Fairfield City Council

PROSPECT CREEK FLOODPLAIN MANAGEMENT PLAN

Flood Study Review

February 2006

Prepared by:

BEWSHER CONSULTING PTY LTD

P O BOX 352 EPPING NSW 1710

Telephone (02) 9868 1966
Facsimile (02) 9868 5759
E-mail: postmaster@bewsher.com.au
ACN 003137068

TABLE OF CONTENTS

Page

1.0 BACKGROUND **2**

2.0 HYDROLOGIC REVIEW **3**
- 2.1 Aerial Reduction Factors 3
- 2.2 Embedded Design Storms 3
- 2.3 Rainfall Patters 4
- 2.4 Intensity-Frequency-Duration Curves 4
- 2.5 Rainfall Loss Method 4
- 2.6 Review of Detention Basins 4
- 2.7 Model Verification 5
- 2.8 Revised Flow Estimates 6

3.0 HYDRAULIC REVIEW **9**
- 3.1 WBM Review of TUFLOW Model 9
- 3.2 Other WBM Recommendations 11
- 3.3 Changes Upstream of Widemere Road 12
- 3.4 Model Calibration 12
- 3.5 Design Boundary Conditions 15

4.0 DESIGN FLOOD BEHAVIOUR **16**

5.0 REFERENCES **17**

TABLES

Table A1 – Peak Flow Estimates from Updated RAFTS model 7
Table A2 – WBM TUFLOW model updates and recommendations 10
Table A3 – TUFLOW Calibration to January 2001 Flood 13

FIGURES

Figure A1 – Subcatchment Boundaries
Figure A2 – TUFLOW Model Calibration to January 2001 Flood
Figure A3 – 20 Year Flood Level Contours and Extents
Figure A4 – 50 Year Flood Level Contours and Extents
Figure A5 – 100 Year Flood Level Contours and Flood Extents
Figure A6 – PMF Flood Level Contours and Flood Extents

1.0 BACKGROUND

Flood behaviour throughout the Prospect Creek catchment was previously documented in the Lower Prospect Creek Floodplain Management Study (Willing & Partners, 1990) and the Upper Prospect Creek Floodplain Management Study (Willing & Partners, 1993).

A review of Prospect Creek Flood Levels was completed in 2004 by Cardno Willing. The study was based on a RAFTS hydrologic catchment model and a TUFLOW 2-dimensional hydraulic model.

A further review of these models was undertaken as part of the current floodplain management plan being prepared by Bewsher Consulting. Some of the RAFTS modelling assumptions were varied to ensure consistency with other concurrent studies being prepared elsewhere in Fairfield City Council. Several changes to the TUFLOW model were also made, based on recommendations made by WBM Pty Ltd, who are the authors of this model.

Changes that have been made to both models are outlined in Sections 2.0 and 3.0. The changes also necessitated further model calibration, which is discussed in Section 4.0. Design flood behaviour has been presented as flood extents and flood contours for the 20 year, 50 year, 100 year and PMF floods, whilst the floodplain has been divided into three flood risk areas (high, medium and low). These results are provided on Figures A3 to A7. The information has also been provided in digital format for incorporation in Council's GIS computer system.

2.0 HYDROLOGIC REVIEW

A review of the RAFTS modelling assumptions included in the 2004 Prospect Creek Study was undertaken by Fairfield City Council in 2005, in conjunction with a number of overland flood studies to be undertaken throughout the LGA.

The review recommended a number of changes to the 2004 Prospect Creek RAFTS model to simplify future assessments and ensure consistency between the various studies. Changes that were subsequently made to the modelling assumptions are outlined below.

2.1 Areal Reduction Factors (ARFs)

Areal reduction factors are applied to point rainfall estimates derived from Australian Rainfall & Runoff (AR&R) to account for the likely variability of rainfall over the catchment. As catchment areas increase, a greater reduction is usually required.

The 2004 Prospect Creek model adopted an ARF of 0.877 when considering the 9 hour storm over the whole Prospect Creek catchment, and an ARF of 0.906 when considering the 2 hour storm over the upper catchment. A subsequent discussion paper (Cardno Willing, 2004) recommended areal reduction factors for local studies that varied from 0.92 (1 hour storm) to 0.877 (9 hour storm).

AR&R also notes that point rainfall may be taken to represent the total rainfall over small areas (eg $4km^2$), implying that no areal reduction factor is required for small catchment areas or where short duration floods are critical.

A simple, consistent approach to estimating areal reduction factors that can be applied over all catchments within the Fairfield LGA is desirable. Since the range in values is small (for durations between 1 and 9 hours), a uniform value of 0.9 has been adopted for all catchments where the critical duration is 1 hour or more, and no areal reduction factor applied where the critical duration is less than 1 hour.

Results from sensitivity modelling indicate that this change would increase peak flows in Prospect Creek for the 9 hour 100 year flood by +2 to +3%.

2.2 Embedded Design Storms

Design storms for the 2004 Prospect model were derived by embedding the 2 hour or 9 hour storm burst within the observed 2001 flood. This made little difference to the 9 hour flood, but tended to mask the effects of shorter duration floods in smaller catchment areas. Effectively, small duration events such as the 2 hour storm became very similar to the longer 9 hour design storm.

