Western Bay of Plenty District Council

Te Puke Stormwater Modelling

Stage 7 Modelling Report

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1 Introduction

1.1 Background

In November 2012 Opus produced *Te Puke MIKE URBAN Stormwater Modelling, Stage 2 – Modelling Report* (Opus, 2012) which outlined the construction of a MIKE URBAN hydraulic model for the stormwater system of Te Puke.

This was followed by an update during Stage 4 in April 2014 in which changes were made to the Stage 2 MIKE URBAN model and scenarios for a 1 in 5 year and a 1 in 50 year Average Recurrence Interval (ARI) event were simulated. These changes were outlined in *Te Puke Stormwater Modelling, Stage 4 – Modelling Report and Network Upgrade Costings* (Opus, 2014a).

Opus produced *Western Bay of Plenty Stormwater Modelling guidelines (Opus, 2014b) as* part of Stage 5. An independent peer review in 2014 of the flood mapping identified that the flood extent in the vicinity of open channels and water courses in the catchment were not adequately shown. As a result, the open channels were moved from MIKE URBAN to the MIKE 21 surface as part of Stage 6.

1.2 Purpose

The purpose of this report is to outline the changes made to the Stage 4 MIKE FLOOD model as part of Stage 6, and to present the results of the new model "nested rainfall" scenarios that are based on these revisions (Stage 7). All modelling is for the existing degree of catchment development and the existing stormwater network.

1.3 Model Scenarios

The revised model serves as the basis of two scenarios; 50 year ARI and 10 year ARI, both of which use a 24-hour duration nested storm supplied by Western Bay of Plenty District Council (WBOP DC). Each scenario has been simulated using MIKE FLOOD (MIKE URBAN-MIKE 21 coupled) computational hydraulic model. The scenarios are:

- 50-year ARI, 24-hour duration nested storm
- 10-year ARI, 24-hour duration nested storm

The above scenarios are for existing infrastructure, existing catchment development only.

