Report

Waima Modelling Report

24 AUGUST 2012

Prepared for

Northland Regional Council

36 Water Street
Whangarei 0140

42071138

URS

Project Managers:

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Jess Wallace/Justine Bennett
Associate Water Resources Engineer/Principal Evironmental Scientist

URS New Zealand Limited

URS Centre, 13-15 College Hill
Auckland 1011
PO Box 821, Auckland 1140New Zealand

T: 64 9 355 1300
F: 64 9 355 1333

Principal-In-Charge:

……
John Male
Principal Hydrologist

Author:

……
Jorge Astudillo
Senior Water Resources Engineer

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Table of Contents

Tables

Figures

Table of Contents

Appendices

Abbreviations

Abbreviation	Description

1 Introduction

1.1 Project Background

The Priority River 2011/2012 project seeks to improve the work that was done for the Priority Rivers Flood Risk Reduction Project as reported in 2010. The Waima River catchment was contained in the previous Waima & Punakitere Rivers Model (catchment 21). For that model the LiDAR information available was incomplete for the Waima catchment and a limited set of survey points was used to generate a rough ground model of the missing area. The quality of that ground model was insufficient, and the Waima River catchment model was found by the Northland Regional Council to be in need of improvement in order to provide confidence in the flood mapping for the catchment.

More recently, new LiDAR data became available for the area and enabled revision of the previous model to complete this scope of work. In addition to the LiDAR some new client requirements for the modelling work requested the inclusion of:

- new survey in some areas,
- more detail in the 1D model,
- inclusion of 2D areas in specific locations of interest, and
- more detail in the distribution of the runoff over the river network.

The improved model was run for the design events of 10yrs and 100yrs with climate change. The results from the revision were merged to the previous Waima & Punakitere River models to complete the flood mapping exercise for this major catchment.

Below is a description of the Waima River catchment and more detail regarding the scope and objectives for this modelling work.

1.2 Catchment Description

The previous model covered the Punakitere and Waima Rivers, together with a large number of tributaries over the total catchment area of 517 km². This report focusses specifically on the Waima River catchment, with references where relevant, to the Punakitere River.

The Waima and Punakitere Catchment is the largest catchment area in the Priority River project. It actually consists of two separate river systems with a common discharge point to the Hokianga harbour. The Waima River has catchment area of 55.7 km² and a main channel length of approximately 22 km.

State Highway 12 runs through the northern portion of the catchment, from Kaikohe to Waima. The catchment includes a number of other notable features such the Waima Primary School, Waima Forest and an airstrip.

Topography

The Waima catchment is dominated by the Waima Ranges at its head. The area is extremely steep and covered in native forest with few areas of exotic forest. The river opens onto an alluvial floodplain. Several old river channels are clearly visible across the alluvial fan indicating that the river has changed course many times. At the top of this fan the settlement of Waima is sited. The dynamic nature of this river and sediment system will continue overtime and therefore must be accommodated.

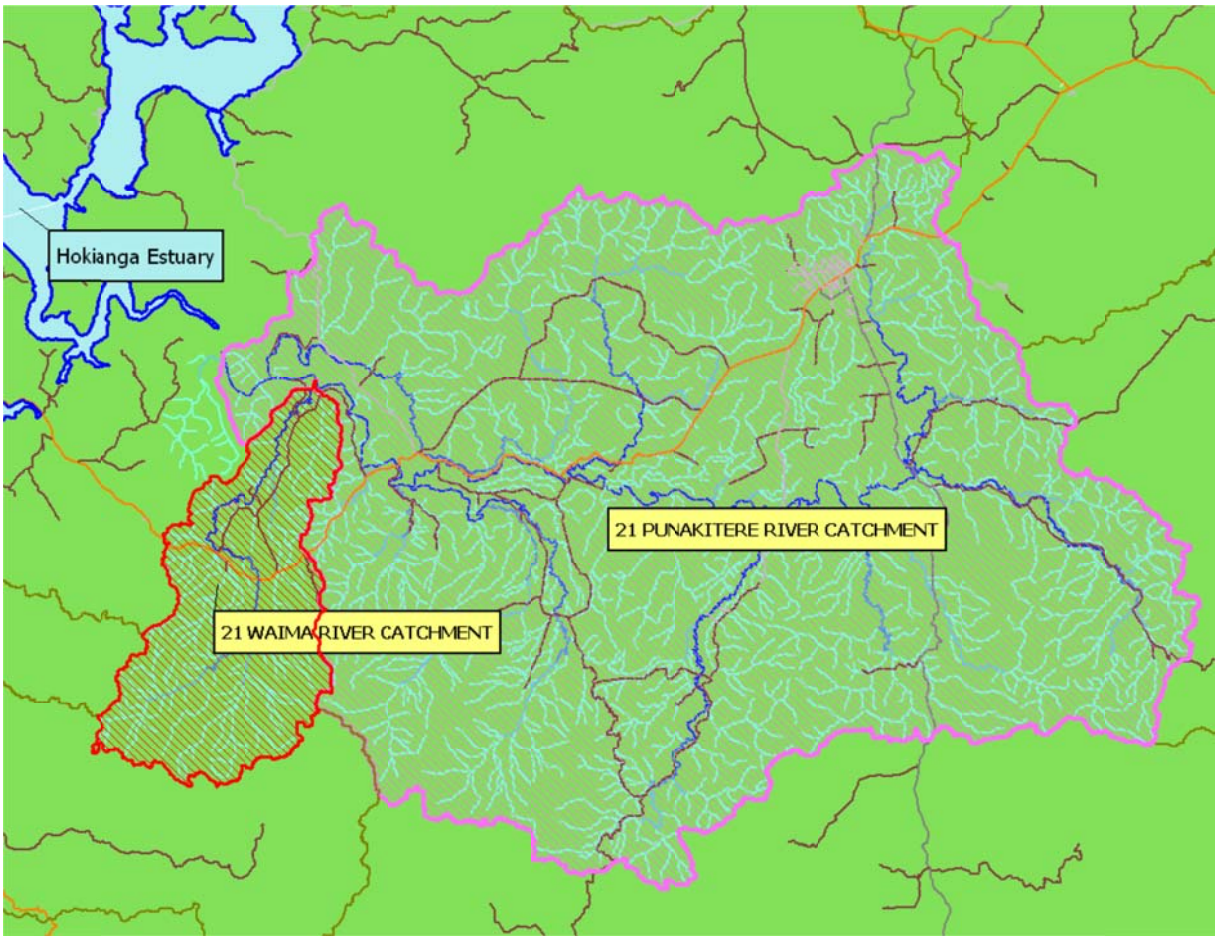
1 Introduction

Short duration, but high intensity rainstorms have caused widespread slipping in the upper catchment of the Waima River. At the exit of the gorge, debris has been deposited which has built up creating a dam, causing the river to create a new channel some distance from its previous course.

The river is cutting into a hillside to the east of the alluvial fan, causing the deep clay subsoil to slide off the underlying soft mudstone and sandstone bedrock as a large mudslide. Large volumes of sediment are being contributed to the river system and an ancient urupa (cemetery) along the ridge top is under threat. A small tributary stream on the western edge of the fan is also eroding its banks and threatening another urupa (cemetery).

Floods bring large volumes of boulders and debris down from the Waima Range and the eastern edge of the Waipoua Plateau. These are deposited in the channel from where the river emerges from the gorge to downstream of Pera Road. The relatively soft rock breaks down gradually to fine gravel and sand before it is carried into the lower parts of the valley but the larger, harder boulders are dropped closer to the gorge.

Figure 1-1 General location plan of the Waima catchment and tributaries



1.3 General Modelling Approach

The present project work continues the modelling methodology explained in the NRC Priority Rivers Modelling Report, Feb 2010. This modelling report is prepared as a supplementary report to the NRC Priority Rivers Modelling Report, Feb 2010. GIS and integrated modelling are central to the modelling methodology. This method assures a comprehensive model, more accurate outputs and the ability to be continually upgraded.

1.4 Modelling Scope

This work package treats the Waima River as a separate catchment model with the downstream boundary at the confluence with Punakitere River taken from the previous model.

New LiDAR was available in the area to generate a 1m ground model of main river network and flood plains. The revised Waima model was then run for a 12 hour design storm and flood maps were created from their results and included in Appendix A. The new flood maps were combined with the flood maps from the previous model to generate a final flood map for the Punakitere & Waima Rivers catchment.

Model Objectives

- Create a new ground model for the Waima Catchment based on the previous and new LiDAR information.
- Re-build the Waima river model using 1D, 2D and quasi 2D objects.
- Process new survey data and include in model.
- Run a 12 hour storm for the 10yr and 100yr with climate change ARI design events.
- Generate the respective flood maps for each design event.
- Merge flood maps to generate a combined representation of the Punakitere & Waima River catchments

Issues identified during model improvement

- Some sub-catchments required break down or re-delineation for a better distribution of runoff.
- Several storages were included for tributaries.

2

Data Collection

2.1 Data Collection

NRC provided URS with a new set of data to re-build the Waima River model. The list of data received is listed and described below:

- Extra LiDAR area for the upper part of the catchment.
- New Survey for a bridge and three culverts at the upper catchment.
- Floor survey and comparison with LIDAR.

Also, all previous data and the IWRS model were available as a basis for this work. For details refer to NRC Priority Rivers Modelling Report, Feb 2010.

2.2 Data Processing and Analysis

2.2.1 Survey data process and other GIS tasks

The modelling tasks were assisted by GIS. Additional LiDAR was processed in GIS and merged with the previous data set; 2D break lines and sub-catchment re-delineation were also assisted by GIS.

2.2.2 Surveyed Floor Levels

There is no debris level survey in the Waima Catchment; instead some property floor levels were available in the area, however the datum is unreliable (unknown datum). These points were processed in GIS and flood level results were taken from the model as part of the modelling tasks to enable NRC to review and assess properties at risk.

3

Modelling Methodology

3.1 Previous IWRS Model Analysis

As part of the first stage of NRC Priority River Models in 2010, a model of Waima catchment was built and run for a 48hr design event. The previous model developed by URS was used as the the starting point of this work.

The previous model was mainly defined with a 2D mesh covering the whole catchment. However, an important area of the Waima River had no LiDAR information and a few surveyed points were used to interpolate a ground surface to assist the 2D modelling work.

The sub-catchment definition was generally well defined; however the revised approach for this 2012 modelling considered subdividing some of the sub-catchments to provide a better resolution of the distribution of the runoff over the flood plains and each main tributary.

Following below is a description of the main aspects of the model build.

3.2 Hydraulic and Hydrological Features

The 2012 model of the Waima catchment has the following general features that can be classified as hydraulic and hydrological:

Hydraulic

1. All hydraulic objects were re-built in the new version of Waima model. Cross sections, 2D areas, storage areas, spills, structures, were defined in detail based on the new scope and data available for this work.
2. The main stream of the Waima catchment is modelled with 1D-objects that allow more efficient and accurate inclusion of survey cross sections and some structures.
3. All flood plains in the main valley (adjacent to Waima River) are modelled as a 2D mesh connected through lateral spills based in a new 1m grid ground model that takes into account the new LiDAR data.
4. The 2D mesh has 1 – 2 metre resolutions along all streams and channels of importance, and is included inside the 2D polygons. Roads and other structures also have also a higher resolution of between 2 – 10 metres. The rest of the mesh (mainly flat and homogenous flood plains) has a resolution from 10 – 25 meters approximately.
5. The 2012 survey data was included in the model. It considers one bridge and few culverts in the zone of the alluvial fan in the upper catchment.
6. The original 2010 modelling approach considered that all sub-catchments discharged directly into the main streams and flood plains would flood as a result of the river spilling on those areas. However, for a better description of the runoff and surface flow, sub-catchments have now been modelled to discharge in three main categories: runoff direct to streams, runoff over flood plains, and tributaries discharging on 2D mesh. In this way the volume of the floods is better defined for each unit.
7. The flood maps for the Waima River will be merged with the previous flood maps for the rest of the Punakitere Rivers catchment (Catchment 21). For that purpose, the water level series of those previous results at the downstream end of Waima River were used as the level boundary condition for the 2012 Waima model. In this way, the merged final flood map will

3 Modelling Methodology

have coherent levels where the two areas meet. For example, the new 10yrs, 12 hour design event takes the levels from the 10yrs 48hours design event of the previous model as a boundary condition.

Hydrological

1. The same hydrological model was used for this new version of Waima model, which is based on the US SCS method. All hydrological parameters were taken unchanged from previous model; such as CN values, time of concentration, time of peak, etc. For more details refer to the NRC Priority Rivers Modelling Report, Feb 2010.
2. In order to discharge the runoff in more detail (as described above in the hydraulics features, bullet point 6), it was necessary to break down some sub-catchments and recalculate the SCS hydrological parameters of the new subcatchment shapes.
3. The previous 2010 model used a 48hr storm. As the new Waima catchments has a shorter time of concentration (of about 5 hours), it was expected that a shorter duration with higher intensities storm would produce more floods. For that reason, the model was tested to compare the floods produced for a 48 hours storm against a 12 hours storm, for a 10yrs and 100yrs with climate change scenarios. The results showed that 12 hours is more critical and this duration was then chosen to run with the 2012 Waima model. The final merged Waima /Punakitere flood map is a combination of the results for both of these storm durations.
4. Adjustments were necessary to meet the river peak flow with a tide peak level at boundary. The downstream level boundary series was not modified, but the 12hrs design rain was positioned on a time basis that would generate a flow that would meet peaks at the downstream end of the catchment (tide peak levels with river peak flows).
5. The areal reduction factor was set at ARF=1 and the US SCS method was applied for the hydrological model, as was specified in the previous Punakitere & Waima Rivers model.

