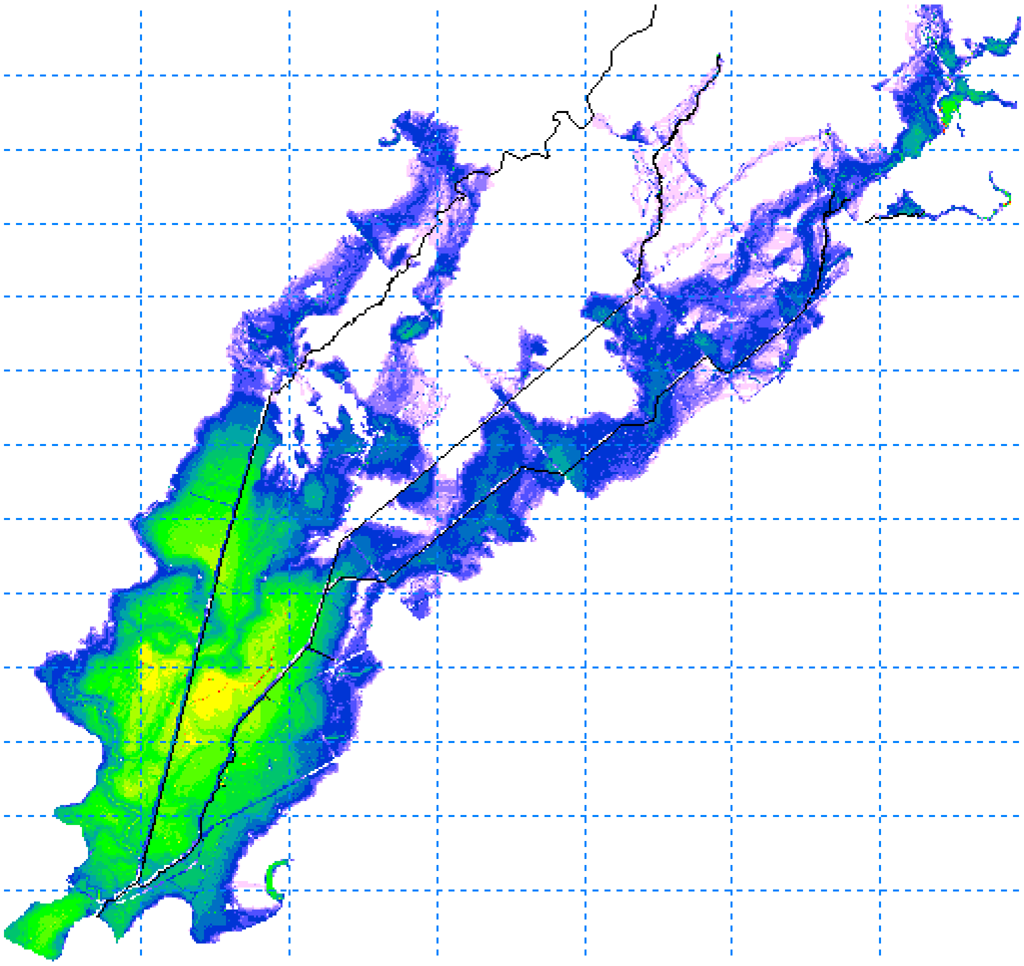
Taonui Basin Model Runs

Renewed application of 2006 MIKE FLOOD model



Horizons Regional Council

Report

April 2017

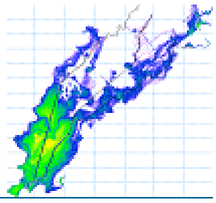
The expert in **WATER ENVIRONMENTS**

This report has been prepared under the DHI Business Management System certified by Bureau Veritas to comply with ISO 9001 (Quality Management)

Taonui Basin Model Runs

Renewed application of 2006 MIKE FLOOD model

Prepared for	Horizons Regional Council
Represented by	Mr Jon Bell



200-year flood extent

Project manager	Dragan Tutulic

Project number	44801004
Approval date	20th April 2017
Revision	Final 1.0
Classification	Restricted

DHI Water and Environment Ltd• ecentre, Gate 5, Oaklands Road• Albany 0752 Auckland• New Zealand•
Telephone: +64 9 912 9638 • Telefax: • info.nz@dhigroup.com• www.dhigroup.com

CONTENTS

FIGURES

1 Introduction

1.1 Background: the Taonui Basin and the 2006 model

The Taonui Basin is a very flat area bordered by the Oroua stopbanks to the west and the Manawatu stopbanks to the south and east. The basin is drained by a network of large drainage channels including Main Drain and Burkes Drain, with water discharging to the Manawatu River through floodgates near Rangiotui. The basin is used as a flood detention storage for excess floodwaters in Mangaone Stream and the Oroua and Manawatu Rivers. Floodwaters enter the basin via a number of constructed spillways and (in large events) overtopping and breaching of the Oroua and Mangaone stopbanks. Local runoff makes a minor but not negligible contribution to flooding in the basin.

In 2006 a MIKE FLOOD model of the Basin and its contributing catchments was assembled (DHI 2007). Inflowing streams including Taonui Stream, plus the drainage network, are modelled in MIKE 11, and the Basin is represented by 25 m square cells in MIKE 21. Local runoff contributing floodwaters in the basin are represented in MIKE 11 by 25 catchments using a Model B hydrological model.

1.2 Project Brief

This work was instigated by a Memorandum from Horizons Regional Council (Horizons) dated 11 August 2016. This Memorandum stated two objectives for the study:

- *Model the June 2015 flood event; and*
- *Re-run the 100 & 200 year design floods with the addition of a short length of stopbanking to protect properties in the Benmore Avenue area.*

The deliverables for both objectives were stated as "*flood maps showing the extent and depth of flooding, as well as maps of the modelled water surfaces*".

