STATE EMERGENCY SERVICE

TASMANIAN STRATEGIC FLOOD MAP
RUBICON STUDY AREA DESIGN FLOOD
MODELLING

ADDENDUM TO CALIBRATION REPORT

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MARCH 2023

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TASMANIAN STRATEGIC FLOOD MAP RUBICON STUDY AREA DESIGN FLOOD MODELLING

ADDENDUM TO CALIBRATION REPORT
MARCH 2023

Project Tasmanian Strategic Flood Map Rubicon Study Area Design Flood Modelling	Project Number 120038
Client State Emergency Service	Client's Representative Chris Irvine
Project Manager Fiona Ling	

Revision History

Revision	Description	Distribution	Authors	Reviewed by	Verified by	Date
0	Draft report for review	Chris Irvine, SES	Sarah Blundy, Holly Taylor, Evmen Wong	Daniel Wood	Fiona Ling	JULY 22
1	Design Report	Chris Irvine, SES	Sarah Blundy, Evmen Wong	Daniel Wood	Fiona Ling	AUGUST 22
2	Report with minor revisions	Chris Irvine, SES	Sarah Blundy, Evmen Wong	Daniel Wood	Fiona Ling	MARCH 23

Cover image: From Port Sorell, Tasmania: Travel guide and things to do - https://www.traveller.com.au/port-sorell-tasmania-travel-guide-and-things-to-do-1303bo

TASMANIAN STRATEGIC FLOOD MAP RUBICON STUDY AREA DESIGN FLOOD MODELLING

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LIST OF DIAGRAMS

LIST OF ACRONYMS

AEP	Annual Exceedance Probability
AMS	Annual Maximum Series
ARF	Areal Reduction Factor
ARR	Australian Rainfall and Runoff
ATP	Areal Temporal Patterns
Bureau/BoM	Bureau of Meteorology
CC	Climate Change
CFEV	Conservation of Freshwater Ecosystem Values (DPIPWE/DNRE)
CL	Continuing Loss
DEM	Digital Elevation Model
DNRE	Department of Natural Resources and Environment Tasmania (formerly DPIPWE)
DPIPWE	Department of Primary Industries, Water and Environment
DRM	Direct Rainfall Method
DTM	Digital Terrain Model
FFA	Flood Frequency Analysis
FLIKE	Software for flood frequency analysis
FSL	Full Supply Level
GIS	Geographic Information System
GEV	Generalised Extreme Value distribution
HAT	Highest Astronomical Tide
HSA	Human Settlement Area
ICM	Infoworks ICM software (Innovyze)
IL	Initial Loss
IFD	Intensity, Frequency and Duration (Rainfall)
LiDAR	Light Detection and Ranging
mAHD	meters above Australian Height Datum
NTC	National Tide Centre
PERN	Catchment routing parameter in RAFTS
Pluvi	Pluviograph – Rain gauge with ability to record rain in real time
PTP	Point Temporal Patterns
R	Channel routing param in WMAWater RAFTS WBNM hybrid model
RAF	RAFTS Adjustment Factor
RAFTS	hydrologic model
RCP	Representative Concentration Pathways (RCPs) (CC scenarios)
RORB	RORB hydrological modelling software
SES	State Emergency Service
TUFLOW	one-dimensional (1D) and two-dimensional (2D) flood and tide simulation software (hydrodynamic model)
TP	Rainfall Temporal Patterns

1. INTRODUCTION

This report is an addendum to the Tasmanian Strategic Flood Map Rubicon Study Area Calibration Report (WMAwater, 2023). The study area, available data, model calibration, limitations and uncertainty statements are provided in the calibration report.

This report outlines the data, methodology and the results of modelling the design flood events for the Rubicon Study Area.

2. DATA

2.1. Previous Flood Studies

There were no previous flood studies for this study area provided to WMAwater as part of the project data library.

2.2. Flow Data

Flood Frequency Analysis (FFA) was performed on annual maximum series (AMS) from flow gauges within the catchment. The gauges used for FFA are shown in Table 1. The other gauges in the study area were not included in the FFA due to insufficient record length, inconsistent datasets and/or unreliable rating curves. More detail on the quality of the gauge data is provided in the calibration report (WMAwater, 2022).

A rating at Rubicon River at Tidal limit was created for this project using a local hydraulic model (WMAwater, 2021c), and this was used in calibration. The DNRE ratings show evidence of major changes to the rating curve in 1989 and 1999, therefore the revised rating was only applied to AMS events since 1999, with the original DNRE flows used prior to this.

Table 1: Flow gauges used for FFA

Gauge number	Gauge name	River	Period of record	Number of points in AMS
17200-1	Rubicon River at Tidal Limit	Rubicon River	22/06/1967 - present	52

2.3. Design Inputs

The design inputs used in the study (Intensity Frequency Duration (IFD) depths, losses, pre-burst rainfalls, Areal Reduction Factors (ARFs) and temporal patterns) were obtained through the ARR Data Hub (Babister et. al., 2016) and the Bureau of Meteorology website (Bureau of Meteorology, 2019).

2.3.1. Design Rainfall Depths and Spatial Pattern

Intensity Frequency Duration (IFD) information was sourced from the Bureau of Meteorology website (Bureau of Meteorology, 2019). IFD information was sourced for each individual sub-catchment to give a spatial pattern across the study area. Examples of sub-catchment rainfalls are shown in Figure A 1 to Figure A 3.

2.3.2. Temporal Patterns

ARR 2016 Book 2 Chapter 5 (Ball et. al., 2019) recommends the use of areal temporal patterns for catchments with area greater than 75 km^2. Therefore, for the flood frequency analysis, the areal temporal patterns relevant to this location were downloaded from the ARR Data Hub. An example of the temporal patterns downloaded from the Data Hub is shown in Figure A 4.

For selection of the final design runs applicable to the entire study area, areal and point temporal patterns were downloaded from the ARR Data Hub. Temporal patterns were filtered for embedded bursts and in some cases patterns with large, embedded bursts causing significant outliers were removed. When assessing the reference critical flow for each sub-catchment (as described in the Hydrology Methods Report), point temporal patterns were used for sub-catchments with an upstream area of less than 75 km^2 and to assess shorter storms if the critical duration on a larger catchment was identified as 12 hours (the shortest duration available with areal temporal patterns).

2.3.3. Pre-burst

Pre-burst rainfall depths were taken from the ARR Data Hub as a ratio of the IFD depths. As Initial Losses (ILs) calibrated to the FFA were greater than 0 there was no need to include sensitivity to adding a pre-burst temporal pattern for this study area, as the pre-burst has effectively been removed from the IL with some IL depth remaining.

2.3.4. Losses

Initial values for sub-catchment initial loss (IL) and continuing loss (CL) were derived from the unpublished Hydrologic Soil Groups of Tasmania data that was provided for use in this project (DPIPWE 2019).

2.3.5. Baseflow

Baseflow was calculated for each calibration event and was found to be less than 5% of the event peaks. In line with ARR 2016 Book 5 Chapter 4 (Ball et. al., 2019), where baseflows of less than 5% are considered a small component compared to runoff, a simplified approach to baseflow calculations was used. Hydrodynamic modelling of the calibration events showed that large flood events in this study area were peak rather than volume driven. Baseflows will be a small component of the hydrograph for the AEPs of interest (2%, 1% and 0.5%) and therefore baseflow was not included in the design events.

2.3.6. Direct Rainfall

Two hour direct rainfall storms were created using each sub-catchment's IFD depths using the method described in the Hydrodynamic Method Report (WMAwater, 2021b).

2.3.7. Climate Change

2.3.7.1.   Rainfall Factors

Climate change factors for the study area were downloaded from the ARR Data Hub. ARR recommends the use of the RCP4.5 and RCP8.5 values, however the Tasmanian Interim Planning Scheme recommends the use of RCP8.5 and this has been adopted for this project. RCP8.5 results for the year 2090, give a rainfall scaling factor of 16.3% to be applied to the IFDs.

2.3.7.2. Boundary Conditions

Sea level rise was included in the climate change scenario and was applied at the downstream boundary of the hydrodynamic model. The rise in water level was taken from the Tasmanian Local Council Sea Level Rise Planning Allowances, which uses sea level rise projections based on RCP 8.5 for 2100. This gave a rise in sea level of 0.82 m for the Latrobe Council area.

The levels from this document were deemed most appropriate to be consistent with best practise planning around Tasmanian Councils.

3. OVERVIEW OF METHODOLOGY

The hydrological and hydrodynamic design modelling methodology has been outlined in the Hydrology Methods Report (WMAwater, 2021a) and the Hydrodynamic Methods Report (WMAwater 2021b). Details on the methods are only included in this report where they deviate from the methods described in these reports or are specific for this catchment.

The modelling method for the design events includes the following steps.
- Data preparation
    - Fitting FFA to suitable flow records
    - Extraction of design data – IFDs, temporal patterns, pre-burst rainfalls from ARR DataHub (automated in the modelling process), derivation of direct rainfall storms
- Hydrologic modelling
    - Identification of flow gauge locations
    - Identification of dam and diversion locations
    - Sub-catchment delineation
    - Include dam storage and spillway ratings where required
    - Event calibration for PERN parameter and event losses, using automated WMAwater RAFTS modelling tool, IDW rainfall surfaces and available flow data.
    - Output event sub-catchment rainfalls, routing parameters and event losses for input to hydraulic model
    - Calibration of design losses to FFA using automated WMAwater RAFTS model
    - Run design events in WMAwater RAFTS modelling tool, with design data, calibrated routing parameters and design losses. Outputs design sub-catchment rainfalls for input to hydrodynamic model.
- Hydrodynamic modelling
    - Run design events and direct rainfall through the calibrated hydrodynamic model with the applicable downstream boundary levels and dam initial conditions.
    - Output design event and direct rainfall results for processing.
- Mapping
    - Convert design event and direct rainfall results to a grid format with a grid resolution of at least 10 m.
    - Envelope design event results to produce the maximum envelope of the inputs.
    - Filter direct rainfall results using a peak flood depth filter of 0.1 m. Clip direct rainfall results to the design event envelope.
    - Output the design event envelope and filtered direct rainfall results for mapping.

4. CALIBRATION OF DESIGN LOSSES

FFA was undertaken at the gauge identified in Table 1. The results of the FFA are shown in Figure 1. The fitting method and distribution that provided the best fit to the data at the gauge site is shown in Table 2.

Table 2: Fitting method and distribution used for FFA

Gauge number	Gauge name	Fitting method	Distribution
17200-1	Rubicon River at Tidal Limit	Bayesian	Log Pearson III

The calibrated external hydrologic model for each study area was run through the solver and the initial and continuing losses that best matched the FFA were estimated. As the events of relevance to this study are of 2% AEP or larger, the results were weighted to this end of the FFA curve. The catchment-average continuing loss was distributed across the study area using the hydrological soil group final infiltration rates.

The percentage differences between the FFA and the modelled peak flow for the 2% and 1% AEP events are shown in Table 3. The modelled data provided a good fit to the FFA 1% and 2% AEP peak flows.

Table 3: FFA and modelled peak flows

Parameter	Rubicon River at Tidal Limit	
	2% AEP	1% AEP
FFA peak flow (m^3/s)	282	315
Modelled peak flow (m^3/s)	265	315
Peak flow difference (%)	-6%	0.0%

In calibration, separate losses were applied in the Greens Creek catchment for the 2016 calibration event. This was attributed to the large number of upstream storages in this area of the study area. As the assumption for design modelling is that storages are at FSL, the Rubicon losses have been applied across the entire study area. As there is only 7 years of data available at the Greens Creek gauge it is not possible to undertake FFA at this gauge for verification. Use of the Rubicon losses gives a 1% AEP peak flow approximately 40% higher than the 2016 flow. This is similar to the relationship between the Rubicon River at Tidal Limit gauge 1% AEP flow and modelled 2016 flow peak (no observed peak was available here as the gauge recording failed during the event).

The adopted loss values are shown in Table 4, and comparisons to site FFAs are shown in Figure 1.

Table 4: Adopted losses

Initial Loss (mm)	Continuing Loss (mm/h)			
	Soil Type A	Soil Type B	Soil Type C	Soil Type D
15	2.30	1.20	0.55	0.28

5. DESIGN EVENT MODELLING

5.1. Design Event Selection

Design inputs were run through the calibrated hydrological model across the entire study area with a range of ARFs to select representative ARFs, storm durations and temporal patterns to be run through the hydrodynamic model. The selected storms and the number of sub-catchments best represented by each are shown in Table 5. The temporal patterns for each selected run are shown Figure 2 and Figure A 4.

Table 5: Selected storms for each AEP with the number of sub-catchments best represented by each set

AEP	Storm duration (min)	ARF bin	# sub-catchments
2%	360	25	9
2%	540	45	24
2%	720	75	6
1%	360	25	9
1%	540	45	22
1%	720	75	8
0.5%	360	25	10
0.5%	540	45	21
0.5%	720	75	8

Diagram 1 shows the ARF-duration-TP set used to give representative flows for each sub-catchment for the 1% AEP event. Headwater sub-catchments where only direct rainfall is applied are also shown. In the headwater catchments, direct rainfall was defined as the dominating event, with the rainfall intensities factored to account for losses via a runoff coefficient. For this study area, a runoff coefficient of 60% was adopted. Although direct rainfall is applied to all sub catchments, the mapping process detailed in Section 3 ensures that primary flow paths are not defined by this event.
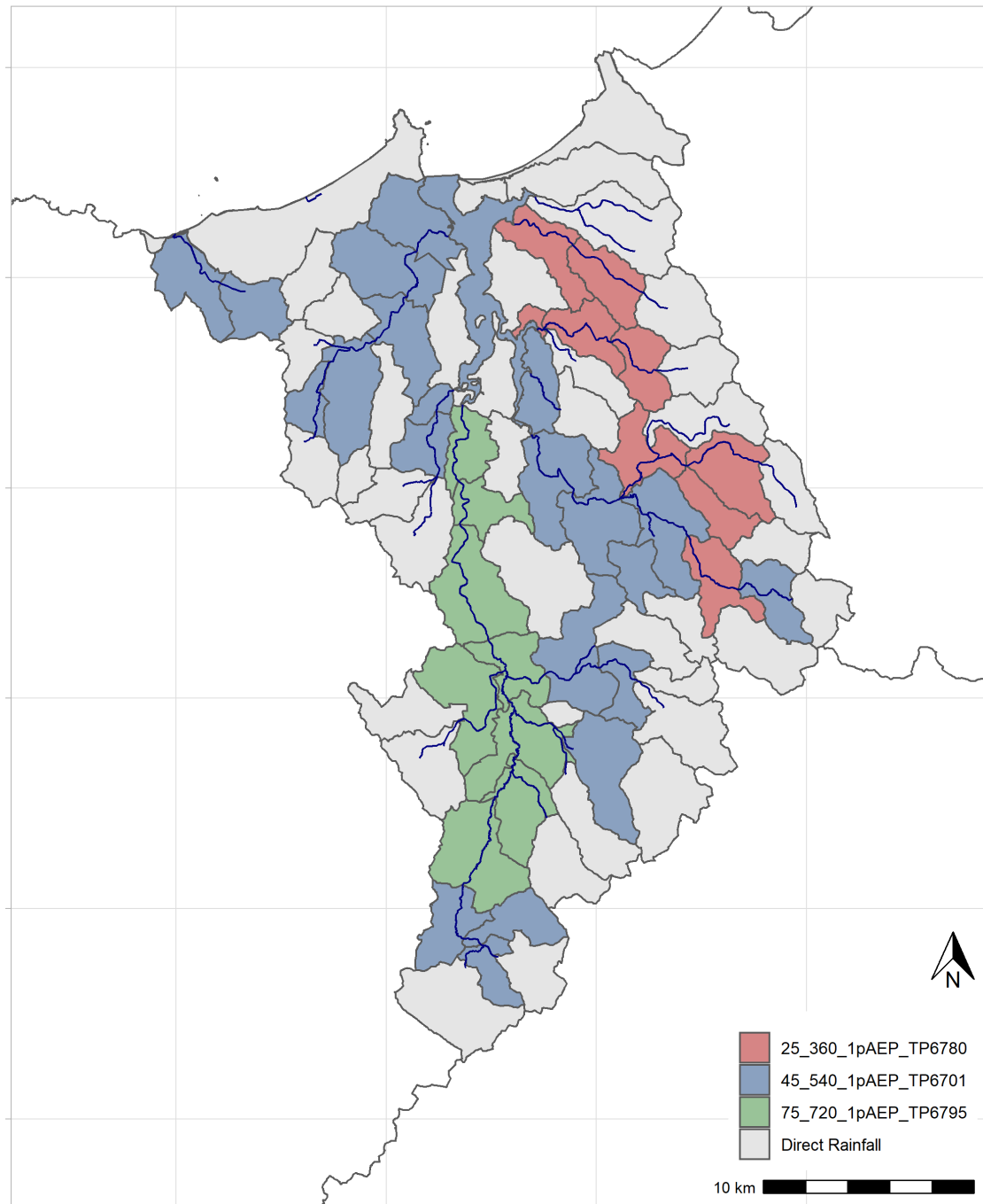
Diagram 1: ARF set relevant for each sub-catchment for the 1% AEP event

The selection of four ARF-duration-TP sets per AEP does introduce errors when compared to running the ideal ARF-duration-TP set through the hydrodynamic model for each sub-catchment, however running thousands of runs of the hydrodynamic model is not computationally feasible. The percentage errors for each sub-catchment are shown in Figure B 1 to Figure B 3, and a summary of the magnitude of the errors is shown in Table 6. Each sub-catchment's absolute percentage error is calculated using the following equation:

SC_Q_Peak$_{ref}$ = Sub-catchment peak flow run with ARF from that sub-catchment's ARF bin, with critical duration calculated at this gauge, and TP above the mean selected.

