



## TUFLOW 2011-09 Release Notes

This document describes new features and commands for TUFLOW Release 2011-09. This release coincides with two other announcements:

- The ISIS update supporting the release of ISIS-TUFLOW-PIPE (ISIS-ESTRY link).
- The first module of the TUFLOW Tutorial Model Wiki that provides full support for GIS platforms that use .shp files (ArcGIS and SAGA are the two additional GIS software in addition to MapInfo).

There are a range of other features for the 2011-09 release being finalised that are being rolled out in 2011-09 updates. Some of these features will/have been presented at the various TUFLOW workshops in October/November 2011 in the UK and in March 2012 in Australia.

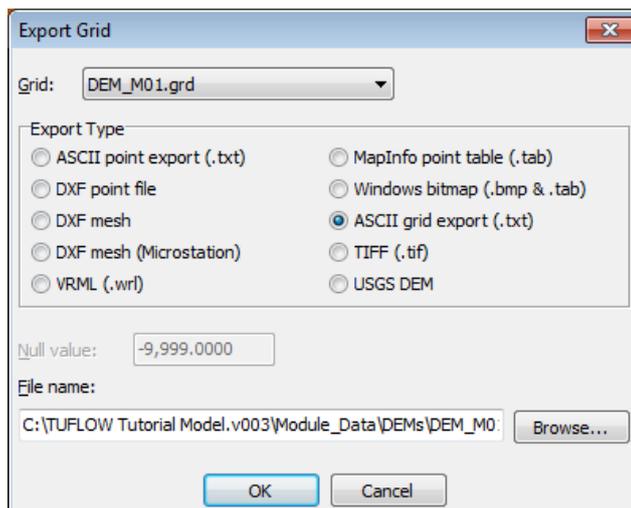
The default settings have been left unchanged from the 2010-10 release, so the results from simulations carried out using 2010-10 builds should be identical, however, as discussed below in the notes for 2011-09-AE this is sometimes out of our control due to the way the compiler optimises the code. It is generally recommended that if using a new build with an established model that test runs are carried out and comparisons made between the old and new builds (using Data, Data Calculator... in SMS and subtracting the two maximum h data sets is an easy way to do this).

### Build 2011-09-AF

Notes on new features, enhancements, and bug fixes in Build 2011-09-AF are below. Testing on a range of models has shown 2011-09-AF gives identical results to 2011-09-AE.

#### New Features

- 1 Direct reading of DEM Grids (**at last, no more creating, point inspections and export of Zpts!**).
  - (a) New .tgc command "Read Grid Zpts [ {} | ADD | MIN | MAX ]== <ESRI ASCII Grid>" that TUFLOW directly interrogates (point inspects) to set the Zpt elevations. This command is similar to "Read TIN Zpts ==" but works on a grid rather than a TIN.
  - (b) The only Grid format supported at present is the ESRI ASCII Grid format (same .asc format as used by TUFLOW\_to\_GIS to export grids).
    - (i) Nearly all 3D surface software (12D, ArcGIS, Discover, Vertical Mapper) offer this format for exporting grids. For example, in Vertical Mapper from Grid Manager, use Tools, Export... and chose ASCII grid export (.txt) as per below:



(ii) TUFLOW will accept any file extension at present as there doesn't seem to be a standard.

- (c) By using this command, your TUFLOW model will very likely become cell size independent, so to change cell size only involves changing the .tgc "Cell Size ==" setting, and reducing your timestep. It's as simple as that.

Changing a 2D domain's orientation and dimensions will also be very very easy. If you need to change a 2D domain's orientation and/or overall dimensions, there is no need to regenerate, import into a GIS, point inspect and export your 2d\_zpt layer(s) as these layers are no longer needed. All that needs to be done is change the 2d\_loc layer or your "Orientation" and/or "Grid Size" commands.

- (d) Testing thus far shows this new command to be very fast (much faster than doing a point inspection in Vertical Mapper, which is not particularly slow). And by default an XF file is written that carries out a binary dump of the Zpts so 2<sup>nd</sup>, 3<sup>rd</sup>, ... time round it's even faster (seconds for tens of millions of points!). If you want to use or not use XF files for that layer, use the "XF ON" or "XF OFF" options (eg. to not use specify "Read Grid Zpts XF OFF ==").
- (e) Like other .tgc commands, you can specify "Read Grid Zpts" as often as you like. You can also specify ADD, MIN or MAX in the same way as for other similar commands.
- (f) It is planned to extend this capability to some other inputs such as direct reading of land-use grids (eg. satellite imagery) for defining materials, and grids of rainfall variation to set the 2d\_rf f1 and f2 attributes.

