Q&A [Flood Modelling 101]		
	Question	**Answer**
1	what hydraulic modelling which is suitable for flooded areas whose rivers have been damaged due to mining activities	If you can collect the topography data for the river and catchment after the mining activities, hydraulic modelling software such as TUFLOW with a 2nd order spatial solution and all terms (i.e.. inertia and turbulence) will be suitable.
2	I mean flooded areas that due to mine damage have sedimentary factors and very damaged and special soils , is there a special modeling for this	You could consider sediment transport coupled hydraulic modelling, though it's worth noting that this is still an area of active research. Here's a paper of interest: https://www.tuflow.com/media/5404/2019-numerical-modelling-of-bed-sorting-and-armouring-in-meandering-channels-applications-from-the-east-fork-lewis-river-ridgefield-pits-area-usa-gao-et-al-isrs-china.pdf
3	What should managers/ reviewers/ interpreters look out for if they have technical (but not modelling) skills?	They should be asking for evidence that the modelling is being quality controlled using the tests such as cell size results convergence as presented in the webinar (and explained in greater details in our 2D cell size webinar - https://www.tuflow.com/library/webinars/#nov2020_2d_cell_size). For modelling that is to be used for providing more precise metrics (e.g. for building floor levels) ensure the software being used is at the more accurate end of the spectrum and that there is good quality data being used. If calibration data or anecdotal evidence exists, calibration or checking of the model should be carried out to help reduce the modelling uncertainty.
4	Some water authorities require <10mm (or 0mm) impacts on infrastructure projects. Does the panel have any views on these sort requirements considering the limits of accuracy that hydraulic models have and the uncertainty in hydrology?	Please see this Wiki page: https://wiki.tuflow.com/index.php?title=Modelling_Accuracy_Uncertainties_Impact_Mapping
5	how would you decide whether to use a 1D link as an open channel as opposed to letting 2D do its stuff	The number of 2D cells across channel is critical. Based on the ARR 2D modelling guidelines you should be aiming for 6 cells across the river, creek or drain (if not using SGS). Here's a link to the guideline: https://downloads.tuflow.com/_archive/Australian_Rainfall_Runoff_Project15_TwoDimensional_Modelling_DraftReport.pdf However, use of SGS (Sub-Grid Sampling) does allow use of a much fewer cells across a waterway whilst preserving the total conveyance of the waterway. The only downside of SGS is that if the velocity distribution across the waterway, or for example the super-elevation of the water surface around a bend, is important then you'll need sufficient cells to accurately reproduce the velocity distribution or water level variation. Quadtree grids or flexible mesh can be useful for this purpose.

Q&A [Flood Modelling 101]		
	Question	**Answer**
6	apologies for a super basic question about cell size - given a 90m dem and an area of interest say 900mx900m - is the cell size a matter of dividing the 900/90?	
7	apologies for a super basic question about cell size - given a 90m dem and an area of interest say 900mx900m - is the cell size a matter of dividing the 900/90?	I'd say depends on what you are modelling and depth of water, if you have a relatively flat area a more detailed grid won't really give good bang for buck. I'd recommend doing a sensitivity test with finer and coarser grids and seeing how much changes results. If there is an unacceptable change keep reducing the cell size till results converge noting that going much smaller the DEM cell size is somewhat pointless. Pavlina will specifically answer this question via demonstration in the second half of the webinar. I recommend staying online to watch her examples Best practice is to do cell size result convergence testing to confirm your cell size assumptions are appropriate. Our 2D cell size webinar outlines that process - https://www.tuflow.com/library/webinars/#nov2020_2d_cell_size)
8	How can I get started as a student and where can I find real or learning projects? also how can I integrate python into this?	Here is a suite of free tutorials: https://wiki.tuflow.com/index.php?title=Tutorial_Introduction Also, here's some eLearning courses. The python for TUFLOW course is free: https://www.tuflow.com/training/training-catalogue/#!d=e-learning
9	Does modelling depends on current LIDAR of the landform?	2D modelling will require a Digital Elevation Model covering the area. This could be LiDAR or other elevation data - e.g. photogrammetry, high resolution ground survey.
10	Can We provide underground stormwater storage system if my lot is flood affected and located near beach? Depending on contours, Site falls to rear and there is no easement facilities provided by council. However, underground system is possible way to control overflow from RWT, but is that feasible enough to design that storage system under flood affected zone? Flood planning controls already applied to the property in accordance with PMF levels	Site specific information (catchment area, rainfall intensity, etc) is needed to answer this question and the analysis would normally be carried out by a qualified practitioner. However, assuming that the catchment area extends well beyond your property boundary it would be highly unlikely that you could contain sufficient water in an underground storage to make an appreciable difference.