Replacement of the embedded storm approach with the standard AR&R rainfall bursts was considered desirable for consistency with other studies underway. The effect of longer duration storms and additional runoff volume was considered by testing storm durations ranging from 25 minutes to 36 hours.

In relation to Prospect Creek, this change tended to reduce 100 year peak flows for the 9 hour flood by -2% to -3%, whereas the impact in the upper catchment areas for the 2 hour storm saw larger reductions of up to -12%.

2.3 Rainfall Patterns

Rainfall patterns used to describe the 9 hour storm burst in the 2004 Prospect Creek model were found to contain some discrepancies for the 50 and 100 year floods when compared to data provided in AR&R. These patterns were amended for consistency with AR&R.

The effect of this change was to reduce peak flows throughout the catchment for the 9 hour 100 year flood by -4% to -6%.

2.4 Intensity-Frequency-Duration Curves

The 2004 Prospect Creek model incorporated design rainfall bursts derived from data included in AR&R. However, Council has subsequently adopted standardised rainfall intensity-frequency-duration curves throughout the LGA, and adoption of these standard values was considered desirable for consistency with other studies that are underway.

The effect of adopting the standard rainfall-intensity-duration values leads to a reduction in peak flows of around -2% to -3% for the 100 year flood.

2.5 Rainfall Loss Method

Rainfall losses were determined in the 2004 Prospect Creek model using the ARBM loss model. The ARBM loss model is influenced by antecedent wetness conditions, which in itself is influenced by assumptions with embedded storms. It was also noted that the assumed start time of the storm affected the results from the model (presumably as a result of higher evaporation during the middle of the day).

A simple approach, independent of storm duration, embedded storms and commencement time was preferred for the overland flood studies currently underway. It was subsequently decided to adopt an initial/continuing loss rate method for all RAFTS models.

Adopted loss rates, after review of the model calibration to the 2001 flood, were as follows:

Pervious areas	IL=15mm	CL=1.5mm/hr
Impervious areas	IL=1.5mm	CL= 0mm/hr
Lumped areas	IL= 7mm	CL=1.0mm/hr

The different approach to rainfall losses was found to affect results by less than 1% in the 100 year flood. Some small increases were evident in the upper catchment, whilst small reductions occurred in the lower catchment.

2.6 Review of Detention Basins

The representation of the detention basins in the RAFTS model was also briefly reviewed, in particular the two largest basins at Hassall Street and Rosford Street.

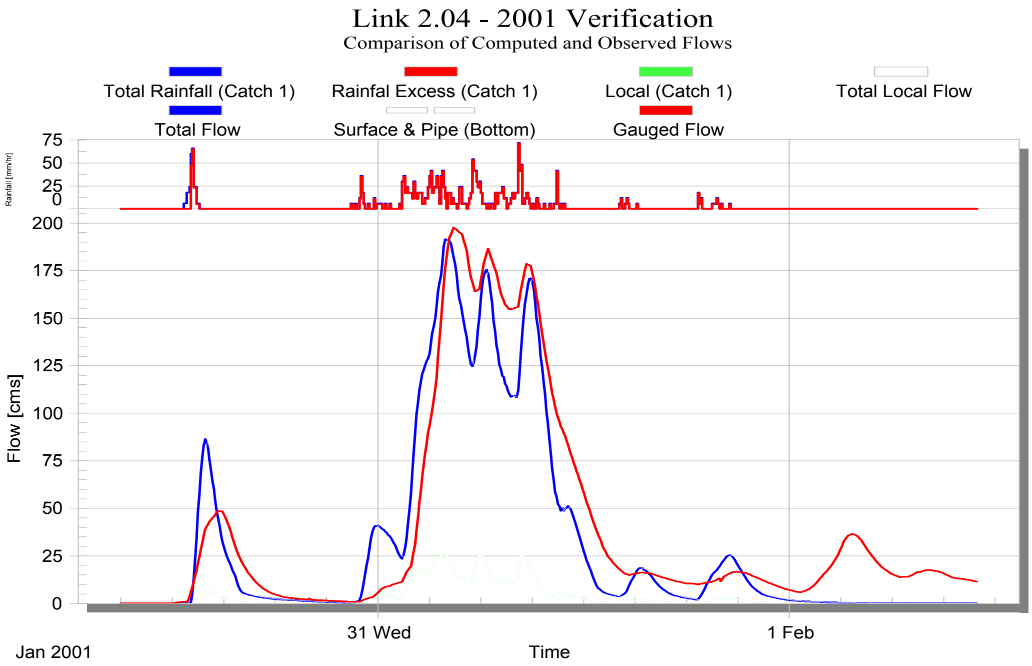
The outlets from these two basins were specified as stage-discharge relationships. The stage-discharge curve specified for the Hassall Street basin appeared to be based on the old outlet configuration for this basin, prior to two of the four cell culverts being blocked. This led to lower predictions of water levels within the basin.

The stage-discharge curve for the Hassall Street basin was therefore reduced to account for the current outlet conditions. No change was considered necessary for the Rosford Street Basin, which recently had one of five cells blocked.

2.7 Model Verification

The changes to the RAFTS modelling approach outlined above could potentially affect the performance of the model to predict historical flood behaviour. The 2004 RAFTS model had previously been calibrated to a hydrograph recorded on Orphan School Creek in the January 2001 flood. A review of the updated RAFTS model was also made by comparing computed flows with observed flows.

