To	**Yelia Pandika & Rudy Van Drie - Wollongong City Council**
From	**Leon Collins - Advisian**
Date	**21st December 2018**
Project	**Review of Allans Creek Flood Study**
Subject	**Results Using Updated WBNM Hydrologic Model Parameters**
REF	**301015-03839**

1. INTRODUCTION

This memorandum follows on from the previous memorandum, reference *mo301015-03839_Allans Creek FS_Review of WBNM Parameters_181127.pdf* dated 27th November 2018. It details outcomes from discussions of the previous memorandum, and summarises work undertaken to refine and finalise WBNM model parameters for the *Review of Allans Creek Flood Study*.

A discussion of the recommendations outlined in the memorandum dated 27th November 2018 was held between Advisian and Rudy Van Drie of Wollongong City Council via email and telephone on Friday 30th November 2018. While it was considered that a WBNM runoff lag parameter value of between 1.50 and 1.60 may be appropriate for the Allans Creek catchment, it was agreed to proceed with a value of 1.50 for the following reasons.

- A parameter value of 1.50 was considered to provide a better match to the timing and shape of recorded water levels for the October 1999 and March 2011 flood events at the Byarong Creek gauge and Blackmans Parade Upstream gauge, respectively.
- A parameter value of 1.50 provides a slightly better TUFLOW calibration to surveyed flood levels.
- A parameter value of 1.50 results, on average, in marginally higher peak simulated flood levels (in comparison to a value of 1.60) and, in consideration of the objectives of the study and without sufficient evidence to the contrary, it would be preferable to adopt this slightly more conservative value.

The following sections document the refinement of WBNM stream lag parameters required to achieve sound agreement between hydrographs simulated using the WBNM and TUFLOW models, and model calibration results achieved using a WBNM runoff lag parameter value of 1.50.

2. REFINEMENT OF WBNM STREAM LAG PARAMETER 'F'

The WBNM hydrologic model is to be used in this study to assess critical storm durations and to determine 'average' ARR 2016 temporal rainfall patterns. This requires that the stream routing behaviour of the model is reliable. The best available information on routing behaviour in the catchment comes from the TUFLOW hydraulic model that has been developed for this study.

Accordingly, stream lag parameters have been modified throughout the catchment to achieve a suitable level of agreement with TUFLOW simulated hydrographs at a range of locations (*refer* **Attachment B**). Adopted stream lag parameters are discussed in the following and are presented graphically in **Figure 1**.

Byarong Creek Catchment

- Upper catchment:
  - A stream lag parameter value of 0.6 was adopted for subareas along the main watercourse
  - This was based on TUFLOW results which indicated that flow is quite constrained within the channel in this area (i.e. natural flood storage is relatively low), with high associated velocities
  - This represents a reduction in stream lag from previous simulations, with the aim of achieving a better match to 'peakier' TUFLOW hydrographs in upper Byarong Creek.
  - A stream lag parameter value of 0.5 was adopted for subareas along part of a small tributary north of Valley Drive.
- Downstream of Aviemore Place, Figtree
  - A stream lag parameter of either 1.0 or 0.75 was adopted for subareas along the main watercourse
  - A value of 1.0 was assigned where significant overbank flow and/or storage was evident in TUFLOW results
  - A value of 0.75 was assigned where TUFLOW results showed that flood flows were predominantly confined to the creek channel
  - Overall this represents a slight increase in stream lag along this length of creek compared to previous simulations. This was required to better match TUFLOW hydrographs by delaying peak flows slightly, and counteracting some of the reduction in stream lag applied in upper Byarong Creek.
- Heavily urbanized areas
  - A stream lag parameter value of 0.85 was adopted for heavily urbanized areas
  - This represents a lower than natural stream lag associated with piping of flows, and/or roadways acting as flow paths in such areas
  - The value of 0.85 was determined based on analysis of small urbanized catchments such as that draining to Phillips Crescent, Mangerton, where it was found to result in an excellent match to the TUFLOW hydrograph.

Branch Creek Catchment

- Upstream of Jacaranda Ave:
  - A stream lag parameter value of 1.0 was predominantly adopted for subareas along the main watercourse
  - This was based on the apparent level of storage evident in TUFLOW results, and the already appropriate match to TUFLOW hydrographs achieved using this value
- Downstream of Jacaranda Ave:
  - A stream lag parameter value of 0.70 to 0.75 was adopted for subareas along the main watercourse upstream of about Lewis Drive
  - This was in consideration of TUFLOW flood flows predominantly confined to the creek channel, and with the aim of achieving a better match to a 'peakier' TUFLOW hydrograph
  - Downstream of Lewis Drive a stream lag parameter value of 1.0 was adopted in consideration of an increase in overbank flow and/or storage evident in TUFLOW results

- Heavily urbanized areas
  - A stream lag parameter value of 0.85 was adopted for heavily urbanized areas.

Brandy & Water Creek Catchment

- Upstream of Darragh Drive:
  - A stream lag parameter value of 0.55 was adopted for subareas along the main watercourse
  - This was based on TUFLOW results which indicated that flow is quite constrained within the channel in this area (i.e. natural flood storage is relatively low), with high associated velocities
  - A lower stream lag of 0.5 was adopted along one tributary to achieve a better match to TUFLOW hydrographs
- Downstream of Darragh Drive:
  - A stream lag parameter value of 1.0 was adopted for subareas along the main watercourse
  - A significant increase in overbank flow and/or storage is evident in TUFLOW results in this area
- Heavily urbanized areas
  - A stream lag parameter value of 0.85 was adopted for heavily urbanized areas

American Creek Catchment

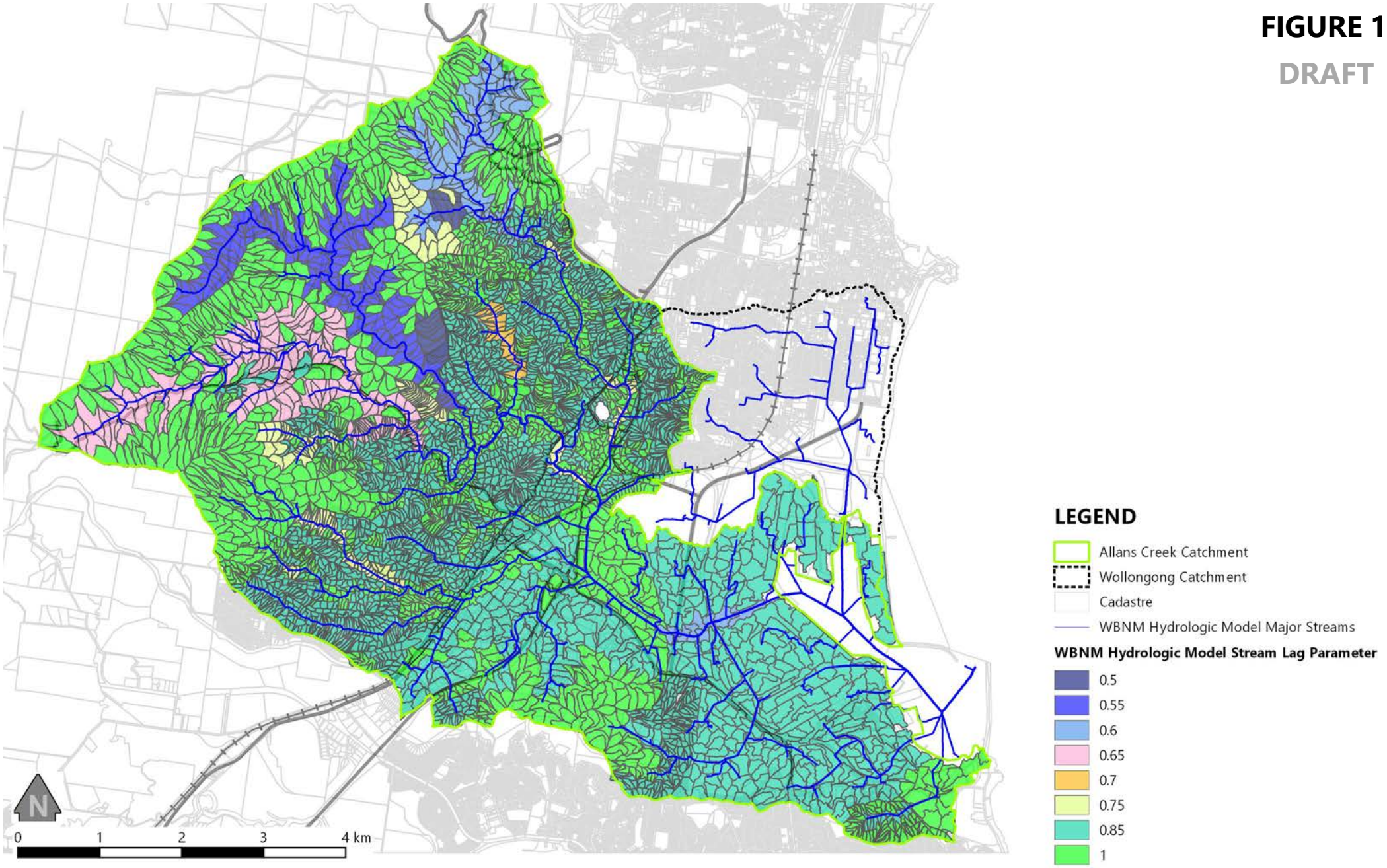
- Upstream of Booreea Blvd, Cordeaux Heights:
  - A stream lag parameter value of 0.65 was adopted for subareas along the main watercourse
  - This was based on TUFLOW results which indicated that flow is generally constrained within the channel in this area (i.e. natural flood storage is relatively low), with high associated velocities
  - This represents a reduction in stream lag from previous simulations, with the aim of achieving a better match to 'peakier' TUFLOW hydrographs along American Creek.
- Between Cordeaux Road and Princes Hwy:
  - A stream lag parameter value of 0.85 to 1.0 was adopted for subareas along the main watercourse
  - A significant increase in overbank flow and/or storage evident in TUFLOW results in this area
- Heavily urbanized areas
  - A stream lag parameter value of 0.85 was adopted for heavily urbanized areas

Allans Creek Catchment:

- A stream lag parameter value of 0.75 to 1.0 was adopted for subareas along the main watercourse and tributaries in consideration in the relative degree of storage evident in the TUFLOW results, and with an aim of achieving a better match to the TUFLOW hydrographs.