SC_Q_Peak$_{sel}$ = Sub-catchment peak flow run with ARF, storm duration and TP from the selected pattern as shown in Diagram 1

$$\text{Absolute subcatchment percentage error} = \left| \frac{(\text{SC\_Q\_Peak}_{sel} - \text{SC\_Q\_Peak}_{ref})}{\text{SC\_Q\_Peak}_{ref}} \right| \times 100$$

Table 6: Sub-catchment errors using the ARF-TP-duration sets shown in Table 5 for each AEP

AEP	Absolute sub-catchment error		
	Mean across sub-catchments	90th %ile across sub-catchments	Max of all sub-catchments
2%	5.0	8.4	11.8
1%	2.4	8.2	11.9
0.5%	2.1	7.8	11.4

The selected storms and direct rainfall were then run through the calibrated hydrodynamic model as documented in the calibration report (WMAwater, 2023). For the design event modelling, a static tailwater level set to the highest astronomical tide was adopted for the downstream boundary. This data was provided by the National Tide Centre (NTC) in 5 km^2 grid cells, and the mean value of these grid cells within the study area was used.

Table 7 summarises the downstream boundary levels for each design event.

Table 7. Downstream boundary levels for each AEP

AEP	Downstream boundary
2%	HAT (1.84 mAHD)
1%	
0.5%	
1% CC	HAT + sea level rise (2.66 mAHD)

5.2. Design Event Results

The results of the design event modelling are shown in Figure 3 to Figure 18 in terms of peak flood level, depth, velocity, and hydraulic hazard for the 2%, 1%, 1% CC, and 0.5% AEP design events. The results shown are of the design event envelope and filtered direct rainfall results, as detailed in Section 3. A critical event plot for the 1% AEP design event is provided in Figure 19.

For direct rainfall only, in some areas the peak flow for headwater catchments was found to be higher in the hydrodynamic model than in the external hydrologic model. To ensure that the overestimation of these peak flows in the headwater catchments would not impact the design results, the direct rainfall results were clipped to the headwater catchments before the envelope of the design runs and direct rainfall was calculated.

The outcomes of the design event modelling have been reviewed against the gauge FFA. Design extents and levels were not able to be compared to existing studies as none were provided.

5.2.1. Review of Results at Rubicon River at Tidal Limit Gauge

A review of the design flows produced from the hydrodynamic model at Rubicon River at Tidal Limit gauge was undertaken, by comparing to the flows derived from the FFA. The modelled peak flows show a good match to the 2% and 1% FFA peak flows at this location (Table 8). There is an overestimation in the 0.5% AEP. There is a notable change in slope in the IFD rainfalls in many areas across Tasmania (example shown in Diagram 2) which results in a widescale trend of overestimation of the modelled 0.5% AEP event when using the same losses as the 1% AEP.

Table 8: Design flows at Rubicon River at Tidal Limit

Parameter	2% AEP	1% AEP	1% AEP CC	0.5% AEP
Modelled peak flow (m3/s)	269	320	408	429
FFA peak flow (m3/s)	282	315	n/a	345
Peak flow difference (%)	-5%	+2%	n/a	+24%
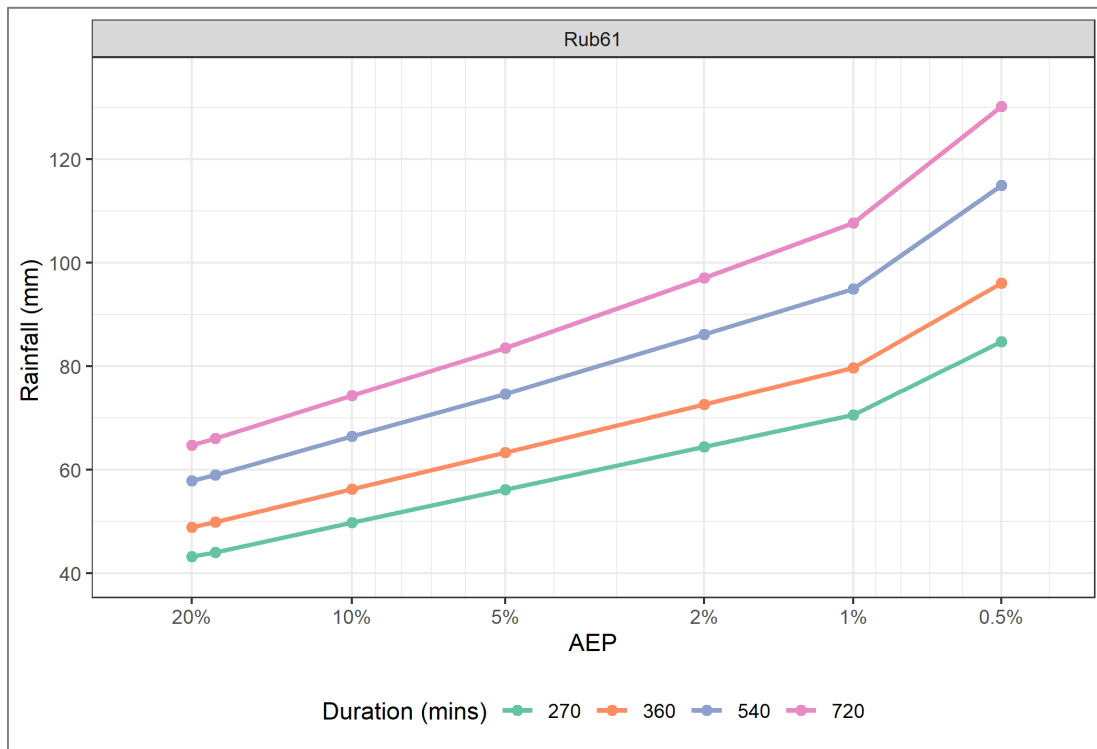
Diagram 2 Sub-catchment IFD rainfall totals showing change in slope at 1% AEP.

6. LIMITATIONS

A detailed uncertainty assessment of the data, hydrological calibration and hydrodynamic model is contained in the Rubicon Calibration Report (WMAwater, 2023).

The selection of limited duration-TP-ARF sets introduces some errors across the catchment as described in Section 5.1. This is appropriate for a regional method, however site-specific ARFs, critical durations and TP selection should be used for detailed design modelling at specific locations.

As discussed in Section 5.2 there is some uncertainty introduced by the direct rainfall application on the headwater catchments. While the method used is appropriate for broad scale mapping, a full design event assessment should be undertaken for any future focussed studies in this area.

7. REFERENCES

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WMAwater (2021c): Tasmanian Strategic Flood Map, Flow Gauge Rating Revision, Draft, Dec 2021.

WMAwater (2023): Tasmanian Strategic Flood Map Rubicon Catchment Model Calibration Report, March 2023. Report for State Emergency Service, Tasmania.

