WAIHO RIVER

8 November 2016

2D Hydraulic Modelling based on LiDAR

Report prepared for WCRC

by Matthew Gardner

Land River Sea Consulting Ltd

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2D HYDRAULIC MODELLING BASED ON LIDAR

TABLE OF CONTENTS

1. INTRODUCTION

BACKGROUND

The Waiho River is located on the West Coast of the South Island of New Zealand, running from the Franz Josef Glacier in the Southern Alps to the Tasman Sea, approximately 10km southwest of Okarito. The river is crossed by the State Highway 6 (SH6) Bridge which is operated by the New Zealand Transport Authority (NZTA) and runs adjacent to the town of Franz Josef / Waiau, situated on the true right bank of the river.

The area has a high level of geologic activity, with the Alpine Fault running through the town of Franz Josef itself and crossing the river in the vicinity of the SH6 Bridge. The river is fed by meltwater from the Franz Josef Glacier in its upper reaches which is currently in a state of retreat (Mills, 2012). The river has been steadily aggrading in recent years and it is possible that the retreating of the glacier will result in an increase in the volumes of sediment entering the river and ultimately increase the rates of aggradation.

The main tributary of the Waiho River within the study area is the Callery River which enters the Waiho River immediately upstream of SH6. Figure 1-1 shows the location of the Waiho River as well as the catchment boundaries which feed the river within the study area.

Figure 1-1 – Location and catchment boundary of the Waiho River and the town of Franz Josef

SCOPE OF STUDY

LiDAR (Light Detection and Ranging) data has been procured for a large area in the Waiho River catchment in June 2016. Due to the lack of detailed topographic data, previous modelling of the Waiho River has been largely 1-dimensional with the most recent modelling being carried out in MIKE11 (Gardner, 2014). With the newly available LiDAR data it has been possible to increase the scope of the modelling to include the entire floodplain as well as the river downstream from the Helipad bank, which was previously excluded from the model scope.

This modelling examines the existing flood risk for an estimated 1 in 100 year river flow for the existing scenario, and then examines a range of potential scenarios which include:

- Complete removal of South Bank down stream from the SH1 Bridge (Ie true left bank stopbank)
- A breach immediately adjacent to the Mueller Wing of the scenic circle hotel (as occurred in March 2016)
- Raising South Bank to an approximate 1 in 100 year flood level.

LIMITATIONS

The Waiho River is acknowledged to be one of the most dynamic environments in New Zealand. Due to the dynamic nature of the catchment any modelling is likely to have several limitations. The most significant of these limitations for the modelling carried out in this scenario are considered to be:

1. The model simulates a fixed bed situation (ie the bed level is not changing dynamically during the flood).
2. The river bed level is based on the levels measured by LiDAR on the 1st – 2nd of June 2016.

Despite these limitations, it is expected that the model should be able to give a reasonable estimate of the likely flood extents and depths in the modelled simulations, and is suitable to be used as a planning tool for investigating the potential effects of flood and breach scenarios.

2. MODEL BUILD

This model has been built using MIKE 21. MIKE 21 is an advanced, industry leading software package by the Danish Hydraulic Institute (DHI), and is used in many major investigations in New Zealand as well as internationally. The model has been developed using the latest version of the DHI software at the time of this project which is version 2016 SP2.

There are several components to setting up a MIKE21 model. The following section summarises the basics of the model setup.

TERRAIN DATA

A Digital Elevation Model (DEM) has been constructed using the most recent LiDAR data available. The LiDAR data was collected in June 2016 by New Zealand Aerial Surveys Ltd. The DEM was generated in ARCGIS 10.3 from the raw LAS files provided by the surveyors. A grid size of 6m has been adopted, which is sufficient to allow for a reasonably high level of resolution and will also allow for reasonable model run times.

In order to minimise file sizes and reduce computation times the grid system has been rotated and aligned so that the greatest portion of the river runs parallel to the grid.

In order to achieve this, the grid has been rotated anticlockwise by 42.5 degrees about the following NZTM grid coordinates:

x = 1369855

y = 5189166

This rotation does not impact on the display of the result files, which can be exported directly into any GIS programme for display.

