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Technical Memorandum

From:	BMT	To:	QRA, File
Date:	05 February 2020	CC:	
Subject:	BRCFS Model Amendment Pack (803.tcf)		

1 Overview

This technical memorandum details an amended release of the Brisbane River Catchment Flood Study (BRCFS) TUFLOW Detailed Model. The amended release (version 803) includes amendments considered technically minor to the original TUFLOW Detailed Model (version 605) and was prompted by a query from Brisbane City Council (BCC) regarding the representation of backflow into the Milton area of Brisbane. In this area a modelled pipe was of insufficient size to allow for water levels in Milton to fill to the same approximate water level as that in the Brisbane River.

In implementing a model amendment for Milton, BMT has also taken the opportunity to incorporate other model improvements based on user feedback as well as knowledge gained from continued use of the model in the Brisbane River Strategic Floodplain Management Plan (BRSFMP). These additional improvements have been included for completeness and provide additional model outputs. They have no notable bearing on the technical model results at a regional scale.

All implemented amendments are of a minor technical nature and result in little to no difference in main river levels from those documented in the BRCFS. For example, in the 1 in 100 AEP, at the 28 reporting locations used in the BRCFS, the maximum absolute change in peak water level was 0.01m and the average change was 0.003m (3mm). Localised differences in peak level within the floodplain are more pronounced where a specific amendment has been made. For example, at Milton where the model amendment incorporated a larger stormwater pipe, an increase in backflow now occurs from the river into a localised basin. As a consequence, the peak level in this basin has increased by up to approximately 0.4m in the 1 in 50 and 1 in 100 AEP events.

The sub-set of 60 Monte Carlo events used by the Detailed Model to simulate the AEP events, remains unchanged. These events were selected from the BRCFS Fast Model which has not been amended. The differences in peak flood level between the original Detailed Model (v605) and the amended Detailed Model (v803) at reporting locations are minimal and well within the differences in peak level generally noted between the Fast Model and the Detailed Model.

A complete set of peak water levels and flows at the 28 reporting locations for the amended Detailed Model are provided in Appendix A along with differences from the original Detailed Model.

Appendix B presents peak flood level difference maps across the model domain which highlight any differences in peak flood level between the two Detailed Model versions for the 1 in 10, 1 in 100 and 1 in 2000 AEP. In all cases, the resulting differences in the flood surfaces are considered minimal except for highly localised areas impacted by a specific amendment.

Appendix C contains a table of locations affected by localised, noteworthy, increases in flood level. These areas are also discussed further in the sections below.

In addition, the 2011 calibration event was simulated in the amended model as a check that the calibration performance had not been adversely affected by the model amendments. The calibration performance for the 2011 event is considered to be an overall minor improvement with flood levels matching closely at calibration points in Milton and Rosalie.

Amended model input files are provided with the model amendment pack in a folder structure that mirrors that of the original model folder structure. This enables the amended files to slot into the original data supply. The amended model version is 803 (was previously 605). All 60 events that comprise the 11 AEPs in the BRCFS have been simulated in the amended model (v803) and a complete set of amended design peak level surfaces for the 11 modelled AEPs is provided. This includes difference grids for each AEP comparing peak water surfaces for the amended model with the original model.

The draft of this memorandum documenting the model amendment has been reviewed and endorsed by the Independent Panel of Experts (IPE). Their responding memorandum is included in Appendix E.

For future use of the model it is recommended that version 803 is adopted over version 605.

The remainder of this memorandum details the specific model amendments and any associated differences in model results.

2 Model Amendments

2.1 Stormwater (backflow) Pipes

To represent inundation due to backwater or backflow, the larger stormwater pipes in the inner Brisbane area were represented in the Detailed Model. Pipe sizes, particularly at the outlets, were generally based on conservative assumptions, especially where data was unavailable, to allow conservatively high backflow into the basin area from the river so that peak water levels in the basin were similar to those in the river at the flood peak. If the basin is still filling from backwater effects at the time of the peak in the river, a lower peak in the basin can still occur, noting that the magnitude of local inflows and river overtopping will also influence basin levels. Furthermore, in the design scenarios, backflow prevention devices were assumed to be open (i.e. in a failed state), which is also a conservative assumption that is intended to provide a worst case or maximum extent scenario for flooding within the basins.

At the locations shown in Figure 2-1, the peak water surface level within a basin that is connected to the river via stormwater drains was found to be lower than that in the adjacent river for some design floods. Where this was occurring, it was apparent that the dimensions of the stormwater pipes connecting the basin to the river were not sufficiently large to allow basin and river peak water levels to equalise.

At these locations, the pipe dimensions have been upsized as part of this model amendment so that basin and river peak water levels equalise. The locations of upsized pipes or additional pipes are shown in Figure 2-1 and tabulated in Table 2-1.

It is important to note that these pipes generally remain of indicative size. In addition, locations are approximate in order to tie in with the 30m model grid. Their function in the model is to allow backwater to enter adjacent floodplain areas separated from the main river by higher ground where stormwater pipes are present, and this mechanism of inundation can potentially occur.

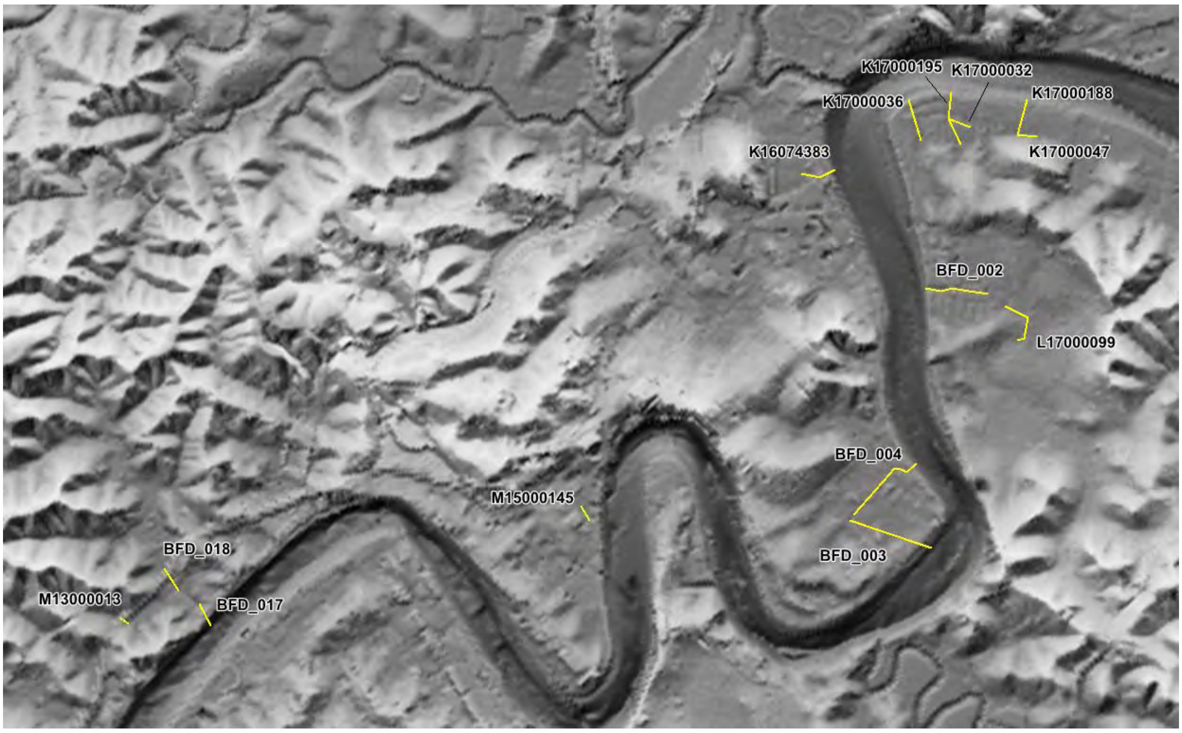


Figure 2-1 Locations of Pipes (and Associated Model IDs) that have been amended

Table 2-1 Amended Backflow Pipes

Pipe ID	Approximate Location	Amendment/Comment
M13000013	Milton	Pipe size increased to allow more backflow
BFD_017	Milton	Pipe size increased to allow more backflow. Pipe length amended
BFD_018	Milton	Pipe size increased to allow more backflow. Pipe length amended
M15000145	CBD	New pipe added to permit further backflow inundation
BFD_003	New Farm	Pipe size increased to allow more backflow
BFD_004	New Farm	Pipe size increased to allow more backflow
K16074383	Newstead	Pipe size increased to allow more backflow
L17000099	Hawthorne	New pipe added to connect to ponded water in flood surface
BFD_002	Hawthorne	Pipe size increased to allow more backflow
K17000036	Bulimba	Pipe size increased to allow more backflow
K17000195	Bulimba	Pipe size increased to allow more backflow. Pipe location amended to tie in with new pipe K17000032
K17000032	Bulimba	New pipe added to permit further backflow inundation
K17000188	Bulimba	Pipe size increased to allow more backflow
K17000047	Bulimba	New pipe added to connect to ponded water in flood surface

2.1.1 Difference in Model Results

The amended pipe sizes permit more riverine water to backflow up the pipe and inundate adjacent floodplain areas to a greater extent. For more frequent modelled events (up to and including a 1 in 20 AEP), there is no material difference in peak flood levels in backwater areas as the river levels are not sufficient to cause inundation. For very rare events (the 1 in 500 AEP or rarer), there is also little to no difference in results from that previously modelled as the riverbanks at these locations are overtopped, permitting water to spill into the backwater areas via overtopping.

