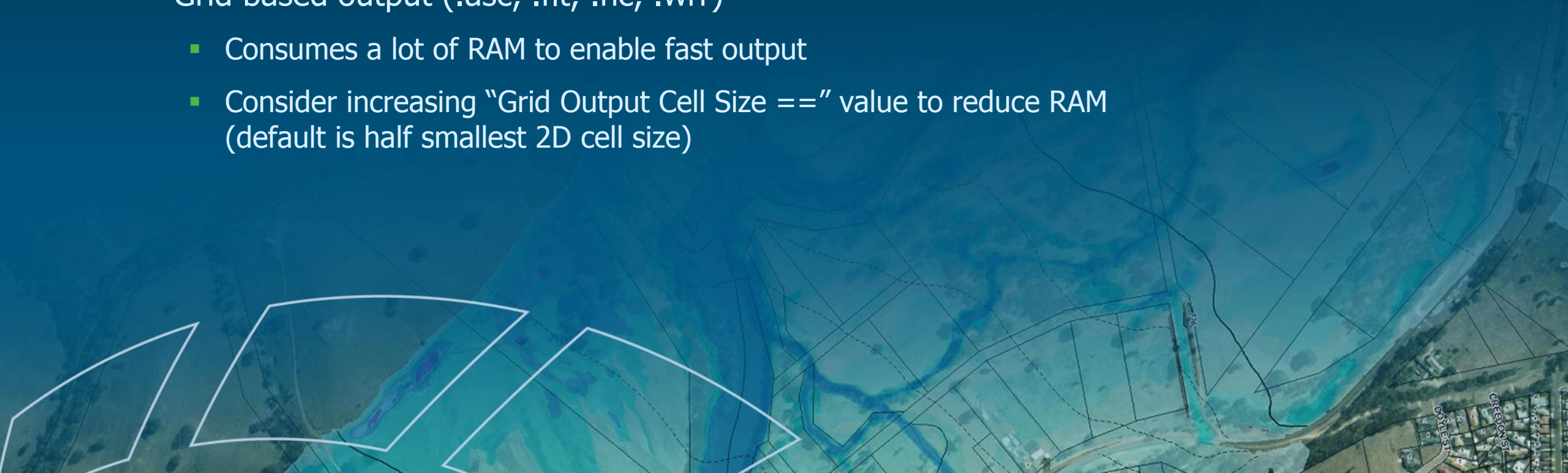
- Changed approach to how FLC values are applied
- Previous releases CUMULATE used
- 2015-11 Release PORTION is default
- Can also override default using CUMULATE or PORTION in 2d\_lfc Shape\_Options (4<sup>th</sup> attribute)





# Memory Optimisation

- Improved CPU RAM memory optimisation for Classic CPU solver and GPU solver
- GPU Solver runs now do not allocate RAM for unsupported Classic features
- Grid based output (.asc, .flt, .nc, .wrr)
  - Consumes a lot of RAM to enable fast output
  - Consider increasing “Grid Output Cell Size ==” value to reduce RAM (default is half smallest 2D cell size)



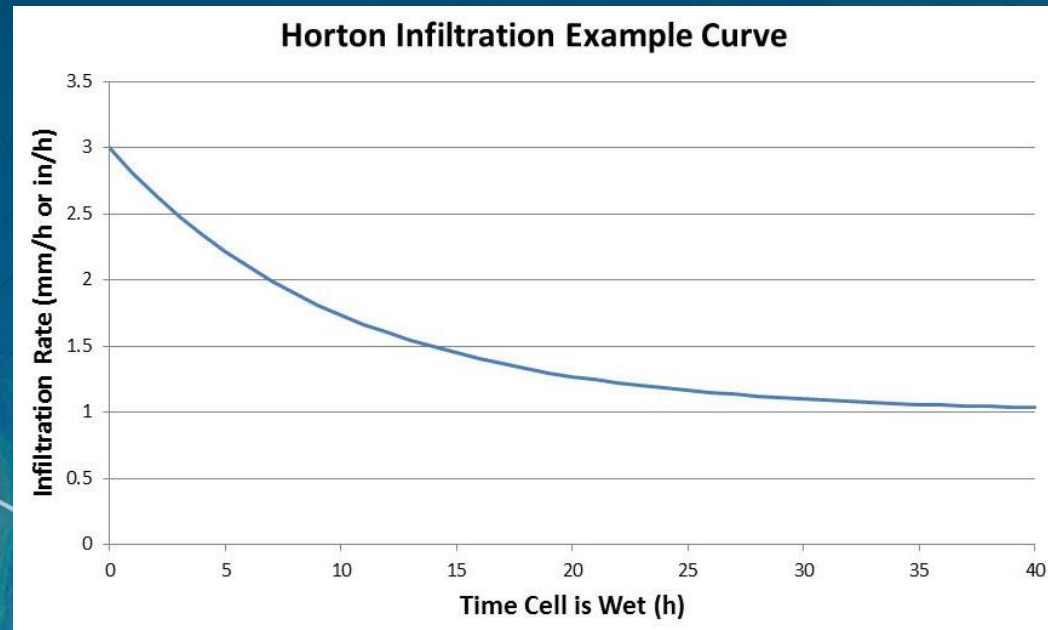
# Set IWL == AUTO

- Set IWL "AUTO" option
  - Sets the IWL in 1D and 2D domains to the boundary water level
  - If more than one water level boundary and starting level is different an ERROR occurs
  - Applies to HT and HS boundaries
  - Use "Set IWL == AUTO" in .tcf (applies to both 1D and 2D)
  - Only applies to 1D nodes / 2D cells allocated a zero IWL (the default value) (for example, can still use "Read GIS IWL ==" to set the IWL in a lake)
  - Very useful when running 11,340 simulations of different starting levels!



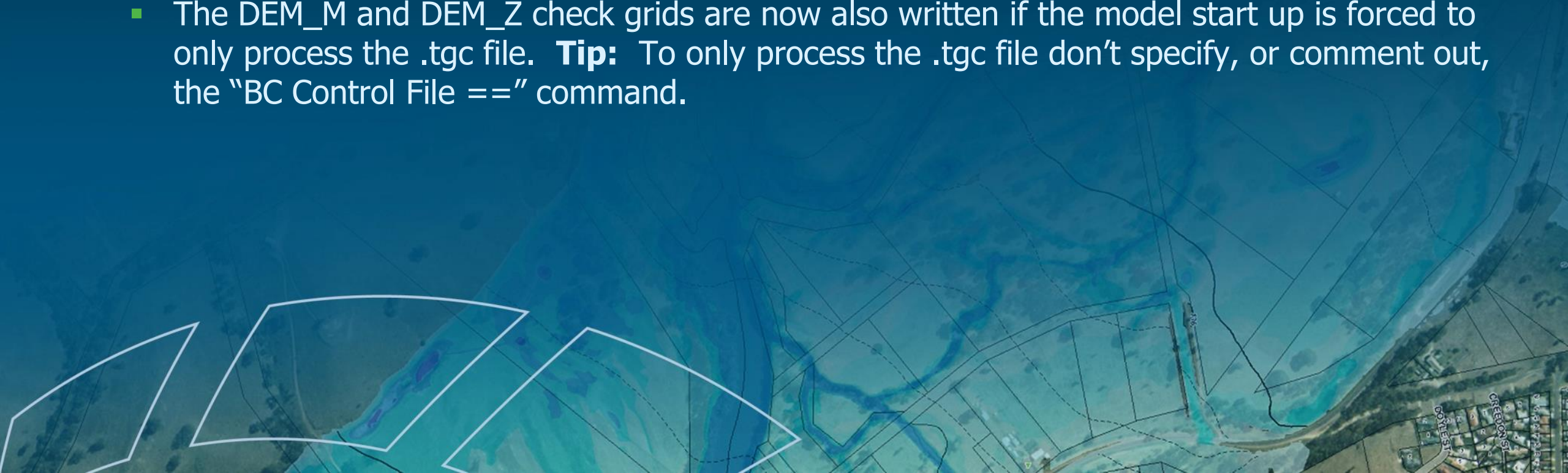
# Horton Infiltration

- $f = f_c + (f_0 - f_c)e^{-kt}$ 
  - $f_0$  is the initial infiltration rate in mm/h or in/h,  $f_c$  is the final (indefinite) infiltration rate,  $t$  is time in hours and  $k$  is the Horton decay rate
  - time  $t$  is the period of time that the cell is wet
- If an initial loss (IL) is specified, the initial loss is applied first, followed by the Horton infiltration



