

ITEM 11 POST EXHIBITION - FAIRY AND CABBAGE TREE CREEKS FLOOD STUDY 2020

The review of Fairy and Cabbage Tree Creeks Flood Study was publicly exhibited from 6 April to 11 May 2020. Community consultation has been completed and the Flood Study is now finalised. It is recommended Council adopt the Fairy and Cabbage Tree Creeks Flood Study (2020) which will inform land use planning and planning certificates.

The study area encompasses various suburbs such as Balgownie, Mount Pleasant, Mount Ousley, Fairy Meadow, North Wollongong, Keiraville and Gwynneville. It drains from Illawarra escarpment to the Tasman sea through Fairy Lagoon. The study area also includes the Smith Street and Belmore Basin catchments which drain to Belmore Basin Harbour. The major tributaries draining the catchment are Cabbage Tree Creek, Fairy Creek and Towradgi Arm. A number of major transport links also pass through the catchment including the Princes Motorway (M1), Mount Ousley Road, Princes Highway, Memorial Drive and the Illawarra Railway. The study improves the accuracy and reliability of flood levels and flood behaviour in the Fairy and Cabbage Tree Creeks Catchment.

The reports and flood models for the Fairy and Cabbage Tree Creeks Flood Study (2020) will be placed on the NSW Flood data portal so that they can be publicly accessed. This will lead to a greater understanding of flood behaviour and flood risk and will provide a background for the Flood Risk Management Study and Plan.

RECOMMENDATION

- 1 Council adopt the Fairy and Cabbage Tree Creeks Flood Study (2020).
- 2 Persons who made submissions be thanked and advised of Council's decision.

REPORT AUTHORISATIONS

Report of: Andrew Heaven, Manager Infrastructure Strategy and Planning (Acting)
Authorised by: Andrew Carfield, Director Infrastructure + Works - Connectivity Assets + Liveable City

ATTACHMENTS

- 1 Community Engagement Report
- 2 Executive Summary - Fairy Cabbage Tree Creeks Flood Study 2020
- 3 Submissions - Key Themes and Responses

BACKGROUND

The NSW Government's Floodplain Development Manual provides a framework to ensure the sustainable use of floodplain environments and incorporates the NSW Flood Prone Policy. Under the Policy, the management of flood liable land remains the responsibility of Local Government with State Government subsidising flood mitigation works to alleviate existing problems and providing specialist technical advice to assist Councils in performing their floodplain management responsibilities.

The Policy provides for technical and financial support by the State Government through five stages:

- 1 Flood Study – Determines the nature and extent of flooding;
- 2 Floodplain Risk Management Study – Evaluates risks and management options for the floodplain in respect of both existing and proposed development;
- 3 Floodplain Risk Management Plan – Involves formal adoption by Council of a plan of management for the floodplain;
- 4 Implementation of the Plan – Voluntary house purchase, flood readiness and response plans, construction of flood mitigation works to protect existing development and use of planning controls (LEP, DCP) to ensure new development is compatible with the flood hazard.

- 5 Review – Reviews are recommended on average every five (5) years and are also generally recommended after significant flood events, policy changes, or land use changes and where impediments to floodplain management plan implementation exist that warrant a review.

Fairy and Cabbage Tree Creeks Flood Study (2020)

In 2018, Advisian was commissioned by Wollongong City Council (WCC) to review the Fairy and Cabbage Tree Creeks Flood Study (2010) to take into consideration Council's updated Conduit Blockage Policy (2016). The review incorporates new survey data, more detailed modelling techniques, the updated blockage factors, and additional development within the catchment.

New hydrologic and hydraulic models have been developed and calibrated and verified to historic flood data to confirm their ability to simulate catchment flood behaviour.

Attachment 2 to this report provides an executive summary of the final report recommended for adoption by Council.

PROPOSAL

The Fairy and Cabbage Tree Creeks Flood Study (2020) be adopted. After adoption, undertake the following actions -

- Update the flood planning levels - Planning & Environment;
- Update of the relevant Section 10.7 planning certificate - Planning & Environment;
- Provide flood level information advice in accordance with new study results - Infrastructure & Works.

CONSULTATION AND COMMUNICATION

On 2 April 2020, the draft flood study was presented to the Central Floodplain Risk Management Committee who recommended public exhibition of the draft report.

The final draft Flood Study report went on public exhibition from 6 April 2020 through to 11 May 2020. The draft Flood study report, maps and presentation videos were shared with the community and key stakeholders. Letters were sent to more than 16,300 residents and property owners in the catchment area inviting them to learn more and join the conversation. Emails with this information were sent to community, education, Register of Interest (flood), business, government and emergency services' stakeholders. The information was also available through Council's Customer Service Centre.

In line with Australian and NSW Government guidelines for COVID-19, some changes were made to the community engagement approach. Instead of having face-to-face conversations, the following opportunities were offered for people to learn more and provide feedback:

- A project webpage on www.our.wollongong.nsw.gov.au for people to:
 - a) Read the FAQ, draft Study and view a Floodplain Risk Management Process diagram to learn more about the Study, how we manage flood risk and what we will use the flood study information for;
 - b) View a video presentation on the flood study report and flood-modelling results;
 - c) View short flood-modelling videos that help explain flood behaviour in the catchment;
 - d) Post questions in an online Q&A, for response by Council flood engineers;
 - e) Provide feedback on the flood study via the online form;
- Phone or Skype video calls for people to talk to a flood engineer;
- Email submissions to the Engagement team.

There were 32 submissions. Five people also posted questions to an online Q&A on the project webpage, which were responded to by Council flood engineers. Feedback themes relating to the flood

study focused on the study area, mapping and flood modelling. Expansion of the study area to include the William Street Creek was welcomed. It was noted that the flood modelling has good correlation with actual observations.

Other feedback themes related to Council's floodplain risk management work, flood mitigation, creek and vegetation maintenance, perceived causes of flooding, observations of flooding, requests for flood levels for individual properties, the community engagement approach and a request for pathways along the creeks.

PLANNING AND POLICY IMPACT

This report contributes to the delivery of Our Wollongong 2028 Goal 1 "We Value and Protect Our Environment". It specifically delivers on the following:

Community Strategic Plan	Delivery Program 2018-2021	Operational Plan 2019-20
Strategy	3 Year Action	Operational Plan Actions
1.1.3 The potential impacts of natural disasters, such as those related to bushfire, flood and landslips are managed and risks are reduced to protect life, property and the environment	1.1.3.2 Establish effective urban stormwater and floodplain management programs	Develop and implement Floodplain Risk Management Plans

SUSTAINABILITY IMPLICATIONS

The Fairy and Cabbage Tree Creeks Flood Study 2020 represents the best available flood information to Council. The flood information provided allows to estimate more accurately potential flood damages and benefits of potential flood risk mitigation measures. The data from the flood study will inform the identification and development of sustainable flood risk mitigation options as part of the floodplain risk management study and plan.

RISK MANAGEMENT

The flood study has been developed in accordance with the NSW Government's floodplain development manual and associated guidelines, therefore in accordance with Section 733 of the Local Government Act Council is exempt from liability when advice is provided based on information from the flood study.

FINANCIAL IMPLICATIONS

The Fairy and Cabbage Tree Creeks Flood Study (2020) cost \$154,770 excluding GST. Pending adoption of the study, financial assistance approval has been received from State Government to undertake subsequent floodplain risk management study and plan for this catchment.

CONCLUSION

The Fairy and Cabbage Tree Creeks Flood Study (2020) was prepared with the cooperation, assistance and support of many stakeholders, including community members and State government representatives and the Central Floodplain Risk Management Committee.

The study improves the accuracy and reliability of flood levels and flood behaviour in the Fairy and Cabbage Tree Creeks Catchment. The reports and flood models for the Fairy and Cabbage Tree Creeks Flood Study (2020) will be placed on the NSW Flood data portal so that they can be publicly accessed. This will lead to a greater understanding of flood behaviour and risk and wiser decision making.

OUR WOLLONGONG

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Fairy and Cabbage Tree Creeks Flood Study Engagement Report - May 2020

Z20/109832

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The information in this report is based on data collected from community members who chose to be involved in engagement activities and therefore should not be considered representative.

This report is intended to provide a high-level analysis of the most prominent themes and issues. While it's not possible to include all the details of feedback we received, feedback that was relevant to the project has been provided to technical experts for review and consideration.

Executive Summary

As part of Council's commitment to managing flood and stormwater in our region, an update of the Flood Study for the Fairy and Cabbage Tree Creeks catchment was completed. The Study explains the ways flooding happens in the catchment, which covers an area between Towradgi and Crown Street, Wollongong, and will form a basis for the ongoing management of flood risk in the catchment.

Council staff shared the draft Study with the community and key stakeholders. During the public exhibition period, 6 April to 11 May 2020, letters were sent to more than 16,300 residents and property owners in the catchment area inviting them to learn more and join the conversation. Emails with this information were sent to community, education, Register of Interest (flood), business, government and emergency services' stakeholders. The information was also available through Council's Customer Service Centre.

