Modelling Group
WATER NEW ZEALAND

Modelling Symposium

Whats next for Chch flood modelling?

Presented by
Tim Preston
(Christchurch 13/3/2024)

GHD

water NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa

Introduction

The major elements of Christchurch flood modelling schematisation were determined in 2016/17. Changes in the seven years since have been incremental, not major.

However;

- we have lessons learned from using the models and
- opportunities from new technologies

Motivation - do more, better and faster

Time to reconsider alternatives

Contents

Mesh

Reduction in M11

Model integration

Joint probability

Radar rainfall

Impervious coverage

LiDAR cross sections

Depth tolerance

Data centric modelling

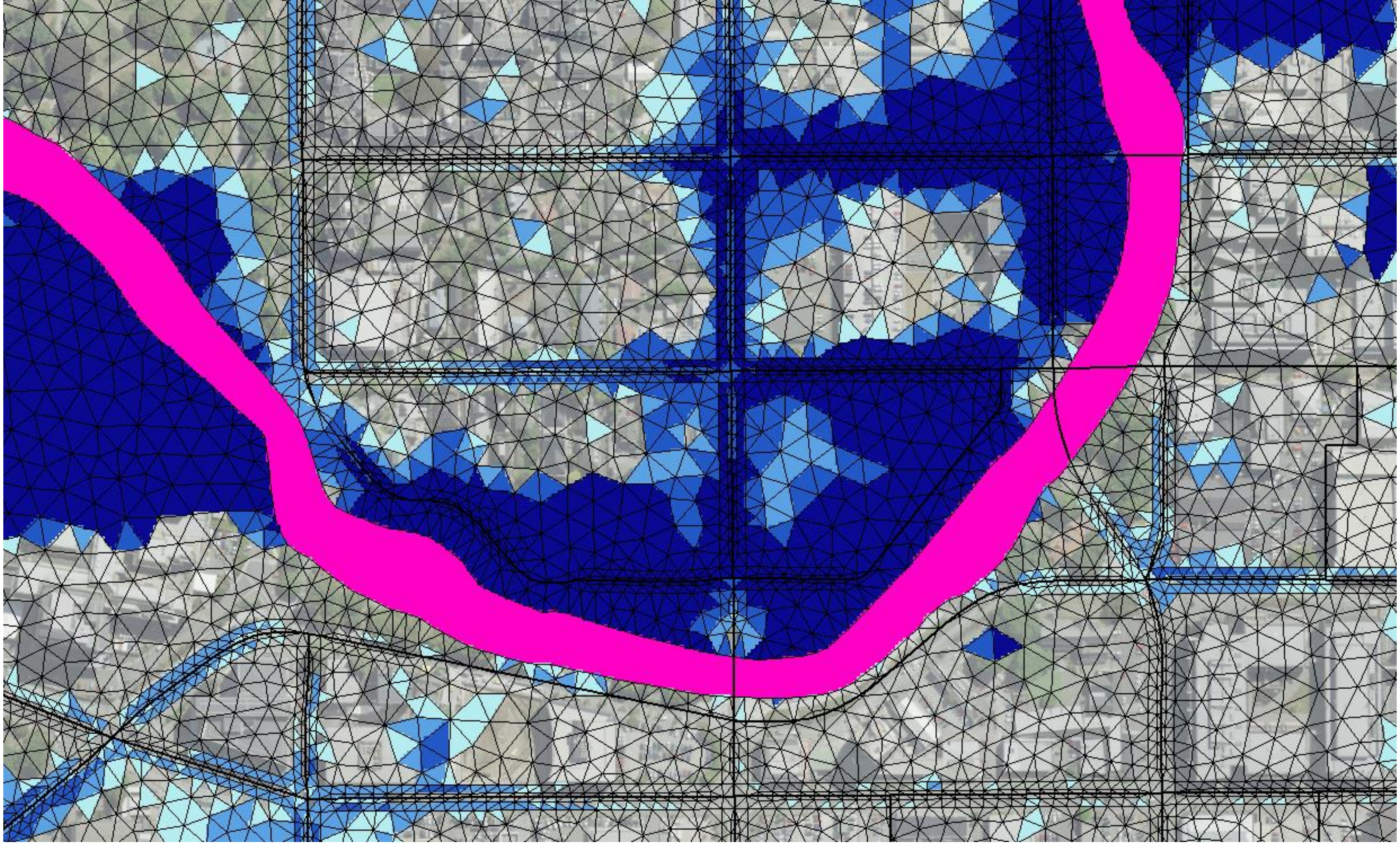
Triangular mesh

A success in it's time (2016) when GPU computation was new and triangular mesh came with that, but

- costly to generate and update
- secondary features are often deleted by higher priority features
- Has driven blockouts to delete road (bridge) surfaces

Triangular mesh does not seem to be popular in Australasia with peer organisations

Triangular mesh



Alternative mesh1

The most popular form of mesh remains simple grid (uniform size)

- In an urban setting like Christchurch, a grid size of circa 2x2m would be expected to generate comparable hydraulic fidelity to the current mesh

	Triangular mesh	Uniform grid
Cell count (millions)	1.8	30
Average size	$70m^2$	$4m^2$
Minimum size	$12m^2$	$4m^2$

GPU computational speed seems almost unlimited, but the 30 million cell count may exceed memory capacity on typical desktop computing