FIGURE 1

DRAFT



Advisian
WorleyParsons Group

180928_QGIS_AllansCkFS_Stage2_Figs.qgs
Fg301015-03839_180928_AllansCkFS_Stage2_A4L.pptx

WBNM HYDROLOGIC MODEL STREAM LAG PARAMETER

3. COMPARISON OF FINAL WBNM HYDROGRAPHS TO GAUGE DATA

Comparisons of WBNM simulated hydrographs to water level gauge data for a runoff lag parameter '*C*' value of 1.5 with revised WBNM stream lag parameter values are presented in **Figures 2** to **4** for the August 1998, October 1999 and November 2011 flood events, respectively.

The results are summarised as follows:

- August 1998
  - The timing and shape of the WBNM simulated hydrograph compares well to the timing and shape of water levels recorded at the Byarong Creek gauge
- October 1999
  - The timing and shape of the WBNM simulated hydrograph compares reasonably to the timing and shape of water levels recorded at the Byarong Creek gauge
- March 2011
  - The timing and shape of the WBNM simulated hydrograph compares reasonably to the timing and shape of water levels recorded at the Blackmans Parade Upstream gauge
  - Further investigation was undertaken to improve the timing of the rising limb of the simulated hydrograph, but a better match could not be achieved. However, the WBNM-TUFLOW hydrograph comparison at this location for the August 1998 event (*refer* **Attachment B**) shows good agreement, suggesting that the WBNM stream routing behavior upstream of the Blackmans Parade gauge is appropriate. It is therefore possible that the difference in timing to recorded water levels is influenced by factors such as differences between applied and actual rainfall, and/or structural blockages.

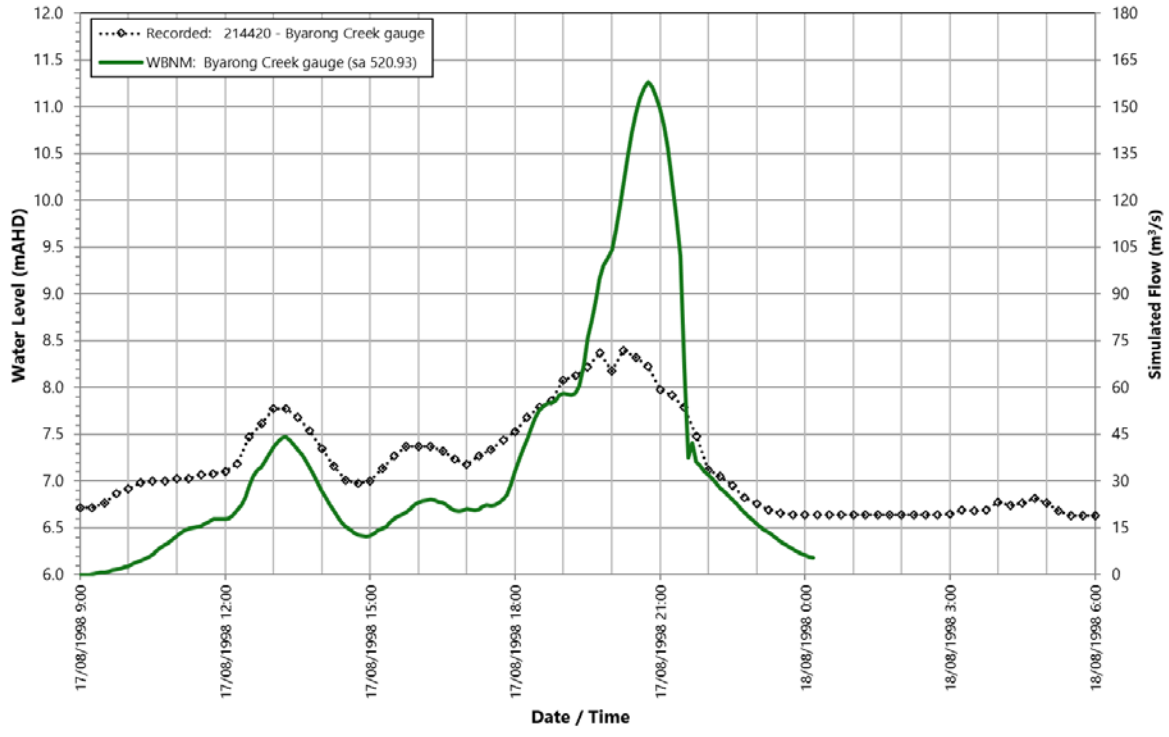


Figure 2 Comparison of WBNM hydrograph to water level record for August 1998 flood

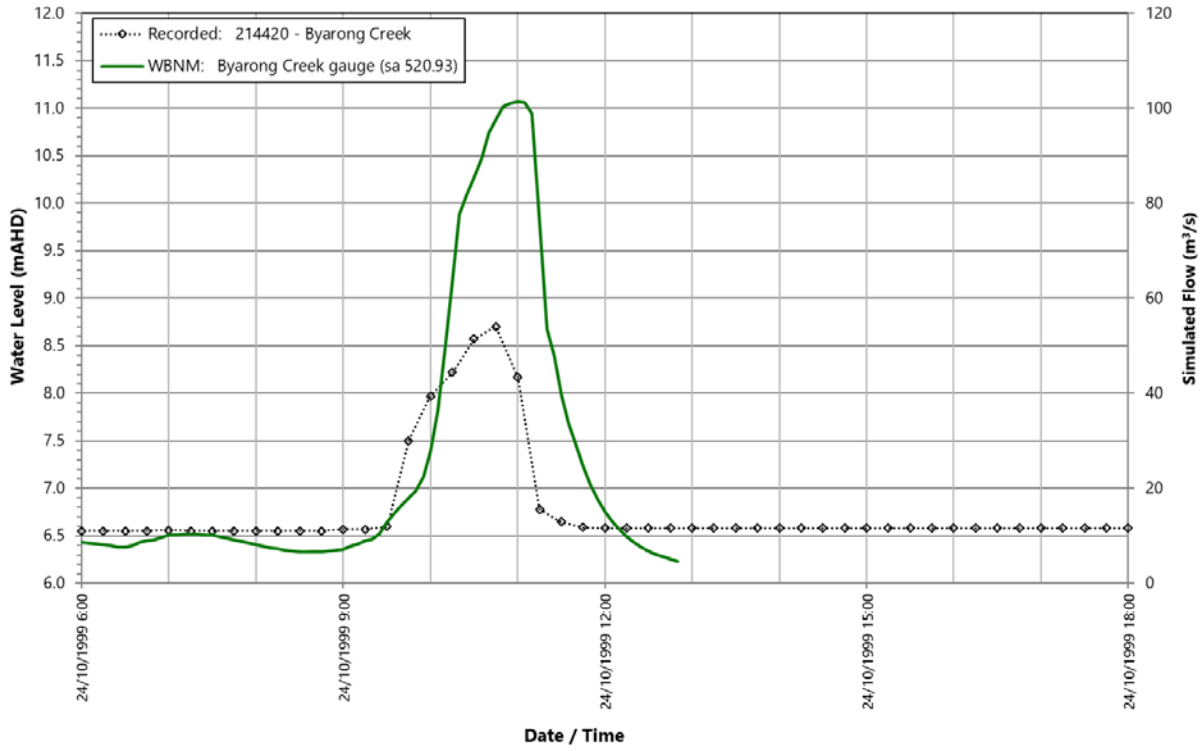


Figure 3 Comparison of WBNM hydrograph to water level record for October 1999 flood