The modelled extent is shown in Figure 2-1 below.

Figure 2-1 – Rotated Modelled Extent

BED RESISTANCE

Bed resistance has been applied as a Manning's 'n' value and has been spatially varied based on a visual analysis of the aerial photography. The Manning's 'n' values which have been applied are presented in Table 2-1 below.

Table 2-1 – Flooplain Manning's 'n' values

	Mannings 'n'
Grass/Pasture	0.035
Rough Grass	0.04
Industrial	0.09
Vegetation	0.09
Vineyards	0.07
Residential	0.12
River Bed	0.05
Road	0.017

BOUNDARY CONDITIONS

There are only two boundary conditions in this model, which are the input flow hydrograph and the downstream tide boundary.

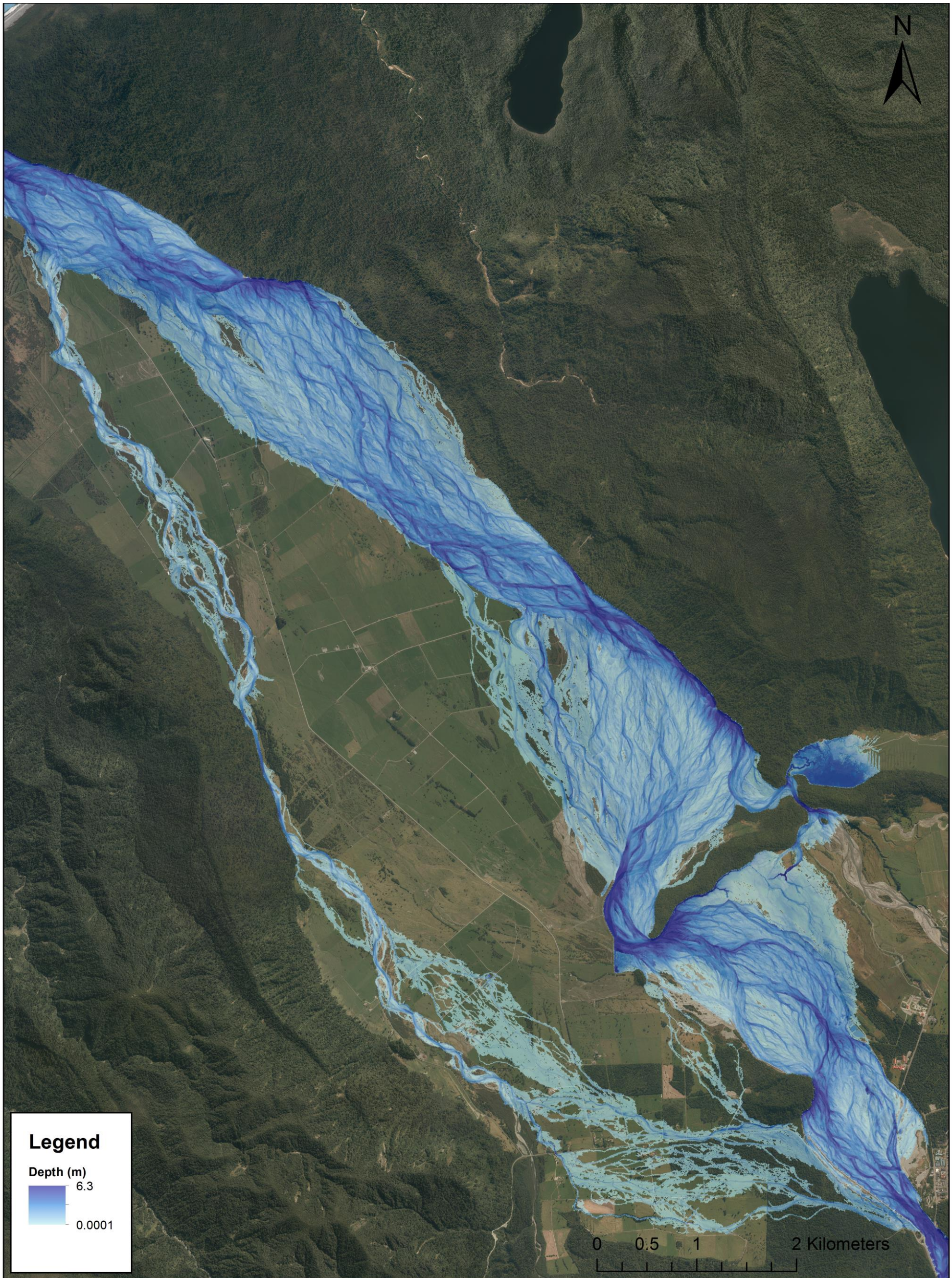
The inflow hydrograph has been taken from the previous MIKE11 modelling, full details can be found in the modelling report (Gardner, 2014).