# DEM\_M Check Grid

- New DEM\_M check grid containing the final material values in grid (ASC or FLT) format. Similar to the DEM\_Z check grid. The DEM\_M check grid can be included/excluded from being written using the DEM\_M flag for "Write Check Files INCLUDE or EXCLUDE ==".
- The DEM\_M and DEM\_Z check grids are now also written if the model start up is forced to only process the .tgc file. **Tip:** To only process the .tgc file don't specify, or comment out, the "BC Control File == " command.





# Scenarios and Events automatically set as Variables

- Any scenarios and events are now automatically set as a variable that can be used within your control files.
- For example, if your model results are to be output to different folders depending on Scenario 1 (~s1~), enter the following into the .tcf file noting the use of << and >> to delineate the variable name as described in Item 15 in these notes.

Output Folder == ..\results\<<~s1~>>

In the case above if Scenario ~s1~ is set to "OpA", TUFLOW automatically sets a variable named "~s1~" to a value of "OpA", and the output will be directed to ..\results\OpA.

# Pit Default Road Crossfall ==

- Specifies the crossfall slope of the roads
- The depth used for interpolating the flow in a Q pit based on a triangular cross-section (not a rectangular one)
- Increases the amount of water captured by Q pits, especially for larger cell sizes
- Plan to offer ability to assign different road crossfalls to different Q pits
- Testing to-date very encouraging
- Also, building in functionality to cater for approach flow pit curves (12D testing for their TUFLOW 2D linkage)



# TUFLOW Override Files

- Allows user to apply commands after processing of the .tcf file
  - Commands repeated in override files will prevail over those in .tcf file
- Two (optional) override files (must be in same folder as .tcf)
  - “\_TUFLOW\_Override.tcf” – always applied
  - “\_TUFLOW\_Override\_<computer\_name>.tcf” – only applied for simulations carried out on that computer
- Example, if the .tcf file directs output to the D: drive, but for computer “CRUNCHER” output is to the E: drive, create a file “\_TUFLOW\_Override\_CRUNCHER.tcf” that contains:  
“Output Drive == E”
- Only use global commands and be careful!
- If you can’t find a command, check whether there is an override file!!!

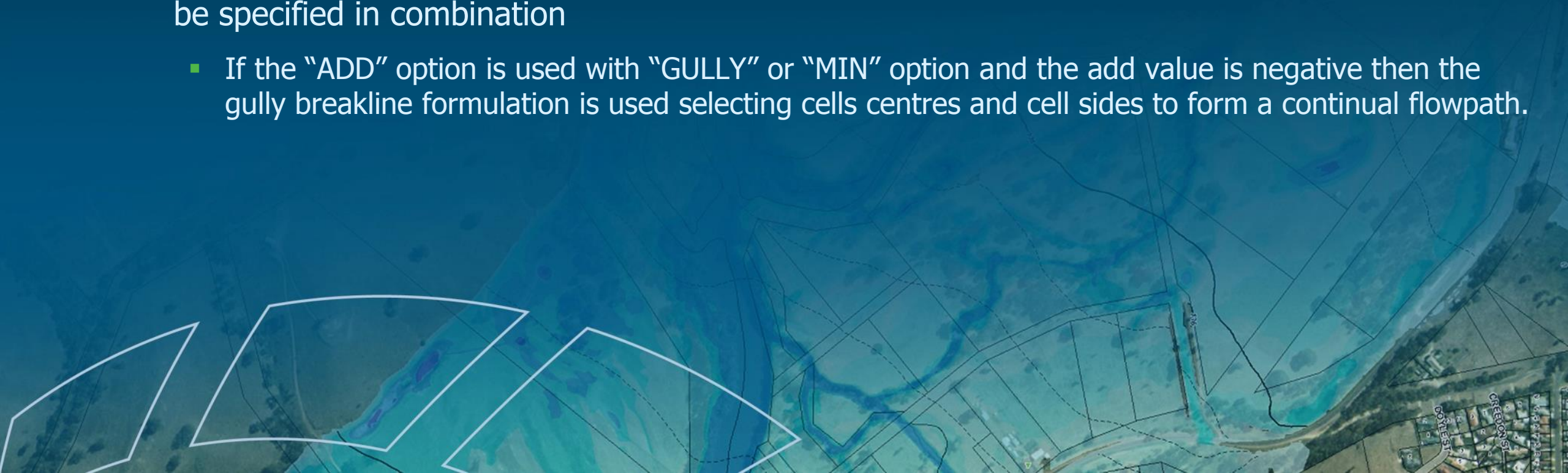
# Minor Enhancements

- Energy output for 1D and 2D tracked as a maximum every timestep
  - Code rework allows easy addition of other outputs to be tracked
- In rare cases the SX 1D/2D exchange may occur on “dry” cells – this was a numerical precision issue – now fixed
  - Can use “SX Flow Distribution Cutoff Depth == ” controls when SX cells exchange water
  - Default 0.005m – set to 0.0 for backward compatibility
- FLC can now be specified as FLC per metre (or foot)
  - Specify “FLC/L” instead of “FLC” for .tgc commands



# Minor Enhancements

- Additional empty files for soils and output zones (2d\_soil and 2d\_oz) are now output if using the "Write Empty GIS Files == " command
- The Read GIS Z Shape format has been enhanced to allow the "GULLY" and "ADD" flags to be specified in combination
  - If the "ADD" option is used with "GULLY" or "MIN" option and the add value is negative then the gully breakline formulation is used selecting cells centres and cell sides to form a continual flowpath.



# Minor Enhancements (cont)

- New ERROR message if Global Rainfall loss command occurs after the Global Rainfall BC. Previously these commands were ignored. For example, an error will occur for the following commands as the rainfall loss command occurs after the rainfall BC command.
  - Global Rainfall BC == rainfall\_name
  - Global Rainfall IL == 10
  - Global Rainfall CL = 2



# Minor Enhancements (cont)

- If running TUFLOW in test mode (with input switch -t) the simulation now terminates later after the writing off all check files, including the DEM\_Z and DEM\_M
- Evacuation Route (2d\_zshr) can now be triggered on "Energy Depth". This is calculate as  $(\text{depth} + \text{velocity}^2/2 \times \text{gravity})$ . This is specified with the cut off type as "Energy". Options are now Depth, VxD, Velocity or Energy.
- New command "GIS Object Ignored == ERROR | WARNING". Sets the error level for when a GIS object is being ignored. For example "Ellipse" type objects are not processed in TUFLOW. If set to error, the simulation will halt. If set to warning a message is logged to the .tlf and the simulation will continue. Warning is set if a defaults == Pre 2015 is set.