## 2 Specify clip regions for "Read TIN Zpts ==" and the new "Read Grid Zpts ==" commands.

- (a) These commands now accept a second argument to specify a GIS layer containing one or more polygons to clip the area of Zpts to be inspected. For example, the command below will only assign elevations to Zpts that lie inside polygons in the 2d\_clip\_DEM layer.

```
Read GRID Zpts == DEM\DEM_M01.txt | DEM\2d_clip_DEM.mif
```

- (b) This is particularly useful for clipping out a TIN or DEM due to unwanted or irregular triangulation around the periphery, especially for secondary TINs/DEMs of proposed developments lying within the primary TIN/DEM.

**Note: For your base Zpts from the primary DEM or TIN, do not clip this with your active 2d\_code layer as this will cause problems with Zpts along any external 2d\_bc boundaries. If no clip layer is specified, "Read GRID Zpts ==" or "Read TIN Zpts ==" assigns all Zpts falling within the TIN/Grid an elevation irrespective of whether a cell is active or inactive.**

- (c) The attributes of the clip layer are not used, and only polygons are processed. Polygons can have holes in them if required.

## 3 XF files now automatically generated for "Read TIN Zpts ==" command.

- (a) By default, an XF file of the Zpts assigned an elevation from a "Read TIN Zpts" command is created so that loading up the Zpts is pretty well instantaneous for subsequent runs using that TIN. If the TIN is updated, TUFLOW will automatically resample the Zpts and create a new XF file.
- (b) The XF file can be switched on or off from the global default setting using "XF ON" or "XF OFF" as mentioned above for the new Read Grid Zpts command.

## Enhancements

### 4 ISIS-TUFLOW HX Links

- (a) The HX cells in the 1d\_to\_2d\_check layer are now colour coded to represent the ISIS unit/node that the flow in/out across the HX cells is associated with. By default HX cells are assigned to the upstream river unit as a lateral flow.
- (b) The ISIS river units listed in the .csv files created if using "Write X1D Check Files == ON" were in some situations incorrect – this would be evidenced by the number of river units being different to the number of data columns. This has been corrected in this build.
- (c) In collaboration with Halcrow we are looking into options to improve the ISIS-TUFLOW HX linking that in some situations can be problematic, especially where a V-shape profile forms in the ISIS longitudinal profile just upstream of junction. If you have a model that experiences this behaviour,

please email [support@tuflow.com](mailto:support@tuflow.com) or [isis@halcrow.com](mailto:isis@halcrow.com) as there is a new feature that we're testing available in this build.

- (d) As a consequence of these investigations, significant improvements to the ISIS-TUFLOW linking in problematic models has resulted from:
  - (i) Setting the new "Mass Balance Corrector == ON" command – see description in Build 2011-09-AB below.
  - (ii) Assigning a FLC (typically 0.1 to 0.5 in value) to HX lines using the 2d\_bc "a" attribute. For HX lines running along the river banks, especially those with high overtopping velocities, improved stability and representation of the energy lost as the water peels off from the river to floodplain or vica versa can be realised.

Please email any feedback from using the above to [support@tuflow.com](mailto:support@tuflow.com) or [isis@halcrow.com](mailto:isis@halcrow.com).

## Bug Fixes

- 5 Fixed bug if Code -1 cells occurred in outer area of 2D domain – see <http://www.tuflow.com/forum//index.php?showtopic=1007>
- 6 Fixed bug in 2011-09 release that caused TUFLOW to stop if an XY ERROR, WARNING or CHECK occurred before \_messages layer is created – only known to occur for ERROR 2132.
- 7 Fixed bug that didn't correctly assign BC (box culvert) types in 2d\_fcsh layers. The bug is evidenced by a CHECK 2097 message at U and V points indicating that the BC soffit is below the Zpt and the cell side is blocked preventing flow through the FC shape. Also the U and V Zpts in the 2d\_zpt\_check layer would be set very high at the instability detection level. See <http://www.tuflow.com/forum//index.php?showtopic=1008>.
- 8 QGIS Null entries in the attribute data are now recognised and are treated as blank for character attributes and zero for real or integer attributes.

## Build 2011-09-AE

Notes on new features, enhancements, and bug fixes in Build 2011-09-AE:

### New Features

- 9 New Storage Reduction Feature (SRF).
  - (a) The storage of 2D cells may now be reduced (for example to model hypothetical filling, or reduced storage from buildings), or increased. For example, if a cell has a SRF value of 0.1, then its storage (surface area) is reduced by 10%. If the SRF value is less than zero, the storage is increased. The default SRF value is, of course, zero, ie. no change in storage.
  - (b) SRF values are assigned to cells in one or both of the following ways:
    - (i) Using the new .tgc "Set SRF ==" and "Read GIS SRF ==" commands. The 2d\_srf layer has only one attribute being a float or real value nominally called SRF.
    - (ii) Assigned to materials as follows.
      - For .tmf files, the optional SRF value is the 10th number. If no 10th number exists, no SRF is applied. For unrequired intermediate values (eg. if varying n with depth or IL and CL values are not needed), these may now be entered as blanks separated by commas. For example, a line in the .tmf file for Material ID 10, that only sets the Manning's n and SRF values would be:  
10, 0.050, , , , , , , 0.1 ! future rural residential with 10% loss of storage for house pads
      - For material .csv files, the SRF value goes into the 5th column as a single number. If no 5th column entry exists, no SRF is applied.
    - (iii) You can check the SRF value applied by viewing the SRF attribute in the 2d\_grd\_check layer.
    - (iv) Note that a user can use a combination of material SRF values and "Read GIS SRF" layers, but the latter prevails. The order is dependent on that in the .tgc file. For example, if a cell's storage is adjusted by both "Read GIS SRF ==" and "Read GIS Mat ==" layers, the latter will prevail.

- 10 Hazard (Velocity times Depth) or Velocity can now be used for the cutoff values for evacuation routes. To set up:
- (a) For VxD: For the Cut\_Off\_Type attribute specify one of “VxD”, “Z0” or “Hazard”
  - (b) For Velocity: Specify one of “V” or “Velocity”
  - (c) For Depth (the default) you can optionally specify “Depth”
  - (d) More than one 2d\_zshr layer may be used if different cutoff types are required.
- 11 People Hazard categories based on the Australian Rainfall and Runoff (ARR) Project 10 Stage One report, published by Engineers Australia, are now available via the “Map Output Data Types ==” command. The acronyms are:
- (a) ZPA: Hazard to Adults
  - (b) ZPC: Hazard to Children
  - (c) ZPI: Hazard to Infants and frail/elderly people.

The values in the ZPA, ZPC and ZPI output are (see table and figure further below):

- 0 = Safe (no hazard)
- 1 = Low Hazard
- 2 = Moderate Hazard
- 3 = Significant Hazard
- 4 = Extreme Hazard

There is also a new .tcf command “ZP Hazard Cutoff Depth ==”. If one value is specified, the cutoff depth to define when the Safe category applies is the same for ZPA, ZPC and ZPI. If three values are specified, these are the cutoff depths for ZPA, ZPC and ZPI respectively. The default is “ZP Hazard Cutoff Depth == 0.01”, ie. if the depth is below 0.01m (1cm), the hazard category is Safe for ZPA, ZPC and ZPI.

The Engineers Australia report may be downloaded from <http://www.tuflow.com/Download/Publications/2010.04 - ARR Project 10 Stage1 report Final.pdf> and relevant tables and figures are reproduced below.

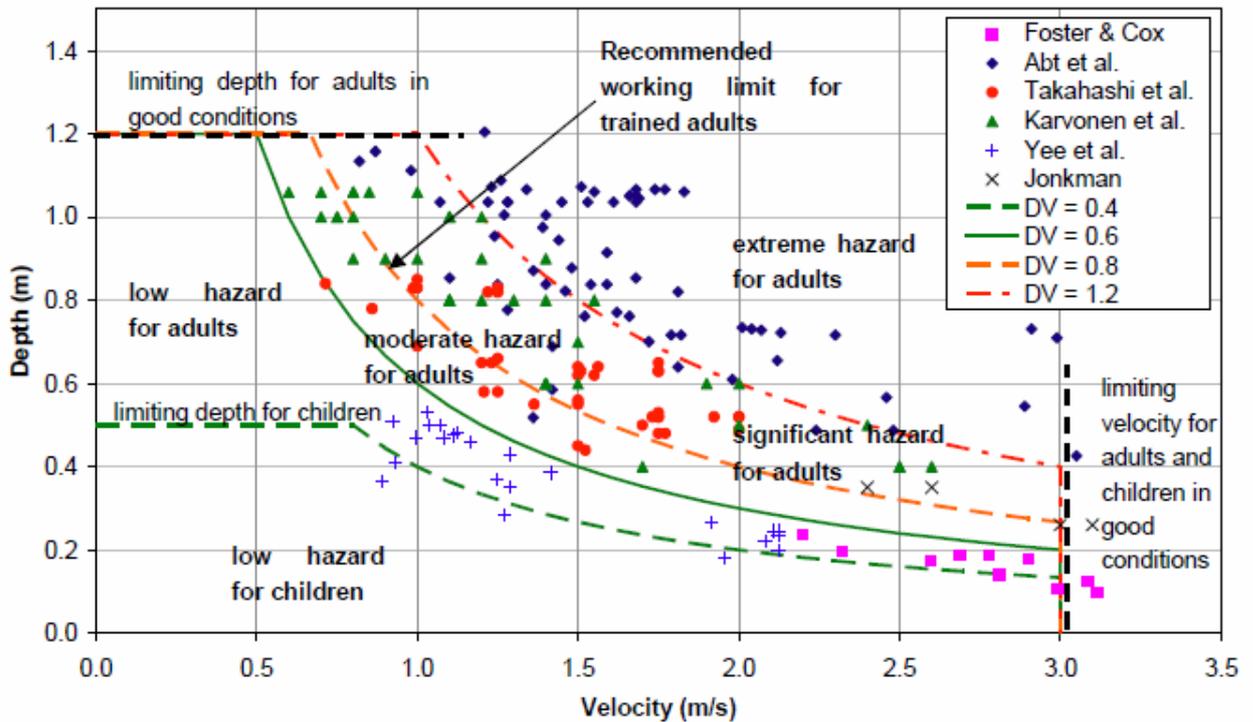
**Table 5** Flow hazard regimes for infants, children and adults