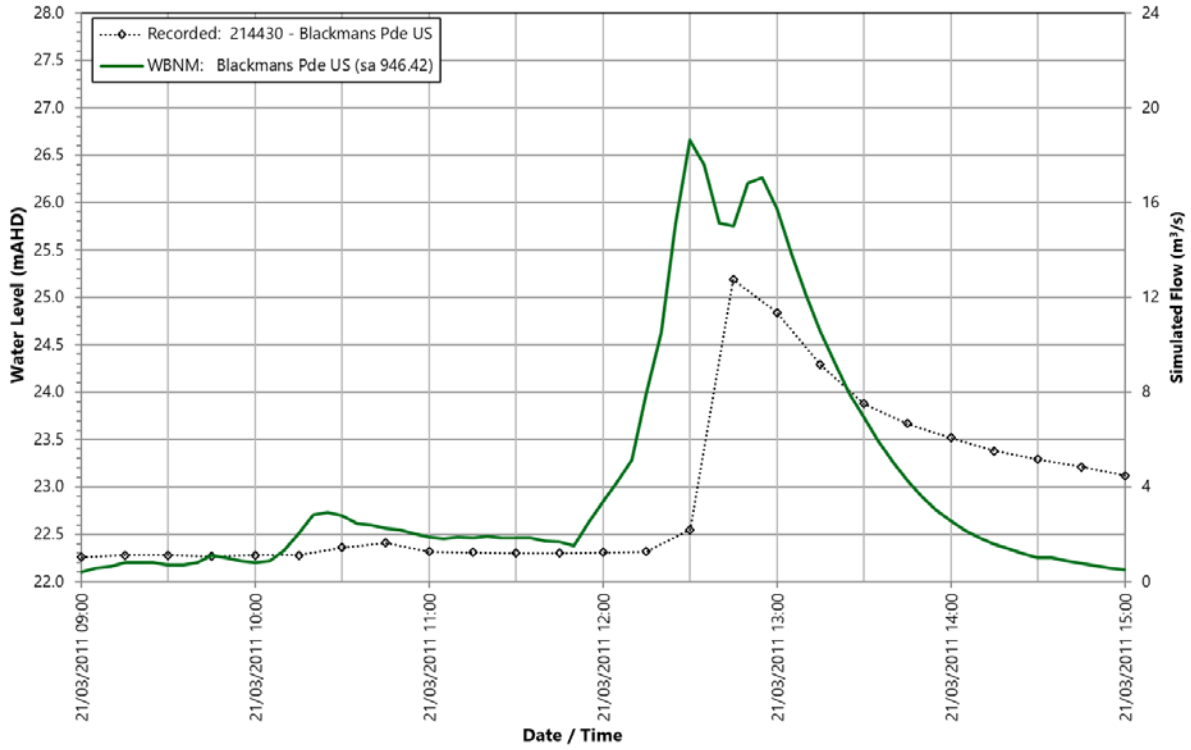


Figure 4 Comparison of WBNM hydrograph to water level record for March 2011 flood

4. TUFLOW GAUGE DATA CALIBRATION AND VERIFICATION RESULTS

Comparisons of TUFLOW simulated flood levels to available water level records for the August 1998, October 1999 and March 2011 flood events are presented in **Figures 5**, **6** and **7** respectively. The results are summarised as follows.

- August 1998
  - It can be seen that the flood levels simulated by TUFLOW follow the recorded data quite closely up until about 7:30 pm. At this time there is a sharp rise in the simulated flood level that is not reflected in the recorded data.
  - Evidence suggests that the actual flood peak was significantly higher than that recorded by the Byarong Creek gauge. Two surveyed flood marks near the American Creek M1 culverts had RLs of approximately 9.9 mAHD. Given expected flood surface gradients the peak flood level at the Byarong Creek gauge would be expected to have been higher than this. The simulated peak flood level is therefore considered to be within the expected range.
- October 1999
  - The simulated timing of the start of the rising limb of the flood compares well to recorded levels
  - The peak flood level under the adopted blockage scenario compares well to the surveyed flood level at the gauge location, which is significantly higher than that recorded by the gauge
  - The simulated falling limb of the flood is longer than that recorded, however the significant difference between surveyed and recorded flood levels casts some doubt on the recorded data
- November 2011
  - While there are differences in the shape of the recorded and simulated flood level hydrographs, the WBNM hydrologic and TUFLOW hydraulic models provide an excellent representation of the level and timing of the flood peak.

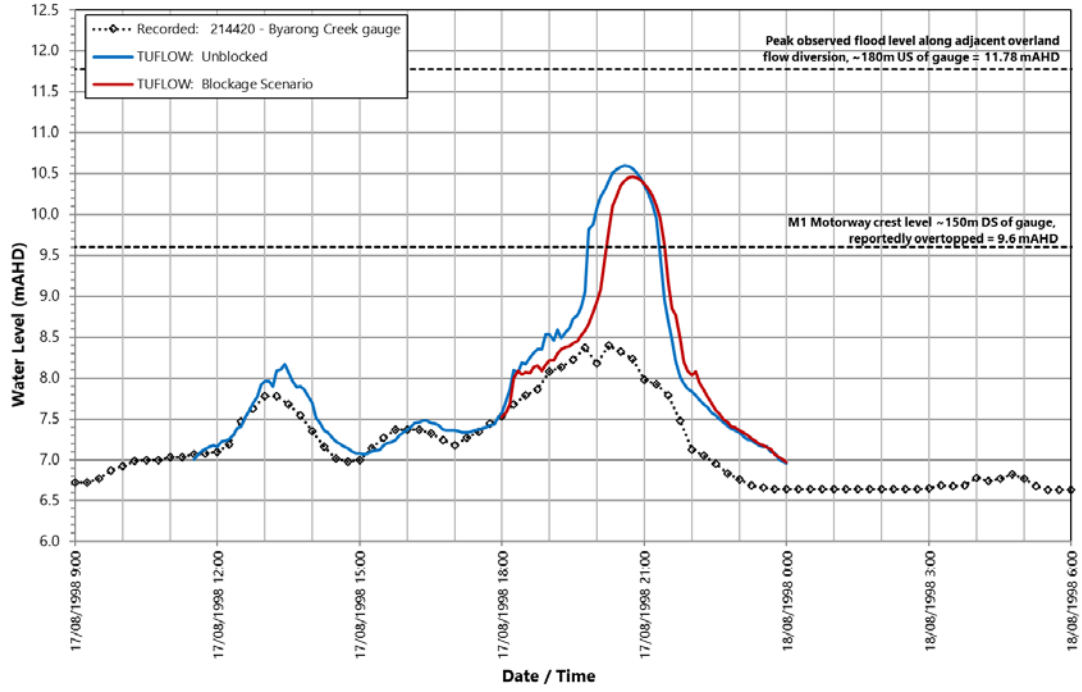


Figure 5 Comparison of TUFLOW calibration results to water level record for August 1998 flood

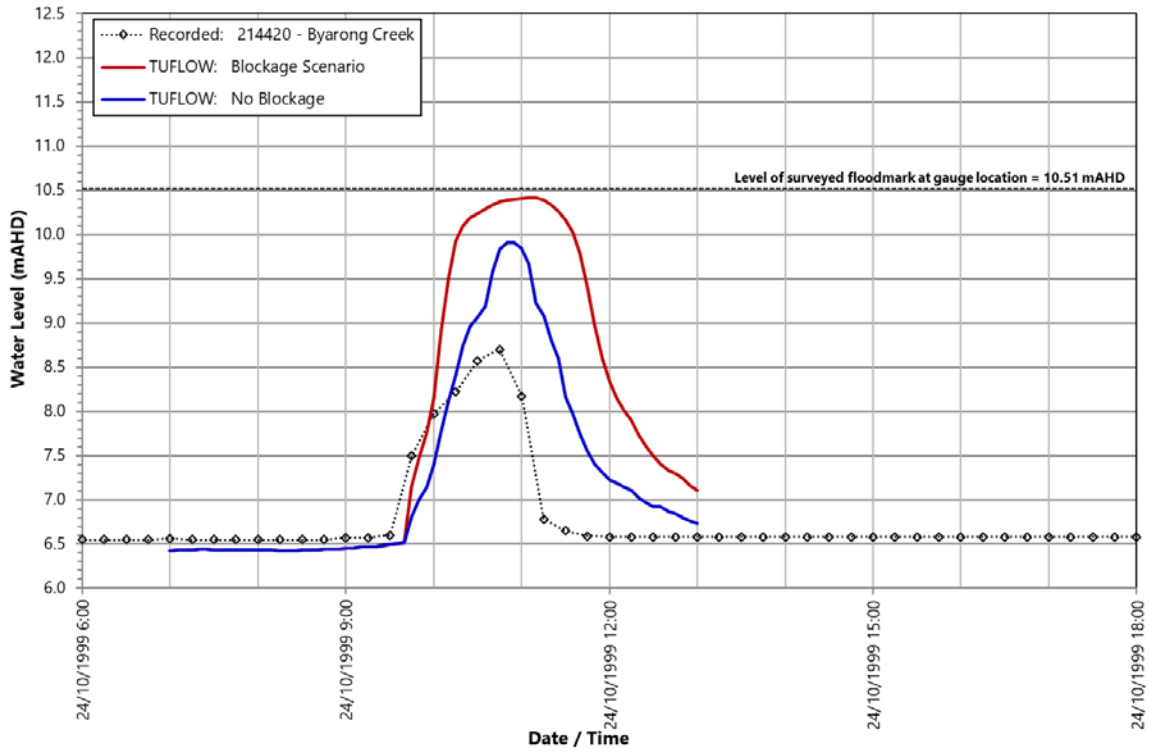


Figure 6 Comparison of TUFLOW calibration results to water level record for October 1999 flood