Due to the fact that we the area adjacent to the coast is not considered a high area of interest for this study, the coastal boundary condition has been set at a fixed level of 0m.

3. RESULTS

The results have been presented as maps of flood depth for the following scenarios:

- Existing scenario
- Complete removal of South Bank downstream from the SH1 Bridge (Ie true left bank stopbank)
- A breach immediately adjacent to the Mueller Wing of the scenic circle hotel (as occurred in March 2016)
- Raising South Bank to an approximate 1 in 100 year flood level.



PROJECT
Waiho River Modelling

TITLE
100 Year Flow - Existing Scenario

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	27 October 2016	WCRC005	1:35,000	01

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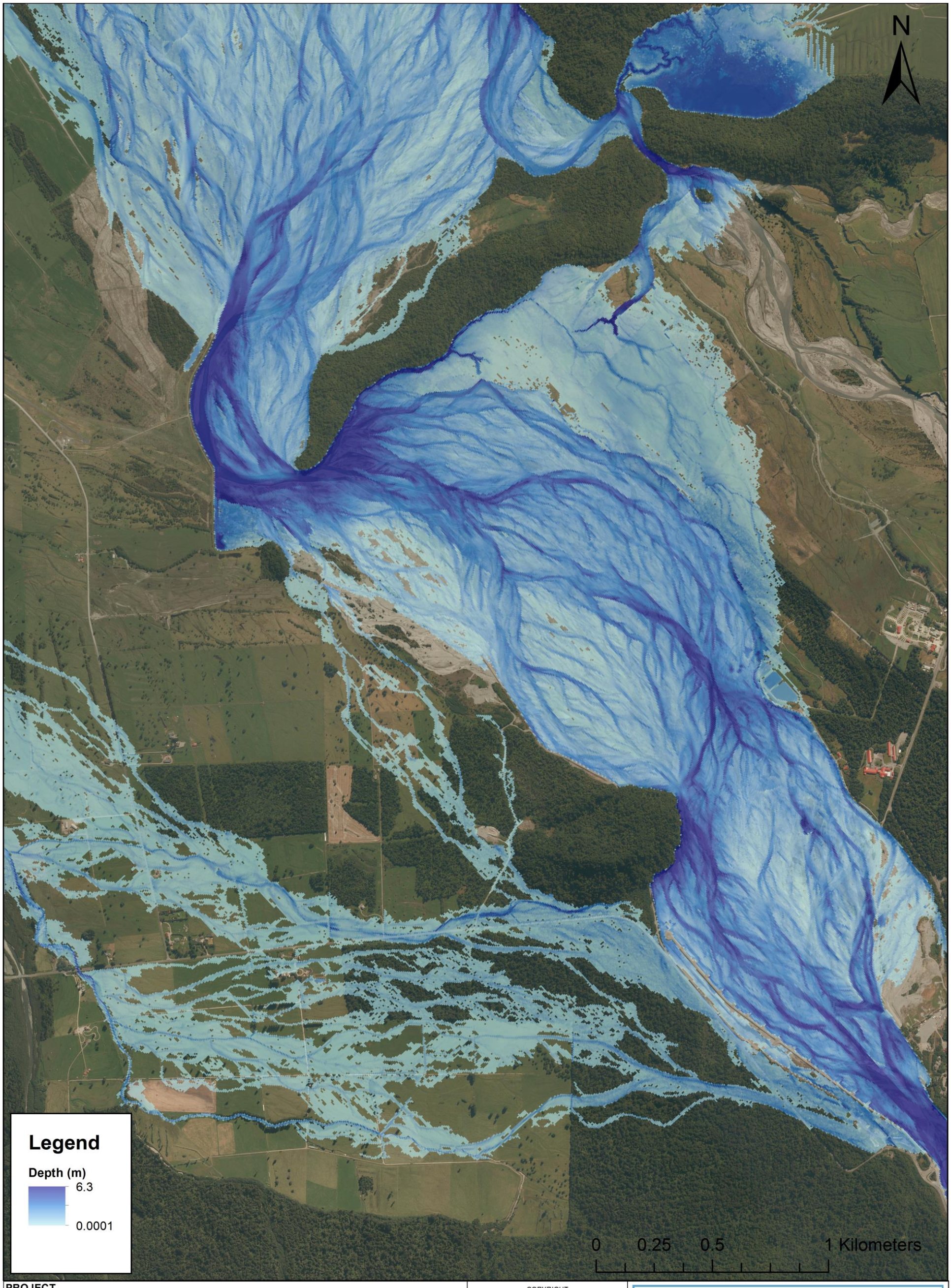