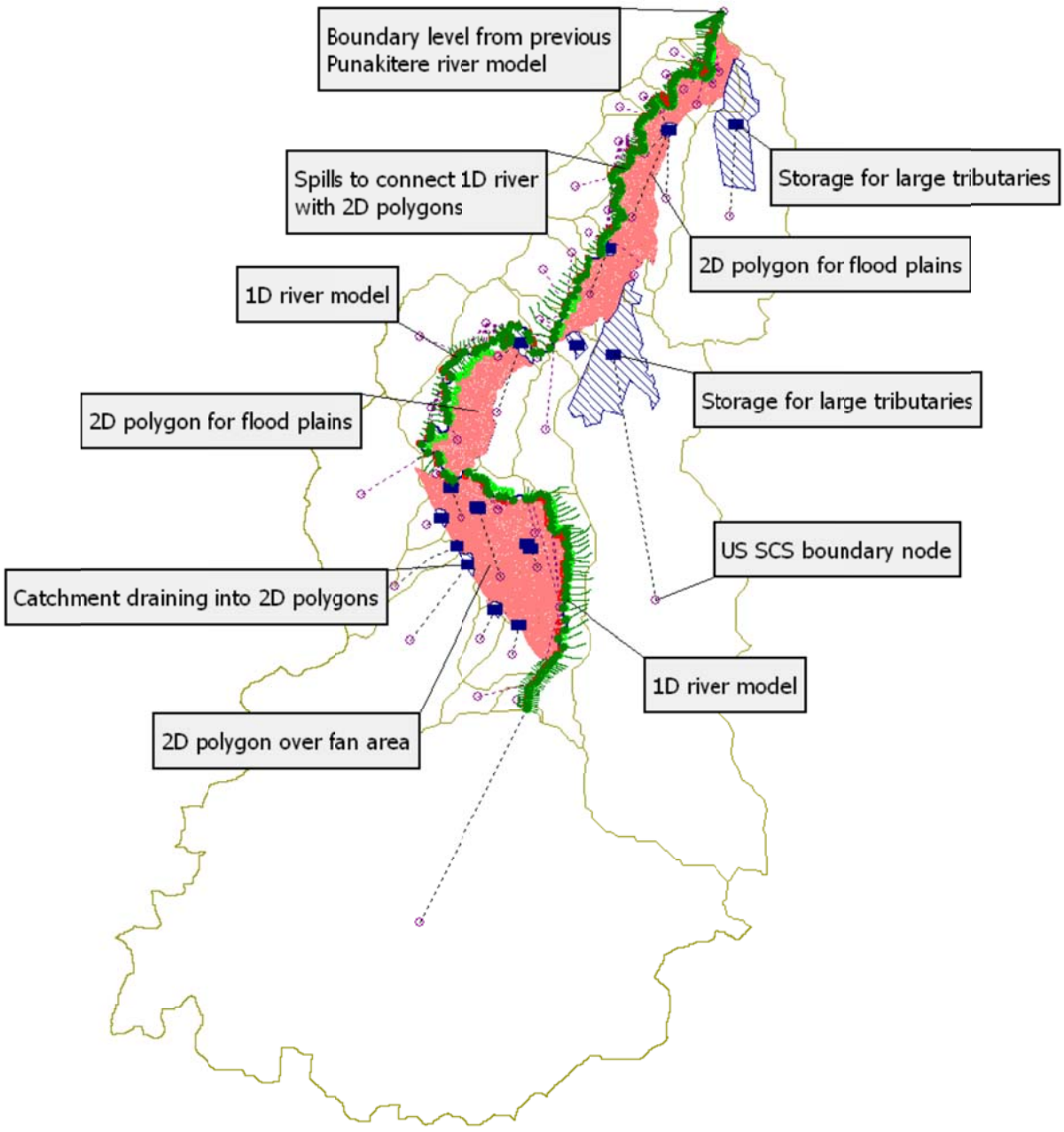
Figure 3-1 outlines a general description of the modelling approach. The table below summarized the general features of the Waima model.

Table 3-1 Waima model general features

Catch Name	WAIMA RIVER
Catch ID	21b
Priority	4
Design Storm Duration (hrs.)	12
ARF	1.00
Rain profile	NRC
Hydrological Model	US SCS

3 Modelling Methodology

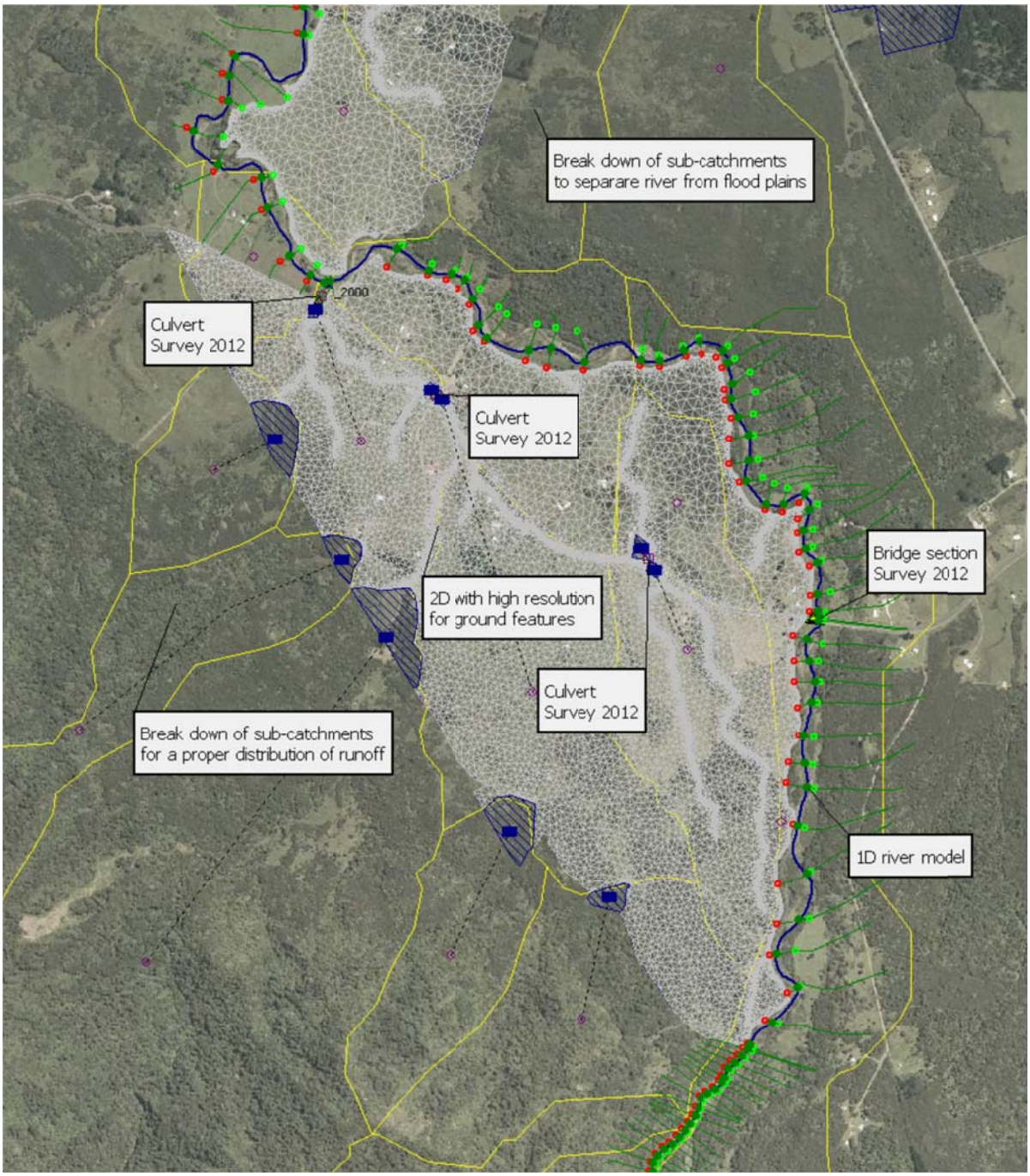
Figure 3-1 General description of new Waima Model



3 Modelling Methodology

Figure 3-2 below shows the upper part of the 2012 Waima River model. It shows the main 1D river; and the 2D mesh with different resolutions as described previously as well as some sub-catchments discharging into the 2D mesh before reaching the main river.

Figure 3-2 Upper part of new Waima River model



3.3 Model Parameters

The scope of work for this catchment does not include either a model calibration or model verification task. For the main hydraulic and hydrological parameters the following values were used (in accordance with the previous 2010 model and other NRC catchment models) as shown in Table 3-1 below.

Table 3-2 Modelling parameters

Variable	Value
HYDRAULIC MODEL	
Manning	
Main channels	0.020 - 0.060
Flood plains	0.070
2D polygons	0.055
Spill coefficient	
Natural bank	0.59
Roads	0.82
Upper storage outlets	1.00
Orifice coefficients (culverts)	1.00
HYDROLOGICAL MODEL	
US SCS Method	
ARF	1.0
CN	*as per land use*
Time of Concentration	*as per TP108*

The CN values were taken as the same as previous Waima model. For more details refer to the NRC Priority Rivers Modelling Report, Feb 2010.

3.4 Design Events

As previously mentioned, the 2012 Waima model considers a 12 hour duration storm event, instead of the previous 48 hours. The final merged flood map is a combination results from both of these events.

The design events simulated for the Waima model have the following features:

1. The spatial distribution of the rain was applied using the Hirds V3 distribution. This was applied as a factor between 0 and 1 over the US SCS hydrographs for each sub-catchment. The nominal rainfall depth was set at the maximum which correspond to a factor of 1.0. For more details of this methodology refer to the NRC Priority Rivers Modelling Report, Feb 2010.
2. No areal reduction factor was applied (ARF=1.00)
3. Two ARI events were simulated: 100yrs plus climate change; and 10 years plus climate change. Table 3-2 below shows the rainfall depths for the 12 hour duration storms.
4. The same rainfall pattern was used as in the previous NRC Priority Rivers work. For more details refer to NRC Priority Rivers Modelling Report, Feb 2010.
5. The boundary level conditions were taken from the previous 2010 model results (48 hour design event) at the bottom end of Waima River such that the new 12 hour design event takes the water level series from the respective 48 hour design event of the previous model. In this way, the merged final flood map will have consistent levels at joining area.

Table 3-3 Design storm rain depth

Design Storm	12 hrs Average rain depth (mm)	12 hrs max rain depth (mm)	12 hrs min rain depth (mm)	[12 hrs average rain depth] x ARF (mm)
Distribution factor	0.908	1.00	0.80	-
ARF	-	-	-	1.00
ARI 010	108.5	119.52	95.62	108.5
ARI 100F	202.2	222.75	178.20	202.2

4

Modelling Results

The location and floor level of 54 houses is known and presented in Appendix B. The datum used for this floor survey has not been confirmed and is unreliable as it does not match with the OTP LiDAR elevations. The flood levels in the vicinity of these houses were extracted from design event simulations and shown in Table 3-3 below. From data analysis it seems that the survey datum is 30 to 40 cms above the OTP datum, in these circumstances, it appears that less than 10 houses are at different levels of risk. Further confirmation of the OTP floor level is required to confirm this statement.

Table 4-1 Flood levels at vicinity of houses in Waima River

Name ID	Floor Level [m] [unknown datum]	Elevation 10yrs [m OTP]	Elevation 100yrsCC [m OTP]
Point House #01	12.00	11.51	11.96
Point House #02	14.00	12.44	13.49
Point House #03	14.00	13.07	13.47
Point House #04	14.71	12.94	13.66
Point House #05	15.45	13.31	14.13
Point House #06	16.98	16.15	16.15
Point House #07	21.01	20.34	20.34
Point House #08	20.64	20.34	20.34
Point House #09	20.71	19.75	19.75
Point House #10	22.26	21.60	21.60
Point House #11	32.02	29.80	30.52
Point House #12	30.96	29.43	30.17
Point House #13	32.64	29.08	29.71
Point House #14	35.32	33.62	33.62
Point House #15	36.38	34.82	34.91
Point House #16	37.30	36.35	36.35
Point House #17	38.40	37.75	37.75
Point House #18	38.48	38.03	38.04
Point House #19	40.51	39.54	39.55
Point House #20	40.45	39.09	39.26
Point House #21	39.88	39.47	39.66
Point House #22	39.50	38.83	38.83
Point House #23	40.30	38.96	38.96
Point House #24	43.50	42.65	42.68
Point House #25	43.26	41.57	41.57
Point House #26	45.16	43.79	43.79
Point House #27	42.38	41.08	41.33
Point House #28	45.29	44.35	44.38
Point House #29	45.31	44.92	44.97
Point House #30	44.34	43.62	43.64
Point House #31	44.60	43.52	43.53
Point House #32	44.22	43.07	43.08
Point House #33	47.09	46.63	46.67
Point House #34	47.01	46.97	47.03

4 Modelling Results

Table 4-2 Flood levels at vicinity of houses in Waima River (continuation)

Name ID	Floor Level [m] [unknown datum]	Elevation 10yrs [m OTP]	Elevation 100yrsCC [m OTP]
Point House #35	54.02	53.23	53.23
Point House #36	52.12	49.84	49.84
Point House #37	52.45	50.86	50.86
Point House #38	52.31	50.86	50.86
Point House #39	53.62	51.59	51.59
Point House #40	54.49	53.34	53.34
Point House #41	52.79	51.81	51.81
Point House #42	53.16	53.26	53.26
Point House #43	53.17	52.84	52.84
Point House #44	57.69	56.90	56.90
Point House #45	57.61	56.61	56.61
Point House #46	58.95	58.42	58.42
Point House #47	62.32	60.10	60.10
Point House #48	65.79	65.34	65.34
Point House #49	66.64	65.11	65.13
Point House #50	67.13	66.41	66.41
Point House #51	69.38	68.36	68.36
Point House #52	67.83	67.01	67.01
Point House #53	68.34	67.30	67.30
Point House #54	77.30	76.91	76.91

5

Discussion

The 2012 Waima River model presents important improvements made to the previous Priority River models. The major improvements are:

- The incorporation of more 2D areas with more detailed representation of the ground features.
- More detail in the definition of lateral spills from the river system.
- More storage areas were included to assist with the distribution of runoff for main tributaries.
- The subdivision of sub-catchments to provide greater resolution over areas of interest

It is important to note that the main river has been carefully separated from the flood plain and in most cases is defined by an elevated bank or a road. The level of this elevated bank/road has to be reached and exceeded by the water on either side in order to spill over to the other. The new sub-catchments discharge into different model objects separated by this bank or road that is described as a spill or in some cases covered by a 2D mesh.

To complement the previous features sub-catchment delineation also needed to incorporate LiDAR features (such road and river banks) in their definition for a better distribution of the runoff over the different flooding areas.

The Waima catchment does not have useful data to allow a calibration or validation of model results. Therefore most parameters have been defined based on similarities with other catchments and based on general experience. However, the detailed approach for the modelling objects provides more confidence so as to reduce some uncertainties related to the hydraulic performance, and limit the uncertainties to parameters such roughness, CN values or certain head loss coefficients.

As a result of this modelling work, the model reproduces the flood extents with an improved level of confidence and within the expected range of flood elevation.