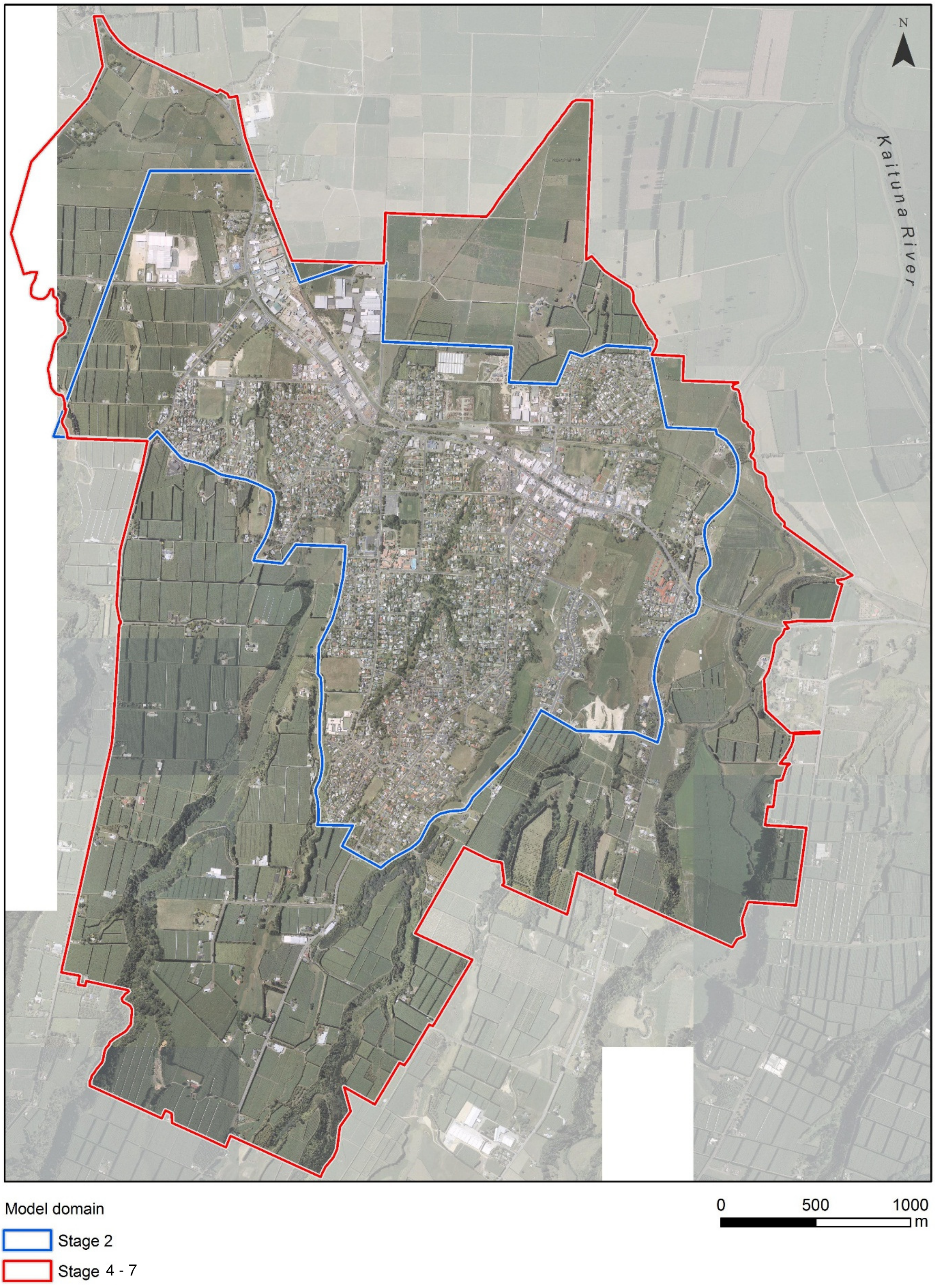

Figure 1 Comparison of model domains between Stages 2 and 4

2 Model Build

2.1 Introduction

The Stage 4 model was adapted during Stage 6 and 7. This section describes the changes made to the model.

2.2 Piped Network

There has been no change to the piped network since Stage 4 (Opus 2014a).

2.3 Open Channel Network

As part of Stage 6, existing open channels in MIKE URBAN have been removed and were transferred to the MIKE 21 surface (Figure 2).

The upstream inflows have also been transferred to MIKE 21. The downstream boundaries in MIKE URBAN were replaced by sumps with a constant water level in MIKE 21. This is detailed in Section 2.5 and 2.6.

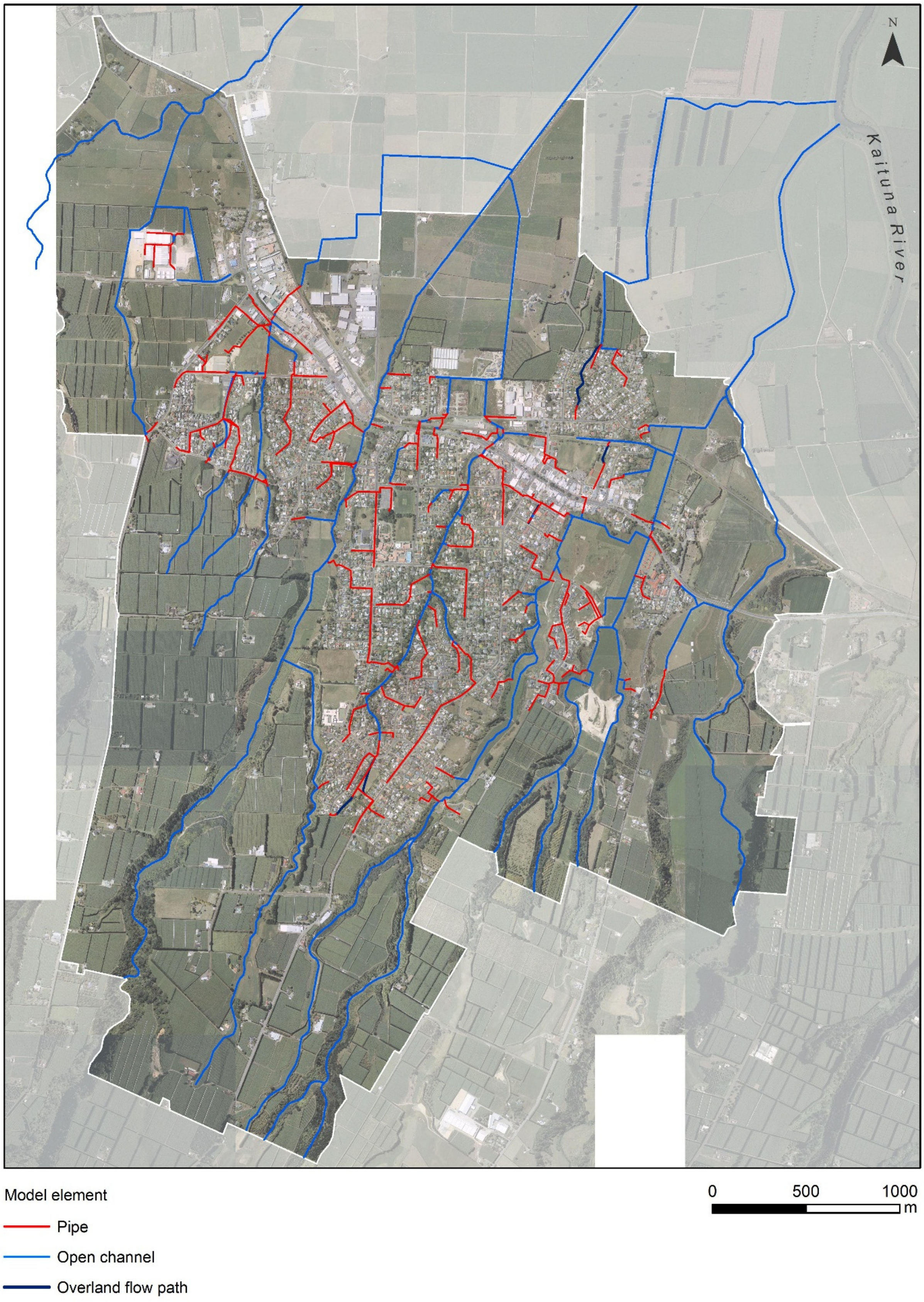

Figure 2 Te Puke stormwater drainage network in the Stage 7 MIKE FLOOD model

2.4 Catchments

The MIKE URBAN model uses two types of catchments. These are shown in Figure 3. The MIKE URBAN catchments are those used directly in the model for generating runoff. These cover the existing extent of stormwater infrastructure. The area and imperviousness values of these catchments are used to convert rainfall intensity to runoff volumes which are then assigned to model nodes during the network simulation. The catchments north of the model domain are included since the channels that run through them control the downstream water level boundaries and resultant backwater effects into the model domain.