The comparison of computed and observed flows for the January 2001 flood is illustrated below.



The overall shapes of the calculated and recorded flow hydrographs are consistent, and the calculated peak flow is within 3% of the recorded peak. This was considered to be suitable verification of the revised RAFTS model.

2.8 Revised Flow Estimates

The 2004 Prospect Creek RAFTS model was updated to include the changes listed above. The sub-catchment boundaries and other catchment parameters were unchanged from the 2004 model. A map showing these subcatchment areas and their node numbers is illustrated in Figure A1.

The updated model was then used to generate new flow hydrographs throughout the Prospect Creek catchment for the 20 year, 50 year and 100 year floods. A range in storm durations from 25 minutes to 36 hours was tested to determine the critical storm duration at various locations throughout the catchment. No changes were made to the estimates previously provided for the PMF flood.

Peak flow estimates from the model are provided in Table A1.

Table A1
Peak Flow Estimates from Updated RAFTS model

Link Label	PMF		100 Year		50 Year		20 Year	
	Peak Inflow (m^3/s)	Critical Storm (mins)	Peak Inflow (m^3/s)	Critical Storm (mins)	Peak Inflow (m^3/s)	Critical Storm (mins)	Peak Inflow (m^3/s)	Critical Storm (mins)
ReC1	30.0	60	5.2	120	4.5	120	3.9	360
ReC2	42.2	60	7.2	360	6.3	360	5.4	360
ReC3	29.7	60	5.8	120	5.1	120	4.4	360
ReC4	28.3	60	5.6	120	4.9	120	4.2	360
ReC5	27.8	60	5.5	120	4.8	120	4.1	360
ReC6&7	36.7	60	7.2	360	6.3	360	5.4	360
ReC8	15.4	60	3.2	120	2.8	120	2.3	120
ReC9	28.7	60	5.7	120	5.0	120	4.2	360
ReC10	29.4	60	5.1	120	4.4	120	3.8	360
ResDum	268.0	60	50.1	120	43.8	120	37.6	360
Reserv	637.0	60	219.1	25	194.8	25	173.5	25
P2	49.6	60	18.2	25	16.2	25	15.0	25
P4U	79.8	60	22.6	30	20.0	30	17.4	30
Dum130.6	79.8	60	22.6	30	20.0	30	17.4	30
A4-1	17.3	60	5.6	25	5.0	25	4.7	25
H1	32.4	60	12.8	25	11.4	25	10.5	25
A4	107.3	60	40.4	25	36.1	25	33.2	25
A3	211.5	60	81.3	25	72.9	25	67.0	25
G2	65.6	60	25.8	25	23.2	25	21.5	25
G1	144.7	60	46.8	25	42.0	25	37.4	25
A2	450.0	60	145.2	25	130.4	25	115.5	25
A1	484.8	60	152.4	25	136.5	25	120.7	25
P3	564.8	60	163.4	25	146.7	25	128.4	30
T1	564.8	60	163.4	25	146.7	25	128.4	30
U130.6	641.5	60	179.8	25	161.5	25	141.8	30
R-I01C	4.5	60	1.4	120	1.2	90	1.1	120
P5C	27.1	60	9.8	25	8.9	25	8.4	25
U130	27.1	60	9.8	25	8.9	25	8.4	25
dumP5	664.1	60	182.6	30	164.1	30	143.9	30
R-F01C	7.1	60	2.1	120	1.8	120	1.5	120
R-G01C	2.9	60	1.0	120	0.8	120	0.7	120
P5B	21.7	60	5.4	120	4.6	120	3.8	90
P5	18.3	60	5.9	25	5.3	25	5.0	25
U129.7	39.2	60	8.9	120	7.8	25	7.1	25
P6	61.2	60	19.5	25	17.3	25	15.7	25
dumP6	762.3	60	194.9	30	174.8	30	151.7	30
Hassal	762.3	60	194.9	30	174.8	30	151.7	30
R-D01C	5.5	60	1.6	120	1.4	120	1.2	120
R-E01C	6.7	60	2.0	120	1.7	120	1.5	120
R-C01C	4.4	60	1.2	120	1.1	120	0.9	120
R-B01C	12.7	60	3.1	120	2.6	120	2.1	120
R-A01C	3.3	60	0.9	120	0.8	120	0.6	120
P5A	67.0	60	13.0	120	11.6	25	10.8	25
Basin14	40.7	60	12.8	25	11.4	25	10.4	25
F1	94.3	60	17.9	25	15.9	25	14.3	25
P7	151.1	60	28.6	30	25.8	30	22.4	120
U128.6	151.1	60	28.6	30	25.8	30	22.4	120
dumP7	957.1	60	81.5	540	75.0	540	66.5	540
P8	83.7	60	30.8	25	27.6	25	25.0	25
U128.5	184.0	60	63.2	25	56.3	25	50.9	25
dumP8	1083.6	60	104.8	540	95.2	540	84.9	540
Rosford	1083.6	60	104.8	540	95.2	540	84.9	540
C1	40.6	60	11.4	25	10.2	25	9.4	25
P9	129.2	60	32.4	25	29.1	25	26.0	25
U125.5	129.2	60	32.4	25	29.1	25	26.0	25
dumP9	1135.7	60	98.4	540	91.4	540	81.3	540
B1	41.4	60	15.2	25	13.6	25	12.6	25
P10	147.7	60	46.3	25	41.3	25	36.3	25
U124.9	147.7	60	46.3	25	41.3	25	36.3	25
dumP10	1218.2	60	114.3	540	104.0	540	94.0	540
P11	136.7	60	45.2	25	40.2	25	36.1	25
U124.4	136.7	60	45.2	25	40.2	25	36.1	25
dumP11	1248.9	60	126.0	540	115.5	540	104.1	540
D1	93.1	60	25.6	25	22.8	25	20.5	25
P12	181.3	60	40.9	25	36.8	25	32.0	25
U123	181.3	60	40.9	25	36.8	25	32.0	25
dumP12	1347.1	60	155.2	120	137.6	120	121.3	720
P13	71.4	60	26.9	25	24.2	25	22.0	25
U121.3	71.4	60	26.9	25	24.2	25	22.0	25
dumP13	1379.8	120	156.9	540	142.3	540	127.7	540
P14	119.0	60	42.4	25	38.4	25	35.0	25
U121	119.0	60	42.4	25	38.4	25	35.0	25

