



# North and South Esk Rivers Flood Modelling and Mapping Update Levee Breach Assessment

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## Document Control Sheet

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<p><b>Synopsis: This technical report presents the methodology and results of the levee breach assessment undertaken for the North and South Esk Rivers Flood Modelling and Mapping Update.</b></p>		

### REVISION/CHECKING HISTORY

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# 1 Introduction

BMT was commissioned by the City of Launceston (Council) to undertake an update of the North and South Esk Rivers flood modelling and mapping, originally completed by BMT (formerly known as BMT WBM) in 2008 (BMT WBM 2008). The methodology and results of the flood model and mapping update are presented in BMT (2018a) and BMT (2018b).

The Launceston Flood Protection System (LFPS) is a system of levees constructed on both banks of the North Esk River and the east bank of Home Reach (Tamar Estuary). The extent of the levee system is shown in Figure 1-1. Following BMT WBM (2008), the LFPS was upgraded to provide protection up to the 95% confidence level, 1 in 200 Annual Exceedance Probability (AEP) design flood level (4.5 m AHD) with 0.6 m freeboard (as determined by the 2008 study), equating to a design levee height of 5.1 m AHD. Following a revision to the design event flood levels in BMT (2018a), the level of protection provided by the LFPS has been reassessed as the 1% AEP design flood level (4.6 m AHD) plus 0.5 m freeboard under existing climate conditions and approximately the 1% AEP design flood level (5.1 m AHD) without freeboard under the 2050 climate conditions.



Figure 1-1 LFPS Layout

A levee breach analysis was undertaken to better define residual consequence in areas protected by the LFPS for flood planning and emergency response purposes. The levee breach assessment does not assign a likelihood (probability) to a potential levee breach, rather defines the consequences (flood behaviour) should the breach occur. This report presents the methodology and results from the analysis.



## 2 Methodology

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To assess the consequences of levee breaches across Launceston, a series of levee breaches at 23 locations, shown in Figure 3-1 and Figure 3-2, have been modelled for the 20%, 10%, 5%, 2% and 1% AEP events under a 2050 climate condition. A 'no levee' scenario has also been modelled.

The TUFLOW hydraulic model described in BMT (2018a) was used for this assessment. Due to the large number of model runs required, the model mapping outputs were limited to the area protected by the LFPS to reduce output file sizes. Please note this does not impact on flood model setup, or hydraulic calculations, only the extent of the mapping outputs.

The Levee Breach scenarios were modelled using the 'variable z shape' function in TUFLOW which allows topography changes to be during a model simulation based on a time or flood behaviour trigger. For this assessment levee breaches were modelled as an instantaneous 40 m wide breach in the levee, occurring at the time of the peak flood level in the adjacent section of waterway. Consequently, the water level which initiates the breach was different for each modelled AEP event. Each levee breach was modelled individually.

The 'No Levee' scenario was modelled by removing all levee survey breaklines from the model and adjusting the base topography to remove any remnant levee which had been picked up in the LiDAR data.

## 3 Results

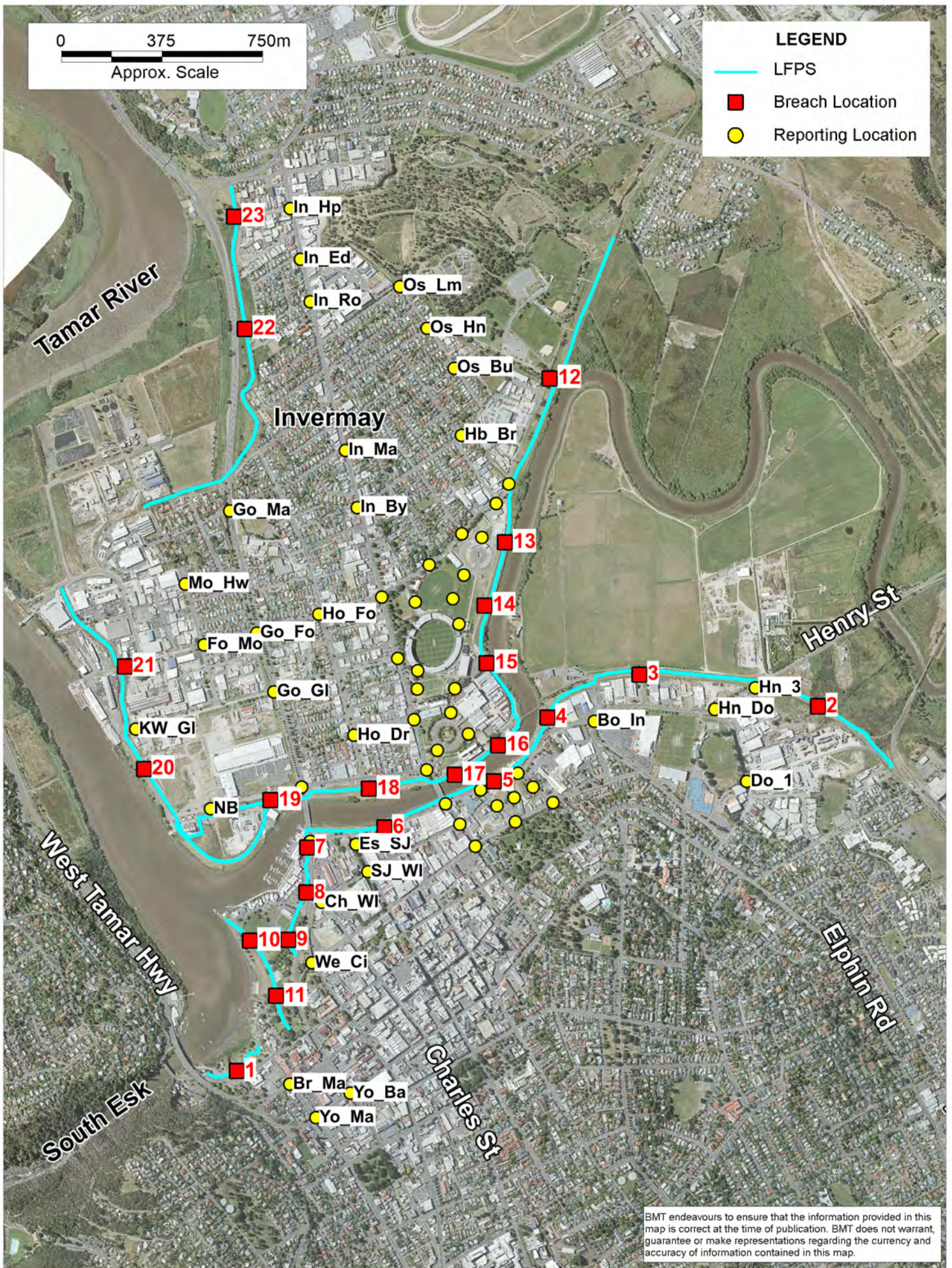
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A series of 60 output locations, shown in Figure 3-1 and Figure 3-2, were included in the model to interpret the results of the Levee Breach scenarios. For each output location and breach scenario the following parameters have been output:

- Time to inundation
- Time to inundation greater than 300 mm depth
- Duration of Inundation greater than 300 mm depth (up to 1 week)
- Time to velocity greater than 2 m/s
- Duration of velocity greater than 2 m/s depth (up to 1 week)
- Peak depth
- Peak velocity
- Peak depth-velocity product

The combined outputs, i.e. the critical output of each of the 23 levee breach scenarios at each location are presented in Appendix A. The combined outputs also indicate which levee breach resulted in the peak parameter reported.



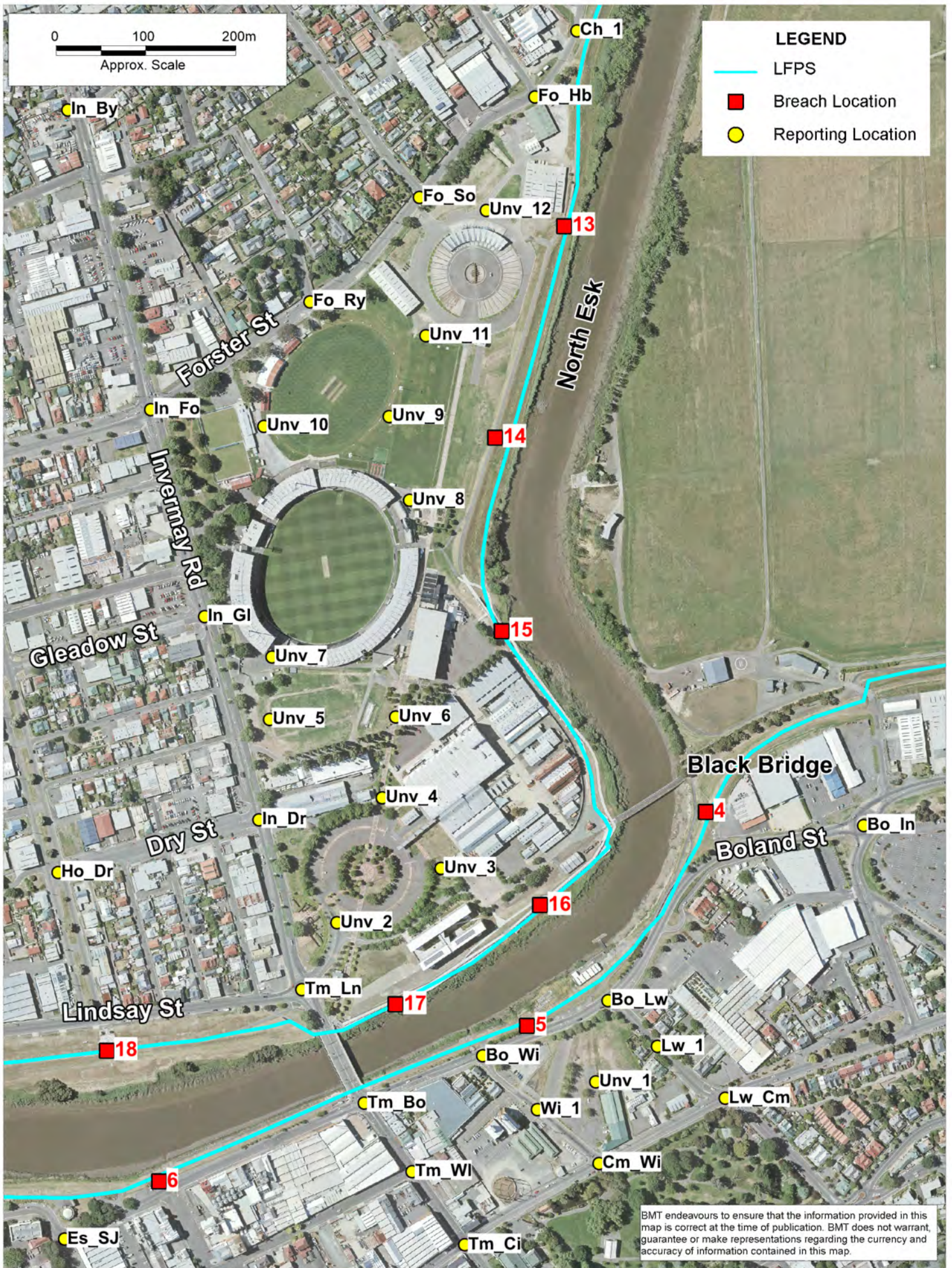


**Figure 3-1  
Levee Breach and Reporting Locations**

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**Figure 3-2**  
**Levee Breach and Reporting Locations (UTAS)**

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### 3.1 Mapping Outputs

This section provides a brief overview of the floodplain mapping process and results. For both the combined Levee Breach and No Levee scenarios the mapping methodology adopted in BMT (2018a) was adopted. The mapping outputs for the combined Levee Breach scenarios (maximum of the 23 scenarios) are presented in Appendix B and the No Levee scenario is presented in Appendix C.

The flood mapping products presented in the following sections have also been supplied to council in GIS format.

#### 3.1.1 Flood Level Mapping

Flood level mapping for the combined Levee Breach scenarios are presented in Appendix B, Figure B-1 to Figure B-5 and the No Levee scenario is presented in Appendix C, Figure C-1 to C-5.

Table 3-1 shows a comparison of the 2050 Climate Conditions flood levels behind the LFPS at the corner of Goderich St (East Tamar Highway) and Gleadow Street between the Base Case (intact levee), combination of Levee Breach and No Levee scenarios.

**Table 3-1 Comparison of 2050 Climate Conditions Peak Flood Levels at the Corner of Goderich St and Gleadow St**

AEP	Flood Level (m AHD)		
	Intact Levee	Combination of Levee Breach Scenarios	No Levee
20%	-	1.9	2.1
10%	-	2.1	2.7
5%	-	2.6	3.4
2%	-	3.8	4.2
1%	2.1	4.6	4.9

#### 3.1.2 Flood Depth Mapping

Flood depth mapping for the combined Levee Breach scenarios are presented in Appendix B, Figure B-6 to Figure B-10 and the No Levee scenario is presented in Appendix C, Figure C-6 to C-10.

Along with peak flood depth, Figure B-6 to Figure B-10 show the time to inundation greater than 300 mm depth from levee breach. Figure B-7 shows that in the 10% AEP the majority of Invermay is inundated to a depth greater than 300 mm, but the time to reach this depth is generally greater than 2 hours. However, for the 2% AEP event, these 300 mm depth inundation times are much shorter, particularly through the University of Tasmania Inveresk site, ranging from less than 15 minutes up to 45 minutes in most locations.

#### 3.1.3 Flood Velocity Mapping

Flood velocity mapping for the combined Levee Breach scenarios are presented in Appendix B, Figure B-11 to Figure B-15 and the No Levee scenario is presented in Appendix C, Figure C-11 to C-15.

## Results

The flood velocity mapping is designed to depict both the magnitude (grid format) and direction of the flow (direction vectors) velocities. Flow direction vectors could not be presented in this mapping for clarity reasons but have been produced (and provided in Council).

### 3.1.4 Flood Hazard Mapping

Flood hazard mapping for the combined Levee Breach scenarios are presented in Appendix B, Figure B-16 to Figure B-20 and the No Levee scenario is presented in Appendix C, Figure C-16 to C-20.

Hazard mapping was undertaken using the combined flood hazard criteria presented in Book 6, Chapter 7 of ARR 2016. As shown in Figure 3-3, hazard is defined in terms of the depth and velocity-depth product as follows:

- (1) **Generally safe for vehicles, people and buildings** - velocity x depth less than 0.3 m<sup>2</sup>/s if depth is less than 0.3 m and velocity is less than 2 m/s
- (2) **Unsafe for small vehicles** - velocity x depth less than 0.6 m<sup>2</sup>/s if depth is less than 0.5 m and velocity is less than 2 m/s
- (3) **Unsafe for vehicles, children and the elderly** - velocity x depth less than 0.6 m<sup>2</sup>/s if depth is less than 1.2 m and velocity is less than 2 m/s
- (4) **Unsafe for vehicles and people** - velocity x depth less than 1 m<sup>2</sup>/s if depth is less than 2 m and velocity is less than 2 m/s
- (5) **Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure** - velocity x depth less than 4 m<sup>2</sup>/s if depth is less than 4 m and velocity is less than 4 m/s
- (6) **Unsafe for vehicles and people. All building types considered vulnerable to failure** - velocity x depth greater than 4 m<sup>2</sup>/s



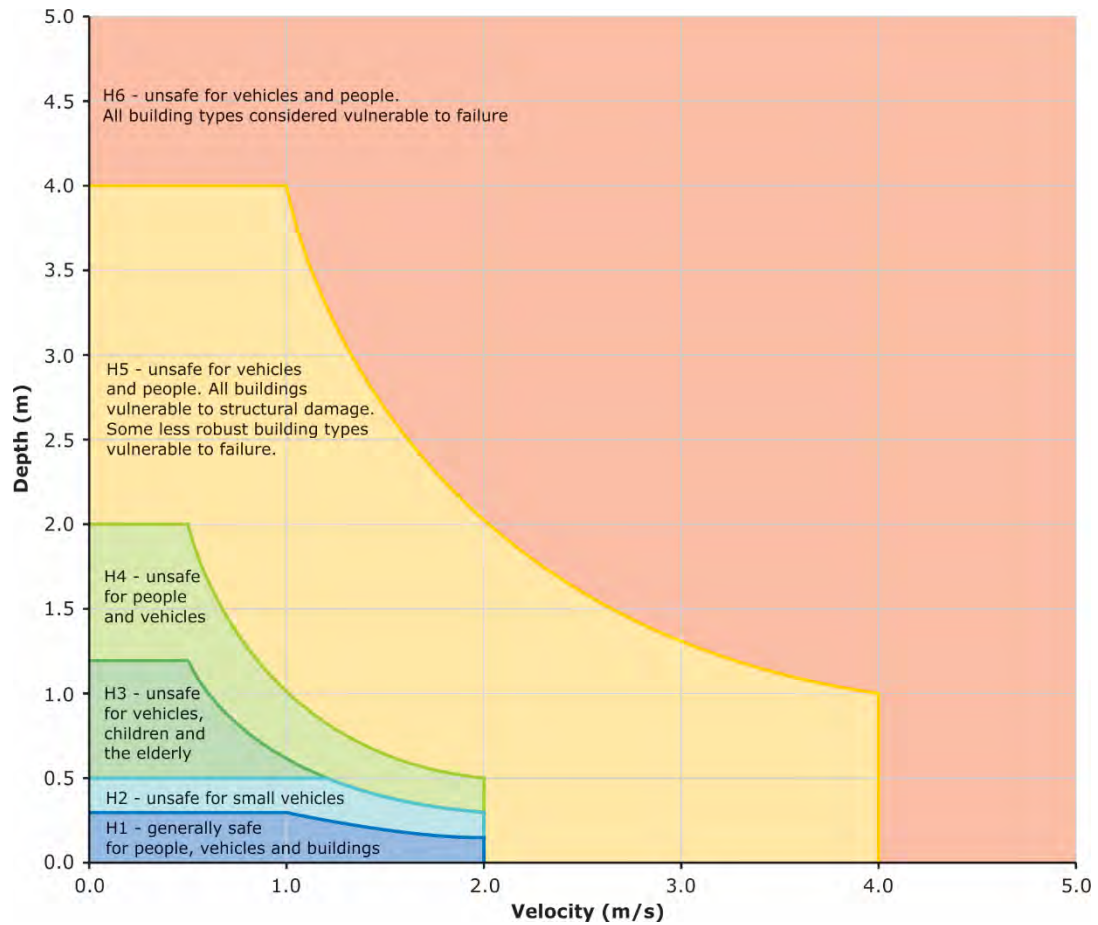


Figure 3-3 Combine Flood Hazard Curves (Ball et al. 2016)

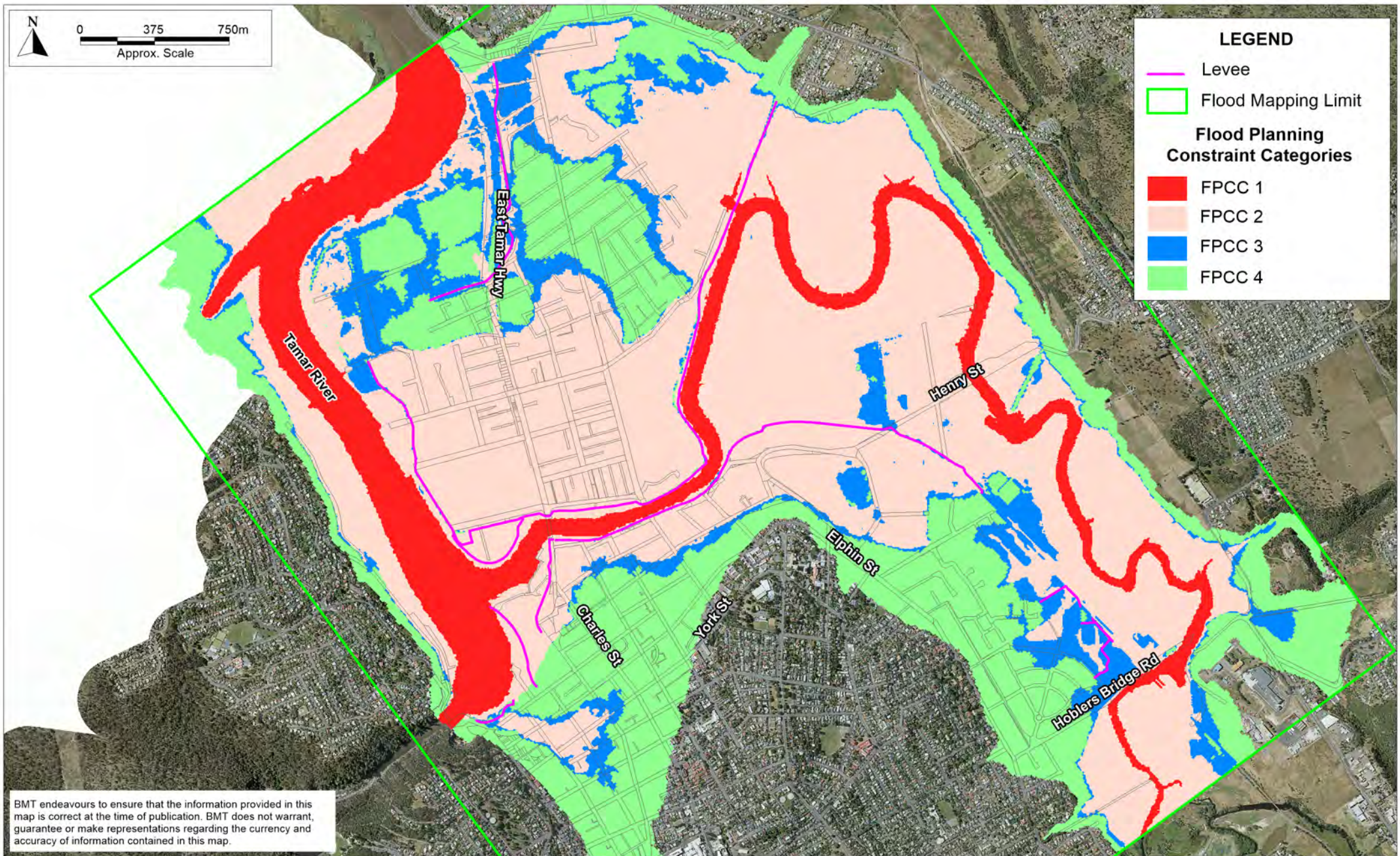
### 3.1.5 Flood Planning Constraint Mapping

To assist Council with land use planning activities, a flood planning constraint map has been developed for 2050 climate conditions. *Guideline 7-5: Flood Information to Support Land-use Planning* of the Australian Disaster Resilience Handbook Collection (AIDR 2017) identifies four flood planning constraint categories (FPCCs) across a floodplain. For Launceston the FPCC mapping has been produced using the following categorisation:

- **FPCC 1** - Areas of flood hazard class 6 (Section 3.1.4) in the defined flood event (DFE) which is the 1% AEP event
- **FPCC 2** - Areas of flood hazard class 5 in the DFE or of flood hazard class 6 in the 1 in 2000 AEP event (Base Case (intact levee) scenario used to represent 1 in 2000 AEP event)
- **FPCC 3** – Areas within the DFE extent
- **FPCC 4** – Areas within the PMF extent (Base Case scenario used to represent PMF)

The combined Levee Breach and No Levee scenarios FPCC Maps are presented in Figure 3-4 and Figure 3-5 respectively. Please note, the extent of FPCC 3 does not include an allowance for freeboard. However, it is recommended that an allowance freeboard be considered when developing flood planning controls.

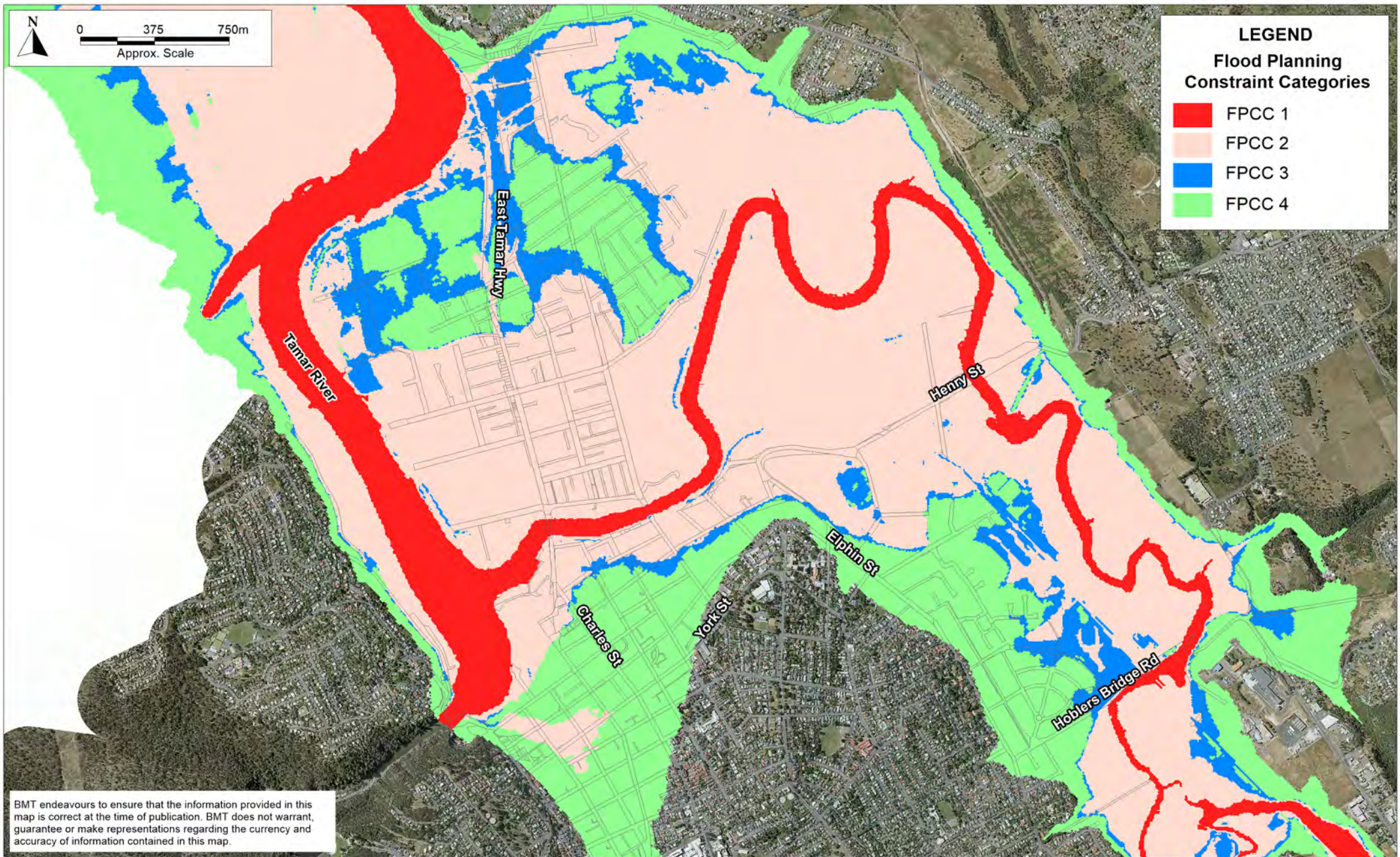




**Figure 3-4 Combined Levee Breach Scenarios  
Flood Planning Constraint Map**







**Figure 3-5 No Levee  
 Flood Planning Constraint Map**





## 4 Summary and Recommendations

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This report documents the levee breach assessment undertaken as part of the North and South Esk Rivers Flood Modelling and Mapping Update. The results of the levee breach assessment provide flood behaviour information that enables the residual consequence in areas protected by the LFPS to be defined. It should be noted that this levee breach assessment does not assign a likelihood (probability) to levee breach, rather defines the consequences (flood behaviour).

