Moutere Catchment Flood Modelling Report & Design Floor Level Assessment

Tasman District Council

6/11/2023

e2 environmental CONSULTING ENGINEERS

Quality Control

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EXECUTIVE SUMMARY

Tasman District Council (TDC) engaged e2Environmental Ltd. (e2) to conduct a flood modelling exercise to assess flood depths and flood hazard in the Moutere catchment. Although the entire catchment has been modelled, the primary area of interest covers the Moutere Valley floor from the Upper Moutere down to the coast and includes all major drainage channels throughout the valley floor.

A two-dimensional only approach and direct rainfall method (DRM) using DHI MIKE Flood software package was adopted following a scoping meeting onsite between TDC and e2. To develop a model with accurate enough resolution while maintaining practical model runtime, the flood model was divided into three zones of resolution, with higher resolution focussed on the valley floor.

The model was calibrated and validated using three historical flood events(April 1976, July 1983, and March 2016) with rainfall from nearby recorder stations and aerial photos and debris lines captured both during and after the events.

The model was found to be most sensitive to antecedent conditions and the infiltration rate of the underlying soils. Sensitivity testing was performed to refine these parameters and to ensure confidence in model results.

Design flood conditions were run for the 2% AEP, 1% AEP, and 0.4% AEP rainfall events with the inclusion of climate change conditions for an RCP8.5 scenario for the period 2081 -2100.

The analysis shows that the majority of the Moutere Valley floor is flooded under design conditions with varying depths and velocities throughout the catchment.

Sensitivity modelling results provide a level of confidence around the potential variability that could be expected in flood levels and velocity depending on the behaviour and direction of real storms and the condition of the soils preceding any future flood event.

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1 INTRODUCTION

1.1 Background

Tasman District Council (TDC) manages the setting of required floor levels for new developments throughout the Tasman region. To ensure this is done to an appropriate standard that protects structures from flooding, catchments are modelled for both hydrology and hydraulics to determine potential flood depths through existing and potential future developed areas.

The Moutere Catchment, and the developed areas within the catchment, currently lacks accurate data on potential flood depths that could be experienced during large runoff and flooding events. e2Environmental Ltd (e2) was engaged by TDC to carry out hydrology and hydraulic overland flood modelling for design events to establish expected flood depths / levels throughout the current and potential future developed areas of the catchment. The expectation is that the final agreed and accepted flood depths/levels from this modelling will be translated into required floor levels for any future development within the Moutere catchment.

1.2 Description of the Area of Interest

The Moutere River catchment is located approximately 25 km north west of Nelson in the Tasman District and has an area of approximately 15,000 ha. The upper catchment begins in the Moutere Hills and extends north to the Moutere inlet, located just south of Motuteka. The hill areas are typically low rolling hills, while the valley floor has a relatively flat grade of approximately 0.6%.

Land use within the catchment consists predominantly of pasture (high producing exotic grassland), exotic forestry and horticulture (orchards, vineyards and perennial crops). There has been a shift in the distribution of these land uses throughout the catchment over the last 20 to 30 years. Figure 1 shows the distribution of land use throughout the catchment in 1996 and 2018. The images show that the amount of exotic forestry (shown in red) throughout the catchment has reduced as crops have been harvested and not replanted. This has typically been replaced by pasture (shown in green), particularly in the eastern hills around the Braeburn / Harakeke area.

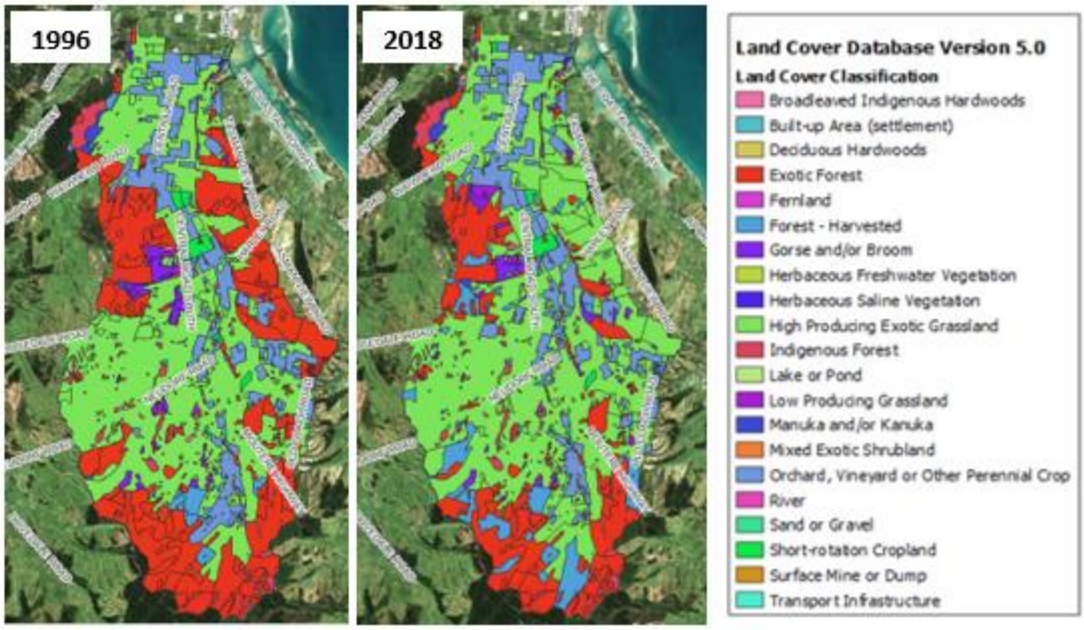

Figure 1: Land use change within the Moutere catchment between 1996 and 2018 as classified by Landcare Research's Land Cover Database Version 5.0

The Moutere River has been highly modified since the arrival of early settlers in the area, with the straightening of the lower reaches and formation of the NZ Company ditch. In addition, there is an extensive network of drainage channels throughout the catchment.

1.3 Study Objectives

The objectives of this modelling exercise are to:

- Establish expected flood depths/ levels throughout the current and potential future developed areas of the catchment. These flood depth/levels need to be understood for the expected future conditions under climate change conditions to ensure future development is appropriately planned.
- Produce accepted flood depths/levels that can be translated into required floor levels for any future development within the Moutere catchment.

1.4 Purpose of the Report

This modelling report documents the review of the collected data, the relevant characteristics of the catchment, the hydrology and hydraulic modelling approaches, the schematisation of the model, an assessment of the model confidence, and the modelling results.

2 DATA COLLECTION AND REVIEW

2.1 Topographic Data

The most recent topographic data for the floodplain area is obtained from Land Information New Zealand (LINZ) Data Service. The relevant layers are detailed below in Table 1.

The LiDAR data was merged to create a single topographical file of the Moutere River catchment.

Table 1: Topographical data

LiDAR	Coverage	Year surveyed	Cell size	Source
Nelson and Tasman LiDAR DEM	This data set covers the majority of the area of interest including the Moutere River floodplain and most of the upper catchment	2008-2015	1 m	LINZ
Tasman DEM	This data set covers a relatively small area of upper catchment at the southern extent of the area of interest	2020-2022	1 m	LINZ

2.2 Historic Rainfall Record

The most relevant TDC managed rainfall gauging site for this project is Moutere at Kellings Road, with records available from 1961 to present. However, rainfall collected during the April 1976 event was only recorded on a daily-totals basis whereas the more recent events were recorded on an hourly basis. Further afield from Kellings Road are three other TDC managed rainfall recorders: Motueka at Blue Glen, Riwaka South at Moss Bush, and Stanley Brook at Malcolms. To model the April 1976 an average unit rainfall distribution approach using these three alternative sites was used to obtain an average hourly rainfall distribution for the Moutere catchment. All other events modelled for validation in this project used the Kellings Road hourly rainfall data.

2.3 Flow Data

There are currently no flow gauging sites managed by TDC located on the Moutere River.

A flow record and gauging data is available for the Moutere River at Old House Road for the period from 29 December 1961 to 20 January 1986.

2.4 Aerial Photographs

The historic aerial photography used in the study are based on the latest available from LINZ.

2.5 Historic Flood Pattern

The relevant historic flood extents that are available and have been obtained for this project are as follows:

- 1980 Powelly Creek flood extent
- 1982 Powelly Creek flood extent

- 1983 Moutere flood extent
- 1990 Moutere flood extent

2.6 Land Use Type

The existing land use type data was available and obtained from IRIS "Land Cover Database Version 5.0". The majority of the land use in the catchment is made up of pasture (high producing exotic grassland), horticulture (orchards, vineyards and other perennial crops) and exotic forestry. Land cover categorisations as classified by the Land Cover Database Version 5.0 are illustrated in Figure 2.

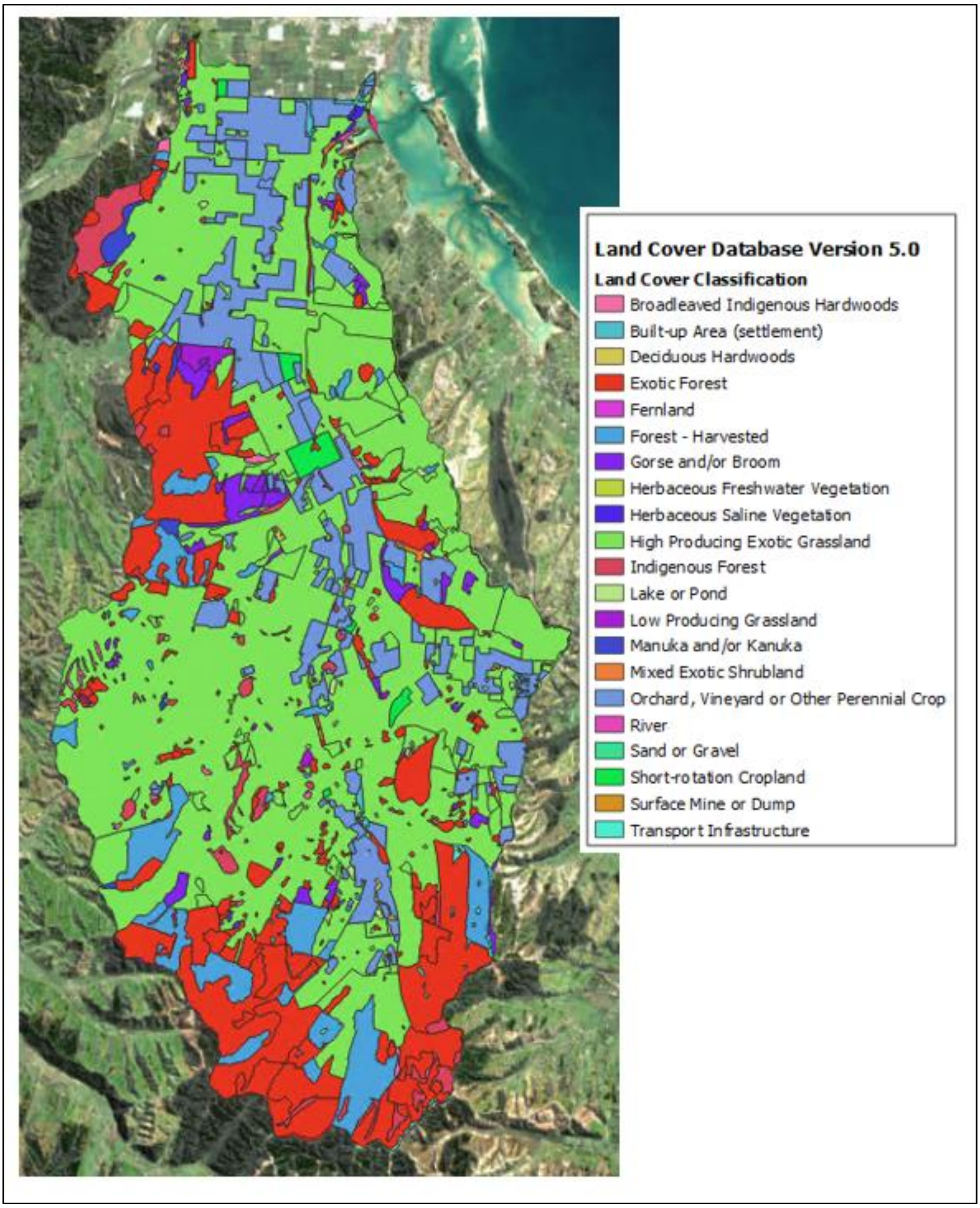

Figure 2: Land cover categorisations as classified by the Land Cover Database Version 5.0 for the Moutere Catchment

2.7 Soil Drainage

A soil drainage map was available and obtained from IRIS "S-map Soil Drainage Dec 2022". However, as illustrated in Figure 3 this data only covered part of the catchment. As such, the drainage properties for much of the catchment were undefined.

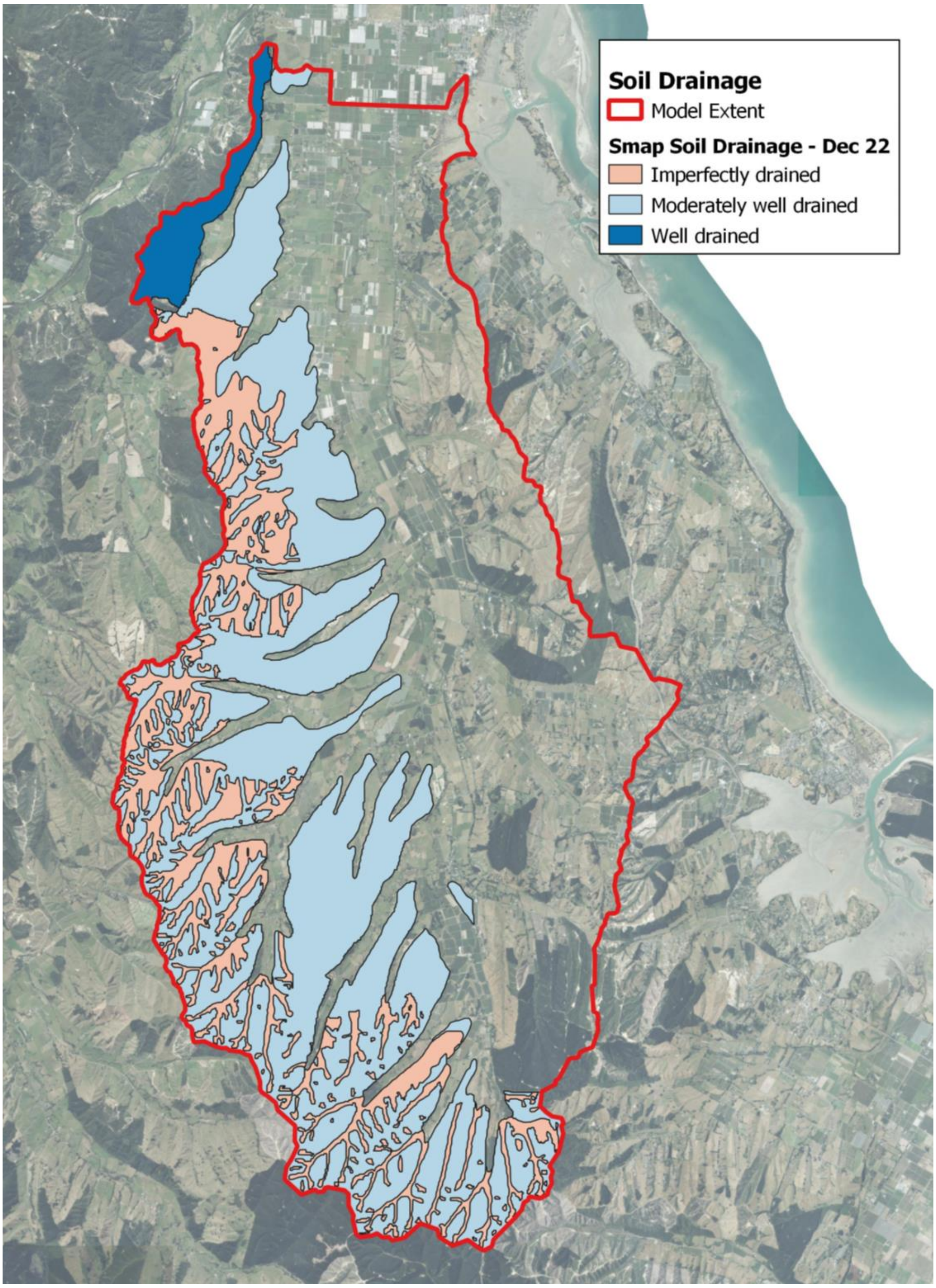

Figure 3: Soil drainage as classified by S-map Soil Drainage Dec 22

Feedback received from TDC is that soils within the Moutere catchment are mostly imperfectly drained Moutere clay, with some Separation Point Granite.

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3 MODEL LOG AND FILE NAMING

3.1 Model Log

A model log for this modelling exercise has been developed and provided as an additional spreadsheet file. The model log documents the model naming and simulation log sheet. The simulation log sheet documents all relevant elements of model development process. The model log should be read together with this document and other documents referenced in the model log spreadsheet.

A print of the model log that displays all the important simulation files is attached in Appendix A.

3.2 Naming Convention

A naming convention in accordance with the TDC modelling guideline was used. The model log spreadsheet "01 SimNaming" Tab contains the information that should be included in the simulation/result file. They are:

1. A numbering identifier (Counter)
2. River name
3. Land use type
4. Rainfall scenario (AEP)
5. Rainfall duration
6. Downstream boundary condition
7. Climate change
8. Simulation type (base, certainty, hydrology, calibration etc.)

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4 MODEL BUILD

4.1 Modelling Software

The hydrology and hydraulic models were simulated using GPU processed DHI MIKE 21 software package released in 2016 (Service Pack 3).

4.2 Coordinate System

All geospatial files are in terms of the New Zealand Transverse Mercator 2000 (NZTM2000) Coordinate reference system. The vertical datum used is New Zealand Vertical Datum 2016 (NZVD2016).

4.3 Two-dimensional Hydrology and Flexible Mesh Hydraulic Model

In consultation with TDC, a two-dimensional hydrology and flexible mesh hydraulic modelling approach was adopted. It is considered that the topographical data contains adequate detail to accurately represent conveyance through the catchment's river and drainage channels. In addition, there are no major townships within the catchment with stormwater reticulation requiring the inclusion of a one-dimensional model. A two-dimensional only model allows the model to be updated efficiently as new topographic data (i.e., LiDAR) becomes available. A small number of culvert and bridge linkages have been added to the model as 1D elements to ensure accurate conveyance in critical locations.