The work was described in a proposal from DHI dated 3rd October 2016. An important preliminary step was identified, that of confirming the locations and form of inflows from the Manawatu and Oroua Rivers. This proposal included rerunning the 100-year and 200-year events with the present catchment, both to confirm the validity of updating the model to 2016 software and to provide a baseline against which the effects of the stopbanking could be assessed.

With agreement from Horizons, mapping of the flooding extent and depth was to be provided by .dfs2 files produced within the MIKE 21 component of the model.

2 Methodology

2.1 The original numerical model

DHI assembled the original numerical model in MIKE FLOOD software in 2006. The model, its input data and results from model runs are described in detail in the model report (DHI 2007). The main features are summarised here for convenience:

2.1.1 Hydrological computations in MIKE 11

DHI's Urban Model B was applied. This method incorporates a simple initial and continuing-loss model and a kinematic routing component.

The contributing local catchment was delineated into 25 sub-catchments (Figure 1), with areas ranging from 2 to 22 km^2. The drainage path for each catchment was determined from a close analysis of the land level data, to obtain the hydraulic length and slope for runoff calculations. For all events, an initial loss of 20 mm and continuing losses of 2 mm/hr were assumed.

Rainfall for each sub-catchment was derived by weighting the two gauges at Valley Road and Palmerston North.

2.1.2 MIKE 11 Hydraulic Model

The MIKE 11 hydraulic model (Figure 1) includes Taonui Stream, Burkes Drain, Main Drain, Whiskey Creek and Kairanga Drain, as well as a short reach of "Airport Stream" between the Milsons Line gauge recorder and the end of the stopbanks on Richardsons Line. Mangaone Stream is not included as it is embanked for most of its length within the model area.

The MIKE 11 model also includes a number of secondary drains which pass local runoff through the stopbanks of Main Drain and Burkes Drain, and are fitted with non-return flapgates.

A number of spillways constructed in the embankments of Burkes Drain are also included, as short branches incorporating a weir structure, and linked to the 2D model of the floodplain. These spill water from Burkes Drain into the Taonui Basin when the Rangiotu flood gates close during high Manawatu river stage.

16 culverts and 7 bridges are modelled where roads cross the main drainage channels.

The Rangiotu floodgates at the downstream end of Burkes drain have been included as two sets of one-way culverts, representing the upper and lower gates respectively.

2.1.3 MIKE 21 Model

The MIKE 21 model is bounded by the Oroua and Manawatu stopbanks to the south and west, the Mangaone stopbanks to the east and the railway line to the north. Model grid size of 25 m was selected as a reasonable compromise between model resolution and the model run times achievable in 2006. The grid's dimensions are 848 x 862 grid cells, with 352,500 active cells.

All roads were burnt into the model grid, as well as the stopbanks on Mangaone Stream, Main Drain and Burkes Drain, and guide banks downstream of the Mangaone and Kopane spillways.

2.1.4 Inflows

There are number of source inflows to the MIKE 21 model domain at constructed spillways (which discharge onto the floodplain) and where stopbank overtopping or breaching occurs in the modelled scenario. The constructed spillways are located at Kopane and Rangiotu on the Oroua River, Hamilton's Line on the Manawatu River, and Flygers Line on Mangaone Stream.

Inflows to the MIKE 21 domain also occur at the outlets of the catchments modelled in MIKE 11.