DV ( $m^2s^{-1}$ )	Infants, small children (H.M ≤ 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  $3.0 \text{ ms}^{-1}$  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 ( $D.V > 1.2 \text{ m}^2\text{s}^{-1}$ )



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

- 12 Variable Z Shapes can now be restored once or repeatedly. Examples would be a breach of a flood defence wall or levee that is reinstated 6 hours later, or a sand bar of a creek entrance that repeatedly opens up and closes. To use this new feature:
  - (a) Add two more attributes to the 2d\_vzsh layer as follows:
    - (i) Restore\_Interval, Float/Real value equal to the time in hours between when the variable Z shape as finished and when to start restoring the Zpts back to their original values.
    - (ii) Restore\_Period, Float/Real value equal to the time in hours needed to restore the Zpts back to their original values.
  - (b) If the above attributes are not added (ie. there is less than 10 attributes), or Restore\_Period is zero or negative, there will be no restoration of the Z shape.
  - (c) If the keyword "REPEAT" is included in the "Shape\_Options" attribute, the variable Z shape will repeatedly function indefinitely.
  - (d) Note: If two or more additional attributes have been added to a 2d\_vzsh layer for the user's own reference, then the above attributes will need to be inserted otherwise the user's attributes will be interpreted as the ones above.
- 13 Tracking of maximums and minimums every timestep for PO and LP output is now available.
  - (a) To activate this feature, enter "Maximums and Minimums Time Series == ON" in the .tcf file.
  - (b) If activated, four more rows are added near the top of the \_PO.csv file, and columns in the \_LP.csv files, containing the Maximum, Time of Maximum, Minimum, and Time of Minimum values.
  - (c) The \_TS.mif layer also contains the tracked values. Note, the max/min values in the \_TS.mif layer if this feature is not activated are not tracked every timestep, but are the max/min values based on the "Time Series Output Interval".
  - (d) This feature will most likely be made the default setting in the next major release as part of a general reworking of TUFLOW output for the new User Defined TUFLOW Output feature.

- 14 New SA flow feature to model seepage or infiltration based on a varying water level or flow rate elsewhere in the model. This feature was recently used to model the seepage of groundwater into a coastal lagoon that was dependent on the water level in the lagoon as observed from long-term historical measurements. Notes on this feature are:
- (a) For example, to set the SA flow in/out of a model based on the water level somewhere in the model:
    - (i) Create a 2d\_po point object of Type "H\_" at the location of the water level to be used to set the SA in/outflow.
    - (ii) Add "Read GIS PO == ..." to your .tcf file if not already there.
    - (iii) Create a new 2d\_sa layer (call it 2d\_sapo) and add two attributes as follows:
      - PO\_Type Char of length 16
      - PO\_Label Char of max length 40
    - (iv) Digitise your SA polygon(s) covering the area of seepage or infiltration and for the attributes:
      - Set the Name attribute to the name of the water level vs flow curve in the BC database.
      - Set PO\_Type to "H\_".
      - Set PO\_Label to the PO Label of the relevant 2d\_po "H\_" point to be used to determine the flow from the h vs Q curve.
    - (v) Add "Read GIS SA PO == ..." to your .tbc file.
  - (b) To base the SA flow on the flow elsewhere in the model, use a Q\_ PO type.
  - (c) To check the SA in/outflow:
    - (i) View the \_MB.csv files. The SA in/outflow from the seepage or infiltration will be part/all of the SS columns.
    - (ii) Add "SS" to the "Map Output Data Types ==" command. This outputs over time the net in/outflow from all source flows (ST, SA, SX).