4.4 Direct Rainfall Method (DRM)

The direct rainfall method (sometimes referred to as "rain on grid" (RoG) method) was applied to the 2D hydrology and flexible mesh hydraulic model. The rainfall was applied directly to the 2D mesh elements, and the infiltration loss was setup as the only loss in the model. The runoff was routed through the catchment with shallow water equations. The major factors that affect the amount of runoff calculated include: the mesh size, rainfall depth, surface roughness, slope between neighbouring meshes, and rainfall losses.

4.5 Topographic Data Source

The 2008-2015 Nelson and Tasman LiDAR DEM was used to interpolate the 2D surface elevation. Areas in the model extent not covered by this dataset used the 2020-2022 Tasman DEM to interpolate the 2D surface elevation.

4.6 Model Extent

The model extent covers the Moutere catchment, from the upper catchment to the point of discharge to the estuary at SH60 (The Coastal Highway). The northern boundary of the model extent has been extended beyond the road edge along Chamberlain Street, Hursthouse Street, Wildman Road and High Street South as these roads act as boundaries to overland flow. The model extent is illustrated in Figure 4. A close up showing the roads defining the northern boundary of the model is provided in Figure 5.

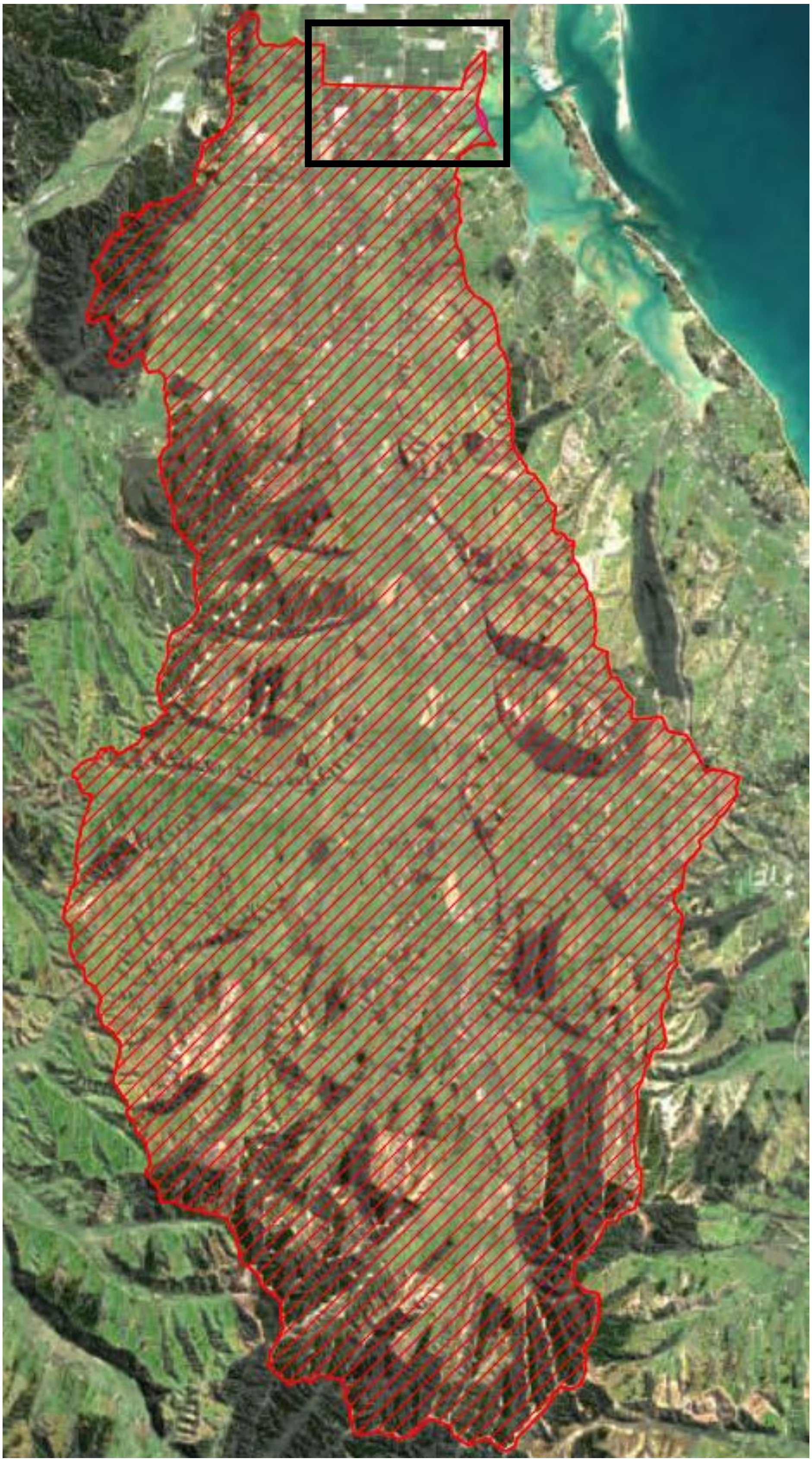

Figure 4: Moutere Flood Model Extent

Figure 5: Roads defining northern boundary of Moutere Flood Model Extent

4.7 Flexible mesh

In order to obtain the most accurate result, without impractically extending the model runtime the model extent was broken down into three separate areas with varied possible maximum mesh element sizes. These areas are summarised in Table 2.

Table 2: Summary of maximum mesh element sizes applied within the model

	Maximum Mesh Element Size	**Description / Reason**
Outer Catchment	100 m^2	This area represents the hillslopes in the outer catchment. Increasing the mesh size in this area will help to reduce the model run time, without having a major impact on the accuracy of the model.
Valley Floor	25 m^2	This area represents the Moutere valley floor or floodplain area. Greater definition is required here to ensure that conveyance is accurately modelled and expected flood depths / levels can be accurately obtained for potential future development within the catchment.
High Resolution	5 m^2	This area represents the Moutere River and other key drainage channels throughout the catchment. It also includes roads that intersect the flow conveyance within the valley floor area. A high level of definition is required for these features to ensure that flow is accurately conveyed through the model.

The distribution of these areas over the model extent is illustrated in Figure 6. The final model has 4,692,443 mesh elements.

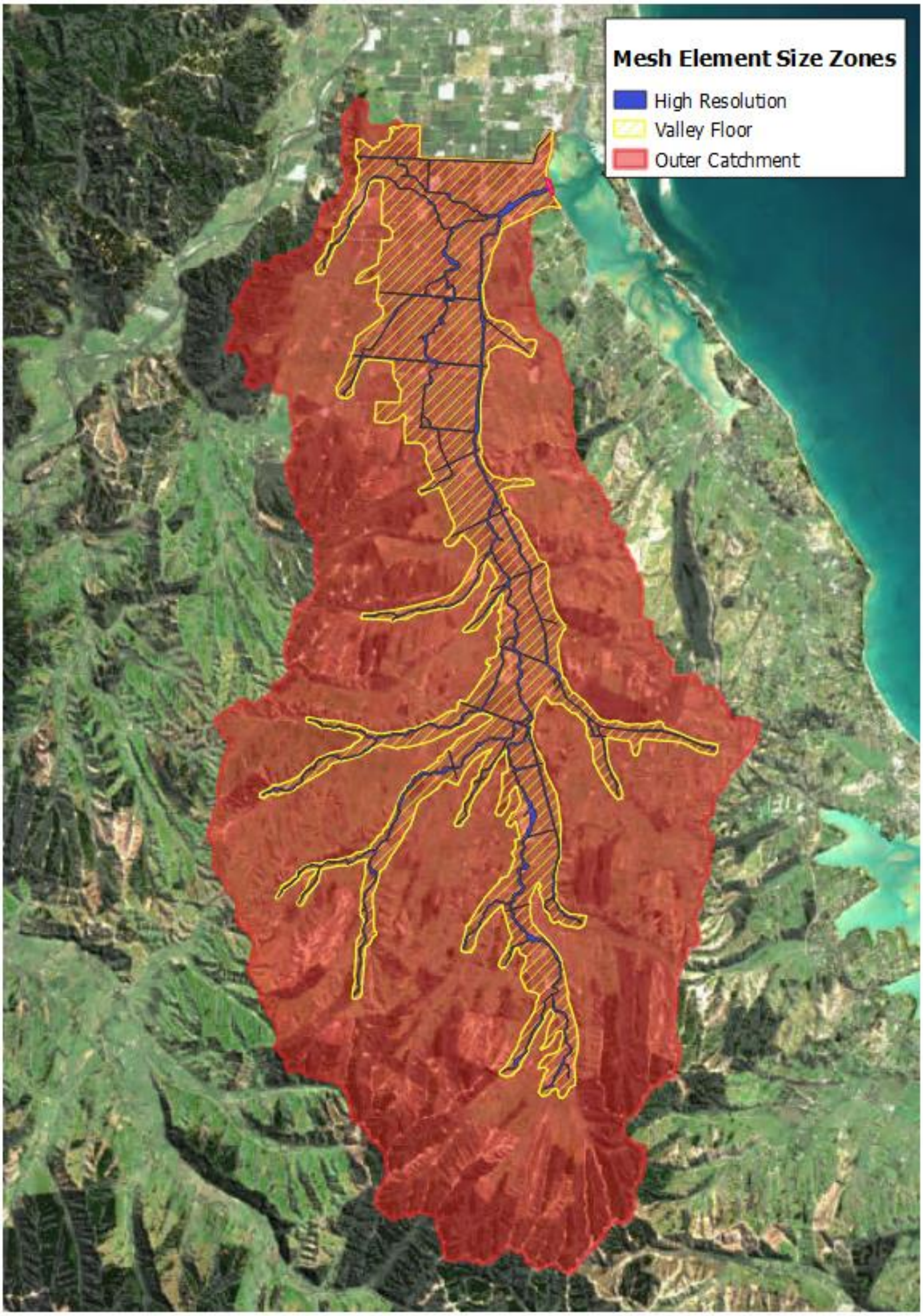

Figure 6: Distribution of different element mesh size zones over the model extent

4.8 Rainfall

In accordance with TDC's modelling guideline, the rainfall depth from NIWA's High Intensity Rainfall System (HIRDS V4) and the HIRDS V4 "North of South Island" temporal pattern was applied to each modelled event. Figure 7 shows the hyetographs used for the design rainfall events. A 'blanketed' rainfall was applied over the whole catchment.

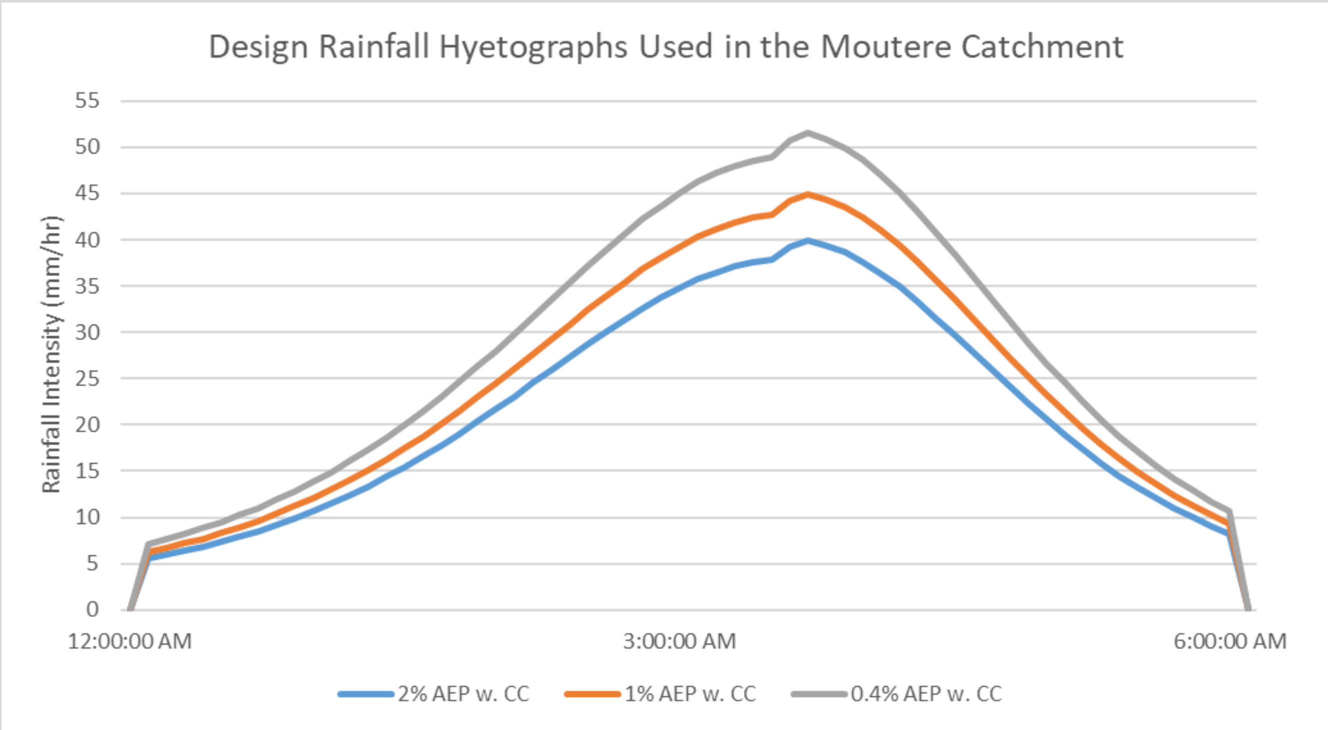

Figure 7: Design Rainfall Hyetographs used in the Moutere catchment

A Gumbel distribution based on historical data for TDC's 'Moutere at Kellings Road' rainfall gauge was also produced. The design rainfall depths associated with the Gumbel distribution were compared with the HIRDS rainfall depths based on historical data for a range of design events. The results of this comparison are shown in Table 3. The rainfall depths were found to be relatively similar for all design events compared, with a maximum difference equivalent to 8.6%.

Table 3: Comparison of rainfall depths based on historical data sourced from HIRDS v4 and Gumbel distribution

ARI	AEP	6-hour		12-hour		24-hour	
		HIRDS	Gumbel	HIRDS	Gumbel	HIRDS	Gumbel
5yr	20%	64	70.1	82.2	89.9	102	109.8
10yr	10%	75.3	82.1	96.3	104.4	120	126.6
20yr	5%	87	94.2	111	118.3	137	142.6
50yr	2%	103	109.4	131	136.3	162	163.4
100yr	1%	116	120.8	147	149.8	181	179

4.9 Climate Change

In accordance with the TDC modelling guideline, the RCP8.5 scenario for the period 2081 - 2100 was used do assess climate change impacts.

4.10 Critical Duration

An initial investigation was conducted to establish the storm duration that will generate the greatest floodplain depth. The test was conducted on the 1% AEP storm events including climate change for the RCP8.5 scenario. The analysis was performed with a low-resolution mesh with a maximum element size of 100 m^2, no infiltration and a generic Mannings n value of 0.04 across the entire catchment. A constant downstream boundary level of RL 1.282 m (NZVD2016) was applied. An overview of the analysis results is provided in Appendix B.

The results showed less floodplain inundation during a 24-hour storm and obvious less floodplain inundation during a 1-hour event when compared with the other design durations. The results also show that the upper Moutere catchment is more sensitive to the shorter duration events, while the lower Moutere catchment is more sensitive to the longer events up to 8-10 hours in duration. Overall, a 6-hour design duration storm event is considered most appropriate to capture inundation effects in the overall Moutere catchment. However, it is recommended that a 100 mm sensitivity freeboard allowance is considered with any results to account for real future storms with durations either side of the 6-hour duration.

4.11 Rainfall Losses

Rainfall loss (i.e., how much rainfall is absorbed by the environment, as opposed to how much becomes runoff) is one of the key flood modelling inputs to the design process that can affect the magnitude of the design flood. Rainfall losses are attributed to processes such as interception by vegetation, infiltration to soil, depression storage and transmission loss through the stream bed and banks. In this modelling exercise, all the losses were assumed to be related to infiltration. Loss decay periods can impact loss rates and runoff over shorter duration events; however, since the critical design duration of 6 hrs was estimated for the Moutere catchment a constant infiltration rate applied across the catchment for the entire duration of the modelled events was considered to be an acceptable practice for this project. Sensitivity testing was performed to confirm this approach.

As outlined in Section 2.7, S-Map's Soil Drainage map is incomplete for the Moutere catchment. Feedback from TDC is that soils within the Moutere catchment are mostly imperfectly drained Moutere clay, with some Separation Point Granite. Based on this an ultimate infiltration rate of 3 mm/hr based on imperfectly drained soils was assumed for the initial model run. The model was calibrated by adjusting the infiltration rates so that the modelled flood extent matched the flood extent shown in aerial photographs for historic flood events. As noted, sensitivity testing was also undertaken to assess the impact of varying the infiltration rate on the flood depth throughout the catchment in each of the simulated design events.

No infiltration was assumed for building footprints and ponded surface water (i.e., dams and the estuary).

4.12 Energy Losses - Roughness

The two-dimensional surface roughness was determined in accordance with the method described in the TDC modelling guideline. The guideline provides a list of roughness values based on the categories of Landcare Research's Land Cover Database (LCDB). However, roughness values for several of the land use categories (based on the most up to date version of the LCDB, v5.0) that fall within the modelled area were not given in the guideline. The gap was filled with commonly accepted values based on experience and industry best practice. Table 4 provides the roughness values used for each land use cover type.

Table 4: Manning's n roughness values used in the model

Land Use Type	Manning's n Used in the Model
High Producing Exotic Grassland	0.05
Orchard, Vineyard or Other Perennial Crop	0.05
Estuarine Open Water	0.022
Broadleaved Indigenous Hardwoods	0.1
Herbaceous Saline Vegetation	0.1
Herbaceous Freshwater Vegetation	0.1
Deciduous Hardwoods	0.125
Exotic Forest	0.15
Indigenous Forest	0.15
Fernland*	0.125
Forest – Harvested*	0.125
Gorse and / or Broom*	0.125
Manuka and / or Kanuka*	0.125
Mixed Exotic Shrubland*	0.125
Low Producing Grassland	0.09
Short-rotation Cropland	0.1
Surface Mine or Dump	0.05
Lake or Pond	0.02
Coastal Sand and Gravel	0.025
Built-up area	0.033
Transport Infrastructure	0.02
Roads	0.02
River	0.04
Buildings	0.33

*The value of n is not provided in the TDC Modelling Guideline 2019

4.13 Energy Losses – Eddy Visosity

Turbulence losses are usually modelled in a two-dimensional model through a viscosity term. The Eddy viscosity is generally unimportant, unless there are deep mixing hydraulics, because the friction forces at the base of the water body dominates in shallow overland flow conditions. In addition, activating the Eddy viscosity term would significantly increase the model runtime. Therefore, the Eddy viscosity term was not included in the model.