In line with Australian and NSW Government guidelines for COVID-19, some changes were made to the community engagement approach. Instead of having face-to-face conversations, the following opportunities were offered for people to learn more and provide feedback:

- A project webpage on www.our.wollongong.nsw.gov.au for people to:
 - Read the FAQ, draft Study and view a Floodplain Risk Management Process diagram to learn more about the Study, how we manage flood risk and what we will use the flood study information for
 - View a video presentation on the flood study report and flood-modelling results
 - View short flood-modelling videos that help explain flood behaviour in the catchment
 - Post questions in an online Q&A, for response by Council flood engineers
 - Provide feedback on the flood study via the online form
- Phone or Skype video calls for people to talk to a flood engineer
- Email submissions to the Engagement team

There were 32 submissions. Five people also posted questions to an online Q&A on the project webpage, which were responded to by Council flood engineers. Feedback themes relating to the flood study focused on the study area, mapping and flood modelling. Expansion of the study area to include the William Street Creek was welcomed. A suggestion was made for improving the resolution of the maps in the draft Study documents that were published on the webpage. It was noted that the flood modelling has good correlation with actual observations.

Other feedback themes related to Council's floodplain risk management work, flood mitigation, creek and vegetation maintenance, perceived causes of flooding, observations of flooding, requests for flood levels for individual properties, the community engagement approach and a request for pathways along the creeks.

Background

Council is committed to finding solutions to reduce the social and economic damages of flooding. In 2016, Council updated its Blockage Policy and resolved to review and update its flood studies. The Fairy and Cabbage Tree Creeks Flood Study is one of 10 studies to undergo review. This catchment covers an area between Towradgi and Crown Street, Wollongong.

Figure 1 Fairy and Cabbage Tree Creeks catchment map



Previous floodplain risk management activities completed by Council in the study area have included the Fairy and Cabbage Tree Creeks Flood Study (2010) and Fairy and Cabbage Tree Creeks Floodplain Risk Management Study and Plan (2010). These studies identified the risk within the catchment and the steps that can be taken to manage this risk now and into the future.

As part of updating the Study, Council's revised Blockage Policy was considered, which helps us work out how blocked stormwater structures might affect flooding. Improved information was used, such as recent data from land surveying. An extended network of drainage pits and pipes was included, as well as improved and more detailed modelling techniques were used. The maps in the Study show what the flood levels are in different areas in the catchment.

At the Central Floodplain Risk Management Committee meeting on 2 April 2020, the public exhibition of the draft Fairy and Cabbage Tree Creeks Flood Study was unanimously

supported. The outcomes of the exhibition and resulting amendments to the Study will be reported to the Central Floodplain Risk Management Committee and Council in view of adopting it in 2020.

The study provides an improved understanding of the potential impacts of floods on the local community and will form a basis for the ongoing management of flood risk in the catchment.

Methods

Our Stakeholders



Our Methods

Table 1: Details of Communication and Engagement Methods

Methods	Details of Methods
Communication Methods	
Presentation	Information about the proposal was presented at the Floodplain Risk Management Committee (Central) Skype video meeting on 2 April 2020
Email to key stakeholders	An email and FAQ were sent to key stakeholders identified through an analysis process
Register of Interest	An email was sent to all participants registered on the Our Wollongong website with an interest in 'Flood'
Letter	A letter about the public exhibition and how to submit feedback (via phone, email, Skype or online) was mailed to local residents and property owners
Frequently Asked Questions	Responses to questions about updates to the Study and floodplain risk management were distributed with the letter and emails and published on the project webpage
Poster	A poster was produced to explain the floodplain risk management process
Our Wollongong Website	<p>The project webpage hosted background info and supporting documents:</p> <ul style="list-style-type: none"> • Frequently Asked Questions with information on the Study and flood risk management • News Feed for updates on project progress • Document Library with the draft Flood Study, Wollongong's Flood History poster and Maintenance of Urban Watercourses on Private Property Factsheet • Floodplain risk management process diagram • Flood modelling videos

	<ul style="list-style-type: none"> • Flooding in Wollongong video • Online Q&A for people to post questions for response by Council flood engineers
Videos	The Flooding in Wollongong video, flood modelling videos and video presentation about the draft Flood Study were used on the Our Wollongong webpage
Engagement Methods	
Our Wollongong Website	An online feedback form was used to capture participant's comments. The page also hosted background information and supporting documents. Flood engineers working on the Study provided responses to questions posted in the online Q&A.
Phone and Skype video calls	A summary of open feedback was noted during phone and Skype video conversations
Email	Open submissions were provided via email
Letter	Open written submissions were posted in

Results

All stakeholders and the wider community were invited to provide feedback on the draft Study. This section provides details on the participation at engagement activities (Table 2), and the feedback received during the exhibition period.

Engagement Participation

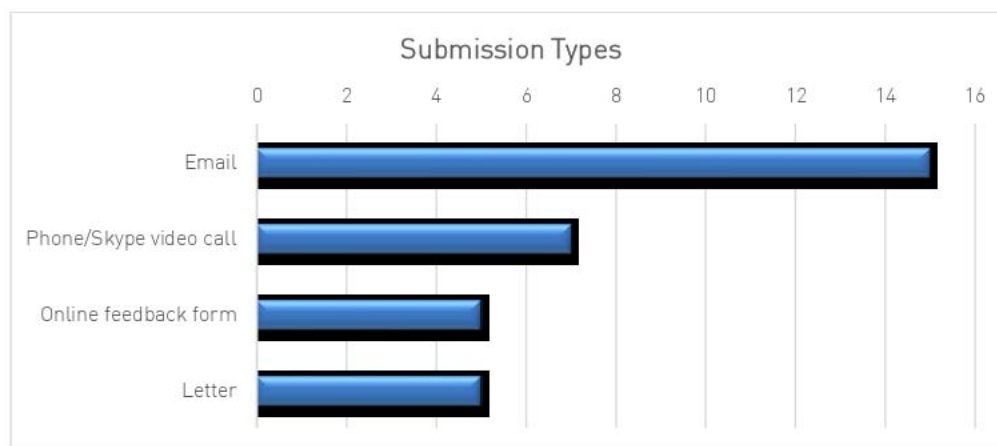
Details of the number of participants for each engagement activity are presented in Table 2.

Table 2: Engagement participation results

Engagement Activities	Participation
Central Floodplain Risk Management Committee Skype video meeting	11
Phone and Skype video calls	7
Online Participation	
• Aware – Total number of people who viewed the project webpage	612
• Informed – Total number of people who clicked a hyperlink, e.g. to download the Flood Study documents or watch a video	471
o Viewed the flood study presentation video	313
• Engaged – Total number of people who actively contributed to the project:	10
o Submitted comments via the feedback form	5
o Posted a question to the Q&A	5

Submission Results

There were 32 submissions, including group submissions from Neighbourhood Forum 5, NSW SES South Eastern Zone, Endeavour Energy and the University of Wollongong.



Five people also posted a total of 7 questions to an online Q&A on the project webpage, which were responded to by Council flood engineers.

Feedback themes focused on the following:

Expansion of the study area

Inclusion of the William Street Creek into the study area was welcomed. Suggestions were made for possible flood mitigation options to explore in the next stage of the flood risk management process, including a detention basin and stormwater drainage upgrades.

Map resolution

A suggestion was made for improving the resolution of the maps in the draft Study documents that were published on the webpage.

I've been trying to see where we live on the maps. You can see the creeks OK, but trying to read the maps themselves, let alone find a street is impossible. Any chance of doing the creek flood overlays on a standard Google type map where you can see things clearly?

Flood modelling

It was noted that the flood modelling has good correlation with actual observations.

The Study is comprehensive, it confirms the modelling is close to actual observed conditions and highlights the restrictions on flood mitigation because of the constraints of delta management, in particular the bridge over Fairy Creek at Squires Way.

Congratulations on a pretty exhaustive study. It was instructive to see how the software has improved, though the basic concepts are pretty well unchanged.

The validation of areas that were reported as previously dry, now wet, was queried. It was asked what the expected confidence in results is.

Council's floodplain risk management work

Several expressed gratitude for Council's work to manage flood risk and stated that they're looking forward to the next stage of the process, the Floodplain Risk Management Plan and Study. Council was commended for the noticeable reduction in flood impacts in the Cabbage Tree Creek area following construction of the Brokers Road detention basin. The University of Wollongong were interested in the implications of the Study on management of the creek/waterway areas. They wanted to find out if the upcoming risk management plan will look at evacuation routes across public roads and whether it will also be publicly exhibited.

The flood retention basin and baffle at Chalmers St, Balgownie seem to be fulfilling it's function, though we haven't had any major rain events to test it.

Conversely, anger was expressed regarding use of Council resources to undertake floodplain risk management. The respondent felt that this responsibility should sit solely with people who buy property on flood-prone land.

YOU KNOW IT FLOODS! LEAVE IT ALONE! It's WOLLONGONGS CHARACTER! ENOUGH WITH WASTING MONEY! You're telling me it's OK for them to accept NO responsibility for choosing a site that historically floods. They knowingly purchased those properties. So, instead you're wasting my money to appease entitled individuals? Tell them to build their houses on stilts as they do in Nimben and Lismore.

Flood mitigation

Several options for flood mitigation were suggested, including drainage to be installed on Smiths Hill, restoring escarpment creeks and streams that were substantially washed away in the 1998 flood to some form of detention basin, and vegetation removal along the creek to "reduce the resistance to flow". There was a request to redo the flood modelling to include some suggested measures. Endeavour Energy supplied information on how they plan for its flood response and the impact of flooding on electricity network distribution. Neighbourhood Forum 5 requested a more comprehensive study of flood affected areas in Keiraville Gwynneville and proposed a number of mitigation measures.