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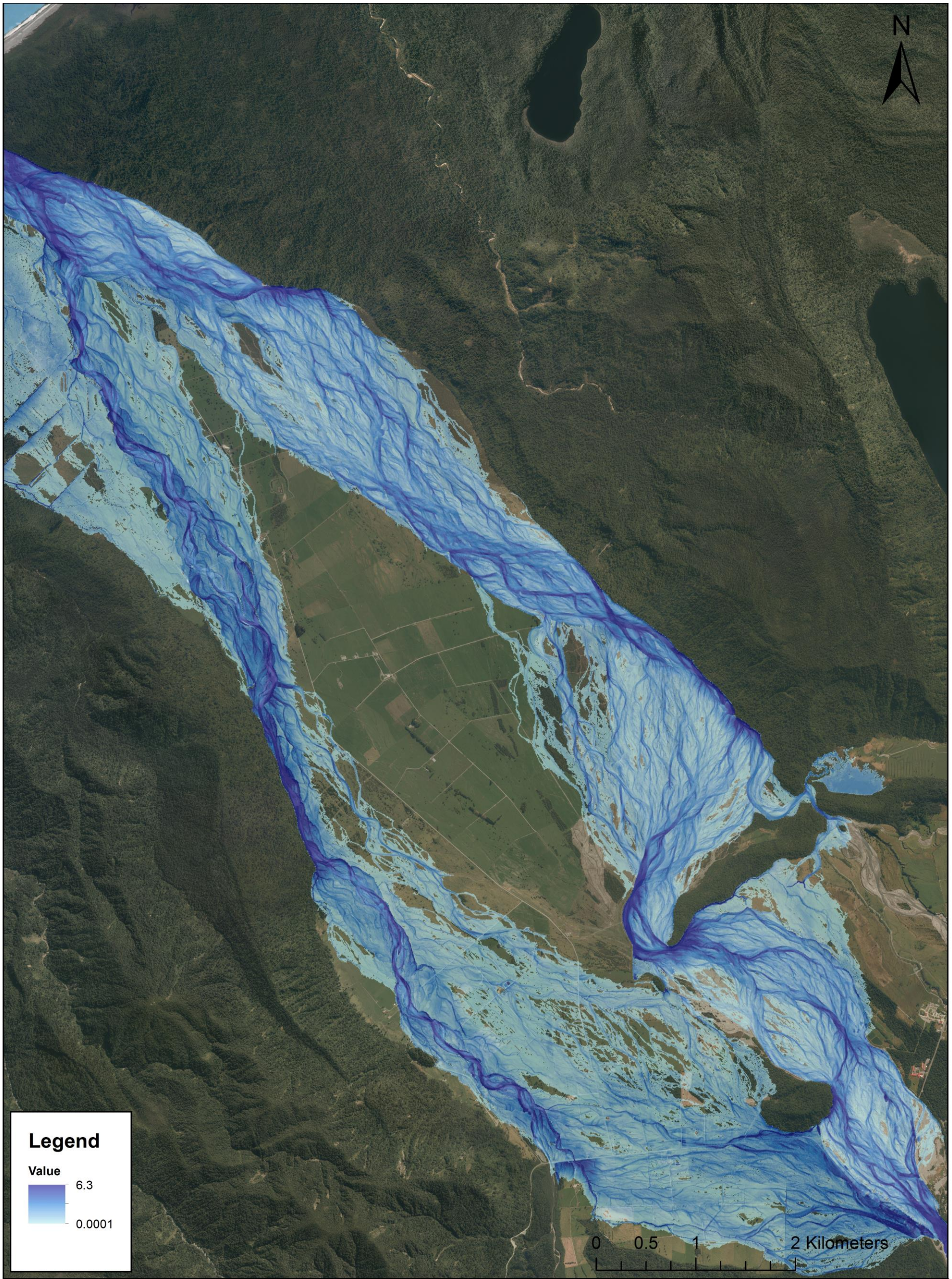
TITLE: **100 Year Flow - Existing Scenario (Bridge to Loop)**				
AUTHOR: Matthew Gardner	DATE: 27 October 2016	JOB CODE: WCRC005	A3 SCALE: 1:15,000	REV: 01



