

Appendix B

Changes Made to GWRC MIKE11 Model to Transform to MIKEFLOOD Model

General Description

Figure B-1 shows the location and chainages of the cross-sections describing the geometry of the main channel of the Waitohu Stream in the GWRC MIKE11 model (Wallace, 2004).

The MIKE11 model was transformed to a MIKEFLOOD model by splicing in a two-dimensional representation of the Waitohu Stream floodplain between cross-section chainages 41184m (just upstream of the Waitohu Valley Road bridge) and 44846m (about 2.7km downstream of the NIMT railway bridge) as seen in Figures 1-2 and 2-1. Upstream and downstream of these two main channel chainages, the MIKE11 part of the MIKEFLOOD model with all its branch network was left unchanged. The main channel branch of the MIKE11 model between the two main channel chainages was also retained except that the cross-section description was changed as detailed below. The overland flow network of the MIKE11 model between the two main channel chainages was deleted (except for the culvert structures under roads and the NIMT railway line) and replaced with the two-dimensional MIKE21 model description of the floodplain.

Two separate MIKEFLOOD models of the existing situation were developed – the first one with the old NIMT railway bridge incorporated as a user-defined culvert structure as per the GWRC MIKE11 model and the second one with the new NIMT railway bridge incorporated as a rectangular-shaped culvert structure.

The expressway bridge crossing was represented in the MIKEFLOOD model of the proposed situation as a 75m wide gap with the active river channel defined by means of additional cross-sections in the main stream channel branch of the MIKE11 component and the berm areas defined as part of the two-dimensional MIKE21 floodplain component. The expressway bridge was not defined specifically as a structure in the model in a similar manner to the existing SH1 and NIMT railway bridges as the flow constriction resulting from the 75m span crossing was not considered to be narrow enough to cause significant head losses.

Cross-Section Changes in Main Stream Channel

Between cross-section chainages 41184m and 44846m along the main stream channel in the MIKE11 component of the MIKEFLOOD models, the left and right bank marker locations were shifted to mark the edge of the main stream channel only. Each of the cross-sections in this main channel reach was connected on the left and right banks by link channels to the two-dimensional MIKE21 floodplain component. The top levels on the left and right bank of each cross-section were used to set the weir levels in the link channels attached to that cross-section. This ensured that the link channels only became active when simulated flood levels in the main stream channel reached the top of the bank on either side.

Additional cross-sections were incorporated as follows in the main stream channel branch of the MIKE11 component of both the existing and proposed MIKEFLOOD models in order to provide greater definition of the active stream channel past the expressway crossing:

- Additional cross-sections based on cross-section 42866m (immediately downstream of the Expressway crossing) were inserted at 42836m (immediately upstream of the proposed Expressway crossing) and 42760m. A datum shift was applied to both additional cross-sections to correct for the streambed slope.
- The relative resistance on the left bank of cross-section 42866m was corrected so that the relative resistance factor was not applied to any part of active channel stream bed (the original GWRC model

configuration applied a relative resistance factor of 1.2 to nearly the middle of the active channel which did not seem intuitively correct).

The new NIMT railway bridge incorporated a waterway area that was in the order of 15m wider than the active stream channel width upstream and downstream and is also located a few metres downstream of where the previous bridge was located. The MIKEFLOOD models of both the existing and proposed situations which incorporated the new railway bridge included additional and modified main channel cross-sections as follows:

- An additional main stream channel cross-section based on the existing cross-section at chainage 43006m was inserted at chainage 42960m upstream of the new railway bridge. A datum shift was applied to correct for the stream bed slope.
- An additional main stream channel cross-section based on the existing cross-section at chainage 43026m was inserted at chainage 43076m downstream of the new railway bridge. A datum shift was applied to correct for the stream bed slope.
- The existing stream channel cross-section upstream of the bridge at chainage 43006m was replaced with a modified cross-section based on the waterway immediately upstream of the new railway bridge.
- The existing stream channel cross-section downstream of the bridge at chainage 43026m was replaced with a modified cross-section based on the waterway immediately downstream of the new railway bridge.
- The existing stream channel cross-section downstream of the bridge at chainage 43016m was deleted.
- The location of the new railway bridge was changed from being at chainage 43010m to chainage 43016m.