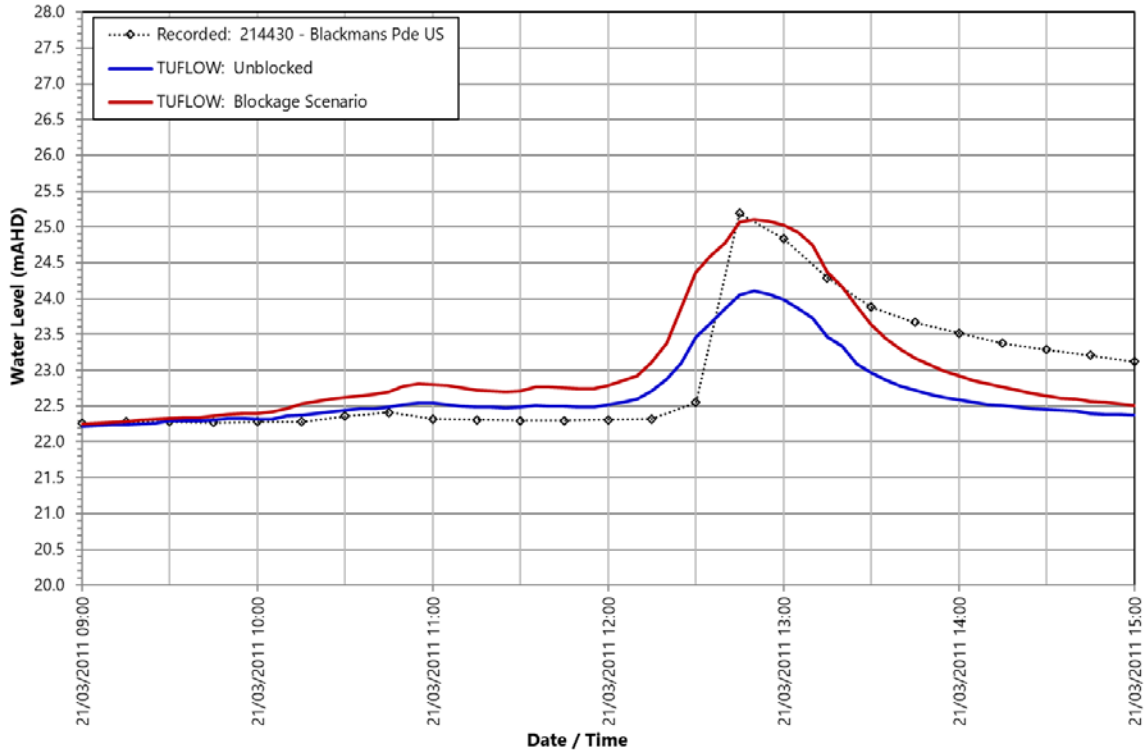


Figure 7 Comparison of TUFLOW calibration results to water level record for March 2011 flood

5. TUFLOW POINT CALIBRATION AND VERIFICATION RESULTS

The results of comparisons of peak simulated flood levels to surveyed flood levels for the August 1998 and October 1999 flood events are presented in **Figures 8** and **9**, and are mapped in **Attachment A**. Key findings include the following:

- For the 1998 event, over 50% of simulated peak flood levels are within +/-0.15m of surveyed flood levels and over 80% are within +/-0.30m
- For the 1999 event, almost 60% of simulated peak flood levels are within +/-0.15m of surveyed flood levels and almost 90% are within +/-0.30m
- For the 1998 event the slightly more than half of simulated peak flood levels are lower than surveyed flood levels (53%), while for the 1999 event more than half of simulated peak flood levels are higher than surveyed flood levels (58%)
- Mean differences for the 1998 and 1999 events are +0.01m and +0.04m respectively, while the 'mean absolute difference' is slightly greater than +/-0.15m for both events.

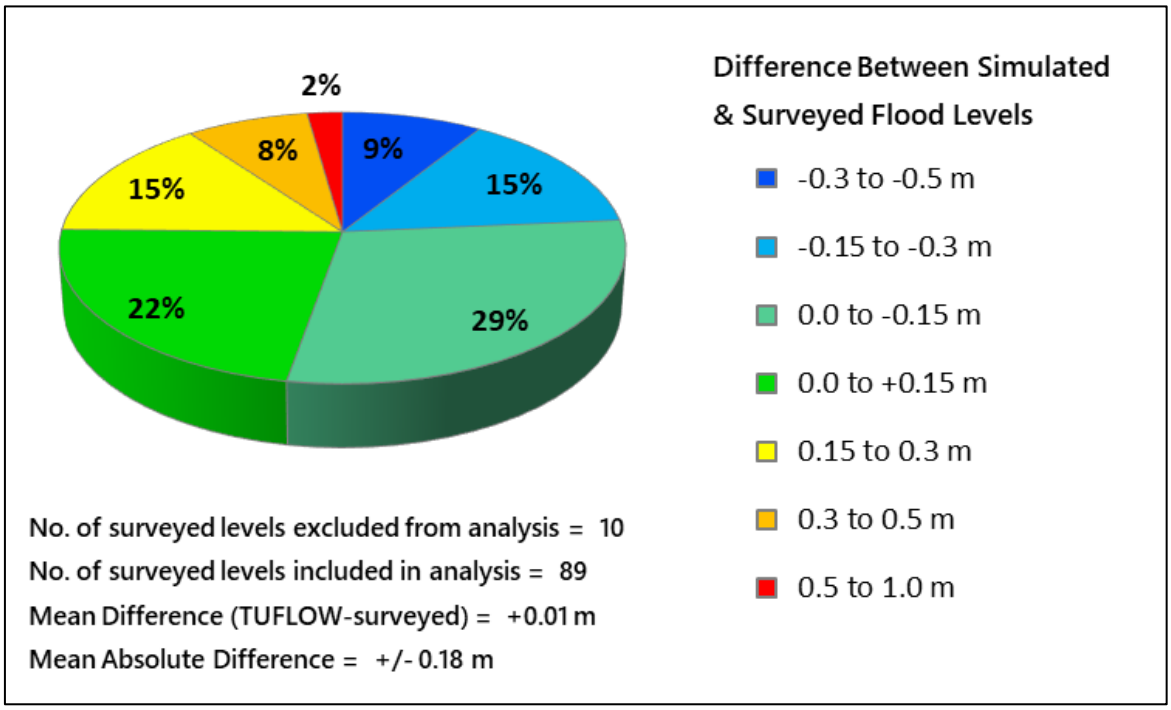


Figure 8 Summary of TUFLOW calibration to surveyed flood levels for August 1998 flood

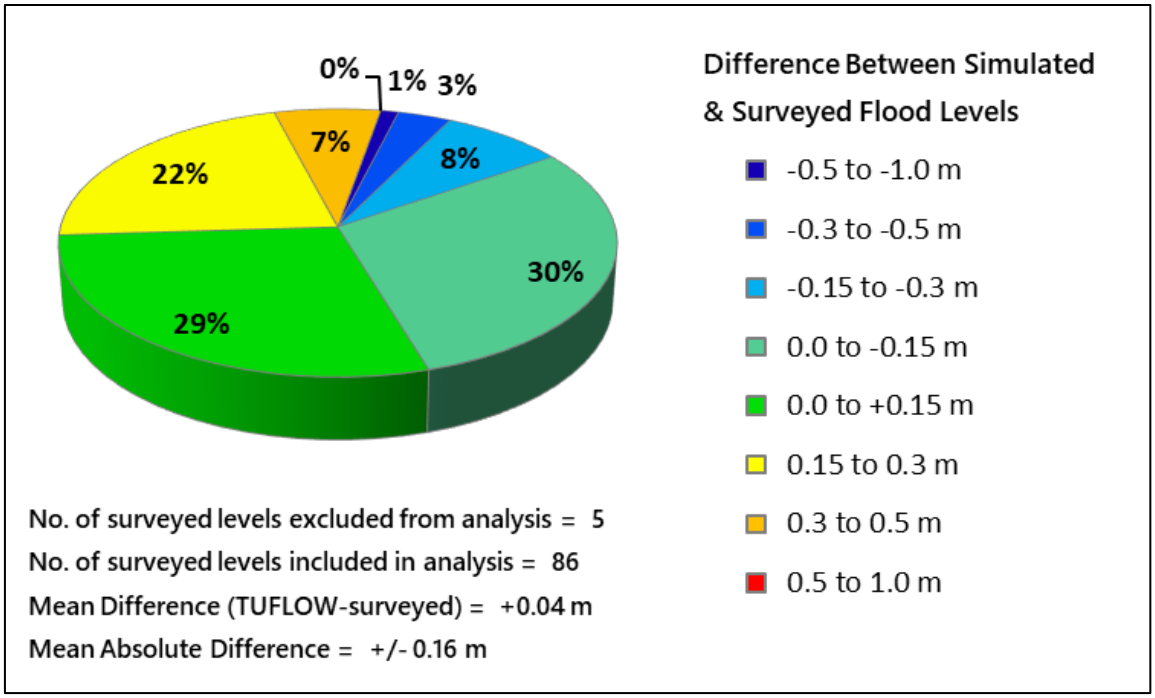


Figure 9 Summary of TUFLOW calibration to surveyed flood levels for October 1999 flood

6. WBNM-TUFLOW HDYROGRAPH COMPARISONS FOR AUGUST 1998 EVENT

Comparisons of flood hydrographs simulated using the WBNM hydrologic and TUFLOW hydraulic models have been undertaken at 60 locations throughout the catchment. These comparisons serve two purposes:

(i) The hydrologic model is to be used to assess 'critical storm duration' at a number of key locations throughout the catchment. It is therefore important that simulated total flows (i.e. routed flows) be reliable at these locations, which is confirmed through the hydrograph comparisons.