Link Label	PMF		100 Year		50 Year		20 Year	
	Peak Inflow (m^3/s)	Critical Storm (mins)	Peak Inflow (m^3/s)	Critical Storm (mins)	Peak Inflow (m^3/s)	Critical Storm (mins)	Peak Inflow (m^3/s)	Critical Storm (mins)
dumP14	1466.1	120	175.5	540	158.6	540	141.5	540
P15	62.4	60	24.4	25	21.8	25	19.8	25
U117.4	62.4	60	24.4	25	21.8	25	19.8	25
dumP15	1500.6	120	183.4	540	165.7	540	147.6	540
E1	49.1	60	18.1	25	16.1	25	14.5	25
P16	79.2	60	28.3	25	25.4	25	23.0	25
U115.8	79.2	60	28.3	25	25.4	25	23.0	25
dumP16	1560.2	120	196.1	540	176.8	540	157.5	540
P17	71.0	60	21.8	25	19.5	25	17.8	25
U115.5	71.0	60	21.8	25	19.5	25	17.8	25
dumP17	1611.0	120	205.4	540	185.0	540	164.5	540
P18	33.5	60	12.0	25	10.7	25	9.7	25
U113.5	33.5	60	12.0	25	10.7	25	9.7	25
dumP18	1626.4	120	207.3	540	186.6	540	165.3	540
Basin18	90.1	60	26.3	120	22.9	120	19.5	120
Basin17	40.0	60	13.1	120	11.6	120	10.2	120
6.03	151.3	60	24.3	120	20.8	120	17.8	120
6.00	561.1	60	130.4	120	113.5	120	94.6	120
6.04	911.7	60	206.0	120	179.0	120	150.5	120
L5	911.7	60	206.0	120	179.0	120	150.5	120
Dum8	2062.5	120	347.4	120	304.8	120	268.1	540
Basin11	166.7	60	34.4	120	29.8	120	25.2	120
Basin8	147.3	60	46.7	120	41.1	120	35.3	120
Basin9	433.0	60	82.5	120	73.0	120	62.9	120
Dum3	488.9	60	81.6	120	67.5	120	62.0	120
Basin10	669.0	60	111.6	120	102.6	120	92.8	120
2.02	756.2	60	96.1	120	87.6	360	79.9	360
Basin4	158.4	60	48.7	120	42.7	120	36.5	120
Basin5	284.1	60	65.9	120	55.2	120	45.3	120
4.02	287.2	60	57.3	120	48.3	120	37.9	120
4.03	322.5	60	63.1	120	52.7	120	41.4	120
4.04	71.6	60	22.7	120	20.1	120	17.2	120
Basin7U	94.9	60	29.1	120	25.3	120	21.9	120
Basin7D	91.5	60	22.2	120	18.6	120	14.6	120
4.06	130.5	60	25.6	120	21.0	120	19.2	120
Dum1	447.4	60	88.7	120	73.0	120	56.3	120
4.07	628.5	60	120.0	120	100.8	120	77.6	360
Basin6	1356.6	60	213.7	120	185.9	120	157.0	360
2.03	1357.4	60	182.6	360	153.1	360	140.4	360
Basin1	159.4	60	44.3	120	38.3	120	32.6	120
Basin2	215.4	60	51.0	120	45.3	120	39.9	120
Basin3	418.2	60	98.2	120	87.8	120	76.9	120
5.03	484.3	60	102.4	120	91.6	120	82.1	120
Dum2	1782.8	60	254.6	120	226.7	120	202.9	120
2.04	1902.1	60	286.0	120	263.2	120	235.7	120
2.10	166.0	60	31.3	120	27.0	120	22.9	120
2.06	207.4	60	41.0	120	35.7	120	30.4	120
2.05	2018.6	60	337.6	120	306.3	120	270.3	120
L21	2018.6	60	337.6	120	306.3	120	270.3	120
1.01	140.4	60	26.9	120	23.4	120	19.9	120
L27	140.4	60	26.9	120	23.4	120	19.9	120
dum1.01	4126.1	120	690.3	120	615.8	120	539.0	540
1.02	129.3	60	39.5	120	34.4	120	29.3	120
L46	129.3	60	39.5	120	34.4	120	29.3	120
1.021	124.0	60	38.0	120	33.1	120	28.2	120
dum1.02	3843.8	120	622.1	540	560.8	540	497.9	540
1.03	100.4	60	21.8	120	19.2	120	16.0	120
L64	100.4	60	21.8	120	19.2	120	16.0	120
dum1.03	3709.1	120	599.8	540	539.2	540	477.1	540
1.03A	54.9	60	14.1	120	12.1	120	10.1	120
1.03B	68.4	60	22.4	90	20.0	120	17.7	120
L70	115.8	60	35.9	120	31.4	120	27.0	120
Dum5	3692.7	120	593.8	540	533.5	540	470.9	540
Dum6	3686.2	120	590.8	540	530.4	540	468.2	540
1.03C	84.8	60	26.0	120	22.7	120	19.6	120
L71	84.8	60	26.0	120	22.7	120	19.6	120
Dum7	3683.1	120	590.2	540	530.1	540	467.5	540
1.04	62.5	60	13.1	120	11.3	120	9.4	120
L73	62.5	60	13.1	120	11.3	120	9.4	120
dum1.04	3636.4	120	579.4	540	519.8	540	458.0	540
Out	3636.4	120	579.4	540	519.8	540	458.0	540