Q&A [Flood Modelling 101]		
	Question	**Answer**
11	How do we make sure the flow of water will come and same as our source model?	Pavlina will touch on checking flows in the model match the boundary applied. A mass balance is a good check on the model, e.g. with no losses the catchment area x rainfall depth should be the volume of water being applied as flow boundary to the hydraulic model. This is particularly important if using separate hydrologic and hydraulic models. If a sub catchment is missed or double counted then both the hydraulic model and the hydrologic model may show 0% mass error, but due to check for any errors a total volume check (Total in from source model - Total out from hydraulic model = Change in hydraulic model volume) should be carried out - this is a fairly standard quality control check that should occur as part of the modelling process. In TUFLOW you should include Plot Output lines downstream of your inflows so you can compare the hydraulic model inflow against the hydrology model results. Our quality control webinar recording includes some information of interest: https://www.tuflow.com/library/webinars/#oct2022_quality_control
12	Can you recommend the size of DEM resolution to simulate flood flow propagation on 1 km2 urban watershed area? Considering the simulation time and accuracy of the results. Thanks.	The finer the DEM resolution you have the better. Your model resolution should be equal or coarser than the DEM resolution. You will need to develop your model and check for cell size results convergence to test if the resolution you have selected is appropriate. Pavlina will discuss this in the 2nd half of the webinar. Our 2D cell size webinar also describes the cell size results convergence to test in detail - https://www.tuflow.com/library/webinars/#nov2020_2d_cell_size)
13	How do you face the challenges in flood modelling due to lack of site-specific and real-time data?	The best thing to do in this case is to build your model using industry standard values. Do sensitivity testing of model inputs to identify if the results change dramatically due to the choices you have made (eg. cell sizes, inflows, boundary influences - Pavlina will show some examples of these). After building your model, any opportunity to conduct community consultation is usually well worthwhile as the locals will have a "feel" whether your model is demonstrating the flood behaviours they've observed.
14	Thank you for the session. I would like to learn hydraulic modeling. Where do I have to start as a beginner? Is Python essential to the learning of modelling software?	There is a suite of free TUFLOW tutorials here: https://wiki.tuflow.com/index.php?title=Tutorial_Introduction Also, here's some eLearning courses. The python for TUFLOW course is free: https://www.tuflow.com/training/training-catalogue/#!d=e-learning

Q&A [Flood Modelling 101]		
	Question	**Answer**
15	How would we acquire river geometries apart from as-built drawing or lidar measurement due to cost constraint? possible to use SRTM DEM or Microwave satellite images?	SRTM is a *very* coarse grid. May be suitable of catchment discretisation of large catchments (100km2 +) but generally should never be used for 1D or 2D flood modelling. For river bathymetry, SRTM or LiDAR won't penetrate accurately below the water surface so ground survey or bathymetric survey will be required. For the floodplain SRTM data may able to be used, provided its vertical accuracy is checked against ground survey data (SRTM is usually very inaccurate in the vertical). For this reason you should approach your local agencies task if they have bathymetry data (Local Council, County or State Department). In some countries these agencies host the data online for download.
16	Where can we find sources for learning hydraulic modelling?	Here is suite of free tutorials: https://wiki.tuflow.com/index.php?title=Tutorial_Introduction Also, here's some eLearning courses: https://www.tuflow.com/training/training-catalogue/#!d=e-learning
17	Where do you see the future path of flood modelling? Is AI and machine learning being used in this space to improve forecasting and modelling?	I think it will definitely play a part in the future of our industry. There will however always be a need for modeller involvement to make sure the assessment approach and results are accurate. AI will only be as good as the information fed into it (garbage in, garbage out), so provided the AI follows the guidelines such as those in the webinar and other sources it will potentially be of value in terms of speeding up the process of tasks that can be automated. The risk is that modellers treat this as a black box (this is happening already!) so there will always be a need to quality control the modelling through checks and reviews.
18	how about when there are no recorded flood levels in the study area? what other methods could be used to know your results are right?	The best thing to do in this case is to build your model using industry standard values. Do sensitivity testing of model inputs to identify if the results change dramatically due to the choices you have made (eg. cell sizes, inflows, boundary influences - Pavlina will show some examples of these). After building your model, any opportunity to conduct community consultation is usually well worthwhile as the locals will have a "feel" whether your model is demonstrating the flood behaviours they've observed.