The second catchment type – Inflow catchments – do not exist explicitly within MIKE URBAN but are instead used to calculate flows which are assigned as boundary conditions to the nodes at the upstream edge of the model domain (Figure 6). The calculated inflows therefore provide the runoff volumes in those parts of the model domain not covered by the MIKE URBAN catchments. Hence, the model considers the full upstream influence of these catchments rather than simply the portion that falls within the model domain. In Stage 4 these inflows were applied to the nodes in the 1-D component of the model whereas from Stage 6 onwards the inflows have been applied to the MIKE 21 surface.

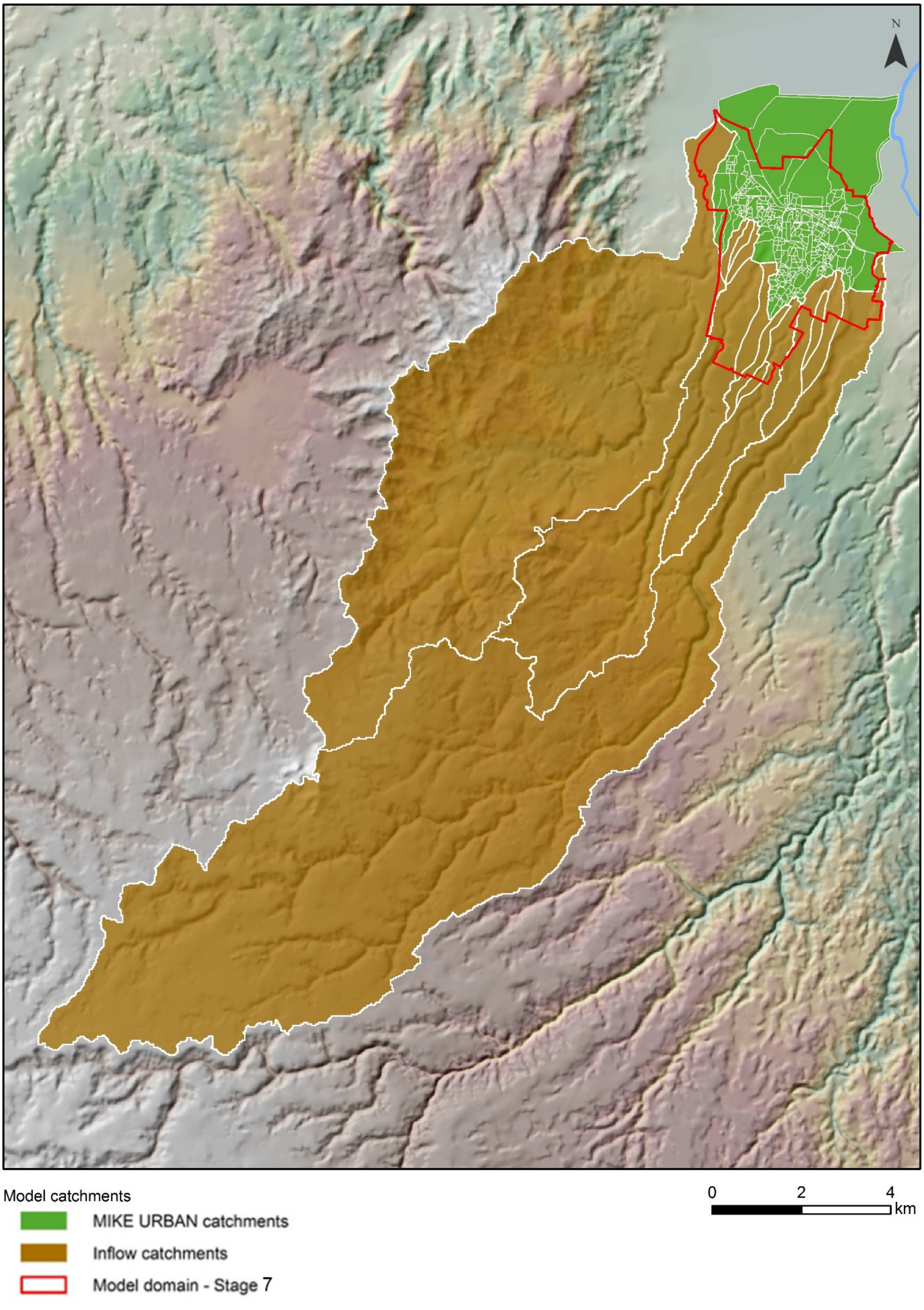

Figure 3 Te Puke catchments

2.5 Boundary Conditions

2.5.1 Rainfall

In Stage 4 the rain was temporally distributed in accordance with that used by Tauranga City Council (Opus, 2012). For Stage 7 this was replaced by a "nested storm" pattern supplied by WBOP DC. The design event intensity over the 24-hour duration is shown in Figure 4.