4.14 Downstream Boundary Condition

4.14.1 Validation Model Runs

A varying sea level with a tide cycle to match the conditions of the day was applied to each validation model run. Tidal data was obtained from TDC's Little Kaiteriteri tidal monitoring site. A 35-minute lag time was applied to represent the time taken for the tide to move from the open ocean to the Moutere River mouth in the Moutere Inlet. This time lag was obtained from TDC and based on previous sea level and storm surge inundation modelling performed by MetOcean Solutions Ltd.

4.14.2 Design Model Runs

The downstream sea level has been set as a medium tide, applied as a steady state constant water level for the duration of the design model runs. Mean sea level has been set at 0.0 m NZVD2016. A sea level rise of 1.36 m has been applied to the mean sea level. This includes the effects of climate change based on an SSP5-8.5 scenario, median sea level rise at 2130 for the Moutere River mouth, and includes 1.21 m of sea level rise. Vertical land movement (VLM) is approximately 1 mm per year at this site. Adding VLM takes the sea level rise for the Moutere River Mouth out to 2130 to 1.36 m.

4.15 Antecedent Condtion

Soil moisture can have great influences on the rainfall-runoff responses. In this modelling exercise the model was simulated with an initial water depth of 1 mm.

4.16 Baseflow

In this modelling exercise, baseflows were not explicitly applied. However, when generating the 2D mesh in the channel, the water surface elevation would have been sampled as bed level. Therefore, the minor loss of conveyance of baseflow during design conditions was, to a general extent, taken into consideration in this project.

4.17 Building Representation

A number of buildings are scattered within the model extent. However, their overall impact on design flood conditions are considered minor and therefore no buildings were explicitly represented in the model.

4.18 Road Representation

Roads were represented as part of the topographic surface used in the model. Roads running across the valley floor, where it may be important to have the road elevation better represented, were included within the high-resolution mesh area, which utilised a smaller mesh size.

4.19 Bridge Representation

The topographic data set used has already removed bridges from the surface along the main river channels, so that the river channels are continuous at the bridge locations. No representation of the bridge piers or decks has been included in the model, as these are likely to have minimal impact on the overall flood conditions.

Conveyance under the SH60 bridge at the Moutere inlet (representing the downstream model boundary) is considered to be critical. As such, the As Built drawings for this bridge were reviewed to ensure that removal of this bridge from the topographic data provided an accurate representation of conveyance at this location. The model results show that the water levels at this bridge are well below the underside of the bridge; therefore, the bridge deck has not been explicitly represented within the model.

4.20 Culvert Representation

The topographic data set used has already removed some of the major culverts along the main river channels from the surface, so that river channels are continuous at these locations. However, the topographic data treats culverts as ground throughout much of the model extent. Given the large number of drainage channels within the catchment, this would have a significant impact on conveyance of flow through the model extent. Therefore, it was determined that runoff should be allowed to flow under the road to ensure model accuracy. This was achieved by manually lowering the surface elevations to match the upstream and downstream channel bed levels in all locations where culverts were identified.

A number of culverts flowing under the road to the estuary were identified. It was considered important for these culverts to be accurately represented in the model. As such these culverts were added to the model in M11. The location of these culverts is illustrated in Figure 8.

Figure 8: Location of culverts discharging to the estuary that were modelled in MIKE 11

Details of the culverts modelled in Mike 11 are provided in Table 5.

Table 5: Details of culverts modelled in MIKE 11

Culvert	US Invert (m RL)	DS Invert (m RL)	Length (m)	Diameter (mm)	Manning's n
C1	1.15	0.88	20	400	0.013
C2	1.81	1.02	15	450	0.013
C3	1.685	0.835	20	400	0.013
Strm1	1.18	0.5	8	600	0.013
BF1	1.45	1.19	8	300	0.013
BF2	1.57	0.96	8	300	0.013
BF3	1.74	1.77	8	600	0.013
BF4	1.6	1.18	8	350	0.013

4.21 Dam Representation

The Moutere catchment contains a series of holding ponds / dams, which will provide some additional storage capacity during a rainfall event. These have been represented based on the topographic data, with the surface water level representing the ground level in these locations.

5 MODEL CALIBRATION / VALIDATION

5.1 Validation Methodology

The following historic rainfall and flood data were available:

- Rainfall records are available from 1961 to present for TDC's Moutere at Kellings Road site. This site is located at approximately the mid-point of the catchment. Limited storm track is available across the catchment. Average hourly rainfall distribution for the April 1976 event was estimated from three surrounding rainfall records: Motueka at Blue Glen, Riwaka South at Moss Bush, and Stanley Brook at Malcolms. All other validation events used hourly rainfall data from the Kellings Road site.
- A flow record and gauging data is available for the Moutere River at Old House Road for the period from 29 December 1961 to 20 January 1986. No current flow record is available.
- Aerial photographs illustrating flood extents are available for a small selection of historic events. GIS layers illustrating flood extent/debris lines are also available for the July 1983 event.

The model validation process involved running the model for three historic flood events. Aerial photographs, that could be georeferenced were available for two of these events allowing the model results to be compared with each photograph at the appropriate timestep. A GIS file showing the flood extent of debris lines was used for the third event to contrast with model results.

The rainfall events assessed in the model validation process are outlined in Table 6.

Table 6: Model validation events

Flood Event	Estimated ARI	Validation Source
23 March 2016	~20 yr	Aerial photographs showing flood extent with timestamp
9 April 1976	~80 yr	Aerial photographs showing flood extent with record of time taken
9 July 1983	~60 yr	GIS shapefile showing flood extent

The key inputs that could be adjusted in the model calibration process are the roughness values, rainfall depth and distribution and infiltration rates. The reliability of the information available for each of these inputs are discussed below:

- **Roughness:** Reliable land use information was available for the catchment, so roughness values are considered to be relatively accurate. In accordance with the TDC modelling guideline, sensitivity testing has been conducted to assess the impact of varying the modelled roughness.

- **Rainfall:** Rainfall depth data is based on HIRDs, so is considered to be accurate for the purposes of modelling the design events. No storm track was available so rainfall was applied as 'blanketed' rainfall over the entire catchment. In reality, there is likely to be some variation in the distribution of rainfall throughout the catchment which could result in variation between the modelled results and actual observed flood extents.
- **Infiltration Rates:** Limited data were available on soil type within the catchment. In addition, infiltration rates are likely to vary based on the antecedent conditions within the catchment. Therefore, this was considered the most uncertain variable in this modelling exercise.

To account for the uncertainty associated with infiltration rates the assumed infiltration rate was adjusted for each of the flood events referenced in Table 6 so that the modelled flood extent matched the flood extent shown in the flood extent imagery as close as possible.

5.2 Validation Results

5.2.1 23 March 2016 flood event

The most recent flood event for which aerial flood photographs were available was the 23 March 2016. Figure 9 and Figure 10 show photographs taken immediately upstream of the point where the Moutere River discharges into the Moutere Inlet around the intersection of Main Road Lower Moutere and Central Road. Both photographs were taken at 8:30 am NZST.

Figure 9: Aerial photograph taken during 23 March 2016 flood event near the intersection of Main Road Lower Moutere and Central Road (looking toward the south east)

Figure 10: Aerial photograph taken during 23 March 2016 flood event near the intersection of Main Road Lower Moutere and Central Road (looking downstream toward Moutere Inlet)

The model was run using rainfall data recorded between 12pm on 23 March 2016 and 12pm on 24 March 2016. An initial model run was completed assuming an infiltration rate of 3 mm/hr. These results showed flood extents far greater than that indicated by the photographs. Subsequent model runs were undertaken adopting infiltration rates of 5, 8, 10, 11, 12, 13 and 15 mm/hr. The resulting flood extents for each of these events are provided in Appendix C.

The modelled flood extent that most closely matched the photographs for the March 2016 event was the simulation adopting an infiltration rate of 11 mm/hr. The flood extent for this model simulation is shown in Figure 11.

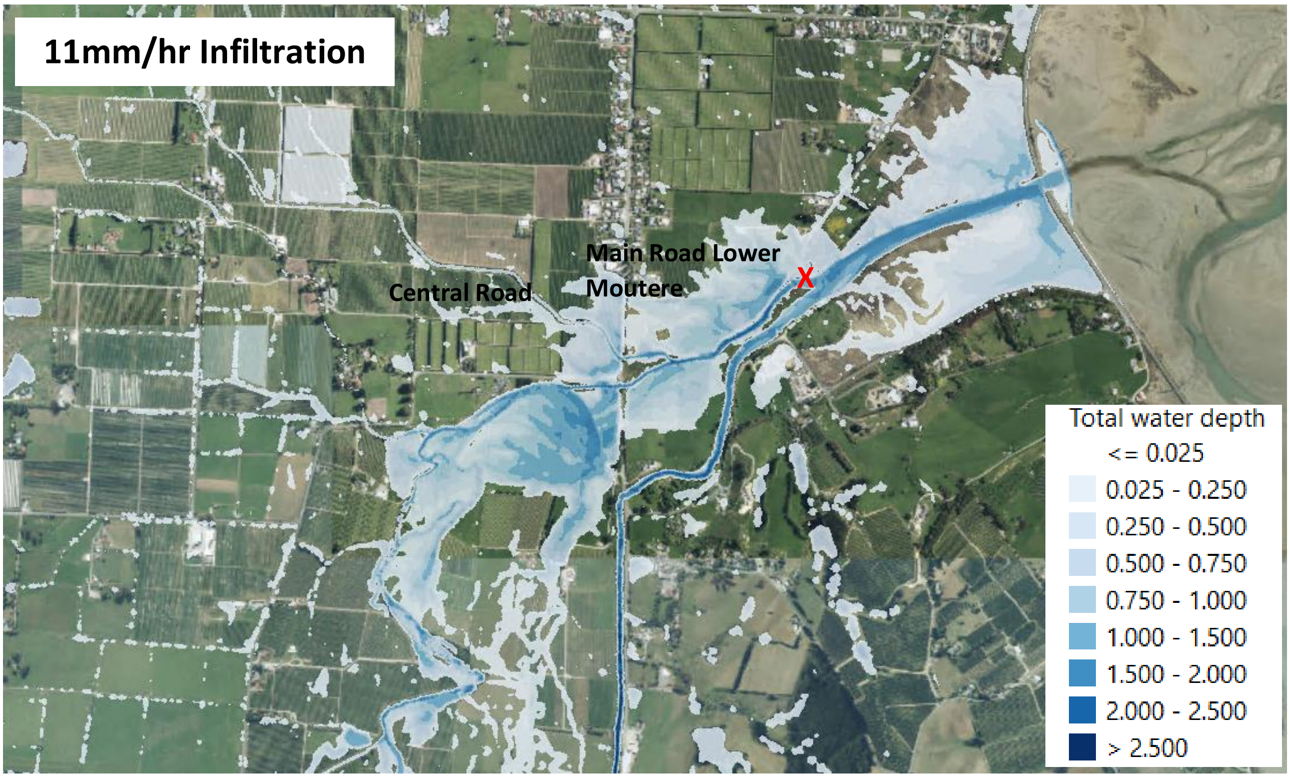

Figure 11: Modelled flood extent for 23 March 2016 event at 08:30am NZST (assuming 11mm/hr infiltration) near the intersection of Main Road Lower Moutere and Central Road

Figure 12 shows the modelled water levels at the Central Plains Culvert for the 23 March 2016 event for a range of modelled infiltration rates. The location of this culvert is illustrated by the red cross in Figures 10 and 11. The results show that the water level at this point in the model ranges from 1.5 m based on an infiltration rate of 15 mm/hr to 3.3 m for an infiltration rate of 5 mm/hr. This shows that flood levels within the Moutere catchment, especially the lower extent of the catchment, are sensitive to changes in the infiltration rate and antecedent conditions within the catchment.

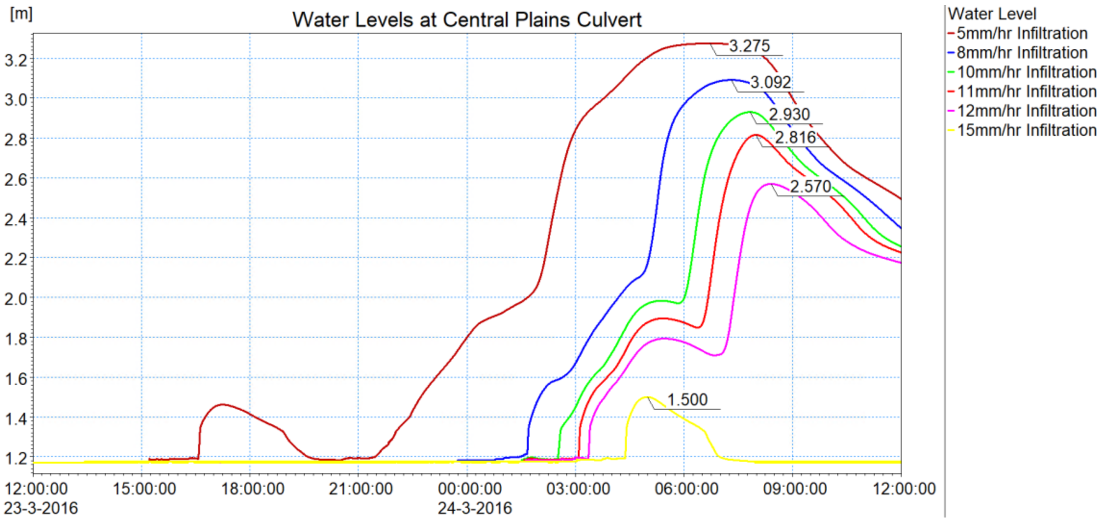

Figure 12: Modelled water levels at Central Plains Culvert (indicated by red cross in Figures 10 and 11) for 23 March 2016 flood event

5.2.2 9 April 1976 flood event

Aerial photographs were also available for a flood event on 9 April 1976. Figure 13, Figure 14 and Figure 15 show photographs taken if the flood extent during this event. All three photographs indicate that they were taken at 4:45pm; however, after discussions with staff at TDC it is suspected that this time represents a return-to-ground time rather than the actual time of the photo.

Figure 13: Aerial photograph showing Moutere River flood extent and modelled flood extent assuming 5 mm/hr infiltration near the sawmill at Wilson's Road during flood event on 9 April 1976

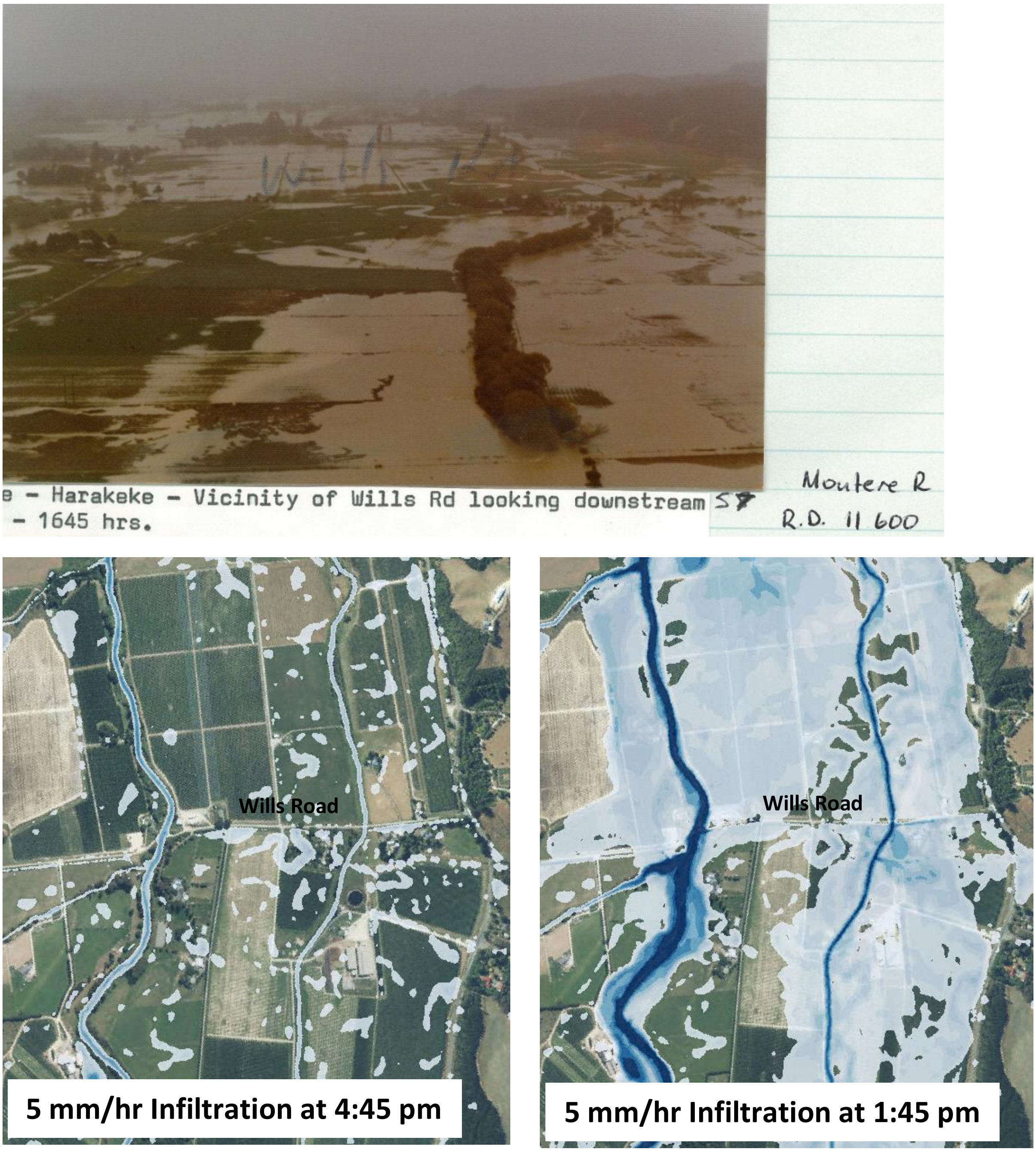

Figure 14: Aerial photograph showing Moutere River flood extent and modelled flood extent assuming 5 mm/hr infiltration in the vicinity of Wills Road looking downstream during flood event on 9 April 1976