Q&A [Flood Modelling 101]		
	Question	**Answer**
19	How different is Tuflow compared to Delft3D or Sobek? Is there cases in which one shines over the others? recommendations???	The Australian Rainfall and Runoff document has a good section in Book 6 on flood hydraulics: http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/ This discusses difference in solution scheme such as finite difference, finite volume, finite element, and implicit versus explicit. We don't comment on other software, but ultimately testing and benchmarking of the solvers using tests and good calibration data such as those presented in the webinar is the key to making good comparisons. Speed and workflow efficiency also needs to be considered along with helpful software support, which is very important for many users.
20	how you estimate Bend losses?	There are some values in the literature but these are usually from flume tests which aren't always representative of the real world. The Brisbane River Study is the best source based on the exhaustive calibration and presence of multiple bends. Slide 23 in the webinar shows the typical values of from the study being: 180 degree bends: 1D = 1.5 and 2D = 0.3 90 degree bends: 1D = 0.75 and 2D = 0.15 The Brisbane River Flood Study reports can be downloaded from: https://www.publications.qld.gov.au/dataset/Brisbane-river-catchment-flood-study I don't have handy where the bend losses are documented but the 1D ones should be in: https://www.publications.qld.gov.au/dataset/Brisbane-river-catchment-flood-study/resource/cc48f70a-13ef-473b-87af-165e27d33587 and the 2D ones in: https://www.publications.qld.gov.au/dataset/Brisbane-river-catchment-flood-study/resource/16440193-2c27-45c6-850a-2ce1b1a30dd5
21	what is some advantage of TUFLOW to use instead of HECRAS for example	We are biased (of course :)) but feedback from users is that TUFLOW seems preferred for numerous reasons including: higher accuracy, better cell size convergence performance, integration with GIS, high workflow efficiency, simulation speeds that are orders of magnitude of faster, ability to model much much larger areas (models with over 10,000,000 2D cells is no problem), can model 1D underground stormwater networks. The other key differentiator seems to be our emphasis on providing high-quality user support, often by the developers of the software, which is not an option for HECRAS.
22	how do you add bend losses in 2D in TUFLOW?	These losses can be applied via the form loss attribute for 1D channels (1d_nwk layer) and using the 2D Form Loss Coefficient (2d_flc) layer in TUFLOW. Specialist layers for bridges and other obstructions such as the layered flow constriction feature (2d_lflc or new 2d_bridge layers) also have the ability to have FLC values to be entered.

Q&A [Flood Modelling 101]		
	Question	**Answer**
23	How do you factor 1D losses in a 2D model? is there a specific TUFLOW tool that allows you to add K values to certain cells?	Yes, the 2D command in TUFLOW is "Read GIS FLC/L ==". It is applied as a polygon for the area of influence. The command goes in the TGC file. If you're modelling in 1D, the 1d_nwk file includes a form loss attribute.
24	how n=0.022+ bend losses, if in the Brisbane River study, use n=0.038, bend loss 2D 180deg=0.3, is that means manning n=0.022+0.3=0.322?	No, the Manning's n is applied to model the bed friction. The bend loss is applied separately and the losses is applied as a multiplier on the velocity head (i.e. v2/2g).
25	How to know whether you're over-fitting the model??? Is there a sweet spot, ratio or a threshold you recommend, or it all falls back on the modeller personal experience?	You know you're over-fitting the model when your improvement of fit stops getting demonstrably better. For benchmarking against measurements of similar uncertainty (eg. flume test measurements) statistical regression measures are useful to monitor/document fit, but for the real-world there is a huge variation amongst the recorded data in terms of accuracy. Therefore, real-world calibrations, in our view, still require considerable judgment by the modellers as to whether the calibration is acceptable or not. To help with this process, in consulting we often categorise flood marks based on their quality to help prioritise the focus of the calibration to the more accurate flood marks. For example, a flood mark based on a high water mark on a wall would be a high quality flood mark, but debris stuck on a small tree that bends over during the flood would be a low quality flood mark as it may not be representative of the flood peak (in this case the modeller should be aiming for the modelled level to be at or above the debris level rather than match the debris level). The first half of our Flood Model Calibration webinar discusses this: https://www.tuflow.com/library/webinars/#202104_cal