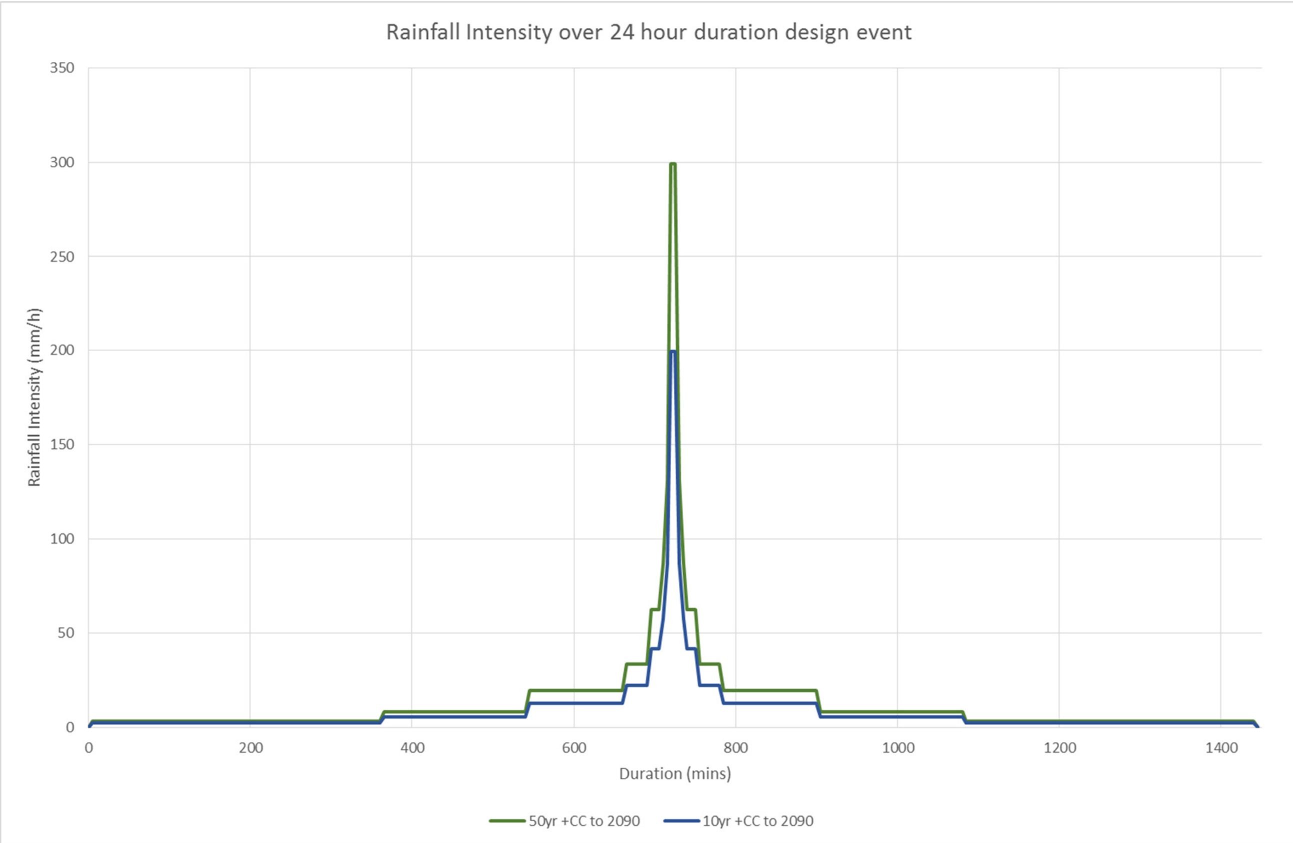

Figure 4 – "Nested storm" rainfall intensity over 24-hour duration

2.5.2 Inflows

Inflows for catchments upstream of the model domain used for the scenarios simulated in Stage 4 were retained for Stage 7. However these inflows were applied directly onto the MIKE 21 component of the MIKE FLOOD model in the location of the Stage 4 nodes (Figure 4). Discharges from the Stage 4 model were proportionally allocated on the basis of catchment areas and applied at the location of the node in Stage 4 (Figure 4). In accordance with the Bay of Plenty Regional Council guidelines (BOPRC, 2012) 2.33-year and 20-year ARI inflows were used for the 10-year and 50-year ARI overall model scenarios respectively. Table 1 details the magnitude of these flows as well as where they were applied to the MIKE 21 surface.