# Minor Enhancements (cont)

- Evacuation Route (2d\_zshr) can now be triggered on "Energy Depth". This is calculate as  $(\text{depth} + \text{velocity}^2/2 \times \text{gravity})$ . This is specified with the cut off type as "Energy". Options are now Depth, VxD, Velocity or Energy.
- New command "GIS Object Ignored == ERROR | WARNING". Sets the error level for when a GIS object is being ignored. For example "Ellipse" type objects are not processed in TUFLOW. If set to error, the simulation will halt. If set to warning a message is logged to the .tlf and the simulation will continue. Warning is set if a defaults == Pre 2015 is set.



# Minor Enhancements (cont)

- It is now possible to specify a default boundary type in the .tbc. This is a command that can be repeated as per the below.
  - BLANK BC TYPE == SX
  - Read GIS BC == mi\2d\_bc\_M02\_culverts\_TD15006.MIF
  - BLANK BC TYPE == NONE !will revert back to an error
- You can also specify a HQ slope in directly in the .tbc, once again this command is repeatable. This will only be used if no boundary name is specified for the HQ (as a slope is given preference over the name).
  - BLANK HQ SLOPE == 0.01
  - This can also be set as a variable:
  - Set Variable HQSlope == 0.02 !This would be in the .tcf or read file.
  - BLANK HQ SLOPE == <<HQSlope>>

# Minor Enhancements (cont)

- New error message returned if GWL or GWD command occurs prior to any soil commands. A "Set Soil", "Read GRID Soil" or "Read GIS Soil" command is required in order to activate the soil infiltration feature. If a ground water level or ground water depth command is specified prior to the soils being activated an error message is returned.
- New error message if a 1d\_bc layer is read into the .tbc file instead of the .ecf or within a 1D domain is now returned. The 1d\_bc and 2d\_bc have a different number of attributes Previously this could cause an ERROR 2041 to be returned, this error indicates that the issue is with a fixed field input. New error returned is:
  - ERROR - Less than 8 attributes for 2d\_bc file <filename>
  - File appears to be a 1d\_bc file and not a 2d\_bc



# Minor Enhancements (cont)

- Non XY spatial messages are output to the \_messages.mif or \_messages\_P.shp
- Located in the top-right spatial extent of the model



# Minor Enhancements (cont)

- Ntew .tcf command "GPU RAM OPTIMISATION == {ON} | OFF". For GPU solver simulations only. Previously when using the GPU solver, some of the memory arrays used in the TUFLOW classic are were still allocated. This removes redundant memory allocation for GPU simulations.
- Coincident Z points in a Z Line or Z Shape layer now flag a warning message: WARNING - Coincident point found, ignoring repeated occurrences. Only the first value is used.



# Bug Fixes

- If a landxml TIN file is written on a single line, an error occurred which caused the console window to close when looking for the start of the TIN data. TUFLOW checks for a gives an ERROR 2315.
- See also <http://www.tuflow.com/forum/index.php?/topic/1294-landxml-from-autocad-civil-3d/>
- If using soils layer inactive cells are not checked, previously ERROR 2314 was returned even if the cell was inactive. Only occurred if "Set Soil == " was not specified in the .tgc.

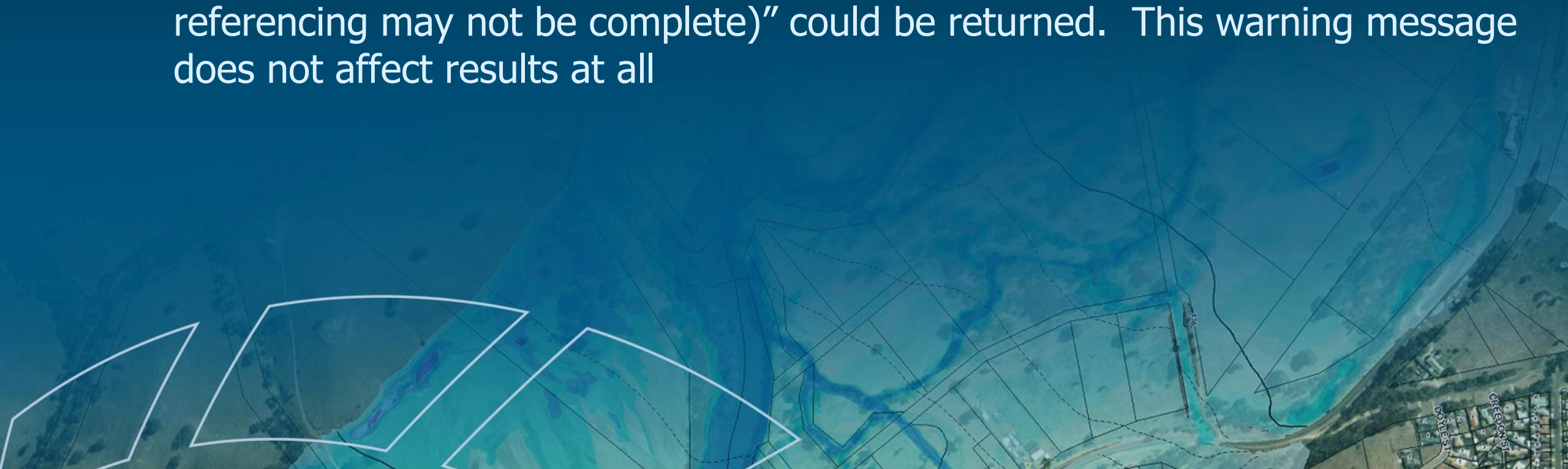
# Bug Fixes (cont)

- ArcMap null values are now ignored in the .dbf file for numeric fields. The .dbf file format does not have a null value attribute, (as a limitation of the format). ArcMap occasionally puts a string character in a numeric field to indicate a null. This is now ignored and a value of 0 is used.
- Fixed bug that could cause error “Should not be here conchn\_2\_pumps\_iOC\_3” to be returned when using a y-Q curve for a pump
- Fixed bug in QGIS project (.qgs) file which caused input files to be incorrectly referenced. The geometry type (\_P = points, \_L = lines or \_R = regions) was added to input filepaths