The Forum suggests an additional detention basin in Beaton Park near Gipps Road; additional debris catchers along the flood routes; better management through the tramway area; reducing the impact from M1 and Rail line; and a better understanding of major flood routes and overland flows, particularly around UOW, M1 and Mt Ousley Rd.

Creek and vegetation maintenance

Requests were made for Council and private landowners to maintain areas such as the detention basin and creek line that sits adjacent to the M1, Mount Keira Road and adjoining block of land fronting Phillips Avenue in West Wollongong, the creek running between Towradgi Beach Hotel and Edgar Street on the eastern side of Pioneer Road, Nyrang Park and the waterway that runs from Wollongong University, along Helen St and down towards TAFE in Lysaght St. It was reported that people using the NSW Government's "Return and Earn" facility behind Fairy Meadow Fraternity Club contribute to stormwater/creek pollution.

Causes of flooding

There was a perception that floods have been caused by a lack of creek maintenance, not enough drainage installed on Memorial Drive; an increase in large developments, changes to the floodplain and watercourse, inadequate stormwater drainage and blocked stormwater pipes. Requests were made to delay the approval of development applications for large developments until the floodplain risk mitigation plan is complete.

Observations of flooding

Accounts of flooding were shared, including rainwater pooling between the southern entrance of Wollongong Surf Leisure Resort Caravan Park and the northern vehicle entrance to North Dalton Park that can last for 2-3 weeks before drying out. Flooding issues in the William Street Creek area, in particular around William Street, Kenneth Grove and Long Street, with the perceived causes discussed. A resident in Rose Parade Mt Pleasant reported that stormwater discharges onto their neighbour's property, then across the rear of their property before flowing onto the rear adjoining reserve.

The water when it flows is sudden and strong, two metres wide and deep. The water is full of household garbage and car related items. The drainage grilles in the reserve we back onto are choked with silt and rubbish from this flow of water and garbage, and so do not function properly.

Flood levels for individual properties

Numerous requests were made seeking updated flood levels specific to individual properties. Information was sought on how to find out whether the flood coding for a property has changed once the updated Flood Study has been finalised. The University of Wollongong were primarily interested in how the updated Study will affect their plans for development at the Innovation Campus. They sought a map with lot-scale detail and asked how to access the updated data for modelling.

Community engagement

Appreciation was shown for the communication and engagement approach for the public exhibition of the draft Study, particularly with the challenge of running community consultation with COVID-19 restrictions in place. It was commented that the letter to residents and Frequently Asked Questions were easy to understand and informative. It was requested to add the NSW SES South Eastern Zone Coordinator of Planning and University of Wollongong Innovation Campus contacts to the email notification list for future exhibitions of flood studies and risk management plans.

It is very pleasing to know that in this difficult COVID19 time, Council has taken whatever steps it could to provide information for residents who would be affected by flooding or who have concerns for neighbours who may be affected, and asking residents to provide feedback on the flood study and giving residents various ways by which this may be done.

Pathways along creeks

A request was made for pedestrian and cycling access alongside the creeks, as well as paths that follow these two creeks under the major roads.



Fairy and Cabbage Tree Creeks Flood Study

Volume 1 – Main Report 2020

Level 17, 141 Walker St
North Sydney NSW 2060
Australia

Revision B

June 2020

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Wollongong City Council

Fairy & Cabbage Tree Creeks Flood Study

Executive Summary

Introduction

The Fairy and Cabbage Tree Creeks catchment is located within the Wollongong City Council Local Government Area (LGA) in the Illawarra Region of New South Wales. The catchment comprises an area of approximately 21 km² draining from the Illawarra Escarpment to the Tasman Sea through Fairy Lagoon, which is an intermittently closed and open lake or lagoon (ICOLL). The study area also includes the Smith Street and Belmore Basin catchments which drain to Belmore Basin Harbour and have a combined area of about 0.7 km².

The study area encompasses suburbs such as Balgownie, Mount Pleasant, Mount Ousley, Fairy Meadow, North Wollongong, Keiraville and Gwynneville. The major tributaries draining the catchment are Cabbage Tree Creek, Fairy Creek and Towradgi Arm. A number of major transport links also pass through the catchment including the Princes Motorway (M1), Mount Ousley Road, Princes Highway, Memorial Drive and the Illawarra Railway.

The catchment has a history of flooding, with extensive damage caused to private and public property located near the creeks and major drainage channels during a flood in August 1998.

Previous floodplain risk management activities completed by Council in the study area have included the *Fairy and Cabbage Tree Creeks Flood Study (BMT WBM 2010)*, *Fairy and Cabbage Tree Creeks Floodplain Risk Management Study and Plan (Bewsher Consulting 2010)*, and the implementation of flood risk management measures including detention basin upgrades, creek modification works, riparian corridor management and voluntary property purchase.

Council engaged Advisian (*part of the Worley Group*) to complete an updated Flood Study for the Fairy and Cabbage Tree Creeks catchment in response to various factors including release of Council's Revised Conduit Blockage Policy (2016), recent improvements in flood modelling technology, the availability of new data, and changes in the catchment.

The study provides an improved understanding of the potential impacts of floods on the local community and will form a basis for the ongoing management of flood risk in the Fairy and Cabbage Tree Creeks catchment.

Flood Model Development

New hydrologic and hydraulic flood models have been developed using the latest available data for the catchment and up-to-date guidelines, modelling software and techniques.

The models underwent calibration and verification to historic flood data for the August 1998 and February 2012 flood events to confirm their ability to reliably simulate catchment flood behaviour.

The models and their outputs will help inform the subsequent preparation of a Floodplain Risk Management Study and Plan for the Fairy and Cabbage Tree Creeks catchment including the assessment of potential floodplain risk management measures.



Wollongong City Council

Fairy & Cabbage Tree Creeks Flood Study

Design Flood Modelling and Mapping

Design flood conditions are estimated from hypothetical design rainfall events that have a particular statistical probability of occurrence. These design floods are used by Council and other agencies to understand flood risk and help plan for the occurrence of flooding.

The probability of a design event occurring can be expressed in terms of percentage Annual Exceedance Probability (AEP), which provides a measure of the relative frequency and magnitude of the flood event. The new WBNM hydrologic and TUFLOW hydraulic models were used to simulate a range of design flood events including the 20%, 10%, 5%, 2% and 1% AEP floods and the Probable Maximum Flood (PMF). These design flood events were assessed for both 'risk management' and 'design' blockage factors as defined in Council's *Revised Conduit Blockage Policy* (2016).

Resultant flood mapping is presented in **Volume 2** of this report. A selection of flood mapping is reproduced at the end of this Executive Summary.

General Description of Flood Behavior

For design flood events up to and including the 1% AEP a critical storm duration of 120-minutes was found for the majority of the study area. This is generally indicative of a 'flashy' catchment where flooding occurs in response to relatively short durations of intense rainfall and flood levels quickly rise and fall over the course of a few hours.

For design flood events up to and including the 1% AEP a longer critical storm duration of 360-minutes was found for the lower catchment, from around Memorial Drive downstream for Cabbage Tree Creek and the Princes Highway downstream for Fairy Creek. This indicates that flooding in these areas is more sensitive to the total volume of rainfall than other parts of the catchment, and that floodwaters may rise somewhat slower and remain elevated for several hours.

Flood model results indicate that flooding can be widespread along the various creeks, and numerous minor tributaries and local overland flow paths in the study area. While numerous properties may be affected, many others are located high on ridges and remain unaffected by flooding even during the PMF.

Flood extents along incised creek channels and in steeper areas of the catchment generally increase in relatively small increments with flood magnitude. However, in the lower, flatter areas of the catchment floodwaters from different tributaries converge and flood extents and depths can increase markedly with flood magnitude particularly in the 1% AEP and PMF events. Such areas include along much of the upstream (western) side of Memorial Drive and the M1 Motorway, Fairy Creek upstream of the Princes Highway, and much of the area to the east of Memorial Drive and the Princes Highway which includes the floodplains of Cabbage tree Creek, Fairy Creek, Fairy Lagoon and Towradgi Arm.

During the 1% AEP flood event, areas of high flood hazard that may pose a significant threat to life and property (e.g. \geq H4 Hazard) are generally constrained to defined water courses, open channels and flood flow paths. However, there are various exceptions most notably Exeter and Achilles Avenues adjacent to lower Fairy Creek in North Wollongong, properties along the western edge of Memorial Drive in Fairy Meadow between Kingsford and Norman Streets, and College Place in Gwyneville. Flood depths and velocities also become significant along various roads in the study area and would affect vehicle stability and pose constraints for evacuation and emergency response.



Wollongong City Council

Fairy & Cabbage Tree Creeks Flood Study

During the PMF event, the extent and degree of hazard posed to life and property would increase significantly, with buildings vulnerable to structural damage or failure in various areas. Evacuation and emergency response constraints would also be significantly worse, with some areas requiring early evacuation to avoid rapid isolation and inundation.

Internal Peer Review

A comprehensive internal peer review of the study was undertaken by a Principal Engineer from the Advisian Water Resources Team. This included review of hydrologic and hydraulic modelling, Quality Assurance processes, reporting and outcomes.

