Throsby, Styx & Cottage Creek Flood Study

Draft

City of Newcastle

RR-05-1468-00

July 2023

Contact Information

Rhelm Pty Ltd
ABN : 55 616 964 517
61-63 Parry Street
Newcastle West NSW 2302
Australia

Lead Author:
Joel Fraleigh
contact@rhelm.com.au

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Foreword

The primary objective of the New South Wales (NSW) Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through the NSW Department of Planning and Environment (DPE) and the NSW State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding, flood risk management, flood emergency management and land-use planning matters.

The *Flood Risk Management Manual, the policy and manual for the management of flood liable land* (DPE, 2023) (the **Manual**) is provided to assist councils to meet their obligations through the preparation and implementation of floodplain risk management plans, through a staged process. **Figure F1**, taken from this manual, documents the process for plan preparation, implementation and review.

The Manual is consistent with Australian Emergency Management Handbook 7: *Managing the floodplain: best practice in flood risk management in Australia* (AEM Handbook 7) (AIDR 2017).

Figure F1. The Floodplain Risk Management Process (DPE, 2023)

The City of Newcastle has committed to prepare a comprehensive flood study for the study area in accordance with the Manual (DPE, 2023). This document relates to the data collection and flood study phase of the process.

Executive Summary

Study Overview and Purpose

The Throsby, Styx and Cottage Creek Flood Study (the **Flood Study**) has been prepared for the City of Newcastle in accordance with the New South Wales (NSW) Flood Prone Land Policy and the principles of the *Flood Risk Management Manual, the policy and manual for the management of flood liable land* (Department of Planning and Environment, 2023) (the **Manual**).

Multiple flood investigations have already been undertaken within the study area; some were only localised studies looking at individual developments. The previous flood study covering this study area was completed in 2008 (BMT WBM, 2008a).

This Flood Study seeks to revise and update the 2008 flood study. It improves upon the understanding of flood behaviour and associated impacts of flooding on the community. The study will inform the ongoing management of flood risk in the study area.

This revised flood study utilises the most recent methodologies outlined in *Australian Rainfall and Runoff 2019* (ARR2019) (Ball et al, 2019), using more contemporary modelling techniques and technologies, and incorporates additional rainfall and flooding data gathered after the completion of the 2008 flood study.

Study Area and Scope

The study area covers the catchments of Styx Creek, Throsby Creek, Cottage Creek and the Newcastle central business district (CBD) with a focus on understanding the flood behaviour and flood risk in these catchments. The study area is shown in **Map G101** (provided in Appendix A of this study and replicated within this executive summary).

The study is a comprehensive technical investigation of flood behaviour that provides the foundation for the development of robust guidance for management of flood risk within the context of a floodplain risk management study and plan. It aims to provide a better understanding of the full range of flood behaviour and consequences. It involves consideration of the local flood history, available flood data, and the development of hydrologic and hydraulic models that are calibrated and verified against historic flood events and extended, where appropriate, to determine the full range of flood behaviour.

Consultation

Comprehensive community engagement was undertaken at key points in the study. This involved:

- A public survey in April 2021 requesting information on the community's experiences of and attitudes towards flooding.
- Collation of public and stakeholder data gathered from previous flood related studies, including a collection of flood observations from the June 2007 "Pasha Bulker" flood event.

The results of the community consultation and flood data collection have been important in assisting with the flood model calibration.

Public exhibition of this draft document will be undertaken to obtain feedback from the community and other stakeholders. The community members which participated in the 2021 public survey and registered their contact details, have been invited directly (via email) to provide feedback on this Draft Flood Study during public exhibition.

Flood Model Development and Calibration

The flood model established as part of the *Throsby, Cottage and CBD Flood Study* (BMT WBM, 2008a) was provided by the City of Newcastle as a base for establishing an updated flood model.

This flood model was updated with the following key datasets:

- Light Detection and Ranging (LiDAR) collected in 2014 and 2021. These data contain both ground elevations in the form of a digital elevation model (DEM) and point cloud data which categorises data based on ground cover (vegetation, roofs, paved surfaces, etc.).
- Ground survey of Waterdragon Creek.
- Updated intensity-frequency-duration (IFD) rainfall data and losses from the Australian Rainfall and Runoff (ARR) data hub (http://data.arr-software.org/).
- Updated stormwater pit and pipe survey information collected in 2020.
- Revised oceanic boundary conditions for coincidence of ocean and catchment flooding based on guidance from the Department of Planning and Environment (DPE).

The hydrologic model was established using the Watershed Bounded Network Model (WBNM) software package, while the two-dimensional (2D) hydraulic modelling package utilised was the TUFLOW software.

The updated flood model was also used to estimate historic flood behaviour using data sourced from local rainfall and water level gauges as well as community observations of flooding (surveyed and estimated). The following flood events were considered when calibrating and validating the flood model:

- Model calibration event: June 2007
- Model validation events: February 1990 and April 1988.

Results of from the June 2007 calibration event showed that the flood model could reproduce observed flood levels within 0.3 m for almost 90% of more than 1,000 data points. **Map G203** (provided in Appendix A of this study and also replicated within this executive summary) illustrates the flood depths modelled for the June 2007 event.

Design Flood Modelling Results

The hydrological and 2D hydraulic models were used to analyse a range of design events, including the Probable Maximum Flood (PMF), 1% annual exceedance probability (AEP), 2% AEP, 5% AEP and 10% AEP events. Storm durations were considered ranging from 10 minutes to 24 hours, using the 10 temporal pattern ensemble approach detailed in ARR2019.

Two climate change scenarios were also modelled considering future increases in rainfall intensity and sea level rise. The 1% AEP event in 2050 was estimated by modelling the 0.5% AEP event with a sea level rise of 0.4 m and the 1% AEP event in 2100 as estimated by modelling the 0.2% AEP event with a sea level rise of 0.9 m.

The City of Newcastle has proposed to adopt the 1% AEP event in 2050 as the Defined Flood Event for flood planning purposes, where development is subject to catchment flash flooding.

The design flood depths and flood levels for the 1% AEP in 2050 and the PMF events, respectively are shown in **Maps G320 and G308** (provided in Appendix A of this study and replicated within this executive summary). In general, flooding in the study area is driven by catchment-generated runoff in the higher elevation areas while oceanic conditions dictate flooding near the foreshore areas; however, there is a significant degree of interaction between these two sources of flooding in the low-lying portions of the study area and along portions of Throsby, Styx and Cottage Creeks.

Blockage of hydraulic structures (i.e. culverts and bridges) was considered in the design event flood modelling. A risk-based approach, using guidance from ARR2019, was adopted to apply a blockage factor based on the likelihood of debris being generated from the catchment draining to each structure and the ability of the watercourse to carry that debris to the structure. Adopted blockage rates increase with the magnitude of the flood event.

Flood Model Sensitivity

A number of assumptions are made when establishing flood models that influence the quantity and timing of flow generated from rainfall, and the resulting flood behaviour. The calibration and validation modelling assists in the selection of suitable modelling parameters. However, sensitivity testing of the models is also undertaken to better understand the confidence in the results.

The established flood model was tested for the sensitivity of results to multiple input parameters including catchment storage and lag, hydrologic model inflows, rainfall losses, hydraulic structure blockage, bridge and culvert losses, and surface roughness. Each of these parameters were varied and the flood model run to test their effect on flood levels in the 1% AEP in 2050 event and/or the June 2007 calibration event.

Results of this sensitivity testing indicated that the flood model is most sensitive to blockage assumptions, with flood levels increasing more than +0.2 m over large sections of the lower lying portions of the study area when the ARR2019 risk-based blockage approach is changed to a blanket 90% blockage rate applied to all hydraulic structures. Conversely, flood levels dropped up to -0.2 m when a 0% blockage rate was applied to all hydraulic structures.