Alternative mesh2

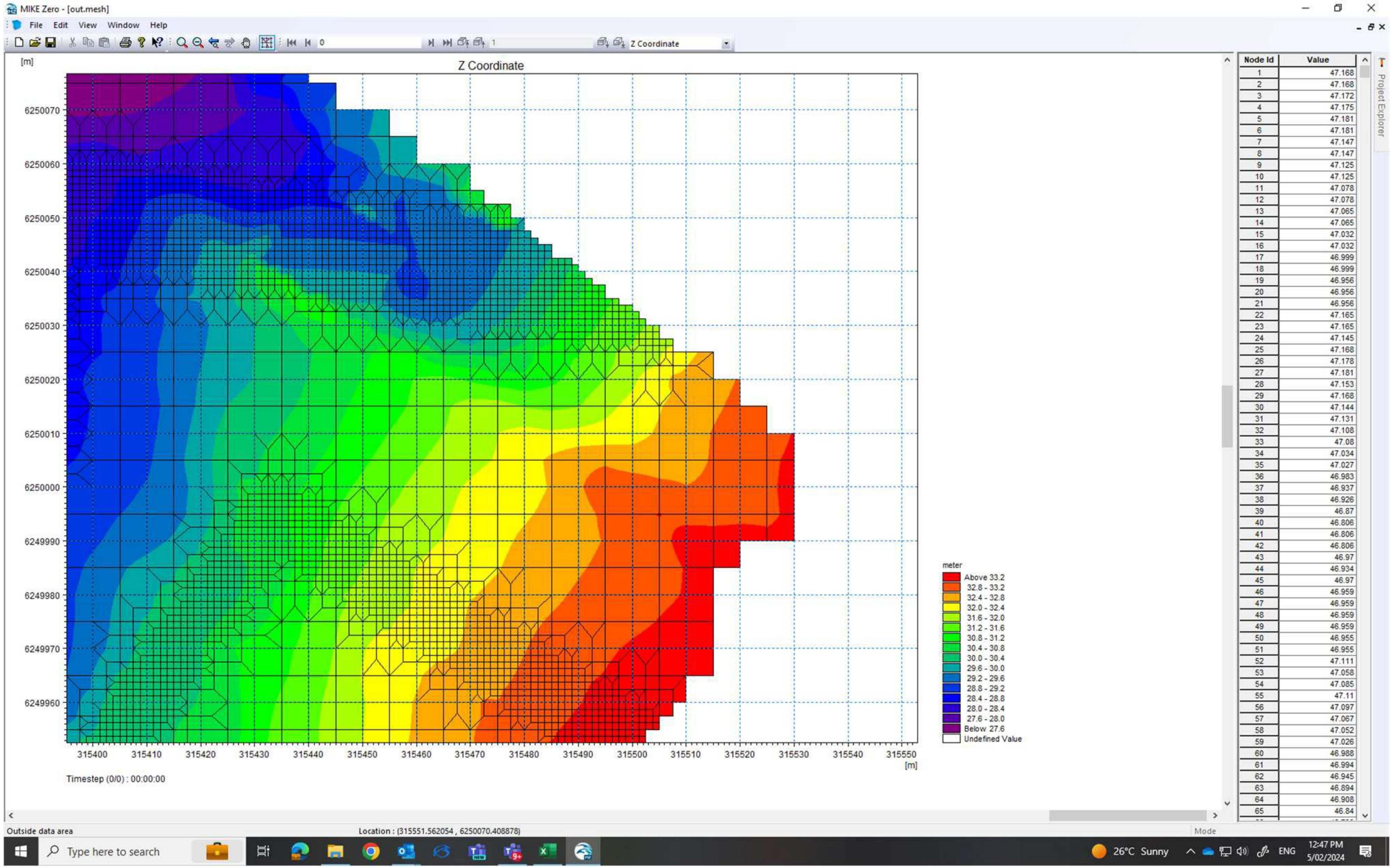
Quadtree is essentially a large grid mesh, where selected cells are subdivided into four, and this process can be repeated to any level of detail

Anticipating primary cells of 16x16m, and four levels of subdivision to the smallest cell of 2x2m, quadtree mesh might look like this

	Triangular mesh	Quadtree mesh	Uniform grid
Cell count (millions)	1.8	10	30
Average size	$70m^2$	$12m^2$	$4m^2$
Minimum size	$12m^2$	$4m^2$	$4m^2$

A system to build a specialised DHI compatible form of quadtree mesh has been developed (credit Tuflow)