(ii) The comparisons provide a form of quality check to confirm that water volume is being conserved within the TUFLOW model. Agreement in the hydrograph shape and peak flows also shows that the differing principals and numerical approaches behind each model are converging on a common result, thus providing additional confidence in the modelling process.

The hydrograph comparisons and a map of their locations are presented in **Attachment B**.

The WBNM and TUFLOW hydrographs show good agreement at almost all locations, providing confidence in the reliability of the WBMN hydrologic model for use in the assessment of critical storm duration.

7. RECOMMENDATIONS

The results presented in this document indicate the following:

- That the WBNM hydrologic model that has been developed as part of this project achieves an acceptable match to the timing and shape of historic flood level hydrographs, particularly for the most significant flood event in August 1998;
- That the stream routing behavior of the WBNM hydrologic model shows good agreement with that of the developed TUFLOW hydraulic model, and is therefore appropriate for use in the assessment of critical storm duration and 'average' ARR2016 temporal rainfall pattern; and,
- That the developed TUFLOW hydraulic model, using local flow hydrograph inputs from the WBNM hydrologic model, effectively reproduces surveyed and recorded flood levels from historic flood events.

In consideration of the above findings, it is recommended that the developed WBNM and TUFLOW models be adopted for use in design flood modelling for the *Allans Creek Flood Study Review* project.

Regards

Leon Collins

Senior Engineer – Water Resources

Reviewed by

Chris Thomas

Principal
Practice Lead - Water Resources

ATTACHMENT A

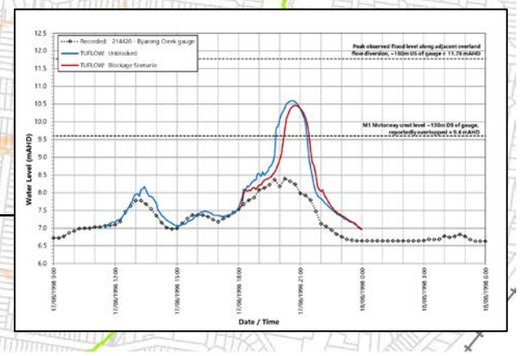
TUFLOW Point Calibration and Verification Maps

Date prepared: 13/12/2018
WBNM version: 181211_AC_CSIM019_STR05_August1998_RF02_C1.5_F04.wbn
TUFLOW version: AC_181130_ALScomb_5mgrd_98blk_Aug98RST

FIGURE A-1

DRAFT

35.51 | 36.93 | 1.41
35.69 | 35.86 | 0.18
35.08 | 34.68 | -0.4
31.78 | 31.78 | 0
25.67 | 25.68 | 0.02
22.03 | 25.54 | 3.52
25.37 | 25.36 | 0
22.52 | 22.49 | -0.02
21.01 | 21.18 | 0.18
20.7 | 20.82 | 0.12
20.13 | 19.94 | -0.19
55.05 | 55.41 | 0.36
54.04 | 54.56 | 0.52
30.29 | 30.21 | -0.08
30.27 | 29.88 | -0.39
30.13 | 30.11 | -0.02
33.89 | 33.89 | 0
17.58 | 17.56 | -0.02
17.45 | 17.32 | -0.13
17.5 | 17.05 | -0.45
15.78 | 16.19 | 0.4
16.58 | 16.32 | -0.26
15.56 | 15.73 | 0.17
16.39 | 16.24 | -0.16
16.54 | 16.27 | -0.27
16.25 | 16.22 | -0.03
40.19 | 40.49 | 0.3
39.21 | 38.95 | -0.26
28.85 | 28.85 | 0
28.71 | 28.83 | 0.12
25.92 | 26.08 | 0.16
19.27 | 19.57 | 0.3
13.69 | 13.62 | -0.07
13.19 | 13 | -0.19
12.59 | 12.15 | -0.44
12.77 | 12.85 | 0.08
12.09 | 12.25 | 0.17
11.78 | 11.96 | 0.18
12.73 | 12.85 | 0.12
11.27 | 11.32 | 0.05
11.78 | 11.62 | -0.16
28.3 | 28.81 | 0.5
14.01 | 13.7 | -0.31
13.82 | 13.7 | -0.12
12.57 | 12.6 | 0.03
14.01 | 13.7 | -0.31
10.85 | 10.99 | 0.14
13.7 | 11.47 | -2.23
11.08 | 10.94 | -0.14
11.15 | 10.87 | -0.28
4.64 | 10.86 | 6.22
10.62 | 10.88 | 0.26
22.93 | 22.73 | -0.2
22.78 | 22.35 | -0.43
20.78 | 20.96 | 0.18
20.92 | 20.86 | -0.06
15.43 | 15.24 | -0.19
17.04 | 15.52 | -1.52
15.8 | 15.52 | -0.28
15.86 | 15.75 | -0.11
17.33 | 17.21 | -0.12
9.88 | 9.91 | 0.03
9.86 | 9.91 | 0.05
8.44 | 8.53 | 0.09
7.29 | 7.43 | 0.14
7.29 | 7.33 | 0.04
7.28 | 7.32 | 0.04



LEGEND

- Allans Creek Catchment
- Wollongong Catchment
- Major Roads
- Railway
- Cadastre

TUFLOW August 1998
VelocityxDepth Product (m^2/s)

- >0.01
- 0.3
- 0.6
- >1.0

Difference to flood mark (m)

- < -1.0
- -1.0 - -0.5
- -0.5 - -0.3
- - 0.3 - -0.15
- -0.15 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0
- ✖ Excluded from analysis

Labels: Survey RL (mAHD) | TUFLOW (mAHD) | Difference (m)

N

0 0.3 0.6 0.9 1.2 km

Advisian
WorleyParsons Group

180928_QGIS_AllansCkFS_Stage2_Figs.qgs
Fg301015-03839_180928_AllansCkFS_Stage2_A3L.pptx

TUFLOW CALIBRATION RESULTS FOR AUGUST 1998 FLOOD EVENT
TILE 1

Date prepared: 13/12/2018
WBNM version: 181211_AC_CSIM019_STR05_August1998_RF02_C1.5_F04.wbn
TUFLOW version: AC_181130_ALScomb_5mgrd_98blk_Aug98RST

FIGURE A-2

DRAFT

15.86 | 15.75 | -0.11
17.33 | 17.21 | -0.12
9.88 | 9.91 | 0.03
9.86 | 9.91 | 0.05
8.44 | 8.53 | 0.09
7.29 | 7.43 | 0.14
7.28 | 7.32 | 0.04
7.29 | 7.33 | 0.04
7.94 | 8.13 | 0.19
36.44 | 36.81 | 0.37
6.61 | 7.09 | 0.48
15.06 | 14.87 | -0.19
37.95 | 38.3 | 0.35
37.81 | 38.02 | 0.21
25.1 | 25.06 | -0.04
24.74 | 24.7 | -0.04
16.53 | 16.55 | 0.02
16.53 | 16.44 | -0.09
16.55 | 16.43 | -0.12
16.25 | 16.36 | 0.11
16.52 | 16.42 | -0.1
16.31 | 16.26 | -0.05
16.17 | 16.32 | 0.15
16.29 | 16.23 | -0.06
16.24 | 16.22 | -0.02
13.06 | 13.18 | 0.12
14.86 | 5.71 | -9.15
3.75 | 4.64 | 0.89
16.14 | 16.11 | -0.03
8.51 | 8.45 | -0.07
22.13 | 22.25 | 0.12
13.21 | 14.18 | 0.97
24.54 | 25.43 | 0.89
5.05 | 4.61 | -0.44
17.88 | 18.23 | 0.35
18.91 | 19.21 | 0.3
18.26 | 19.22 | 0.96
28.4 | 28.46 | 0.06
28.82 | 28.53 | -0.29

N

0 0.3 0.6 0.9 1.2 km

LEGEND

- Allans Creek Catchment
- Wollongong Catchment
- Major Roads
- Railway
- Cadastre

TUFLOW August 1998
VelocityxDepth Product (m^2/s)

- >0.01
- 0.3
- 0.6
- >1.0

Difference to flood mark (m)

- < -1.0
- -1.0 - -0.5
- -0.5 - -0.3
- - 0.3 - -0.15
- -0.15 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0
- Excluded from analysis

Labels: Survey RL (mAHD) | TUFLOW (mAHD) | Difference (m)