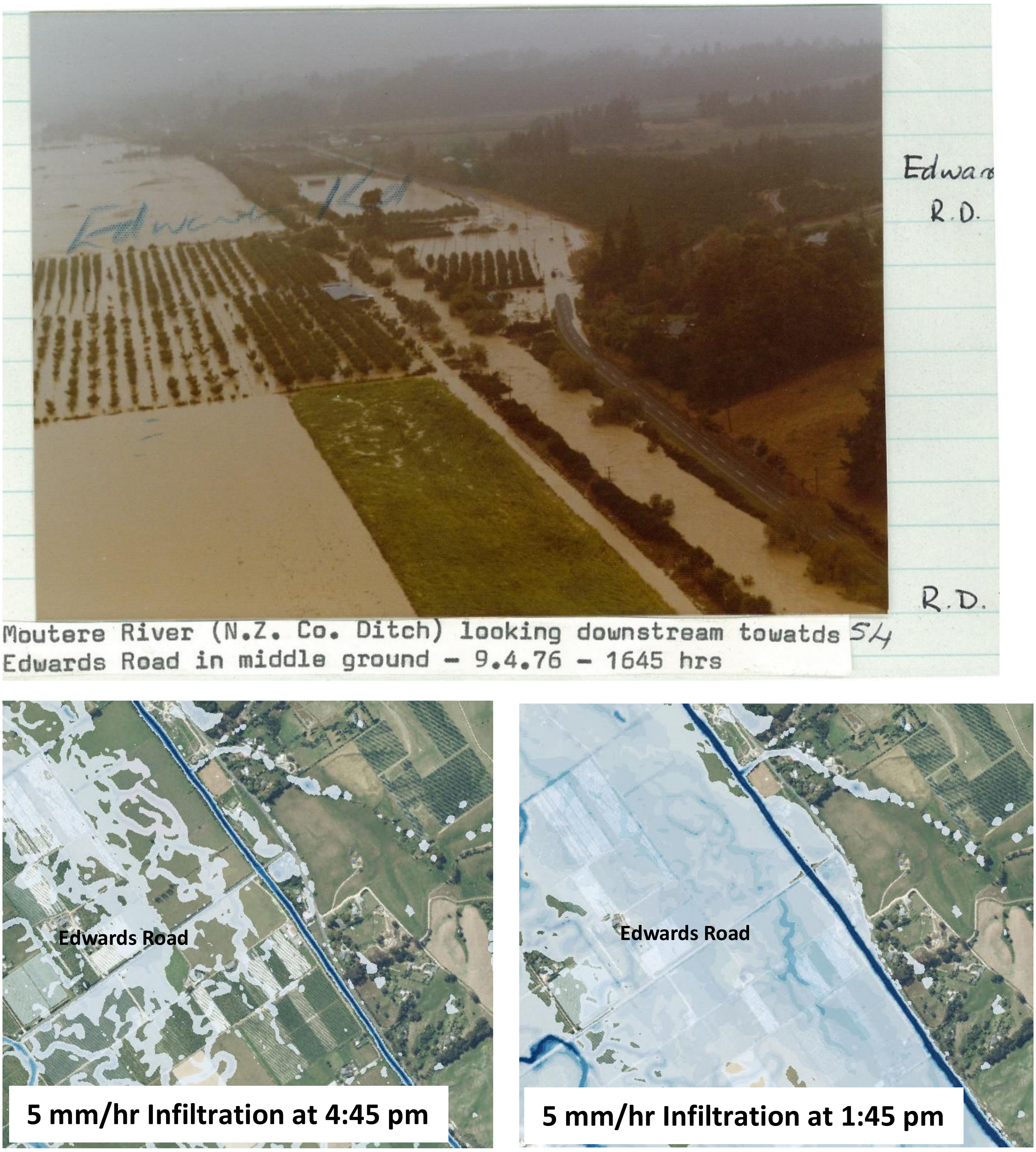

Figure 15: Aerial photograph showing Moutere River flood extent and modelled flood extent assuming 5 mm/hr infiltration around the NZ Company Ditch looking downstream towards Edwards Road during flood event on 9 April 1976

The model was run using daily rainfall data recorded between 6pm on 8 April 1976 and 6pm on 9 April 1976. This rainfall was then distributed on an hourly basis based on an average hourly rainfall analysis of three surrounding rainfall recorders. Simulations were run for infiltration rates of 5 mm/hr, 8 mm/hr and 10 mm/hr. The resulting flood extents for each of these events in the location that each photograph was taken are provided in Appendix C.

The modelled flood extents for each of these simulations were significantly less than that shown in the photographs at 4:45pm. However, the modelled flood extent at the peak of the storm (1:45 pm) appeared to closely match the flood extent shown in the photographs.

For this event, the modelled flood extent that most closely matched the photographs was the simulation adopting an infiltration rate of 5 mm/hr. The flood extent for this model simulation is shown in Figures 13, 14 and 15 alongside the aerial photographs.

The requirement for different modelled infiltration rates for the validation of the 2016 and 1976 event may be the result of longer term antecedent conditions. It is noted that the two years preceding the April 1976 event had a total rainfall of 2,549.8mm, whereas the two years preceding March 2016 had a total rainfall of 1927.8mm. This could mean that the catchment was able to absorb more water in 2016 and hence the requirement of a higher modelled infiltration rate.

5.2.3 9 July 1983 flood event

A GIS shape file was received from TDC which documents the debris lines (i.e., peak flood levels) that occurred during the July 1983 event. Similar to the 1976 modelling, modelled inundation results using 5mm/hr infiltration appear to match well with the recorded debris lines along the valley floor. Total rainfall for the two years preceding the July 1983 event were somewhat similar to 1974 with total rainfall of 1808.8mm. Results for the recorded debris lines and modelled results using 5mm/hr infiltration are present in Figure 16.

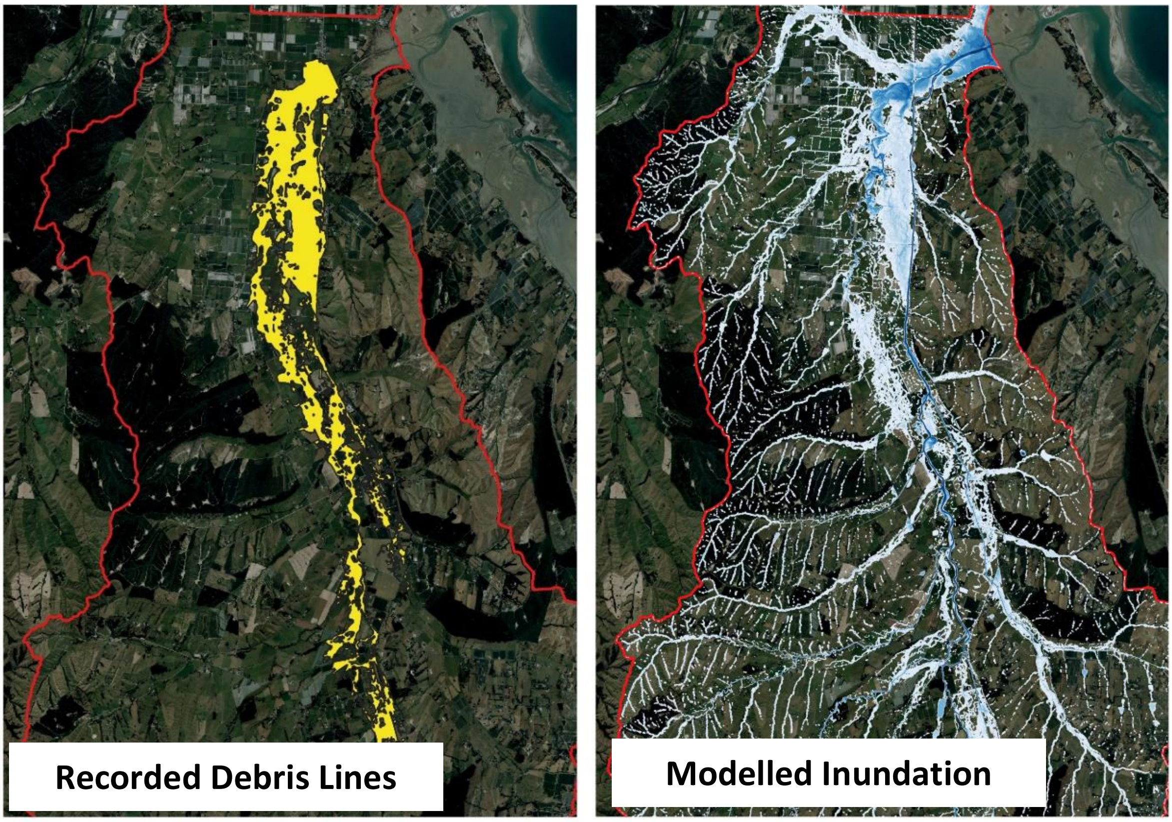

Figure 16: Recorded debris lines showing Moutere River flood extent and modelled flood extent assuming 5 mm/hr infiltration during flood event on 9 July 1983

5.2.4 Discussion of model validation simulations

Based on the above results, the following can be concluded:

- Modelling results using a constant 11mm/hr infiltration and the application of recorded rainfall appear to match well with photographs taken from the air during the March 2016 flood event;
- A reduced modelled infiltration rate of 5mm/hr was required to make peak modelled results match appropriately with aerial photographs taken at the estimated peak time during the April 1976 event;
- Similar to the April 1976 modelled event, the July 1983 required a modelled infiltration rate of 5mm/hr to ensures the modelled peak inundation results matched up with the recorded debris lines captured following the event;
- Antecedent conditions in the catchment are critical, and likely to have an impact on overall flood depth;
- Taking all validation model runs into account, an assumed infiltration rate of 7.5 mm/hr was adopted for the design model simulations. Additional sensitivity model runs were carried using infiltration rates of 5 mm/hr and 10 mm/hr. These results were used to create a flood level difference map, so that areas more susceptible to changes in infiltration rate (i.e., different antecedent conditions) could be identified; and
- In addition to antecedent conditions and the modelled infiltration rate, there are other factors that will cause variation between the modelled results and the actual flood extent. Of note, is the fact that no storm track was available for the modelled storm events and a ‘blanketed’ rainfall was applied across the entire catchment. In reality, there would have been variation in the rainfall distribution across the catchment, which would lead to variation between the model results and actual flood extents.

6 SIMULATION SCENARIOS

A number of model simulations were conducted to investigate various aspects of the model process. The model log attached in Appendix A provides a list of the critical simulations. All design simulations were undertaken for the critical storm duration of 6 hours. In summary, the following nine design scenarios were simulated in this hydraulic modelling exercise:

200-202 Design simulation for 0.4% AEP (1 in 250 year ARI) with climate change for infiltration rate of 5, 7.5 and 10 mm/hr

203-205 Design simulation for 1% AEP (1 in 100 year ARI) with climate change for infiltration rate of 5, 7.5 and 10 mm/hr

206-208 Design simulation for 2% AEP (1 in 50 year ARI) with climate change for infiltration rate of 5, 7.5 and 10 mm/hr

These simulation scenarios consisted of three main design runs (201, 204 and 207), with a design infiltration of 7.5 mm/hr. The additional simulations were undertaken to assess sensitivity to changes in the infiltration rate.

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7 ASSESSMENT OF MODEL CONFIDENCE

7.1 Sensitivity Testing

Sensitivity testing was conducted in order to assess the impact of varying the Manning's roughness values and infiltration rates. Sensitivity testing of the Manning's roughness values was performed on the 1% AEP 6hr design event with climate change. The following scenarios were tested:

- Increase bed roughness by 10%
- Decrease bed roughness by 10%

Sensitivity testing of the modelled infiltration rates was also undertaken for all three design events (i.e., 0.4, 1 and 2% AEP) for the critical 6 hour duration and included climate change. For each design event the modelled infiltration rate of 7.5 mm/hr was varied as follows:

- Increase infiltration rate to 10 mm/hr
- Decrease infiltration rate to 5 mm/hr

7.2 Sensitivity Testing Results

7.2.1 Bed Roughness

Appendix D provides flood maps showing the flood depth for the bed roughness sensitivity simulations. A flood map showing the change in level between these two simulations is also provided.

The results showed that increasing or decreasing the roughness values by 10% did not have a significant impact on flood depth. The flood depth difference map showed that flood levels typically varied between 25 mm and 100 mm across the majority of the catchment between a scenario where the bed roughness is decreased by 10% compared to the design simulation and a scenario where the bed roughness is increased by 10%. However, there are some areas throughout the catchment that are more sensitive to changes in bed roughness. In these locations the variation in flood depth between the two scenarios is in the range of 100-150 mm.

7.2.2 Infiltration Rates

Appendix E provides the flood maps showing the changes in the flood level when the infiltration rate is increased from 5 mm/hr to 10 mm/hr for each of the design simulation events.

The maps illustrate areas that are more sensitive to changes in the infiltration rate and can be used to help apply appropriate freeboard when setting minimum floor levels. The most significant changes in flood level occur on the floodplain downstream of Main Road Lower Moutere.

Changes in flood level are most significant in the 2% AEP event. The greatest increase in flood level in this event reaches over 550 mm around the area where the Moutere River discharges into the Moutere Inlet. The maximum increase in flood level across the majority of the area downstream of Main Road Lower Moutere in the 1% AEP event is 350-400 mm with a few small areas reaching 400-450 mm. The increase is even less pronounced in the 0.4% AEP event with a maximum increase in flood level of 250-300 mm across the majority of the area downstream of Main Road Lower Moutere. In this scenario there are a few small areas where the increase in flood level reaches 300-350 mm.

Across the remainder of the catchment the maximum increase in flood level as a result of increasing the infiltration rate from 5 mm/hr to 10 mm/hr is 250-300 mm. Like, the area downstream of Main Road Lower Moutere, the size of the increase in flood level is less significant in the larger events. The results also show that the land on the western side of the lower valley floor appears to be more susceptible to variation in infiltration than the land on the east.

These results show, that the underlying antecedent conditions, and the resulting infiltration rate can have a significant impact on the flood level within the catchment. It is recommended that the results of these scenarios be used to apply additional freeboard in areas that have been identified as being sensitive to changes in the infiltration rate.

8 RESULTS

8.1 Flood Depth

The purpose of this modelling exercise was to establish expected flood depths/levels throughout the Moutere Catchment. Appendix F provides the flood maps showing modelled flood depth across the catchment for the 2%, 1% and 0.4% AEP design storm events.

The results show that essentially the entire valley floor floodplain area gets flooded in the design events. Therefore, the setting of appropriate floor levels will be critical for future development within the catchment. The flood level information generated by this modelling exercise can be translated into required floor levels for future development within the Moutere catchment.

8.2 Flood Velocities

Appendix G provides a flood map showing predicted flood velocities for the 1% AEP critical duration storm. This map highlights areas within the catchment that are prone to higher flood velocities.

The map identifies several areas in the catchment of high flood velocity, including areas where the velocity exceeds 5 m/s. This information could be useful for informing future land use policy. For example, the hill country in the upper western region of the catchment has some steeper country that results in velocities upwards of 5m/s. Areas like this will have a high tendency to shed unvegetated sediment during large runoff events; therefore, practices like harvesting forestry in these areas would be a less desirable activity and may be better suited to other locations within the catchment. The flood velocity mapping could be used to identify areas where certain land use may be more appropriate than others and make decisions relating to future land use and planning.

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9 CONCLUSIONS

e2Environmental Ltd. (e2) conducted a flood modelling exercise to establish expected flood depths / levels throughout the catchment. The intent is that the final agreed and accepted levels from this modelling exercise will be translated into required floor levels for any future development within the catchment.

A two-dimensional model using DHI's MIKE 21 software package was developed for the catchment. Key aspects of the model development process are as follows:

- A direct rainfall method (DRM) was adopted for all model simulations;
- Initial model simulations were undertaken to identify the critical storm duration;
- The model was validated against historic rainfall events for which aerial flood extents were available;
- Sensitivity testing was undertaken on model input parameters (bed roughness and infiltration rates) to confirm the level of certainty in the modelling results presented in this study;
- Design model runs were undertaken for the 2%, 1% and 0.4% AEP events;
- Flood maps showing modelled flood depth were produced for each of the design event. A flood map showing modelled flood velocity for the 1% AEP event was also produced; and
- Climate change (RCP8.5 for the period 2081-2100) was applied to all design rainfall events.

The following conclusions can be drawn from the model development and results:

- Overall, a 6-hour duration design storm is considered most appropriate to capture inundation effects across the Moutere Catchment. However, it is recommended that a 100 mm sensitivity freeboard allowance should be considered with any results to account for real future storms with durations either side of the 6-hour duration;
- Infiltration rates were considered the most uncertain input parameter in this modelling exercise. Model validation runs showed that the underlying antecedent conditions and resulting infiltration capacity can have a significant impact on the flood level within the catchment;
- Based on the validation model runs an infiltration rate of 7.5 mm/hr is considered an average infiltration rate for the Moutere catchment;
- Additional sensitivity simulations were run for each design event at infiltration rates of 5 mm/hr and 10 mm/hr. The results of these simulations were used do produce a flood depth variation map in order to identify areas within the catchment that are more sensitive to changes in infiltration rate. Given, the sensitivity to this parameter it is recommended that the results of this sensitivity testing be used to apply additional freeboard to required minimum floor levels in areas that have been identified as being sensitive to changes in the infiltration rate;

- Sensitivity testing of bed roughness values showed that flood levels did not vary significantly when modelled roughness values were altered;
- Flood depth maps produced for the design events shows that the entire valley floor floodplain area is affected by flooding; and
- Flood velocity mapping identifies areas within the catchment that are prone to high flood velocities, in some cases greater than 5 m/s. This information could be useful for informing future land use and planning.