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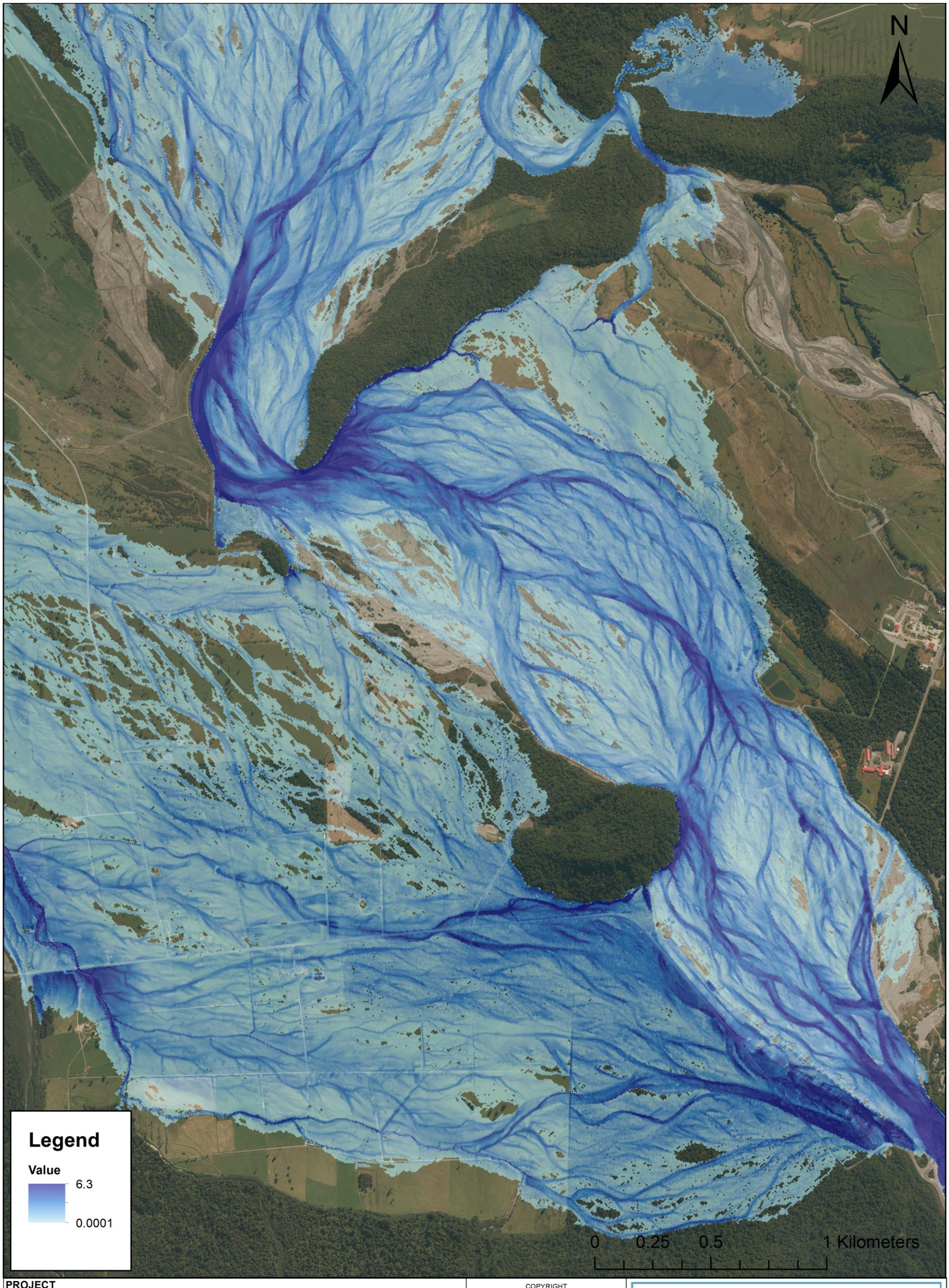
TITLE **100 Year Flow - No South Bank (Full Scale)**					
AUTHOR Matthew Gardner	DATE 27 October 2016	JOB CODE WCRC005	A3 SCALE 1:35,000	REV 01	