Q&A [Flood Modelling 101]		
	Question	**Answer**
26	Any satellite image/DEM (even with 1m resolution) is not accurate for engineering projects, but strangely, I find it modellers applying these images/DEMS taking them as granted and refereeing TO DOZENS OF sources and displaying fancy results. When we talk about accuracy, how could an actual ground survey would replace a satellite image, especially when you're proposing a hydraulic structure (by considering the structure in the model itself). So, my worry is about the pre-processing of data, which many modellers are ignorant about. So, 2D is no doubt a requirement for ONTO (spilled out from channel/river) flow but it would be interesting to know if actually the calibration is done for the overland adverse flows or flow levels. Please share your experiences.	Probably not enough time/space to share our experiences but for flood modelling the best use of topographic data is the combination of DEM data (usually LIDAR) and ground survey of the crest of hydraulic controls (eg. the crest - highest points - along a road embankment or levee) and detailed surveys or design drawings of structures such as bridges. Sometimes the LIDAR can also be used for extracting the crest, especially for areas in your model away from your area of interest. For the crest of natural levees along the river banks, which are key for accurately modelling the overtopping and return of floodwaters, these may need to be ground surveyed especially where vegetation impacts the accuracy of the LIDAR. An example of this is demonstrated in our Flood Model Calibration webinar: https://www.tuflow.com/library/webinars/#202104_cal One of the advantages of TUFLOW is these different topographic data sets can be fed into the model as separate GIS layers rather than having to modify the DEM. This way it's very easy to add, raise, remove a road embankment for example. an example of this workflow is presented in our Flood Model Quality Control webinar: https://www.tuflow.com/library/webinars/#oct2022_quality_control
27	for a slightly harder question; modelling seems to involve cross cutting concerns in terms of calibration, wherein the human is trained to produce a model to fit certain results; I'm a software engineer looking over your shoulders here and I'm investigating inverting this training and doing it via machine learning; it would be great to hear a few sentences on using things like decision trees and other ml techniques to automate this calibration step	I think we need to workshop this one so that we can explain the challenges/nuances of flood model calibrations (they are all so different!) and you can educate us on how best to integrate this knowledge into machine learning. If you'd like to discuss further, please contact us on support@tuflow.com.
28	Apologies- "how could an actual ground survey would replace a satellite image" shall be read as "how could an actual ground survey would replace a satellite image"	If you call the survey data lower in the TUFLOW TGC file than the satellite data it will take preference. The survey data will be used in this part of the model instead of the satellite data

Q&A [Flood Modelling 101]		
	Question	**Answer**
29	Does the use of hydrologic modelling software such as RORB and flood frequency analysis help with hydraulic modelling calibration and testing model sensitivity?	Yes! The runoff from a catchment into a flood model is often one of the areas of greatest uncertainty (catchment runoff is a complex process!). This is best carried out using hydrologic models such as RORB with direct rainfall directly onto the 2D model (SGS essential for this!) increasingly demonstrating good results (but with much longer run times of course). Any calibration of the catchment runoff at stream gauges will further reduce the uncertainty. Flood frequency analyses can also certainly help as a cross-check on the hydrologic modelling and sometimes the hydraulic (flood) modelling provided hysteresis is accounted for (it will occur in the flood model but is usually not shown on rating curves). For example, some recent changes to ARR rainfall in SE QLD has occurred because the design rainfall depths did not align with design flows calculated using flood frequency analysis. All the tools help collectively improve an assessment's accuracy.
30	Will there be an addon for ArcGIS 3.x?	There is one which is available via https://downloads.tuflow.com/ArcGISPro/TUFLOW_addin.0.2.2.zip
31	If I have LiDAR, what resolution would you recommend using	Not sure if you are referring to DEM resolution or hydraulic model resolution? For hydraulic model resolution, there is always a trade of between higher accuracy and slower runtimes. Checking cell size results convergence is highly recommended to optimise your 2D model's cell size. Please watch our 2D cell size webinar - https://www.tuflow.com/library/webinars/#nov2020_2d_cell_size)

