REPORT

Brightwater & Wakefield TUFLOW Model Build

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1 Introduction

1.1 Scope

Tonkin & Taylor Ltd (T+T) was engaged by Tasman District Council (Council) to undertake a “2D+” flood modelling of the combined urban drainage area of Brightwater and Wakefield, for the purpose of identifying and mitigation existing stormwater flood issues.

Previous modelling by SKM (now Jacobs) for TDC in this area was undertaken for the purpose of assessing flood hazard arising from the main rivers, and for identifying mitigation options. The assessment was reported on in the report titled “Brightwater – Wakefield Flood Hazard Mapping”, dated 12 December 2013 (SKM 2013). The model was built to understand flooding from the large river systems in this area, and did not include the stormwater pipe network. Since the focus of this present study is on local stormwater issues that may be significantly affected by existing stormwater infrastructure, a new model was developed that could include the pipe networks.

Other updated information since the earlier modelling that has been included in this model update include:

- NIWA’s rainfall databaseHIRDS (now version 4);
- Ministry for the Environment’s (MfE) guidance on the effects of climate change on rainfall;
- LiDAR ground surface model (last flown in 2016).

The 2D+ modelling methodology of this study uses TUFLOW software to deliver efficient models with shorter run times than the alternative more detailed methodologies. This improves the usefulness of the models to assess options and scenarios, by significantly reducing modelling cost and programme.

The methodology allows representation of the effect of Council’s stormwater pipe network on stormwater flooding. This is important, as the immediate purpose of this model is to identify existing flooding issues and develop and test mitigation options.

Because of the difference in rainfall data, flow records, climate change guidance, LiDAR data and (to a lesser degree) modelling methodology, this present study is considered to supersede the SKM 2013 study.

The scope of works included the following:

- Build a 2D flood model covering the urban areas of Brightwater and Wakefield, using the following:
  - Rain-on-grid approach with river inflows at boundaries;
  - Hydraulic representation of all stormwater pipes 225 mm diameter and larger;
- Validate the model;
- Run sensitivity assessment by varying key parameters to produce fuzzy map overlay with predicted flood extents;
- Using the validated model, undertake simulation of design events of 1%, 10%, and 50% Annual Exceedance Probability (AEP) rainfall for present day and a 2090 climate horizon with different storm durations.

This report summarises the model build and results. All levels presented in this report are to the 2016 New Zealand Vertical Datum (NZVD2016) unless noted otherwise.

1.2 Hydrological setting

Wakefield and Brightwater are located south-east of Richmond near the head of the Waimea plains. The Wai-iti River flows north adjacent to Wakefield and then past Brightwater where it joins the Wairoa River. The total catchment area to the confluence of the Wai-iti and Wairoa Rivers is approximately 750 km². In addition, several smaller catchments contribute to smaller scale but more frequent local flooding at the two townships.

2 Modelling approach

The purpose of the flood model is to provide Council with an understanding of what urban areas within Wakefield and Brightwater may be subject to flooding under different sets of conditions, and to provide a tool to use for developing mitigation options. A 2D 'rain-on-grid' model was created for Wakefield / Brightwater using TUFLOW software. Lumped catchment hydrological inputs were assessed for the upstream catchments, to constrain the model extents for purposes of modelling efficiency.

T+T selected the TUFLOW HPC (Heavily Parallelised Compute) solver for this model. TUFLOW HPC solver utilises GPU hardware which provides significant reduction in run-times when compared to classic CPU hardware. The GPU hardware also enables smaller grid sizes to be used. Smaller grid sizes are desirable as they provide finer resolution, which enables more accurate modelling of overland flow paths. TUFLOW HPC can simulate both boundary inputs (river flows) and rainfall with use of GPU hardware (previously only CPU compatible).

HPC can also simulate 1D elements within a 2D domain. However, 1D elements such as pipes were not explicitly represented in the model and instead the DEM was modified to represent pipes as open channels with equivalent hydraulic performance. Further discussion on this approach is given in Section 3.2.4. A notable limitation of this approach is in the lack of representation of detailed 1D hydraulic structures, however for the initial purposes of this model this was deemed adequate. It is recognised that future updates to the model, developed on an as-needed basis, will include further consideration of this.

3 Model inputs

3.1 General parameters

The general parameters used in the TUFLOW model are summarised in Table 3.1.

Table 3.1. Summary of hydraulic model parameters

Parameter	Value
Model cell size	A cell size of 2 m by 2 m (4 m²) has been used for the Wakefield / Brightwater model.
Timestep	The TUFLOW GPU model utilises an adaptive timestep based on a maximum Courant number of 1.
Viscosity	The default viscosity approach in TUFLOW GPU is a Smagorinsky method. The default Smagorinsky coefficient of 0.20 has been adopted for this modelling.

3.2 Spatial data

3.2.1 Model extent

The extent of the model was set to include the urban areas of Wakefield and Brightwater and surrounding floodplain. Flows from five upstream catchments are assessed through lumped catchment hydrology and introduced to the model as point sources at the model boundary. The model extent and location of these five river inflows is shown in Figure 3.1.

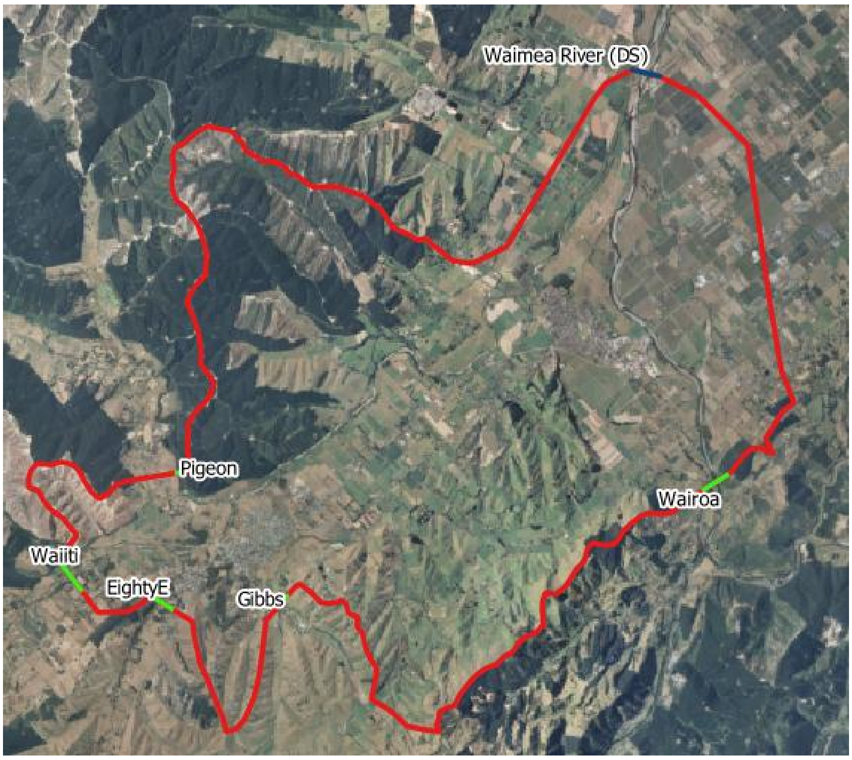

Figure 3.1. Wakefield and Brightwater Tuflow model extent (in red). Labelled parts of the extent polygon show lumped catchment inflow locations (in green) and downstream boundary location (in blue).

3.2.2 Digital elevation model

The digital elevation model (DEM) for ground levels used in the model was provided by Council and based on LiDAR surveys. The DEM represents a bare earth terrain, with all buildings and above-ground features detected having been removed. Using this approach, it is sometimes possible that flooding is shown to occur through the area occupied by large buildings. The intention is that the results from this model be used to identify key areas in need of flood mitigation works. Further, more targeted analysis (which may include more modelling) is expected to be required at a localised scale when individual areas are selected.

The LiDAR was flown in 2016, and has been converted by Council to the current vertical datum, NZVD 2016. We note that this is a different source of ground surface information as was used in the previous modelling study, and that differences between model results (depths, extents) from this and previous studies may arise from this.

3.2.3 Land use (surface roughness)

Surface roughness values adopted in the model were based on land use as categorised in Landcare Research's Land Cover Database version 4.1 (LCDB4). This database was released in July 2015 and was the most current at the time of the modelling. This data is freely available from the Land

Research Information Systems portal (https://lris.scinfo.org.nz). The land use of the Wakefield / Brightwater area according to LCDB4 is shown in Figure 3.3.2. Details of specific roughness values applied to the different land uses are summarised in Table 3.2.

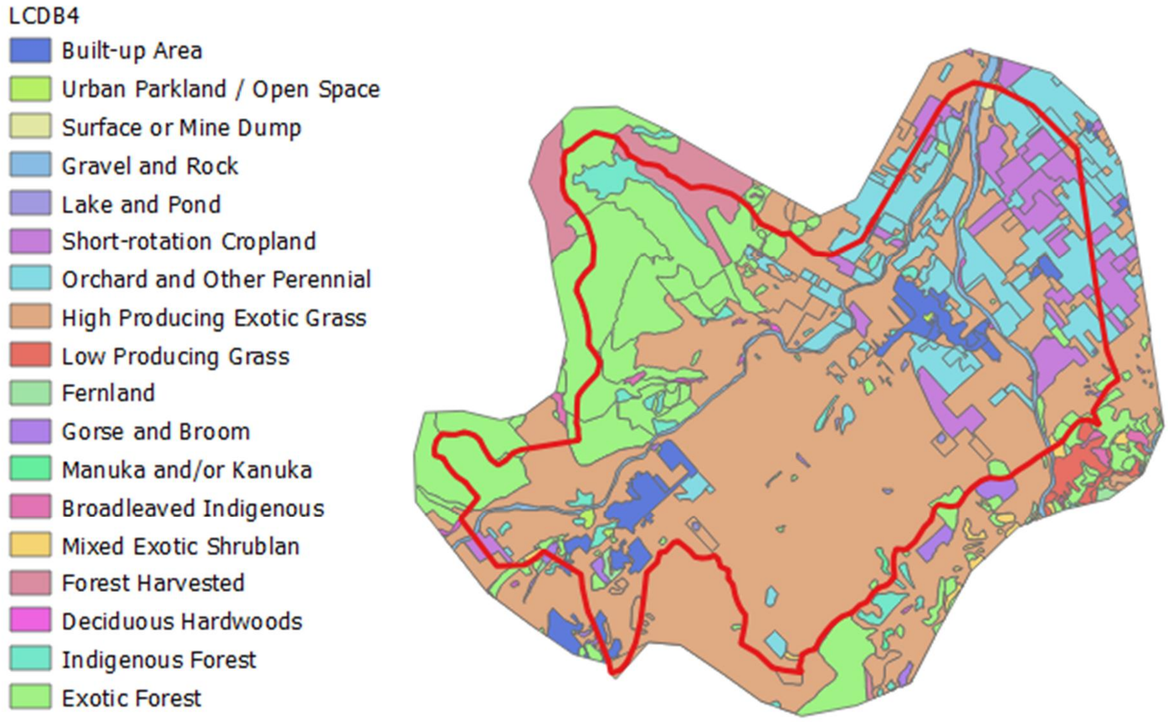

Figure 3.3.2. Landuse in Wakefield and Brightwater (sourced from Landcare)

In addition to the above, all road centrelines were located in GIS and buffered to a width of 8 m. The resulting areas were overlaid with a Manning's 'n' roughness value of 0.02.

Table 3.2. LCDB4 Land types and corresponding Manning's 'n' roughness values and impervious fractions

Description	Code	Manning's n	Fraction Impervious
Built-up Area	1	Depth Varying	0.25[1]
Urban Parkland/ Open Space	2	0.033	0
Surface or Mine Dump	6	0.05	0
Gravel and Rock	16	0.039	0
Lake and Pond	20	0.02	0
Short-rotation Cropland	30	0.1	0
Orchard and Other Perennial	33	0.05	0
High Producing Exotic Grass	40	0.05	0
Low Producing Grassland	41	0.09	0
Fernland	50	0.16	0
Gorse and Broom	51	0.125	0
Manuka and/or Kanuka	52	0.1	0
Broadleaved Indigenous Hard	54	0.1	0

Description	Code	Manning's n	Fraction Impervious
Mixed Exotic Shrubland	56	0.08	0
Forest Harvested	64	0.16	0
Deciduous Hardwoods	68	0.125	0
Indigenous Forest	69	0.15	0
Exotic Forest	71	0.15	0
Roads	88	0.02	1.0

1 This value has been estimated at a global scale for the built-up area shown in the LCDB4 land use layer, which includes many areas of limited or no impervious surface covering. This is appropriate for broad-scale investigation, but could be refined as more detailed investigations are required.

A depth-varying Manning's 'n' was used for 'Built-up Area' as this allows for a low roughness to be used at shallow depths to represent roofs and driveways. At higher depths, an increased roughness is applied to represent overland flow through urban areas, where fences and buildings provide an impediment to flow. The depth varying roughness is outlined in Table 3.3.

Table 3.3. Depth varying Manning's n coefficients for urban areas

Depth	Manning's n
Less than 50 mm	0.015
50 mm – 100 mm	The value varies linearly from 0.015 to 0.05
Greater than 100 mm	0.05

3.2.4 Stormwater infrastructure

Primary (piped) flow in the catchment was represented in the model by modifying the DEM to replace stormwater pipes with open channels with equivalent hydraulic performance (termed "simulated pipes"). Only pipes larger than 225 mm in diameter were represented due to constraints with the model grid size (a smaller grid size would be required to represent smaller pipes, and this would significantly affect model run times). This approach has been demonstrated to produce reliable results in previous studies[1] and is considered appropriate given the fact that smaller pipes carry a relatively small proportion of total flood volume in larger events. GIS files with pipe locations and sizes were provided by Council. The locations of the simulated pipes are shown in red in Figure 3.3 and Figure 3.4. Note that in the simulation of these pipes, the DEM is modified so that the hydraulic effects (volume and conveyance) of such pipes is replicated.

[1] Tonkin + Taylor (August 2014), Increased Flood Vulnerability: Overland Flow Model Build Report, published on the Canterbury Geotechnical Database.

Figure 3.3. Wakefiled pipe network included in the model

Figure 3.4. Brightwater pipe network included in the model

3.2.5 Missing culvert data

Results from preliminary model runs showed ponding behind road embankments in several places where satellite imagery or local knowledge indicated that a culvert or road bridge existed, but where none was present in the model. i.e. where the preliminary model was artificially storing water behind embankments. Culvert information was not available at these locations in Council's Top of The South Maps web platform at the time of the model build. For the purposes of this model, Council requested that these culverts be modelled as circular pipes with 900 mm diameter. Therefore, in addition to the modelled pipes described in Section 3.2.4, seven culverts were added as a consequence of this data check, with assumed diameters of 900 mm, at the locations listed below:

- SH6 between Telenius Road and Roughton Lane
- Telenius Road
- Higgins Road near Barton Lane
- Higgins Road near Mount Heslington Road
- Barton Lane near Higgins Road
- Bridge Valley Road
- Pigeon Valley Road

The model can be updated to actual dimensions if these culverts are surveyed at a future stage.

3.3 Hydrological assessment

The purpose of the hydrological assessment was to use NIWA's High Intensity Rainfall Design System (HIRDS V4) storm rainfall and hyetographs to generate 10 and 100 year ARI inflow time series and rainfall hyetographs for input to the hydraulic model. This section presents the data, methodology and results of the hydrological assessment.

3.3.1 Study area and catchment characteristics

Figure 3.5 shows the catchments and centroid locations used to generate HIRDS V4 data.

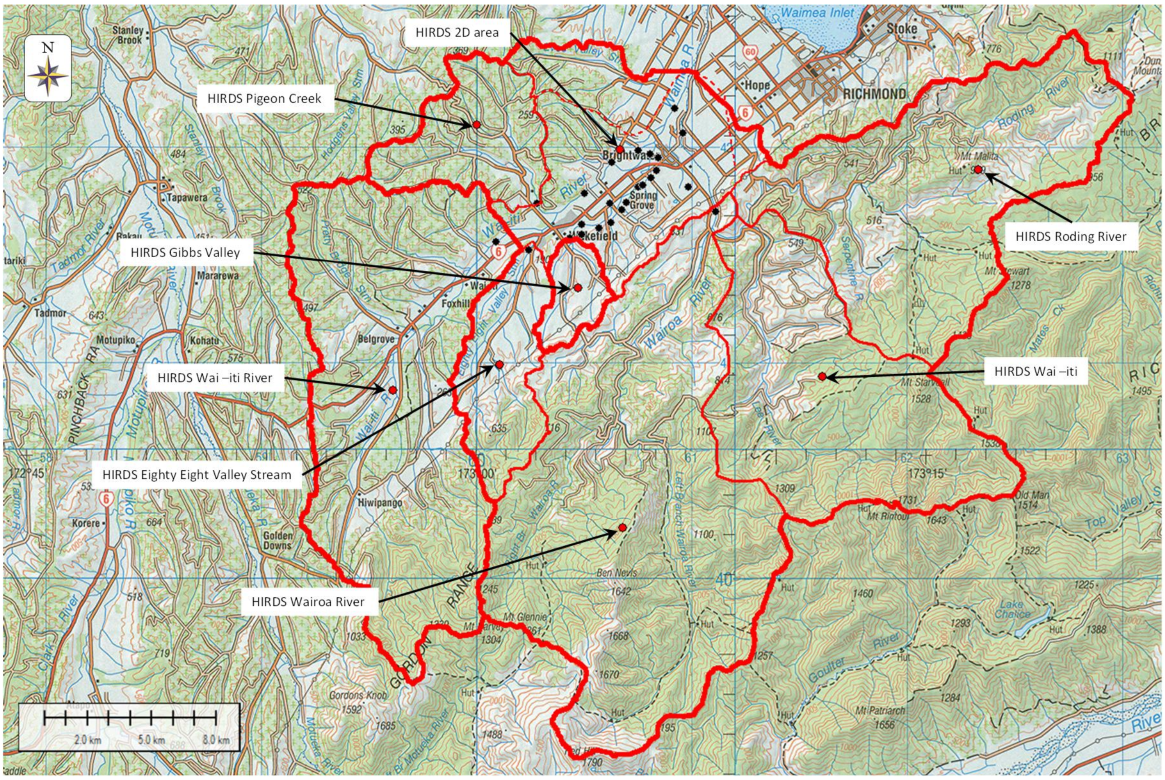

Figure 3.5: Catchment map

The HIRDS storm rainfall data used in the analyses are summarised in Table 3.4. An areal reduction factor (ARF) was applied to the rainfall using the general formula in the HIRDS V4 document with ARF dependent on storm duration, average recurrence interval (ARI) and catchment area for the whole catchment contributing to runoff from the 2D model area (784 km^2).

