ARUP

Technical Note

Project title	RFD 2022 Major Flood Model Update Byron Creek (BYR) Catchment
Job number	305456-00
File reference	Peer Review Technical Note
cc	Alana Mosely
Prepared by	Greg Rogencamp, Kok Keng Tan
Date	3 February 2025
Subject	Independent Technical Review – Technical Note

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1. Introduction

City of Moreton Bay (CMB) is currently undertaking a major flood model update of the Byron Creek (BYR) Catchment and has commissioned Arup to undertake an independent technical review of the hydrologic and hydraulic models in line with CMB project brief requirements.

This technical note documents the methodology and findings associated with the review.

2. Supplied Data

This technical review has been undertaken using the following supplied data:

CMB Methodology Reports:

- RFD ARR 2019 Methodology and Pilot Study Report (Arup, 2021)
- Draft HEH Modelling Methodology technical note (BMT, 2022)
- Bridge modelling method technical note (BMT, 2022)

WBNM Model:

- Model file and associated results (ARFa) for existing and future conditions

TUFLOW Model:

- TUFLOW Control file (BYR_R_003a_~s1~_~e1~~e2~_~e3~_03.tcf)
- All associated TUFLOW model input files for design events
- All associated TUFLOW model results and log files for design events
- Check files for selected 1% AEP E00 run

Report

The following documentation was received:

- A work in progress report to assist with the flood model review
- Internal self-check records for base model development dated July 2024

Other

- Memo for IFD sensitivity analysis modelling for Redcliffe catchment (Water Tech, 2023)

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3. Summary and Recommendation

The models and methodology were generally found to be sound and in line with current best industry practices. Of note, the WBNM model for this study is not HEH trained. Whilst there are minor departures from CMB methodology and some engineering judgement exercised, given the scale and locality of the catchment, the final outcome is considered acceptable., given the scale and locality of the catchment, the final outcome is considered acceptable. For details of review elements and comments, refer to the 'Flood Model Verification Record' attached at the end of this technical note.

Reliance Statement

The sole purpose of this technical note the associated services performed by Arup is in accordance with the scope of services set out in the contract between Arup and CMB for the Project. In preparing this technical note, Arup has relied upon, and presumed accurate, information provided by CMB. Except as otherwise stated in this technical note, Arup has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Arup has undertaken this peer review in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures, and practices at the date of issue of this technical note. For the reasons outlined above however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in the technical note, to the extent permitted by law.

This assessment has been prepared on behalf of, and for the exclusive use of, CMB, and is subject to, and issued in accordance with, the provisions of the contract between Arup and CMB. Arup accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this technical note and flood modelling by any third party.

DOCUMENT CHECKING

	Prepared by	Checked by	Approved by
Name	Kok Keng Tan	Greg Rogencamp	Greg Rogencamp
Signature			

Attached: QA review form

ARUP

Subject	Flood Model Verification Record		
Date	15 November 2024	Doc Ref	305456_BYR_CHECK
v123123			

Flood Assessment Model Checklist			
Project Name	RFD 2022 Major Flood Model Update Byron Creek (BYR) Catchment	**Date**	15/11/2024
		Version	2

DESIGNER		
Company / Staff	**CMB**	

REVIEWER		
Company / Staff	**Arup**	Greg Rogencamp, Kok Keng Tan

Notes:

- This checklist is a tool to be used by modellers as a QA mechanism.
- This checklist is a general overview of typical design elements.
- This checklist is to be used for all phases of design. It is to be completed and included at each formal review phase of the project. It is best employed as a living document during the execution of a project.