DHI Quadtree mesh



Next mesh steps

Reconsider ways to simplify and improve on the current triangular mesh

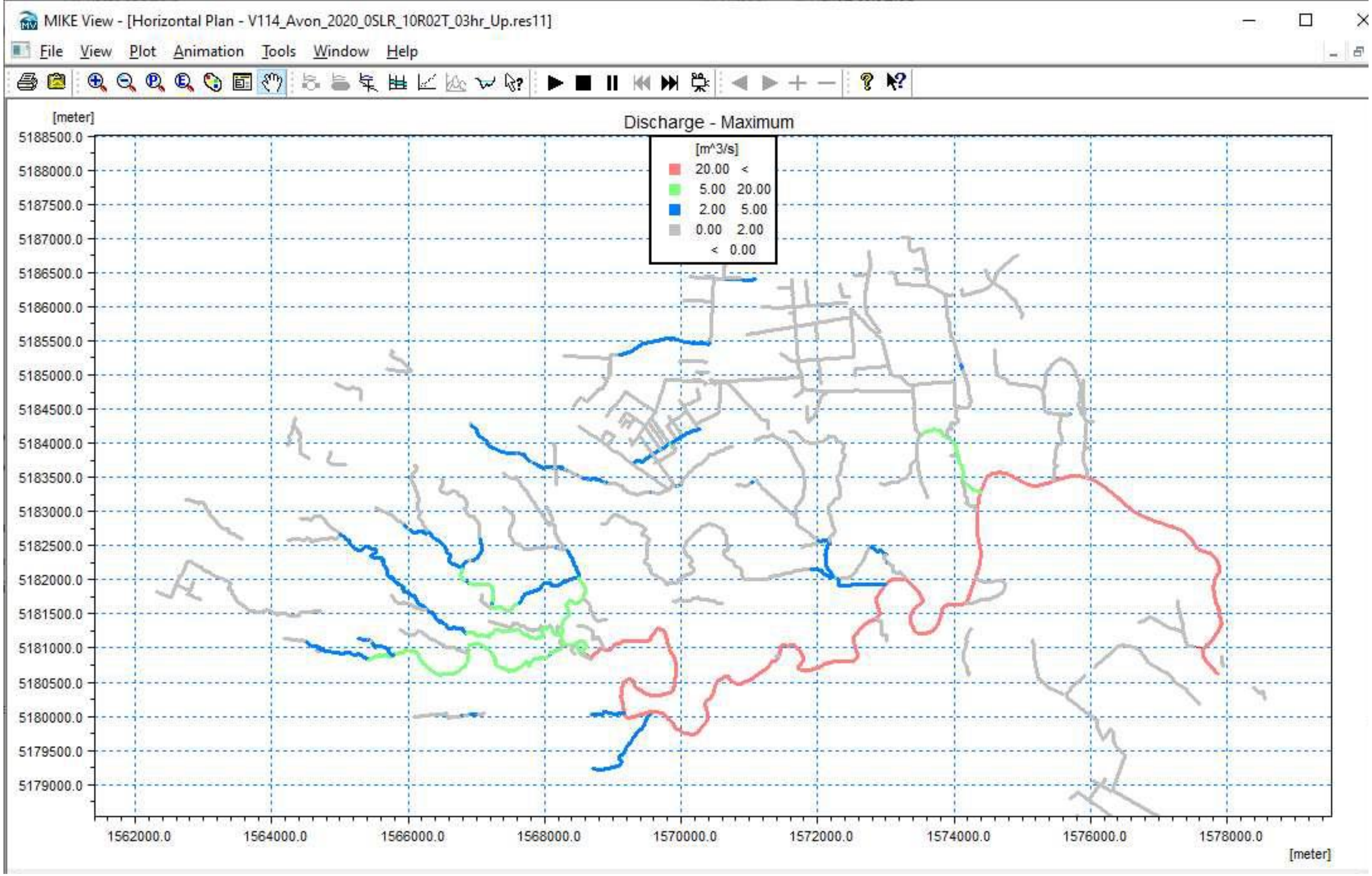
Pilot study to build an Avon quadtree mesh and test performance (maybe)

M11 Reduction

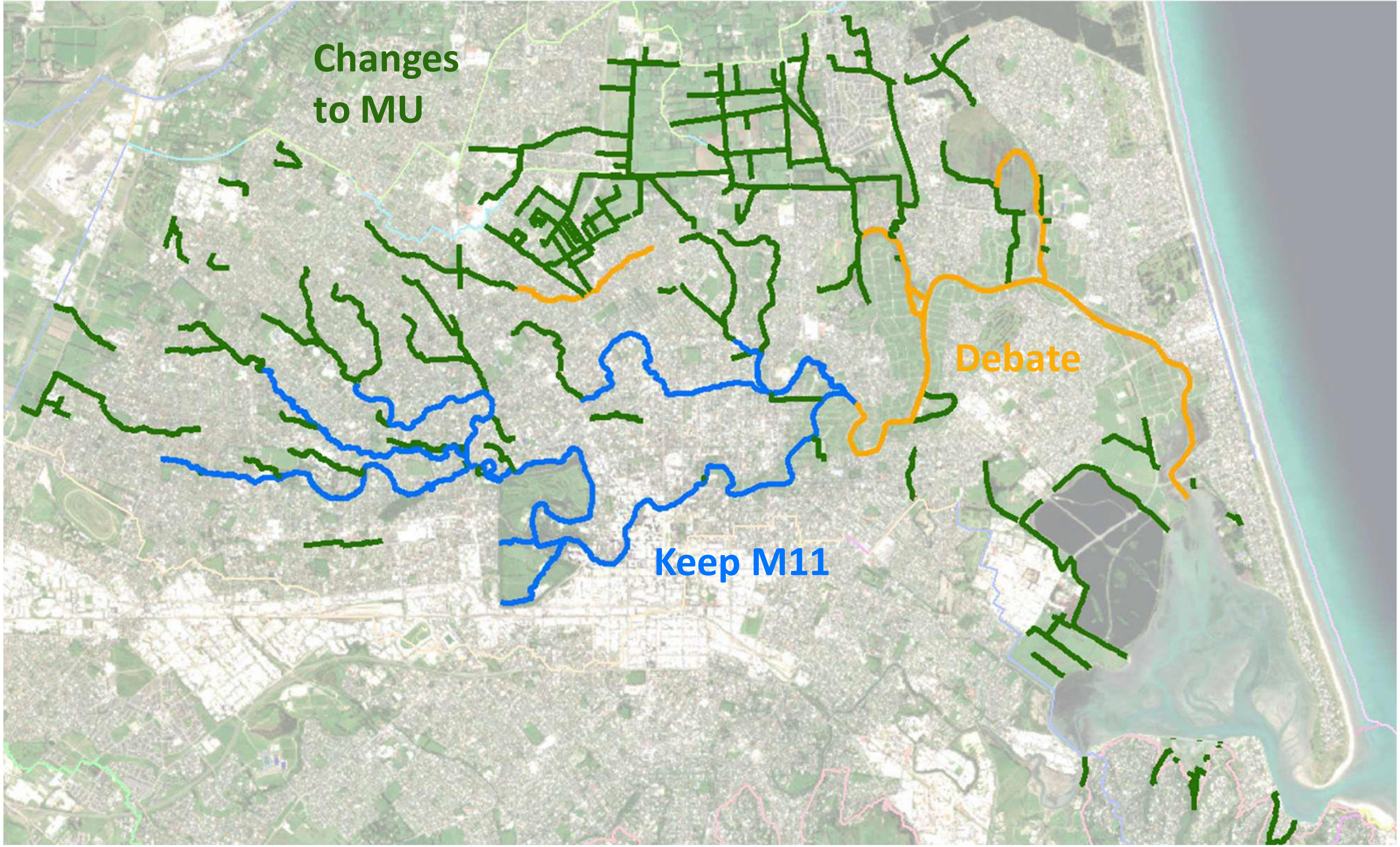
Less river (M11) modelling and more urban (MU) channels because of