Table 3.4: HIRDS data

Catchment	10 year ARI (mm)						100 year ARI (mm)					
	1h	6h	12h	24h	48h	72h	1h	6h	12h	24h	48h	72h
Total catchment ARF	0.51	0.81	0.87	0.91	0.93	0.95	0.43	0.77	0.84	0.89	0.92	0.94
2D area	34	76	99	124	150	164	54	118	152	189	226	246
Eighty Eight	33	72	94	118	145	161	53	112	143	179	217	239
Gibbs Valley	34	74	96	121	148	165	55	115	147	183	222	245
Lee River	36	86	115	148	181	199	57	133	176	225	273	297
Pigeon Creek	34	75	98	124	152	168	53	116	150	188	227	250
Roding River	35	98	136	179	219	238	56	152	210	274	334	362
Wai-iti River	31	68	89	113	140	157	50	106	136	171	209	231
Wairoa River	29	89	132	188	251	289	44	136	200	282	375	428

The soil permeability was assessed based on the Landcare Research soil permeability shown in Figure 3.6 and land use from the World Imagery map shown in Figure 3.7. The Google Earth imagery was also used to assess catchment land use.

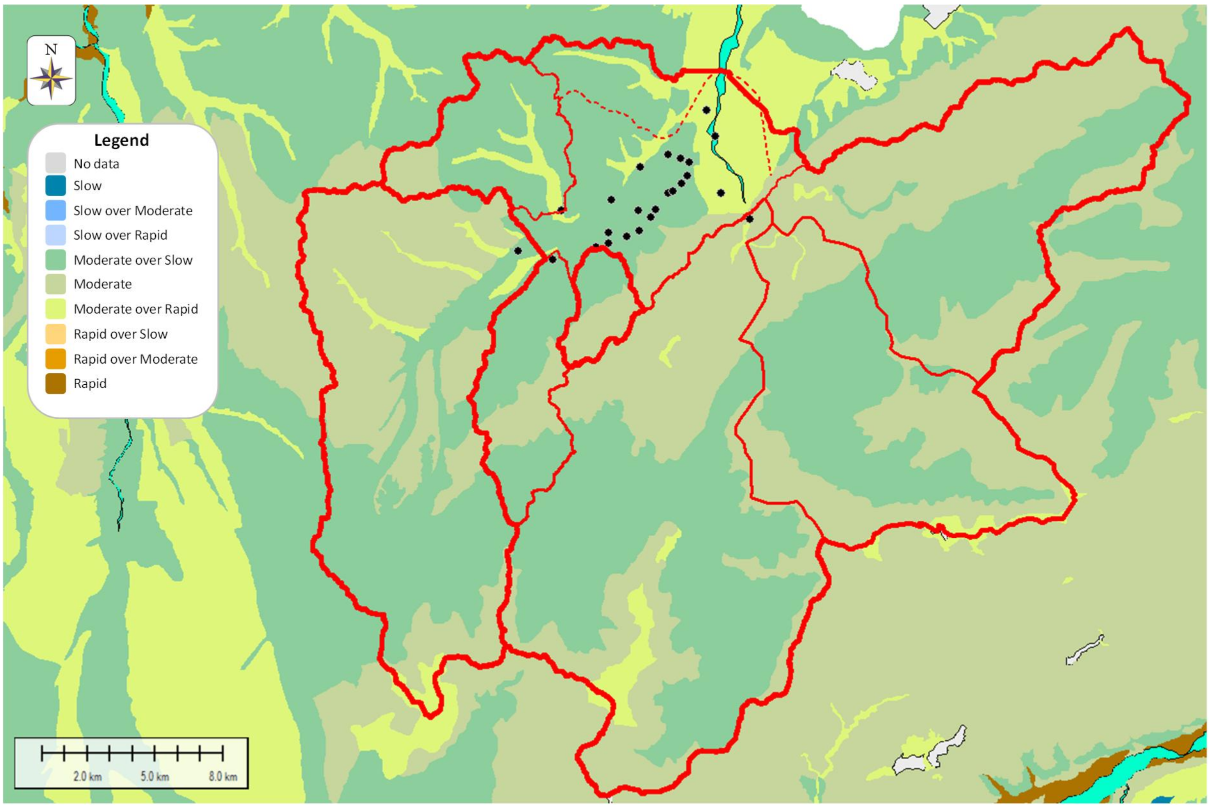

Figure 3.6: Landcare Research soil permeability classification

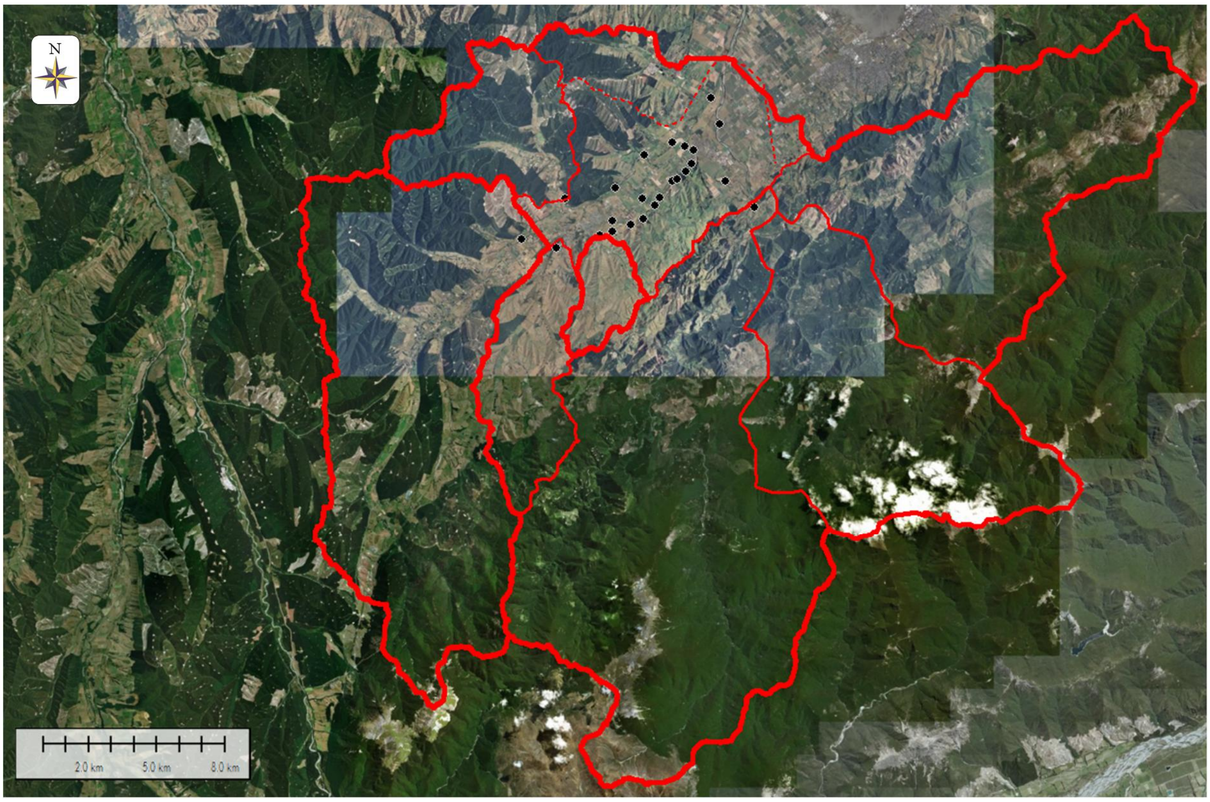

Figure 3.7: Land use

Catchment characteristic are summarised in Table 3.5, with estimated parameters calculated using the SCS methodology.

Table 3.5: Catchment characteristics

Catchment	Area (km^2)	Curve number (CN)	Soil storage (S) (mm)	Ia (mm)	Longest water course (km)	Slope (m/m)	Tc (hours)	Lag (min)
Wairoa River	209	57	189	38	40	0.014	9.4	377
Lee River	115	57	189	38	28	0.017	7.1	282
Roding River	131	57	193	39	35	0.009	9.9	398
Wai-iti River	164	59	178	36	28	0.016	7.0	281
Pigeon Creek	36	58	181	36	11	0.015	3.9	155
Gibbs Valley	11	65	137	27	6	0.012	2.5	98
Eighty Eight Valley	37	66	133	27	14	0.019	3.9	157

3.3.2 Rainfall-runoff modelling

A HEC-HMS model was used to simulate runoff from the catchments and generate inflow time series to the 2D modelling area for 10 year and 100 year ARI storm events with durations of 1, 6, 12, 24, 48 and 72 hours. The SCS Unit Hydrograph with losses modelled using the SCS CN method was used in the simulations.

This modelling adopted MfE's projected temperature increases of 0 and 2.58 degrees for present day and RCP8.5 2090 scenarios respectively.

3.4 Infiltration losses

The Horton loss model was used to model the rainfall infiltration losses in the model. The Horton approach utilises the equation:

$$f = f_c + (f_0 - f_c)e^{-kt}$$

Where f_0 is the initial infiltration rate in mm/h, f_c is the final (indefinite) infiltration rate, t is time in hours and k is the Horton decay rate. For the TUFLOW implementation, the time (t) is the period of time that the cell is wet.

For the base case with starting parameters, the values adopted are summarised in Table 3.6 and shown in Figure 3.8. These parameters are best developed through calibration, which has not been carried out in detail as part of this model build. To ensure a conservative outcome the initial loss was set to zero. The spatial extent of soil types shown in Figure 3.8 have been sourced from Landcare Research's FSL Soil Drainage Class layer. The data is freely available from the Land Research Information Systems portal (https://lris.scinfo.org.nz).

Table 3.6. Soil infiltration parameters using Horton Loss model

Soil type	Initial loss (mm)	Initial loss rate, f_0 (mm/hr)	Ultimate infiltration rate, fc (mm/hr)	Horton decay rate, k (1/hr)
Poorly drained	0	2.0	1.50	0.294
Imperfectly drained	0	3.5	3.00	0.256
Moderately drained	0	8.0	7.49	0.233
Well drained	0	25.0	22.5	0.208

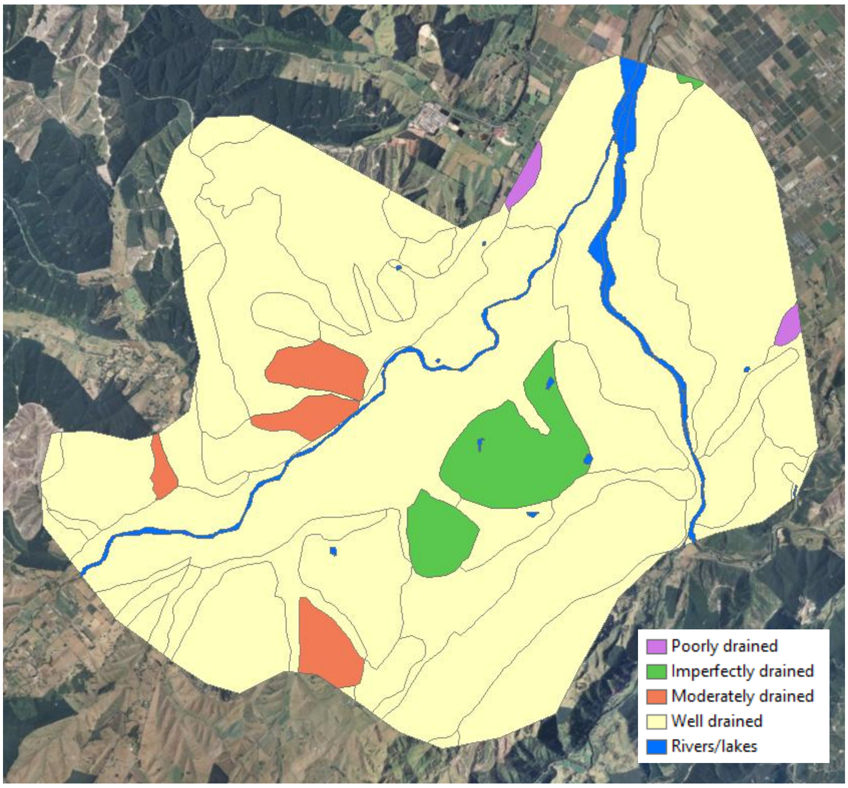

Figure 3.8. Modelled soil infiltration properties

3.5 Downstream boundary

The downstream boundary for the model is on the Waimea River below the confluence of the Wai-iti and Wairoa Rivers as shown in Figure 3.1. At this boundary a Q-H relationship is automatically applied by TUFLOW based on a Manning's formulation of the cross section and assumed channel slope of 0.01 m/m. The location of the downstream boundary is far enough downstream so as to not influence model results in the areas of interest.

4 Initial model runs

As part of the model development process, a series of initial model runs was conducted to locate areas where the automated model build process may have missed relevant detail. For example, where the piped system is connected via pipes of diameter smaller than the threshold 225 mm, or where box culverts (with no diameter) are located. These were termed "model snags" and were rectified after having been initially identified.

5 Model validation

Model validation ideally follows a model calibration process, and normally involves running selected historic rainfall records through the calibrated model to check that the modelled results (flow rates, flood depths and extents) match well with observed data. As agreed with Council, the approach taken for this study was to compare peak flows at key locations around the model with those used in previous work undertaken by SKM for Council, and to undertake a sensitivity analysis to assess how sensitive the modelling results are to the various input parameters.

The SKM 2013 model was focused on river flooding (rather than more minor stormwater catchment flooding), and was based on the estimation of flows from lumped catchments upstream of the model boundary. This is similar to the approach taken in this study, although this study has also included rainfall-on-grid inputs and the urban stormwater pipe network to assess stormwater flooding also.

SKM arrived at their lumped catchment inflow hydrographs by estimating peak flows through normal hydrological assessment (range of methods assessed, including rational method, gauge data), and then synthesising a hydrograph shape at each inflow location by averaging a number of selected storm hydrographs. These synthesised hydrographs were then scaled up to design peak flows, with a corresponding increase in total storm volumes.

Since the SKM 2013 assessment, NIWA has updated their rainfall database, and provided regional design storm profiles for New Zealand, including a set for catchments in the Nelson/Tasman/Marlborough districts referred to as “north of the south”. We have used these rainfall values and profiles as described in the hydrology section above, and derived flow hydrographs that are different to those used previously by SKM. In general, the flow peaks are not dissimilar, though the hydrographs are significantly smaller in terms of overall flow volume. In addition to a difference in hydrology, the LiDAR-derived ground surface has been updated in the new model, using LiDAR data flown in 2016. This will produce observable differences in flood extents and depths where flowpaths have changed as a result of this update.

We have adopted the HIRDS-derived hydrographs for the purposes of this study, noting that this approach is more easily defended through reference to NIWA’s national study than the previously used scaled hydrographs.

Historic events

Modelling of two historic events (Jan 1986 and May 2011) was carried out, based on observed data provided by Council. It should be noted that while hydrology from past events has been applied, the DEM surface used in the model is from 2016 LiDAR. This will influence validity of flood extents where the ground surface has changed between the storm dates and 2016. For purposes of comparison, model results were overlaid against flood extents produced for these same events in the SKM report.

Figure 5.1 and Figure 5.2 below show a side by side comparison of the updated model results and the previous SKM results, together with the outline of observed extents for each event.

Figure 5.1 presents the comparison for the January 1986 event. The similarity of the two plots shows a good match between the current model with both the historic extents and the SKM model results.

Figure 5.2 presents the same analysis for the May 2011 event. The right hand plot shows that SKM have achieved a reasonably good match with the historic extents. The left hand plot shows the results from the current (T+T) model, which indicates a number of outbreak flowpaths that were not observed during the May 2011 event. Flooding from the Wairoa River is more widespread. Notes from SKM’s model build document indicate that they too initially had widespread flooding when calibrating to this event. To achieve calibration SKM needed to modify the DEM and river channels, and also alter Manning’s n values significantly. A similar set of changes could conceivably be made to the current DEM to achieve a similarly close match. However, given that the current model’s DEM reflects changes in the river morphology since the May 2011 event, and that the purpose of the model is to predict future flood risk, it was considered beyond the scope of the present study to alter the DEM and roughness values for the river to improve the match in modelled extents for this event.

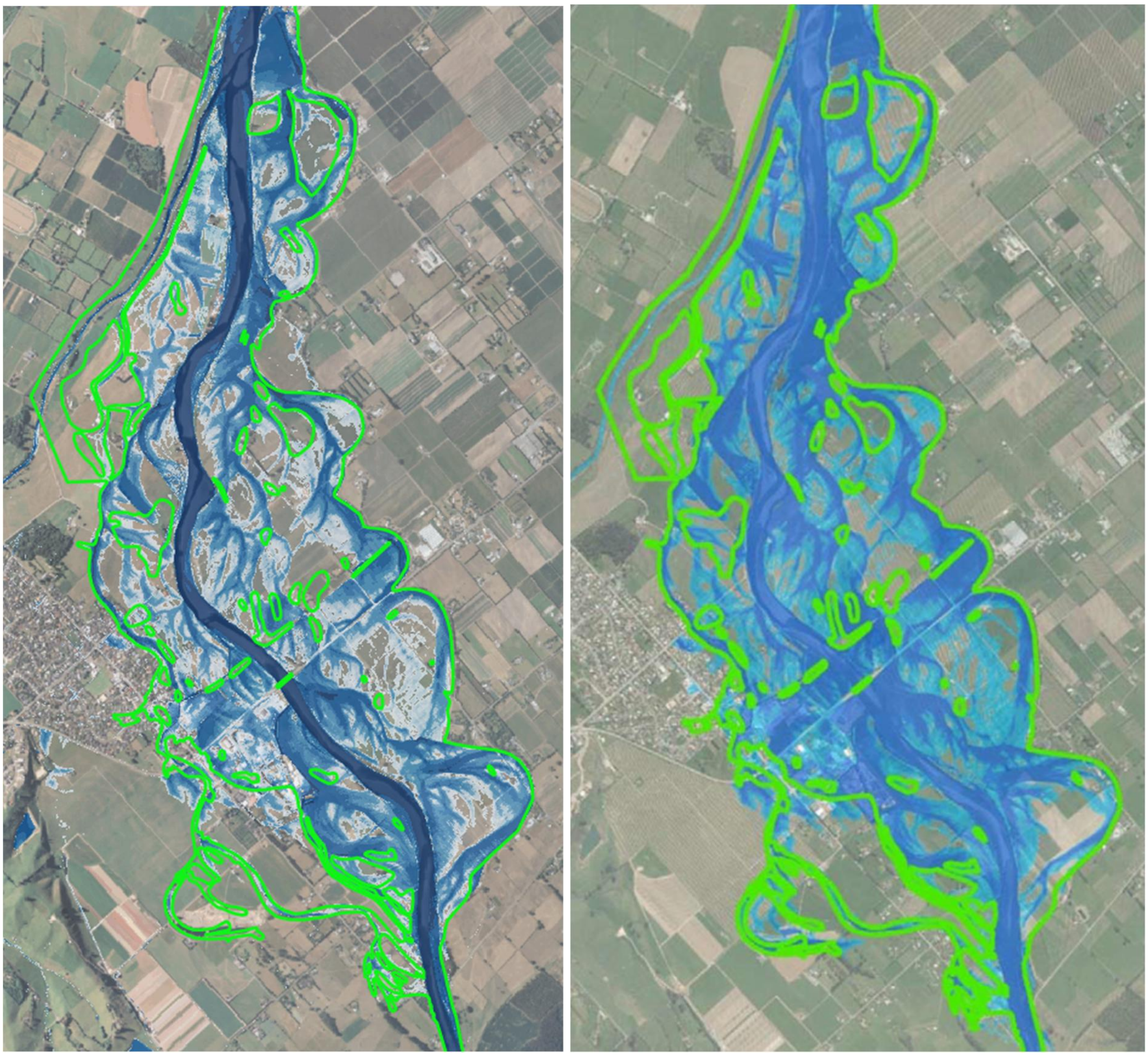

Figure 5.1. January 1986 event. T+T model results (left), SKM model results (right), and historic extent (green)