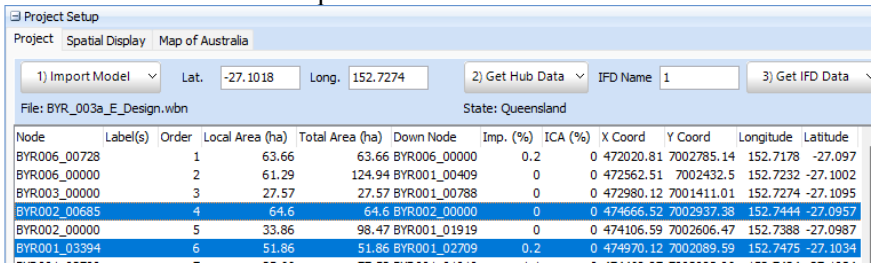
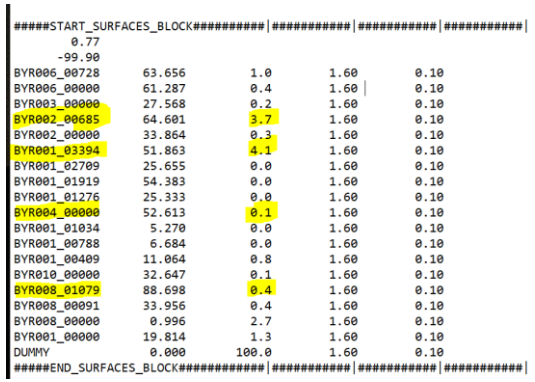
1 Calibration Performance Checklist

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
WBNM and TUFLOW Calibration Performance				
Other comments/issues	Model is uncalibrated.		Commentary. No action.	Closed

2 WBNM Hydrologic Modelling Checklist

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Catchment Definition				
Catchment boundary drawn correctly	Appropriate.		Commentary. No action.	Closed
Sub-catchment boundaries drawn correctly	Minor refinement to sub-catchment delineation could be considered in future revisions to better reflect terrain and maintain consistency in sizes. 15/11/24: Response noted. No action required.	Noted, to be considered in future update	Commentary. No action.	Closed
Network structure is correct	Spot check WBNM indicate appropriate.		Commentary. No action.	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Subareas, reaches and nodes names appropriate	Appropriate.		Commentary. No action.	Closed
Output locations are consistent with project goals	Appropriate.		Commentary. No action.	Closed
Areas have been entered correctly	Appropriate.		Commentary. No action.	Closed
Surface type division is appropriate and correct	Appropriate.		Commentary. No action.	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Impervious fractions have been entered correctly	FI was based on EIA raster. Method appropriate. However, minor inconsistency was observed between FI against aerial imagery. For example, sub-area BYR_01_03394 and BYR_02_00685 which consisted of various buildings and sealed road, appear to have FI of 0.2% and 0% only. On the other hand, the sub-area with the highest FI of 2.9% (BYR_08_01079) consist of gravel road and forested areas; and sub-area BYR_04_00000, consisting only minimal portion of impervious features, has a FI of 2.3%. No changes are required at this time, but it is recommended to review the method for deriving EIA raster in future revisions. **15/11/24:** The source data in design event wbn files align with those in response. The initial comment was made due to the anomaly when solely viewed in SI. No action required. 	Please advise how those FI values were derived; we identify different values within the .wbn file 	Commentary. No action.	Closed
Slope calculations are appropriate and correct	N/A		Commentary. No action.	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Routing calculations are correct	Appropriate.		Commentary. No action.	Closed
Special elements have been entered correctly	No special elements were defined. Several farm dams observed from aerial (i.e. within sub-areas BYR_01_03394, BYR_02_00685) were not represented in WBNM/TUFLOW model. The scale of these features relative to the catchment is insignificant. Hence, deemed to have limited influence to the overall outcome. Hence, this approach is deemed acceptable. Appropriate. 15/11/24: Response noted. No action required.	Farm dams are upstream of the hydraulic model input. Future model updates to consider inclusion of dams within hydrologic model, or re-delineation of the sub-catchments with respect to farm dam locations.	Commentary. No action.	Closed
Rainfall				
IFD method and parameters are correct	Appropriate.		Commentary. No action.	Closed
Pre-Burst Application	Appropriate		Commentary. No action.	Closed
Duration and intensities are correct	Appropriate.		Commentary. No action.	Closed
Temporal patterns and zones are correct	Selection of temporal patterns and zones are appropriate. Embedded burst used for existing and future conditions runs. 15/11/24: Response noted. No action required.	Embedded burst filtering used for existing/future runs.	Commentary. No action.	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
ARF applied correctly	ARFa adopted. Appropriate.		Commentary. No action.	Closed
Allowance for Climate Change incorporated as per brief	Appropriate		Commentary. No action.	Closed
Extreme event modelling methodology is in line with ARR19	Appropriate		Commentary. No action.	Closed
Losses and coefficients				
Loss method and values is appropriate	Appropriate		Commentary. No action.	Closed
Simulation				
Run time step and duration are appropriate	Appropriate		Commentary. No action.	Closed
Hydraulic Equivalence Performance				
Model Performance	N/A: Critical event is determined in TUFLOW. WBNM model is not HEH trained.		Commentary. No action.	Closed