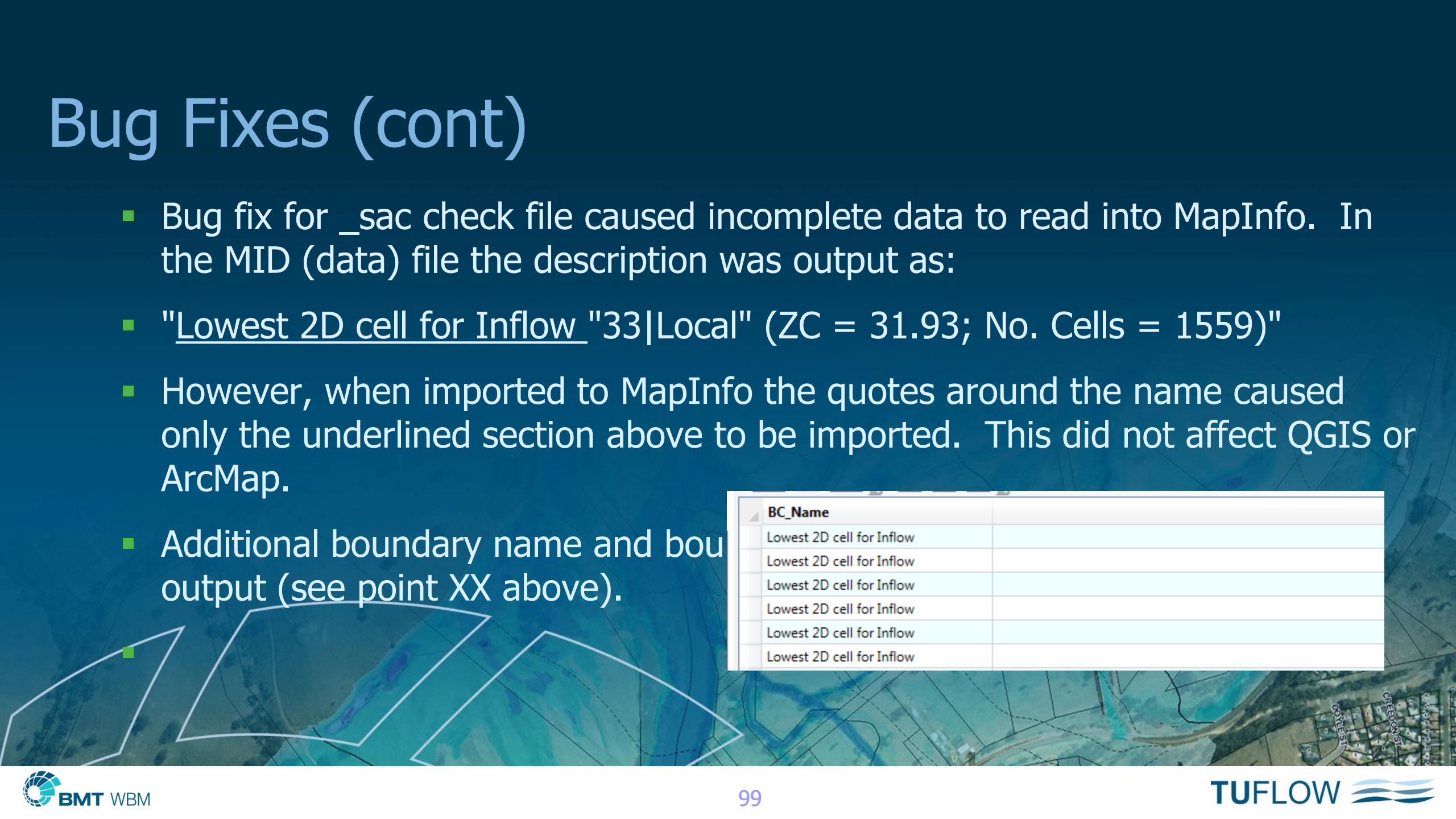
# Bug Fixes (cont)

- Fixed bug that would cause Warning 0317 to occur if “Write Timeseries Online” or “Write PO Online” options were enabled. Previously “WARNING 0317 - Exceeded limit of input GIS layers that can be tracked (layer referencing may not be complete)” could be returned. This warning message does not affect results at all



# Bug Fixes (cont)

- Bug fix for \_sac check file caused incomplete data to read into MapInfo. In the MID (data) file the description was output as:
- "Lowest 2D cell for Inflow "33|Local" (ZC = 31.93; No. Cells = 1559)"
- However, when imported to MapInfo the quotes around the name caused only the underlined section above to be imported. This did not affect QGIS or ArcMap.
- Additional boundary name and bou output (see point XX above).



BC_Name	
Lowest 2D cell for Inflow	
Lowest 2D cell for Inflow	
Lowest 2D cell for Inflow	
Lowest 2D cell for Inflow	
Lowest 2D cell for Inflow	
Lowest 2D cell for Inflow	



# Bug Fixes

- `_messages.csv` file now correctly loads into Excel
- If “ERROR 1101 - Less than the mandatory 20 1d\_nwk attributes found” occurred TUFLOW did not exit – now corrected
- If no `.ecf` file and no “Start 1D Domain ==”, but 1D commands prefixed in `.tcf` by “1D” this did not activate the 1D/2D linkage – now does
- Fixed bug where `.tcf` lines starting with “1D” outside an If Scenario block are not applied
- `2d_lfc Invert` attribute sometimes did not recognise the 99999 (ignore) option
- Bug fix that does not clear flow regime flags (`.TSF` layer and `.eof` file) for 2013 new structure routines – flags are sometimes not correct

# Bug Fixes

- Velocities of culverts on WLLs now displayed correctly (2015-03-AB)
- Selection of primary upstream and downstream channels now correctly takes into account bed slope (2015-03-AC)
- Fixed bug that did not add (accumulate) FLCs if using "Read Grid FLC =="
- In an operational structure logic block the name of an input variable was lost and appeared as blank in the output files

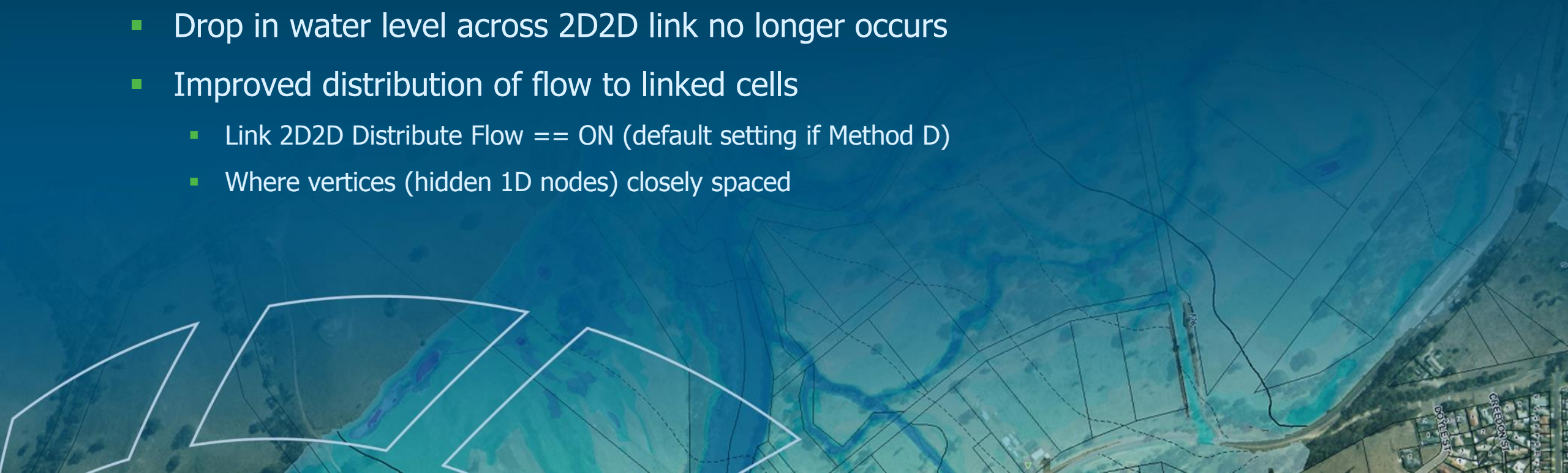


Following slides are features in 2013-12,  
but built in since last UK Conference



# 2D/2D Link Enhancements

- Build 2013-12-AC or later
- New default "Link 2D2D Approach == METHOD D"  
(Previous default "Link 2D2D Approach == METHOD B")
- Drop in water level across 2D2D link no longer occurs
- Improved distribution of flow to linked cells
  - Link 2D2D Distribute Flow == ON (default setting if Method D)
  - Where vertices (hidden 1D nodes) closely spaced