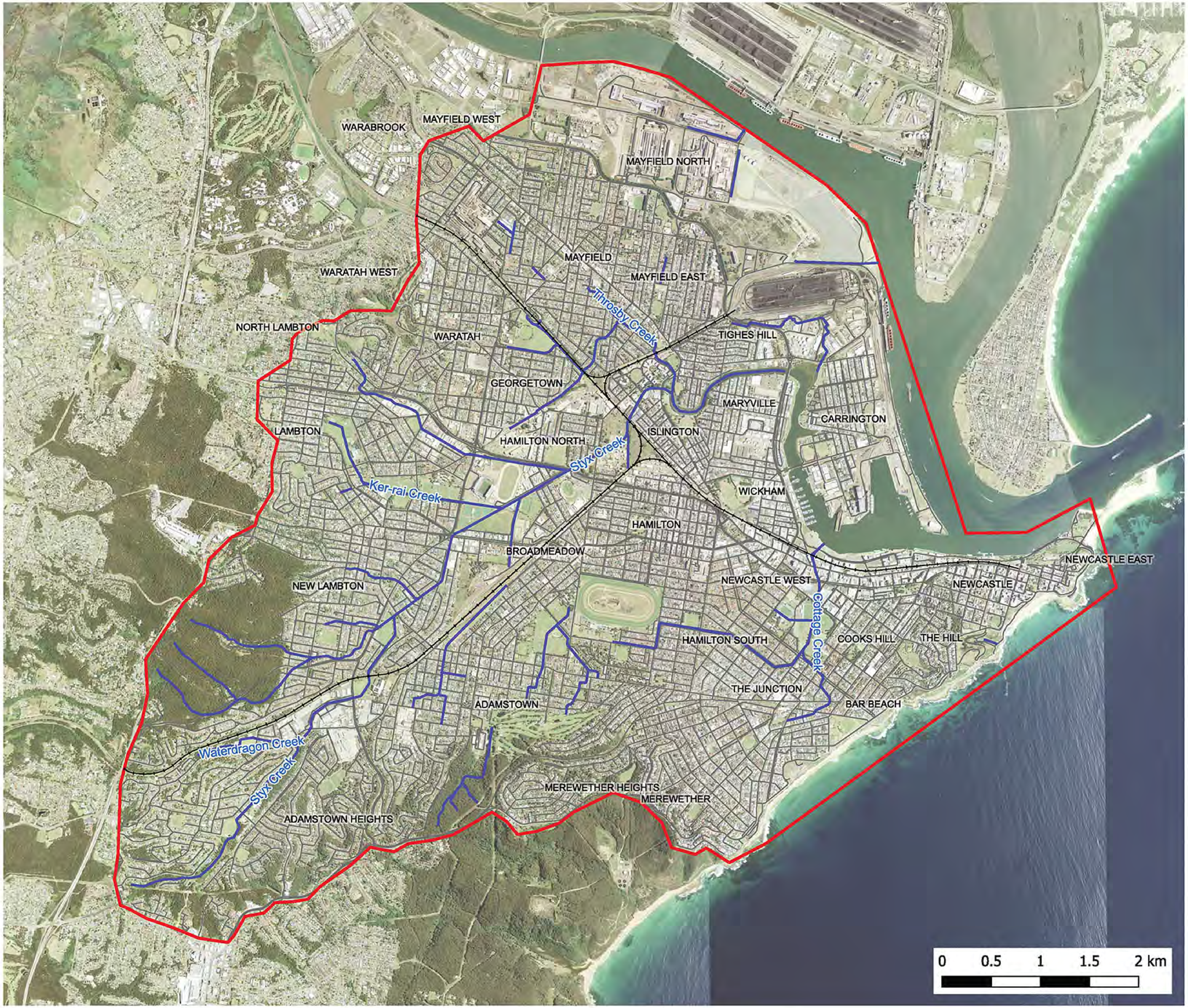
The flood model is also sensitive to the adopted surface roughness, for both the 2D ground surface portion of the model and the one-dimensional (1D) pipe and concrete channels. Flood levels varied from +0.2 m to -0.2 m, although this is largely limited to areas of higher velocity flows. Widespread changes to flood levels across the study area were generally limited to +/- 0.05 m.

The model was not particularly sensitive to the remaining parameters tested (i.e. less than a +/- 0.1 m impact).

The results of the sensitivity testing provides confidence that the model parameters selected accurately represent flood behaviour in the study area.

Conclusion

This flood study provides an understanding of the flood risk within the study area and provides the City of Newcastle with the tools for flood-related planning. This information and the flood models prepared for this flood study can be used to assess and recommend flood management strategies as part of a Floodplain Risk Management Study and Plan.



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Map G101

Throsby, Styx and Cotage Creek Flood Study

Study Area

Legend

- Study Area
- Rail Line
- Roads
- Watercourses (Creeks, Channels, and Drains)

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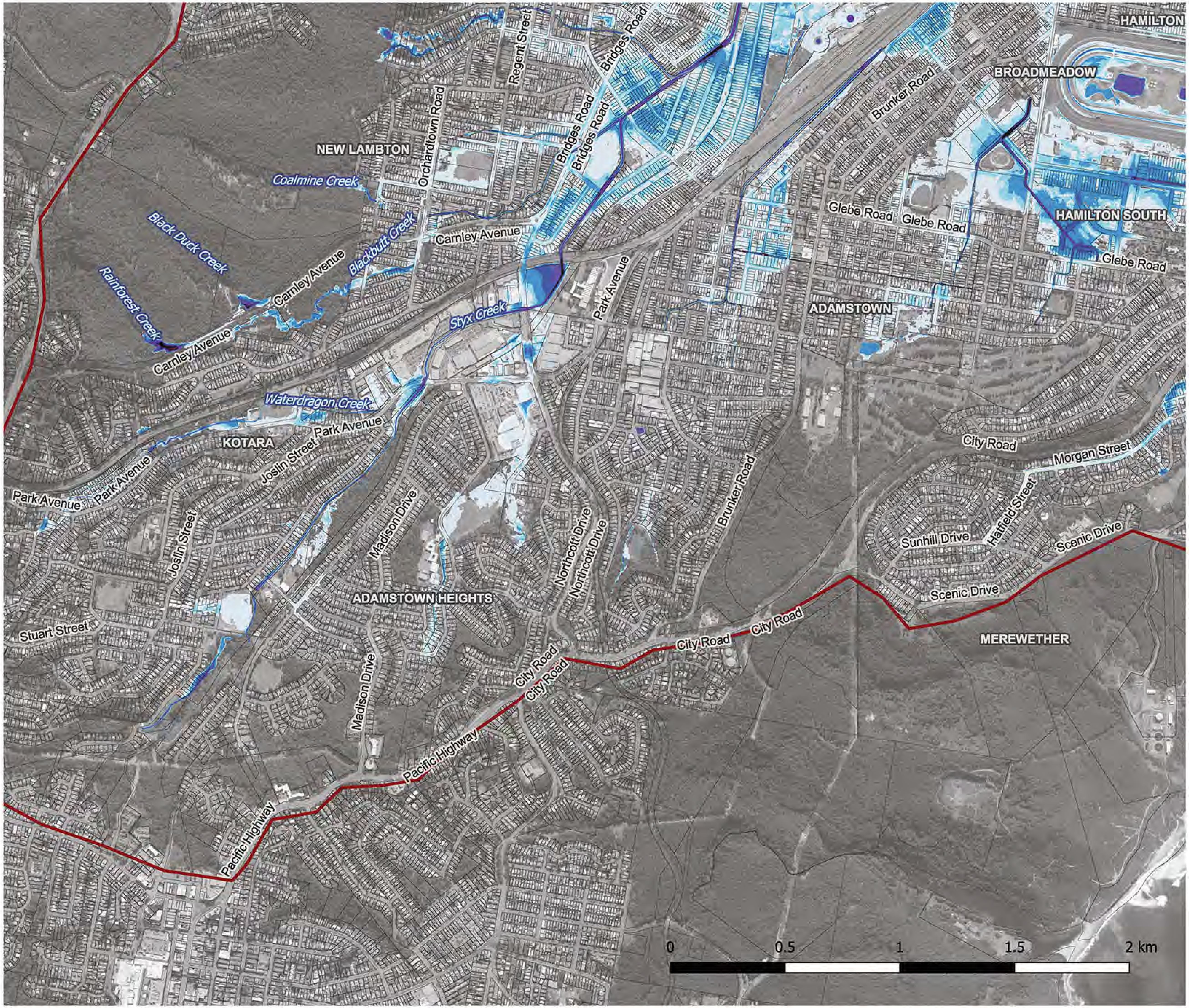

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Map G203a

Throsby, Styx and Cottage Creek Flood Study

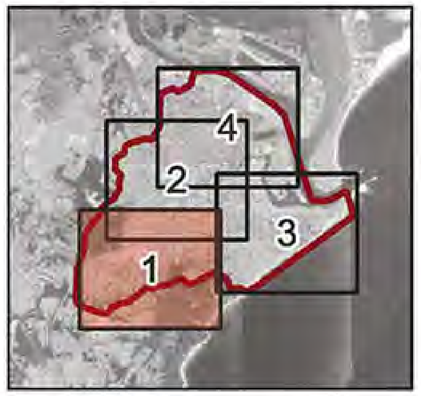
Modelled Flood Depth and Elevation
2007 Flood Event - Calibration
Map 1 of 4

Legend

- Study Area
- Cadastre

Peak Flood Depth (m)