3 TUFLOW Hydraulic Modelling checklist

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
General setup				
Any changes to model version since calibration review?	N/A. Model is uncalibrated. 15/11/24: Response noted.	Uncalibrated model, but utilising roughness parameters adopted from 'regional calibration' process i.e. in line with other basins within the local government area for which calibration and validation completed	Commentary. No action.	Closed
Model simulation run to completion?	Yes.		Commentary. No action.	Closed
Are event (~e~) and or scenario (~s~) logic commands used? If yes, are the options listed in the handover document?	Yes.		Commentary. No action.	Closed
Terrain Representation (2D Domain)				
Is the cell (grid) size appropriate for the intended purpose of the modelling?	Generally appropriate. Of note, within the area of interest (CMB LGA), the 5m grid resolution coupled with use of terrain modifiers would result in slight misalignment in cross-sectional view when plotting flood levels against directly against source LiDAR, particularly in narrow watercourses / area which have been lowered by topography modifiers. However, this is not visually detectable in plan view.		Commentary. No action.	Closed
Is the cell size smaller than water depth in main	Wu sub-grid turbulence scheme used. Appropriate.		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
channel/flow path of the subject study? If yes, Wu sub-grid turbulence scheme (i.e. 2020 TUFLOW HPC or newer) must be used.				
Is the model grid orientation appropriate?	Cell orientation is setup orthogonal to east/west. Not ideal for this catchment but consistent with regionwide RFD modelling approach. Appropriate.		Commentary. No action.	Closed
Is sub-grid sampling (SGS) used as the topography sampling method	N/A. SGS not used.		Commentary. No action.	Closed
Are topography modifiers appropriately applied?	Topography modifiers applied for watercourses as 'gully' with a 5m width. Majority of watercourses are wider than 5m. The crossings along Pegs Road also have been smoothed out by 'gully' lines. Approach appropriate. 15/11/24: Response noted. No action required.	Some topography modifiers to be improved in future update, to further correct errors in input LiDAR. Noting this road is outside Council's Local Government Area and modelling approach unlikely to affect area of interest.	Commentary. No action.	Closed
Other Issues/Comments	'Bumps' were noted along the watercourses due to the use of the 2019 LiDAR as source data. Despite the use of topography modifiers which resolved some areas, the issue still prevailed along most watercourses. A comparison with aerial imagery suggests that these bumps are unlikely to be real. It is recommended to verify these features against newer LiDAR and consider correcting them with thicker streamlines in future revisions if issue prevails.	Owing to catchment slope, the 'bumps' are likely to cause predominately localised erroneous model results. The majority of watercourses affected by the erroneous input terrain are outside Council's Local Government Area. Where exists within Council's LGA, a 'limited reliability' note is to be added to the model result. A future model update is to further improve the	Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	15/11/24: Response noted. No action required.	topography modifiers to further resolve the issue, as required.		
Roughness				
Are the manning's values appropriate?	Manning's n values consistent with region wide RFD studies. Deemed appropriate. However, minor observations noted as follow: • Pegs Road is an unsealed dirt road which ideally be defined with a higher Manning's n (Currently 0.015). Although, this change would have no material effect on the overall results. • The modelled watercourses are defined with Manning's n value of 0.03 over a cell width. With flood flows primarily contained within this land use type, its parametrisation is important. It is difficult to determine if this value accurately represents the ground conditions (i.e. whether if it is indeed waterbody, or dry creek bed). No changes are required but it is recommended to review in future model revisions. 15/11/24: Response noted. No action required.	Noting Pegs Road is outside of Moreton Bay Local Government Area and the roughness value very unlikely to have an impact on model results in area of interest. Adopting different values for gravel/dirt roads to be considered in next flood model update. Ground-truthing of waterway condition to be undertaken to inform waterway roughness value for next flood model update.	Commentary. No action.	Closed
Is / are the Materials Layer(s) delineation reasonable relative to the model cell size?	Overall, approach is consistent with other RFD studies, this is considered appropriate. However, minor observations noted as follow: • Definition of 'waterbody' could be improved against site observations. • Delineation of Pegs Road (unsealed dirt road) could be improved against the grid resolution, as it currently is reflected with alternating cells between 'bitumen'	Noted, per above.	Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	and 'vegetation' type. Although, this change would have no material effect on the overall results. No changes are required but it is recommended to review in future model revisions. 15/11/24: Response noted. No action required.			
If multiple material input layers are used, is data layering of the Materials Layer(s) correct (i.e. The order of the files with the TUFLOW Geometry Control File)? Note, bottom most layer takes precedence where datasets overlap.	Appropriate		Commentary. No action.	Closed
1d Hydraulic Structures				
Are the pipe/channel alignments correct?	N/A		Commentary. No action.	Closed
Are pipes connected throughout system (any snapping issues)?	N/A		Commentary. No action.	Closed
Is network free of grade or cover issues?	N/A		Commentary. No action.	Closed
Do drainage network asset sizes logical (i.e. increase as move down system)?	N/A		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are pipe lengths defined properly?	N/A		Commentary. No action.	Closed
Are pipe manning's n appropriate? Is the manhole loss approach appropriate?	N/A		Commentary. No action.	Closed
Is the pipe geometry orientation appropriate for Engelund losses?	N/A		Commentary. No action.	Closed
Are additional form loss pipe losses set correctly where required?	N/A		Commentary. No action.	Closed
Are contraction coefficients appropriate?	N/A		Commentary. No action.	Closed
Is pit modelling approach appropriate?	N/A		Commentary. No action.	Closed
Are pit loses set appropriately?	N/A		Commentary. No action.	Closed
Is the model 1D network free from Additional Nodal Area (ANA) values, of if	N/A		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
these have been used are the values appropriate?				
Are entry/exit losses set or are they automatically defined for pipes that have SX outlets?	N/A		Commentary. No action.	Closed
2d Hydraulic Structures				
Are there any culverts represented as 2D bridges? 2D bridges should not be used for Culvert representation unless the culvert size is greater than the cell size.	N/A		Commentary. No action.	Closed
Is the approach used to define the additional hydraulic losses associated with bridges appropriate? What bridge form loss calculation method has been used (Method A (cumulative), Method B(Portion), Method C, Method D). Note, Method C and D are only available from release version 2020-10-AA or newer.	N/A		Commentary. No action.	Closed