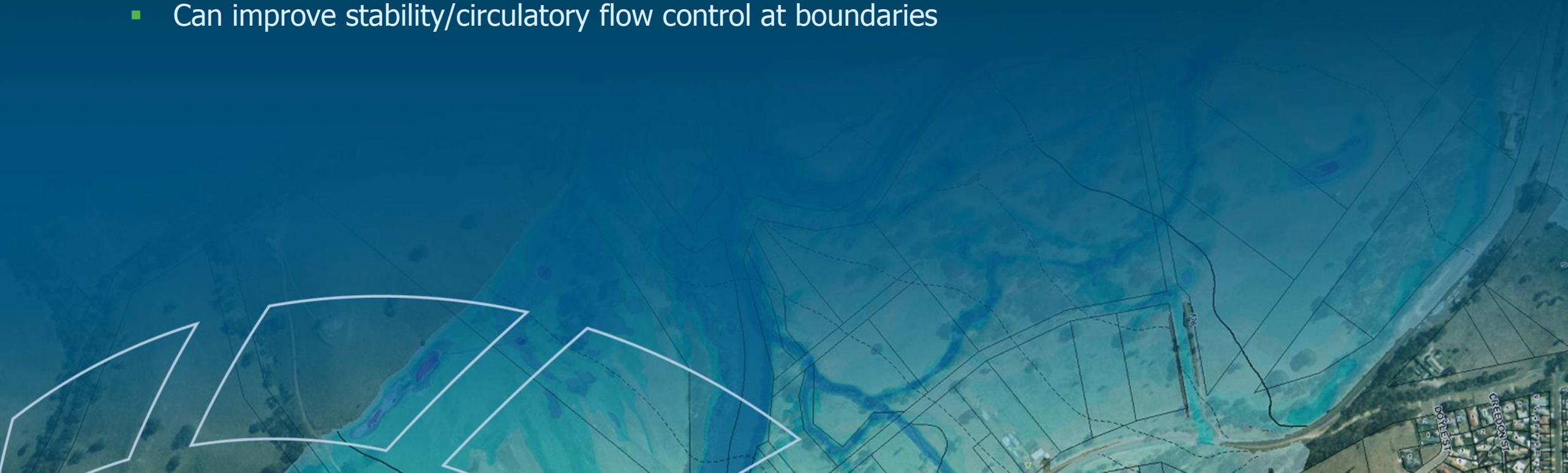




# Boundary Viscosity Factor ==

## New .tcf command

- If Method D is set to 1.0 by default
- If zero eddy viscosity term not applied at boundaries (including 2D2D links) (previous approach used for dry and wet boundaries)
- Can improve stability/circulatory flow control at boundaries



# Link 2D2D Global Stability Factor ==

## New .tcf command

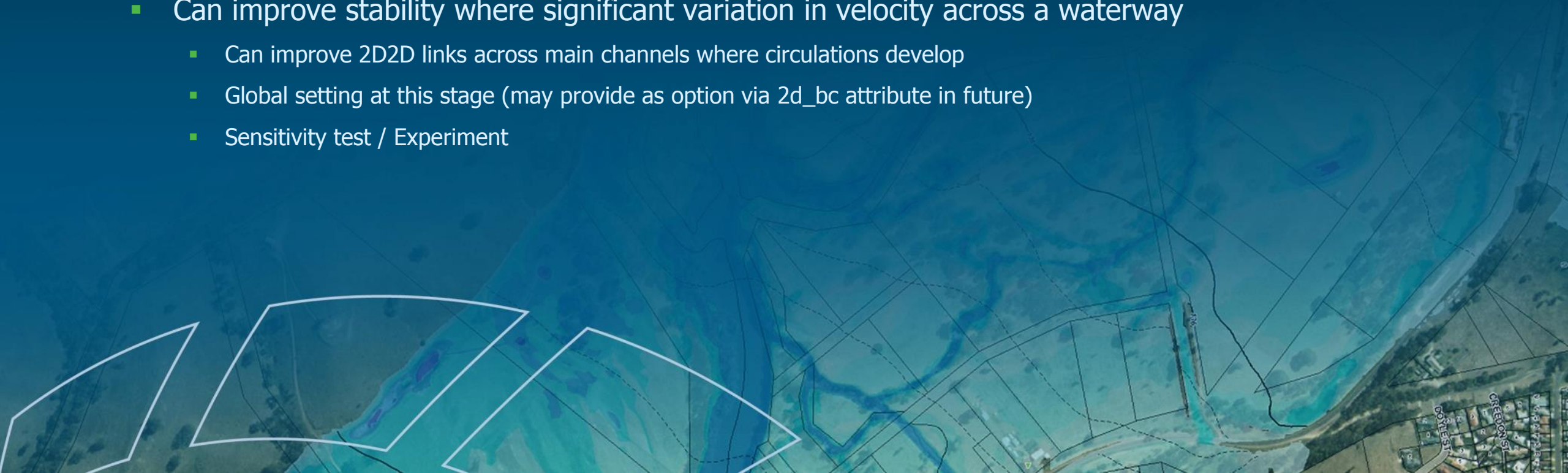
- Factors all hidden 1D node storages
- Can improve stability
- Useful if sensitivity testing the effect of increasing 1D hidden node storages on model results
- Usually values  $>1$  and  $<5$  don't significantly affect results
  - For steady-state runs, storage not relevant once steady conditions reached, therefore, larger numbers can be used
- On top of any additional storage using the 2d\_bc "a" attribute
  - Default value for "a" for Method D is 1.0 (prior methods used 2.0)



# Link 2D2D Adjust Velocity Head Factor ==

## New .tcf command

- Adjusts the water level along 2D2D links by portion of the velocity head
  - 1.0 adjusts downwards by the full  $V^2/2g$
  - 0.0 (the default) no adjustment
- Can improve stability where significant variation in velocity across a waterway
  - Can improve 2D2D links across main channels where circulations develop
  - Global setting at this stage (may provide as option via 2d\_bc attribute in future)
  - Sensitivity test / Experiment



# CWF

- New .tgc commands
  - Set CWF ==
  - Read GIS CWF ==
  - Read Grid CWF ==





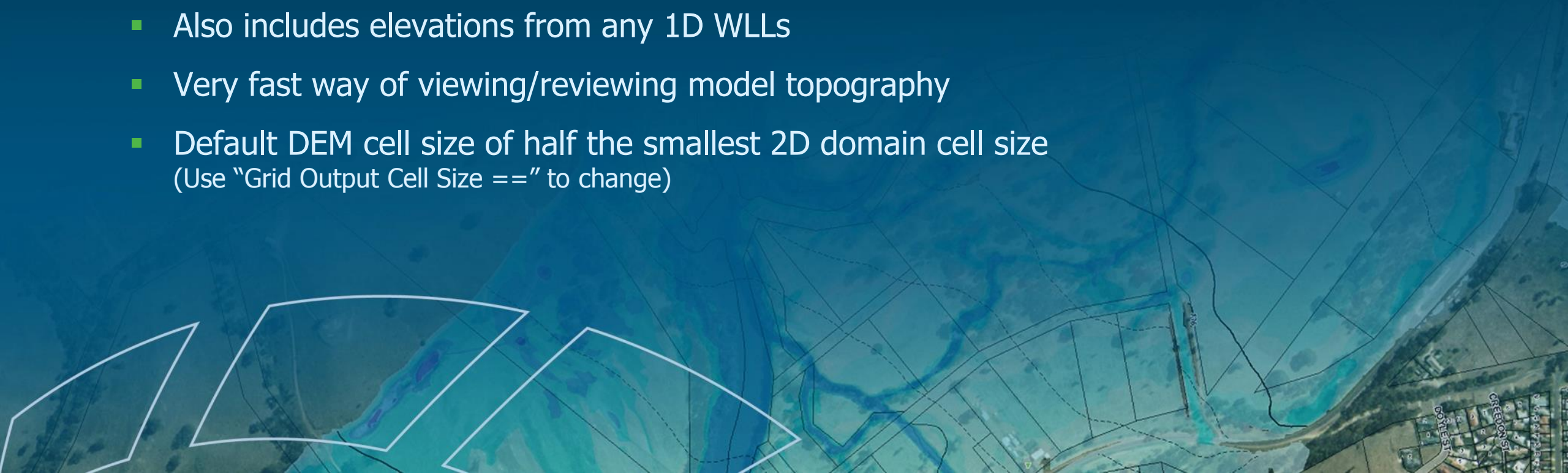
# Select Attribute in GIS Layer

- .tgc Read GIS == commands that require only one attribute (eg. Code, Mat, Soil, GWL, GWD, IWL, CnM, WrF, FLC, CWF, SRF, Zpt)
- Attribute no longer needs to be the first attribute
- Example
  - A building outline layer has four attributes: "Prop\_ID", "Material", "SRF", "Pad\_Depth"
  - Rather than copy the layer three times can specify

```
Read GIS Mat == 2 | gis\2d_buildings.shp  
Read GIS SRF == 3 | gis\2d_buildings.shp  
Read GIS Zpt ADD == 4 | gis\2d_buildings.shp
```