APPENDICES

APPENDIX A – Model Log

APPENDIX B – Critical Storm Duration Analysis Results

APPENDIX C – Infiltration Sensitivity Testing Results

APPENDIX D – Bed Roughness Sensitivity Results

APPENDIX E – Infiltration Sensitivity Results

APPENDIX F – Design Flood Depth Results

APPENDIX G – Design Velocity Results for 1% AEP

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Upper Motueka River Model Development
Tasman District Council

APPENDIX A – Model Log

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Moutere Modelling Log

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Counter	River / Catchment	Land Use	Rainfall Scenario AEP	Rainfall Scenario Duration	Downstream Boundary Conditions	Climate Change	Type (Base, Certainty, Option)	File Name	Comment
0	Moutere	prelim					Base		
1	Moutere	prelim					Base		
2	Moutere	prelim					Base		
3	Moutere	prelim					Base		
4	Moutere	prelim					Base		
5	Moutere	prelim					Base		
6	Moutere	prelim					Base		
7	Moutere	prelim					Base		
10	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	010_Moutere_Existing_Validation_23Mar2016	23Mar2016 event with 3mm/hr infiltration
11	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	011_Moutere_Existing_Validation_23Mar2016_10mmperhrInfiltration	self-explanatory from file name
12	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	012_Moutere_Existing_Validation_23Mar2016_15mmperhrInfiltration	self-explanatory from file name
13	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	013_Moutere_Existing_Validation_23Mar2016_11mmperhrInfiltration	self-explanatory from file name
14	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	014_Moutere_Existing_Validation_23Mar2016_12mmperhrInfiltration	self-explanatory from file name
15	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	015_Moutere_Existing_Validation_23Mar2016_13mmperhrInfiltration	self-explanatory from file name
16	Moutere	Existing	9Apr1976	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	016_Moutere_Existing_Validation_9April1976_10mmperhrInfiltration	self-explanatory from file name
17	Moutere	Existing	9Apr1976	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	017_Moutere_Existing_Validation_9April1976_5mmperhrInfiltration	self-explanatory from file name
18	Moutere	Existing	9Apr1976	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	018_Moutere_Existing_Validation_9April1976_8mmperhrInfiltration	self-explanatory from file name
19	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	019_Moutere_Existing_Validation_23Mar2016_5mmperhrInfiltration	self-explanatory from file name
20	Moutere	Existing	23Mar2016	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	020_Moutere_Existing_Validation_23Mar2016_8mmperhrInfiltration	self-explanatory from file name
21	Moutere	Existing	9Jul1983	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	021_Moutere_Existing_Validation_9Jul1983_10mmperhrInfiltration	self-explanatory from file name
22	Moutere	Existing	9Jul1983	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	022_Moutere_Existing_Validation_9Jul1983_8mmperhrInfiltration	self-explanatory from file name
23	Moutere	Existing	9Jul1983	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	023_Moutere_Existing_Validation_9Jul1983_12mmperhrInfiltration	self-explanatory from file name
24	Moutere	Existing	9Jul1983	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	024_Moutere_Existing_Validation_9Jul1983_3mmperhrInfiltration	self-explanatory from file name
25	Moutere	Existing	9Jul1983	Measured duration	Recorded Tide Signal + 35min for lag	No CC	Validation	025_Moutere_Existing_Validation_9Jul1983_5mmperhrInfiltration	self-explanatory from file name
100	Moutere	Existing	100yr	4hr	1.36mMeanTideCC	RCP 8.5 2100	Duration Sensitivity	100_Moutere_Existing_DurationSensitivity_100yr_4hr_1pt36mMeanTideCC	Design conditions with higher resoltuion mesh to check 4hr duration peak flooding
101	Moutere	Existing	100yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Duration Sensitivity	101_Moutere_Existing_DurationSensitivity_100yr_6hr_1pt36mMeanTideCC	Design conditions with higher resoltuion mesh to check 6hr duration peak flooding
102	Moutere	Existing	100yr	9hr	1.36mMeanTideCC	RCP 8.5 2100	Duration Sensitivity	102_Moutere_Existing_DurationSensitivity_100yr_9hr_1pt36mMeanTideCC	Design conditions with higher resoltuion mesh to check 9hr duration peak flooding
103	Moutere	Existing	100yr	12hr	1.36mMeanTideCC	RCP 8.5 2100	Duration Sensitivity	103_Moutere_Existing_DurationSensitivity_100yr_12hr_1pt36mMeanTideCC	Design conditions with higher resoltuion mesh to check 12hr duration peak flooding
200	Moutere	Existing	50yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	200_Moutere_Existing_Design_50yr6hr_5mmperhrInfiltration	Lower infiltration sensitivity run
201	Moutere	Existing	50yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	201_Moutere_Existing_Design_50yr6hr_7pt5mmperhrInfiltration	Main Design Run
202	Moutere	Existing	50yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	202_Moutere_Existing_Design_50yr6hr_10mmperhrInfiltration	Higher infiltration sensitivity run
203	Moutere	Existing	100yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	203_Moutere_Existing_Design_100yr6hr_5mmperhrInfiltration	Lower infiltration sensitivity run
204	Moutere	Existing	100yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	204_Moutere_Existing_Design_100yr6hr_7pt5mmperhrInfiltration	Main Design Run
205	Moutere	Existing	100yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	205_Moutere_Existing_Design_100yr6hr_10mmperhrInfiltration	Higher infiltration sensitivity run
206	Moutere	Existing	250yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	206_Moutere_Existing_Design_250yr6hr_5mmperhrInfiltration	Lower infiltration sensitivity run
207	Moutere	Existing	250yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	207_Moutere_Existing_Design_250yr6hr_7pt5mmperhrInfiltration	Main Design Run
208	Moutere	Existing	250yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Design	208_Moutere_Existing_Design_250yr6hr_10mmperhrInfiltration	Higher infiltration sensitivity run
209	Moutere	Existing	100yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Sensitivity	209_Moutere_Existing_Design_100yr6hr_7pt5mmperhrInfiltration_sens_plus10percentrough	Sensitivity run to check effects of reduced roughness on design run
210	Moutere	Existing	100yr	6hr	1.36mMeanTideCC	RCP 8.5 2100	Sensitivity	210_Moutere_Existing_Design_100yr6hr_7pt5mmperhrInfiltration_sens_minus10percentrough	Sensitivity run to check effects of increased roughness on design run

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APPENDIX B – Critical Storm Duration Analysis Results

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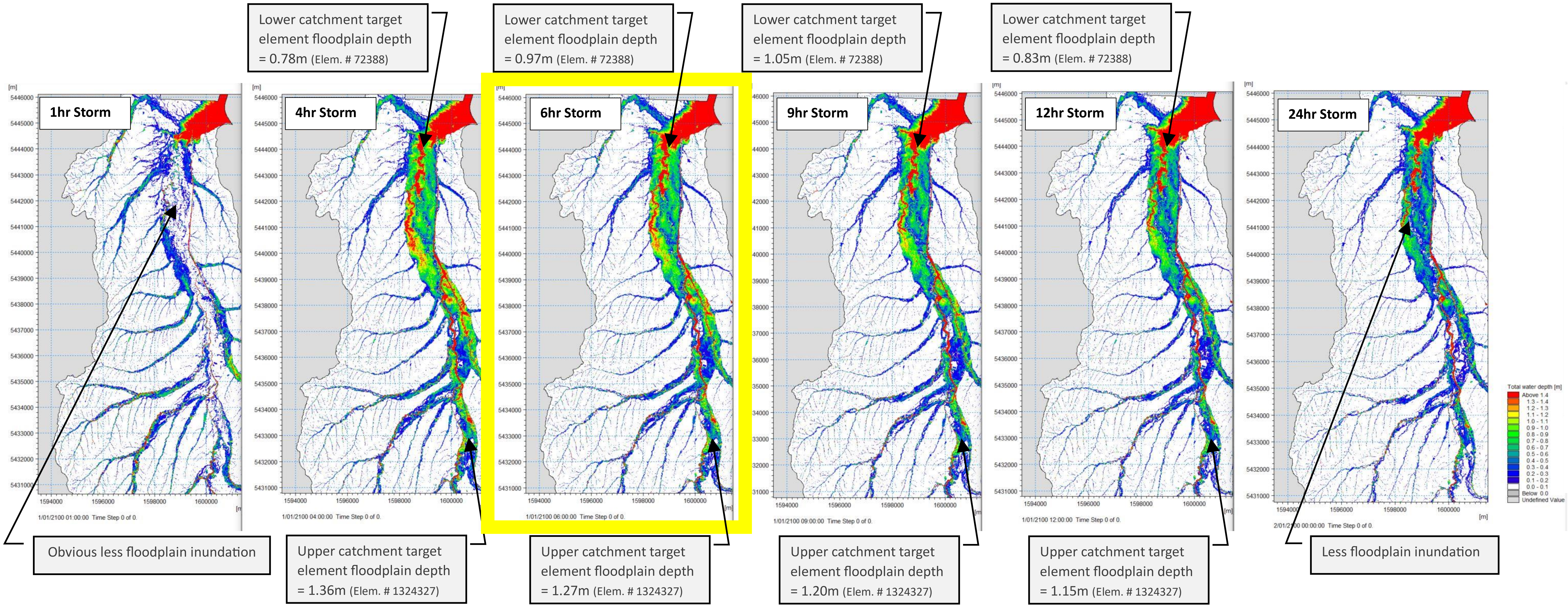
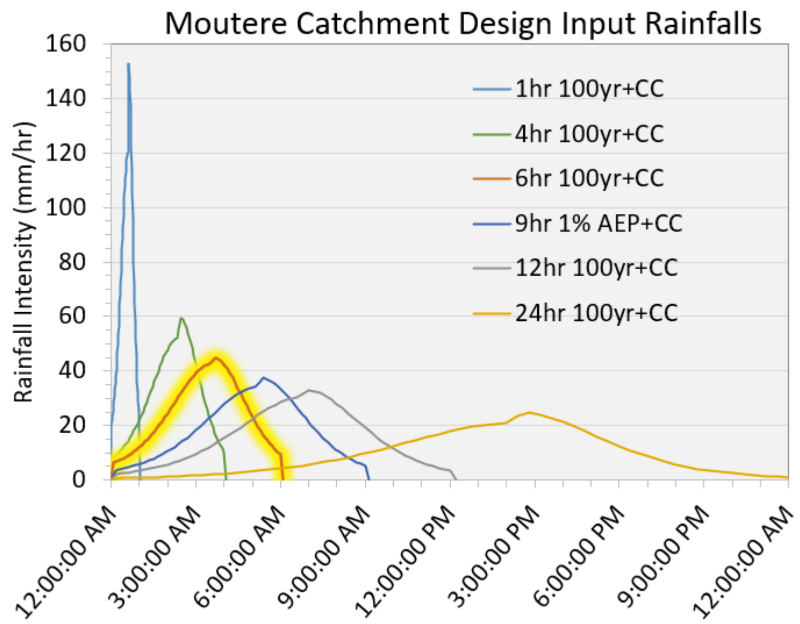
Moutere Catchment Critical Storm Analysis
Max. Inundation Results
for 1% AEP +CC (RCP8.5) Rainfall Events



NOTES:

- Analysis performed with a low resolution mesh with maximum element size of 100m^2;
- Analysis performed with no infiltration and generic Mannings n value = 0.04 across entire catchment;
- Analysis performed with constant downstream boundary level set to RL 1.282m NZVD2016;
- 1hr and 24hr storm durations show signs of less floodplain inundation when compared to the other storm durations, indicating a critical duration some duration between these extents;
- The upper Moutere catchment is more sensitive to the shorter duration events, while the lower Moutere catchment is more sensitive to the longer events up to 8-10hr in duration;
- Analysing the results above, a **6hr design duration storm event** is considered most appropriate to capture inundation effects in the overall Moutere catchment; and
- A caveat to the previous bullet is that a **100mm sensitivity freeboard allowance** should be considered with any results to account for real future storms with durations either side of the design 6hr duration.



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APPENDIX C – Infiltration Sensitivity Testing Results

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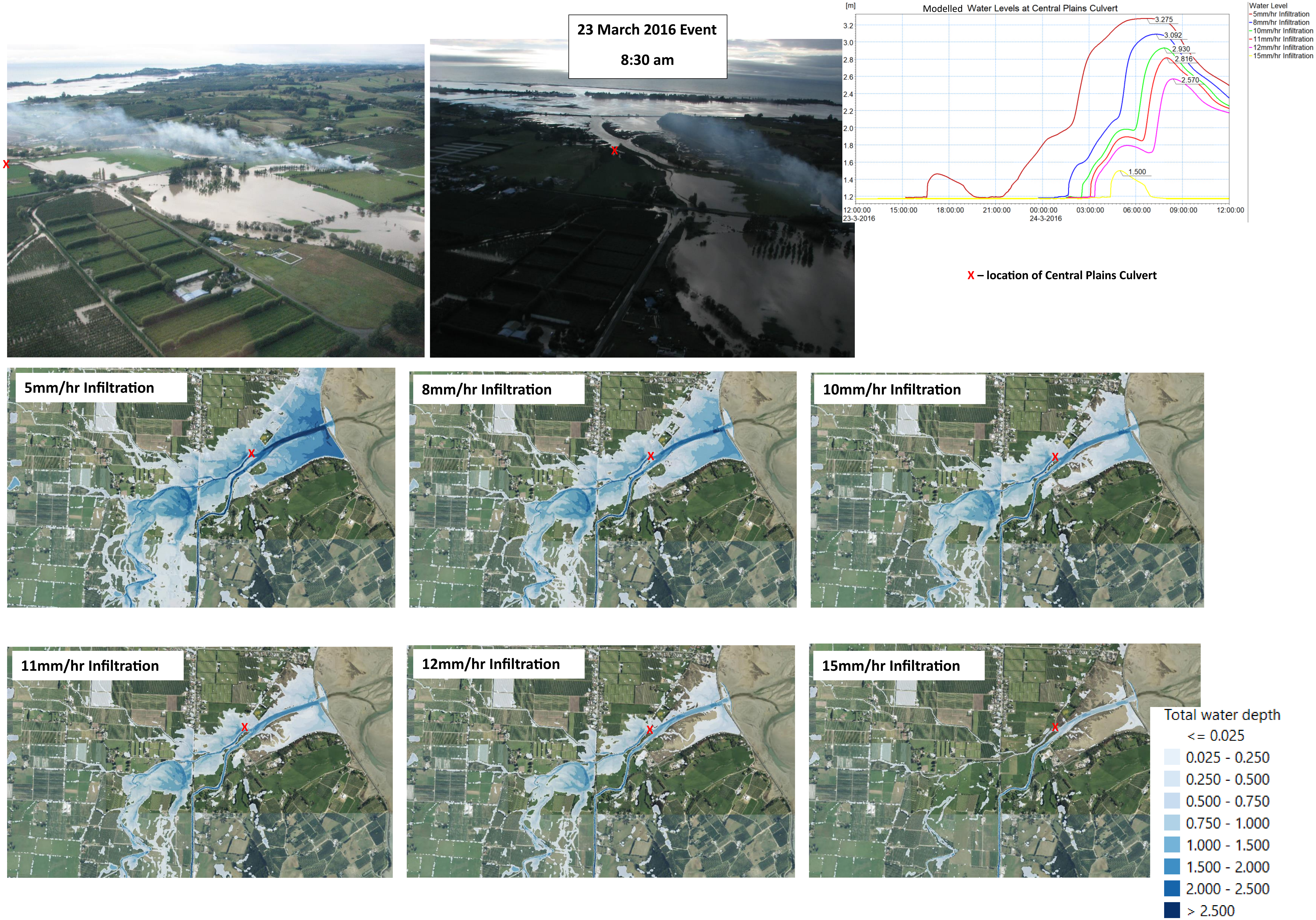
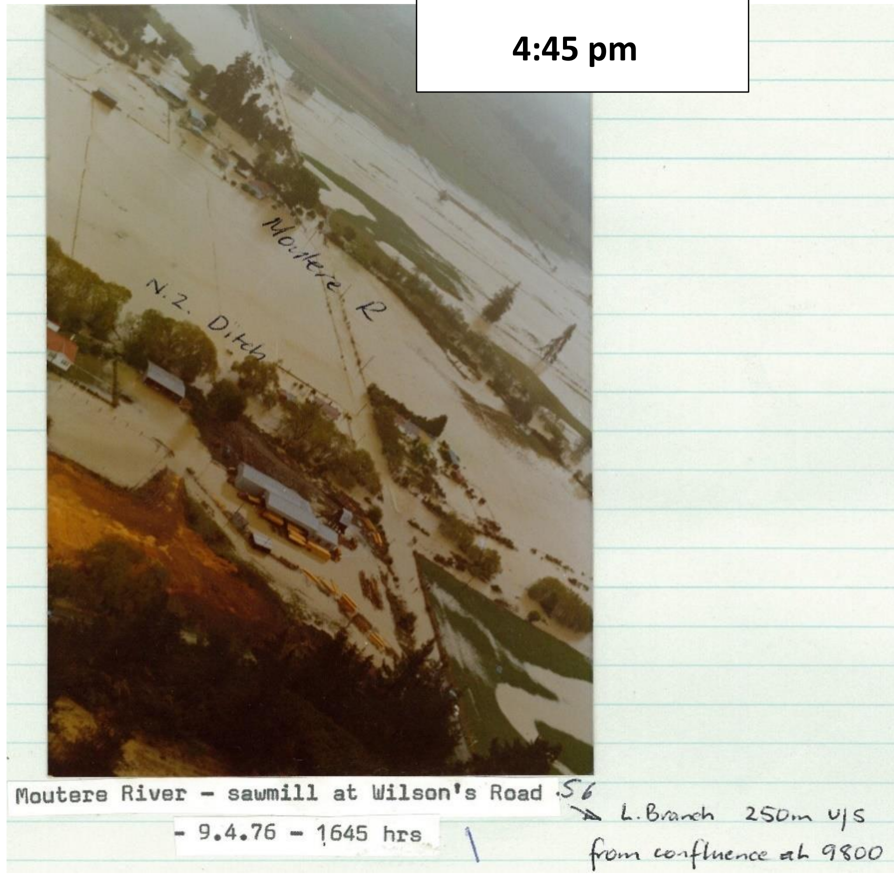
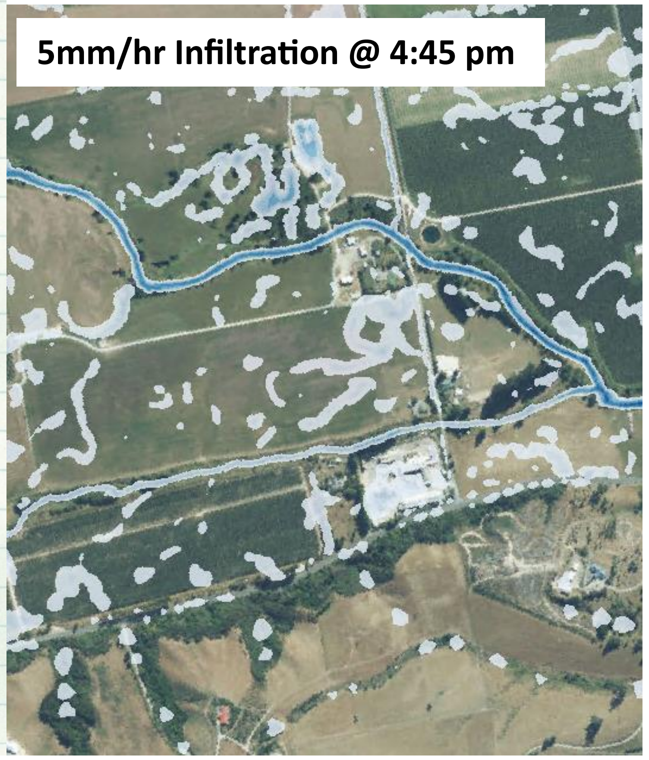
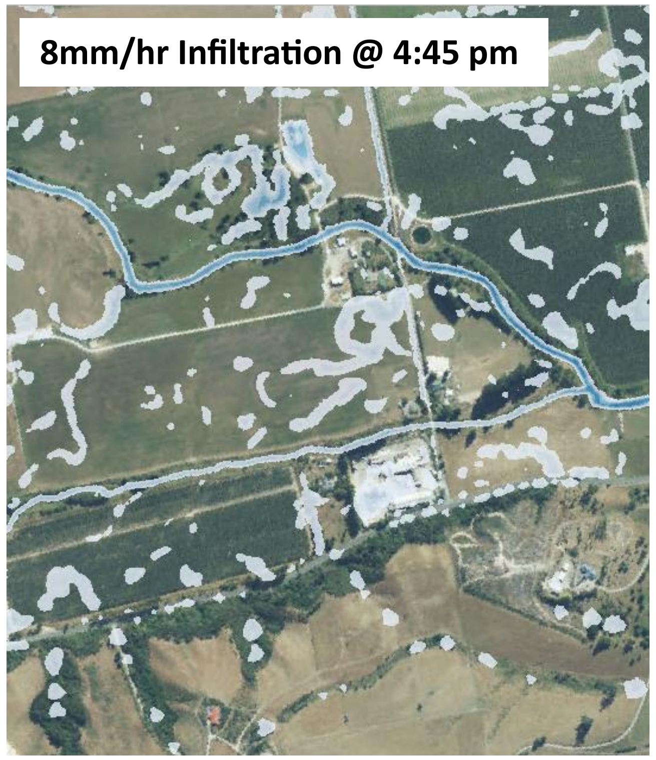