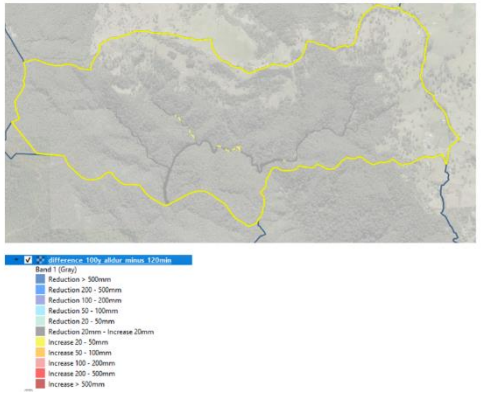
Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Provide spreadsheets outlining how form loss values are derived with reference to publications including page, chapter, section table etc.	N/A		Commentary. No action.	Closed
Other hydraulic structures	N/A		Commentary. No action.	Closed
Boundary Conditions				
Are tailwater level(s) or slope parameters associated with HQ downstream boundaries correct? Note, the 2020-10-AA version of HPC and newer uses a consistent approach with Classic for HQ boundaries.	HQ boundaries defined with 'd' parameter which appears to be redundant and not used. Recommended to remove in future. Draw down noted at tailwater boundary (outside CMB LGA) but does not affect results within area of interest. Overall appropriate.	Boundary file to be edited to remove 'd' parameter for clarity. HQ slope to be amended in future RFD update.	Commentary. No action.	Closed
Are the model upstream and downstream boundaries a sufficient distance away from the study area?	Appropriate.		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are model inflows correct?	No issues found.		Commentary. No action.	Closed
Is the flow distribution acceptable?	No issues found.		Commentary. No action.	Closed
Are the 1D-2D linkages defined correctly?	N/A		Commentary. No action.	Closed
Are there terrain adjustments at 1D-2D linkages? If yes, are they appropriate?	N/A		Commentary. No action.	Closed
Are IWL conditions applied correctly?	No issues found.		Commentary. No action.	Closed
TUFLOW Run Files				
Is the 2D dtStar value reported in the *<<simulation>>.hpc.dt.csv* file greater than recommended minimum relative to the grid cell size for TUFLOW HPC simulations based on the dominant control number (courant, celerity or diffusion number)?	Spot check conducted. Generally acceptable.		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are TUFLOW default parameters used? If non-default values are used, list them and justify their use?	No issues found.		Commentary. No action.	Closed
Log File				
If HPC, are there no repeat timestep, if there are, are they acceptable?	HPC HCN repeated timesteps common however generally acceptable.		Commentary. No action.	Closed
Are there no Negative Depth Warnings, if there are, are they acceptable?	A number of runs displayed one or two warning messages for unstable timestep correction. However generally acceptable.		Commentary. No action.	Closed
Messages Layer				
Are there no ERRORs in the messages layer?	None identified.		Commentary. No action.	Closed
CHECK 2118 and WARNING 2118: Are ZC values lowered by a reasonable amount and do the lowered cells match the neighbouring terrain?	N/A		Commentary. No action.	Closed
WARNING 1100: Are the invert mismatches acceptable?	N/A		Commentary. No action.	Closed
CHECK 1401 and CHECK 1402: Are these failures in automatic manholes creation ok?	N/A		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
CHECK 1111: Are these overwrites mistakes or by design?	N/A		Commentary. No action.	Closed
Are the other Checks and Warnings in the messages layer acceptable?	This is coded in tcf file "SX ZC Check == OFF". Suggest removing it. 15/11/24: Response noted. Comment closed.	Recommendation accepted, will be updated for final model.	Low	Closed
Results				
