Appendix C

Digital Copies of Models

MEMORANDUM

Date:	19 June 2008
To:	RTA, Ray Tester
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From:	Tami Norton
Job no:	2116784D/MO_4324
Re:	Woomargama Bypass, HW02 Hume Highway – Proposed Bridge modeling for Options A & B Summary Results – TUFLOW Modelling

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Introduction

The RTA requested that PB perform detailed 2-Dimensional analysis of the Hume Highway, Bypass Options A2 creek crossings of Wilson Creek and Mountain Creek and the Option B crossing of Mountain Creek in the vicinity of Woomargama. The modelling is necessary for the cost analysis for this option and structures are a crucial component of the costing.

Background

PB was originally contracted to perform Mountain Creek Flood Study that analysed the existing conditions flooding of Mountain Creek using surveyed cross-sections provided by the RTA (August through September 2007). An XP-RAFTS hydrologic model was developed to provide inflows for the Mountain Creek MIKE11 hydraulic model. PB prepared an existing conditions Flood Study report that included the water levels at the cross-section locations and provided existing flows and velocities at the proposed Options A, B and C locations.

PB was subsequently asked by the RTA to provide estimated bridge opening lengths for two of the proposed bypass Options A and B (Option C has been eliminated as an option). PB provided estimated bridge opening lengths based on non-detailed analyses methods, i.e. top widths estimated from the existing conditions MIKE11 model. These estimated bridge openings were then analysed in MIKE11 by including an approximate bridge cross-section in the model at the proposed bypass crossing of Mountain Creek. An estimate of 150m for the bridge opening was reported to the RTA at the confluence of Wilson and Mountain Creeks and the Mountain Creek crossings for both Options A and B.

PB was then asked to provide a more detailed analysis to more accurately estimate the Option A bridge openings as it has become essential to the cost estimate for the Option. Additionally, PB was to incorporate a second bridge opening to address the natural springs located along the Option A alignment. It was agreed that with the limited survey data a HEC-RAS model would be a better tool for modelling the proposed bridge scenarios than MIKE11. PB then developed a HEC-RAS model as described in the previous memo, *Woomargama Bypass, HW02 Hume Highway – Proposed Bridge modelling for Option A Summary Results*.

The findings from these initial investigations were limited by the amount of survey data available to define Mountain Creek and Wilson Creek. The 1-dimensional models were therefore not able to adequately simulate flood behaviour in the Mountain Creek floodplain. It was identified that a 2-dimensional model would provide a better representation of the floodplain behaviour during critical design flood events.

Adopted Approach

To better define the behaviour of flooding a TUFLOW model for the exiting and proposed scenarios for the Mountain/Wilson Creek floodplain was developed. The proposed scenarios included Options A and B, with the Hume Highway crossing of both Mountain and Wilson Creeks. The objectives of this modelling are:

- Establish existing conditions water levels and flooding extends to use as base conditions to compare with the proposed conditions.
- Identify structures and properties that may be impacted by flooding.
- Determine the minimum bridge length openings required to meet the design criteria regarding afflux and scour.

It is important to note that the TUFLOW modelling performed for this project was developed based on limited DTM and survey data. Break line inverts were interpolated from known data points, but due to the distance between the points, the accuracy of the interpolated portions of the DTM is not suitable for use for any other purposes other than for estimating required bridge lengths for the RTA's costing analysis. This model is not intended for use for detailed or final design.

Design Criteria

The design criteria outlined in a memo distributed by SKM on 13/05/2008 are as follows:

The project works must be designed to take into account of the hydraulic performance so that inundation levels upstream and downstream of the project boundary are not increased in the 100 year ARI event by any more than the following:

- *Rural land without buildings or sensitive structures - 0.25m.*
- *Rural land where buildings or sensitive structures are already below the 100 year ARI flood level - 0.05m.*
- *Any land where buildings or sensitive structures previously not inundated in the 100 year ARI event would be at increased risk of inundation (including allowance for afflux) - 0.00m.*

Watercourses must have impacts assessed for a 50 year and 100 year Average Recurrence Intervals (ARI) and the Probable Maximum Flood (PMF). The following minimum Average Recurrence Intervals are to be applied to the transverse (cross) drainage design:

- *Culverts where surcharge is allowable - 50 years*
- *Culverts where surcharge is undesirable - 100 years*
- *Major storm event check for no property damage - 100 years*
- *Major storm event check for no structure damage - 2000 years.*

Scour protection shall be designed for all areas susceptible to scouring or erosion including batters and bridge abutments. Scour protection must be designed for a minimum maintenance free life of 50 years.

Revised XP-RAFTS Model

The existing conditions XP-RAFTS model developed as part of the Mountain Creek Flood Study did not include a node at the upstream end of the existing Hume Highway crossing of Wilson Creek. To provide a correct inflow at this point in the TUFLOW model, the XP-RAFTS model was updated to include a node at this location. Inflows input into the TUFLOW model are listed below in Table 1.

Table 1 TUFLOW Inflows

Node	Description	100-yr ARI Q (m^3/s)
u/s bridge (Mountain Creek)	Contributing u/s existing Hume Hwy bridge, Mountain Creek	254
u/s culvert (Wilson Creek)	Contributing u/s existing Hume Hwy culvert, Wilson Creek	112
WC3A (Wilson Creek)	Lateral inflow for contribution	21

	area between the Wilson/Mountain Creek confluence and d/s of Hume Hwy crossing of Wilson Creek	
MC5 (Mountain Creek)	Lateral inflow for contributing area between just d/s of Option B alignment crossing of Mountain Creek and the Wilson/Mountain Creek confluence	55

Hydraulic Modelling

The existing conditions and several scenarios for Options A and B were modelled as described in the following sections. All scenarios were run for the 100-yr ARI storm event.