Table 1 Estimated peak discharges for the catchments upstream of Te Puke

Name	Stage 4 Node	Stage 7 MIKE 21 coordinate		Estimated Peak Discharge (m^3/s)	
		(j)	(k)	2.33-yr ARI	20-yr ARI
Raparapahoe River	FNJN0155	25	958	15.49	16.98
		26	958	15.49	16.98
		27	958	15.49	16.98
		28	958	15.49	16.98
		29	958	15.49	16.98
Raparapahoe Canal Tributary 1	FNJN0156	166	630	0.32	0.35
Raparapahoe Canal Tributary 2	FNJN0157	205	636	0.24	0.26
Raparapahoe Canal Tributary 3	FNJN0158	196	553	0.61	0.67
Ohineangaanga Stream	FNJN0159	130	220	8	8.78
		131	220	8	8.78
		132	220	8	8.78
Ohineangaanga Tributary	FNJN0160	199	84	1.48	1.63
Waiari Tributary 1a	FNJN0162	251	41	0.88	0.96
Waiari Tributary 1b	FNJN0164	273	27	0.3	0.33
Waiari Tributary 1c	FNJN0165	314	8	5.64	6.19
Waiari Tributary 2a	FNJN0167	518	334	2.59	2.85
Waiari Tributary 2b	FNJN0168	558	293	0.48	0.52
Waiari Tributary 3	FNJN0169	606	321	1.1	1.21
Waiari Stream	FNJN0170	776	295	35.87	39.24
		777	295	35.87	39.24
		778	295	35.87	39.24

2.5.3 Downstream Boundaries

The downstream boundaries were applied as 'sumps' directly into the MIKE 21 element of the model. Two types of sumps were used in the model. The first type of sump was introduced to allow water to leave the model domain without influencing the flood extent or depth. The second sump was introduced at the downstream end of the open channel watercourses to account for the backwater effect from the Kaituna River. Figure 5 shows the location of these sumps.