The most affected AEPs modelled are therefore the mid-range 1 in 50, 1 in 100 and 1 in 200 AEPs.

Some general commentary on differences in results at the locations in Table 2-1 is provided below for the most affected AEPs. For ease of reporting, these lower areas of the floodplain are referred to as basins. It should be noted that this is not an official term for these areas.

Milton Area

In both the 1 in 50 and 1 in 100 AEPs, the peak levels in the Milton basin increase by up to 0.4m with an associated increase in flood extent. In the 1 in 200 AEP, the embankments are overtopped and the amended pipe dimensions have negligible effect on peak flood levels.

Brisbane CBD

The additional stormwater pipe included in Brisbane CBD makes no difference to results in the 1 in 50 AEP (river levels too low to enter pipe) and 1 in 200 AEP (drowned out). In the 1 in 100 AEP the difference is localised to approximately two 30m grid cells with peak levels increasing by the order of 0.2m.

New Farm

The New Farm area, near New Farm Park shows peak level increases from the 1 in 50 AEP through to the 1 in 500 AEP. The peak level increases are approximately 0.05m in the 1 in 100 AEP. The increases occur across the majority of the inundated areas for each respective event. The flood extents in New Farm are similar to previously modelled which is expected given the minor increases in flood level.

Newstead

In the 1 in 50 AEP, there is additional inundation in the vicinity of Waterfront Park across approximately 30 modelled 30m grid cells. In the 1 in 100 AEP there are localised increases of up to 0.2m. For larger events there is no increase in peak flood levels.

Hawthorne

Towards the north of the suburb of Hawthorne, backwater effects from the Brisbane River enter the suburb via the suburb of Bulimba. Amended pipe sizes in Bulimba have increased backwater inundation affecting (increasing) flood levels in Hawthorne by up to 0.4m in the 1 in 100 AEP event and 0.1m in the 1 in 200 AEP event. The area affected by increases is approximately 8ha. The flood extent increases by approximately 80 grid cells in the 1 in 100 AEP event and there is no noticeable change in flood extent in the 1 in 200 AEP.

Bulimba

No notable inundation to the suburb of Bulimba is predicted for events up to and including the 1 in 50 AEP. In the 1 in 100 AEP event, the suburb is inundated via backflow mechanisms and peak levels increase by up to 0.2m in affected areas due to amended pipe sizes. In the 1 in 200 AEP peak level increases are typically up to 0.1m across the inundated extent with larger increases of around 0.2m noted in the vicinity of Johnston Park.There is no noticeable change in flood extent in the 1 in 100 AEP and a minor increase in flood extent in the 1 in 200 AEP (by around 30 grid cells).

2.2 Peak Level Discontinuities

Following the release of the BRCFS, Brisbane City Council identified 27 locations with apparent discontinuities in peak water level, typically between the river and the adjacent floodplain. The discontinuities were presented on a series of maps and include those due to backflow stormwater pipes (discussed in Section 2.1) as well as other discontinuities which may or may not be due to genuine hydraulic effects. A simplified overview map showing the 27 locations is included in Appendix D. It was requested that BMT review these locations.

The discontinuities not already addressed though stormwater pipe amendments (see Section 2.1) were investigated by further inspection of model grids. If deemed necessary, a modelling 'fix' was applied, typically through the incorporation of a breakline forming a 'gully' to aid flow into an area where the resolution of the modelled terrain was artificially constraining the propagation of backwater. In other instances, the discontinuity was deemed to be a genuine hydraulic effect and no further action was taken. The fixes are incorporated into the breakline file '2d_zsh_D_GULLY_brkline_803.MIF' which supersedes '2d_zsh_D_GULLY_brkline_601.MIF'.

An example of an implemented fix is described below in Section 2.2.1 and locations where a fix has been implemented, resulting in a localised noteworthy change in flood level, are summarised in Section 2.2.2.

2.2.1 Example of Discontinuity Fix

A lower peak flood level was identified across a small area of floodplain near Kholo compared to the peak level in the adjacent river. Upon inspection it was noted that a farm dam was present at this location (see area circled in Figure 2-2) and during the 1 in 100 AEP flood, water was beginning to spill over the dam wall from the river into the impounded dam lake. The water level in the dam did not reach the same peak level as the river level, which started to decrease before the dam was full.

Whilst the hydraulic effect is genuine, it is more meaningful to have a peak flood level that is consistent with that in the river at this location. Therefore, to resolve the issue, a breakline was used to form a gully which 'cuts though' the dam allowing water to enter the reservoir without having to overtop the dam wall. This allows water levels in the dam reservoir to rise and fall with that of the connected river (via a small tributary).

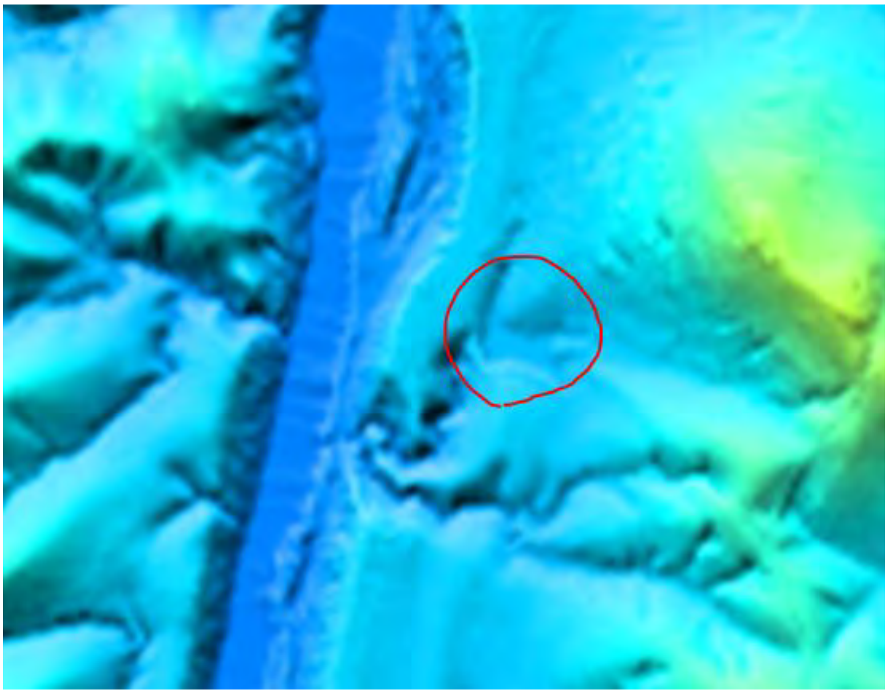


Figure 2-2 Farm Dam shown in DEM Near Kholo

2.2.2 Difference in Model Results

Typically where such a fix has been applied, changes to water levels are localised to the immediate proximity of where the fix was applied. Furthermore, only one or two AEPs are usually affected as the created gully was either located above the peak water level for smaller events, or drowned out in larger events. A summary is provided below of localised areas where the fix resulted in more notable differences in model results. In all cases, the main river levels are not affected by the fix by any distinguishable amount as evidenced by the difference mapping presented in Appendix B.

Goodna CBD

A breakline was included to cut a gully through an underpass thereby allowing flood water to propagate through the underpass shown as blocked (solid) in LiDAR data. This only affects the 1 in 50 AEP flood extent (see Figure 2-3 below) as the embankment is overtopped in larger events.

Figure 2-3 Goodna CBD breakline addition. Magenta area is new flood extent in 1 in 50 AEP

Breakfast Creek

Two minor breaklines have been added to represent minor drains that discharge into Breakfast Creek. The 1 in 100 AEP is the most affected event with increases of up to 0.5m. However, the additional flooding is predominantly contained within the immediate proximity of the breaklines themselves (which represent small channels). See Figure 2-4.

Figure 2-4 Breakfast Creek Drains

Brisbane City Botanic Gardens

A breakline was added within the Brisbane City Botanic Gardens to connect an isolated area of ponding to the flood extent within the CBD, thereby allowing peak flood levels to better equalise between the two areas. The event most affected is the 1 in 100 AEP event (see Figure 2-5) with no changes predicted for larger events.

Figure 2-5 Breakline Added in Brisbane City Botanic Gardens

2.3 Other General Model Improvements

Other minor improvements have been made to the Detailed Model and are briefly described below:

- **Topography patch within Brisbane CBD** to fill the deep foundations for a high rise building that were apparent in the 2014 LiDAR data used to build the model DEM. The depth of the foundations meant that local model inflows (which are applied to the lowest cells) were being applied to this area as well as to the river. This resulted in local inundation in a few model cells in the CBD when no overtopping of riverbanks (or flow through stormwater pipes) was occurring. The issue only affected events more frequent than the 1 in 100 AEP and was resolved by the topography fix.
- **Amendments to Riverwalk structure**. The way the Riverwalk structure was modelled was overcompensating on blockage factors but understating the form losses. These have been rectified but the net result is essentially the same (one effectively cancelled the other out).
- **Amendments to the Riverside Expressway**. This has been amended to be modelled as a TUFLOW layered flow constriction instead of the older type flow constriction. This provides consistency of approach with other structures and improves future compatibility (for example, it is compatible with TUFLOW HPC whereas the older style flow constriction is presently not). The same structure losses and dimensions are applied as previously and there is effectively no change to the model results from this amendment except for the most extreme events (1 in 10,000 AEP and higher) where localised increases in flood level across the structure are apparent.