PROJECT
Waiho River Modelling

TITLE
100 Year Flow - No South Bank (Bridge to Loop)

AUTHOR	DATE	JOB CODE	A3 SCALE	REV
Matthew Gardner	27 October 2016	WCRC005	1:15,000	01

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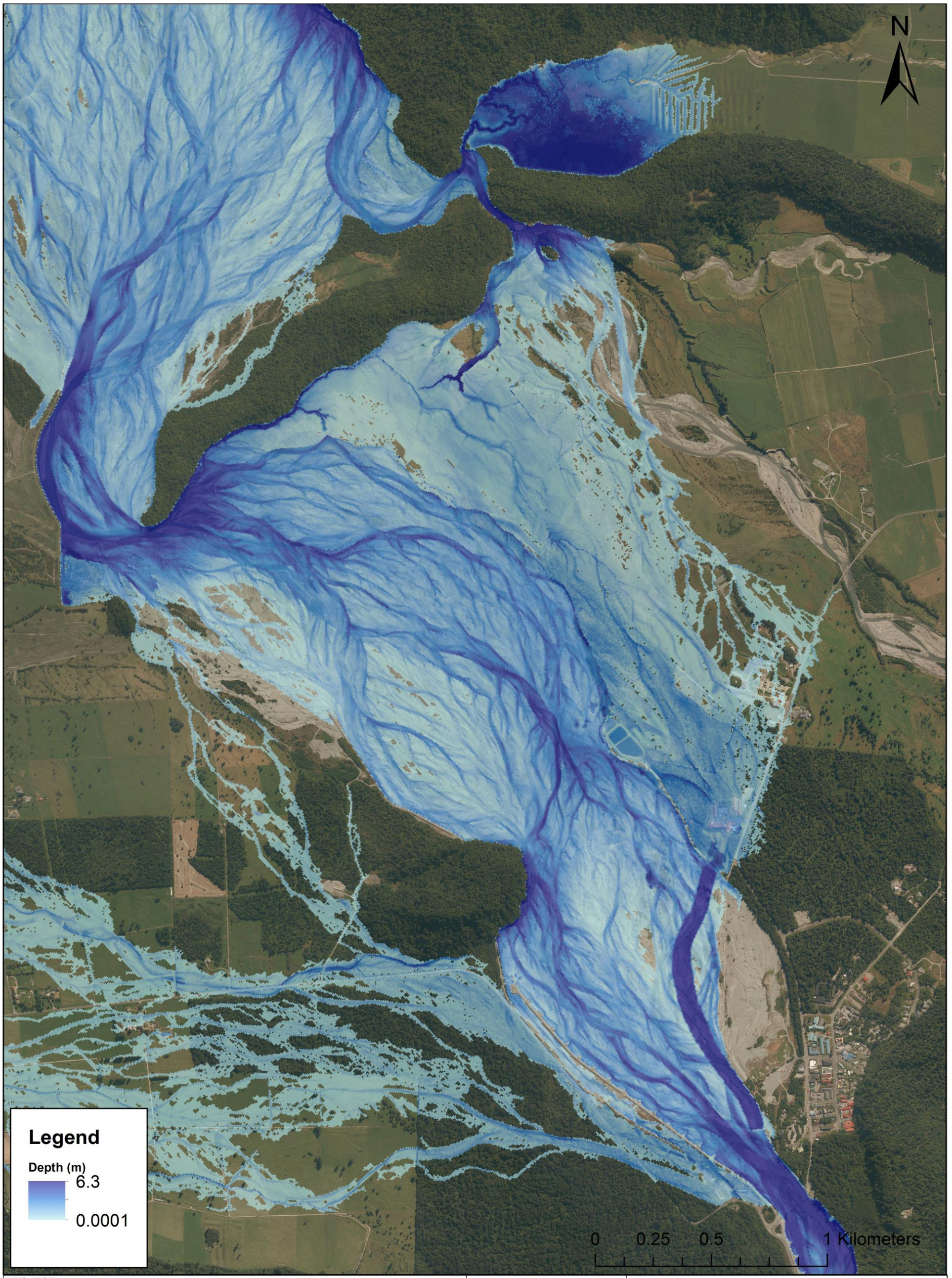