It is recommended that this levee breach consequence flood behaviour information be incorporated into future flood planning and emergency response planning.

## 5 References

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Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I (Ed) (2016), *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia).

BMT (2018a), *North and South Esk Rivers Flood Modelling and Mapping Update Volume 1: Technical Report* (Doc. Ref: R.M20921.002.01.Final.docx), BMT.

BMT (2018b), *North and South Esk Rivers Flood Modelling and Mapping Update Volume 2: Flood Mapping* (Doc. Ref: R.M20921.003.00.Mapping.docx), BMT

BMT WBM (2008), *River Tamar & North Esk River Flood Study Final Report*, BMT WBM.

Levee Breach Results Table

## Appendix A Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Tamar St - Boland St (Tm_Bo)	Time to Inundation (min)	-	-	-	20 (L06)	20 (L06)
	Time to 300 mm Depth (min)	-	-	-	40 (L05)	20 (L06)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	25	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.9 (L05)	1.82 (L03)
	Peak Velocity (m/s)	-	-	-	1.1 (L06)	1.5 (L06)
	Peak DxV (m2/s)	-	-	-	0.3 (L06)	0.5 (L06)
Tamar St - Cimiterie St (Tm_Ci)	Time to Inundation (min)	-	-	-	60 (L05)	20 (L05)
	Time to 300 mm Depth (min)	-	-	-	-	40 (L06)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	-	32
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.28 (L05)	1.21 (L03)
	Peak Velocity (m/s)	-	-	-	0.2 (L05)	0.8 (L05)
	Peak DxV (m2/s)	-	-	-	0	0.3 (L02)
Boland St - Willis St (Bo_Wi)	Time to Inundation (min)	-	-	80 (L05)	10 (L05)	10 (L05)
	Time to 300 mm Depth (min)	-	-	150 (L06)	10 (L05)	10 (L05)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.42 (L06)	1.33 (L05)	2.25 (L03)
	Peak Velocity (m/s)	-	-	0.1 (L05)	0.5 (L02)	0.5 (L03)
	Peak DxV (m2/s)	-	-	-	0.3 (L05)	0.6 (L06)
Cimiterie St - Willis St (Cm_Wi)	Time to Inundation (min)	-	-	-	30 (L05)	10 (L05)
	Time to 300 mm Depth (min)	-	-	-	90 (L05)	20 (L05)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	6	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.38 (L05)	1.31 (L03)
	Peak Velocity (m/s)	-	-	-	0.2 (L06)	0.7 (L02)
	Peak DxV (m2/s)	-	-	-	0.1 (L06)	0.4 (L06)



Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Lawrence St - Cimiterie St (Lw_Cm)	Time to Inundation (min)	-	-	-	180 (L05)	20 (L05)
	Time to 300 mm Depth (min)	-	-	-	-	50 (L05)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	-	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.28 (L03)	1.24 (L03)
	Peak Velocity (m/s)	-	-	-	0.5 (L05)	0.6 (L09)
	Peak DxV (m2/s)	-	-	-	0	0.3 (L05)
Boland St - Lawrence St (Bo_Lw)	Time to Inundation (min)	-	-	10 (L05)	10 (L05)	OT
	Time to 300 mm Depth (min)	-	-	-	20 (L05)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	10 (L05)	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	0.3	OT
	Peak Depth (m)	-	-	0.12 (L05)	1.07 (L03)	2.03 (L03)
	Peak Velocity (m/s)	-	-	0.5 (L05)	2 (L05)	2.4 (L05)
	Peak DxV (m2/s)	-	-	0.1 (L05)	0.9 (L05)	1.9 (L05)
Lawrence St 1 (Lw_1)	Time to Inundation (min)	-	2480 (L02)	30 (L05)	10 (L05)	OT
	Time to 300 mm Depth (min)	-	-	50 (L05)	10 (L05)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	-	0.26 (L02)	0.72 (L03)	1.69 (L03)	2.66 (L03)
	Peak Velocity (m/s)	-	-	0.3 (L03)	0.5 (L05)	0.6 (L05)
	Peak DxV (m2/s)	-	-	0	0.4 (L05)	0.7 (L05)
Willis St 1 (Wi_1)	Time to Inundation (min)	-	-	140 (L06)	10 (L05)	10 (L05)
	Time to 300 mm Depth (min)	-	-	-	10 (L05)	10 (L05)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.18 (L06)	1.09 (L05)	2.01 (L03)
	Peak Velocity (m/s)	-	-	0	0.4 (L03)	0.4 (L06)
	Peak DxV (m2/s)	-	-	0	0.2 (L05)	0.4 (L05)
Tamar St - William St (Tm_WI)	Time to Inundation (min)	-	-	60 (L06)	20 (L05)	20 (L06)
	Time to 300 mm Depth (min)	-	-	80 (L06)	20 (L05)	20 (L06)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.59 (L06)	1.49 (L05)	2.42 (L03)
	Peak Velocity (m/s)	-	-	0.1 (L05)	0.5 (L07)	0.4 (L06)
	Peak DxV (m2/s)	-	-	0	0.2 (L06)	0.5 (L06)

Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
University 1 (Unv_1)	Time to Inundation (min)	-	-	-	10 (L05)	10 (L05)
	Time to 300 mm Depth (min)	-	-	-	40 (L05)	10 (L05)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	17	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.55 (L03)	1.53 (L03)
	Peak Velocity (m/s)	-	-	-	0.1 (L05)	0.2 (L06)
	Peak DxV (m2/s)	-	-	-	0.1 (L05)	0.1 (L05)
Tamar St - Lindsay St (Tm_Ln)	Time to Inundation (min)	-	-	20 (L17)	10 (L17)	10 (L18)
	Time to 300 mm Depth (min)	-	-	-	240 (L18)	20 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.28 (L21)	1.5 (L18)	2.31 (L18)
	Peak Velocity (m/s)	-	-	0.7 (L17)	1 (L17)	1.2 (L17)
	Peak DxV (m2/s)	-	-	0	0.2 (L17)	0.7 (L17)
Invermay Rd - Dry St (In_Dr)	Time to Inundation (min)	-	2280 (L21)	50 (L17)	30 (L18)	20 (L18)
	Time to 300 mm Depth (min)	-	-	780 (L21)	120 (L18)	30 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	21	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.06 (L21)	0.49 (L21)	1.71 (L18)	2.52 (L18)
	Peak Velocity (m/s)	-	0.1 (L21)	0.7 (L16)	1 (L17)	1.3 (L17)
	Peak DxV (m2/s)	-	0	0	0.2 (L17)	0.5 (L17)
Invermay Rd - Forster St (In_Fo)	Time to Inundation (min)	890 (L21)	210 (L21)	110 (L12)	40 (L14)	30 (L13)
	Time to 300 mm Depth (min)	2990 (L21)	830 (L21)	210 (L21)	70 (L18)	40 (L13)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.36 (L21)	0.57 (L21)	1 (L21)	2.22 (L18)	3.03 (L18)
	Peak Velocity (m/s)	0.4 (L12)	0.6 (L12)	0.7 (L12)	0.9 (L14)	1.1 (L13)
	Peak DxV (m2/s)	0	0	0.1 (L12)	0.3 (L12)	0.5 (L13)
Invermay Rd - Gleadow St (In_Gl)	Time to Inundation (min)	1590 (L21)	130 (L15)	60 (L15)	40 (L18)	30 (L18)
	Time to 300 mm Depth (min)	-	2210 (L21)	310 (L21)	70 (L18)	30 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.16 (L21)	0.37 (L21)	0.8 (L21)	2.02 (L18)	2.83 (L18)
	Peak Velocity (m/s)	0.2 (L21)	0.4 (L15)	0.6 (L15)	0.7 (L15)	0.8 (L15)
	Peak DxV (m2/s)	0	0	0	0.2 (L18)	0.5 (L18)



Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Forster St - South St (Fo_So)	Time to Inundation (min)	820 (L12)	70 (L12)	40 (L13)	20 (L13)	OT
	Time to 300 mm Depth (min)	1570 (L12)	90 (L12)	50 (L13)	20 (L13)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	0.65 (L21)	0.86 (L21)	1.29 (L21)	2.51 (L18)	3.31 (L18)
	Peak Velocity (m/s)	0.3 (L21)	0.4 (L21)	0.7 (L21)	0.9 (L14)	0.9 (L12)
	Peak DxV (m2/s)	0	0.1 (L12)	0.3 (L12)	0.9 (L12)	1.6 (L12)
Forster St - Ray St (Fo_Ry)	Time to Inundation (min)	-	2260 (L21)	100 (L12)	30 (L13)	20 (L13)
	Time to 300 mm Depth (min)	-	-	770 (L21)	80 (L13)	30 (L13)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	22	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.07 (L21)	0.49 (L21)	1.72 (L18)	2.52 (L18)
	Peak Velocity (m/s)	-	0.1 (L21)	0.5 (L12)	0.9 (L12)	1.1 (L13)
	Peak DxV (m2/s)	-	0	0	0.4 (L12)	0.8 (L13)
Forster St - Herbert St (Fo_Hb)	Time to Inundation (min)	760 (L12)	50 (L12)	40 (L12)	20 (L12)	20 (L13)
	Time to 300 mm Depth (min)	-	-	910 (L21)	40 (L12)	20 (L13)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	2	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.03 (L12)	0.12 (L12)	0.32 (L21)	1.53 (L18)	2.32 (L18)
	Peak Velocity (m/s)	0.4 (L12)	0.6 (L12)	0.8 (L12)	0.9 (L12)	1 (L12)
	Peak DxV (m2/s)	0	0.1 (L12)	0.2 (L12)	0.7 (L12)	1.1 (L12)
Churchill Park Dr 1 (Ch_1)	Time to Inundation (min)	40 (L12)	30 (L12)	20 (L12)	10 (L12)	20 (L12)
	Time to 300 mm Depth (min)	1490 (L12)	40 (L12)	30 (L12)	20 (L12)	20 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	4	15	24	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.4 (L12)	0.71 (L12)	1.11 (L12)	1.86 (L12)	2.44 (L12)
	Peak Velocity (m/s)	0.1 (L12)	0.4 (L12)	0.5 (L12)	1.2 (L18)	1.2 (L16)
	Peak DxV (m2/s)	0.1 (L12)	0.2 (L12)	0.5 (L12)	1.3 (L12)	2.2 (L12)
University 9 (Unv_9)	Time to Inundation (min)	1840 (L21)	100 (L15)	30 (L14)	10 (L14)	10 (L14)
	Time to 300 mm Depth (min)	-	810 (L12)	50 (L14)	20 (L14)	10 (L14)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.3 (L21)	0.51 (L21)	0.94 (L21)	2.16 (L18)	2.97 (L18)
	Peak Velocity (m/s)	0	0	0.1 (L14)	0.2 (L14)	0.3 (L14)
	Peak DxV (m2/s)	0	0	0	0.1 (L14)	0.3 (L14)

Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
University 10 (Unv_10)	Time to Inundation (min)	1610 (L21)	170 (L15)	60 (L14)	30 (L14)	20 (L14)
	Time to 300 mm Depth (min)	-	1500 (L21)	160 (L12)	30 (L14)	20 (L14)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.24 (L21)	0.46 (L21)	0.88 (L21)	2.11 (L18)	2.91 (L18)
	Peak Velocity (m/s)	-	-	0.1 (L12)	0.1 (L14)	0.2 (L13)
	Peak DxV (m2/s)	-	-	0	0.1 (L14)	0.1 (L14)
University 11 (Unv_11)	Time to Inundation (min)	-	-	730 (L21)	30 (L14)	OT
	Time to 300 mm Depth (min)	-	-	-	260 (L21)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	-	-	0.26 (L21)	1.48 (L18)	2.28 (L18)
	Peak Velocity (m/s)	-	-	0	0.2 (L13)	0.2 (L13)
	Peak DxV (m2/s)	-	-	0	0	0.1 (L13)
University 12 (Unv_12)	Time to Inundation (min)	-	810 (L13)	20 (L13)	10 (L13)	OT
	Time to 300 mm Depth (min)	-	-	-	10 (L13)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	-	0.01 (L13)	0.22 (L13)	1.36 (L18)	2.15 (L18)
	Peak Velocity (m/s)	-	0	0.1 (L13)	0.3 (L13)	0.5 (L13)
	Peak DxV (m2/s)	-	0	0	0.2 (L13)	0.5 (L13)
University 6 (Unv_6)	Time to Inundation (min)	-	30 (L15)	20 (L15)	20 (L15)	10 (L15)
	Time to 300 mm Depth (min)	-	-	-	20 (L15)	20 (L15)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.07 (L15)	0.2 (L15)	1.2 (L18)	2.01 (L18)
	Peak Velocity (m/s)	-	0.1 (L15)	0.1 (L15)	0.2 (L15)	0.3 (L15)
	Peak DxV (m2/s)	-	0	0	0.1 (L15)	0.2 (L15)
University 2 (Unv_2)	Time to Inundation (min)	-	30 (L17)	10 (L17)	10 (L17)	20 (L17)
	Time to 300 mm Depth (min)	-	80 (L17)	20 (L17)	10 (L17)	20 (L17)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	2	16	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.33 (L17)	0.62 (L17)	1.68 (L18)	2.49 (L18)
	Peak Velocity (m/s)	-	0.1 (L16)	0.1 (L17)	0.2 (L17)	0.3 (L17)
	Peak DxV (m2/s)	-	0	0.1 (L17)	0.2 (L17)	0.4 (L17)



Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
University 3 (Unv_3)	Time to Inundation (min)	-	60 (L16)	20 (L16)	10 (L16)	20 (L17)
	Time to 300 mm Depth (min)	-	-	50 (L16)	10 (L16)	20 (L17)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	6	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.14 (L16)	0.45 (L16)	1.32 (L18)	2.13 (L18)
	Peak Velocity (m/s)	-	0.1 (L16)	0.1 (L16)	0.2 (L16)	0.3 (L16)
	Peak DxV (m2/s)	-	0	0.1 (L16)	0.2 (L16)	0.3 (L16)
University 4 (Unv_4)	Time to Inundation (min)	-	50 (L15)	30 (L15)	20 (L15)	20 (L17)
	Time to 300 mm Depth (min)	-	-	-	30 (L15)	20 (L16)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.09 (L15)	0.3 (L16)	1.49 (L18)	2.3 (L18)
	Peak Velocity (m/s)	-	0	0.1 (L15)	0.1 (L15)	0.2 (L16)
	Peak DxV (m2/s)	-	0	0	0.1 (L16)	0.2 (L16)
University 5 (Unv_5)	Time to Inundation (min)	980 (L15)	90 (L15)	50 (L15)	30 (L15)	20 (L18)
	Time to 300 mm Depth (min)	-	1550 (L21)	100 (L15)	30 (L15)	30 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.21 (L21)	0.42 (L21)	0.85 (L21)	2.07 (L18)	2.88 (L18)
	Peak Velocity (m/s)	0	0	0.1 (L15)	0.2 (L15)	0.2 (L15)
	Peak DxV (m2/s)	0	0	0	0.1 (L15)	0.2 (L15)
University 7 (Unv_7)	Time to Inundation (min)	1710 (L21)	90 (L15)	50 (L15)	30 (L15)	20 (L15)
	Time to 300 mm Depth (min)	-	930 (L21)	60 (L15)	30 (L15)	20 (L15)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.25 (L21)	0.47 (L21)	0.9 (L21)	2.12 (L18)	2.93 (L18)
	Peak Velocity (m/s)	0	0.1 (L16)	0.1 (L15)	0.2 (L15)	0.2 (L15)
	Peak DxV (m2/s)	0	0	0	0.1 (L15)	0.2 (L15)
University 8 (Unv_8)	Time to Inundation (min)	-	50 (L15)	20 (L14)	10 (L14)	10 (L14)
	Time to 300 mm Depth (min)	-	-	30 (L14)	10 (L14)	10 (L14)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	31	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.22 (L15)	0.55 (L21)	1.77 (L18)	2.57 (L18)
	Peak Velocity (m/s)	-	0.2 (L15)	0.2 (L15)	0.2 (L15)	0.3 (L15)
	Peak DxV (m2/s)	-	0	0.1 (L14)	0.2 (L14)	0.3 (L14)

Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Charles St - Lindsay St (Ch_Ln)	Time to Inundation (min)	1110 (L21)	330 (L21)	70 (L18)	20 (L18)	OT
	Time to 300 mm Depth (min)	-	910 (L21)	250 (L21)	30 (L18)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	0.27 (L21)	0.48 (L21)	0.91 (L21)	2.13 (L18)	2.94 (L18)
	Peak Velocity (m/s)	0	0	0.3 (L18)	1.2 (L18)	1.4 (L18)
	Peak DxV (m2/s)	0	0	0	0.2 (L18)	0.5 (L19)
Goderich St - Forster St (Go_Fo)	Time to Inundation (min)	860 (L21)	150 (L21)	90 (L21)	50 (L21)	30 (L21)
	Time to 300 mm Depth (min)	-	2300 (L21)	320 (L21)	80 (L21)	50 (L21)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.13 (L21)	0.35 (L21)	0.77 (L21)	2 (L18)	2.8 (L18)
	Peak Velocity (m/s)	0.2 (L21)	0.3 (L21)	0.4 (L21)	0.7 (L21)	1 (L21)
	Peak DxV (m2/s)	0	0	0.1 (L21)	0.3 (L21)	0.5 (L21)
Goderich St - Mayne St (Go_Ma)	Time to Inundation (min)	-	-	990 (L21)	260 (L21)	130 (L18)
	Time to 300 mm Depth (min)	-	-	-	260 (L21)	130 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.03 (L21)	1.56 (L18)	2.37 (L18)
	Peak Velocity (m/s)	-	-	0.1 (L21)	0.1 (L21)	0.4 (L13)
	Peak DxV (m2/s)	-	-	0	0	0
Boland St - Innes St (Bo_In)	Time to Inundation (min)	-	-	250 (L03)	40 (L03)	20 (L22)
	Time to 300 mm Depth (min)	-	-	-	80 (L03)	30 (L03)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.25 (L03)	1.24 (L03)	2.2 (L03)
	Peak Velocity (m/s)	-	-	0.1 (L03)	1.5 (L05)	1.6 (L05)
	Peak DxV (m2/s)	-	-	-	0.4 (L05)	0.9 (L05)
Charles St - Esplanade (Ch_Es)	Time to Inundation (min)	-	-	10 (L07)	10 (L07)	OT
	Time to 300 mm Depth (min)	-	-	60 (L07)	10 (L07)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	-	-	0.97 (L07)	2.02 (L06)	2.76 (L03)
	Peak Velocity (m/s)	-	-	1.5 (L07)	1.4 (L07)	0.6 (L07)
	Peak DxV (m2/s)	-	-	0.6 (L07)	1 (L07)	1.1 (L07)



Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Esplanade - St John St (Es_SJ)	Time to Inundation (min)	-	-	-	10 (L06)	10 (L07)
	Time to 300 mm Depth (min)	-	-	-	30 (L07)	10 (L07)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	17	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.89 (L06)	1.63 (L03)
	Peak Velocity (m/s)	-	-	-	1.6 (L06)	1.6 (L05)
	Peak DxV (m2/s)	-	-	-	0.4 (L06)	0.9 (L06)
St John St - William St (SJ_WI)	Time to Inundation (min)	-	-	-	-	40 (L08)
	Time to 300 mm Depth (min)	-	-	-	-	250 (L05)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	-	4
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	-	0.35 (L03)
	Peak Velocity (m/s)	-	-	-	-	0.7 (L06)
	Peak DxV (m2/s)	-	-	-	-	0.1 (L08)
Forster St - Montague St (Fo_Mo)	Time to Inundation (min)	20 (L21)	20 (L21)	20 (L21)	10 (L21)	OT
	Time to 300 mm Depth (min)	30 (L21)	20 (L21)	20 (L21)	20 (L21)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	1.14 (L21)	1.36 (L21)	1.78 (L21)	3.01 (L18)	3.81 (L18)
	Peak Velocity (m/s)	0.2 (L21)	0.2 (L21)	0.5 (L18)	0.9 (L18)	0.8 (L21)
	Peak DxV (m2/s)	0.2 (L21)	0.2 (L21)	0.4 (L21)	0.8 (L21)	1.3 (L21)
North Bank (NB)	Time to Inundation (min)	-	-	-	50 (L20)	30 (L20)
	Time to 300 mm Depth (min)	-	-	-	560 (L18)	190 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	28	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.82 (L18)	1.63 (L18)
	Peak Velocity (m/s)	-	-	-	0.8 (L20)	0.9 (L20)
	Peak DxV (m2/s)	-	-	-	0	0.1 (L18)
Kings Wharf Rd - Gleadow St (KW_Gl)	Time to Inundation (min)	780 (L21)	100 (L21)	50 (L20)	20 (L20)	20 (L21)
	Time to 300 mm Depth (min)	3770 (L21)	800 (L21)	100 (L21)	30 (L20)	20 (L20)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.32 (L21)	0.54 (L21)	0.96 (L21)	2.19 (L18)	2.99 (L18)
	Peak Velocity (m/s)	0.1 (L21)	0	0.5 (L15)	0.6 (L18)	0.6 (L15)
	Peak DxV (m2/s)	0	0	0	0.1 (L21)	0.2 (L20)

Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Goderich St - Gleadow St (Go_Gl)	Time to Inundation (min)	2300 (L21)	770 (L21)	110 (L21)	40 (L18)	20 (L18)
	Time to 300 mm Depth (min)	-	3800 (L21)	400 (L21)	110 (L18)	40 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	5	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.09 (L21)	0.3 (L21)	0.73 (L21)	1.95 (L18)	2.76 (L18)
	Peak Velocity (m/s)	0.1 (L21)	0.4 (L21)	0.8 (L21)	1.2 (L18)	1.7 (L18)
	Peak DxV (m2/s)	0	0	0.1 (L21)	0.4 (L18)	1 (L18)
Holbrook St - Dry St (Ho_Dr)	Time to Inundation (min)	910 (L21)	230 (L21)	10 (L18)	10 (L18)	OT
	Time to 300 mm Depth (min)	1190 (L21)	340 (L21)	60 (L18)	10 (L18)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	0.54 (L21)	0.76 (L21)	1.19 (L21)	2.41 (L18)	3.22 (L18)
	Peak Velocity (m/s)	0.4 (L21)	0.4 (L21)	0.5 (L21)	1.1 (L18)	1.8 (L18)
	Peak DxV (m2/s)	0	0	0.1 (L18)	0.8 (L18)	1.7 (L18)
Holbrook St - Forster St (Ho_Fo)	Time to Inundation (min)	780 (L21)	140 (L21)	100 (L21)	50 (L18)	30 (L18)
	Time to 300 mm Depth (min)	1610 (L21)	760 (L21)	130 (L21)	60 (L18)	40 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.43 (L21)	0.64 (L21)	1.07 (L21)	2.29 (L18)	3.1 (L18)
	Peak Velocity (m/s)	0.2 (L21)	0.4 (L21)	0.5 (L18)	0.7 (L21)	0.8 (L18)
	Peak DxV (m2/s)	0	0.1 (L21)	0.1 (L21)	0.3 (L18)	0.6 (L18)
Invermay Rd - Bryan St (In_By)	Time to Inundation (min)	-	-	450 (L21)	160 (L18)	80 (L18)
	Time to 300 mm Depth (min)	-	-	830 (L21)	220 (L21)	110 (L18)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	10	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.41 (L21)	1.63 (L18)	2.44 (L18)
	Peak Velocity (m/s)	-	-	0.1 (L21)	0.2 (L16)	0.2 (L18)
	Peak DxV (m2/s)	-	-	0	0	0
Herbert St - Bruan St (Hb_Br)	Time to Inundation (min)	-	-	50 (L12)	30 (L12)	30 (L12)
	Time to 300 mm Depth (min)	-	-	80 (L12)	40 (L12)	30 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	3	24	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.38 (L12)	1.17 (L12)	1.79 (L12)
	Peak Velocity (m/s)	-	-	0	0.1 (L18)	0.1 (L16)
	Peak DxV (m2/s)	-	-	0	0	0



Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Oswald St - Lamont St (Os_Lm)	Time to Inundation (min)	-	770 (L12)	70 (L12)	30 (L12)	30 (L12)
	Time to 300 mm Depth (min)	-	-	90 (L12)	40 (L12)	30 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	9	70	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.18 (L12)	0.64 (L12)	1.43 (L12)	2.01 (L12)
	Peak Velocity (m/s)	-	0.1 (L12)	0.6 (L12)	0.7 (L12)	0.8 (L12)
	Peak DxV (m2/s)	-	0	0.2 (L12)	0.6 (L12)	0.9 (L12)
Oswald St - Burns St (Os_Bu)	Time to Inundation (min)	-	-	-	60 (L12)	40 (L12)
	Time to 300 mm Depth (min)	-	-	-	150 (L12)	50 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	2	21
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.32 (L12)	0.95 (L12)
	Peak Velocity (m/s)	-	-	-	0.1 (L12)	0.2 (L12)
	Peak DxV (m2/s)	-	-	-	0	0.1 (L12)
Oswald St - Henty St (Os_Hn)	Time to Inundation (min)	80 (L12)	50 (L12)	40 (L12)	20 (L12)	20 (L12)
	Time to 300 mm Depth (min)	740 (L12)	60 (L12)	40 (L12)	20 (L12)	20 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	8	18	26	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.48 (L12)	0.79 (L12)	1.23 (L12)	2.02 (L12)	2.65 (L12)
	Peak Velocity (m/s)	0.1 (L12)	0.3 (L12)	0.1 (L12)	0.3 (L12)	0.1 (L12)
	Peak DxV (m2/s)	0	0	0.1 (L12)	0.2 (L12)	0.1 (L12)
Invermay Rd - Hope St (In_Hp)	Time to Inundation (min)	-	790 (L12)	100 (L12)	60 (L12)	10 (L23)
	Time to 300 mm Depth (min)	-	-	110 (L12)	70 (L12)	60 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	8	49	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.16 (L12)	0.6 (L12)	1.37 (L12)	1.81 (L12)
	Peak Velocity (m/s)	-	0.2 (L12)	0.3 (L12)	0.4 (L12)	0.5 (L12)
	Peak DxV (m2/s)	-	0	0.1 (L12)	0.3 (L12)	0.5 (L12)
Invermay Rd - Eddington Cres (In_Ed)	Time to Inundation (min)	-	730 (L12)	80 (L12)	50 (L12)	30 (L23)
	Time to 300 mm Depth (min)	-	780 (L12)	90 (L12)	50 (L12)	50 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	6	21	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	0.5 (L12)	0.95 (L12)	1.72 (L12)	2.19 (L12)
	Peak Velocity (m/s)	-	0.4 (L12)	0.4 (L12)	0.6 (L12)	0.7 (L12)
	Peak DxV (m2/s)	-	0	0.2 (L12)	0.4 (L12)	0.7 (L12)

Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
Invermay Rd - Rosslyn Rd (In_Ro)	Time to Inundation (min)	-	-	-	80 (L12)	60 (L12)
	Time to 300 mm Depth (min)	-	-	-	90 (L12)	70 (L12)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	15	30
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.61 (L12)	1.1 (L12)
	Peak Velocity (m/s)	-	-	-	0.1 (L12)	0.2 (L14)
	Peak DxV (m2/s)	-	-	-	0.1 (L12)	0.2 (L12)
Montague St - Howard St (Mo_Hw)	Time to Inundation (min)	60 (L21)	40 (L21)	40 (L21)	20 (L21)	20 (L21)
	Time to 300 mm Depth (min)	160 (L21)	60 (L21)	50 (L21)	30 (L21)	20 (L21)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	>1 Week	>1 Week	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	0.7 (L21)	0.91 (L21)	1.34 (L21)	2.57 (L18)	3.37 (L18)
	Peak Velocity (m/s)	0.2 (L21)	0.2 (L21)	0.2 (L21)	0.3 (L18)	0.4 (L21)
	Peak DxV (m2/s)	0	0.1 (L21)	0.1 (L21)	0.2 (L21)	0.3 (L21)
Charles St - William St (Ch_W)	Time to Inundation (min)	-	-	90 (L07)	10 (L08)	10 (L08)
	Time to 300 mm Depth (min)	-	-	150 (L07)	10 (L08)	10 (L09)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	>1 Week	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	0.33 (L07)	1.38 (L06)	2.12 (L03)
	Peak Velocity (m/s)	-	-	0.1 (L07)	0.4 (L08)	1.5 (L08)
	Peak DxV (m2/s)	-	-	0	0.4 (L08)	1.2 (L08)
Wellington St - Cimitiere St (We_Ci)	Time to Inundation (min)	-	-	-	40 (L08)	20 (L08)
	Time to 300 mm Depth (min)	-	-	-	-	30 (L08)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	-	21
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.23 (L06)	0.97 (L03)
	Peak Velocity (m/s)	-	-	-	0.1 (L06)	0.4 (L08)
	Peak DxV (m2/s)	-	-	-	0	0
Brisbane St - Margaret St (Br_Ma)	Time to Inundation (min)	-	-	-	30 (L01)	20 (L01)
	Time to 300 mm Depth (min)	-	-	-	50 (L01)	20 (L01)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	1.15 (L01)	1.92 (L01)
	Peak Velocity (m/s)	-	-	-	0.3 (L01)	0.4 (L01)
	Peak DxV (m2/s)	-	-	-	0.1 (L01)	0.5 (L01)



Levee Breach Results Table

Location	Parameter	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP <sup>1</sup>
York St - Bathurst St (Yo_Ba)	Time to Inundation (min)	-	-	-	90 (L01)	30 (L01)
	Time to 300 mm Depth (min)	-	-	-	110 (L01)	40 (L01)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.89 (L01)	1.66 (L01)
	Peak Velocity (m/s)	-	-	-	0.4 (L01)	0.9 (L01)
	Peak DxV (m2/s)	-	-	-	0.1 (L01)	0.5 (L01)
Henry St 3 (Hn_3)	Time to Inundation (min)	-	-	250 (L03)	60 (L02)	OT
	Time to 300 mm Depth (min)	-	-	-	90 (L02)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	-	-	0.26 (L03)	1.25 (L03)	2.21 (L03)
	Peak Velocity (m/s)	-	-	0.1 (L02)	0.5 (L02)	0.5 (L02)
	Peak DxV (m2/s)	-	-	0	0.2 (L02)	0.6 (L02)
Henry St - Dowling St (Hn_Do)	Time to Inundation (min)	280 (L02)	130 (L02)	60 (L03)	30 (L03)	OT
	Time to 300 mm Depth (min)	-	730 (L02)	90 (L03)	30 (L03)	OT
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	>1 Week	>1 Week	>1 Week	OT
	Time to 2 m/s Velocity (min)	-	-	-	-	OT
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	OT
	Peak Depth (m)	0.17 (L02)	0.66 (L02)	1.12 (L03)	2.11 (L03)	3.07 (L03)
	Peak Velocity (m/s)	0.2 (L02)	0.2 (L02)	0.4 (L02)	0.6 (L06)	0.6 (L02)
	Peak DxV (m2/s)	0	0	0.1 (L02)	0.5 (L02)	0.9 (L02)
Dowling St 1 (Do_1)	Time to Inundation (min)	-	-	-	120 (L02)	50 (L02)
	Time to 300 mm Depth (min)	-	-	-	160 (L03)	60 (L02)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	18	>1 Week
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.76 (L03)	1.73 (L03)
	Peak Velocity (m/s)	-	-	-	0.2 (L05)	0.3 (L05)
	Peak DxV (m2/s)	-	-	-	0	0.3 (L05)
York St - Margaret St (Yo_Ma)	Time to Inundation (min)	-	-	-	150 (L01)	30 (L01)
	Time to 300 mm Depth (min)	-	-	-	-	40 (L01)
	Duration above 300 mm Depth (hrs) <sup>2</sup>	-	-	-	-	20
	Time to 2 m/s Velocity (min)	-	-	-	-	-
	Duration above 2 m/s Velocity (hrs) <sup>2</sup>	-	-	-	-	-
	Peak Depth (m)	-	-	-	0.23 (L01)	1.01 (L01)
	Peak Velocity (m/s)	-	-	-	0.1 (L01)	0.6 (L01)
	Peak DxV (m2/s)	-	-	-	0	0.3 (L01)

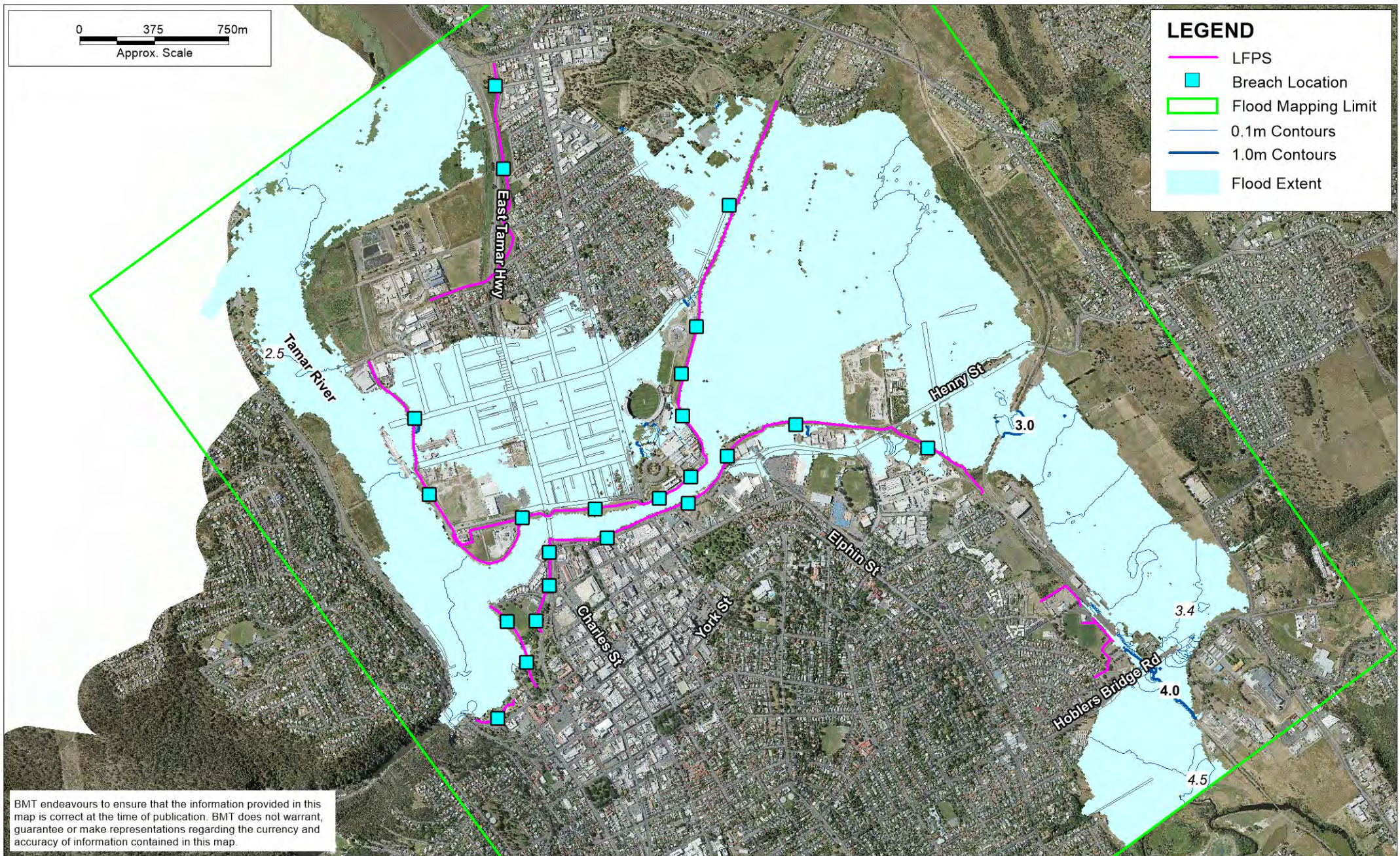
**Levee Breach Results Table**

1. The levee system overtops in some location in the 1% AEP, 2050 Climate Conditions events. Where this affected the results, "OT" has been specified.
2. The model was run for 168 hours (1 week), therefore when a location was still inundated at the end of the model run inundation has been recorded as > 1 week

## Appendix B Combined Levee Breach Scenarios Mapping

- Figure B-1 Combined Levee Breach Scenarios Mapping 20% AEP Event Flood Level
- Figure B-2 Combined Levee Breach Scenarios Mapping 10% AEP Event Flood Level
- Figure B-3 Combined Levee Breach Scenarios Mapping 5% AEP Event Flood Level
- Figure B-4 Combined Levee Breach Scenarios Mapping 2% AEP Event Flood Level
- Figure B-5 Combined Levee Breach Scenarios Mapping 1% AEP Event Flood Level
  
- Figure B-6 Combined Levee Breach Scenarios Mapping 20% AEP Event Flood Depth
- Figure B-7 Combined Levee Breach Scenarios Mapping 10% AEP Event Flood Depth
- Figure B-8 Combined Levee Breach Scenarios Mapping 5% AEP Event Flood Depth
- Figure B-9 Combined Levee Breach Scenarios Mapping 2% AEP Event Flood Depth
- Figure B-10 Combined Levee Breach Scenarios Mapping 1% AEP Event Flood Depth
  
- Figure B-11 Combined Levee Breach Scenarios Mapping 20% AEP Event Flood Velocity
- Figure B-12 Combined Levee Breach Scenarios Mapping 10% AEP Event Flood Velocity
- Figure B-13 Combined Levee Breach Scenarios Mapping 5% AEP Event Flood Velocity
- Figure B-14 Combined Levee Breach Scenarios Mapping 2% AEP Event Flood Velocity
- Figure B-15 Combined Levee Breach Scenarios Mapping 1% AEP Event Flood Velocity
  
- Figure B-16 Combined Levee Breach Scenarios Mapping 20% AEP Event Flood Hazard
- Figure B-17 Combined Levee Breach Scenarios Mapping 10% AEP Event Flood Hazard
- Figure B-18 Combined Levee Breach Scenarios Mapping 5% AEP Event Flood Hazard
- Figure B-19 Combined Levee Breach Scenarios Mapping 2% AEP Event Flood Hazard
- Figure B-20 Combined Levee Breach Scenarios Mapping 1% AEP Event Flood Hazard