6

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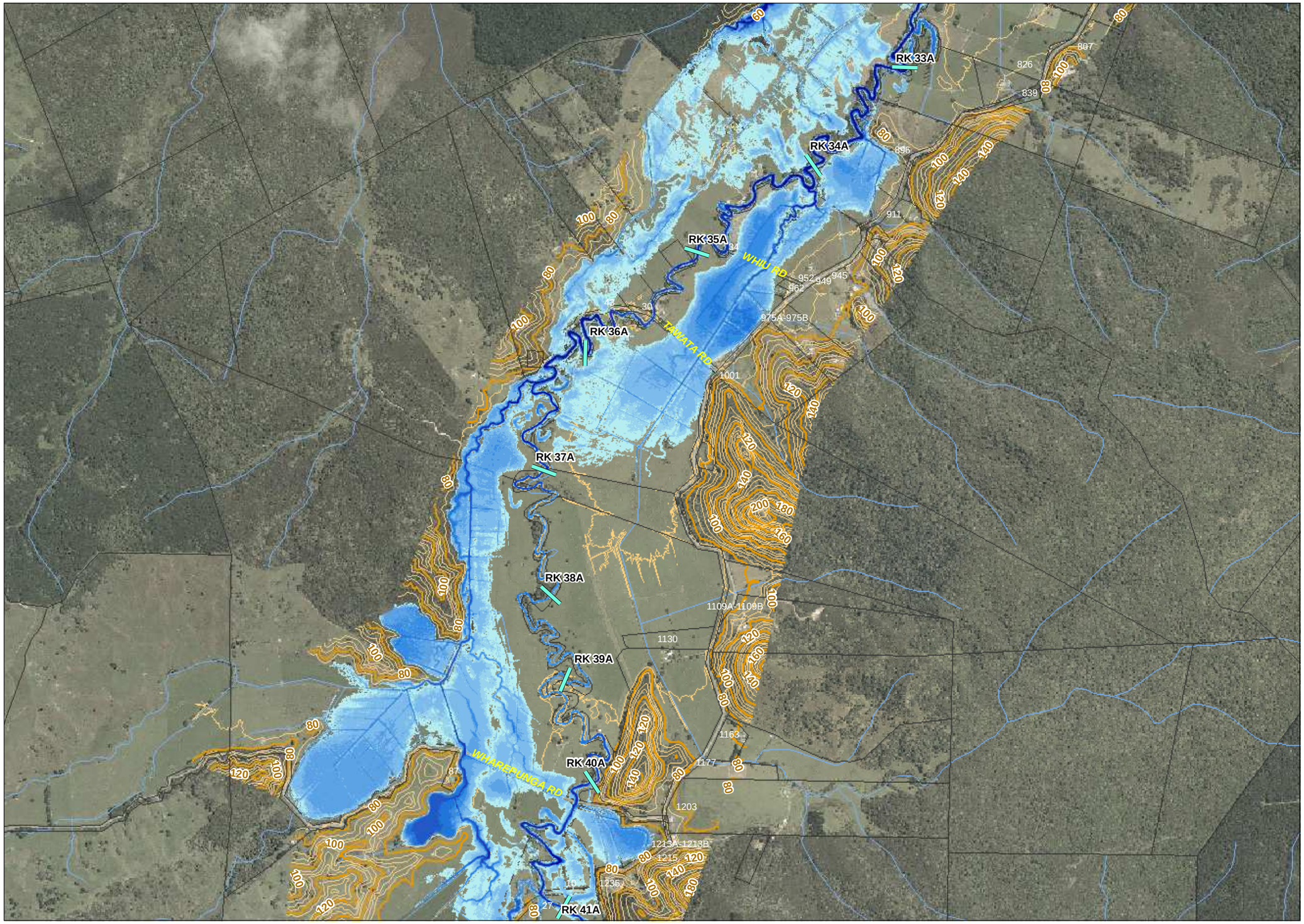
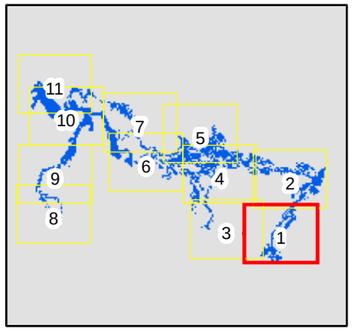
A

Appendix A Flood Maps





10 year ARI

Duration 48h

River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
- 0.16 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

Final

WAIMA RIVER 10 YEAR ARI

URS

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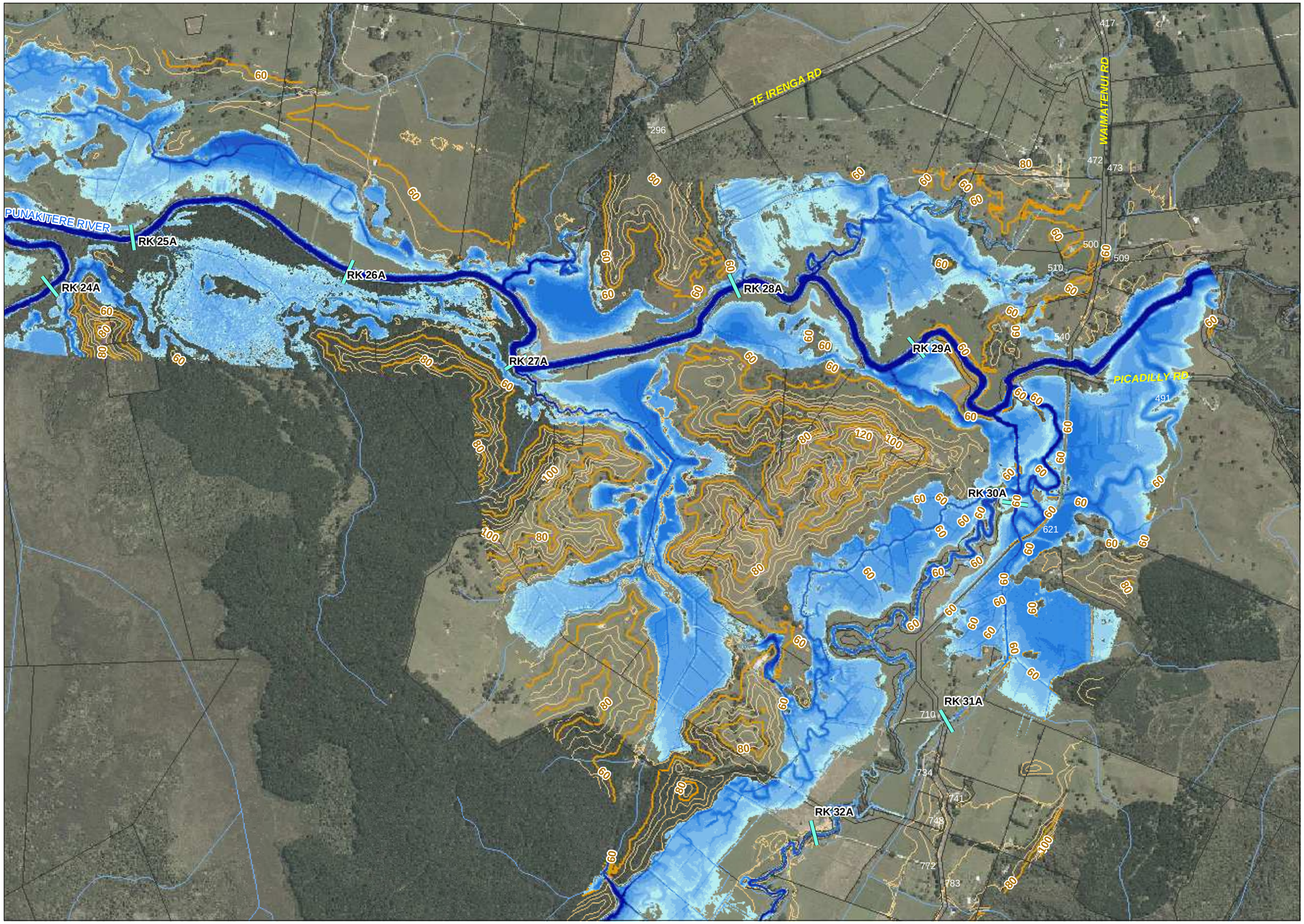

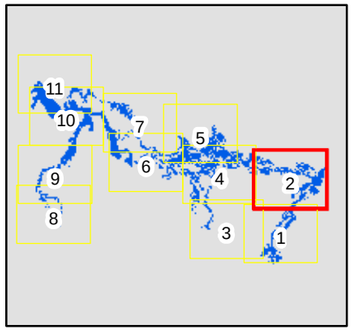

N

Scale 1:15,000

10 year ARI
Duration 48h

River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
- 0.16 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

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FLOOD MAPS

Final

WAIMA RIVER 10 YEAR ARI

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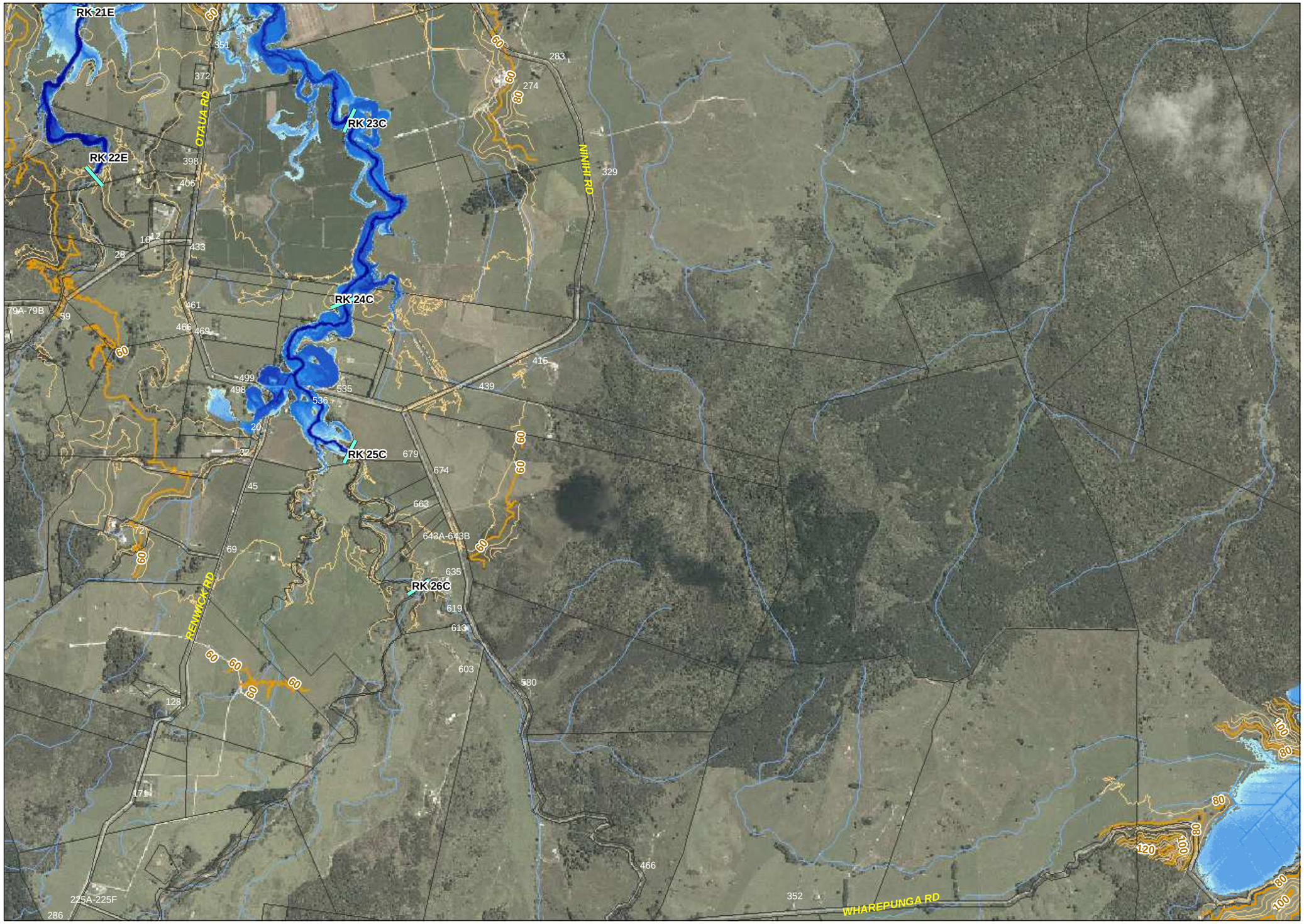

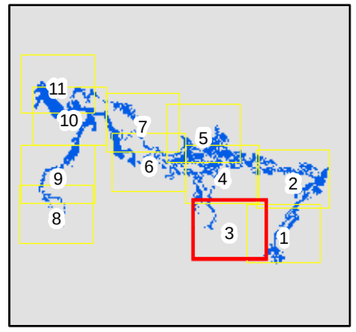

N

10 year ARI

Duration 48h

River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
- 0.16 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

Scale 1:15,000

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FLOOD MAPS

WAIMA RIVER 10 YEAR ARI

Final

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RK 24B
RK 19A
RK 21D
RK 22D
RK 23D
RK 24D
RK 20A
RK 21A
RK 22A
RK 23A
RK 24A
RK 19C
RK 19E
RK 20C
RK 20E
RK 21C
RK 22C
PUNAKITERE RIVER
PUNAKITERE RD
ROGER RD
MANGATOKA RD
OTHIN RD
NIHIHI RD
3687
3743
4120
103
44
268
234
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240
258
168
322
60
80
40

N

Waima River Location

11
10
7
5
6
4
9
2
8
3
1

10 year ARI
Duration 48h
River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
- 0.16 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

Scale 1:15,000

Manaaki Awa the River Care Group
NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