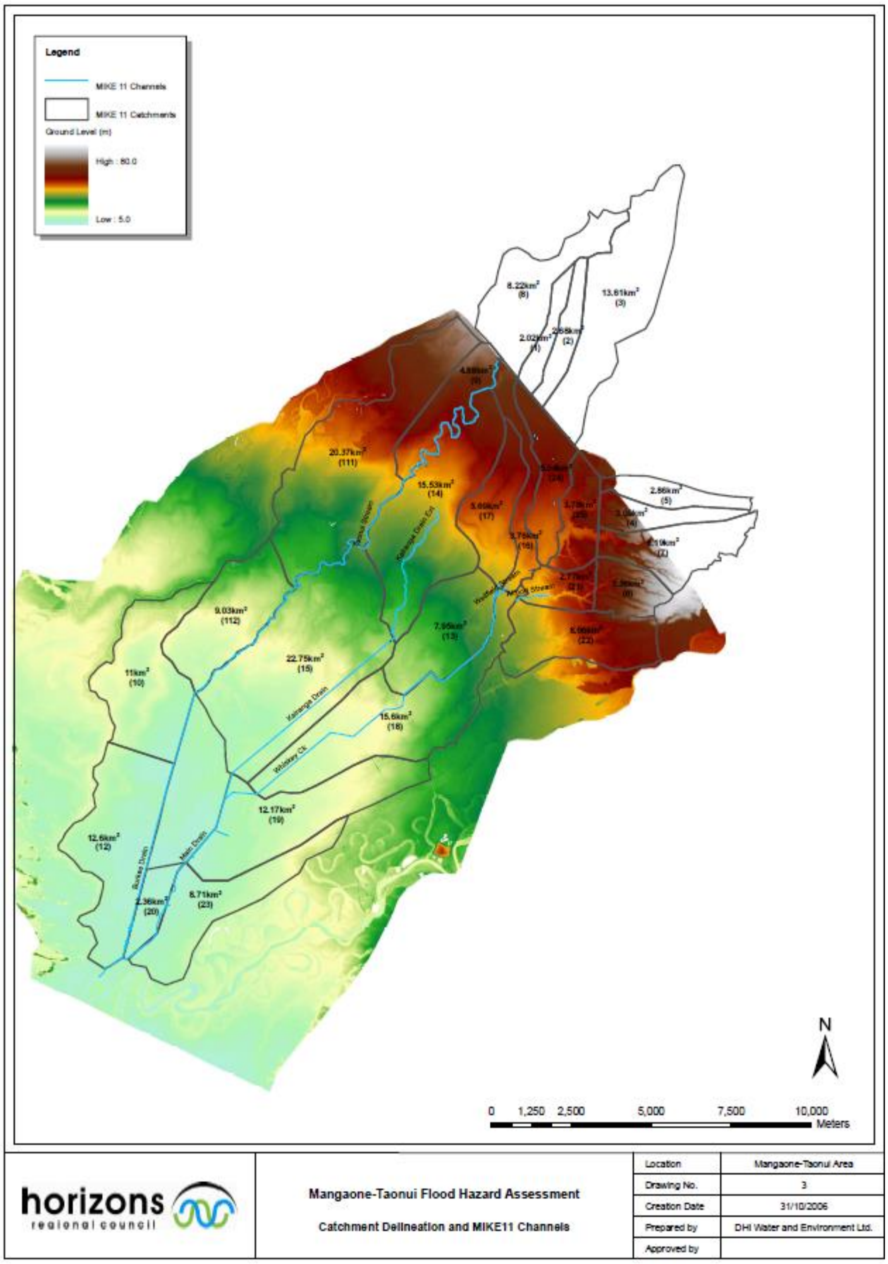


Figure 1 Local catchments and MIKE 11 network (DHI 2007)

2.2 Rejuvenation of the existing model.

The pre-existing numerical hydraulic model of the Taonui Basin is a MIKE FLOOD model created in 2006. DHI's MIKE software has undergone a number of changes since then. It was therefore necessary to confirm that when run in the latest MIKE software release, i.e. release 2016 with service pack 3, the model gives comparable results to those from 2006.

On inspection, the 2006 model did not have any hydraulic features that might have been incompatible with 2016 software, although specification of time series data had to be updated to meet 2016 requirements.

The 100-year design event, as modelled in 2006, was then simulated again. The modelled flood extent for this event was inspected, comparing 2006 model output (Figure 2) with 2017 output (Figure 7).

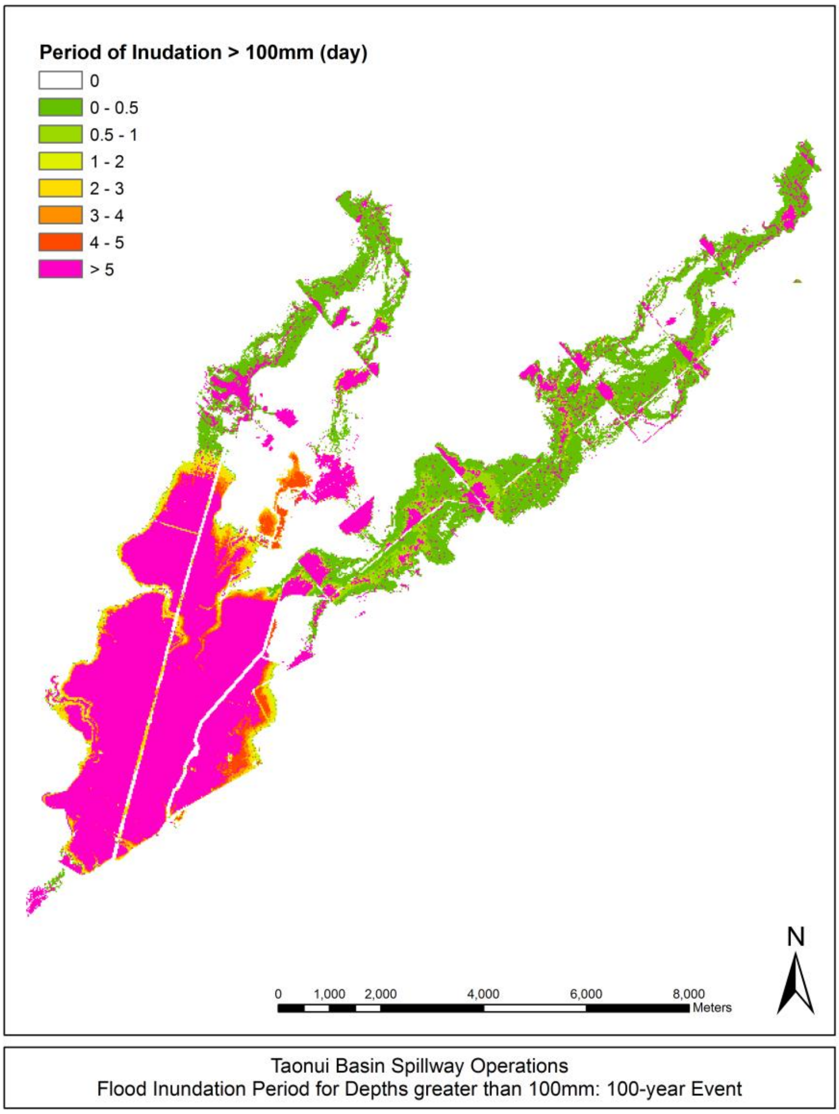


Figure 2 2006 modelling result: flood depth exceeding 100mm in 100-year event

Noting that Figure 2 effectively does not show flooding lasting less than a day, the two results can be regarded as the same.

2.3 Simulation of June 2015 Event

Horizons provided time series of the boundary conditions for the recent significant event in June 2015 - rainfall, spilling inflows from two designed spillways, and water level at two locations (in the Manawatu River downstream of the Burke's Drain outlet (Figure 3), and in Mangaone tream). These model inputs were applied to the new version of the model to simulate the event, to provide some validation of the new model version.