- <= 0.01
- 0.01 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- > 4



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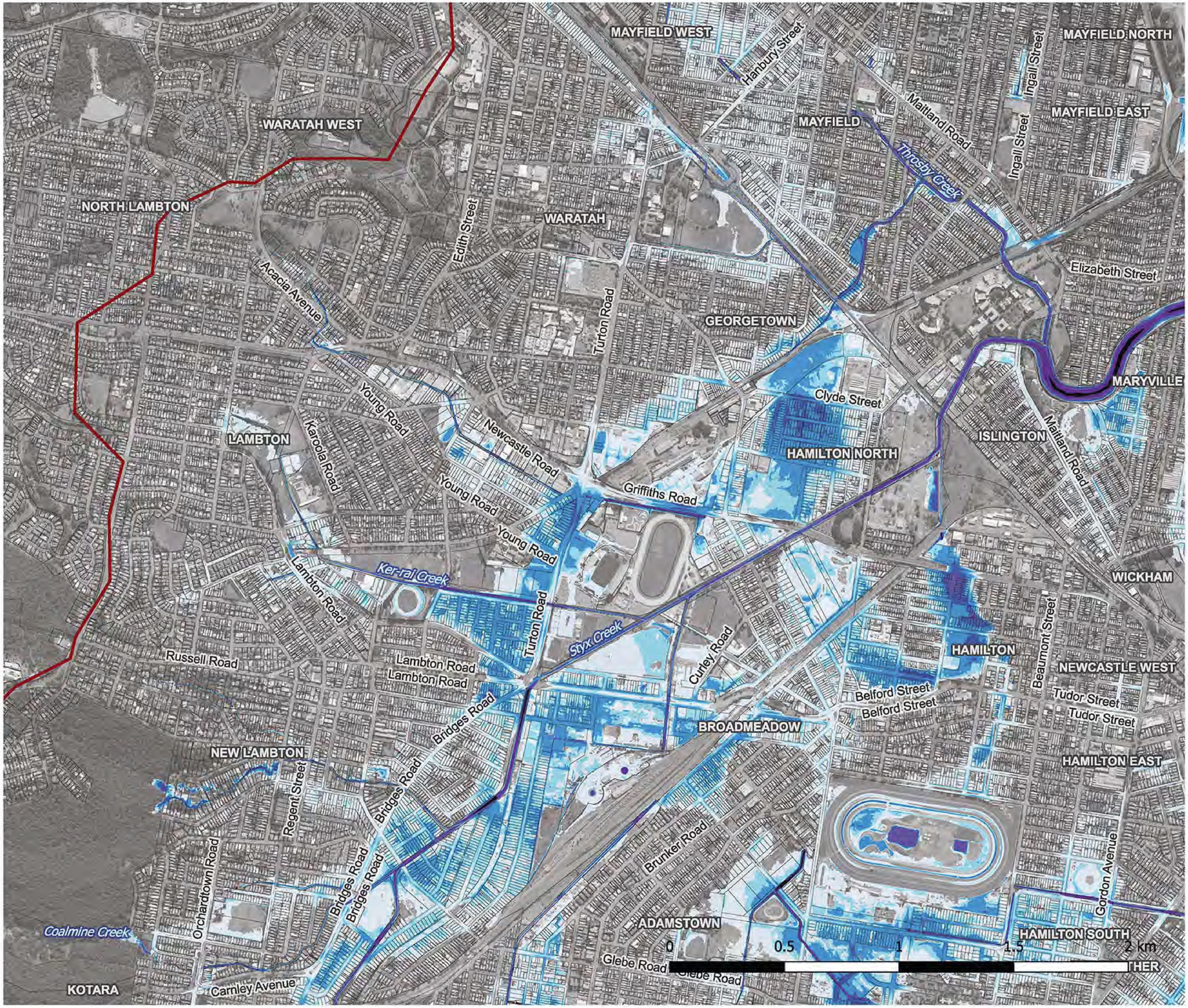

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Map G203b

Throsby, Styx and Cottage Creek Flood Study

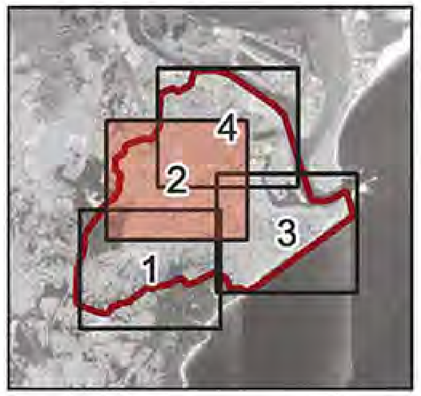
Modelled Flood Depth and Elevation
2007 Flood Event - Calibration
Map 2 of 4

Legend

- Study Area
- Cadastre

Peak Flood Depth (m)

- <= 0.01
- 0.01 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- > 4



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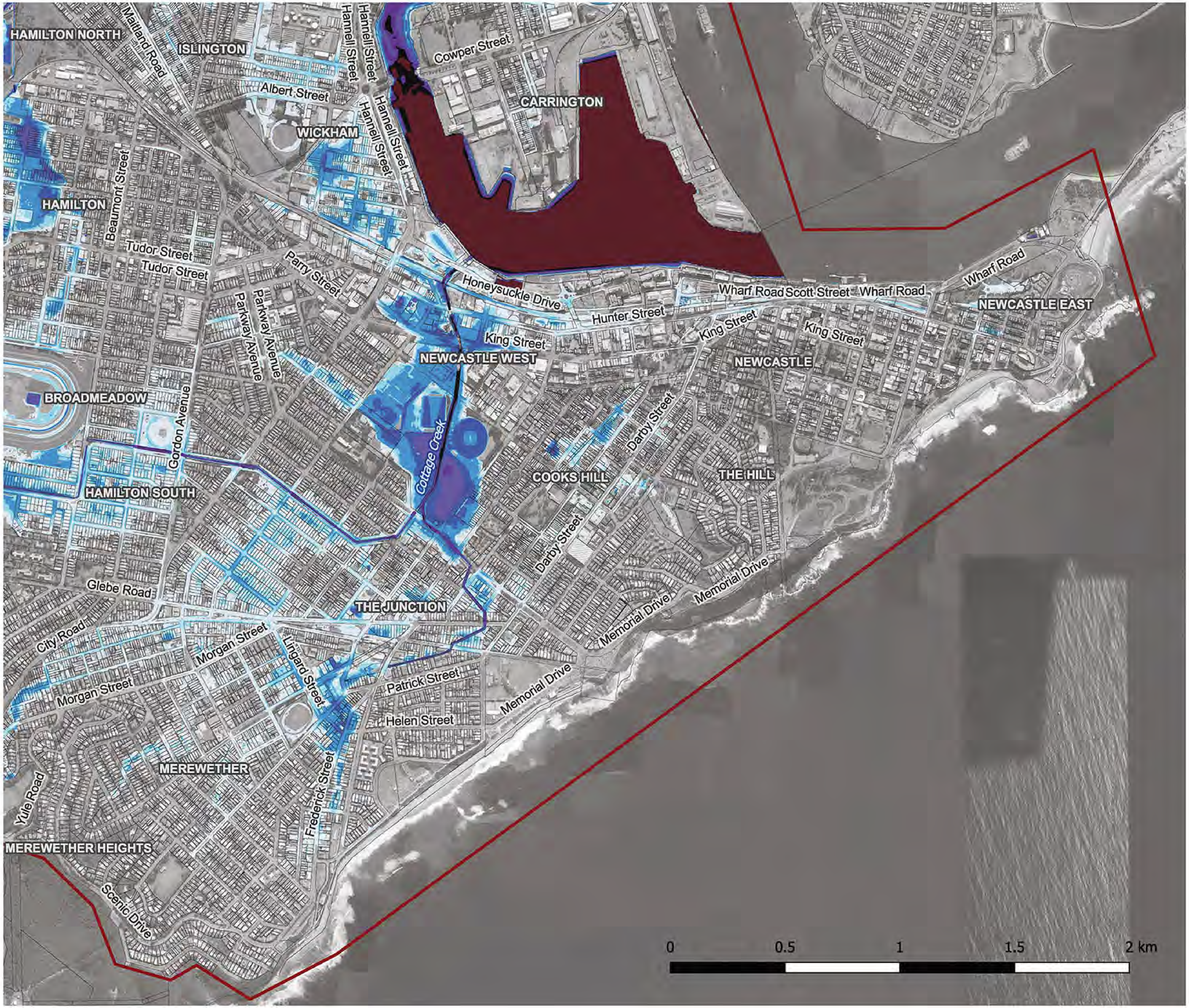