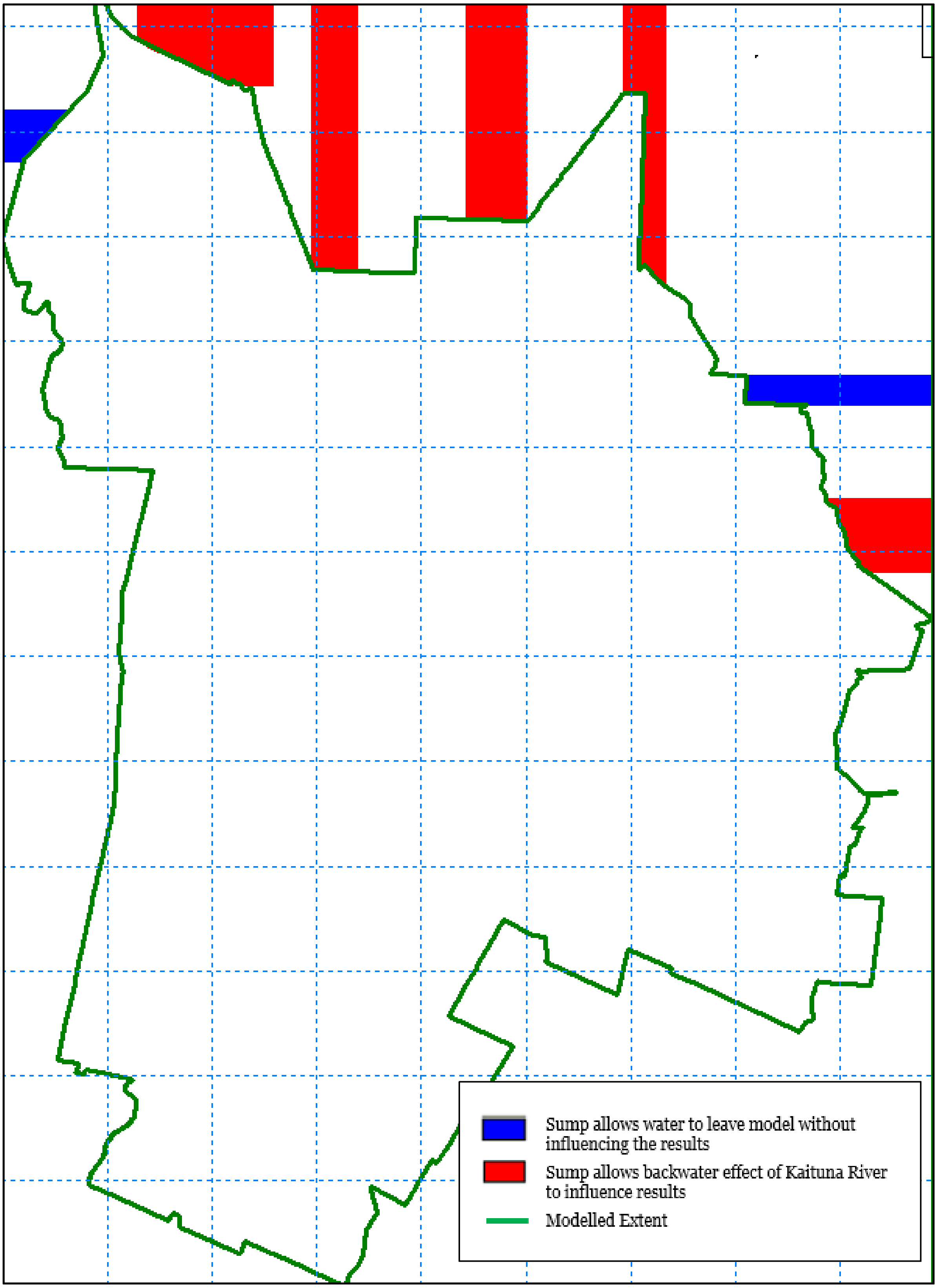

Figure 5 - Location of sumps

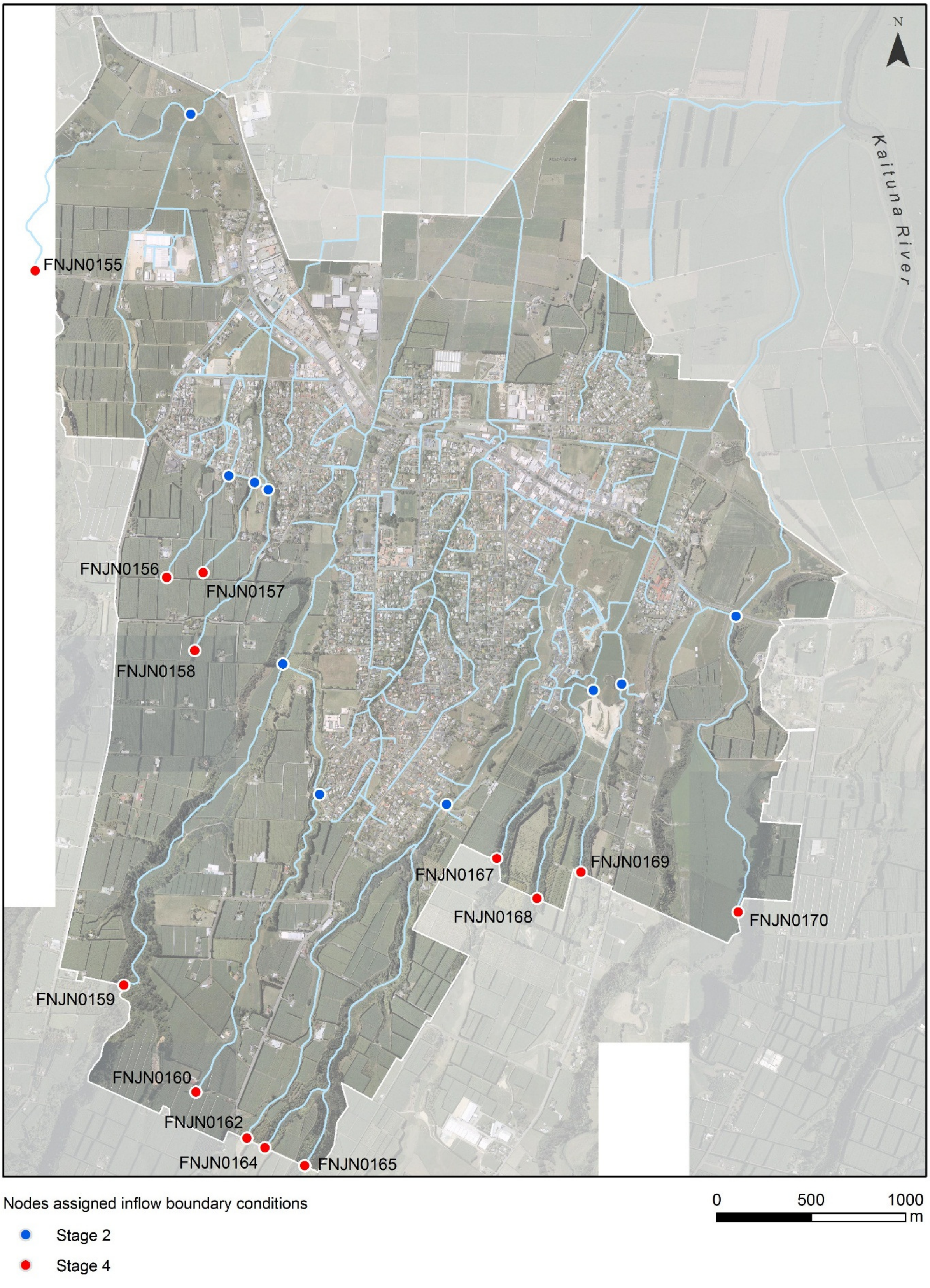

Figure 6 Location of inflow boundary conditions in the Stage 4 MIKE URBAN model

3 Model Results

3.1 Introduction

MIKE FLOOD was used to analyse two additional design events for the Te Puke stormwater model. These were:

- 10-year ARI event as a result of a 10-year ARI, 24-hour duration nested design rainfall event with 2.33-year inflows and downstream water levels.
- 50-year ARI event as a result of a 50-year ARI, 24-hour duration nested design rainfall event with 20-year inflows and downstream water levels.

3.2 Flood extent

A flood depth map was produced for the 50-year, 24-hour nested storm and the 10-year, 24-hour nested storm scenarios (existing infrastructure) using MIKE FLOOD. The output from MIKE FLOOD was a grid file of water depth. A water level grid was created from this by adding the depth values to the ground levels of the DEM. These flood maps are shown in the Appendix.