Is *Map Output Data Types == dt* specified for review of the location that defines the minimum timestep for the simulation?	No issues identified.		Commentary. No action.	Closed
Are there any topographic or boundary condition input definition errors which correlate to the location of minimum timestep?	No issues identified.		Commentary. No action.	Closed
Check results stability at Culvert SX inlet/outlet; where instability existing consider using SX polygon with A Factor set to 5.	N/A		Commentary. No action.	Closed
Are there PO lines at all key locations?	Generally appropriate.		Commentary. No action.	Closed
Are pipes flowing full where expected (refer to _CCA.mif)?	N/A		Commentary. No action.	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are maximum water surface levels (h) realistic?	No issues identified.		Commentary. No action.	Closed
Are maximum velocities (v) realistic?	Spot check for 1% AEP revealed very high velocities (more than 10m/s) along a steep section. Generally appropriate.		Commentary. No action.	Closed
Are flows in pipes and channels realistic?	N/A		Commentary. No action.	Closed
Is the model extent sufficient, such that the area of inundation does not abut against the model extent code boundary for the largest modelled flood event?	No issues identified.		Commentary. No action.	Closed
Do flood extents for the range of modelled event magnitude follow a logical order of progression (1% > 2% > 5% AEP etc.)	No issues identified.		Commentary. No action.	Closed
Critical Duration Distribution is realistic?	A review of the supplied processed grid was conducted. Overall, it appears realistic, as the critical duration decreases with larger storm events. Compared to the previous study however, the critical durations have generally increased. In particular, the 1% AEP distribution seems slightly out of place, as in the most upstream watercourses, slightly longer durations are noted as critical (3 and 4.5 hours). Please review. 15/11/24: Response noted. Comment closed.	The increase in critical durations from 002 results is likely caused by the change in IFDs and TPs due to ARR19 and LIMB. Regarding the longer durations being critical; a difference raster between maxmax 1% AEP peak water level and the 120min median peak water level was calculated per below. It shows that the difference is limited to 20mm for >90% of the inundated area. Therefore, the 1%	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		AEP peak water level is effectively 120min critical for the entire inundation area. 		
Other Issues/Comments	The updated flood study produced design flood levels significantly lower than the previous study, with a difference of 0.7m when comparing the 1% AEP flood levels. As noted in the report, this reduction is attributed to both changes in Manning's n values and a decrease in peak flow. Comparison between a 60 minute 002c event against a 120 minute 003a event indicate that the updated flows are 31% lower in 1% AEP. How does the IFD and flows compare across a common duration? 15/11/24: Response noted. Comment closed.	A comparison between LIMB and 1987 IFDs was completed for 8 locations in BYR catchment. All locations showed the same trend, that for durations less than 2 or 3 hours, the LIMB IFDs are lower than the '87 IFDs, per example below.	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		2020 Less 1987 **Button 1** As Percent of '87 values: *Positive means 2020 higher*		