PROJECT: **Waiho River Modelling**				
TITLE: **100 Year Flow - Breach as occured in March 2016**				
AUTHOR: Matthew Gardner	DATE: 27 October 2016	JOB CODE: WCRC005	A3 SCALE: 1:15,000	REV: 01

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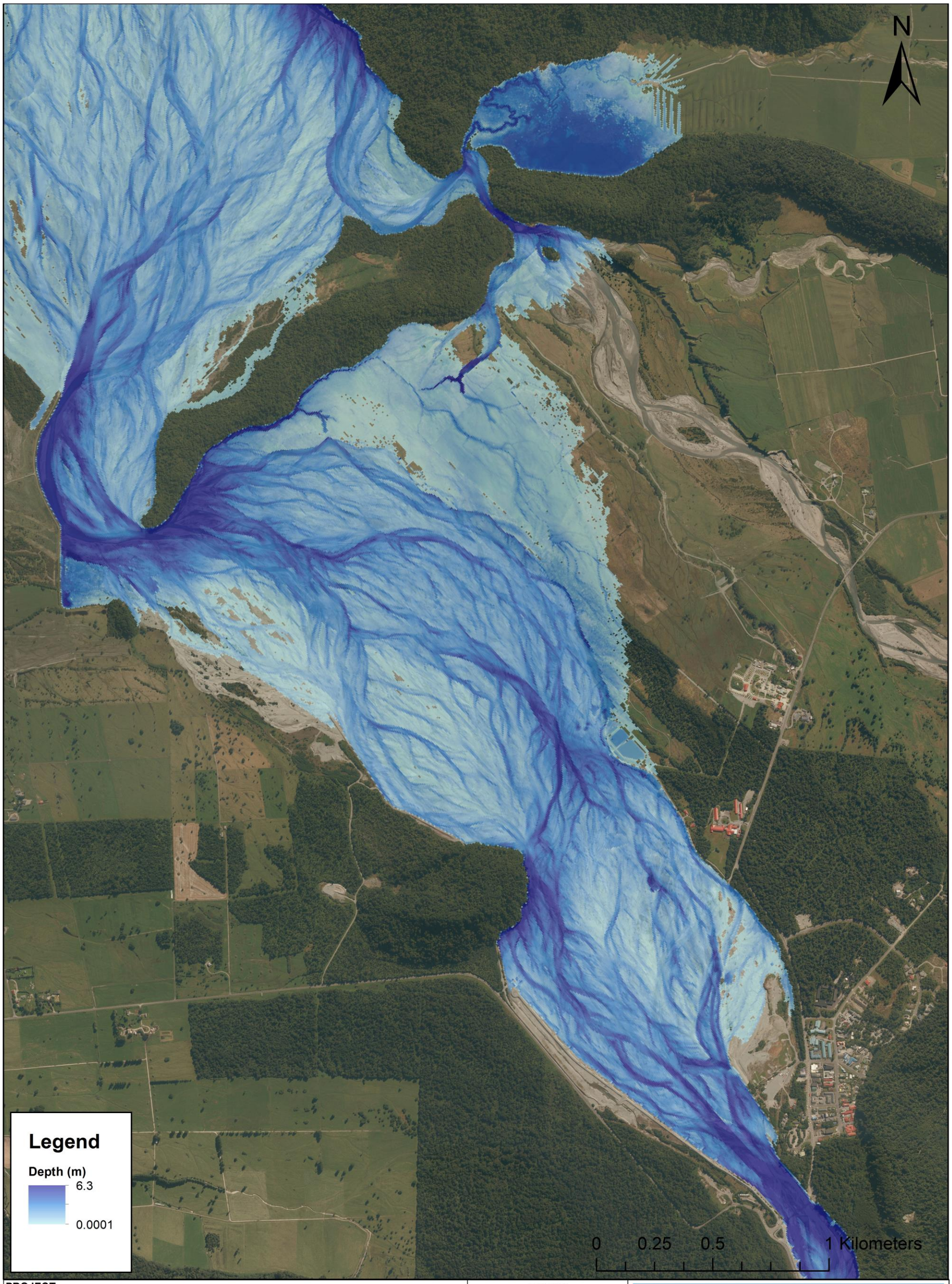