- **A stability fix for a localised area within the Lockyer Creek catchment**. A localised area away from the creek itself, experienced an instability during a model simulation as part of the BRCSFMP. A stability fix was developed and applied in that study in the form of a localised area of increased model roughness. This fix has also been applied in this model amendment for consistency and to further improve the robustness of the model.
- **Additional Plot Output (PO) locations** are included (every 2km). This will have no effect on results but will aid the end user in extracting boundary conditions if a local model is being developed.
- **Australian Disaster Resilience Handbook 7 hazard output** (type ZAEM1) is now enabled in the model. This will not affect results.

3 Checks on Model Calibration

Appendix B presents peak flood level difference maps for AEPs ranging from the 1 in 10 to the 1 in 2000 AEP for the base case (B15) simulations. The differences are between the amended model (v803) and the original model (v605). In all cases, the amendments made to the model have only local effects and the peak flood levels in the main river are typically either unchanged or show minor differences within a localised reach. This confirms that the model calibration is still valid following these minor amendments.

As a further check, the 2011 calibration event was resimulated in the amended model.

Figure 3-1 and Figure 3-2 present the modelled time series of water levels at Centenary Bridge and the City Gauge respectively for the 2011 event. These were two of the reporting locations used in the BRCFS on the lower Brisbane River. Each plot contains the results from simulating the 2011 event in the version 605 (original) model and version 803 (amended) model. As evident in the plots, the results are practically identical with no discernible change in the magnitude or timing of the flood.

Figure 3-3 presents a histogram of differences at flood marks between modelled and recorded peak flood levels. A similar plot was included in Milestone Report 3 (MR3) of the BRCFS. The mean value is the same as in MR3 and the standard deviation has slightly decreased.

Drawing 3-1 presents a map showing the calibration performance to flood marks in the Brisbane inner city area (region E as mapped in the flood study). This region covers the area in which the majority of amendments have been made, including the upsized pipes into backwater areas.

As shown, at the majority of flood marks the calibration results are within 0.15m of the recorded peak levels. Of note are the calibration flood marks within the Milton basin which fall within the 0.15m tolerance indicating that the upsizing of the pipes in this area has improved the overall outcome in this localised area.

Overall the calibration results for the 2011 calibration event are considered marginally better than those previously presented in the flood study. However, the differences in peak river levels are so minor that the performance of the model is considered to be the same, except for localised backwater areas which have undergone amendments (see above) and which have no bearing on main river levels.

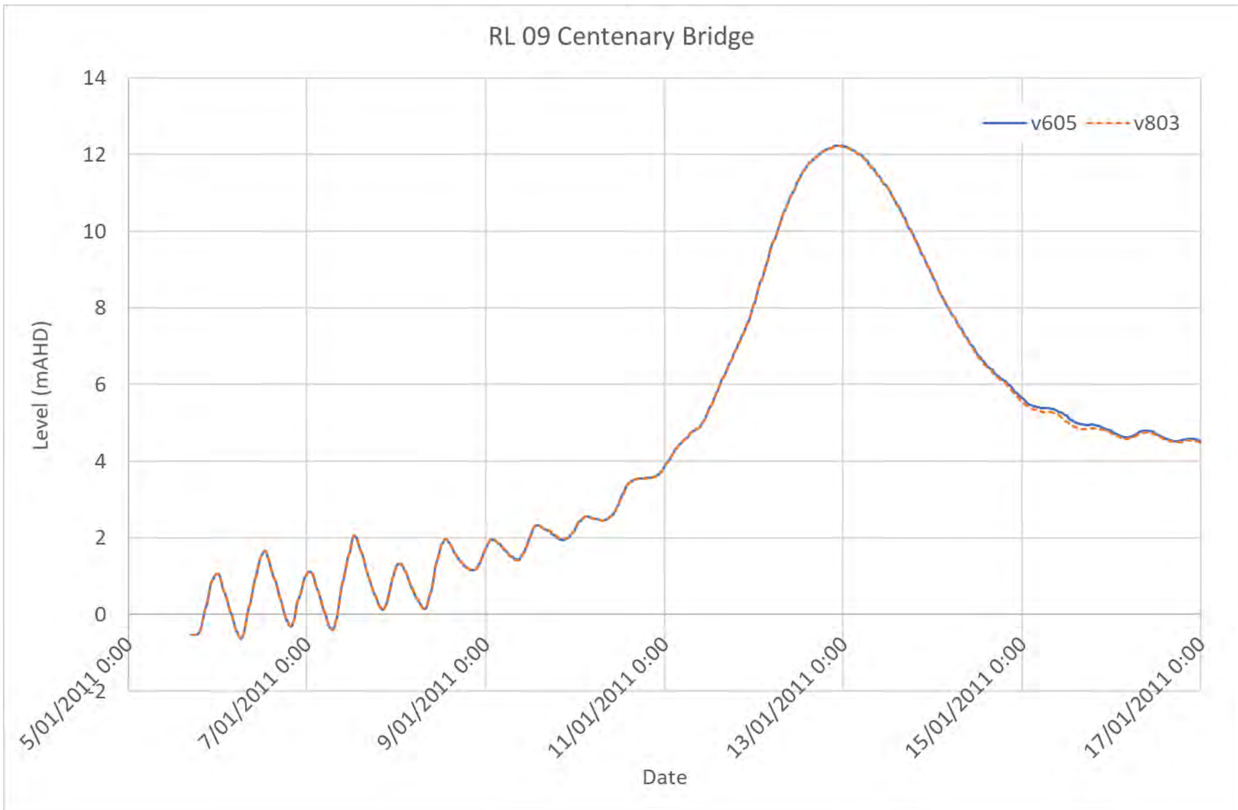


Figure 3-1 Modelled Water Levels at Centenary Bridge for 2011 Event (v605 vs v803)

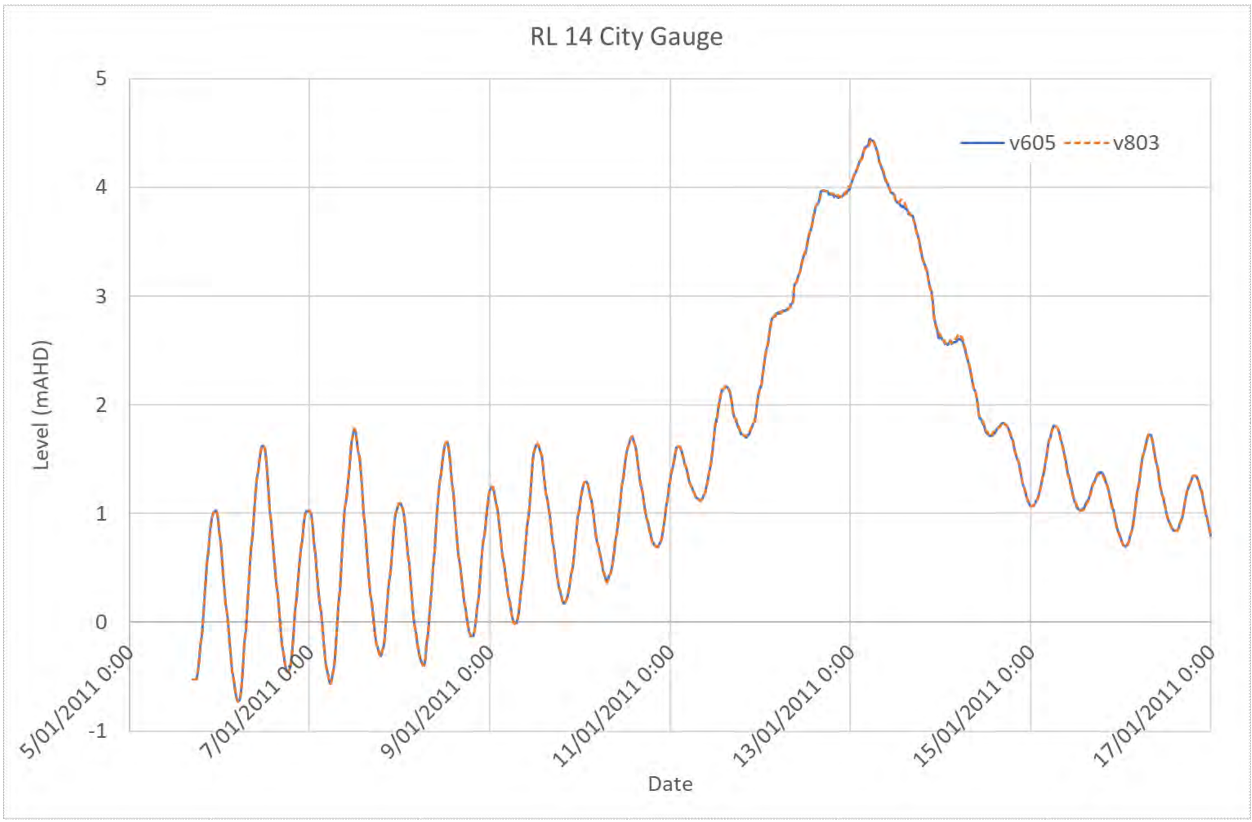


Figure 3-2 Modelled Water Levels at Brisbane City Gauge for 2011 Event (v605 vs v803)

