



Rapid Creek Flood Study



ADDENDUM 1

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- 6 December 2013





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1. Introduction

This report is an addendum to the Rapid Creek Flood Study and outlines updates made to the hydraulic model used to simulate the flood behaviour of Rapid Creek. Updates to the hydraulic model were made using recently collected in-bank channel survey and bathymetric survey of the estuary in order to improve the representation of the creek channel within the hydraulic model.

The hydraulic model of Rapid Creek was developed in the hydrodynamic modelling package TUFLOW. The original TUFLOW model was set up representing the creek channel and floodplain in the 2D model domain and hydraulic structures modelled as 1D elements. The invert of the creek channel in the 2D domain was defined using the limited field survey available and assumptions of water depth within the tidal limit. It was recommended that additional survey be collected and the model representation of the creek be improved by defining the channel as a 1D network within the 2D domain.

Following the recommendations, additional survey was collected during October and November 2012. The additional survey collected includes:

- Field survey of creek cross sections at selected locations between Trower Road and Henry Wrigley Drive.
- Bathymetric survey of the estuary downstream of Trower Road.

The channel representation in the TUFLOW model was improved using all the survey data sets available. The field survey of creek cross sections was used to represent the creek upstream of Trower Road as a 1D channel in the model. The bathymetric survey was used to update the representation of the channel within the tidal limit, replacing previous assumptions made on the water depth.

The updated TUFLOW model was recalibrated to the February 2011 flood event by adjusting the Manning's 'n' roughness value of the 1D channel. A satisfactory calibration to recorded flood levels was achieved and the calibrated model was used to simulate the Q100 and PMF design storm events with a downstream sea level equivalent to a highest astronomical tide (HAT) plus 0.8 m sea level rise.



2.1D/2D model development

This section describes the updates to the model terrain and model structure that were made to improve the representation of the creek channel in the model. Inflows to the model, the downstream boundary conditions, and the land use delineation were all consistent with the original TUFLOW model.

The benefit of a 1D/2D model of Rapid Creek is that it enables the creek channel to be more accurately represented in the model. Modelling the creek channel in 2D can result in a poor representation of the channel, as shown in Figure 2-1. A finer 2D cell size can be used to improve the channel's representation in 2D, however this would result in far more computing requirements and model run times. Alternatively, the main channel can be represented in 1D and the floodplain in 2D as shown in Figure 2-2.



Figure 2-1 - Example of poor 2D representation of a creek channel (from TUFLOW manual, 2010)

2.1. Model terrain

2.1.1. 1D channel

Cross sections of the creek to define the 1D channel were sourced from the following:

- Field survey of the creek channel between the flood control weir and Henry Wrigley Drive. The survey was collected as part of a previous SKM project.
- Field survey of the creek channel between McMillans Rd and the gauging station (G8150127). The survey was collected as part of a previous SKM project.
- Additional surveyed cross sections at selected locations between Trower Road and Henry Wrigley Drive collected in October 2012.





• Figure 2-2 - Modelling the main channel in 1D and the flood plain in 2D (from TUFLOW manual 2010)

2.1.2. 2D domain

Ground surface elevations of the TUFLOW model's 2D domain were defined using the following data sets:

- Digital Elevation Model (DEM) developed from photogrammetry (2011) of the study area.
 The DEM was provided by the then Department of Lands and Planning.
- Bathymetric survey of the estuary downstream of Trower Road collected in November 2012.

2.2. Model structure

The model structure was updated so that a 2.8 kilometre length of the creek from the flood control weir to Trower Road was represented in the model as a 1D channel. The actual bathymetry is combined with the DEM and is justified because the channel is wide at bed level. The 1D channel was defined from each top of bank using 22 available surveyed cross sections. The 1D channel and hydraulic structures were modelled as 1D elements nested within the 2D model domain. The 2D domain was defined at a 5 metre grid spacing. The extents of the TUFLOW models 1D and 2D domains are shown in Figure 2-3.





Figure 2-3 – Rapid Creek TUFLOW model extent

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3. Model calibration

The 1D/2D TUFLOW model calibration was revisited using the water levels recorded at the gauging station (G8150127) and the surveyed flood marks from the February 2011 flood event. The calibration of the model was updated by adjusting the Manning's 'n' roughness value of the 1D channel until a satisfactory match to the surveyed and recorded peak flood levels was achieved.

3.1. Selected hydraulic roughness values

A Manning's 'n' roughness value of 0.1 to 0.12 was applied to the 1D channel for the model calibration. The land use categories within the models 2D domain and their Manning's 'n' roughness values adopted for the model calibration are shown in Table 3-1.