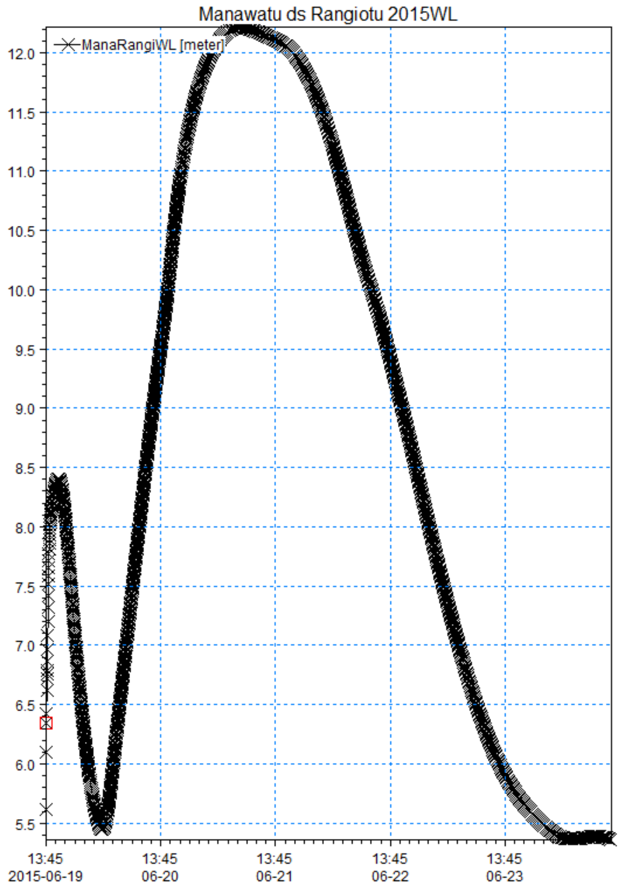


Figure 3 June 2015 Manawatu River levels downstream of Rangiotu, provide by Horizons

The inflow hydrographs provided by Horizons are shown in Figure 4. Both the Kopane and Rangiotu spillways are on the Oroua River. It is not known whether there were any inflows at further locations on either the Oroua or the Manawatu River.

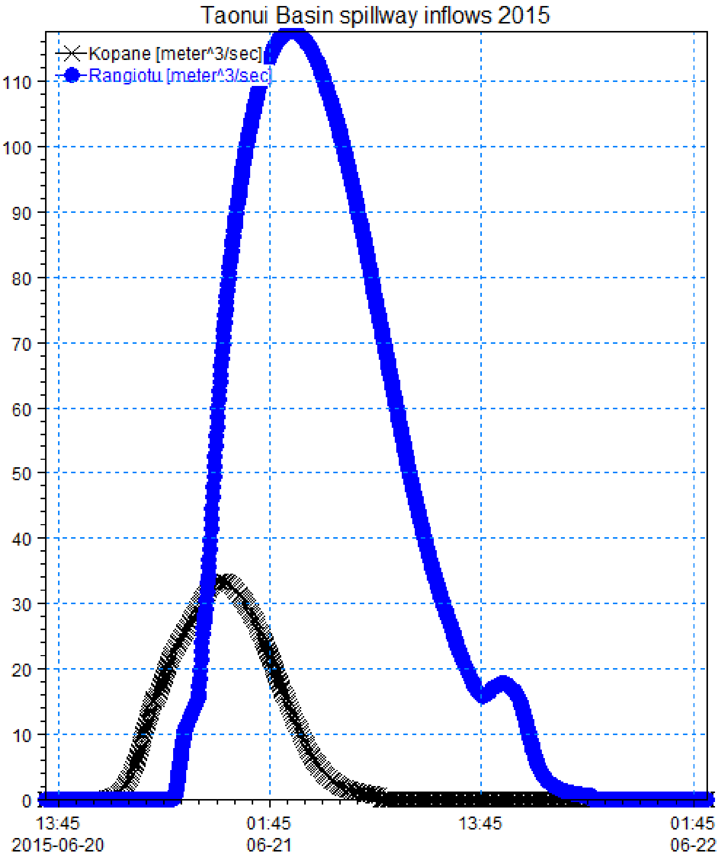


Figure 4 June 2015 inflow hydrographs at the Kopane and Rangiotu spillways, provide by Horizons

2.4 Simulation of design events to assess proposed stopbank

The 200-year event design event, as modelled in 2006, was simulated afresh. This simulation, plus the comparable 100-year simulation already completed, provide the baseline from which the effects of any changes in the basin can be assessed.

A proposed stopbank along Whiskey Creek (Figure 5) was then added to the model. Horizons supplied xyz values for the berm of the stopbank, which was defined within the MIKE 21 part of the model as a dyke (i.e. a weir of varying crest level).