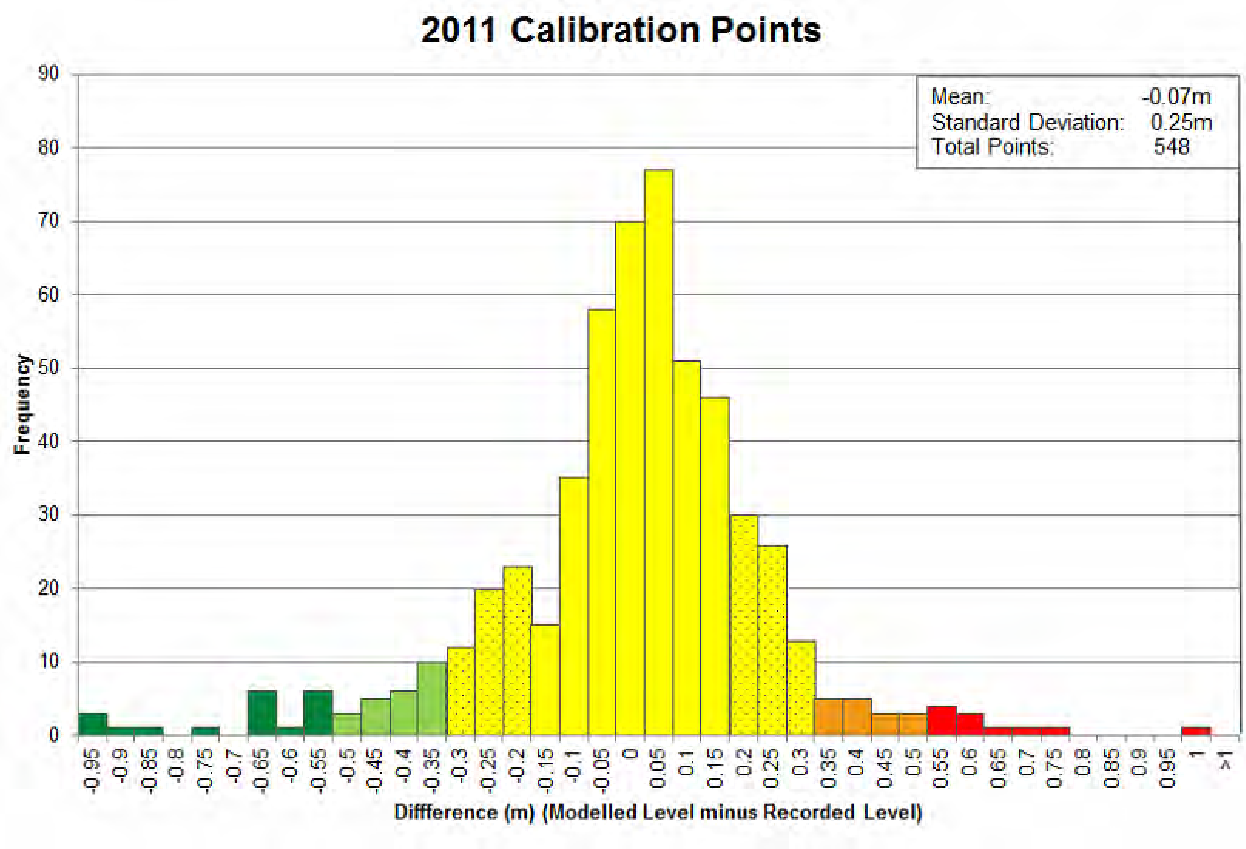
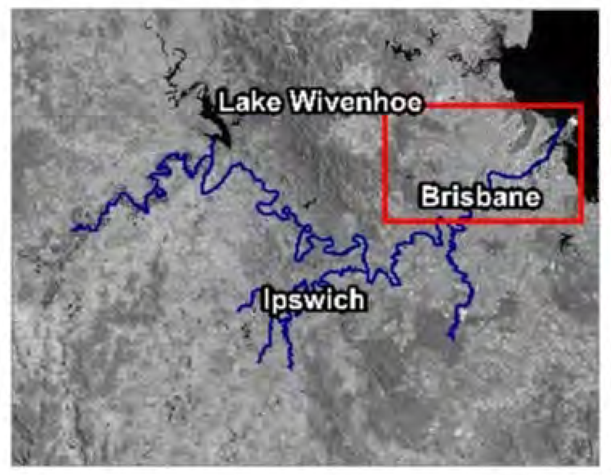


Figure 3-3 Histogram of revised 2011 calibration results



LEGEND

- Gauging Station
- Recorded Flood Extent (from various sources)

Detailed Model Version: 803

Calibration Points
(modelled minus recorded)

- ▲ > 0.5 m
- ▲ 0.3 to 0.5 m
- ▲ 0.15 to 0.3 m
- ● -0.15 to 0.15 m
- ▼ -0.3 to -0.15 m
- ▼ -0.5 to -0.3 m
- ▼ < -0.5 m

Note:
- Any recorded flood levels that were the result of local flooding have not been shown.

Title:
DM 2011 Calibration - Region E

N

0km 1 2
Scale - Inset

0km 2 4
Scale - Main Map

Drawing: **3-1**

Rev: **A**

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4 Additional Checks on Model Volume

As an additional check as to how the model amendments affect the model results, the peak water surfaces for the 11 AEPs have been used in conjunction with the model topography to determine a peak water surface volume. This has been done for both the original and the amended surfaces and a comparison has been made. Table 4-1 presents the results of the volumetric assessment.

Table 4-1 Volumetric Assessment of Peak Flood Level Surfaces

AEP Identifier	Volume (ML)			Change in Volume (%)
	Version 605 Grids	Version 803 Grids	Change in Volume	
D0002	316,863	316,868	6	0.002%
D0005	493,528	493,458	-70	-0.014%
D0010	646,024	646,052	28	0.004%
D0020	843,351	843,425	74	0.009%
D0050	1,201,645	1,201,835	190	0.016%
D0100	1,700,676	1,700,739	63	0.004%
D0200	2,148,640	2,148,147	-493	-0.023%
D0500	2,667,700	2,667,200	-500	-0.019%
D2000	3,546,342	3,546,024	-319	-0.009%
DK010	5,022,844	5,022,556	-288	-0.006%
DK100	9,326,892	9,323,691	-3,201	-0.034%

As shown in Table 4-1, the changes in volume for the new flood surfaces compared to the original flood surfaces are minimal.

5 Data Supplied

This release is an amendment to User Package A of the BRCFS and concerns the following:

- Item A_001 'Detailed Model'; and
- Item A_002 'AEP Flood Surfaces'.

Details of the supplied amended files are provided below.

5.1 A_001 'Detailed Model'

Only amended model files have been supplied with the release. The folder structure containing the amended files mirrors that of the original handover, so the user can simply copy and merge the files into the original folder structure. The results folder, which contains all the raw model output, has been prefixed with an underscore. This is to minimise the risk of a user inadvertently activating a supplied batch file and overwriting supplied results.

A readme file (Amended_files.txt) is supplied in the 'A_001_Hydraulic_Models' folder that lists the amended model input files with a brief explanation.

A full set of raw results files and model log files are supplied with the release. The format and results types are the same as those previously issued and reference should be made to the Detailed Model User Guide for descriptions. The only addition is the ZAEM1 output, which corresponds to the classified hazard output based on the Australian Disaster Resilience Handbook 7.

5.2 A_002 'AEP Flood Surfaces'

All amended flood surfaces are referenced with model version '803'. The following additional output types are supplied with the AEP flood surfaces:

- Peak classified hazard based on the Australian Disaster Resilience Handbook 7. This is processed from the raw TUFLOW ZAEM1 output into grid suffixed with 'ZA'.
- 'Source' grids (_src.asc) that spatially reference the component grids that make up the respective AEP flood surface. These should be considered with the accompanying _src_legend.csv that links the source grid values to a component input.
- Difference grids showing the change in peak flood level between the amended model (803) and the original model (605). For each AEP these grids are contained within a sub-folder 'dH_from_605' and each sub-folder contains the following:
  - A grid containing the difference (in metres) between the 805 surface and the 605 surface (805 minus 605). An example name is 'dh_B15D0100_H_803_605.asc'.
  - A grid showing the residual changes in flood extent for areas of non-overlap. Grid cells are classified with values of -99 if they were wet but are now dry and +99 if they were dry and are now wet. An example name is 'dh_B15D0100_H_803_605_wd.asc'.
  - MapInfo format dh grids (files end in .tab and .grd).
  - A batch file (.bat) used to generate the difference grids.
  - Colour palates (.vcp) for MapInfo software to aid when looking at the difference grids.

6 Limitations

The Detailed Model is designed to provide accurate flood mapping from Brisbane River riverine flooding at a regional scale based on present day conditions. As such, the model is designed for regional flood management planning and development control. Where the flood maps extend into the tributaries, the flood information provided is caused by Brisbane River backwater effects, and not that from local flooding (which may be higher). A full description of the Detailed Model limitations is contained within the BRCFS Milestone Report 6.

Representation of stormwater pipes within the Detailed Model was appropriate for a regional scale riverine model. Pipe sizes were approximated to ensure pipes were of a functional size to allow for hydraulic characteristics such as full backwater conveyance into small tributaries. As such the modelled representation of these pipes is not considered suitable for local catchment modelling.

It should be noted that the amended model will not generate identical results for the climate change simulations and other sensitivity scenarios modelled in the original study. These scenarios have not been simulated using the amended model. However, based on our findings of minimal differences between the original and amended models for base case events, negligible or no change is expected except within localised areas that have had specific targeted amendments made.

7 Future Use of the Model

From a regional perspective, the vast majority of applications, it will make minimal difference to project outcomes if the original model is used in place of the model containing the amendments. However, within Brisbane, and for new applications of the model, it is recommended that the amended version of the model, is used in place of the original modelling. For any localised applications of the model in areas that have been subject to a specific modelling fix, for example the Milton basin, it is strongly recommended that the amended model is used.

If the model is to be used for any impact assessment where a base case result is to be compared to a design case[1], then it is imperative that the same version of the model is used. For example, a design case peak flood surface derived using the amended model should not be compared to a base case surface derived from the original model.