Final

WAIMA RIVER 10 YEAR ARI

URS

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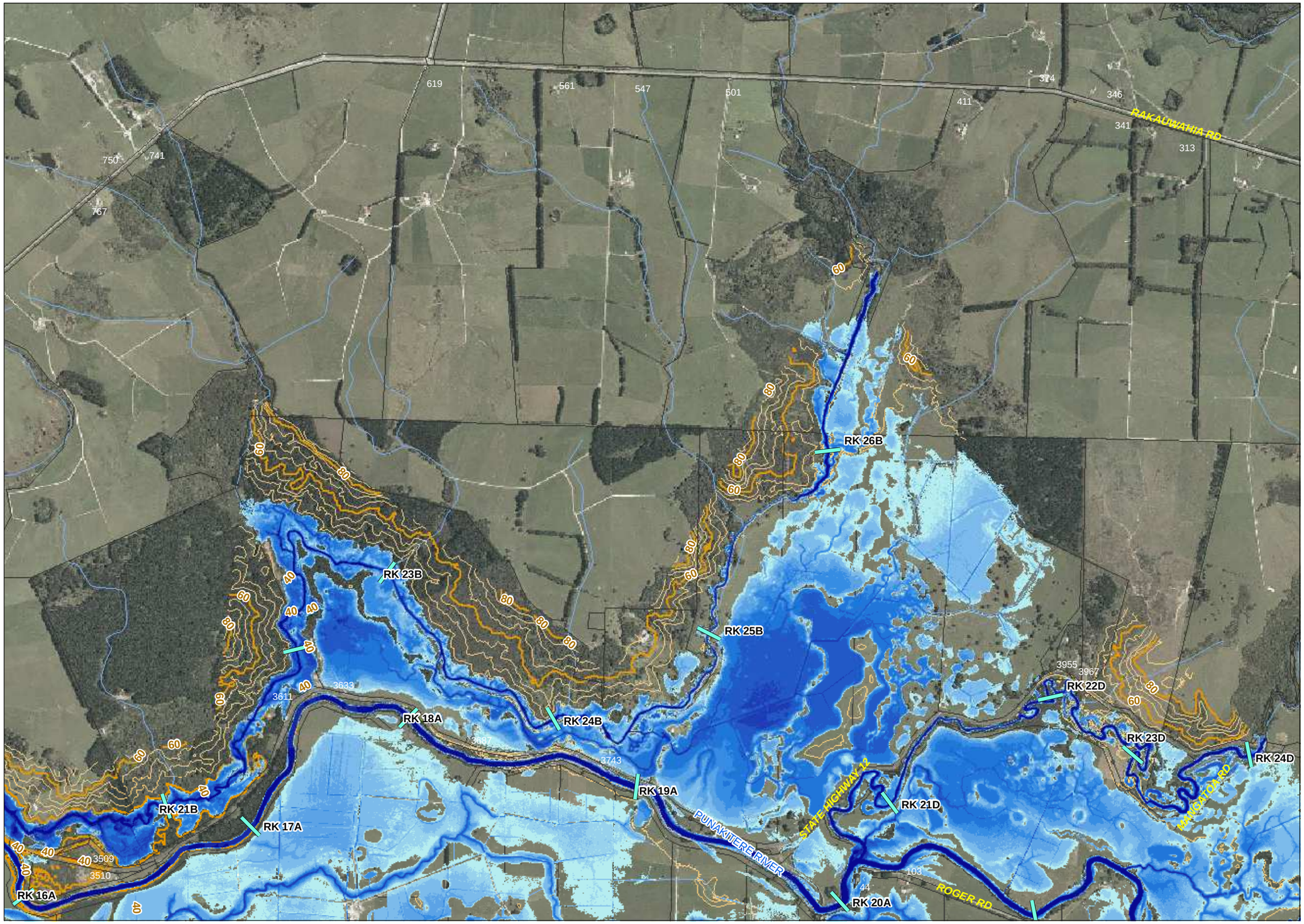

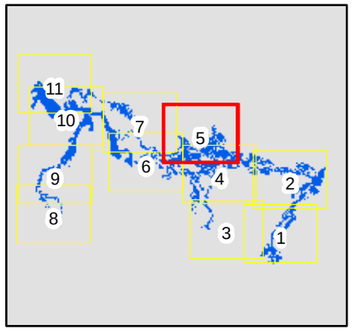

10 year ARI

Duration 48h

River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
- 0.16 - 0.25
- 0.26 - 0.50
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Scale 1:15,000

Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

Final

WAIMA RIVER 10 YEAR ARI

URS

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Rev. **A** A3

RK 09A
RK 10A
RK 11A
RK 12A
RK 13A
RK 14A
RK 14C
RK 15A
RK 15C
RK 16A
RK 16C
RK 17A
RK 17C
RK 18B
RK 18C
RK 18E
RK 19B
RK 20B
RK 21B
RK 23B
PUNAKITERE RIVER
STATE HIGHWAY 12
PUHA RD
TAHEKE RD
RAMSEY RD
OTAUA RD

Waima River Location

10 year ARI
Duration 48h
River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
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Scale 1:15,000

Manaaki Awa The River Care Group
NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 10 YEAR ARI

Final

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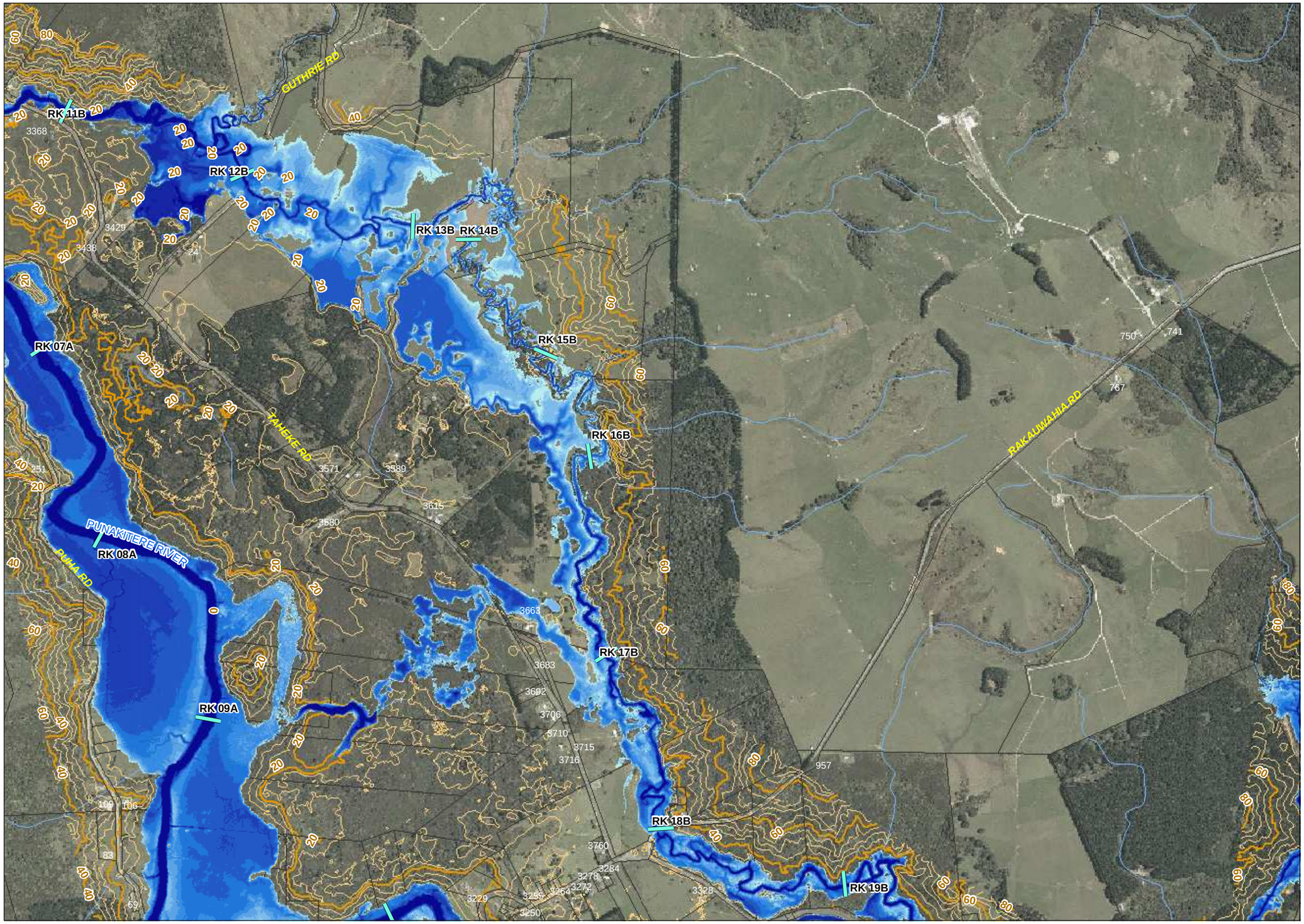

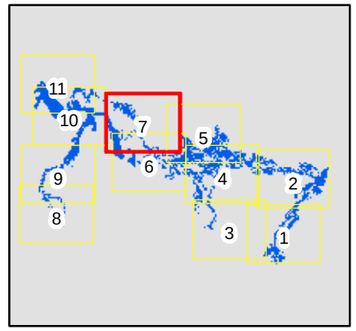

10 year ARI

Duration 48h

River Kilometre, Rk

Flood Depth, m

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

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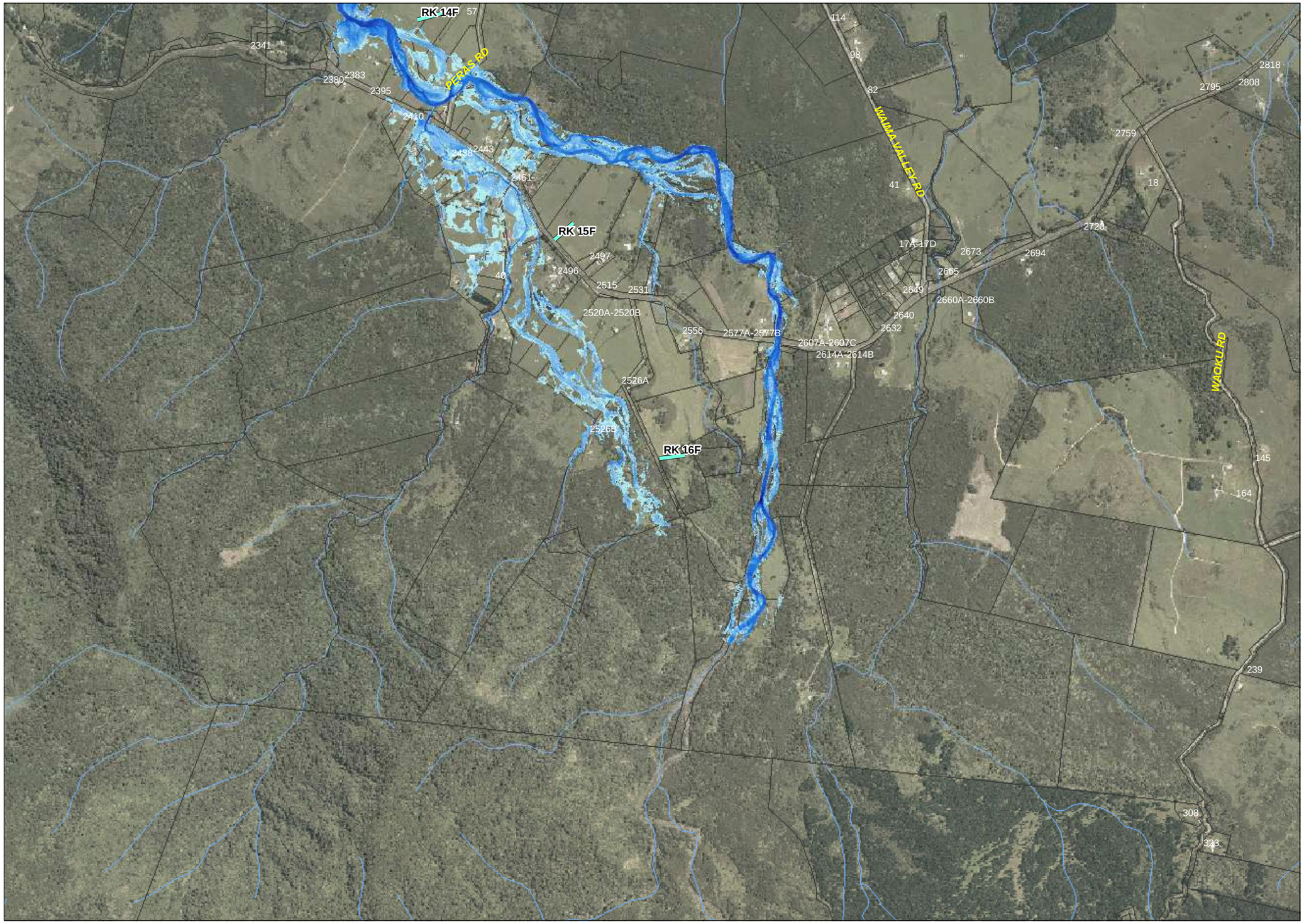

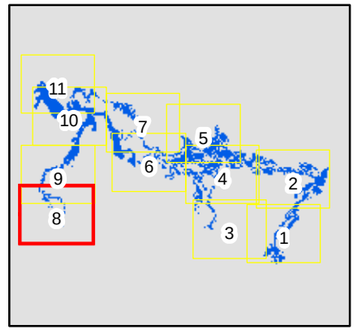

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River Kilometre, Rk

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

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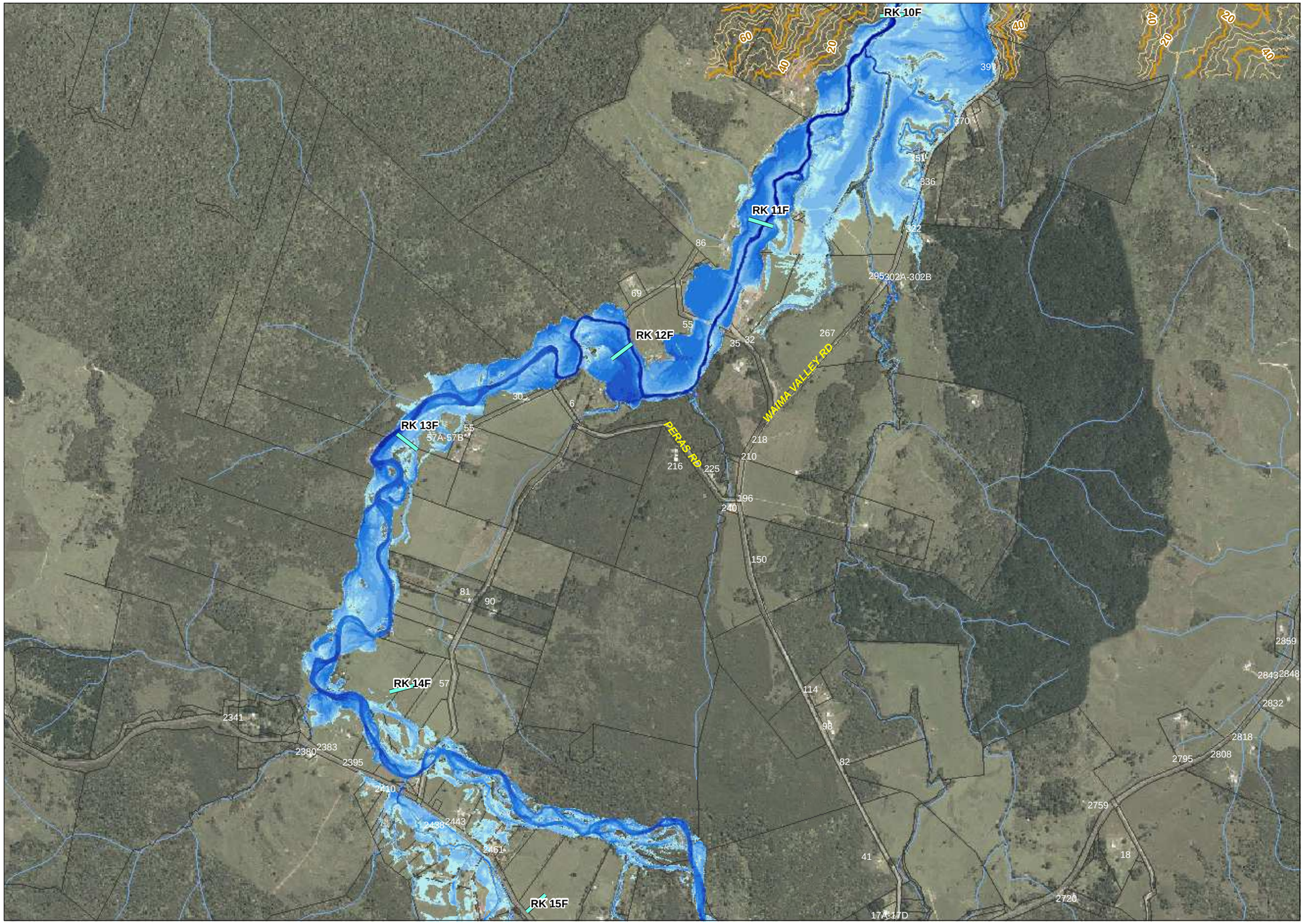