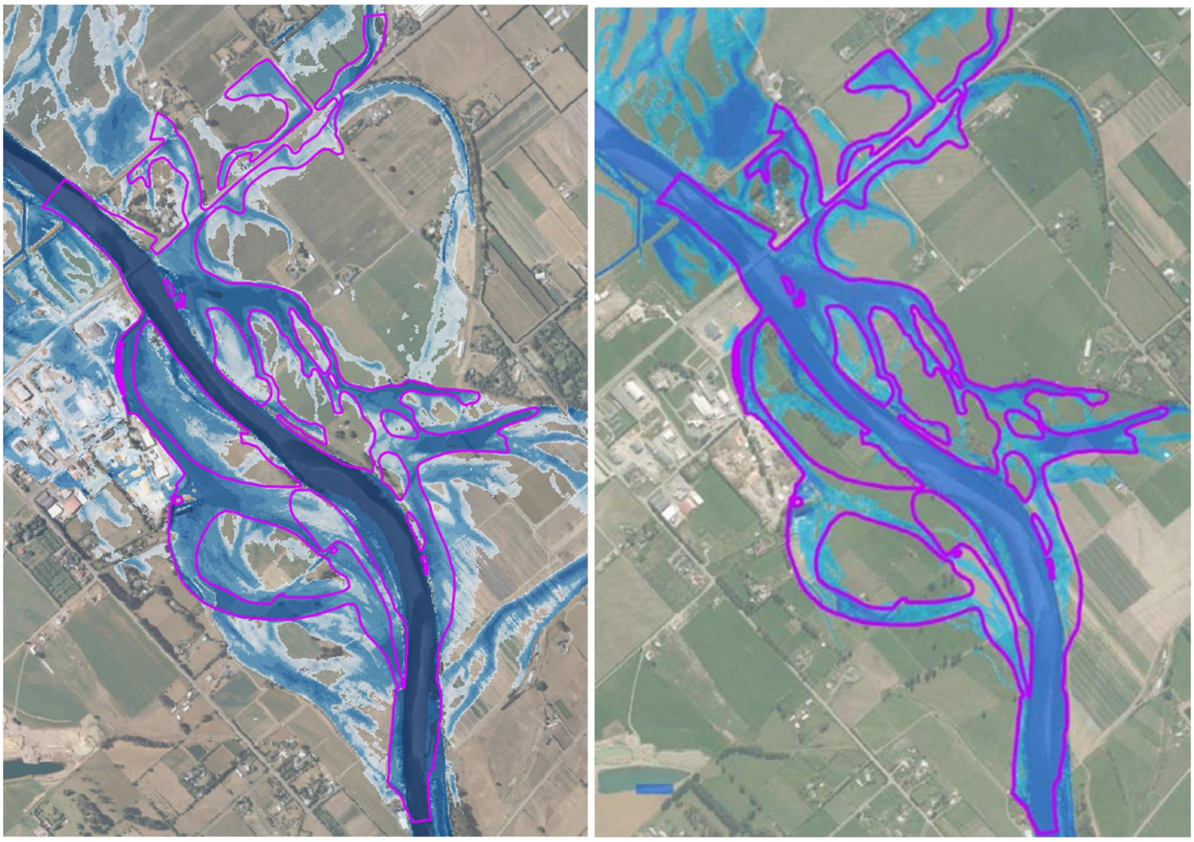

Figure 5.2. May 2011 event. T+T model results (left), SKM model results (right), and historic extent (purple)

6 Model sensitivity

A series of tests on parameter sensitivity was conducted. Sensitivity was tested by varying the parameters below and recording the areas subject to at least 100 mm flood depth.

- Manning's n +/- 10%
- Hydrological losses +/- 10%
- Rainfall depth +/- 10%

The rainfall sensitivity was undertaken as a proxy for spatial rainfall variation, recognising that the applied rainfall was derived as a point rainfall estimate.

Once the above sensitivity runs were undertaken the resulting flood depths were normalised and aggregated. The resulting map gives what is essentially an aggregated "count" of the number of instances (i.e. number of sensitivity runs) for which the flood depth in each grid cell exceeds a value of 100 mm.

These results are shown in Figure 6.1 and Figure 6.2. Yellow shows where 1 or 2 sensitivity model runs indicate flooding greater than 100 mm (low confidence), orange where 3 or 4 runs flood that area (medium confidence), and blue shows the area that is flooded in every sensitivity run (high confidence). As shown in Figure 6.1, there is high parameter confidence in most flooded areas and closer to the major rivers. Figure 6.2 shows a close-up of an area of flooding which is shown to be more sensitive to modelling parameter selection.

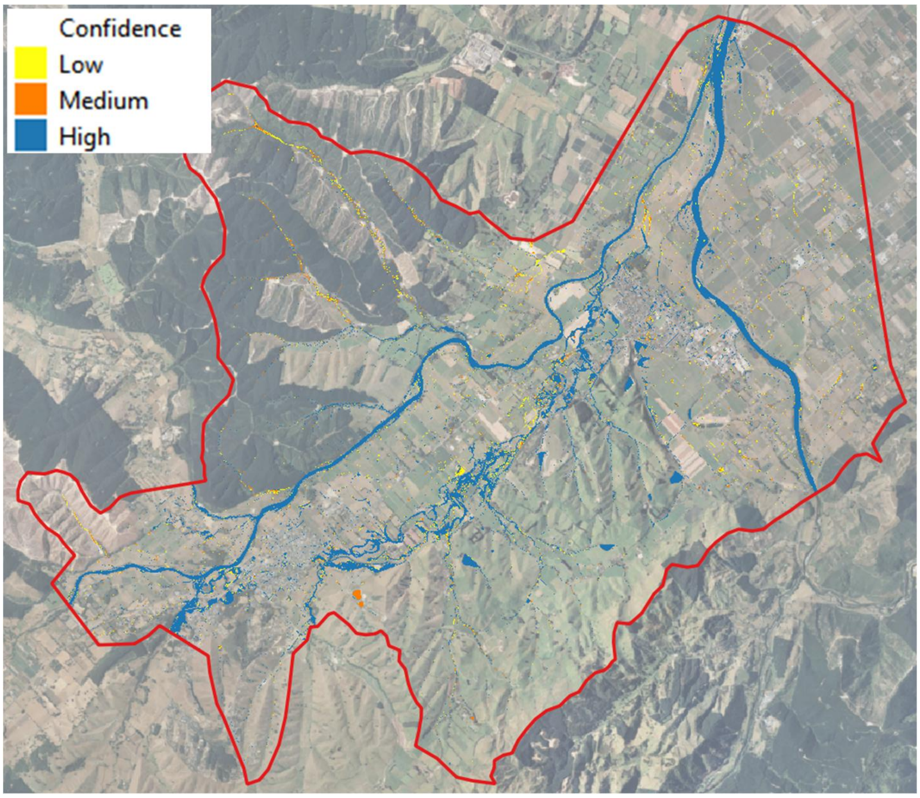

Figure 6.1. Model sensitivity results

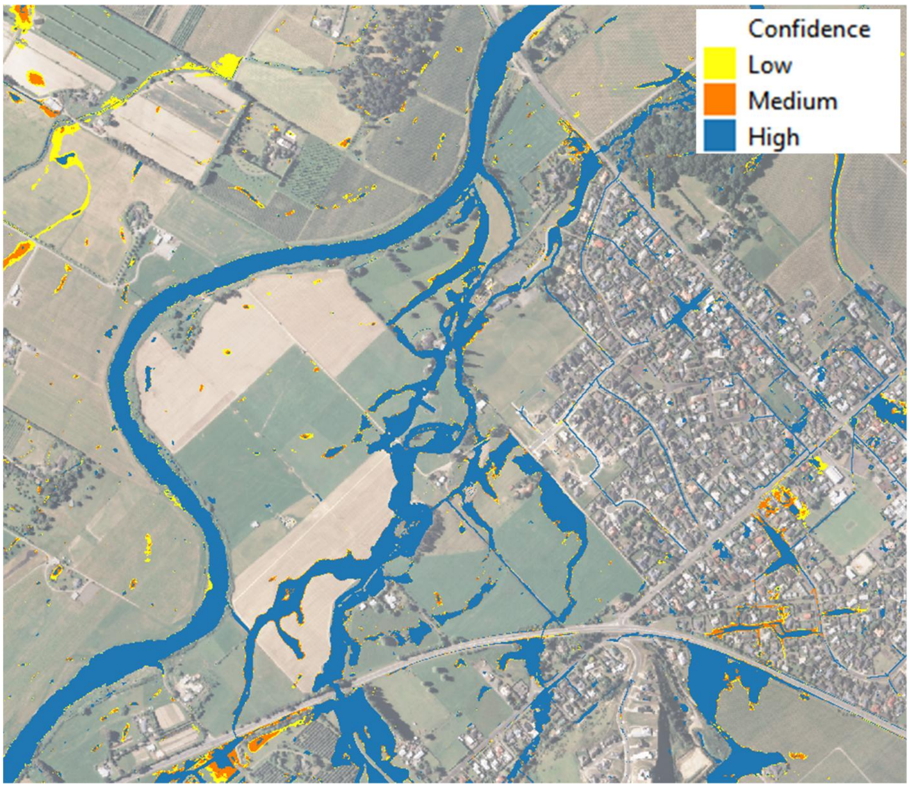

Figure 6.2. Model sensitivity for Brightwater township

7 Design event results

The design events modelled are shown in Table 7.1.

Table 7.1. Modelled events

AEP	Storm Duration	Total Rainfall Depth	Figure numbering	
			Wakefield	Brightwater
1% present day	1 hour	23 mm	A1	B1
	6 hour	92 mm	A2	B2
	12 hour	128 mm	A3	B3
	24 hour	168 mm	A4	B4
	48 hour	209 mm	A5	B5
	72 hour	231 mm	A6	B6
10% present day	6 hour	62 mm	A7	B7
	48 hour	140 mm	A8	B8
50% present day	6 hour	42 mm	A9	B9
	48 hour	94 mm	A10	B10
1% 2090 RCP8.5	6 hour	119 mm	A11	B11
	48 hour	249 mm	A12	B12
10% 2090 RCP8.5	6 hour	79 mm	A13	B13
	48 hour	165 mm	A14	B14
50% 2090 RCP8.5	6 hour	53 mm	A15	B15
	48 hour	109 mm	A16	B16

As shown, a range of storm durations was simulated for the present day 1% AEP event, i.e. 1, 6, 12, 24, 48, and 72 hour.

WaterRide software was then used to generate a map showing which of these storm durations produced the greatest flood depths spatially across the floodplain. See Figure 7.1 below.

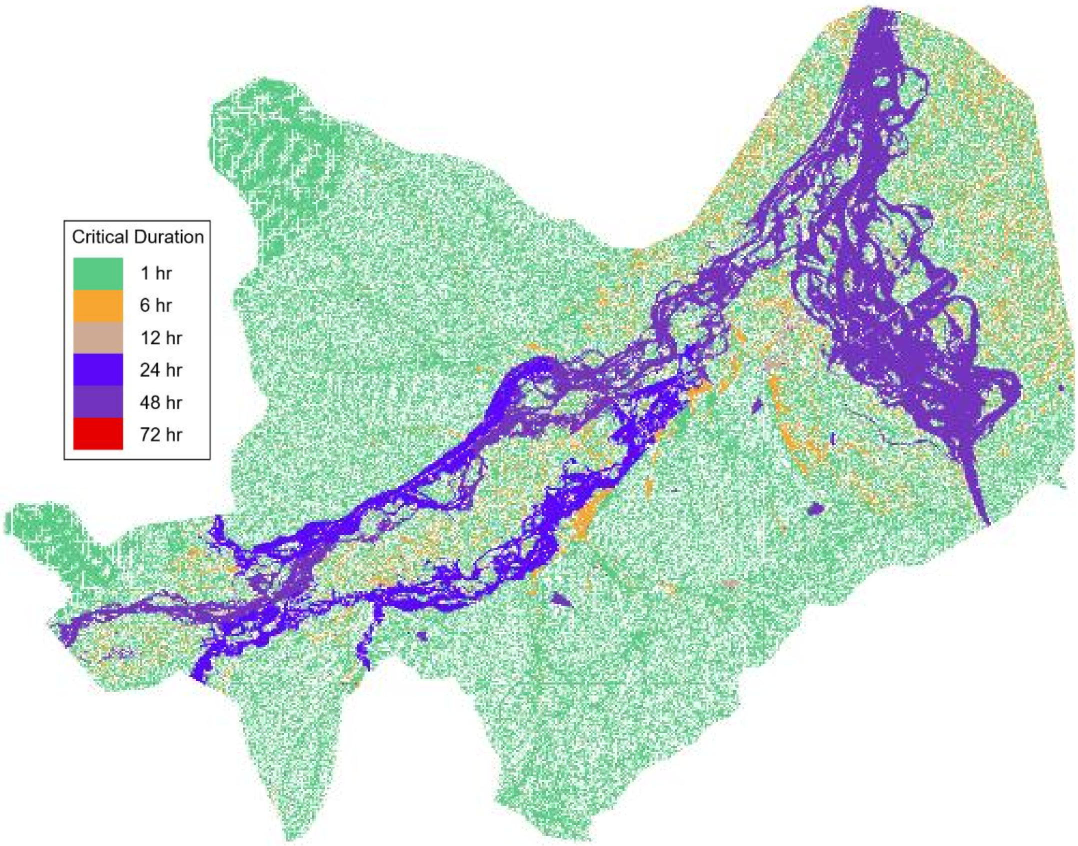

Figure 7.1. Spatial mapping of critical storm duration (i.e. which storm duration results in greatest flood depth at each grid cell in the model)

Broadly speaking, shorter duration events cause higher peaks in smaller catchments while longer events cause higher peaks in large catchments as seen from the river inflows for Wairoa and Wai-iti. More specifically, the model results indicate the following critical storm durations:

- 48 hour for the two large river floodplains (Wai-iti and Wairoa);
- 24 hour for the Pitfure Stream floodplain;
- 6 hour for most other areas of interest in this study;
- 1 hour for smaller tributaries and flooding areas across the model domain.

Upon analysis, it was found that while in some areas the 1 hour and 24 hour events produced the greatest flood depths, the difference between depths at these durations and the combined 6 hour / 48 hour results were not sufficient to warrant running these two storm durations, and modelling could focus on the 6 hour and 48 hour events only, with minimal impact on modelled flood results.

Given the spatial variation in critical storm durations across the modelled area, we recommend reference to the critical storm duration map (refer Figure 7.1 above) when determining which duration to consider for assessment and design in a particular location.

8 Results and findings

The current modelling generally supports the findings of earlier work (SKM 2013) as to the flood hazard arising from the major river systems. The change in approach to a rainfall-on-grid model has allowed mapping of flood hazard outside the main river floodplains, including urban areas, and incorporates latest ground survey and rainfall data. As such, this recent modelling should be used in preference to the earlier SKM 2013 modelling, particularly for these urban areas. This modelling indicates the following flooding issues in the two townships:

Brightwater

- Pitfure Stream, North and South of SH6 in large events of all durations;
- Outbreaks of the Wairoa River in events 24 hrs and longer, in particular upstream of SH6 and East of Ellis Street;
- South of SH6 opposite Rintoul Place;
- Surface flooding of Rintoul Place and Hollis Place / Starvel Street junction.

Wakefield

- Outbreaks of the Wai-iti River in events 12 hrs and longer;
- Outbreak of Eighty-Eight Valley Stream in events 6 hr and longer;
- Ponding behind SH6 between Eighty-Eight Valley Road and Wakefield Township;
- Some surface flooding of properties between SH6 and Arrow Street and south of Edward Street.

Flood depth maps for the two townships are provided in Appendices A and B, and WaterRide result files for each simulation have been provided to Council.

These outputs can be used as the basis for assessing existing hazard exposure and developing a prioritised works programme for mitigating flood risk.

9 Applicability

This report has been prepared for the exclusive use of our client Tasman District Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:

....

Quinn Hornblow
Water Resources Engineer

Authorised for Tonkin & Taylor Ltd by:

....