3.0 HYDRAULIC REVIEW

The 2004 Prospect Creek Study used the TUFLOW hydraulic model to convert flow hydrographs into flood levels and velocities throughout the floodplain. Separate TUFLOW models were developed for the upper catchment area (upstream of Widemere Road) and the main catchment area (from Widemere Road to the Hume Highway). A separate model was also developed for the PMF flood, with a larger grid size of 20m.

Council sought a review of the TUFLOW model by the authors of the software (WBM Pty Ltd) in late 2004. This included an overall review of the model structure and advice concerning the potential amalgamation of the individual models into a single TUFLOW model.

Following the model review, a single TUFLOW model was developed for the whole study area, capable of modelling all flood events. Some refinements to the TUFLOW model were also made directly by WBM, whilst a number of other recommendations were provided.

Further refinement of the TUFLOW model was also undertaken during 2005, to provide more detailed representation of flood behaviour in the channel upstream of Widemere Road. This included additional survey and modifying the model to account for channel clearing that was undertaken by Council in 2005.

Finally, the model was recalibrated to the January 2001 flood, and revised flood behaviour determined for a range of design floods.

3.1 WBM Review of TUFLOW model

The WBM review indicated that on the whole, the Prospect Creek TUFLOW model was set up satisfactorily. There were, however, a number of measures proposed to improve the model structure, including the amalgamation of the individual models into a single model.

These model refinements were subsequently implemented by WBM. Some of the changes made to the model were a result of additional features recently developed in the TUFLOW software. All the latest TUFLOW model runs are based on the TUFLOW Build (2004-11-AK).

The description of the refinements made to the Prospect Creek TUFLOW model by WBM, and other recommendations that were proposed for further consideration, are listed in Table A2.

Table A2
WBM TUFLOW model updates and recommendations

Original Model	Updated Model
The exit losses on circular culverts Rosfp, Wide Rd and Has-lowp, and rectangular culverts RosB, GibbsB1, GibbsB2 and Has Box are all well below 1.0 (0.2, 0.2, 0.1, 0.2, 0.2, 0.2, 0.1 respectively). Where the flow velocity from culvert to receiving waterway does not change greatly, these exit losses may be justified. In the case of Has Box, for example, which is the outlet from a detention basin, and the velocities at the flood peak are in excess of 6m/s, it is our view that the full (or close to full) exit loss of 1.0 should apply. Sensitivity testing on the Has Box culvert shows that using an exit loss of 1.0 increases flood levels upstream by ~0.45m, and causes flow over the detention basin's spillway. The other culverts mentioned above have not been investigated further.	The exit losses have been left unchanged, however, it is strongly recommended that validation of these losses are made given their significant influence on upstream flood levels.
Culvert contraction coefficients for all culverts was 0.	The height culvert contraction coefficient has been set at 0.6 and the width culvert contraction coefficient has been set at 1.0
As identified in our review, cross-section top widths have been adjusted to more appropriately represent the width of the 2D domain they replace. However, Channels L26 and OSC2 remain wider than the 2D domain. The data for these channels are from a MIKE 11 processed cross-section data file that cannot be easily adjusted as the profiles for these channels are not included in the file.	Channels L26 and OSC2 have remained unchanged, and remain wider than the 2D domain they replace. If the profiles for these cross-sections can be found, the cross-sections can be trimmed accordingly. Alternatively, manual manipulation of the processed data is an option.
A significant number of channels are less than 20m long, particularly in the Widem model. Many of these may not be necessary.	Originally very short channels were removed as part of the process to increase the computation timestep to 5s. However, as the 2s timestep is required for continuity at high velocity culverts such as Has Box, the short channels have been reinstated and are in the updated model.
RosB rectangular culvert and RosBw weir.	The HX boundary connected to the RosB rectangular culvert and RosBw weir has been changed to a SX boundary connected to RosB culvert, with the HX boundary acting as the weir, providing an improved model schematisation.
Conversion of S channels to B channels at bridges.	It is recommended that bridge decks be checked to ensure the maximum elevation of the B channel cross section coincides with the underside of the deck. It has been assumed that the top of the S channel is the underside of the bridge deck.