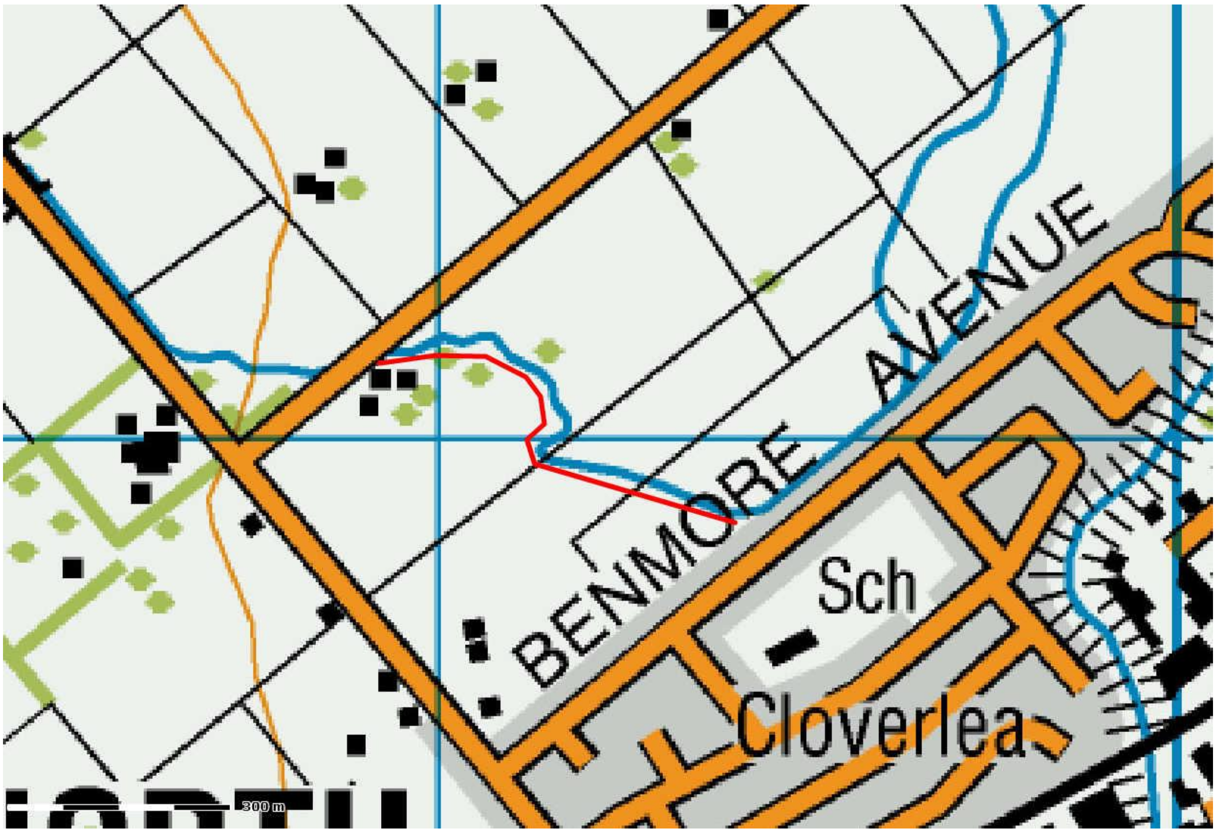


Figure 5 Map of part of Whiskey Creek, showing the proposed stopbank

3 Results

3.1 June 2015 Event

Peak overland flood depths for the 2015 event are shown in Figure 6.

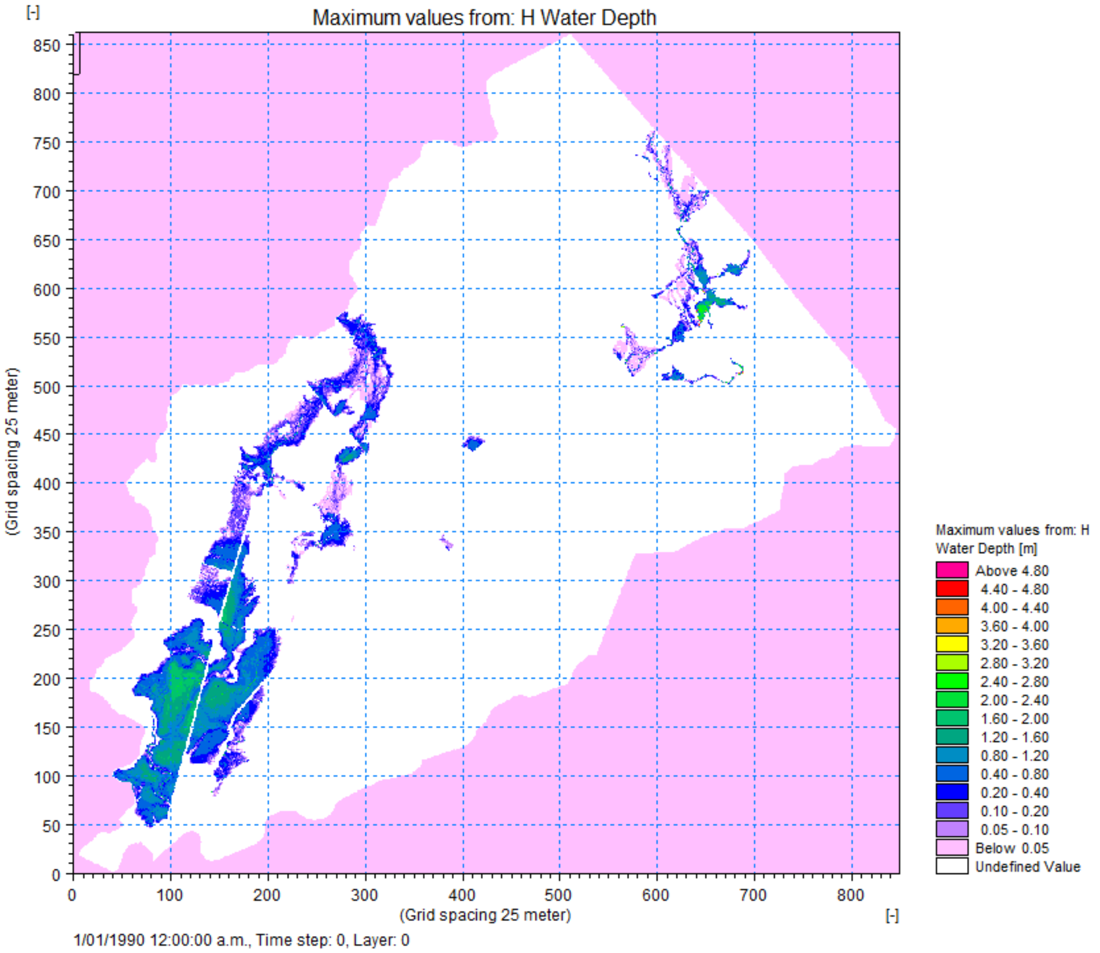


Figure 6 Maximum modelled flood depths, event of June 2015

The output files were checked to confirm that they appear reasonable, and delivered to Horizons. Comparison with the flooding extent observed in 2015 indicates that the modelled flood depths and volume of water are somewhat less than those actually occurring.

It would be possible to improve the agreement between modelled and observed flooding by adjusting rainfall-runoff losses, but this improvement is expected to be minor. From discussion with Horizons, it seems likely that the larger flood volume is primarily due to further inflows from the Manawatu River or Oroua River.

It was agreed with Horizons that, given that the discrepancy between modelled and observed flooding in the June 2015 event is minor and easily explained, this model run has confirmed the general validity of the numerical model.

3.2 Design event: baseline cases

Overland flooding depths and extent for the 100-year event are shown in Figure 7, and for the 200-year event in Figure 8.