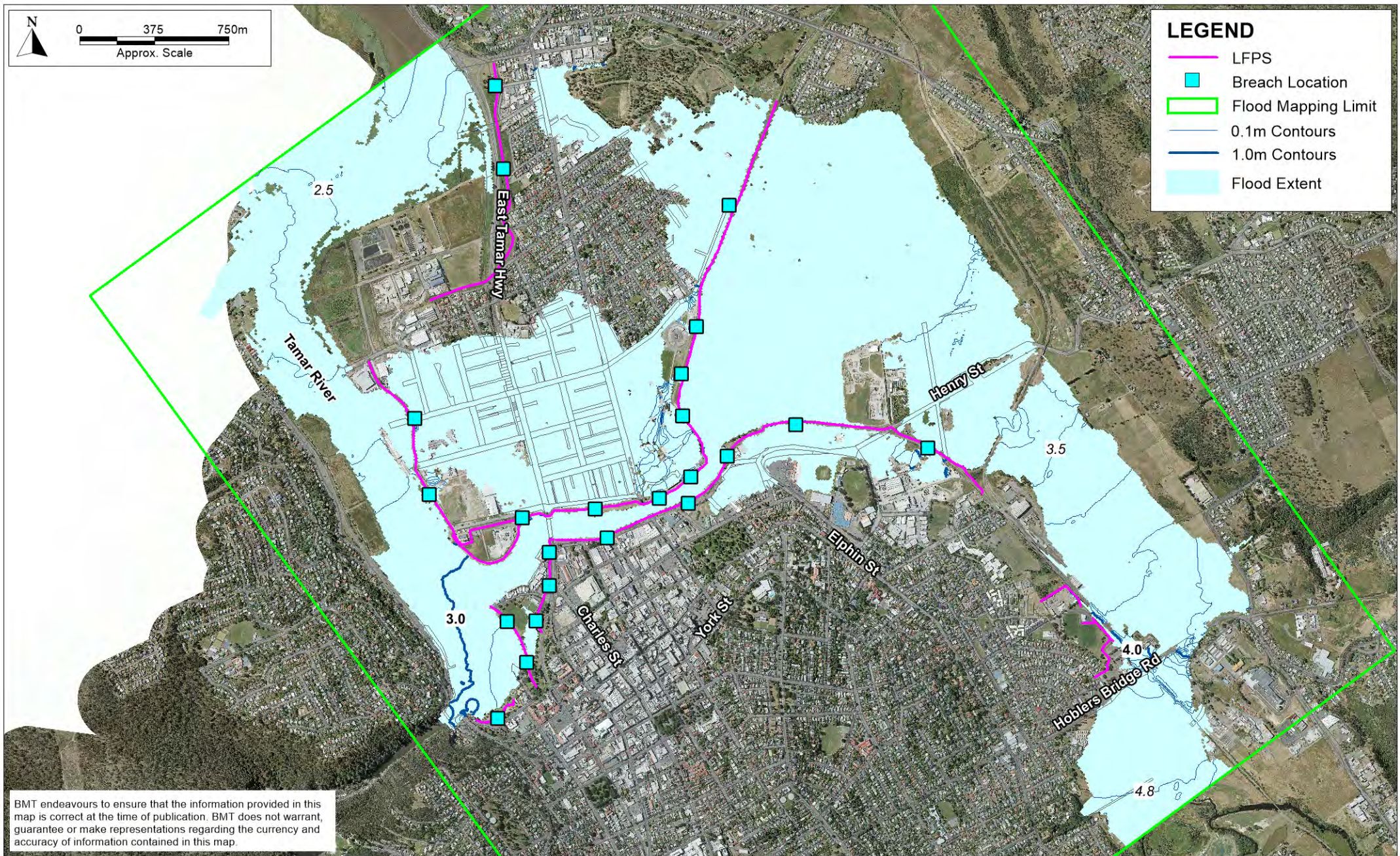




**Figure B-1 Combined Levee Breach Scenarios Mapping  
20% AEP Event Flood Level**



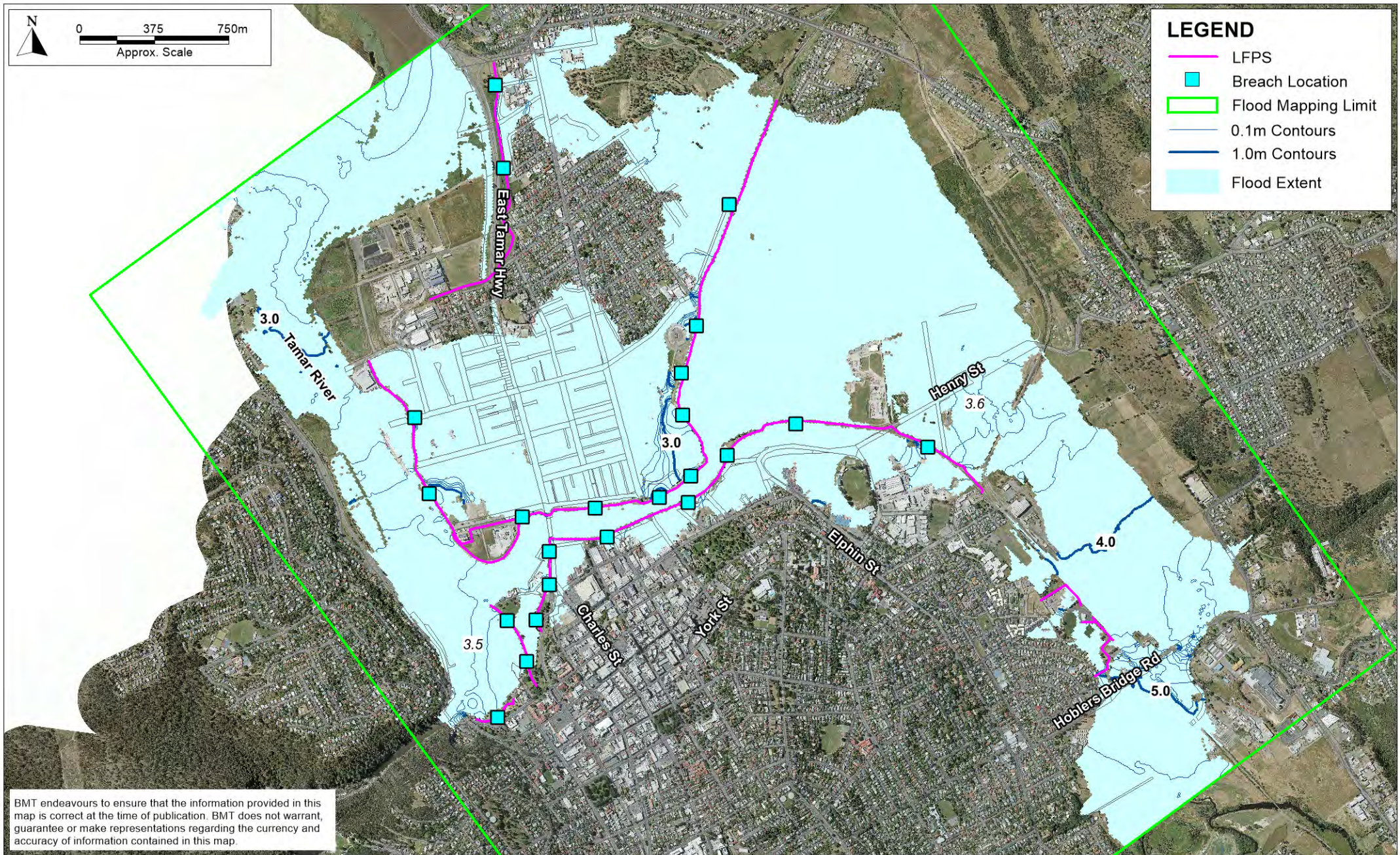




**Figure B-2 Combined Levee Breach Scenarios Mapping  
10% AEP Event Flood Level**



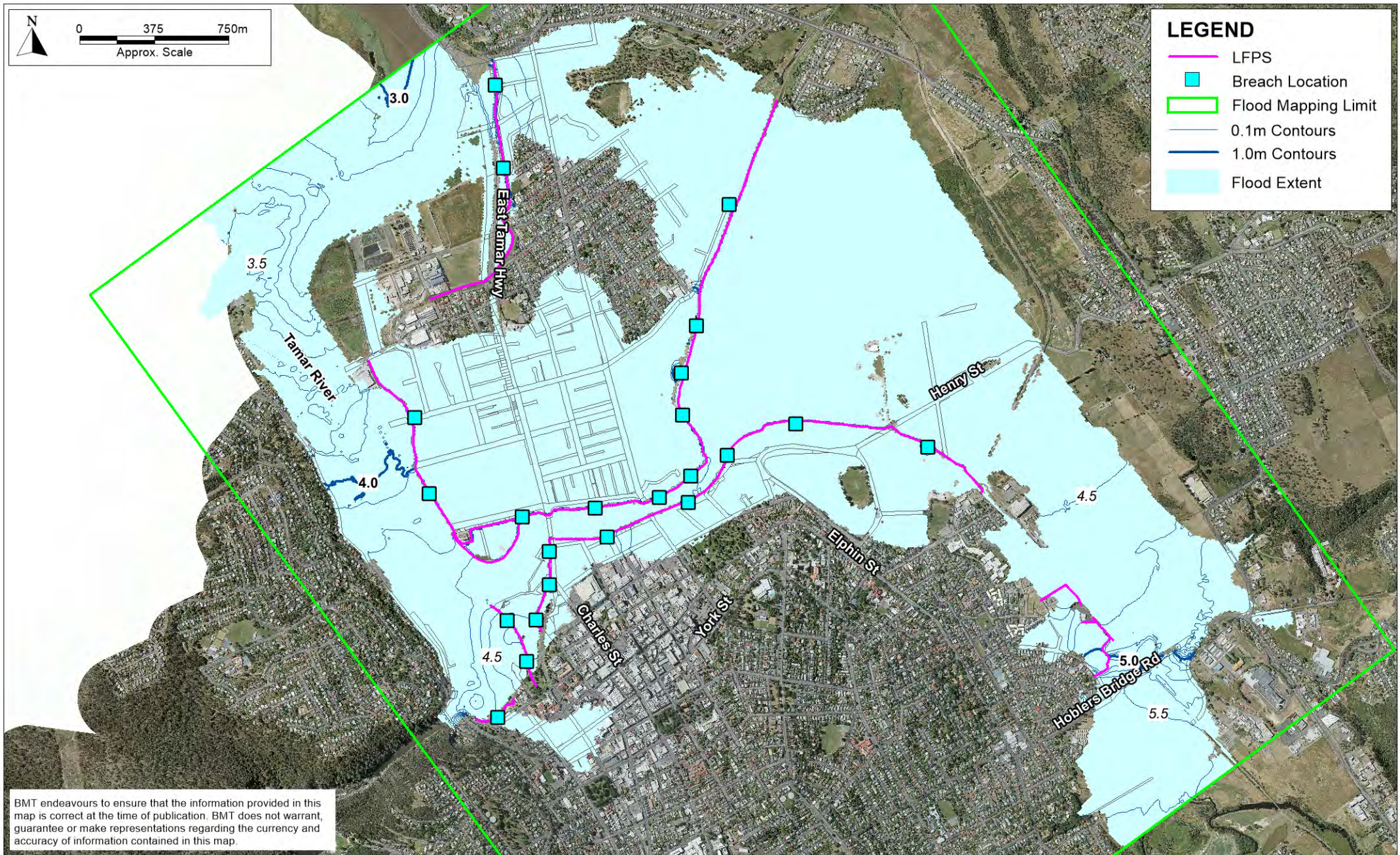




**Figure B-3 Combined Levee Breach Scenarios Mapping  
5% AEP Event Flood Level**



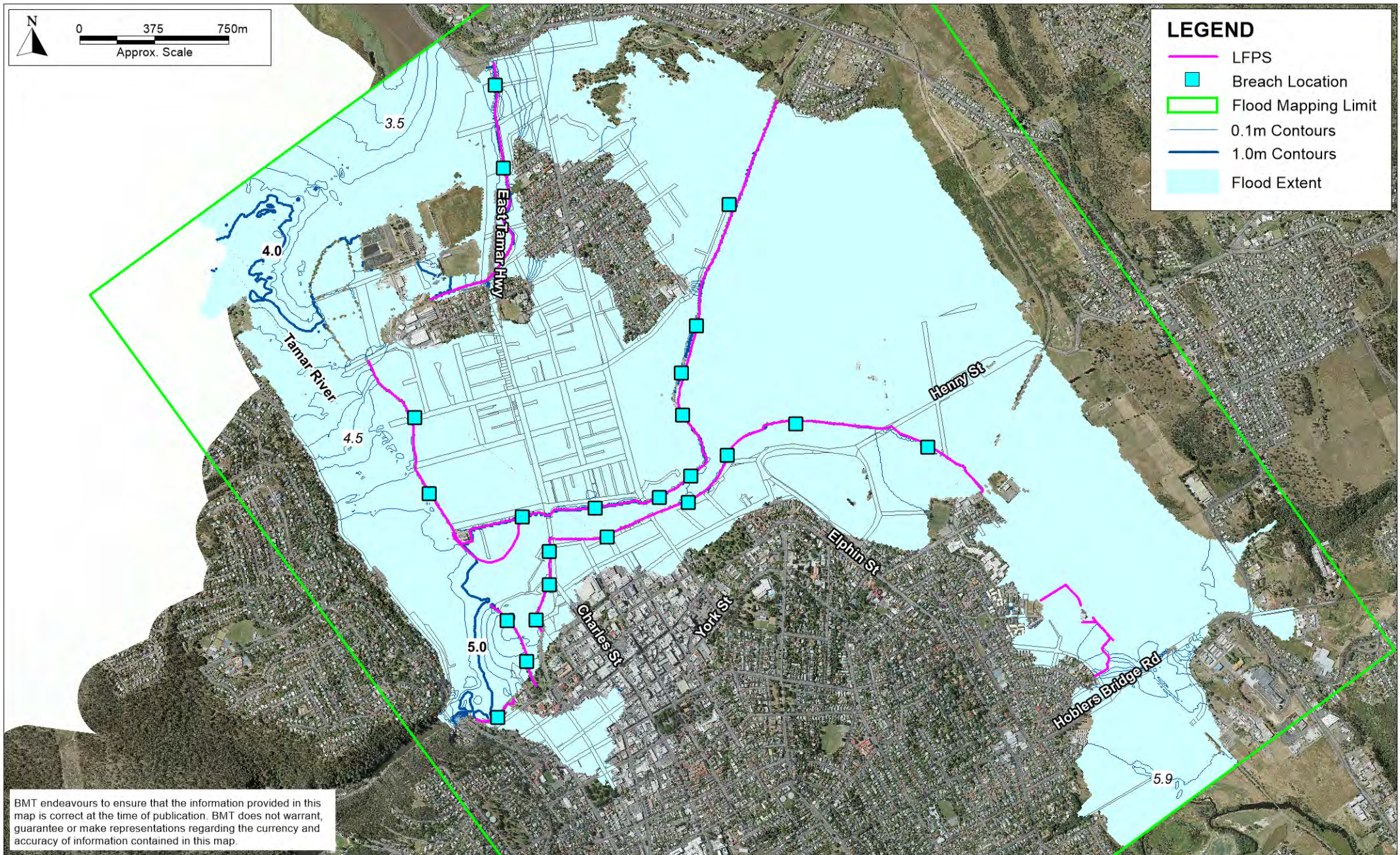




**Figure B-4 Combined Levee Breach Scenarios Mapping  
2% AEP Event Flood Level**



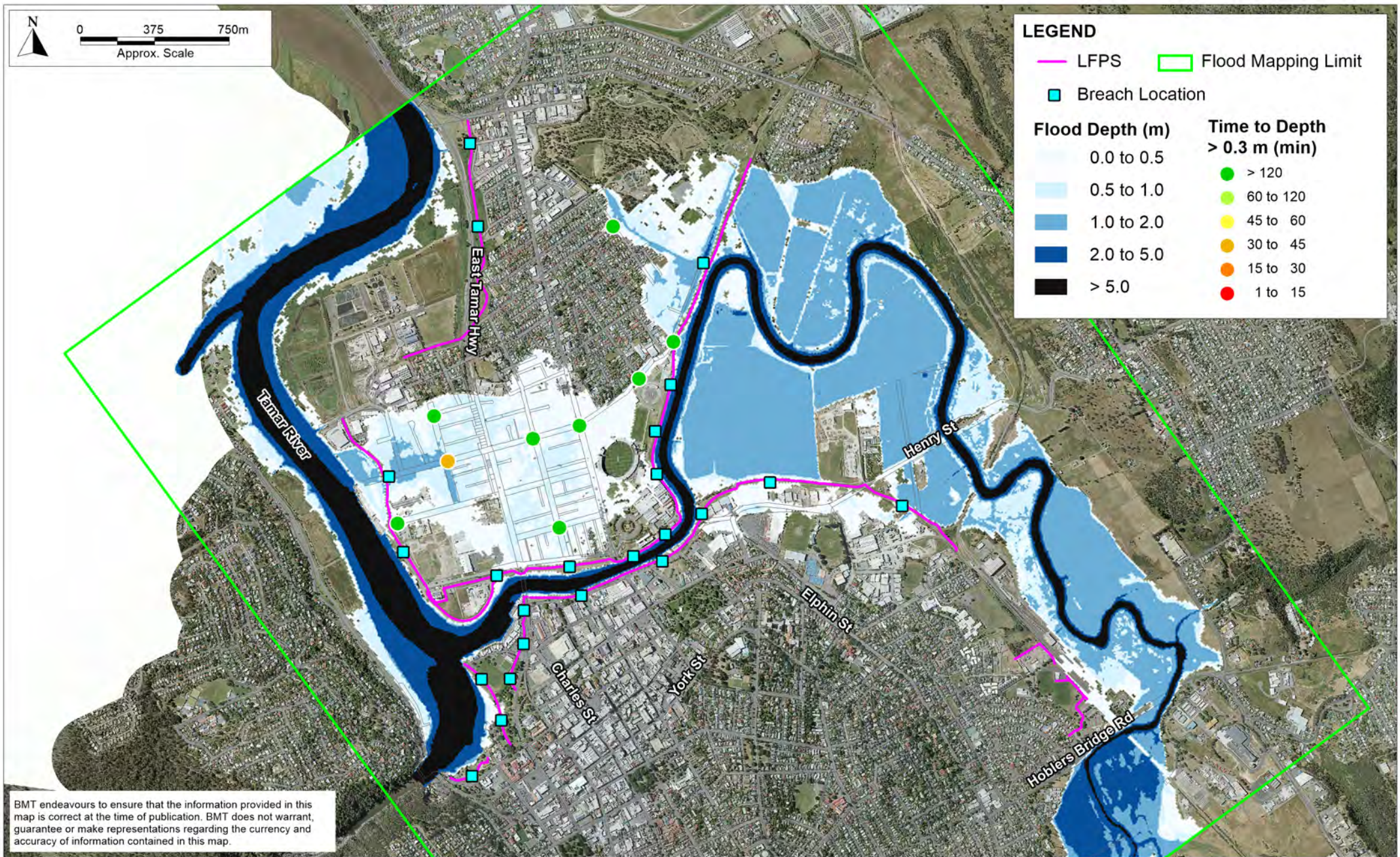




**Figure B-5 Combined Levee Breach Scenarios Mapping  
1% AEP Event Flood Level**





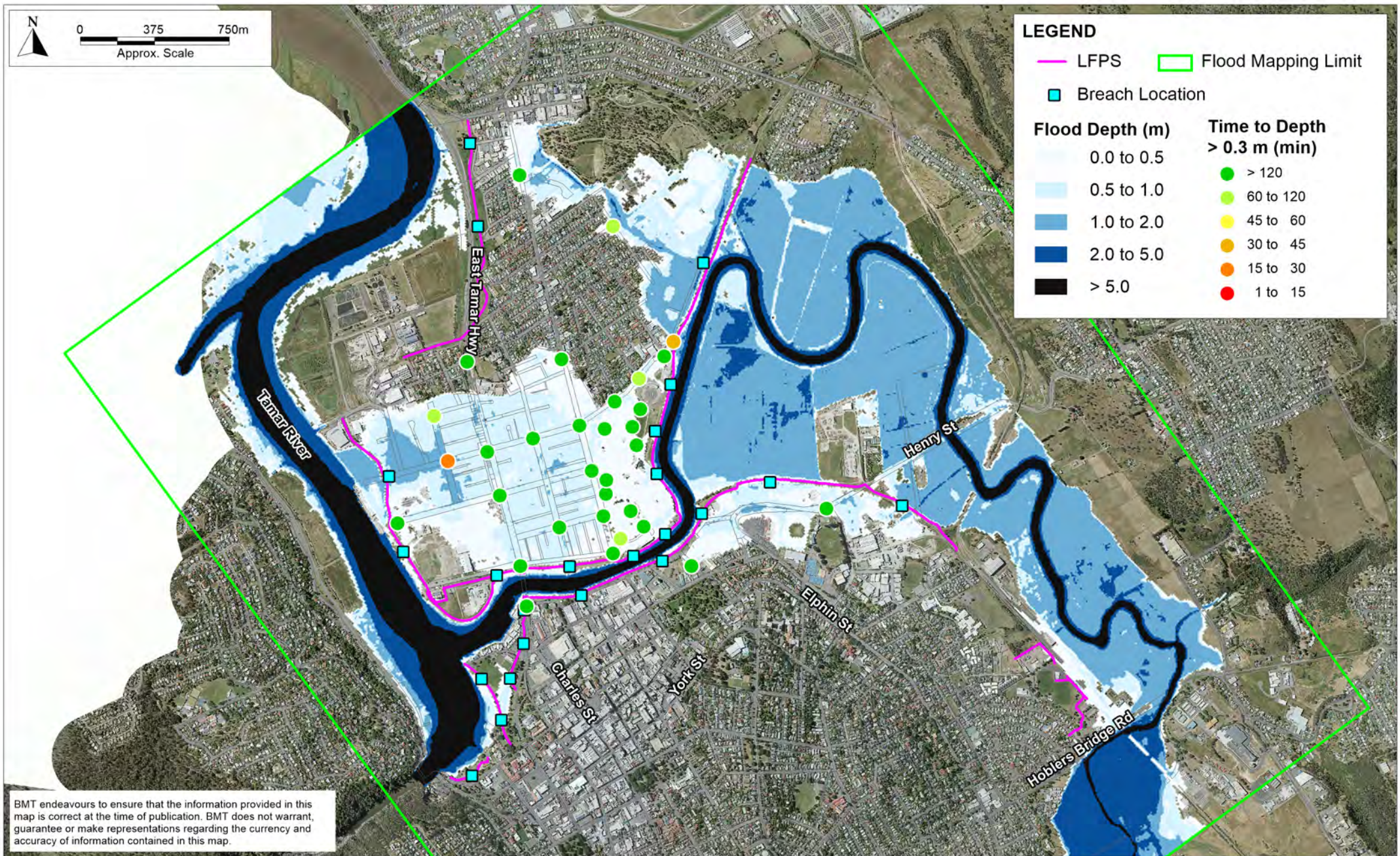


BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

**Figure B-6 Combined Levee Breach Scenarios  
20% AEP Event Flood Depth**



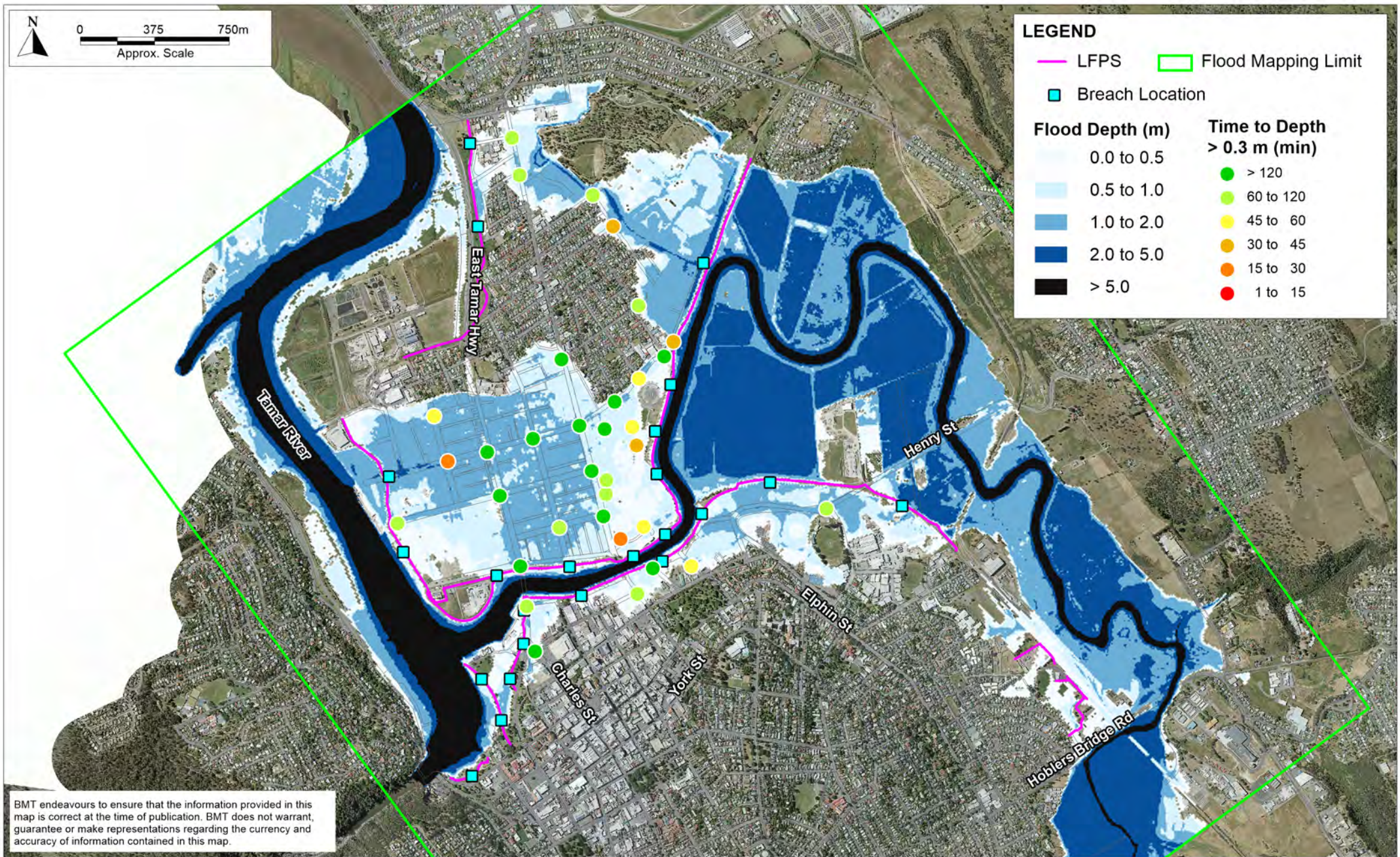




**Figure B-7 Combined Levee Breach Scenarios  
10% AEP Event Flood Depth**



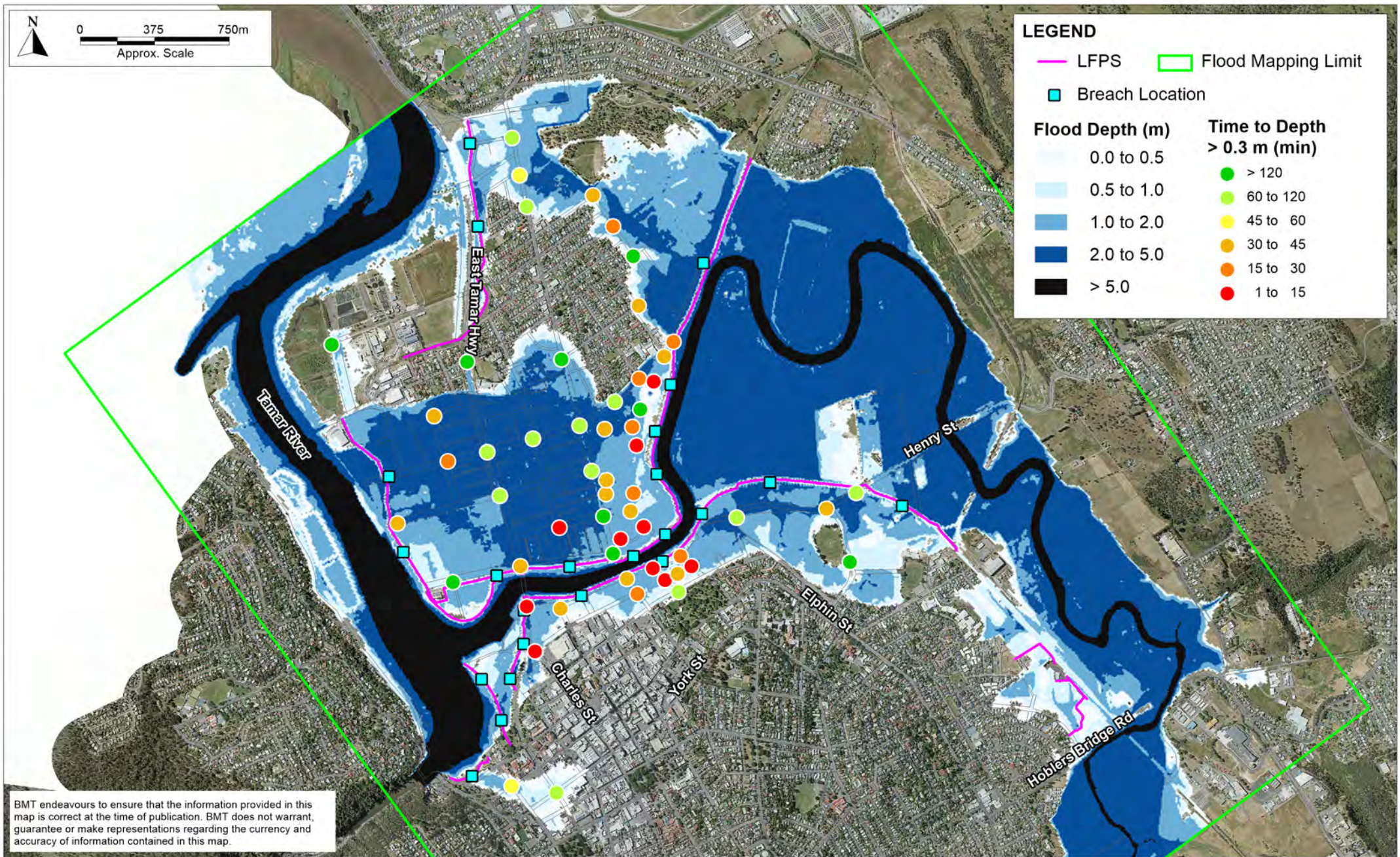




**Figure B-8 Combined Levee Breach Scenarios  
5% AEP Event Flood Depth**