3.3 Comparison to Stage 2 results

Table 2 shows the water levels at the downstream end of the model predicted by the Stage 2 model compared to the water levels predicted by the developed Stage 7 model for the 50-year ARI event scenario.

Table 2 – Comparison of modelled downstream water levels

MIKE URBAN Link	MIKE 21 COORDINATE	WATER LEVELS (m)	
		MIKE URBAN Stage 2	MIKE 21 Stage 7
FLOD0122	(222, 1147)	7.64	7.12
FLOD0041	(328, 967)	6.79	5.98
FLOD0025	(501, 1014)	5.75	4.88
FLOD0056	(633, 952)	3.73	3.03
FLOD0092	(818, 685)	4.69	3.30

The differences between Stage 2 and Stage 7 are likely to be partly related to the way the channels have been represented in MIKE 21 in Stage 7 whereas they were represented in 1-D in MIKE URBAN in Stage 2. In Stage 2 the water would have been confined in the open channels in the MIKE URBAN model, whereas the Stage 7 model results show significant breakout from the channels. Another reason is that they are not a direct comparison due to the difference in the rainfall applied to the model between the two stages.

4 Conclusions

Flood mapping for the 50-year ARI, 24-hour duration nested rainfall event shows shallow surface flooding in the vicinity of residential areas, with deeper flooding largely confined to rural areas, park land and open channels.

5 References

Bay of Plenty Regional Council (2012), *"Hydrological and Hydraulic Guidelines"*, Bay of Plenty Regional Council, 2012.

Opus (2012), "*Te Puke MIKE URBAN Stormwater Modelling. Stage 2: Modelling Report*", a report prepared by Opus International Consultants for Western Bay of Plenty District Council, Reference 3-50909.00, November, 2012.

Opus (2014a), "*Te Puke Stormwater Modelling. Stage 4: Modelling Report and Network Upgrade Costings*", a report prepared by Opus International Consultants for Western Bay of Plenty District Council, Reference 3-53063.00, April 2014.

Opus (2014b), "*Western Bay of Plenty Stormwater Modelling guidelines*", a report prepared by Opus International Consultants for Western Bay of Plenty District Council, August 2014.