- M11 blockout conflicts with road intersections
- Costs to build and check lateral linking lines
- Depth tolerance
- Inability to connect sump inlets to M11
- M11 to MU couples (key stability risk troublespots)

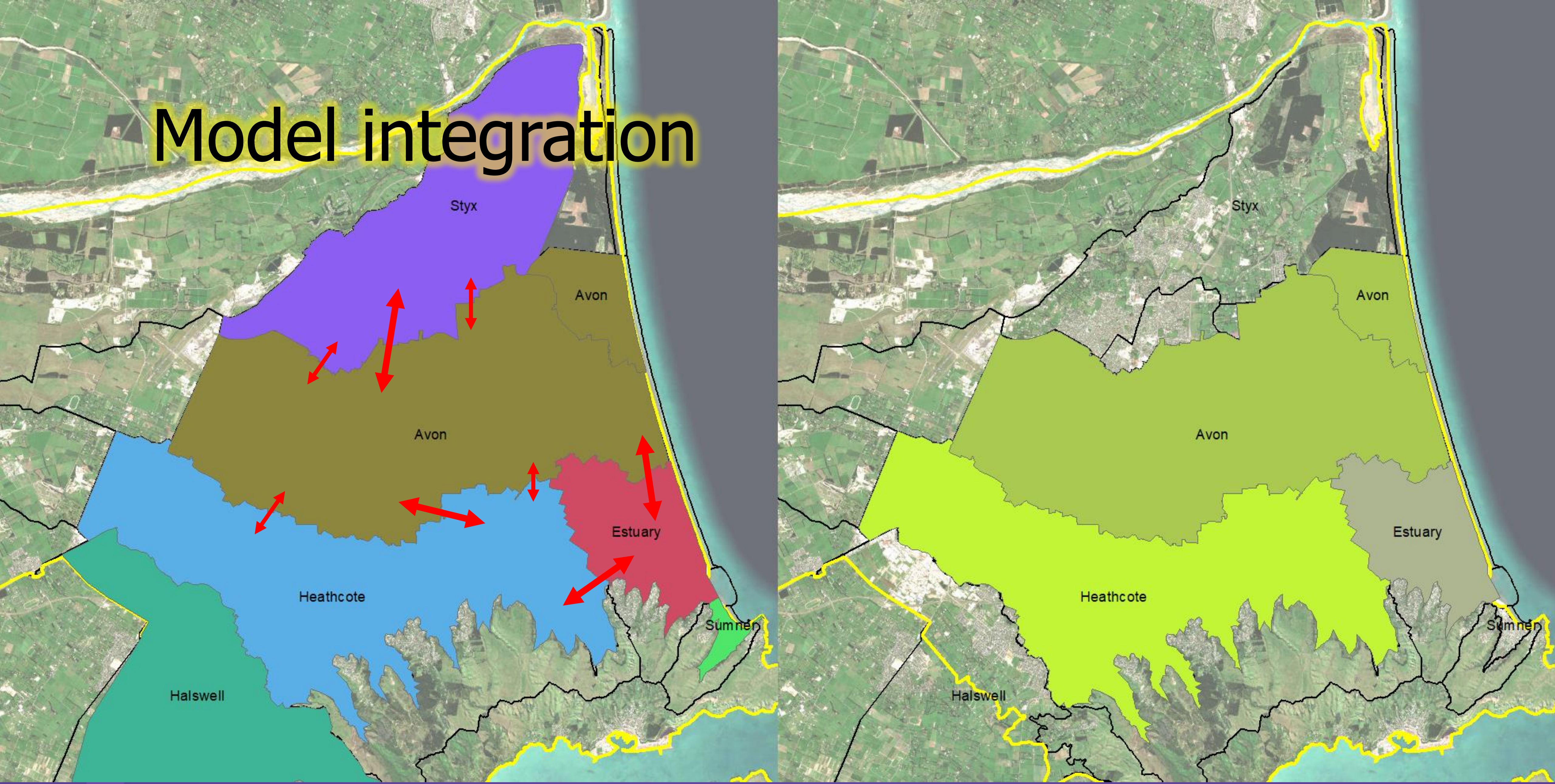
M11 Reduction



M11 Reduction



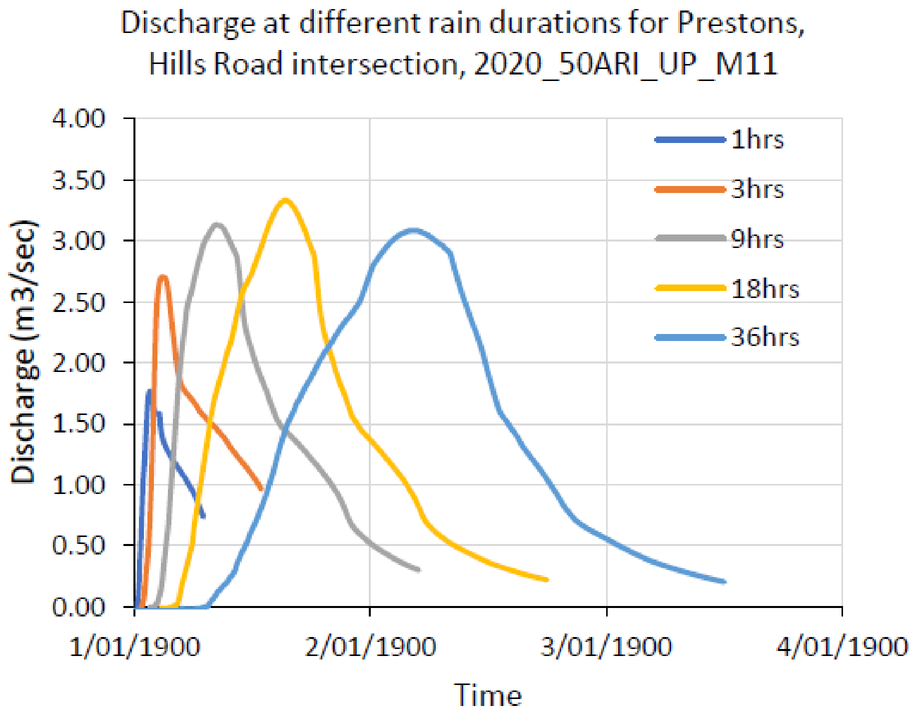
Model integration



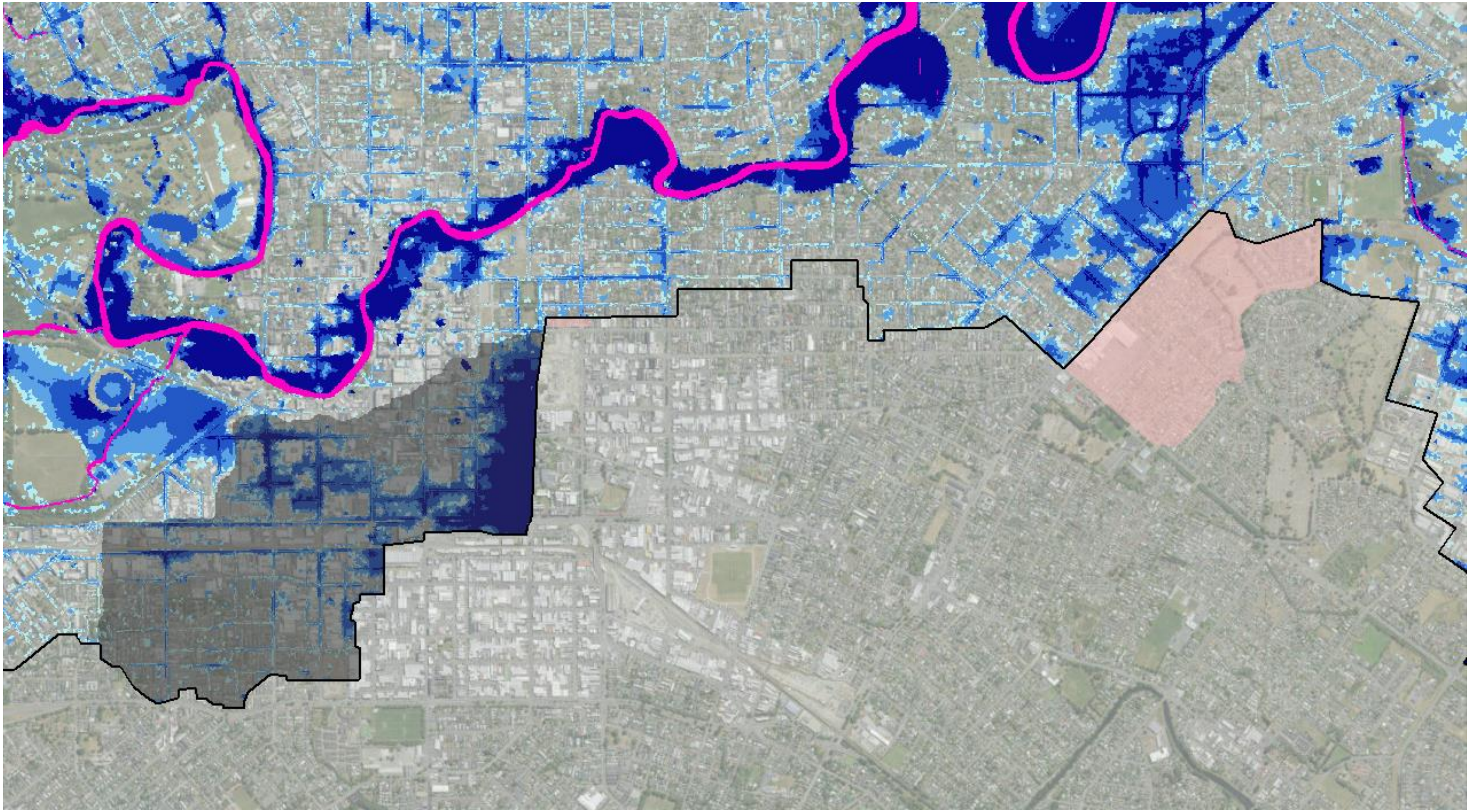