# \_DEM\_Z Grid Check Layer

- ASC or FLT grid of the final model ground elevations (Default is FLT; use "Grid Format == ASC" for ASC)
- Similar to generating a DEM from the 2d\_zpt\_check layer
- Also includes elevations from any 1D WLLs
- Very fast way of viewing/reviewing model topography
- Default DEM cell size of half the smallest 2D domain cell size (Use "Grid Output Cell Size == " to change)



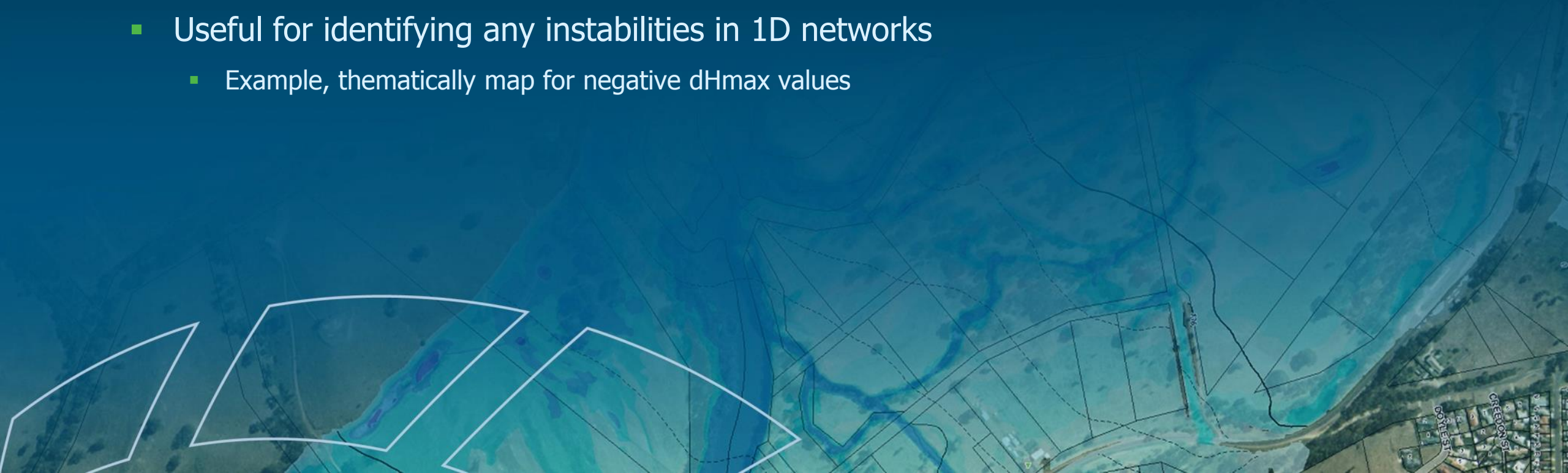


# User Control of Large Check Layers

- Write Check Files [ {ALL} | NONE | EXCLUDE | INCLUDE ] == <prefix\_list>
- Default is to write ALL check files
- Use NONE to turn off writing of check files
- Use EXCLUDE or INCLUDE to specify particular files
- Examples
  - Write Check Files EXCLUDE == zpt uvpt ! excludes writing zpt\_check and uvpt\_check layers
  - Write Check Files INCLUDE == DEM\_Z ! only write the DEM of the model's elevations
  - Suppress check files for all simulations by specifying "Write Check Files NONE" in a "\_TUFLOW\_Override.tcf" file

# \_mmQ New Attributes

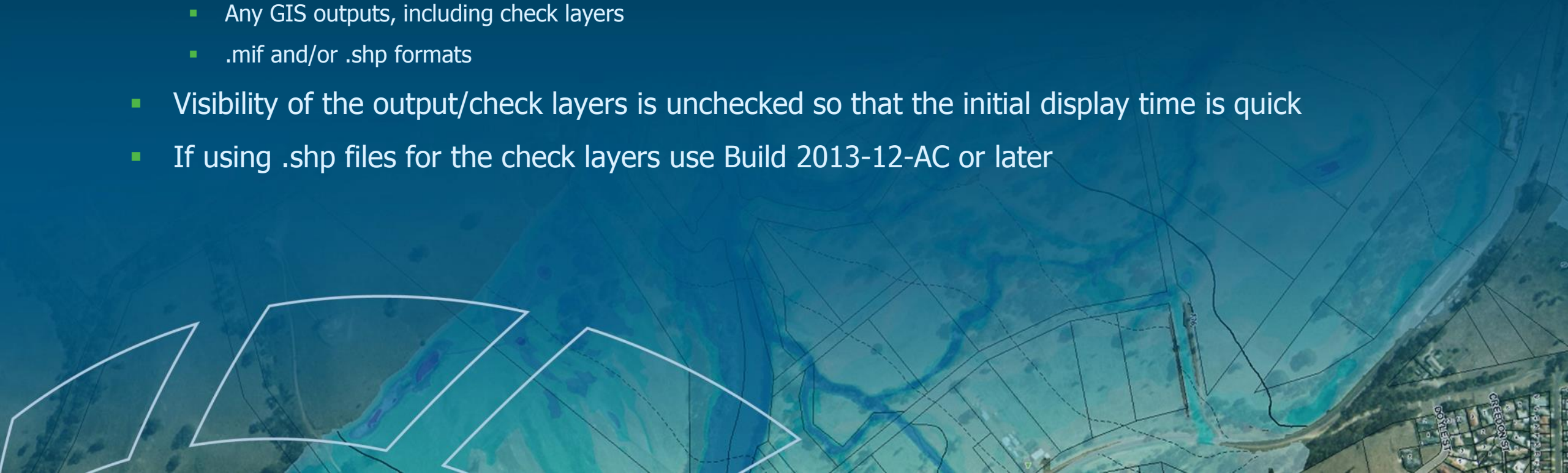
- Two additional attributes
  - dHmax – difference in maximum water levels along a channel
  - pSmax – water surface slope (%) of maximum water levels
- Useful for identifying any instabilities in 1D networks
  - Example, thematically map for negative dHmax values