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Map G203c

Throsby, Styx and Cottage Creek Flood Study

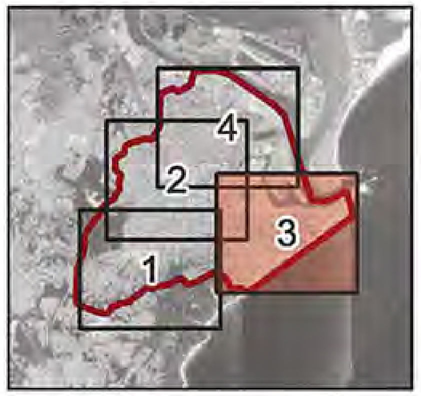
Modelled Flood Depth and Elevation
2007 Flood Event - Calibration
Map 3 of 4

Legend

Study Area
Cadastre

Peak Flood Depth (m)

- <= 0.01
- 0.01 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- > 4



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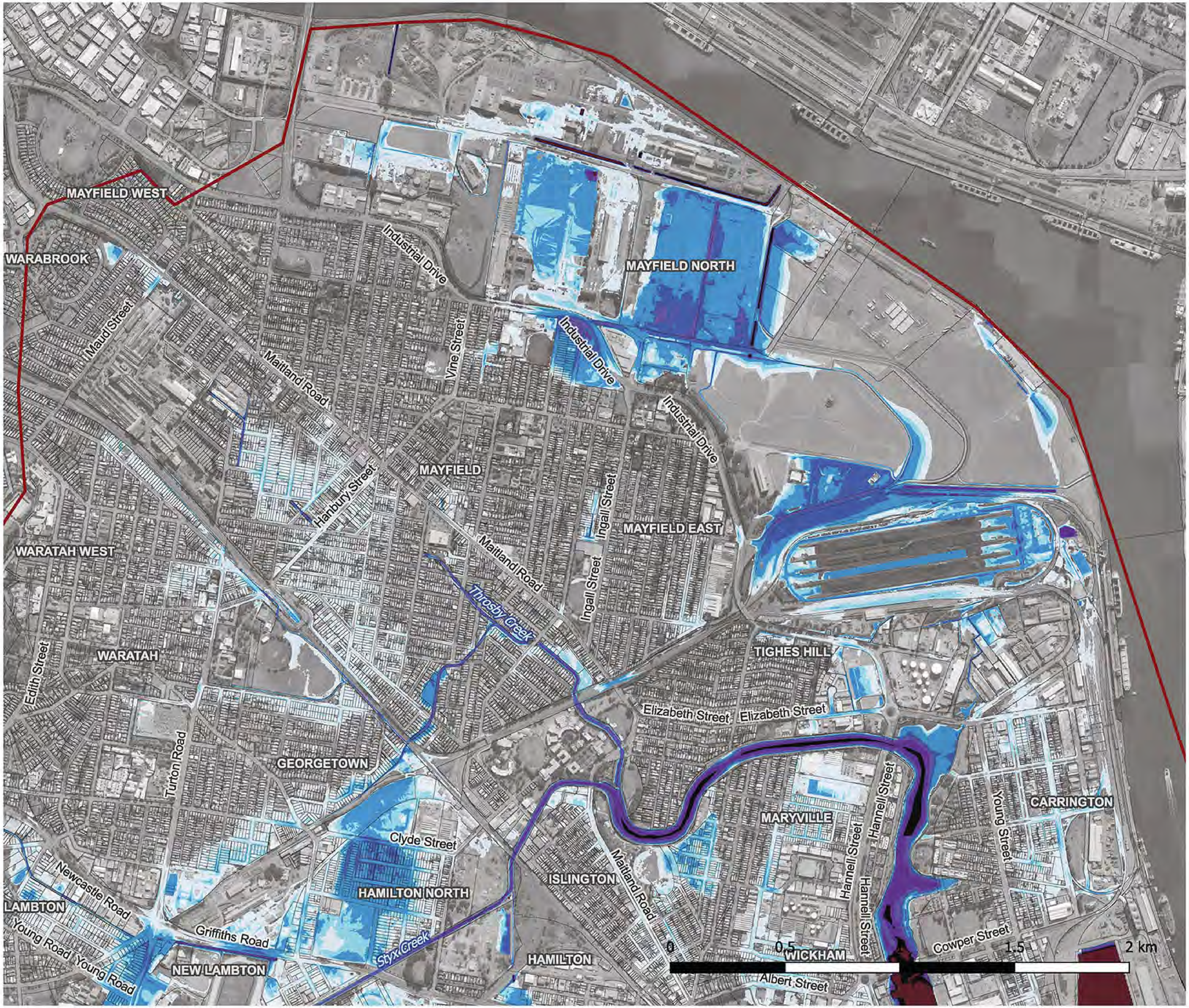

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Map G203d

Throsby, Styx and Cottage Creek Flood Study

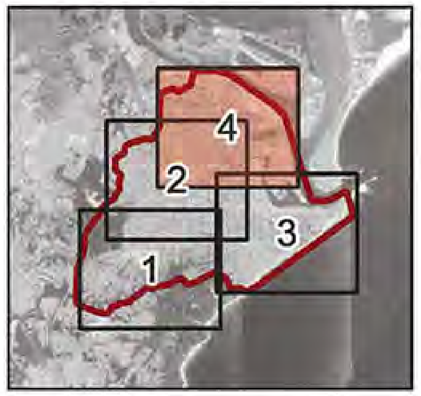
Modelled Flood Depth and Elevation
2007 Flood Event - Calibration
Map 4 of 4

Legend

- Study Area
- Cadastre

Peak Flood Depth (m)

- <= 0.01
- 0.01 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- > 4



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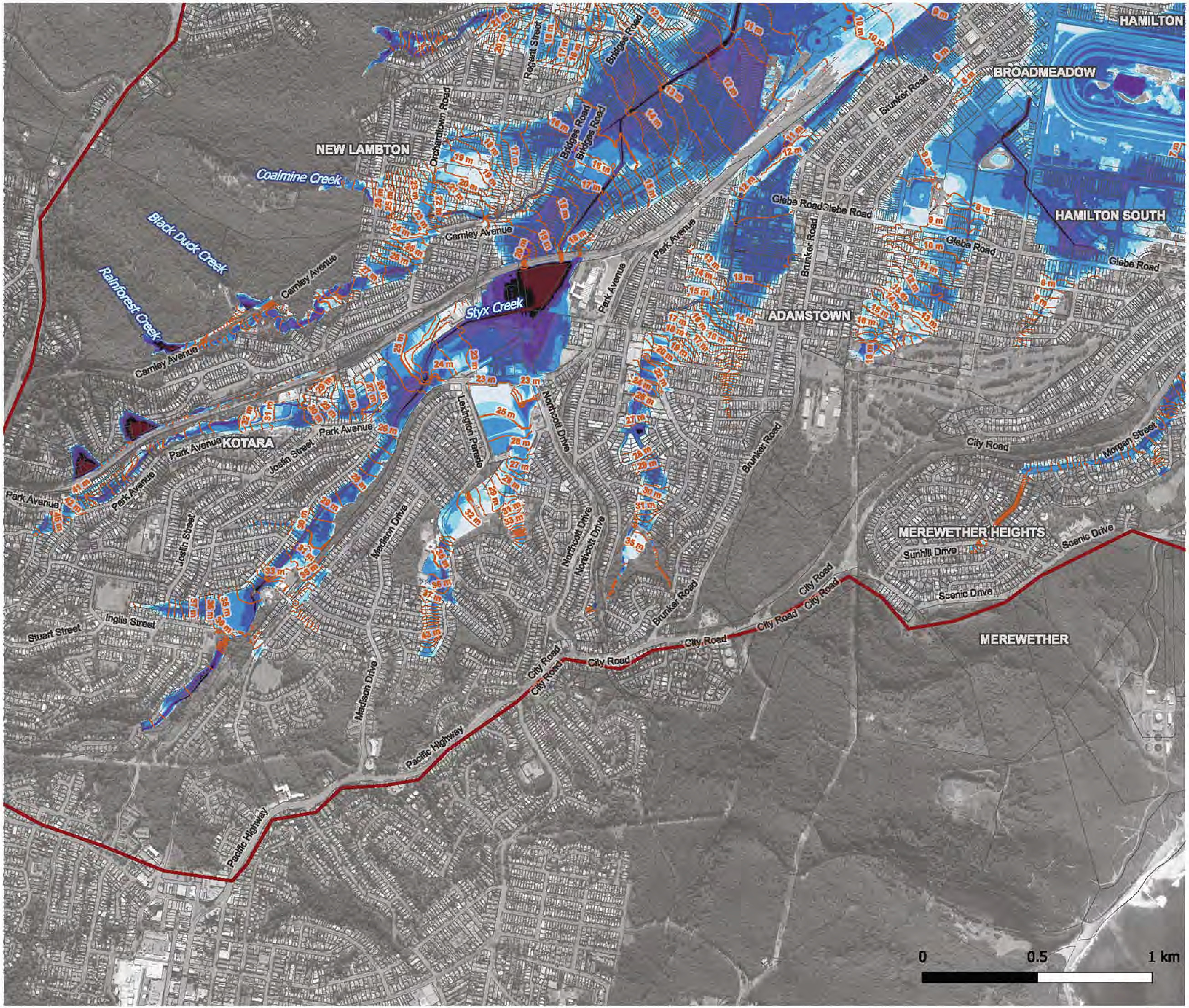