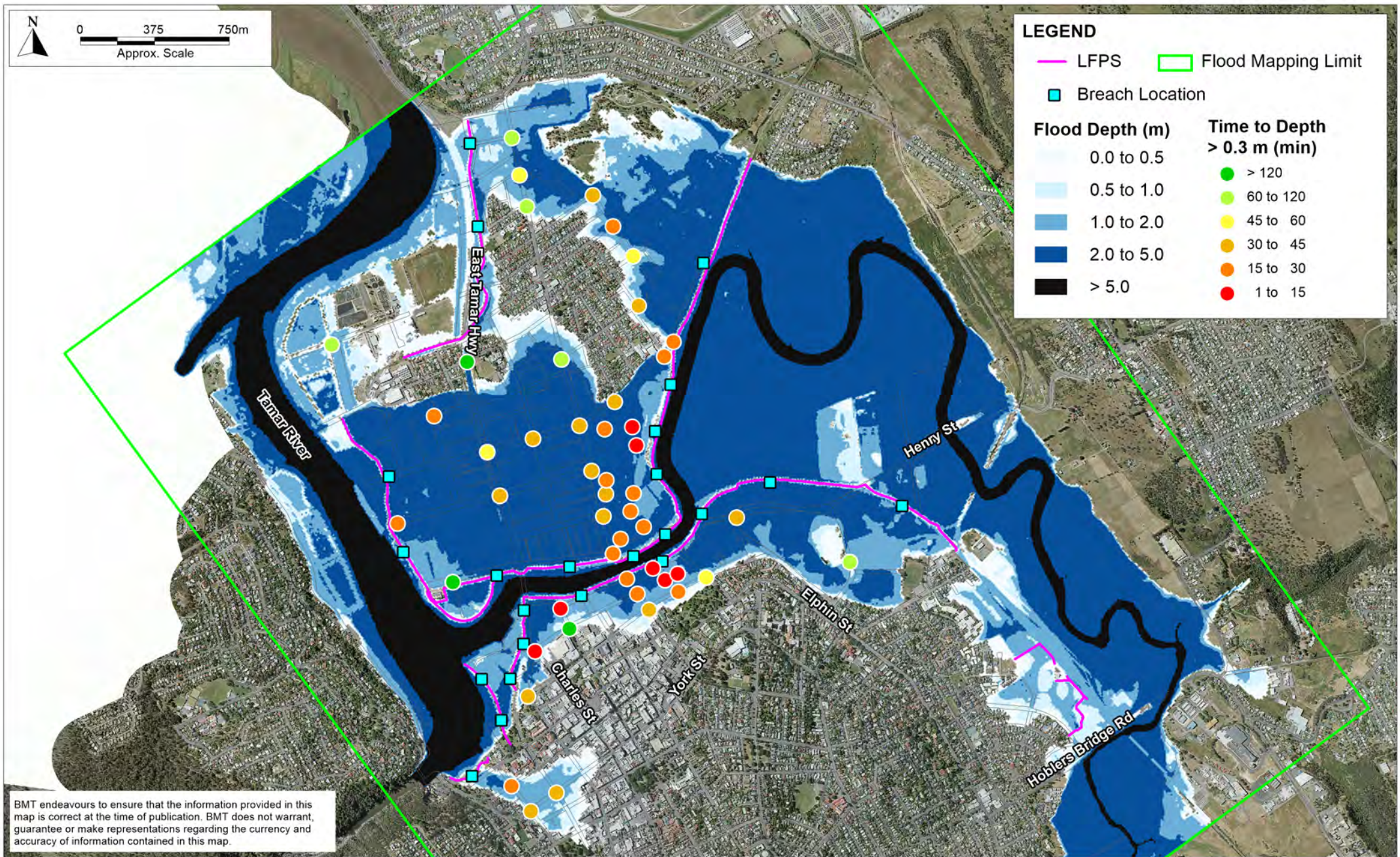




**Figure B-9 Combined Levee Breach Scenarios  
2% AEP Event Flood Depth**



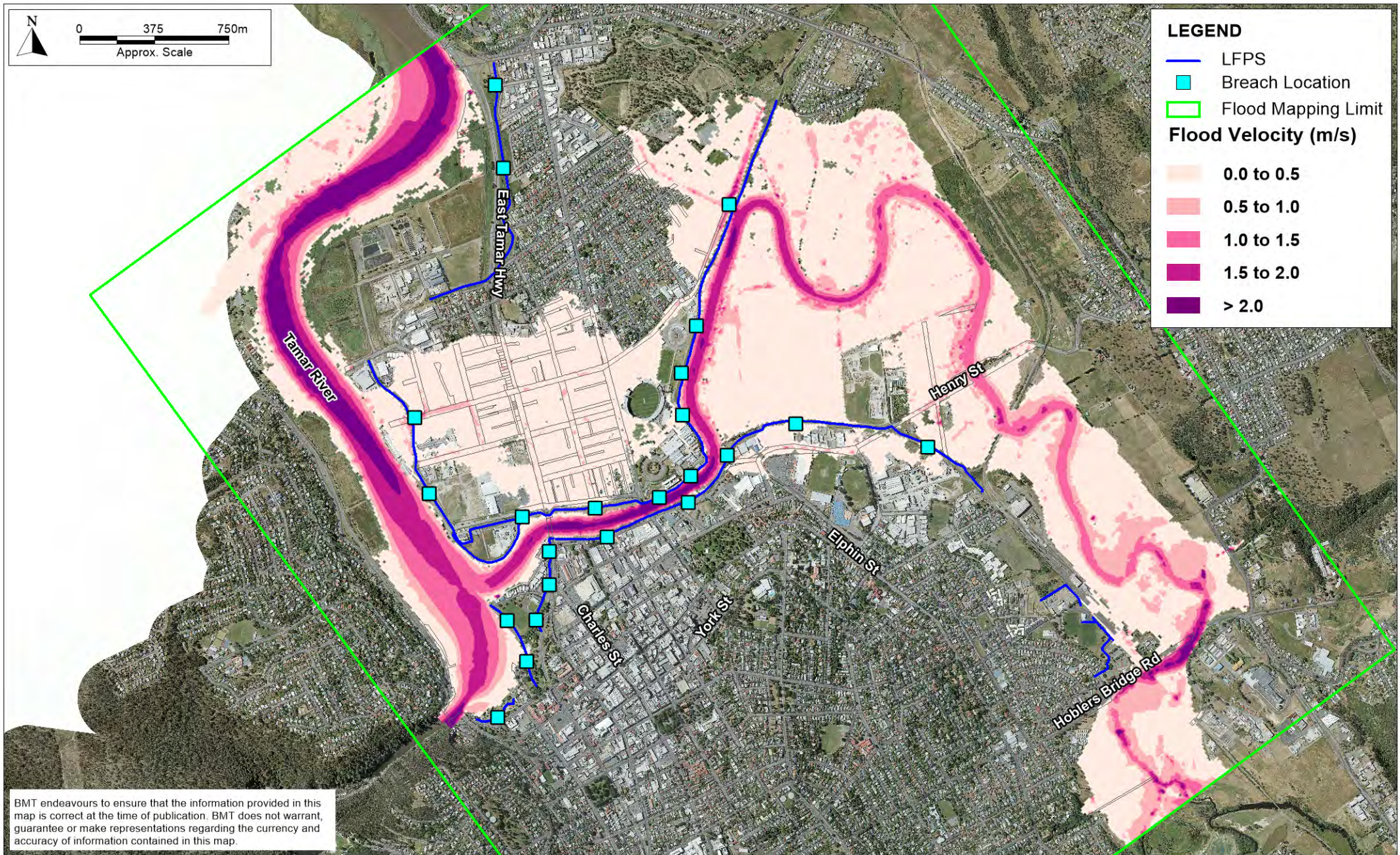




**Figure B-10 Combined Levee Breach Scenarios  
1% AEP Event Flood Depth**



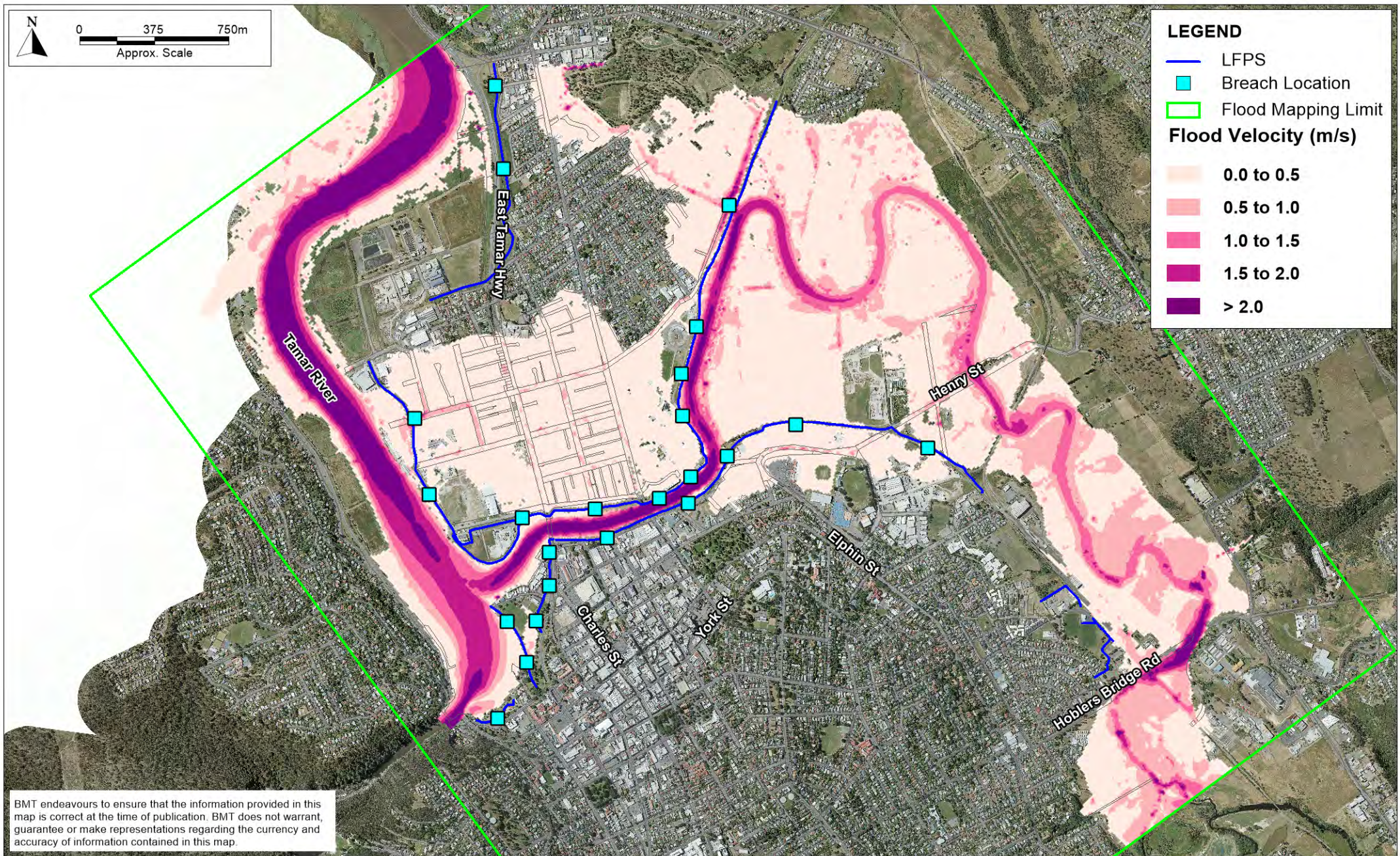




**Figure B-11 Combined Levee Breach Scenarios Mapping  
20% AEP Event Flood Velocity**



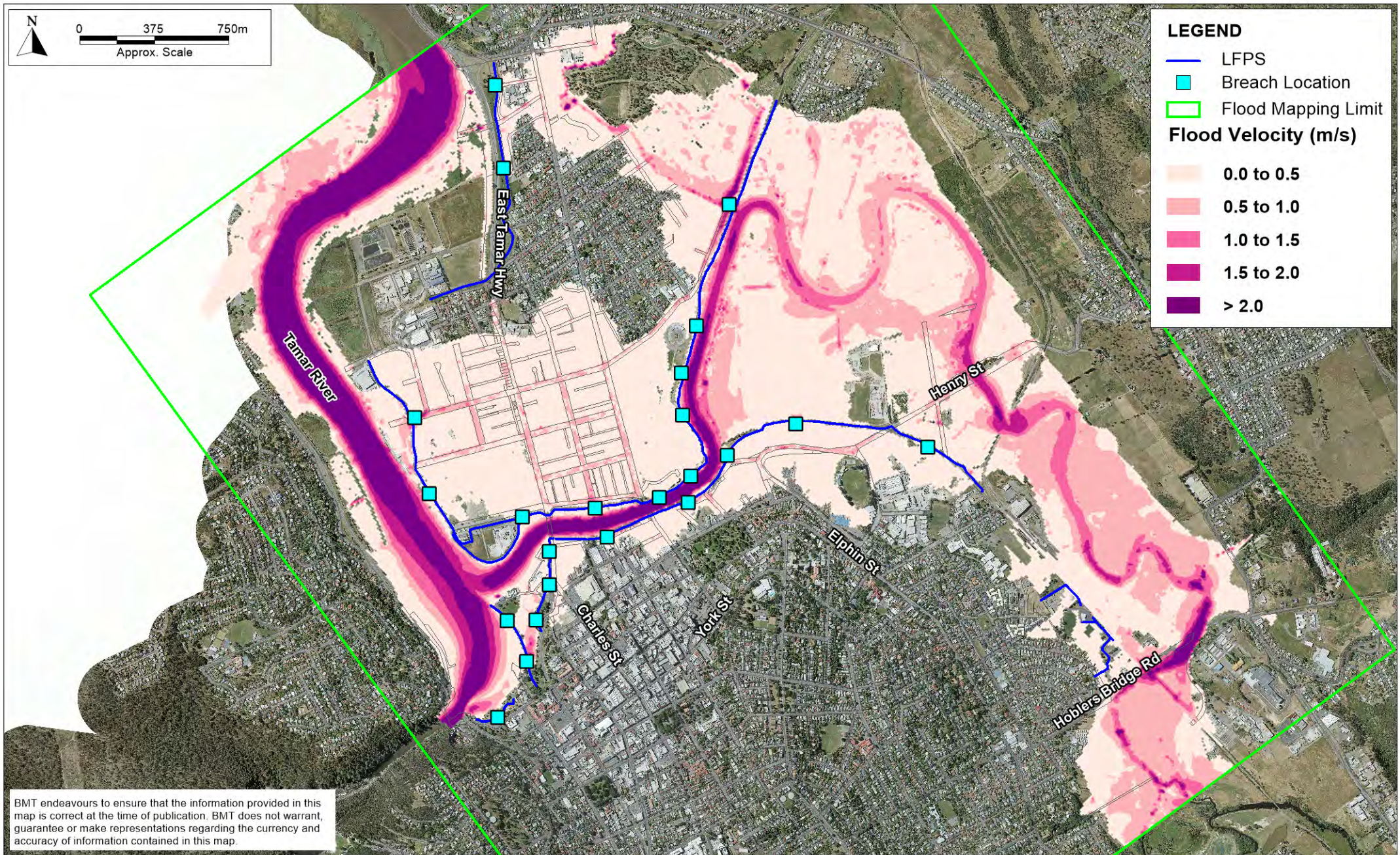




**Figure B-12 Combined Levee Breach Scenarios Mapping  
10% AEP Event Flood Velocity**



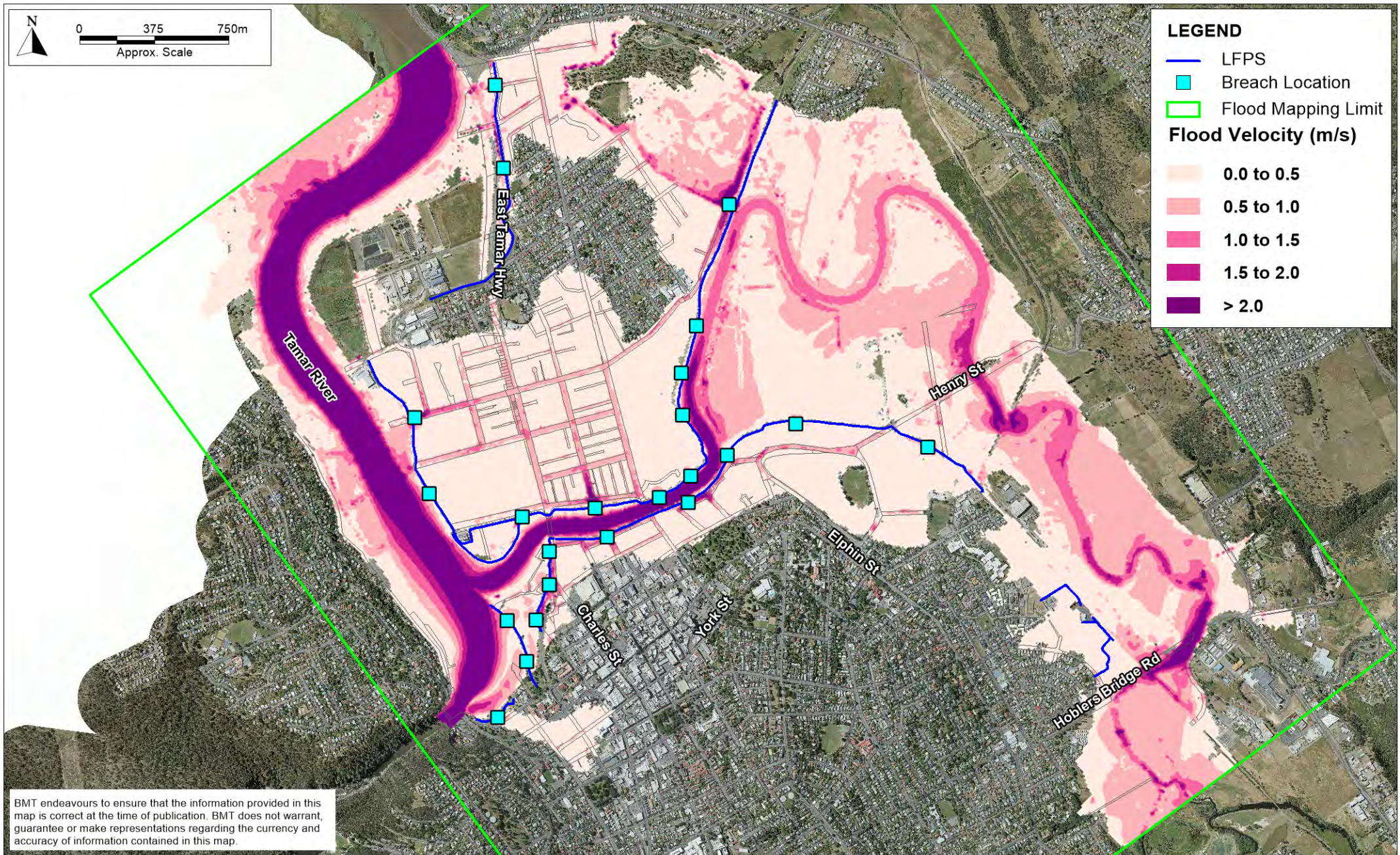




**Figure B-13 Combined Levee Breach Scenarios Mapping  
5% AEP Event Flood Velocity**



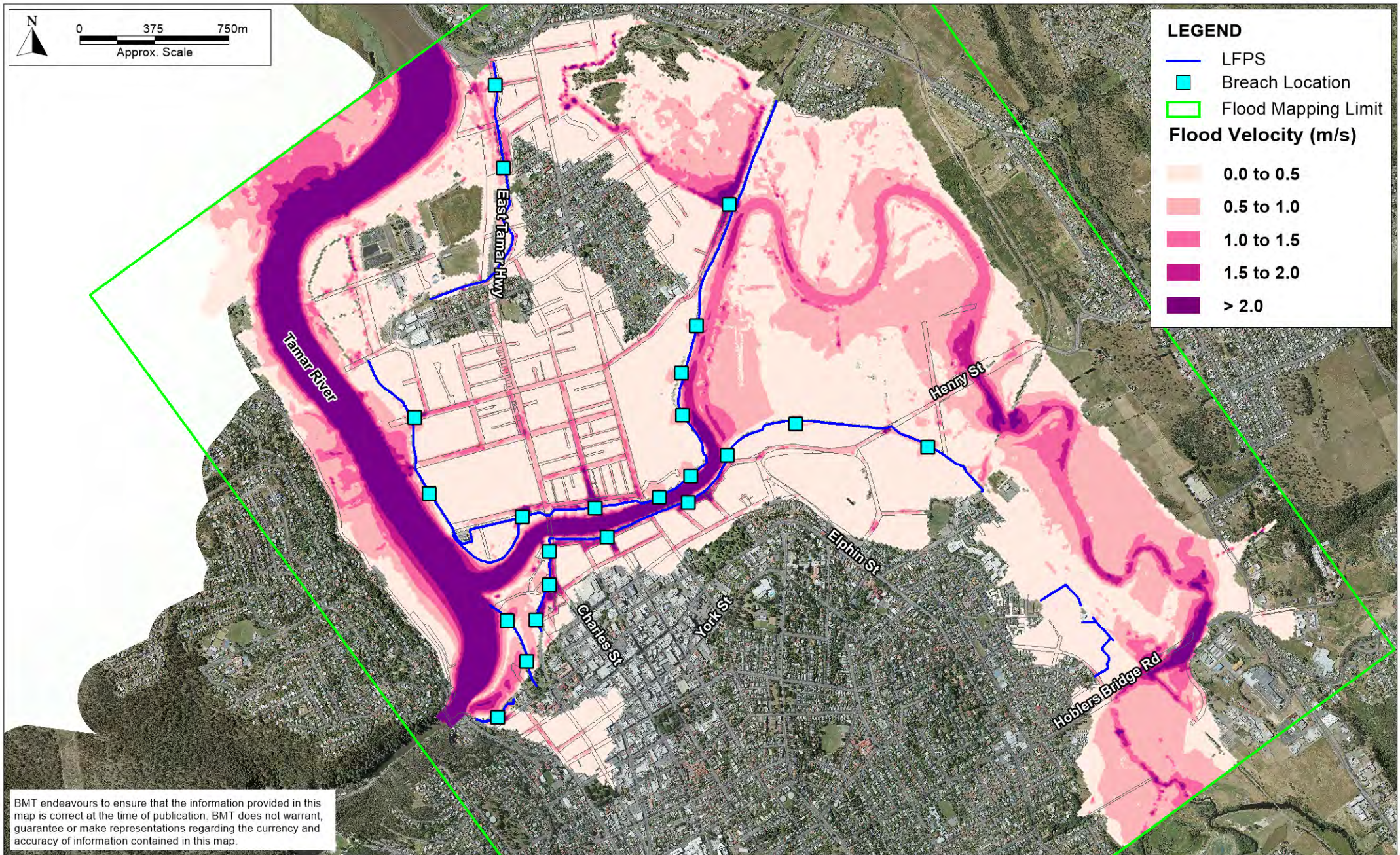




**Figure B-14 Combined Levee Breach Scenarios Mapping  
2% AEP Event Flood Velocity**



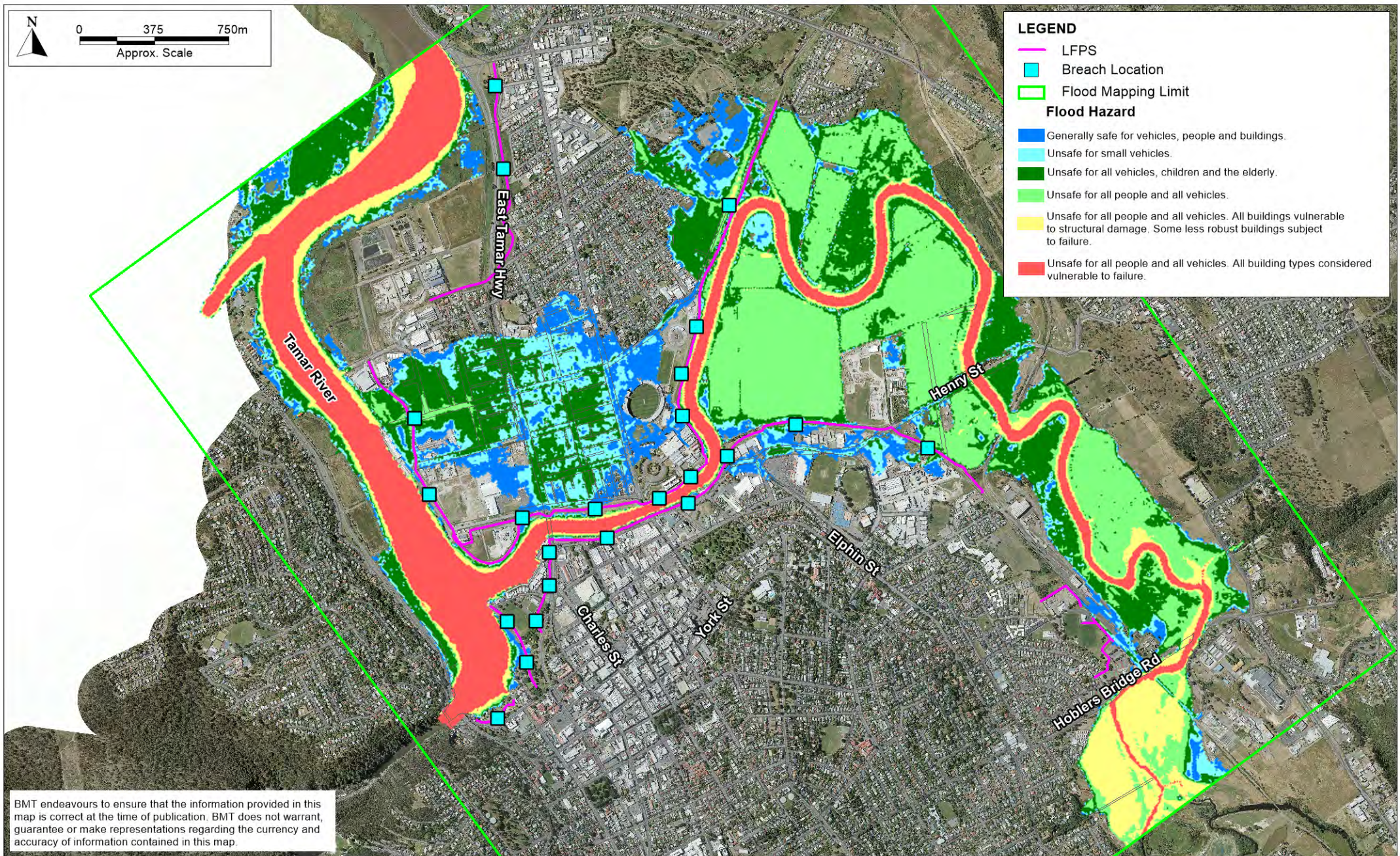




**Figure B-15 Combined Levee Breach Scenarios Mapping  
1% AEP Event Flood Velocity**





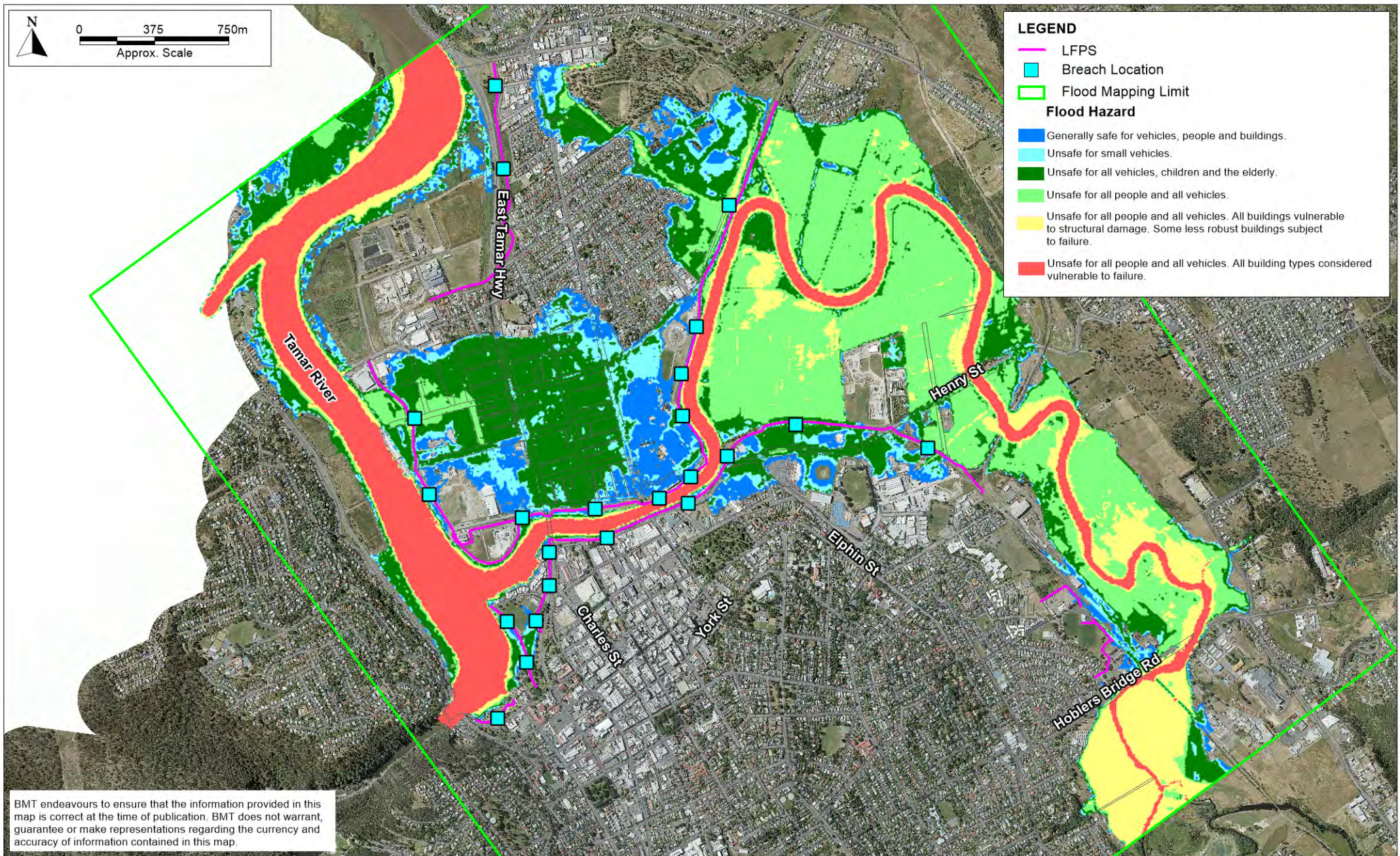


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**Figure B-16 Combined Levee Breach Scenarios Mapping  
20% AEP Event Flood Hazard**