Original Model	Updated Model
	FairfieldSt and VineB (formerly S channels but changed to B channels) have zero flow width at the top of the cross-section – it is recommended that these be checked (this is normally only carried out where the bridge deck slopes or is arched).
Z-lines (3D breaklines) at Embankments and Road/Railway crossings.	These should be checked as they may require extending (at present they do not extend the whole way across the floodplain). An example is the Hume Highway where flood water is flowing over the road to the west of the creek crossing. Z lines do not use the RIDGE (or MAX) flag attached, and are significantly lowering Zpts in some locations, particularly 2d_zln_noFairSchLeve. It is recommended that the elevations on these Z lines are checked, as normally Z lines raise elevations (unless using the GULLY option). In the updated model, the Z lines do not have the RIDGE option, but should be included following elevation checking.
Reducing conveyance with height warnings.	The updated model utilises a new feature in TUFLOW that forces a parallel channel analysis for all 1d_tab XZ cross-sections. This ensures that reducing conveyance does not occur when the wetted perimeter suddenly increases compared with a small increase in the flow area. The conveyance of the cross-sections using this approach is slightly higher, and there is a justification for increasing the Manning n values by around 10% to compensate for this. The 1d network Manning's n values have been increased by 10% in the updated model.

3.2 Other WBM Recommendations

Other recommendations included in WBM's review, but not implemented, were subsequently considered by Bewsher Consulting. Those recommendations that were subsequently implemented include:

- Exit loss coefficients on all circular and rectangular culverts were increased to 1.0, with the exception of the Hassall Street and Rosford Street detention basin outlets where a coefficient of 0.5 was adopted;
- Channel sections L26 and OSC2, which were noted as being wider than the 2D domain where they are located, were reduced in width by manual manipulation of the processed data;
- The close spacing of 1D cross sections upstream of Widemere Road were replaced with more typically spaced cross sections, based on actual survey undertaken by Council;

- Representation of the Fairfield Street and Vine Street bridges in the model were reviewed, with amendments being made to the Vine Street bridge based on the available design drawings for this structure;
- Z-lines (3D breaklines) at embankments and road/railway crossings were reviewed. Most of these were considered to be providing a suitable supplement to the DEM in order to represent the top of bridges or embankments across the creek or basin outlets, otherwise missing from the DEM. The one exception was the z-line across the Rosford Street Basin, which was found to be artificially raising ground levels immediately in front of the basin outlet and restricting basin outflows. This problem was rectified by slightly adjusting the entrance location to the basin outlet.
- Manning's coefficients were reviewed as part of further model calibration.

3.3 Changes upstream of Widemere Road

A number of model refinements were made in the upper catchment, between Widemere Road and Davis Road, to provide greater definition in this part of the model. The changes include:

- Improved representation of flows over Widemere Road by including the longitudinal road profile as a weir;
- Inclusion of surveyed channel cross sections in the model in lieu of data extracted from the ALS survey, which was thought to be erroneous due to dense vegetative cover;
- Modification of channel sections to account for the removal of silt and vegetation from within the concrete channel, undertaken by Council during 2005;
- More refined representation of overbank roughness, at a detail sufficient to include individual buildings (n=0.2), paved areas (n=0.02), and other vegetative cover (n=0.07 to 0.10);
- Inclusion of the above ground pipeline on the north side of the stormwater channel, which tends to restrict flow onto the northern floodplain. This was included in the model by setting a 0.3m 'lid' on top of those cells intersected by the pipeline.

3.4 Model Calibration

The 2004 Prospect Creek TUFLOW model had previously been calibrated to the January 2001 flood. Due to the number of changes made to this model, it was considered appropriate to further check this calibration.

The January 2001 flood was the largest flood recorded in Prospect Creek since at least 1988. In the upper catchment areas, the flood was estimated to be between a 20 year and 50 year flood event. The flood was less severe in Lower Prospect Creek as it coincided with lower flooding from the Georges River. The 2004 Prospect Creek study provided tabulated flood height observations throughout the catchment. This data has been supplemented with additional data from Council reports and files. The complete list of available data is provided in Table A3.