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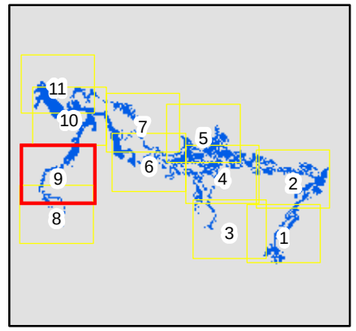

10 year ARI

Duration 48h

River Kilometre, Rk

Flood Depth, m

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Scale 1:15,000

Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 10 YEAR ARI

Final

URS

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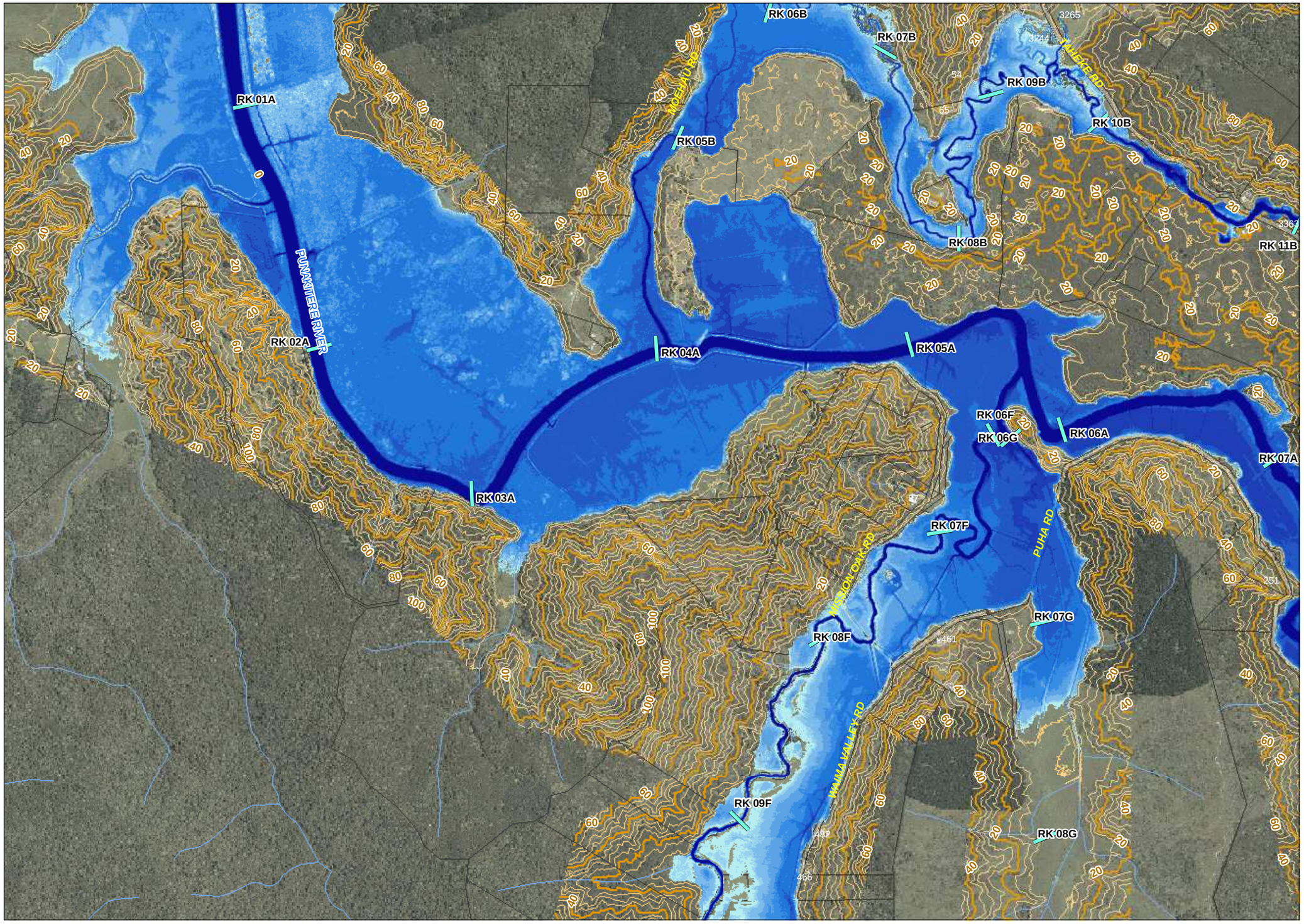

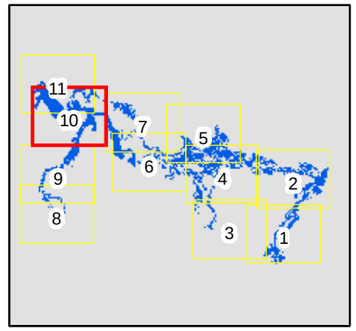

10 year ARI

Duration 48h

River Kilometre, Rk

Flood Depth, m

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Scale 1:15,000

Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 10 YEAR ARI

Final

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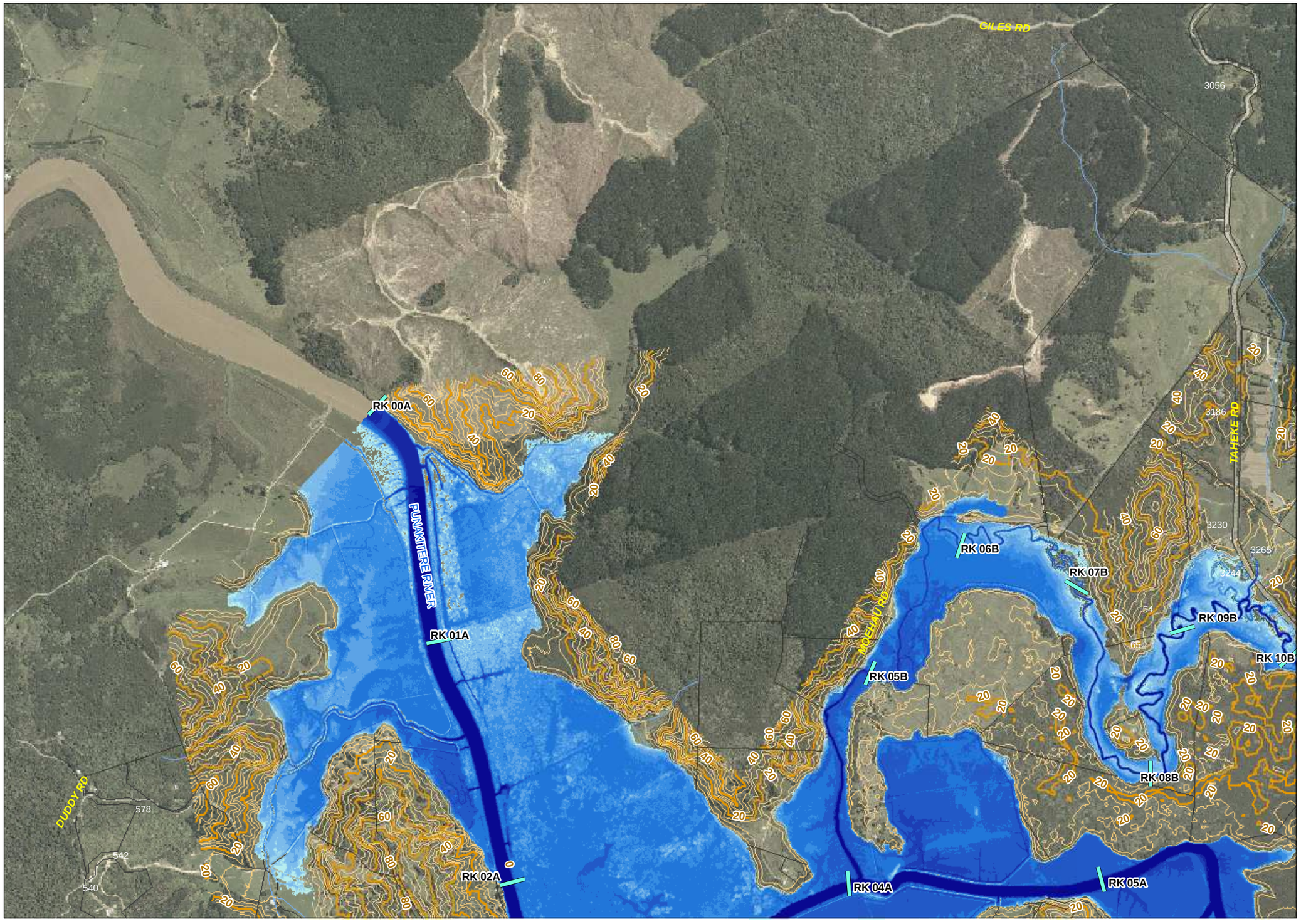

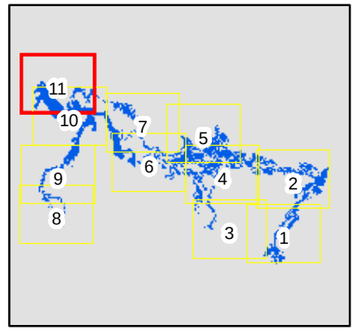

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10 year ARI

Duration 48h

River Kilometre, Rk

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Scale 1:15,000

Manaaki Awa
The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

Final

WAIMA RIVER 10 YEAR ARI

URS

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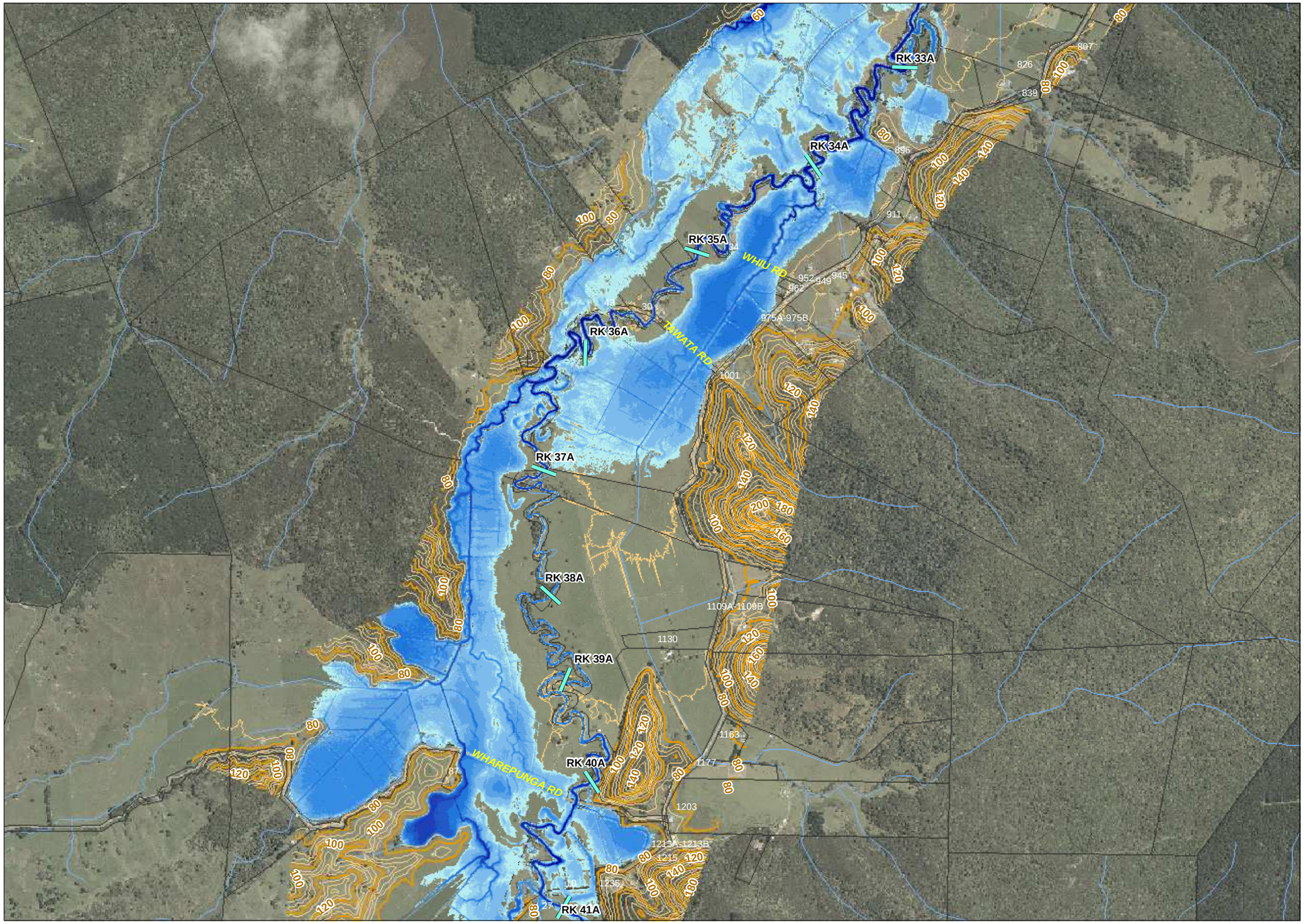

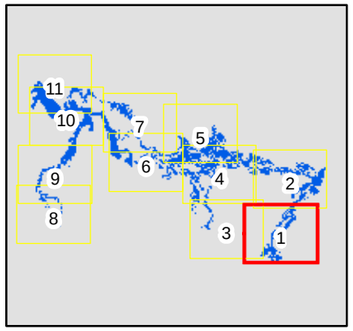

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100 year ARI plus Climate Change