MIKE21 Floodplain Component

The two-dimensional MIKE21 floodplain component between cross-section chainages 41184m and 44846m along the main stream channel in the MIKE11 component of the MIKEFLOOD models was defined based on LiDAR-sourced topographic data using a 5m x 5m grid.

Bridge and Culvert Representation

The Waterworks bridge (chainage 39252m), Ringawhata Road bridge (chainage 39510m), Waitohu Valley Road bridge (chainage 41485m) and the pre-2009 NIMT railway bridge (chainage 43010m) on the Waitohu Stream were each represented as irregular-shaped culvert structures in the MIKE11 network file for the original GWRC Waitohu Stream and floodplain model. The existing SH1 bridge (chainage 42550m) was represented as a Federal Highway Administration (FHWA) WASPRO type bridge structure in the MIKE11 network file.

For the MIKEFLOOD model, the representation of these structures was retained in the MIKE11 component except for the post-2009 NIMT railway bridge which was relocated slightly to chainage 43016m and the geometry redefined based on details derived from an as-built drawing.

In addition, further MIKE11 model elements were inserted in the proposed situation model to represent:

- the 8m x 2.5m box culvert in the southern (left bank) approach embankment of the Expressway bridge crossing of the Waitohu Stream and floodplain;
- the 10m x 1.5m box culvert in the northern (left bank) approach embankment of the Expressway bridge crossing of the Waitohu Stream and floodplain; and

- the 4m x 1.5m box culvert for the Greenwood sub-catchment.

Flow Resistance

The flow resistance description in the unmodified and modified MIKE11 components of the MIKEFLOOD models was retained based on the calibration determined by GWRC (Wallace, 2004) for the February 2004 flood event and other floods. Table B-1 summarises the main stream channel Manning's n roughness values from the MIKE11 components of the models within the area of interest to this investigations study (the model chainages in the table are shown in Figure B-1).

Table B-1 Main stream channel Manning's n roughness values in MIKE11 components of MIKEFLOOD models

Model Reach	Model Chainage (m)	Manning's n Values
Upstream boundary of model to halfway between Waitohu Valley Road bridge and SH1 bridge	39242 - 42051	0.037 - 0.039
halfway between Waitohu Valley Road bridge and SH1 bridge down to upstream of SH1 bridge	42196 - 42341	0.042 - 0.044
Upstream and downstream of SH1 bridge	42521 - 42576	0.046 - 0.050
Downstream of SH1 bridge to upstream of NIMT railway bridge	42771 - 42886	0.041 - 0.045
Upstream of NIMT railway bridge to confluence with Ngatotara Catchment inflow point	43006 - 45697	0.035 - 0.038

The Manning's n channel roughness values given in Table B-1 are typical of those expected for a relatively steep gravel bed river.

Within the two-dimensional MIKE21 component of the MIKEFLOOD models, the flow resistance of the floodplain with a largely pastoral type land use was defined by a Manning's n surface roughness value of 0.040. There is no way to confirm the validity of this particular value but it fits the general description of the floodplain.

The banks and berms of the main stream channel are lined with willow trees and this is reflected by the higher relative resistance values applied on both banks on many the channel cross-sections in the original configuration of the MIKE11 model. Along the main stream channel reach where the MIKE11 component is linked to the two-dimensional MIKE21 floodplain component in the MIKEFLOOD models, a narrow swathe of the berm on each bank was defined with a higher Manning's n surface roughness value of 0.060 to reflect the presence of these willow trees and the higher flow resistance that they create with their trunks and hanging branches.

Boundary Conditions

These were left unchanged from the original MIKE11 model.

Appendix II – Waitohu Cross-Section Location and MIKE 11 Chainages



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Figure B-1 MIKE11 model cross-section locations and chainages along Waitohu Stream (after Wallace (2004))