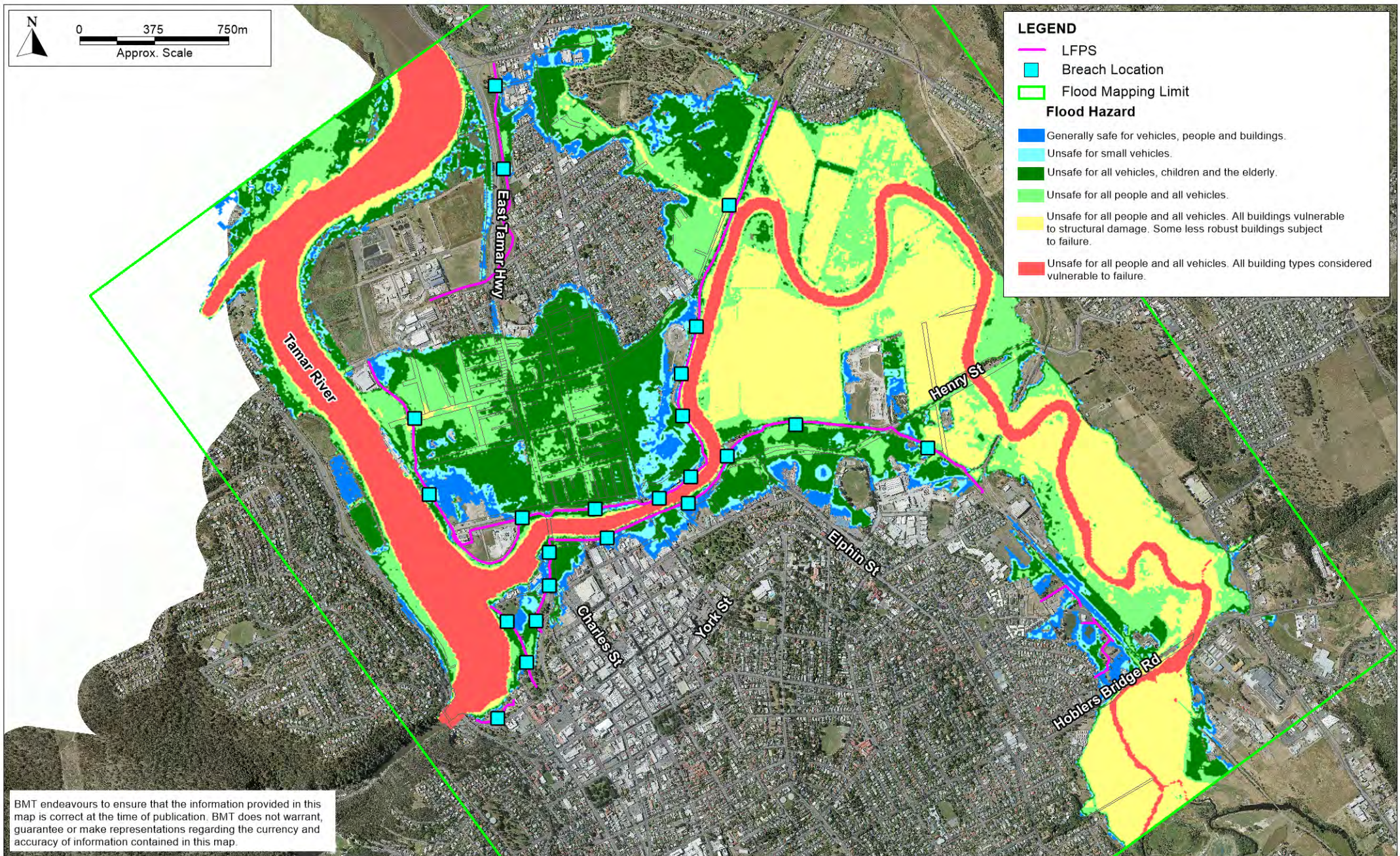


BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

**Figure B-17 Combined Levee Breach Scenarios Mapping  
10% AEP Event Flood Hazard**



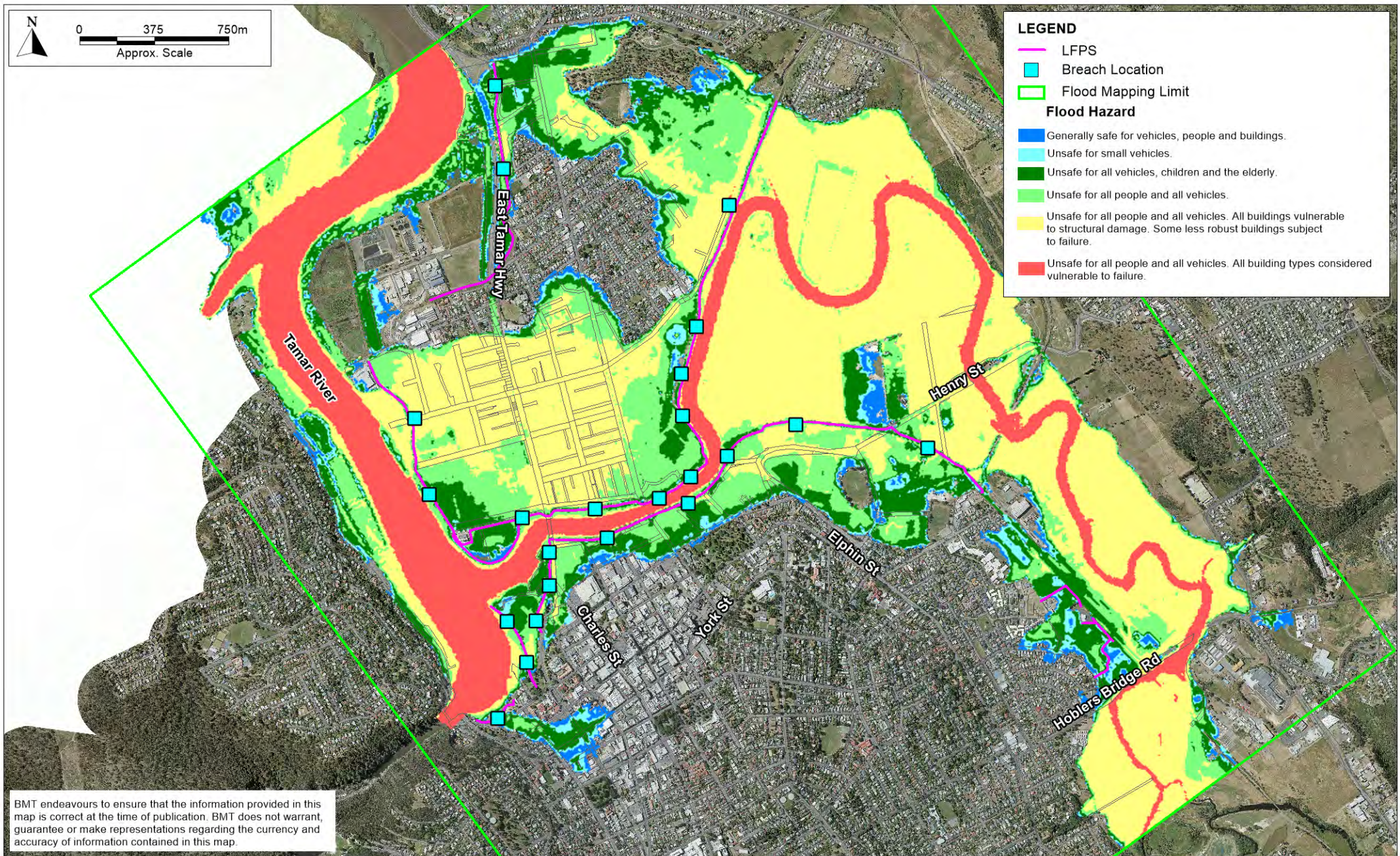




**Figure B-18 Combined Levee Breach Scenarios Mapping  
5% AEP Event Flood Hazard**



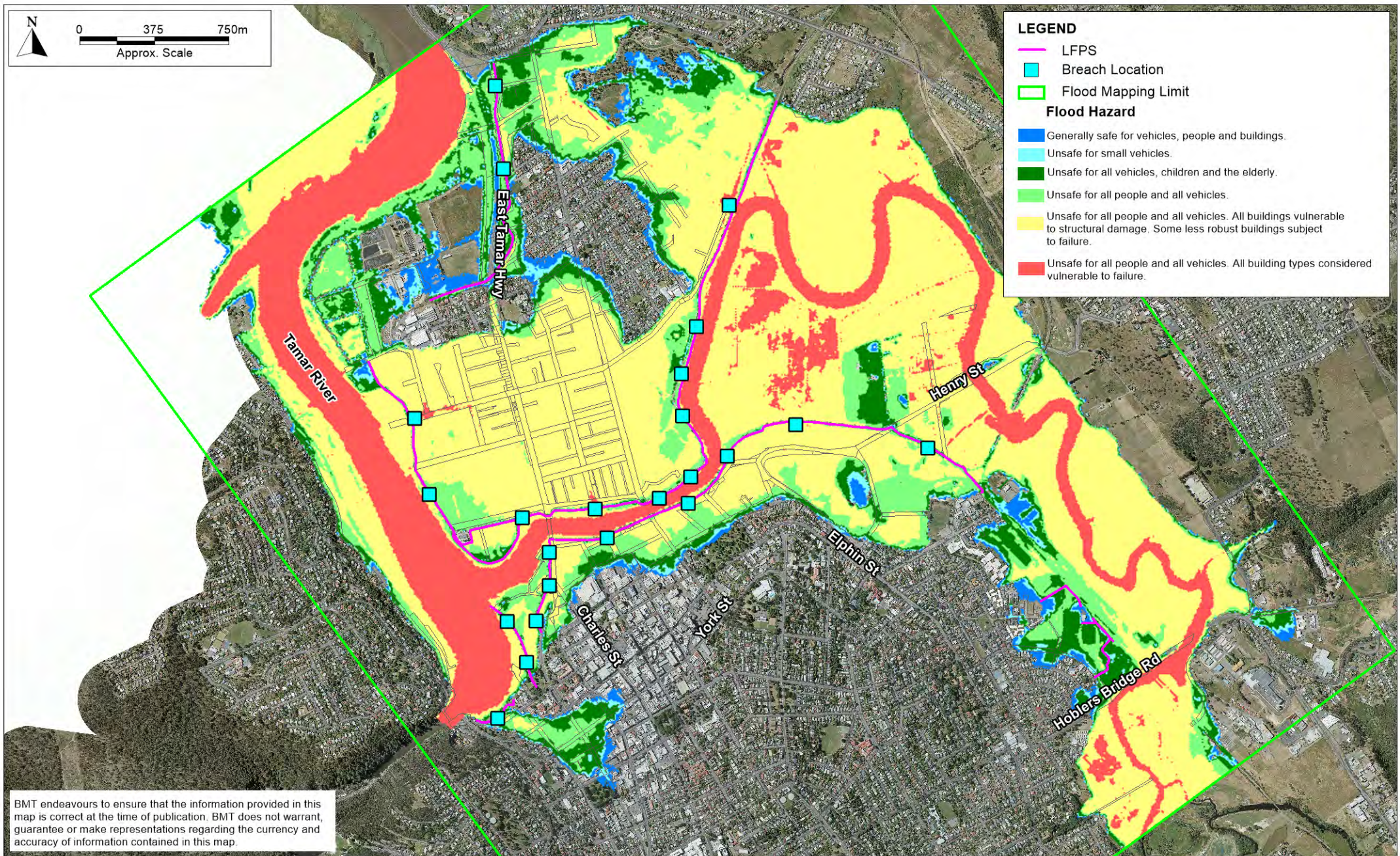




**Figure B-19 Combined Levee Breach Scenarios Mapping  
2% AEP Event Flood Hazard**







**Figure B-20 Combined Levee Breach Scenarios Mapping  
1% AEP Event Flood Hazard**





No Levee Scenario Mapping

## Appendix C No Levee Scenario Mapping

Figure C-1 No Levee Scenario Mapping 20% AEP Event Flood Level

Figure C-2 No Levee Scenario Mapping 10% AEP Event Flood Level

Figure C-3 No Levee Scenario Mapping 5% AEP Event Flood Level

Figure C-4 No Levee Scenario Mapping 2% AEP Event Flood Level

Figure C-5 No Levee Scenario Mapping 1% AEP Event Flood Level

Figure C-6 No Levee Scenario Mapping 20% AEP Event Flood Depth

Figure C-7 No Levee Scenario Mapping 10% AEP Event Flood Depth

Figure C-8 No Levee Scenario Mapping 5% AEP Event Flood Depth

Figure C-9 No Levee Scenario Mapping 2% AEP Event Flood Depth

Figure C-10 No Levee Scenario Mapping 1% AEP Event Flood Depth

Figure C-11 No Levee Scenario Mapping 20% AEP Event Flood Velocity

Figure C-12 No Levee Scenario Mapping 10% AEP Event Flood Velocity

Figure C-13 No Levee Scenario Mapping 5% AEP Event Flood Velocity