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Map G308a

Throsby, Styx and Cottage Creek Flood Study

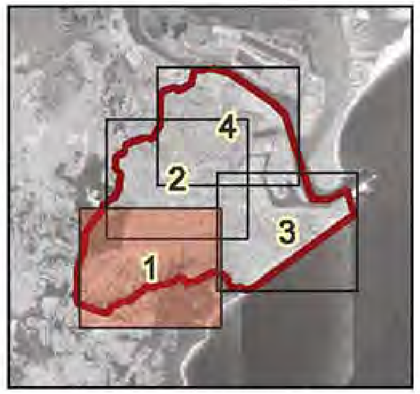
Peak Flood Depth and Elevation
PMF
Map 1 of 4

Legend

Study Area
Cadastre

Water Level Contours
5m
1m

Peak Flood Depth (m)
<= 0.01
0.01 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
> 4



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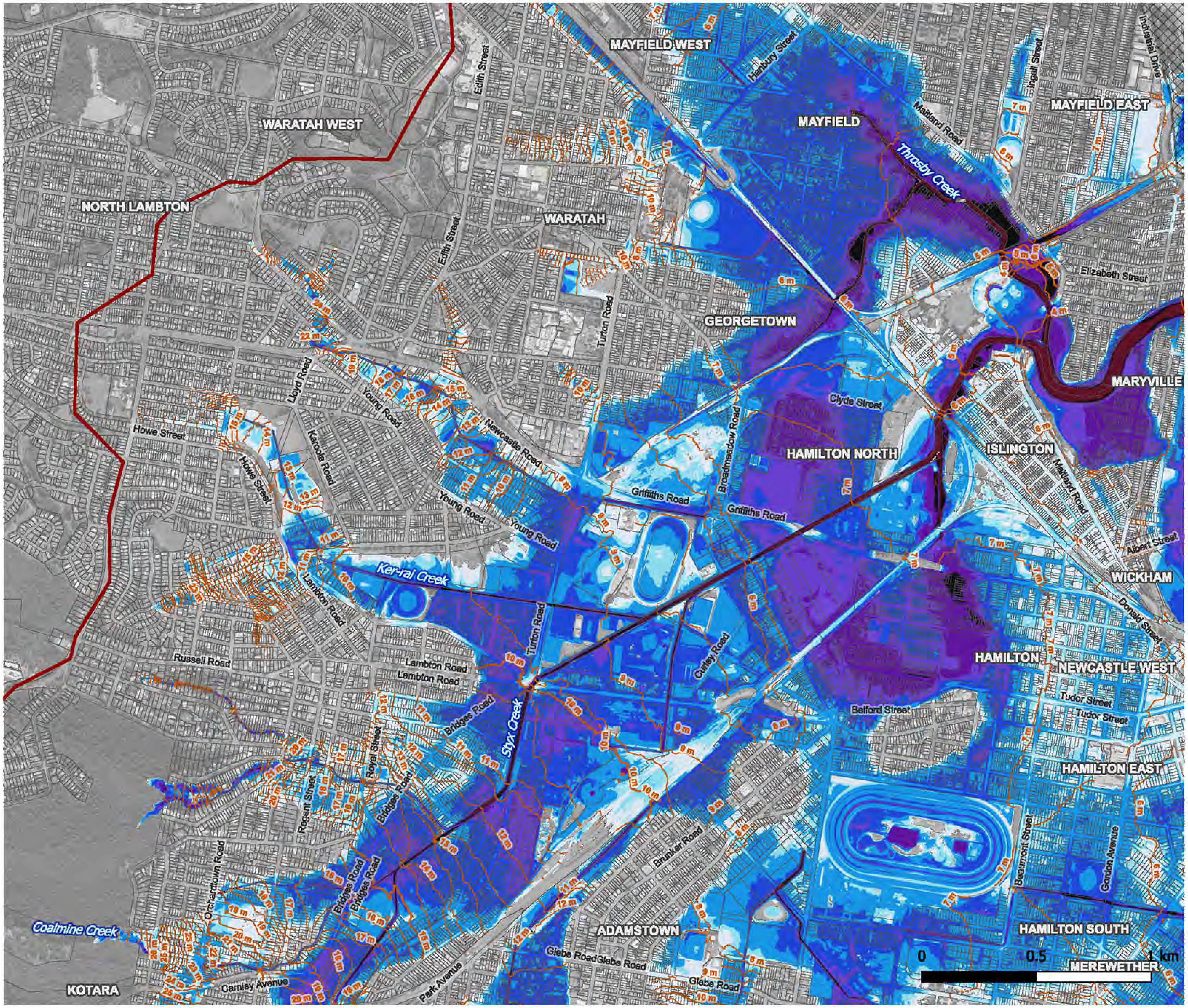

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Map G308b

Throsby, Styx and Cottage Creek Flood Study

Peak Flood Depth and Elevation PMF Map 2 of 4

Legend

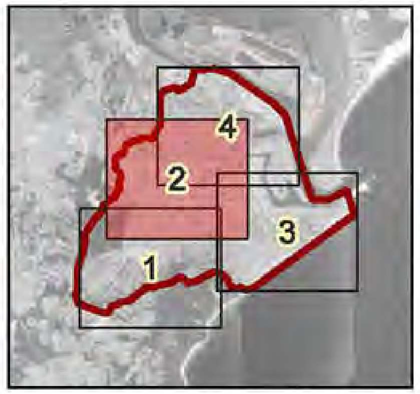
- Study Area
- Cadastre

Water Level Contours

- 5m
- 1m

Peak Flood Depth (m)

- <= 0.01
- 0.01 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- > 4



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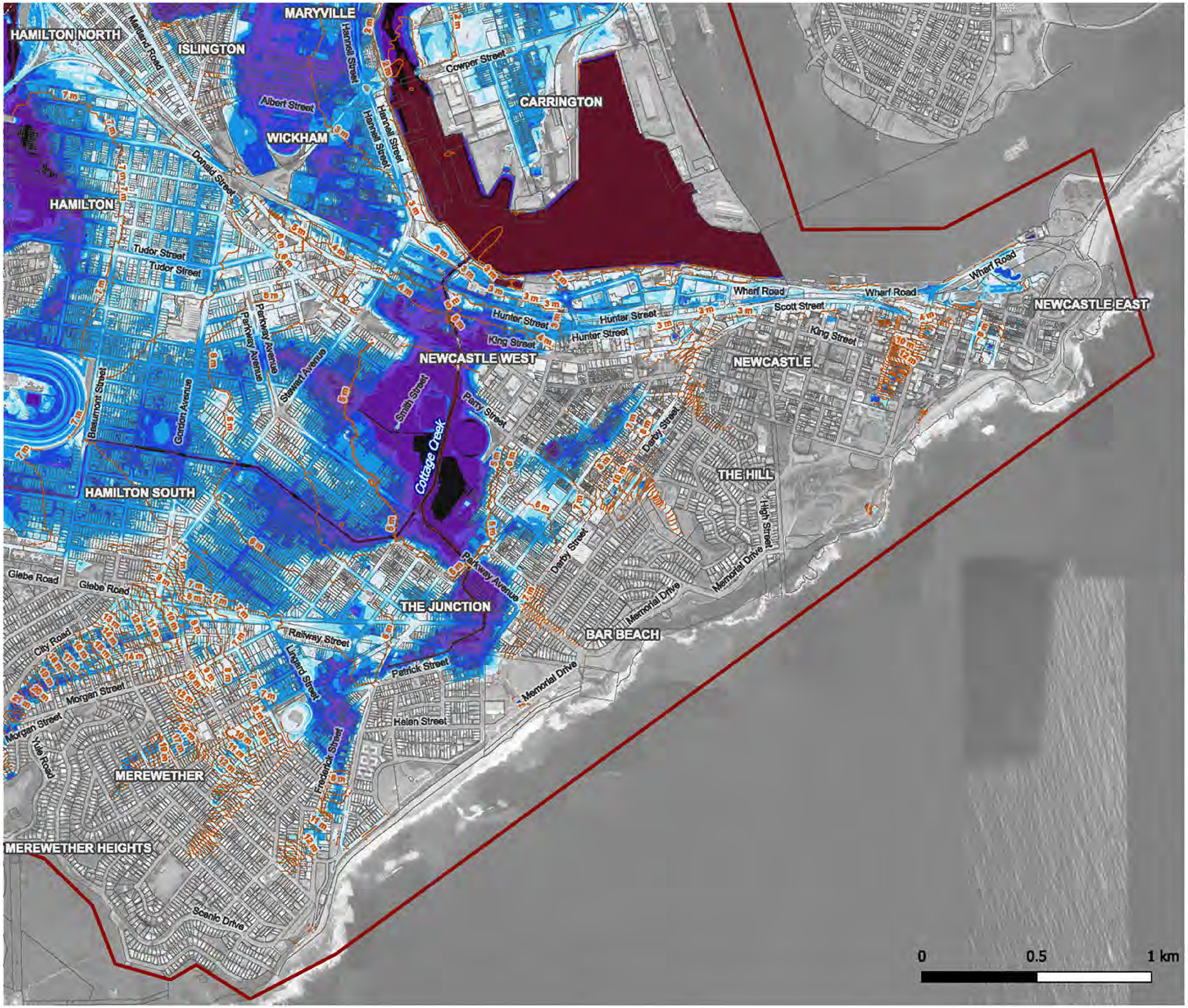