23 March 2016 Event
8:30 am
Modelled Water Levels at Central Plains Culvert
[m]
Water Level
5mm/hr Infiltration
8mm/hr Infiltration
10mm/hr Infiltration
11mm/hr Infiltration
12mm/hr Infiltration
15mm/hr Infiltration
3.275
3.092
2.930
2.816
2.570
1.500
12:00:00 23-3-2016
15:00:00
18:00:00
21:00:00
00:00:00 24-3-2016
03:00:00
06:00:00
09:00:00
12:00:00
X – location of Central Plains Culvert
5mm/hr Infiltration
8mm/hr Infiltration
10mm/hr Infiltration
11mm/hr Infiltration
12mm/hr Infiltration
15mm/hr Infiltration
Total water depth
<= 0.025
0.025 - 0.250
0.250 - 0.500
0.500 - 0.750
0.750 - 1.000
1.000 - 1.500
1.500 - 2.000
2.000 - 2.500
> 2.500

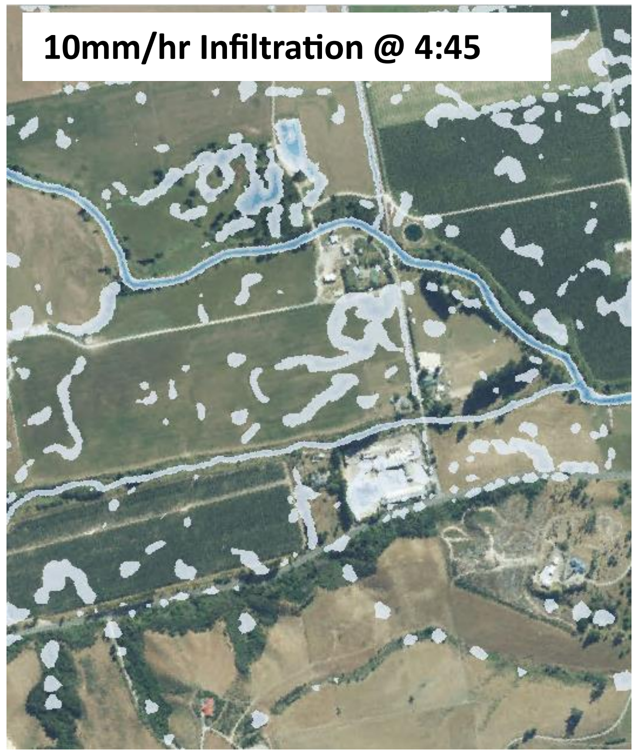
9 April 1976 Event

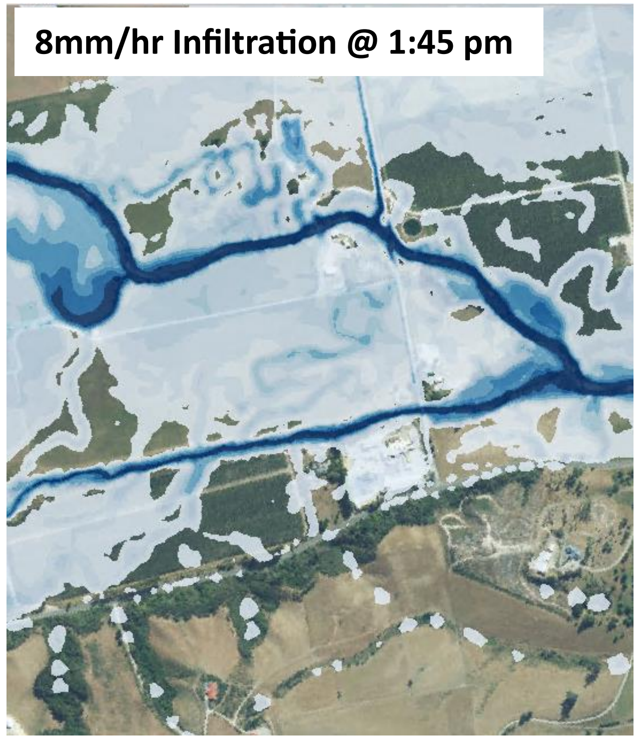
4:45 pm











e – Harakeke – Vicinity of Wills Rd looking downstream 58
– 1645 hrs.

Moutere R
R.D. 11 600


5mm/hr Infiltration @ 4:45 pm


5mm/hr Infiltration @ 1:45 pm


8mm/hr Infiltration @ 4:45 pm

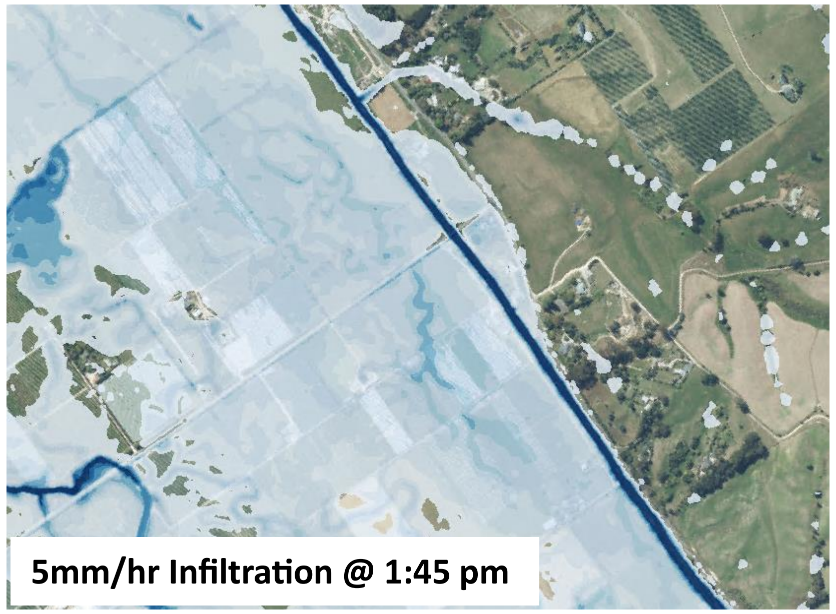

8mm/hr Infiltration @ 1:45 pm


10mm/hr Infiltration @ 4:45


10mm/hr Infiltration @ 1:45

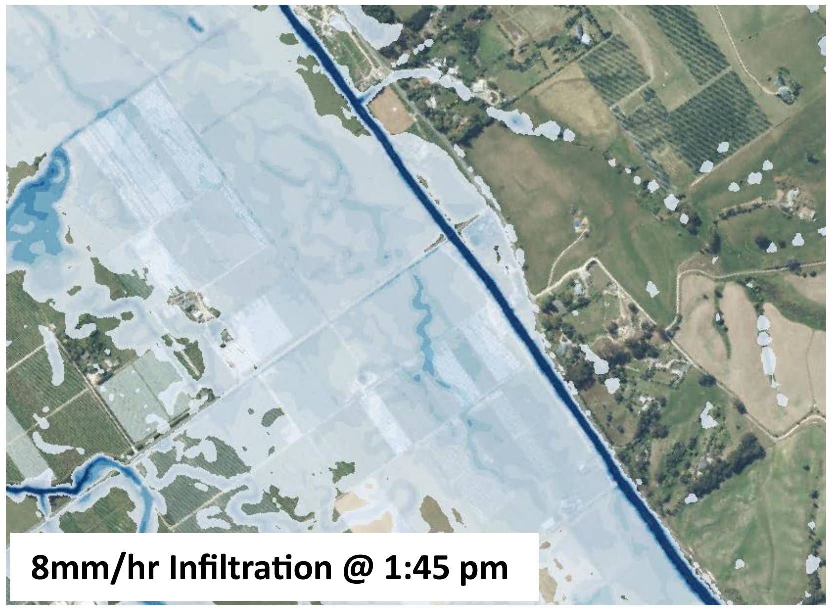
Moutere River (N.Z. Co. Ditch) looking downstream towatds Edwards Road in middle ground - 9.4.76 - 1645 hrs 54

5mm/hr Infiltration @ 4:45 pm

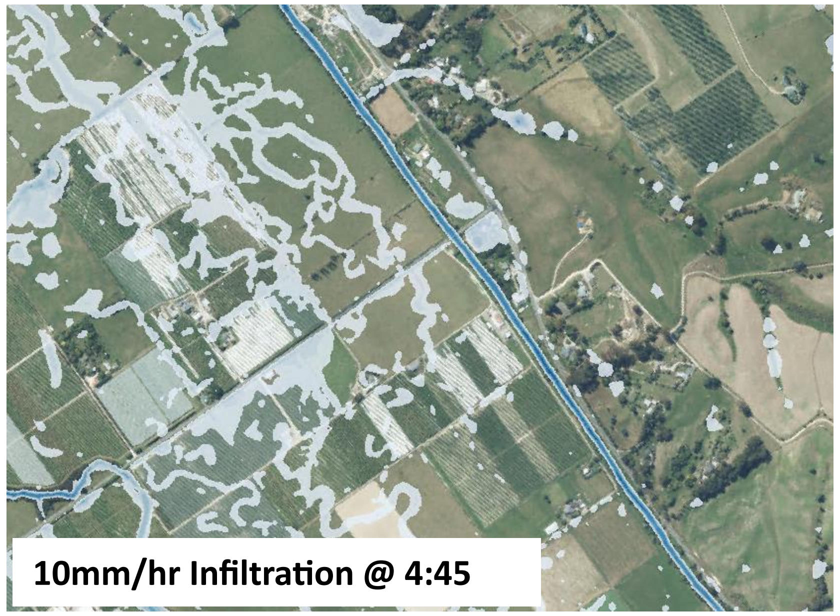


5mm/hr Infiltration @ 1:45 pm

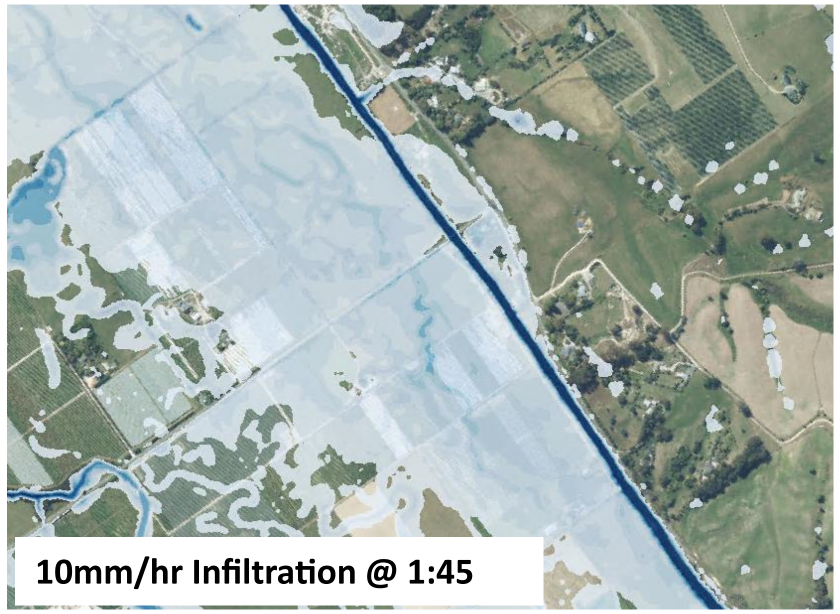
8mm/hr Infiltration @ 4:45 pm



8mm/hr Infiltration @ 1:45 pm



10mm/hr Infiltration @ 4:45



10mm/hr Infiltration @ 1:45

APPENDIX D – Bed Roughness Sensitivity Results

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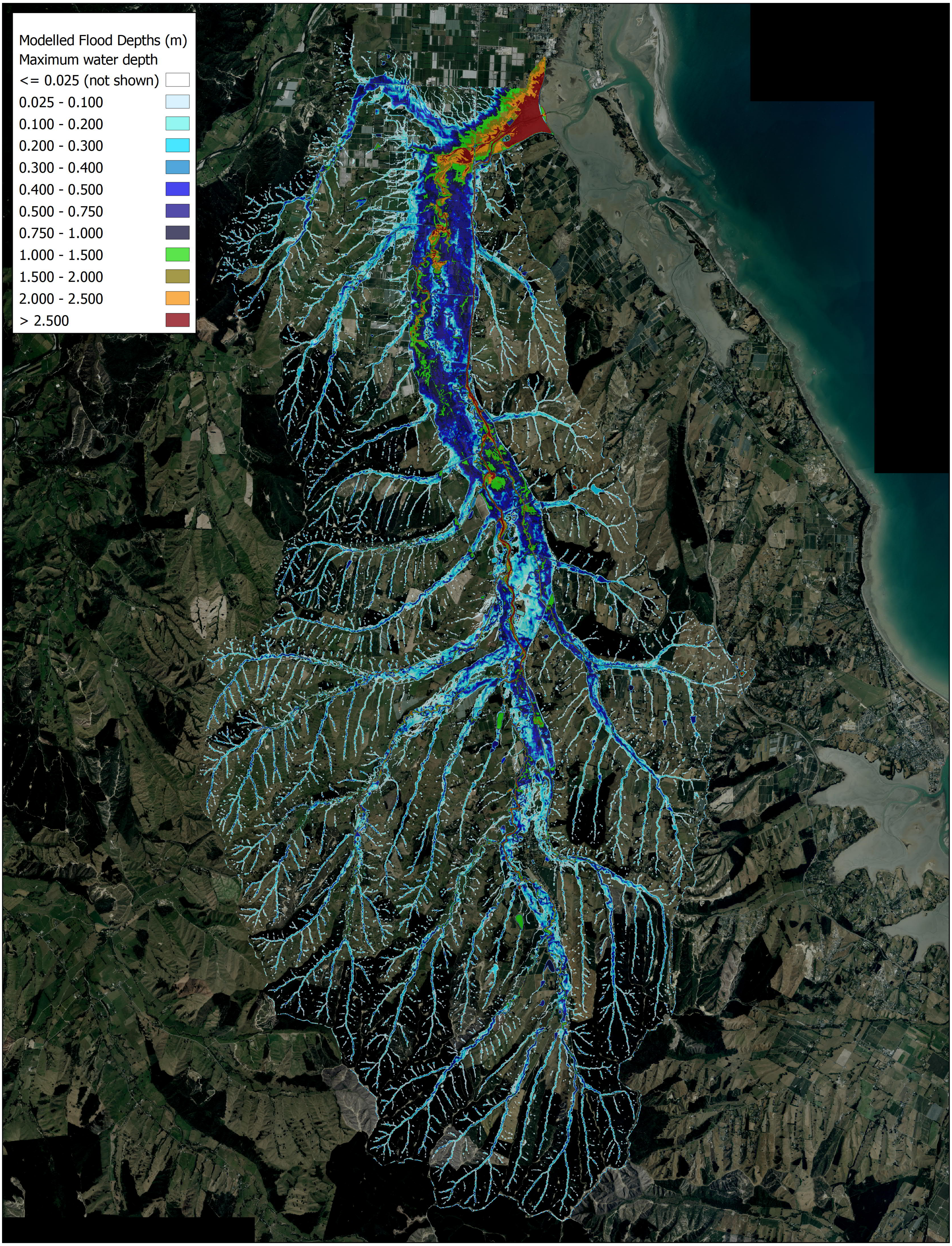

Paper Size A3

1,000 0 1,000 2,000 m

Scale: 1 : 64997 (A3)
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

e2 environmental CONSULTING CIVIL ENGINEERS

Tasman District Council
Moutere Catchment Flood Modelling

Job Number	23002
Revision	01
Date	02/11/2023

Sensitivity Simulation ~100yr 6hr Storm Event Predicted Flood Depths
RCP8.5 Climate Change Conditions out to 2100 (1% AEP)
Catchment Infiltration = 7.5mm/hr -10% Overall Bed Roughness