Q&A [Flood Modelling 101]		
	Question	**Answer**
32	What is the main difference between 1st order model and 2nd order model?	Bill discusses it briefly in this past webinar: https://www.tuflow.com/library/webinars/#jul2019_how_wrong Essentially it's like comparing a linear fit (1st order) through 3 points with a quadratic fit (2nd order). The quadratic fit will have a much lower numerical error of fit. This Wikipedia page gives a nice description: https://en.wikipedia.org/wiki/Order_of_approximation. In hydraulics, when computing variables at cell faces, a 2nd order solution uses interpolation where possible which is more accurate. The first order solution typically applies the cell value from the upstream cell as the face value, which is very stable but has a small error that increases energy losses and causes numerical errors. The advantages of 1st order are it's simpler to code up and slightly faster to compute, especially if the physical terms like turbulence and inertia are omitted. However, this all comes at the cost of accuracy in the hydraulic solution which can be significant in the case of fast flowing, complex hydraulic systems such as for the Brisbane River benchmark model shown in the webinar or around hydraulic structures. Cell size results convergence is also usually poor for these situations if using 1st order. A good test is to run the model using 1st order and 2nd order and compare the differences. If differences are acceptably small then it's fine to run 1st order. We find that for many flood models 2nd order is needed due to the fast flowing hydraulics, but for coastal models 1st order is often OK due to the more benign hydraulics of coastal tidal flows.
33	Hi, As a Council/review Authority, what parameters should we ask the consultant to submit (when we don't have facilities to check the model)?	We recommend asking for the complete modelling dataset. This includes all model input and output file. Although Council do not have facility to check the model, they may be a need to do work using the flood model in the future. Having an archive of the model files will allow council or council's consultant to build on the prior modelling work rather than starting from scratch. The added benefit of this approach is that consistent assessment methodologies will be applied to for the multiple assessments in the same jurisdiction.
34	could you please explain more about QA , road embankments must be enforced?	Please watch both of these webinars (Quality control and Calibration). They discuss it: https://www.tuflow.com/library/webinars/#oct2022_quality_control https://www.tuflow.com/library/webinars/#202104_cal Also see Q26.
35	how do we check water levels for 1% AEP-PMF with freeboard?	Compare your hydraulic flood model result against flood frequency analysis results if possible. Remember, neither will be right so it's a check - don't take the FF analysis as being 100% correct - it's just a statistical fit/extrapolation.
36	Sorry, 1st order model and 2nd order model difference.	Please see Q32

Q&A [Flood Modelling 101]		
	Question	**Answer**
37	I have found flood depth different from 1D and 2D simulation in same river from observe water level. 1D is very closed which is only 0.5 m different with observed water level but 2D is 4 m different from observed water level, Please suggest how we can calibrate the 2D model to be reliable which parameters I have to set good accordingly. Thank you	Check whether your 2D software is suitable and double check the models' inputs. If you're using TUFLOW, please email support@tuflow.com with details of your model and we'll help you out (you should not get this difference if using TUFLOW provided the model inputs are all consistent). If you're not using TUFLOW we'd be still happy to see if we can help you out as this shouldn't be the case if the models are well set up. This model calibration webinar recording may also be of use: https://www.tuflow.com/library/webinars/#202104_cal
38	can you have one grid size over the channel, and a different cell size over the plain in TUFLOW?	Yes, you can vary cell size using Quadtree grids.
39	Would you please explain 1st order and 2nd order solutions?	Please see Q32
40	Is 2m resolution fair enough?	The resolution of the modelling will depend on the purpose of the modelling as well as the available input data. For example, for flood forecasting a 2m cell size over a large catchment may provide runtimes that are too long for the intended purpose and a spatial accuracy that's an overkill. If 5m DEM is the highest resolution available, then modelling at 2m is probably not warranted. As Pavlina discussed, cell size convergence testing is highly recommended to understand the predicted flood behaviour as cell size changes and to optimise your 2D cell size. Please also watch our 2D Cell Size webinar - https://www.tuflow.com/library/webinars/#nov2020_2d_cell_size)
41	Pardon my ignorance, but what is Quadtree?	Quadtree will let you refine your cell size by a factor of four down 9 levels. See "The power of Quadtree" on this page of the website: https://www.tuflow.com/products/TUFLOW/ Here is a video describing it: https://www.tuflow.com/library/videos/#howtoquadtree Our Next Generation 2D Hydraulic Modelling webinar would also be worthwhile watching: www.tuflow.com/library/webinars/#quadtree
42	triangular mesh vs quadrilateral mesh, which one is better for 2D model?	For flexible meshes, the best approach is to use quadrilaterals in primary waterways with the elements aligned to the direction of flow. For fixed grid models, especially if using SGS (sub-grid sampling), there is no need to align the grid in any particular orientation. For further discussion on this see these webinars: www.tuflow.com/library/webinars/#sep2020_future www.tuflow.com/library/webinars/#maximise_accuracy