Mark Foley
Project Director

Report reviewed by Damian Velluppillai, Senior Water Engineer

QUHO
p:\1004543\1004543.3000\issueddocuments\20200309quho_bwwakefield tuflow build.fnl.docx

Appendix A: Wakefield Flood Depth Maps

AEP	Storm Duration	Total Rainfall Depth	Figure No.
1% present day	1 hour	23 mm	A1
	6 hour	92 mm	A2
	12 hour	128 mm	A3
	24 hour	168 mm	A4
	48 hour	209 mm	A5
	72 hour	231 mm	A6
10% present day	6 hour	62 mm	A7
	48 hour	140 mm	A8
50% present day	6 hour	42 mm	A9
	48 hour	94 mm	A10
1% 2090 RCP8.5	6 hour	119 mm	A11
	48 hour	249 mm	A12
10% 2090 RCP8.5	6 hour	79 mm	A13
	48 hour	165 mm	A14
50% 2090 RCP8.5	6 hour	53 mm	A15
	48 hour	109 mm	A16

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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ARCFILE Figure A1.mxd		
SCALE (AT A3 SIZE) 1:10,000		
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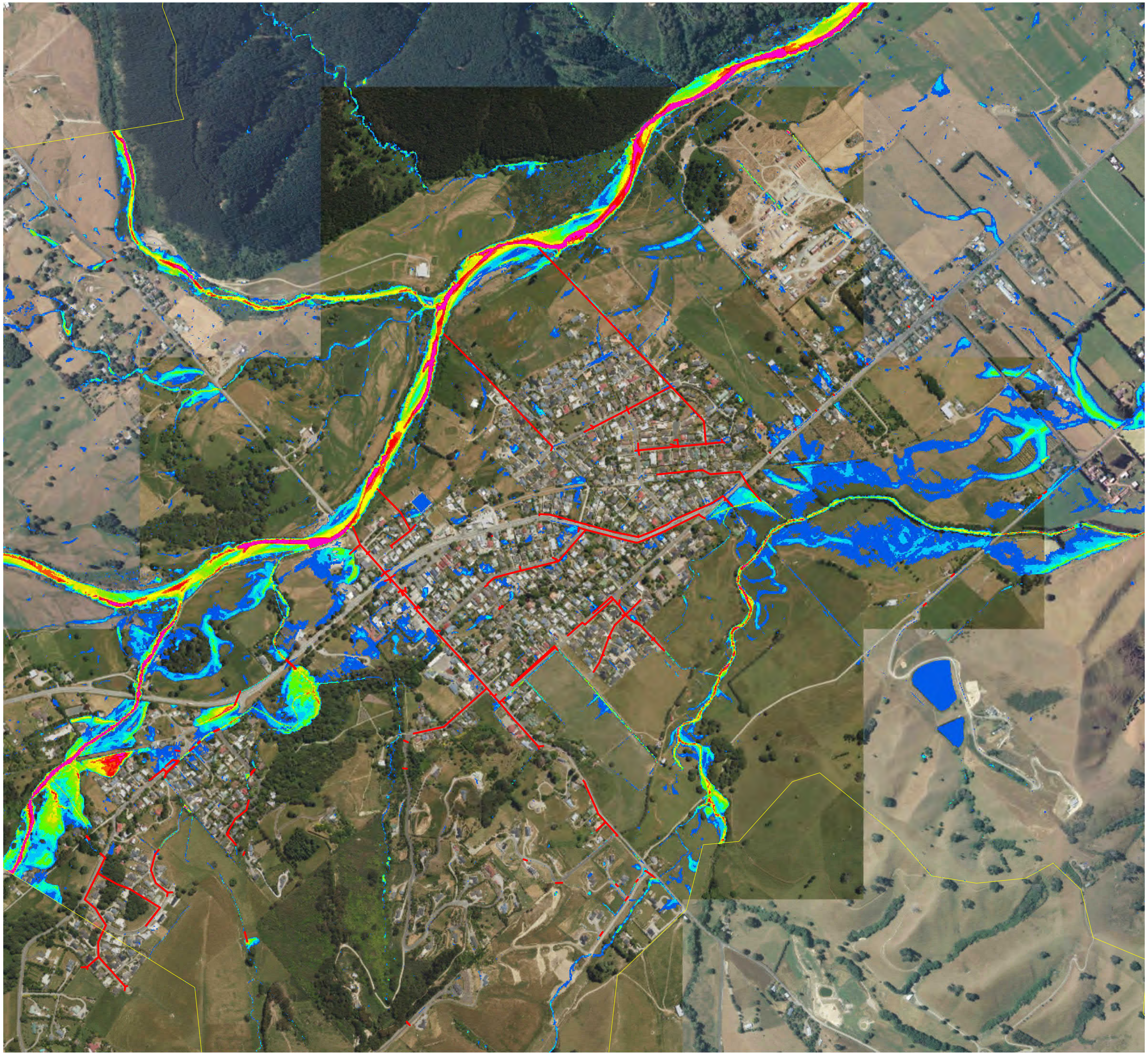
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 1% AEP 1hr event

Figure A1.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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ARCFILE Figure A2.mxd

SCALE (AT A3 SIZE) 1:10,000

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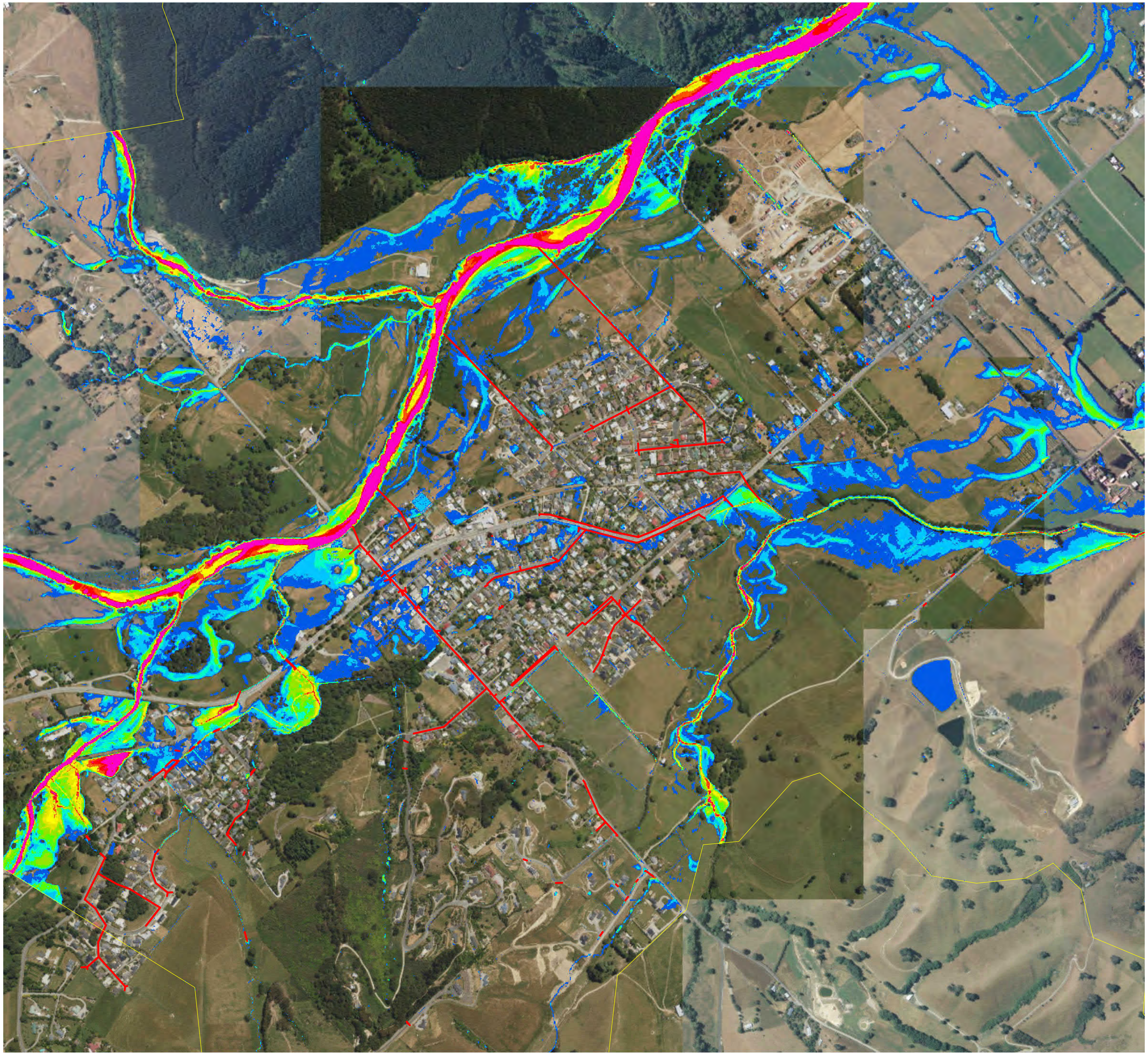
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 1% AEP 6hr event

Figure A2.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

N

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:

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ARCFILE Figure A3.mxd

SCALE (AT A3 SIZE) 1:10,000

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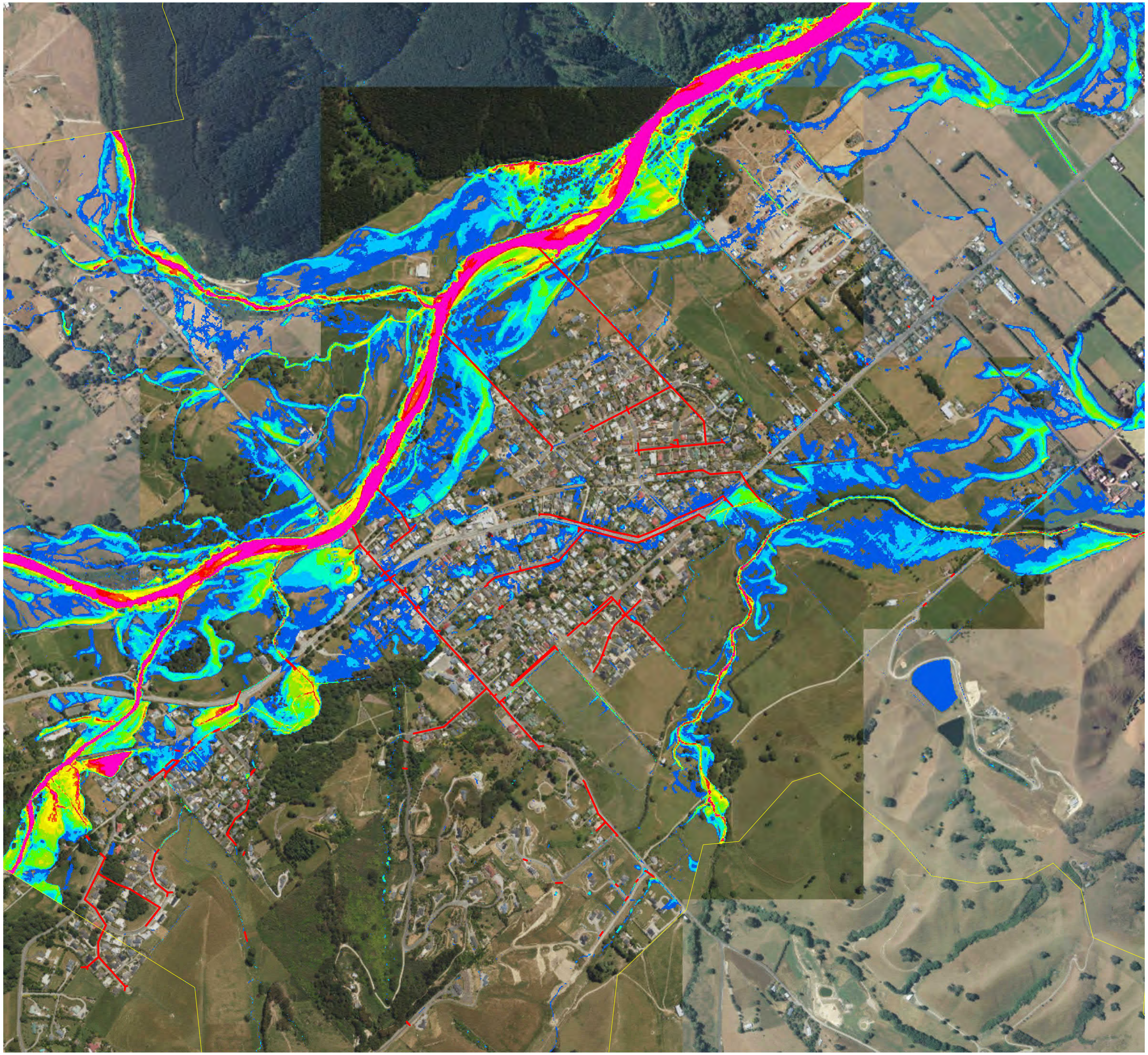
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 1% AEP 12hr event

Figure A3.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:

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ARCFILE Figure A4.mxd

SCALE (AT A3 SIZE) 1:10,000

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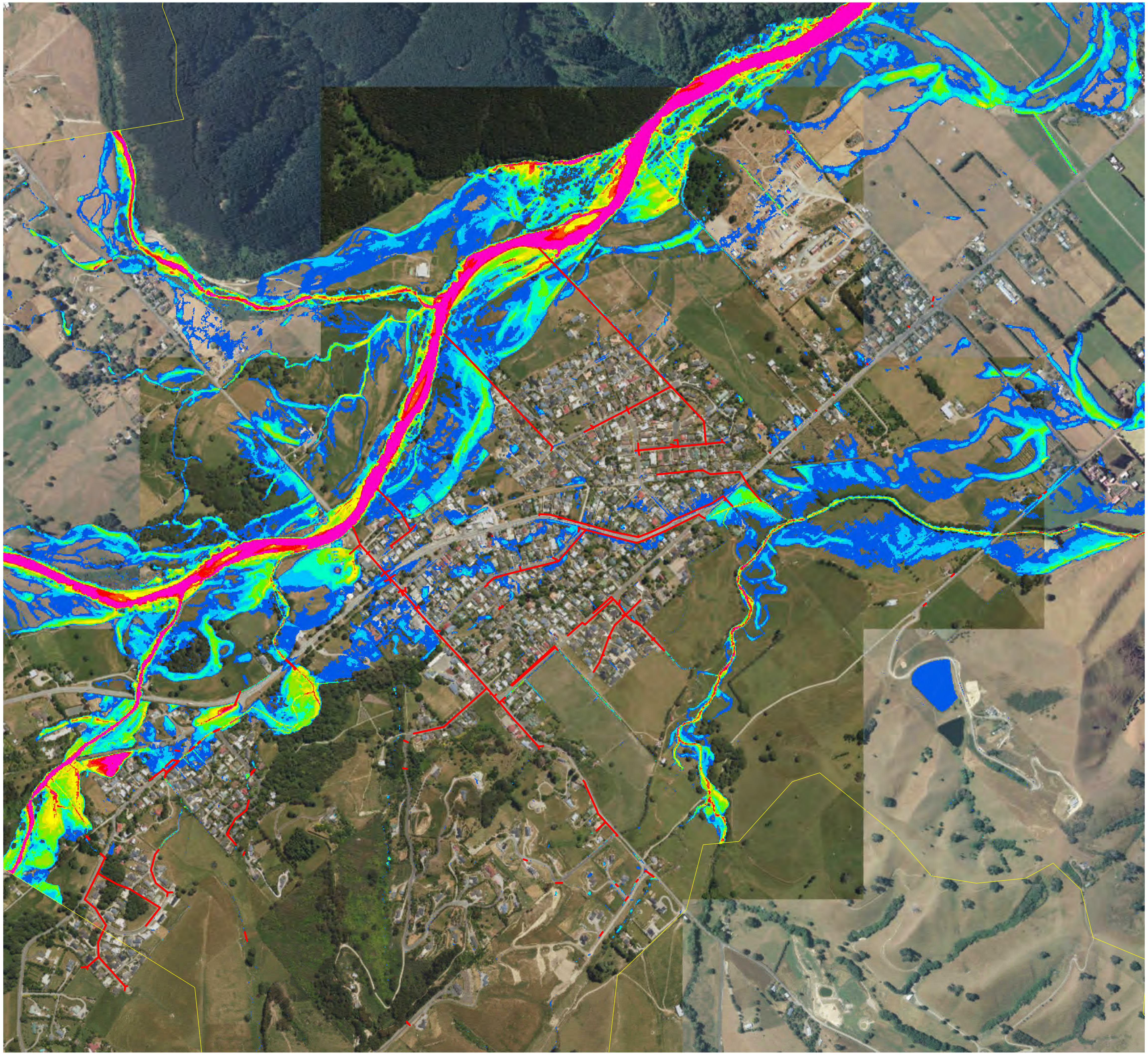
TASMAN DISTRICT COUNCIL

WAKEFIELD FLOOD MODELLING

Present day 1% AEP 24hr event

Figure A4.



LEGEND

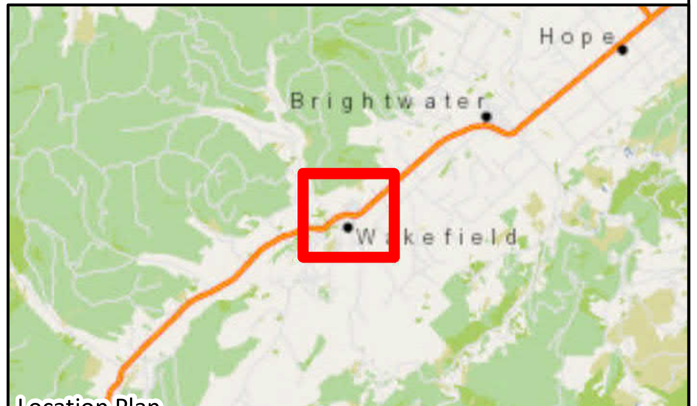
Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

N

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)



Location Plan

Notes:
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APPROVED	DNV	Mar.20
ARCFILE Figure A5.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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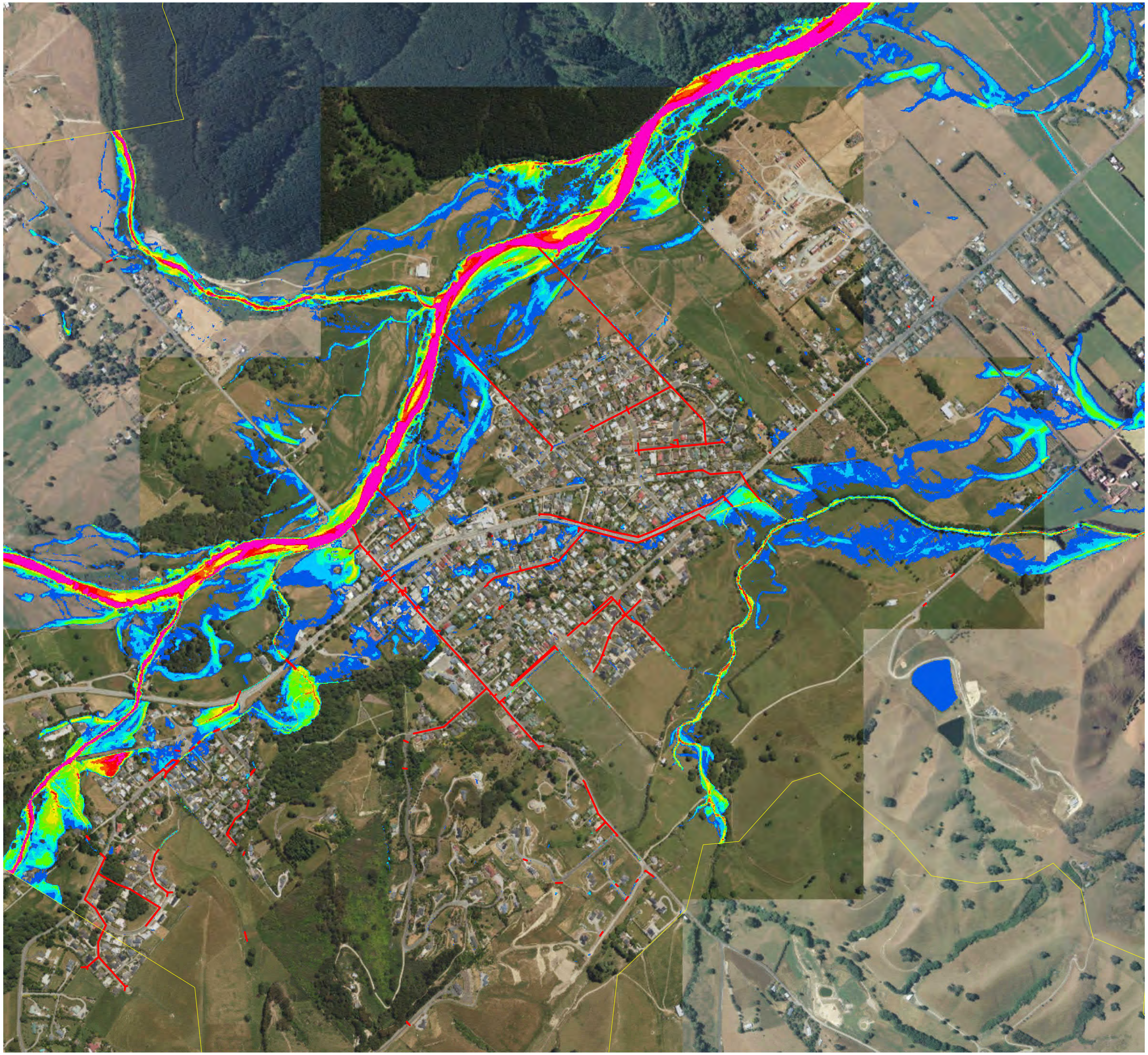
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 1% AEP 48hr event