[1] A design case is an updated version of the base case model which includes features associated with, for example, a proposed development.

Appendix A Tabulated Results

A1 Revised Base Case (B15) Peak Levels and Flows at Reporting Locations

		Peak Flood Level (mAHD)											Peak Flood Flow (m^3/s)										
		AEP (1 in ....)											AEP (1 in ....)										
ID	Reporting Location	2	5	10	20	50	100	200	500	2000	10000	100000	2*	5	10	20	50	100	200	500	2000	10000	100000
RL_01	Lockyer Creek at Tarampa	45.34	56.81	59.89	60.77	60.95	60.98	61.03	61.11	61.28	61.50	63.18	0	566	1072	1937	3381	4269	5749	8090	11193	15019	34731
RL_02	Wivenhoe Dam Tailwater	23.31	33.00	36.06	38.89	44.17	48.40	49.75	50.69	52.17	55.29	63.28	0	704	939	1557	3757	6922	10157	12394	16336	21779	44230
RL_03	Lockyer Creek at Lyons Bridge	47.62	60.06	62.97	63.89	64.24	64.31	64.40	64.53	64.75	65.07	66.39	0	568	1013	1875	3260	4175	5646	7989	11097	14924	34615
RL_04	Brisbane River at Lowood Pump Station	20.76	31.03	33.66	36.27	40.94	45.32	47.27	48.56	50.98	54.54	63.01	0	1040	1844	2781	5457	9758	13036	15785	20367	29326	52605
RL_05	Brisbane River at Savages Crossing	20.80	26.92	29.41	32.07	37.02	41.67	44.49	46.70	49.72	53.44	61.91	59	1068	1880	2843	5449	9275	12115	14651	19541	27706	51841
RL_06	Brisbane River Upstream Mt Crosby Weir	7.43	10.58	13.11	15.66	20.29	25.11	28.02	30.91	34.33	37.89	45.74	53	1073	1916	3013	5339	8648	11152	13512	18801	26827	50696
RL_07	Brisbane River downstream Mt Crosby Weir	4.29	9.11	11.81	14.92	19.78	24.76	27.62	30.53	33.85	37.44	45.26	52	1069	1909	3018	5354	8666	11167	13549	18779	26811	50651
RL_08	Brisbane River at Moggill	1.73	4.12	6.89	9.92	14.31	18.17	20.30	22.60	25.42	28.77	35.98	-422	1845	2966	4341	6864	9943	11888	14740	19492	28436	57166
RL_09	Brisbane River at Jindalee	1.60	2.20	3.40	5.68	9.17	12.32	14.16	16.10	19.08	22.96	31.05	-894	1932	3012	4475	6767	9474	11327	13847	18095	27236	56614
RL_10	Brisbane River at Tennyson	1.59	1.86	2.43	3.83	6.40	9.35	11.03	13.05	15.80	20.32	28.81	-1231	2122	3149	4746	6892	9200	10970	13285	17250	25824	56137
RL_11	Brisbane River at Fairfield	1.59	1.82	2.26	3.48	5.64	8.19	9.82	11.77	14.61	19.45	28.31	-1351	2169	3166	4768	6878	9194	10932	13215	17216	25786	56125
RL_12	Brisbane River at Toowong	1.58	1.76	2.08	3.13	4.68	6.74	8.28	10.07	12.88	17.54	26.10	-1474	2226	3183	4778	6864	9154	10929	13194	17199	25751	56087
RL_13	Port Office Gauge	1.59	1.69	1.85	2.29	3.28	4.60	5.83	7.40	9.96	14.85	24.00	-1639	2318	3222	4794	6893	9143	10979	13204	17188	25721	56012
RL_14	Brisbane City Gauge	1.59	1.69	1.84	2.23	3.19	4.53	5.75	7.30	9.88	14.69	23.70	-1647	2324	3224	4797	6893	9148	10988	13208	17193	25728	56028
RL_15	Brisbane River at Hawthorne	1.60	1.64	1.69	1.89	2.28	2.85	3.36	4.30	6.04	9.04	16.19	-1871	2452	3412	4897	6975	9235	11067	13275	17164	25749	56018
RL_16	Brisbane River at Gateway Bridge	1.59	1.63	1.68	1.75	1.83	1.89	2.32	2.67	2.99	4.75	8.17	-2314	2839	4056	5223	7158	9378	11294	13397	17172	25876	55998
RL_17	Warrill Creek at Amberley	20.78	26.15	27.28	27.46	28.17	28.31	28.59	28.76	29.82	31.68	36.66	18	599	981	1105	1986	2166	2465	2950	3811	4610	7043
RL_18	Purga Creek at Loamside	22.26	27.09	27.61	27.77	27.91	28.65	28.76	28.90	29.86	31.71	36.67	7	300	470	544	633	1076	1176	1254	1043	1781	2137
RL_19	Bremer River at Walloon	20.26	25.29	26.34	27.22	27.76	28.25	28.51	29.15	29.88	31.91	36.66	45	727	1125	1734	2353	3064	3612	4272	4321	7256	9188
RL_20	Bremer River at Three Mile Bridge	12.53	20.18	22.27	23.46	25.46	26.33	27.49	28.27	29.65	31.65	36.65	44	698	1024	1368	1865	2537	2891	3565	3495	6576	7863
RL_21	Bremer River at One Mille Bridge	6.63	16.87	19.38	20.65	23.34	24.51	26.38	27.29	28.97	31.16	36.56	43	1318	1929	2351	3265	4010	4921	5774	7050	9420	13987
RL_22	Bremer River at David Trumpy Bridge	1.89	11.77	14.76	16.08	18.67	20.13	21.84	23.42	25.74	28.97	36.12	48	1274	1887	2271	3225	3802	4818	5613	6934	9302	13467
RL_23	Bremer River at Hancock Bridge	1.97	13.76	16.62	18.02	20.84	22.11	23.96	24.86	26.61	29.14	36.18	45	1302	1910	2323	3241	3874	4889	5692	7034	9367	13807
RL_24	Bremer River at Bundamba Confluence	1.78	8.24	11.67	13.18	16.16	18.76	20.82	23.02	25.66	28.95	36.10	-102	1255	1907	2227	3203	3628	4550	5449	6436	9151	11647
RL_25	Bremer River at Warrego Highway	1.76	6.96	10.16	12.06	15.75	18.72	20.79	23.02	25.65	28.95	36.09	-142	1253	2035	2214	3176	3402	4274	5275	6170	9118	10470
RL_26	Bundamba Creek at Hanlon St Alert	1.79	8.23	11.67	13.18	16.14	18.76	20.82	23.02	25.66	28.95	36.10	-99	1247	1891	2212	3190	3619	4549	5436	6432	9141	11653
RL_27	Woogaroo Creek at Brisbane Road Alert	2.79	3.16	5.47	8.40	12.58	16.50	18.71	20.99	23.82	27.63	35.23	-575	1857	2944	4316	6815	9803	11663	14368	18940	27856	56935
RL_28	Oxley Creek at Rocklea	1.61	2.54	4.30	5.49	7.04	9.65	11.27	13.12	15.81	20.33	28.82	92	233	421	604	656	782	-788	1013	-1681	-3388	-7322

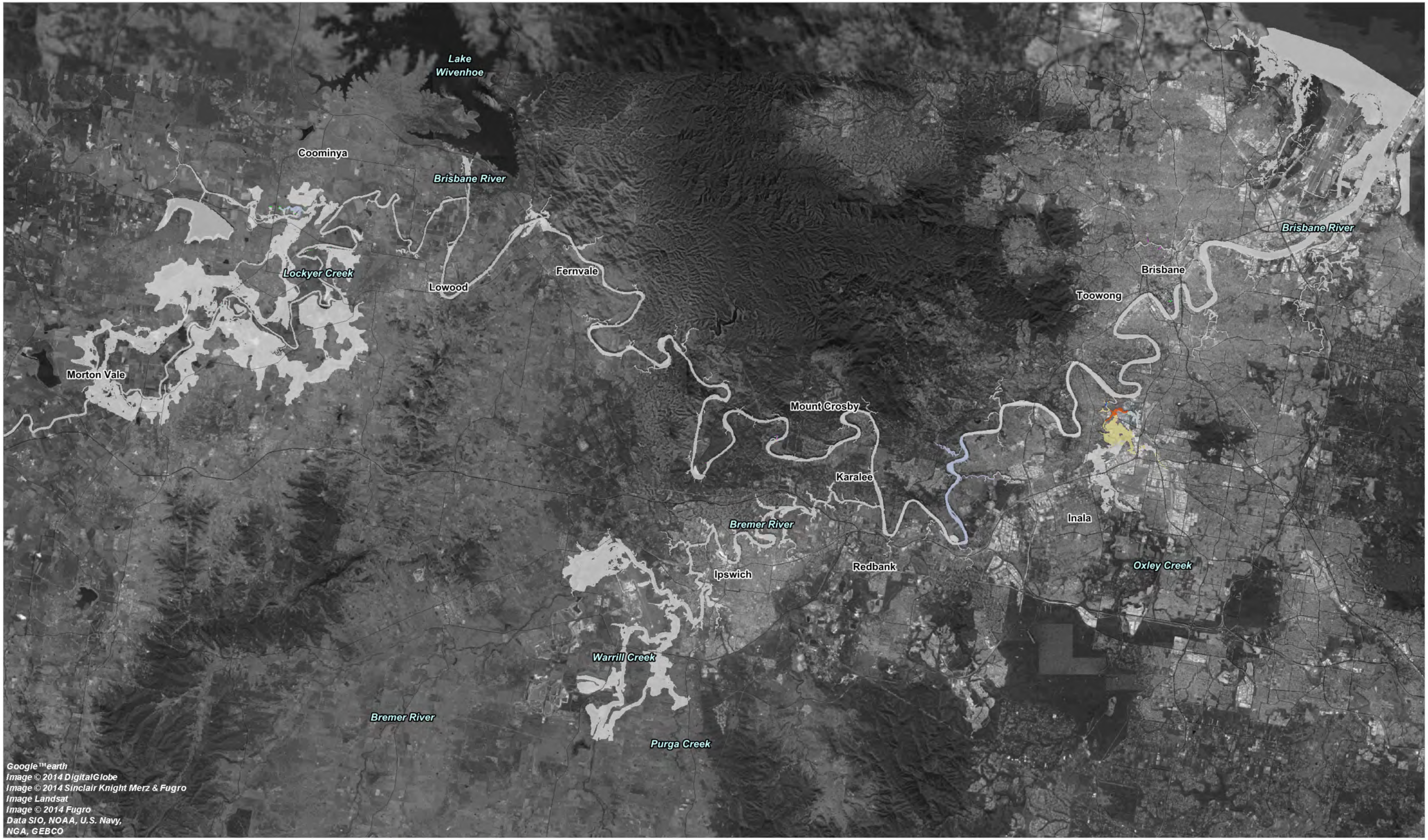
*Negative flows shown for the 1 in 2 AEP event are peak tidal flows and not flood flows