PROJECT: **Waiho River Modelling**				
TITLE: **100 Year Flow - Southbank Rasied to 100 year level**				
AUTHOR: Matthew Gardner	DATE: 27 October 2016	JOB CODE: WCRC005	A3 SCALE: 1:15,000	REV: 01

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4. GENERAL CONCLUSIONS

The following general conclusions can be drawn from this modelling exercise.

EXISTING SCENARIO

- The South Bank is likely to overtop during a 100 year event, leading to partial inundation of downstream properties / farmland before the flood waters enter Docherty's Creek. (NB: There is the potential that the south bank will fail to a degree if it is overtopped and that the flooding may be worse than shown in this modelling – a partial breach has not been simulated to date)
- The State Highway will be completely inundated.
- The bank/access road protecting the treatment ponds is likely to overtop/fail during a 100 year event further damaging the remaining ponds and any infrastructure in place.
- The upgraded stopbank protecting the site of the Mueller Hotel, is expected to withhold a significant flood providing bed levels haven't aggraded significantly above their existing levels.

SOUTH BANK REMOVED

- Removing the South Bank will reduce the pressure on the North Bank infrastructure.
- A very significant amount of land will be sacrificed due to the volume of flood water which will be allowed to flood this land to the true left of the main channel.
- The existing State Highway will be completely inundated.

SOUTH BANK RAISED TO A 100 YEAR LEVEL

- Raising the South Bank to a 100 year level has the effect of preventing flood waters from flowing towards Docherty's Creek and protects the land on the true left bank of the river.
- Flood levels will be raised within the main channel and pressure on the North Bank is increased.
- The flood extent downstream from the Waiho Loop is not expected to differ.

BREACH ADJACENT TO THE MUELLER HOTEL

- Results show that if this breach was to occur again, all properties downstream of the Mueller Hotel would likely be flooded, however the majority of the flood waters are unlikely to flow north and into the Tatare River, similar to what occurred in March 2016.

FUTURE MODELLING

Now that the model has been setup, it is relatively simple to conduct further runs and explore the likely effect of varying flows, mitigation measures, or breach locations. It is likely that a new scenario would take up to 2 hours to run and present the results in the form of a flood map.

5. REFEERENCES

Gardner, M (2014). Waiho River – Hydraulic Modelling and Analysis. Land River Sea Consulting Ltd.