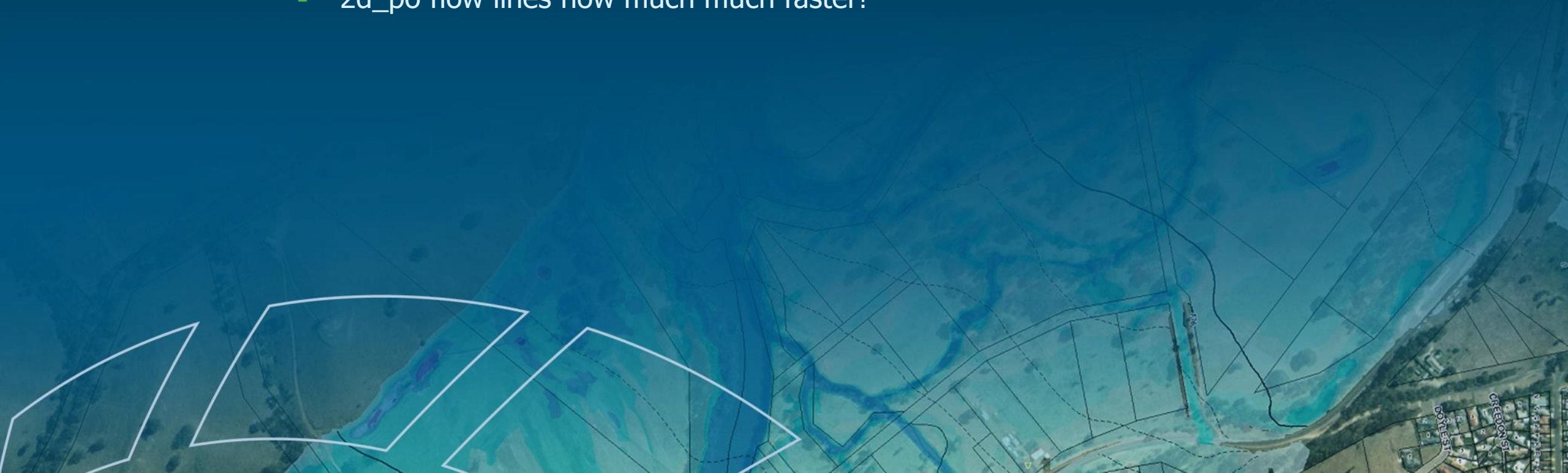
# .qgs QGIS Workspace File

- Similar to MapInfo .wor file, TUFLOW now also writes a .qgs file
- Opening this file in QGIS opens all
  - GIS inputs
  - Any GIS outputs, including check layers
  - .mif and/or .shp formats
- Visibility of the output/check layers is unchecked so that the initial display time is quick
- If using .shp files for the check layers use Build 2013-12-AC or later



# Miscellaneous

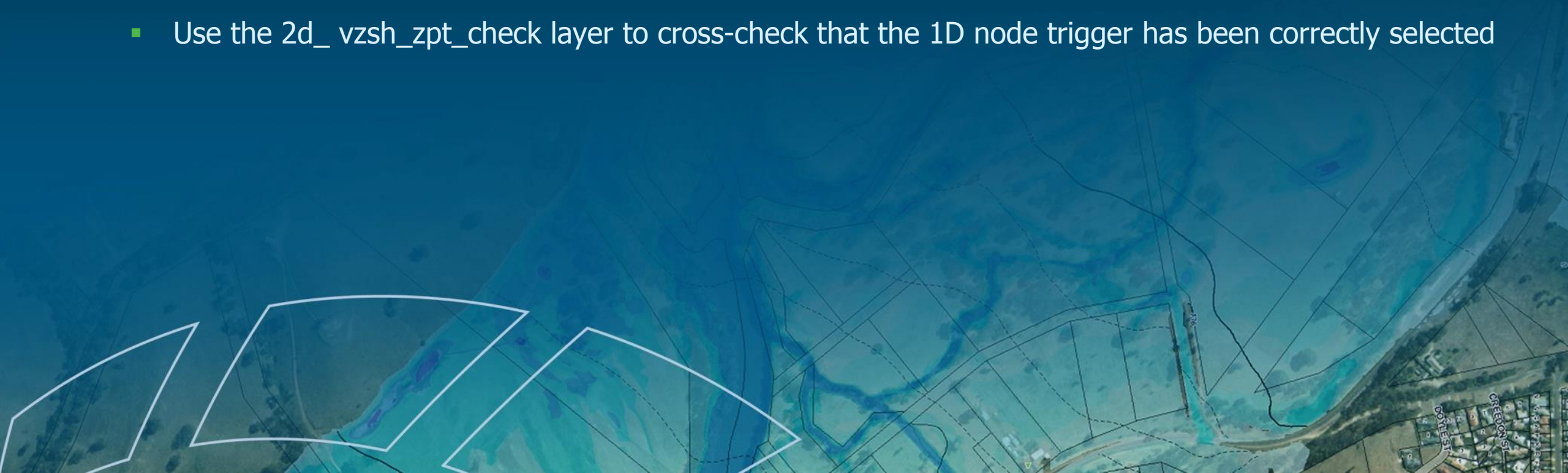
- "Read GIS SA RF ==" and "Read GIS RF ==" now treat negative rainfall values as a loss, eg. evaporation or infiltration (previously treated as zero)
- 2d\_po flow lines now much much faster!





# 2D Variable Z Shapes Triggered by 1D Water Level

- A 2d\_vzsh object can now be triggered by a 1D water level
- Trigger point is snapped to the 1D node or channel end
- Shape\_Options attribute must be "Trigger 1D"
- Use the 2d\_vzsh\_zpt\_check layer to cross-check that the 1D node trigger has been correctly selected



# People Hazard Categories

## Engineers Australia Recommendations

- ZPA – Hazard to Adults
- ZPC – Hazard to Children
- ZPI – Hazard to Infants and Elderly

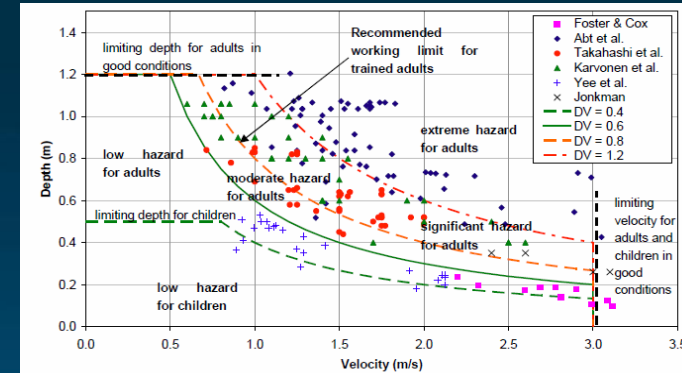


Figure 8 Proposed hazard regimes as a function of depth and velocity and compared to available experimental data.

Table 5 Flow hazard regimes for infants, children and adults

DV ( $\text{m}^2\text{s}^{-1}$ )	Infants, small children (H.M $\leq 25$ ) and frail/older persons	Children (H.M = 25 to 50)	Adults (H.M > 50)
0	Safe	Safe	Safe
0 – 0.4	Extreme Hazard; Dangerous to all	Low Hazard <sup>1</sup>	Low Hazard <sup>1</sup>
0.4 – 0.6		Significant Hazard; Dangerous to most	
0.6 – 0.8		Extreme Hazard; Dangerous to all	Moderate Hazard; Dangerous to some <sup>2</sup>
0.8 – 1.2			Significant Hazard; Dangerous to most <sup>3</sup>
> 1.2			Extreme Hazard; Dangerous to all

<sup>1</sup> Stability uncompromised for persons within laboratory testing program at these flows (to maximum flow depth of 0.5 m for children and 1.2 m for adults and a maximum velocity of  $3.0 \text{ m s}^{-1}$  at shallow depths).