Model integration underway

Proceeding with caution

- Adjusting model boundaries to minimise floodplain interaction
- Preparing for more (dozens) of piped interactions
- Online dbase system to share timeseries at interaction locations
- Exchange pipe timeseries at adjacent boundaries
- Time series interpolation tool being developed to fill in gaps when adjacent models use differing setups like rainfall durations (credit T+T)



Boundary adjustments



Joint probability

Defines sea level conditions coincident with river flooding

Improvements to the 2020 mathematical techniques

Expansion to Heathcote, Styx, Sumner and inland estuary

Due to publish in May

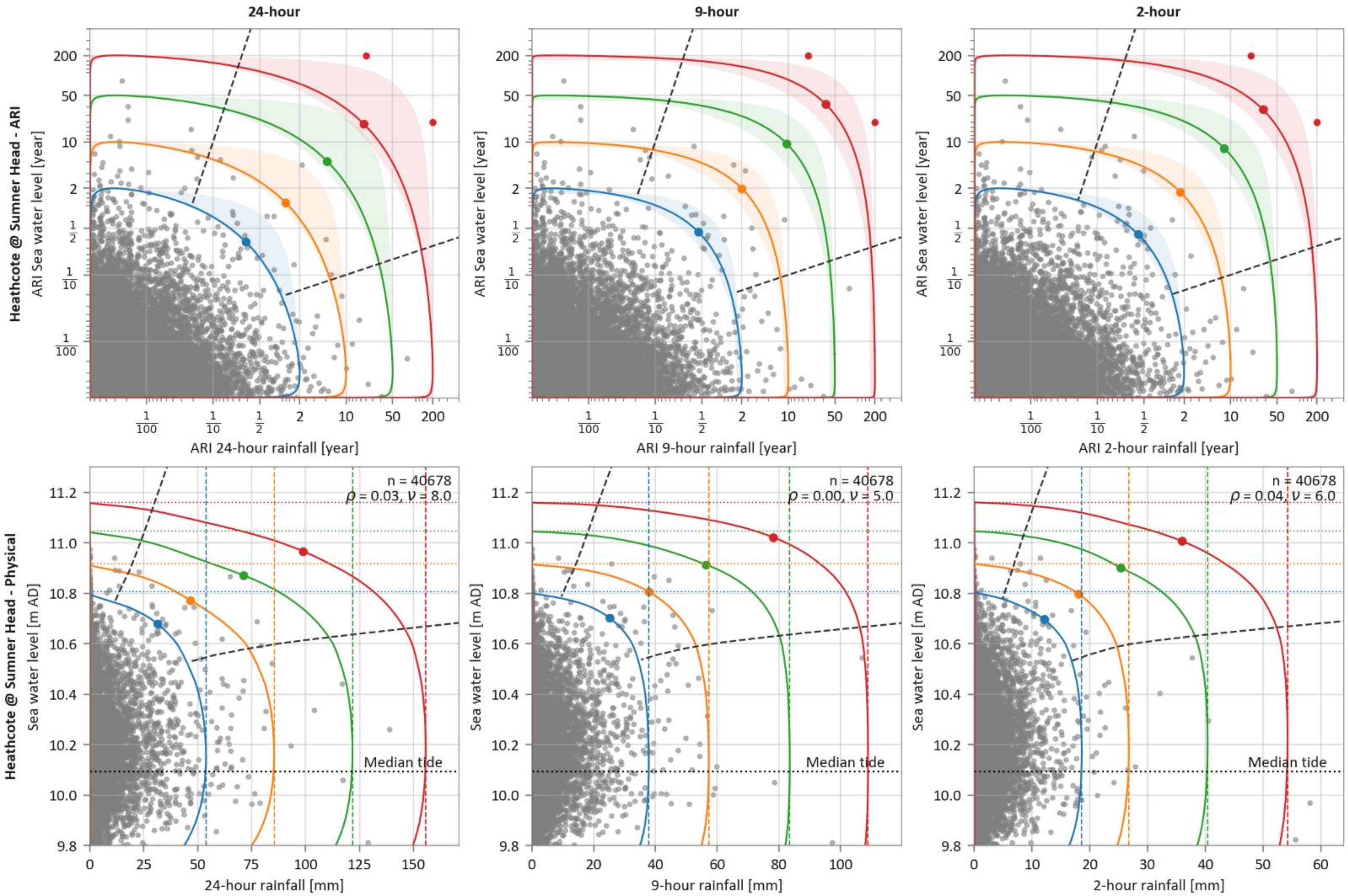
Inland locations have higher correlation and higher joint extreme conditions