Figures

FIGURE 1
Rubicon River US Tidal Limit

J:/Jobs/120038/Hydrology/Statewide/FFA_Calibration/Rubicon/Rbcon_Tdal/Run_Creation/run_output/20220520_1711-calib_ATP_v1/outputs/plots/FFA/FFA_Rub79_lognormal_ModAsPts.png
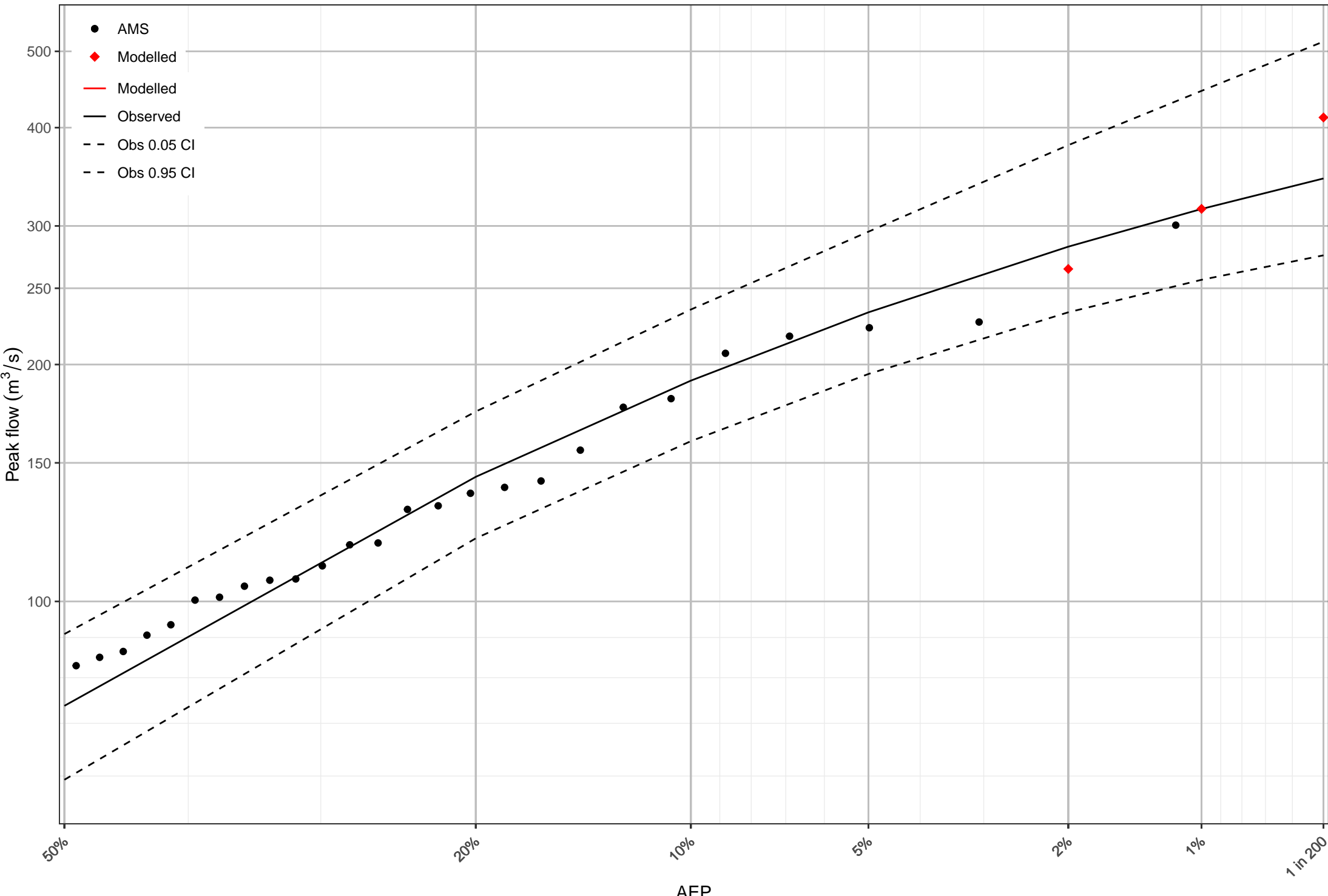
FIGURE 2
SELECTED DESIGN TEMPORAL PATTERNS ALL AEPS
BY STORM DURATION AND ARF AREA
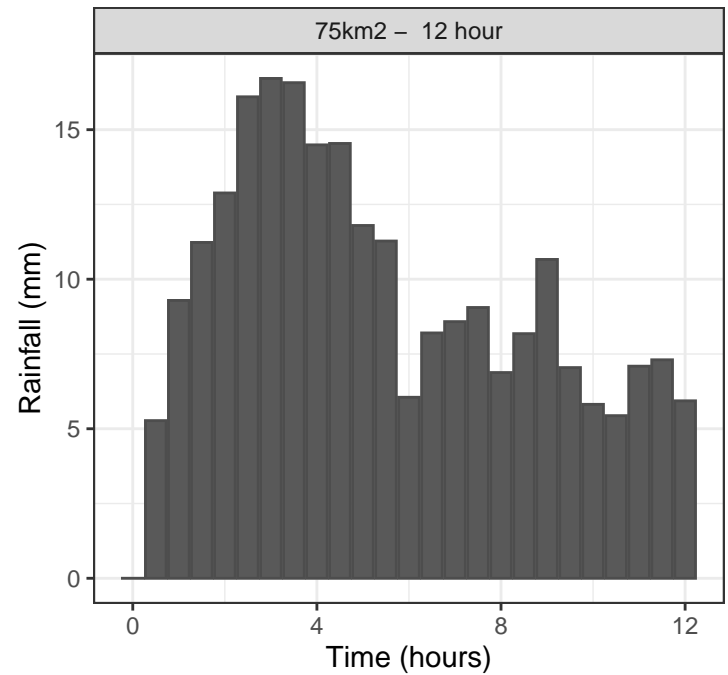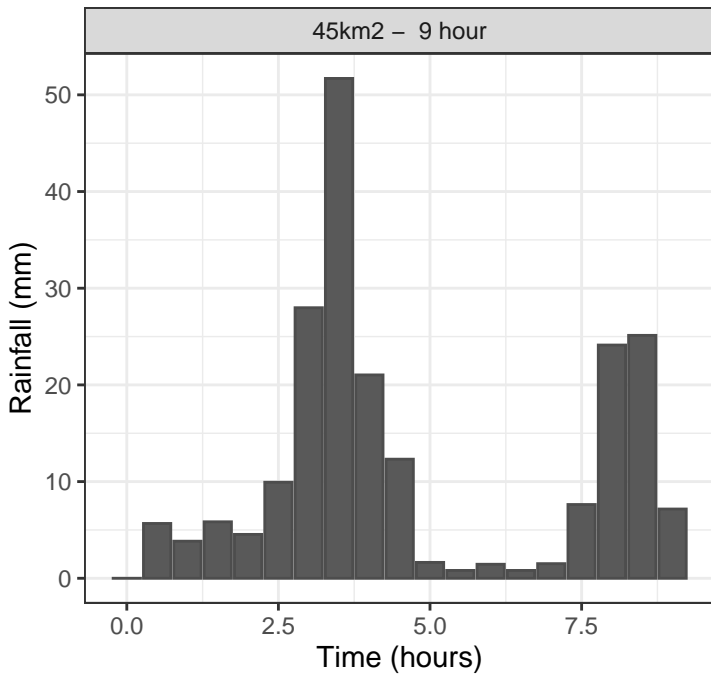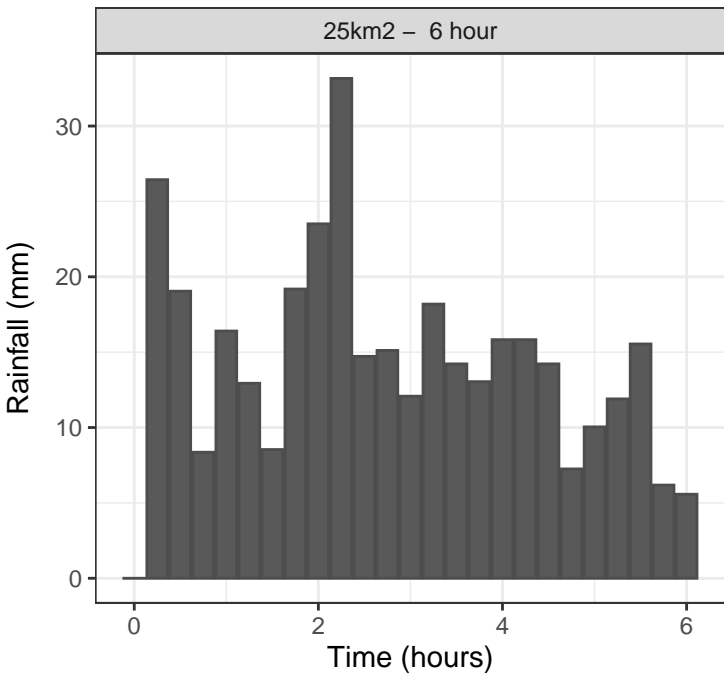
FIGURE 3
**RUBICON CATCHMENT
2% AEP DESIGN EVENT
PEAK FLOOD LEVEL**
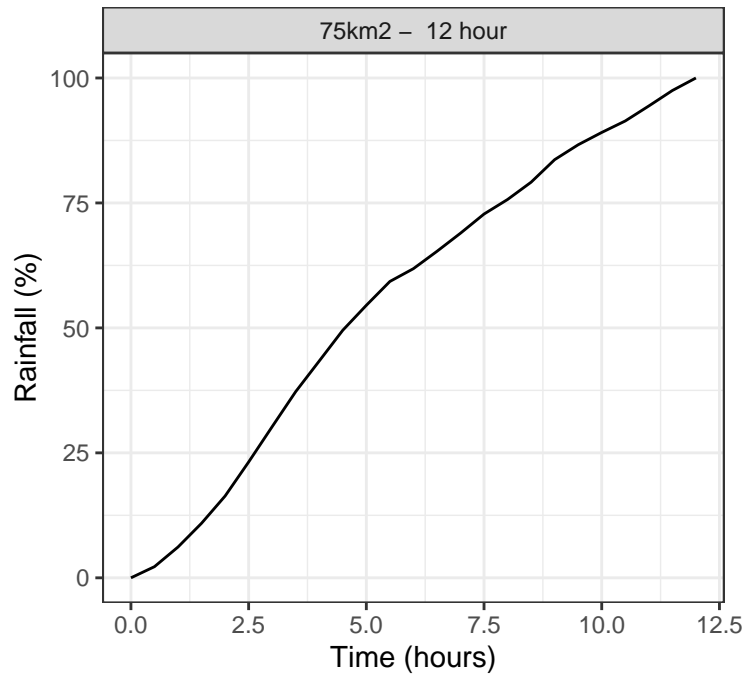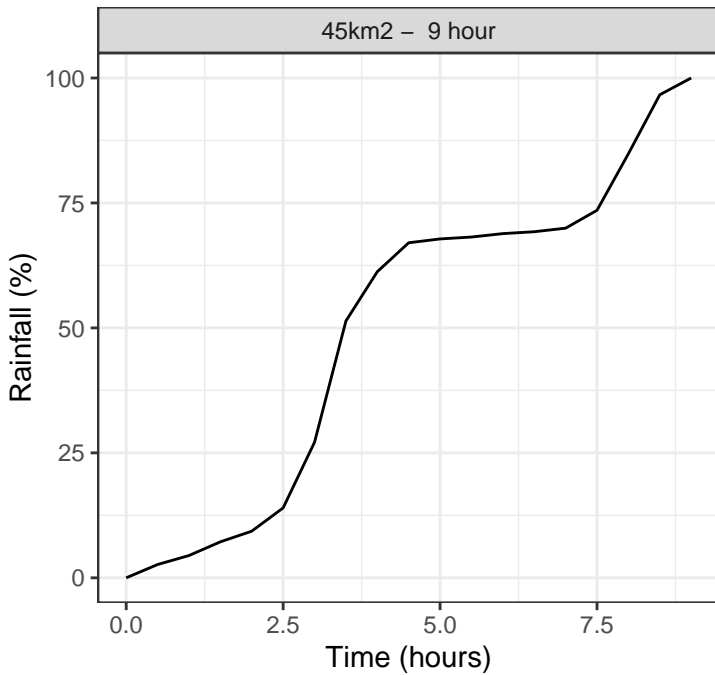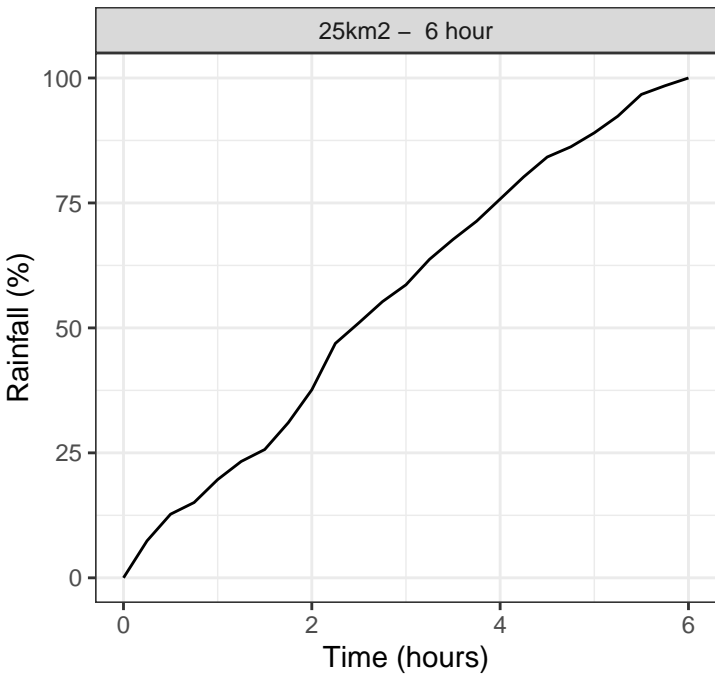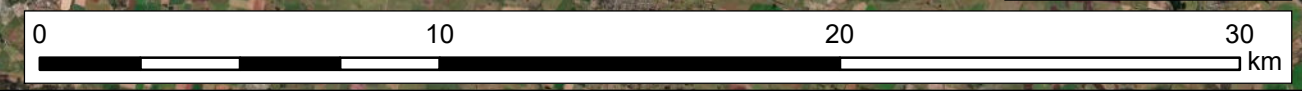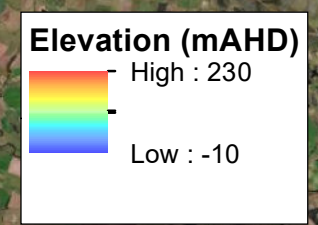
PORT SORELL

Elevation (mAHD)
High : 230
Low : -10

N

0   10   20   30   km

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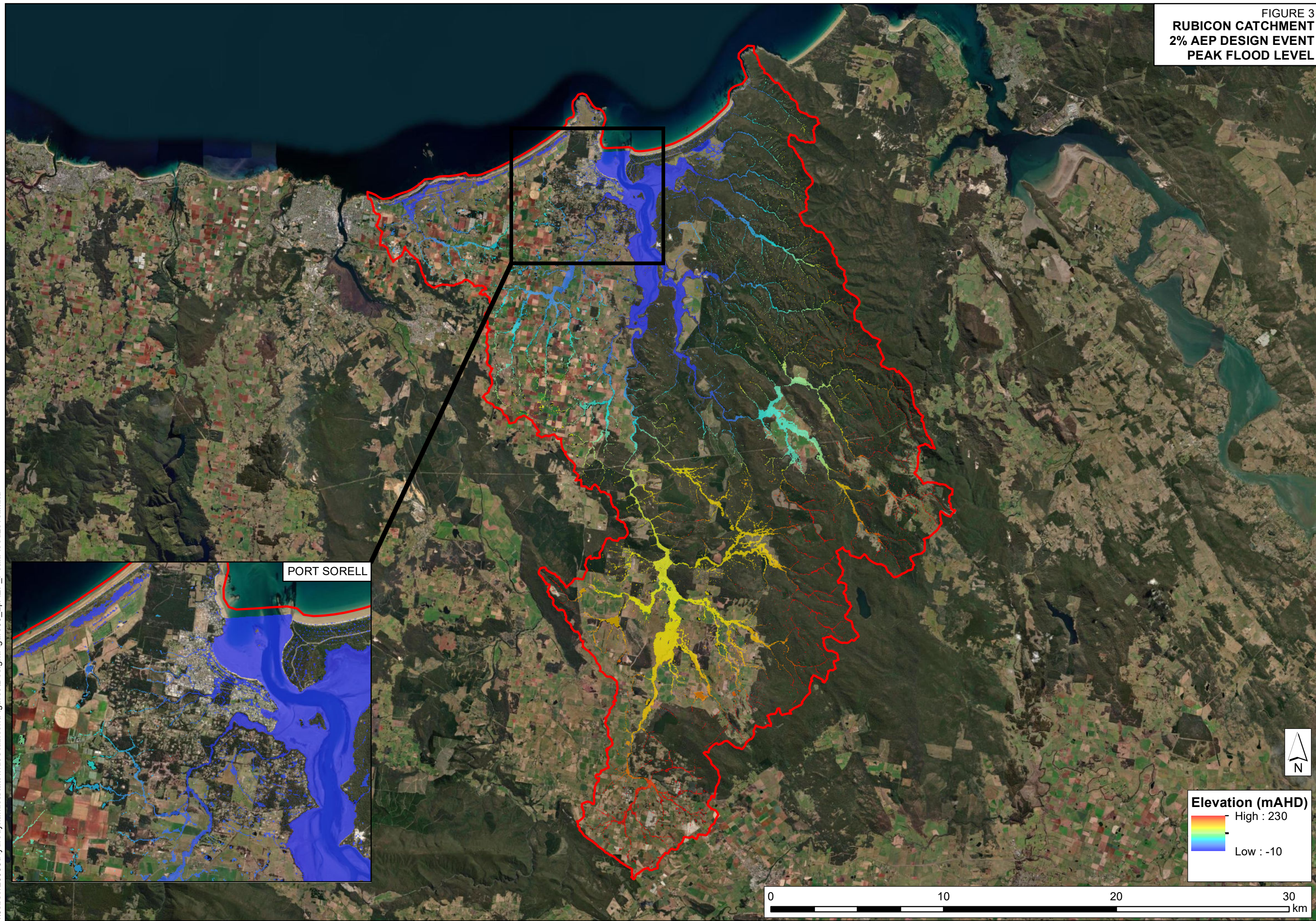
FIGURE 4
RUBICON CATCHMENT
2% AEP DESIGN EVENT
PEAK FLOOD DEPTH

PORT SORELL

Depth (m)
< 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 10
> 10

N

0   10   20   30
km

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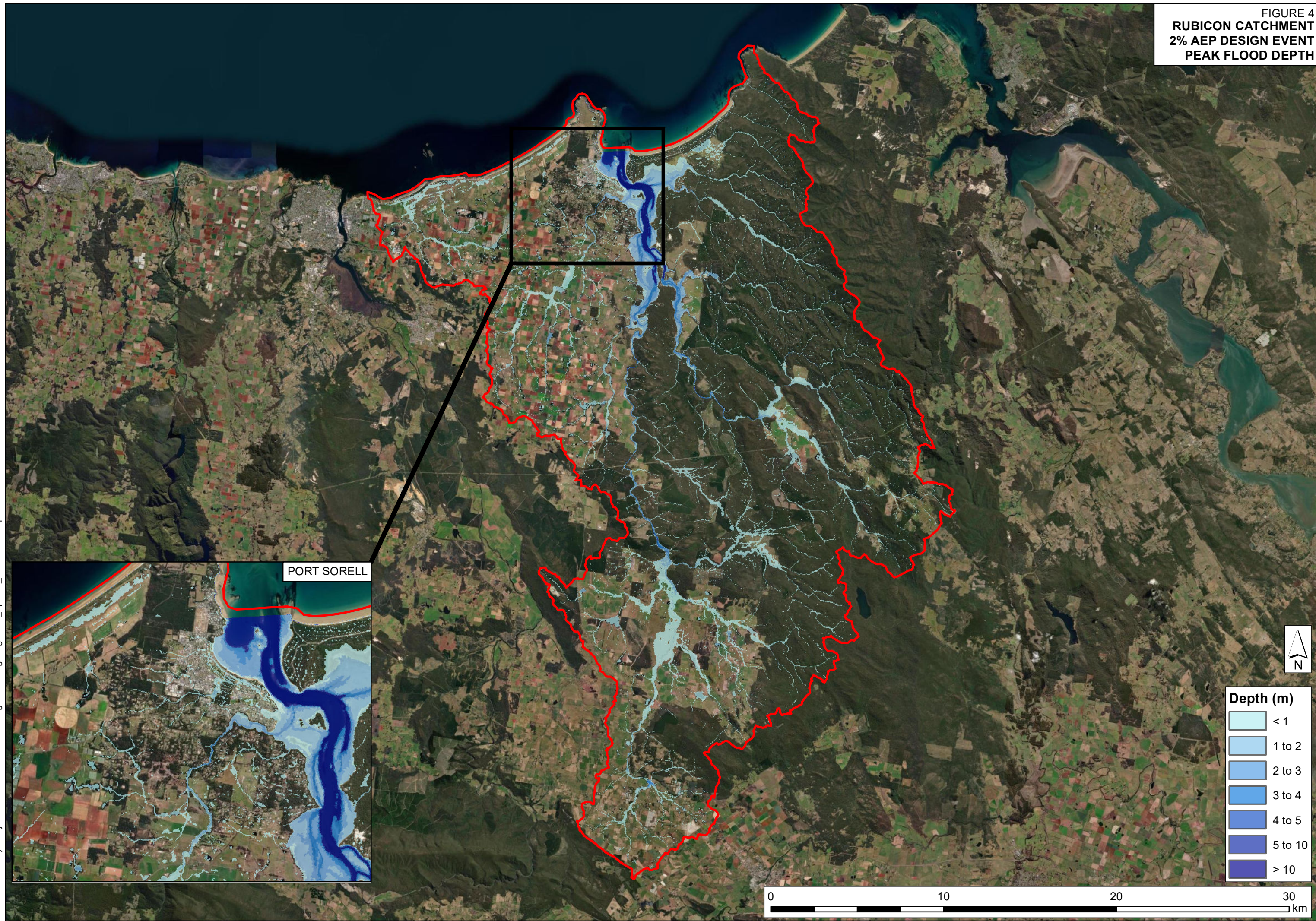
FIGURE 5
RUBICON CATCHMENT
2% AEP DESIGN EVENT
PEAK FLOOD VELOCITY