Table A3
TUFLOW Calibration to January 2001 Flood

Location	Source	Observed Level	Calculated Level	Difference	Comment
Widemere Rd - Edge of bitumen	FS Review - Table A8	31.51	31.64	0.13	
D/S Widemere LHS		31.24	31.27	0.03	
Outlet of Hassal St Basin		28.45	30.65		Unlikely to represent peak level
Underside of Gas sign		28.38	30.65		Unlikely to represent peak level
High water mark on tree	Council field notes & Table	25.09	25.25	0.16	
Gipps Rd Bridge		24.63	25.11	0.48	
Casuarina tree at Rosford St low flow	Table A8	23.4	24.23		Dubious reading & uncertain location
Outlet of Rosford St Basin		22.35	22.44	0.09	
Rosford St - Low flow outlet	Table A8	22.33	22.35	0.02	
Water level mark Rosford St	Table A8	22.32	22.31	-0.01	
Justin St		20.1	19.95	-0.15	
Paint mark on sewer vent	Table A8	19.74	19.30	-0.44	
End Little St near creek		19.62	19.30	-0.32	
127 Oxford St	Surveyed level (external)	18.43	17.81	-0.62	
115 Oxford St	Surveyed level (external)	18.4	17.46	-0.94	
13 Vineyard St	Surveyed level (external)	18.27	17.29		Inconsistent with adjacent observations
Gauge at Kenyons Bridge LB		18.25	18.38	0.13	
119 Oxford St	Surveyed level (external)	18.05	17.81	-0.24	
Cumberland Highway Smithfield	Services Committee report	17.77	18.17	0.40	
Cumberland Highway Bridge		17.62	18.17	0.55	
3 Kiola St	Surveyed level (external)	17.53	17.48	-0.05	
19 Vineyard St	Surveyed level (external)	17.5	17.30	-0.20	
20 Vineyard St	Surveyed level (external)	17.38	17.30	-0.08	
16 Vineyard St	Surveyed level (external)	17.38	17.29	-0.09	
18 Chisolm St	Surveyed level (external)	17.28	16.75		Inconsistent with adjacent observations
9 Kaluna St	Surveyed level (external)	17.12	16.97	-0.15	
13 Braemar St	Surveyed level (external)	16.94	16.97	0.03	
27 Chisolm St	Surveyed level (external)	16.88	16.57	-0.31	
7 Braemar St	Surveyed level (external)	16.69	16.91	0.22	
22 Alt St	Surveyed level (external)	16.57	16.23	-0.34	
4 Cooper St	Surveyed level (external)	16.56	16.29	-0.27	
31 Chisolm St	Surveyed level (external)	16.49	16.45	-0.04	
29 Chisolm St	Surveyed level (external)	16.46	16.53	0.07	
2 Cooper St	Surveyed level (external)	16.43	16.24	-0.19	
20 Alt St	Surveyed level (external)	16.41	16.23	-0.18	
33 Alt St	Surveyed level (external)	16.39	16.16	-0.23	
25 Alt St	Surveyed level (external)	16.31	16.23	-0.08	
24 Alt St	Surveyed level (external)	16.23	16.22	-0.01	
31 Alt St	Surveyed level (external)	16.22	16.23	0.01	
6 Cooper St	Surveyed level (external)	16.19	16.33	0.14	
38 Hemingway St	Surveyed level (external)	14.93	14.81	-0.12	
43 Hemingway St	Surveyed level (external)	14.63	14.30	-0.33	
41 Hemingway St	Surveyed level (external)	14.6	14.29	-0.31	
Pathway U/S Fairfield Rd Bridge		13.18	12.64		Inconsistent with adjacent observations
16 Jervis	Surveyed level (external)	12.76	12.69	-0.07	
14 Jervis St	Surveyed level (external)	12.68	12.72	0.04	
Cawarra Pl	Wet carpet 1.59m above garage	12.67	12.78	0.11	
Cawarra St - mark on tree	Table A8	12.58	12.78	0.20	
38 Ace Ave	Surveyed level (external)	12.55	12.12		Inconsistent with adjacent observations

Location	Source	Observed Level	Calculated Level	Difference	Comment
Peg near path U/S bridge		12.51	12.64	0.13	
46 Ace Ave	Flood level 0.40m above floor	12.34	12.24	-0.10	
44 Ace Ave	Flood level 0.40m above floor	12.33	12.21	-0.12	
42 Ace Ave	Flood level 0.36m above floor	12.32	12.17	-0.15	
48 Ace Ave	Flood level 0.25m above floor	12.29	12.25	-0.04	
Polding Street North, Fairfield	Services Committee Report	12.18	12.56	0.38	
D/S Fairfield Rd bridge	Approximate location	12.17	12.27	0.10	
40 Ace Ave	Surveyed level (external)	12.15	12.15	0.00	
Fairfield High School	Approximate location	11.96	11.81	-0.15	
u/s Fairfield Railway Bridge	2001 Report	9.01	9.08	0.07	
The Horsley Drive, Fairfield	Services Committee Report	8.62	8.76	0.14	
upstream bridge	Mark Rice	7.26	7.10	-0.16	
Vine St Bridge, Fairfield	Services Committee Report	6.44	6.11	-0.33	
34 Vincent Cr	2001 Report	5.45	5.42	-0.03	
13 Artie St	2001 Report	5.42	5.45	0.03	
Sandal Crescent, Carramar	Services Committee Report	5.02	5.22	0.20	
Upstream side of Lansdowne Bridge	Services Committee Report	4.23	4.32	0.09	
Day Street, Lansvale	Services Committee Report	3.62	3.65	0.03	
				-0.048	Mean
				26	Number above
				33	Number below
				0.246	Standard Deviation
				-0.035	50 percentile difference

One of the main changes to the model was the method of calculating conveyance in the 1D channel elements. This was introduced via a software upgrade by WBM, which significantly improved stability within the Prospect Creek model. As a consequence, however, the new method increases channel conveyance and so tends to reduce flood levels. To compensate for this reduction, WBM increased channel roughness coefficients by 10%. On review of the calibration data, and in conjunction with other changes made to the TUFLOW model, it was considered that a further increase in channel roughness was warranted to achieve an adequate match with flood levels recorded from the 2001 flood. The exception was the area downstream of Orphan School Creek, where coefficients were actually reduced. It was considered that the roughness coefficients were previously too high in this region to compensate for a model stability problem that was occurring in this vicinity. Roughness coefficients across the floodplain remained unchanged.