### Enhancements

- 15 If opening or writing to an XMDF file fails, TUFLOW now repeatedly tries to open/write to the file rather than terminate. Reasons for an XMDF file not being able to be opened or written to are the usual suspects such as network connection is down, disk is full, file is protected by another application. Note, software such as SMS open XMDF files as read-only meaning that TUFLOW can continue to write to the XMDF file and that the results of the simulation can be viewed whilst the simulation is running.
- 16 TUFLOW AD module has been updated with the new GIS routines.
- 17 Increased the limit on the maximum number of vertices for a single region or aggregated region (including regions with holes) from 100,000 to 500,000.
- 18 Increased the limit on the maximum number of 2D cells that can be selected by a polyline from 10,000 to 50,000.
- 19 Increased the limit on the maximum number of XZ points in a 1D cross-section from 1,000 to 100,000. Also see <http://www.tuflow.com/forum/index.php?showtopic=978>. We are also planning to increase the limit in xsGenerator.exe utility accordingly.

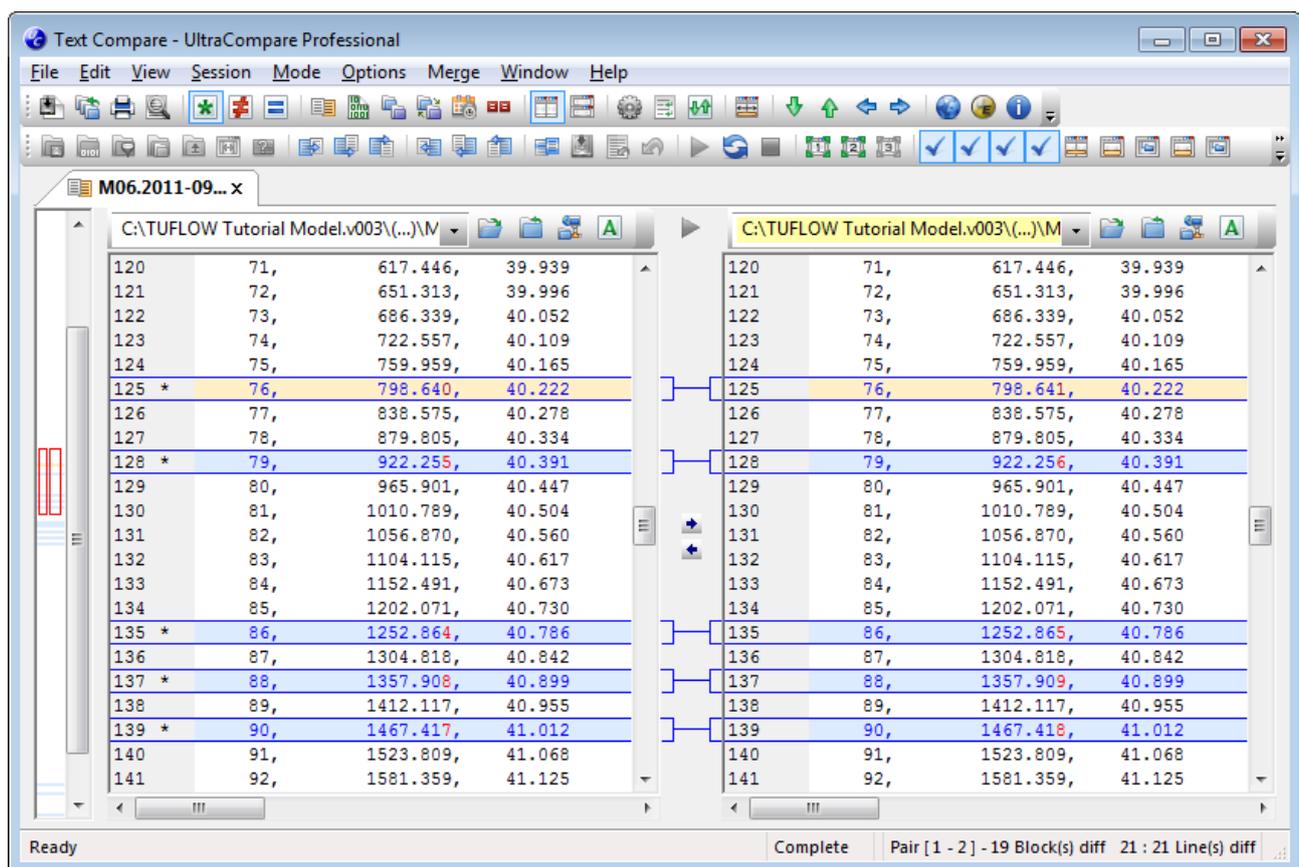
### Bug Fixes

- 20 Fixed a bug with restart files created by 2011-09 builds. Restart files generated by 2010-10 or earlier builds should now work with Build 2011-09-AE. Any restart files created by Builds 2011-09-AA to AD will need to be regenerated using Build 2011-09-AE or 2010-10 and earlier.
- 21 Fixed a bug in the 2011-09 release that fails to keep trying for a WIBU licence if all licences are taken. This applies to both Local and Network WIBU dongles. The bug does not exist in the 2010-10 or earlier releases. Also see <http://www.tuflow.com/forum/index.php?showtopic=997>.
- 22 The quotes placed around the message attribute in the \_message.mif/.shp layers are now correctly applied and the attributes for these layers should now be read in correctly by GIS software.
- 23 Fixed a minor bug with nested If Scenarios. TUFLOW would previously stop if this bug occurred.