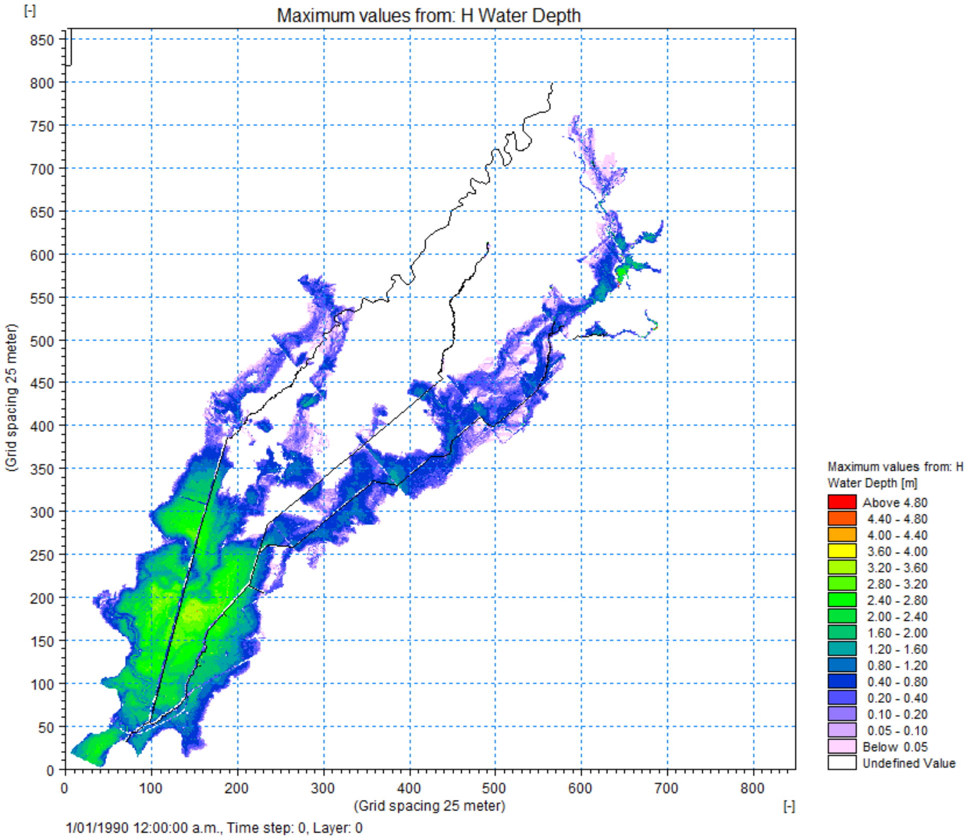


Figure 7 Overland flooding extent and depths, 100-year design event, base case

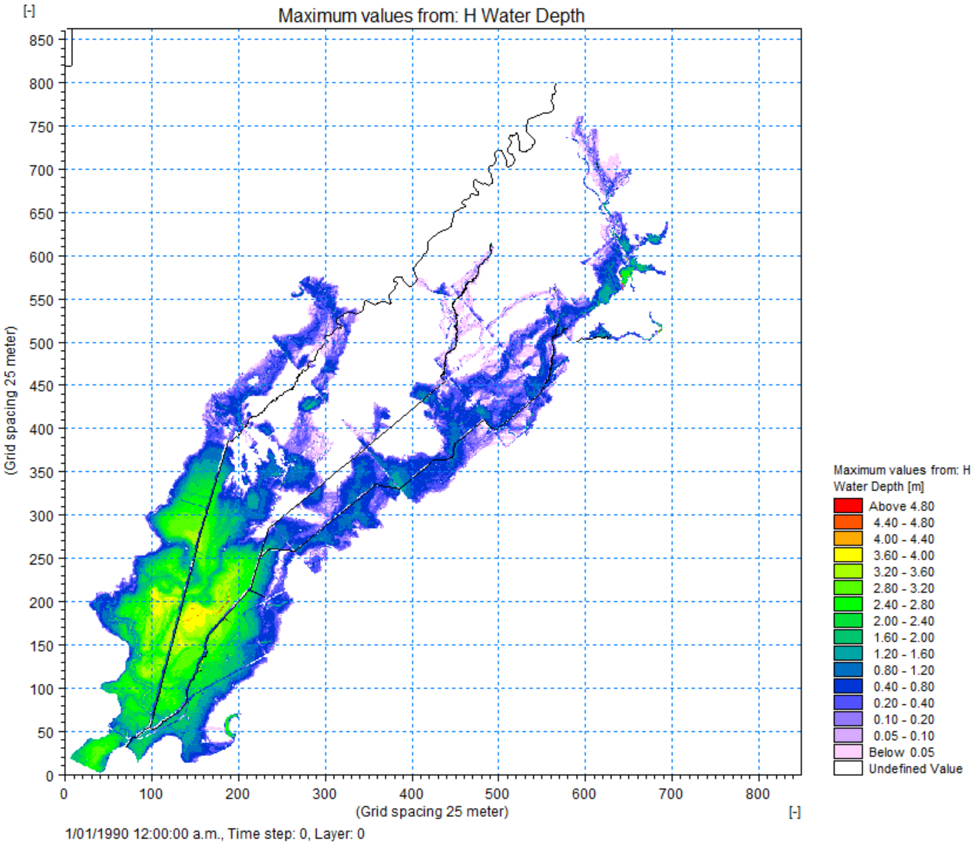


Figure 8 Overland flooding extent and depths, 200-year design event, base

3.3 Effect of the proposed stopbank

In Figure 9 to Figure 12 the proposed stopbank is shown as a red line, and waterways modelled in MIKE 11 are shown as black lines.

Overland flooding depths and extent with the proposed stopbank in place are shown in Figure 9 and Figure 10 for the 100-year and 200-year events respectively.