Figure C-14 No Levee Scenario Mapping 2% AEP Event Flood Velocity

Figure C-15 No Levee Scenario Mapping 1% AEP Event Flood Velocity

Figure C-16 No Levee Scenario Mapping 20% AEP Event Flood Hazard

Figure C-17 No Levee Scenario Mapping 10% AEP Event Flood Hazard

Figure C-18 No Levee Scenario Mapping 5% AEP Event Flood Hazard

Figure C-19 No Levee Scenario Mapping 2% AEP Event Flood Hazard

Figure C-20 No Levee Scenario Mapping 1% AEP Event Flood Hazard

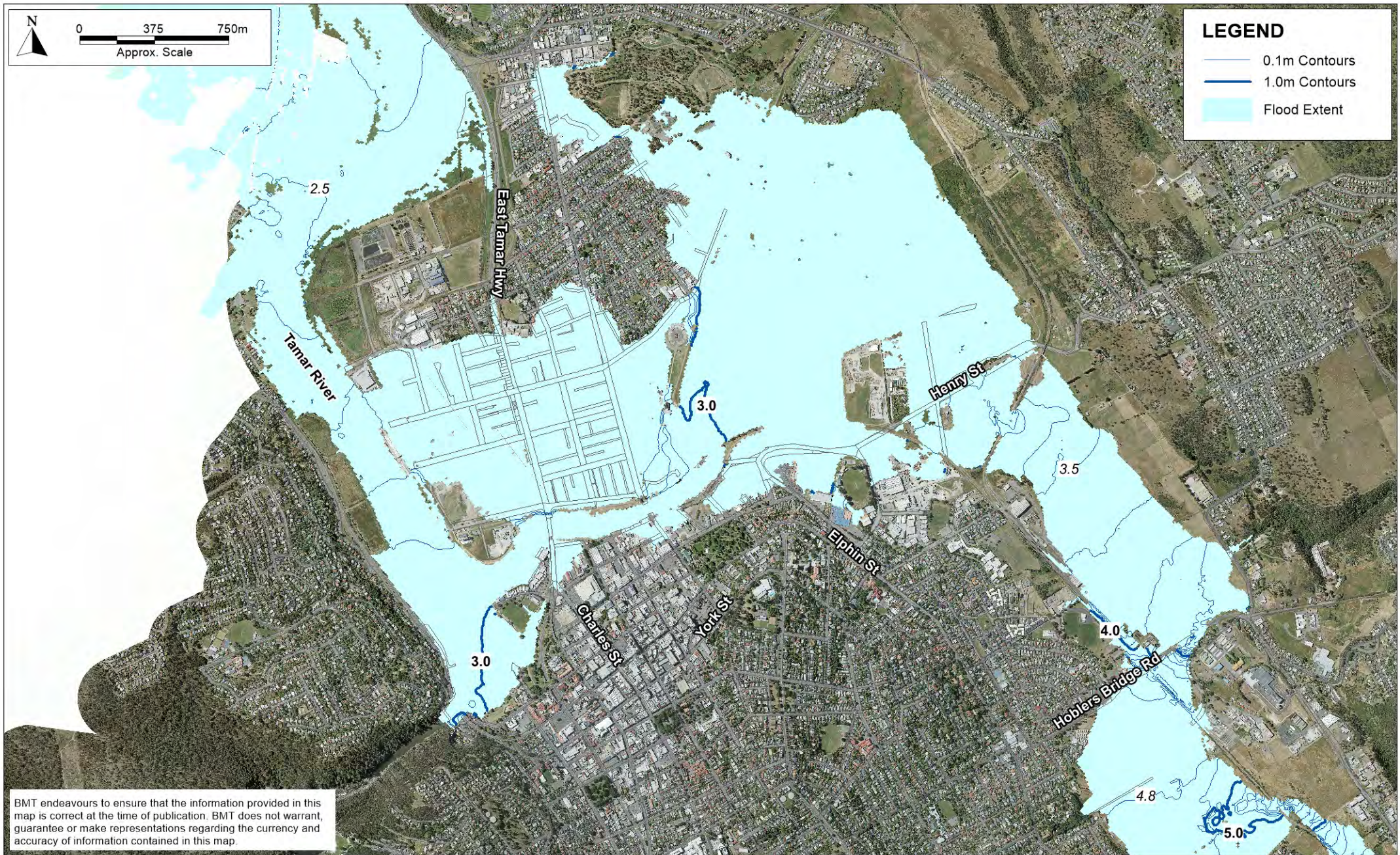




**Figure C-1 No Levee Scenario Mapping  
20% AEP Event Flood Level**



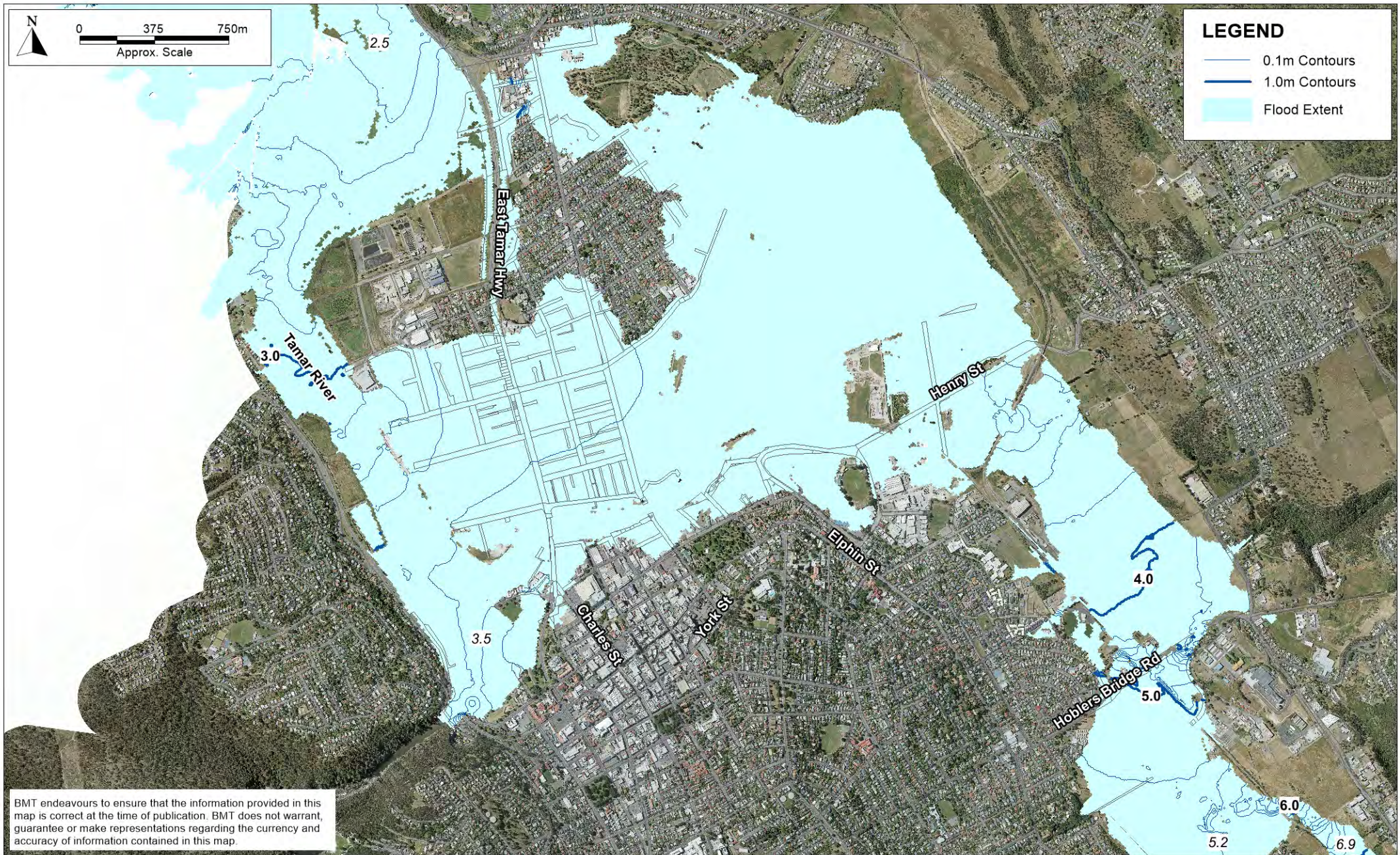




**Figure C-2 No Levee Scenario Mapping  
10% AEP Event Flood Level**



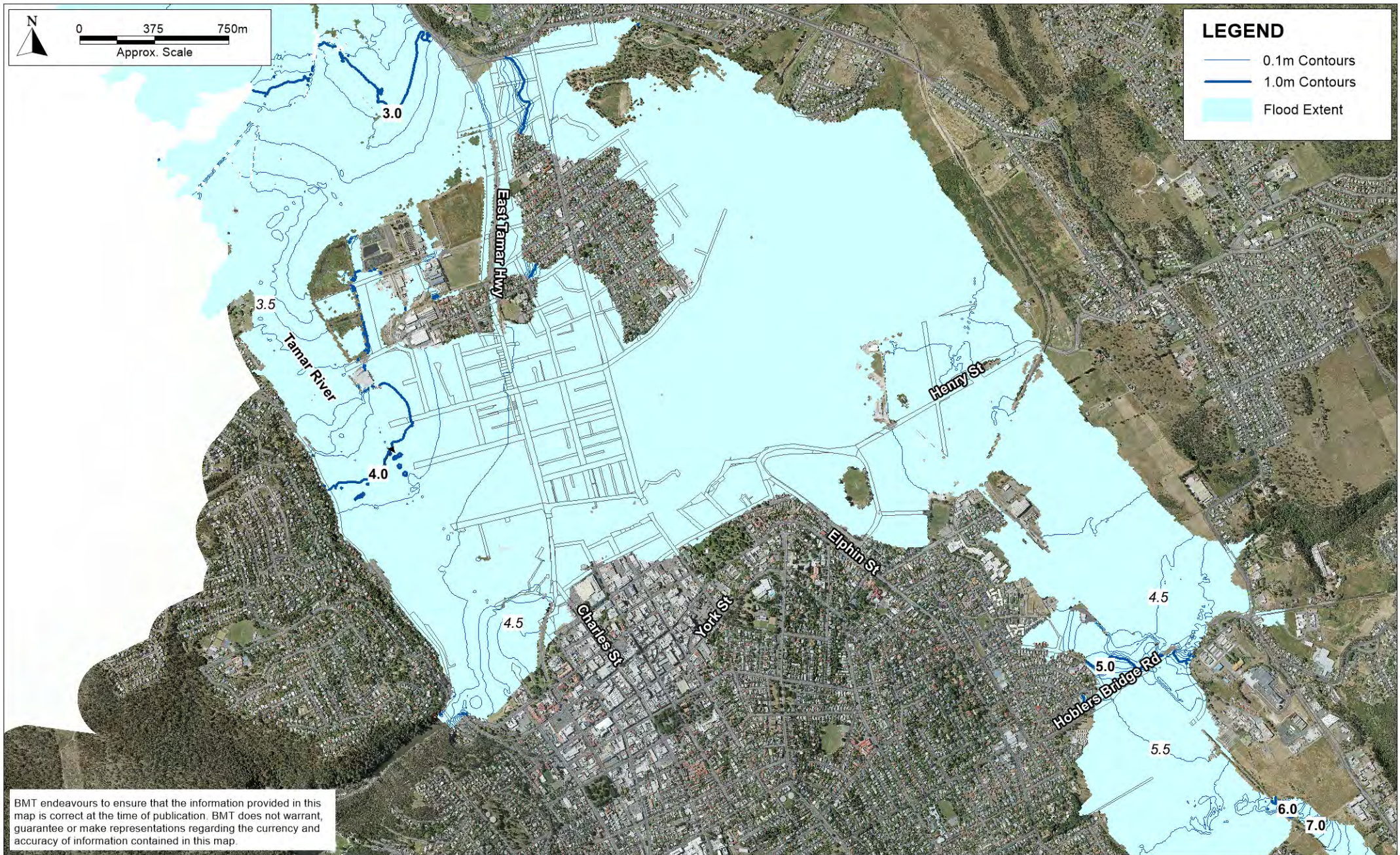




**Figure C-3 No Levee Scenario Mapping  
5% AEP Event Flood Level**



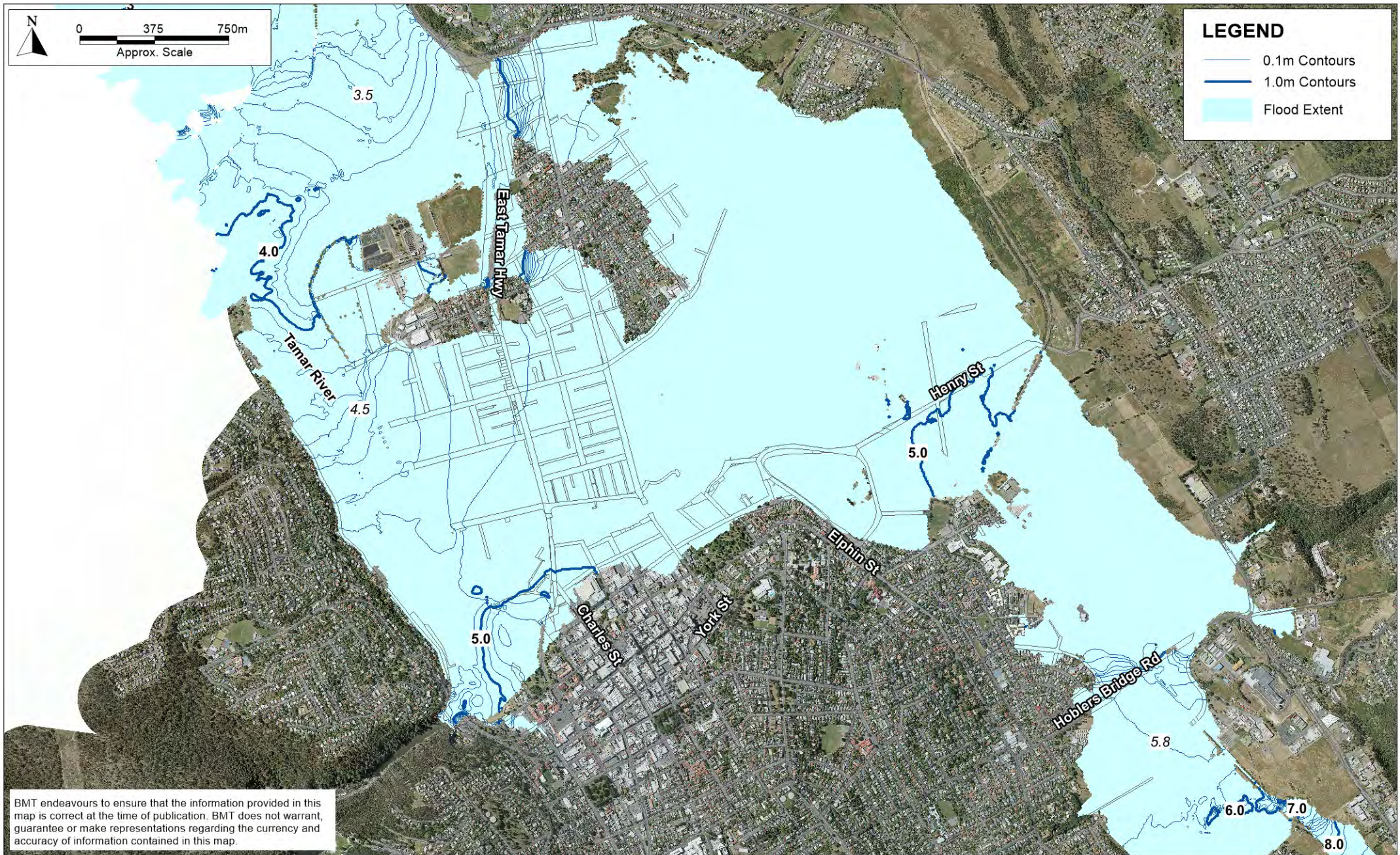




**Figure C-4 No Levee Scenario Mapping  
2% AEP Event Flood Level**



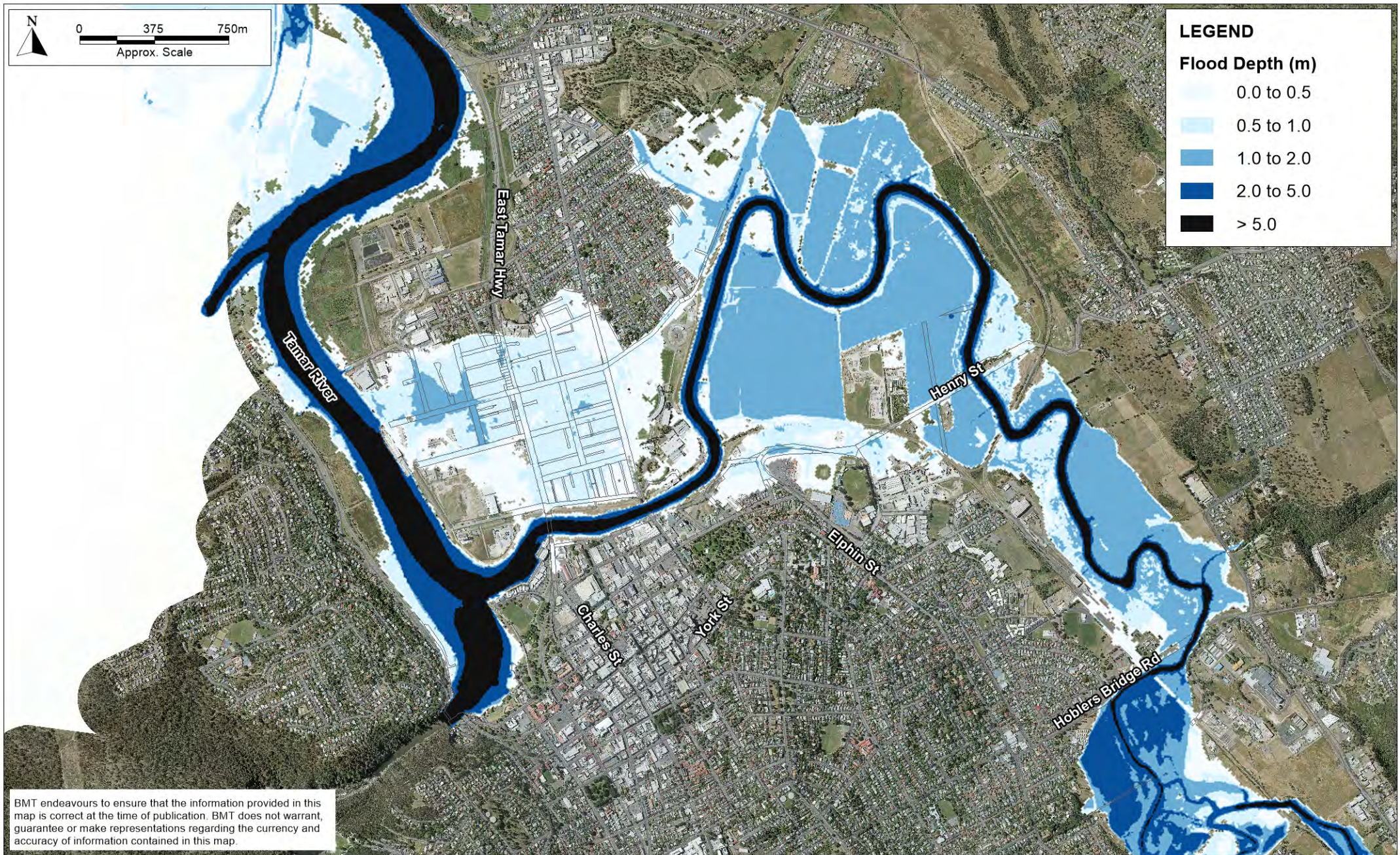




**Figure C-5 No Levee Scenario Mapping  
1% AEP Event Flood Level**



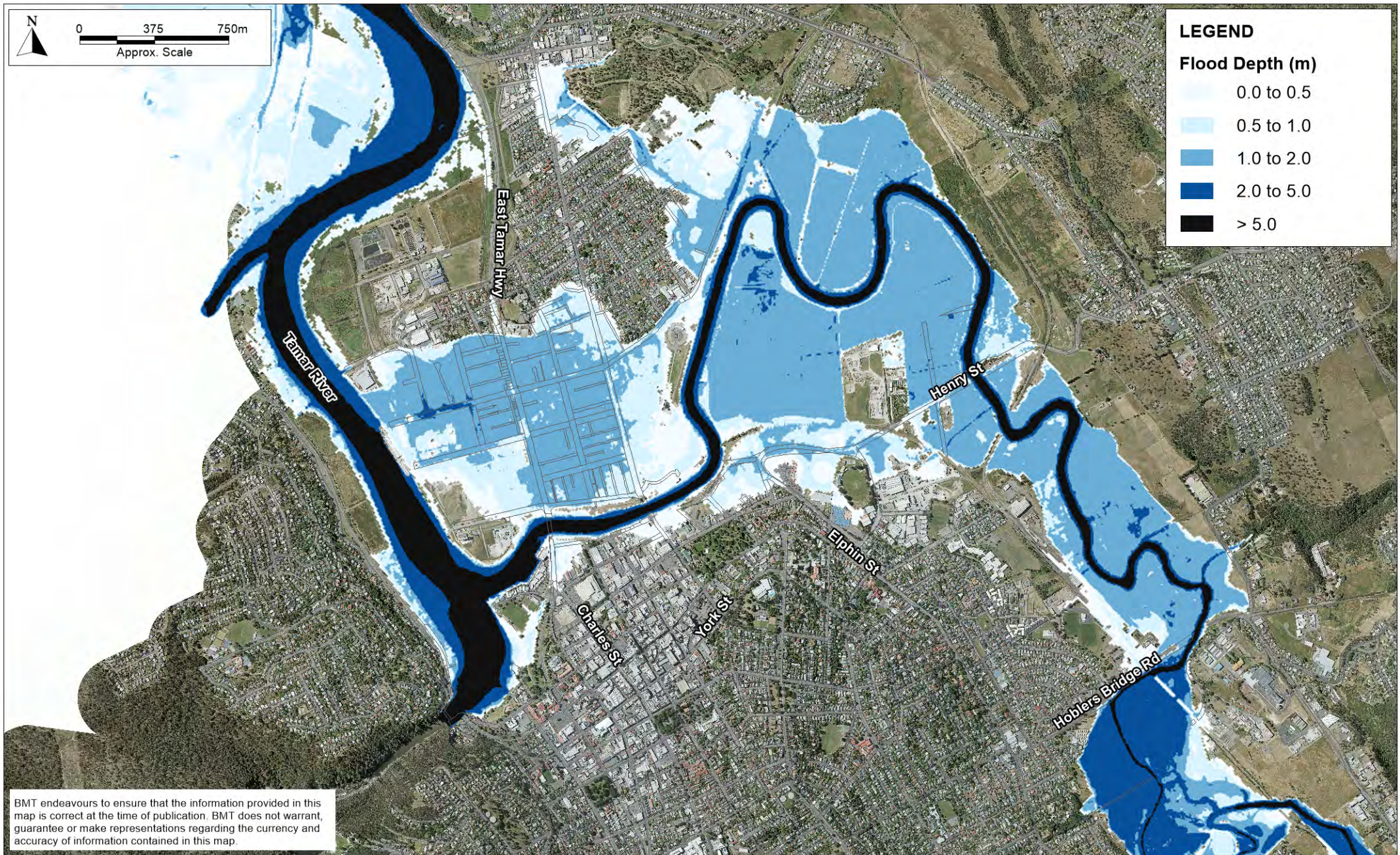




**Figure C-6 No Levee Scenario Mapping  
20% AEP Event Flood Depth**



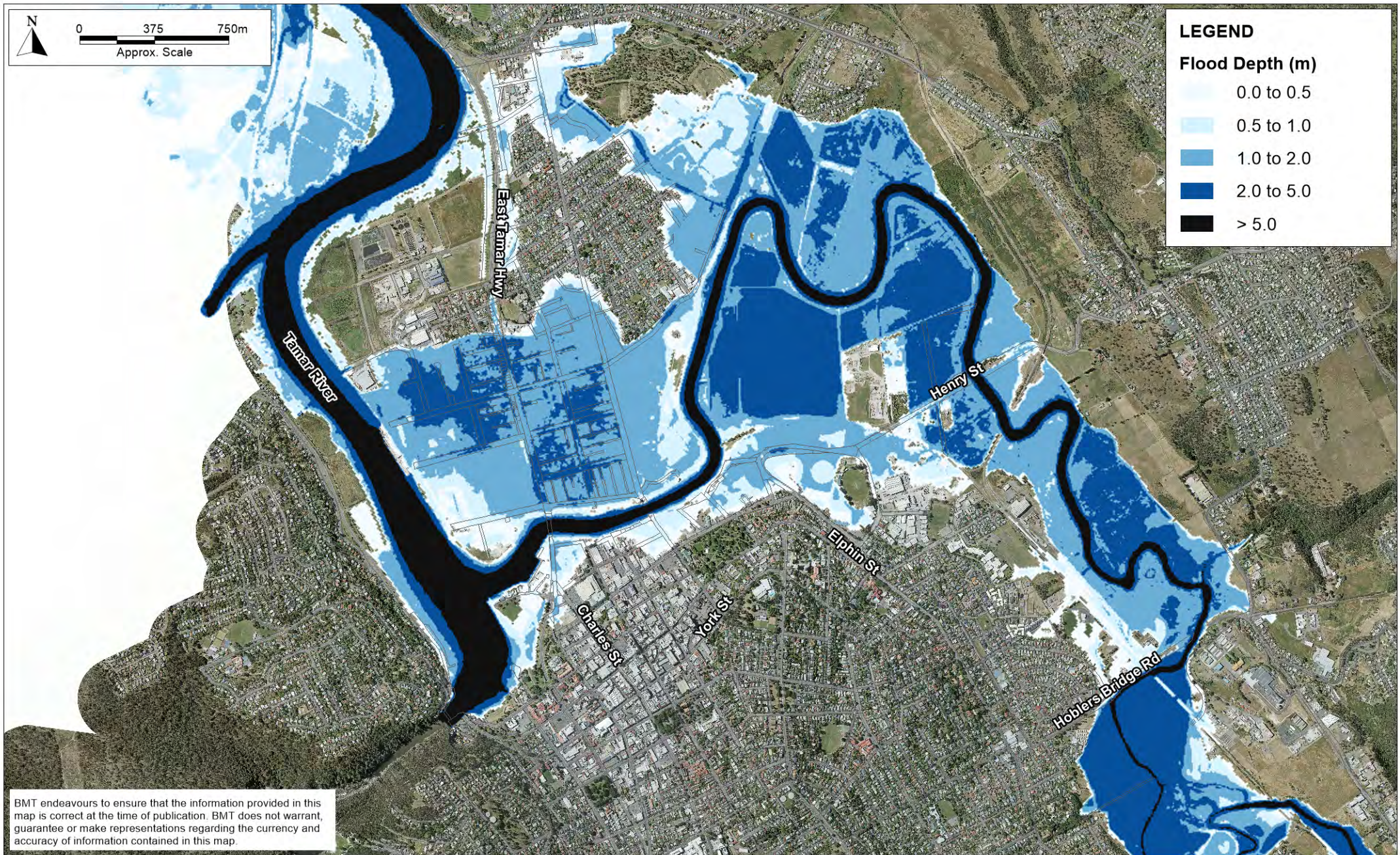




**Figure C-7 No Levee Scenario Mapping  
10% AEP Event Flood Depth**



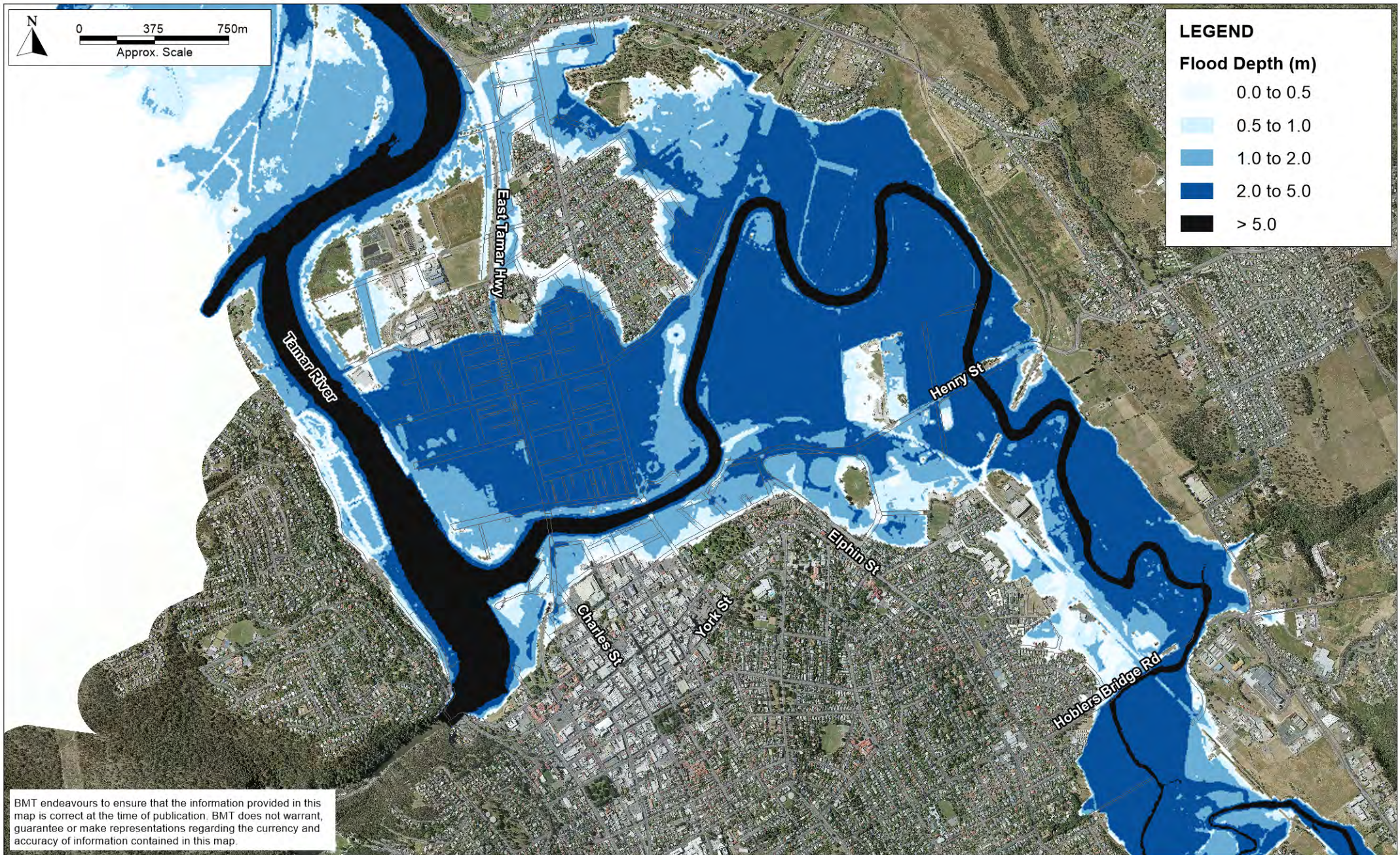




**Figure C-8 No Levee Scenario Mapping  
5% AEP Event Flood Depth**