The modelling review found that the processes of model development, calibration and design flood estimation were thorough and appropriate for achieving the objectives of the study.

Blockage Policy Sensitivity

As noted previously, Council's *Revised Conduit Blockage Policy* (2016) includes two different sets of blockage factors, namely 'risk management' and 'design' blockage factors. To quantify the relative impact of these blockage factors on peak design flood levels a comparison was undertaken as discussed in the following. Similarly, a comparison was undertaken between the 2016 Blockage Policy and the 2002 Blockage Policy adopted in the previous flood study.

2016 Blockage Policy Risk Management vs Design Blockage Factors

The revised 2016 blockage policy 'risk management' factors were found to result in higher 1% AEP peak flood levels upstream of many structures relative to the 'design' blockage factors. The magnitude of these increases is often less than 0.1 m, though localised differences in 1% AEP peak flood levels of up to 0.45 m were observed.

Overall the degree of impact of the 'risk management' factors relative to 'design' factors is relatively low, particularly in comparison to that found in the *Allans Creek Flood Study* (Advisian 2019), for example.

It is noted that the use of two sets of blockage factors complicates floodplain management and modelling in the catchment, as it:

- Significantly increases the number of design flood simulations and analysis that is required
- Creates parallel sets of model results and flood mapping which could cause confusion.

2016 Blockage Policy vs 2002 Blockage Policy

To determine the degree of any changes in peak flood levels that are attributable to the adoption of Council's *Revised Conduit Blockage Policy* (2016) a comparison between the following scenarios was made for the 1% AEP events using the new TUFLOW hydraulic model:

- 2016 policy 'design' blockage factors
- 2002 policy blockage factors as described in Section 6.4 of *Fairy and Cabbage Tree Creeks Flood Study* (BMT WBM 2010).

The revised 2016 blockage policy 'design' factors result in a decrease in 1% AEP peak flood levels upstream of many structures relative to the 2002 Blockage Policy. This includes widespread decreases along the upstream (western) edge of the M1 Motorway, Memorial Drive and the Illawarra Railway. No increases in peak flood level were indicated by the model results.



Wollongong City Council

Fairy & Cabbage Tree Creeks Flood Study

Potential Impacts of Climate Change

To assess the potential impacts of climate change on flooding in the study catchments the following scenarios were investigated:

- **Scenario ID 5A:** 1% AEP event with 20% increase in rainfall intensity
- **Scenario ID 5B:** 1% AEP and PMF events with 0.4m increase in ocean level (2050 conditions)
- **Scenario ID 5C:** 1% AEP and PMF events with 0.9m increase in ocean level (2100 conditions)
- **Scenario ID 5D:** 1% AEP event with 20% increase in rainfall intensity and 0.4m increase in ocean level
- **Scenario ID 5E:** 1% AEP event with 20% increase in rainfall intensity and 0.9m increase in ocean level.

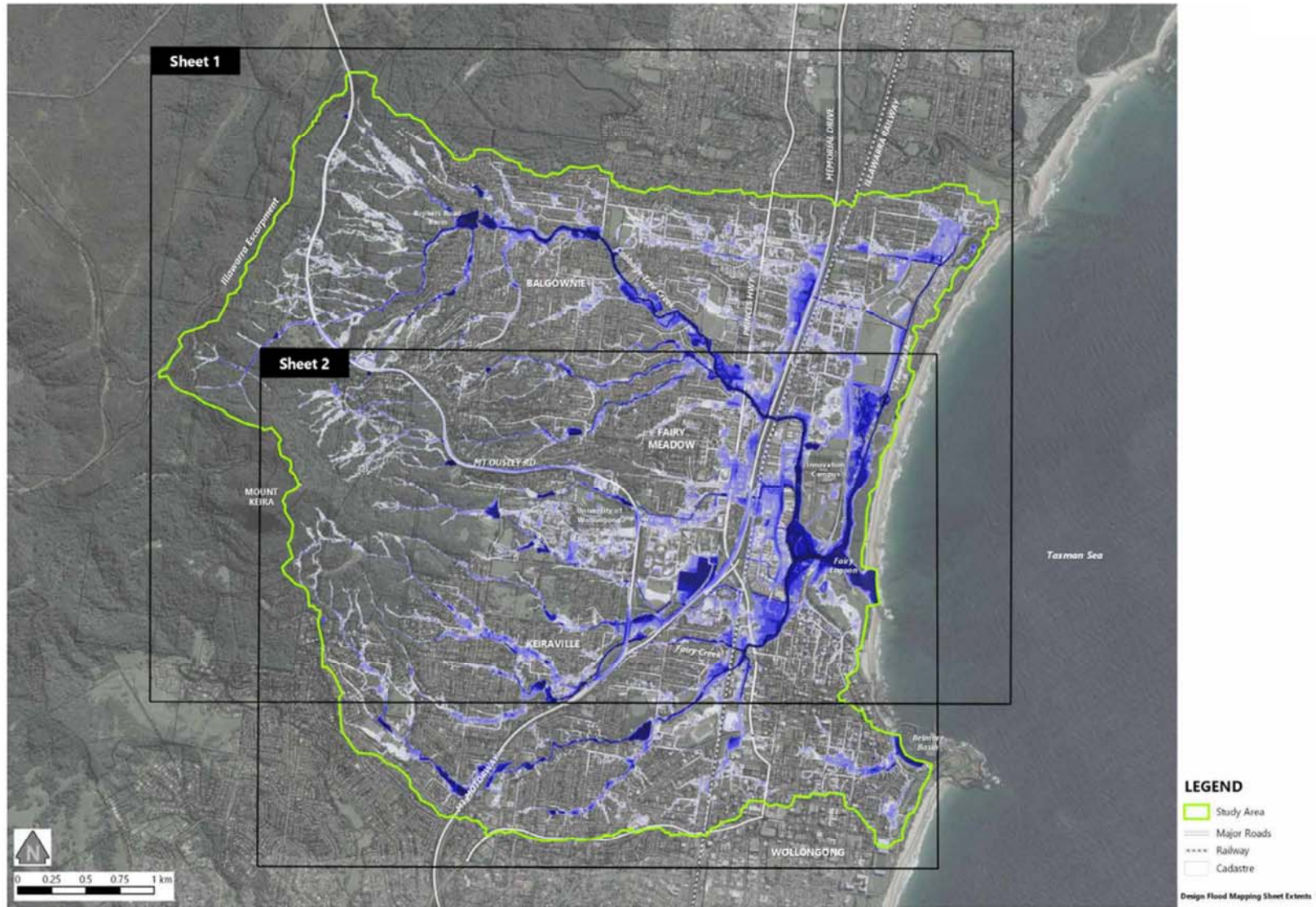
The findings are summarised as follows:

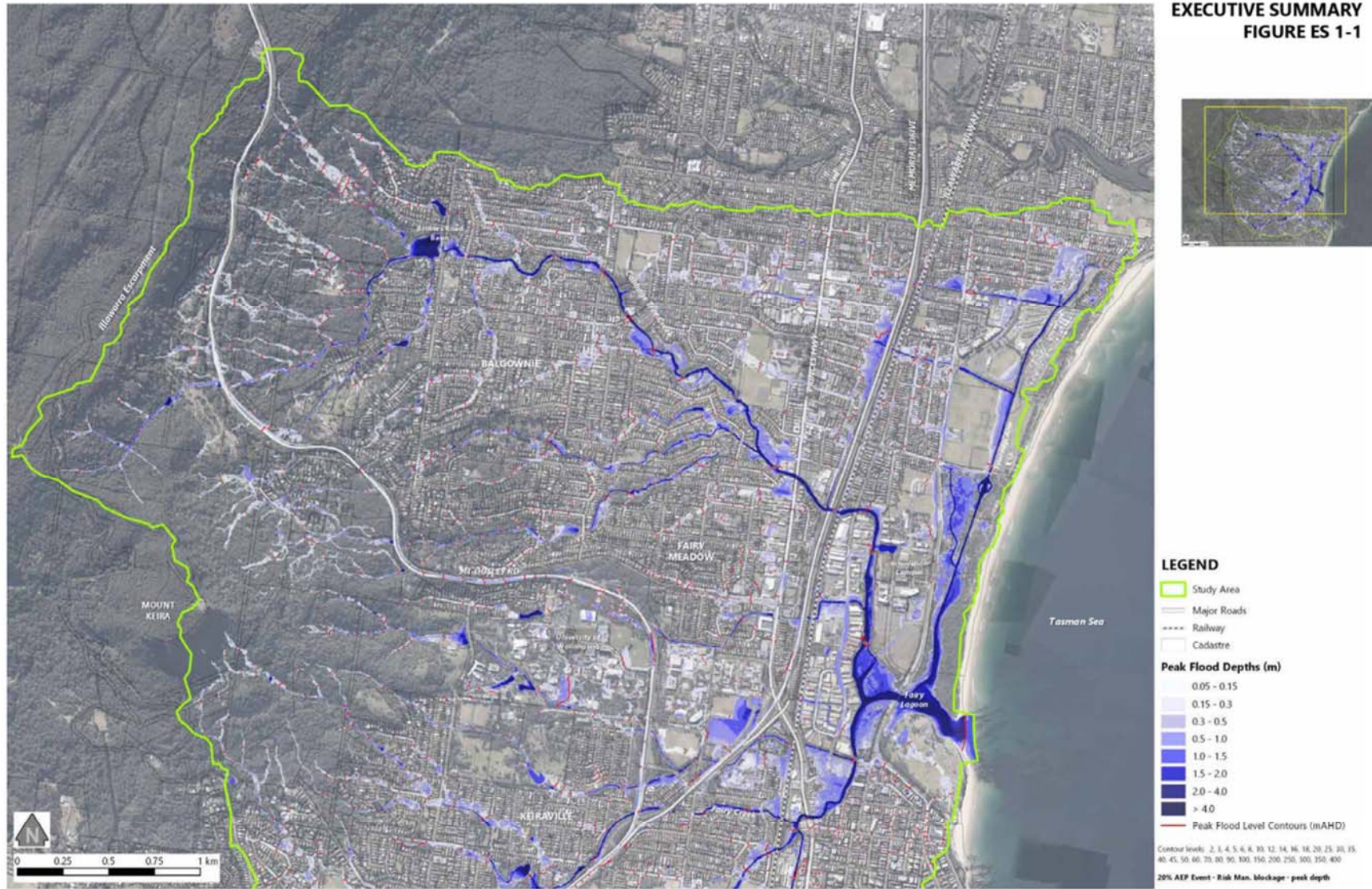
- The investigated sea level rise scenarios of up to 0.9 m would be expected to cause little change to existing flood conditions and impacts with the exception of flooding of Towradgi Arm, Fairy Lagoon, Fairy Creek downstream of the Princes Highway, and Cabbage Tree Creek downstream of Puckey Avenue. The greatest impacts on flood affectation of properties would occur at Achilles and Exeter Avenues, Ajax Avenue, Ralph Black Drive and Montague Street.
- Increases in the intensity of heavy rainfall events would be expected to have a more significant impact on flooding. Flood model results indicate that a 20% increase in rainfall intensity for the 1% AEP event would lead to increases in peak flood level of 0.1 m or more along most tributaries, including significant areas with increases of more than 0.25 m and localised increases of up to about 0.5 m.
- Additional impacts caused by up to 0.9 m of sea level rise in conjunction with a 20% increase in rainfall intensity (beyond those caused by the 20% increase in rainfall intensity alone) would be expected to be limited to the lower parts of the catchment including Towradgi Arm, Fairy Lagoon, Fairy Creek downstream of the Princes Highway, and Cabbage Tree Creek downstream of Puckey Avenue.
- Peak flood levels in the Smith Street catchment showed negligible sensitivity to sea level rise of up to 0.9 m.