Q&A [Flood Modelling 101]		
	Question	**Answer**
43	is quadtree same as refinement region/breaklines in hec-ras?	It is different. Quadtree will let you refine your cell size by a factor of four down 9 levels. See "The power of Quadtree" on this page of the website: https://www.tuflow.com/products/TUFLOW/ Here is a video describing it: https://www.tuflow.com/library/videos/#howtoquadtree Our Next Generation 2D Hydraulic Modelling webinar would also be worthwhile watching: www.tuflow.com/library/webinars/#quadtree
44	how is bathymetry usually obtained? boat with side scanners?	Yes, this is becoming more prevalent. Previously cross-sections surveyed at regular intervals was quite common.
45	hey maybe I missed this but I get why it makes sense for the boundary to not be smaller than the stream but how is it that it's fine to be bigger? Is it still just being put into the stream and not being spread evenly over the entire length?	TUFLOW has built in calculations to estimate the appropriate instantaneous water depth and velocity distribution along the flow boundary line based on the instantaneous flow value, topography cross-section at the flow boundary line and the topography slope. This is a more rigorous approach than simply distributing the flow evenly along the flow boundary line.
46	Please explain a bit more about downstream boundary condition	TUFLOW supports a range of downstream boundary options covering the variety needed to replicate physical flow behaviour. Probably the two most commonly used downstream boundaries are HT (water levels vs time) and HQ (water level vs flow)
47	Is not n = 0.022 high for a river?	The 0.022 value was used for the lower sections of the Brisbane river, which is a large tidal river with a fine grain sand bed. This value is in agreement with industry standard values. Here are a few guideline documents supporting the value: - https://www.oregon.gov/ODOT/GeoEnvironmental/Docs_Hydraulics_Manual/Hydraulics-08-A.pdf - https://downloads.tuflow.com/_archive/Australian_Rainfall_Runoff_Project15_TwoDimensional_Modelling_DraftReport.pdf

Q&A [Flood Modelling 101]		
	Question	**Answer**
48	Why should we use TUFLOW over MIKE 11?	Whether you use MIKE or TUFLOW is your choice. TUFLOW's 1D solver (ESTRY) solves the full one-dimensional (1D) free-surface St Venant flow equations using a Runge-Kutta explicit solver. TUFLOW 1D has seen continuous development since 1972. The network schematisation technique used by TUFLOW 1D allows realistic simulation of a wide variety of 1D and quasi-2D situations including: complex river geometries; associated floodplains and estuaries; and urban channel and pipe network systems. There is a considerable amount of flexibility in the way network elements can be interconnected, allowing the representation of a river and floodplain by many parallel channels with different resistance characteristics and the simulation of braided streams and rivers with complex branching. This flexibility also allows a variable resolution within the network so that areas of particular interest can be modelled in fine detail, with a coarser network representation being used elsewhere. In addition to the traditional open channel flow situations, a wide range of additional 1D channel types are available including: - Circular, rectangular (box) and irregular culverts; - Pit or manhole inlets; - Bridges; - Weir channels (including V-notch, ogee, crump broad crested and user defined); - Spillway, radial and sluice gates; - Pumps; and - User defined structures. All channel types can be specified as uni-directional, which allows flow
49	how many people watched this and how many countries? I want to tell my colleagues.	1,400 people registered from 80 countries :)