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Map G308c

Throsby, Styx and Cottage Creek Flood Study

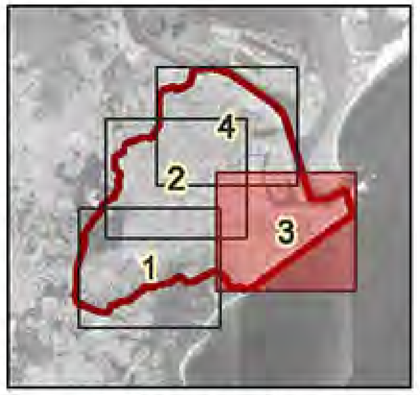
Peak Flood Depth and Elevation
PMF
Map 3 of 4

Legend

Study Area
Cadastre

Water Level Contours
5m
1m

Peak Flood Depth (m)
<= 0.01
0.01 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
> 4



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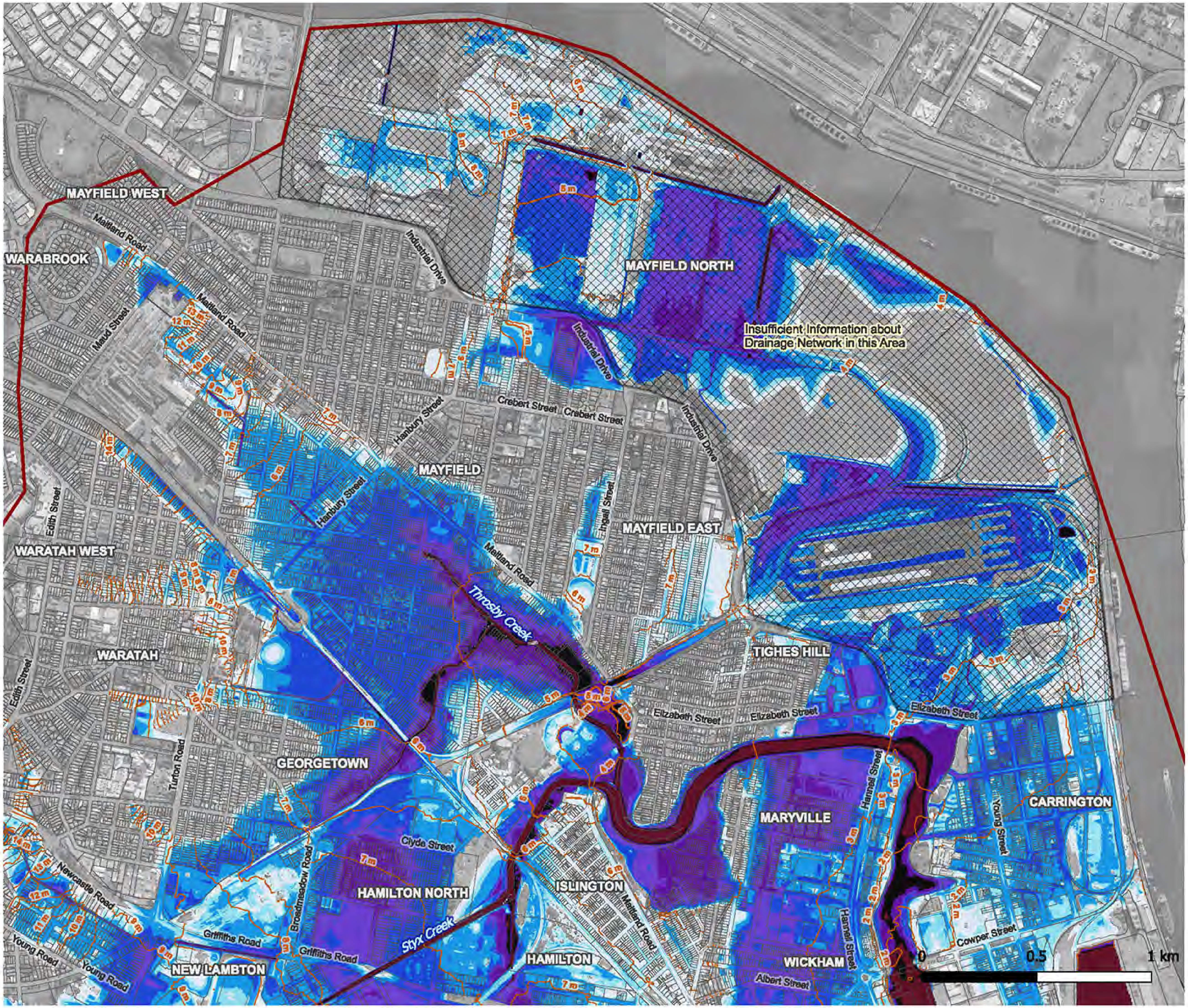

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Map G308d

Throsby, Styx and Cottage Creek Flood Study

Peak Flood Depth and Elevation
PMF
Map 4 of 4

Legend

Study Area
Cadastre

Water Level Contours
5m
1m

Peak Flood Depth (m)
<= 0.01
0.01 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
> 4

Scale : 1:15000@A3
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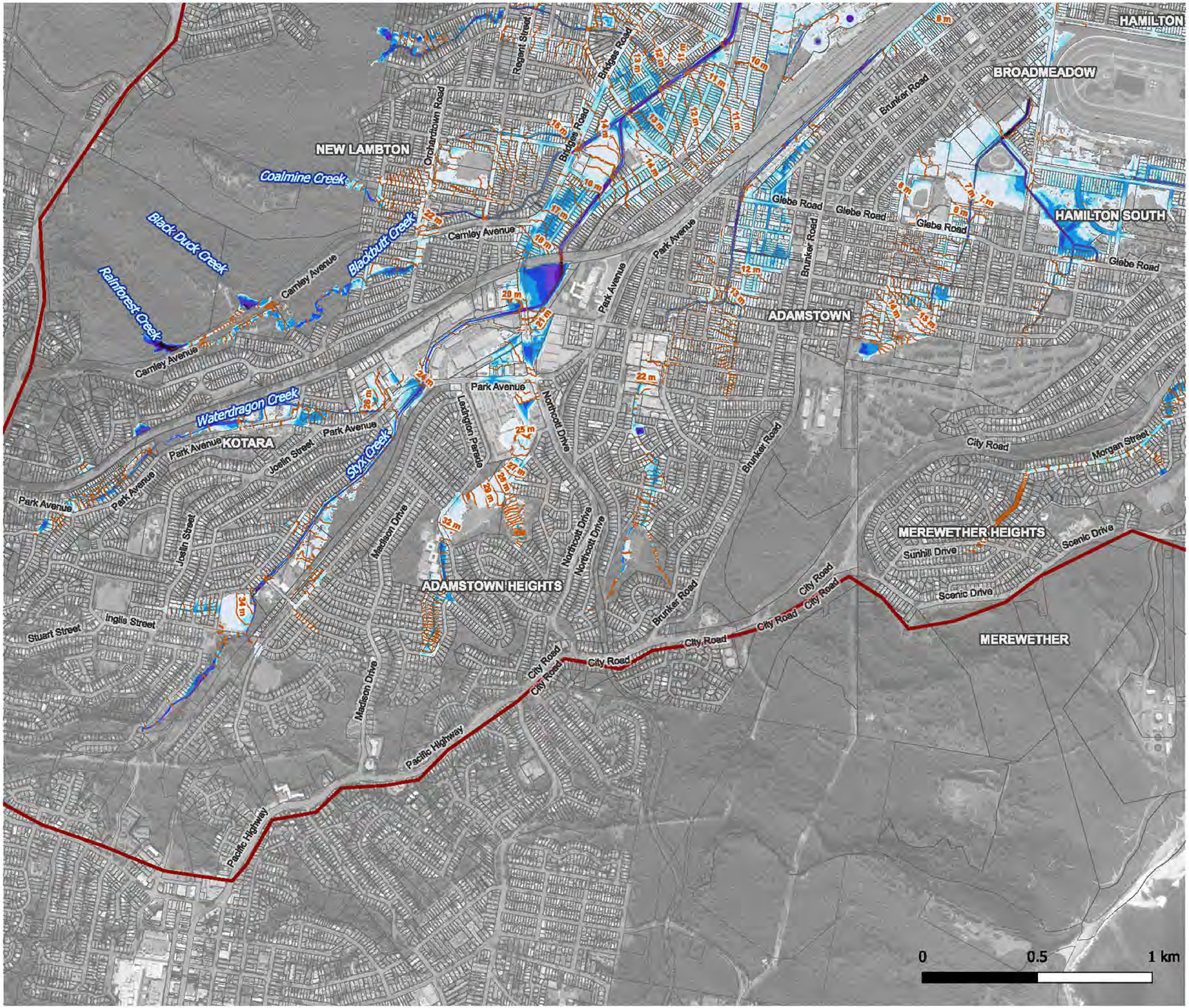