<sup>2</sup> Working limit for trained safety workers or experienced and well equipped persons ( $D.V < 0.8 \text{ m}^2\text{s}^{-1}$ )

<sup>3</sup> Upper limit of stability observed during most investigations ( $D.V > 1.2 \text{ m}^2\text{s}^{-1}$ )



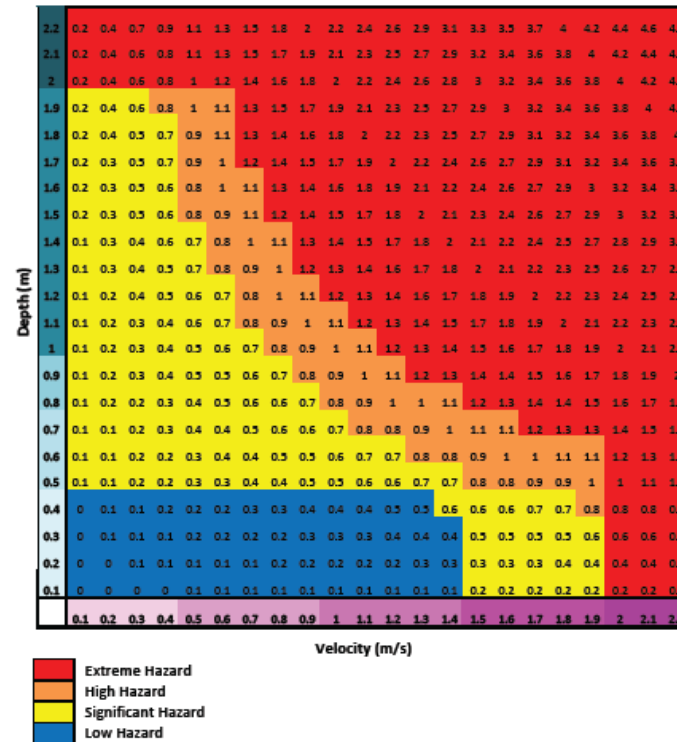
# QRA and MBRC Flood Hazard Categories

- ZQRA
- ZMBRC

## Schedule 4 - Flood hazard criteria

### Indicative flood hazard criteria

The following indicative flood hazard criteria have been prepared for use in preparing flood investigations (level 2), and planning evaluations based on latest available engineering guidance. In the absence of other more appropriate flood hazard definitions, the criteria below may be used.



### Rules

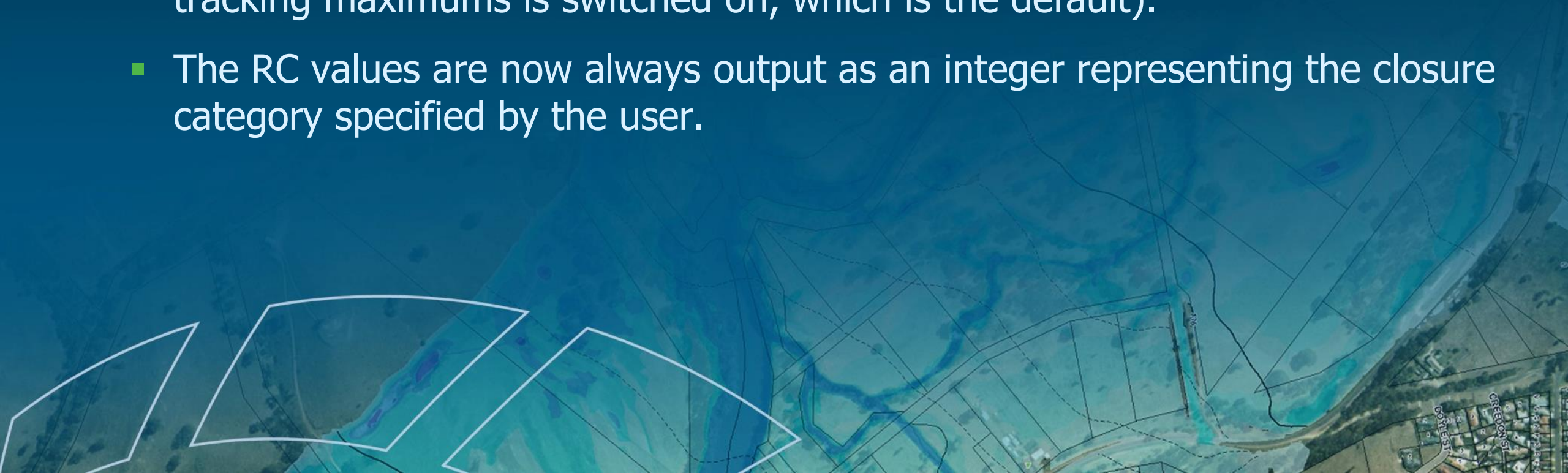
	Low	Significant	High	Extreme
Depth	<0.5	<2	<2	2+
Velocity	<1.5	<2	<2	2+
DxV Ratio	<0.6	0.6 to <0.8	0.8 to <1.2	1.2 +

### Rationale

1. **Low** – self evacuation possible for adults and children, vehicle stability within tolerance for large 4WD
2. **Significant** – working limit for trained safety workers, Vehicle evac unsuitable, Building Code limitation
3. **High** – limit of uncompromised stability for adults (dangerous to most)
4. **Extreme** – in excess of known stability limits

# RC Map Output Enhancements

- (used for animating route closures and levee overtopping):
- The maximum RC category value is now tracked every timestep and output (if tracking maximums is switched on, which is the default).
- The RC values are now always output as an integer representing the closure category specified by the user.





# Demo Model ==

- New command to run Demonstration Models without a licence
- Demo models to be placed progressively on Wiki  
(will be announced via Forum)
- Demo models
  - Provided with brief documentation/commentary
  - No step-by-step instructions as with Tutorial Models
  - Allows trained users to see how models can be set up
  - Include advanced features not in Tutorial Models
- USA FMA Challenge Models nearly ready to go
- Other benchmark models

# Option to make XF files Simulation Dependent

- “XF Files Include in Filename == <text>” adds text to the end of the .xf filenames
- For example, if two models use the same DEMs for setting Zpt values so that XF files are not always being recreated

In Model 1's .tcf file:

XF Files Include in Filename == M1

In Model 2's .tcf file:

XF Files Include in Filename == M2

- If the same .tcf file is being used to run both models, use the scenario name

XF Files Include in Filename == <<~s1~>>



# New .tsf file

## TUFLOW Summary File

- Concise summary of simulation
- Can be used for plotting/monitoring key measures (eg. %ME)
- Update during a simulation using .tcf command  
"TSF Update Interval == [ {0} | <interval\_in\_sec> ]"
  - 0 (zero) will only write the file at the start and end of the simulation

# Mx ... on Console Window

- Only if maximums are being tracked  
(ie. "Maximums and Minimums == ON")
- After "Mx"
  - First two numbers % 1D nodes and 2D cells that reached a new maximum last timestep
  - Third number time in decimal hours since no new maximum
- Precision issues



# Miscellaneous

- “Global Rainfall BC == <BC\_name>” .tbc command now applies to all active cells
- If only one rainfall hyetograph, this command negates the need for a 2d\_rf layer



# Miscellaneous

- Hazard (VxD) can now be used for cut-off values for evacuation routes
- Variable Z Shapes can now be restored
  - Reinstatement of a levee breach
  - Repeated opening and closing of a lagoon entrance
- SA inflows can now be based on the 2d\_po water level or flow elsewhere
  - Use "Read GIS SA PO == ..." in .tbc file
- Velocity (V\_) LP output
- New folders automatically created
- Speed Up PO Maximums



# Miscellaneous

- "Read GRID Location == <dem.asc>" to set the 2D grid extent
- "Read TIN Zpt == <file.2dm>" now recognises .2dm files
- "Zpt Range Check == <zmin>, <zmax>"
  - Defaults are -9,998 to 99,998
- "End After Maximum == <eam>" terminates a simulation <eam> hours after the last time a new maximum was recorded anywhere in the model
  - "End Time == " is the upper limit to finish the simulation

thank you