A2 Change in Peak Level and Flow (v803 minus v605)

		Difference in Peak Flood Level (m) (803 vs 605)											Difference in Peak Flood Flow (m^3/s) (803 vs 605)										
		AEP (1 in ....)											AEP (1 in ....)										
ID	Reporting Location	2	5	10	20	50	100	200	500	2000	10000	100000	2*	5	10	20	50	100	200	500	2000	10000	100000
RL_01	Lockyer Creek at Tarampa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0	0	0	0	-1	0	0	0	-1	-2	0
RL_02	Wivenhoe Dam Tailwater	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	-2	-1	1	0	0	0	0	0	0	4
RL_03	Lockyer Creek at Lyons Bridge	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0	0	0	1	0	1	-1	0	-1	-3	-1
RL_04	Brisbane River at Lowood Pump Station	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	-1	0	-1	0	2
RL_05	Brisbane River at Savages Crossing	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	-7	0	-1	0	-10	-2	1	0	0	2
RL_06	Brisbane River Upstream Mt Crosby Weir	0.00	-0.01	0.01	0.01	0.00	-0.01	-0.01	-0.01	0.00	-0.04	0.00	0	-1	1	5	5	-6	-2	2	-4	-13	5
RL_07	Brisbane River downstream Mt Crosby Weir	0.00	-0.01	0.00	0.02	0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0	-1	1	5	5	-6	-3	3	-1	0	3
RL_08	Brisbane River at Moggill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0	-1	1	2	2	-6	1	2	-2	0	1
RL_09	Brisbane River at Jindalee	0.00	0.01	-0.01	0.00	0.01	-0.01	0.00	-0.01	0.00	-0.01	-0.01	0	-1	16	-7	-4	-2	14	2	1	2	-11
RL_10	Brisbane River at Tennyson	0.00	0.00	0.01	-0.01	0.00	-0.01	-0.01	-0.01	0.00	-0.01	-0.03	-1	0	16	8	53	2	-6	-1	-2	0	29
RL_11	Brisbane River at Fairfield	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	-0.01	-0.02	-0.03	-1	-1	16	19	37	3	-2	6	-4	1	30
RL_12	Brisbane River at Toowong	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	-0.02	0.00	-0.01	-0.04	-2	-7	11	13	25	5	0	1	-5	8	12
RL_13	Port Office Gauge	0.00	0.00	0.00	0.00	0.02	0.01	0.00	-0.01	-0.01	0.00	0.00	-2	-1	2	11	28	-33	1	-8	1	26	30
RL_14	Brisbane City Gauge	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	-0.01	0.00	0.00	-2	-1	0	12	26	-31	1	-9	1	26	37
RL_15	Brisbane River at Hawthorne	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	-2	0	-7	-12	38	-18	-7	1	-1	37	18
RL_16	Brisbane River at Gateway Bridge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-4	4	6	-7	19	-11	17	5	4	33	17
RL_17	Warrill Creek at Amberley	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0	0	0	0	0	0	0	0	1	0	0
RL_18	Purga Creek at Loamside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
RL_19	Bremer River at Walloon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0	0	0	0	0	0	0	0	0	0	0
RL_20	Bremer River at Three Mile Bridge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
RL_21	Bremer River at One Mille Bridge	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
RL_22	Bremer River at David Trumpy Bridge	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	1	0	0	0	0	0	0
RL_23	Bremer River at Hancock Bridge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	-1	1	0	0	0	0	0
RL_24	Bremer River at Bundamba Confluence	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0	0	1	0	0	0	1	0	-1	0	0
RL_25	Bremer River at Warrego Highway	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0	0	0	0	0	0	0	0	-2	1	-1
RL_26	Bundamba Creek at Hanlon St Alert	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1	0	0	0	1	0	-1	0	0
RL_27	Woogaroo Creek at Brisbane Road Alert	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01	0	5	4	-1	1	-2	1	1	-5	0	3
RL_28	Oxley Creek at Rocklea*	0.00	0.00	0.15	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	-0.02	0	0	9	0	1	3	11	-3	3	-34	4

*The 1 in 10 AEP result at Oxley Creek is a minor anomaly and is considered to be a limitation of the model cell size at this location

Appendix B Difference Mapping



LEGEND

Major Road

Peak Flood Impact (m)

- Less than -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.01
- -0.01 to 0.01
- 0.01 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- Greater than 0.50
- Increase in Inundation Extent
- Decrease in Inundation Extent

Title:

1 in 10 AEP, Peak Flood Level Difference (v803 minus v605)

Drawing: A1

Rev: A

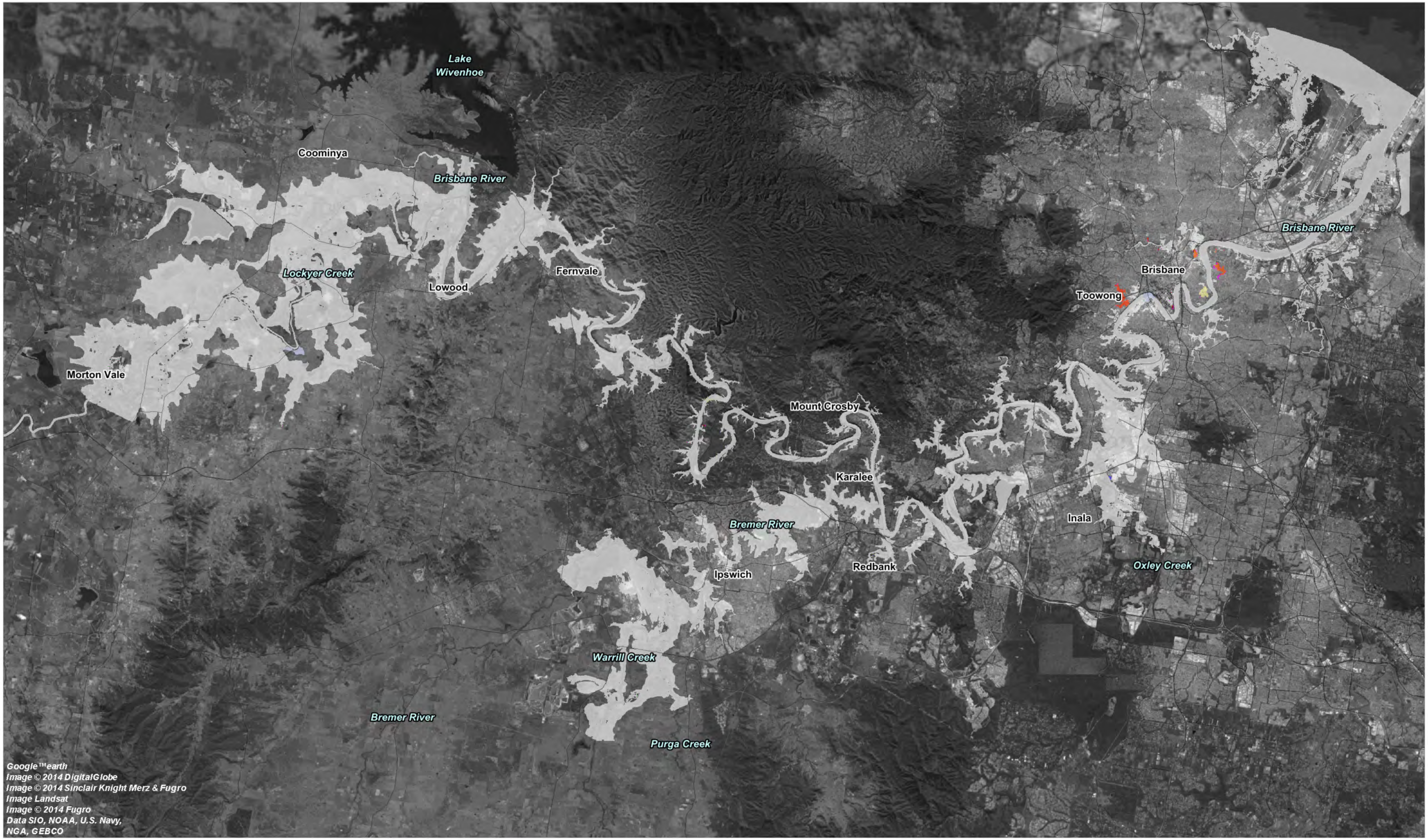
N

0 5 10km

Approx.Scale

www.bmt.org

Filepath : B:\B20702 BRCFS Hydraulics\60_Mapping\DRG\MR3_Final\FLD_051_190815_1 in 10 AEP_Level_Impact.wor