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Map G320a

Throsby, Styx and Cottage Creek Flood Study

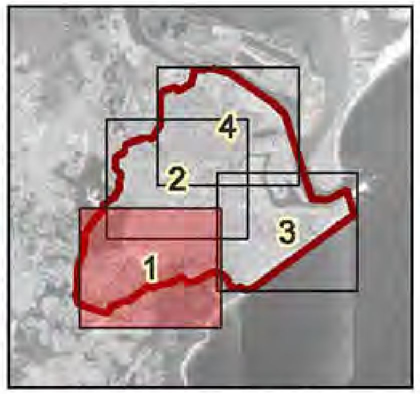
Peak Flood Depth and Elevation
1% AEP in 2050 (0.5% AEP, 0.4m SLR)
Map 1 of 4

Legend

Study Area
Cadastre

Water Level Contours
5m
1m

Peak Flood Depth (m)
<= 0.01
0.01 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
> 4



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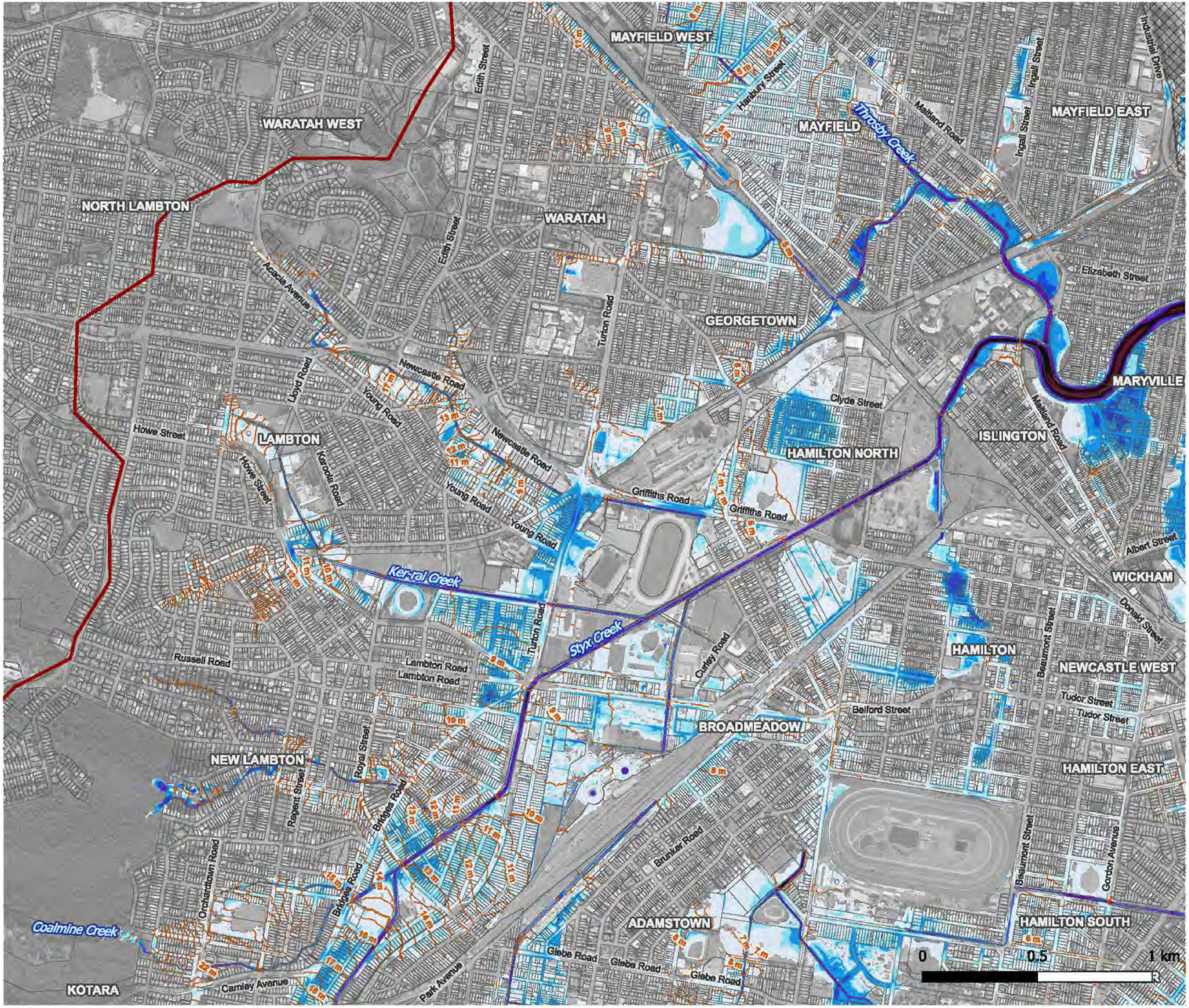

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Map G320b

Throsby, Styx and Cottage Creek Flood Study

Peak Flood Depth and Elevation
1% AEP in 2050 (0.5% AEP, 0.4m SLR)
Map 2 of 4

Legend

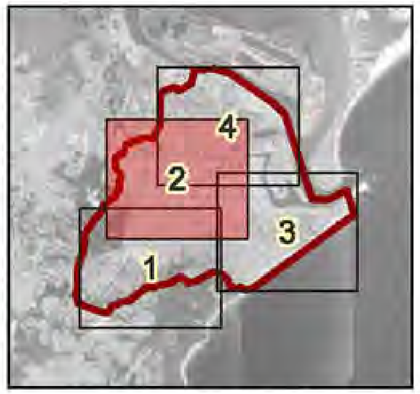
- Study Area
- Cadastre

Water Level Contours

- 5m
- 1m

Peak Flood Depth (m)