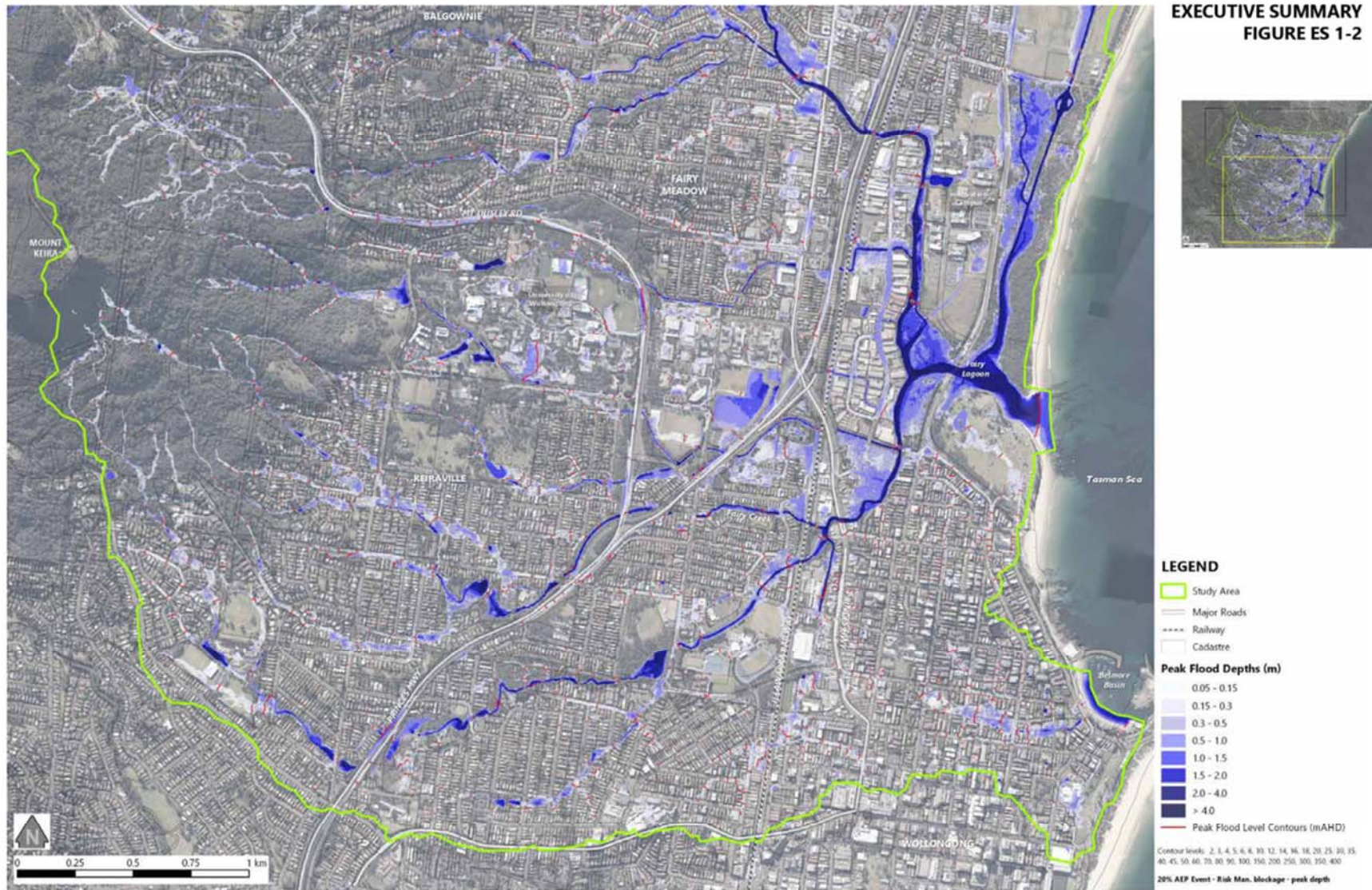
Recommendations

It is recommended that the new hydrologic and hydraulic models developed and calibrated as part of the *Fairy and Cabbage Tree Creeks Flood Study (Advisian 2020)* be adopted for use in the next stage of the floodplain management process (i.e., the Floodplain Risk Management Study).

It is also recommended that the implications of *Australian Rainfall and Runoff 2019 (ARR 2019)* be assessed in the subsequent Floodplain Risk Management Study.