Land use category	Manning's 'n'
Road corridors	0.035
Residential lots	0.500
Open space with scattered vegetation	0.045
Rural lots	0.070
Creek channel through mangroves	0.100
Estuary channel / open water	0.030
Mangroves	0.300
Riparian bank vegetation	0.150
Mango plantation	0.090
University campus	0.100

Table 3-1 – Land use categories and adopted Manning's 'n' roughness values

3.2. Calibration to gauge G8150127 records

During the February 2011 flood event the gauge recorded a peak flood level of 6.83 m AHD at midnight on 16th February. A graph showing the recorded flood levels over the 15th and 16th of February compared with flood levels from the calibrated 1D/2D TUFLOW model is shown in Figure 3-1.

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• Figure 3-1 – Recorded and modelled flood levels at gauge G8150127

The 1D/2D TUFLOW model was able to reproduce the recorded peak flood level at the gauge to within 70 mm, producing a peak flood level of 6.90 m AHD at midnight on 16 February 2011. There is again a poorer fit to recorded levels over the 24 hours prior to the peak of the flood. This is considered to be the result of the URBS hydrologic model flows compared to the actual gauged flows. However, there is a slight reduction in these differences for the updated model.

Flows at the gauge extracted from the TUFLOW model compared with the recorded gauged flows and the URBS hydrologic model flows are shown in Figure 3-2. The peak flow at the gauge from the TUFLOW model is 169 m³/s compared to the recorded and URBS- modelled peak flow of 166 m³/s.





Figure 3-2 – Recorded and modelled flow at gauge G8150127

3.3. Calibration to recorded flood marks

The flood mark locations along with their surveyed level and the peak flood levels produced by the updated TUFLOW model are shown in Figure 3-3 and Figure 3-4.

As shown in Figure 3-3, nine flood marks were surveyed between Trower Rd and McMillans Rd, the majority adjacent to residential areas on the left overbank area of the creek. There is very good agreement between the modelled and surveyed levels with 8 of the 9 modelled peak flood levels within 0.03 m or 30 mm of the surveyed flood marks. The modelled flood level at the ninth location is within 60 mm of the surveyed level.

Another nine flood marks were surveyed between McMillans Road and the flood control weir, as shown in Figure 3-4. Six modelled levels show good agreement and are within 0.1m of the recorded levels. However, three modelled levels show a poorer fit and are lower than the recorded level by between 0.13 m and 0.27 m. The poorest fit is to the recorded level upstream of Henry Wrigley Drive. The poor fit could be the result of either:

Blockage of the Henry Wrigley Drive culverts during the February 2011 event causing an increase in the recorded upstream flood level.

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- The URBS model underestimating the peak flow from the flood control weir.
- Local turbulence.

3.4. Model limitations

In summary, the TUFLOW model was updated to represent the creek channel above Trower Road in the 1D domain, and maintaining the representation of the floodplain in the 2D domain. The 1D/2D TUFLOW model was recalibrated and is able to reproduce the majority of surveyed peak flood levels from the February 2011 event to within 0.10 m. The model is considered satisfactorily calibrated to this event and appropriate for modelling the design storm event scenarios of interest to this study i.e. the Q20 flood event and larger.

It is important to note that the model has not been validated against another historical event due to the lack of historical flood data. Validation of the model to another historical event would further improve confidence in the model's ability to simulate flood behaviour of Rapid Creek.





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Legend





Modelled flood extent

Figure 3-4



А

Meters



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TUFLOW calibration to recorded flood levels

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4. Design flood modelling

4.1. Design events

The calibrated 1D/2D TUFLOW model was used to simulate the following design flood scenarios:

- Q100 with Highest Astronomical Tide + 0.8 m sea level rise (4.16 m).
- PMF with Highest Astronomical Tide + 0.8 m sea level rise (4.16 m).

Design inflow hydrographs for the TUFLOW model were extracted from the URBS hydrologic model and a static downstream water level boundary was applied. The model was run for multiple duration storm events so that critical flood heights, depths and velocities were obtained. Design durations modelled typically ranged from the 45 minute storm up to the 6 hour storm.

4.2. Floodplain mapping

Floodplain maps for the two design flood scenarios noted above are provided in the Appendix. Note that flooding in the university area (north of Lakeside Drive and south of University Drive) is more extensive in these maps than previously because of inclusion of the actual representation of the bathymetry.

The Q100 flood levels which have been calculated using 1D channel representation, with actual bathymetry downstream of Trower Rd, and 2D representation of the flood plain can be taken as giving the best currently available estimates of the extent of flooding for land use planning.

Similarly the extent of the Probable Maximum Flood can be taken as the best currently available for emergency planning.



Appendix A Amended flood plain maps

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	Computed February 2011 Flood Extent and Flood Surface Contours
SKM	Figure

Flood Extent









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