Duration 48h

River Kilometre, Rk

Flood Depth, m

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Scale 1:15,000

Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

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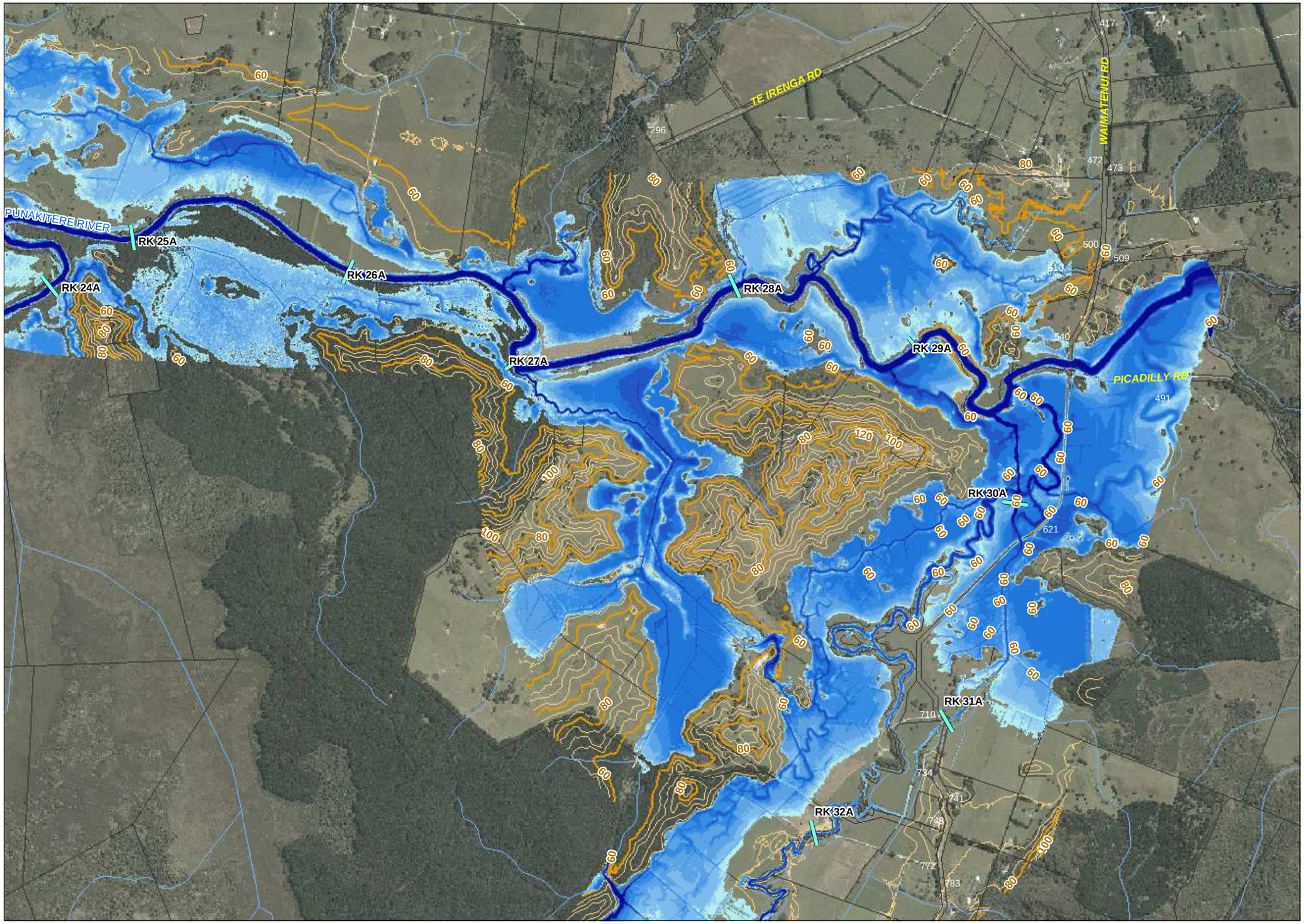

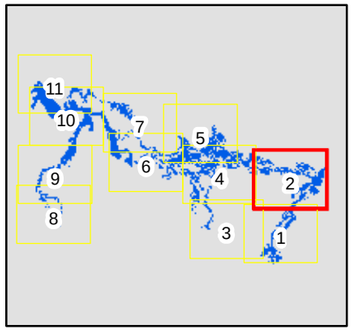

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100 year ARI plus Climate Change

Duration 48h

River Kilometre, Rk

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

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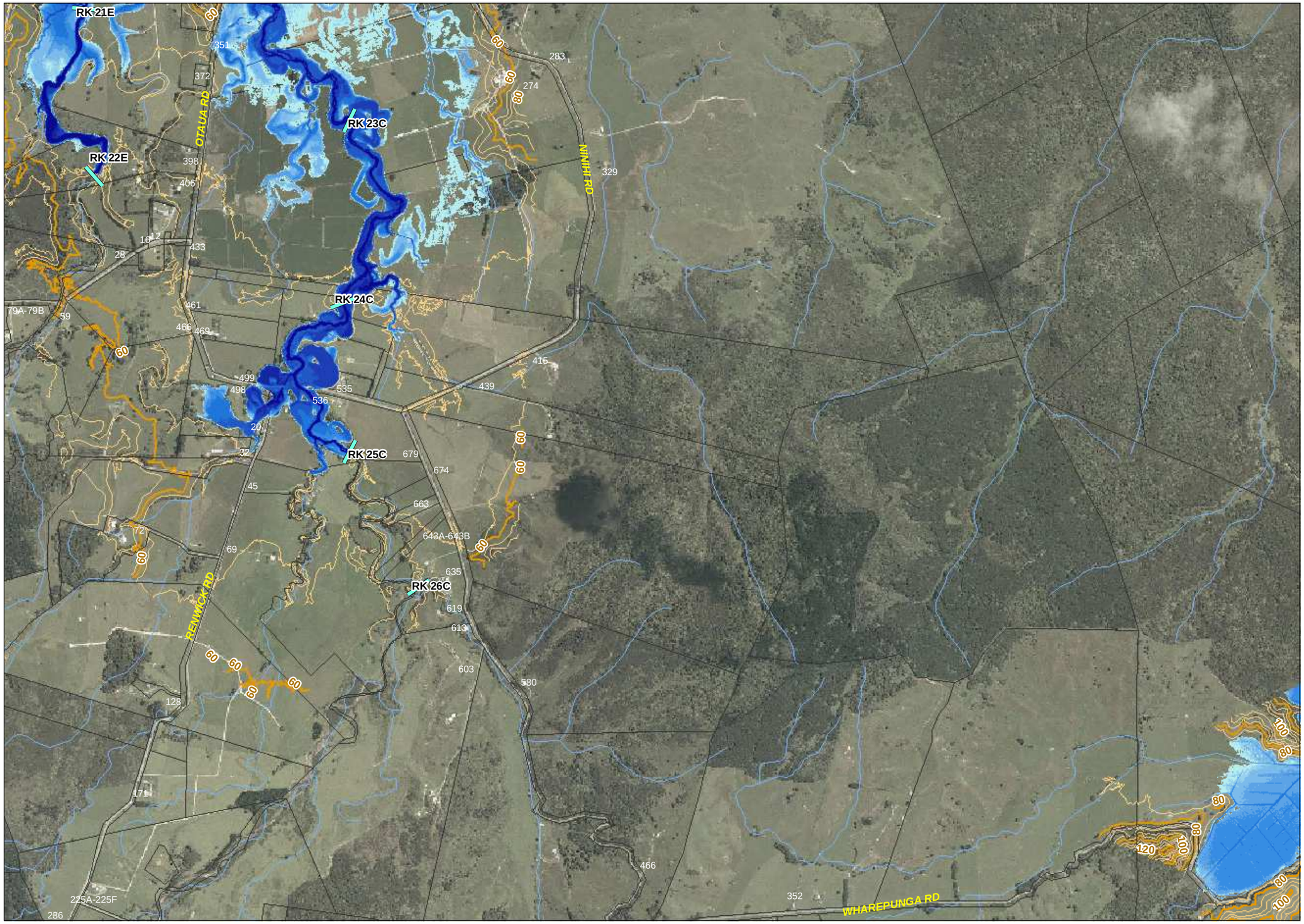

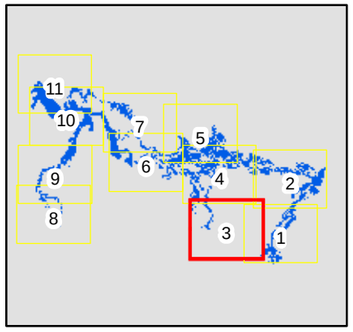

100 year ARI plus Climate Change

Duration 48h

River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
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Scale 1:15,000

Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

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RK 18A
RK 24B
RK 19A
RK 21D
RK 22D
RK 23D
RK 24D
RK 20A
RK 21A
RK 22A
RK 23A
RK 24A
RK 19C
RK 19E
RK 20C
RK 20E
RK 21C
RK 22C
PUNAKITERE RIVER
PUNAKITERE RD
ROGER RD
MANGATOA RD
OTAUA RD
RUNRIL RD
3687
3743
4120
103
44
268
234
199
267
144
137
139
142
27
194
240
168
258
322

N

Waima River Location

100 year ARI plus Climate Change
Duration 48h

River Kilometre, Rk

Flood Depth, m

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Scale 1:15,000

Manaaki Awa The River Care Group
Northland Regional Council

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

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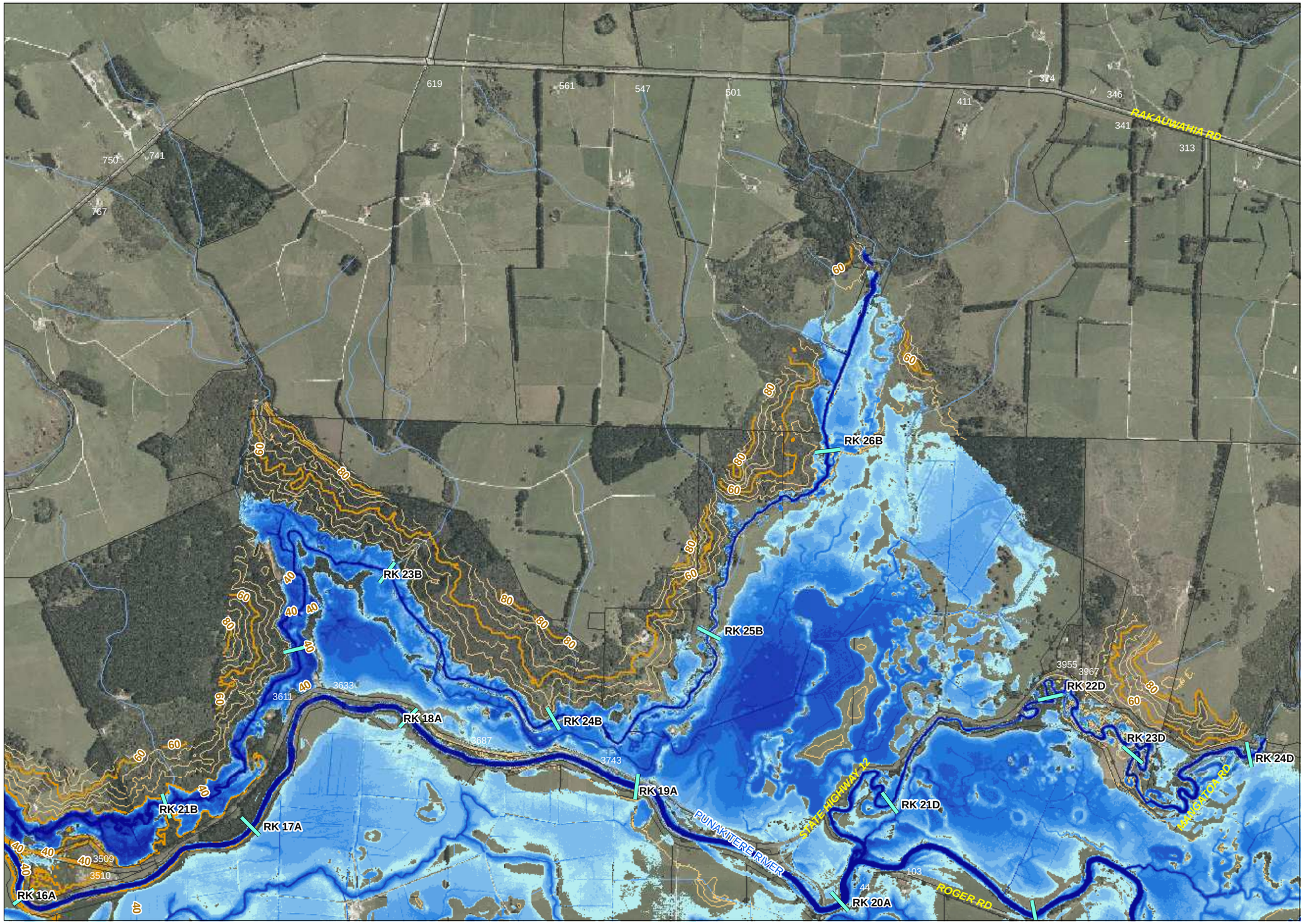