DTM Data

SKM provided PB with a 2m x 2m grid to use for the TUFLOW modelling. Upon inspection of the grid data, it was discovered that the grid was inadequate for the purposes of the modelling. PB requested the raw DTM data from SKM and determined that the data did not include break lines or detail to define the top of bank or other floodplain features within the Mountain Creek floodplain. PB incorporated the existing RTA survey points and created break lines to define the flow paths within the floodplain based on aerial photo inspection and limited contour data. Given the level of accuracy of the DTM data and to save on computational time, a 5m x 5m grid was developed for TUFLOW modelling.

TUFLOW modelling

Model Extents

The TUFLOW modelling encompasses the area shown in Figure 1. Houses (or other buildings) located in the vicinity of the Mountain and Wilson Creek floodplains have also been identified from inspection of the aerial photography.

Figure 1 TUFLOW Model Extent showing Option A and B Alignments & Structures (model extent shown in orange)

Existing Conditions

The existing conditions model includes the existing Mountain Creek bridge and the existing culvert crossing of Wilson Creek. The Mountain Creek bridge is modelled as a flow constriction. The Wilson creek culvert is defined as a 1-D structure link to the 2D- network.

Proposed Bridge Scenarios

Option A

In addition to the existing Hume Highway bridge crossing, Option A consists of several proposed bridges that are modelled as flow constrictions:

- Wilson Creek crossing – existing 1-D culvert removed and replaced by flow constrictions
- Confluence of Wilson and Mountain Creeks
- Natural Spring crossing
- Mountain Creek crossing.

SKM's MX design file (received 13/05/08) was used to locate the Option A alignment. The z-point elevations were adjusted along the alignment for each scenario to represent the proposed roadway embankment.

Four (4) bridge opening scenarios were modelled for Option A. Scenario 1 models one long bridge that spans Mountain Creek and the natural spring. Scenarios 2 through 4 consist of varying bridge openings for the Mountain Creek and Natural spring crossings. The bridge widths for the confluence of Wilson and Mountain Creeks and the Wilson Creek crossing were set at the widths shown in SKM's MX design file for all four scenarios. Table 2 summarises the opening sizes used for each scenario:

Table 2 Option A – Modelled Bridge Lengths (NB= northbound, SB=south bound)

Scenario	Mountain Creek	Natural Spring	Confluence of Wilson and Mountain Creek	Wilson Creek	Total Bridge Length
1	SB - 670 m	SB - 200 m	SB - 220 m	SB - 65 m	2,015 m
	NB - 740 m	NB - 200 m	NB - 240 m	NB - 80 m	
2	SB - 240 m	SB - 250 m	SB - 220 m	SB - 65 m	1,605 m
	NB - 260 m	NB - 250 m	NB - 240 m	NB - 80 m	
3	SB - 200 m	SB - 200 m	SB - 220 m	SB - 65 m	1,420 m
	NB - 215 m	NB - 200 m	NB - 240 m	NB - 80 m	
4	SB - 230 m	SB - 200 m	SB - 220 m	SB - 65 m	1,495 m
	NB - 260 m	NB - 200 m	NB - 240 m	NB - 80 m	

Option B

Option B consists of the existing Hume Highway bridge crossing of Mountain Creek, the existing culvert crossing of Wilson Creek, and the proposed bridge crossing of Mountain Creek. The proposed bridge crossing of Mountain Creek is modelled as a flow constriction. SKM's MX design file (received 26/05/08) was used to locate the Option B alignment. The z-point elevations were adjusted along the alignment for each scenario to represent the proposed roadway embankment. Two (2) bridge opening scenarios were modelled for Option B. Table 3 summarises the opening sizes used for each scenario:

Table 3 Option B – Modelled Bridge Lengths

Scenario	Mountain Creek	Total Bridge Length
1	185 m	370 m
2	360 m	720 m

TUFLOW Results

Existing Baseline Conditions

Figure 2 shows the resulting 100-yr water-depths and flood plain extents. Only three (3) of the houses (as shown in green on Figure 1) are shown to be 'wet' during the 100-yr ARI event. Table 4 summarises the resulting water levels at these houses.

Table 4 Water levels at 'wet' houses for Existing Conditions

Structure Number	100- yr Water Level (m)
"House 18"	307.9
"House 19"	307.8
"House 20"	307.8

Option A

Figures 3 through 6 show the resulting afflux impacts for each of the four bridge scenarios modelled, and are based on the 100-year ARI storm event. No structures are shown to be 'wet' for any of the scenarios. The three structures that are 'wet' for the existing conditions are located within the Option A proposed alignment footprint and are presumed to be properties that would be purchased should Option A be selected as the preferred option. Table 5 summarises the average afflux upstream of the Option A alignment for each scenario.

Table 5 Option A Scenarios – Average Afflux

Afflux (m)			
Scenario			
1	2	3	4
0.00	0.28	0.58	0.57

Option B

Figures 7 and 8 show the resulting average afflux impacts for the two bridge scenarios modelled, and are based on the 100 year ARI storm event. Only the three structures are shown to be 'wet' during the existing 100-yr ARI event are shown as 'wet' for the two proposed scenarios. However, there is no change in water levels at these structures. Table 6 summarises the average afflux for the two scenarios.

Table 6 Option B Scenarios – Average Afflux

Afflux (m)	
Scenario	
1	2
0.12	0

Conclusions

Option A - Scenario 1 meets the RTA design criteria while scenarios 2, 3 and 4 all exceed the criteria. However, scenarios 2 and 4 indicate only localised accedence of the criteria just upstream of the Option A alignment and may still be viable if the community determines that the impacts are acceptable.

Option B - Scenarios 1 and 2 were both meet the RTA criteria.

TUFLOW Figures