LEGEND

Major Road

Peak Flood Impact (m)

- Less than -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.01
- -0.01 to 0.01
- 0.01 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- Greater than 0.50

- Increase in Inundation Extent
- Decrease in Inundation Extent

Title:

1 in 100 AEP, Peak Flood Level Difference (v803 minus v605)

Drawing: **A2**

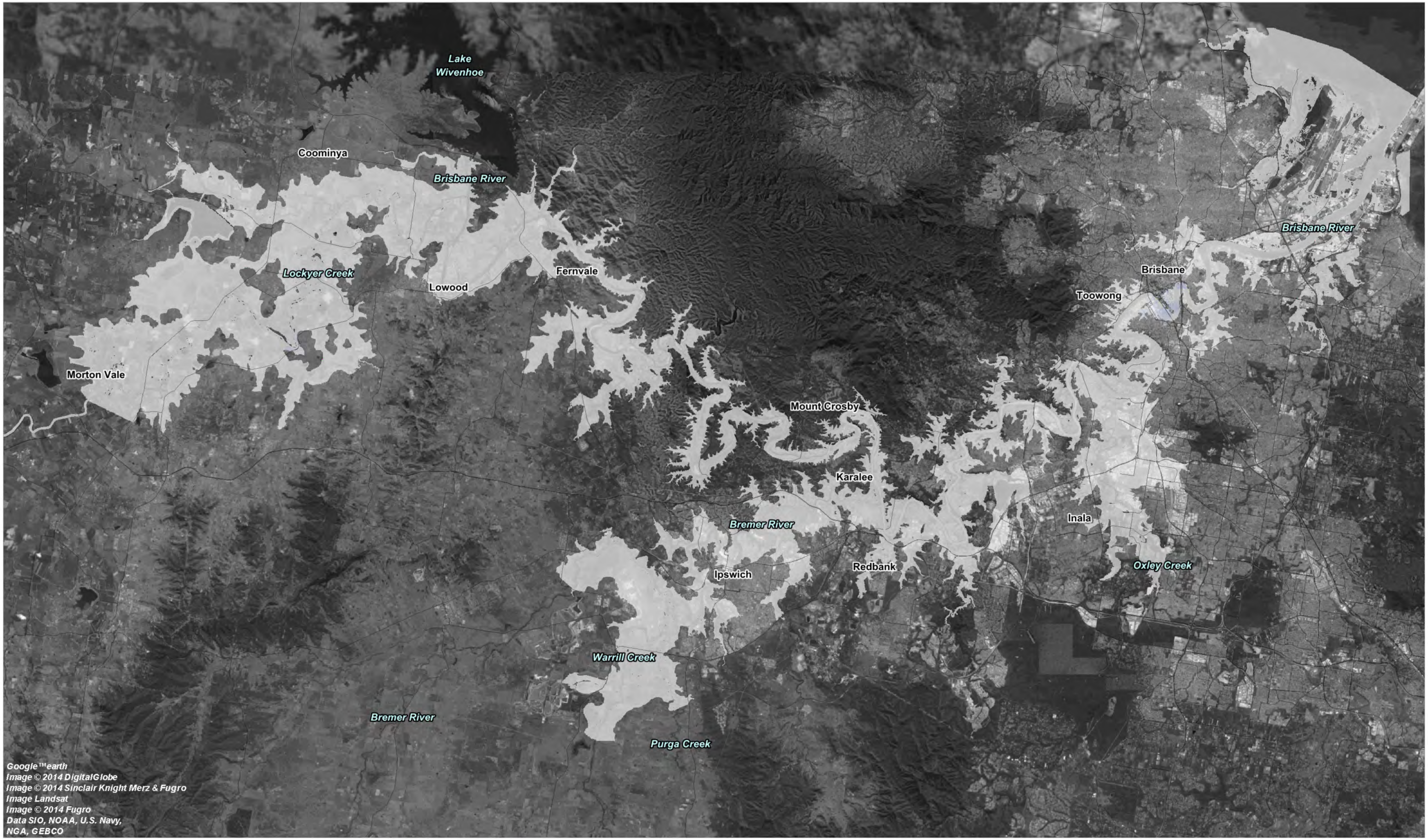
Rev: **A**

N

0 5 10km
Approx.Scale

BMT
www.bmt.org

Filepath : B:\B20702 BRCFS Hydraulics\60_Mapping\DRG\MR3_Final\FLD_052_190815_1 in 100 AEP_Level_Impact.wor



LEGEND

Major Road

Peak Flood Impact (m)

- Less than -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.01
- -0.01 to 0.01
- 0.01 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- Greater than 0.50

- Increase in Inundation Extent
- Decrease in Inundation Extent

Title:

1 in 2000 AEP, Peak Flood Level Difference (v803 minus v605)

Drawing: A3

Rev: A

N

0 5 10km

Approx. Scale

BMT

www.bmt.org

Filepath : B:\B20702 BRCFS Hydraulics\60_Mapping\DRG\MR3_Final\FLD_053_190815_1 in 2000 AEP_Level_Impact.wor

Appendix C Localised Differences in Flood Level

Table C-1 Localities with noteworthy localised differences in flood level

Suburb or Location	Reason for local change	Affected AEPs (1 in Y)	Typical max. change in peak flood level (m) [1 in Y AEP event]
Milton	Amended pipe	20, 50, 100	0.4m [50 & 100 AEP]
Brisbane CBD	Amended pipe	100	0.2m [100 AEP]
Brisbane CBD	Topo. amendment to fill excavated foundations	20, 50	was wet now dry [20 & 50 AEP]
Brisbane CBD	Gully line in city botanic gardens	100	1.4m [100 AEP]
New Farm	Amended pipe	50, 100, 200, 500	0.05m [100 AEP]
Newstead	Amended pipe	50, 100	0.2m [100 AEP]
Hawthorne	Amended pipe	100, 200	0.4m [100 AEP]
Bulimba	Amended pipe	100, 200	0.2m [100 AEP]
Wilston	Gully line in tributary of Breakfast Creek	2, 5, 10, 20, 50, 100,	0.3m [100 AEP]
Herston	Gully line in tributary of Breakfast Creek	2, 5, 10, 20, 50, 100,	0.4m [100 AEP]
Goodna CBD	Breakline through underpass	50	was dry now wet [50 AEP]
Oxley Creek / Rocklea	Limitations associated with 30m cell size. Modelling artefact.	10	0.15m [10 AEP]

Appendix D Brisbane City Council Discontinuity Identification

Potential Sites Identified by Brisbane City Council as having discontinuities.

Appendix E IPE Memorandum

IPE Memorandum on BRCFS Model Amendment 1 Updates – January 2020

1. Introduction

This memorandum details the formal review carried out by the Independent Panel of Experts (IPE) regarding Amendment 1 updates to the Brisbane River Catchment Flood Study (BRCFS) 'Detailed Model' model by BMT WBM. This has been undertaken for the Queensland Reconstruction Authority (QRA) on behalf of the Brisbane River Strategic Floodplain Management Plan (SFMP) Implementation Management Group. This review has been carried out by the IPE in accordance with the Brief provided by QRA, dated 30 October 2019. The review was initiated as Brisbane City Council (BCC) requested formal sign off from the members of the BRCFS Independent Panel of Experts.

1.1. Background

In the final report of the Queensland Flood Commission of Inquiry of March 2012 (QFCoI), the Commission found that *"government agencies need to engage in a process of floodplain management involving a combination of land planning and building controls, emergency management procedures, and structural mitigation measures."*

The Brisbane River Catchment Flood Study (BRCFS) was released in May 2017 in response to Recommendation 2.2 of the QFCoI which said; *"Brisbane City Council, Ipswich City Council and Somerset Regional Council and the Queensland Government should ensure that, as soon as practicable, a flood study of the Brisbane River catchment is completed in accordance with the process determined by them under recommendations 2.5 and 2.6."* Recommendation 2.12 further requires councils to prepare Floodplain Management Plans.

The Brisbane River Strategic Floodplain Management Plan (BRSFMP) was released in April 2019 and used the BRCFS outputs to analyse risk; test options for mitigation; assess the feasibility, costs and benefits of various options using an integrated assessment framework; and to make recommendations for floodplain management at the regional level in the Brisbane River catchment.

At the time of the BRSFMP development, BCC undertook an investigation into the BRCFS 'Detailed Model' and raised a number of queries regarding peak flood levels in localised areas of the floodplain within their local government area. These queries typically concerned local basin areas, separated from the river by features such as embankments, but connected to the adjacent river by stormwater pipes. It was noted that several of these basins appeared to present lower peak flood levels than those of the adjacent river.

This issue was raised with, and investigated by, BMT WBM. They identified that modelling schematisation of these areas used pipe sizes that were not sufficiently large enough to properly simulate the actual hydraulic capacity of existing systems. Consequently, the backwater flooding from the Brisbane River was not modelled correctly for a number of areas, impacting over 1000 properties.

It is understood that the refined model will be released as “Amendment 1” once it has been reviewed and approved for adoption by an IPE, similar in process and prudency for release of the original BRCFS model.