Otherwise similarity across catchments

Looking to investigate the practical implications of various coincidences

Credits GHD/PDP/HKV

Joint probability



Rainfall radar

Reprocessed 2017 radar data (credit WeatherRadar and Mott McD)

Better (quantified) rainfall from radar

Good on the flat land, bad on the hillside

Opportunities to 'better calibrate' radar site for even better results but

Motivation on the flat land is weak, quality on the hillside is poor

Considering whether there is a business case to do more

Rainfall radar

Weather Radar New Zealand Ltd.
101 Pakenham Street, 1010 Auckland

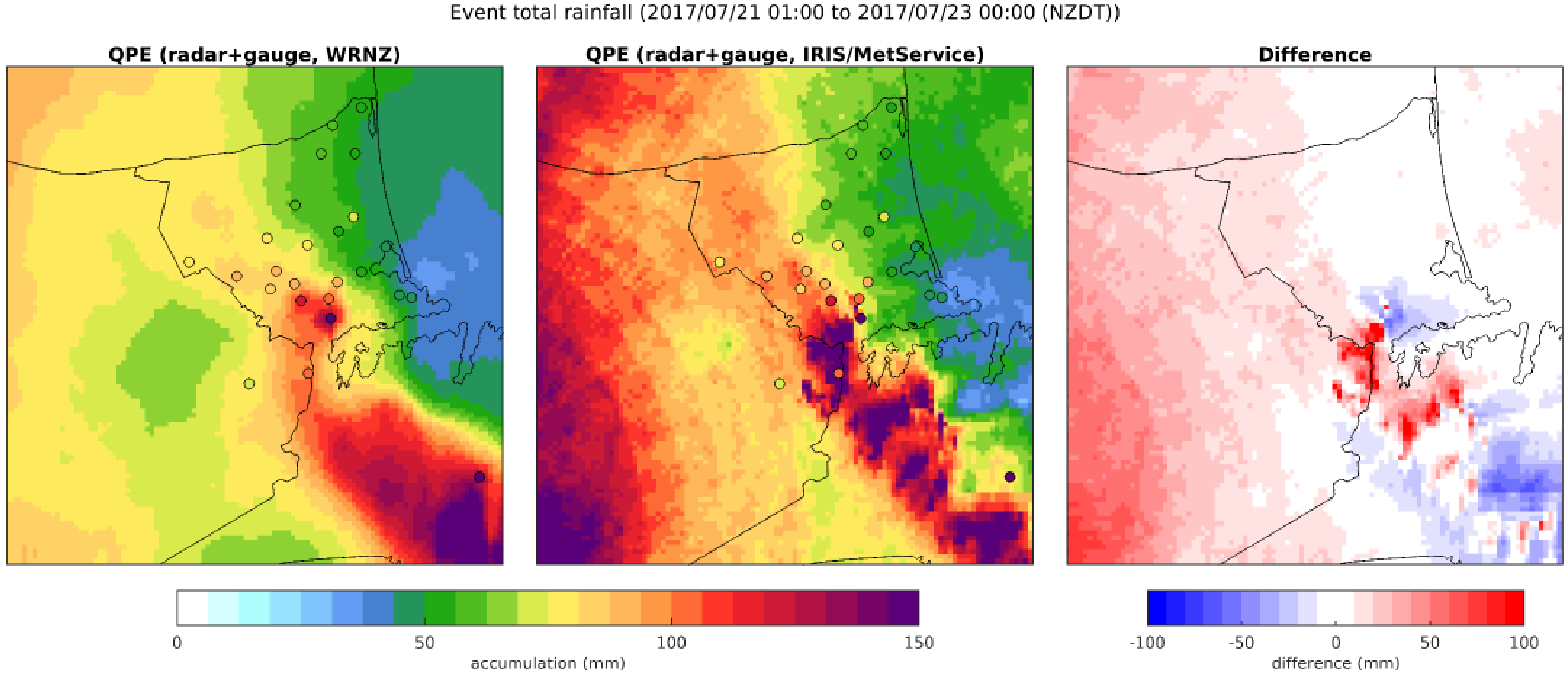


Figure 6: QPE total accumulations for the July 2017 event, prepared with the WRNZ methodology (left) and as provided by MetService from the IRIS software (middle). The MetService data has been re-gridded to the WRNZ analysis grid to allow a difference comparison (right), which highlights significant differences around the topography of the Port Hills, along with artificial range-based artefacts- ring pattern.

Impervious coverage

Defacto impervious data from satellite imagery, incl infrared, 10m resolution, and evident blurring larger than 10m (roads poorly represented)

New impervious data from aerial photography, 0.075m resolution sharp images, excl infrared

Processing with AI to recognise landuse classifications and pervious or impervious (credit Lynker)