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

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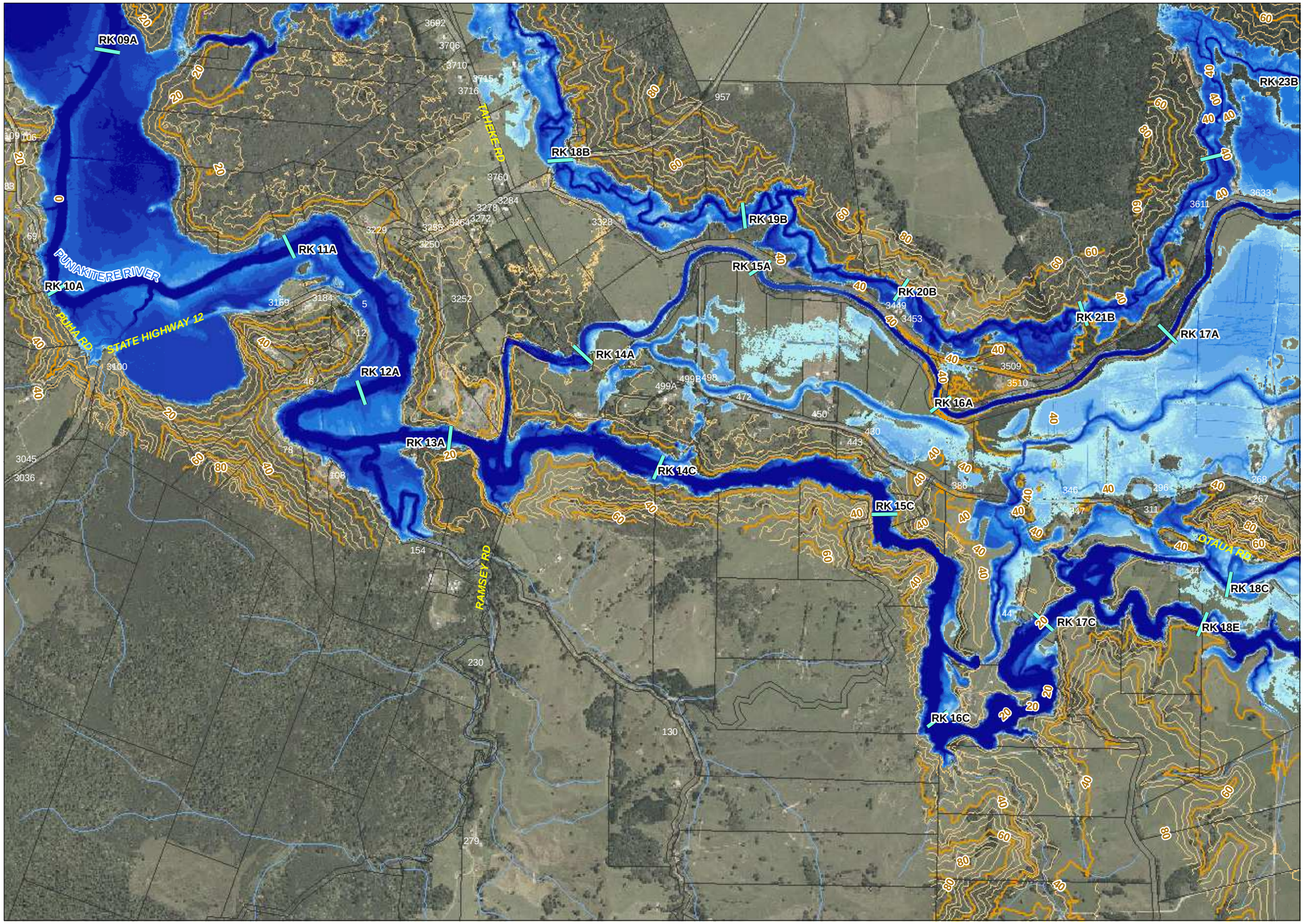
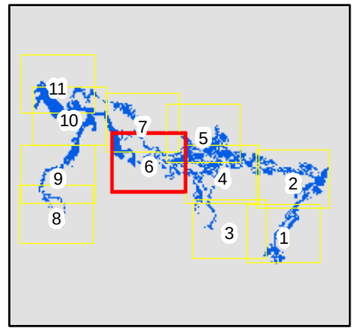
Sheet 5 of 11

Rev. **A** A3





100 year ARI plus Climate Change

Duration 48h

River Kilometre, Rk

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

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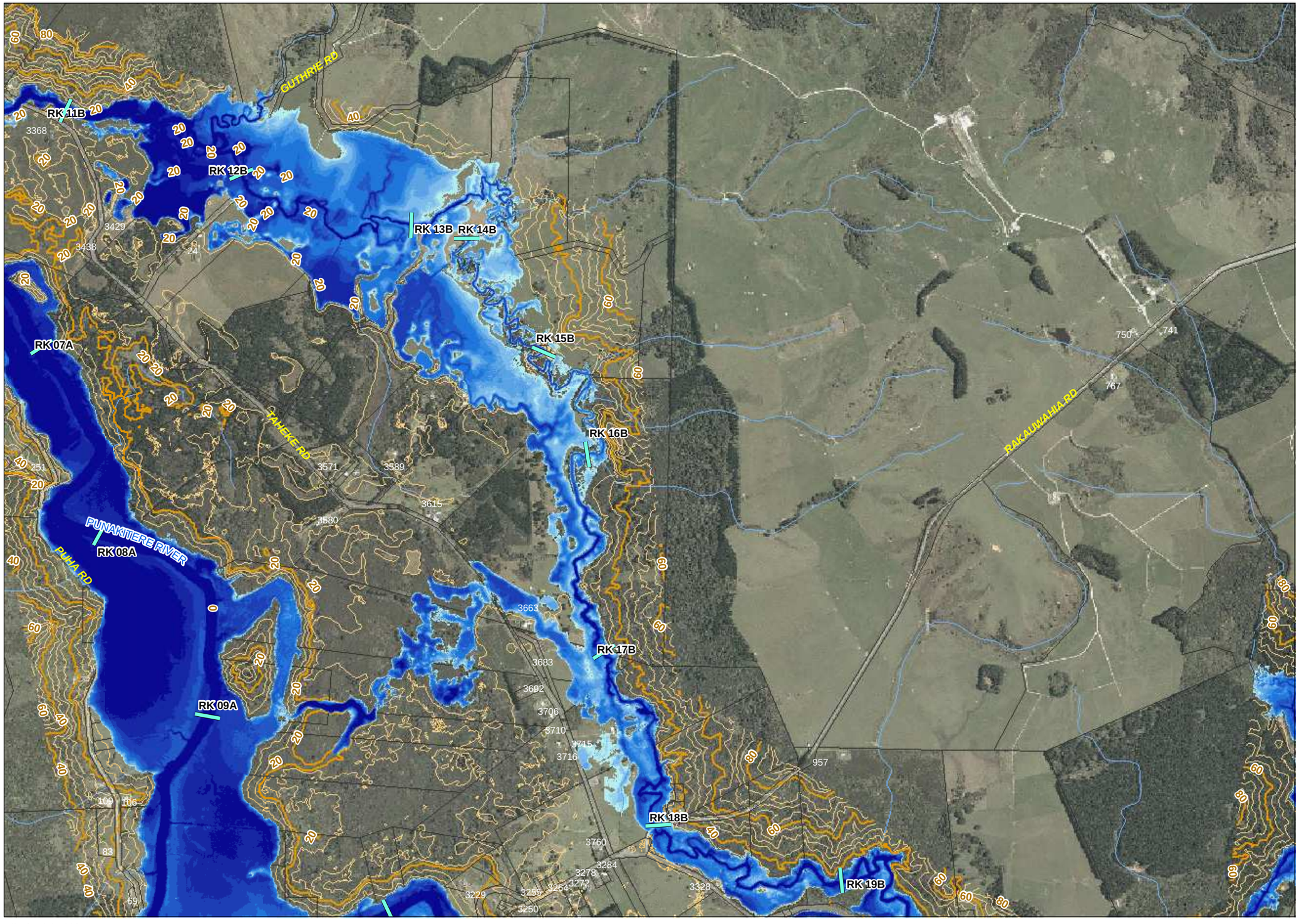

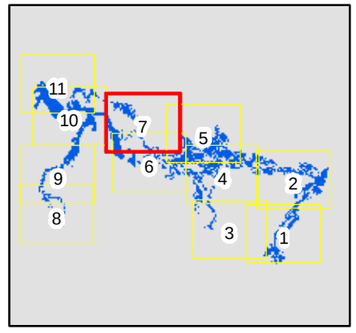

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

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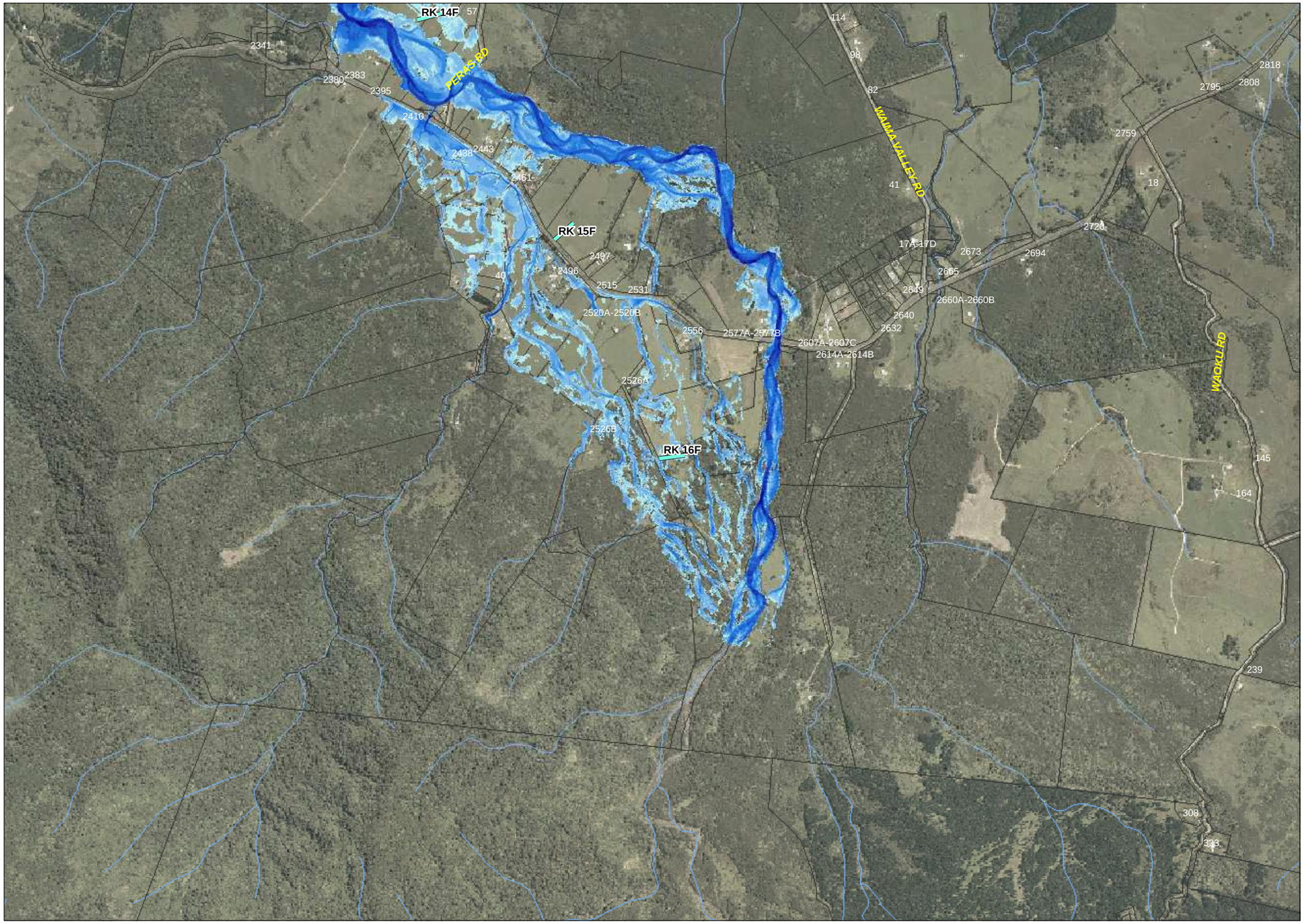

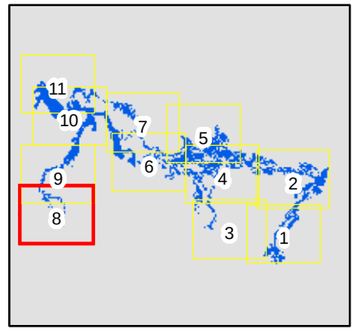

100 year ARI plus Climate Change

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

URS

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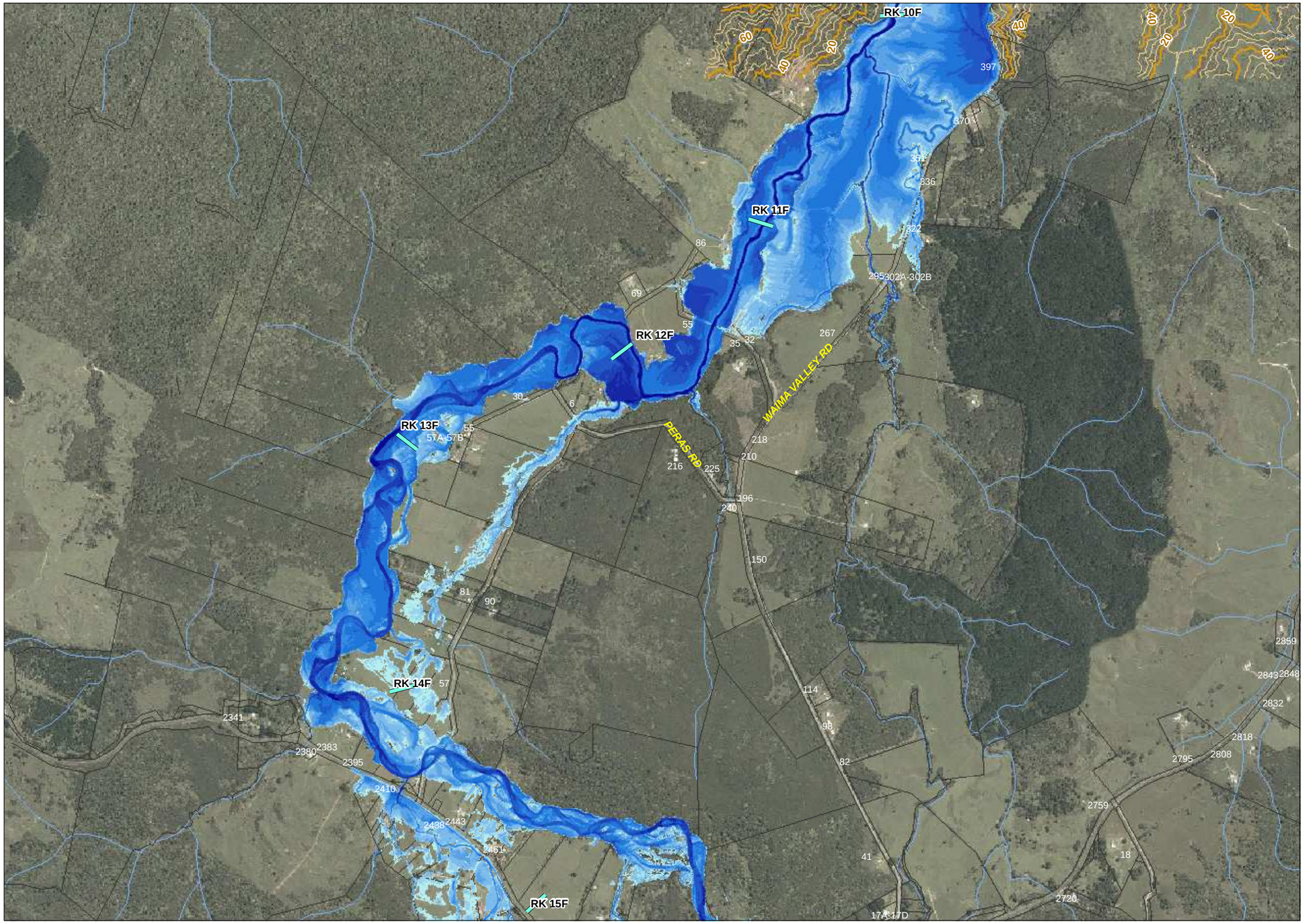
Sheet 8 of 11