Duration	Duration in min	1 Yr 1EY	2 Yr 0.5EY	5 Yr 0.2EY	10 Yr 10%	20 Yr 5%	50 Yr 2%	100 Yr 1%
5 min	5	9%	-2%	-9%	-12%	-18%	-24%	-28%
10 min	10	12%	3%	-5%	-9%	-16%	-24%	-30%
15 min	15	11%	3%	-4%	-8%	-15%	-23%	-29%
20 min	20	9%	2%	-4%	-7%	-14%	-22%	-28%
25 min	25	7%	1%	-4%	-7%	-13%	-20%	-26%
30 min	30	6%	0%	-5%	-7%	-12%	-19%	-24%
45 min	45	2%	-3%	-6%	-6%	-10%	-15%	-19%
1 hour	60	-1%	-4%	-6%	-6%	-9%	-12%	-15%
1.5 hour	90	-3%	-6%	-6%	-5%	-6%	-8%	-9%
2 hour	120	-5%	-7%	-6%	-4%	-4%	-4%	-4%
3 hour	180	-6%	-7%	-6%	-3%	-1%	0%	2%
4.5 hour	270	-6%	-6%	-4%	-1%	1%	4%	7%
6 hour	360	-6%	-5%	-3%	1%	3%	7%	9%
9 hour	540	-5%	-3%	-1%	3%	5%	9%	11%
12 hour	720	-5%	-2%	0%	4%	6%	9%	12%
18 hour	1080	-4%	-1%	1%	5%	7%	9%	11%
24 hour	1440	-3%	0%	2%	5%	6%	8%	10%
30 hour	1800	-3%	1%	2%	5%	6%	7%	8%
36 hour	2160	-3%	1%	2%	5%	6%	7%	7%
48 hour	2880	-3%	1%	2%	4%	5%	5%	6%
72 hour	4320	-1%	3%	2%	4%	4%	4%	4%

Structure Blockage				
Structure Blockage Calculation and Application	N/A		Commentary. No action.	Closed