Advisian
WorleyParsons Group

180928_QGIS_AllansCkFS_Stage2_Figs.qgs
Fg301015-03839_180928_AllansCkFS_Stage2_A3L.pptx

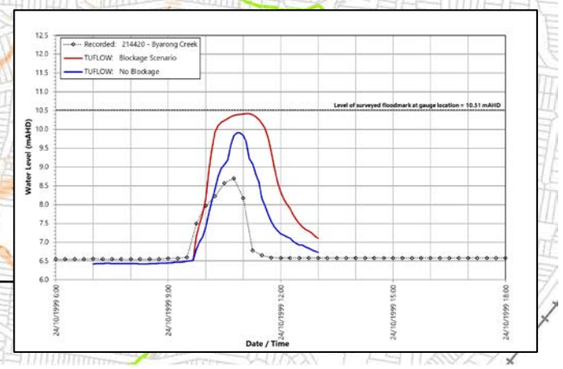
TUFLOW CALIBRATION RESULTS FOR AUGUST 1998 FLOOD EVENT
TILE 2

Date prepared: 13/12/2018
WBNM version: 181211_AC_CSIM019_STR05_Oct1999_RF04_C1.5_F04.wbn
TUUFLOW version: AC_181130_ALScomb_5mgrd_99blk_Oct1999

FIGURE A-3

DRAFT

35.13 | 35.5 | 0.37
34.38 | 34.46 | 0.09
33.02 | 33.13 | 0.11
27.47 | 27.72 | 0.25
28.94 | 28.85 | -0.09
22.02 | 21.96 | -0.05
21.3 | 21.12 | -0.18
21.16 | 20.97 | -0.18
21.12 | 21.03 | -0.09
20.57 | 20.49 | -0.08
18.65 | 18.61 | -0.04
16.75 | 16.81 | 0.06
16.98 | 17.08 | 0.1
16.8 | 16.74 | -0.06
16.4 | 16.68 | 0.28
16.39 | 16.67 | 0.28
16.19 | 16.56 | 0.37
16.15 | 16.57 | 0.42
15.22 | 15.58 | 0.36
13.93 | 13.95 | 0.02
15.44 | 15.73 | 0.29
15.43 | 15.64 | 0.22
14.16 | 14.38 | 0.23
12.08 | 12.13 | 0.05
12.09 | 12.11 | 0.02
12.04 | 12.1 | 0.06
12 | 12.1 | 0.1
11.63 | 11.81 | 0.19
11.62 | 11.83 | 0.21
10.93 | 11.17 | 0.25
11.87 | 11.99 | 0.12
11 | 11.07 | 0.07
11.13 | 11.29 | 0.16
12.15 | 12.16 | 0.01
11.88 | 11.65 | -0.23
11.49 | 11.95 | 0.46
11.5 | 11.95 | 0.45
11.01 | 11.16 | 0.15
12.14 | 12.15 | 0.01
11.04 | 11.01 | -0.03
10.16 | 10.36 | 0.2
10.51 | 10.42 | -0.09
11.04 | 11 | -0.04
11.2 | 10.99 | -0.21
11.1 | 10.48 | -0.62
9.1 | 9 | -0.1
42.84 | 41.69 | -1.15
33.42 | 33.61 | 0.19
33.44 | 33.66 | 0.22
18.66 | 18.57 | -0.09
34.82 | 35.23 | 0.41
13.77 | 13.7 | -0.07
13.62 | 13.56 | -0.06
13.04 | 12.53 | -0.51
13.87 | 13.95 | 0.08
13.86 | 13.93 | 0.07
13.2 | 12.95 | -0.25
13.4 | 12.95 | -0.45
13.72 | 13.86 | 0.14
15.51 | 15.31 | -0.21
15.15 | 15.34 | 0.19
15.53 | 15.26 | -0.27
15.89 | 15.78 | -0.11
15.91 | 15.8 | -0.11
20.98 | 21.19 | 0.21
24.43 | 24.4 | -0.02
29.58 | 29.49 | -0.09
29.78 | 29.74 | -0.04
20.62 | 20.53 | -0.09
7.82 | 7.34 | -0.47
9.16 | 9.56 | 0.4
9.51 | 9.15 | -0.37
9.65 | 9.57 | -0.08



N

0 0.3 0.6 0.9 1.2 km

LEGEND

- Allans Creek Catchment
- Wollongong Catchment
- Major Roads
- Railway
- Cadastre

TUFLOW October 1999
VelocityxDepth Product (m^2/s)

- >0.01
- 0.3
- 0.6
- >1.0

Difference to flood mark (m)

- < -1.0
- -1.0 - -0.5
- -0.5 - -0.3
- - 0.3 - -0.15
- -0.15 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0
- ✖ Excluded from analysis

Labels: Survey RL (mAHD) | TUFLOW (mAHD) | Difference (m)

Advisian
WorleyParsons Group

180928_QGIS_AllansCkFS_Stage2_Figs.qgs
Fg301015-03839_180928_AllansCkFS_Stage2_A3L.pptx

TUFLOW VERIFICATION RESULTS FOR OCTOBER 1999 FLOOD EVENT PART 1

Date prepared: 13/12/2018
WBNM version: 181211_AC_CSIM019_STR05_Oct1999_RF04_C1.5_F04.wbn
TUUFLOW version: AC_181130_ALScomb_5mgrd_99blk_Oct1999

FIGURE A-4

DRAFT

15.91 | 15.8 | -0.11
9.1 | 9 | -0.1
24.43 | 24.4 | -0.02
20.62 | 20.53 | -0.09
29.58 | 29.49 | -0.09
29.78 | 29.74 | -0.04
7.82 | 7.34 | -0.47
9.16 | 9.56 | 0.4
9.51 | 9.15 | -0.37
9.67 | 9.57 | -0.1
9.65 | 9.57 | -0.08
9.6 | 9.57 | -0.03
11.51 | 11.56 | 0.05
19.32 | 19.43 | 0.11
15.24 | 15.15 | -0.09
13.82 | 13.85 | 0.02
14.33 | 14.3 | -0.03
14.96 | 14.86 | -0.1
25.87 | 25.97 | 0.1
97.2 | 97.4 | 0.2
96.72 | 97.35 | 0.63
16.39 | 16.27 | -0.12
16.11 | 16.19 | 0.09
15.99 | 16.27 | 0.28
22.9 | 23.11 | 0.21
22.75 | 22.93 | 0.18
25.65 | 25.74 | 0.09

N

0 0.3 0.6 0.9 1.2 km

LEGEND

- Allans Creek Catchment
- Wollongong Catchment
- Major Roads
- Railway
- Cadastre

TUFLOW October 1999
VelocityxDepth Product (m^2/s)

- >0.01
- 0.3
- 0.6
- >1.0

Difference to flood mark (m)

- < -1.0
- -1.0 - -0.5
- -0.5 - -0.3
- - 0.3 - -0.15
- -0.15 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- > 1.0
- ✖ Excluded from analysis

Labels: Survey RL (mAHD) | TUFLOW (mAHD) | Difference (m)

Advisian
WorleyParsons Group

180928_QGIS_AllansCkFS_Stage2_Figs.qgs
Fg301015-03839_180928_AllansCkFS_Stage2_A3L.pptx