1.2. The Brief

The role of the IPE is to provide advice to the BRSFMP Management Group on the BRCFS Model Amendment 1 and its suitability for adoption and publication. Advice will be based on the IPE’s fit-for-purpose review of the BRCFS Amendment 1 in its entirety (including inputs such as: model files and outputs, QRA model amendment discussion paper, peer review completed by Mark Babister of WMA Water, and BMT supporting Technical Memorandums).

Advice provided by the IPE will be used as part of the government decision making process and will not represent or pre-empt any government position. The IPE have no statutory powers, nor any regulatory role.

Any decisions made based on the IPE’s advice will be the responsibility of the BRSFMP Management Group, and ultimately the BRSFMP Steering Committee.

The IPE members are required to:

- Maintain strict confidentiality,
- Adhere to the milestones and timelines for the work programs as agreed,
- Interact and report regularly and communicate fully with relevant project staff or delegates,
- Develop high quality conclusions and recommendations.

The deliverable is a co-signed technical memorandum, this document, providing a concise statement regarding the acceptability of the model amendment for adoption by the BRSFMP Management Group.

1.3. Process of Flood Modelling

Well established hydrologic and hydraulic flood models are a very powerful tools for estimating flood hazard. They provide high resolution spatial data on flood behaviour and can be used for objective scenario testing and planning. However, even though these models may be detailed in resolution and well calibrated, such as those developed for the BRCFS, it is critically important to recognize that they are simplified schematisations of the complexity of the real world. For this reason, these models need to be used appropriately and carefully, and checked before being used for purposes different from which they were developed.

This simplified representation of the real world also means that models will never be perfect and can always be improved. The art of modelling is to create a suitably reliable and substantiable representation of the key processes of interest so the model can not only reliably reproduce observed events, but also be used to examine the expected results from a range of different events from those that have been observed. It is also of importance to note that additional model complexity will not necessarily produce more reliability. It is good data and modeller skill that creates reliability.

For these reasons, improvements and updates to the BRCFS models need to be seen as a positive and worthy improvement process. It is our expectation that future discoveries of local modelling deficiencies are likely to continue. Therefore, we expect that the, improvement, updating and checking process will not end with Amendment 1.

2. IPE Review of Model Amendment 1

2.1. Provided Data

The data in BRCFS Amendment 1 was used for this review:

- Item 1: BMT Amendment 1 Technical Memorandums dated 18 November 2019,
- Item 2: Mark Babister of WMA Water model review memorandum dated 8 June 2018 based on an earlier version of the Item 1 memo dated 18 May 2018
- Item 3: Model files and results for BRCSFS Model Version 803 (Amendment 1) and 605 (Original)
- Item 4: Spreadsheet capturing stakeholder comments on the 18 November Technical Memorandum and BMT responses titled *Technical Memo Model Amendment Review Comments* (provided more for background purposes than for review).

The IPE were also provided a presentation by BMT which was followed with a detailed question and answer session with the key modellers.

3. WMA Water Review (Item 2)

The WMA Water review carried out a high level assessment of the impact of the earlier versions of the changes on the model calibration and recommended a series of tests that could be used by BCC or BMT to quantify the changes in modelled water levels and flow rates.

The testing by WMA Water showed that the propagation of the flood wave moving down the Brisbane River was so slightly changed that it was at the limits of measurement. This means that the overall regional model calibration was unaffected by the changes but localised changes in the flood levels do occur.

The relatively high velocities present in the Brisbane River during flooding means that real world flood levels can be quite sensitive to minor changes in channel geometry and roughness. In these situations, model results can potentially be even more sensitive than seen in the real world due to the effects of modelling schematisation simplifications which can then also produce minor numerical artefacts to appear and disappear without apparent real world cause.

The review recommended the following:

- Review model PO data at key locations to assess the changes to flow rates within the Brisbane River;
- Update the volumetric assessment to incorporate the out of bank changes (including newly flooded and no longer flooded areas);
- In addition to assessing the design event outputs, assessment of the calibration events (2011 flood etc.) should be undertaken.

These recommendations were subsequently and satisfactorily implemented by BMT WBM as reported in their revised memo (Item 1).

4. Scope of Model Amendments

4.1. Stormwater pipes

BMT WBM has made changes to 14 stormwater (backflow) pipes, with 10 pipes being increased in capacity and 4 new pipes added. Each of these pipes has been assumed to be open to allow flow in both directions, with net capacity similar to real world conditions. That is, the modelled pipe sizing is nominal only with the objective of allowing the occurrence of full backwatering of small tributaries. It is important that the supporting model documentation is clear that these pipe sizes are indicative.

Using indicative pipes is defendable as the 60 design events were selected to reproduce peak levels and not the duration of near peak levels that can affect backwater if undersized pipes are used.

4.2. Peak level discontinuities

BCC has identified 27 locations where apparent peak level discontinues have been found. Many of these were addressed by the stormwater pipes described above while some others were addressed by “burning” or “enforcing” nominal gully connections that have not been picked up by the model grid. This is standard industry approach and is defendable.

Like the stormwater nominal pipe sizes, these changes need to be well documented for easy identification by the user. It is also reassuring that each was assessed separately, and some discontinuities were deemed genuine and not changed.

4.3. Other model improvements

This covers a range of minor changes and additional outputs. The model changes include fixing a localised basement hole in the LIDAR, updating and refining structure losses and the approach used, and a model stability fix. Each of these is an example of ongoing model improvement and refinement. The additional outputs will make future checking easier and ensure different users use the same hazard output.

4.4. Changes to model results

BMT WBM have rigorously checked and documented all the model changes. BMT WBM confirmed during the presentation that they had thoroughly checked for further backwater flooding anomalies.

4.5. Changes to model calibration

The additional check on model calibration as outlined in the WMA Water memorandum (Item 2) has confirmed that the changes are making no measurable change to the propagation of the flood wave down the Brisbane River for the 2011 event. Any small changes that occur are relatively localised.

5. Other Observations

Other observations made by the IPE during the conduct of their review are as follows:

- Future changes and updates of the BRCFS model can be expected and need to be accommodated as part of the continuous model improvement process.
- It is pleasing to observe that the existing BRCFS model has demonstrated robustness in that implementing the above amendments appears to have not adversely affected model performance, while slightly improving its calibration in the river and significantly improving the calibration in the overbank areas.
- This review and the work by BMT WBM have highlighted that there is a risk of confusion between models developed for main river floods, and models developed for local catchment flooding.
- Consideration of the limitation of the BRCFS model's application to river flooding with tributary backwater (reference Section 8.1 recommendations of the BRCFS Milestone 5 Report, also see Appendix A of this memorandum) provides a reasonable basis by which future changes of a similar nature can be addressed without need for IPE signoff.

6. Recommendations

This assessment has highlighted that while the model is only suitable for assessing main river flooding and the backwater it causes. Flood assessment in the backwater areas is complex and needs careful analysis. It is important that all users of this model are made aware that the backwater pipes are conceptual and not suitable for use in local catchment modelling.

7. Conclusions

Version 803 of the Brisbane River catchment flood model should be used for all further flood work. This version incorporates a number of improvements which result in a more reliable version of the model.

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Appendix A

Section 8.1 of BRCFS Milestone 5 Report.

8.1 Riverine versus Local Flooding

Brisbane River riverine flooding is the inundation caused by flooding in the Brisbane River. As required by the ITO, to meet the objective of quantifying riverine flooding the modelling needs to include areas that experience inundation caused or exacerbated by elevated water levels in the Brisbane River; inundation of this nature is often referred to as flooding due to backwater effects. Notably, this includes the lower sections of Lockyer Creek and the Bremer River extending up into Warrill and Purga Creeks, but also includes all numerous smaller side tributaries. Localised flooding, that is flooding caused by rainfall within a tributary's catchment, is a different flooding mechanism and may cause higher or lower flood levels, and different flood behaviour compared with backwater flooding from the Brisbane River. For example, a local creek may also be prone to flash flooding with little warning time and rapidly rising flood levels, which would contrast with backwater flooding that rises slowly and steadily as the Brisbane River rises. Where the flood maps extend into the tributaries, the flood information provided is caused by Brisbane River backwater effects, and not that from local flooding. Note that all tributaries contribute runoff to the system for the flood events simulated, however, the rainfall onto the catchments of the local tributaries is typically not of the intensity and duration that would be representative of the critical storm event for simulating localised flooding of an equivalent AEP. When information is sought on flood levels for local tributaries, both this assessment and that from local tributary modelling that may have been undertaken and in the ownership of local councils should be considered. Advice should be sought from the local council in such situations. Recommendations on integrating maximum flood surfaces derived from local studies with the riverine flooding surfaces from the BRCFS, for the same AEP, are:

- The higher of the two surfaces should be used (ie. take the maximum of the local and riverine surfaces).
- Review the tailwater (river) conditions used at the downstream riverine boundary of the local flood modelling for consistency with the riverine flood levels from the BRCFS. Joint probability considerations should be taken into account (ie. a 1 in 100 AEP local event peaking at the same time as a 1 in 100 AEP riverine flood has a much lower AEP of occurrence than a 1 in 100 AEP). If the original riverine boundary is deemed to be inconsistent, the local flood modelling should be reworked using a boundary consistent with the BRCFS.
- Due to joint probability considerations, the expectation is that riverine boundaries used for existing local flood modelling would be lower than the Brisbane River riverine levels from the BRCFS (for the same AEP). Therefore, taking the maximum of the two surfaces as recommended above will produce a seamless transition between local and riverine flooding. The exception maybe for the creek outlets where the riverine flood level is controlled by the ocean storm tide and a higher storm tide level was used for the local flood study compared with those adopted for the BRCFS. In this case, the riverine or storm tide boundary would need to be reviewed as recommended above.