Rev. **A** A3



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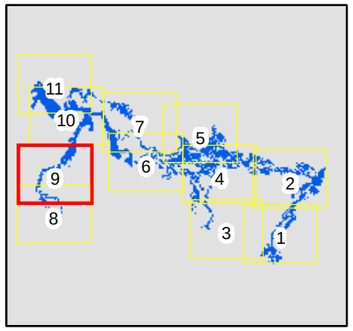

100 year ARI plus Climate Change

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Manaaki Awa The River Care Group

NORTHLAND REGIONAL COUNCIL

FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

URS

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RK 01A
RK 02A
RK 03A
RK 04A
RK 05A
RK 05B
RK 06B
RK 06A
RK 06F
RK 06G
RK 07A
RK 07B
RK 07F
RK 07G
RK 08B
RK 08F
RK 08G
RK 09B
RK 09F
RK 10B
RK 11B
PUNAKITERE RIVER
MOEJAU RD
THIEKE RD
MISSION OAK RD
PUHA RD
WAIMA VALLEY RD
3265
3244
3367
251
461
462
466

N

Waima River Location

11 10 7 5 6 4 9 2 8 3 1

100 year ARI plus Climate Change
Duration 48h
River Kilometre, Rk

Flood Depth, m

- 0.06 - 0.15
- 0.16 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

Scale 1:15,000

Manaaki Awa The River Care Group
NORTHLAND REGIONAL COUNCIL

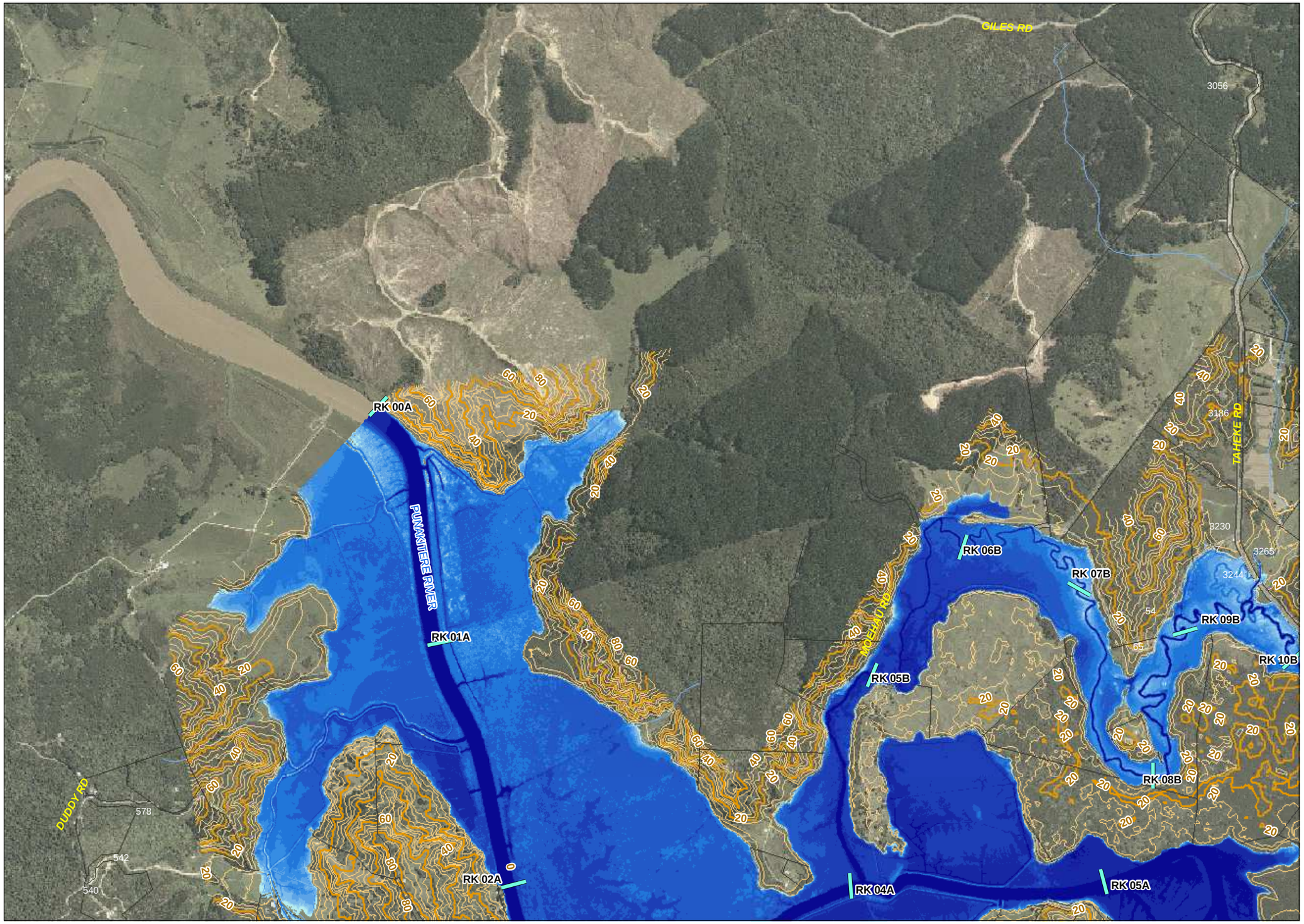
FLOOD MAPS

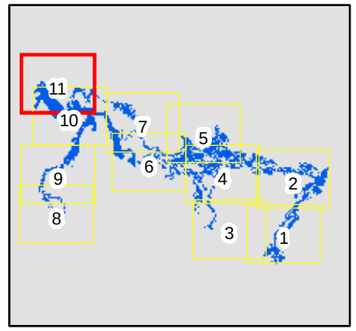
WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

Final

URS

File: 42071138\FloodMaps\21_WAIMA_AND_PUNAKITERE_RIVERS\Flood_Maps.mxd Drawn: **FP** Approved: **JW** Date: 13/07/2012 Rev. **A** A3





N

100 year ARI plus Climate Change

Duration 48h

River Kilometre, Rk

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FLOOD MAPS

WAIMA RIVER 100 YEAR ARI PLUS CLIMATE CHANGE

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B

Appendix B Floor Survey

Y co-ord	House	Floor Level	RL Survey	LiDAR Elevation	Model Elevation		Address
m NZTM	#	(m, datum?)	(m, datum?)	[m OTP]	10yrs [m OTP]	10yrsCC [m OTP]	
6075168.22	1	12.00		11.188	11.51	11.96	NA
6074944.15	2	14.00		13.206	12.44	13.49	Mr BUSELICH - 2665,RD3 Kaikohe, 0473
6074734.09	3	14.00		13.127	13.07	13.47	NA
6074634.81	4	14.71		14.238	12.94	13.66	THE OWNERS - C/- Denny Makara, Waima Valley Road, RD 3 KAIKOHE, 0473
6074525.27	5	15.45		15.139	13.31	14.13	NEREHONA TRUST - 15A Manapouri Street, Tikipunga,
6074398.20	6	16.98		16.235	16.15	16.15	Mr OBOYLE & Mrs DODDS - PO Box 92, Rawene, 0443
6074219.19	7	21.01		20.364	20.34	20.34	Mrs MOKARAKA & Mr BEDDGOOD - PO Box 89, Kaikohe, 0440
6074215.43	8	20.64	20.64	20.329	20.34	20.34	Mrs MOKARAKA & Mr BEDDGOOD - PO Box 89, Kaikohe, 0440
6074158.96	9	20.71		19.86	19.75	19.75	Mr BEDDGOOD - Mr M Rawai, PO Box 49, Kaikohe, 0440
6074116.70	10	22.26		21.673	21.60	21.60	Mr PEEHIKURU - C/- Mary Bedggood Estate Trustee, PO Box 49, Kaikohe, 0440
6073043.35	11	32.02		30.696	29.80	30.52	Mr NORMAN - 1156 State Highway 12, RD 3, Kaikohe, 0473
6073065.63	12	30.96	30.96	30.699	29.43	30.17	Mr NORMAN - 1156 State Highway 12, RD 3, Kaikohe, 0473
6073000.80	13	32.64		31.312	29.08	29.71	Mr NORMAN - 1156 State Highway 12, RD 3, Kaikohe, 0473
6072857.97	14	35.32		33.474	33.62	33.62	Mrs MORUNGA - C/- Mrs Ada Clark Morunga, 2443 State Highway 12, RD 3, Kaikohe, 0473
6072823.58	15	36.38		35.092	34.82	34.91	Mr WHARERAU - 103B Taharangi Street, Koutu, Rotorua, 3010 & Mr WHARERAU - 2408 State Highway 12, RD 3, Kaikohe,
6072760.39	16	37.30		36.435	36.35	36.35	THE OWNERS - State Highway 12, RD 3, Kaikohe, 0473
6072701.70	17	38.40		37.886	37.75	37.75	Mr WILCOX - Main Road, RD 3, Kaikohe, 0473
6072700.84	18	38.48		38.065	38.03	38.04	Mr WILCOX - Main Road, RD 3, Kaikohe, 0473
6072616.36	19	40.51		39.487	39.54	39.55	Rameka WHARERAU - RD 3, Kaikohe, 0473
6072664.40	20	40.45		38.841	39.09	39.26	Mrs MAY - 2446 State Highway 12, RD 3, Kaikohe, 0473
6072655.31	21	39.88		39.308	39.47	39.66	Mrs MAY - 2446 State Highway 12, RD 3, Kaikohe, 0473
6072753.19	22	39.50		38.889	38.83	38.83	Mrs MORUNGA - C/- Mrs Ada Clark Morunga, 2443 State Highway 12, RD 3, Kaikohe, 0473
6072737.18	23	40.30		39.423	38.96	38.96	Mrs MORUNGA - C/- Mrs Ada Clark Morunga, 2443 State Highway 12, RD 3, Kaikohe, 0473
6072587.33	24	43.50		42.727	42.65	42.68	Mr & Mrs HOHEPA - 2465 State Highway 12, RD 3, Kaikohe,
6072599.88	25	43.26		42.292	41.57	41.57	Mr & Mrs HOHEPA - 2465 State Highway 12, RD 3, Kaikohe,
6072558.76	26	45.16		43.759	43.79	43.79	Mr & Mrs HOHEPA - 2465 State Highway 12, RD 3, Kaikohe,

6072583.43	27	42.38		40.817	41.08	41.33	MINISTRY OF EDUCATION - C/- Waima Primary School - Board of Trustees, RD 3 KAIKOHE, 0473
6072476.10	28	45.29		44.524	44.35	44.38	MINISTRY OF EDUCATION - C/- Waima Primary School - Board of Trustees, RD 3 KAIKOHE, 0473
6072458.79	29	45.31	45.31	44.865	44.92	44.97	MINISTRY OF EDUCATION - C/- Waima Primary School - Board of Trustees, RD 3 KAIKOHE, 0473
6072486.49	30	44.34		43.769	43.62	43.64	MINISTRY OF EDUCATION - C/- Waima Primary School - Board of Trustees, RD 3 KAIKOHE, 0473
6072490.39	31	44.60		43.609	43.52	43.53	MINISTRY OF EDUCATION - C/- Waima Primary School - Board of Trustees, RD 3 KAIKOHE, 0473
6072505.97	32	44.22		42.935	43.07	43.08	MINISTRY OF EDUCATION - C/- Waima Primary School - Board of Trustees, RD 3 KAIKOHE, 0473
6072390.95	33	47.09		46.692	46.63	46.67	THE OWNERS - State Highway 12, RD 3, Kaikohe, 0473
6072373.39	34	47.01		46.976	46.97	47.03	THE OWNERS - State Highway 12, RD 3, Kaikohe, 0473
6072141.68	35	54.02		53.177	53.23	53.23	THE OWNERS - C/- Mere Pehi Sullivan, 5 Hamilton Street,
6072284.62	36	52.12		49.938	49.84	49.84	THE OWNERS - C/- Nicholas Hohepa, 2496A State Highway 12, RD 3, Kaikohe, 0473
6072251.39	37	52.45		50.731	50.86	50.86	THE OWNERS - C/- Nicholas Hohepa, 2496A State Highway 12, RD 3, Kaikohe, 0473
6072250.77	38	52.31		50.777	50.86	50.86	THE OWNERS - C/- Nicholas Hohepa, 2496A State Highway 12, RD 3, Kaikohe, 0473
6072217.54	39	53.62		51.598	51.59	51.59	THE OWNERS - C/- Nicholas Hohepa, 2496A State Highway 12, RD 3, Kaikohe, 0473
6072175.53	40	54.49		53.191	53.34	53.34	THE OWNERS - C/- Nicholas Hohepa, 2496A State Highway 12, RD 3, Kaikohe, 0473
6072298.18	41	52.79		52.025	51.81	51.81	Mr HOHEPA - 31 Leaity Street, Moerewa, 0211
6072274.36	42	53.16		52.736	53.26	53.26	Mr HOHEPA - 31 Leaity Street, Moerewa, 0211
6072268.72	43	53.17		52.625	52.84	52.84	Mr HOHEPA - 31 Leaity Street, Moerewa, 0211
6072192.42	44	57.69		56.817	56.90	56.90	Mrs DE THIERRY - 2531 State Highway 12, RD 3, Kaikohe,
6072208.09	45	57.61		56.64	56.61	56.61	Mrs DE THIERRY - 2531 State Highway 12, RD 3, Kaikohe,
6072031.72	46	58.95		58.23	58.42	58.42	Cherie & Elizabeth TAWHAI - 37A Bond Street, Ealing London, W5 5AS, United Kingdom,
6072006.02	47	62.32		60.225	60.10	60.10	Cherie & Elizabeth TAWHAI - 37A Bond Street, Ealing London, W5 5AS, United Kingdom,
6071954.08	48	65.79		65.556	65.34	65.34	Mrs MOOHAN - 3 Te Puni Grove, Elderslea, Upper Hutt, 5018
6072042.62	49	66.64		65.458	65.11	65.13	Mrs BEDGGOOD - 2577 State Highway 12, RD 3, Kaikohe,

6072003.75	50	67.13		66.486	66.41	66.41	Mrs BEDGGOOD - 2577 State Highway 12, RD 3, Kaikohe,
6071932.90	51	69.38		68.364	68.36	68.36	Mrs MACDOUGALL - 253 Hibiscus Coast Highway, Orewa, 0932 & Mr ABSOLUM - PO Box 198, Kaikohe, 0440
6071815.64	52	67.83		66.818	67.01	67.01	Mr CASSIDY - Counter Delivery, Kaikohe PostShop, Kaikohe,
6071782.42	53	68.34		67.571	67.30	67.30	Mr CASSIDY - Counter Delivery, Kaikohe PostShop, Kaikohe,
6071530.67	54	77.30		76.902	76.91	76.91	Mrs WHARERAU - S Puru, 11 Tango Place, Henderson,

URS New Zealand Limited
URS Centre, 13-15 College Hill
Auckland 1011
PO Box 821, Auckland 1140New Zealand

T: 64 9 355 1300
F: 64 9 355 1333

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