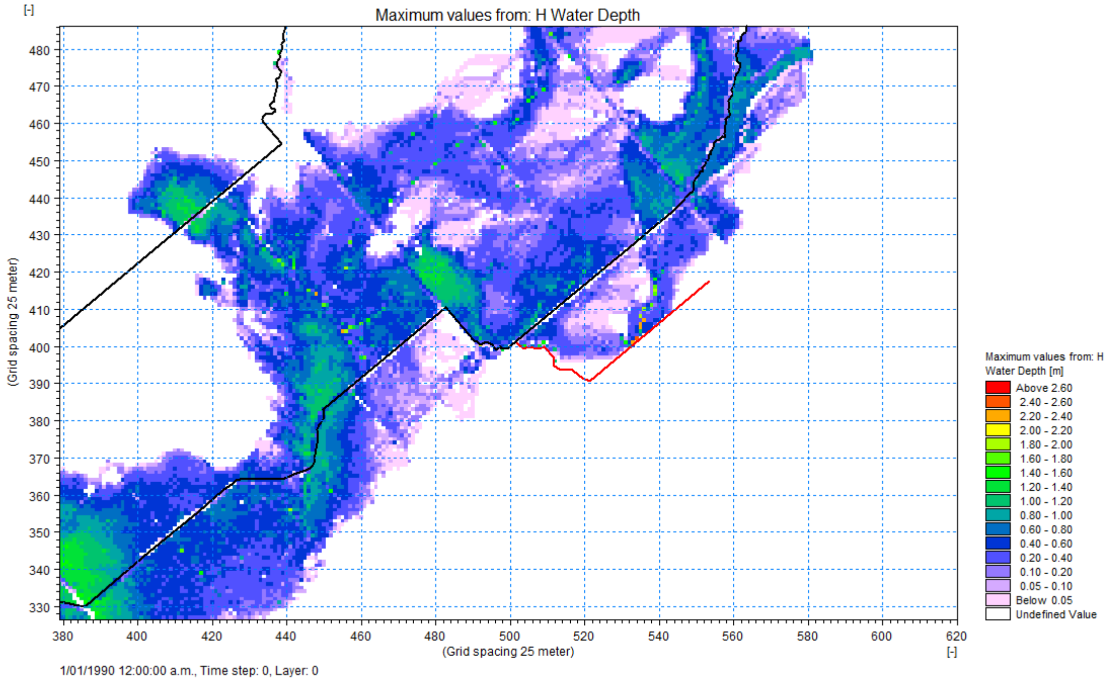


Figure 9 Modelled peak water level near Whiskey Creek, with proposed stopbank, 100-year design event

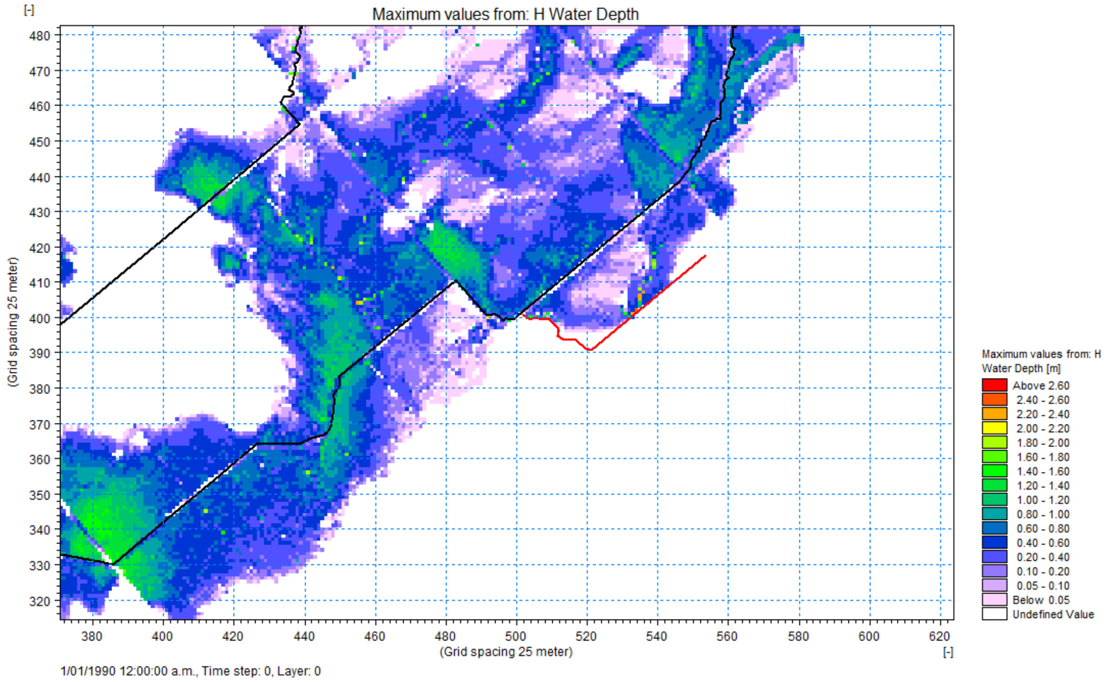


Figure 10 Modelled peak water level near Whiskey Creek, with proposed stopbank, 200-year design event

The changes in these depths effected by the stopbank for the 100-year event are shown in Figure 11 and Figure 12 for the 100-year and 200-year events respectively.