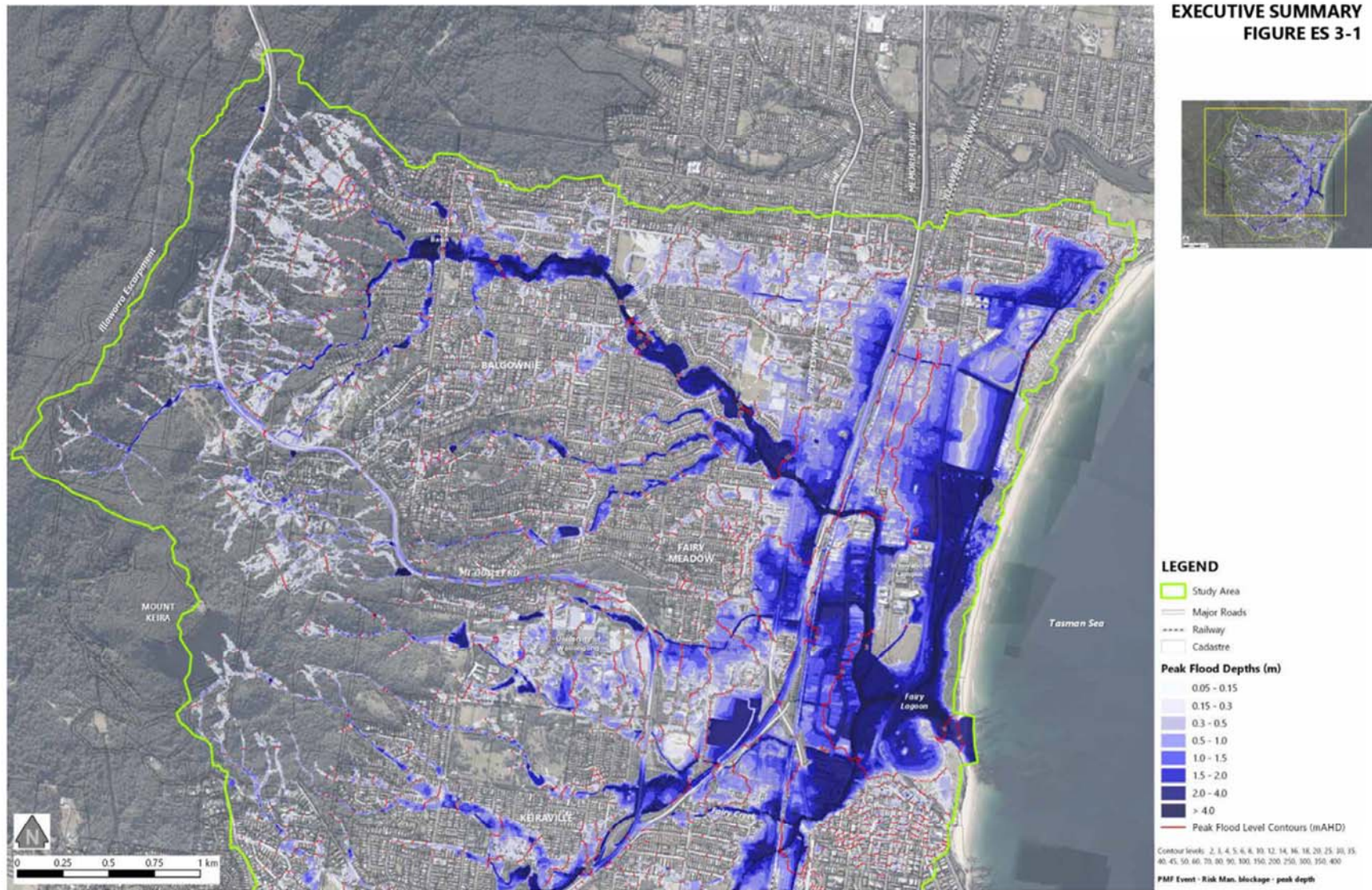


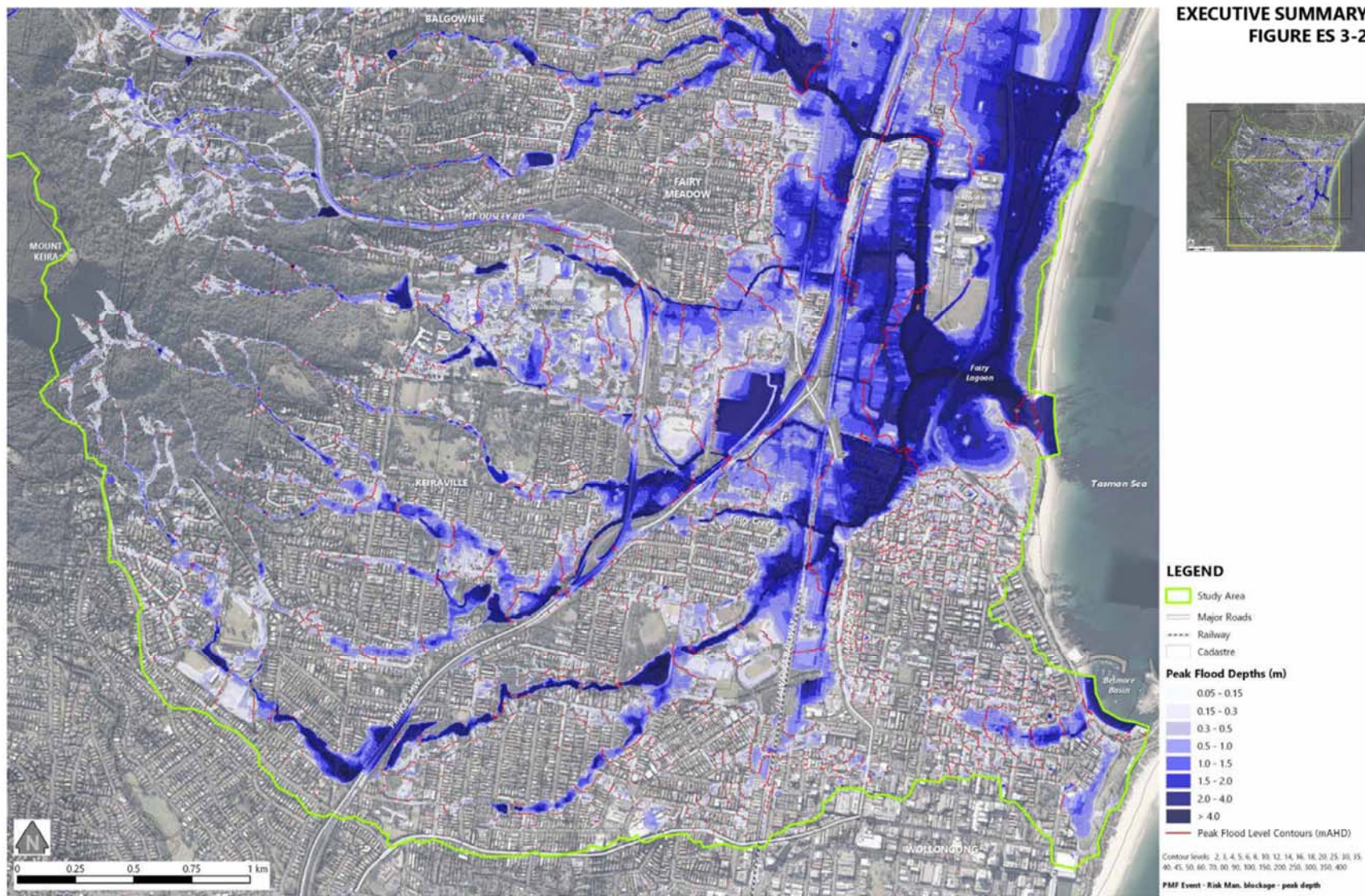




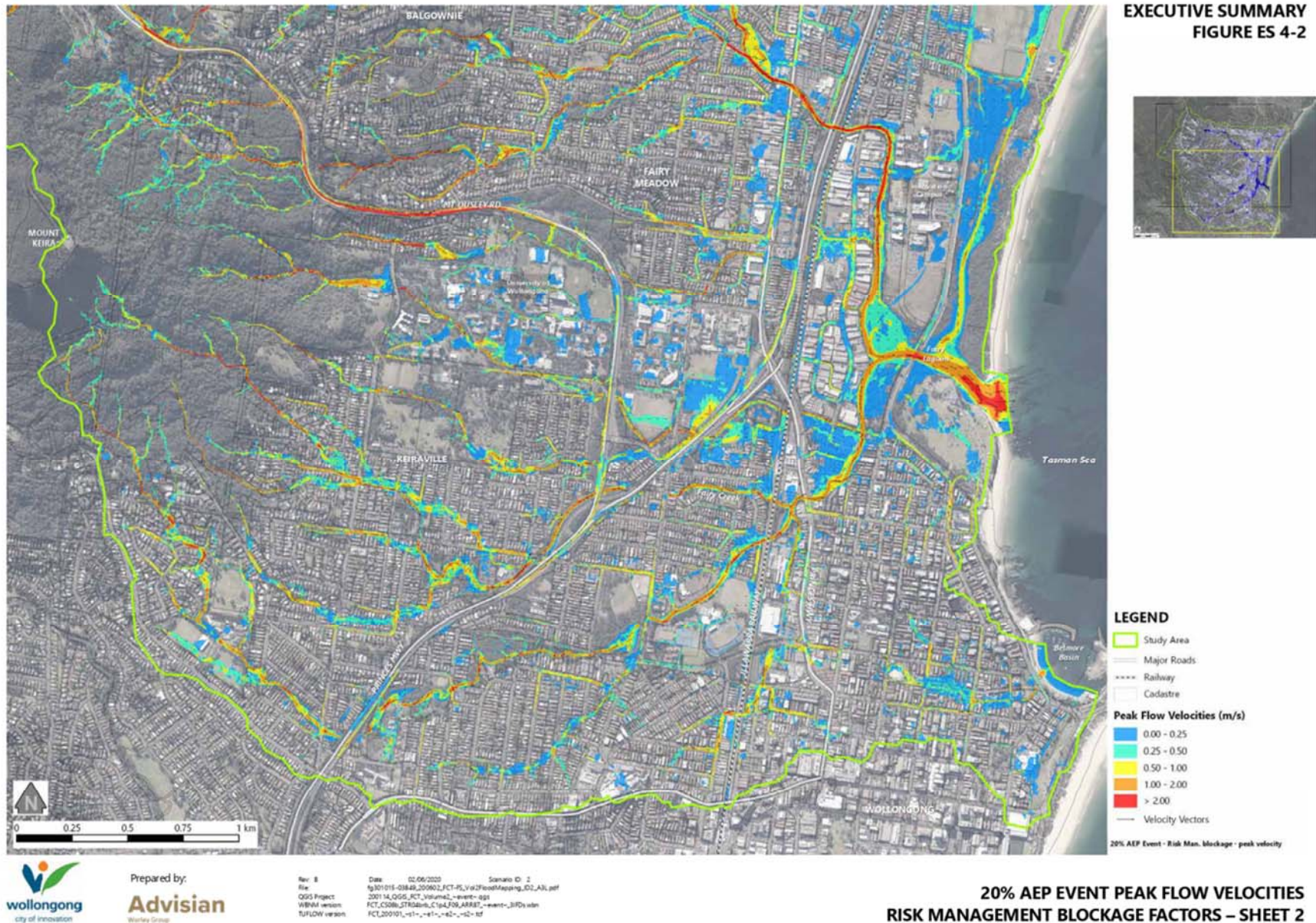




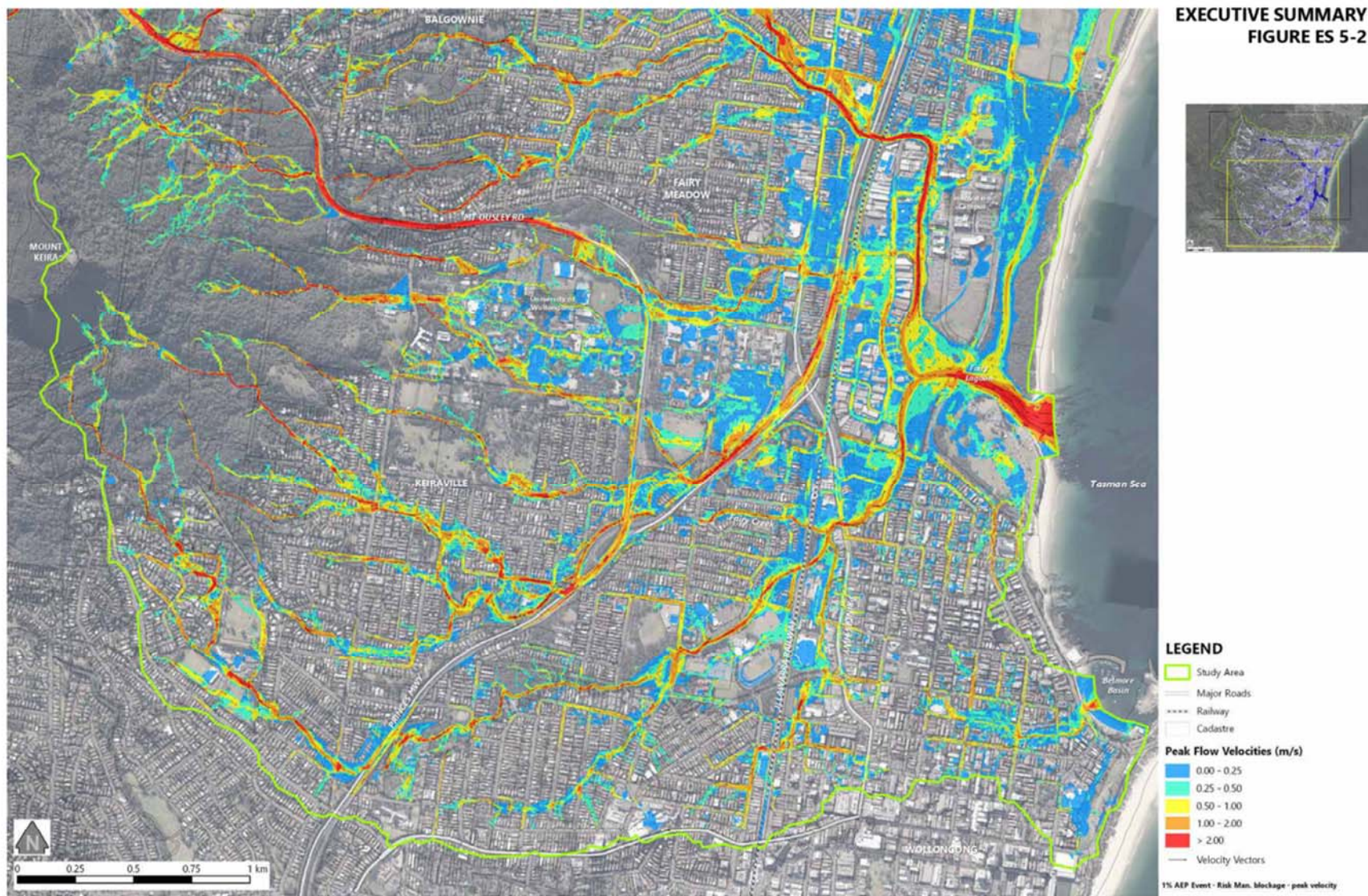




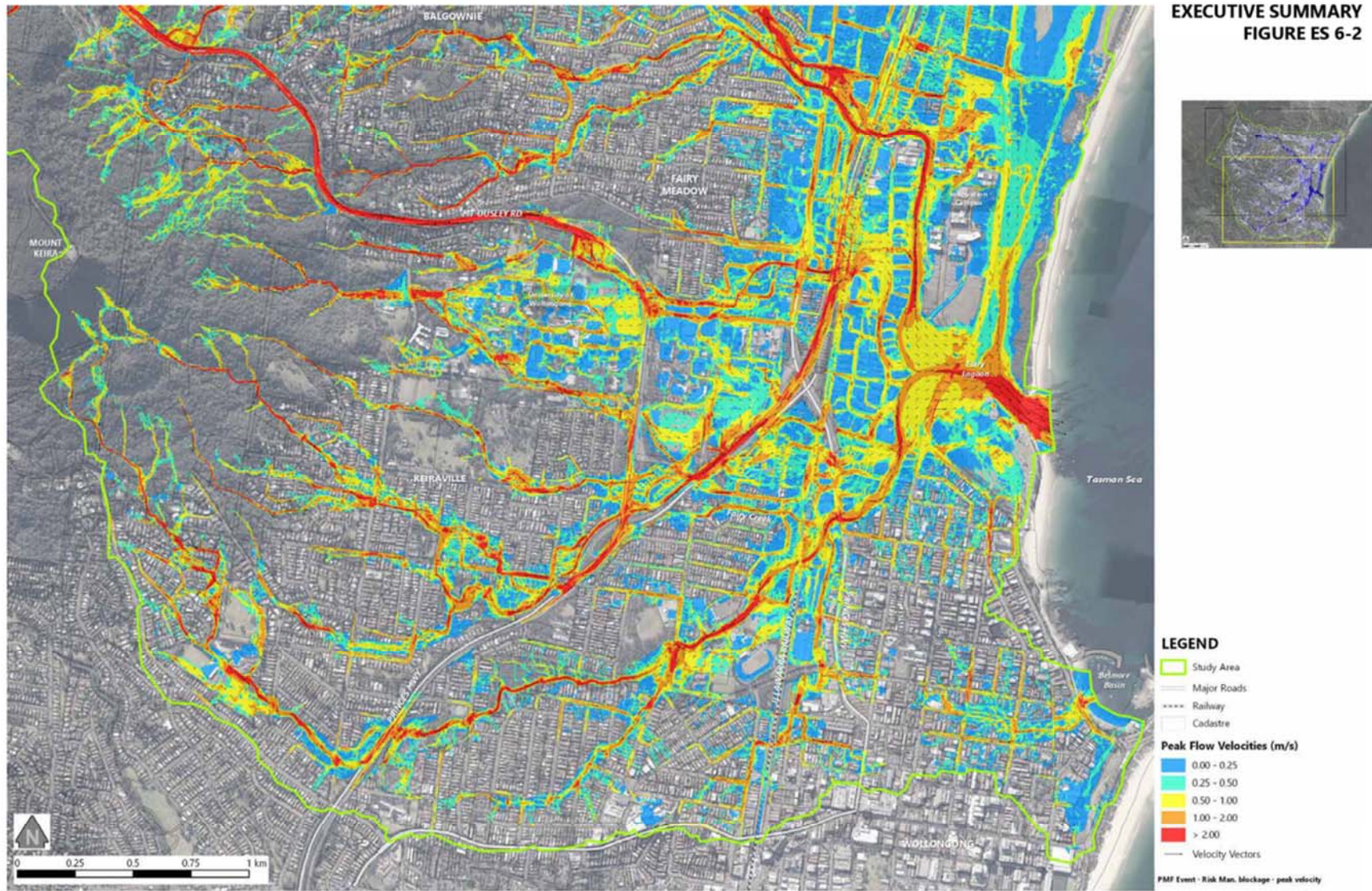


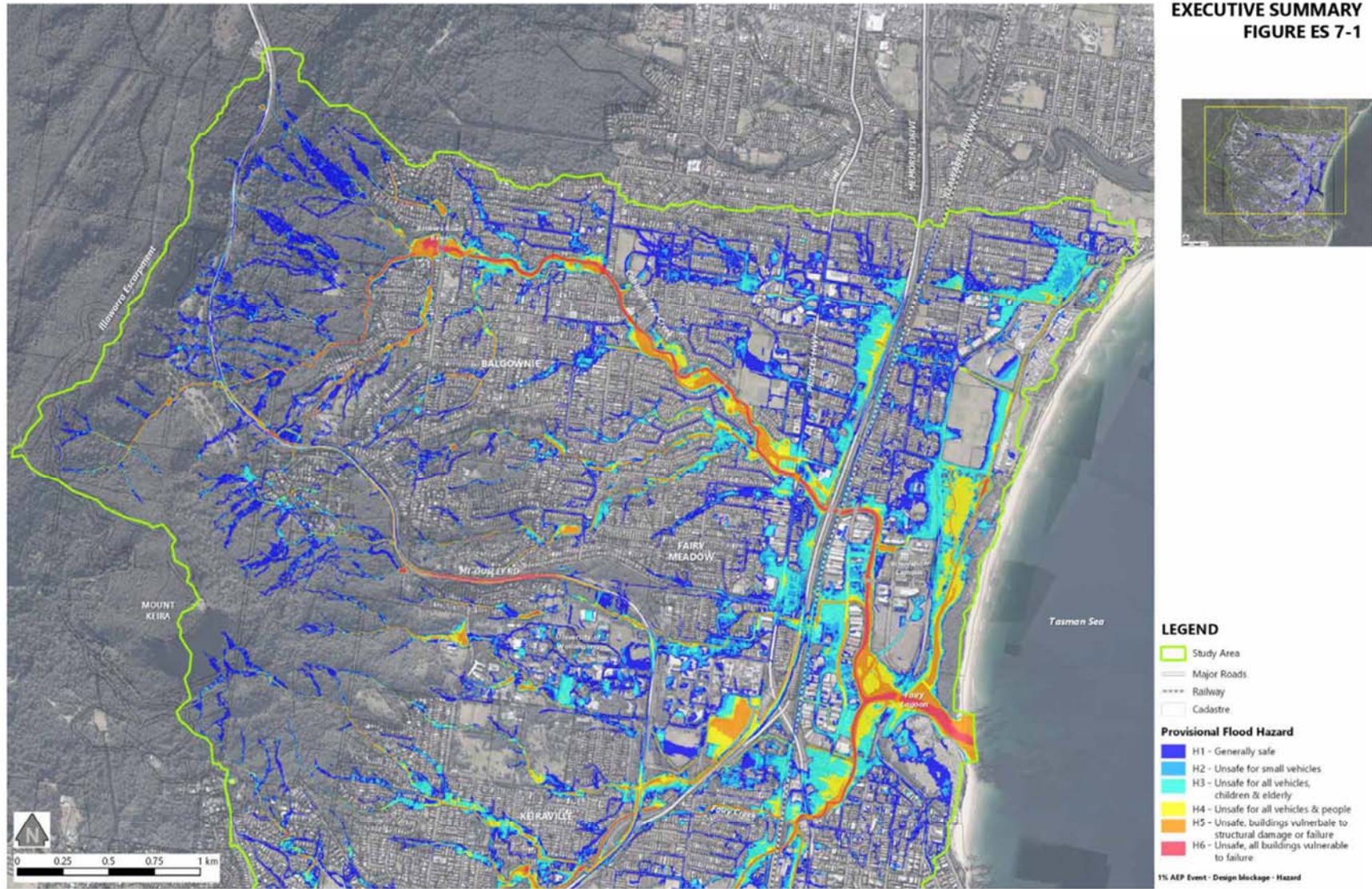




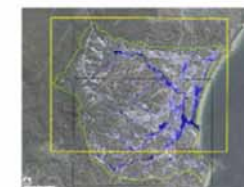















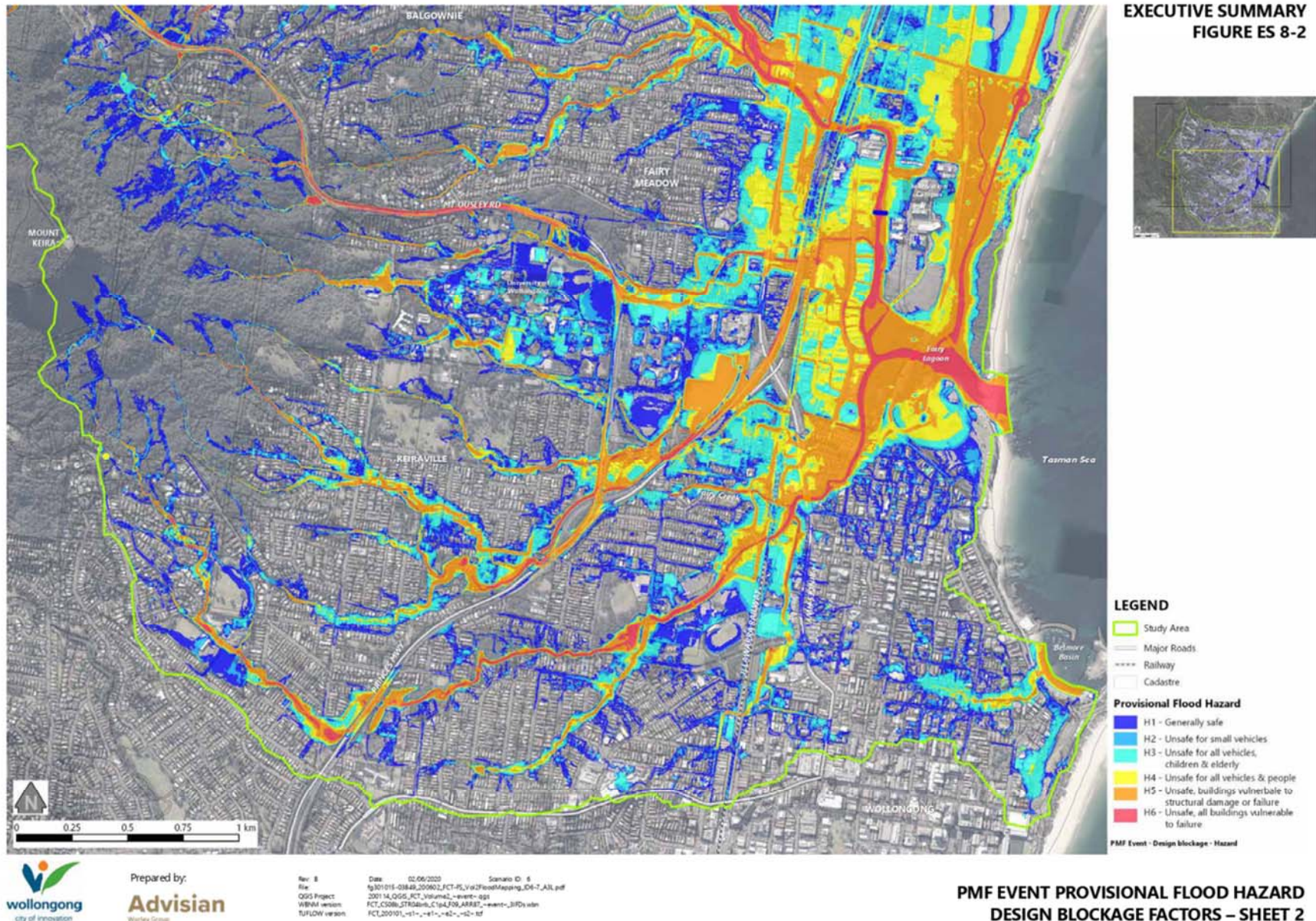
LEGEND

-  Study Area
 Major Roads
 Railway
 Cadastre

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerable to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure

PMF Event - Design blockage - Hazard



Fairy and Cabbage Tree Creeks Flood Study 2020

Comments from the submissions related to -

Key themes	Council's response
Extent of the Study	The flood study covers an extended area comparing to previous flood study including Smith Street and Belmore Basin catchment. It also includes all the creeks and basins within the Fairy Creek and Cabbage Tree Creek catchments, some of which were not modelled previously.
Resolution of the maps	The resolution of flood mapping was selected in order to cover the large study area. Owing to the large catchment size mapped and relatively narrow waterways, it can be difficult to determine specific values at an individual property from the flood mapping. However, it is not the purpose of flood mapping to inform individual property owners or developers of specific details at a property. It is intended to place all output files on the SES flood data portal so that they can be downloaded and prepared at a finer scale resolution. After the adoption of the Flood Study customers also can apply to council for detailed flood information for any specific property.