- <= 0.01
- 0.01 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- > 4



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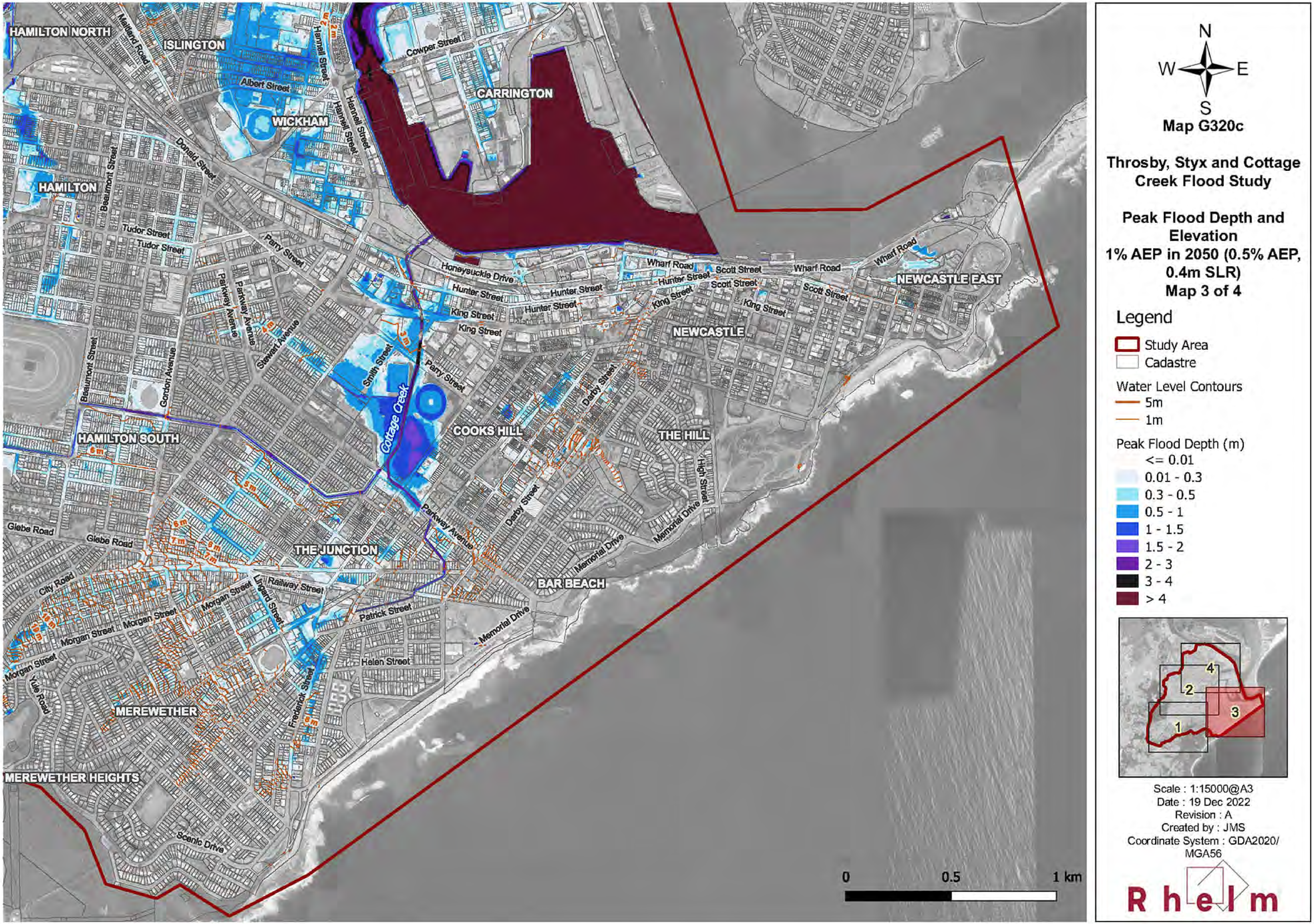
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Map G320c
Throsby, Styx and Cottage Creek Flood Study
Peak Flood Depth and Elevation
1% AEP in 2050 (0.5% AEP, 0.4m SLR)
Map 3 of 4
Legend
Study Area
Cadastre
Water Level Contours
5m
1m
Peak Flood Depth (m)
<= 0.01
0.01 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
> 4
4
2
3
1
Scale : 1:15000@A3
Date : 19 Dec 2022
Revision : A
Created by : JMS
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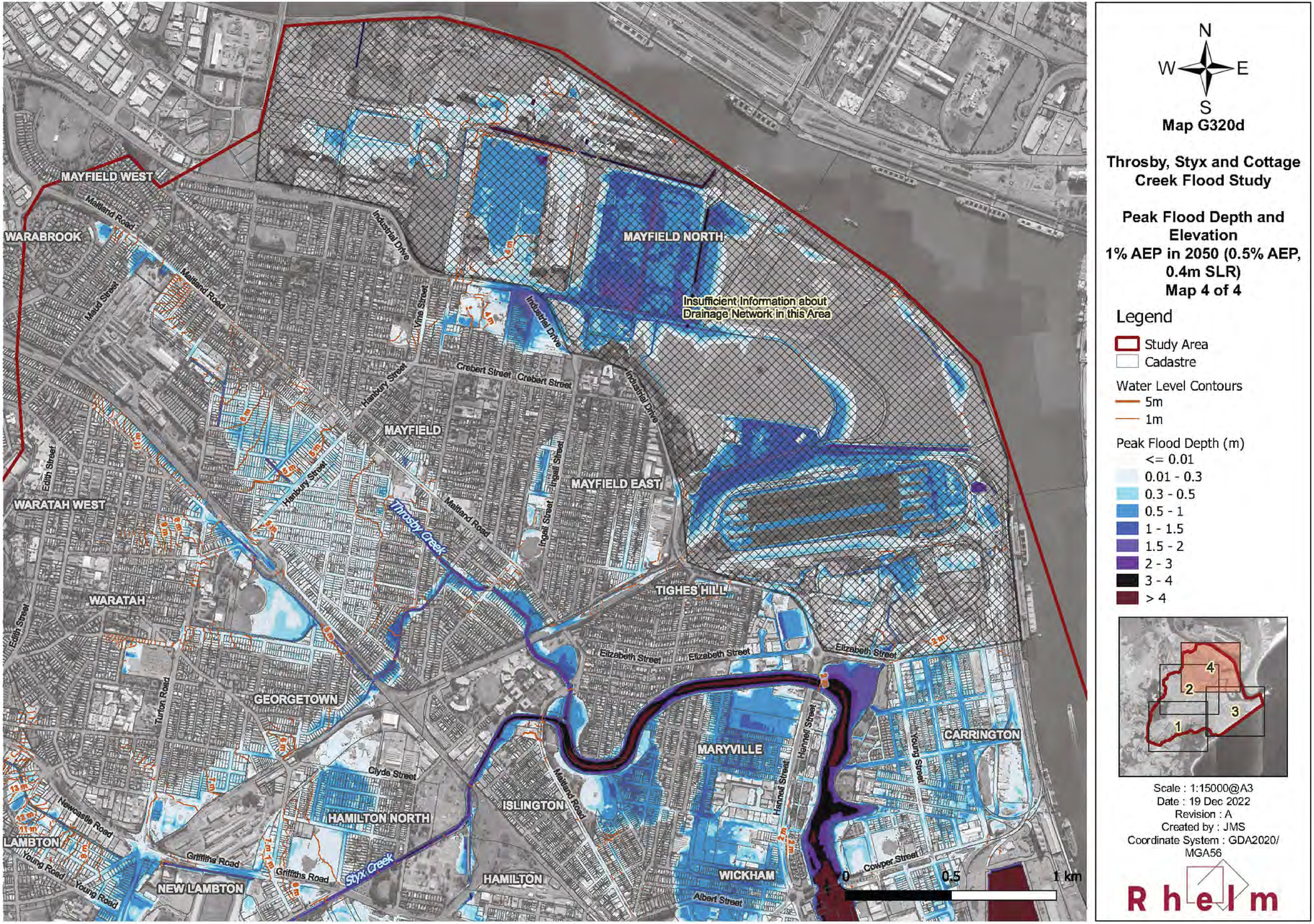
0
0.5
1 km
HAMILTON NORTH
ISLINGTON
CARRINGTON
WICKHAM
HAMILTON
NEWCASTLE EAST
NEWCASTLE
COOKS HILL
THE HILL
HAMILTON SOUTH
THE JUNCTION
BAR BEACH
MEREWETHER
MEREWETHER HEIGHTS
Cottage Creek
Cowper Street
Albert Street
Donald Street
Beaumont Street
Tudor Street
Parry Street
Honeysuckle Drive
Hunter Street
King Street
Wharf Road
Scott Street
Smith Street
Parkway Avenue
Stewart Avenue
Gordon Avenue
Darby Street
Memorial Drive
High Street
Glebe Road
City Road
Railway Street
Morgan Street
Patrick Street
Helen Street
Frederick Street
Yule Road
Scenic Drive
Hannell Street
Maitland Road
Lingard Street



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Map G320d
Throsby, Styx and Cottage Creek Flood Study
Peak Flood Depth and Elevation
1% AEP in 2050 (0.5% AEP, 0.4m SLR)
Map 4 of 4
Legend
Study Area
Cadastre
Water Level Contours
5m
1m
Peak Flood Depth (m)
<= 0.01
0.01 - 0.3
0.3 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
> 4
1
2
3
4
Scale : 1:15000@A3
Date : 19 Dec 2022
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MAYFIELD WEST
WARABROOK
MAYFIELD NORTH
Insufficient Information about Drainage Network in this Area
MAYFIELD
MAYFIELD EAST
WARATAH WEST
WARATAH
TIGHES HILL
GEORGETOWN
MARYVILLE
CARRINGTON
ISLINGTON
HAMILTON NORTH
LAMBTON
NEW LAMBTON
HAMILTON
WICKHAM
Maitland Road
Industrial Drive
Vine Street
Maud Street
Crebert Street
Hanbury Street
Ingall Street
Edith Street
Throsby Creek
Styx Creek
Elizabeth Street
Turton Road
Clyde Street
Newcastle Road
Griffiths Road
Young Road
Hannell Street
Young Street
Cowper Street
Albert Street
0
0.5
1 km