PORT SORELL

Velocity (m/s)
- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 5
- > 5

0   10   20   30 km
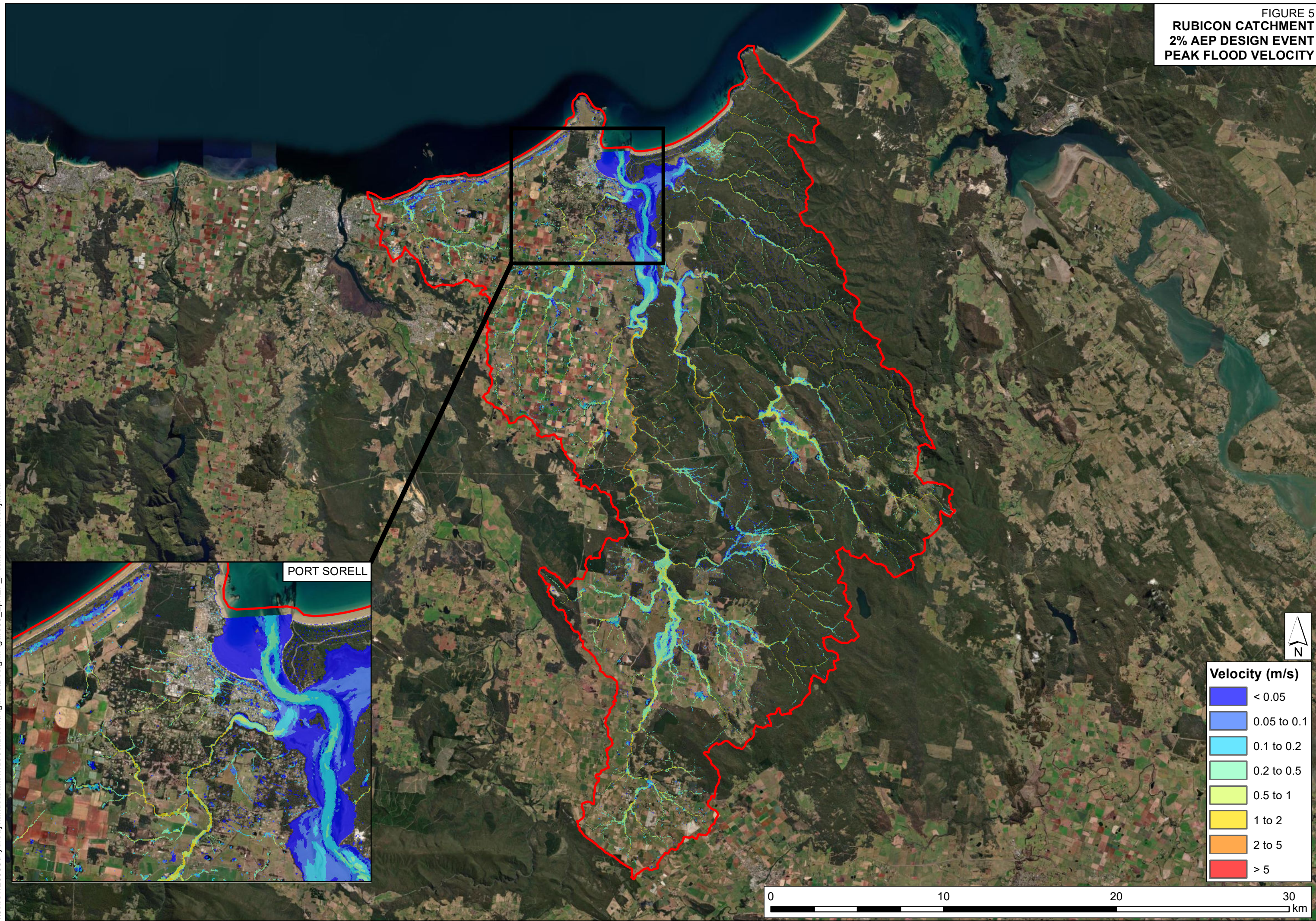
FIGURE 6
RUBICON CATCHMENT
2% AEP DESIGN EVENT
PEAK HYDRAULIC HAZARD

PORT SORELL

Hydraulic Hazard

- H1 - No constraints
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children and the elderly
- H4 - Unsafe for all people and all vehicles
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction
- H6 - Unconditionally dangerous

0   10   20   30 km

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FIGURE 7
**RUBICON CATCHMENT
1% AEP DESIGN EVENT
PEAK FLOOD LEVEL**

PORT SORELL

Elevation (mAHD)
High : 230
Low : -10

0   10   20   30
km

N

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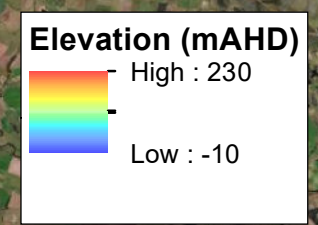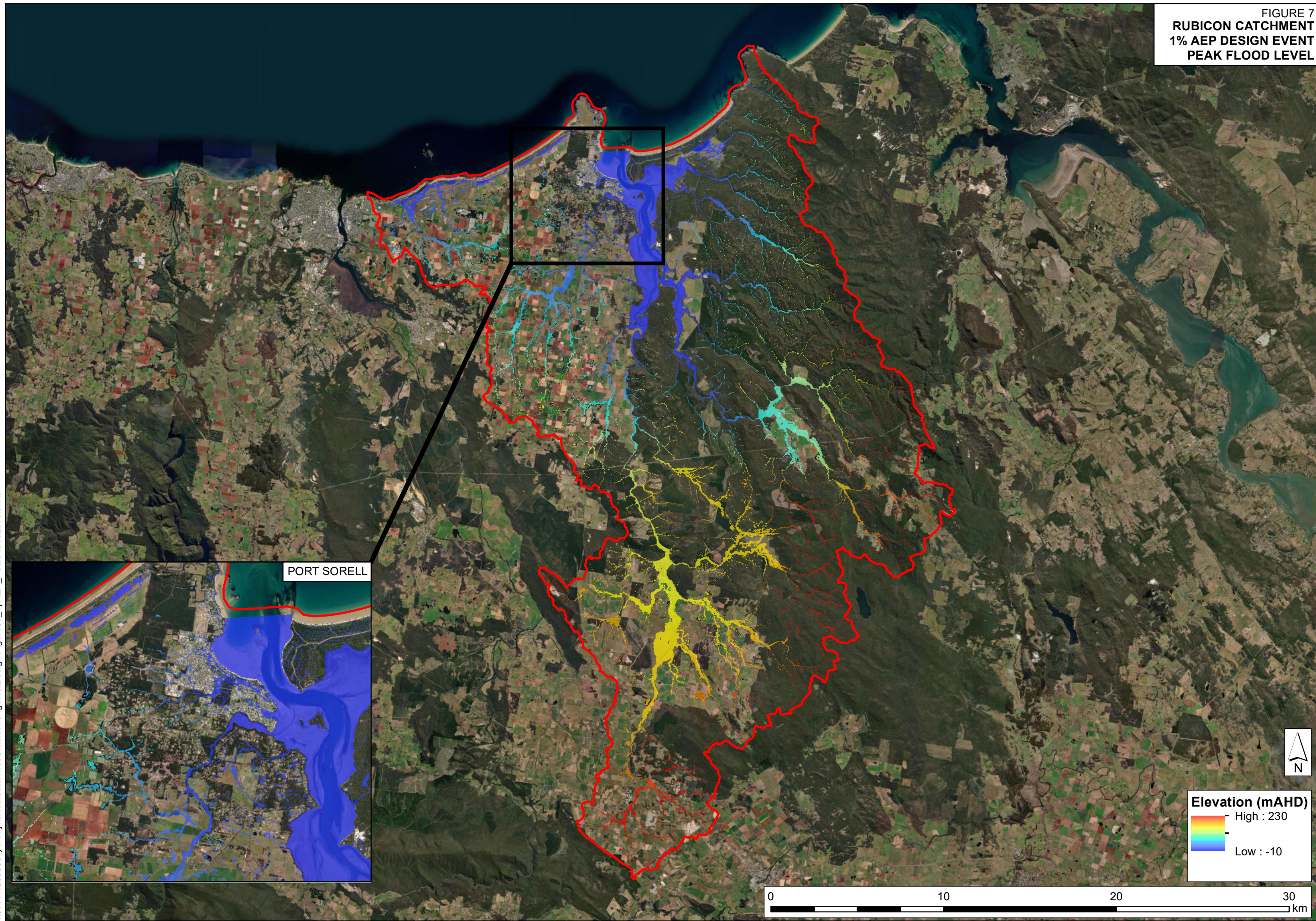
FIGURE 8
RUBICON CATCHMENT
1% AEP DESIGN EVENT
PEAK FLOOD DEPTH

PORT SORELL

Depth (m)
< 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 10
> 10

N

0   10   20   30
km

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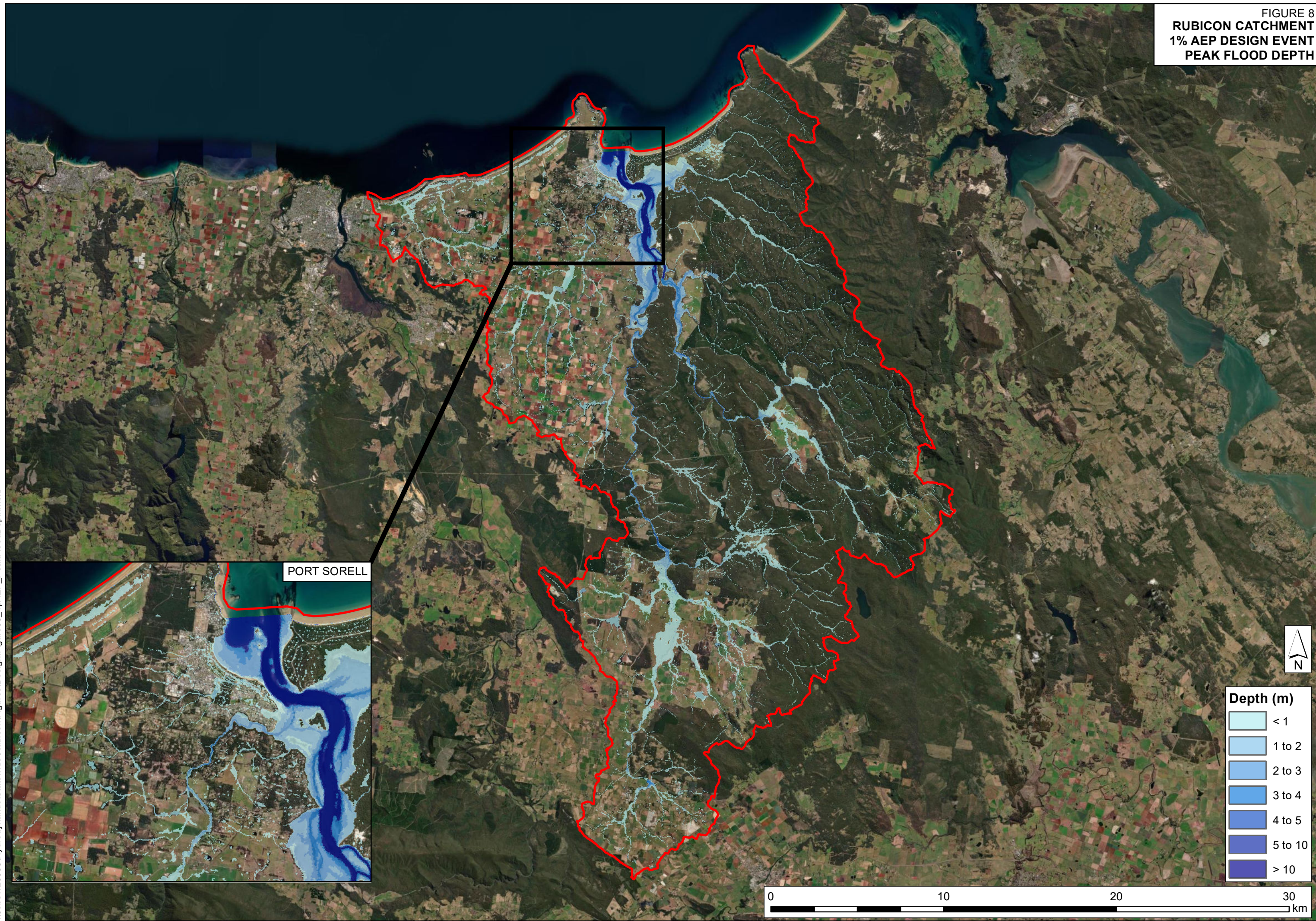
FIGURE 9
RUBICON CATCHMENT
1% AEP DESIGN EVENT
PEAK FLOOD VELOCITY

PORT SORELL

Velocity (m/s)

	< 0.05
	0.05 to 0.1
	0.1 to 0.2
	0.2 to 0.5
	0.5 to 1
	1 to 2
	2 to 5
	> 5

0   10   20   30 km
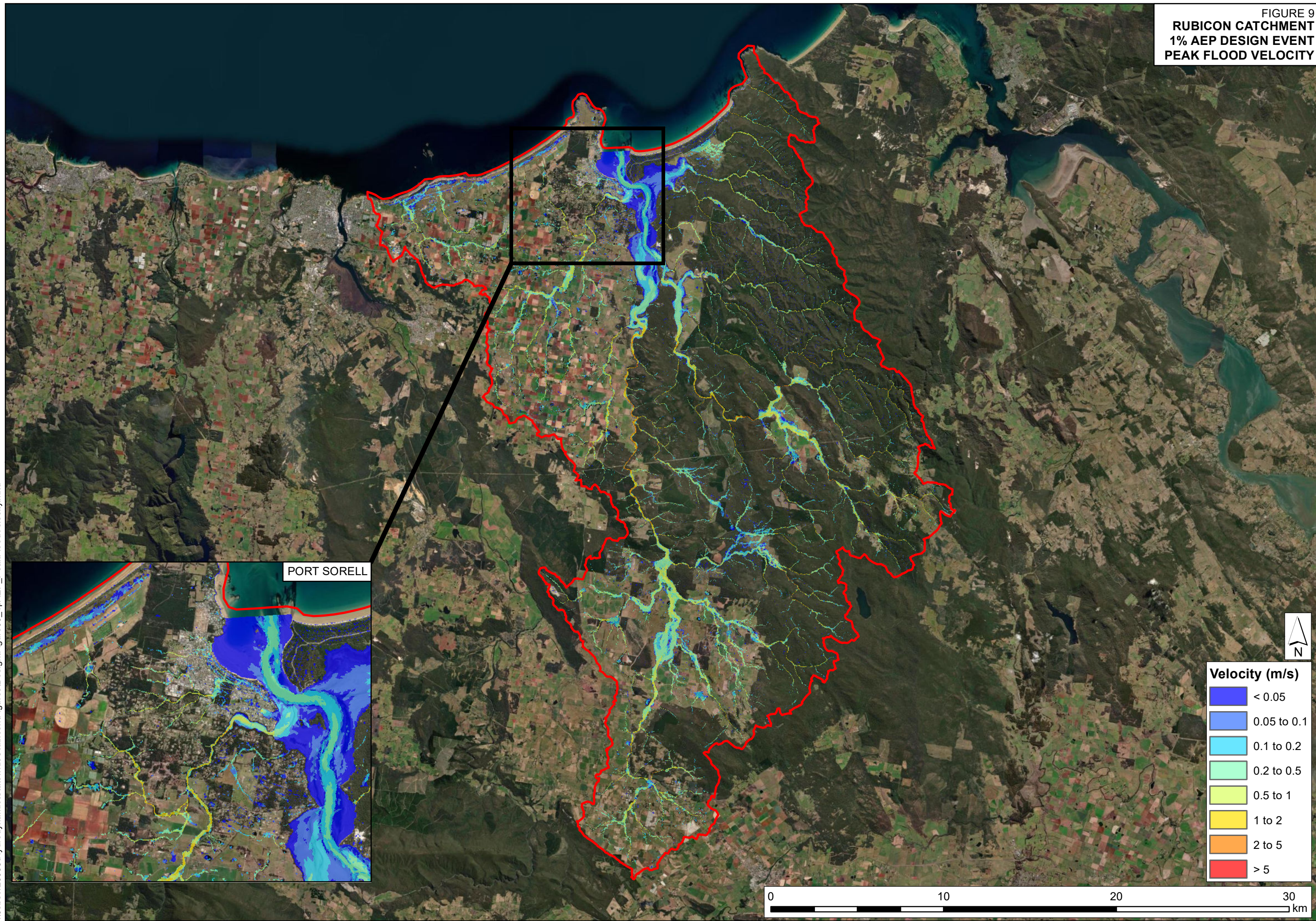
FIGURE 10
RUBICON CATCHMENT
1% AEP DESIGN EVENT
PEAK HYDRAULIC HAZARD