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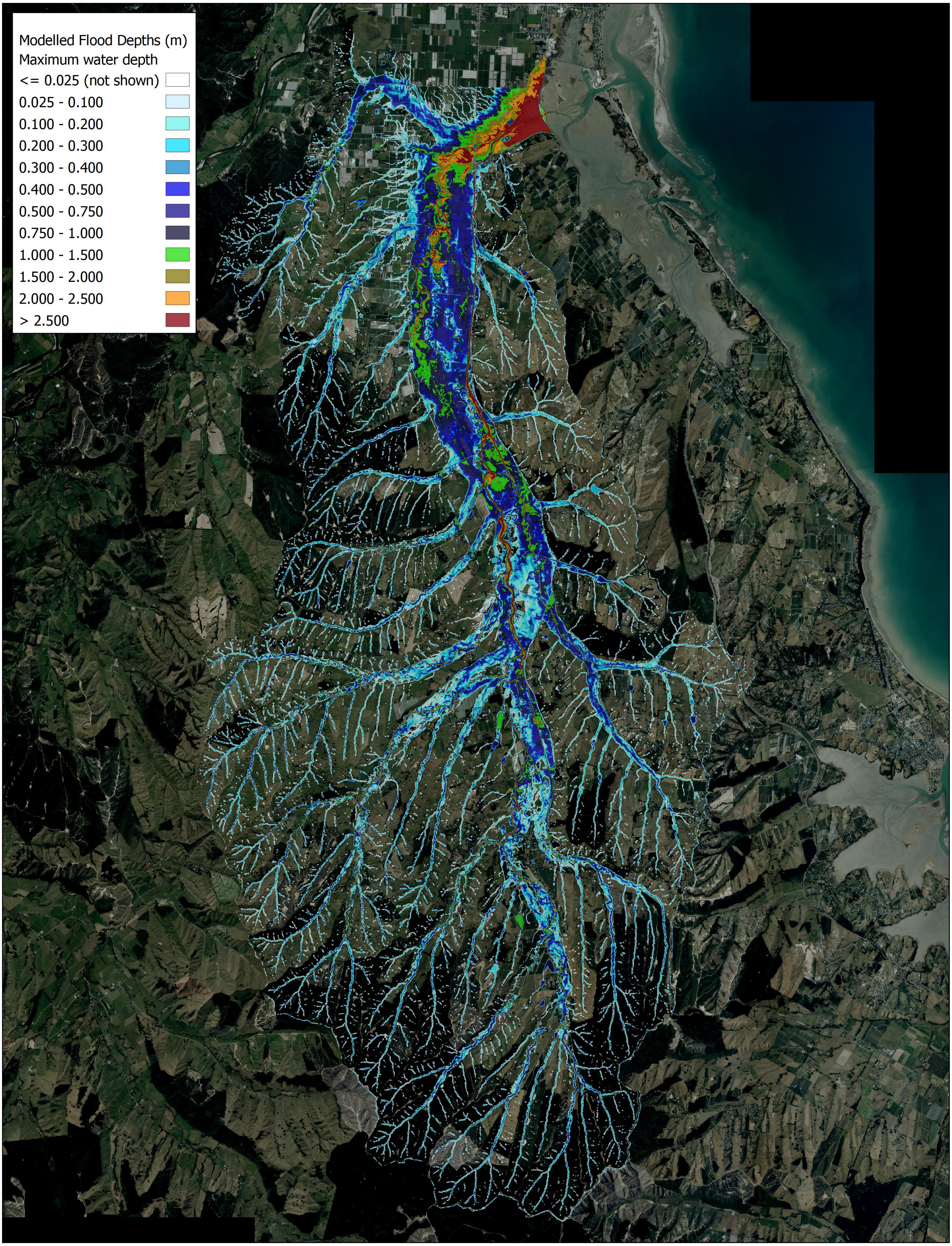

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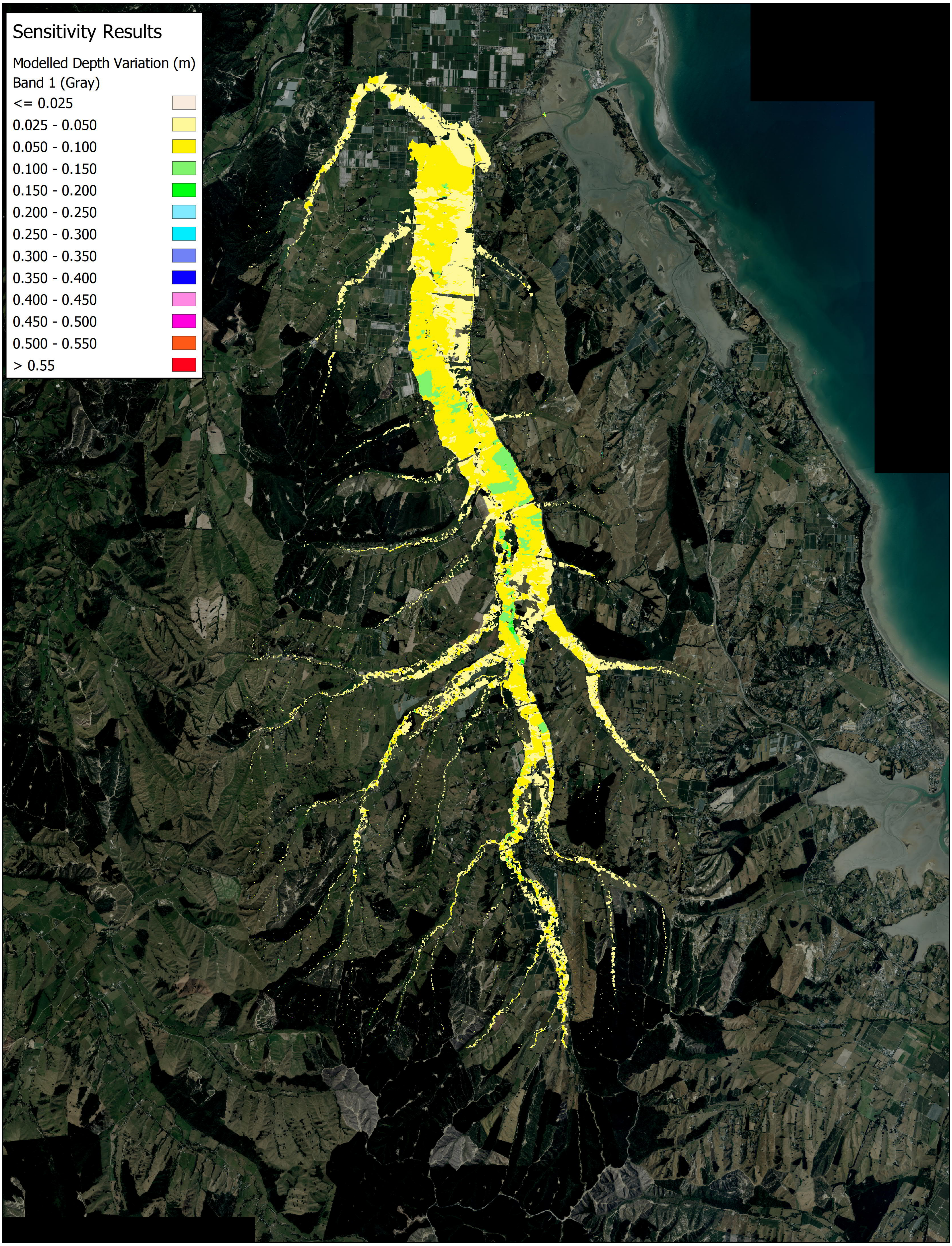
Tasman District Council
Moutere Catchment Flood Modelling

Job Number	23002
Revision	01
Date	02/11/2023

Sensitivity Simulation -~100yr 6hr Storm Event Predicted Flood Depths
RCP8.5 Climate Change Conditions out to 2100 (1% AEP)
Catchment Infiltration = 7.5mm/hr +10% Overall Bed Roughness



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(7.5mm/hr Infiltration)

Tasman District Council
Moutere Catchment Flood Modelling

Sensitivity Simulation
~100yr 6hr Storm Event RCP8.5 Climate Change Conditions to 2100 (1% AEP)
Potential Variance in Flood Depth for -10% to +10% of Design Roughness

Job Number	23002
Revision	01
Date	2/11/2023

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APPENDIX E – Infiltration Sensitivity Results

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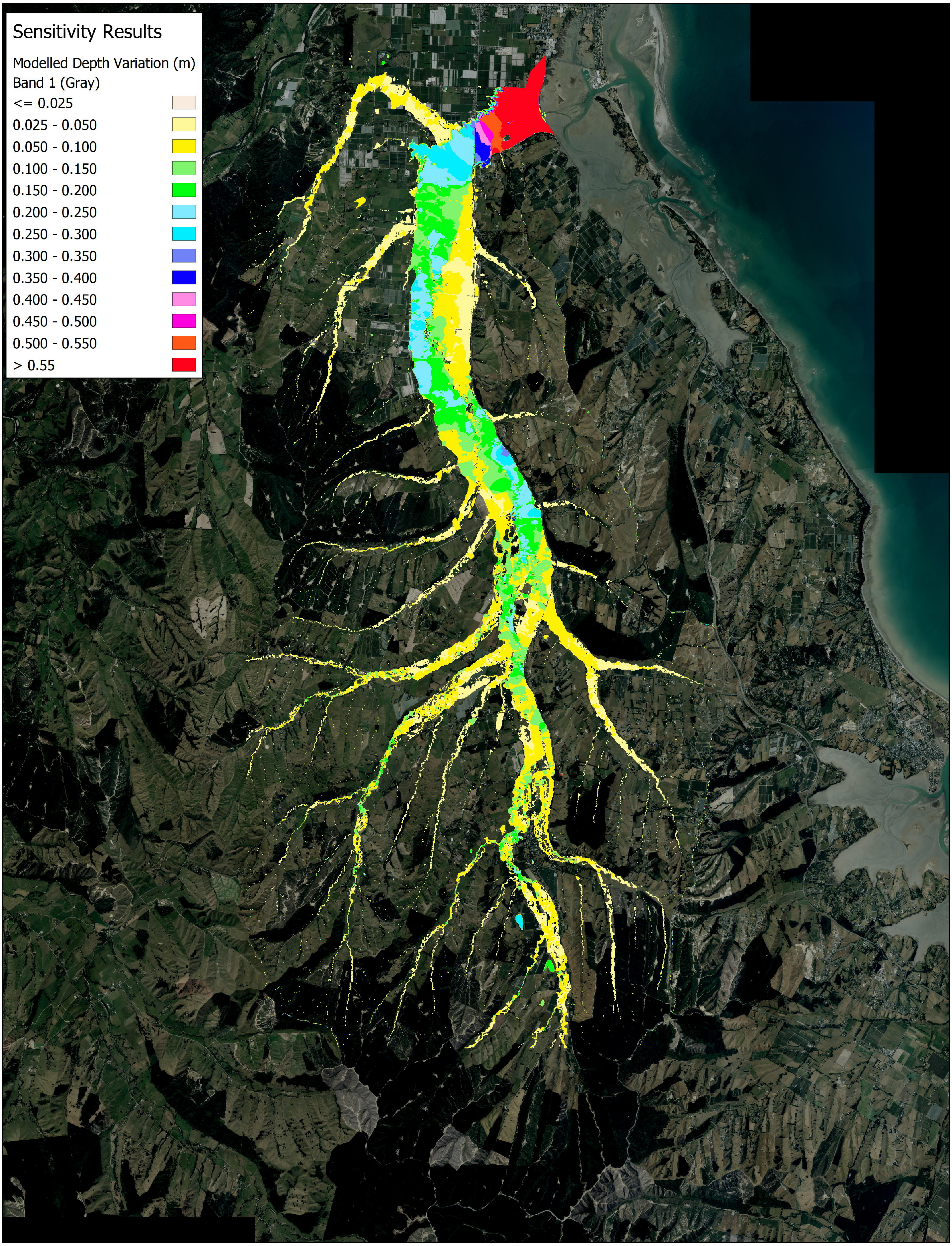

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Tasman District Council
Moutere Catchment Flood Modelling

Sensitivity Simulation
~50yr 6hr Storm Event RCP8.5 Climate Change Conditions out to 2100 (2% AEP)
Potential Variance in Flood Depth for 5mm/hr to 10mm/hr Infiltration

Job Number	23002
Revision	01
Date	02/11/2023

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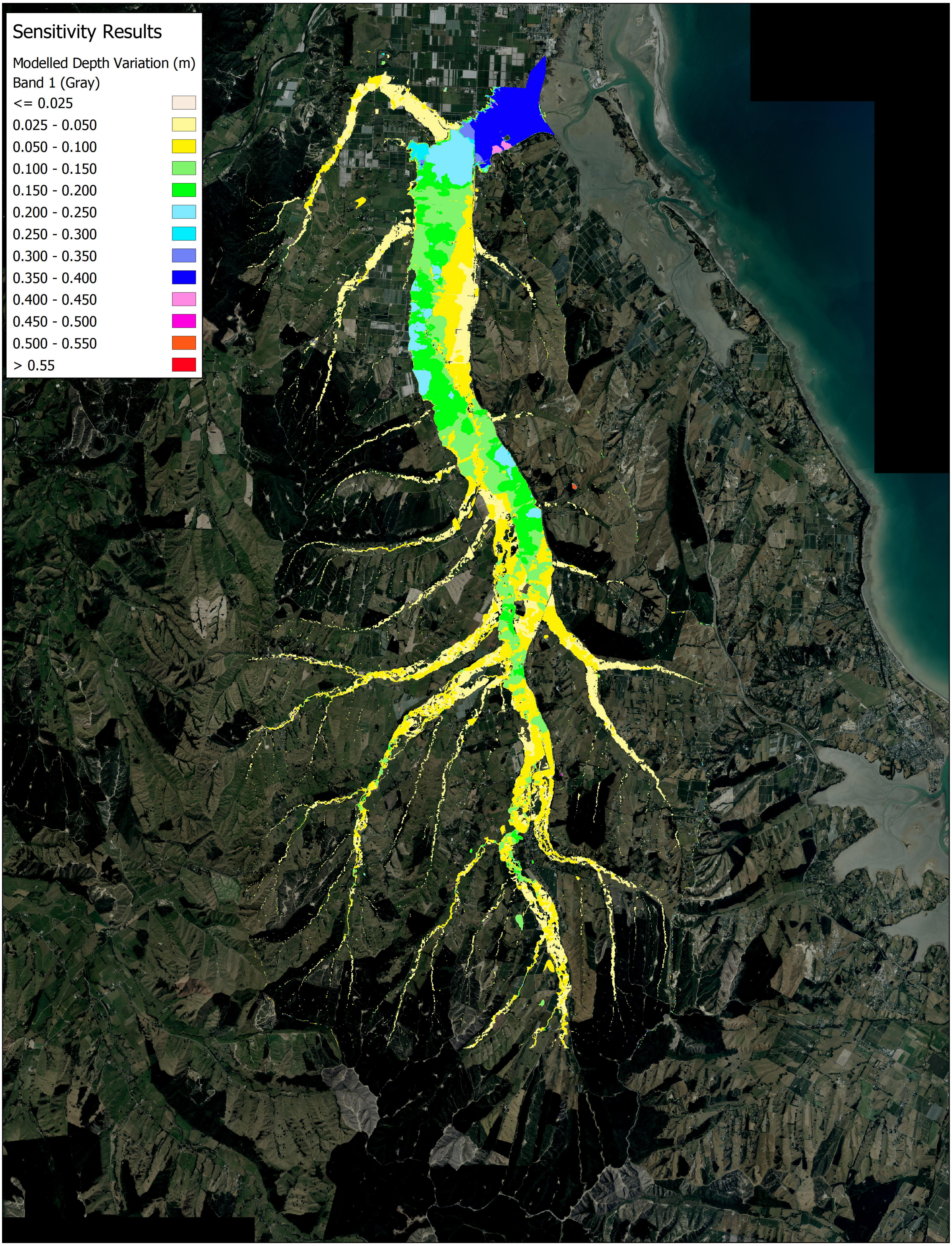

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Tasman District Council
Moutere Catchment Flood Modelling

Sensitivity Simulation
~100yr 6hr Storm Event RCP8.5 Climate Change Conditions out to 2100 (1% AEP)
Potential Variance in Flood Depth for 5mm/hr to 10mm/hr Infiltration

Job Number	23002
Revision	01
Date	02/11/2023

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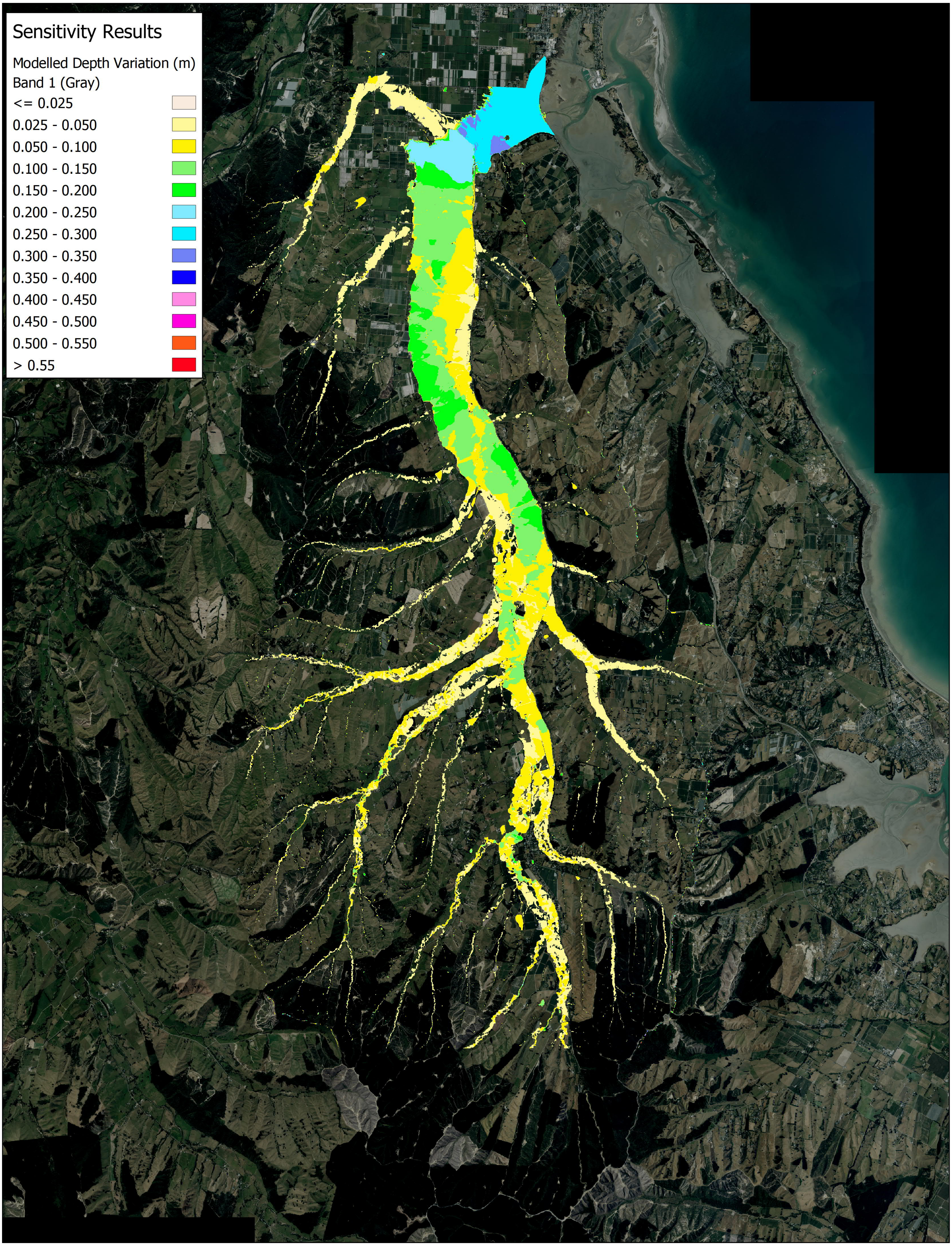