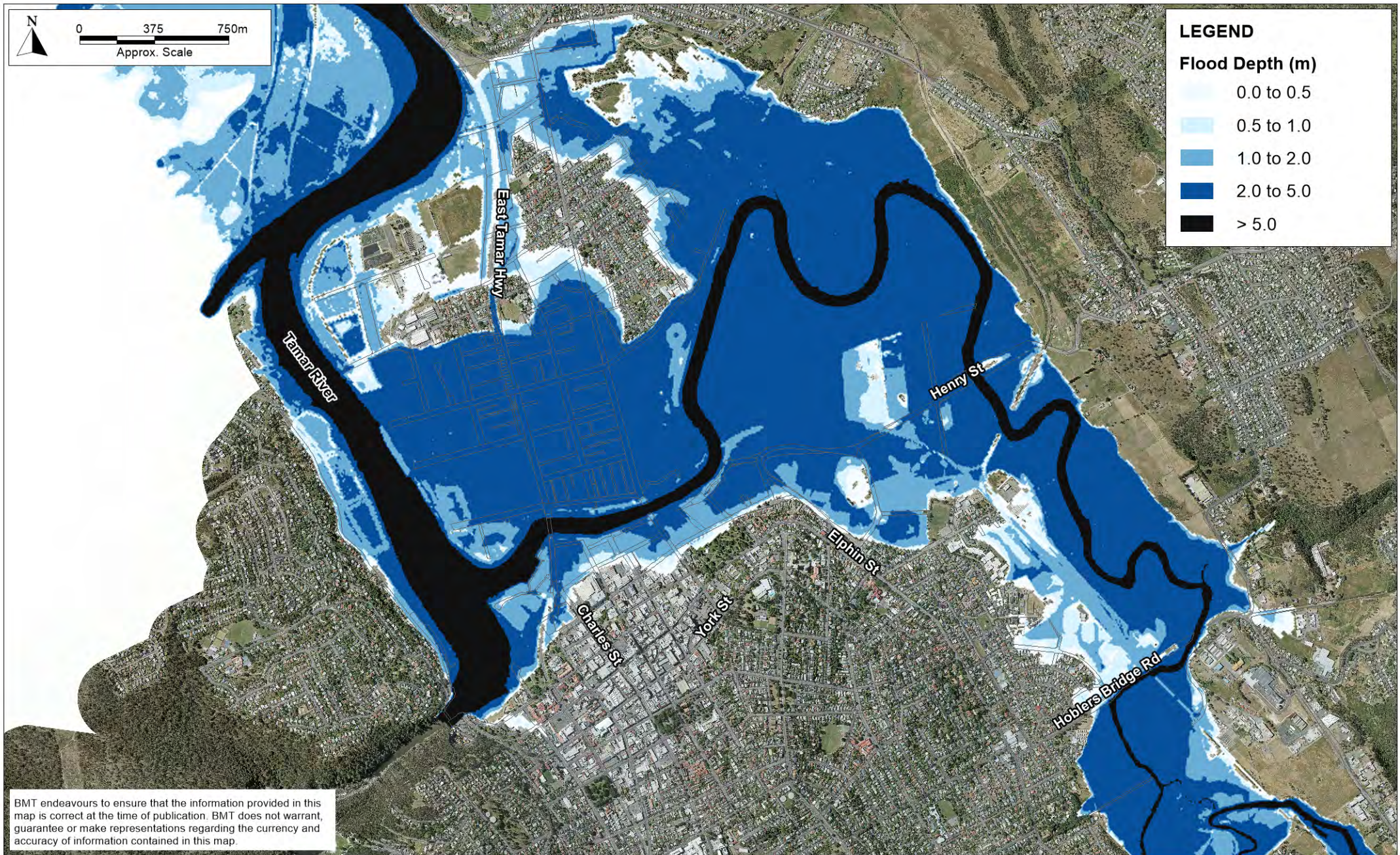




**Figure C-9 No Levee Scenario Mapping  
2% AEP Event Flood Depth**



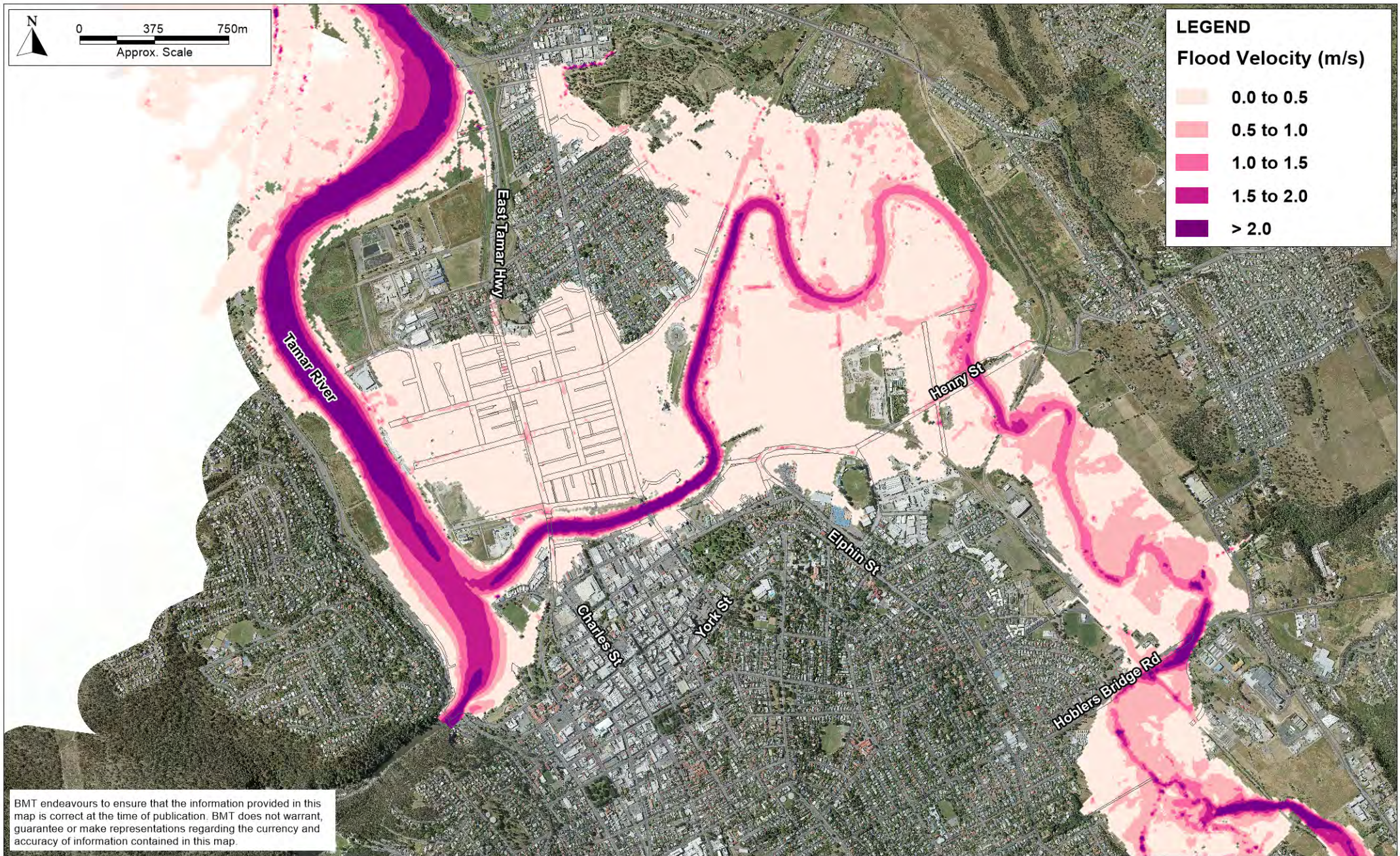




**Figure C-10 No Levee Scenario Mapping  
1% AEP Event Flood Depth**



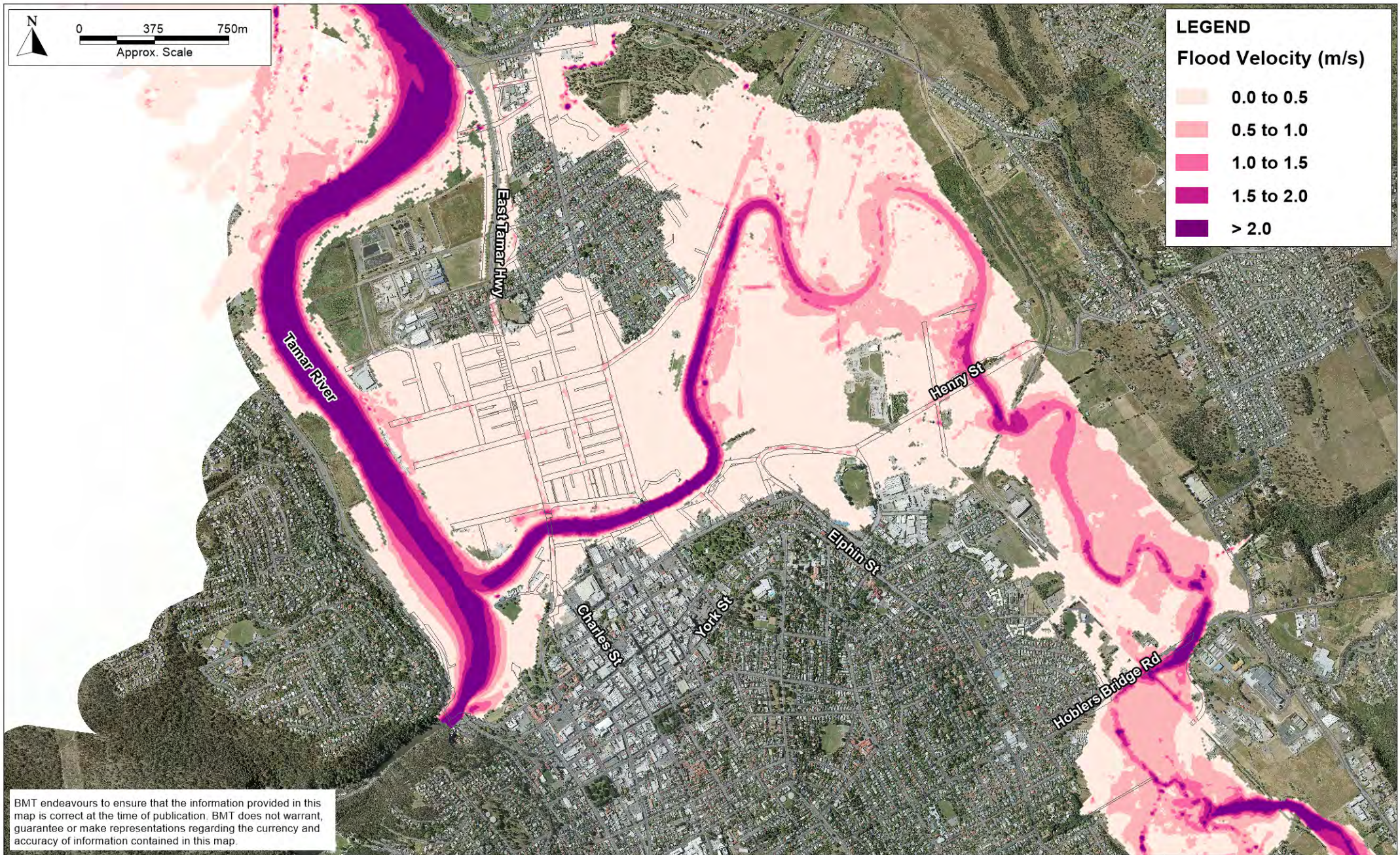




**Figure C-12 No Levee Scenario Mapping  
 10% AEP Event Flood Velocity**



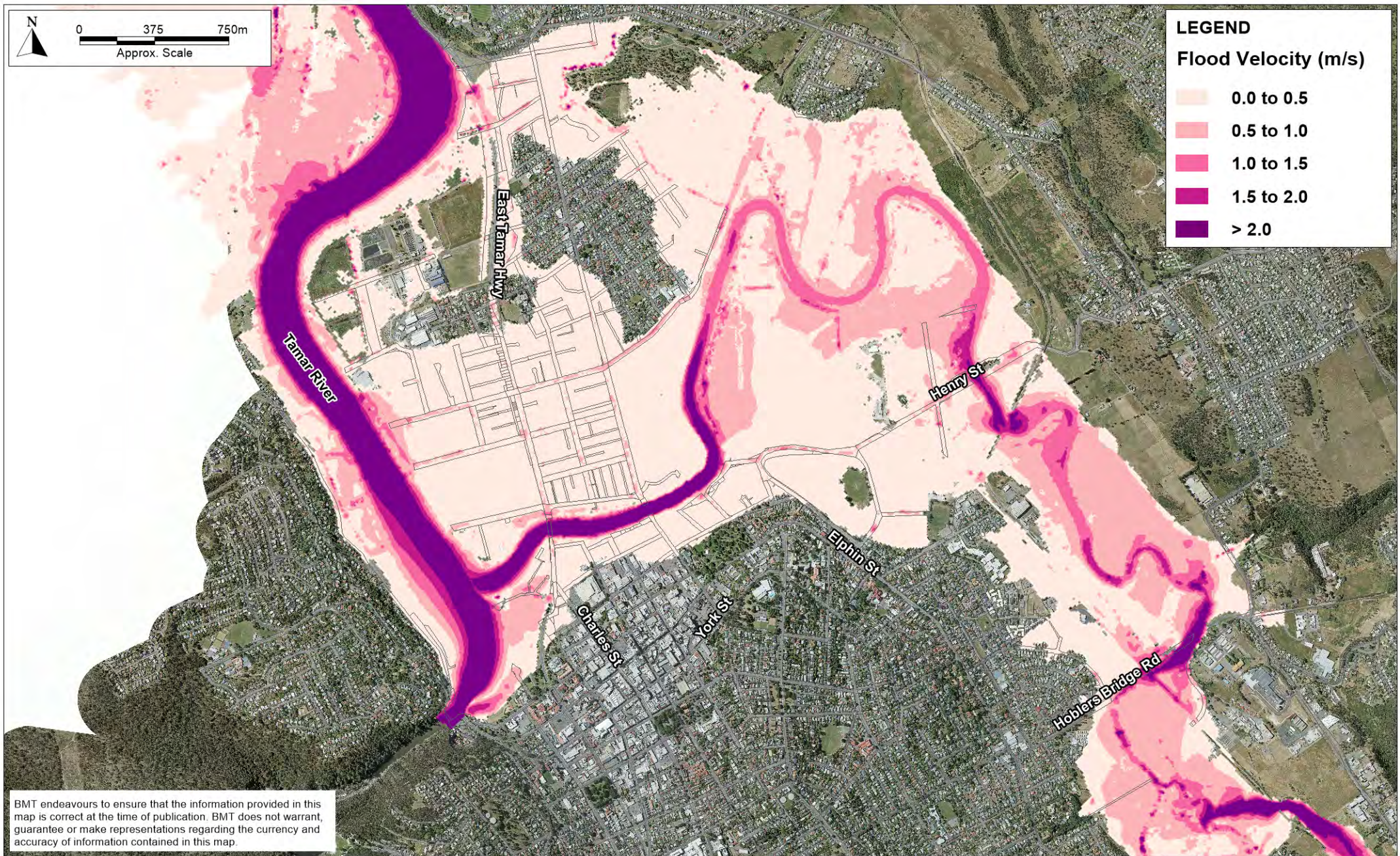




**Figure C-13 No Levee Scenario Mapping  
5% AEP Event Flood Velocity**



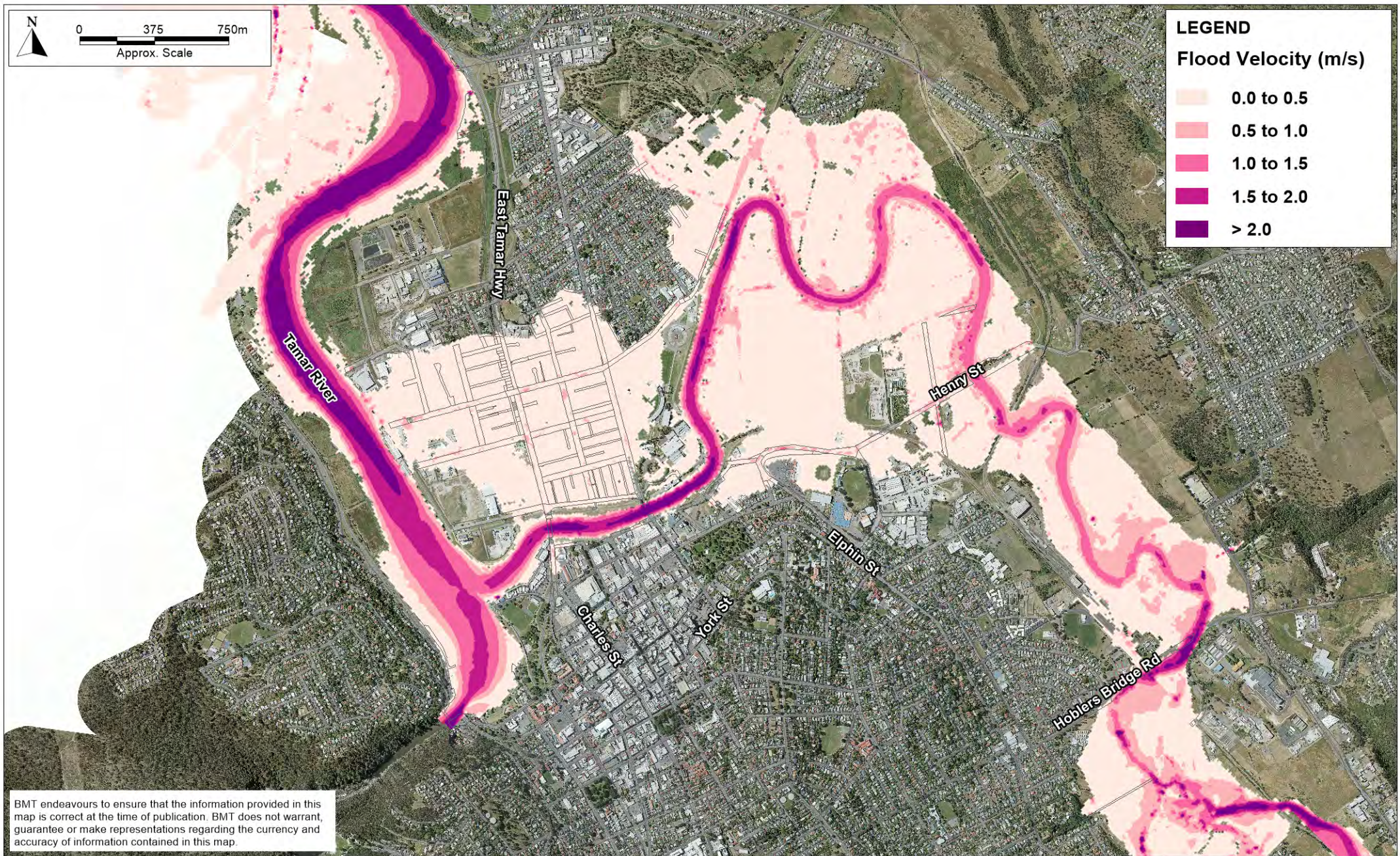




**Figure C-14 No Levee Scenario Mapping  
2% AEP Event Flood Velocity**



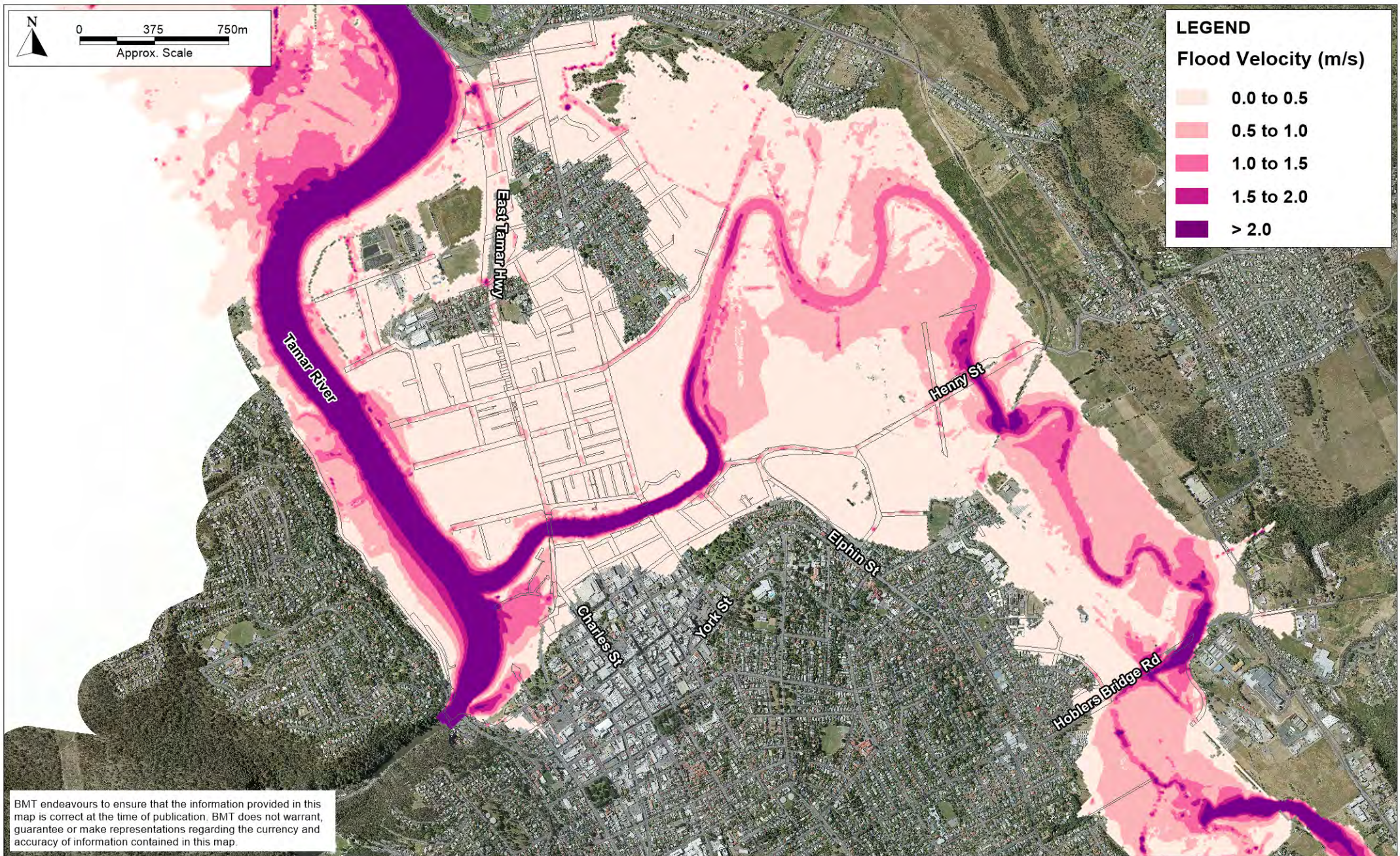




**Figure C-11 No Levee Scenario Mapping  
20% AEP Event Flood Velocity**



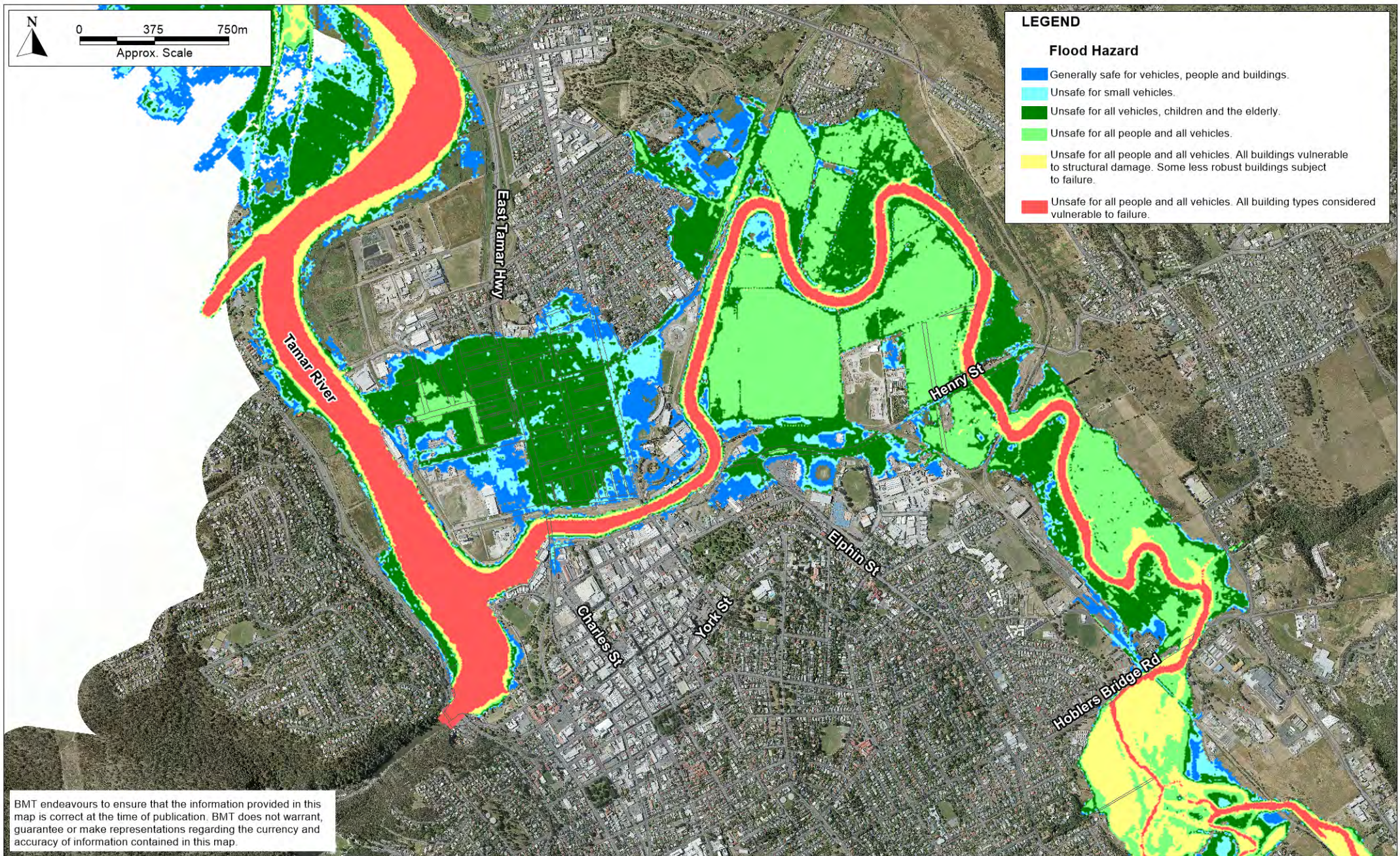




**Figure C-15 No Levee Scenario Mapping  
 1% AEP Event Flood Velocity**



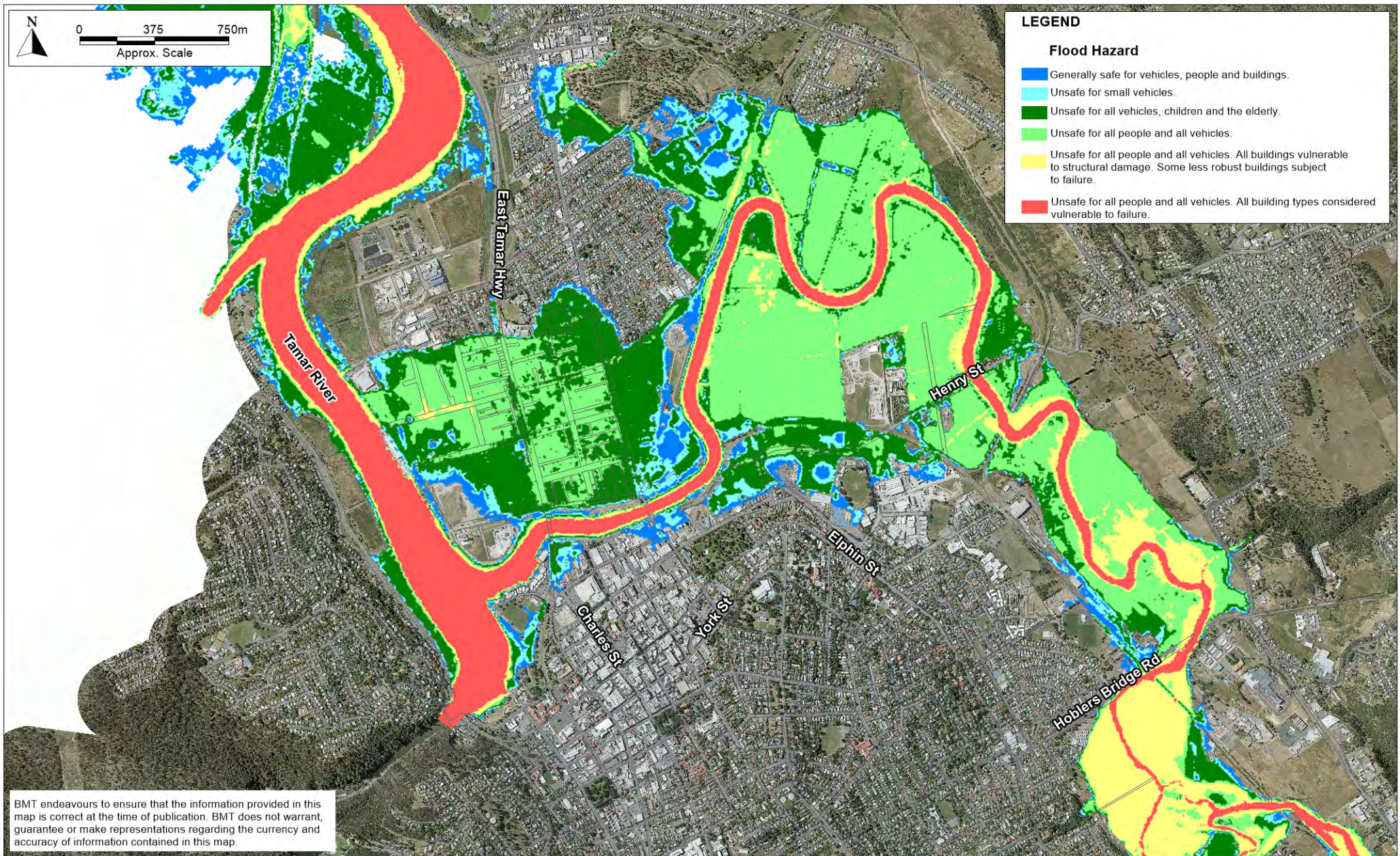




**Figure C-16 No Levee Scenario Mapping  
20% AEP Event Flood Hazard**



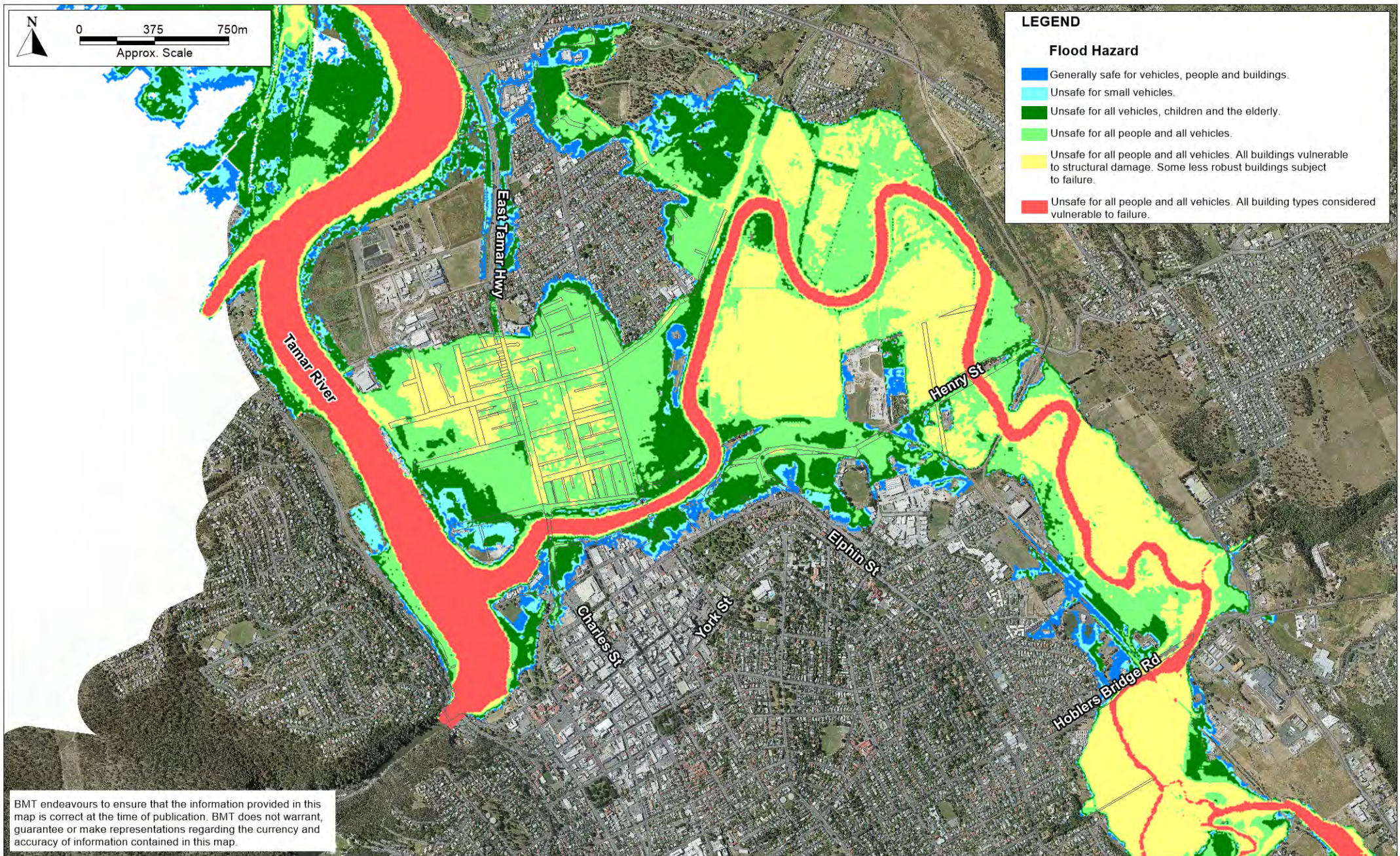




**Figure C-17 No Levee Scenario Mapping  
10% AEP Event Flood Hazard**



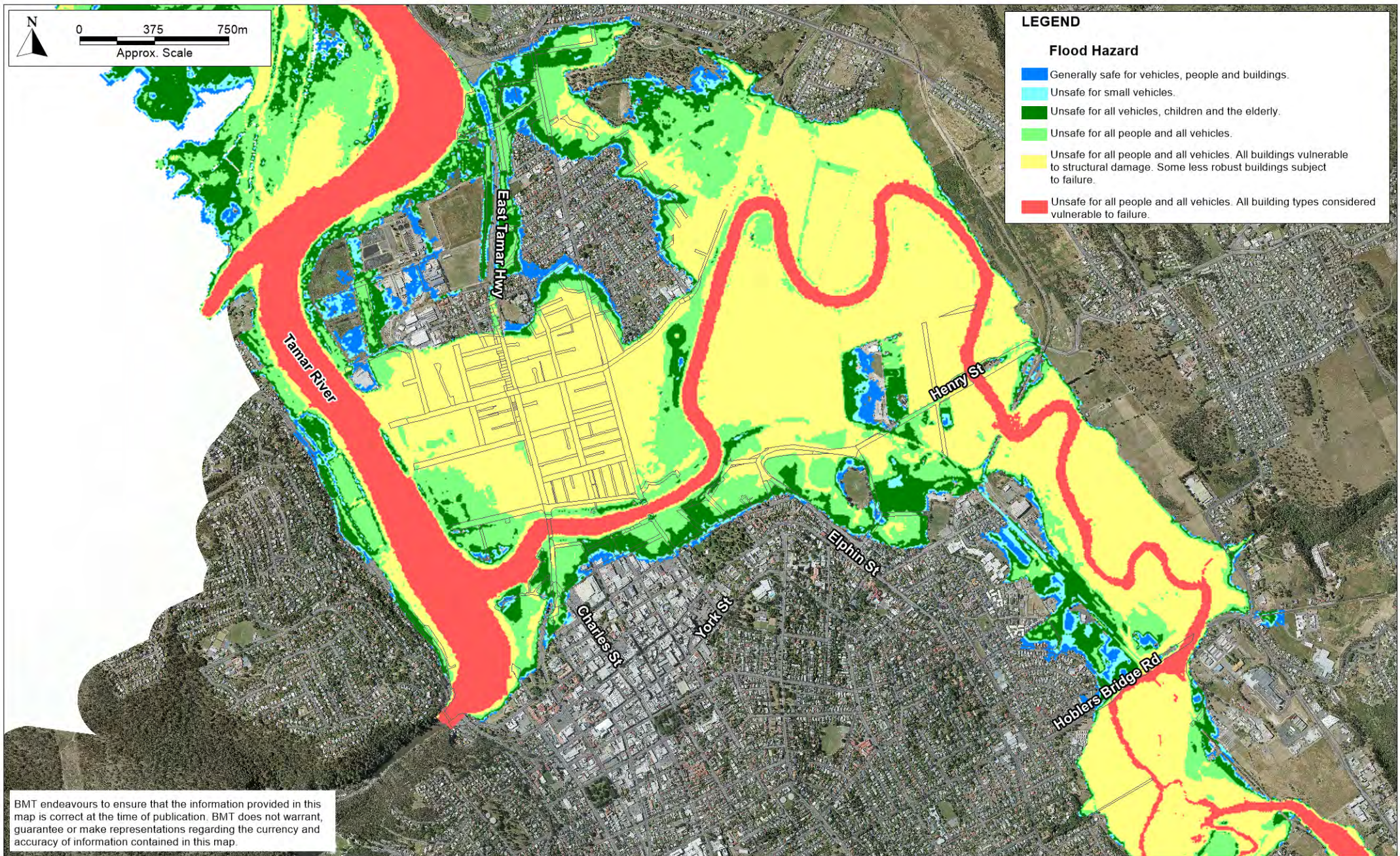




**Figure C-18 No Levee Scenario Mapping  
5% AEP Event Flood Hazard**



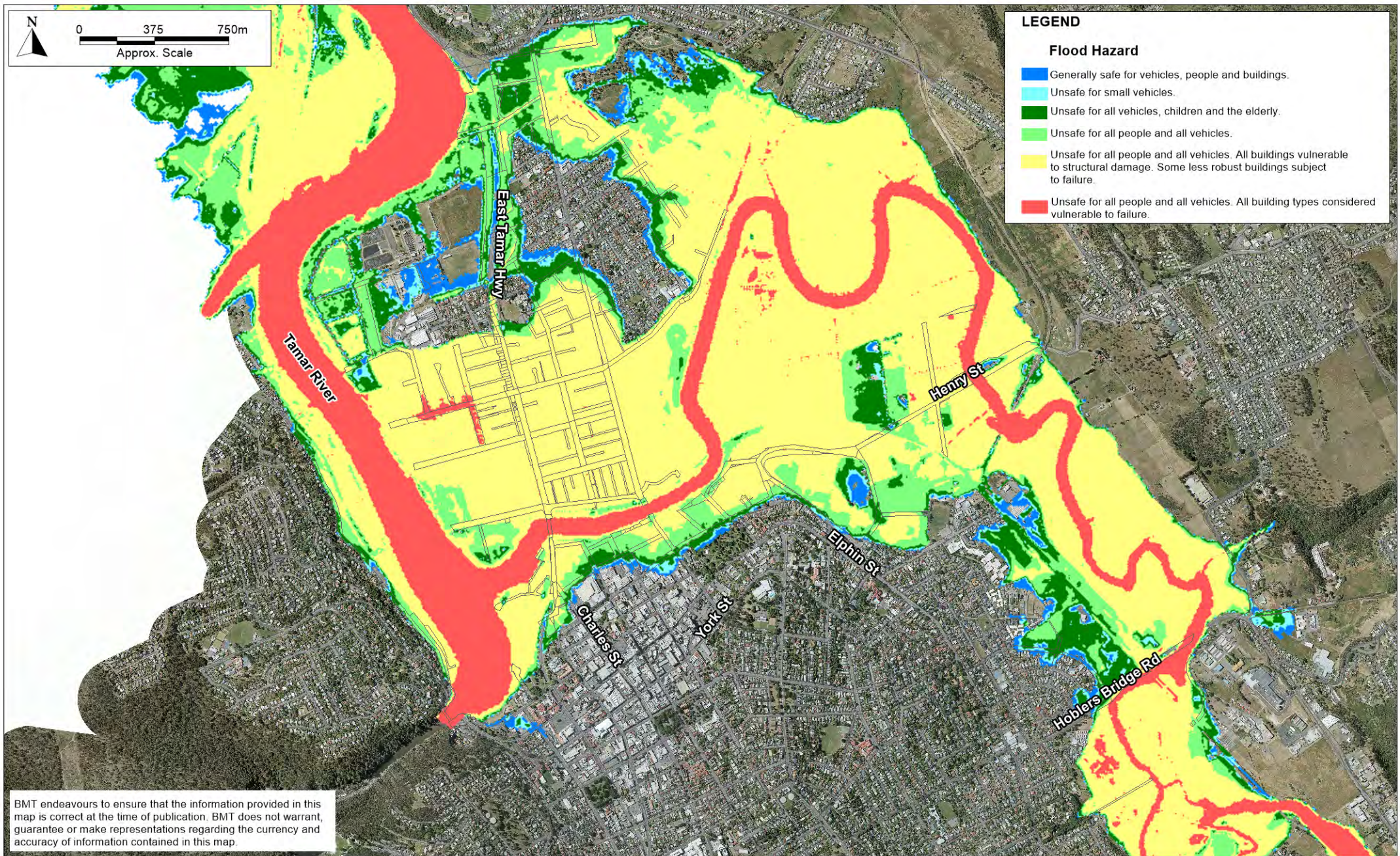




**Figure C-19 No Levee Scenario Mapping  
2% AEP Event Flood Hazard**







**Figure C-20 No Levee Scenario Mapping  
1% AEP Event Flood Hazard**







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