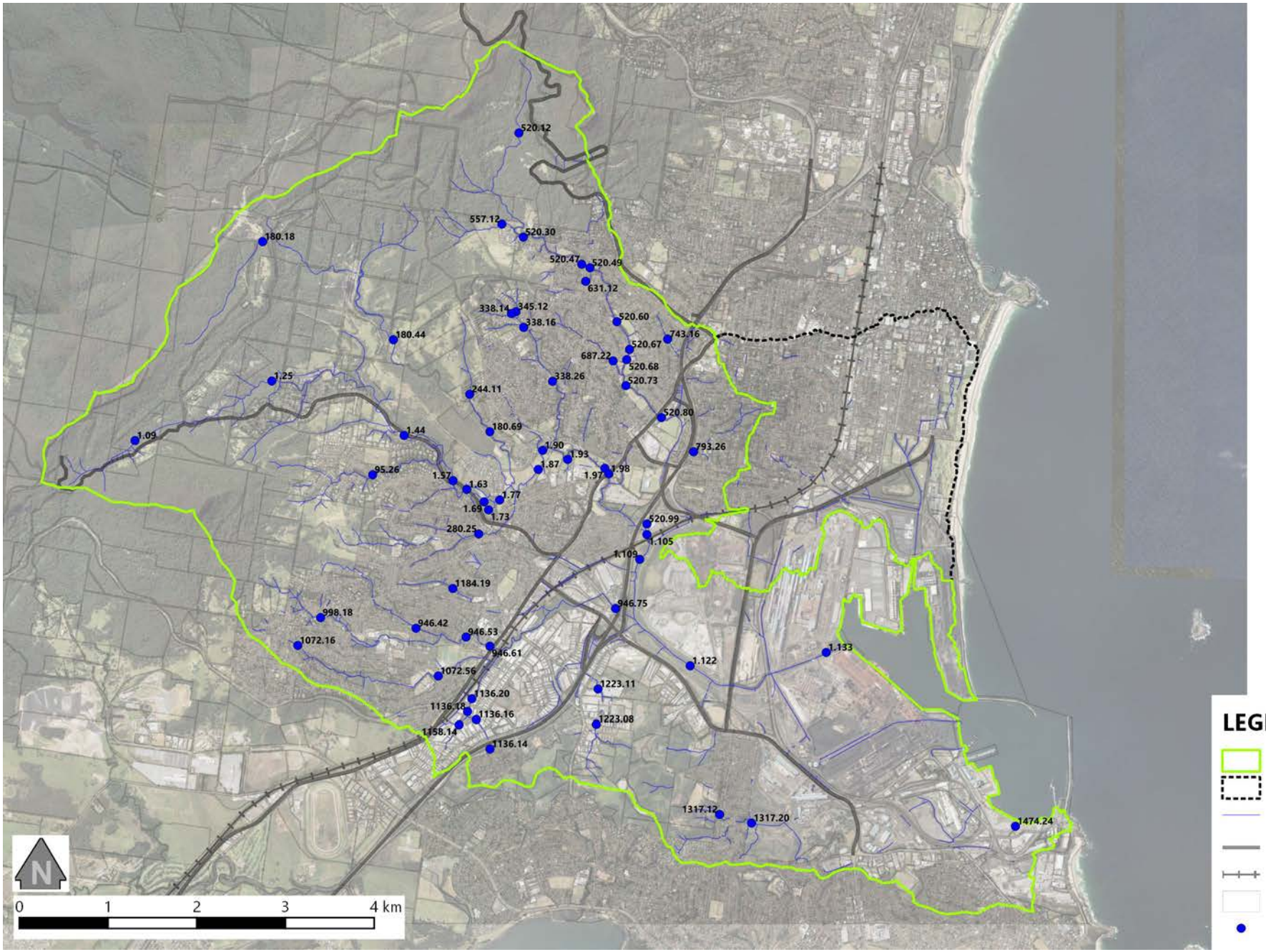
TUFLOW VERIFICATION RESULTS FOR OCTOBER 1999 FLOOD EVENT
TILE 2

ATTACHMENT B

August 1998 WBNM-TUFLOW Hydrograph Comparisons

FIGURE B-1

DRAFT



Advisian
WorleyParsons Group

180928_QGIS_AllansCkFS_Stage2_Figs.qgs
Fg301015-03839_180928_AllansCkFS_Stage2_A4L.pptx

WBNM AND TUFLOW FLOW COMPARISON LOCATIONS

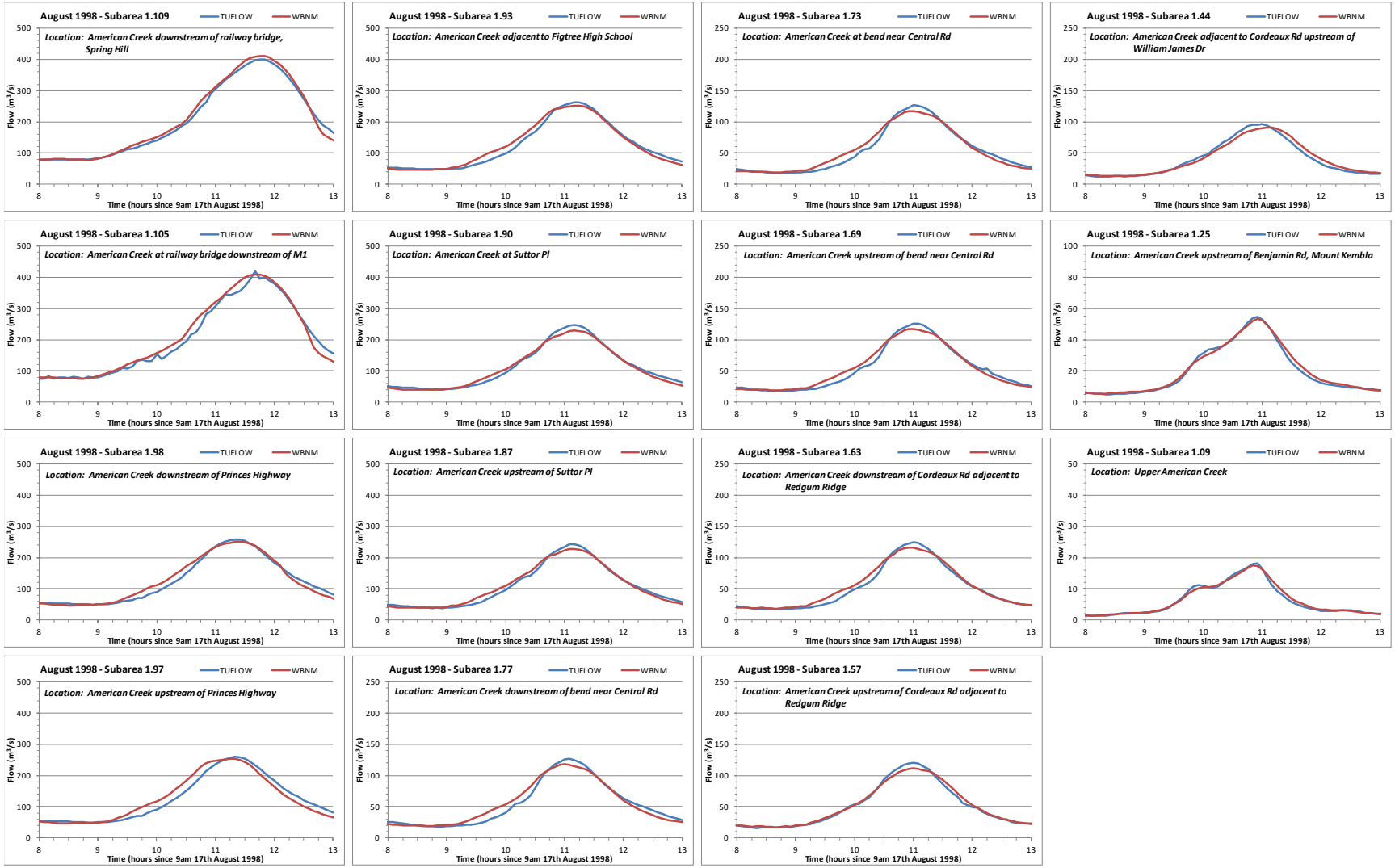


Figure B-2 Comparison of simulated August 1998 WBNM and TUFLOW hydrographs along American Creek

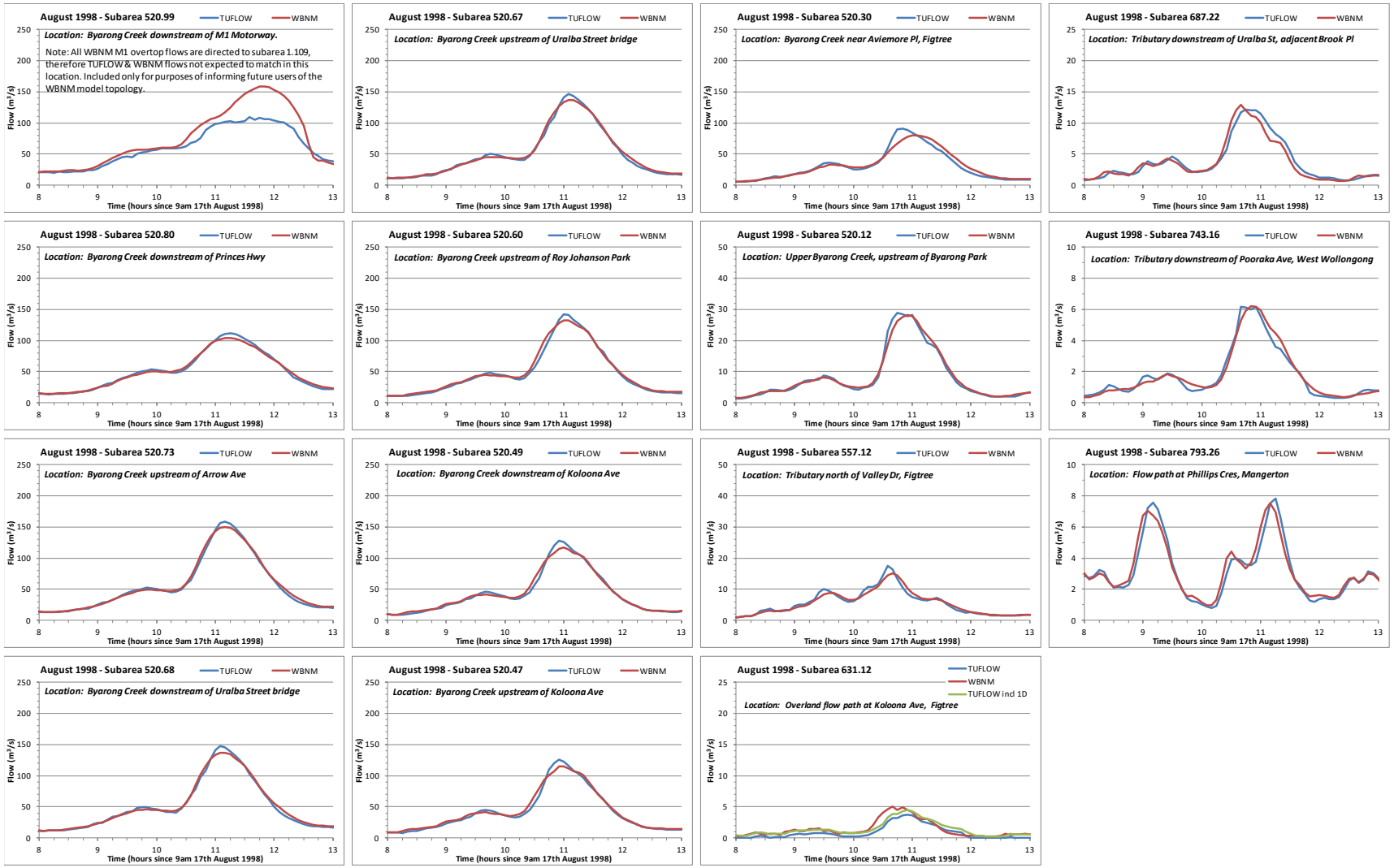


Figure B-2 Comparison of simulated August 1998 WBNM and TUFLOW hydrographs along Byarong Creek and tributaries