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Tasman District Council
Moutere Catchment Flood Modelling

Sensitivity Simulation
~250yr 6hr Storm Event RCP8.5 Climate Change Conditions out to 2100(0.4% AEP)
Potential Variance in Flood Depth for 5mm/hr to 10mm/hr Infiltration

Job Number	23002
Revision	01
Date	02/11/2023

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APPENDIX F – Design Flood Depth Results

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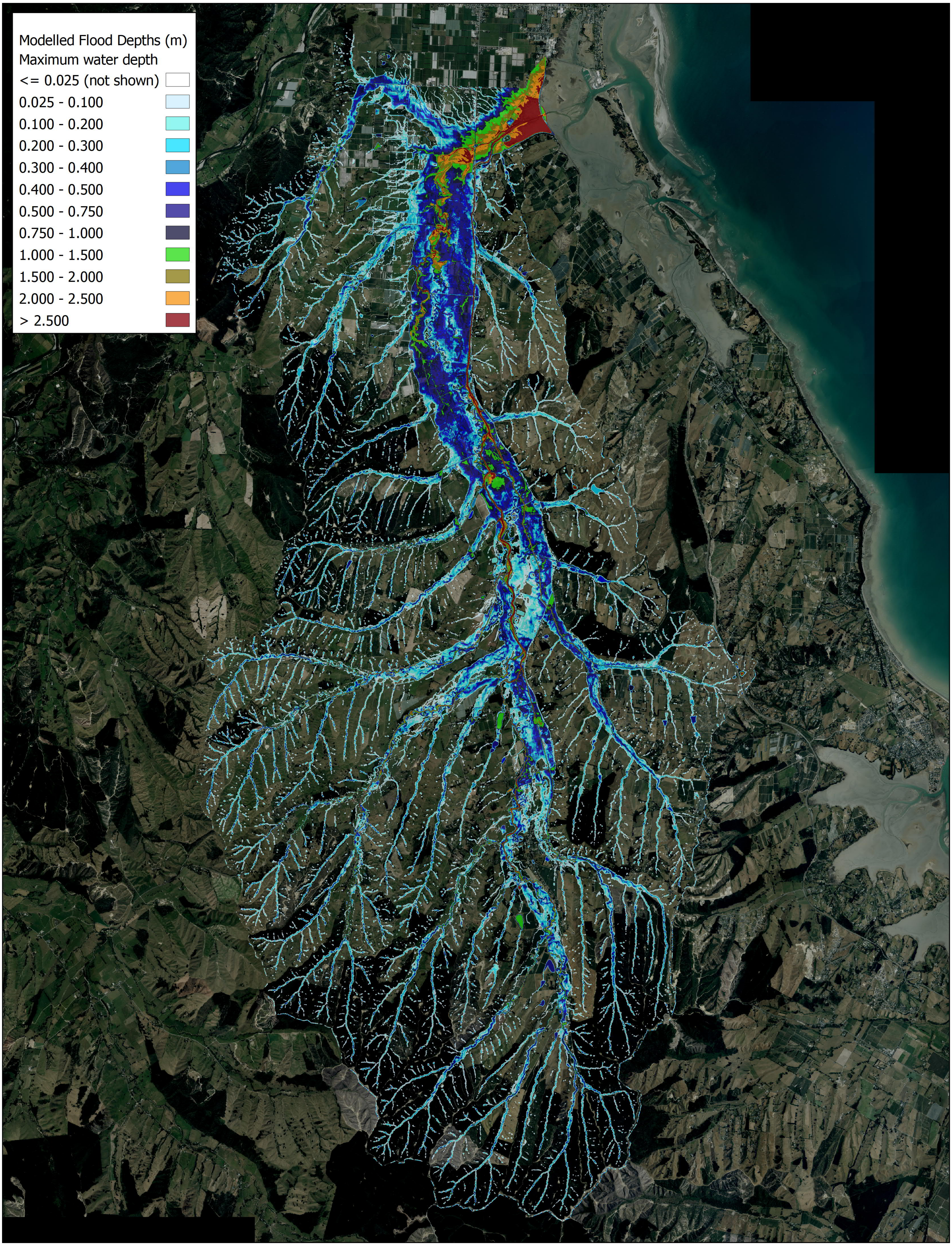

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Tasman District Council
Moutere Catchment Flood Modelling

~50yr 6hr Storm Event Predicted Flood Depths (2% AEP)
RCP8.5 Climate Change Conditions out to 2100
Catchment Infiltration = 7.5mm/hr

Job Number	23002
Revision	01
Date	02/11/2023

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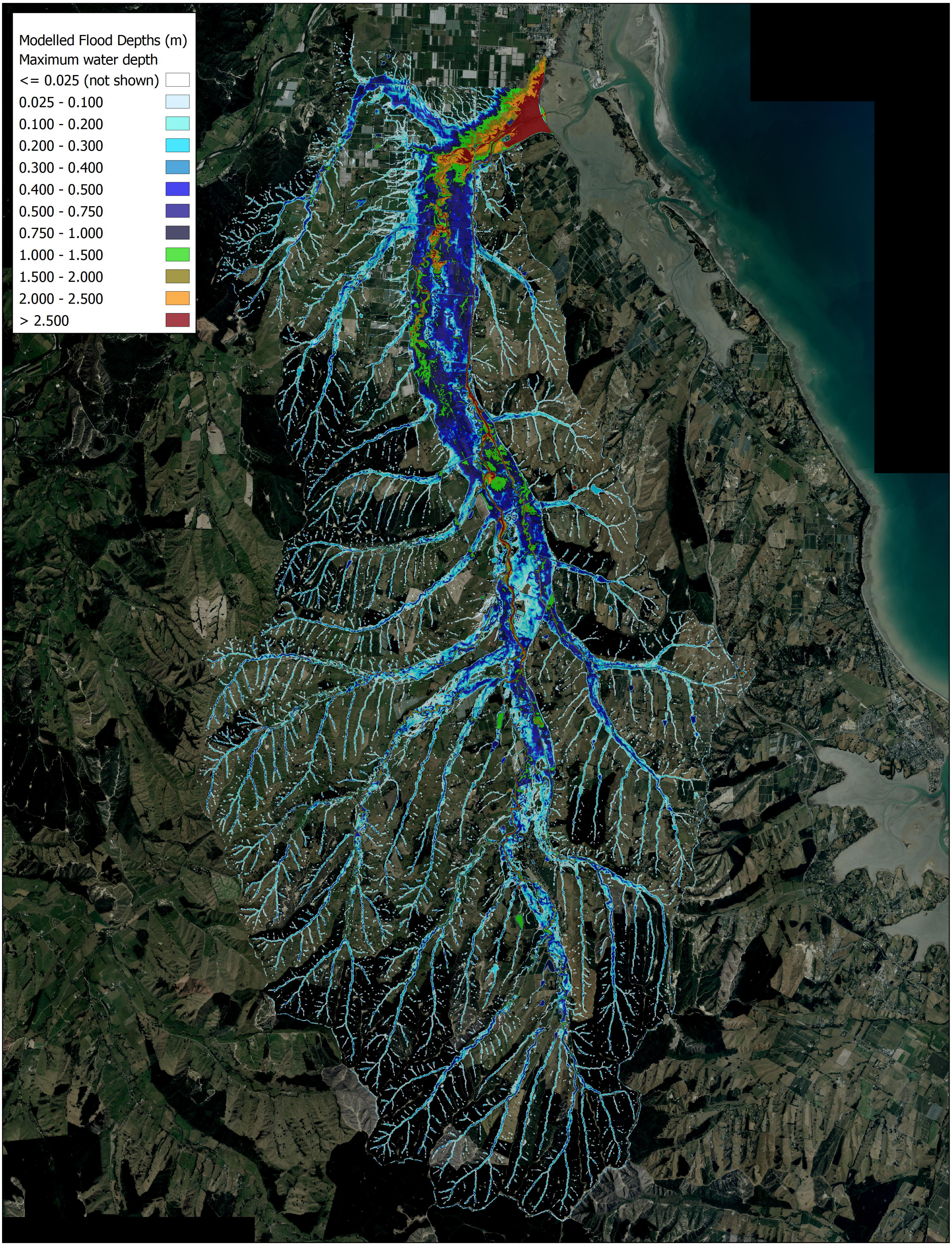

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Tasman District Council
Moutere Catchment Flood Modelling

~100yr 6hr Storm Event Predicted Flood Depths (1% AEP)
RCP8.5 Climate Change Conditions out to 2100
Catchment Infiltration = 7.5mm/hr

Job Number	23002
Revision	01
Date	02/11/2023

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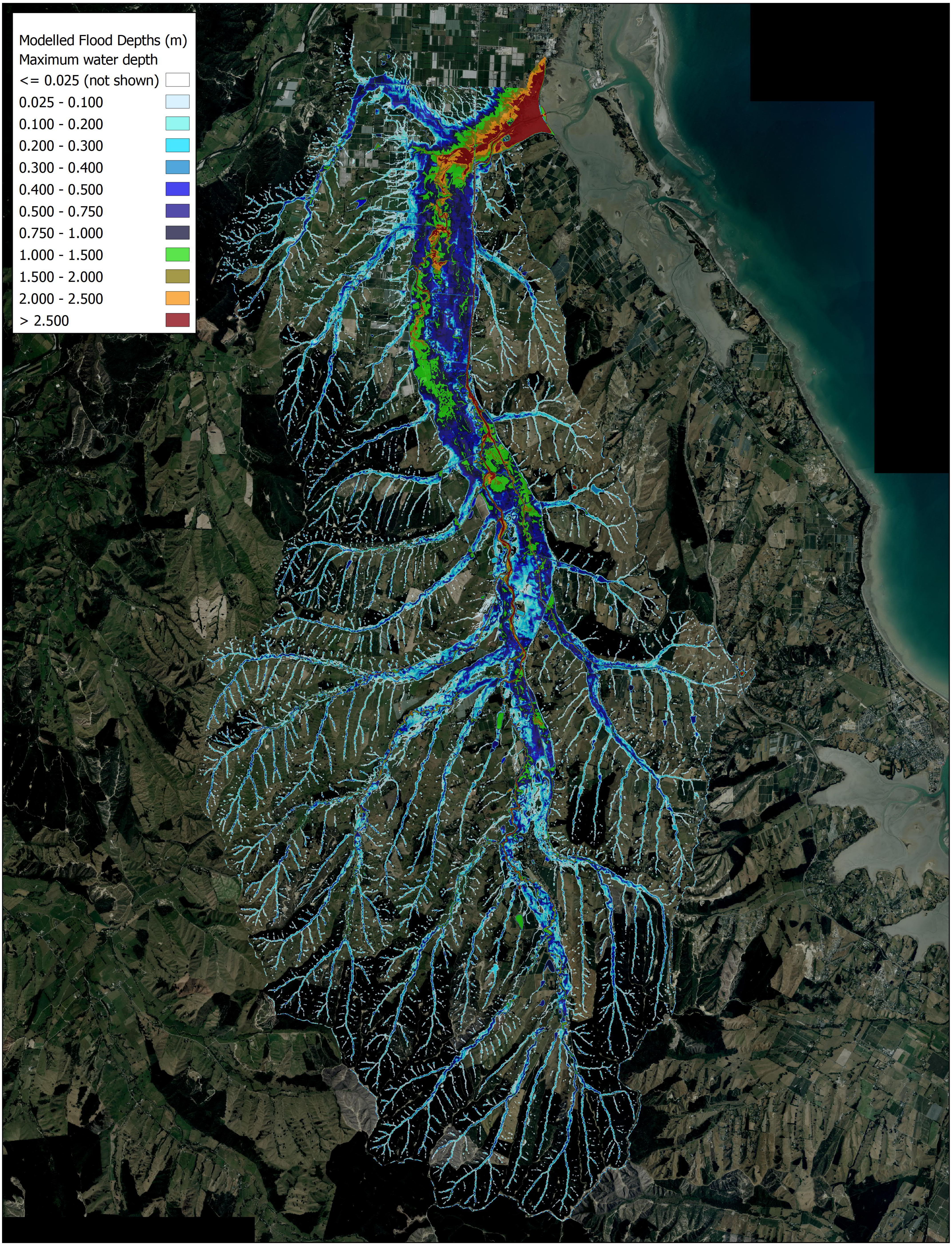

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Tasman District Council
Moutere Catchment Flood Modelling

~250yr 6hr Storm Event Predicted Flood Depths (0.4% AEP)
RCP8.5 Climate Change Conditions out to 2100
Catchment Infiltration = 7.5mm/hr

Job Number	23002
Revision	01
Date	02/11/2023

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APPENDIX G – Design Velocity Results for 1% AEP

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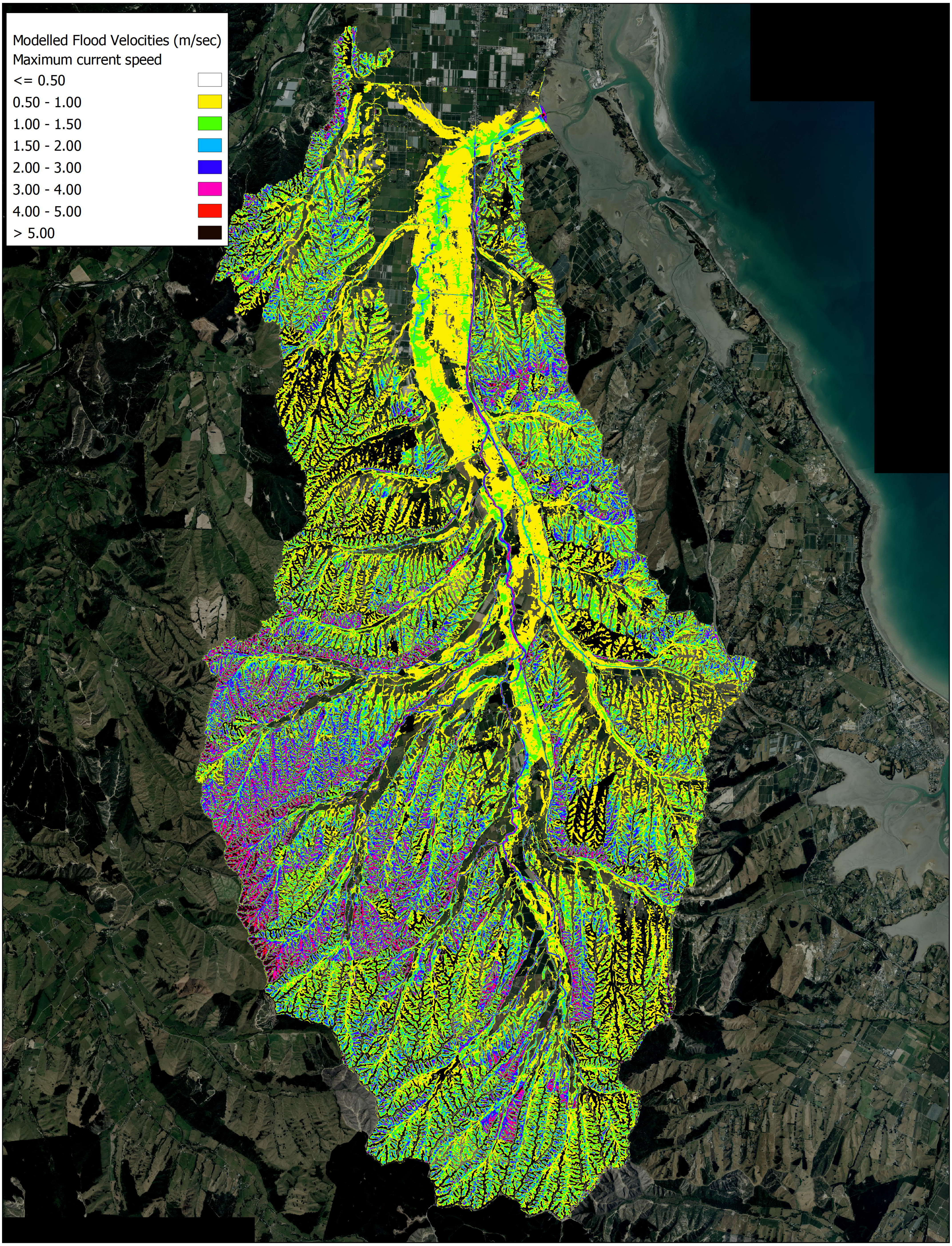

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Scale: 1 : 64997 (A3)
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

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(7.5mm/hr Infiltration)

Tasman District Council
Moutere Catchment Flood Modelling
~100yr 6hr Storm Event Predicted Flood Velocities (1% AEP)
RCP8.5 Climate Change Conditions out to 2100
Catchment Infiltration = 7.5mm/hr

Job Number	23002
Revision	01
Date	02/11/2023

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