PORT SORELL

Hydraulic Hazard

H1 - No constraints

H2 - Unsafe for small vehicles

H3 - Unsafe for all vehicles, children and the elderly

H4 - Unsafe for all people and all vehicles

H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction

H6 - Unconditionally dangerous

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure10_1pAEP_PeakHydraulicHazard.mxd
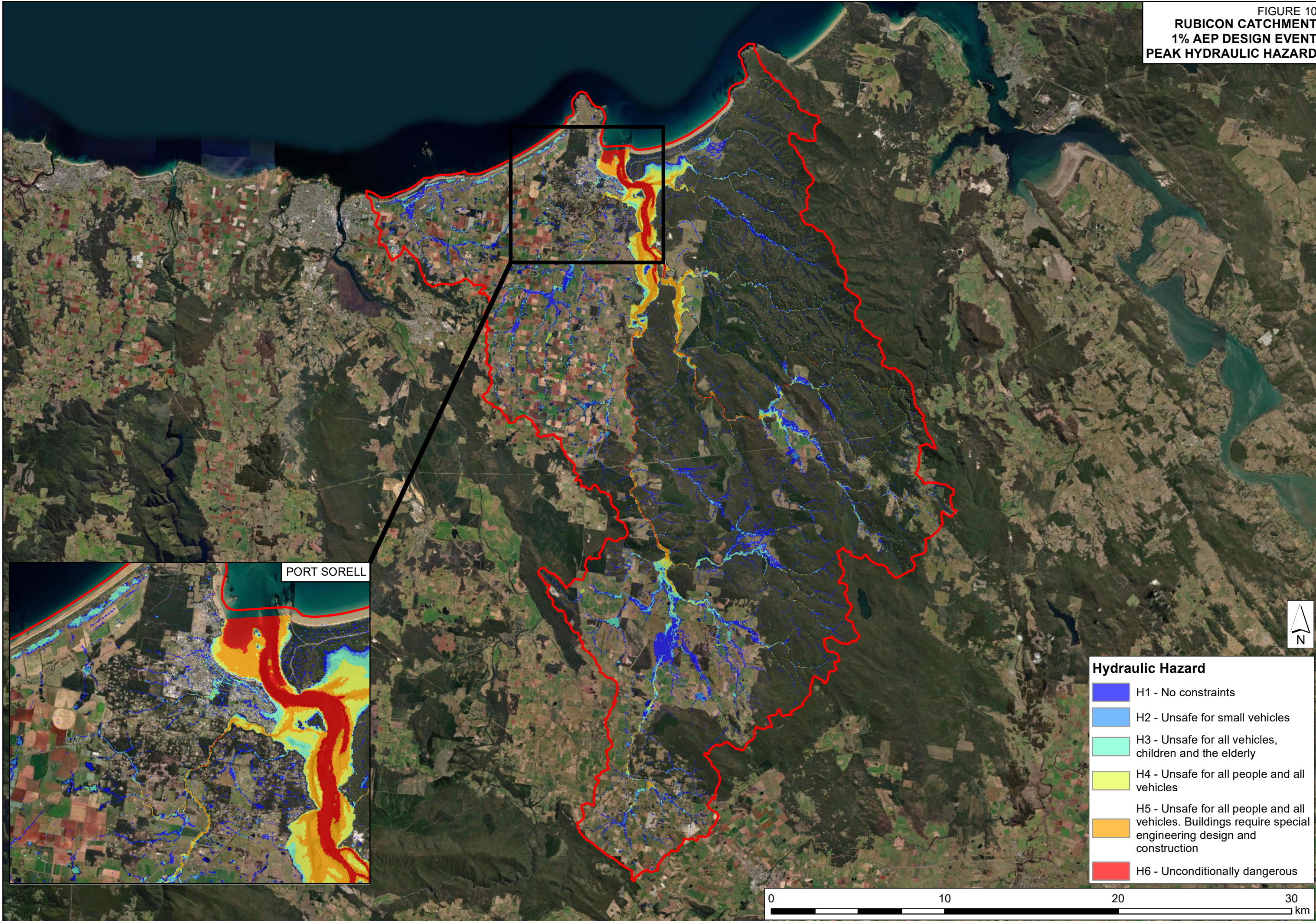
FIGURE 11
RUBICON CATCHMENT
1% AEP CC DESIGN EVENT
PEAK FLOOD LEVEL

PORT SORELL

Elevation (mAHD)
High : 230
Low : -10

N

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure11_1pAEP_CC_PeakFloodLevel.mxd
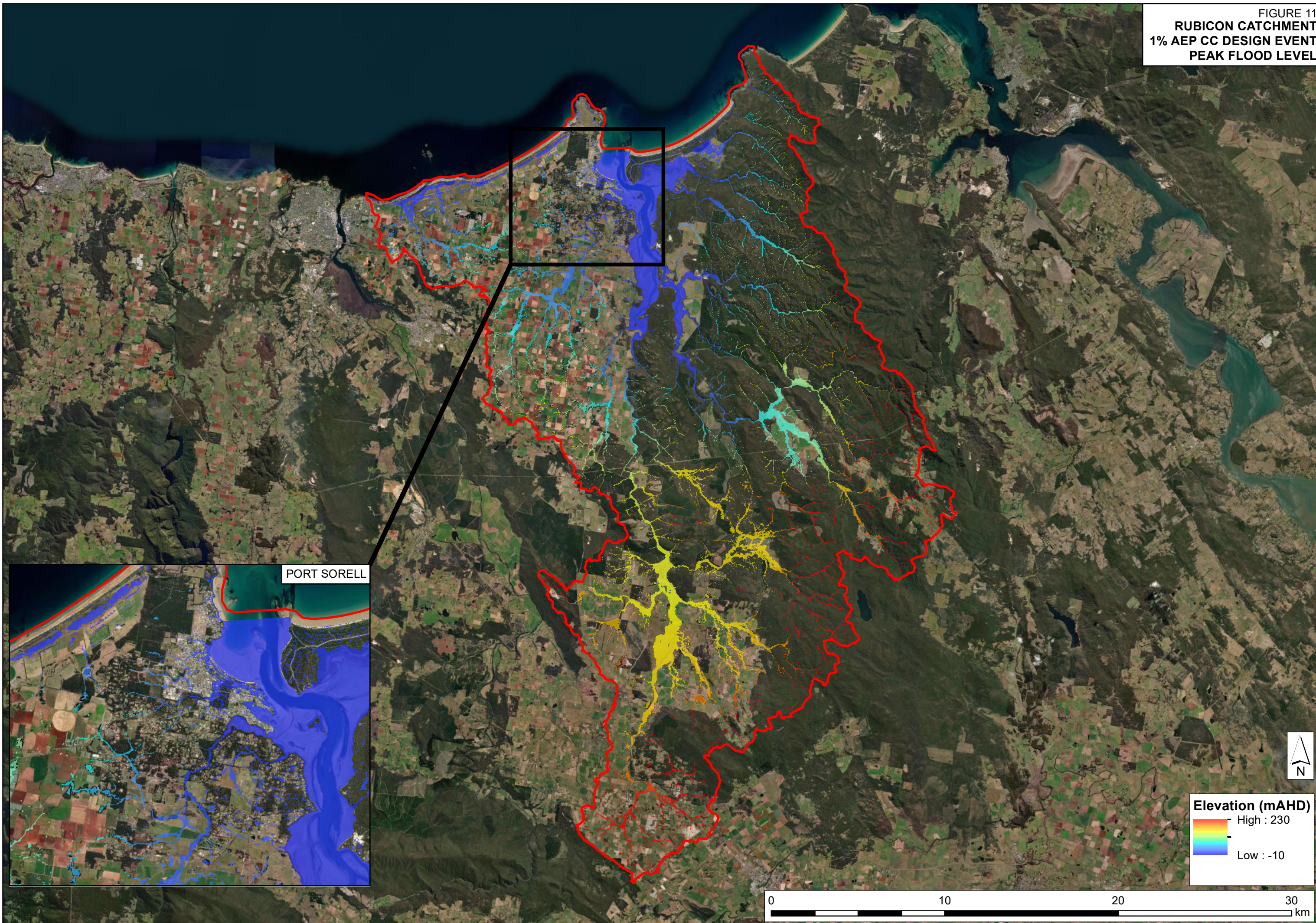
FIGURE 12
RUBICON CATCHMENT
1% AEP CC DESIGN EVENT
PEAK FLOOD DEPTH

PORT SORELL

Depth (m)
< 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 10
> 10

N

0   10   20   30
km
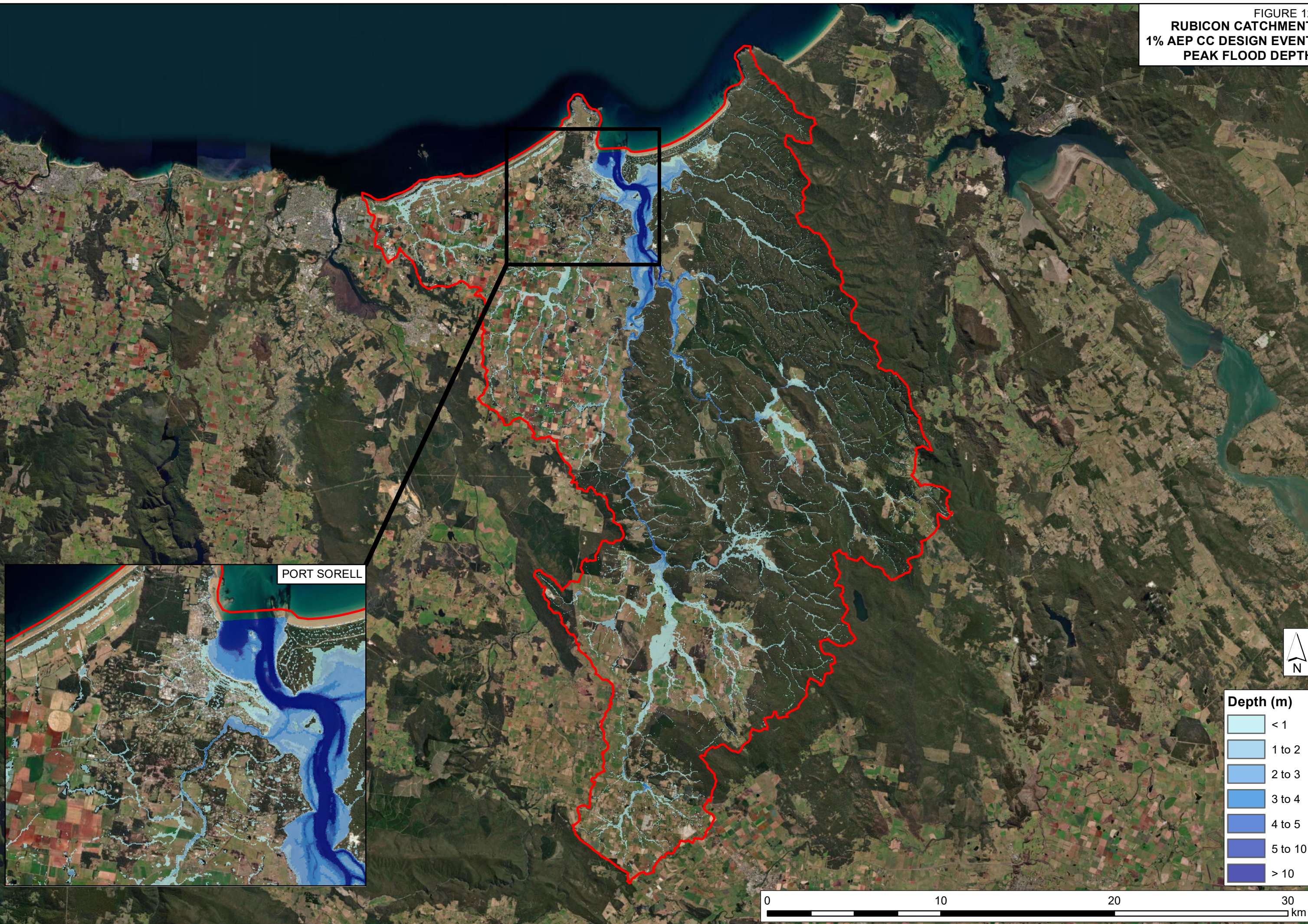
FIGURE 13
RUBICON CATCHMENT
1% AEP CC DESIGN EVENT
PEAK FLOOD VELOCITY

PORT SORELL

Velocity (m/s)
- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 5
- > 5

N

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure13_1pAEP_CC_PeakFloodVelocity.mxd
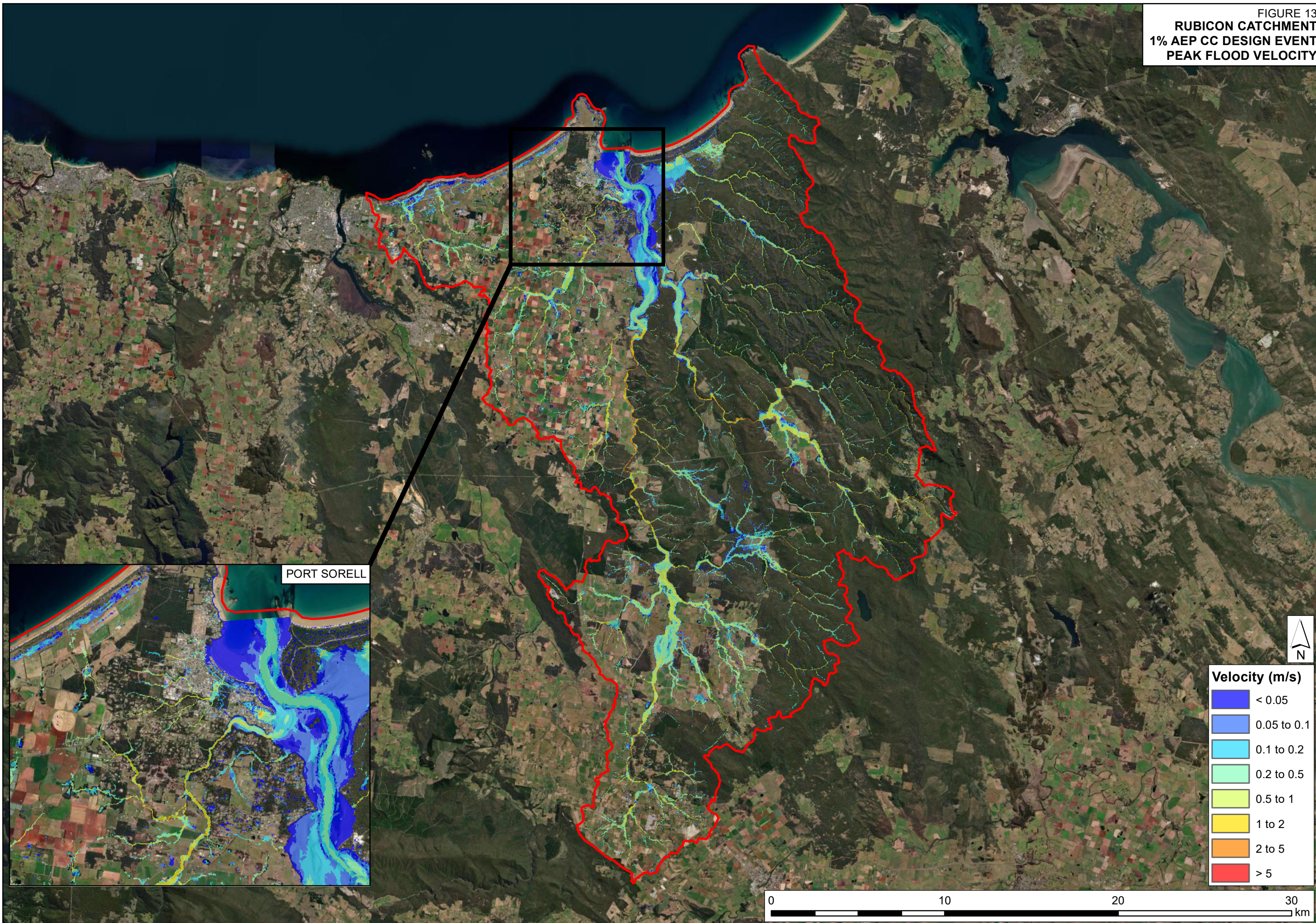
FIGURE 14
RUBICON CATCHMENT
1% AEP CC DESIGN EVENT
PEAK HYDRAULIC HAZARD