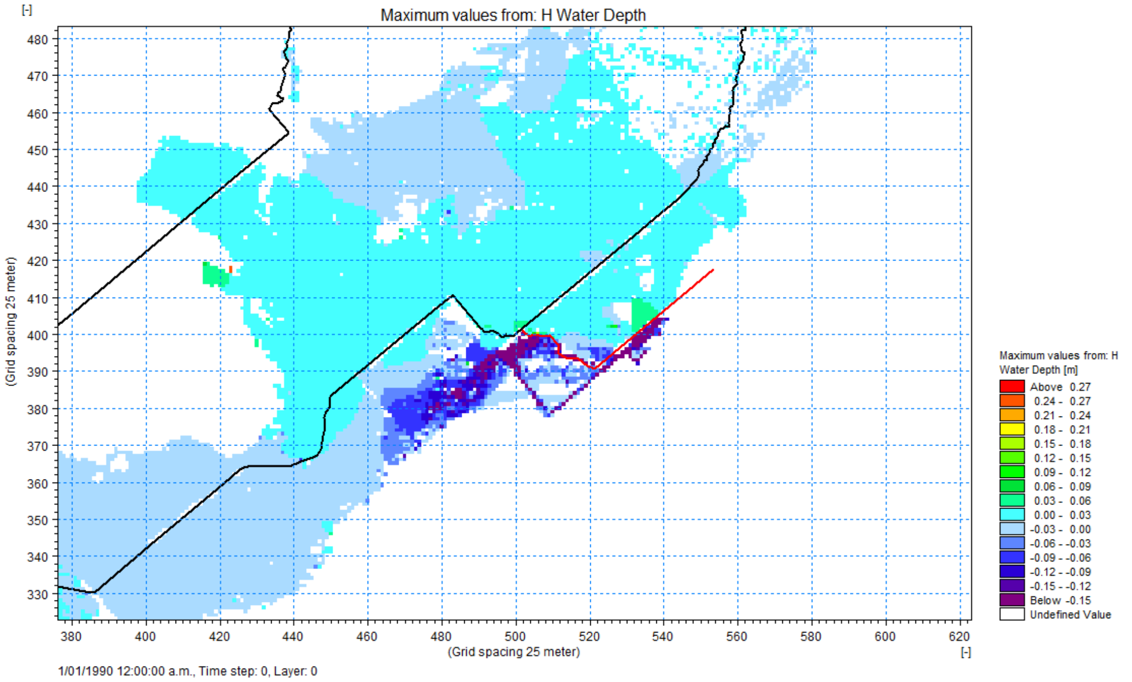


Figure 11 Modelled difference in peak water level near Whiskey Creek due to proposed stopbank, 100-year design event

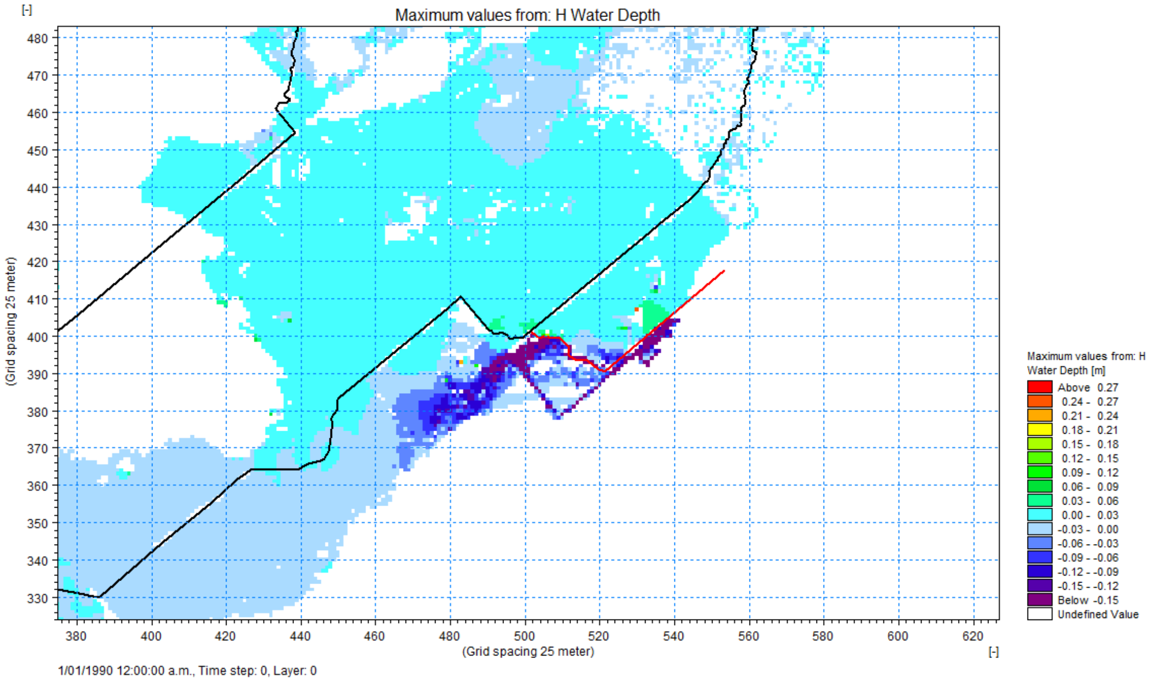


Figure 12 Modelled difference in peak water level near Whiskey Creek due to proposed stopbank, 200-year design event

These figures show the stopbank protecting an area to the south-west nearly 1km in length, as well as land immediately south of the proposed stopbank. Flood levels north-west of the stopbank are increased, but by a negligible amount.

4 Conclusions

A MIKKE FLOOD model of the Taonui Basin, assembled in 2006, has been updated to run in the 2016 version of the software. This required only minor adjustments with no effect on the hydrological and hydraulic computations.

The model has been successfully run with the 100-year and 200-year design river flow events (including design rainfall events on the local catchment). Visual comparison of the 100-year event with that obtained in 2006 showed no obvious differences.

The model has been run applying rainfall, inflows and water levels measured during a significant event in June 2015. The computed flooding extent has been compared with the extent observed at the time; the extent and volume of floodwater in the Basin appears to be somewhat smaller than observed, but by an amount believed to be consistent with further inflows from minor overtopping of river stopbanks.

The 100-year and 200-year events have been re-run incorporating a proposed stopbank at Whiskey Creek, on the outskirts of Palmerston North. The stopbank protects an area of about 40 hectares from significant flooding, with negligible effect on peak flood levels elsewhere.

5 References

/1/ DHI, March 2007, *Mangaone Stream and Taonui Basin Floodplain Hazard Assessment: Hydraulic modelling and mapping*.