- 24 Fixed a bug where if there are more than 10,000 regions to be TINned in a Read GIS Shape command, if using XF files and/or specified the WRITE TIN option, TUFLOW would stop with an ERROR 2415. This message is now given as WARNING 2415 TUFLOW continues without writing anymore XF files or TINs for the remaining regions.

**Important Note for Build 2011-09-AE**

The results obtained from Build 2011-09-AE should be identical to those from earlier builds and the 2010-10 release. However, during quality control testing of the 2011-09-AE release it appears that for SP (single precision) builds the optimised compiler code is being treated slightly differently to previous builds. While most SP models tested gave identical results, a couple gave very slightly different results (averaging a fraction of mm difference). For example, for automatically generated 2D QH boundaries for SP builds, the flow values were different at the 7<sup>th</sup> significant figure (see image below comparing 2d\_bc\_tables\_check.csv files), which causes very slightly different results. After much frustration and rebuilding of the code base we've identified that the compiler is optimising code for the 2011-09-AE single precision builds differently, thereby causing the slight inconsistencies (un-optimised code works fine, but is much slower!). Therefore, as always, it is recommended to cross-check new builds by re-running established models and comparing with the original results.



## Build 2011-09-AD

Notes on bug fixes in Build 2011-09-AD:

- 25 TUFLOW now checks the date of .xf files with their original .tab layers. For all prior builds, including prior to 2011-09, that include the XF file feature, the only date comparison was with the .mid file. This meant that if a 2d\_zpt.tab layer was updated and saved but **not** exported to .mif/.mid, TUFLOW would not issue an ERROR or WARNING 0004 if an XF file existed from a previous run.
- 26 The Ignore attribute in the 1d\_nwk and 1d\_mh layers is now treated as a Character of length 1 (previously set as a Logical) as some GIS software have problems with Logical attributes in the .shp format. Note, there is no need to change the Ignore attribute in 1d\_nwk and 1d\_mh MapInfo layers from Logical to Character, as TUFLOW recognises either specification. For .shp files, it is recommended that a Character of length 1 is used. Regenerating empty layers will now set the Ignore attribute as a Character. For the Ignore attribute, if a "T", "t", "Y" or "y" is specified, the object will be ignored (T for True and Y for Yes). Any other entry, including a blank field, will treat the object as active.
- 27 Import of \_TS.mif layers into MapInfo if 2D PO lines are present now works. This bug does not occur in releases prior to 2011-09.
- 28 The \_messages.shp layer and any unclosed .shp check layers are now closed off neatly if TUFLOW stops with an ERROR message during the input phase. For prior builds these layers could not be opened in a GIS.
- 29 2d\_zsh layers with aggregated polylines cause an ERROR 0308 if writing check files is switched on. This bug does not occur in releases prior to 2011-09.
- 30 Fixed bug that didn't correctly set the wet/dry flags for the maximum and /or minimum map output if using the SMS High Res output option in combination with a Map Cutoff Depth == greater than zero.
- 31 Fixed bug that did not copy a file when using -c or -ca if the path to the file included a forward slash. TUFLOW is happy to accept forward slashes in pathnames, but when copying a model these files were omitted.
- 32 Fixed bug that when copying a model using -c or -ca the existing .xmdf file was deleted (and therefore the results for that simulation were lost!). This bug does not occur for .dat files.
- 33 If one or more null cells are located outside the reduced computational domain used by the 2011-09 release for minimising run times, the .2dm file would contain nodes with zero ID in the .2dm mesh file – this is now fixed. Note that the outlying null cells are included in the mesh as would be the case with releases prior to 2011-09.

## Build 2011-09-AC

Notes on bug fixes in Build 2011-09-AC:

- 1 x1d\_channels\_check layer now written in .mif format correctly. This bug does not occur in releases prior to 2011-09.
- 2 1d\_to\_2d\_check layer now exports SX cells correctly in .mif format. This bug does not occur in releases prior to 2011-09.
- 3 Excessive whitespace in check layers for the .mif format after Style lines has been removed – check files are now back to a similar size as per releases prior to 2011-09..

## Build 2011-09-AB

Notes on new features and bug fixes in Build 2011-09-AB:

- 1 A nice new feature that carries out an additional iteration of the mass balance equation every half timestep is being made available. By switching this feature on using the command below, significant reductions in mass error can result for problematic models, particularly those with steep and/or very shallow flow. Improvements in model stability and "smoothness" also occur, with larger timesteps being feasible in many cases. So far testing on a range of models indicates changes in peak water levels vary from a few mm to a few cm if this feature is used. This feature is being released for testing in the wider TUFLOW community, and all going well, will likely become the default in the next major release (any feedback, good or bad, would be appreciated by emailing [support@tuflow.com](mailto:support@tuflow.com)). The downside to this feature is that it will add around 5 to 10% to your simulation time, although this may easily be recovered if a larger timestep can be used. To switch this feature on, use the following command in the .tcf file.