PORT SORELL

Hydraulic Hazard

H1 - No constraints

H2 - Unsafe for small vehicles

H3 - Unsafe for all vehicles, children and the elderly

H4 - Unsafe for all people and all vehicles

H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction

H6 - Unconditionally dangerous

N

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure14_1pAEP_CC_PeakHydraulicHazard.mxd
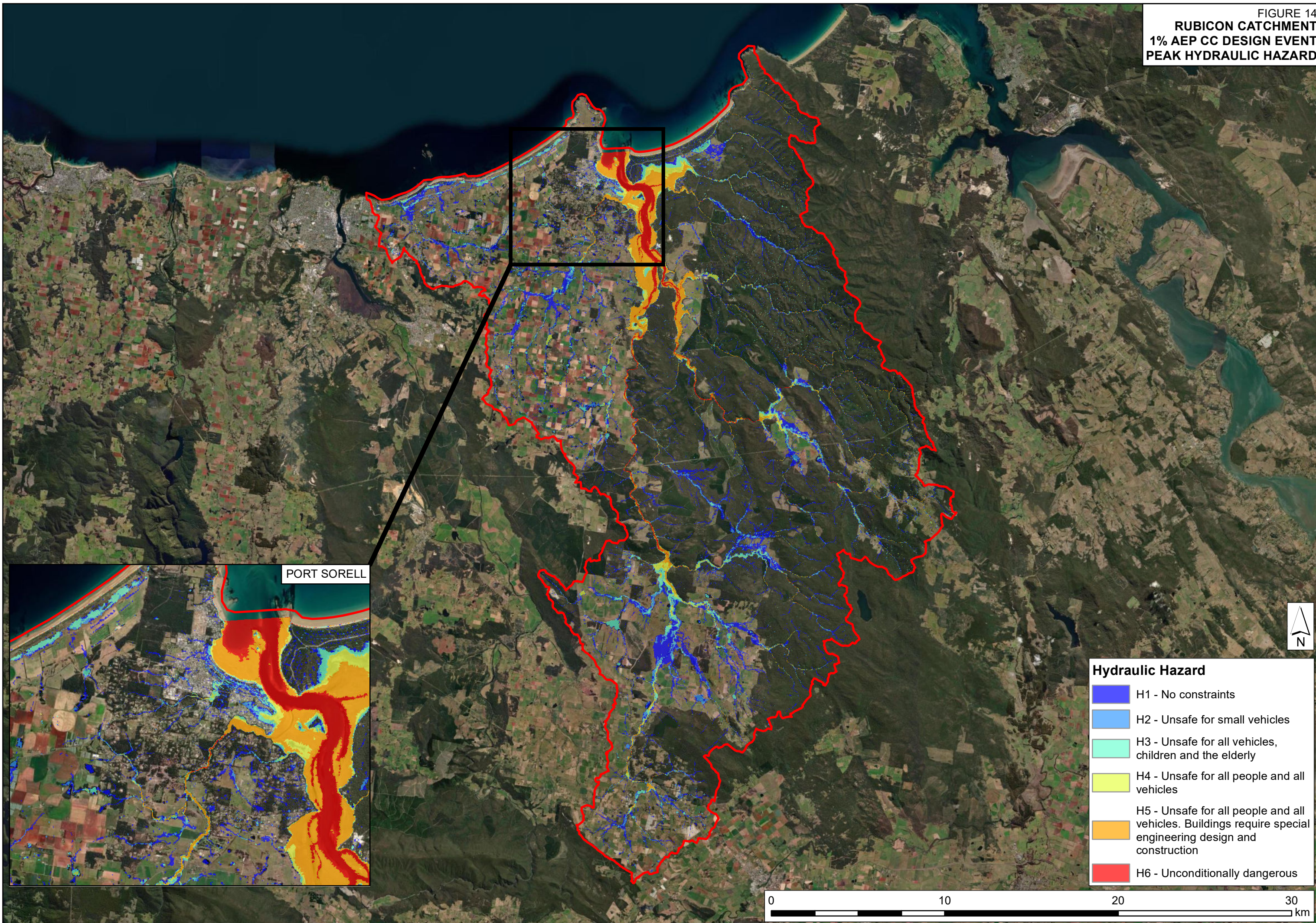
FIGURE 15
RUBICON CATCHMENT
0.5% AEP DESIGN EVENT
PEAK FLOOD LEVEL

PORT SORELL

Elevation (mAHD)
High : 230
Low : -10

J:\Jobs\120036\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure15_0.5pAEP_PeakFloodLevel.mxd

0   10   20   30
km
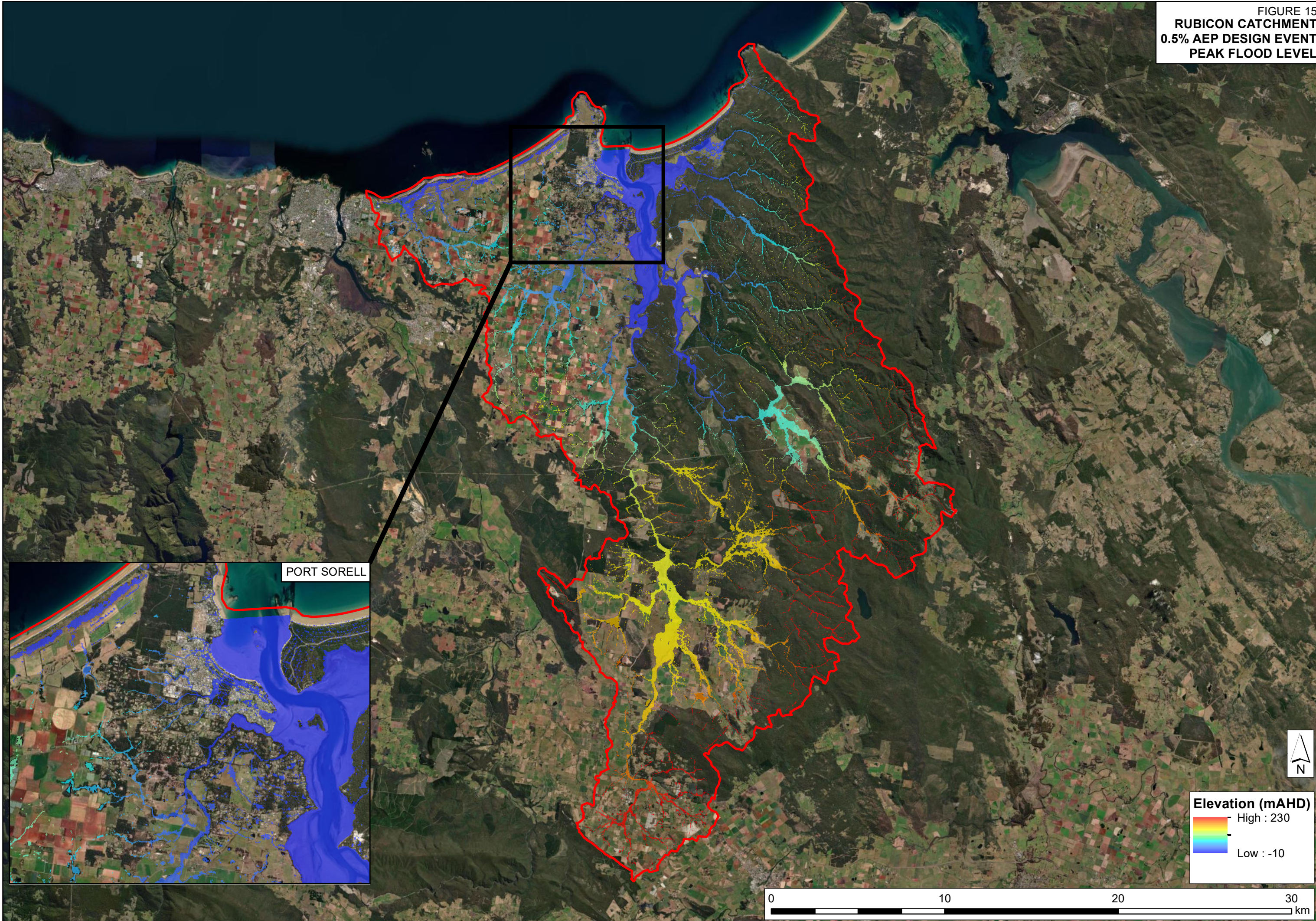
FIGURE 16
RUBICON CATCHMENT
0.5% AEP DESIGN EVENT
PEAK FLOOD DEPTH

PORT SORELL

N

Depth (m)
< 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 10
> 10

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure16_0.5pAEP_PeakFloodDepth.mxd
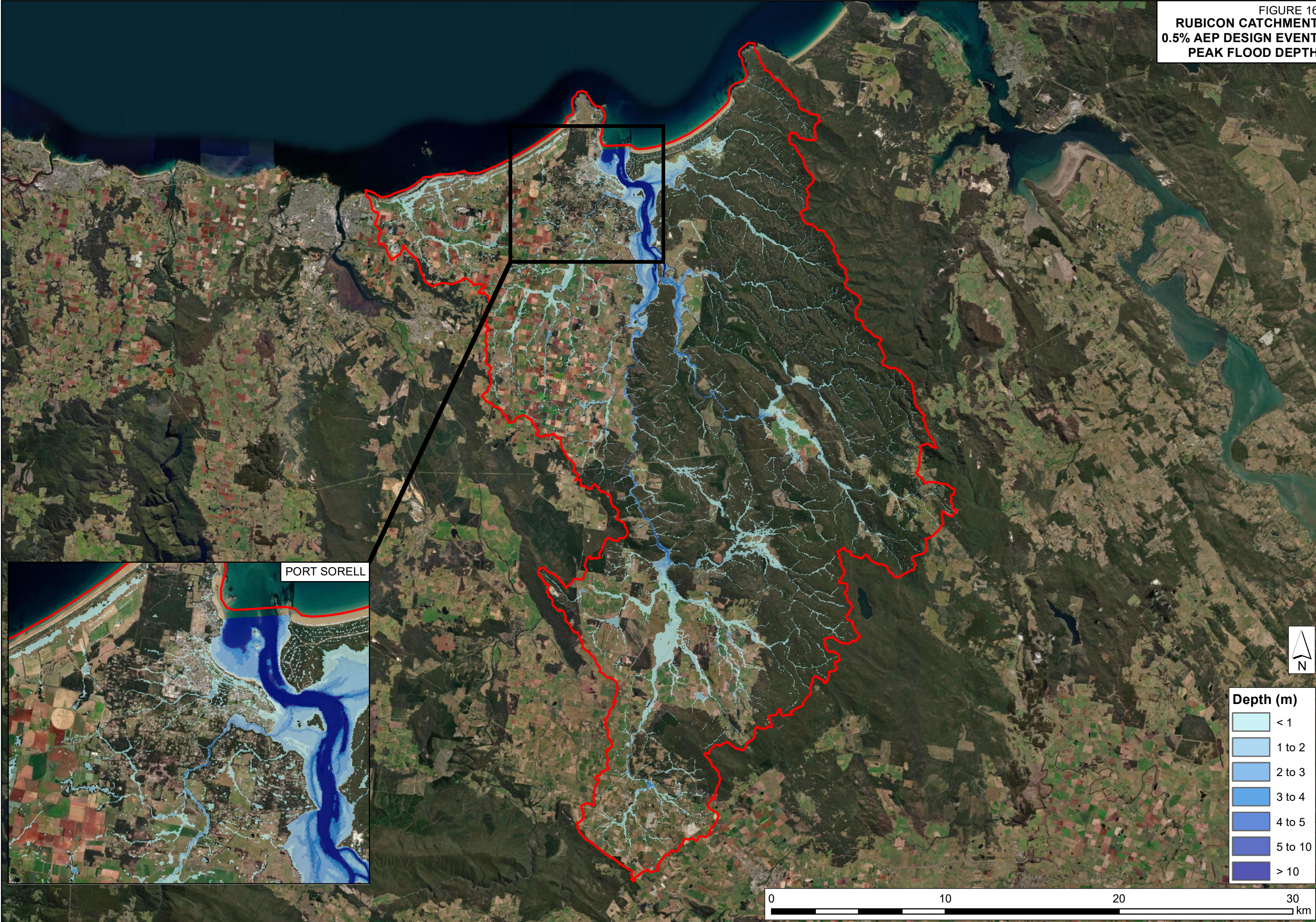
FIGURE 17
**RUBICON CATCHMENT
0.5% AEP DESIGN EVENT
PEAK FLOOD VELOCITY**

PORT SORELL

Velocity (m/s)

	< 0.05
	0.05 to 0.1
	0.1 to 0.2
	0.2 to 0.5
	0.5 to 1
	1 to 2
	2 to 5
	> 5

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure17_0.5pAEP_PeakFloodVelocity.mxd

PORT SORELL

Hydraulic Hazard

H1 - No constraints

H2 - Unsafe for small vehicles

H3 - Unsafe for all vehicles, children and the elderly

H4 - Unsafe for all people and all vehicles

H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction

H6 - Unconditionally dangerous

N

0   10   20   30
km

FIGURE 19
RUBICON CATCHMENT
1% AEP DESIGN EVENT
CRITICAL EVENT

PORT SORELL

Critical Event

- 25km ARF bin - 360min
- 45km ARF bin - 540min
- 75km ARF bin - 720min
- Direct Rainfall