Figure A5.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:

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ARCFILE Figure A6.mxd

SCALE (AT A3 SIZE) 1:10,000

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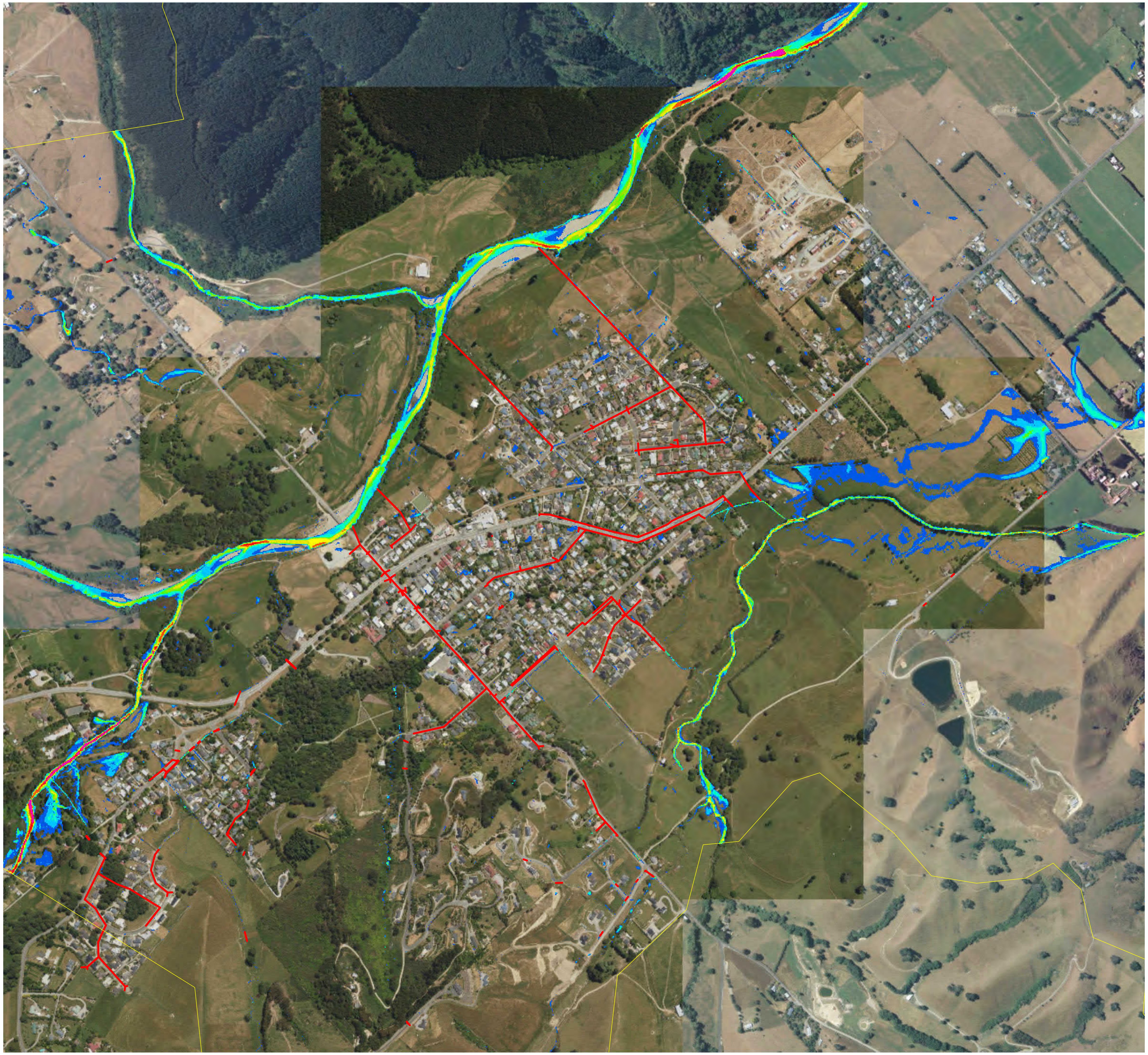
TASMAN DISTRICT COUNCIL

WAKEFIELD FLOOD MODELLING

Present day 1% AEP 72hr event

Figure A6.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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DRAWN	QUHO	Oct.19
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ARCFILE Figure A7.mxd		
SCALE (AT A3 SIZE) 1:10,000		
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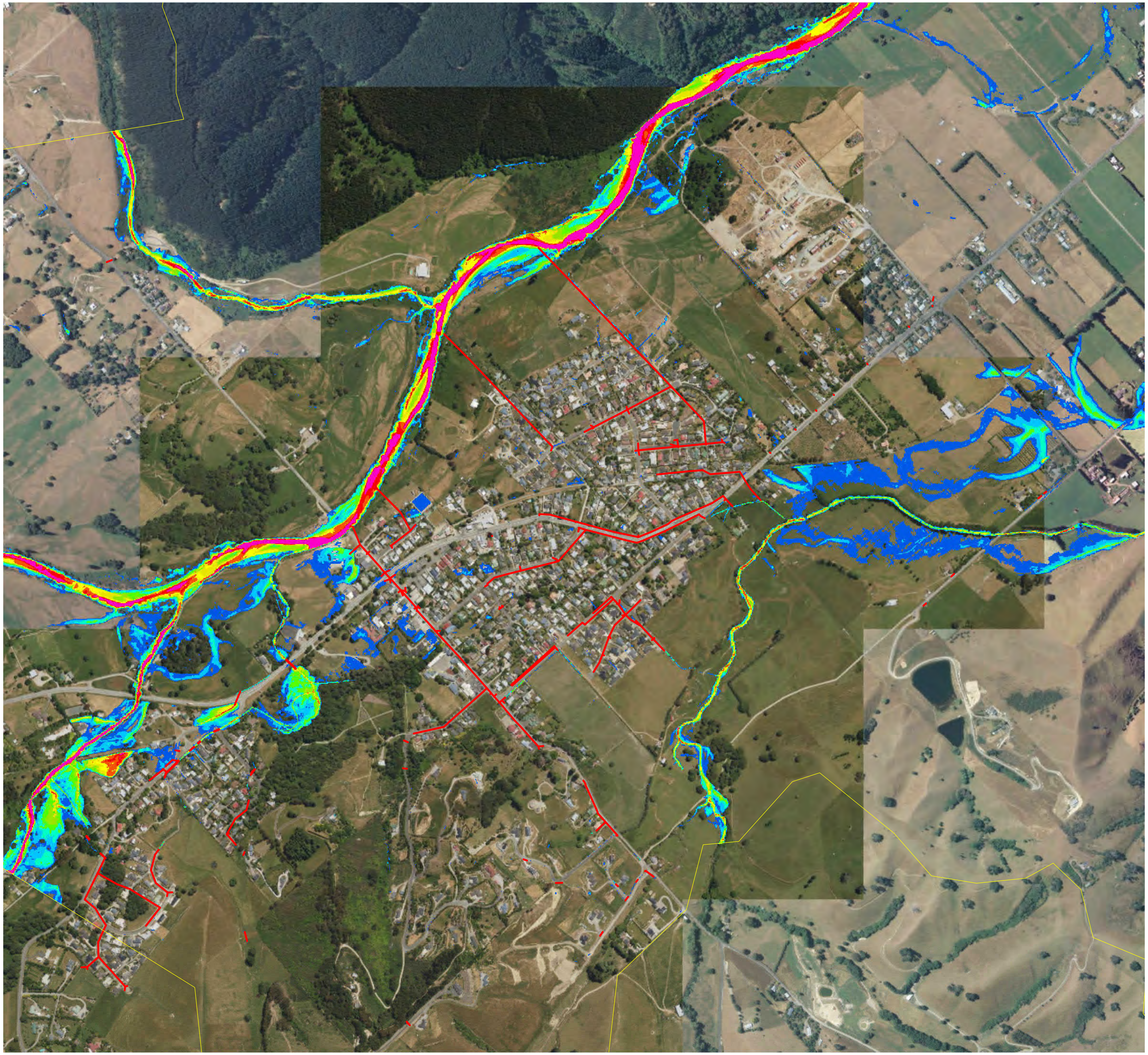
TASMAN DISTRICT COUNCIL

WAKEFIELD FLOOD MODELLING

Present day 10% AEP 6hr event

Figure A7.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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ARCFILE
Figure A8.mxd

SCALE (AT A3 SIZE)
1:10,000

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TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 10% AEP 48hr event

Figure A8.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
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APPROVED	DNV	Mar.20

ARCFILE Figure A9.mxd

SCALE (AT A3 SIZE) 1:10,000

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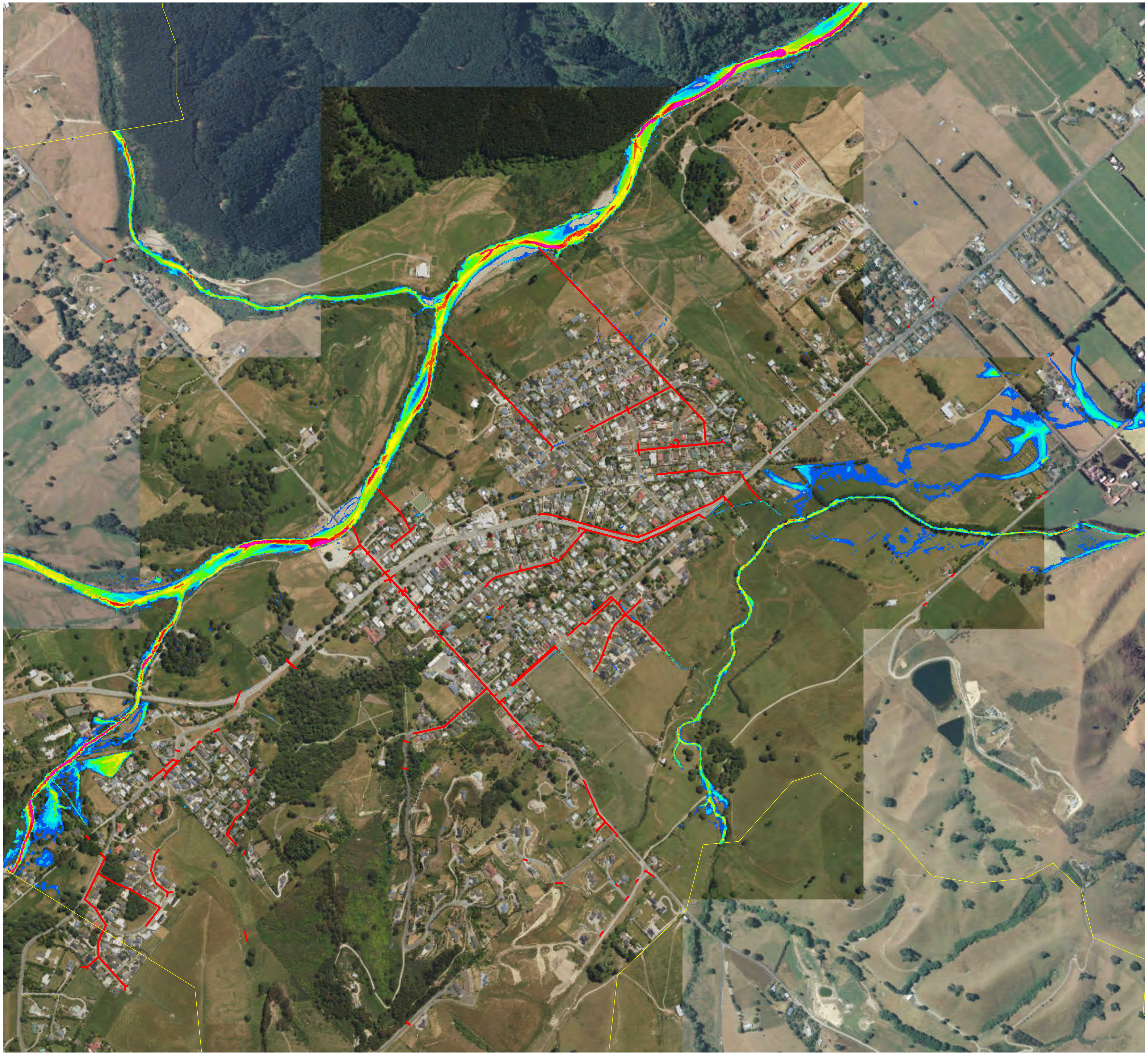
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 50% AEP 6hr event

Figure A9.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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DRAWN	QUHO	Oct.19
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ARCFILE Figure A10.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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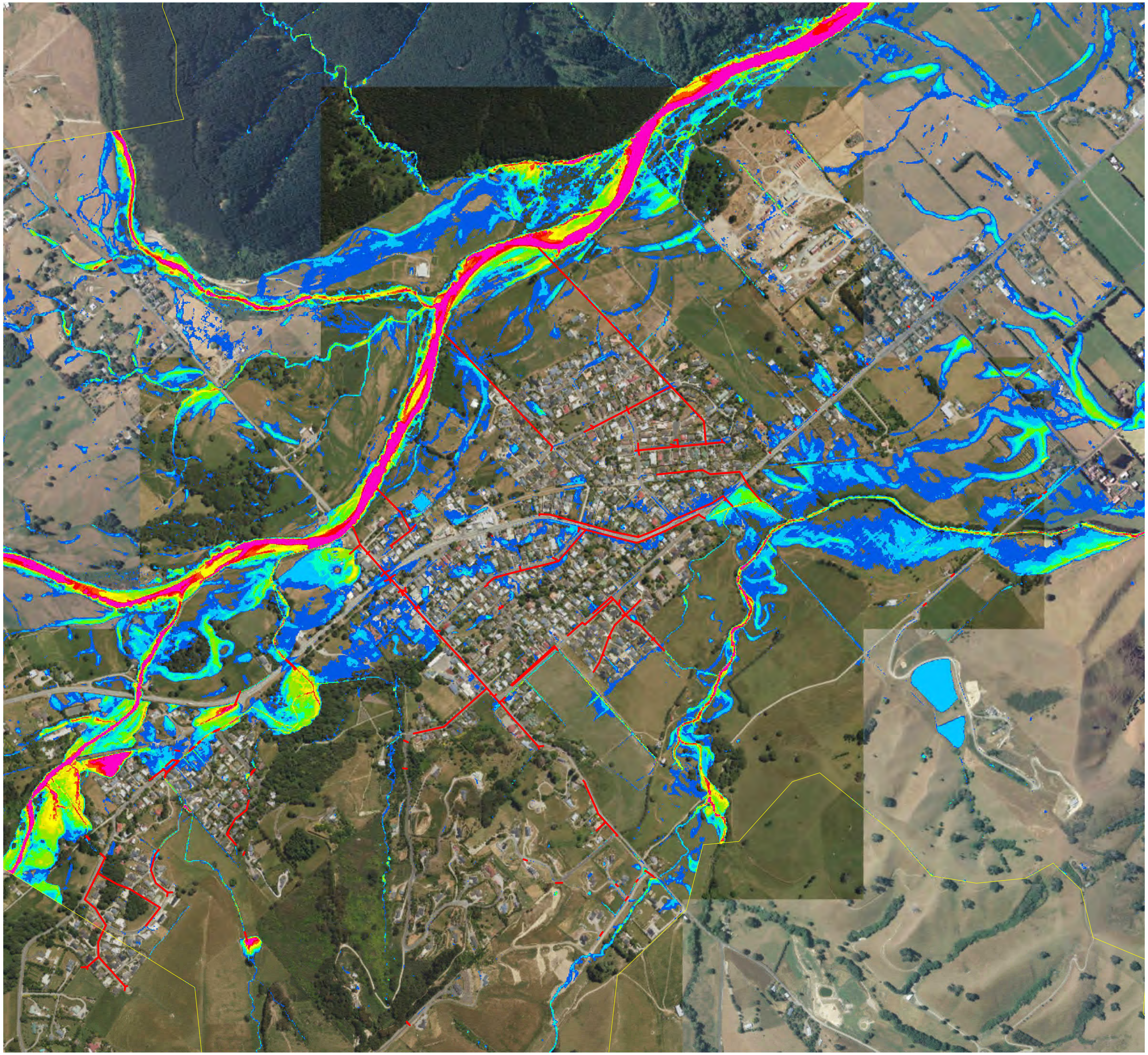
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
Present day 50% AEP 48hr event

Figure A10.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure A11.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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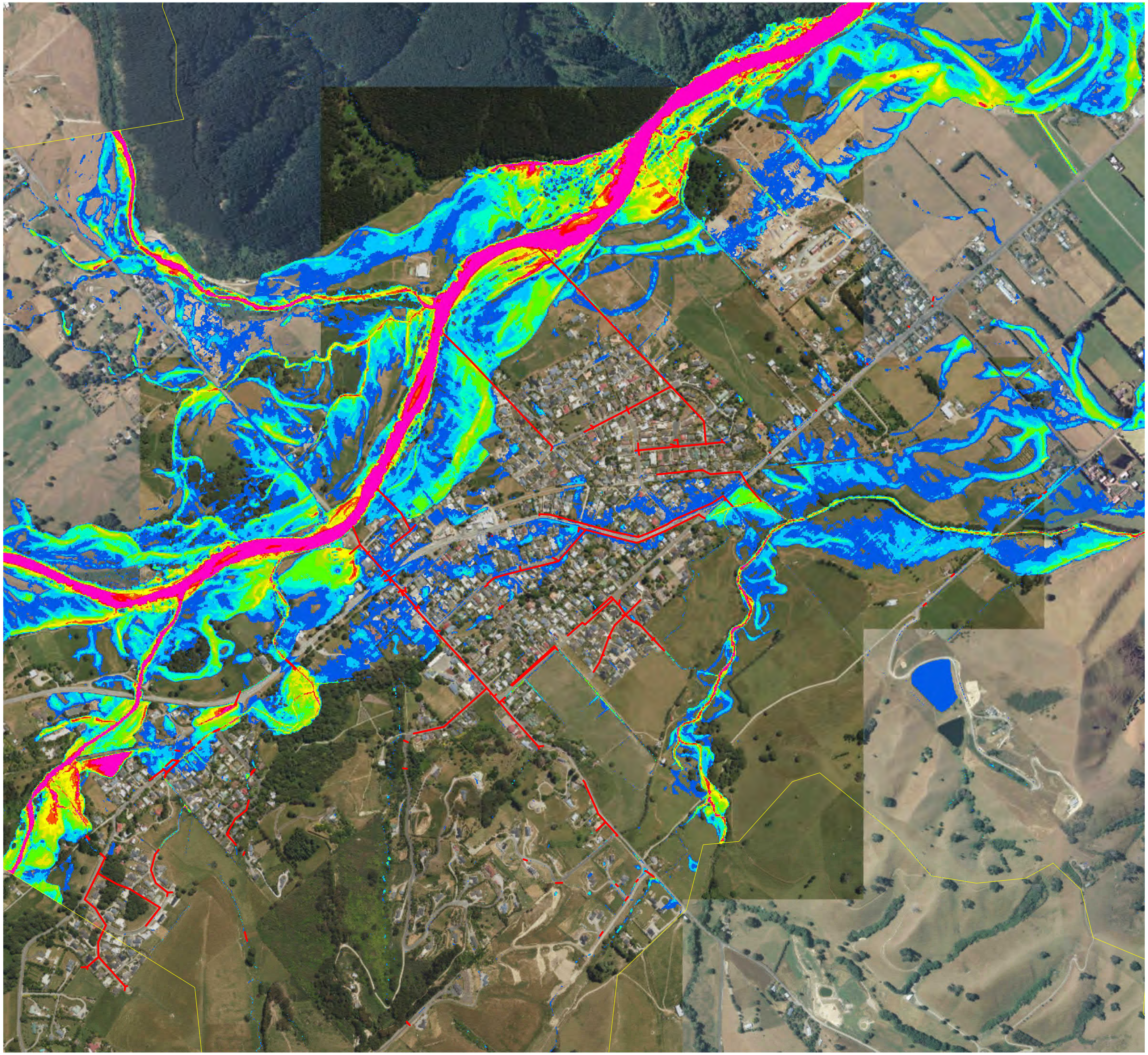
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
2090 RCP8.5 1% AEP 6hr event