### Mass Balance Corrector == ON

- 2 Build 2011-09-AA will produce the error message "ERROR 0251 - Cannot have more than 10 GIS layers open at once." for some models. This limit is a hangover from the 2010-10 release which only applied to input layers. With the reworking of GIS routines to write output and check .shp layers, this limit can be exceeded in some cases. The limit has been increased to 100 which hopefully should be ample (let us know if it isn't!). TUFLOW also now checks for any unclosed layers at the end of the simulation and closes them off neatly. If an unclosed layer exists "WARNING 0255 - One or more GIS layers not closed during simulation - please notify [support@tuflow.com](mailto:support@tuflow.com)." occurs. This does not affect the simulation or GIS layers, but if you see this message please email [support@tuflow.com](mailto:support@tuflow.com) your .tif file.
- 3 A bug in Build 2011-09-AA that causes TUFLOW to stop in some instances where a nested If Scenario occurs after an Else command has been fixed.

## Build 2011-09-AA

Notes on the new features available in Build 2011-09-AA are:

- 1 **ISIS-ESTRY Link (ISIS-TUFLOW-PIPE):** ISIS and the 1D solution of TUFLOW (ESTRY) can now be linked in a similar manner to linking ISIS with TUFLOW 2D domains. The main driver for this feature is for ISIS-TUFLOW models to utilise the powerful pipe network and manhole modelling capabilities of TUFLOW and be able to link these networks into an ISIS river model.

Notes on the ISIS-ESTRY link are:

- (a) ISIS and ESTRY nodes will be considered as linked if:
  - (i) An ESTRY node in a 1d\_nwk layer, and an ISIS node in a "Read GIS ISIS Nodes ==" or "Read GIS ISIS Network ==" layer are snapped.
  - (ii) The ESTRY node has a Conn\_2D attribute (which has been renamed for 2011-09 empty layers as Conn\_1D\_2D) of either "X1DH" or "X1DQ".
  - (iii) If Conn\_1D\_2D is blank then "X1DH" is assumed.
  - (iv) A connector "X" channel type can be used to connect the end of the linked ESTRY channel to the ESTRY node snapped to the ISIS node if the end of the ESTRY channel and the snapped ISIS/ESTRY nodes are not in the same location.
  - (v) Note that the upstream and downstream Inverts for the ESTRY node linked to ISIS should be set to -99999 unless the node is also being used to set the inverts of channels snapped to it.
- (b) An "X1DH" link means an ISIS 1D water level is being applied at the ESTRY node, ie. ISIS sends ESTRY a water level and ESTRY sends back a +/- flow to ISIS.
- (c) An "X1DQ" link means an ISIS in/outflow is being applied at the ESTRY node, ie. ISIS sends ESTRY a +/- flow and ESTRY sends back a water level.
- (d) For most ISIS-ESTRY links an ESTRY X1DH (the default) would be used. An X1DQ might be more appropriate where an ISIS model stops and flows into an ESTRY model.

(e) Other Notes:

(i) The mass balance \_MB1D.csv file includes four new columns:

- X1DH V In: The volume of water in via a X1DH link.
- X1DH V Out: The volume of water out via a X1DH link.
- X1DQ V Out: The volume of water out via a X1DQ link.
- X1DQ V In: The volume of water in via a X1DQ link.

(ii) The type or existence of a connection can be checked by viewing the Conn\_1D\_2D attribute in the 1d\_nwk\_N\_check layer.

(iii) The \_messages.mif layer contains CHECK 1393 messages at each ESTRY node linked to an ISIS node.

2 **Full .shp File Support:** All TUFLOW GIS outputs (eg. check layers) can now be in .shp file format making the use of ArcGIS much more streamlined, and products such as SAGA that don't recognise the .mif format a good option for using TUFLOW. There are number of new commands associated with this major feature:

(a) SHP Projection == <.prj\_file>. This .tcf command is similar to the MI Projection command that sets the .shp file projection for checking whether input layers are in the same projection, and for setting the projection of all output layers (eg. check layers). An example is:

```
SHP Projection == ..\model\shp\Projection.prj
```

If a model has a mixture of .mif and .shp files as input, then both MI Projection and SHP Projection should be specified.