N

0   10   20   30
km

J:\Jobs\120038\Hydrodynamic\Statewide\Rubicon\Figures\Design\Figure19_1pAEP_CriticalEvent.mxd
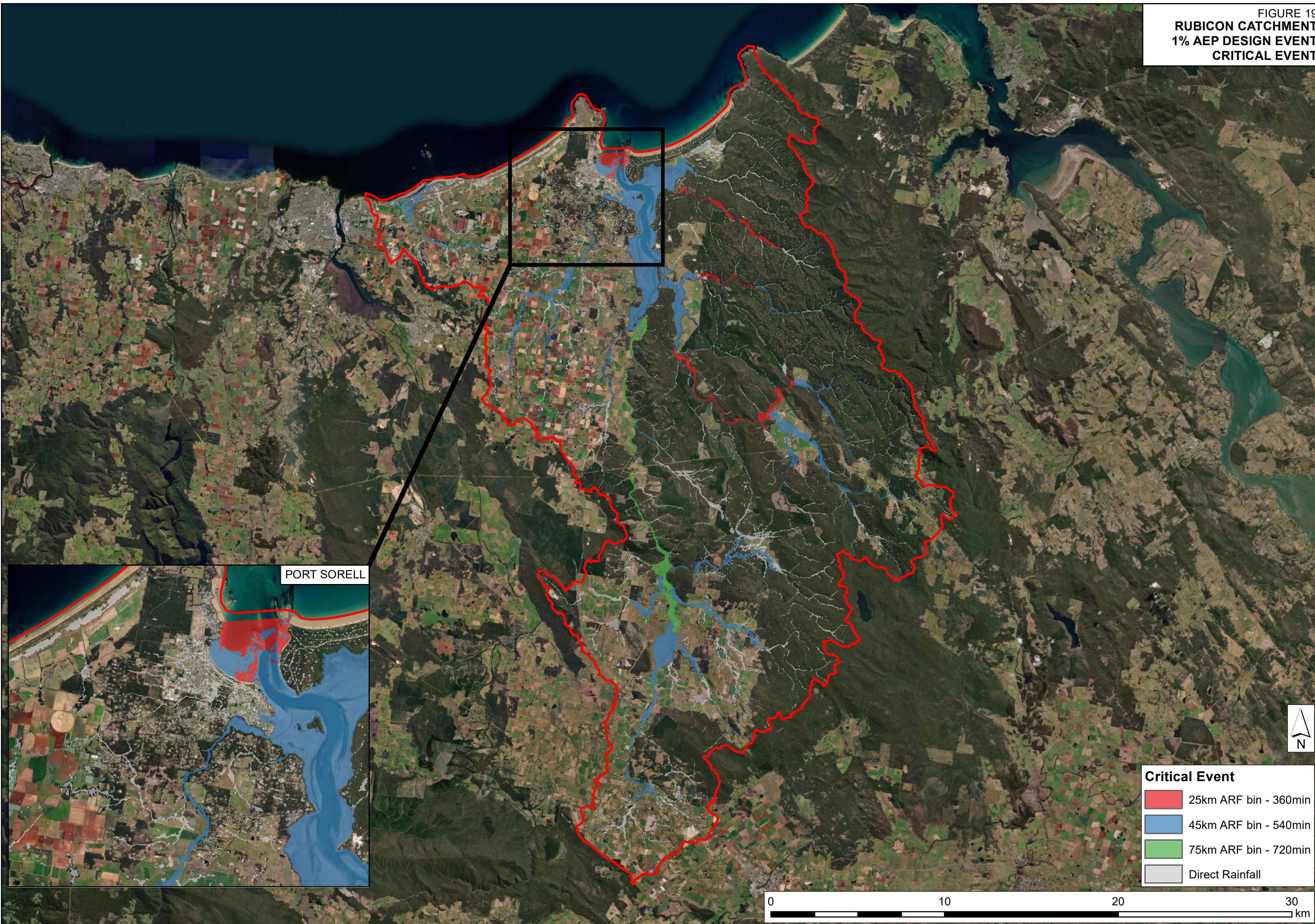
Appendix A

APPENDIX A.   DESIGN EVENT DATA

FIGURE A1
DESIGN RAINFALL DEPTHS
540MIN 2%AEP

Event Rainfall (mm)

108
104
100
96
92
88
84
80
76

N

10 km
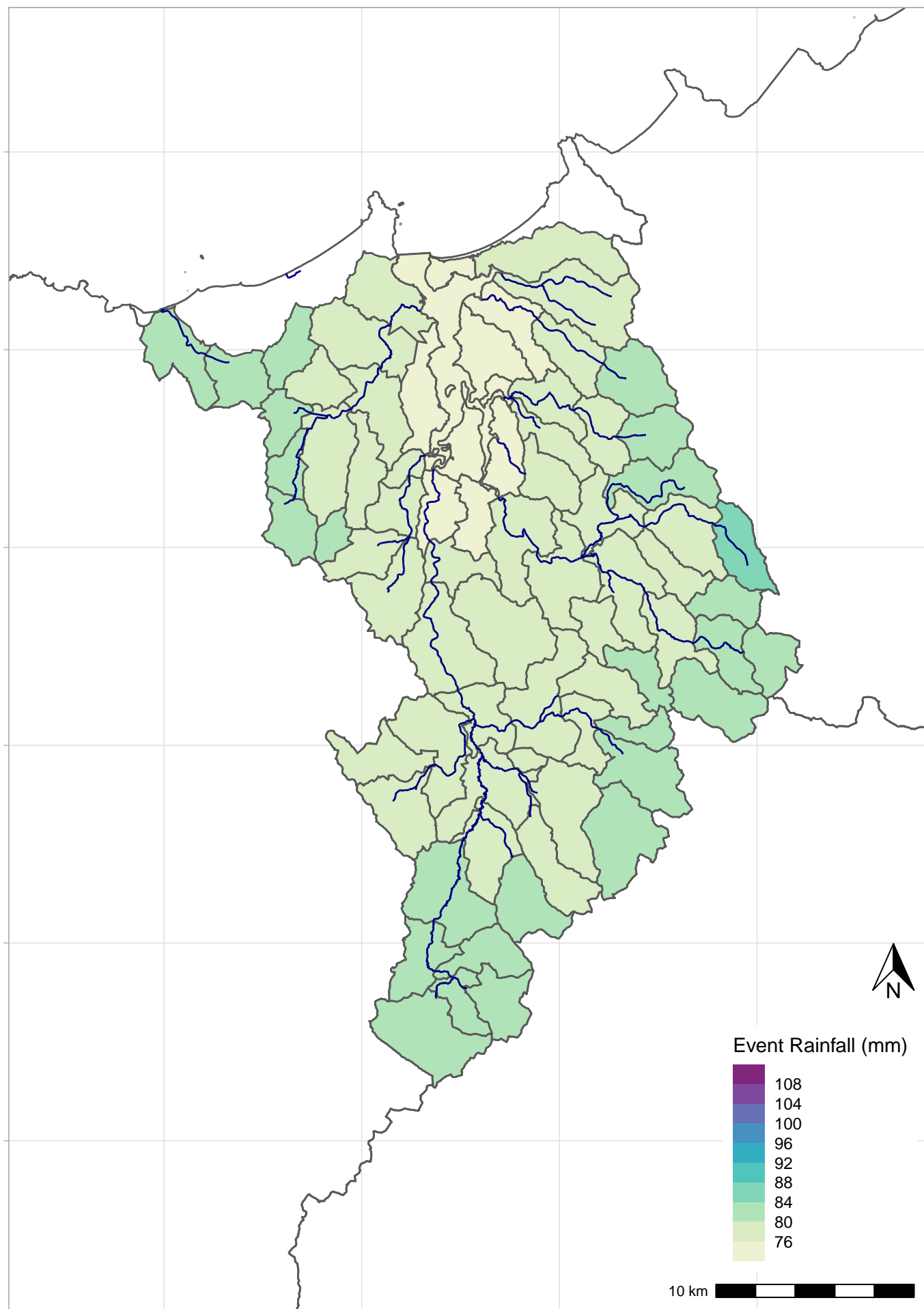
FIGURE A2
DESIGN RAINFALL DEPTHS
540MIN 1%AEP

Event Rainfall (mm)

108
104
100
96
92
88
84
80
76

10 km
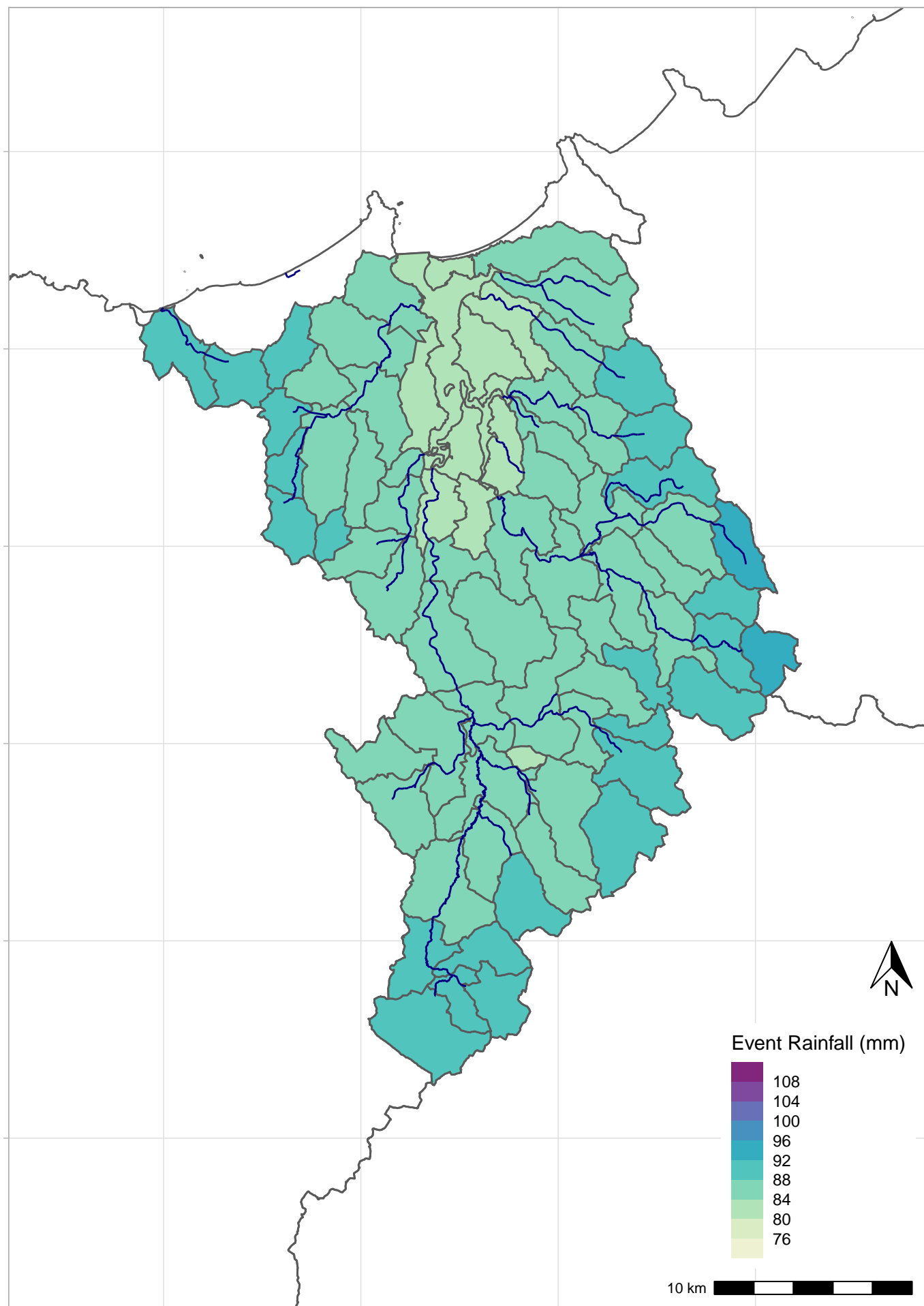
FIGURE A3
DESIGN RAINFALL DEPTHS
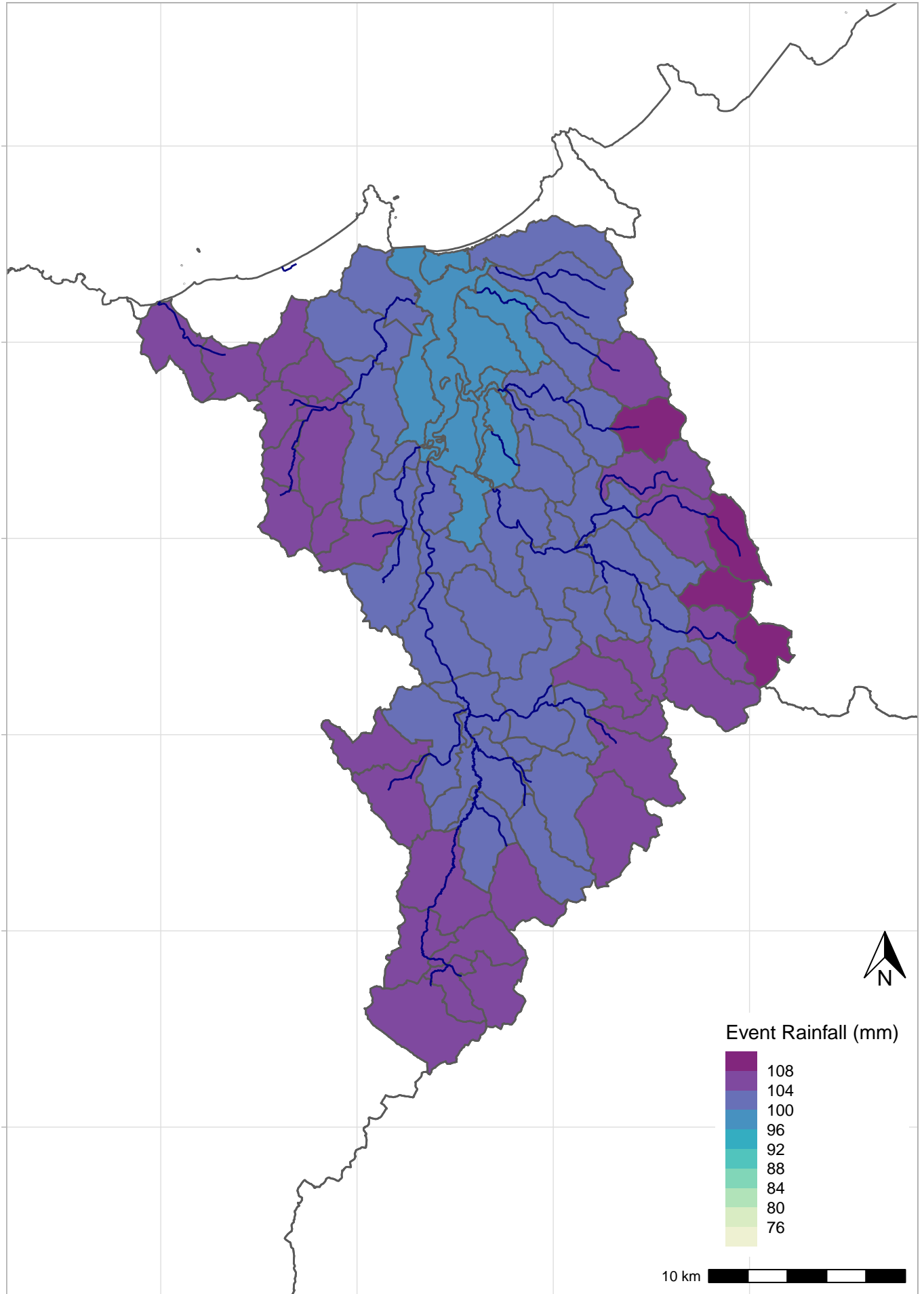**540MIN 0.5%AEP**

Event Rainfall (mm)