Flood Levels for individual properties	At the stage of draft final, the detailed flood information for individual properties is not available. However, customers can apply to council for detailed flood information for any specific property once the study is adopted. In addition, all data including model results will be uploaded to the SES flood data portal from where it can be downloaded and used for various purposes.
Flood Level change comparing to previous study.	A map showing the change in flood level comparing to previous study is included in the report. The purpose of the map is to highlight overall change in flood level throughout the catchment rather than individual property level. For the majority of areas flood levels have reduced when compared to previous study. At the same time there are some areas where flood levels have increased or where flood prone areas have now been mapped when they were not mapped in the previous study. Details can be downloaded from SES flood data portal once the flood study is adopted.
Flooding impacts on residents property	The purpose of a flood study is to describe flood behaviour. Options to reduce flooding on private property will be considered as part of the future review of the Floodplain Risk Management Study and Plan.
Flood mitigation options	Potential flood mitigation options will be considered as part of the future review of the Floodplain Risk Management Study and Plan. At that time, consultation will be undertaken with residents to get their thoughts on

	potential options. Council encourages the community to participate and provide their feedback during that time.
Requests for creek maintenance	Where maintenance was requested for sections of creek on Council property, they were forwarded to Council's maintenance crews for action. Where it was brought to Council's attention that maintenance was required on private land, residents were advised of their responsibilities in person or by letter.
Pathways along creeks	<p>The intent of a flood study is to describe flood behaviour and identify areas that are flood prone. This work helps to inform the next stage of our flood risk management process, where we look at what the risks/damages from floods might be and what we could do to mitigate (reduce) those risks.</p> <p>Council has a number of strategies and plans that inform where our cycleways and shared paths are built and planned to for the future. These are developed with input from people in our community, which helps us to prioritise the areas where cycleways are most needed.</p>
Impact of the flood study on home insurance premiums	A factsheet on home insurance flood premiums was made available on the project webpage. People were advised that the standard definition of 'flood' for insurance purpose may or may not apply to their properties. They were also advised that the standard definition does not include overland flows and that overland flows are typically covered as a standard inclusion in home insurance policies. Council doesn't have any say in what and how flood data is used for setting flood premiums. We recommend that homeowners contact their insurer about the flood premium for their property.