(b) Empty .shp files can now be created using the command below. If the second argument is MIF or is omitted, the empty files are in the .mif format. As with writing empty .mif files, ensure that you've specified the projection to be used using the MI Projection or SHP Projection command as described above prior to the command below.

```
Write Empty GIS Files == ..\model\shp\empty | SHP
```

(c) The default output format for GIS check layers and GIS outputs such as the \_TS layers is the .mif format. To produce check and output GIS layers as .shp files specify the following command in the .tcf file.

```
GIS Format == SHP
```

Note that the format of an input layer is solely controlled by the file extension (ie. .mif for the MIF format and .shp for the SHP format).

3 **Reworking of GIS Routines:** Please note that the 2011-09 release includes a complete reworking of all GIS TUFLOW routines so that irrespective of the GIS format the same routines are used to read and write GIS layers. This means that all the old .mif routines have been replaced (major undertaking!) by the new ones. Whilst we have carried out major testing of both .mif and .shp files for input and output, please don't hesitate to contact [support@tuflow.com](mailto:support@tuflow.com) should any problems or issues arise, even if using the traditional .mif format.

The new routines, whilst a major exercise, now allow the easy inclusion of other GIS formats. We would be pleased to hear of any other open GIS formats that TUFLOW modellers would like to have incorporated. Please send suggestions to [support@tuflow.com](mailto:support@tuflow.com).

4 **Ignoring of Redundancy Around Model:** TUFLOW now automatically strips any redundant rows/columns around the active area of the model to reduce simulation times. Whilst simulation times are largely dependent on the number of wet cells, a model with a large amount of superfluous space around the outside can run significantly slower than if the grid was reduced to the minimum needed. In one extreme case where a small sub-part of a model was being run on its own, the simulation time was

reduced by a factor of 15 by this new feature.

Note, the amount of RAM consumed by the model is not reduced, only the computational effort in some of the TUFLOW routines that need to scan the whole model.

- 5 **Nested If Scenarios:** The powerful If Scenario command can now be nested up to 10 levels (if you need more than 10, or 2 for that matter, you may do the head in of your reviewer...). The extract below from a .tcf file of a super model is shown below. The model is actually a combination of models that can be simulated at different resolutions and in different configurations depending on the simulations objective. Out of interest, the same .tcf file is also used to simulate all historical and design flood events.

The excerpt below shows the Casino sub-model being able to be run at either a 20m or 60m resolution using the same .tcf file. The logic as to which other sub-models/boundaries the Casino sub-model needs is built into the .tbc file using nested If Scenarios.

```
#####
### CASINO DOMAIN ###
#####

IF SCENARIO == CAS

  ESTRY Control File == ..\model_CAS\CAS_001.ecf

  ! Cell size dependent commands
  IF SCENARIO == 20m  ### 20m grid Domain
    START 2D domain == CAS_20m
      Geometry Control File == ..\model_CAS\CAS_20m_001.tgc
      Timestep == 7.5
    END 2D Domain
  ELSE IF SCENARIO == 60m  ### 60m grid Domain
    START 2D domain == CAS_60m
      Geometry Control File == ..\model_CAS\CAS_60m_001.tgc
      Timestep == 20
    END 2D Domain
  ELSE
    Pause == Should not be here - invalid CAS cell size scenario specified.
  END IF

  ! Cell size independent commands
  BC Control File == ..\model_CAS\CAS_001.tbc
  Read GIS IWL == ..\model_CAS\2D_iwl\2D_iwl_CAS_001.mif

END IF
```

- 6 **Pause command:** The new Pause command causes TUFLOW to stop whenever it encounters it. In the example above, the Pause command is used to pause the simulation and display the message shown as a cross-check that an appropriate cell size scenario has been specified. The user has the option to continue or discontinue the simulation via a dialog window.

7 **New SA Commands:**

- (a) New .tcf command "SA Minimum Depth == <depth\_metres>" to set the minimum depth a wet cell must have to apply an SA inflow. This can resolve a problem that has occurred where large SA inflows onto very shallow, high roughness areas can appear to gradually flow up hill. This was being caused by the SA inflow being greater than the rate at which the flow was travelling overland and the water would slowly creep up the dry slope at the edge of the flooded area. Using a SA Minimum Depth of around 0.1m ensures that this does not occur. Note that the only cases this problem has been seen to occur was when modelling an extreme flood event (PMF) on gently sloping high roughness areas.

- (b) New .tcf command “SA Proportion to Depth == [ ON | {OFF} ]” to proportion SA inflows according to the depth of water. This feature also enhances SA inflows by applying an inflow in proportion to the depths of water of the wet cells contained within the SA polygon. Where the SA hydrographs have been derived by a hydrologic model that has already included an routing effects, this feature will tend to place more inflows in the deeper areas (ie. the creeks, rivers and downstream areas of the SA region), and hence reduce any routing duplication effects.
- (c) The default setting for 2011-09 is not to use the above commands, however, it is likely that a future release will set these as the default.