The comparison of computed and observed flood heights in provided in Table A3. The location of these points is also shown on Figure A2, along with a colour coding showing where agreement in values to ±0.2m has been achieved, where calculated levels exceed +0.2m, and where calculated levels are less than -0.2m from observed levels. There are also a number of outliers in the data set where the observed levels are considered unreliable based on a comparison of adjacent levels or by comparison with ground levels at these locations.

A statistical assessment of the difference between calculated and observed flood heights is included in Table A3. Of the 67 observed flood heights, 7 were excluded from this assessment due to reliability concerns. Of the remaining 60 observations, the mean difference between calculated and observed levels is -0.05m, with roughly similar numbers of points where calculated levels overestimate the observed levels (26) to those that underestimate it (33).

Based on these results, it can be concluded that the model is adequately calibrated to the January 2001 flood.

3.5 Design Boundary Conditions

Design boundary conditions are required for the TUFLOW model. These consist of inflow hydrographs at the upper end of the model and at other intermediate points within the catchment, and stage hydrographs at the downstream end of the model.

Inflow hydrographs were determined from the RAFTS hydrologic model described in Section 2. Various storm durations were included in each model run to determine which duration provided the highest flood levels at different locations within the study area.

The downstream stage hydrograph was based on flood hydrographs provided in the Georges River Flood Study (PWD, 1991) at the junction of Prospect Creek and the Georges River. This is the same boundary condition as adopted in the 2004 Prospect Creek Study. Another important consideration is the phasing difference between peak flood heights in the Georges River and the timing of flood flows in Prospect Creek. Initial sensitivity testing indicated that flood levels in Lower Prospect Creek (downstream of Vine Street) were sensitive to both the level in the Georges River and the phasing difference between the two floods.

This aspect of flood behaviour was extensively studied in the 1990 Lower Prospect Creek Flood Study (Willing & Partners, 1990). The approach adopted in the 1990 study was to adjust the timing of the Prospect Creek storm so that the peak rainfall intensity of the Prospect Creek storm (9 hour duration) coincided with the peak rainfall intensity from the Georges River storm (36 hour duration). The embedded storm approach adopted in the 2004 Prospect Creek Study yielded a similar outcome. This same philosophy was adopted in the current review for floods up to the 100 year event. The PMF was adjusted so that peak flows in Prospect Creek coincided with peak flood heights in the Georges River.

4.0 DESIGN FLOOD BEHAVIOUR

The TUFLOW model was used to generate flood conditions for the 20 year, 50 year, 100 year and PMF floods. A range of storm durations was included in each assessment, and maximum flood heights extracted. The critical storm duration for the 100 year flood ranged from 25 minutes or 2 hours in the upper catchment and smaller tributaries; 9 hours through the majority of the middle parts of the catchment; and 12 hours through the lower parts of the river (downstream of Vine Street).

TUFLOW can directly map the extent of flood inundation by producing a flood grid of 'wet' cells. The grid size in the Prospect Creek TUFLOW model is 10m, which results in a fairly coarse representation of the extent of flooding. To improve this resolution, each flood grid was extrapolated across the floodplain and then subtracted from the surface DEM to define the extent of flooding more precisely. This approach led to an improved mapping resolution of 2m (horizontally).

Maps showing the extent of flood inundation and flood level contours for the 20 year, 50 year, 100 year and PMF floods are included on Figures A3 to A6. The floodplain has further been delineated into three flood risk precincts (high, medium and low).

All mapping has been provided to Council as A1 hard copy plans and in digital format for inclusion in their GIS computer system. Additionally, flood data has been extracted for each property within the floodplain and assigned to Council's cadastre database.

Comparison of the revised flood level estimates with those previously adopted by Council indicates that:

- There is little difference in design flood levels in the lower reaches of Prospect Creek (downstream of Vine Street) due to the dominant influence of tailwater levels from the Georges River;
- New estimates upstream of Vine Street have generally been reduced by between 0.1 to 0.2m for floods up to the 100 year event, due mainly to a reduction of design flows;
- Some localised regions have seen flood level increases of up to 0.2m for floods up to the 100 year event, due to consideration of shorter duration floods on tributary creeks and other changes to the model including re-calibration;
- The extent of flooding in the PMF has not varied significantly;
- On a property basis, flood levels for the 100 year flood have:
  - Have remained the same (within ±0.1m) for 1,056 properties (53%);
  - reduced by more than 0.1m for 693 properties (35%); and
  - increased by more than 0.1m for 251 properties (12%).
- On a property basis, an additional 190 properties (2.5%) will include a flood notation that it is affected by the PMF (ie a low flood risk) where previously no flood notation would have been provided. Some properties may no longer receive a flood notification.

5.0 REFERENCES

Public Works Department, 1990, “Georges River Flood Study”

Willing & Partners, 1990, “Lower Prospect Creek Floodplain Management Study”

Willing & Partners, 1993, “Upper Prospect Creek Floodplain Management Study”

Cardno Willing, 2004, “Review of Prospect Creek Flood Levels”

LIST OF FIGURES

Figure A1 – Subcatchment Boundaries

Figure A2 – TUFLOW Model Calibration to January 2001 Flood

Figure A3 – 20 Year Flood Level Contours and Extents

Figure A4 – 50 Year Flood Level Contours and Extents

Figure A5 – 100 Year Flood Level Contours and Flood Extents

Figure A6 – PMF Flood Level Contours and Flood Extents