108
104
100
96
92
88
84
80
76

N

10 km

FIGURE A4
**DESIGN AREAL TEMPORAL PATTERNS
DURATIONS FROM 4.5 TO 24 HOURS**
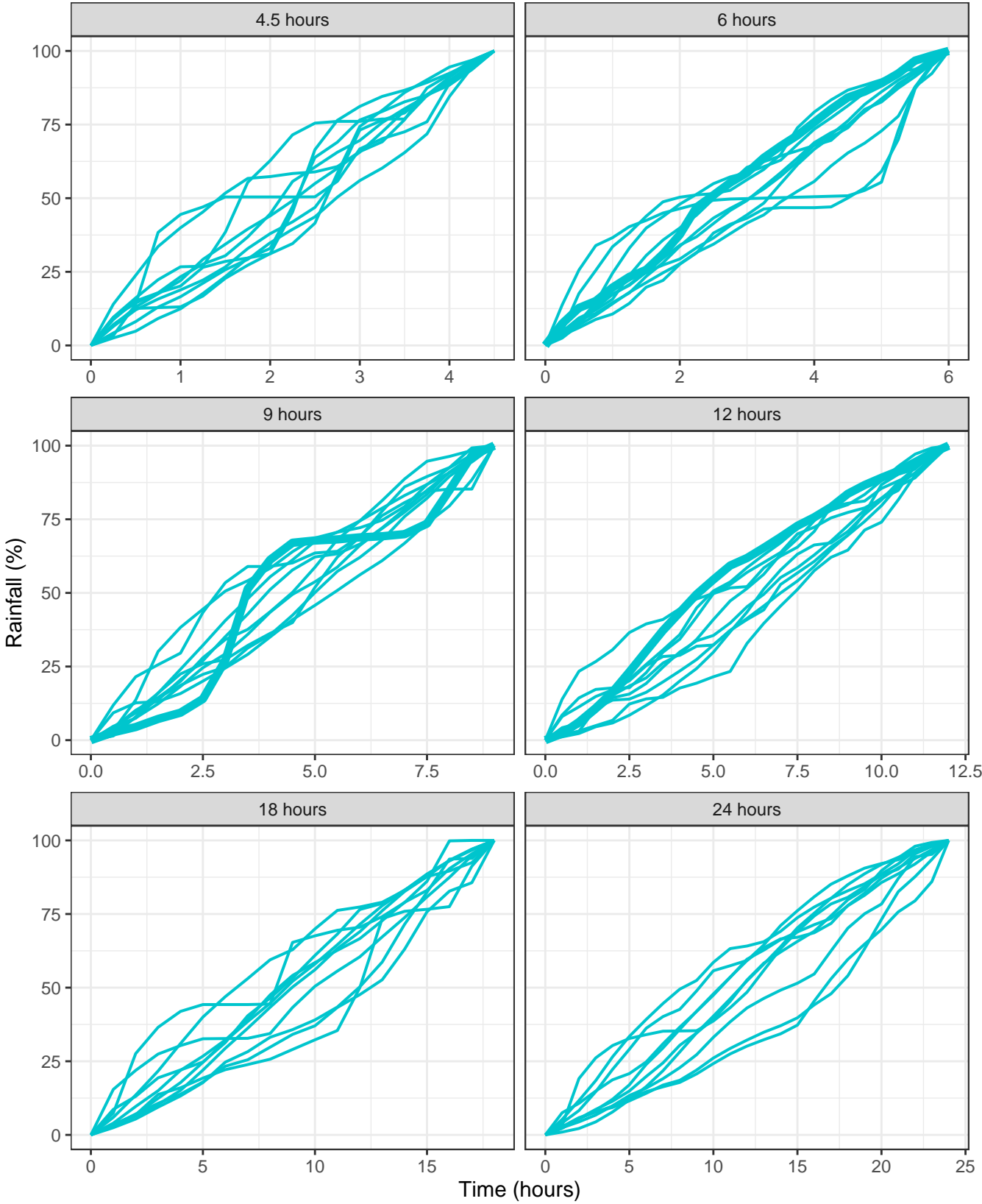
Appendix B

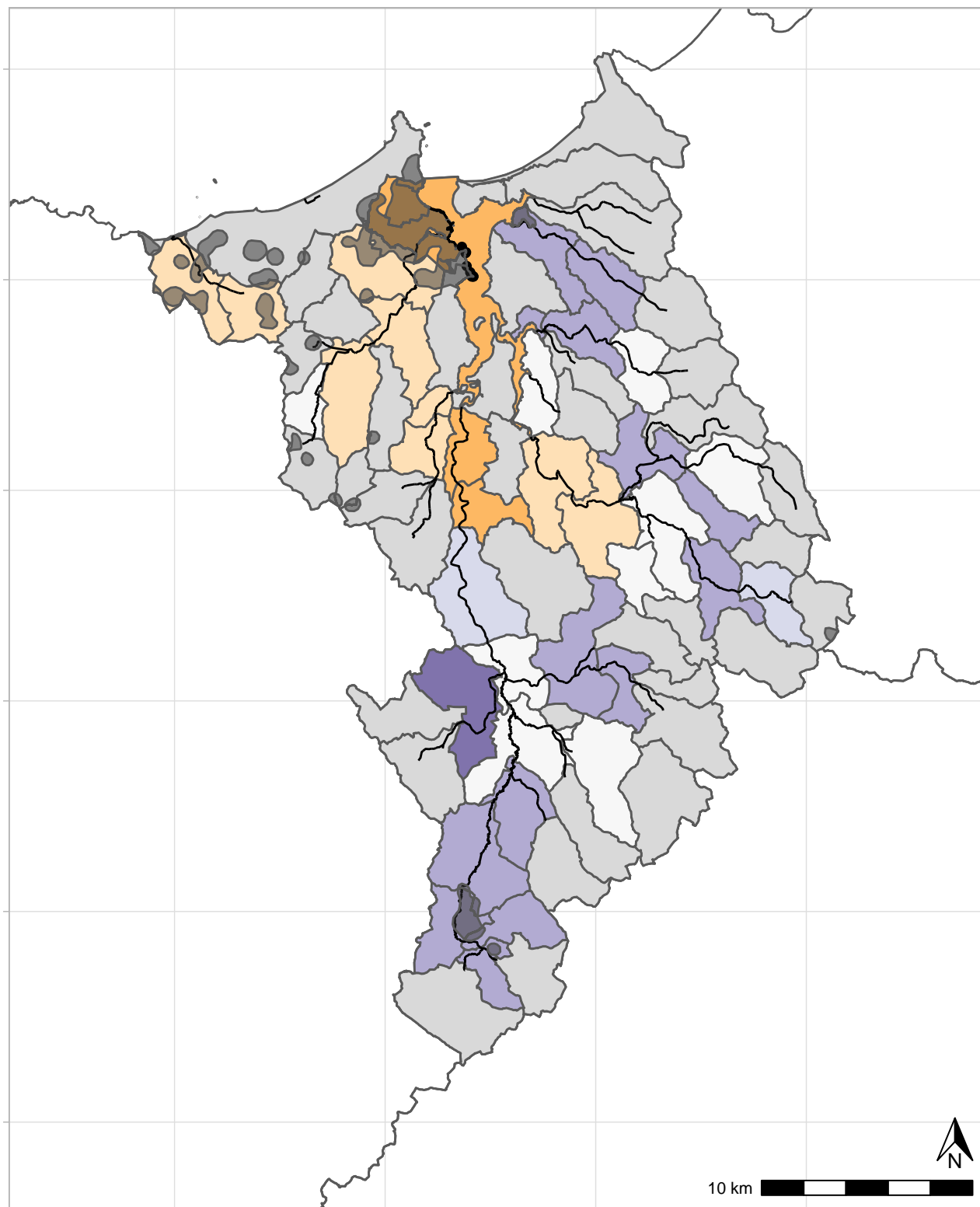# APPENDIX B. DESIGN PEAK ERRORS

Figure B1
Rubicon Catchment
Percentage error in peak flows using selected runs
2%AEP

% error

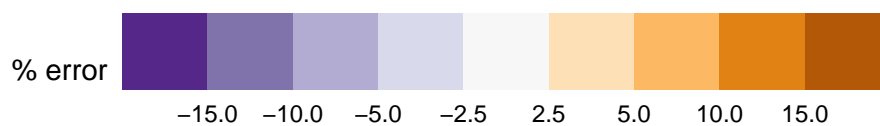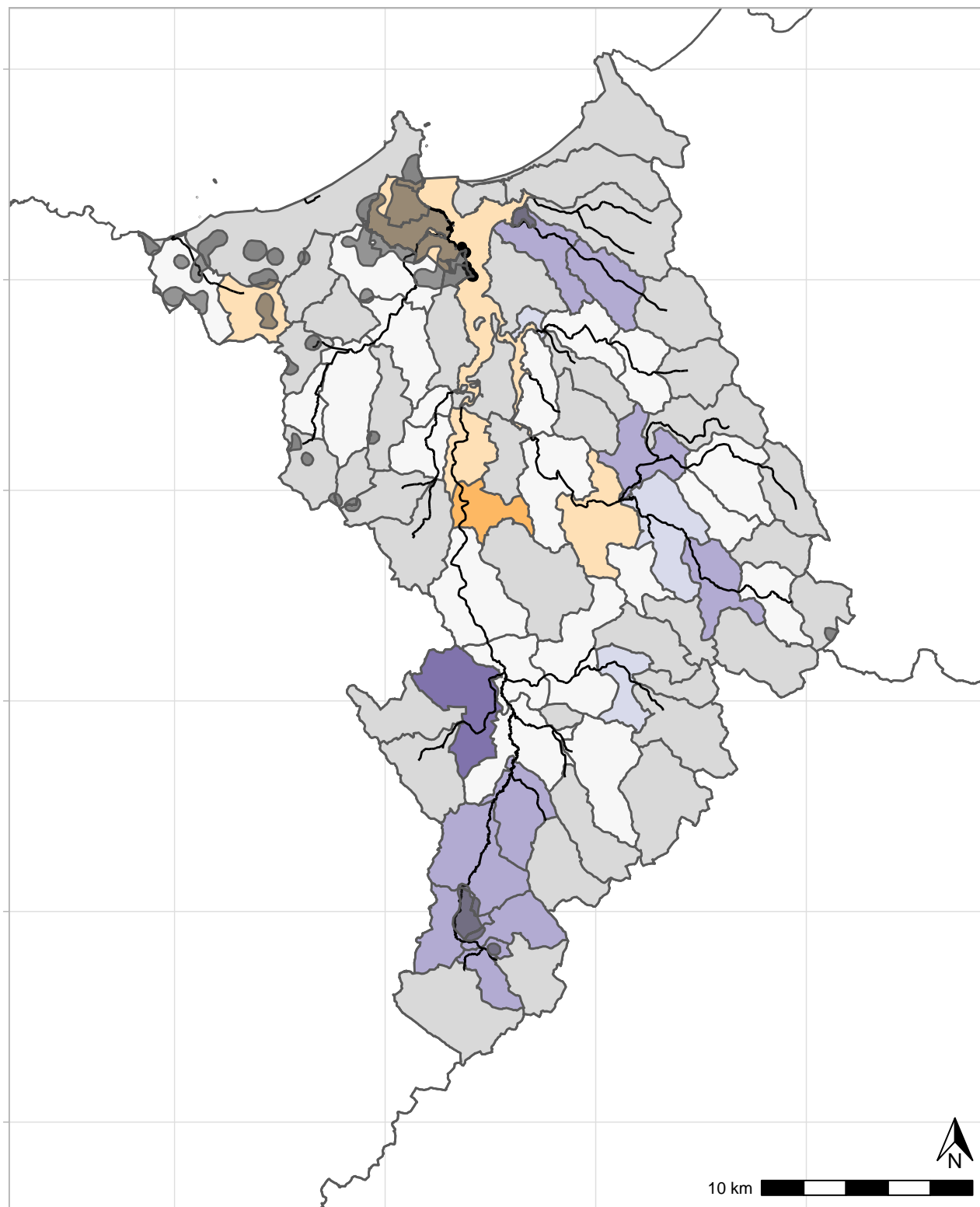−15.0 −10.0 −5.0 −2.5 2.5 5.0 10.0 15.0

HSA

Headwater

10 km

N
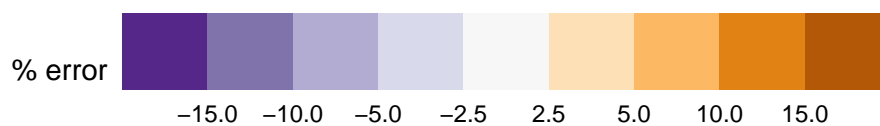
created by J:/Jobs/120038/Hydrology/Statewide/Design_Events/Rubicon/7_Rubicon_Design_Report_Plots.R

Figure B2
Rubicon Catchment
Percentage error in peak flows using selected runs
1%AEP

% error

−15.0 −10.0 −5.0 −2.5 2.5 5.0 10.0 15.0

HSA

Headwater

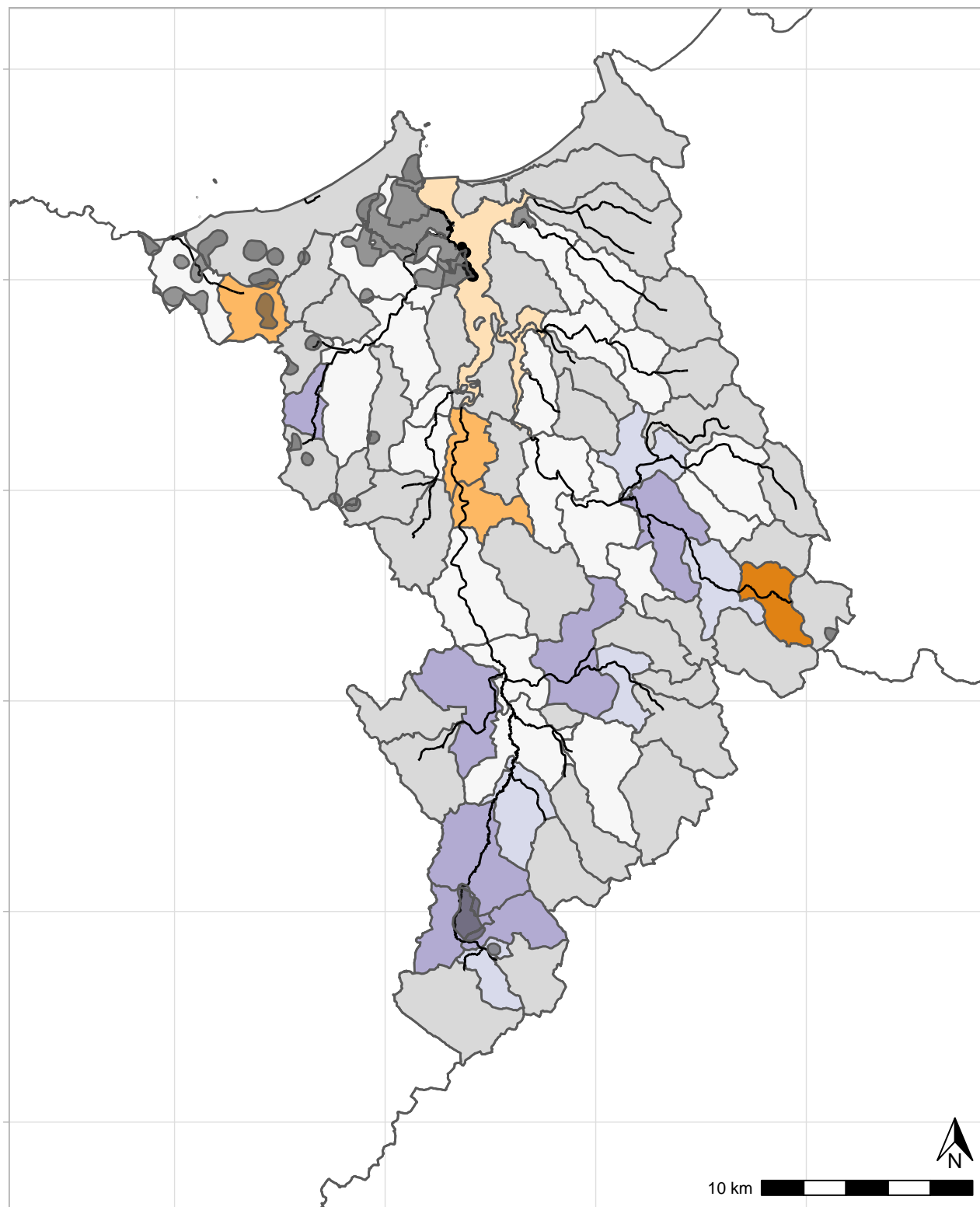created by J:/Jobs/120038/Hydrology/Statewide/Design_Events/Rubicon/7_Rubicon_Design_Report_Plots.R

Figure B3
Rubicon Catchment
Percentage error in peak flows using selected runs
0.5%AEP

% error

−15.0 −10.0 −5.0 −2.5 2.5 5.0 10.0 15.0

HSA

Headwater

10 km

N