Good quality metrics on random point assessment

Room to improve on road surface outlines and on gravel

More inspection in progress

Impervious coverage

Impervious coverage

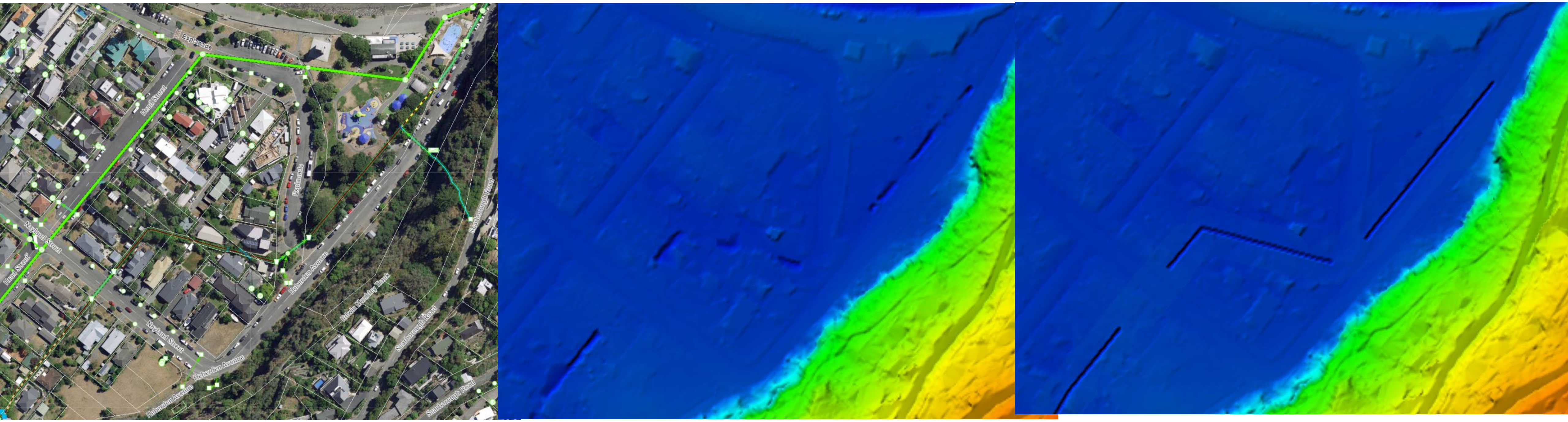
LiDAR cross sections

Specialised reprocessing of LiDAR point cloud data (credit Landpro)

Objective to maximise quality of open channel geometry

Improving on the default processed “1m raster” data

Before and after

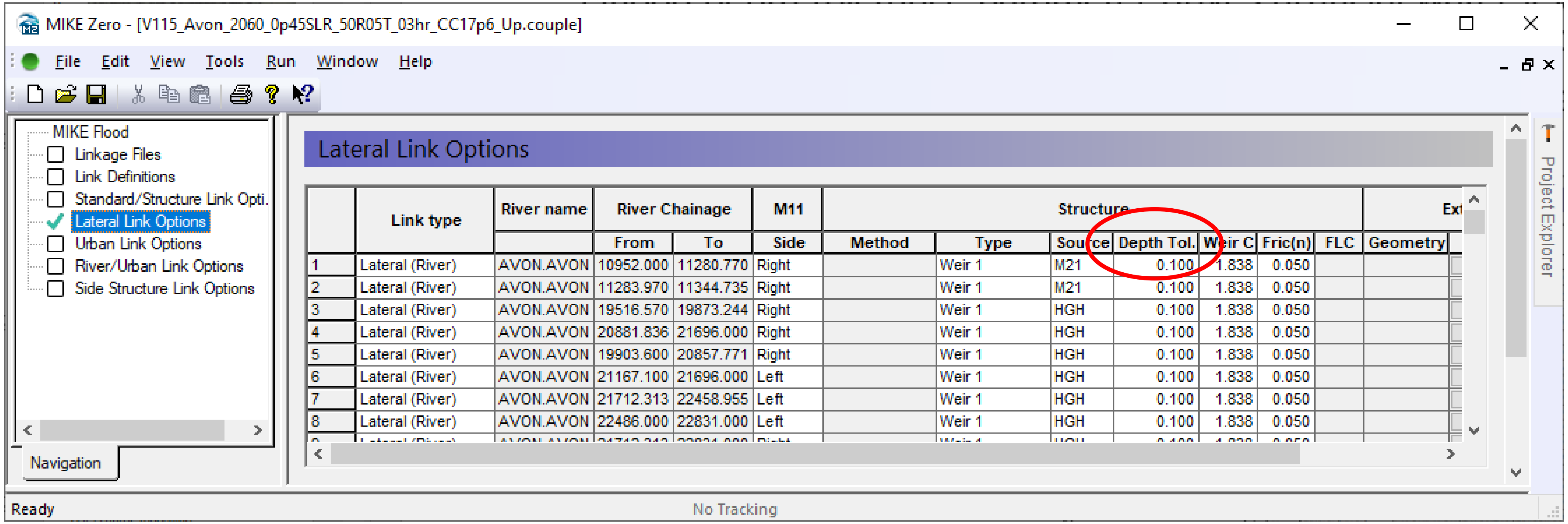


Very early days but looks promising so far

Depth tolerance

Mflood depth tolerance parameter drives artificial water level differences between river and floodplain (M11 – M21), but beneficial to model stability

Current practices 0.100 – 0.300m tolerance, unacceptable to Council



Depth tolerance

Early results (credit Antoinette@DHI) indicate that v2020 might be intrinsically better so as to work with acceptable tolerance such as 0.025m

Further options being considered include;

- Conversion to MU open channels (CRS linking method)
- Adjusting the location of the linking line (and hence level), to avoid high depths
- More testing and trials are anticipated

Data centric modelling

Aligning input data and modelling data to reduce the efforts for interaction and model updates (model data certainly and GIS data hopefully)

Work has been happening in the other two waters

Aspirational and just starting maybe in stormwater (David!)


FEEDBACK
IDEA
RESPONSE
OPINION
SURVEY
ADVICE
COMMENT
RESULT
RATING

Modelling Group
WATER NEW ZEALAND

Modelling Symposium

Thank you!
Questions? Patai?