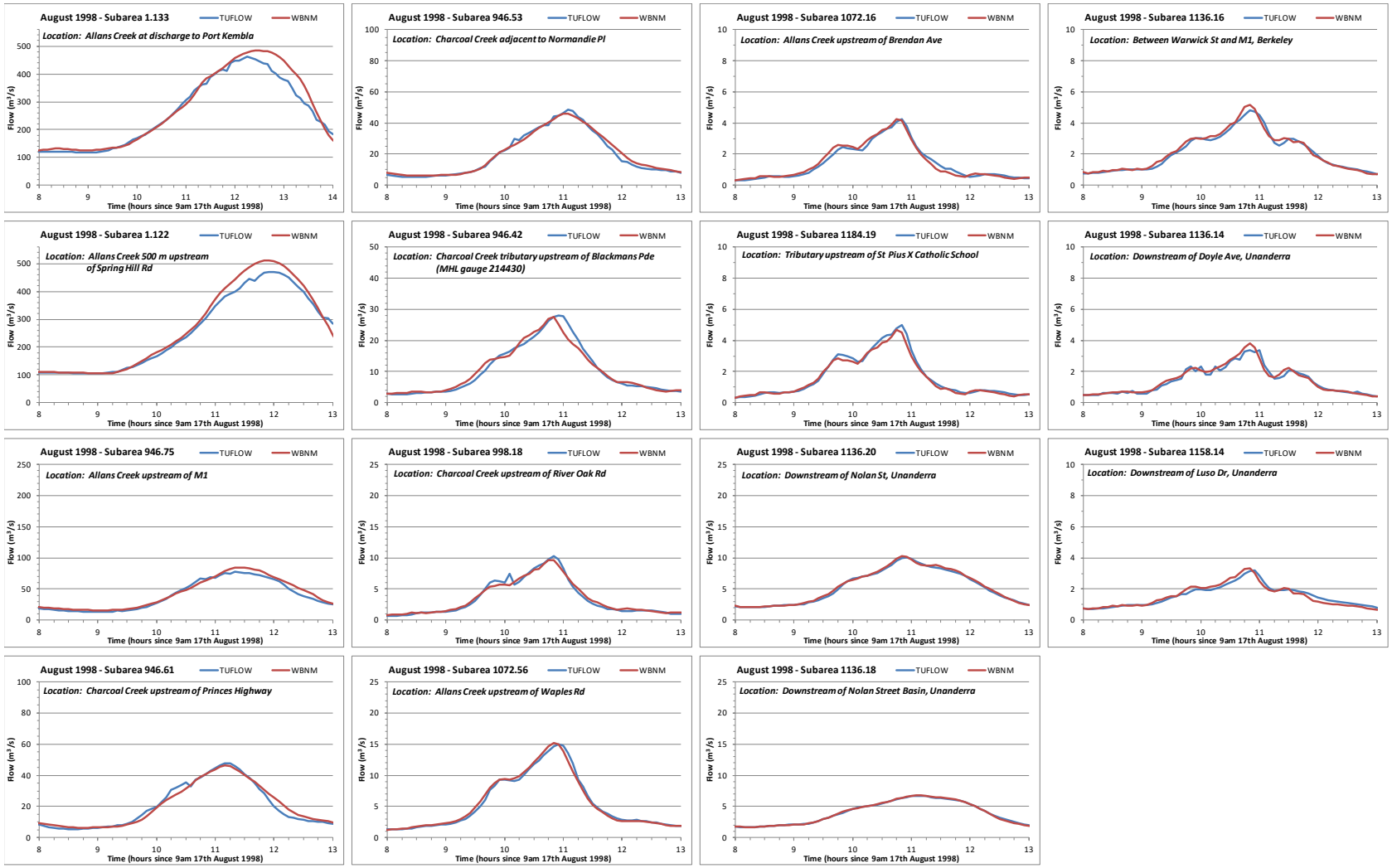


Figure B-3 Comparison of simulated August 1998 WBNM and TUFLOW hydrographs along Allans Creek, Charcoal Creek and tributaries

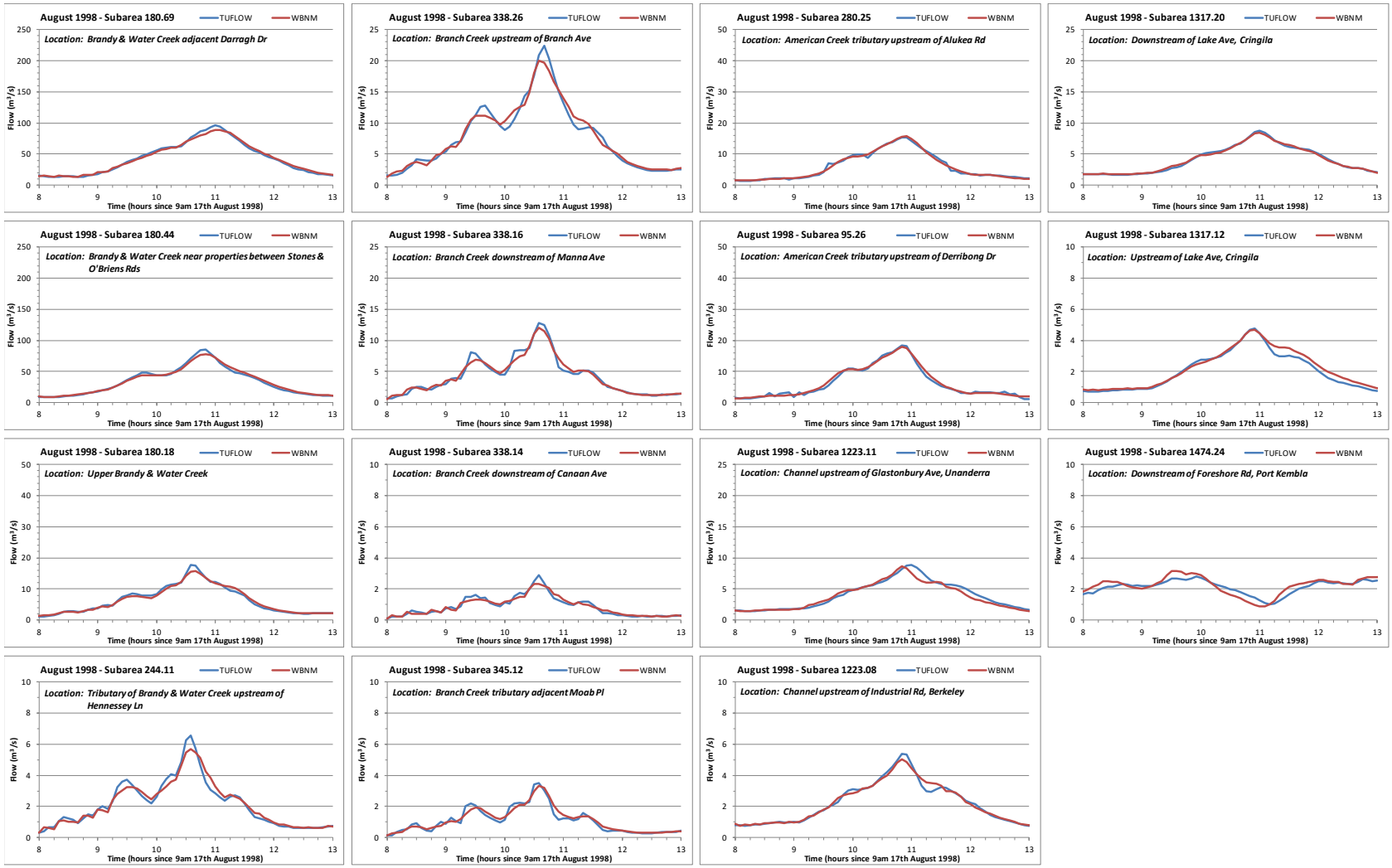


Figure B-4 Comparison of simulated August 1998 WBNM and TUFLOW hydrographs along Barandy & Water Creek, Branch Creek and industrial areas