Appendix

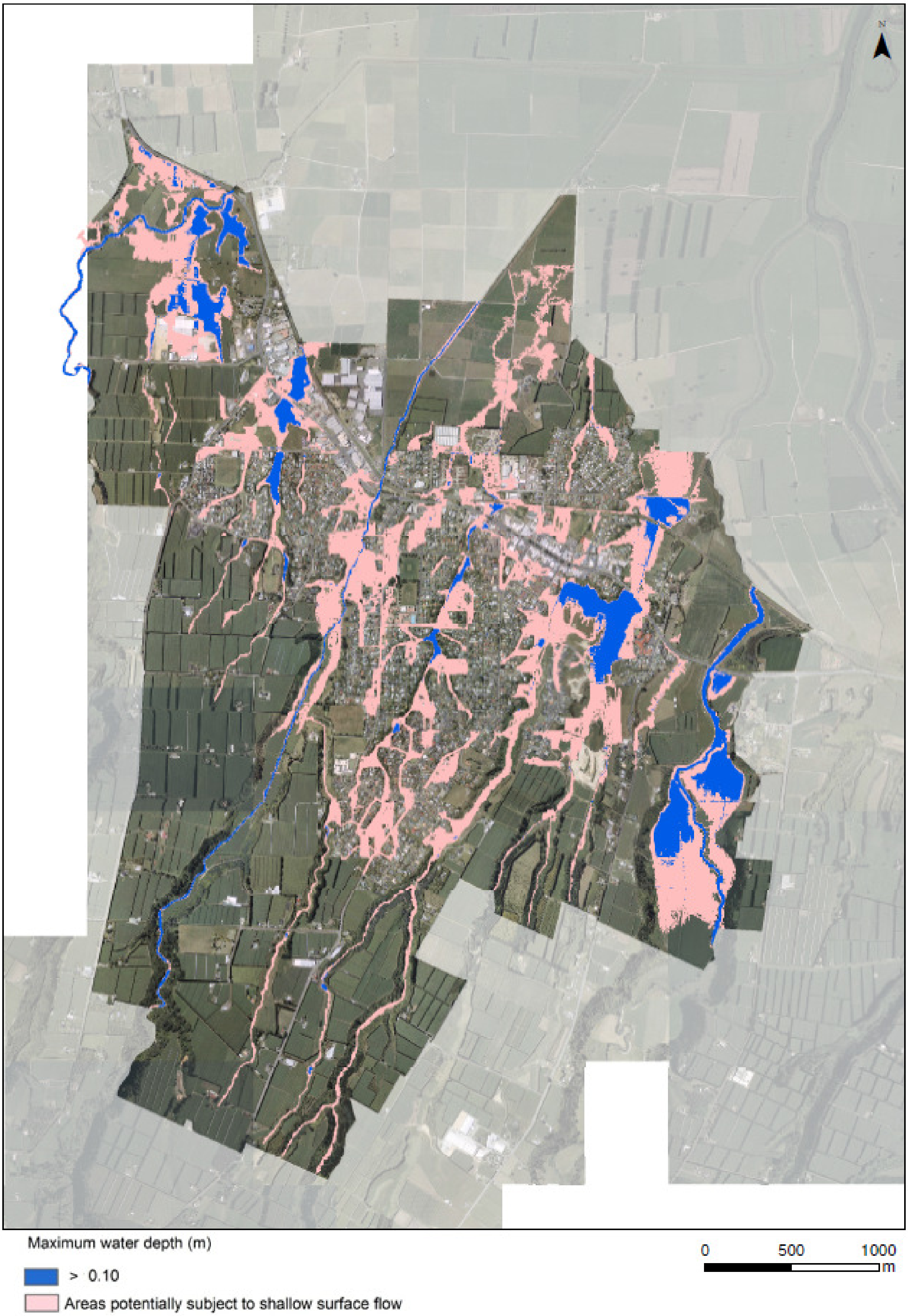

Figure 7 – Flood depth for the 10-year 24-hour duration design "nested storm" rainfall event

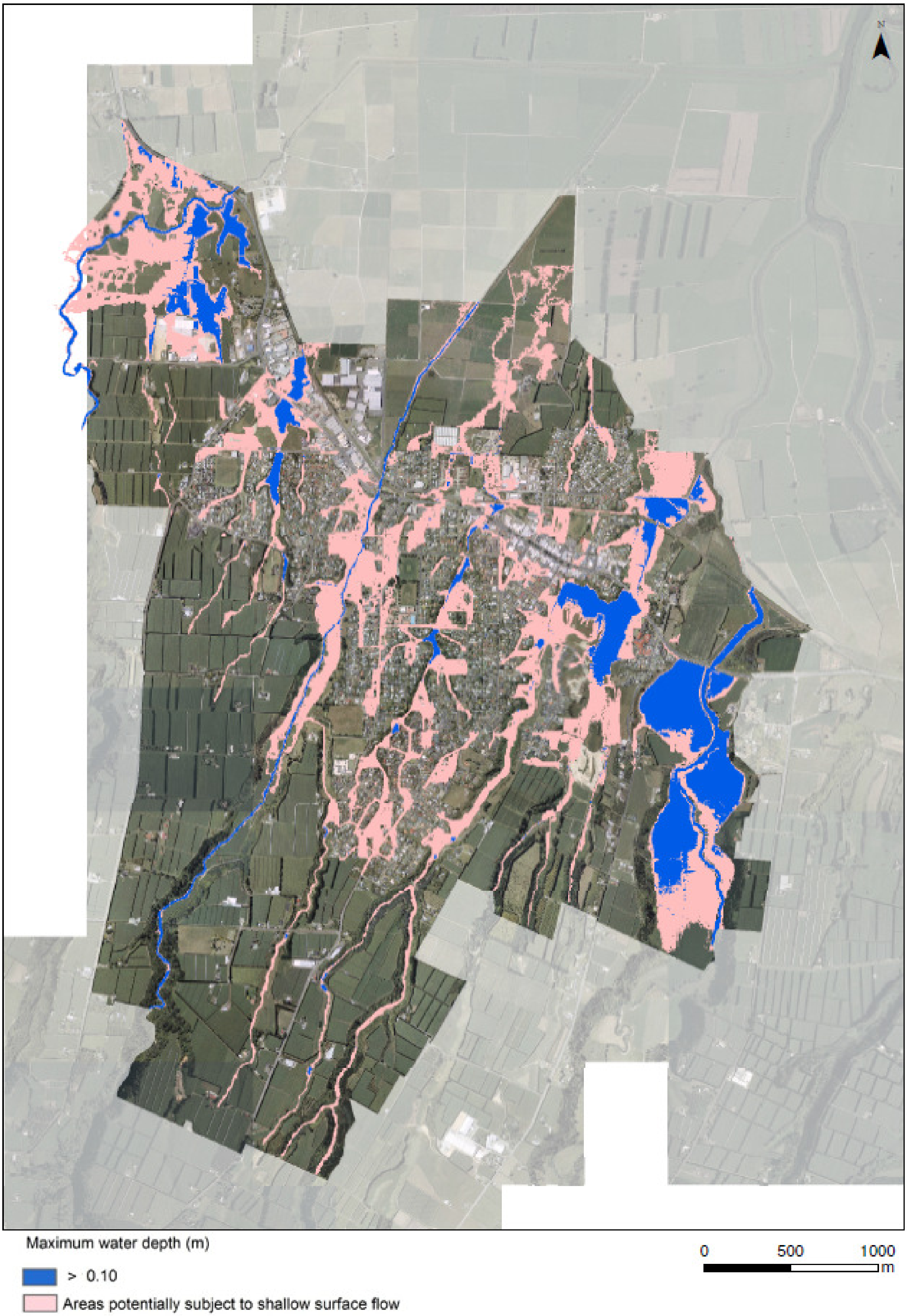

Figure 8 – Flood depth for the 50-year 24-hour duration design “nested storm” rainfall event

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