Figure A11.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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ARCFILE Figure A12.mxd		
SCALE (AT A3 SIZE) 1:10,000		
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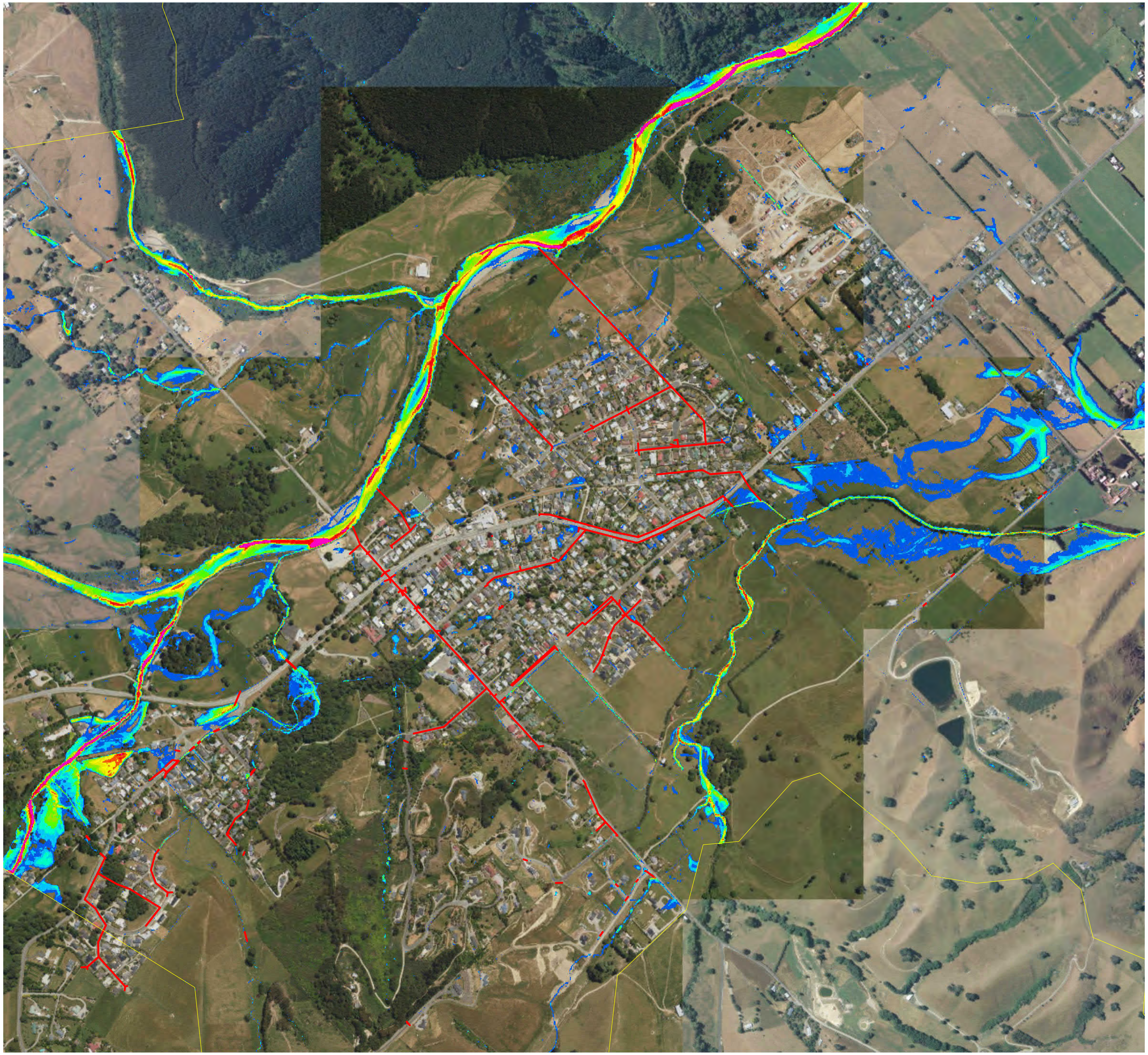
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
2090 RCP8.5 1% AEP 48hr event

Figure A12.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:

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ARCFILE Figure A13.mxd

SCALE (AT A3 SIZE) 1:10,000

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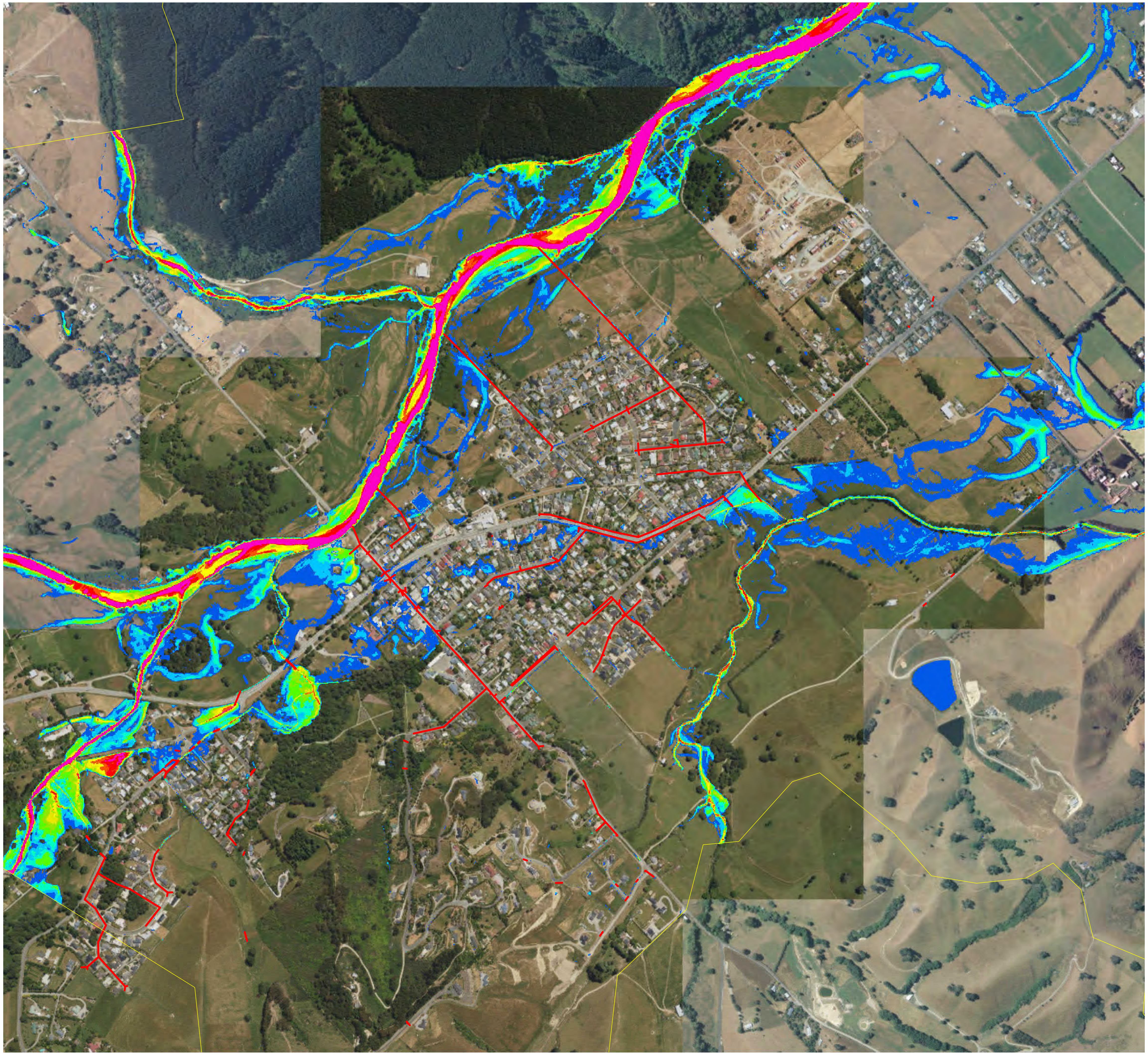
WAKEFIELD FLOOD MODELLING

2090 RCP8.5 10% AEP 6hr event

Figure A13.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Notes:

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DRAWN	QUHO	Oct.19
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ARCFILE Figure A14.mxd

SCALE (AT A3 SIZE) 1:10,000

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TASMAN DISTRICT COUNCIL

WAKEFIELD FLOOD MODELLING

2090 RCP8.5 10% AEP 48hr event

Figure A14.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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APPROVED	DNV	Mar.20

ARCFILE
Figure A15.mxd

SCALE (AT A3 SIZE)
1:10,000

PROJECT No.
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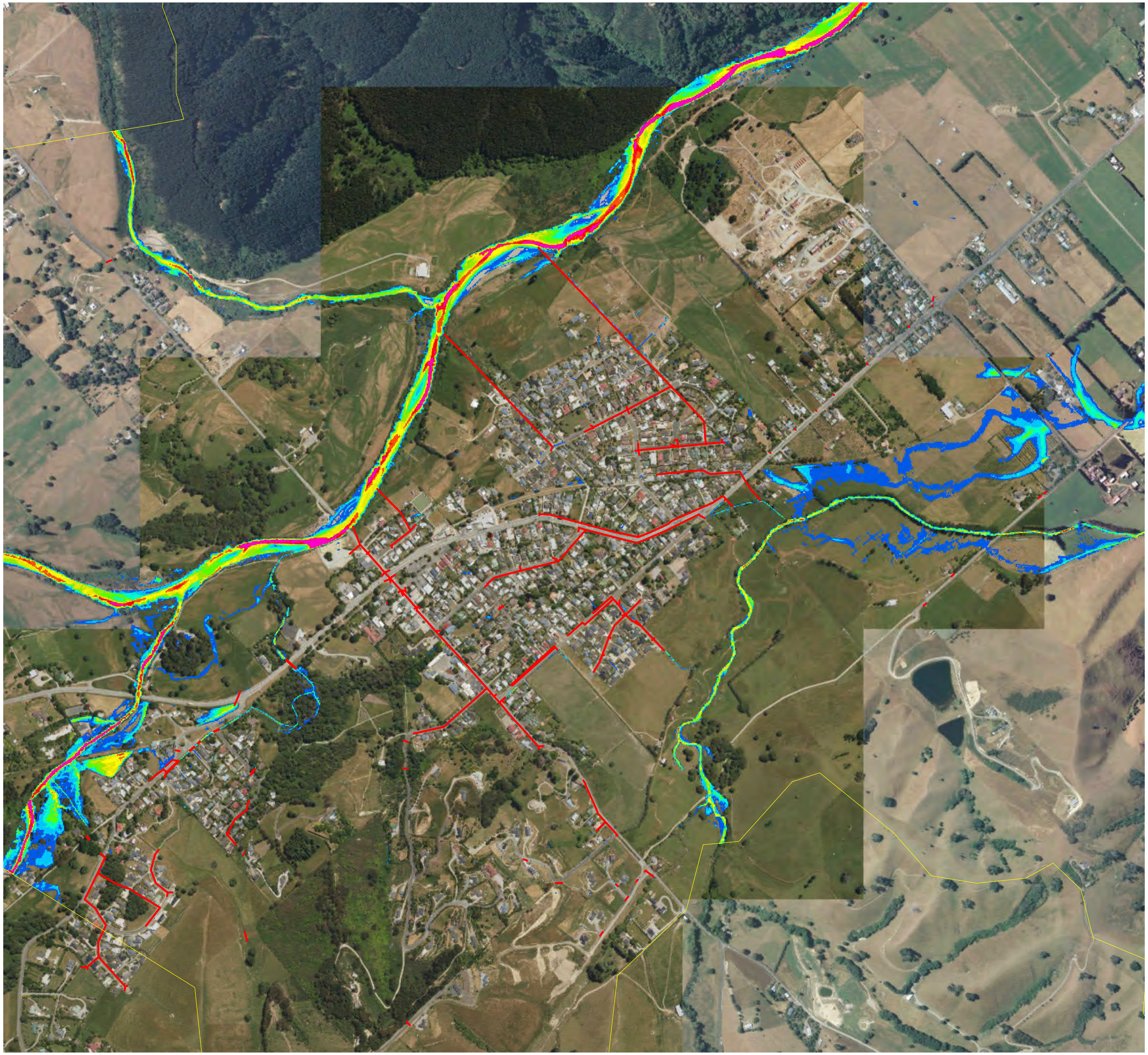
TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
2090 RCP8.5 50% AEP 6hr event

Figure A15.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure A16.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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TASMAN DISTRICT COUNCIL
WAKEFIELD FLOOD MODELLING
2090 RCP8.5 50% AEP 48hr event

Figure A16.

Appendix B: Brightwater Flood Depth Maps

AEP	Storm Duration	Total Rainfall Depth	Figure No.
1% present day	1 hour	23 mm	B1
	6 hour	92 mm	B2
	12 hour	128 mm	B3
	24 hour	168 mm	B4
	48 hour	209 mm	B5
	72 hour	231 mm	B6
10% present day	6 hour	62 mm	B7
	48 hour	140 mm	B8
50% present day	6 hour	42 mm	B9
	48 hour	94 mm	B10
1% 2090 RCP8.5	6 hour	119 mm	B11
	48 hour	249 mm	B12
10% 2090 RCP8.5	6 hour	79 mm	B13
	48 hour	165 mm	B14
50% 2090 RCP8.5	6 hour	53 mm	B15
	48 hour	109 mm	B16

LEGEND

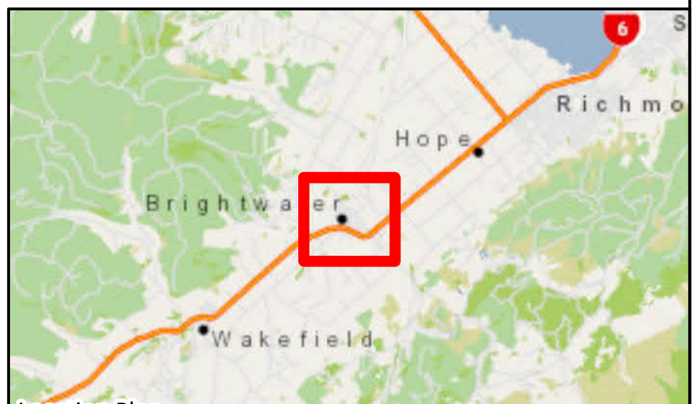
Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N



Location Plan

Notes:
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2. Modelling based on 2016 LiDAR data supplied by Tasman District Council.

DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure B1.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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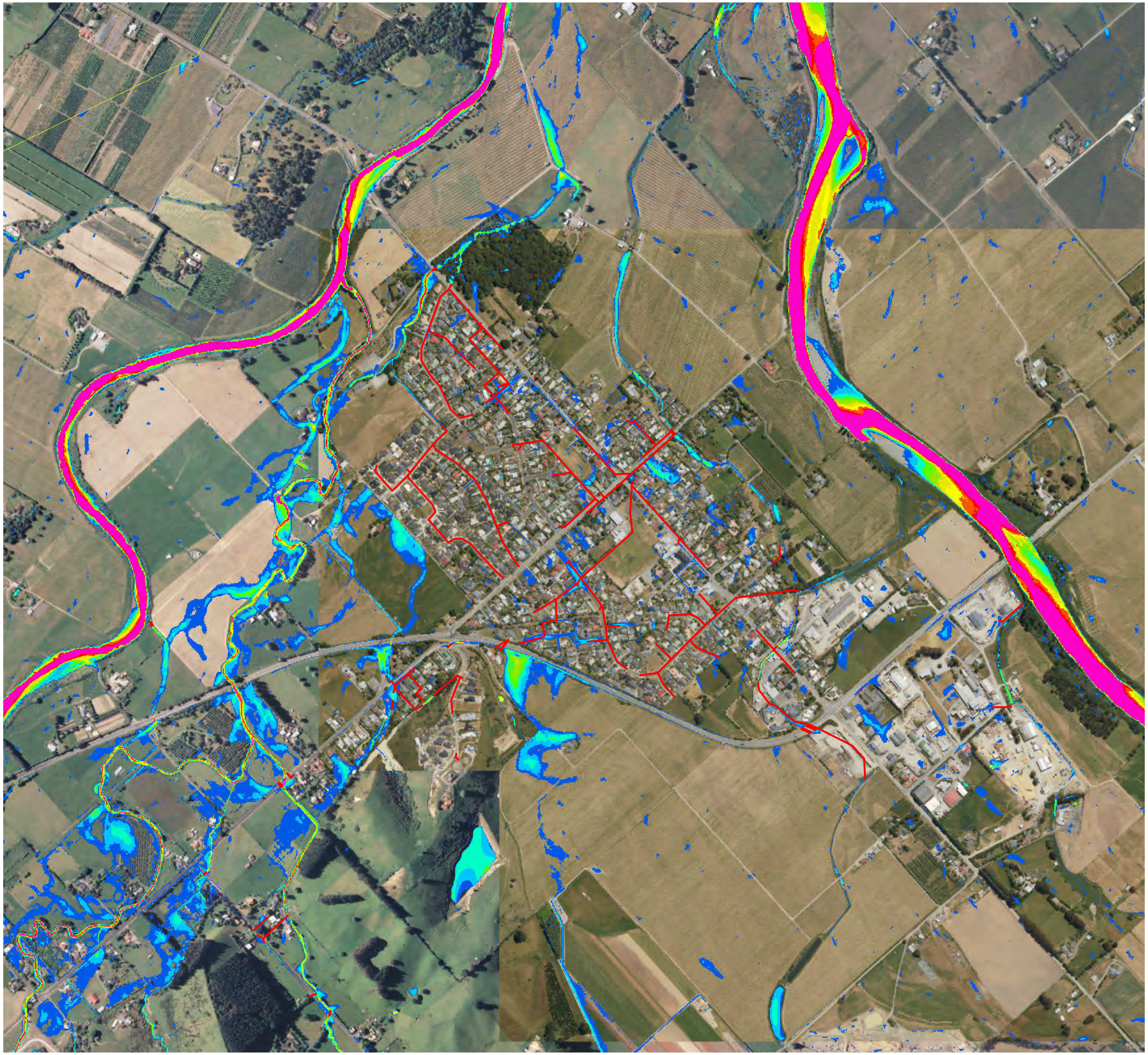
TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
Present day 1% AEP 1hr event

Figure B1.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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2. Modelling based on 2016 LiDAR data supplied by Tasman District Council.

DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure B2.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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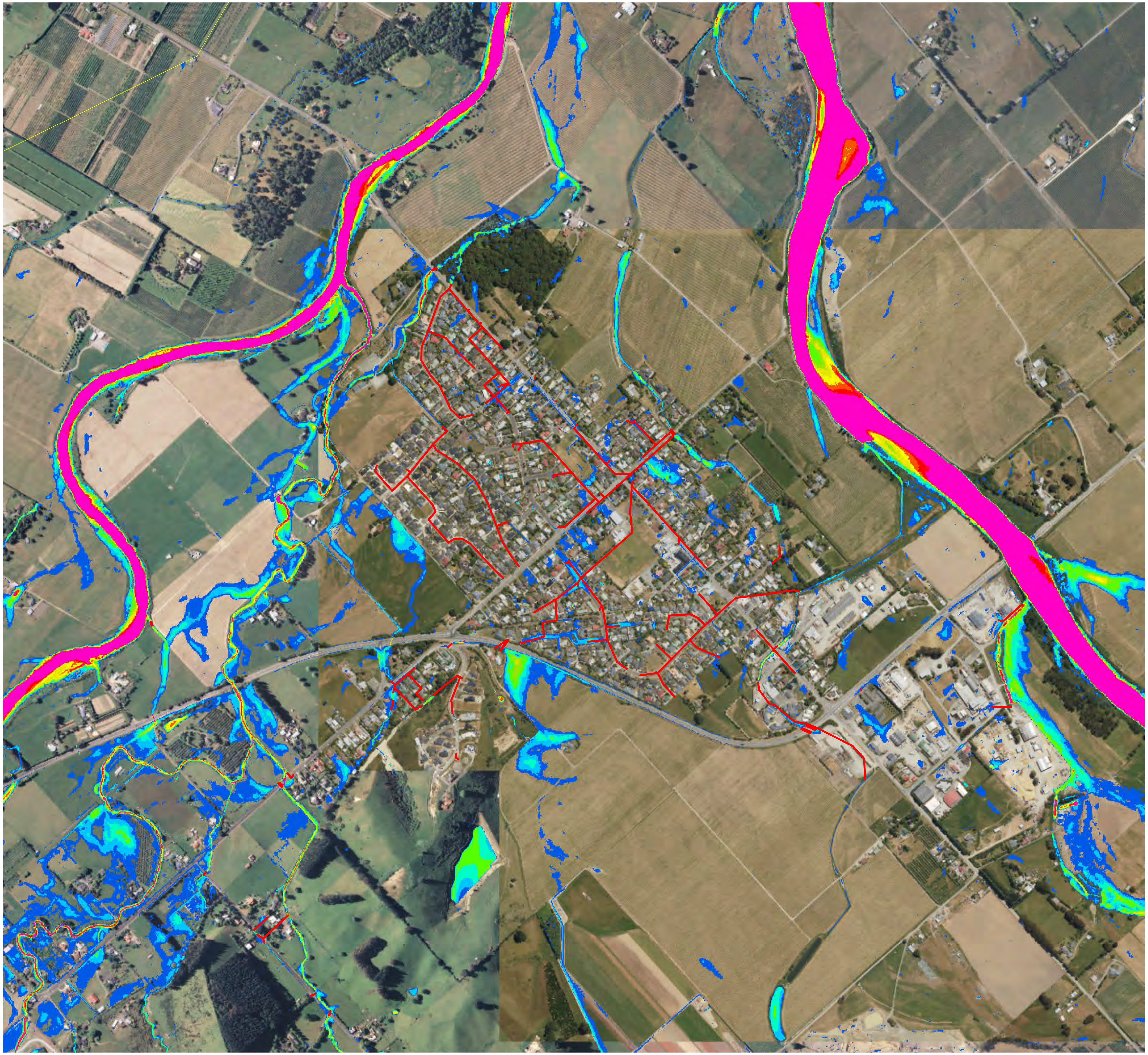
TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
Present day 1% AEP 6hr event

Figure B2.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
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ARCFILE Figure B3.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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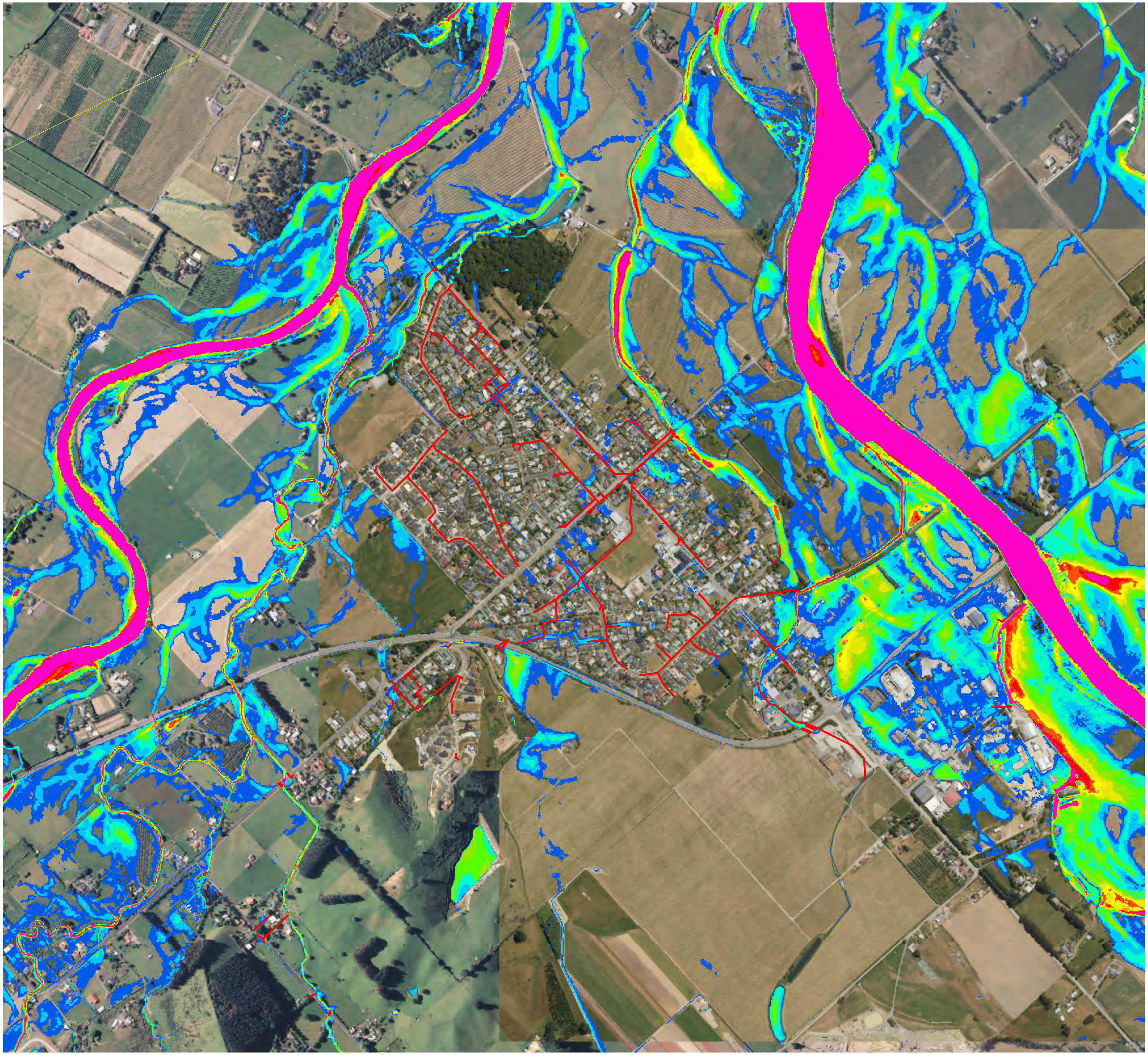
TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
Present day 1% AEP 12hr event

Figure B3.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Notes:

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DRAWN	QUHO	Oct.19
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APPROVED	DNV	Mar.20
ARCFILE Figure B4.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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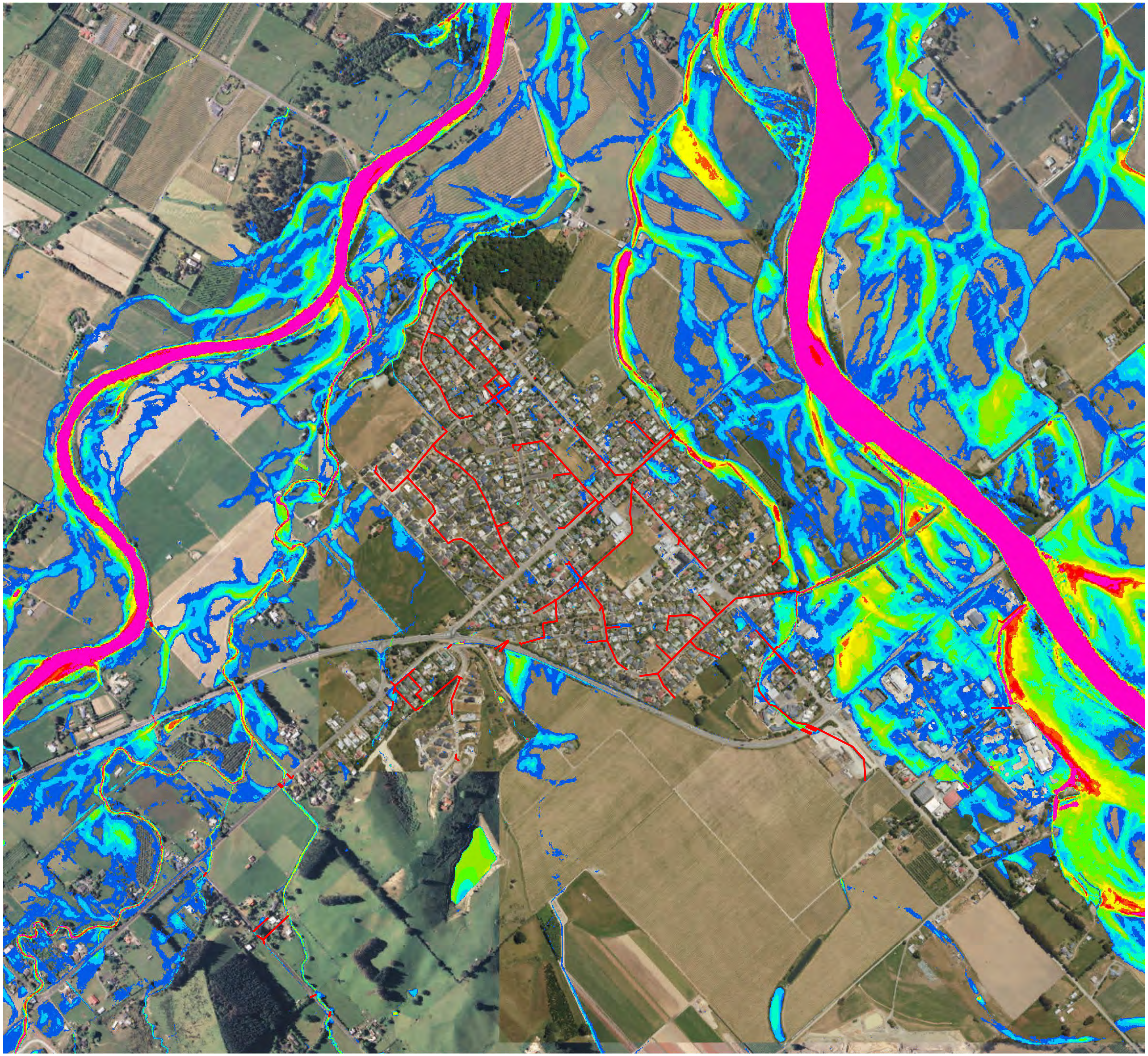
TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

Present day 1% AEP 24hr event

Figure B4.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure B5.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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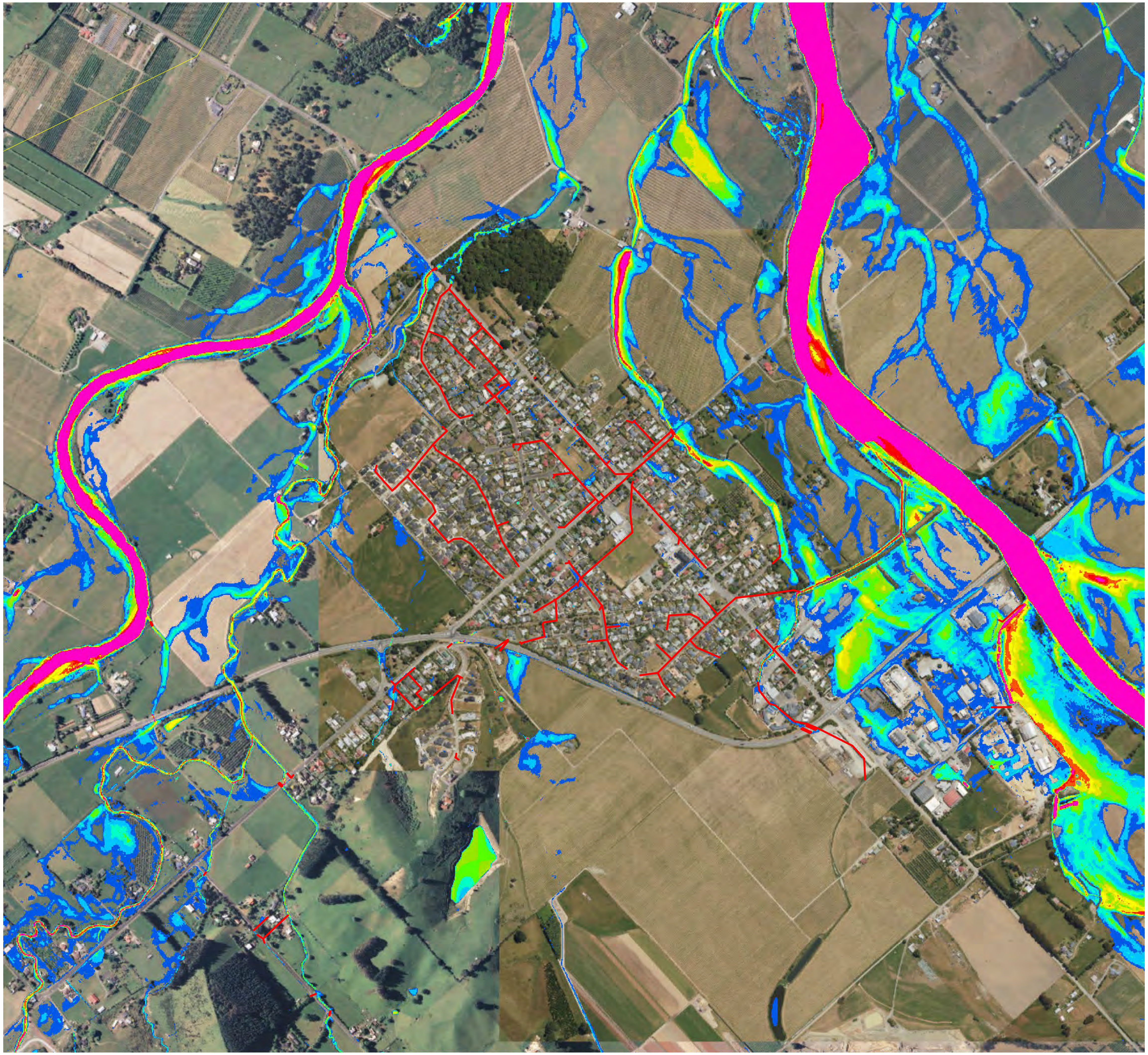
TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
Present day 1% AEP 48hr event

Figure B5.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure B6.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
Present day 1% AEP 72hr event

Figure B6.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:

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2. Modelling based on 2016 LiDAR data supplied by Tasman District Council.

DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure B7.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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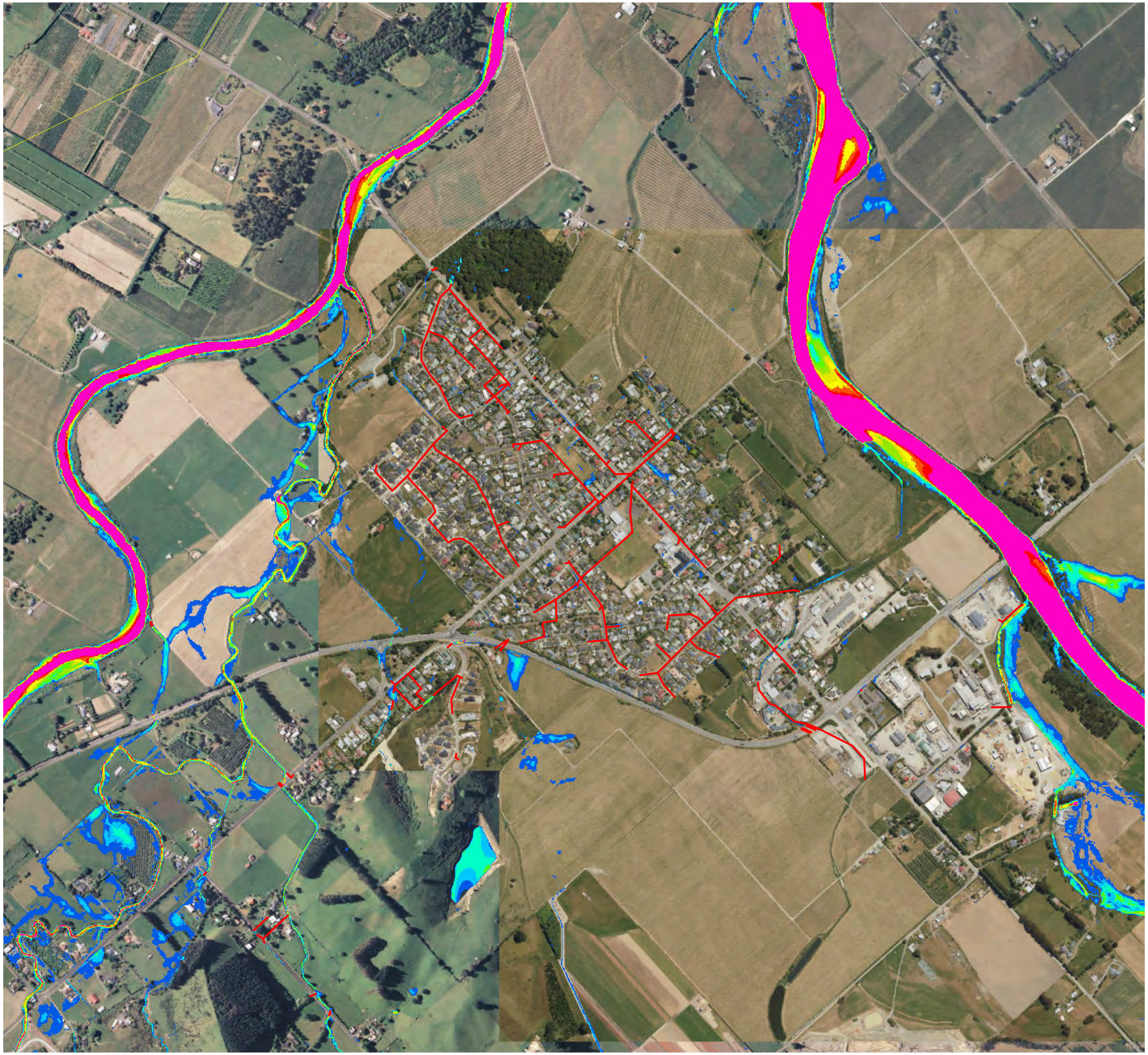
TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

Present day 10% AEP 6hr event

Figure B7.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20

ARCFILE Figure B8.mxd

SCALE (AT A3 SIZE) 1:10,000

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TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
Present day 10% AEP 48hr event

Figure B8.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:

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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20
ARCFILE Figure B9.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

Present day 50% AEP 6hr event

Figure B9.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:

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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20

ARCFILE Figure B10.mxd

SCALE (AT A3 SIZE) 1:10,000

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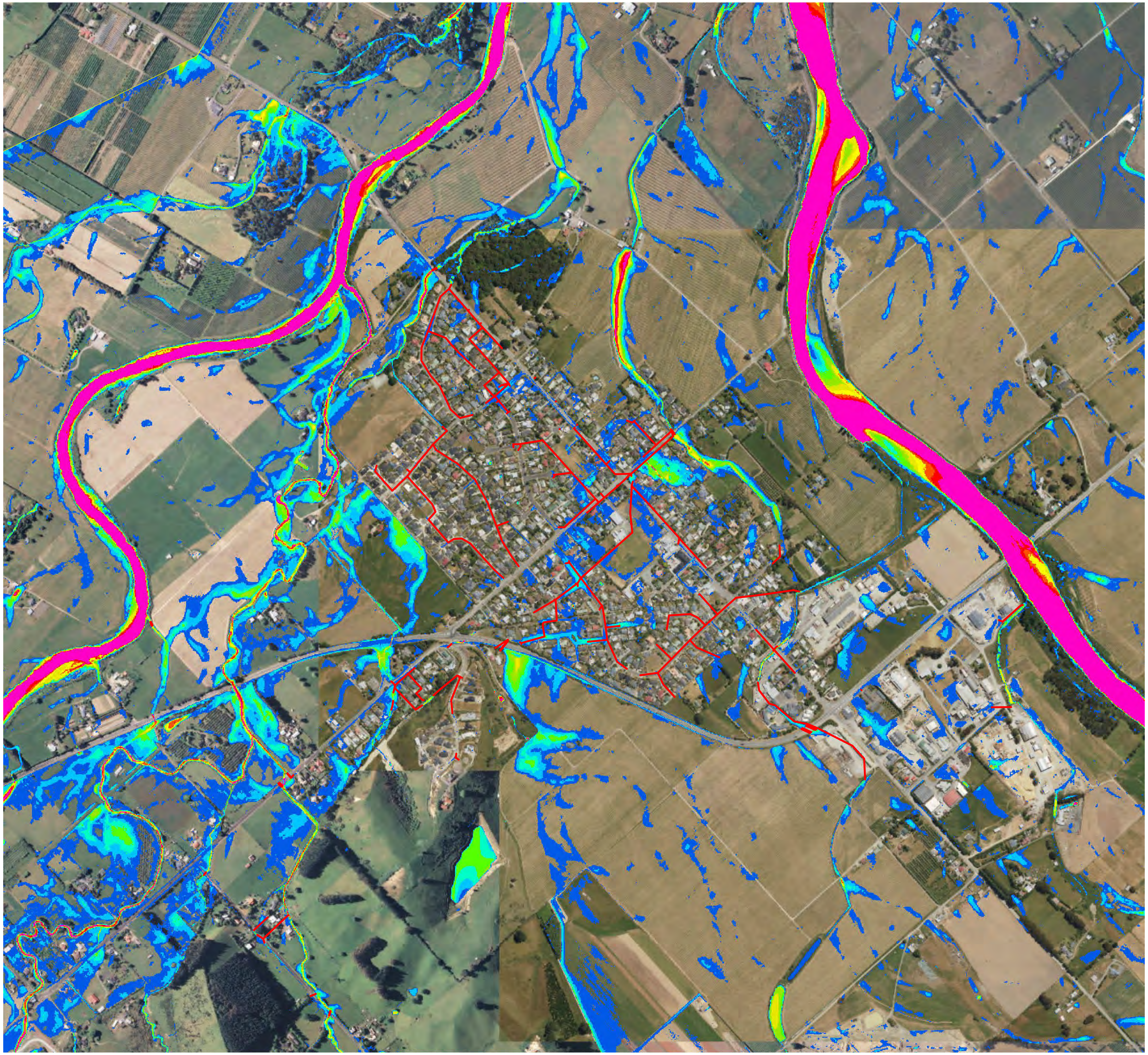
TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

Present day 50% AEP 48hr event

Figure B10.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
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ARCFILE Figure B11.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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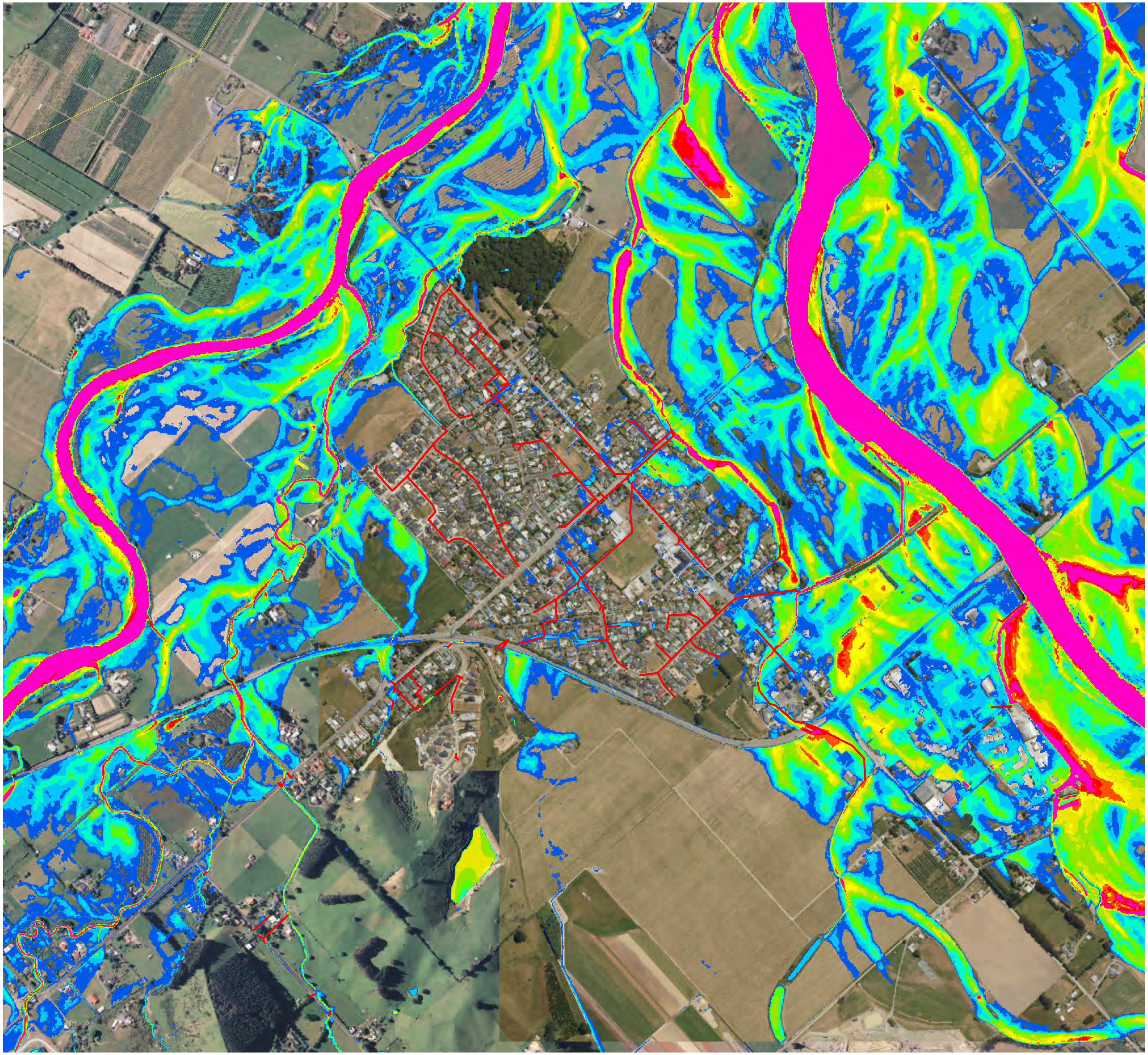
TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

2090 RCP8.5 1% AEP 6hr event

Figure B11.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

Location Plan

Notes:
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DRAWN	QUHO	Oct.19
CHECKED	DNV	Mar.20
APPROVED	DNV	Mar.20

ARCFILE
Figure B12.mxd

SCALE (AT A3 SIZE)
1:10,000

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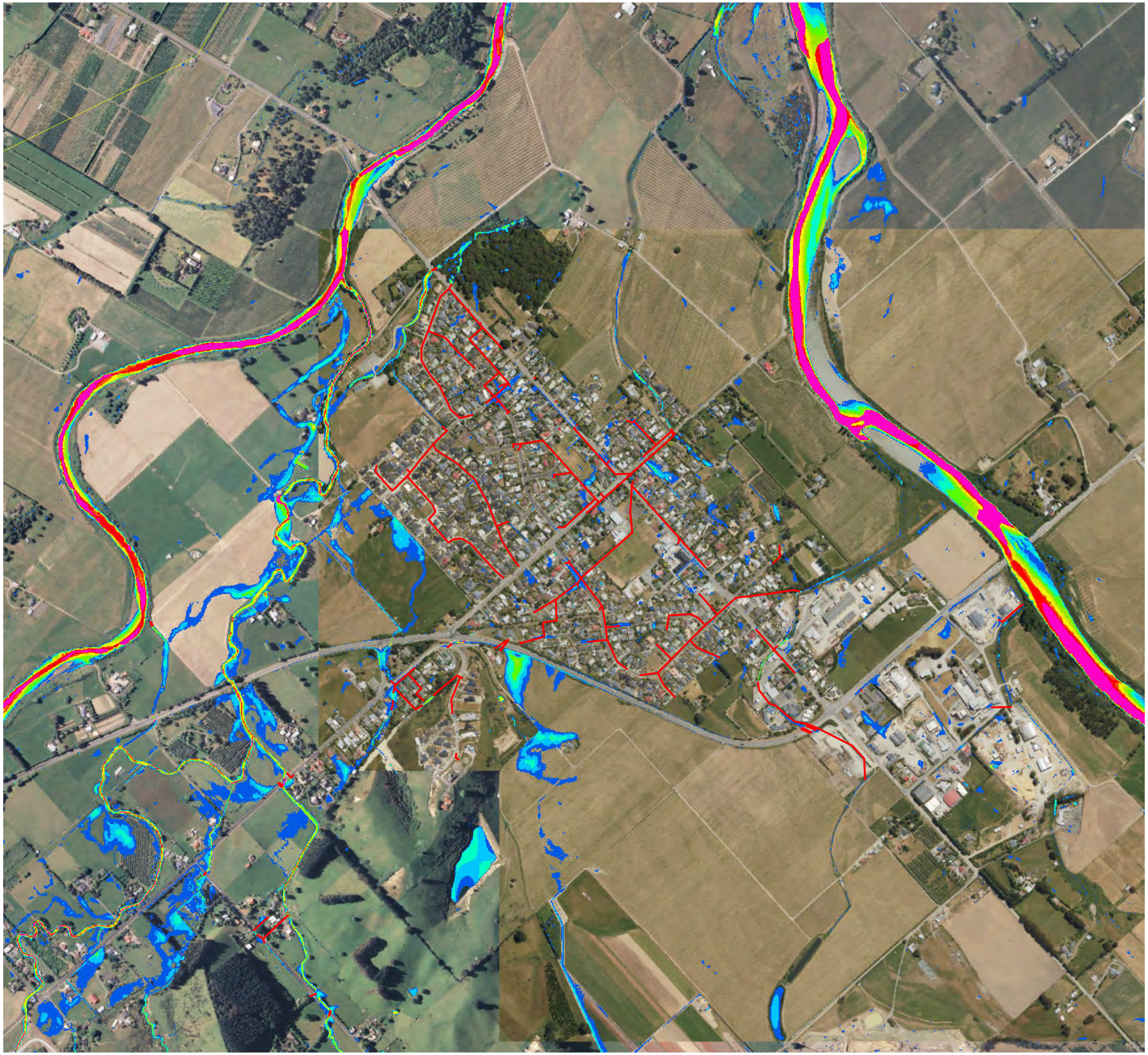
TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
2090 RCP8.5 1% AEP 48hr event

Figure B12.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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DRAWN	QUHO	Oct.19
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ARCFILE
Figure B13.mxd

SCALE (AT A3 SIZE)
1:10,000

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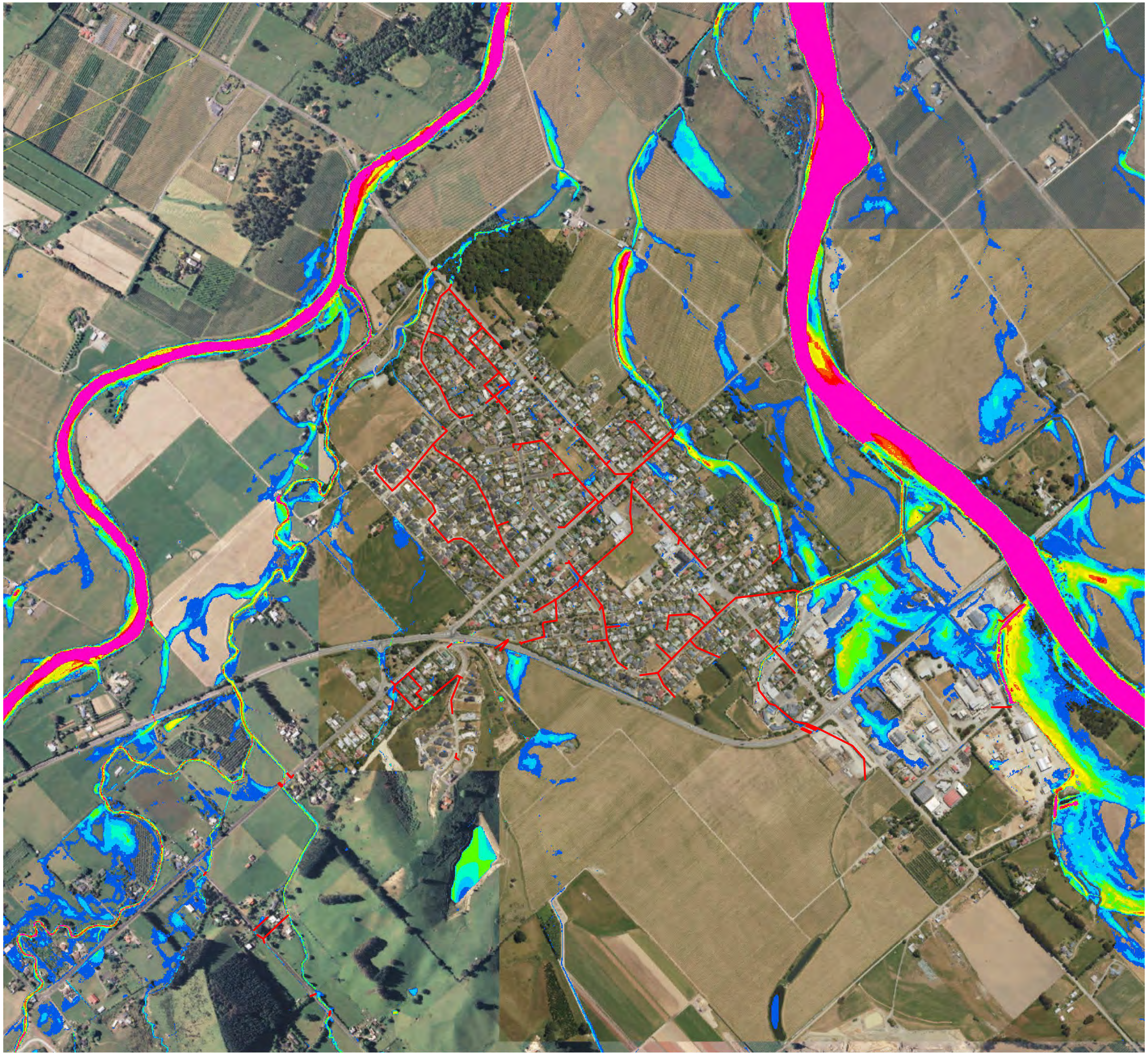
TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

2090 RCP8.5 10% AEP 48hr event

Figure B13.



LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

N

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DRAWN	QUHO	Oct.19
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APPROVED	DNV	Mar.20
ARCFILE Figure B14.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
2090 RCP8.5 10% AEP 48hr event

Figure B14.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Notes:
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DRAWN	QUHO	Oct.19
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APPROVED	DNV	Mar.20
ARCFILE Figure B15.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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TASMAN DISTRICT COUNCIL
BRIGHTWATER FLOOD MODELLING
2090 RCP8.5 50% AEP 6hr event

Figure B15.

LEGEND

Modelled Flood Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- 1.3 - 1.5
- 1.5 - 1.7
- 1.7 - 1.9
- > 1.9
- Modelled Pipes
- Model Boundary

A3 SCALE: 1:10,000

0 0.1 0.2 0.3 0.4 0.5 (km)

Location Plan

Notes:

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DRAWN	QUHO	Oct.19
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APPROVED	DNV	Mar.20
ARCFILE Figure B16.mxd		
SCALE (AT A3 SIZE) 1:10,000		
PROJECT No. 1004543.3000		

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TASMAN DISTRICT COUNCIL

BRIGHTWATER FLOOD MODELLING

2090 RCP8.5 50% AEP 48hr event

Figure B16.